NJCAT TECHNOLOGY VERIFICATION

Aqua-Ponic^{TM} Stormwater Biofiltration System

(Addendum with revised sizing charts pgs. 35-37)

AquaShield^{TM}, Inc.

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TABLE OF CONTENTS

Page

List of Figures

Page

List of Tables

Page

1. Description of Technology

The Aqua-Ponic™ Stormwater Biofiltration System (Aqua-Ponic™) is a post-construction, custom engineered, modular stormwater quality treatment structure. An illustration of the AP-2 test unit is provided below in **Figure 1**.

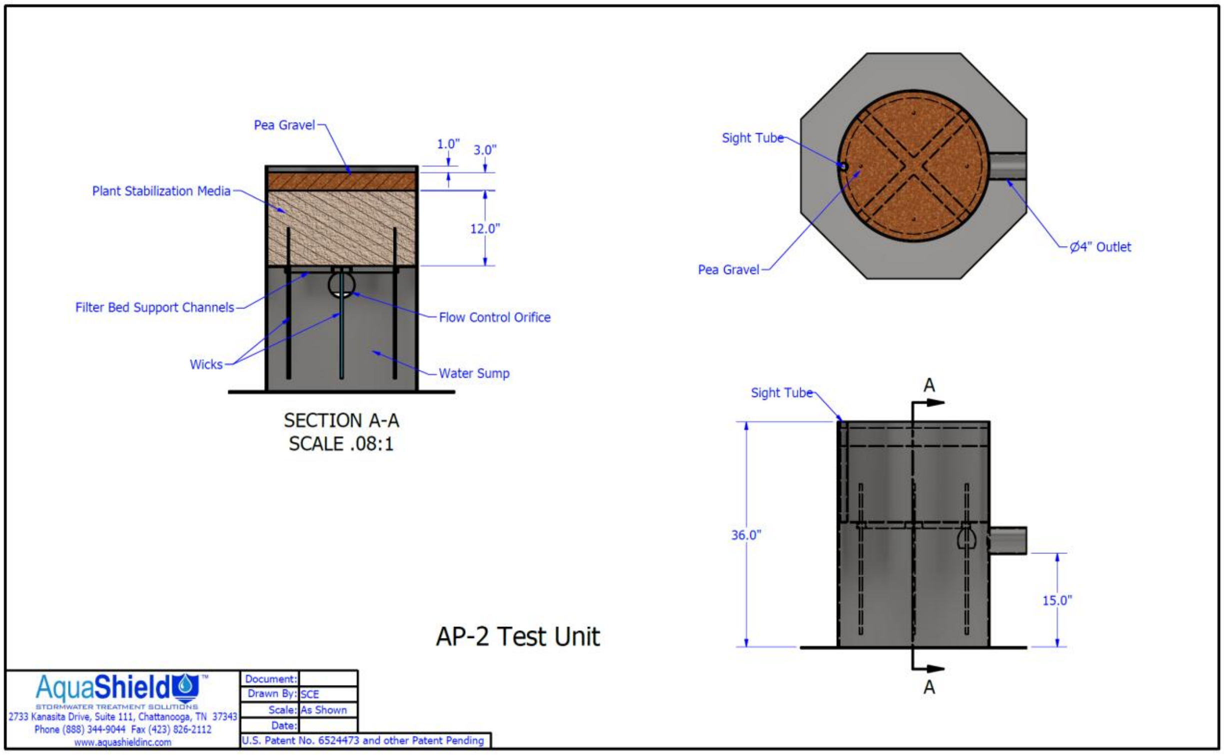

Figure 1 Aqua-Ponic^{TM} Test Model AP-2

Aqua-Ponic™ technology is unique when compared to other currently available manufactured biofiltration devices. While filtration is common to all of these systems, the Aqua-Ponic™ combines filtration with the principles of hydroponic horticulture all within a single modular structure. Hydroponics is a method of hydroculture for growing plants without soil by instead using mineral nutrient solutions in a water solvent. Terrestrial plants may be grown with only their roots exposed to the nutrient liquid, or the roots may be physically supported by a plant stabilization medium. Nutrients are supplied via the stormwater runoff itself and wicked up from the underlying water sump which provides a sustainable biofiltration system that is compatible with Green Infrastructure and Low Impact Development practices. Aqua-Ponic™ systems include media that not only filters pollutants from stormwater runoff but also provides plant stabilization. Operation begins when stormwater runoff enters the top of an Aqua-Ponic™ via sheetflow.

The top of the Aqua-Ponic™ is comprised of a pea gravel layer having a minimum thickness of three inches which serves to disperse runoff across the treatment area of the device while protecting and securing the underlying plant stabilization filter media having a minimum thickness of 12 inches. No cartridges or containment boundaries are used for both media layers. Pollutants of concern are captured by the media and plant root-ball network(s) as runoff percolates downward under gravity flow conditions. While the plant stabilization filter bed removes pollutants from stormwater runoff, the nutrients contained in runoff serve as an asset for plant sustainability via nutrient uptake.

Filtered water continues downward through a perforated metal sheet that supports the overlying plant stabilization filter bed. After the water passes through the metal sheet it enters an underlying water sump which functions as a reservoir for the vegetation during quiescent periods. Treated water in excess of the sump storage volume exits the system via the outlet pipe opening just below the base of the plant stabilization filter media (**Figure 1**). The test unit utilized a one-inch diameter sight tube positioned at the edge of the structure and opposite the effluent pipe opening which allowed for direct observation of the water level within the two media layers during test runs. Commercial models include a two-inch diameter capped inspection tube to allow for observation of water levels in the sump as well as to facilitate the addition of water to the sump if necessary.

A flow control orifice positioned within the unit at the opening to the outlet pipe serves to effectively distribute influent runoff across the effective filtration treatment area of a system.

A series of wicking ropes are suspended from the base of the plant stabilization filter bed and extend downward to near the base of the sump. These wicking ropes provide moisture and nutrients to the plants root systems during quiescent periods to provide a sustainable biofiltration system.

2. Laboratory Testing

Laboratory testing has been conducted to verify that the Aqua-Ponic™ is eligible for certification by the New Jersey Department of Environmental Protection (NJDEP) as an 80% Total Suspended Solids (TSS) removal device.

The Aqua-Ponic™ was tested in accordance with the "*New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device*" (NJDEP 2013). Testing was conducted in Chattanooga, Tennessee at the hydraulics laboratory of AquaShield™, Inc. under the direct supervision of Southern Environmental Technologies, Inc. of Sewanee, Tennessee.

The independent observer, Mr. Nicholas Tovar, was approved by NJCAT as cited in the Quality Assurance Project Plan (QAPP).

2.1 Test Unit

The full scale, commercially available Aqua-Ponic™ Model AP-2 test unit is a single component structure constructed of polymer coated steel. The AP-2 has an inner diameter of two feet and a corresponding effective filtration treatment area of 3.14 ft^2.

Key dimensions of the test unit were measured by the independent observer prior to the beginning of the testing program to ensure that the test unit and test loop setup dimensions matched those shown in **Figures 1** and **2**.

The AP-2 test loop is illustrated below in **Figure 2** as a recirculating water supply system.

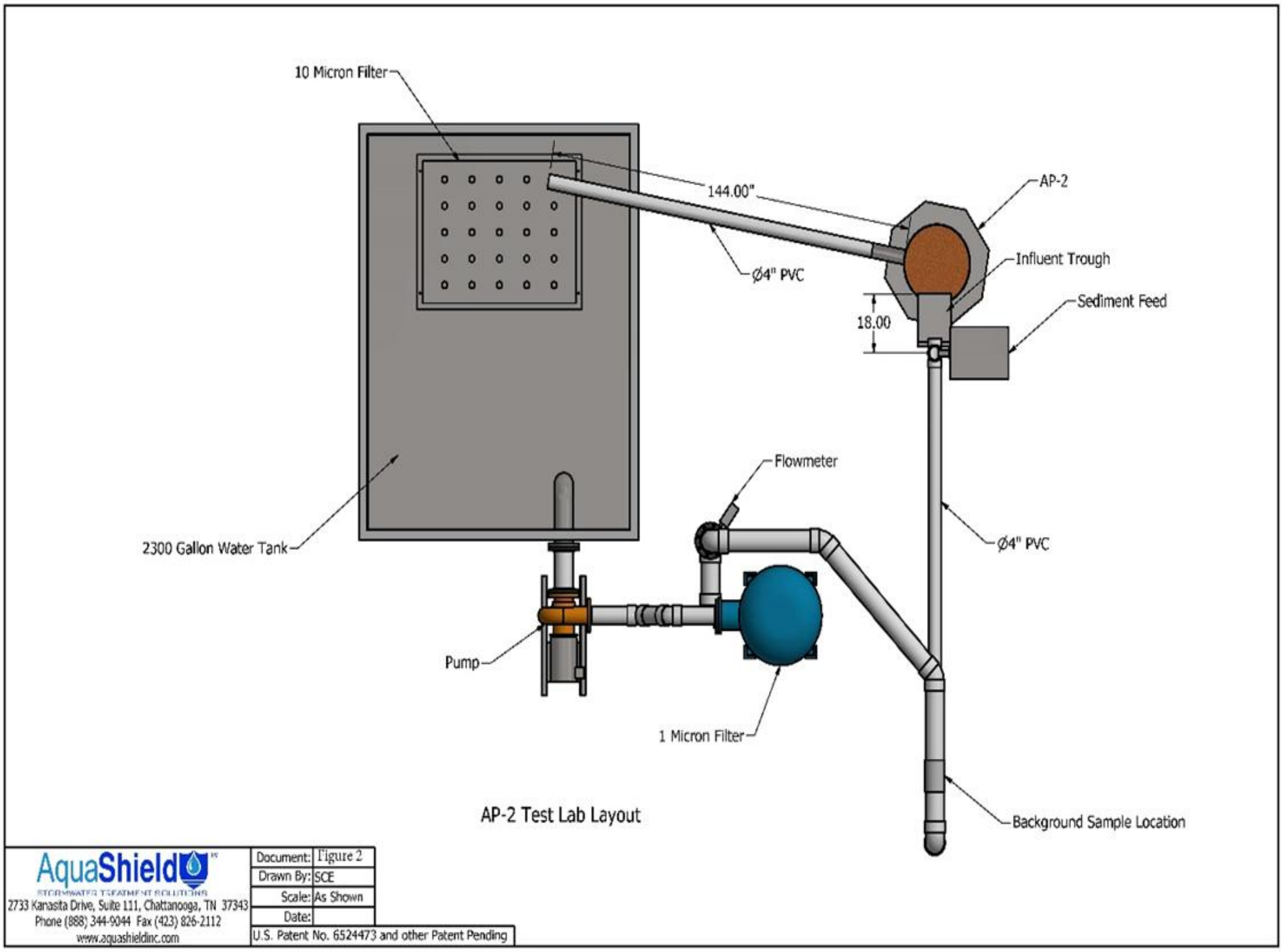

Figure 2 Illustration of AP-2 Test Loop Setup

2.2 Test Setup

A 10 hp Berkeley Model B5ZPBH centrifugal pump draws water from a 2,300-gallon water supply tank via a 6-inch diameter Schedule 40 PVC pipe. A 1-micron filter assembly manufactured by Filtra Systems, Model # FSSB-080808CSVR2, Option B, provides background sediment filtration at a position downstream of the 10 hp pump and upstream of the background sample port location. Water from the pump enters the mid-section of the background filtration assembly and exits near the base. Effluent piping from the background filter assembly is then routed vertically upward through an inline Badger M-2000 flow meter that was pre-calibrated and certified by the manufacturer. The flow meter calibration certificate was included in the QAPP. The accuracy of the flow measurement is reported by the manufacturer as ±2.0%. The test flow rate is averaged according to the recorded flow rate. The maximum allowable coefficient of variance (COV) for flow documentation is 0.03. Flow data is recorded every 60 seconds throughout the duration of the test using a Lascar EL-USB-4 Data Logger.

Water passing through the flow meter is then routed onward to an elevated platform where the drop-down tee for the background sample port is positioned. The 6-inch diameter influent pipe is reduced to four inches in diameter downstream of the background sample port and upstream of the sediment injection location. The 4-inch diameter piping run is set at approximately 1.0% downward slope toward the test unit and the influent flow trough. This 4-inch diameter influent pipe includes an open sediment feed port (tee) for injecting sediment through the crown of the pipe at a distance of 18 inches (1.5 feet) upstream of where water free falls into the test unit. Test sediment injection uses an IPM Systems Auger® volumetric screw feeder Model VF-2 with an attached vibrator mounted on the hopper. The sediment feeder assembly is positioned adjacent to and above the 4-inch diameter influent pipe to accommodate sediment feed sampling and injection. Both the background sample location and the auger feeder are situated on the raised platform to allow for the influent flow to enter from the top of the AP-2.

Immediately downstream and juxtaposed to the test sediment injection point is a 12-inch wide trough that extends 18 inches (1.5 feet) straight to the AP-2 where influent water free falls onto the pea gravel layer. The trough simulates sheetflow onto and across the top of the Aqua-Ponic™ test unit. The effluent piping run extends from the stubout pipe of the test unit to the 2,300-gallon water supply tank. A Fernco™ coupler connects the AP-2 to the effluent conveyance pipe. A downward slope of approximately 1.0% is set for the 4-inch diameter PVC effluent piping run leading to the effluent sample location at the edge of the 2,300-gallon water supply tank. Water free falls from the effluent pipe into the water tank where effluent samples are collected from the discharge by the grab sampling method as cited in Section 5G of the protocol (sweeping motion).

Water temperature measurements are obtained within the 2,300-water supply tank using a calibrated Lascar EL-USB-TC temperature data logger with a Lascar K-type thermocouple probe. The temperature reading is documented to assure an acceptable testing temperature not to exceed 80° F.

2.3 Test Sediment

All test sediment used for both the removal efficiency testing and the sediment mass loading capacity testing was blended in December 2017 by Good Harbour Laboratories (GHL) of Mississauga, Ontario using high purity silica obtained from various suppliers in North America.

All blending activities took place at the GHL facility. Three random sediment samples were collected in December 2017 by GHL from sediment blends and delivered at that time to Maxxam Analytics in Mississauga for particle size distribution (PSD) analysis using ASTM D 422-63. The PSD of each of the three samples were averaged and reported as the overall PSD (**Table 1 and Figure 3**). The test sediment blend has an average median (d_{50}) particle size of 66 microns (µm) which meets the protocol d_{50} specification of ≤ 75 µm.

This test sediment was placed in shipping containers by GHL, security sealed by GHL and transported in January 2018 to the AquaShield™ laboratory test facility in Chattanooga, Tennessee. All container seals were intact upon receipt in January 2018 and no material has been added to the test sediment while in the possession of AquaShield™. Note that this test sediment has been used for prior AquaShield™ verifications of the Aqua-Filter™ Model AF-2.1, the XCelerator™ Model XC-2 and now the Aqua-Ponic™ Model AP-2. The test sediment was opened and security sealed at the initiation and conclusion of each of those testing programs under the observation of the independent observer. The same observer for this AP-2 testing program had sealed this test sediment in association with the most recent testing program associated with the XCelerator™ XC-2. Security seals were also used at the conclusion of each day of observation and at the conclusion of the AP-2 testing program.

2.4 Removal Efficiency Testing

Removal efficiency testing was performed in accordance with Section 5 of the NJDEP Laboratory Protocol for Filtration MTDs. The Aqua-Ponic™ was tested at a maximum treatment flow rate (MTFR) of 21.9 gpm (0.05 cfs, or 7.0 gpm/ft^2 of filtration area). The test sediment mass was fed into the flow stream at a known rate using a screw auger. Sediment was introduced at a rate within 10% of the targeted concentration of 200 mg/L influent concentration throughout the duration of the removal efficiency testing program.

Test runs 1 through 10 apply to TSS removal efficiency testing while test runs 11 through 17 are associated with the sediment mass loading capacity testing. **Table 2** depicts the sediment removal efficiency sampling frequency for sediment feed, background and effluent samples for runs 1 through 10. **Table 2** also includes sampling frequency for runs 11 through 17 at the MTFR for the sediment mass loading capacity testing. See Section 2.5 for an explanation of test runs with respect to the MTFR.

Three sediment feed samples were collected per run including one sample at the start of dosing, one in the middle of the run and one toward the end of dosing to allow at least three residence times to pass prior to when drawdown began. Sediment feed rate samples were collected from the injection point using clean, laboratory-supplied 1-liter plastic bottles. Sediment feed samples were collected over a 60 second period and timed to the nearest second. A factory-calibrated stopwatch was used for timing all sediment feed sampling intervals. The QAPP includes the calibration document for the stopwatch. Sediment feed samples were weighed by the observer to the nearest milligram using a calibrated Tree® Model HRB-413 electronic balance. This data was used to confirm that the sediment feed rate COV stayed below the limit of 0.10 as required by the protocol.

Table 1 Particle Size Distribution of Test Sediment

Particle Size (Microns)	Test Sediment Particle Size (% Less Than)[1]				NJDEP Specification[2]	QA/QC
	Sample 1	Sample 2	Sample 3	Average		
1,000	100	100	100	100	100	PASS
500	94	94	94	94	95	PASS
250	89	89	89	89	90	PASS
150	82	81	81	81	75	PASS
100	62	61	61	61	60	PASS
75	54	52	52	53	50	PASS
50	46	45	44	45	45	PASS
20	38	37	36	37	35	PASS
8	20	19	20	20	20	PASS
5	14	13	12	13	10	PASS
2	6	8	5	6	5	PASS
d_{50}	62 µm	67 µm	68 µm	66 µm	≤ 75 µm	PASS

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

[2]A measured value may be lower than a target minimum % less than value by up to two percentage points provided that the measured d_{50} value does not exceed 75 microns.

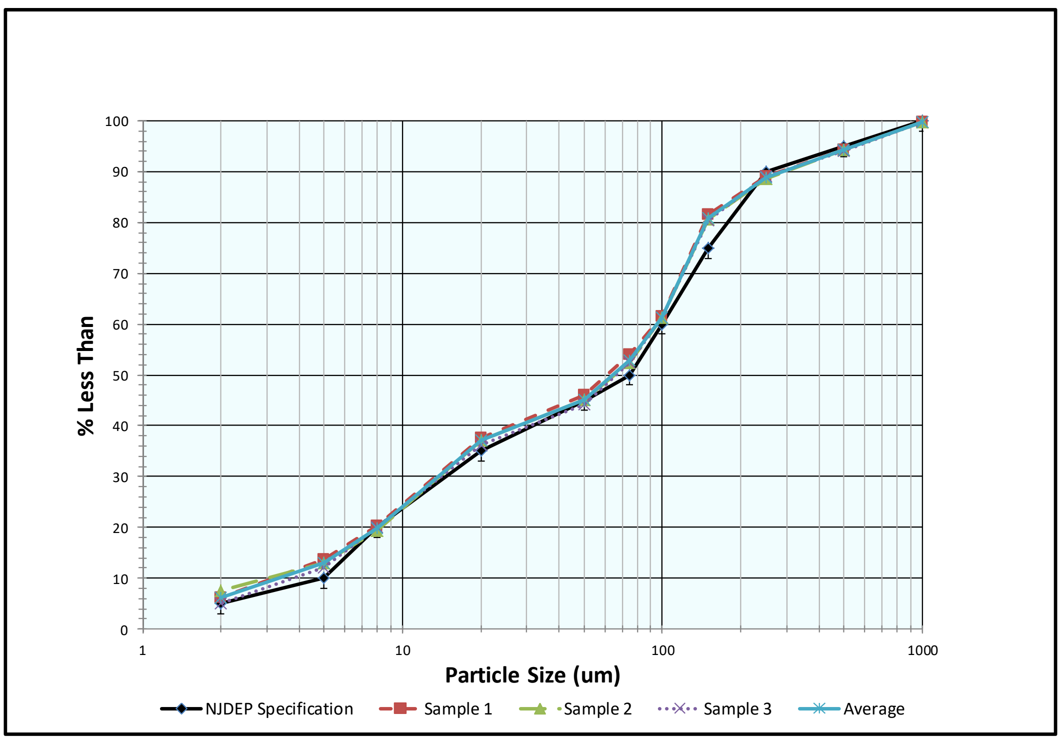

Figure 3 Comparison of Test Sediment PSD to NJDEP PSD Specification

Table 2 Sampling Frequency for Removal Efficiency Runs 1 through 10 and Sediment Mass Loading Capacity Runs 11 through 17

Scheduled time (min:sec)	Sample			
	Feed Rate*	Effluent TSS	Background TSS	Drawdown TSS
0:00	Start sediment feed			
1:00	1			
12:00		1	1	
24:00		2		
25:00	2			
36:00		3	2	
48:00		4		
49:00	3			
60:00		5	3	
60:00	End flow			
64:00				1
68:00				2

* Feed rate = 60 seconds

Before each test run a quantity of test sediment was taken from the test sediment container and weighed to the nearest hundredth of a pound. This sediment mass represents the influent test sediment added to the sediment feeder. After each test run the sediment feeder was emptied and the remaining test sediment was weighed to the nearest hundredth of a pound. This sediment weight is subtracted from the initial sediment weight along with the mass of the sediment feed rate samples to determine the total sediment mass added during that test run. The average influent TSS concentration used for calculating removal efficiency was calculated using **Equation 1** below.

$$Average\ Influent\ Concentration\ \left(\frac{mg}{L}\right) = \frac{Total\ mass\ added}{\begin{array}{c}Total\ volume\ of\ water\ flowing\\ through\ the\ MTD\ during\ addition\\ of\ test\ sediment\end{array}}$$

Equation 1 Calculation for Average Influent Sediment Concentration

Background samples were collected at the valved sample port using clean, laboratory-supplied 1-liter plastic bottles. Influent background samples were collected at the same time as odd numbered effluent grab samples (first, third, fifth). Background samples were time stamped and confirmed by the observer that each background sample was properly recorded.

During each test run the flow meter data logger recorded flow rates once per minute. Once constant flow rate and test sediment feed were established, three MTD detention times passed before the first of five effluent samples were collected. All effluent samples were collected in clean, laboratory-supplied 1-liter plastic bottles using a sweeping grab sampling motion through the effluent stream as described in Section 5G of the protocol. Samples were then time stamped and confirmed by the observer that each effluent sample was properly recorded.

Two drawdown samples were collected for all test runs at four-minute intervals following the end of the test flow period. Test runs and drawdown flow were considered complete when the effluent drawdown flow decreased to a trickle thus allowing the next test to commence.

Due to the physical nature of the test set up it was not practical to completely isolate and capture the draw down volume for every test run. The total drawdown volume was calculated based on both the pea gravel and plant stabilization filter media void volume (estimated at 40%), plus the volume contained between the invert of the outlet pipe up to the base of the filter bed, and additionally, the volume contained from the top of the pea gravel bed up to the top rim of the test unit itself.

A chain of custody form was completed for each test run and samples were transported to the independent laboratory for TSS analysis in security sealed coolers. All background, effluent and drawdown samples were analyzed by AIRL, Inc. of Cleveland, Tennessee in accordance with ASTM D 3977-97 (re-approval 2019) "Standard Test Methods for Determining Sediment Concentrations in Water Samples."

The TSS removal efficiency for each tested flow rate was calculated following **Equation 2** as follows:

$$Removal\ Efficiency\ (\%) = \frac{\begin{pmatrix} Average\ Influent \\ TSS\ Concentration\ X \\ Total\ Volume \\ of\ Test\ Water \end{pmatrix} - \begin{pmatrix} Adjusted\ Effluent \\ TSS\ Concentration\ X \\ Total\ Volume \\ of\ Effluent\ Water \end{pmatrix} - \begin{pmatrix} Average \\ Drawdown\ Flow \\ TSS\ Concentration\ X \\ Total\ Volume \\ of\ Drawdown\ Water \end{pmatrix}}{\begin{matrix} Average\ Influent\ TSS\ Concentration\ X \\ Total\ Volume\ of\ Test\ Water \end{matrix}} \times 100$$

Equation 2 Equation for Calculating Removal Efficiency

2.5 Sediment Mass Loading Capacity Testing

Sediment Mass Loading Capacity Testing is represented in this AP-2 testing program by runs 11 through 17. Per the protocol these runs are an extension of the removal efficiency testing and are used to determine the maximum mass of test sediment that can be captured by the MTD prior to either an unacceptable loss of hydraulic capacity at design driving head, unacceptable head loss at MTFR, or an unacceptable reduction in pollutant removal efficiency at MTFR, each occurring as a result of filter media occlusion.

Although the protocol allows for the influent concentration to be increased to 400 mg/L for the mass loading capacity testing, runs 11 through 17 were conducted at the targeted 200 mg/L concentration. The testing program was discontinued at the conclusion of run 17 although the cumulative average TSS removal efficiency did not drop below 80.0%. The testing program was concluded at a corresponding cumulative average TSS removal efficiency of 80.06%.

2.6 Scour Testing

No scour testing was performed for this testing program since Aqua-Ponic™ systems are designed to be installed only in offline configurations.

3. Performance Claims

In keeping with the NJCAT verification process, Aqua-Ponic™ performance claims are cited below.

Total Suspended Solids Removal Rate

For the particle size distribution specified by the NJDEP Filtration MTD protocol, the Aqua-Ponic™ Model AP-2 at an MTFR of 7.0 gpm/ft^2 of effective filtration treatment area will demonstrate 80.0% TSS removal efficiency.

Maximum Treatment Flow Rate

The MTFR for the Aqua-Ponic™ Model AP-2 was demonstrated to be 21.9 gpm (0.05 cfs) which corresponds to a surface area loading rate of 7.0 gpm/ft^2 (0.016 cfs/ft^2) of effective filtration treatment area.

Wet Volume and Detention Time

The wet volume and detention time of the Aqua-Ponic™ depends on flow rate and model size. Detention time for the Aqua-Ponic™ is calculated by dividing the operating wet volume by the flow rate. The operating wet volume is defined as the surface area of the Aqua-Ponic™ multiplied by the depth of the entire Aqua-Ponic™ system as measured from the top of the pea gravel layer to the base of the unit, minus the volume of the pea gravel and plant stabilization filter media bed having an approximated porosity of 40%. The tested AP-2 has a calculated detention time of 139 seconds at the tested MTFR.

Effective Filtration Treatment Area (EFTA)

The effective filtration treatment area of the Aqua-Ponic™ models vary with model size. The tested Aqua-Ponic™ Model AP-2 has an EFTA of 3.14 ft^2 corresponding to the two-foot inner diameter of the device.

Sediment Mass Load Capacity

The tested Aqua-Ponic™ Model AP-2 exhibited a sediment mass loading capacity of 28.76 pounds (13.047 kg, 9.16 lbs/ft^2 of effective filtration treatment area) for runs 1 through 17.

Maximum Allowable Inflow Drainage Area

To ensure that the expected annual sediment load in a typical rainfall year does not exceed the design capacity, the sediment mass capture capacity of 28.76 pounds (13.047 kg) of sediment is used to limit the treatable drainage area of the Aqua-Ponic™ system. Given the protocol requirements for "Maximum Allowable Inflow Drainage Area," the Aqua-Ponic™ Model AP-2 demonstrates that it can effectively treat 0.05 acre on an annual basis.

4. Supporting Documentation

The NJDEP Procedure (NJDEP, 2013a) for obtaining verification of an MTD from NJCAT requires that copies of laboratory test reports, including all collected and measured data, all data from performance test runs, all pertinent calculations, etc. be included in this section. It is the understanding of AquaShield™ that this was discussed with NJDEP and it was agreed that as long as such documentation could be made available by NJCAT upon request that it would not be necessary to include all such supporting documentation in verification reports. Supporting documentation is being held by the independent observer and NJCAT.

4.1 Removal Efficiency

In accordance with the NJDEP Filtration MTD Protocol, sediment removal efficiency testing was conducted on the AP-2 in order to establish the ability of the system to remove the specified test sediment at the target MTFR with the goal to demonstrate at least 80% sediment removal as defined in the protocol. The MTFR established through this testing program to establish the removal efficiency (10 runs) is 21.9 gpm (0.05 cfs, or 7.0 gpm/ft^2).

Test runs 1 through 10 represent sediment Removal Efficiency Testing while test runs 11 through 17 represent Sediment Mass Loading Capacity Testing. The cumulative TSS removal efficiency by mass did not fall below 80% after Run 17; however, the testing program was concluded with run 17 at 80.06% cumulative TSS removal efficiency by mass. Given the continuing decline in removal efficiency, it was considered that little benefit would be gained through additional test runs to better define which run would result in less than 80.0% cumulative TSS removal efficiency by mass.

None of the sediment feed samples exceeded one minute for any of the tests. The inlet feed concentration COV did not exceed 0.10 for any test flow rate. The average influent sediment concentration was calculated using Equation 1 from Section 2.4 herein. Average effluent sediment concentrations were adjusted by subtracting the measured background concentrations. No background TSS concentrations exceeded the 20 mg/L maximum allowed by the protocol. Also note that background sample concentrations listed as 2 mg/L represent one half of the method detection limit of 4 mg/L (reported by the laboratory as < 4 mg/L).

The flow meter and data logger took a reading every 60 seconds. Flow rate data for sediment removal efficiency and sediment mass loading capacity testing is summarized in **Table 3** including compliance to the protocol.

Maximum temperatures for removal efficiency and sediment mass loading capacity testing are summarized in **Table 4**. Recorded water temperatures did not exceed 80°F during any of the test runs. Run 8 experienced an apparent malfunction of the water temperature recording device which was noticed approximately 30 minutes into the 60-minute run since the 80°F compliance alarm light was flashing red. The water temperature was quickly checked with an infrared thermometer which indicated that the water in the supply tank was in compliance. In an effort to reboot the temperature recording instrument it was immediately unplugged and plugged back in. The alarm light immediately began to flash green indicating that the test water temperature was in compliance.

Influent sediment concentrations for removal efficiency and sediment mass loading capacity testing are summarized in **Table 5**.

Background sediment concentrations for removal efficiency and sediment mass loading capacity testing are summarized in **Table 6**.

Adjusted effluent sediment concentrations for removal efficiency and sediment mass loading capacity testing are summarized in **Table 7**.

Removal efficiency results are presented in **Table 8**. Data from the 10 removal efficiency test runs indicate 82.02 % cumulative TSS removal efficiency by mass at the MTFR of 7.0 gpm/ft^2 of filter surface area.

Table 3 Summary of Flow Rates for Removal Efficiency and Sediment Mass Loading Capacity Testing

Run	Average Flow Rate (gpm)	COV	Compliance (COV ≤ 0.03)
1	22.0	0.004	Yes
2	22.0	0.006	Yes
3	22.0	0.002	Yes
4	22.0	0.005	Yes
5	22.1	0.005	Yes
6	22.0	0.004	Yes
7	22.0	0.004	Yes
8	21.8	0.003	Yes
9	21.9	0.005	Yes
10	22.0	0.004	Yes
Average flow rate through run 10: 21.98 gpm			
11	22.1	0.005	Yes
12	22.1	0.004	Yes
13	21.7	0.005	Yes
14	21.8	0.003	Yes
15	21.9	0.004	Yes
16	21.8	0.004	Yes
17	21.4	0.003	Yes

Table 4 Temperature Data for Removal Efficiency and Sediment Mass Loading Capacity Testing

Run	Maximum Temperature (°F)	Compliance (Max ≤ 80°F)
1	78.5	Yes
2	79.0	Yes
3	77.5	Yes
4	78.0	Yes
5	78.5	Yes
6	78.5	Yes
7	79.0	Yes
8	78.0	Yes
9	78.0	Yes
10	78.5	Yes
11	75.0	Yes
12	74.5	Yes
13	75.5	Yes
14	75.5	Yes
15	76.0	Yes
16	75.0	Yes
17	75.0	Yes

Table 5 Summary of Influent Sediment Concentrations for Removal Efficiency and Sediment Mass Loading Capacity Testing

Run	Influent Concentration (mg/L)[1]	Mass Loading Rate (g/min) / Influent Concentration (mg/L)			Mean (g/min / mg/L)	COV	Compliance (COV ≤ 0.10)
1	199.9	16.153/194.2	17.099/205.6	17.476/210.1	16.909/203.3	0.040	Yes
2	213.6	16.724/201.1	18.392/221.2	18.030/216.8	17.715/213.0	0.050	Yes
3	185.5	16.169/194.4	17.259/207.5	16.958/203.9	16.795/202.0	0.034	Yes
4	190.1	17.713/213.0	16.259/195.5	17.619/211.9	17.197/206.8	0.047	Yes
5	198.6	18.432/220.6	18.072/216.3	15.968/191.1	17.491/209.4	0.076	Yes
6	204.5	16.399/197.2	17.829/214.4	17.064/205.2	17.097/205.6	0.042	Yes
7	195.3	17.034/204.8	17.133/206.0	15.309/184.1	16.492/198.3	0.062	Yes
8	206.6	16.307/197.9	17.291/209.8	16.414/199.2	16.671/202.3	0.032	Yes
9	205.3	16.281/196.7	16.840/203.4	18.459/223.0	17.193/207.7	0.066	Yes
10	204.4	16.830/202.4	16.768/201.6	18.155/218.3	17.251/207.4	0.045	Yes
11	217.2	17.520/209.7	18.711/224.0	17.944/214.8	18.058/216.2	0.033	Yes
12	212.8	17.544/210.0	16.954/202.9	18.193/217.8	17.564/210.2	0.035	Yes
13	198.3	15.897/193.8	15.825/192.9	16.505/201.2	16.076/196.0	0.023	Yes
14	206.3	15.839/192.2	17.468/212.0	18.090/219.5	17.132/207.9	0.068	Yes
15	205.8	16.301/196.9	16.497/199.3	16.685/201.6	16.494/199.3	0.012	Yes
16	205.8	16.982/206.1	18.129/220.0	18.949/230.0	18.020/218.7	0.055	Yes
17	201.1	15.484/191.4	17.051/210.8	15.642/193.4	16.059/198.5	0.054	Yes

[1] Influent concentration per Equation 1.

Table 6 Summary of Background Sediment Concentrations for Removal Efficiency and Sediment Mass Loading Capacity Testing

Run	Background Sediment Concentration (mg/L)*			Compliance (≤ 20 mg/L)
	Sample 1	Sample 2	Sample 3	
1	2	2	2	Yes
2	2	2	2	Yes
3	2	2	2	Yes
4	2	2	2	Yes
5	2	2	2	Yes
6	2	2	2	Yes
7	2	2	2	Yes
8	2	2	4	Yes
9	2	2	2	Yes
10	4	6	8	Yes
11	2	2	2	Yes
12	2	2	2	Yes
13	2	2	2	Yes
14	2	2	4	Yes
15	2	2	2	Yes
16	2	2	4	Yes
17	2	2	2	Yes

* Values listed as 2 mg/L represent one-half of the method detection limit of 4 mg/L. Concentrations less than 4 mg/L were reported by the laboratory as < 4 mg/L.

Table 7 Adjusted Effluent Concentrations for Removal Efficiency and Sediment Mass Loading Capacity Testing

Run	TSS Concentration (mg/L)						
	Effluent #	**1**	**2**	**3**	**4**	**5**	**Average**
1	Background	2	2	2	2	2	2
	Effluent	32	32	32	37	34	33.4
	Adjusted Average Sediment Concentration						**31.4**
2	Background	2	2	2	2	2	2
	Effluent	34	36	37	38	40	37
	Adjusted Average Sediment Concentration						**35.0**
3	Background	2	2	2	2	2	2
	Effluent	29	30	30	31	36	31.2
	Adjusted Average Sediment Concentration						**29.2**
4	Background	2	2	2	2	2	2
	Effluent	34	33	33	39	35	34.8
	Adjusted Average Sediment Concentration						**32.8**
5	Background	2	2	2	2	2	2
	Effluent	33	33	36	41	40	36.6
	Adjusted Average Sediment Concentration						**34.6**
6	Background	2	2	2	2	2	2
	Effluent	42	41	39	41	44	41.4
	Adjusted Average Sediment Concentration						**39.4**
7	Background	2	2	2	2	2	2
	Effluent	39	38	35	39	28	35.8
	Adjusted Average Sediment Concentration						**33.8**
8	Background	2	2	2	3	4	2.6
	Effluent	39	39	42	44	47	42.2
	Adjusted Average Sediment Concentration						**39.6**

9	Background	2	2	2	2	2	2
	Effluent	48	40	42	42	47	43.8
	Adjusted Average Sediment Concentration						**41.8**
10	Background	4	5	6	7	8	6
	Effluent	50	48	41	46	50	47.0
	Adjusted Average Sediment Concentration						**41.0**
11	Background	2	2	2	2	2	2
	Effluent	43	45	51	52	53	48.8
	Adjusted Average Sediment Concentration						**46.8**
12	Background	2	2	2	2	2	2
	Effluent	48	51	52	52	53	51.2
	Adjusted Average Sediment Concentration						**49.2**
13	Background	2	2	2	2	2	2
	Effluent	42	45	45	51	54	47.4
	Adjusted Average Sediment Concentration						**45.4**
14	Background	2	2	2	3	4	2.6
	Effluent	47	47	47	53	53	49.4
	Adjusted Average Sediment Concentration						**46.8**
15	Background	2	2	2	2	2	2
	Effluent	42	44	50	55	56	49.4
	Adjusted Average Sediment Concentration						**47.4**
16	Background	2	2	2	3	4	2.6
	Effluent	42	48	50	50	48	47.6
	Adjusted Average Sediment Concentration						**45.0**
17	Background	2	2	2	2	2	2
	Effluent	43	50	51	51	52	49.4
	Adjusted Average Sediment Concentration						**47.4**

Sediment mass loading per run and mass captured per run, as listed below in **Tables 8 and 9**, were calculated using **Equation 3** and **Equation 4** as follows:

$$Mass\ Loading\ (kg) = Influent\ TSS\ \left(\frac{mg}{L}\right)\ x\ Influent\ Volume\ (L)\ x\ 1{,}000$$

Equation 3 Sediment Mass Loading per Run

$$Mass\ Captured\ (kg) = Mass\ Loading\ (kg) - Mass\ Effluent\ (kg) - Mass\ Draindown\ (kg)$$

Equation 4 Mass Captured per Run

Table 8. TSS Removal Efficiency Results

Run	Average Influent TSS (mg/L)	Average Adjusted Effluent TSS (mg/L)	Average Adjusted Drawdown TSS (mg/L)	Influent Volume (L)	Effluent Volume (L)	Drawdown Volume (L)	Mass Loading (kg)	Mass Captured (kg)	Test Run RE by Mass (%)	Cumulative Removal Efficiency by Mass (%)
1	199.9	31.4	38.0	4,739.4	4,658.1	81.3	0.947	0.798	84.27	84.27
2	213.6	35.0	43.5	4,740.9	4,659.6	81.3	1.013	0.846	83.51	83.88
3	185.5	29.2	42.0	4,740.1	4,658.9	81.3	0.879	0.740	84.19	83.97
4	190.1	32.8	39.5	4,740.1	4,658.9	81.3	0.901	0.745	82.69	83.66
5	198.6	34.6	40.5	4,761.3	4,680.0	81.3	0.945	0.780	82.54	83.44
6	204.5	39.4	51.0	4,740.9	4,659.6	81.3	0.969	0.782	80.70	82.97
7	195.3	33.8	48.5	4,740.1	4,658.9	81.3	0.926	0.764	82.51	82.90
8	206.6	39.6	57.0	4,697.0	4,615.8	81.3	0.971	0.783	80.64	82.61
9	205.3	41.8	50.0	4,719.7	4,638.4	81.3	0.969	0.771	79.57	82.27
10	204.4	41.0	48.0	4,740.1	4,658.9	81.3	0.969	0.774	79.88	82.02
Total Mass							9.489	7.783	82.02	--
Cumulative TSS Removal Efficiency by Mass										**82.02**

The total mass input for runs 1 through 10 was 20.92 pounds (9.489 kg) while the total mass captured for the same runs was 17.16 pounds (7.783 kg). The cumulative TSS removal efficiency by mass was 82.02% for runs 1 through 10.

Excluded Data/Results

No data was excluded for the sediment removal efficiency testing.

4.2. Sediment Mass Loading Capacity

The sediment mass loading capacity test was a continuation of the TSS removal efficiency test. Results of this testing are included in **Table 9**. The MTFR loading rate was 7.0 gpm/ft^2 of effective filter area.

Table 9. Sediment Mass Loading Capacity Results

Run	Average Influent TSS (mg/L)	Average Adjusted Effluent TSS (mg/L)	Average Adjusted Drawdown TSS (mg/L)	Influent Volume (L)	Effluent Volume (L)	Drawdown Volume (L)	Mass Loading (kg)	Mass Captured (kg)	Test Run RE by Mass (%)	Cumulative Removal Efficiency by Mass (%)
11	217.2	46.8	56.5	4,762.0	4,680.8	81.3	1.034	0.811	78.43	81.67
12	212.8	49.2	52.5	4,761.3	4,680.0	81.3	1.013	0.779	76.90	81.25
13	198.3	45.4	54.5	4,674.3	4,593.1	81.3	0.927	0.714	77.02	80.94
14	206.3	46.8	50.0	4,697.8	4,616.5	81.3	0.969	0.749	77.30	80.67
15	205.8	47.4	55.0	4,719.0	4,637.7	81.3	0.971	0.747	76.93	80.42
16	205.8	45.0	41.5	4,696.3	4,615.0	81.3	0.967	0.755	78.08	80.27
17	201.1	47.4	47.0	4,610.8	4,529.6	81.3	0.927	0.709	76.48	80.06
Total Mass Runs 1-17							16.297	13.047	80.06	--
	Cumulative TSS Removal Efficiency by Mass Runs 1 - 17 = 80.06%									

The total mass input for runs 1 through 17 was 35.93 pounds (16.297 kg) while the total mass captured for the same runs was 28.76 pounds (13.047 kg). The cumulative TSS removal efficiency by mass was 80.06% for runs 1 through 17.

Excluded Data/Results

No data was excluded for the Sediment Mass Load Capacity testing. No additional test runs were conducted after Run 17.

4.3 Operating Head

External operating head is defined as any head above or upstream of the filtration zone of the Aqua-Ponic™ system required to initiate system operation. The Aqua-Ponic™ system does not require any external operating head beyond that required to initiate sheetflow into the Aqua-Ponic™ system. The Aqua-Ponic™ system is designed such that in a clean filter, the initial (internal) head is approximately 0.25 inches above the surface of the plant stabilization filter media bed and contained within the overlying pea gravel layer. During the course of the 17-run test program the internal head increased approximately three inches within the pea gravel layer such that, at the conclusion of testing, the operational water level coincided with the surface of the pea gravel, approximately 20 inches above the invert elevation of the outlet pipe.

5. Design Limitations

The Aqua-Ponic™ is an engineered system designed to meet site-specific installation requirements. General terms of design parameters and limitations are cited in this section.

Operating Head

An external bypass or flow control/storage is required for any flows in excess of the MTFR. As each site is a unique design, every Aqua-Ponic™ system is custom-engineered by AquaShield™ to maintain the design MTFR for the site operating head conditions. AquaShield™ engineers can assist with this design.

Media Thickness

Aqua-Ponic™ systems utilize a minimum of three inches for the pea gravel and a minimum of 12 inches for the plant stabilization filter media.

Soil Characteristics

AquaShield™ specifies that installations utilize stone backfill material. Site-specific native soils can be used as backfill provided that the material substantially conforms to the backfill specification. AquaShield™ engineers can assist contractors with backfill questions when using native soil.

Sheetflow Influent Velocity

The Aqua-Ponic™ is designed to receive stormwater runoff as sheetflow. Consideration should be given to address whether any disturbance to the plants and/or media could result from an excessive sheetflow influent velocity.

Discharge from Aqua-Ponic™ systems is intended to be connected to a site conveyance piping network. AquaShield™ engineers can collaborate with site design engineers to facilitate an appropriate conveyance design as warranted to ensure proper operation of an Aqua-Ponic™ facility.

Maximum Water Quality Treatment Flow Rate

The maximum water quality treatment flow rate varies by Aqua-Ponic™ model size and should be taken into consideration for site designs. AquaShield™ engineers can assist site designers with model sizing and managing peak flow rates.

Maintenance Requirements

Aqua-Ponic™ systems should be inspected and maintained following the recommendations and guidelines included in the Inspection & Maintenance Manual at:
https://www.aquashieldinc.com/uploads/1/3/6/1/13618853/njdep_ap_i_m_manual_4-26.pdf.

Section 6 herein includes additional maintenance information.

Installation Limitations

Pick weights vary by Aqua-Ponic™ model size. AquaShield™ can provide contractors with model-specific pick weights prior to delivery.

Configurations

Aqua-Ponic™ technology allows for stormwater runoff to enter the device from the top via sheetflow. The tested influent trough configuration simulated influent sheetflow. Inflow can be from any direction including 360 degrees since the technology is based on the vertical downflow of water under gravity flow conditions.

The Aqua-Ponic™ is an off-line device and an upstream bypass design is necessary in order to convey flows that exceed the MTFR of the unit. AquaShield™ engineers can assist with this design.

Aqua-Ponic™ installations can utilize an outlet pipe in any direction from the water sump. Multiple outlet pipes can also be used since all effluent conveyance is post-filtration. However, the combined flow must be controlled to equal the MTFR allowance. AquaShield™ engineers can assist site designers with custom configurations.

Loading

Aqua-Ponic™ systems utilize a construction material that is rated for HS-25 loading. However, it should be kept in mind that Aqua-Ponic™ systems are inherently designed not to be installed directly within traffic areas. Contact AquaShield™ engineering staff when loading conditions may be a necessary facility design consideration.

Pretreatment Requirements

The Aqua-Ponic™ system does not require pretreatment. Good housekeeping practices within and adjacent to the drainage area for the device may better facilitate system operation by decreasing maintenance frequency as site conditions allow.

Depth to Seasonal High-Water Table

Aqua-Ponic™ performance is independent of high groundwater conditions. AquaShield™ routinely performs buoyancy calculations for all system installations as needed to ensure long term functionality should this condition be of concern. Anti-floatation controls can be added for system installations when necessary.

Pipe Size

Aqua-Ponic™ systems are designed to receive stormwater runoff under sheetflow.

6. Maintenance Plan

The Aqua-Ponic™ Inspection and Maintenance Manual is available at:
https://www.aquashieldinc.com/uploads/1/3/6/1/13618853/njdep_ap_i_m_manual_4-26.pdf.

Maintenance frequency for the Aqua-Ponic™ will ultimately be determined by site-specific pollutant loading conditions. Inspections of the plants, top gravel layer and the upper portion of the plant stabilization filter media can be accomplished from the surface without special tools. A shovel and rake may better facilitate an inspection event. AquaShield™ recommends periodic inspections following installation to determine a site-specific maintenance cycle to ensure functionality of the vegetation and media.

We recommend that periodic system inspections be performed to determine the pollutant and trash loading characteristics. In general, quarterly inspections should be performed during the first year of operation to better anticipate maintenance frequency in the first year and subsequent years of operation.

An Aqua-Ponic™ maintenance event should first determine any obvious signs of plant distress, degradation, displacement, sediment or trash accumulation, or oil in the upper layers of the unit. The top gravel layer should be completely replaced and can be removed by shoveling or vacuuming. The top several inches of the underlying plant stabilization filter media may be replaced at the same time if warranted. Care should be taken not to damage the plants or disturb rootballs during limited media replacement. Care should also be taken when replacing a plant or plant area to avoid disturbing remaining plants.

Depending on site conditions, it may be necessary to remove all the media and all the plants and completely replace these components of the system. It is recommended that the wicking ropes be replaced if a system is fully replaced with stabilization media and plants.

Sediment can accumulate in the base of the water supply sump over a period of time. After removing the pea gravel layer, the plants and the plant stabilization filter media bed, the perforated metal plate should be removed to access the water supply sump from the surface for the purpose of vacuuming water and any accumulated sediment. The wicking ropes should also be replaced at this time. The perforated metal plate with the new wicking ropes should be set in place prior to installing the plant stabilization filter media on top of the plate.

AquaShield™ can provide the plant stabilization filter media, wicks and any associated grommets. Although unlikely, the supporting stainless-steel plate can also be supplied by AquaShield™ if its replacement is necessary. While we recommend that the pea gravel be replaced as warranted, it may be feasible to wash the gravel during a maintenance event. However, in most cases it is more efficient to replace the pea gravel to avoid disposal of water that was used to clean the gravel.

All inspection and maintenance activities can be performed from the surface and without the need for AquaShield™ personnel to be present. We recommend that all materials removed during the maintenance process be handled and disposed in accordance with all applicable federal, state and local guidelines. Depending on the influent pollutant characteristics of the facility drainage area, it may be appropriate to perform Toxicity Characteristics Leaching Procedure (TCLP) analyses on representative samples of the spent filter media to ensure that the handling and disposition of materials complies with any applicable environmental regulations and practices.

7. Statements

The following signed statements from the manufacturer, third party observer and NJCAT are required to complete the NJCAT verification process. Additionally, this report has been subjected to public review and all comments and concerns have been satisfactorily addressed.

September 10, 2020

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

Re: Verification of Aqua-Ponic™ Stormwater Biofiltration System to NJDEP Filtration Laboratory Testing Protocol

An AquaShield™, Inc. Aqua-Ponic™ Model AP-2 Stormwater Biofiltration System (Aqua-Ponic™) was recently tested for performance verification in compliance with the NJDEP Filtration Laboratory Testing Protocol. As specified by the "Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology," this letter serves as the AquaShield™ statement that all procedures and requirements identified in the above-cited protocol and process document were met or exceeded. The AP-2 sediment removal efficiency and sediment mass loading capacity testing conducted at the AquaShield™ laboratory facility in Chattanooga, Tennessee were conducted under the direct and independent supervision of Mr. Nicholas Tovar of Southern Environmental Technologies, Sewanee, Tennessee. All water quality samples were analyzed by the independent analytical laboratory, AIRL, Inc. of Cleveland, Tennessee. The test sediment particle size distribution was prepared by Good Harbour Laboratories of Mississauga, Ontario and analyzed by Maxxam Analytics of Mississauga. Preparation of the verification report and the supporting documentation fulfill the submission requirements of the process document and protocol.

Sincerely,

AquaShield™, Inc.

Mark B. Miller

Mark B. Miller
Research Scientist

2733 Kanasita Drive, Suite 111 • Chattanooga, TN 37343 • Phone (423) 870-8888 • www.aquashieldinc.com

Southern Environmental Technologies, Inc.

900 Old Sewanee Road, Sewanee, TN 37375
Phone: 423-605-5569 Fax: 423-710-3094
www.southernenvironmental.us

August 26, 2020

Dr. Richard Magee
Executive Director
New Jersey Corporation for Advanced Technology

RE: Third party observation of testing of the Aqua-Ponic Model AP-2 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 (January 25, 2013)

Dear Dr. Magee,

The purpose of this letter is to confirm that I directly witnessed all of the Aqua-Ponic Model AP-2 testing conducted at the AquaShield facility in Chattanooga, Tennessee on July 24, July 27-30, August 10-14, and from August 18-19, 2020. I can attest that the testing was done in accordance with the above referenced protocol, as required by the Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology, for use in accordance with the Stormwater Management Rules N.J.A.C. 7:8 (January 25, 2013).

Prior to testing, I witnessed the unsealing of the test sediment for TSS Removal Efficiency that had been mixed and supplied to AquaShield by Good Harbour Laboratories of Mississauga, Ontario.

During the testing, I witnessed the sampling during every run and personally weighed all influent test sediment feed samples. I also inspected all sample bottle labels and confirmed the chains of custody for all analyzed samples.

Sincerely

Nicholas Tovar

Nicholas Tovar
Project Manager

CC: Mark Miller & Stuart Ellis, AquaShield, Inc.

Southern Environmental Technologies, Inc.

900 Old Sewanee Road, Sewanee, TN 37375
Phone: 423-605-5569 Fax: 423-710-3094
www.southernenvironmental.us

August 26, 2020

Dr. Richard Magee
Executive Director
New Jersey Corporation for Advanced Technology

RE: Performance Verification of the Aqua-Ponic Model AP-2

Dear Dr. Magee,

I have been contracted, as a representative of Southern Environmental Technologies, Inc., by AquaShield, Inc., to witness the performance testing of their Aqua-Ponic Model AP-2 Stormwater Biofiltration System 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 (January 25, 2013).

Southern Environmental Technologies, Inc. (SET) is an independent Environmental and Civil Engineering Field Services Company located in Sewanee, Tennessee.

I, the undersigned, on behalf of SET, confirm:

■ that I do not have any conflict of interest in witnessing the contracted testing. Potential conflict of interest may arise, in particular, as a result of economic interests, political or national affinities, family or emotional ties, or any other relevant connection or shared interest;

■ that I will inform NJCAT, without delay, of any situation constituting a conflict of interest or potentially giving rise to a conflict of interest;

■ that I have not granted, sought, attempted to obtain or accepted and will not grant, seek, attempt to obtain, or accept any advantage, financial or in kind, to or from any party whatsoever, constituting an illegal or corrupt practice, either directly or indirectly, as an incentive or reward relating to the award of the contract.

Sincerely, Date

Nicholas Tovar **August 26, 2020**

Nicholas Tovar

Project Manager

Southern Environmental Technologies, Inc.

CC: Mark Miller & Stuart Ellis, AquaShield, Inc.

Center for Environmental Systems

Stevens Institute of Technology

One Castle Point,

Hoboken, NJ 07030-0000

September 10, 2020

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 full-scale, commercially available AquaShield Aqua-Ponic™ Model AP-2 Stormwater Biofiltration System, and observed by Nicholas Tovar, Project Manager, Southern Environmental Technologies, Inc., Sewanee, Tennessee, the test protocol requirements contained in the *"New Jersey Laboratory Testing Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device, January 25, 2013)"* (NJDEP Filtration Protocol) were met or exceeded. Specifically:

Test Sediment Feed

The mean PSD of the AquaShield test sediment comply with the PSD criteria established by the NJDEP filtration protocol. The AquaShield removal efficiency test sediment PSD analysis was plotted against the NJDEP removal efficiency test PSD specification. The test sediment was shown to be finer than the sediment blend specified by the protocol (<75µm); the test sediment d_{50} was approximately 66 microns.

Removal Efficiency (RE) Testing

Seventeen (17) removal efficiency testing runs were completed in accordance with the NJDEP test protocol. Ten (10) of the 17 test runs were conducted during RE testing and seven (7) during mass loading capacity testing. The target flow rate and influent sediment concentration were 22 gpm and 200 mg/L. The Aqua-Ponic™ Model AP-2 Stormwater Biofiltration System demonstrated a cumulative TSS removal efficiency by mass of 80.06% over the course of the 17 test runs.

Sediment Mass Loading Capacity

Mass loading capacity testing was conducted as a continuation of RE testing. Mass loading test runs were conducted using identical testing procedures and targets as those used in the RE runs. Testing concluded after test run 17.

The total influent mass loaded through run 17 was 35.93 lb. (16.297 kg) and the total mass captured by the Aqua-Ponic™ was 28.76 lb. (13.047 kg). This is equivalent to a sediment mass loading capacity of 9.16 lb./ft^2 of effective filtration treatment area.

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

Scour Testing

The Aqua-Ponic™ is designed for off-line installation. Consequently, scour testing is not required.

Sincerely,

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

8. References

ASTM D422-63. *Standard Test Method for Particle Size Analysis of Soils.*

ASTM D3977-97 (re-approval 2019). *Standard Test Methods for Determining Concentrations in Water Samples.*

AquaShield™, Inc. *Verification Testing of the Aqua-Ponic™ Model AP-2 in Accordance with the NJDEP Laboratory Testing Protocol 2013, Quality Assurance Project Plan*. July 27, 2020.

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

NJDEP 2013b. *New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device.* Trenton, NJ. January 25, 2013.

VERIFICATION APPENDIX

Introduction

- Manufacturer: AquaShield™, Inc., 2733 Kanasita Drive, Suite 111, Chattanooga, Tennessee 37343. *General Phone: (423) 870-8888*. Website: www.aquashieldinc.com.

- MTD: Aqua-Ponic™ Stormwater Biofiltration System (Aqua-Ponic™). Verified Aqua-Ponic™ models are shown in **Table A-1.**

- TSS Removal Rate: 80%

- Off-line installation

Detailed Specification

- **Table A-1** includes Aqua-Ponic™ MTFRs and maximum allowable drainage areas for the verified models. **Table A-2** includes Aqua-Ponic™ model scaling ratios while **Table A-3** lists storage capacities compared to the maximum allowable drainage areas.

- Aqua-Ponic™ technology does not require an external operating (driving) head to achieve operating conditions.

- Drawdown flow through the Aqua-Ponic™ is regulated by a flow control orifice. Drawdown in a clean filter is approximately 15 minutes.

- Pick weights and installation procedures vary with model size. AquaShield™ can provide contractors with project-specific unit pick weights and installation instructions as warranted prior to delivery.

- An Inspection and Maintenance Manual is provided for each project installation and is also available to download at: https://www.aquashieldinc.com/uploads/1/3/6/1/13618853/njdep_ap_i_m_manual_4-26.pdf.

- This device 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. Aqua-Ponic™ Model MTFRs and Maximum Allowable Drainage Areas

Aqua-Ponic™ Model	Diameter (ft)	Effective Filtration Treatment Area (ft^2)	MTFR (cfs)	Maximum Allowable Drainage Area (acres)
AP-2	2	3.14	0.05	0.05
AP-3	3	7.07	0.11	0.11
AP-4	4	12.57	0.20	0.19
AP-5	5	19.63	0.31	0.30
AP-6	6	28.27	0.44	0.43
AP-7	7	38.48	0.60	0.59
AP-8	8	50.27	0.79	0.77
AP-9	9	63.62	0.99	0.97
AP-10	10	78.54	1.23	1.20
AP-11	11	95.03	1.48	1.45
AP-12	12	113.10	1.77	1.73
AP-13	13	132.73	2.07	2.03

Table A-2. Aqua-Ponic™ Model Scaling Ratios

Aqua-Ponic™ Model	MTFR (cfs)	Effective Filtration Treatment Area (EFTA) (ft^2)	Wet Volume (WV) (ft^3)	Ratio MTFR to EFTA	Ratio WV to EFTA
AP-2	0.05	3.14	7.07	0.0156	2.25
AP-3	0.11	7.07	15.91	0.0156	2.25
AP-4	0.20	12.57	28.28	0.0156	2.25
AP-5	0.31	19.63	44.17	0.0156	2.25
AP-6	0.44	28.27	63.61	0.0156	2.25
AP-7	0.60	38.48	86.58	0.0156	2.25
AP-8	0.79	50.27	113.11	0.0156	2.25
AP-9	0.99	63.62	143.15	0.0156	2.25
AP-10	1.23	78.54	176.72	0.0156	2.25
AP-11	1.48	95.03	213.82	0.0156	2.25
AP-12	1.77	113.10	254.48	0.0156	2.25
AP-13	2.07	132.73	298.64	0.0156	2.25

Table A-3. Aqua-Ponic™ Maximum Allowable Drainage Areas

Aqua-Ponic™ Model	MTFR (cfs)	Storage Capacity/ft² of Filtration Area (lbs/ft²)[1]	EFTA (ft²)	Storage Capacity (lbs)	Maximum Allowable Drainage Area (acres)[2]
AP-2	0.05	9.16	3.14	28.8	0.05
AP-3	0.11	9.16	7.07	64.8	0.11
AP-4	0.20	9.16	12.57	115.1	0.19
AP-5	0.31	9.16	19.63	179.8	0.30
AP-6	0.44	9.16	28.27	259.0	0.43
AP-7	0.60	9.16	38.48	352.5	0.59
AP-8	0.79	9.16	50.27	460.5	0.77
AP-9	0.99	9.16	63.62	582.8	0.97
AP-10	1.23	9.16	78.54	719.4	1.20
AP-11	1.48	9.16	95.03	870.5	1.45
AP-12	1.77	9.16	113.10	1036.0	1.73
AP-13	2.07	9.16	132.73	1215.8	2.03

1. Based on test results of 28.76 lbs. of sediment captured at the conclusion of run 17 with 80.06% removal efficiency.
2. Maximum Allowable Drainage Area (acres) = Weight of TSS captured before capture efficiency drops below 80%/600 lbs. per acre of drainage area annually. In this case testing was concluded when capture efficiency was 80.06%.

Addendum

Revised Sizing Chart for the Aqua-Ponic™ Biofiltration System

Introduction

Komline-AquaShield (AquaShield™) now has the capability to fabricate the Aqua-Ponic™ Biofiltration System using slightly larger diameters than those listed in Table 1 (pg., 32) . The current Aqua-Ponic™ sizing chart is based on the testing verified in the NJCAT 2020 report of 0.016 cfs/ft^2 of effective filtration treatment area (EFTA) which is identical to the effective sedimentation treatment area or surface area (SA). Table A-4-Table A-6 are the replacement Tables for the new larger diameter models.

Table A-4. Aqua-Ponic™ Model MTFRs and Maximum Allowable Drainage Areas

Aqua-Ponic™ Model	Diameter (ft)	Effective Filtration Treatment Area (ft^2)	MTFR (cfs)	Maximum Allowable Drainage Area (acres)
AP-2	2.5	4.91	0.077	0.07
AP-3	3.5	9.62	0.150	0.15
AP-4	4.5	15.90	0.248	0.24
AP-5	5.5	23.76	0.371	0.36
AP-6	6.5	33.18	0.518	0.51
AP-7	7.5	44.18	0.689	0.67
AP-8	8.5	56.75	0.885	0.87
AP-9	9.5	70.88	1.105	1.08
AP-10	10.5	86.59	1.350	1.32
AP-11	11.5	103.87	1.620	1.59
AP-12	12.5	122.72	1.914	1.87
AP-13	13	132.73	2.070	2.03

Table A-5. Aqua-Ponic™ Model Scaling Ratios

Aqua-Ponic™ Model	MTFR (cfs)	Effective Filtration Treatment Area (EFTA) (ft^2)	Wet Volume (WV) (ft^3)	Ratio MTFR to EFTA	Ratio WV to EFTA
AP-2	0.077	4.91	11.04	0.0156	2.25
AP-3	0.150	9.62	21.65	0.0156	2.25
AP-4	0.248	15.90	35.78	0.0156	2.25
AP-5	0.371	23.76	53.46	0.0156	2.25
AP-6	0.518	33.18	74.66	0.0156	2.25
AP-7	0.689	44.18	99.40	0.0156	2.25
AP-8	0.885	56.75	127.68	0.0156	2.25
AP-9	0.105	70.88	159.48	0.0156	2.25
AP-10	1.350	86.59	194.83	0.0156	2.25
AP-11	1.620	103.87	233.71	0.0156	2.25
AP-12	1.914	122.72	276.12	0.0156	2.25
AP-13	2.070	132.73	298.64	0.0156	2.25

Table A-6. Aqua-Ponic™ Maximum Allowable Drainage Areas

Aqua-Ponic™ Model	MTFR (cfs)	Storage Capacity/ft^2 of Filtration Area (lbs/ft^2)[1]	EFTA (ft^2)	Storage Capacity (lbs)	Maximum Allowable Drainage Area (acres)[2]
AP-2	0.077	9.16	4.91	45.0	0.07
AP-3	0.150	9.16	9.62	88.1	0.15
AP-4	0.248	9.16	15.90	145.7	0.24
AP-5	0.371	9.16	23.76	217.6	0.36
AP-6	0.518	9.16	33.18	304 .0	0.51
AP-7	0.689	9.16	44.18	404.7	0.67
AP-8	0.885	9.16	56.76	519.8	0.87
AP-9	1.105	9.16	70.88	649.3	1.08
AP-10	1.350	9.16	86.59	793.2	1.32
AP-11	1.620	9.16	103.87	951.4	1.59
AP-12	1.914	9.16	122.72	1124.1	1.87
AP-13	2.070	9.16	132.73	1215.8	2.03

1. Based on test results of 28.76 lbs. of sediment captured at the conclusion of run 17 with 80.06% removal efficiency.
2. Maximum Allowable Drainage Area (acres) = Weight of TSS captured before capture efficiency drops below 80%/600 lbs. per acre of drainage area annually. In this case testing was concluded when capture efficiency was 80.06%.