NJCAT TECHNOLOGY VERIFICATION

Removal Efficiency of Suspended Sediment with a Median Particle Size of 110 Microns

SciCloneX Hydrodynamic Separator

Bio Clean Environmental Services Inc.
A Forterra Company

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1. Introduction

In May 2021, the SciCloneX received verification from New Jersey Corporation for Advanced Technology (NJCAT). A month later, in June 2021, certification was received by New Jersey Department of Environmental Protection (NJDEP). The verification and certification were received based upon the NJDEP Laboratory Protocol to Assess Total Suspended Solids removal by a Hydrodynamic Sedimentation Manufactured Treatment Device dated January 25, 2013. The NJDEP protocol requires 50% annualized weighted TSS removal using an influent concentration of 200 mg/L and a particle size distribution with a mean size (d_{50}) that does not exceed 75 microns.

While some jurisdictions across the US use this testing protocol and subsequent NJDEP certification as their own standard in reciprocity, some jurisdictions have historically utilized a standard for 80% TSS removal for hydrodynamic separators based on a particle size distribution more typical for stormwater runoff in those areas. A commonly accepted mean particle size (d_{50}) for the 80% standard is 110 microns. In order to provide these jurisdictions with testing and sizing that are in line with these standards, additional laboratory testing was performed on the SciCloneX utilizing a particle size distribution with a d_{50} of 110 microns. A series of three continuous test runs were performed in triplicate over a range of flow rates. The results of this study will only be submitted to NJCAT for verification, as the test protocol, particle size distribution and influent sediment concentration varies from that required by the NJDEP protocol referenced above. ***Because the testing falls outside of the NJDEP protocol and process, the verification report cannot be submitted to NJDEP for certification.***

2. 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. Only TSS removal performance was verified during this testing.

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 particulates. It is composed of three components: flow splitter, oil/floatables skimmer, and an outlet weir containing 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 each side 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 converge. The now merged flows circle back toward the inlet pipe, creating two concurrent vortex swirls. A majority of the merged flow is directed underneath the flow splitter deck, thus further lengthening the flow path. Larger and medium-sized particulates (sediments) are directed into the sump chamber below as shown in **Figure 3**.

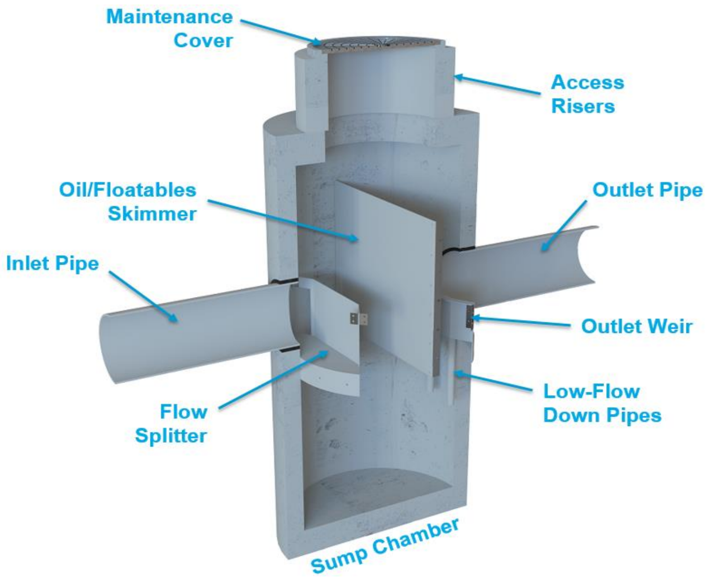

Figure 1 Cut-Away View

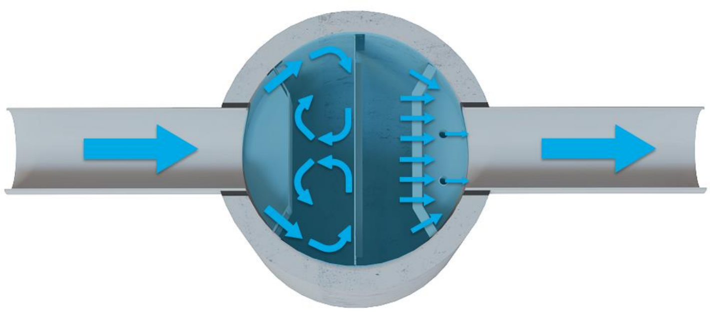

Figure 2 Operational Diagram

The oil/floatables skimmer is installed in the middle of the sump chamber and extends both downward and upward to trap free-floating oils and floatable trash and debris. Water still carrying sediments is forced to travel under the skimmer, which is level and equal in width to the sump chamber diameter, thus creating distributed flow and further reduced velocity. As water passes under the skimmer, a portion of the flow travels downward to the low flow down pipes and the remaining flow travels upward over 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 reduced to enhance settling of remaining sediment. This effect is enhanced at lower flow rates, where a greater percentage of flow travels toward and into the down pipes. 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 thus creates a distributed flow from the system into the outlet pipe. This decreases entrance velocity in the pipe and increases detention time within the unit. **Figure 3** depicts the SciCloneX flow path visually.

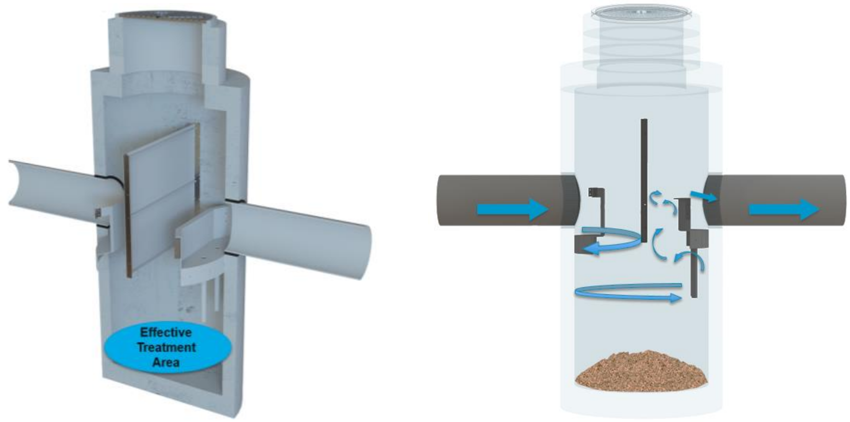

Figure 3 Effective Treatment Area and Flow Path Diagram

The enhanced design of the SciCloneX, with a shorter oil/floatables skimmer, taller outlet weir, and addition of low flow down pipes, maximizes the flow path and minimizes velocity for maximum performance. The system can 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 over the outlet weir to the pipe. The outlet weir creates less turbulent conditions in 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.

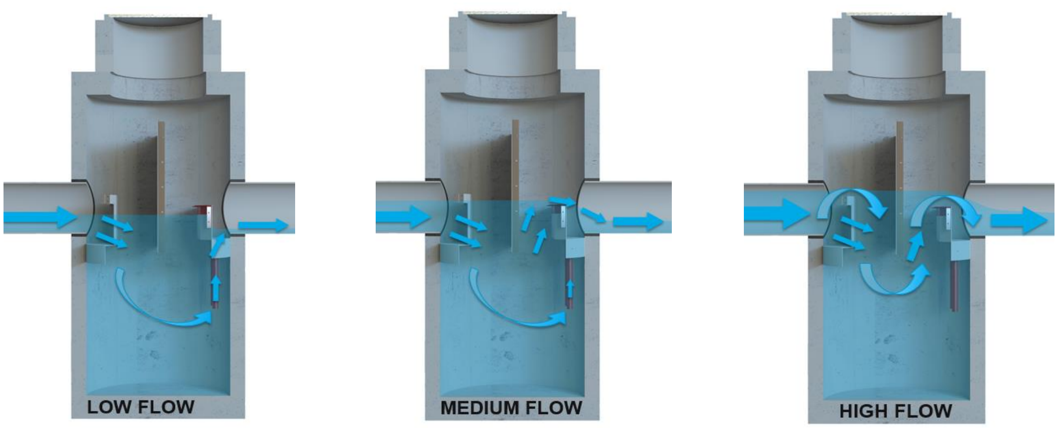

Figure 4 View During Treatment and Bypass Flows (High Flow)

3. Laboratory Testing

Bio Clean Laboratories, based in Oceanside, California, was commissioned by Bio Clean Environmental Services, Inc. to test the SciCloneX. Independent third-party observation was provided by Michael Kimberlain of KimberWorks, Inc. Mr. Kimberlain has an extensive background in water quality. Mr. Kimberlain has no conflict of interest that would disqualify him from serving as the independent third-party observer during this testing process.

3.1 Test Unit

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 structure **Figure 5**. 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 moving and physically supporting the weight of a concrete structure in the lab. Using a fiberglass manhole in lieu of concrete does not affect, nor alter system performance.

The test unit has an effective treatment area of 12.57 square feet with a sediment storage volume of 25.14 cubic feet. The sump depth from outlet pipe invert to false floor is 45 inches. The permeant pool volume is 47.25 cubic feet. A liquid level sensor was installed in the SciCloneX to measure active water level. The measured water level over the range of flows was from 9.5 to 12.6 inches above the invert of the outlet pipe, which equates to a max active operating volume of 13.23 cubic feet. The total operating volume was 60.48 cubic feet at the highest tested flow rate. A safety factor was used in the operating water level for detention time calculations to ensure they were always conservative.

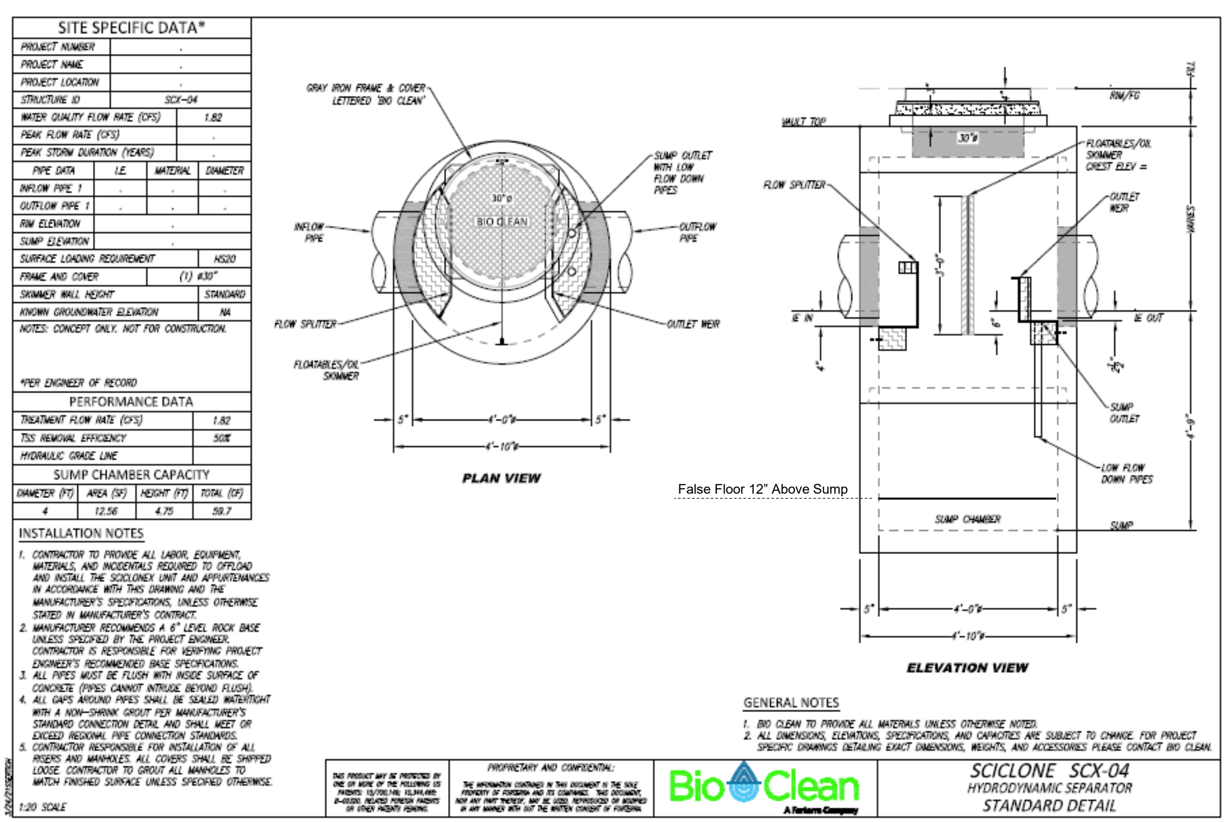

Figure 5 SciCloneX Standard Details

3.2 Test System

The laboratory test set-up was a hydraulic loop, capable of circulating water at a rate of up to 4.9 cubic feet per second (cfs). The performance test loop, illustrated in **Figure 6**, was comprised of water storage tanks, a pump, sediment filter, receiving tank with filtration, inlet junction and flow meter.

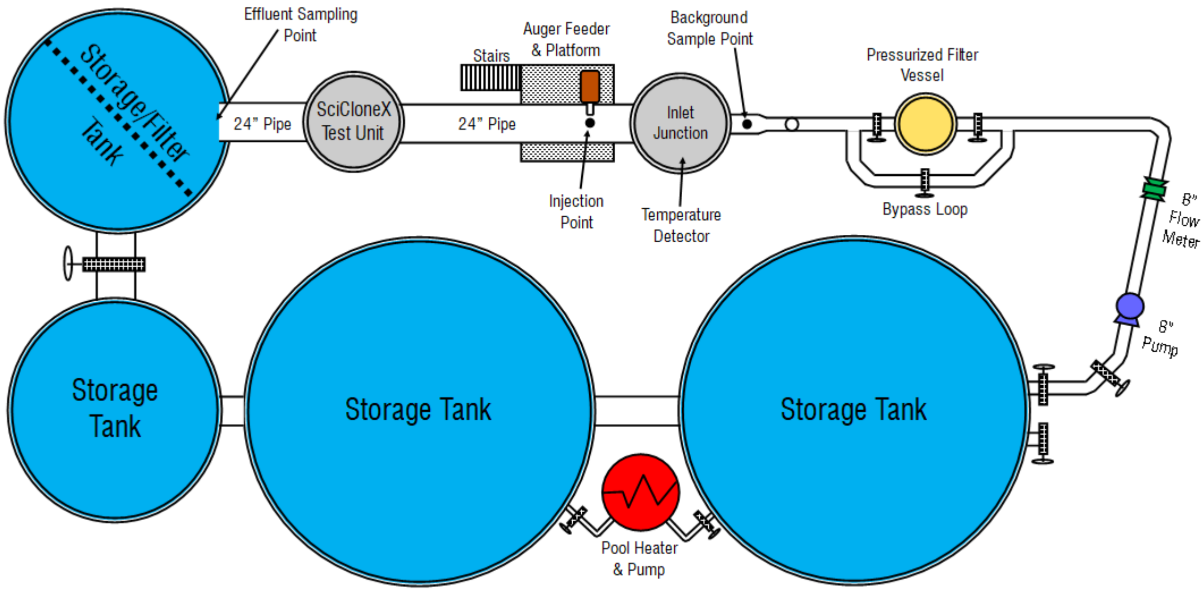

Figure 6 Test Flow Apparatus – Sediment Removal Testing

Water Flow and Measurement

From the water storage tanks, water was pumped using one Xylem AC e-1500, 8x8x9.5B 20 HP (150 - 2000 gpm) centrifugal pump. The pump is controlled by an Aquavar IPC AVA20200B0F0x0x1 VFDs. Flow measurement was done using a 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 five seconds.

The water in the hydraulic 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 7**) 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 8**). 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.

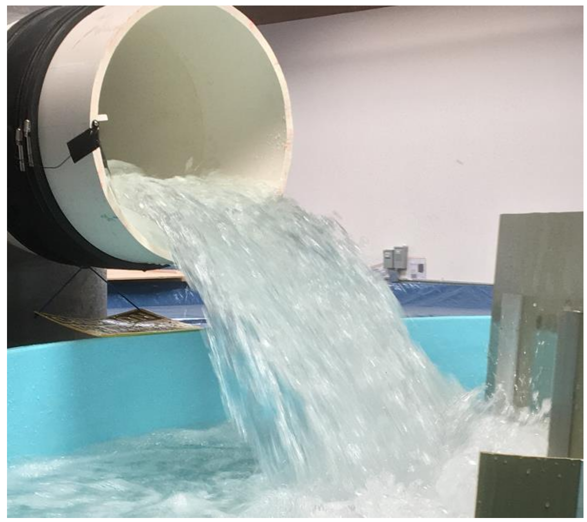

Figure 7 Background Sampling Point

Figure 8 Effluent Sampling Point

Other Instrumentation and Measurement

Water temperature was also taken inside the test unit and inside the inlet junction using two Elitech RC-5+ PDF USB Temperature Data Loggers that automatically log 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) was recorded using a liquid level sensor, model # TL231, installed in the SciCloneX to measure active water level in 5 second intervals. The liquid level sensor was connected to the same MadgeTech CurrentX4 30MA, 4-Channel Current data logger used to record flow data.

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) in the presence of the third-party observer.

3.3 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 inlet pipe (**Figure 9**). The test sediment used for the removal efficiency study was screened in-house using a commercially available silica sand; this particular batch was AGSCO Batch 032221. Bio Clean Laboratories, under the observation of Michael Kimberlain, sent out three samples of sediment for particle size analysis using the methodology of ASTM method D6913 (dry method). The samples were created by taking samples from various levels within each five-gallon bucket and combined into three composite samples, which were then thoroughly mixed before pulling the samples to be sent to the lab. The testing laboratory was IAS Laboratories, an independent test laboratory located in Phoenix, Arizona. The PSD results are summarized in **Table 1** and shown graphically in **Figure 10.** All opening and closing of the buckets and removal and replacement of security tape was done in the presence of the third-party observer. The average moisture content for the three samples was determined to be 0.05%.

Figure 9 Sediment Addition Point

Table 1 PSD of Removal Efficiency Test Sediment

Particle Size (Microns)	Test Sediment Particle Size (% Less Than)				
	Sample 1	Sample 2	Sample 3	Average Test Sediment	US Silica OK-110[1] (Typical)
500	100	100	100	100	100
250	100	100	100	100	100
150	100	100	100	100	98.8
125	87.8	84.8	84.2	85.6	83.8
105	44.8	43.1	43.0	43.6	43
74	3.2	3.1	3.2	3.2	3
63	0.2	0.2	0.2	0.2	0
53	0.1	0.1	0.1	0.1	0
d_{50}	107 µm	108 µm	108 µm	108 µm	109 µm

[1]Particle size data has been interpolated to allow for comparison to the required OK-110.

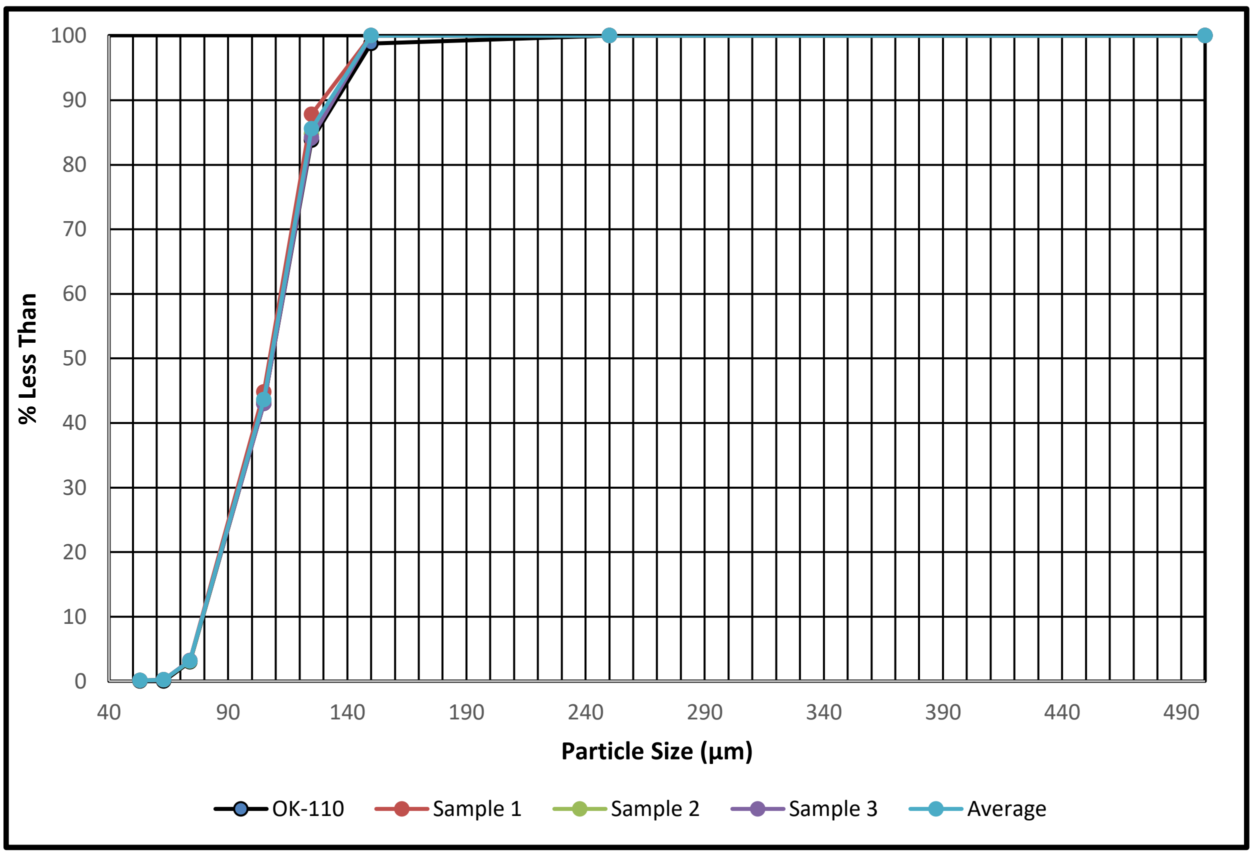

Figure 10 Average Particle Size Distribution of Removal Efficiency Test Sediment

3.4 Removal Efficiency Testing

Removal efficiency testing was conducted on a clean unit with a false floor installed at 50% sump sediment storage depth, 12 inches above the sump floor. Removal efficiency testing was performed using three separate continuous runs performed over a range of flow rates. The three resulting removal efficiencies at each flow rate were plotted and a curve fit applied.

Each continuous run commenced with the highest flow rate and ended with the lowest flow rate as follows: 1.50 cfs, 1.20 cfs, 0.90 cfs, 0.60 cfs and 0.30 cfs. During each continuous run, each flow rate test started once the feed rate was set and the flow rate was stabilized at the target flow rate for a minimum of three detention times. A sediment feed rate sample was collected at the beginning of each flow rate test and a minimum of three detention times passed before the six effluent samples and six time-paired background samples were taken. These samples were taken at evenly spaced 30-second intervals. After all effluent and background samples were collected, the second feed rate sample was taken. Each flow rate trial ended following the second feed rate sample. The flow rate and corresponding feed rate were then re-adjusted and allowed to stabilize before starting the next flow rate test during a continuous run. Testing continued in this manner until the full set of flow rates were completed. The sampling procedure was the same at all flow rates, but the trial duration varied to accommodate differences in detention time (**Table 2)**. The system was cleaned prior to each continuous test, but not between the individual flow rate tests within each continuous test run.

Table 2 Continuous Test Run Plan

Time (mm:ss)	Sample		
START OF CONTINUOUS TEST			
Stabilize flow for minimum duration of 01:57			
00:00	START 1.5 CFS TRIAL		
00:00	FEED 1		
03:00		EFF 1	BACK 1
03:30		EFF 2	BACK 2
04:00		EFF 3	BACK 3
04:30		EFF 4	BACK 4
05:00		EFF 5	BACK 5
05:30		EFF 6	BACK 6
05:30	FEED 2		
06:30	STOP 1.5 CFS TRIAL		
Stabilize flow for minimum duration of 02:27			
00:00	START 1.2 CFS TRIAL		
00:00	FEED 1		
03:30		EFF 1	BACK 1
04:00		EFF 2	BACK 2
04:30		EFF 3	BACK 3
05:00		EFF 4	BACK 4
05:30		EFF 5	BACK 5
06:00		EFF 6	BACK 6
06:00	FEED 2		
07:00	STOP 1.2 CFS TRIAL		
Stabilize flow for minimum duration of 03:15			
00:00	START 0.9 CFS TRIAL		
00:00	FEED 1		
04:30		EFF 1	BACK 1
05:00		EFF 2	BACK 2
05:30		EFF 3	BACK 3
06:00		EFF 4	BACK 4
06:30		EFF 5	BACK 5
07:00		EFF 6	BACK 6
07:00	FEED 2		
08:00	STOP 0.9 CFS TRIAL		

Time (mm:ss)	Sample		
Stabilize flow for minimum duration of 04:53			
00:00	START 0.6 CFS TRIAL		
00:00	FEED 1		
06:00		EFF 1	BACK 1
06:30		EFF 2	BACK 2
07:00		EFF 3	BACK 3
07:30		EFF 4	BACK 4
08:00		EFF 5	BACK 5
08:30		EFF 6	BACK 6
08:30	FEED 2		
09:30	STOP 0.6 CFS TRIAL		
Stabilize flow for minimum duration of 09:46			
00:00	START 0.3 CFS TRIAL		
00:00	FEED 1		
11:00		EFF 1	BACK 1
11:30		EFF 2	BACK 2
12:00		EFF 3	BACK 3
12:30		EFF 4	BACK 4
13:00		EFF 5	BACK 5
13:30		EFF 6	BACK 6
13:30	FEED 2		
14:30	STOP 0.3 CFS TRIAL		
END OF CONTINOUS TEST			

During all testing, the flow rate was held steady at ±2% of the target value with a target coefficient of variation (COV) of less than 0.03. Water temperature remained below 80 °F during all testing.

For each flow test, sediment was fed at a known rate to achieve a target average influent concentration of 280 mg/L (± 10%) with a COV of less than 0.10. Feed rates were determined by sampling the injection stream once at the beginning and once at the end of each of the five flow rates tested during a continuous run. Samples were collected in clean, 500-mL bottles at the feed point for a target duration of 60 seconds. Sediment sample collection time was measured using a Thomas Scientific Model 8788V77 traceable stopwatch. The samples were weighed to the milligram (in-house) using a precision calibrated balance (Mettler Toledo, MS1003TS/00) and feed rate for each test was calculated using **Equation 1**. Average influent TSS concentration was calculated from the average test feed rate and average flow rate for each flow test using **Equation 2**.

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

Equation 1

$$\boldsymbol{Average\ Influent\ TSS}\ (\boldsymbol{mg}/\boldsymbol{L}) = \left(\frac{Average\ Feed\ Rate\ (g/min)\ x\ (\frac{1000\ mg}{g})}{Average\ Flow\ Rate\ (gal/min)x\ \left(\frac{3.78541\ L}{gal}\right)}\right)$$

Equation 2

Six effluent grab samples were taken at evenly spaced intervals during each flow test. After the first feed rate sample was taken, effluent sampling began after a minimum of three detention times. Each sample volume was a minimum of 0.5 L. Samples were collected in clean, 1 L bottles by sweeping the bottle through the cross-section of the free-discharge effluent stream in a single pass. In the cases where the effluent TSS concentration was non-detect (ND), a value of half the reporting limit was substituted. The reporting limit was 1.0 mg/L.

Background samples were taken simultaneously with every effluent sample. Each sample was a minimum of 0.5 L in volume and was collected in a clean, 1 L bottle from the background sampling port. Background samples were collected after the sampling port was opened and the line was flushed. In the cases where the background TSS concentration was non-detect (ND), a value of half the reporting limit was substituted. Average background concentration did not exceed 20 mg/L during any test. Time paired effluent and background TSS concentration measurements were used to calculate an average adjusted effluent TSS value **Equation 3**.

$$\boldsymbol{Average\ Adjusted\ Effluent\ TSS}\ \left(\frac{\boldsymbol{mg}}{\boldsymbol{L}}\right) = \frac{1}{6}\sum_{i=1}^{6}.\ \left[Effluent\ Concentration\ \left({}^{mg}/_{L}\right) - Background\ Concentration\ \left({}^{mg}/_{L}\right)\right]_i$$

Equation 3

Alpha Analytical Laboratories, Inc. of Carlsbad, California performed analysis of all background and effluent samples under test method ASTM D3977 “Standard Test Methods for Determining Sediment Concentrations in Water Samples”.

4. Performance Claims

Verified Total Suspended Solids Removal Rate

In general, the ‘point on a curve’ method to size an MTD for a target removal efficiency of a target particle size is a straightforward approach. The hydraulic loading rate which achieves the target removal efficiency is determined by interpolating or using a curve fit equation from the hydraulic loading rate v removal efficiency data set, which typically spans a large range of tested flow rates.

The testing performed on the SciCloneX resulted in a hydraulic loading rate v removal efficiency curve fit equation on a data set spanning from 0.30 to 1.50 cfs. Removal efficiencies ranged from 99.2% to 68.5% respectively. The curve fit equation was used to determine that the hydraulic loading rate of 37.8 gpm/ft^2 of effective sedimentation treatment area achieved 80% removal efficiency of the target particle size with a d_{50} of 110 µm at the target sediment inlet concentration of 280 mg/L.

Verified Annualized Total Suspended Solids Removal Rate

Net annual sizing is another method for sizing MTDs for a target removal efficiency of a target particle size. This sizing method predicts MTD performance over a typical rain year by using annual rainfall intensity distributions from long-term records to develop a model. The net annual model will vary based on regional rainfall differences, allowing sizing for specific site needs. The model ties the annual occurrence of rainfall intensities to expected performance by applying weighting factors to the MTD removal efficiencies over a range of hydraulic loading rates. The fractional removal efficiencies are then summed to represent the net annualized removal efficiency of the MTD at the treatment flow rate.

In this laboratory testing, the New Jersey rainfall weighting factors in the NJDEP protocol were applied to the SciCloneX curve fit equation to determine the hydraulic loading rate at which an annualized weighted removal efficiency of 80% would occur. The SciCloneX achieved 80% annualized TSS removal of the 110 µm test particle size at a hydraulic loading rate of 59.3 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. A sediment storage depth of 12 inches corresponds to 50% full sediment storage capacity (12.6 cubic feet).

Effective Treatment/Sedimentation Area

The effective treatment area is 12.57 square feet.

Detention Time and Wet Volume

The permanent pool volume for the SciCloneX is 59.7 cu ft (446 gallons) for a 4-foot diameter SciCloneX. 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

In May 2021, the SciCloneX received NJDEP certification qualifying it for online installation for the New Jersey water quality design storm.

5. Removal Efficiency Test Results

Three continuous tests, comprised of five flow rates each, were conducted to evaluate TSS removal of a sediment gradation with a d_{50} of 110 µm. The SciCloneX model SCX-4 obtained a TSS removal efficiency of 80% at a flow rate of 1.061 cfs or 476.2 gpm (37.8 gpm/ft^2) and an annualized weighted removal efficiency of 80.0% at a flow rate of 1.660 cfs or 745.1 gpm (59.3 gpm/ft^2). These performance claims were determined from a curve that is based on the verified test data generated in this study (**Figure 11**).

Summary results from all continuous tests are included in **Table 3**, **Figure 11,** and **Table 4**. Detailed results including sampling times, sample data and QA/QC results from each test are presented in **Table 5** through **Table 20**.

Table 3 Summary of Removal Efficiency Results

Run	Average Flow (gpm)	Average Flow (cfs)	Overall Average Flow (cfs)	Influent TSS (mg/L)	Adjusted Effluent TSS (mg/L)	Removal Efficiency (%)	Overall Average Removal Efficiency (%)	Hydraulic Loading Rate (gpm/sq ft)	Overall Average Hydraulic Loading Rate (gpm/sq ft)
1-0.3	136.3	0.30	0.30	272.9	4.3	98.4%	99.3%	**10.8**	**10.8**
2-0.3	136.0	0.30		276.8	1.7	99.4%		**10.8**	
3-0.3	136.5	0.30		273.4	0.2	99.9%		**10.9**	
1-0.6	271.5	0.60	0.60	282.1	20.4	92.8%	93.9%	**21.6**	**21.6**
2-0.6	271.9	0.61		279.3	18.0	93.6%		**21.6**	
3-0.6	270.7	0.60		279.7	13.6	95.1%		**21.5**	
1-0.9	405	0.90	0.90	284.8	46.0	83.8%	85.7%	**32.2**	**32.2**
2-0.9	405.8	0.90		282.3	45.0	84.1%		**32.3**	
3-0.9	404.7	0.90		284.7	31.1	89.1%		**32.2**	
1-1.2	539.7	1.20	1.20	282.6	74.4	73.7%	74.6%	**42.9**	**43.0**
2-1.2	541.2	1.21		278.6	76.1	72.7%		**43.1**	
3-1.2	539.7	1.20		279.1	63.3	77.3%		**42.9**	
1-1.5	674.4	1.50	1.50	285.6	90.5	68.3%	68.5%	**53.7**	**53.6**
2-1.5	673.6	1.50		281.2	97.9	65.2%		**53.6**	
3-1.5	673.6	1.50		283.5	79.2	72.1%		**53.6**	

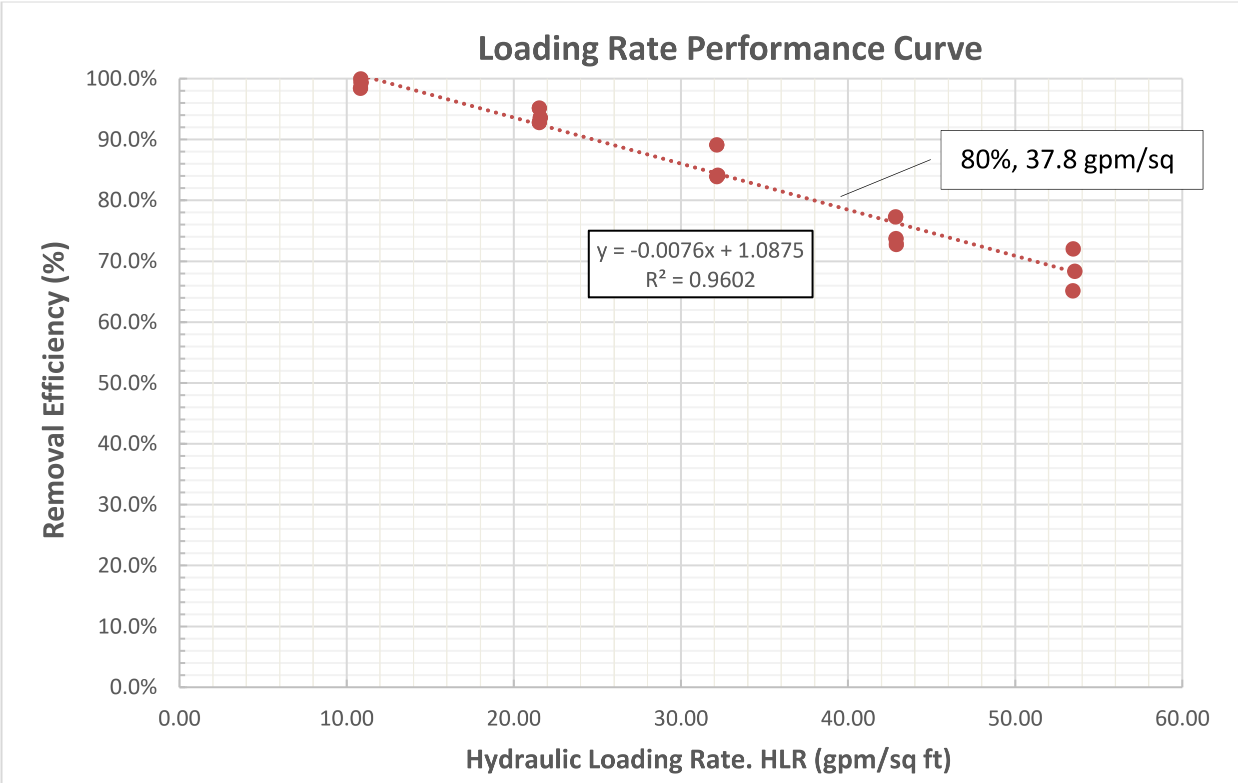

Figure 11 Removal Efficiency Results

Table 4 Annualized Removal Efficiency Results*

Annualized Treatment Hydraulic Loading Rate (gpm/sq ft)	Annualized Treatment Flow Rate for SCX-4 (cfs)	Percent of Treatment Flow Rate (%)	Flow Rate (cfs)	Removal Efficiency (%)	Weighting Factor	Weighted Removal Efficiency (%)
59.3	1.660	25	0.415	97.5	0.25	24.4
		50	0.830	86.2	0.3	25.9
		75	1.245	75.0	0.2	15.0
		100	1.660	63.7	0.15	9.6
		125	2.075	52.4	0.1	5.2
Annualized Removal Efficiency at 59.3 gpm/sq ft (%)						**80.0**

*Per NJDEP Protocol Methodology

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 1.660 cfs (745.1 gpm) is 80.0%, as shown in **Table 4**.

TEST 1 RESULTS

The complete sample data from Test 1 are presented in **Table 5** through **Table 9**. Summary data and QA/QC results for all three runs can be found in **Table 20**. The laboratory TSS reporting limit was 1.00 mg/L. Reported ND values are shown in **Table 5** through **Table 9** as 0.5 mg/L.

Table 5 Test 1 – 1.5 CFS Background TSS, Effluent TSS, and Feed Rate

Elapsed Time	Effluent Sample ID	Effluent Sample (mg/l)	Background Sample ID	Background Sample (mg/L)	Dry Feed Sample ID	Dry Feed Sample (grams)	Actual Dry Sample Duration (sec)
0:00:00					Dry-1	728.353	60.16
0:03:15	Eff-1	93.1	Bg-1	0.5			
0:03:45	Eff-2	92.1	Bg-2	0.5			
0:04:15	Eff-3	102.0	Bg-3	0.5			
0:04:45	Eff-4	91.3	Bg-4	0.5			
0:05:15	Eff-5	76.5	Bg-5	0.5			
0:05:45	Eff-6	90.8	Bg-6	0.5	Dry-2	731.507	59.97

Table 6 Test 1 – 1.2 CFS Background TSS, Effluent TSS, and Feed Rate

Elapsed Time	Effluent Sample ID	Effluent Sample (mg/l)	Background Sample ID	Background Sample (mg/L)	Dry Feed Sample ID	Dry Feed Sample (grams)	Actual Dry Sample Duration (sec)
0:00:00					Dry-1	575.604	60
0:03:45	Eff-1	65.3	Bg-1	0.5			
0:04:15	Eff-2	73.2	Bg-2	0.5			
0:04:45	Eff-3	76.0	Bg-3	0.5			
0:05:15	Eff-4	63.3	Bg-4	0.5			
0:05:45	Eff-5	78.9	Bg-5	0.5			
0:06:15	Eff-6	92.4	Bg-6	0.5	Dry-2	580.784	60.19

Table 7 Test 1 – 0.9 CFS Background TSS, Effluent TSS, and Feed Rate

Elapsed Time	Effluent Sample ID	Effluent Sample (mg/l)	Background Sample ID	Background Sample (mg/L)	Dry Feed Sample ID	Dry Feed Sample (grams)	Actual Dry Sample Duration (sec)
0:00:00					Dry-1	436.277	59.97
0:04:30	Eff-1	42.6	Bg-1	0.5			
0:05:00	Eff-2	40.1	Bg-2	0.5			
0:05:30	Eff-3	52.6	Bg-3	0.5			
0:06:00	Eff-4	41.4	Bg-4	0.5			
0:06:30	Eff-5	51.5	Bg-5	0.5			
0:07:00	Eff-6	51.0	Bg-6	0.5	Dry-2	437.050	60.03

Table 8 Test 1 – 0.6 CFS Background TSS, Effluent TSS, and Feed Rate

Elapsed Time	Effluent Sample ID	Effluent Sample (mg/l)	Background Sample ID	Background Sample (mg/L)	Dry Feed Sample ID	Dry Feed Sample (grams)	Actual Dry Sample Duration (sec)
0:00:00					Dry-1	288.933	60
0:06:15	Eff-1	23.8	Bg-1	0.5			
0:06:45	Eff-2	25.8	Bg-2	0.5			
0:07:15	Eff-3	18.2	Bg-3	0.5			
0:07:45	Eff-4	21.2	Bg-4	0.5			
0:08:15	Eff-5	17.4	Bg-5	0.5			
0:08:45	Eff-6	19.1	Bg-6	0.5	Dry-2	291.344	60.09

Table 9 Test 1 – 0.3 CFS Background TSS, Effluent TSS, and Feed Rate

Elapsed Time	Effluent Sample ID	Effluent Sample (mg/l)	Background Sample ID	Background Sample (mg/L)	Dry Feed Sample ID	Dry Feed Sample (grams)	Actual Dry Sample Duration (sec)
0:00:00					Dry-1	141.586	60.13
0:11:00	Eff-1	6.5	Bg-1	1.5			
0:11:30	Eff-2	0.5	Bg-2	0.5			
0:12:00	Eff-3	6.0	Bg-3	0.5			
0:12:30	Eff-4	7.0	Bg-4	0.5			
0:13:00	Eff-5	2.1	Bg-5	0.5			
0:13:30	Eff-6	7.8	Bg-6	0.5	Dry-2	140.890	60.22

TEST 2 RESULTS

The complete sample data from Test 2 are presented in **Table 10** through **Table 14**. Summary data and QA/QC results for all three runs can be found in **Table 20**. The laboratory TSS reporting limit was 1.00 mg/L. Reported ND values are shown in **Table 10** through **Table 14** as 0.5 mg/L.

Table 10 Test 2 – 1.5 CFS Background TSS, Effluent TSS, and Feed Rate

Elapsed Time	Effluent Sample ID	Effluent Sample (mg/l)	Background Sample ID	Background Sample (mg/L)	Dry Feed Sample ID	Dry Feed Sample (grams)	Actual Dry Sample Duration (sec)
0:00:00					Dry-1	715.553	60.03
0:03:15	Eff-1	99.5	Bg-1	0.5			
0:03:45	Eff-2	96.7	Bg-2	0.5			
0:04:15	Eff-3	93.7	Bg-3	0.5			
0:04:45	Eff-4	101.0	Bg-4	0.5			
0:05:15	Eff-5	93.7	Bg-5	0.5			
0:05:45	Eff-6	106.0	Bg-6	0.5	Dry-2	718.995	60.03

Table 11 Test 2 – 1.2 CFS Background TSS, Effluent TSS, and Feed Rate

Elapsed Time	Effluent Sample ID	Effluent Sample (mg/l)	Background Sample ID	Background Sample (mg/L)	Dry Feed Sample ID	Dry Feed Sample (grams)	Actual Dry Sample Duration (sec)
0:00:00					Dry-1	570.570	60.10
0:03:45	Eff-1	75.1	Bg-1	0.5			
0:04:15	Eff-2	79.8	Bg-2	0.5			
0:04:45	Eff-3	79.7	Bg-3	0.5			
0:05:15	Eff-4	61.2	Bg-4	0.5			
0:05:45	Eff-5	85.2	Bg-5	0.5			
0:06:15	Eff-6	78.8	Bg-6	0.5	Dry-2	571.971	60.03

Table 12 Test 2 – 0.9 CFS Background TSS, Effluent TSS, and Feed Rate

Elapsed Time	Effluent Sample ID	Effluent Sample (mg/l)	Background Sample ID	Background Sample (mg/L)	Dry Feed Sample ID	Dry Feed Sample (grams)	Actual Dry Sample Duration (sec)
0:00:00					Dry-1	434.941	60.09
0:04:30	Eff-1	50.5	Bg-1	0.5			
0:05:00	Eff-2	45.5	Bg-2	0.5			
0:05:30	Eff-3	46.2	Bg-3	0.5			
0:06:00	Eff-4	47.0	Bg-4	0.5			
0:06:30	Eff-5	40.0	Bg-5	0.5			
0:07:00	Eff-6	43.6	Bg-6	0.5	Dry-2	433.041	60

Table 13 Test 2 – 0.6 CFS Background TSS, Effluent TSS, and Feed Rate

Elapsed Time	Effluent Sample ID	Effluent Sample (mg/l)	Background Sample ID	Background Sample (mg/L)	Dry Feed Sample ID	Dry Feed Sample (grams)	Actual Dry Sample Duration (sec)
0:00:00					Dry-1	286.663	60.06
0:06:15	Eff-1	16.6	Bg-1	0.5			
0:06:45	Eff-2	19.5	Bg-2	0.5			
0:07:15	Eff-3	17.5	Bg-3	0.5			
0:07:45	Eff-4	19.9	Bg-4	0.5			
0:08:15	Eff-5	20.7	Bg-5	0.5			
0:08:45	Eff-6	16.7	Bg-6	0.5	Dry-2	289.063	60.1

Table 14 Test 2 – 0.3 CFS Background TSS, Effluent TSS, and Feed Rate

Elapsed Time	Effluent Sample ID	Effluent Sample (mg/l)	Background Sample ID	Background Sample (mg/L)	Dry Feed Sample ID	Dry Feed Sample (grams)	Actual Dry Sample Duration (sec)
0:00:00					Dry-1	146.416	60.13
0:11:00	Eff-1	3.3	Bg-1	0.5			
0:11:30	Eff-2	2.7	Bg-2	0.5			
0:12:00	Eff-3	1.6	Bg-3	0.5			
0:12:30	Eff-4	2.2	Bg-4	0.5			
0:13:00	Eff-5	1.4	Bg-5	0.5			
0:13:30	Eff-6	1.7	Bg-6	0.5	Dry-2	139.288	60.16

TEST 3 RESULTS

The complete sample data from Test 3 are presented in **Table 15** through **Table 19**. Summary data and QA/QC results for all three runs can be found in **Table 20**. The laboratory TSS reporting limit was 1.00 mg/L. Reported ND values are shown in **Table 15** through **Table 19** as 0.5 mg/L.

Table 15 Test 3 – 1.5 CFS Background TSS, Effluent TSS, and Feed Rate

Elapsed Time	Effluent Sample ID	Effluent Sample (mg/l)	Background Sample ID	Background Sample (mg/L)	Dry Feed Sample ID	Dry Feed Sample (grams)	Actual Dry Sample Duration (sec)
0:00:00					Dry-1	721.431	60.07
0:03:15	Eff-1	70.9	Bg-1	0.5			
0:03:45	Eff-2	79.2	Bg-2	0.5			
0:04:15	Eff-3	82.4	Bg-3	0.5			
0:04:45	Eff-4	78.4	Bg-4	0.5			
0:05:15	Eff-5	85.2	Bg-5	0.5			
0:05:45	Eff-6	81.8	Bg-6	0.5	Dry-2	729.909	60.38

Table 16 Test 3 – 1.2 CFS Background TSS, Effluent TSS, and Feed Rate

Elapsed Time	Effluent Sample ID	Effluent Sample (mg/l)	Background Sample ID	Background Sample (mg/L)	Dry Feed Sample ID	Dry Feed Sample (grams)	Actual Dry Sample Duration (sec)
0:00:00					Dry-1	570.689	60.1
0:03:45	Eff-1	57.7	Bg-1	0.5			
0:04:15	Eff-2	67.0	Bg-2	0.5			
0:04:45	Eff-3	58.5	Bg-3	0.5			
0:05:15	Eff-4	70.2	Bg-4	0.5			
0:05:45	Eff-5	68.9	Bg-5	0.5			
0:06:15	Eff-6	60.6	Bg-6	0.5	Dry-2	570.838	60.03

Table 17 Test 3 – 0.9 CFS Background TSS, Effluent TSS, and Feed Rate

Elapsed Time	Effluent Sample ID	Effluent Sample (mg/l)	Background Sample ID	Background Sample (mg/L)	Dry Feed Sample ID	Dry Feed Sample (grams)	Actual Dry Sample Duration (sec)
0:00:00					Dry-1	434.307	60.09
0:04:30	Eff-1	36.5	Bg-1	0.5			
0:05:00	Eff-2	20.6	Bg-2	0.5			
0:05:30	Eff-3	34.4	Bg-3	0.5			
0:06:00	Eff-4	32.7	Bg-4	0.5			
0:06:30	Eff-5	33.6	Bg-5	0.5			
0:07:00	Eff-6	31.9	Bg-6	0.5	Dry-2	438.979	60.06

Table 18 Test 3 – 0.6 CFS Background TSS, Effluent TSS, and Feed Rate

Elapsed Time	Effluent Sample ID	Effluent Sample (mg/l)	Background Sample ID	Background Sample (mg/L)	Dry Feed Sample ID	Dry Feed Sample (grams)	Actual Dry Sample Duration (sec)
0:00:00					Dry-1	286.664	59.9
0:06:15	Eff-1	13.3	Bg-1	0.5			
0:06:45	Eff-2	12.1	Bg-2	0.5			
0:07:15	Eff-3	16.4	Bg-3	1.2			
0:07:45	Eff-4	13.2	Bg-4	0.5			
0:08:15	Eff-5	13.9	Bg-5	0.5			
0:08:45	Eff-6	16.4	Bg-6	0.5	Dry-2	286.591	60.09

Table 19 Test 3 – 0.3 CFS Background TSS, Effluent TSS, and Feed Rate

Elapsed Time	Effluent Sample ID	Effluent Sample (mg/l)	Background Sample ID	Background Sample (mg/L)	Dry Feed Sample ID	Dry Feed Sample (grams)	Actual Dry Sample Duration (sec)
0:00:00					Dry-1	144.495	60.19
0:11:00	Eff-1	1.4	Bg-1	0.5			
0:11:30	Eff-2	0.5	Bg-2	0.5			
0:12:00	Eff-3	0.5	Bg-3	0.5			
0:12:30	Eff-4	0.5	Bg-4	0.5			
0:13:00	Eff-5	1.4	Bg-5	0.5			
0:13:30	Eff-6	0.5	Bg-6	1.0	Dry-2	138.526	60.1

5.1 QA/QC Results

The summary of the test data and QA/QC results are presented below in **Table 20**. The data shows that all QA/QC parameters were met for each portion of test runs 1, 2, and 3. The highest variation in flow rate from the target was 1.68%. All average flows with a variation of more than 1.00% were at the 0.3 cfs portions of each run. Average variation across all portions of all runs was 0.6%. This was well within the 10% variation allowed under the NJDEP protocol. The highest flow rate COV was 0.013, which is less than the 0.03 limit allowed under the protocol. The highest water temperature recorded was 77.9 degrees Fahrenheit. The highest variation of influent concentration from the target was 2.0%. The average variation across all portions of all runs was 0.5%, well within the 10% variation allowed under the NJDEP protocol. The highest COV for feed rate was 0.035, which is well within the limit of 0.1 under the protocol.

Table 20 Run Summary and QA/QC Results

Flow Rate and Water Temperature					
Run	QA/QC Pass/Fail	Target Flow Rate (cfs)	Average Flow Rate (cfs) (+ 10% of Target)	Flow Rate COV (<0.03)	Maximum Water Temperature (°F) (<80 °F)
1-0.3	Pass	0.3	0.30	0.018	77.9
2-0.3	Pass		0.30	0.008	77.3
3-0.3	Pass		0.30	0.008	77.9
1-0.6	Pass	0.6	0.60	0.009	77.9
2-0.6	Pass		0.61	0.008	77.3
3-0.6	Pass		0.60	0.008	77.9
1-0.9	Pass	0.9	0.90	0.002	77.9
2-0.9	Pass		0.90	0.002	77.3
3-0.9	Pass		0.90	0.002	77.9
1-1.2	Pass	1.2	1.20	0.002	77.9
2-1.2	Pass		1.21	0.002	77.3
3-1.2	Pass		1.20	0.002	77.9
1-1.5	Pass	1.5	1.50	0.002	77.9
2-1.5	Pass		1.50	0.002	77.3
3-1.5	Pass		1.50	0.003	77.9
Influent, Feed Rate, and Background Concentration					
Run	QA/QC Pass/Fail	Target Influent TSS (mg/L)	Average Influent TSS (mg/L) (+ 10% of Target)	Feed Rate COV (<0.1)	Average Background TSS (<20 mg/L)
1-0.3	Pass	280.0	272.9	0.002	0.7
2-0.3	Pass		276.8	0.035	0.5
3-0.3	Pass		273.4	0.030	0.5
1-0.6	Pass	280.0	282.1	0.006	0.5
2-0.6	Pass		279.3	0.007	0.5
3-0.6	Pass		279.7	0.000	0.5
1-0.9	Pass	280.0	284.8	0.001	0.5
2-0.9	Pass		282.3	0.003	0.5
3-0.9	Pass		284.7	0.008	0.5
1-1.2	Pass	280.0	282.6	0.006	0.5
2-1.2	Pass		278.6	0.002	0.5
3-1.2	Pass		279.1	0.000	0.6
1-1.5	Pass	280.0	285.6	0.003	0.5
2-1.5	Pass		281.2	0.003	0.5
3-1.5	Pass		283.5	0.008	0.6

5.2 Water Levels and Retention Times

The water level was monitored in real time and recorded in 5 second intervals throughout the duration of each test run. Water maintained a consistent level during all test runs. **Table 21** shows that the recorded 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 to ensure that the 3DT criterion was achieved. Retention times were based on active volume (false floor to water level above pipe invert) for each run.

Table 21 Summary of Water Levels and Run Times

Water Levels and Run Times					
Run	**Average Active Water Level Monitored[1] (ft)**	**Conservative Water Level Used for Detention Time[2] (ft)**	**Detention Time (min)**	**3x Detention Time (min)**	**Sediment Injection Duration (min)**
1-0.3	0.802	1.0	3.31	9.92	4.5
2-0.3	0.791				
3-0.3	0.791				
1-0.6	0.911	1.1	1.69	5.06	5.0
2-0.6	0.906				
3-0.6	0.878				
1-0.9	0.951	1.2	1.15	3.45	6.0
2-0.9	0.972				
3-0.9	0.943				
1-1.2	1.005	1.3	0.88	2.64	7.5
2-1.2	0.994				
3-1.2	0.999				
1-1.5	1.031	1.4	0.72	2.15	12.5
2-1.5	1.048				
3-1.5	1.043				

[1] Measured values from water level sensor and associated output report from data logger. Value shown is average from all data points which were done in 5 second intervals.

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

6. 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.

7. 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 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 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 can be sized for 80% removal of TSS at weighted hydraulic loading rate of 59.3 gallons per minute per square foot of settling surface area or an absolute hydraulic loading rate of 37.8 gallons per minute per square foot of settling surface area. Section 8 includes details pertaining to inspection and maintenance of the SciCloneX.

Maintenance Requirements

Requirements pertaining to maintenance of the SciCloneX 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 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 on-site 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 can be installed online or offline.   The SciCloneX 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 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 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 are 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, 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.

8. 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

The following is a list of equipment to allow for simple and effective inspection of the SciCloneX Hydrodynamic 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 Hydrodynamic 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 Hydrodynamic 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 Hydrodynamic Separator. The 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.

9. Statements

The following attached pages are signed statements from the manufacturer (Bio Clean Environmental, Inc.), the third-party observer (Michael Kimberlain of KimberWorks, LLC).

Bio Clean
A Forterra Company

Date: 8/12/2021

To Whom It May Concern,

We are providing this letter as our statement certifying that this testing strictly followed the procedures as outlined in the attached report. Testing performed at Bio Clean Laboratories, in Oceanside, CA on the SciCloneX in July of 2021 under the strict supervision of Mr. Michael Kimberlain, of KimberWerks, Inc. was conducted in full compliance. 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: 8/12/2021

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August 19, 2021

Richard S. Magee Sc.D., P.E., BCEE
Executive Director
New Jersey Corporation for Advanced Technology
Center for Environmental Systems
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Castle Point on Hudson
Hoboken, NJ 07030
973-879-3056 (M)
rsmagee@rcn.com

Re: **Statement of Third-Party Observer**
Performance Verification of the Bio Clean SciCloneX for 80% RE

Dr. Magee,

KimberWerks, Inc. has been Engaged by Bio Clean to act as the third-party observer for the Performance Verification Testing of their SciCloneX Hydrodynamic Separator. Performance Verification testing was performed by Bio Clean personnel under the direction of Mr. Zach Kent, Managing Director, and began on July 27th, 2021, and ended on July 29th, 2021. The Performance Verification was performed at Bio Clean Laboratories located at 398 Via El Centro, Oceanside, California 92008.

I was personally on site to observe the testing and I remained on site while testing was in process to observe the testing for its full duration. The flow rates and frequency of sampling reported for the performance tests were observed and reported accurately. Grain size analysis and sediment concentration in water samples analysis was performed offsite by third party laboratories. The sampling occurred under my observation and the samples were transported under my direction and control to the laboratories. The verification testing used applicable protocol, as outlined in the Quality Assurance Project Plan (QAPP). I have personally reviewed the data sets and calculations in the Report by Bio Clean date August 2021 and hereby state they conform to my observations while acting as third-party observer.

Please let me know should you have any questions or need any clarification to these statements.

Sincerely,

Michael Kimberlain, P.E., CPSWQ
mkimberlain@kimberwerks.com
(858) 381-6209

KimberWerks, Inc.
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Re: **Third-Party Observer Statement of Disclosure / Disclosure Record**

Dr. Magee,

In accordance with the *Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology (January 25, 2013), Section 4. B Conflict of Interest,* KimberWerks, Inc. would like to inform NJCAT that we have no disclosures that would represent a conflict of interest. KimberWerks, Inc. has no personal, professional, or financial interest in the outcome of the Performance Verification Testing performed by Bio Clean, and has no personal, professional, or financial interest in Bio Clean.

KimberWerks, Inc. is a privately owned Engineering Consulting company that regularly performs work in the areas of Civil Engineering, Storm Water, Wastewater, and Potable Water and as such has in the past Engaged with various Storm Water MTD Manufactures including but not limited to: AbTech, Industries, Inc., Prinsco, Hydro International, Advanced Drainage Systems, Forterra Building Products, Bio Clean, Old Castle Stormwater Solutions, Lane Enterprises, AquaShield, and Jensen Stormwater Systems. None of these engagements present a personal, professional, or financial conflict of interest as the engagements did not include:

- having an ownership stake in any of the companies;
- receiving commission for selling a MTD for a manufacturer;
- having a licensing agreement with the manufacturer; or
- receiving funding or grants not associated with a testing program from the manufacturer.

Please let me know should you have any questions or need any clarification to these statements.

Sincerely,

Michael Kimberlain, P.E., CPSWQ
mkimberlain@kimberwerks.com
(858) 381-6209

10. 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 verified models are shown in **Table A-1** and **A-2**.
- The SciCloneX demonstrated net annual 80% TSS removal for d_{50} 110 micron particles at the target influent sediment concentration of 280 mg/L.
- In May 2021, the SciCloneX received NJDEP certification qualifying it for online installation for the New Jersey water quality storm design.

Detailed Specification

- Sizing tables for the SciCloneX can be found in **Table A-1** and **A-2** below.
- 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

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

(Median Particle Size of 110 µm and 280 mg/L TSS Influent Concentration)

Model #	Manhole Diameter[1] (ft)	Annualized Maximum Treatment Flow Rate (cfs)	Effective Treatment Area (sq ft)	Hydraulic Loading Rate (gpm/sq ft)	100% Maximum Sediment Storage Depth (ft)	100% Max Sediment Storage Volume[3] (cu ft)
SCX-3	3	0.94	7.1	59.3	2.0	14.2
SCX-4	4	1.66	12.6	59.3	2.0	25.2
SCX-5	5	2.59	19.6	59.3	2.0	39.2
SCX-6	6	3.74	28.3	59.3	2.0	56.6
SCX-7	7	5.09	38.5	59.3	2.0	77.0
SCX-8	8	6.65	50.3	59.3	2.0	100.6
SCX-10	10	10.37	78.5	59.3	2.0	157.0
SCX-12	12	14.94	113.1	59.3	2.0	226.2
SCX-14	14	20.33	153.9	59.3	1.0	307.8

NOTES:

1. In some areas SciClone units are available in other diameters. Units not listed here are sized not to exceed 59.3 gpm/ft^2 of effective treatment during the peak water quality flow.
2. 100% Sediment Storage Capacity is equal to manhole diameter x 24 inches of sediment depth. Each SciClone unit has a 24 inch deep sediment sump.

Table A-2 Standard Dimensions for SciCloneX Models

Model #	Effective Treatment Area (sq ft)	Effective Treatment Depth[1] (in)	Chamber Depth[2] (in)	Aspect Ratio[3]	Maximum Pipe Diameter (in)
SCX-3	7.1	45	57	n/a	18
SCX-4	12.6	45	57	0.94	24
SCX-5	19.6	45	57	n/a	30
SCX-6	28.3	45	57	n/a	36
SCX-7	38.5	68	80	0.81	42
SCX-8	50.2	78	90	0.81	48
SCX-10	78.5	96	108	0.80	60
SCX-12	113.1	116	128	0.81	72
SCX-14	153.9	135	147	0.80	84

NOTES:

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. All models are geometrically proportional to the tested CSX-4 within the allowable ±15% (0.79 -1.09) tolerance.