NJCAT TECHNOLOGY VERIFICATION

StormKleener™ Filter Cartridge System

Lane Enterprises Inc.

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1. Description of Technology

The Lane StormKleener™ Filter Cartridge System (StormKleener Filter) is a storm water treatment device consisting of one or multiple cylindrical sand media-filled cartridges housed in a containment or carrier vault. The filter cartridge removes contaminants using media filtration. The filter is designed to allow the up-flow of water through the cartridge for filtering. The filtering mechanism takes place radially during flow through the filter media. Water (shown in red) enters the bottom of the filter through mesh tubes (22” in height) that are open at the bottom of the filter and plugged at the top. Water flows radially from this mesh tube, through the sand filter media, and into another mesh tube that is open at the top and plugged at the bottom. As the filtered water (shown in green) rises in the filter it exits from the mesh tubes open at the top and over the top of the center drain tube and exits. The center drain tube is approximately 2” higher than the mesh tubes open at the top. Once the water reaches the top it exits the filter through a 2” PVC center down drain and leaves the vault through the floor piping (**Figure 1**). The contaminants remain trapped in the filter and in the containment vault.

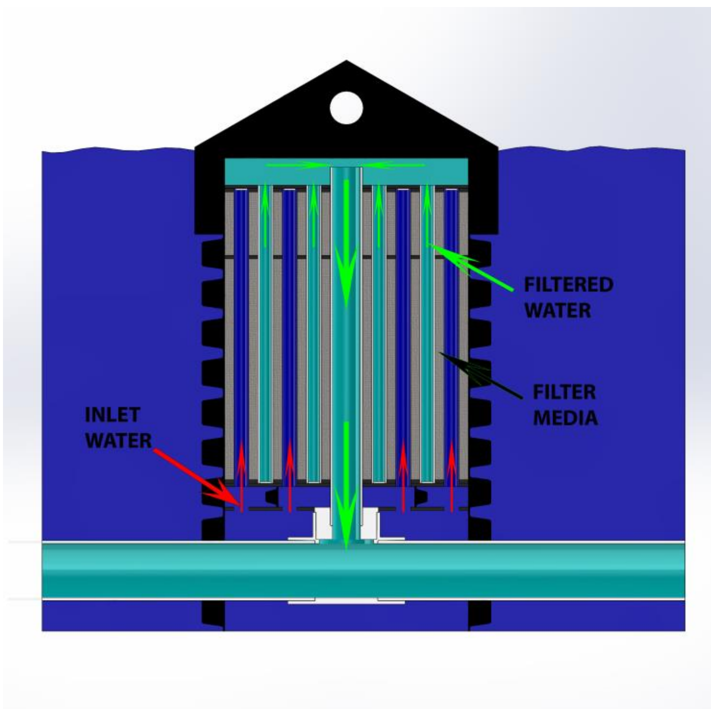

Figure 1 Section View of the StormKleener Filter

There are four phases of flow as described below.

Charging / Filling Operation – Water enters the meshed tubing open to the bottom of the cartridge and filters radially through the media into the mesh tubing open to the top of the filter. A relief valve is installed on the top of the filter to allow air to escape during the filling process.

Traditional Flow under Head - Once the storm water has reached the top of the filter, it is driven by head through the filter system and begins to flow down the center drain tube and exits the system as siphon flow. The water level in the vault will decrease until a steady-state condition is reached at the minimum driving head. A flow constrictor orifice maintains the flow rate.

Siphon Flow - As the storm water subsides, the water level in the vault will decrease due to siphon flow. Stormwater remaining in the containment vault will continue to be treated and filtered until the water level reaches the bottom of the filter and air enters the filter at the bottom.

Backwash - Once the water has reached the bottom of the filter cartridge, a siphon break occurs. The break in the siphon allows air to reenter the filter. This causes the flow in the filter to reverse and backwash the filter media. The backwash deposits the pollutants into the containment vault and cleans the filter.

2. Laboratory Testing

The test program was conducted at the Alden Research Laboratory, Inc. (Alden), Holden, Massachusetts, under the direct supervision of Alden's senior stormwater engineer, James Mailloux. Alden has performed verification testing on approximately twenty Hydrodynamic Separator and Filtration Manufactured Treatment Devices (MTDs) for multiple manufacturers under various state and federal testing protocols. Particle size distribution (PSD) analysis was conducted by GeoTesting Express Inc., Acton, Massachusetts, and water quality samples collected during this testing process were analyzed by Alden.

Laboratory testing was done in accordance with the New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device (January 2013) (NJDEP Filtration Protocol). Prior to starting the performance testing program, a quality assurance project plan (QAPP) was submitted to and approved by the New Jersey Corporation for Advanced Technology (NJCAT).

2.1 Test Setup

The laboratory test used a full-scale, 18-inch diameter by 3-ft high StormKleener Filter (**Figure 2**) filled with sand media that was installed in a test tank in a manner consistent with commercial installations and meeting the criteria established in the NJDEP Filtration Protocol. The filter media is 22" in total depth from top to bottom with 24 - 0.870" mesh tubes providing the interface between the filter and the media. The filter was installed in a 31.9" x 31.9" x 6.0-ft high acrylic tank for flow visualization. A 6-inch inlet pipe, with an invert elevation of 5 ft above the tank floor, was located in the upstream wall of the tank. A 4-inch outlet pipe conveyed the filtered flow out through the opposite wall, near the floor. In commercial installations a bypass pipe, with an invert elevation of 5 ft, is located in the sidewall of the vault and sets the maximum driving head elevation. This pipe was omitted from the laboratory setup, as all testing was conducted below bypass. A drain-down filter was installed 180 degrees from the outlet pipe to allow standing water to drain from the vault during dry-weather conditions. The drain down filter is 2” diameter perforated pipe filled with sand filter media and a geotextile filter fabric surrounding the sand. The total length of the drawn down filter is 6 inches and has a threaded connection for attachment to the outlet piping. The drain-filter flow was calculated to be 0.03 gpm (0.1% of MTFR).

A photograph showing the filter installed in the test tank is shown on **Figure 3**. The test tank floor area was 7.07 ft^2, which is equivalent to the least amount of floor surface area per 18-inch diameter cartridge in a typical commercial installation.

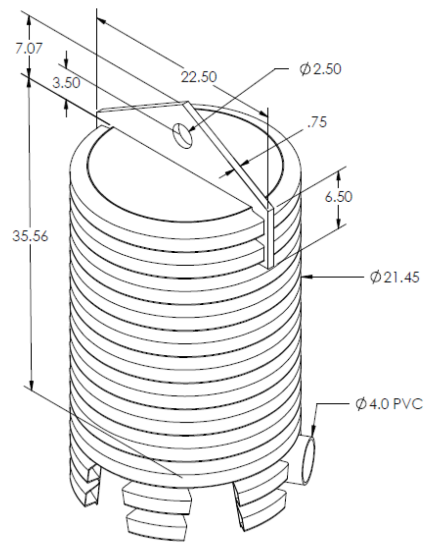

Figure 2 Isometric Drawing of the StormKleener Filter

Figure 3 Laboratory Test Setup of the StormKleener Filter

The filter cartridge test unit was installed in the Alden test loop, shown on **Figure 4,** which is set up as a recirculation system. The loop is designed to provide metered flow up to approximately 17 cfs. Flow was supplied to the unit with a 20HP laboratory pump, drawing water from a 50,000-gallon supply sump. The test flow was set and measured using a differential-pressure meter and control valve. A Differential Pressure (DP) cell and computer Data Acquisition (DA) program was used to record the test flow. A minimum of 25 feet of straight 6" PVC influent pipe conveyed the metered flow to the unit. A 1-ft length of 4" acrylic pipe free-discharged the effluent flows to a return channel and supply sump. The influent and effluent pipes were set at 1% slopes. A 6" tee was located 4 pipe-diameters (2 ft) upstream of the test unit for injecting sediment into the crown of the influent pipe, using a variable-speed auger feeder. Filtration of the supply sump, to reduce background concentration, was performed with an in-situ filter wall containing 1-micron bag filters.

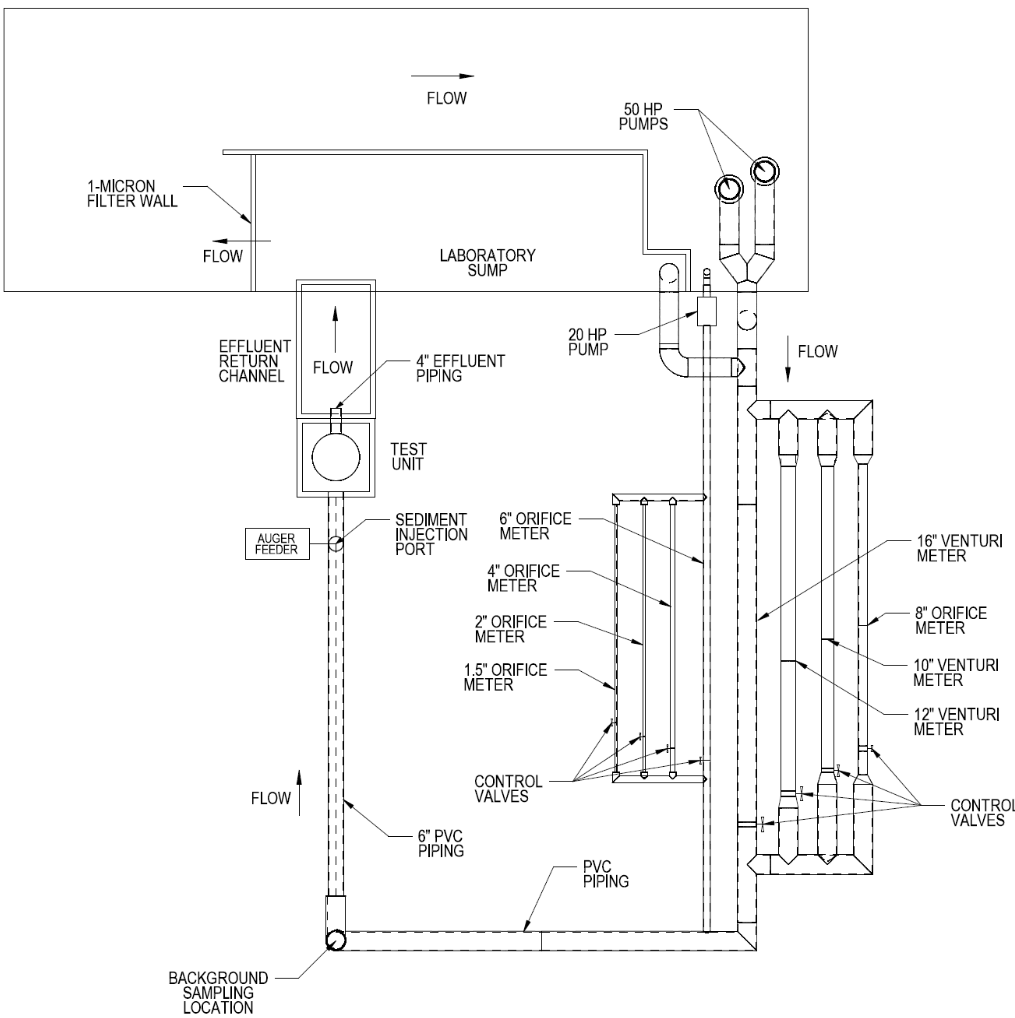

Figure 4 Plan View of Alden Flow Loop

2.2 Hydraulic Testing

The filter cartridge was tested with clean water to determine its hydraulic characteristic curves, including loss coefficients (Cd's). Flow and water level measurements were recorded during steady-state flow conditions using the computerized DA system, which included a data collect program, 0-250" Rosemount DP cell (flow), and Omegadyne PX419 0-2.5 psi Absolute-Pressure (AP) cell (water elevations). The pressure cell was mounted to measure water levels from the floor of the test unit. The system loss across the unit was determined by adding the velocity head to the pressure measurements taken in the outlet pipe. Flows were set and measured using calibrated flow meters and control valves. Each test flow was set and operated at steady state for approximately 10 minutes, after which time a minimum of 60 seconds of flow and pressure data were averaged and recorded for each pressure tap location. Water elevations were measured in the containment vault and effluent pipe, one pipe-diameter downstream of the unit.

2.3 Removal Efficiency Testing

Sediment testing was conducted to determine the removal efficiency, as well as sediment mass loading capacity. The sediment testing was conducted on a clean cartridge filter at the 100% MTFR of 30 gpm. The protocol required that a minimum of ten 30-minute test runs be conducted. The captured sediment was not removed from the chamber between tests. The test sediment was prepared by Alden to meet the PSD gradation of 1-1000 microns of **Table 1.**

Table 1 Test Sediment Particle Size Distribution

Particle Size[1] (Microns)	Target Minimum % Less Than[2]
1,000	100
500	95
250	90
150	75
100	60
75	50
50	45
20	35
8	20
5	10
2	5

1. The material shall be hard, firm, and inorganic with a specific gravity of 2.65. The various particle sizes shall be uniformly distributed throughout the material prior to use.
2. A measured value may be lower than a target minimum % less than value by up to two percentage points, provided the measured d_{50} value does not exceed 75 microns.

The sediment is silica based, with a specific gravity of 2.65. Three random PSD samples of the test sediment were analyzed by GeoTesting Express, an independent certified analytical laboratory, using ASTM D 422-63 (Reapproved 2007) "Standard Test Method for Particle Size Analysis of Soils". The average of the three samples was used for compliance with the protocol.

The target influent sediment concentration was 200 mg/L (+/-20 mg/L) for all tests. The concentration was verified by collecting a minimum of three timed dry samples at the injector and correlating the data with the measured average flow to verify the influent concentration values for each test. The allowed Coefficient of Variance (COV) for the measured samples is 0.10. The moisture content of the test sediment was determined using ASTM D4959-07 for each test conducted and was utilized in the final removal calculation.

The protocol requires the temperature of the supply water to be below 80 degrees F.

Five (5) time-stamped effluent samples were collected from the end of the outlet pipe during each run. A minimum of 3 detention times were allowed to pass before collecting a sample after the start of sediment feed and when the feed was interrupted for measurements. Three (3) background samples of the supply water were collected with each odd-numbered effluent sample (1, 3 and 5). The background data was used to adjust the measured effluent concentrations. Collected samples were analyzed for Suspended Solids Concentration (SSC) using ASTM D3977-97 (2013).

After a run, the injection feed was stopped and time-stamped. The flow was stopped after less than one (1) detention time had passed. The drawdown flow was calculated by measuring the vault water elevation every 1-second until the water level dropped low enough to break the siphon. Two (2) evenly-spaced effluent samples were collected from the pipe during drawdown. The spacing of the samples was based on the vault water volume. The average background concentration was used to adjust the vault drawdown concentrations. Since the supply water concentration typically increases over time in a closed-loop system, the use of the average background is considered conservative.

2.4 Sediment Mass Loading Capacity Testing

Sediment mass load capacity testing of the StormKleener Filter was conducted in accordance with the NJDEP Filtration Protocol. After performing the removal efficiency evaluation, additional tests were conducted using a target influent TSS concentration of 400 mg/L (±10%). Background, effluent and drawdown samples were collected in the same manner as the TSS removal efficiency testing.

2.5 Scour Testing

The StormKleener Filter system is designed with an internal bypass (located in vault wall) for on-line operation. Therefore, a 200% MTFR scour test, using 1-1000-micron sediment, was conducted on the filter to qualify it as an on-line system.

2.6 Instrumentation and Measuring Techniques

Flow

The inflow to the test unit was measured using one of three (3) calibrated differential-pressure flow meters (1.5", 2" or 4"). Each meter is fabricated per ASME guidelines and calibrated in Alden's Calibration Department. The high and low-pressure lines from each meter were connected to manifolds containing isolation valves. Flows were set with a control valve and the differential head from the meter was measured using a Rosemount® 0 to 250-inch DP cell, also calibrated at Alden. The test flow was averaged and recorded every ten (10) seconds throughout the duration of the test using the in-house computerized DA program. The accuracy of the flow measurement is ±2%. A photograph of the flow meters is shown on **Figure 5.**

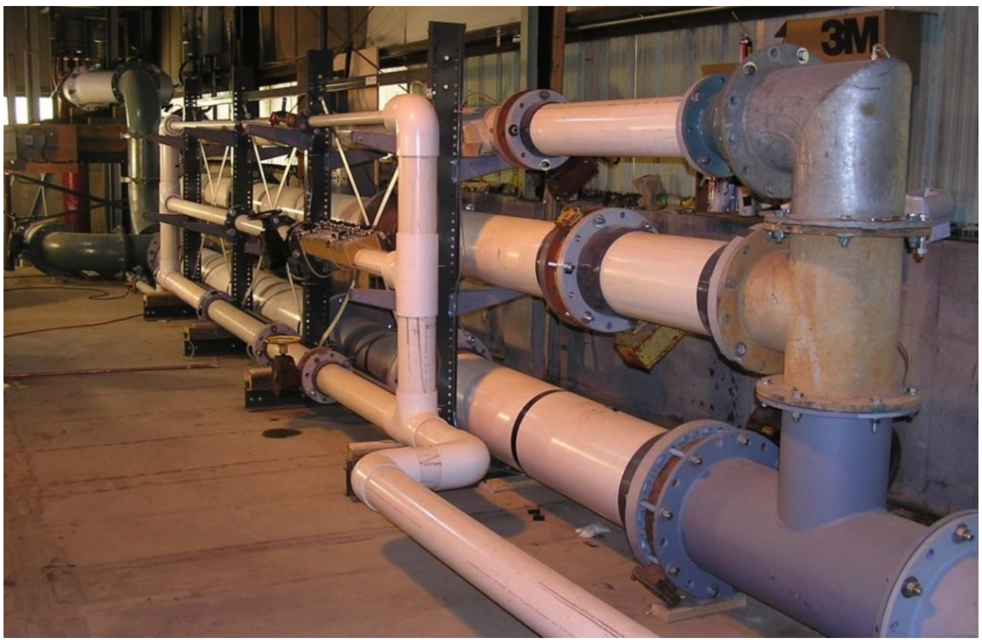

Figure 5 Photograph Showing Laboratory Flow Meters

Temperature

Water temperature measurements within the supply sump were obtained using a calibrated Omega® DP25 temperature probe and readout device. The calibration was performed in Alden's Calibration Department. The temperature reading was documented at the start and end of each test, to assure an acceptable testing temperature of less than 80 degrees F.

Pressure Head

Pressure head measurements were recorded in the test vault using a piezometer tap installed in the tank wall and an Omegadyne PX419, 0 - 2.5 psi cell. The pressure cell was calibrated at

Alden prior to testing. Accuracy of the readings is ± 0.001 ft. The cell was installed at a known datum in relation to the tank floor, allowing for vault elevation readings through the full range of flows. A minimum of 60 seconds of pressure data was averaged and recorded for each pressure tap during steady-state hydraulic testing, using the computerized DA program. Driving head measurements were averaged and recorded every ten (10) seconds during removal efficiency testing and are referenced to the vault floor. A photograph of the pressure instrumentation is shown on **Figure 6**.

Figure 6 Pressure Measurement Instrumentation

Sediment Injection

The test sediment was injected into the crown of the influent pipe using an Auger® volumetric screw feeder, model VF-1, shown on **Figure 7**. The auger feed screw, driven with a variable-speed drive, was calibrated with the test sediment prior to testing, to establish a relationship between the auger speed (0-100%) and feed rate in grams/minute. The calibration, as well as verifications of the test sediment feed was accomplished by collecting timed dry samples of 0.1-liter, up to a maximum of 1-minute, and weighing them on an Ohaus® 4000g x 0.1g, model SCD-010 digital scale. The feeder has a hopper at the upper end of the auger to provide a constant supply of test sediment. The allowable COV for the injection is 0.10.

Figure 7 Photograph Showing Variable-Speed Auger Feeder

Sample Collection

Effluent samples were collected in 2-liter containers from the end of the 4-inch effluent pipe. Background concentration samples were collected from the center of the vertical pipe upstream of the test unit with the use of a calibrated isokinetic sampler, shown on **Figure 8**.

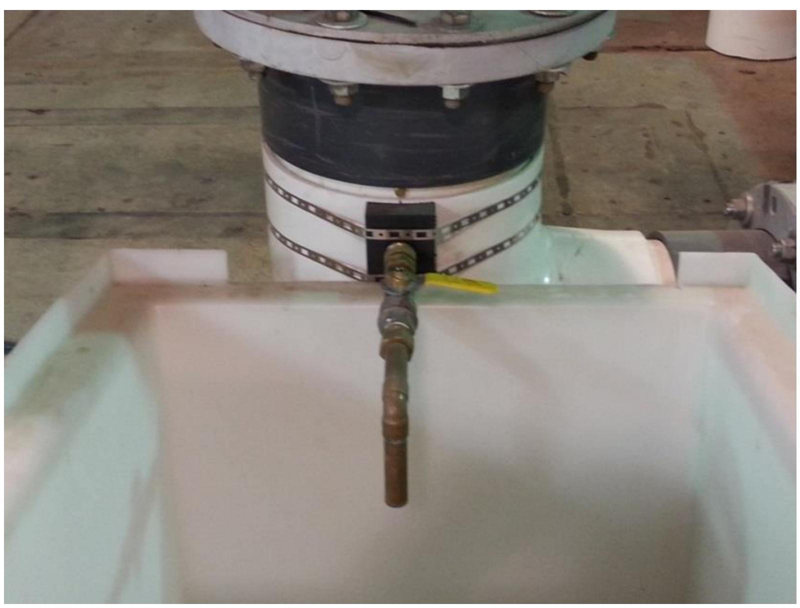

Figure 8 Photograph Showing the Background Isokinetic Sampler

Sample Concentration Analysis

Effluent and background concentration samples were analyzed by Alden in accordance with Method B, as described in ASTM Designation: D 3977-97 (Re-approved 2013), "Standard Test Methods for Determining Sediment Concentration in Water Samples". The required silica sand used in the sediment testing did not result in any dissolved solids in the samples and therefore, simplified the ASTM testing methods for determining sediment concentration.

All samples were collected in graduated 2-liter beakers which were weighed prior to sampling. Collected samples were weighed and filtered through a pre-rinsed Whatman® 934-AH, 47-mm, 1.5-micron, glass microfiber filter paper, using a laboratory vacuum-filtering system. Once filtered, each sample and dish were dried and weighed to the nearest 0.0001-gram, using an AND® analytical balance. Net sediment weight (mg) was determined by subtracting the dried filter weight (tare) from the dried sample weight and multiplying the result by 1,000. The net sample volume, in liters, was determined by subtracting the beaker and net sediment weight from the overall sample weight and dividing by 1,000. Each sample sediment concentration, in mg/liter, was determined by dividing the net sediment weight by the net sample volume.

2.7 Data Management and Acquisition

A designated Laboratory Records Book and printed data sheets were used to document the conditions and pertinent data entries for each test run conducted. All entries are initialed and dated.

A personal computer running an Alden in-house Labview® DA program was used to record all data related to instrument calibration and testing. A 16-bit National Instruments® NI6212 Analog to Digital (A/D) board was used to convert the signal from the pressure cells. Alden's in-house data collection software, by default, collects one second averages of data at a raw rate of 250 Hz. The system allows very long contiguous data collection by continuously writing the collected 1-second averages and their RMS values to disk. The data output from the program is in tab delimited text format with a user-defined number of significant figures. The recorded data files were imported into a spreadsheet for further analysis and plotting.

Excel based data sheets were used to record all sediment related data used for quantifying injection rate, effluent and background sample concentrations. The data was input to the designated spreadsheet for final processing.

2.8 Quality Assurance and Control

All instruments were calibrated prior to testing and periodically checked throughout the test program. Instrumentation calibrations were provided.

Flow

The flow meters and pressure cells were calibrated in Alden's Calibration Laboratory, which is ISO 17025 accredited. All pressure lines were purged of air prior to initiating each test. A standard water manometer board and Engineers Rule were used to measure the differential pressure and verify the computer measurement of the selected flow meter.

Sediment Injection

The sediment feed (g/min) was verified with the use of a digital stop watch and 4000g calibrated digital scale. The tare weight of the sample container was recorded prior to collection of each sample. The samples were a minimum of 0.1 liters in size, with a maximum collection time of 1-minute.

Sediment Concentration Analysis

All sediment concentration samples were processed in accordance with the ASTM D3977-97 (2013) analytical method. Gross sample weights were measured using a 4000g x 0.1g calibrated digital scale. The dried sample weights were measured with a calibrated 0.0001g analytical balance. Any change in filter weight due to processing was accounted for by including three control filters with each test set. The average of the three values, which was +/- 0.1-0.5 mg, was used in the final concentration calculations.

Analytical accuracy was verified by preparing two blind control samples and processing using the ASTM method. The final calculated values were within 0.26% and 0.87% of the theoretical sample concentrations, with an average of 0.57% accuracy. This value was not corrected for particles smaller than the filter designation of 1.5 microns and therefore considered conservative.

3. Performance Claims

Per the NJDEP verification procedure and based on the laboratory testing conducted at Alden on the StormKleener Filter, the following are the performance claims made for the cartridge filter.

Total Suspended Solids (TSS) Removal Efficiency

Based on the laboratory testing conducted in accordance with the NJDEP Filtration Protocol (NJDEP 2013), the StormKleener Filter achieved an 80% TSS removal efficiency.

Maximum Treatment Flow Rate (MTFR)

The MFTR varies among the different models of StormKleener Filters available. However, the loading rate remains the same on each filter. The test unit was a single 18-inch diameter StormKleener Filter with an MTFR of 30 gpm and an effective filtration treatment area of 10.0 ft^2. The flow through each cartridge is regulated by an orifice to maintain the flow rate. The loading rate is 3.0 gpm/ft^2 of filter treatment surface area.

Effective Sedimentation/Filtration Treatment Areas

The Effective Sedimentation Area (ESA) increases as the number of cartridges increases. A larger system with multiple cartridges increases the ESA. Under the test condition with a single cartridge, the ESA and the ratio of ESA to Effective Filtration Treatment Area (EFTA) were 7.07 ft^2 and 7.07/10.0 (0.70) respectively. This ratio is maintained or increases in field installations.

Detention Time and Wet Volume

Detention time of the StormKleener Filter will vary with model size and configuration. The detention time of the single cartridge test unit was 1 minute and 47 seconds. Since the test unit represents the smallest allowable ratio of effective sedimentation area per filter cartridge and the surface area specific hydraulic loading rate of all cartridges remains constant at 3.0 gpm/ft^2 of media surface area, the detention time for commercially available units will be the same or longer than the detention time of the tested unit.

The StormKleener Filter does not maintain a permanent wet volume. The minimum operational wet volume for the StormKleener Filter (to initiate siphon flow) is 21 cubic feet per cartridge. At maximum driving head (bypass elevation), the wet volume is 35 cubic feet per cartridge. The system drains down between each storm event.

Effective Filtration Treatment Area

The effective filtration treatment area of the StormKleener Filter used during the testing is 10.0 ft^2.

Sediment Mass Load Capacity

The sediment mass loading capacity varies with the StormKleener Filter Cartridge size and the number of cartridges installed in the system. Based on the laboratory testing results, the 18-inch StormKleener Filter has a mass loading capacity of 13.9 lbs. This is equivalent to a sediment mass loading capacity of 1.39 lbs/ft^2 of filter surface area.

Maximum Allowable Inflow Drainage Area

Based on the NJDEP requirement to determine maximum allowable inflow area using 600 lbs of sediment per acre annually and the tested sediment mass loading capacity for the StormKleener Filter of 13.87 lbs. per 18-inch diameter cartridge (1.39 lbs/ft^2 of filter surface area), this StormKleener Filter has a maximum allowable inflow drainage area of 0.023 acres per filter cartridge.

4. Supporting Documentation

The NJDEP Procedure (NJDEP, 2013a) for obtaining verification of a stormwater manufactured treatment device (MTD) from the New Jersey Corporation for Advanced Technology (NJCAT) requires that "copies of the laboratory test reports, including all collected and measured data; all data from performance evaluation test runs; spreadsheets containing original data from all performance test runs; all pertinent calculations; etc." be included in this section. This was discussed with NJDEP and it was agreed that as long as such documentation could be made available by NJCAT upon request that it would not be prudent or necessary to include all this information in this verification report. This information was provided to NJCAT and is available upon request.

4.1 Test Sediment PSD Analysis

The sediment particle size distribution (PSD) used for removal efficiency testing exceeded the NJDEP PSD sediment specifications (**Table 1**) across the entire distribution. The specific gravity of the sediment mix was 2.65. A commercially-available blend was provided by AGSCO Corp., a QAS International ISO-9001 certified company, and adjusted by Alden to meet the NJDEP %-finer acceptance criteria. Test batches of approximately 30 lbs each were prepared in individual 5-gallon buckets, which were arbitrarily selected for the removal testing. Three samples were collected from random batches and analyzed in accordance with ASTM D422-63 (2007), by GeoTesting Express, an ISO/IEC 17025 accredited independent laboratory. The average of the samples was used for compliance to the protocol specifications. The D_{50} of the samples ranged from 64 to 69 microns, with an average of 66 microns. The PSD data of the samples are shown in **Table 2** and the corresponding curves are shown on **Figure 9**.

Table 2 PSD Analysis of Alden NJDEP 1-1000 Micron Test Sediment

Particle size (µm)	Sample 1 (%-finer)	Sample 2 (%-finer)	Sample 3 (%-finer)	Average (%-finer)	NJDEP (%-finer)	QA/QC
1000	100	100	100	**100**	100	Pass
500	96	96	95	**96**	95	Pass
250	92	93	91	**92**	90	Pass
150	73	75	77	**75**	75	Pass
100	60	61	62	**61**	60	Pass
75	51	52	53	**52**	50	Pass
50	47	46	46	**46**	45	Pass
20	37	34	35	**35**	35	Pass
8	21	20	22	**21**	20	Pass
5	15	14	16	**15**	10	Pass
2	6	6	7	**6**	5	Pass
D_{50}	**69**	**66**	**64**	**66**	**<75**	Pass

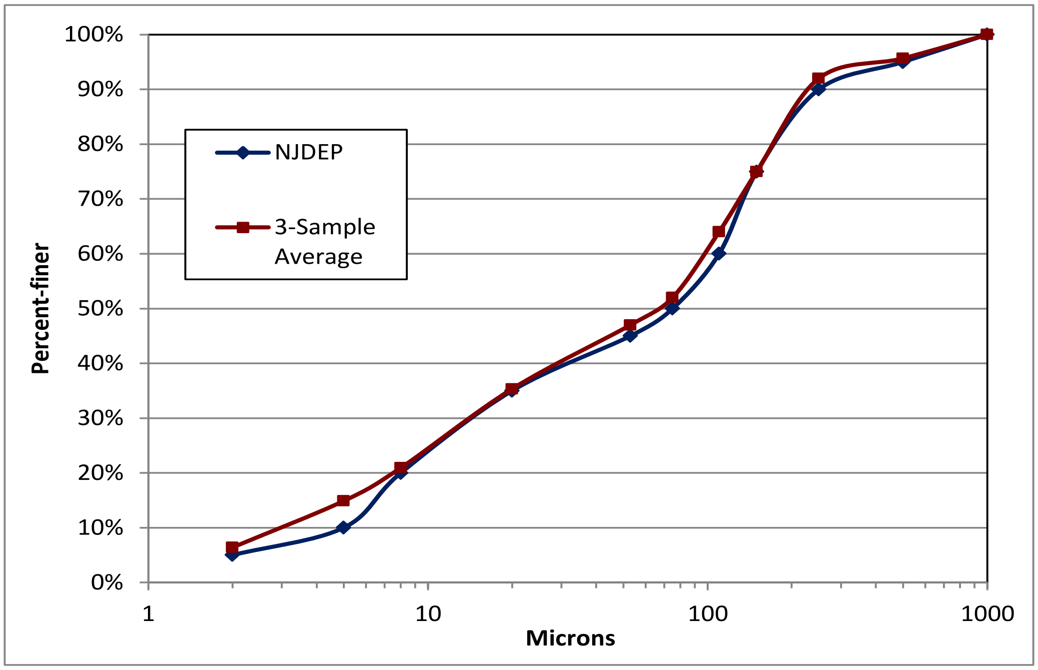

Figure 9 Comparison of PSD Curves of NJDEP and Alden Test Sediment

4.2 Removal Efficiency

Ten (10) removal efficiency test runs were conducted at a target flow of 30 gpm (100% MTFR). The minimum sediment injection duration of the runs was 34 minutes, with a target influent sediment concentration of 200 mg/l. An additional run (Run 11) was conducted as per the mass loading criterion. Run 11 is discussed below in Section 4.3. All test runs met or exceeded the protocol testing criteria. (**Table 3)**

The measured flow for the 10 runs ranged from 29.9 gpm to 30.1 gpm, with an average flow of 30.0 gpm. The COV for runs 1-10 was 0.001. The maximum recorded temperature for the runs ranged from 76.0 to 78.5 degrees F. Three (3) feed rate samples were collected per trial to verify the sediment delivery rate and resulting influent concentration. All sediment feed rate samples were collected in clean sampling containers over an interval of 1 minute. Average influent TSS was calculated using **Equation 1**. The measured injected influent concentrations for runs 1-10 ranged from 201 to 204 mg/L, with injection COVs ranging from 0.004 to 0.012. The maximum background concentration was 2.0 mg/L. (**Table 3**)

Equation 1 Average Influent TSS

$$Average\ Influent\ TSS\ \left(\frac{mg}{L}\right) = \frac{Average\ Feed\ Rate\ \left(\frac{g}{min}\right) \times \frac{1000\ mg}{g}}{Average\ Water\ Flow\ Rate\ \left(\frac{gal}{min}\right) \times \frac{3.785\ L}{gal}}$$

Table 3 Summary of Test Parameters

Run #	Test Duration	Measured Flow		Max Temp	Max Background	Influent Concentration (mg/L)			QA/QC Compliant
	minutes	gpm	COV	Deg. F	mg/L	Minimum	Maximum	COV	
1	34	30.0	0.001	78.4	1.0	203	206	0.007	Yes
2	34	29.9	0.001	76.0	0.3	200	203	0.008	Yes
3	34	30.0	0.001	76.3	1.3	201	203	0.006	Yes
4	34	30.1	0.001	76.4	0.8	199	203	0.009	Yes
5	34	30.0	0.001	77.1	1.1	201	206	0.012	Yes
6	34	30.1	0.001	77.2	2.0	199	204	0.012	Yes
7	34	29.9	0.001	78.3	0.8	201	206	0.012	Yes
8	34	29.9	0.001	78.4	1.0	200	202	0.004	Yes
9	34	30.0	0.001	77.3	1.0	200	202	0.004	Yes
10	34	30.0	0.001	77.3	1.2	201	204	0.006	Yes
11	61	30.0	0.003	78.5	5.6	398	401	0.004	Yes

Background, effluent and drawdown TSS samples were collected in clean 1-liter bottles, with each sample exceeding the minimum required 500 mL sample volume. The average adjusted effluent and adjusted drawdown concentrations are shown in **Table 4**. The average adjusted effluent concentrations ranged from 29.8 to 46.3 mg/L and the average drawdown concentrations ranged from 19.7 to 31.0 mg/L. The drawdown duration for the ten (10) runs was approximately 1.6 minutes.

Table 4 Adjusted Effluent and Drawdown Concentrations

Run #	Flow	Adjusted Effluent Concentrations (mg/L)							Adjusted Drawdown Concentrations (mg/L)		
	gpm	#1	#2	#3	#4	#5	#6	Average	#1	#2	Average
1	30.0	42.1	44.1	42.1	40.8	40.2	-	**41.9**	33.8	28.2	**31.0**
2	29.9	35.6	29.4	36.7	40.8	46.0	-	**37.7**	28.6	23.0	**25.8**
3	30.0	20.1	15.4	30.4	41.4	41.5	-	**29.8**	25.8	22.2	**24.0**
4	30.1	20.0	39.8	38.3	37.7	34.0	-	**33.9**	24.7	25.2	**24.9**
5	30.0	46.5	48.4	45.5	46.0	44.8	-	**46.3**	29.1	25.6	**27.4**
6	30.1	40.0	45.0	42.5	43.6	43.4	-	**42.9**	30.9	26.6	**28.8**
7	29.9	43.7	45.5	43.5	45.5	45.8	-	**44.8**	26.0	22.8	**24.4**
8	29.9	42.5	43.1	38.5	37.0	34.7	-	**39.2**	21.5	17.9	**19.7**
9	30.0	37.8	37.2	41.5	39.4	40.1	-	**39.2**	25.1	21.2	**23.1**
10	30.0	38.4	39.7	41.3	41.2	39.3	-	**40.0**	29.1	25.2	**27.2**
11	30.0	84.4	94.0	95.3	109.0	103.0	99.8	**97.6**	59.0	50.8	**54.9**

The individual and cumulative mass removal efficiencies are shown in **Table 5**. The removal efficiency was calculated from **Equation 2**.

Equation 2 Removal Efficiency (RE)

$$\boldsymbol{RE}\ (\%) = (\mathbf{100}\%) \times \frac{\left[\begin{array}{c}\boldsymbol{Average\ Influent\ TSS}\ \left(\frac{\boldsymbol{mg}}{\boldsymbol{L}}\right) \\ \times\ \boldsymbol{Influent\ Volume}\ (\boldsymbol{L})\end{array}\right] - \left[\begin{array}{c}\boldsymbol{Average\ Adjusted\ Effluent\ TSS}\ \left(\frac{\boldsymbol{mg}}{\boldsymbol{L}}\right) \\ \times\ \boldsymbol{Effluent\ Volume}\ (\boldsymbol{L})\end{array}\right] - \left[\begin{array}{c}\boldsymbol{Average\ Adjusted\ Drawdown\ TSS}\ \left(\frac{\boldsymbol{mg}}{\boldsymbol{L}}\right) \\ \times\ \boldsymbol{Drawdown\ Volume}\ (\boldsymbol{L})\end{array}\right]}{\left[\begin{array}{c}\boldsymbol{Average\ Influent\ TSS}\ \left(\frac{\boldsymbol{mg}}{\boldsymbol{L}}\right) \\ \times\ \boldsymbol{Influent\ Volume}\ (\boldsymbol{L})\end{array}\right]}$$

The run removal efficiencies ranged from 77.5% to 85.3%, with an average removal efficiency of 80.6%. The cumulative mass removal efficiency for the 10 runs was 80.6% also.

Table 5 Removal Efficiency Summary

Run #	Average Influent Concentration	Average Adjusted Effluent Concentration	Average Adjusted Drawdown Concentration	Influent Volume	Effluent Volume	Drawdown Volume	Mass Loading	Mass Captured	Run Removal Efficiency by Mass
	mg/L	mg/L	mg/L	L	L	L	kg	kg	%
1	204	41.9	31.0	3854	3764	90	0.788	0.628	**79.6**
2	201	37.7	25.8	3851	3758	93	0.776	0.632	**81.4**
3	202	29.8	24.0	3861	3769	92	0.780	0.665	**85.3**
4	201	33.9	24.9	3871	3777	94	0.779	0.648	**83.2**
5	204	46.3	27.4	3864	3769	95	0.788	0.611	**77.5**
6	202	42.9	28.8	3866	3767	99	0.779	0.615	**78.9**
7	203	44.8	24.4	3849	3756	93	0.781	0.611	**78.2**
8	201	39.2	19.7	3849	3754	95	0.773	0.625	**80.8**
9	201	39.2	23.1	3865	3769	95	0.778	0.628	**80.7**
10	203	40.0	27.2	3858	3760	98	0.782	0.629	**80.4**
						Total Mass Runs 1-10	7.804	6.292	
								Average Removal Efficiency by Mass Through Run 10	**80.6**
11	399	97.6	54.9	6920	6815	105	2.761	2.090	
						Total Mass Runs 1-11	10.565	8.382	
								Average Removal Efficiency by Mass Through Run 11	**79.3**

The maximum allowable driving head prior to bypass is 5.0 ft. The maximum measured driving head, which occurred at the end of each run, was 1.61 ft. The measured driving head at the start and end of each run, as well as the removal efficiency are shown on **Figure 10.**

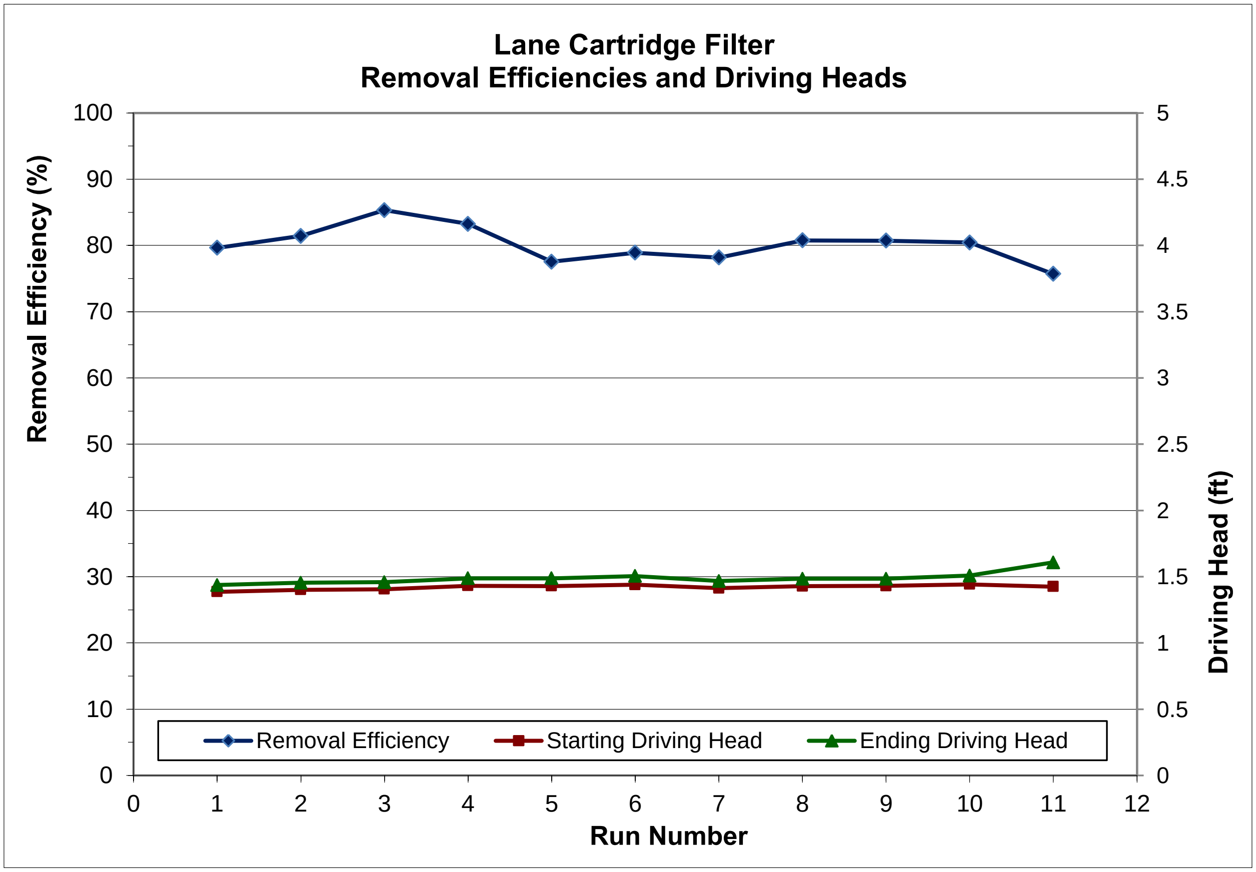

Figure 10 Removal Efficiency and Driving Head Data

4.3 Sediment Mass Loading Capacity

Mass loading capacity testing was conducted as a continuation of removal efficiency testing. Mass loading testing was conducted using identical testing procedures and targets as those used in the removal efficiency runs, the only change was to increase the target influent concentration to 400 mg/L and test for a duration approximately twice as long. The average measured flow was 30.0 gpm, with a COV of 0.003. The influent concentration was 399 mg/L, with a COV of 0.004. The average adjusted effluent concentration was 97.6 mg/L and the average drawdown concentration was 54.9 mg/L. The drawdown duration was approximately 2 minutes. The maximum driving head, which was recorded at the end of Run 11, was 1.61 ft., which is well below the set height of 5 ft. The cumulative mass removal efficiency dropped below 80% during this run (**Table 5**), so that mass loading capacity for the StormKleener Filter is based on runs 1-10 only.

A total of 17.20 lb. (7.804 kg) was injected into the test unit during runs 1-10, with a total capture amount of 13.87 lb. (6.292 kg). This results in a maximum allowable impervious inflow drainage area of 0.023 acres per filter cartridge.

4.4 Scour Test

The StormKleener Filter is designed with an internal vault bypass pipe for on-line operation. Therefore, a 200% MTFR scour test, using 1-1000-micron sediment, was conducted on the filter to qualify it as an on-line system. All sediment that settled within the treatment vault was removed, dried and quantified after the completion of all removal efficiency tests. The sediment collected outside of the cartridge constituted 86% of the total mass, with the remaining 14% of the mass collected from under the cartridge. The tested cartridge filter was placed back into the test tank and the tank floor outside of the cartridge was preloaded to the 50% sediment capacity depth of 3". The floor beneath the cartridge was preloaded to a depth of 1.5", based on the measured area and captured-mass ratios.

The scour test was conducted with clean water (<20 mg/L). The measured average flow was 60.1 gpm and the COV was 0.002. The flow was reached within 5 minutes of initiating the test. A total of 15 effluent samples were collected at 2-minute intervals. Background samples were collected with each odd-numbered effluent sample, for a total of 8 samples.

The maximum background concentration was 0.7 mg/L and the average adjusted effluent concentration was 1.01 mg/L. The maximum temperature was 75.0 degrees F. The measured water level was 3.0 ft. The test results are shown in **Table 6** and flow data shown on **Figure 11.**

Table 6 200% MTFR Scour Data

Sample #	Timestamp (minutes)	Effluent Concentration mg/L	Background Concentration mg/L	Adjusted Effluent Concentration mg/L
1	2	2.00	0.47	1.50
2	4	1.73	0.56	1.24
3	6	1.86	0.65	1.36
4	8	1.51	0.52	1.01
5	10	1.11	0.38	0.61
6	12	2.01	0.45	1.52
7	14	1.99	0.52	1.49
8	16	3.11	0.38	2.61
9	18	0.97	0.24	0.47
10	20	0.94	0.38	0.44
11	22	2.10	0.52	1.60
12	20	0.80	0.53	0.30
13	26	0.75	0.55	0.25
14	28	0.83	0.62	0.34
15	30	0.95	0.70	0.45
Average		1.51	0.50	1.01

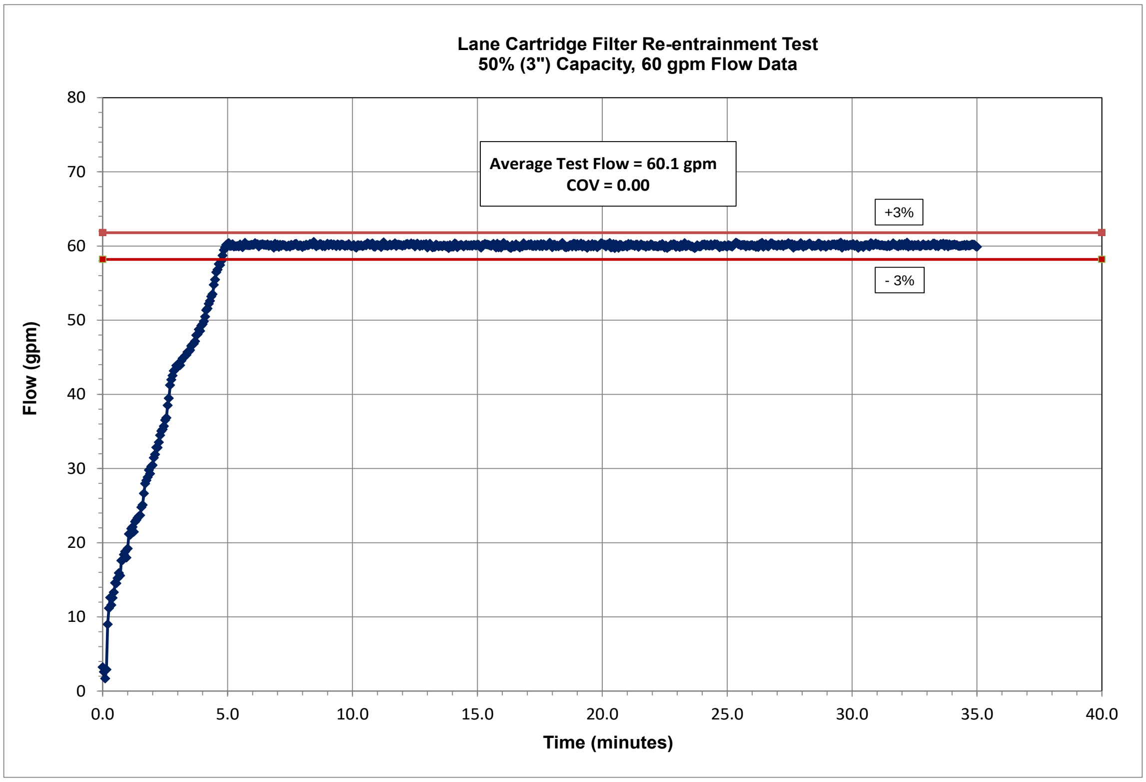

Figure 11 200% MTFR Scour Test Flow Data

4.5 Hydraulics

Steady-state pressure measurements were recorded on a clean filter to establish the hydraulic characteristic curves. Recorded flows ranged from approximately 25 to 85 gpm, at which point the allowable maximum driving head of 5.0 ft was reached. The recorded data is shown in **Table 7** and corresponding curves on **Figure 12.**

Table 7 Measured Hydraulic Data

Flow		Tank	Outlet Pipe	Outlet El. (B') Corrected for Energy	Filter Loss Tank-Outlet A-B'	Loss Coefficient
gpm	cfs	[A] ft	[B] ft	ft	ft	Cd
25.1	0.06	1.194	0.351	0.390	0.804	0.089
30.2	0.07	1.392	0.365	0.410	0.982	0.097
45.0	0.10	2.045	0.392	0.458	1.587	0.114
60.1	0.13	2.893	0.4144	0.503	2.390	0.124
80.0	0.18	4.433	0.4791	0.544	3.889	0.129
85.3	0.19	4.864	0.4739	0.548	4.316	0.131

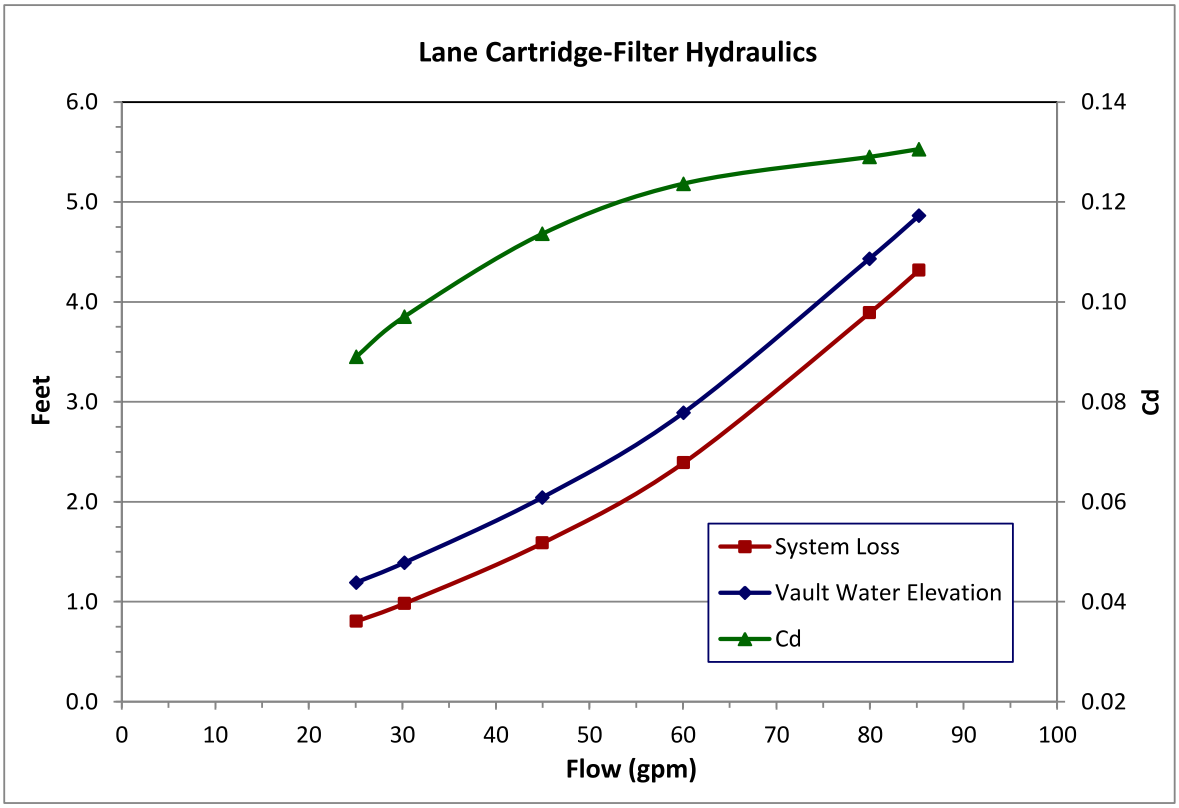

Figure 12 StormKleener Filter Hydraulic Characteristic Curves

5. Design Limitations

Required Soil Characteristics

The StormKleener Filter is suitable for installation in all types of soils.

Slope

The StormKleener Filter is recommended to be installed at 0% slope. Steep pipe slopes (>25 degrees) may present a fabrication or installation challenge. However, due the different configurations and materials that can be used in the fabrication of the StormKleener Filter vaults, accommodations can be made for severe grades entering the structure. Configurations, therefore, can be designed to accommodate sloping surface grades. The Lane Engineering Team should be consulted if concerns regarding slope or other site conditions exist.

Maximum Flow Rate

The maximum treatment flow rate for the StormKleener Filter is a function of model size and the number and size of the filter cartridges contained in the unit. The StormKleener Filter is rated

This was rounded to 3.0 in section 3.

for a hydraulic loading rate of 2.97 gpm/ft^2 of filter media surface area.

Maintenance Requirements

StormKleener Filter maintenance will be affected by the pollutant loading at each individual site. Detailed maintenance information is provided in **Section 6**.

Driving Head

The amount of driving head required for normal operation of the StormKleener Filter is typically fixed and dependent on the cartridge height. The minimum driving head required to start flow (the initiation of siphon flow) of the filter is 35.56-inches. Once flow has started the driving head may reduce and flow through the filters will continue. Site condition limitations may constrain the amount of driving head available for the StormKleener Filter. In this case, flow is typically backed up into the upstream piping during operation until minimum driving head is provided. The amount of head needed to maintain flow may then drop during operation. The StormKleener Filter can be designed to accommodate much higher driving head when needed.

Installation Limitations

The StormKleener Filter has very few limitations. Lane's engineering team works with consulting engineers to determine the best design and installation alternatives for specific sites. The flexibility of the cartridges and carrier vaults eliminates most site constraints which may be present.

Configurations

The StormKleener Filter is typically comprised of a vault or manhole structure that house the media-filled filter cartridges. The StormKleener Filter is also offered in plastic, steel, and concrete structures. Other configurations include panel vaults, box culverts, curb inlets, large diameter corrugated metal pipe, and structural plate. The filter cartridges operate consistently and act independently, regardless of housing, which enables linear scaling.

Structural Load Limitations

Most StormKleener Filter configurations are designed for H-25 traffic loading. Lane's engineering team ensures that the configuration is appropriate for the site-specific loading conditions during the design process.

Pre-treatment Requirements

The StormKleener Filter does not require additional pretreatment. If desirable, pretreatment may be provided upstream of the filters to reduce the pollutant load reaching the filter media and extend the useful life of the cartridges. However, all sediment capacity and maintenance recommendations assume no additional pretreatment is provided.

Limitations in Tailwater

Tailwater has the potential to impact the operation of the StormKleener Filter. Any applications where the filter will be subject to tailwater conditions should be reviewed with Lane's engineering team to evaluate the potential impact on performance.

Depth to Seasonal High-Water Table

The StormKleener Filter is not typically impacted by high ground water since the unit is fully contained in a vault, manhole or other closed structure. Lane's engineering team is available to consult on the need for water tightness and/or concerns related to buoyancy.

6. Maintenance

Maintenance Procedures

Maintenance of the StormKleener Filter is a simple process. The instructions for maintenance can be found in their design manual which is available on our website at: http://lane-enterprises.com/transfer/Lane-StormKleener-Design-Manual-WEB.pdf. The process is simple and easy to follow and consists of both inspection and maintenance.

1. Inspection - vault interior to determine the need for maintenance.
2. Maintenance - cartridge replacement and sediment removal

Inspection and Maintenance

During the first year of operation, inspection of the StormKleener Filter should be conducted quarterly. The maintenance frequency during the first year or two may be increased on new sites until the site is fully stabilized. After the first year the inspection frequency can be increased to once yearly. If the inspection indicates that maintenance is required, it should take place as soon as practical. Inspection should be performed before the winter season. During the inspection, the need for maintenance should be determined. If disposal during maintenance will be required, samples of the accumulated sediments and filtration media should be collected. Maintenance (replacement of the filter cartridges and removal of accumulated sediments) should be performed during periods of dry weather. In addition, the StormKleener Filter should be checked after major storms for high sediment accumulation that may be caused by localized erosion in the drainage area. It may be necessary to adjust the inspection/ maintenance schedule depending on the actual operating conditions encountered by the system. In general, inspection activities can be conducted at any time, and maintenance should occur, if warranted, during dryer months in late summer to early fall.

Maintenance Frequency

The primary factor for determining frequency of maintenance for the StormKleener Filter is sediment loading. The system will remove solids from water by trapping particulates inside the cartridges and depositing them on the vault floor during backwash. The flow through the system will naturally decrease as more and more particulates are trapped. Eventually the flow through the cartridges will be low enough to require replacement. This will be indicated by a longer retention time of stormwater in the vault.

The average maintenance lifecycle is approximately 1-5 years. Site conditions greatly influence maintenance requirements. Units located in areas with erosion or active construction may need to be inspected and maintained more often than those with fully stabilized surface conditions. The StormKleener Filter is not intended for sites which are actively under construction.

Regulatory requirements, unusually naturally occurring events, or manmade events can also increase the maintenance timing. The maintenance frequency may be adjusted as additional monitoring information becomes available during the inspection program. Areas that consistently develop problems should be inspected more frequently than areas that experience fewer problems, particularly after major storms. Inspection and maintenance activities should be scheduled based on the historic records and characteristics of the subject system or site. The site where the system is installed should develop a historical record to determine the optimum requited maintenance schedule.

Inspection Procedures

The inspection should identify the amount of sediment that is deposited in the bottom of the vault as well as the amount of time it takes for water to dissipate after the storm has ended. The inspection should take place during a storm to observe the flow through the filter cartridges as well as the draw down time for water in the vault to fully dissipate and the backwash operation. If the cartridges are in need of replacement, then large amounts of sediments will typically be present, very little flow will be discharged from the drainage pipes, and stormwater will remain for a longer period of time in the vault during drawdown. Typically, when stormwater is still present in the vault after 24 hours then maintenance is required.

Important: Inspection should be performed by a person who is familiar with the operation and configuration of the StormKleener Filter.

To conduct an inspection:

1. Setup required safety equipment and block vehicle and pedestrian traffic.
2. Visually inspect the external condition of the unit and take notes concerning defects/problems.
3. Open the access portals to the vault and allow the system to vent.

4. Without entering the vault, visually inspect the inside of the unit, and note accumulations of liquids and solids.

5. Note level of water if during a storm event.

6. Record and document the sediment level on the floor of the vault. Pictures with date and time stamp are recommended for comparison purposes.

7.. Close and fasten the access portals.

8.. Remove safety equipment and traffic control devices.

9. Note site conditions and any unusual contributors to excess erosion or sediment.

10. If the inspection occurs during a storm event, a follow up inspection for water level and dissipation should take place within the next 24 hours.

9. Determine if maintenance is needed.

Maintenance Decision Tree

The inspection results will determine the need for maintenance. The following information determines if maintenance is required subject to local regulations.

1. Sediment loading on the vault floor.
    - If greater than an average of 4" of sediment is distributed across the vault floor, maintenance should be performed.

2. Standing Water.
    - If more than 8" of standing water above the vault floor is in the vault after 24 hours than maintenance is required.

3. Hazardous material release.
    - If hazardous material release (automotive fluids or other) is reported, maintenance is required.

Maintenance

If the system is contained in a vault structure, entry into the system may be required. Smaller systems contained in catch basins or round manhole structures may not require entry.

Important: If vault entry is required, OSHA rules for confined space entry must be followed.

Filter cartridge replacement should occur during dry weather. Inlets into the vault should be plugged to stop the flow of water during maintenance to prevent personnel injury.

Replacement cartridges are available from Lane Enterprises and should be available prior to maintenance starting on the system. Cartridges can be delivered to the site or other customer facility as required.

> **Warning:** In the case of a spill, the maintenance personnel should discontinue maintenance activities until proper guidance is given. Contact local authorities and Lane Enterprises for instructions.

To conduct cartridge replacement and sediment removal maintenance:

1. Set up safety equipment for personnel entering the system. Setup appropriate traffic and pedestrian control devices.

2. Visually inspect the external condition of the unit and take notes concerning defects and/or problems.

3. Open the doors (access portals) to the vault and allow the system to vent.

4. Without entering the vault, give the inside of the unit, including components, a general condition inspection.

5. Make notes about the external and internal condition of the vault. Make notes regarding sediment buildup inside the tank.

6. Offload the replacement cartridges (up to 150 lbs. each) and stage appropriately.

7. Remove used cartridges from the vault using one of the following methods.

Method 1(Structure built in piping)

1. Maintenance personnel will need to enter the system. Cartridges are lifted off the connectors to the built-in piping. Cartridges are lifted utilizing the built-in lifting mechanism and chain. Once the cartridges are lifted they can be transported to the vault opening. Cartridges should be removed from those nearest to the vault opening and working away. Remove the drawdown filter from each connection to be replaced.

2. Remove the used cartridges (up to 250 lbs. each) from the vault. A lifting mechanism will be required.

3. Set the used cartridge aside or load onto the hauling truck.

4. Continue steps 1 through 3 until all cartridges have been removed.

Method 2

1. This activity will require that maintenance personnel enter the vault to remove the cartridges from the piping laying on the floor and place them under the vault opening for removal. Disconnect each filter cartridge from the floor piping. Cartridges are lifted utilizing the built-in lifting mechanism and chain. Once the cartridges are lifted they can be transported to the vault opening. Cartridges should be removed from those nearest to the vault opening and working away. Remove the drawdown filter from each connection to be replaced.

2. Remove the used cartridges (up to 250 lbs. each) from the vault. A lifting mechanism will be required.

3. Set the empty, used cartridge aside or load onto the hauling truck.

4. Move piping to the side for vault cleanout. Piping must be replaced in system prior to installation of new cartridges.

5. Continue steps 1 through 4 until all cartridges have been removed.

6. Remove accumulated sediment from the floor of the vault. This can most effectively be accomplished by use of a vacuum truck.

7. Replace the piping on the floor of the vault if required.

8. Using the vacuum truck boom, crane, or tripod, lower and install the new cartridges. Install the drain down filters.

9. Close and fasten the door.

10. Remove safety equipment.

11. Finally, dispose of the accumulated materials in accordance with applicable regulations and return the used cartridges to Lane Enterprises.

Material Disposal

The accumulated sediment found in stormwater treatment and conveyance systems must be handled and disposed of in accordance with regulatory protocols. It is possible for sediments to contain measurable concentrations of heavy metals and organic chemicals (such as pesticides and petroleum products). Areas with the greatest potential for high pollutant loading include industrial areas and heavily traveled roads.

Sediments and water must be disposed of in accordance with all applicable waste disposal regulations. When scheduling maintenance, consideration must be made for the disposal of solid and liquid wastes. This typically requires coordination with a local landfill for solid waste disposal. For liquid waste disposal several options are available including a municipal vacuum truck decant facility, local waste water treatment plant or on-site treatment and discharge.

7. Statements

The following signed statements from the manufacturer (Lane Enterprises Inc.), independent testing entity (Alden Research Laboratory Inc.) and NJCAT are required to complete the NJCAT verification process.

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

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717 • 761 • 8175
Fax 717 • 761 • 5055

February 1, 2018

New Jersey Corporation for Advanced Technology
Center for Environmental Systems
One Castle Point
Hoboken, NJ 07030-0000

Re: Lane StormKleener Filter Cartridge Verification Testing

Dear Sir or Madam:

The Lane Filter StormKleener Filter Cartridge has been 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 (January 2013).*

This letter serves to certify that the above protocol was strictly followed and that all requirements were met or exceeded during the testing of the Lane StormKleener Filter Cartridge.

If you have any questions or need any additional information please feel free to contact me.

Sincerely,

Kevin M. Miller, P.E.
Director of Product Development
Lane Enterprises

ALDEN

Solving flow problems since 1894

February 15, 2018

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

Conflict of Interest Statement

Alden Research Laboratory (ALDEN) is a non-biased independent testing entity which receives compensation for testing services rendered. ALDEN does not have any vested interest in the products it tests or their affiliated companies. There is no financial, personal or professional conflict of interest between ALDEN and Lane Enterprises.

Protocol Compliance Statement

Alden performed design research testing, as well as certification testing on the Lane Enterprises StormKleener™ Filter Cartridge System. All data collected on the selected final design was submitted. The Technical Report and all required supporting documentation has been submitted as required by the protocol.

Testing performed by ALDEN on the StormKleener Filter met or exceeded the requirements as stated in the "New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device", (January 25, 2013). A Technical Report and all required supporting documentation has been submitted as required by the protocol.

James T. Mailloux

James T. Mailloux

Senior Engineer
Alden Research Laboratory
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(508) 829-6000 x6446

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

February 14, 2018

Jim Murphy, 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. Murphy,

Based on my review, evaluation and assessment of the testing conducted on the Lane Enterprises StormKleener™ Filter Cartridge System (StormKleener Filter) with sand media at Alden Research Laboratory, Holden, Massachusetts, 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 Filter Protocol, January 2013) were met or exceeded. Specifically:

Test Sediment Feed

The test sediment used for the removal efficiency study was a commercially-available blend provided by AGSCO Corp., a QAS International ISO-9001 certified company, adjusted by Alden to meet the NJDEP % finer acceptance criteria. Three samples of sediment were sent out for particle size analysis using the methodology of ASTM method D422-63. The testing lab was GeoTesting Express Inc. Acton, Massachusetts, an ISO/IEC 17025 accredited independent laboratory. The sediment was found to meet the NJDEP particle size specification, had a d_{50} of 66 microns, and was acceptable for use.

Removal Efficiency Testing

Ten (10) removal efficiency test runs were conducted at the MTFR target flow of 30 gpm. All runs were protocol compliant. The cumulative mass removal efficiency for these 10 runs was

80.6%.

Sediment Mass Loading Capacity

Mass loading capacity testing was conducted as a continuation of removal efficiency testing. Mass loading test runs were conducted using identical testing procedures and targets as those used in the removal efficiency runs, the only change was to increase the target influent concentration to 400 mg/L and test for a duration approximately twice as long. Unfortunately, the cumulative mass loading capacity dropped below 80% during Run 11, so that mass loading capacity for the StormKleener Filter is based on runs 1-10 only. The captured sediment was 13.87 lb. during these 10 runs (1.37 lb./ft^2 of filter surface area).

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

Scour Testing

A scour test was performed on the StormKleener Filter. The average adjusted effluent concentration for the scour test at 60 gpm was 1.01 mg/L, qualifying the cartridge filter for online use at this flow rate.

Sincerely,

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

8. References

ASME 1971. *"Fluid Meters Their Theory and Application- Sixth Edition"*.

ASTM 2013. *"Standard Test Methods for Determining Sediment Concentration in Water Samples"*, Annual Book of ASTM Standards, D3977-97, Vol. 11.02.

ASTM 2007. *"Standard Test Method for Particle Size Analysis of Soils"*, Annual Book of ASTM Standards, D422-63, Vol. 04.08.

ASTM 2007. *"Standard Test Methods for Determination of Water (Moisture) Content of Soil by Direct Heating"*, Annual Book of ASTM Standards, D4959-07, Vol. 04.08.

NJDEP 2013. *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 – Lane Enterprises, 3905 Hartzdale Drive, Suite 514, Camp Hill, PA 17011. Telephone 717-761-8715, Fax 717-761-5055

- MTD - The Lane StormKleener™ Filter Cartridge (StormKleener) available diameters and their verified capacities as well as standard configurations are shown in **Table A-1.** Additional models are available when designed per the applicable capacities and conditions of this verification.

- TSS Removal Rate – 80%

- Media - Sand

- On-Line and Off-Line installations

Detailed Specification

- NJDEP sizing tables and physical dimensions of StormKleener verified filter cartridges are attached (**Table A-1 and A-2)**. These Sizing Tables are valid for NJ following NJDEP Water Quality Design Storm Event of 1.25" in 2 hours (NJAC 7:8-5.5(a)).
- Maximum inflow drainage area
    - For flow through designs, the maximum inflow drainage area is governed by the maximum treatment flow for each cartridge filter and is presented in **Table A-1**.
    - When installed downstream of a detention system that reduces the release rate for the water quality storm the maximum inflow drainage area is often governed by the mass capture capacity. These capacities are expressed as the maximum allowable drainage area in **Table A-1 and Table A-2**

- The driving head will vary for a given filter cartridge based on the site-specific configuration. There is no maximum head, but the minimum head required to start the flow is 35.56". Design support is given by Lane Enterprises for each project and specific drawings will be provided to show pipe inverts, finished elevation, treatment flow rates, maximum flow rates and driving head. For the unit tested the maximum driving head was 32" above the top of the filter.

- The StormKleener™ Filter Cartridge System Design Manual contains the maintenance and inspection guidelines and can be found at http://lane-enterprises.com/transfer/Lane-StormKleener-Design-Manual-WEB.pdf

- This certification does not extend to the enhanced removal rates under NJAC 7:8-5.5 through the addition of settling chambers (such as hydrodynamic separators) or media filtration practices (such as a sand filter).

Table A-1 StormKleener Configurations and New Jersey Treatment Capacities

**Configuration	Number of Cartridges (Each)				Effective Fitration Treatment Area (SqfT)				Maximum Treatment Flow Rate (gpm)				Max Allowable Drainage Area* (acres)			
Diameter	15"	18"	24"	30"	15"	18"	24"	30"	15"	18"	24"	30"	15"	18"	24"	30"
Single Cartridge	-	-	-	-	7	10	18	28	22	30	53	83	0.016	0.023	0.041	0.064
36" Manhole	1	1	0	0	7	10	0	0	22	30	0	0	0.016	0.023	0.000	0.000
60" Manhole	4	2	1	1	28	20	18	28	88	60	53	83	0.064	0.046	0.041	0.064
5' x 5' vault	5	3	1	1	35	30	18	28	110	90	53	83	0.081	0.069	0.041	0.064
5' x 6' vault	6	4	2	1	42	40	36	28	132	120	107	83	0.097	0.092	0.083	0.064
6' x 6' vault	7	5	2	1	49	50	36	28	154	150	107	83	0.113	0.115	0.083	0.064
6' x 8' vault	9	6	3	2	63	60	54	56	198	180	160	166	0.145	0.138	0.124	0.129
6' x 10' vault	12	8	4	3	84	80	72	84	264	240	214	249	0.193	0.184	0.166	0.193
8' x 10' vault	16	11	6	4	112	110	108	112	352	330	321	332	0.258	0.253	0.248	0.258
10' x 15' vault	30	21	11	7	210	210	198	196	660	630	588	581	0.483	0.483	0.455	0.451
10' x 20' vault	40	28	15	10	280	280	270	280	880	840	802	830	0.644	0.644	0.621	0.644
10' x 25' vault	51	35	19	12	357	350	342	336	1122	1050	1016	996	0.821	0.805	0.787	0.773
10' x 30' vault	61	42	23	15	427	420	414	420	1342	1260	1230	1245	0.982	0.966	0.952	0.966

* Based on the equation in the NJDEP Filter Protocol. Maximum Inflow Drainage Area (acres) = Weight of TSS before 10% loss in MTFR (lbs.)/600 lbs. per acre of drainage area annually. This formula anticipates an annual filter maintenance schedule. However, field performance and site conditions may extend the time for maintenance and filter replacement.

** The configurations listed meet the minimum requirement of the ratio of effective sedimentation area (ESA) to effective filtration treatment area (EFTA) of 0.70 as demonstrated in the verification performance testing. Additional configurations meeting this minimum requirement are available.

Table A-2 StormKleener Diameters and New Jersey Treatment Capacities

Diameter of Cartridge	Filter Surface Area (sqft)	Maximum Treatment Flow Rate (gpm)	* Max Allowable Drainage Area (acres)
15"	7	22	0.016
18"	10	30	0.023
24"	18	53	0.041
30"	28	83	0.064

* Based on the equation in the NJDEP Filter Protocol. Maximum Inflow Drainage Area (acres) = Weight of TSS before 10% loss in MTFR (lbs.)/600 lbs. per acre of drainage area annually. This formula anticipates an annual filter maintenance schedule. However, field performance and site conditions may extend the time for maintenance and filter replacement.