NJCAT TECHNOLOGY VERIFICATION

Rapterra™ System

Contech Engineered Solutions

January 2026

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1. DESCRIPTION OF TECHNOLOGY

The Rapterra™ System (Rapterra) is an engineered, biofiltration system (**Figures 1, 2 and 3)** that is typically installed as a standalone, pre-constructed unit designed to treat contaminated runoff in the urban landscape. Rapterra is similar in concept to traditional bioretention systems in its function and applications, however its high flow media allows for a reduction in system footprint. Rapterra provides an effective green infrastructure (GI) practice for tight, highly developed sites such as urban development projects, commercial parking lots, residential streets, and streetscapes.

As illustrated in **Figure 1**, stormwater enters the Rapterra through a pipe, curb inlet, or as sheet flow and then ponds over the pretreatment mulch layer, which captures heavy sediment and debris. To minimize potential disturbance of the mulch layer during operation, the mulch layer is overtopped with synthetic scour protection netting that is staked in place to ensure it remains stationary. The media layer captures finer sediments, reducing the potential for re-suspension during high flow events. Once the stormwater runoff flows down through the media, it continues into an underdrain system where the treated water is discharged. Higher flows bypass the Rapterra via upstream flow control or a downstream inlet structure, curb cut or other appropriate relief. An internal bypass configuration is also available (**Figure 2**).

The Rapterra is available in a variety of precast configurations, and can also be configured as a Rapterra Bioscape, an open top configuration which can be installed directly into an excavated basin, for better aesthetics and effective infiltration into the ground when native soils allow. Both Rapterra precast and Rapterra Bioscape configurations are identical in form and function with the exception of the use of a vault or manhole in precast systems. Rapterra can be configured in many ways to enhance site aesthetics, integrate with other GI practices, or increase runoff reduction through infiltration below or downstream of the system (Note: To meet NJDEP GI standards, solid grate option must also include infiltration of the WQv*)*.

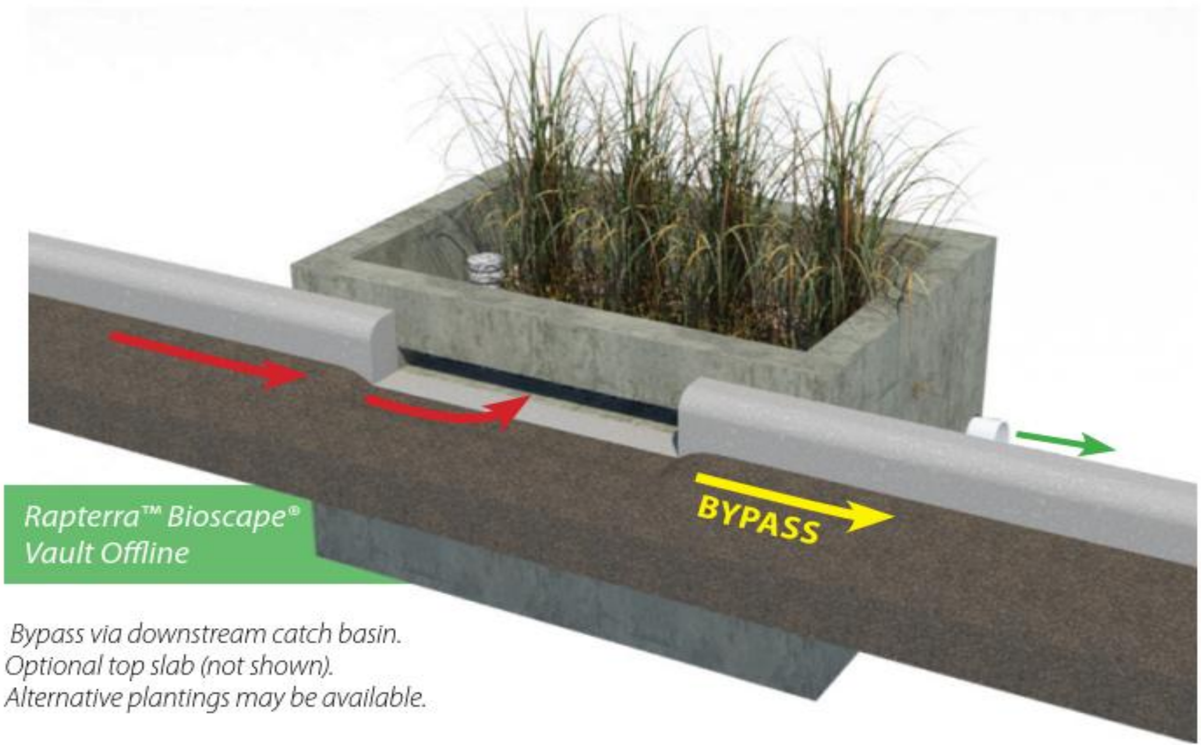

Figure 1 Typical Rapterra Offline Configuration

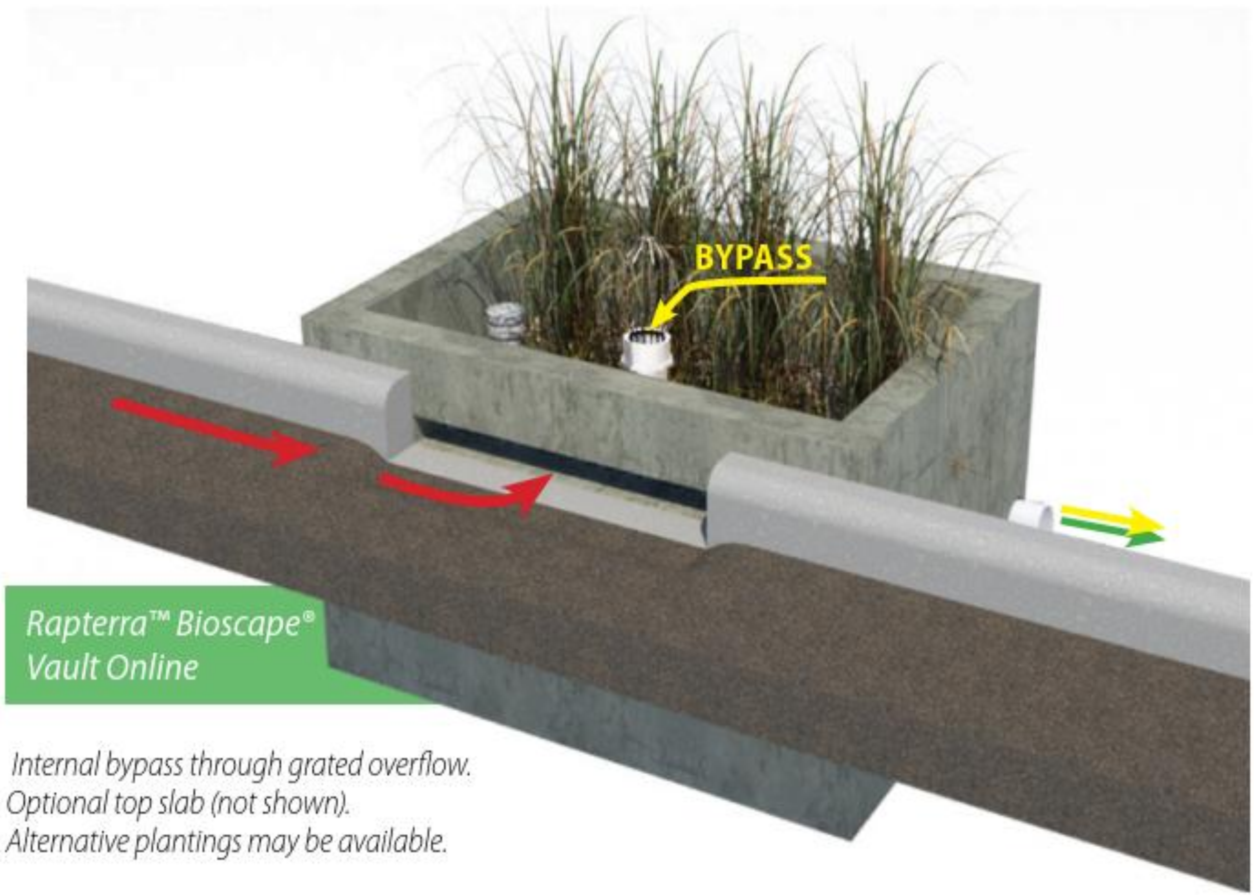

Figure 2 Typical Rapterra Online Configuration

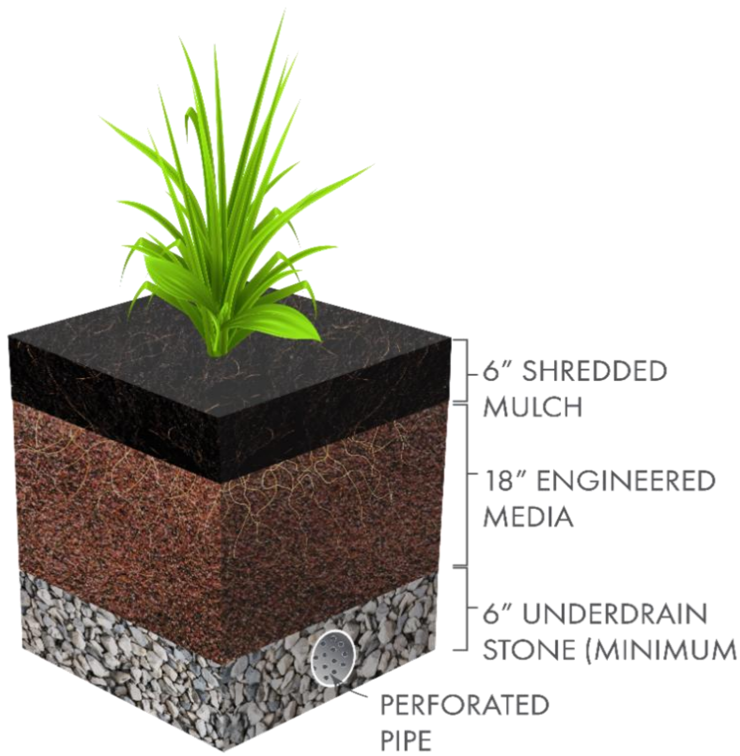

Figure 3 Rapterra Media Profile

2. Laboratory Testing

All testing disclosed in this report was performed in accordance with the New Jersey Department of Environmental Protection (NJDEP) Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device (NJDEP Protocol) dated January 14, 2022 (updated April 25, 2023).

All removal efficiency, sediment mass loading capacity, and scour testing for this project were carried out at Contech's Ashland, Virginia laboratory. Independent third-party observation for all testing was provided by NJCAT approved observer Don Rissmeyer, P.E. from A. Morton Thomas and Associates, Inc. in Richmond, VA. Don Rissmeyer has an extensive background in stormwater, including serving as a qualified third-party observer previously, and has no conflict of interest that would disqualify him from serving as an independent third-party observer during this testing process.

2.1. Test Unit

Laboratory testing was completed on a full-scale, commercially available 3ft diameter Rapterra manhole unit (RTMH) as shown in **Figure 4**. For maneuverability in the laboratory, the Rapterra components as shown in **Figure 3** were housed in a 3 ft diameter by 48 in. tall polyethylene test unit rather than the typical concrete manhole. All Rapterra components and dimensions are consistent with a commercially available unit other than the alternate manhole material. The bottom of the Rapterra system contained an underdrain system consisting of a perforated 6 in. diameter PVC pipe surrounded by ¾ in. stone, which was connected to a clean out/bypass via a 90-degree elbow. Above the underdrain system is 18 in. of Rapterra media, and over top the media was 6 in. of shredded mulch. Over the top of the mulch was scour protection netting. Dissipation stone consisting of 3-6 in. diameter washed stones or cobbles overtopped the mulch surrounding the inlet. The test unit inlet pipe invert to effluent pipe invert distance was 36 in. The cleanout/bypass pipe elevation was 12 in. above the media surface. The effective filtration treatment area of the polyethylene test unit (35.5-in ID) was 6.66 ft^2 when accounting for the clean out/bypass pipe surface area.

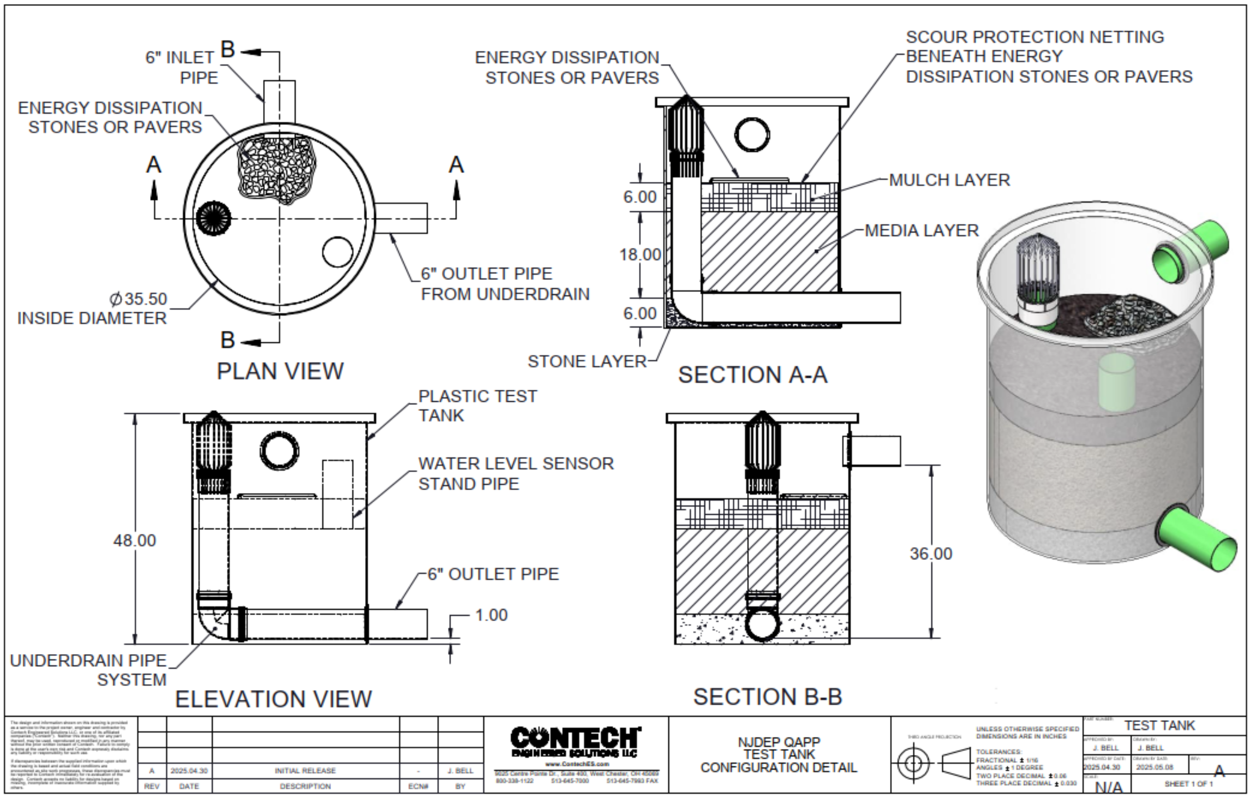

Figure 4 Rapterra Online (RTMH) Test Unit Configuration and Components

2.2. Laboratory Setup

The Rapterra unit was tested on a recirculating test loop system (**Figure 5**). The test unit was supported by an elevated platform to allow free-discharge effluent to collect in the 300-gal effluent collection tank (**Figure 6**). Clean and filtered tap water was drawn from a 2,500-gal supply tank using a 1 HP submersible pump (Pump 1, **Figure 5**) during removal efficiency and sediment mass capacity tests, in conjunction with a second 3/4 HP submersible pump (Pump 2, **Figure 5**) during scour testing. Water was then delivered to the test unit through 6 in. PVC piping installed at a minimum slope of 1%. Flow from Pump 1 and Pump 2 was controlled manually with a 3 in. globe valve and measured by a factory-calibrated Seametrics EX810 electromagnetic flowmeter and logged at a minimum of 1 min intervals. The logged flow data was used to determine test water volume and to verify that each test was conducted at the target flow rate.

Influent water then travels into 6 in. influent piping where background TSS samples were taken from a 3/4 in. PVC pipe sampling port at the bottom of the influent pipe located 28-in. upstream of the sediment injection point. Influent water was then dosed with sediment from an Acrison 105X volumetric sediment feeder with the sediment injection point located 12 in. upstream of the test unit. The sediment feeder was stationed on an Ohaus Defender 5000 scale with digital output for determining sediment mass before and after each test. Influent water then enters the test unit via the 6 in. influent piping. Water surface level (WSL) was measured and logged at a minimum of 1 min intervals by a calibrated Krohne OptiSound VU31 ultrasonic level sensor in a perforated standpipe on top of the media surface and connected to a Lascar Electronics EL-USB-4 Data Logger. Water was treated by the Rapterra and exited the system via the underdrain system. Water exited the 6 in. effluent pipe, installed at a minimum slope of 1%, in a free-fall stream, where effluent TSS grab samples were taken before flow entered a 300-gal effluent tank equipped with a submersible pump.

To complete the test loop, effluent water was filtered and returned via a pump to the supply tank. To minimize potential background sediment concentrations, effluent water was pumped through a cartridge filter housing using a 3/4 HP, submersible pump (Pump 3, **Figure 3**) during removal efficiency and sediment mass capacity tests, in conjunction with a second 3/4 HP submersible pump (Pump 4, **Figure 3**) during scour testing. When necessary, clean water was brought into the source water tank for dilution to ensure background concentrations did not exceed 20 mg/L. Flocculants were not used to reduce background TSS at any time. A calibrated Elitech RC-5+TE thermometer and data logger were installed in the 2,500-gal supply tank and recorded water temperature at a minimum of 1 min intervals, to the nearest 0.1 °F. Water temperature did not exceed 80 °F at any point during testing.

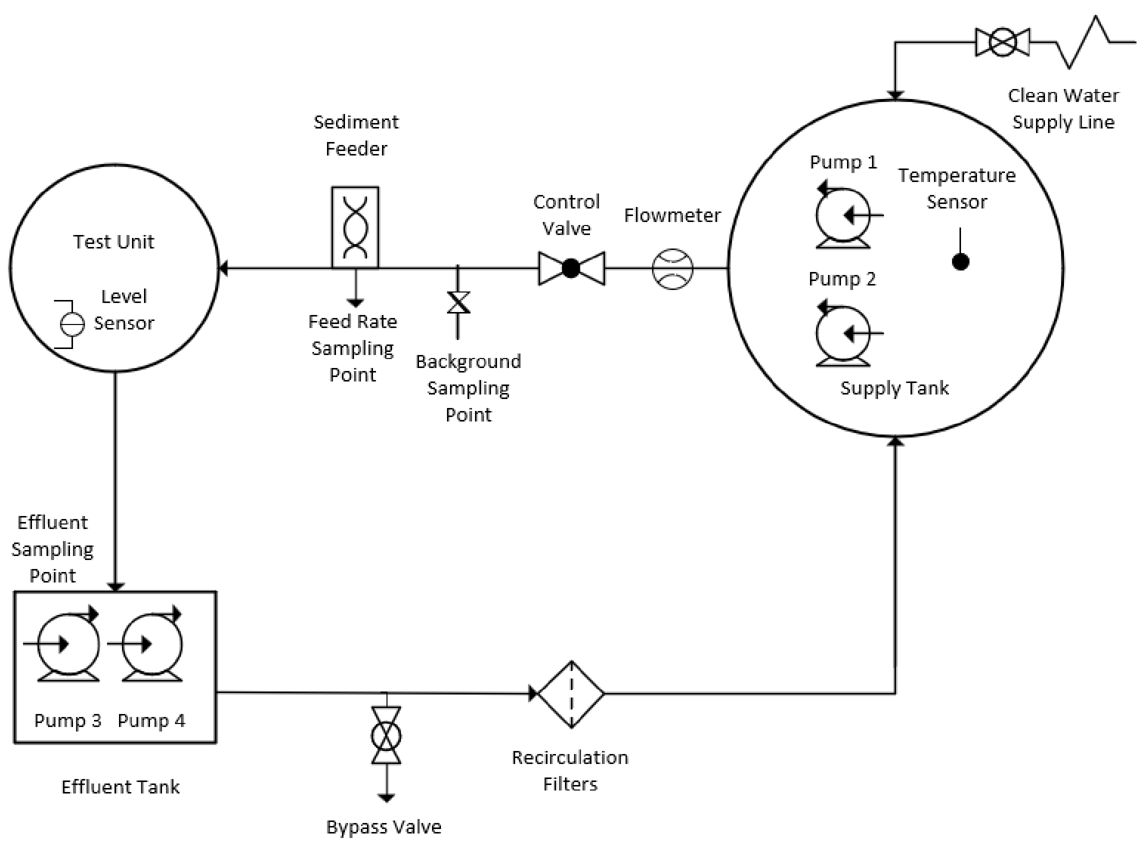

Figure 5 Test System Schematic for Removal Efficiency, Sediment Mass Determination and Scour Testing

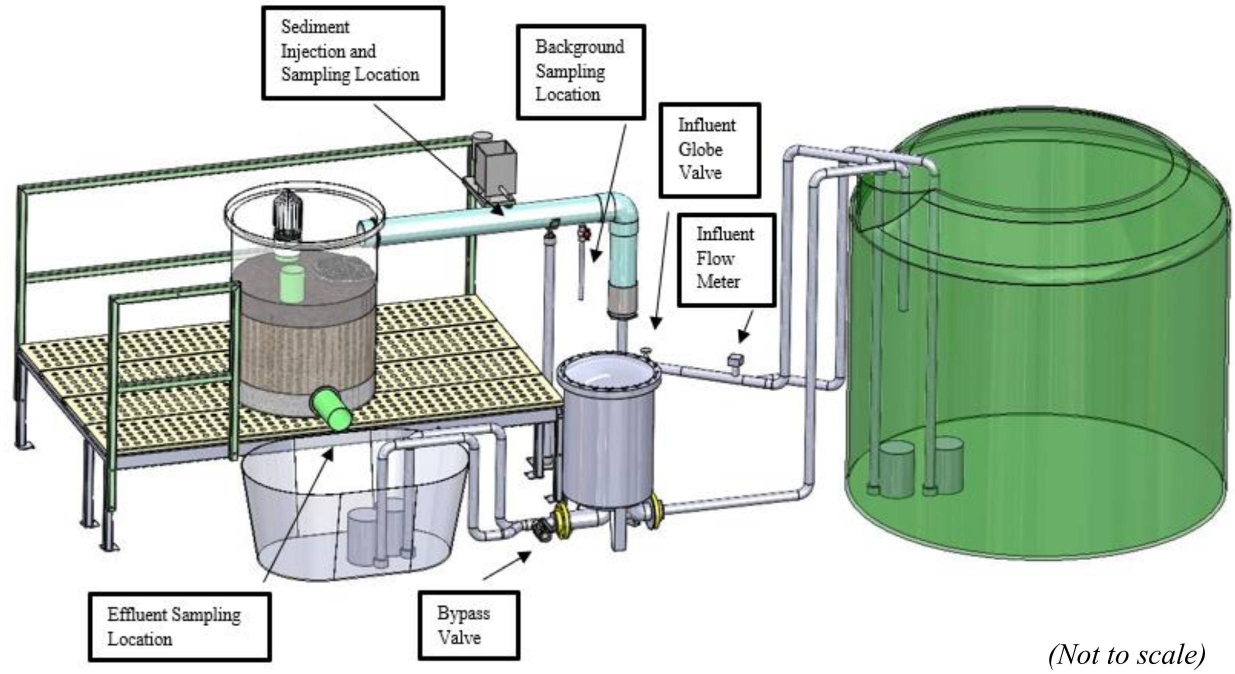

Figure 6 Laboratory Layout - Sampling and Control Locations

2.3. TEST SEDIMENT AND PSD

Test sediment used for removal efficiency and sediment mass loading capacity testing was a silica blended mixture compliant with the NJDEP PSD requirements and provided by AGSCO corporation. Test sediment PSD samples were collected under third-party observation following ASTM E3317(2022) Standard Specification for Silica-Based Sediment for the Evaluation of Stormwater Treatment Devices. PSD sediment samples were sent to GeoTesting Express in Acton, MA, an independent, accredited analytical laboratory, for processing according to ASTM D6913(2017) Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis, ASTM D7928(2021) Standard Test Method for Particle Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis, and ASTM D2216 (2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass. Sediment containers were affixed with quality seals under third-party observation and remained sealed until opened and utilized for testing under 3rd party observation.

Samples for suspended solids concentration (SSC) analysis were sent to Apex Laboratory in Tigard, OR, an independent, accredited analytical laboratory, for analysis according to ASTM D3977-97(2019) Standard Test Methods for Determining Sediment Concentration in Water Samples.

The average PSD was used to determine compliance with the target PSD as outlined in **Table 1** of the NJDEP Protocol. The average sediment moisture content was used in feed rate calculations (**Equation 1**) and influent mass calculations (**Equation 2**).

2.4. REMOVAL EFFICIENCY AND SEDIMENT MASS LOADING CAPACITY TESTING PROCEDURE

Sediment removal efficiency testing followed the effluent grab sampling test method outlined in Section 4.G of the NJDEP Filter Protocol. Testing was performed at a 941 in/hr infiltration rate which is representative of a 65.1 gpm maximum treatment flow rate (MTFR) or 9.78 gpm/ft^2 for a 3 ft diameter Rapterra manhole unit. Sediment removal efficiency and mass load capacity testing were conducted at the target MTFR for 15 tests until the maximum design driving head was reached. Then the influent flow rate was reduced to 90% of the MTFR and testing resumed until maximum design driving head was reached again at test 18, at which time testing was concluded.

For each test, testing commenced once the flow rate was stabilized at the target value. The flow rate was held steady during the test at ±10% of the target value with a coefficient of variation (COV) less than the allowed 0.03. Water temperature remained below 80 °F during all testing. WSL was measured at the media surface to confirm driving head was below the 12 in. maximum design head above the media surface.

Sediment was injected at a known rate to produce a target average influent TSS concentration of 200 mg/L (± 10%) for removal efficiency and sediment mass capacity testing, respectively, with a COV of less than the allowed 0.10. Feed rates were determined by sampling the injection stream at three, evenly spaced intervals throughout each test. Feed rate samples were collected in clean beakers. Each sample was timed to the nearest 0.01 second and was a minimum of 0.1 L or the collection interval did not exceed 1 minute, whichever came first. The samples were weighed (in-house under the third-party observation) to the nearest mg on a calibrated Ohaus Scout SPX223 scale and feed rate was calculated using **Equation 1**. The influent mass injected during each test run was determined by measuring the sediment mass (to the nearest 0.01 kg) in the feeder before and after each test via the Ohaus Defender 5000 scale and subtracting the mass collected for feed rate samples (**Equation 2**). Average influent TSS was calculated by dividing the influent mass injected during each test run by the volume of water sent to the test unit during sediment injection using **Equation 3**.

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

(Equation 1)

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

(Equation 2)

$$Average\ Influent\ TSS\ \left({}^{mg}/_{L}\right) = \frac{Influent\ Mass\ (kg)\ x \left(\frac{1E6\ mg}{kg}\right)}{Average\ Flow\ Rate\ \left({}^{gal}/_{min}\right) \times \left(\frac{3.78541\ L}{gal}\right) \times Time_{sediment\ injection}(min)}$$

(Equation 3)

All effluent, background, and drawdown samples were sent to Apex Laboratory for SSC analysis. Five evenly spaced effluent grab samples were collected during each test. When the sediment stream was interrupted for feed rate sampling, effluent sampling resumed after a minimum of three detention times passed. 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.

Five background TSS samples were taken upstream of the test sediment injection point at paired sampling times with effluent TSS samples. Each sample was a minimum of 0.5 L and collected in a clean, 1-L bottle from the background sampling port. Samples were collected after the port valve was opened and the line was flushed for a minimum of 3 seconds. No background concentrations exceeded 20 mg/L during any test. Paired background TSS concentrations were used to adjust effluent TSS concentrations. The adjusted effluent TSS values were averaged (**Equation 4**) and used to calculate effluent mass (**Equation 5)**.

$$Average\ Adjusted\ Effluent\ TSS\ \left({}^{mg}/_{L}\right) = \frac{1}{5}\sum_{i=1}^{5}\left[Effluent\ TSS\ \left({}^{mg}/_{L}\right) - Background\ TSS\ \left({}^{mg}/_{L}\right)\right]_i$$

(**Equation 4**)

$$Effluent\ Mass\ (\text{mg}) = Average\ Adjusted\ Effluent\ TSS\ \left({}^{mg}/_{L}\right) \times\ Average\ Flow\ Rate\ \left({}^{gal}/_{min}\right) \times \frac{3.78541\ L}{gal} \times Time_{sediment\ injection}(min)$$

(**Equation 5**)

Two evenly volume-spaced drawdown samples were collected at 1/3 and 2/3 of the drawdown volume during the period after flow was suspended at the end of each test. Drawdown flows were retained in a gradated tank for volume measurement. Appropriate drawdown sample times were established prior to the initial removal efficiency test run using the collected clean water operational draindown volume. This data was then applied to the initial test run. The evenly spaced drawdown sampling times were shifted throughout testing to accommodate any changes in drain volume as a result of sediment loading in the system over time. Drawdown flow mass was calculated using **Equation 6**.

$$Drawdown\ Flow\ Mass\ (\text{mg}) = \left(Average\ Drawdown\ Flow\ TSS\ \left({}^{mg}/_{L}\right) - Average\ Background\ TSS\ \left(\frac{mg}{L}\right)\right) x\ Drawdown\ Flow\ Volume\ (L)$$

(Equation 6)

Removal efficiency at MTFR for each test run was calculated using **Equation 7**. Note the numerator is the mass captured during the run.

$$Removal\ Efficiency\ (\%) = \frac{(Influent\ Mass\ (mg) - Effluent\ Mass\ (mg) - Drawdown\ Flow\ Mass\ (mg))}{Influent\ Mass\ (mg)} \times 100$$

(Equation 7)

Cumulative removal efficiency at MTFR was calculated using **Equation 8**.

$$Cumulative\ Removal\ Efficiency\ (\%) = \frac{\sum Influent\ Mass\ \ (mg) - \sum Effluent\ Mass\ (mg) - \sum Drawdown\ Flow\ Mass\ (mg)}{\sum Influent\ Mass\ (mg)} \times 100$$

(Equation 8)

Cumulative mass loaded at MTFR was calculated using **Equation 9**.

$$Cumulative\ Mass\ Load\ (lb) = \frac{\sum Influent\ Mass\ \ (mg)}{\frac{453{,}592\ mg}{lb}}$$

(Equation 9)

Cumulative mass load captured at MTFR was calculated using **Equation 10**.

$$Cumulative\ Mass\ Load\ Capacity\ (lb) = \frac{\sum Influent\ Mass\ \ (mg) - \sum Effluent\ Mass\ \ (mg) - \sum Drawdown\ Flow\ Mass\ (mg)}{\frac{453{,}592\ mg}{lb}}$$

(Equation 10)

2.5 SCOUR TESTING

The Rapterra was tested under online installation conditions following the procedure described in Section 5 of the NJDEP Filtration Protocol. Scour testing was conducted within 96 hours following the conclusion of sediment mass loading capacity testing on a fully loaded test unit (100% sediment mass loading capacity) per Option 3 of the Horizontal Bed Filters section of the NJDEP Filtration Protocol.

The scour test commenced when clear water was introduced to the pre-loaded test unit. Flow was increased to 199% of the MTFR (129.4 gpm) within 3 min of commencement of the test. For the remainder of the test, the flow rate was held steady at ±10% of the target rate with a maximum COV of 0.03 and logged at a minimum of 1 min intervals.

The water temperature did not exceed 80 °F during scour testing and was measured and recorded at a minimum of 1 min intervals. WSL was measured at the media surface to confirm maximum design head above the media surface and logged at a minimum of 1 min intervals.

Effluent sampling began at 1 min and continued every 2 min until a total of 15 samples were collected. Each effluent sample was a minimum of 0.5 L. Effluent samples were collected in clean, 1-L wide mouth bottles by sweeping the bottles through the cross-section of the free-discharge effluent stream in a single pass. Fifteen paired background TSS samples were collected at paired sampling times with effluent TSS samples throughout the duration of the test. Each sample was a minimum of 0.5 L and collected in a clean, 1-L bottle from the background sampling port. Background samples were collected after the port valve was opened and the line was flushed for a minimum of 3 seconds. No background concentration exceeded 20 mg/L. The average effluent TSS concentration measured during scour testing must be no more than 20.0 mg/L to qualify for online installation.

All effluent and background samples were sent to Apex Laboratory for SSC analysis. Paired background TSS was used to adjust effluent TSS.

3. PERFORMANCE CLAIMS

The following performance claims are specific to the 3 ft diameter Rapterra manhole, the unit size tested following the NJDEP Protocol. Additional information for all available models is provided in **Table A-1**.

Verified Total Suspended Solids Removal Rates

The Rapterra exceeded the NJDEP required total suspended solids (TSS) removal rate of 80% at an MTFR of 65.1 gpm. The TSS removal rate of 80.1% was determined according to the procedure and calculations described in the NJDEP Protocol and rounded down to 80% per Section 5.C in the Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology (NJDEP Verification Procedure) dated August 4, 2021.

Maximum Treatment Flow Rate

The 3 ft Rapterra MTFR was determined to be 941 inches/hr. or 65.1 gpm. The corresponding hydraulic loading rate is 9.78 gpm/ft^2 of effective filtration treatment area.

Effective Sedimentation Treatment Area

The effective sedimentation treatment area (ESTA) is the surface area of a 35.5-inch inner diameter circular tank with a 6.25-inch outer diameter bypass pipe occupying an area of 0.21 ft^2. This equates to 6.66 ft^2 of functional area.

Effective Filtration Treatment Area

The effective filtration treatment area (EFTA) is equal to the ESTA of 6.66 ft^2.

Sediment Mass Loading Capacity

The 3 ft Rapterra unit tested has a mass load capacity of 59.0 lbs and mass load capture capacity of 47.8 lbs, or 7.2 lbs/ft^2 of EFTA.

Maximum Allowable Inflow Drainage Area

Based on a sediment mass capture capacity of 47.8 lbs, the 3 ft Rapterra can treat 0.08 acres based on NJDEP's baseline assumption of 600 lbs of sediment loading per acre of drainage area annually.

Detention Time and Wet Volume

The operational wet volume of 20.0 ft^3 for a 3 ft Rapterra produces a detention time of 2.30 minutes at 65.1 gpm. The operational wet volume was conservatively defined using empty test unit dimensions including the 6.66 ft^2 surface area of the Rapterra multiplied by distance from the floor of the test unit to the maximum water surface level of 12 inches over the media.

4. Supporting Documentation

The NJDEP Verification Procedure, Section 5.D requires that copies of the analytical laboratory test reports, all data from performance evaluation test runs, spreadsheets containing original data from all performance test runs, all pertinent calculations, and documentation of any special activities be included in this section. This was discussed with NJDEP and it was agreed that as long as such documentation could be made available by the New Jersey Corporation for Advanced Technology (NJCAT) upon request, it would not be prudent or necessary to include all this information in this verification report.

4.1. Test Sediment PSD

The test sediment PSD and NJDEP specification are presented in **Table 1** and plotted in **Figure 7.** The measured and interpolated result indicates compliance with the requirements of the NJDEP Protocol. The test sediment distribution was finer than the specification, with a d50 particle size of 54 µm. The moisture content was 0.1%.

Table 1 Test Sediment PSD

Particle Size (µm)	Percent Finer by Mass (%)					
	NJDEP Specification	NJDEP Minimum Allowable	Test Sample 1	Test Sample 2	Test Sample 3	Test Sediment Average
1000	100	98	99	100	100	100
500	95	93	97	97	97	97
250	90	88	92	92	92	92
150	75	73	78	78	79	78
100	60	58	61	62	61	61
75	50	50	53	52	53	53
50	45	43	49	49	50	49
20	35	33	34	35	38	36
8	20	18	22	24	25	24
5	10	8	16	17	19	17
2	5	3	8	10	11	10
d50	< 75 µm	-	58 µm	56 µm	47 µm	54 µm

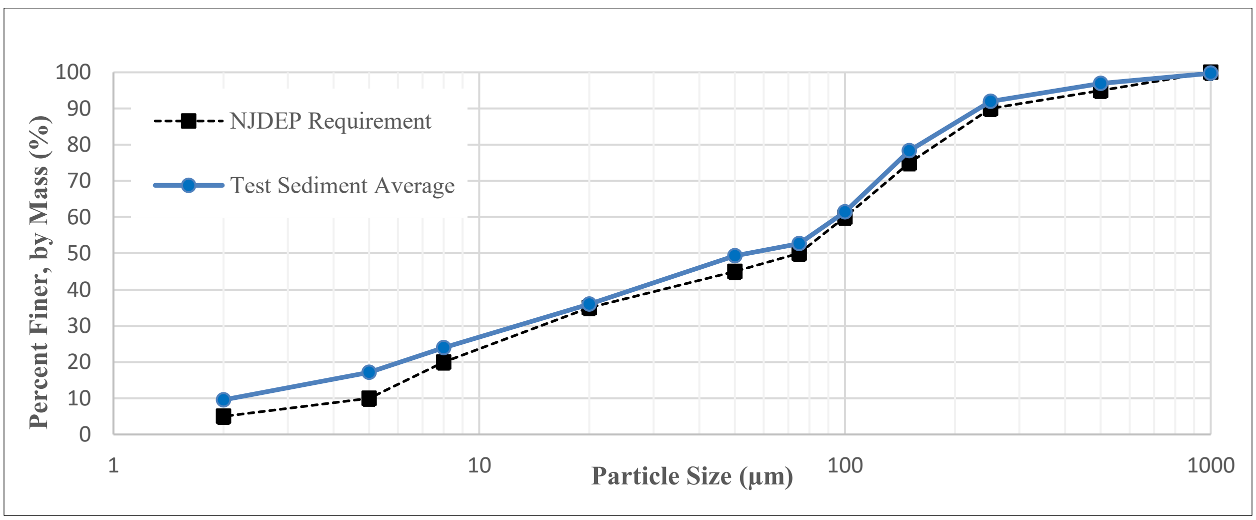

Figure 7 Test Sediment Average PSD

4.2. QA/QC RESULTS

A total of 10 removal efficiency tests and 8 additional sediment mass loading capacity tests were performed in accordance with the NJDEP Filtration Protocol. The target influent concentration and MTFR were 200 mg/L and 64.3 gpm, respectively. The measured MTFR was 65.1 gpm based on the average of the first 10 qualifying tests. All tests met the NJDEP Protocol requirements and QA/QC parameters. **Table 2,**

Table 3, and Table 4 summarize flow rate, water temperature, feed rate, background, and sample volume QA/QC results.

Table 2 Summary of Removal Efficiency Flow and Temperature QA/QC Results

FLOW RATE AND WATER TEMPERATURE					
Test ID	**QAQC PASS/FAIL**	**Target Inflow Rate (gpm)**	**Average Inflow Rate (gpm)** (± 10%)	**Inflow Rate COV** (< 0.03)	**Maximum Water Temperature (°F)** (< 80 °F)
RE-T1	PASS	64.3	64.0	0.005	75.7
RE-T2	PASS	64.3	64.2	0.005	74.6
RE-T3	PASS	64.3	66.3	0.015	74.3
RE-T4	PASS	64.3	64.8	0.013	74.8
RE-T5	PASS	64.3	64.8	0.008	75.7
RE-T6	PASS	64.3	65.4	0.014	78.9
RE-T7	PASS	64.3	65.6	0.006	77.7
RE-T8	PASS	64.3	65.2	0.005	77.5
RE-T9	PASS	64.3	65.5	0.004	77.9
RE-T10	PASS	64.3	65.4	0.006	77.3

Table 3 Summary of Sediment Mass Loading Capacity Flow and Temperature QA/QC Results

FLOW RATE AND WATER TEMPERATURE					
Test ID	**QAQC PASS/FA IL**	**Target Inflow Rate (gpm)**	**Average Inflow Rate (gpm)** (± 10%)	**Inflow Rate COV** (< 0.03)	**Maximum Water Temperature (°F)** (< 80 °F)
RE-T11	PASS	64.3	65.0	0.005	78.2
RE-T12	PASS	64.3	65.4	0.006	77.5
RE-T13	PASS	64.3	65.2	0.005	77.9
RE-T14	PASS	64.3	64.3	0.005	76.4
RE-T15	PASS	64.3	64.3	0.005	77.3
RE-T16	PASS	57.8	58.0	0.005	76.6
RE-T17	PASS	57.8	58.4	0.011	77.7
RE-T18	PASS	57.8	57.7	0.006	75.5

Table 4 Summary of Feed Rate and Background Concentration QA/QC Results

FEED RATE AND BACKGROUND CONCENTRATION									
Test ID	QAQC PASS/FAIL	Target Influent TSS (mg/L)	Average Influent TSS (mg/L) (± 10%)	Moisture Corrected Feed Rate (g/min)			Feed Rate COV (< 0.10)	Average Background TSS (<20 mg/L)	Minimum TSS/DD/BG Sample Volume (mL) (> 500 mL)
RE-T1	PASS	200	190	45.898	46.013	46.310	0.00	2.3	634
RE-T2	PASS	200	189	46.897	46.378	44.112	0.03	3.4	581
RE-T3	PASS	200	204	53.536	50.684	49.259	0.04	4.0	734
RE-T4	PASS	200	208	51.584	51.450	50.235	0.01	3.8	736
RE-T5	PASS	200	202	51.781	48.024	48.658	0.04	3.5	658
RE-T6	PASS	200	203	51.106	49.673	50.017	0.01	2.8	675
RE-T7	PASS	200	204	49.560	50.643	51.841	0.02	1.9	568
RE-T8	PASS	200	205	52.563	47.434	52.117	0.06	2.9	545
RE-T9	PASS	200	193	48.885	48.972	45.720	0.04	3.0	561
RE-T10	PASS	200	199	50.811	50.608	46.472	0.05	2.0	567
RE-T11	PASS	200	206	52.318	46.914	52.653	0.06	2.3	507
RE-T12	PASS	200	207	53.142	50.621	49.978	0.03	2.3	674
RE-T13	PASS	200	196	49.905	49.719	45.551	0.05	2.2	555
RE-T14	PASS	200	207	49.599	51.410	50.276	0.02	2.0	619
RE-T15	PASS	200	208	51.520	48.741	51.749	0.03	2.2	602
RE-T16	PASS	200	205	45.507	45.565	44.111	0.02	2.1	531
RE-T17	PASS	200	209	47.079	46.604	44.540	0.03	2.0	642
RE-T18	PASS	200	191	42.598	40.787	41.552	0.02	2.6	607

4.3 Removal Efficiency Testing

Sediment feed rate, background, effluent and drawdown samples were collected via grab sampling for the 10 removal efficiency tests. The removal efficiency sampling schedule is presented in **Table 5**.

Table 5 Removal Efficiency Sampling Schedule

Sample Time (hh:mm:ss)	Feed Rate Sample	Effluent Sample	Background Sample	Drawdown Sample
00:00:00	1			
00:10:00		1		
00:10:04			1	
00:13:00		2		
00:13:04			2	
00:16:00	2			
00:26:00		3		
00:26:04			3	
00:29:00		4		
00:29:04			4	
00:32:00		5		
00:32:04			5	
00:32:30	3			
1/3 Drawdown Volume				1
2/3 Drawdown Volume				2

The Rapterra achieved a cumulative removal efficiency of 80.1% for tests 1 through 10 at an MTFR of 65.1 gpm or 941 inches/hr. The removal efficiency results are summarized in **Table 6**. Individual effluent and background concentrations are presented for removal efficiency tests 1 through 10 in **Table 7**. All tests met the NJDEP Protocol requirements and QA/QC parameters (**Table 2, 3 and 4**).

Table 6 Summary of Removal Efficiency Results

REMOVAL EFFICIENCY PERFORMANCE SUMMARY													
Test ID	**Average Flow Rate (gpm)**	**Total Test Water Volume (L)**	**Moisture Corrected Sediment Mass Injected (kg)**	**Influent TSS based on Mass Injected (mg/L)**	**Average Adjusted Effluent TSS (mg/L)**	**Effluent Mass (kg)**	**Average Adjusted Drawdown TSS (mg/L)**	**Drawdown Volume (L)**	**Drawdown Mass (kg)**	**Cumulative Mass Captured (kg)**	**Removal Efficiency (%)**	**Cumulative Removal Efficiency (%)**
RE-T1	64.0	7,401	1.37	185	41	0.303	64	148	0.009	1.06	77.3	77.3
RE-T2	64.2	7,414	1.45	196	42	0.309	60	151	0.009	2.19	78.1	77.7
RE-T3	66.3	7,665	1.54	201	43	0.330	49	170	0.008	3.39	78.0	77.8
RE-T4	64.8	7,484	1.55	207	41	0.308	83	151	0.013	4.63	79.3	78.2
RE-T5	64.8	7,489	1.53	204	40	0.299	55	167	0.009	5.84	79.8	78.5
RE-T6	65.4	7,553	1.52	201	36	0.274	68	170	0.012	7.08	81.2	79.0
RE-T7	65.6	7,578	1.55	204	37	0.281	58	178	0.010	8.34	81.2	79.3
RE-T8	65.2	7,539	1.51	201	36	0.268	55	182	0.010	9.57	81.7	79.6
RE-T9	65.5	7,574	1.50	198	35	0.266	68	182	0.012	10.79	81.4	79.8
RE-T10	65.4	7,561	1.51	199	34	0.258	47	185	0.009	12.03	82.3	80.1

Table 7 Removal Efficiency TSS Data

Test ID	TOTAL SUSPENDED SOLIDS CONCENTRATION (mg/L)						Average Adjusted Effluent
RE-T1	Background	1.3	1.5	2.6	2.9	3.3	40.9
	Effluent	41.6	42.5	43.0	41.0	47.9	
RE-T2	Background	2.8	3.1	3.3	3.8	3.8	41.7
	Effluent	42.0	43.4	46.8	47.3	45.9	
RE-T3	Background	4.0	3.9	4.0	4.0	4.1	43.0
	Effluent	51.9	41.4	49.6	45.7	46.4	
RE-T4	Background	3.5	3.7	3.8	4.2	3.9	41.2
	Effluent	43.6	45.6	46.9	44.4	44.4	
RE-T5	Background	3.3	3.4	3.7	3.7	3.6	39.9
	Effluent	41.4	42.6	42.5	45.6	45.0	
RE-T6	Background	2.8	2.6	2.7	2.7	3.0	36.3
	Effluent	37.8	37.4	39.8	38.6	41.5	
RE-T7	Background	1.4	1.4	2.4	1.9	2.6	37.1
	Effluent	38.4	37.5	40.1	38.9	40.5	
RE-T8	Background	2.4	2.4	2.7	3.5	3.7	35.5
	Effluent	36.5	37.5	38.8	39.5	39.9	
RE-T9	Background	3.2	2.8	2.9	3.1	2.8	35.1
	Effluent	36.7	36.6	37.8	39.1	40.3	
RE-T10	Background	1.7	1.8	2.1	2.2	2.1	34.1
	Effluent	32.3	34.4	37.8	38.2	37.8	

4.4 Sediment Mass Loading Capacity Testing

The sediment mass loading capacity testing was a continuation of the removal efficiency study. As required by the NJDEP protocol, all aspects of testing remained the same, except that the MTFR was reduced to 90% of the target after the maximum water surface level (12-in) was initially exceeded. The sediment mass loading capacity sampling schedule remained the same (**Table 5**). An additional 8 sediment mass loading capacity tests were completed, resulting in a total of 18 tests.

The Rapterra achieved a cumulative removal efficiency of 81.0% for a total of 18 tests including 10 removal efficiency tests and 8 sediment mass loading capacity tests. The sediment mass loading capacity results are summarized in **Table 8**. Individual effluent and background concentrations are presented in **Table 9** for sediment mass loading capacity tests 11 through 18. All tests met the NJDEP Filtration Protocol requirements and QA/QC parameters (**Table 2, 3 and 4**). **Tables 6** and **8** illustrate the correlation between sediment mass loading captured and cumulative removal efficiency. Testing was concluded after test 18 since maximum water surface level had been reached at 90% MTFR and all applicable requirements of the protocol had been met.

Table 8 Summary of Sediment Mass Loading Capacity Results

SEDIMENT MASS LOADING CAPACITY PERFORMANCE SUMMARY												
Test ID	Average Flow Rate (gpm)	Test Water Volume (L)	Moisture Corrected Sediment Mass Injected (kg)	Influent TSS based on Mass Injected (mg/L)	Average Adjusted Effluent TSS (mg/L)	Effluent Mass (kg)	Average Adjusted Drawdown TSS (mg/L)	Drawdown Volume (L)	Drawdown Mass (kg)	Cumulative Mass Captured (kg)	Removal Efficiency (%)	Cumulative Removal Efficiency (%)
RE-T11	65.0	7,509	1.54	206	37	0.280	51	197	0.010	13.28	81.2	80.2
RE-T12	65.4	7,556	1.57	208	37	0.278	43	223	0.010	14.57	81.7	80.3
RE-T13	65.2	7,529	1.47	195	34	0.253	41	246	0.010	15.77	82.0	80.4
RE-T14	64.3	7,425	1.54	207	35	0.256	42	254	0.011	17.04	82.7	80.6
RE-T15	64.3	7,433	1.55	209	36	0.266	47	280	0.013	18.32	82.0	80.7
RE-T16	58.0	6,708	1.40	209	34	0.227	57	231	0.013	19.48	82.8	80.8
RE-T17	58.4	6,745	1.37	203	33	0.225	45	254	0.011	20.61	82.7	80.9
RE-T18	57.7	6,669	1.30	194	31	0.206	44	276	0.012	21.68	83.2	81.0

Table 9 Sediment Mass Loading Capacity TSS Data

Test ID	TOTAL SUSPENDED SOLIDS CONCENTRARTION (mg/L)						Average Adjusted Effluent
RE-T11	Background	2.2	1.9	2.3	2.5	2.7	37.3
	Effluent	33.3	37.1	41.6	42.4	43.7	
RE-T12	Background	2.0	2.3	2.6	2.3	2.4	36.8
	Effluent	37.1	37.6	40.0	39.5	41.4	
RE-T13	Background	2.1	2.3	1.9	2.2	2.4	33.6
	Effluent	35.5	35.5	35.6	35.1	37.2	
RE-T14	Background	1.9	2.1	2.1	2.0	1.9	34.5
	Effluent	35.8	36.6	35.5	37.1	37.5	
RE-T15	Background	2.0	2.0	2.3	2.3	2.5	35.8
	Effluent	35.4	34.9	38.3	39.6	42.0	
RE-T16	Background	1.8	2.3	2.1	2.2	2.1	33.9
	Effluent	35.4	35.6	36.0	35.2	37.7	
RE-T17	Background	2.0	2.0	1.9	1.8	2.3	33.3
	Effluent	34.3	33.8	35.1	35.8	37.7	
RE-T18	Background	2.7	2.9	2.4	2.4	2.7	30.8
	Effluent	32.1	32.8	33.3	34.2	34.9	

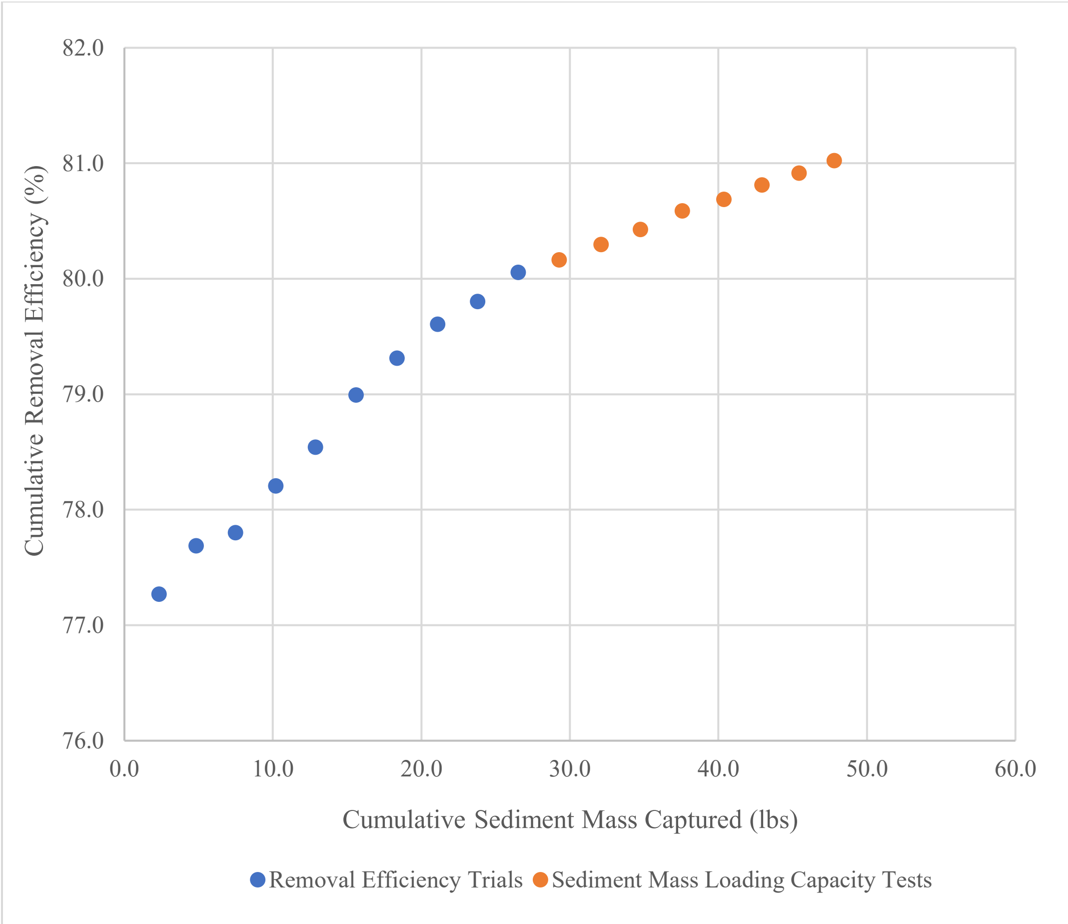

Figure 8 Cumulative Removal Efficiency vs. Cumulative Sediment Mass Captured

4.5 Water Surface Level

The effect of cumulative mass load captured on water surface level measured from the surface of the media is presented in **Table 10** and **Figure 9**. The MTFR was reduced to 90% once the maximum water surface level above the media exceeded 12 inches. Consecutive tests resumed at the reduced MTFR until maximum head above the media was again reached at which time testing was deemed complete. A maximum of 12.4 in. of water surface level was observed above the media during testing.

Table 10 Water Surface Level vs. Cumulative Mass Captured

WATER SURFACE LEVEL		
Test ID	**Maximum WSL (in)**	**Cumulative Mass Captured (kg)**
RE-T1	0.175	1.1
RE-T2	0.075	2.2
RE-T3	0.650	3.4
RE-T4	0.150	4.6
RE-T5	1.325	5.8
RE-T6	3.300	7.1
RE-T7	3.300	8.3
RE-T8	4.775	9.6
RE-T9	5.200	10.8
RE-T10	6.575	12.0
RE-T11	6.825	13.3
RE-T12	8.925	14.6
RE-T13	10.150	15.8
RE-T14	11.000	17.0
RE-T15	12.400	18.3
RE-T16	10.125	19.5
RE-T17	11.700	20.6
RE-T18	12.200	21.7

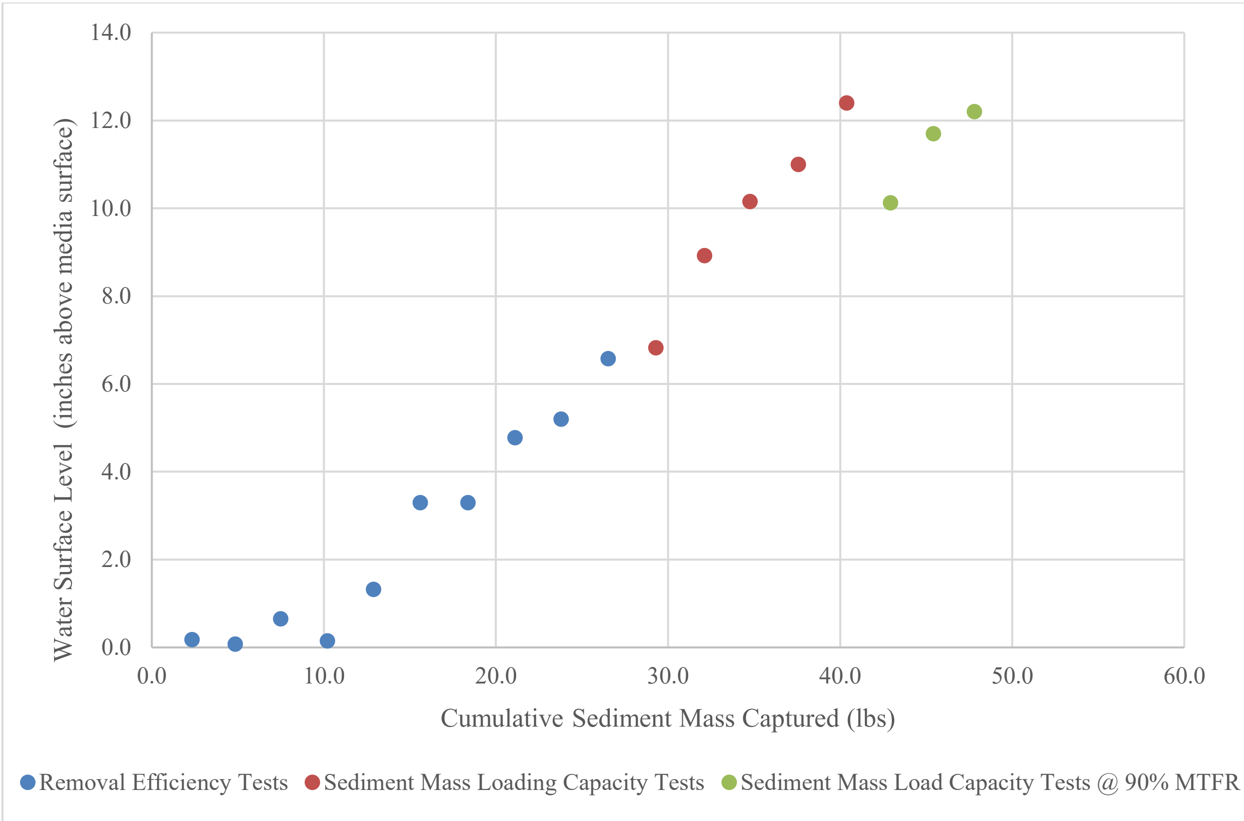

Figure 9 Cumulative Sediment Mass Captured vs. Water Surface Level

4.6 Scour Testing

The scour test flow rate averaged 129.4 gpm (199% of the MTFR) with a COV of 0.005 The maximum water temperature during the scour test was 75.7 °F. No background concentration exceeded 20 mg/L during scour testing. The average adjusted effluent TSS concentration was 1.6 mg/L. Scour test results are presented in **Table 11**.

Table 11 Summary of Scour Test Results

	Scour TSS Concentration (mg/L)														
Sample #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Effluent	9.3	5.0	4.5	4.0	3.8	3.0	2.5	2.4	2.3	1.7	2.0	2.1	1.6	0.9	1.0
Background	1.5	1.8	1.8	1.8	1.8	1.8	1.5	1.7	1.4	1.5	1.0	1.0	1.1	1.1	1.1
Adjusted Effluent	7.8	3.2	2.7	2.2	2.0	1.2	1.0	0.7	0.9	0.2	1.0	1.1	0.5	0.0	0.0
Average Adjusted Effluent Concentration (mg/L)					1.6										

5. DESIGN LIMITATIONS

Contech's engineering staff typically works with the site design engineer to ensure all potential constraints are addressed during the specification process and that the Rapterra system will function as intended. Each install will have unique limitations or requirements; the following limitations should be considered general and are not all inclusive.

Required Soil Characteristics

The functionality of the precast Rapterra system is not affected by existing soil conditions at the install location and as such the unit can be installed in all soil types. Rapterra Bioscape can be installed directly into an excavated basin, providing infiltration when native soils allow. If native soils do not allow infiltration, Rapterra Bioscape may still be used for aesthetic purposes, but no credit will be taken for any infiltration. Site stabilization should occur prior to unit activation to limit construction site sediment loading to the system.

Slope

The top slab can typically be installed at curb grade. It is generally not advisable to install the Rapterra unit with steep curb slopes. When the Rapterra is being considered with steep slopes, Contech recommends contacting their engineering staff to evaluate the design prior to specification.

Flow Rate

The hydraulic loading rate of the Rapterra is 9.78 gpm/ft^2 of effective filtration treatment area, equivalent to an infiltration rate of 941 inches/hour.

Maintenance Requirements

The Rapterra system must be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants depends heavily on specific site activities within the contributing drainage area. See Section 6 for a more detailed discussion of maintenance and inspection requirements.

Driving Head

The bypass mechanism (weir, standpipe, or other) for a given Rapterra system is set at 12 inches above the media surface. The maximum driving head reached during this testing was 12.4 inches.

Installation Limitations

Prior to installation, Contech provides contractors detailed installation instructions and is also available to consult onsite during installation. The Rapterra system is delivered fully assembled in most cases, however some level of onsite supervision may be required for larger systems. Pick weights for Rapterra are provided prior to delivery so that the contractor can secure proper equipment for lifting Rapterra units into place. The Rapterra system cannot be activated until site construction is complete.

Configurations

Rapterra can accept flow through a pipe, curb inlet or grated inlet. Rapterra units can be installed offline or utilize a peak diversion configuration to convey flows around the effective treatment area without the need for an external bypass structure. Rapterra can also be installed online with internal bypass. The Rapterra system is available in a variety of precast configurations and can be configured with or without a top slab. Rapterra can also be configured as a Rapterra Bioscape, an open top configuration which can be installed directly into an excavated basin for better aesthetics and effective infiltration into the soil when native soils allow. Both precast and Bioscape configurations are identical in form and function with the exception of the use of a vault or manhole in precast systems. Rapterra can be configured in many ways to enhance site aesthetics, integrate with other LID practices, or increase runoff reduction through infiltration below or downstream of the system.

Load Limitations

Rapterra systems are designed to support the loading necessary for the particular application and configuration of the system. This can vary depending on whether the system is partially below a traffic area where it would be designed for HS-20 loading or if the unit is in a pedestrian area where it would be designed to support smaller vehicle loads with an HS-20 surcharge. Systems can be structurally designed to meet other site-specific requirements as well. Contech provides technical design support on all projects and can help ensure the system is designed for the appropriate structural load requirements.

Pretreatment Requirements

There are no pre-treatment requirements for the Rapterra system.

Limitations on Tailwater

It is typically recommended that the outlet pipe of the Rapterra system be at an elevation greater than the tailwater created by the receiving body or structure to not allow for water to backup into the system. However, in cases with tailwater above the invert of the outlet pipe, site specific design conditions can be addressed as part of the design process.

Depth to Seasonal High-Water Table

Rapterra unit performance is not typically impacted by high groundwater. Depth of the seasonal high water table is not an issue with precast Rapterra as it includes a precast concrete vault or manhole with a solid floor and the weight of the Rapterra (fully loaded with media and under-drain stone) will weigh more than the water it will displace. If high groundwater is expected, Contech's engineering staff can evaluate whether anti-buoyancy measures are required during the design process. For Rapterra Bioscape applications without a precast vault or manhole, site-specific considerations can be addressed as part of the design process which could include utilizing a liner or vault to prevent groundwater intrusion.

6. MAINTENANCE PLAN

With proper routine maintenance, the biofiltration media within the Rapterra system should last as long as traditional non-proprietary bioretention media. This includes removing debris, replacing pretreatment mulch, and pruning the vegetation. More information is provided in the Rapterra Systems Owner's Manual available at: https://www.conteches.com/media/nj3lv4pd/rapterra-vault-om.pdf

Simple maintenance of the Rapterra is required to ensure it functions as intended and continues effective pollutant removal from stormwater runoff before discharge into downstream waters. Routine maintenance will also extend the longevity of the living biofilter system. The unit will recycle and accumulate pollutants within the biomass but is also subjected to other materials entering the inlet. This may include trash, silt and leaves etc. which will be contained above the mulch layer. Too much silt may inhibit the Rapterra system's flow rate, which is the reason for site stabilization before activation. Regular replacement of the mulch layer also removes accumulated sediment, trash, and debris and minimizes the potential for sediment to migrate and accumulate within the biofiltration media layer.

Frequency

Routine inspection or maintenance visits should be scheduled seasonally; the spring visit allows for cleaning up after winter loads including salts and sands while the fall visit helps the system by removing excessive leaf litter after the growing season. Site conditions, climate and land use can affect maintenance frequency, e.g. some fast food restaurants and other busy commercial properties can require more frequent trash removal. Contributing drainage areas with heavy sediment loading may require additional maintenance visits. Typically, 1-2 routine maintenance visits are required annually.

Maintenance Visit Summary

Each routine maintenance visit consists of the following simple tasks (detailed instructions are provided in the link above).

1. Inspection of Rapterra, cleanout pipe and surrounding area

2. Setting aside of tree grate, erosion control stones, and scour protection netting

3. Removal of accumulated debris, trash, and mulch layer

4. Mulch replacement

5. Plant health evaluation and pruning or replacement as necessary

6. Replace scour protection netting, erosion control stones and tree grate

7. Clean area around Rapterra

8. Complete paperwork

Maintenance Tools, Safety Equipment and Supplies

Ideal tools include a camera, bucket, shovel, broom, pruners, hoe/rake, and tape measure. Appropriate Personal Protective Equipment (PPE) should be used in accordance with local or company procedures. This may include impervious gloves where the type of trash is unknown, high-visibility clothing and barricades when working in close proximity to traffic and also safety hats and footwear. A T-Bar or crowbar should be used for moving the tree grates (up to 170 lbs ea.). Most visits require minor trash removal and a full replacement of mulch. Replacement mulch should be a double shredded, hardwood variety. Some visits may require additional Rapterra engineered soil media which is available from Contech.

7. Statements

The following signed statements from the manufacturer (Contech Engineered Solutions, LLC), third-party observer (Don Rissmeyer) and NJCAT are required to complete the verification process.

CONTECH ENGINEERED SOLUTIONS

Contech Engineered Solutions LLC
9025 Centre Pointe Drive, Suite 400
West Chester, OH 45069
Phone: (513) 645-7000
Fax: (513) 645-7993
www.ContechES.com

11/7/2025

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

RE: 2025 Verification of the Rapterra™ System (Rapterra)

Dr. Richard Magee,

This correspondence is being sent to you in accordance with the "*Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology*" dated January 25, 2013. Specifically, the process document requires that manufacturers submit a signed statement confirming that all of the procedures and requirements identified in the aforementioned process document and the *"New Jersey Department of Environmental Protection (NJDEP) Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device"* January 14, 2022 (updated April 25, 2023). have been met. We believe that the testing executed in Contech's laboratory in Ashland, VA on the Rapterra™ System during the fall of 2025 under the direct supervision of Don Rissmeyer, PE, CFM from A. Morton Thomas and Associates Inc. was conducted in full compliance with all applicable protocol and process criteria. Additionally, we believe that all the required documentation of the testing and resulting performance calculations has been provided within the submittal accompanying this correspondence.

Please do not hesitate to contact me with any additional questions related to this matter.

Respectfully,

Derek M. Berg
Director - Stormwater Regulatory Management - East
Contech Engineered Solutions LLC
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T: 207.885.6174 F: 207.885.9825
DBerg@conteches.com
www.ContechES.com

March 10, 2025

Ms. Mindy Hills, CPSWQ
Project Manager – R&D
Contech Engineered Solutions LLC
10408 Lakeridge Pkwy, Suite 600
Ashland, Virginia 23005
mhills@conteches.com

Re: Potential Conflicts of Interest Statement for Third Party Observer
AMT Project 19-0957.001

To Whom it May Concern,

Per the criteria described in the *"Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology"*, dated August 4, 2021, this letter discloses that we have no conflicts of interest in serving as the designated third-party observer for Contech Engineered Solutions, LLC on this manufactured treatment device (MTD) testing. Reasons are noted as follows:

- Designated staff persons at AMT have no previous or current personal, professional, or financial relationships with Contech Engineered Solutions, LLC, except for prior consulting agreements for a similar role as a third party observer for the Filterra Bioretention System, and other consulting engineering services that have been completed.

- AMT has provided professional services as an engineering consultant or independent third party to other manufacturers of stormwater products over the years, with no history of conflicts of interest or ethical problems in our services provided. Previous and current contracts have included services to: Filterra Bioretention Systems, SWM PAVE through Eagle Bay USA, Midwest Building & Block Company, and ACF Environmental. Our limited work for each client is protected through non-disclosure agreements and is independent of the planned third-party observer services for Contech Engineered Solutions, LLC.

- We do not have any existing or prior ownership stake in the manufacturer, we have not received any commissions for selling or helping to sell MTD's for any clients, we do not have licensing agreements with any manufacturer or have any similar types of arrangements.

Additional information about the AMT professional engineer who will provide third party observation for this project is summarized in the enclosed one-page resume that generally describes similar consulting services to the extent allowed by our non-disclosure agreements. AMT requests that NJCAT confirm that if no conflict of interest exists as a result of this disclosure statement and to advise if any additional information is necessary for your decision, prior to AMT participating in the planned testing as a third-party observer.

Thank you for your consideration.

Sincerely,
A. Morton Thomas and Associates, Inc.

Donald J. Rissmeyer

Don Rissmeyer, PE, CFM (Virginia Professional Engineer #026104)
Senior Associate

October 24, 2025

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

Re: Third-Party Observation Certification for NJCAT Testing of the Rapterra Bioretention System
AMT Project 19-0957.001

To Whom it May Concern,

Based on my direct observations for all the equipment calibration and the performance testing conducted by Contech Engineering Solutions LLC, this letter certifies that the requirements of the approved Quality Assurance Project Plan for NJCAT testing of the Rapterra Bioretention System and the "New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device" have been fully met or exceeded. My signature as third-party observer in this letter is to also establish that the verification report has been reviewed and describes the testing observed.

Also, as described in the AMT letter dated March 10, 2025, as part of the NJCAT approved Quality Assurance Project Plan, AMT has no conflicts of interest that would bias our independent third-party observation of this testing for the Rapterra Bioretention System.

Please let me know if I can provide any additional information.

Sincerely,
A. Morton Thomas and Associates, Inc.

Don Rissmeyer

Don Rissmeyer, PE, CFM
Virginia Professional Engineer No. 026104
Senior Associate

A. MORTON THOMAS AND ASSOCIATES, INC.
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Phone: (804) 276-6231 • www.amtengineering.com

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

December 3, 2025

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

Dear Mr. Mahon,

Based on my review, evaluation and assessment of the testing conducted on a commercially available Contech Rapterra™ System during the fall of 2025 the test protocol requirements contained in the "*New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device*" (NJDEP Filtration Protocol dated January 14, 2022 (updated April 25, 2023) were met or exceeded**.** All removal efficiency, sediment mass loading capacity, and scour testing for this project were carried out at Contech's Ashland, Virginia laboratory. Independent third-party observation for all testing was provided by NJCAT approved observer Don Rissmeyer, P.E. from A. Morton Thomas and Associates, Inc. in Richmond, VA. Specifically:

Test Sediment Feed

Test sediment used for removal efficiency and sediment mass loading capacity testing was a silica blended mixture compliant with the NJDEP PSD requirements and provided by AGSCO corporation. Test sediment PSD samples were collected under third-party observation following ASTM E3317(2022) Standard Specification for Silica-Based Sediment for the Evaluation of Stormwater Treatment Devices. PSD sediment samples were sent to GeoTesting Express in Acton, MA, an independent, accredited analytical laboratory, for processing according to ASTM D6913(2017) Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis, ASTM D7928(2021) Standard Test Method for Particle Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis, and ASTM D2216 (2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass. Sediment containers were affixed with quality seals under third-party observation and remained sealed until opened and utilized for testing under 3^{rd} party observation. The measured and interpolated result indicates compliance with the requirements of the NJDEP Protocol. The test sediment distribution was finer than the specification, with a d50 particle size of 54 µm. The moisture content was 0.1%.

Removal Efficiency (RE) Testing

A total of 10 removal efficiency tests and 8 additional sediment mass loading capacity tests were performed in accordance with the NJDEP Filtration Protocol. The target influent concentration and MTFR were 200 mg/L and 64.3 gpm, respectively. The measured MTFR was 65.1 gpm based on the average of the first 10 qualifying tests. All tests met the NJDEP Protocol requirements and QA/QC parameters. The Rapterra achieved a cumulative removal efficiency of 80.1% for tests 1 through 10.

Sediment Mass Loading Capacity

The sediment mass loading capacity testing was a continuation of the removal efficiency study. An additional 8 sediment mass loading capacity tests were completed, resulting in a total of 18 tests. As required by the NJDEP protocol, all aspects of testing remained the same, except that the MTFR was reduced to 90% of the target after the maximum water surface level (12-in) was initially exceeded. The sediment mass loading capacity sampling schedule remained the same. The Rapterra achieved a cumulative removal efficiency of 81.0% for the 18 tests.

The total influent mass loaded through Run 18 was 59.0 lbs and the total mass captured by the Rapterra System was 47.8. This is equivalent to a sediment mass loading capacity of 7.2 lbs/ft^2 of EFTA.

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

Scour Testing

The scour test flow rate averaged 129.4 gpm (199% of the MTFR) with a COV of 0.005 The maximum water temperature during the scour test was 75.7 °F. No background concentration exceeded 20 mg/L during scour testing. The average adjusted effluent TSS concentration was 1.6 mg/L.

Sincerely,

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

VERIFICATION APPENDIX

Introduction

- Contech Engineered Solutions is the manufacturer of the Rapterra™ System MTD.

  Contech Engineered Solutions
  9100 Centre Point Drive, Suite 400
  West Chester, OH 45069
  Phone: (513) 645-7000
  Fax: (513) 645-7993
  www.ContechES.com

- MTD: Contech Rapterra™ System. Verified standard Rapterra models are shown in **Table A-1**

- TSS removal rate: 80%.

- The Rapterra System MTD qualifies for online installation for flows up to 199% of the MTFR.

  Detailed Specification

- NJDEP sizing table for the Rapterra System is attached (**Table A-1**).

- New Jersey requires that the peak flow rate of the NJWQDS event of 1.25 inch in 2 hours shall be used to determine the appropriate size for the MTD. The Rapterra System has a maximum treatment flowrate (MTFR) of 941 inches per hour, which corresponds to a surface loading rate of 9.78 gpm/ft^2 of effective filtration treatment area.

- Prior to installation, Contech provides contractors detailed installation and assembly instructions and is also available to consult onsite during installation.

- The bypass mechanism (weir, standpipe, or other) for a given Rapterra system is set at 12 inches above the media surface. The maximum driving head observed during testing was 12.4 inches above the media surface.

- See Rapterra System Owner's Manual for detailed maintenance information at: https://www.conteches.com/media/nj3lv4pd/rapterra-vault-om.pdf

- The Rapterra System cannot be used in series with another MTD or a media filter (such as a sand filter) to achieve an enhanced removal rate for total suspended solids (TSS) removal under N.J.A.C. 7:8-5.5.

Table A-1 Rapterra System MTFRs and Maximum Allowable Drainage Area

	Available Rapterra® Media Bay Sizes	Effective Filtration Treatment Area (ft^2)	Treatment Flow Rate (cfs)	Ratio MTFR to EFTA (gpm/ft^2)	Maximum Allowable Drainage Area (ac)
Offline Configuration Rapterra and Rapterra Bioscape Vaults	36" Manhole	6.85	0.149	9.78	0.082
	48" Manhole	12.35	0.269	9.78	0.148
	4x4	15.79	0.344	9.78	0.189
	60" Manhole	19.42	0.423	9.78	0.233
	6x4 or 4x6	23.79	0.518	9.78	0.285
	72" Manhole	28.06	0.611	9.78	0.337
	8x4 or 4x8	31.79	0.693	9.78	0.381
	4.5x7.83 or 7.83x4.5	35.02	0.763	9.78	0.420
	6x6	35.79	0.780	9.78	0.429
	8x6 or 6x8	47.79	1.041	9.78	0.573
	10x6 or 6x10	59.62	1.299	9.78	0.715
	12x6 or 6x12	71.62	1.561	9.78	0.859
	13x7 or 7x13	90.62	1.975	9.78	1.087
	14x8	111.23	2.424	9.78	1.335
	16x8	127.33	2.775	9.78	1.528
	18x8	143.23	3.121	9.78	1.719
	20x8	159.23	3.470	9.78	1.911
	22x8	175.23	3.818	9.78	2.103
Inline Configuration Rapterra and Rapterra Bioscape Vaults	36" Manhole	6.85	0.149	9.78	0.082
	48" Manhole	12.35	0.269	9.78	0.148
	4x4	15.79	0.344	9.78	0.189
	60" Manhole	19.42	0.423	9.78	0.233
	6x4 or 4x6	23.79	0.518	9.78	0.285
	72" Manhole	28.06	0.611	9.78	0.337
	8x4 or 4x8	31.40	0.684	9.78	0.377
	4.5x7.83 or 7.83x4.5	34.64	0.755	9.78	0.416
	6x6	35.40	0.771	9.78	0.425
	8x6 or 6x8	47.40	1.033	9.78	0.569
	10x6 or 6x10	59.01	1.286	9.78	0.708
	12x6 or 6x12	71.01	1.547	9.78	0.852
	13x7 or 7x13	90.01	1.961	9.78	1.080
	14x8	110.38	2.405	9.78	1.325
	16x8	126.38	2.754	9.78	1.517

Peak Diversion Rapterra Vaults	4x4 (6x4 Vault)	15.79	0.344	9.78	0.189
	4x6 (8x4 Vault)	23.79	0.518	9.78	0.285
	6x4 (6x6 Vault)	23.79	0.518	9.78	0.285
	4.5x5.83 (7.83 x 4.5 Vault)	26.02	0.567	9.78	0.312
	6x6 (8x6 Vault)	35.79	0.780	9.78	0.429
	6x8 (10x6 Vault)	47.79	1.041	9.78	0.573
	6x10 (12x6 Vault)	59.62	1.299	9.78	0.715
	7x10 (13x7 Vault)	69.62	1.517	9.78	0.835
	8x10.5 (14x8 Vault)	83.62	1.822	9.78	1.003
	8x12.5 (16x8 Vault)	99.62	2.171	9.78	1.195
	8x14 (18x8 Vault)	111.23	2.424	9.78	1.335
	8x16 (20x8 Vault)	127.23	2.772	9.78	1.527
	8x18 (22x8 Vault)	143.23	3.121	9.78	1.719
	Custom and/or Rapterra Bioscape	Media Area in ft^2 (MA)	0.02179 * MA	9.78	0.012 * MA