NJCAT TECHNOLOGY VERIFICATION

Jensen Deflective Separator (JDS)

Jensen Water Resources

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TABLE OF CONTENTS

Page

List of Figures

Page

List of Tables

Page

1. Description of Technology

The *Jensen Deflective Separator (JDS)* is a Manufactured Treatment Device (MTD), utilizing Hydrodynamic Separation (HDS) for stormwater treatment. The JDS technology is a non-blocking screening, swirl-concentrating treatment process, known as continuous deflective separation, for small as well as very large stormwater flows. The JDS unit consists of a separation chamber and sump, typically deployed in precast concrete manhole structures. The separation chamber has a specially designed inlet that introduces flow into a floatable control cylinder, which is configured on top of a stainless-steel cylindrical screen. The overall unit and treatment process can be seen below (**Figure 1**).

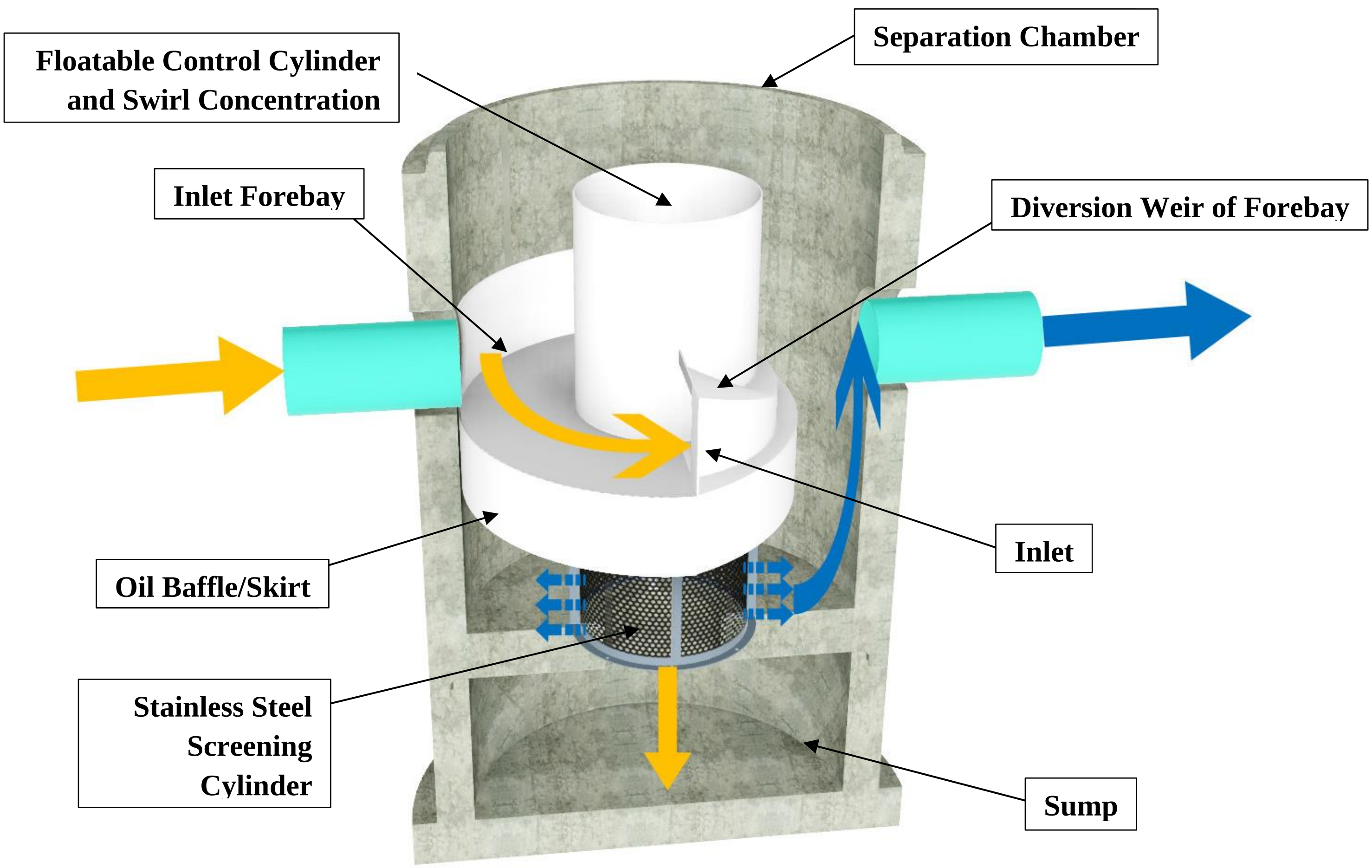

Figure 1 Flow of Typical "Online" JDS Unit

The Jensen Deflective Separator swirl concentrates, screens, baffles and settles pollutants from stormwater flows in relatively small to very large manhole structures. When pollutant laden flow enters the swirl concentrating screening chamber, the contents of the flow are removed through: floatation, baffling, swirl concentration, positive screening through continuous deflection, toroidal sedimentation, and typical sedimentation depending on the physical characterization and speciation of the pollutants. For further literature on toroidal sedimentation please refer to https://en.wikipedia.org/wiki/Torus.

These multiple treatment processes occur in a JDS unit in a balanced hydraulic condition. Stormwater flows are diverted into the separation chamber as a jet (**Figure 2**). This entrance jet forms across the internal face of a stainless-steel screen cylinder located immediately beneath the invert of the jet's entrance. The design relies upon the development of balanced hydraulics of the inlet flow versus the rotational flow across the face of the screen cylinder. The design ratios to produce balanced hydraulics within the JDS for a very large range of treatment flows is the screen functionality design parameter, which plays an important role in the unit's sustained operation. This balance of hydraulics enables this swirl concentrating flow path to enact a continuous deflective screening process that is also non-blocking with no moving parts required to keep the screen clear. Flows across the inside of the stainless-steel screen cylinder's surface eliminate screen clogging.

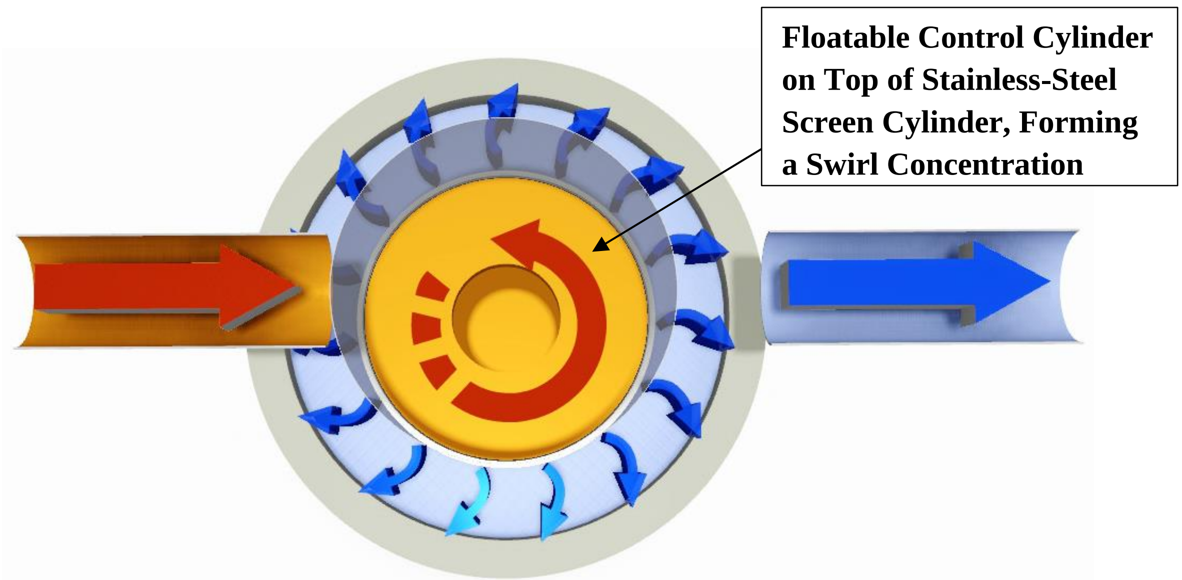

Figure 2 Plan View Treatment Flow Pattern Typical "Online" JDS Unit

The stainless-steel cylindrical screen of the JDS units has punched openings oriented to present the "Blind Side" of the screen to the incoming circular flow (**Figure 3**). This presentation of the "Blind Side" of the screen to the rotational flow within the screening cylinder creates a non-blocking positive screening system. The rotational flow across the screen face ensures that debris does not become pinned to the screen face.

This exposed "Blind Side" surface causes the pollutants in the high velocity region near to the screen surface to be deflected and move towards the center of the cylinder. At the center of the screen cylinder the flow is mostly stagnant. It is a quiet region and has small velocities in relation to the rotational flow at the screen face. The screen is attached to the bottom side of the HDPE inlet riser for the "Online" units (**Figure 4**).

Figure 3 View of the "Blind Side" of 2,400-micron (μm), (2.4-mm) Screen Cylinder

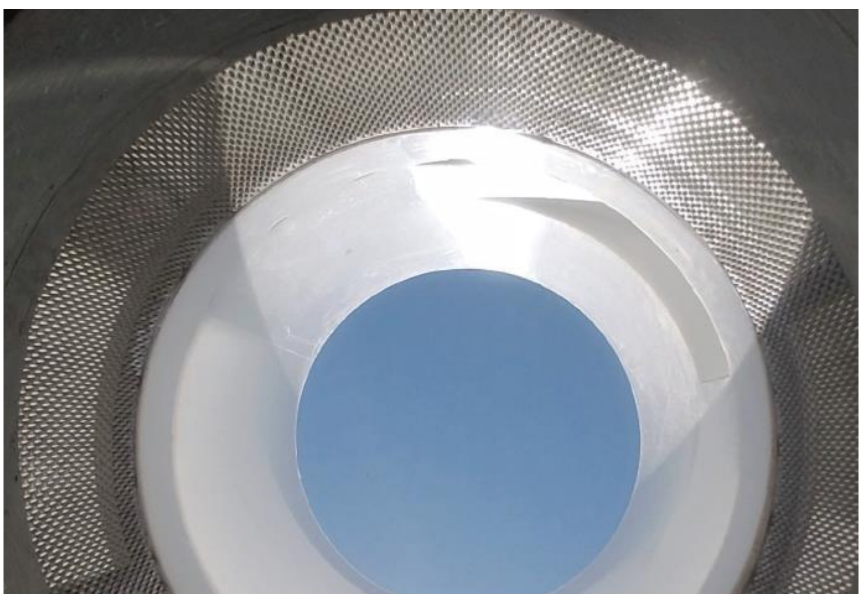

Figure 4 Bottom Up View of Separation Chamber, showing an HDPE Inlet Riser on Top of an Expanded Stainless-Steel Screen Cylinder of an "Online" Unit

Pollutants, such as Styrofoam, may stay afloat if they have a specific gravity (SG) less than 1.0. Oil and grease typically adhere to all floatables and other solids and/or stay afloat on the water's surface. Pollutants like tree leaves and paper products stay afloat for a period before settling as they become water logged.

Both coarse and fine sediments that are swirl-concentrated, as well as deflected by the screen, will settle in the sump as they move toward the stagnant center region, the quiescent zone of the swirl chamber unit. The positive continuous deflective screening process within the unit captures particles larger than the screen aperture, which have a range of SGs. Nutrients that are transported as an attachment to sediments and other solids captured in the JDS unit are among the pollutants removed from stormwater flows.

"Online" units placed within the alignment of the storm drain/channel have internal inlets and bypass weirs within the separation chamber. "Offline" units are placed immediately adjacent to the storm drain/channel alignment. These Offline units will have a separate diversion structure with a weir to divert water quality treatment flows and bypass larger conveyance flows. The Jensen Deflective Separator units are designed to treat the water quality flows and bypass larger flows.

2. Laboratory Testing

Laboratory testing was performed to independently verify that the Jensen Deflective Separator (JDS) is eligible for certification by the New Jersey Department of Environmental Protection (NJDEP) as a 50% Total Suspended Solids (TSS) removal device.

The JDS was tested in accordance with the "*New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device*" (NJDEP 2013). Testing was conducted at Jensen's outdoor stormwater testing facility in Sparks, Nevada.

Performance tests were performed under the direct supervision of Professor Keith Dennett, Ph.D., P.E. Professor Dennett is an Associate Professor in the Department of Civil and Environmental Engineering, University of Nevada, Reno. Professor Dennett serves as the independent third-party observer of all tests on the JDS unit.

2.1 Test Unit

The test unit was a full scale, commercially available Jensen Deflective Separator Model JDS36-1818. The design specifications for the JDS are provided in **Table 1.** Note: The MTFR shown is to be verified during the performance test.

Table 1 JDS36-1818 Dimensions and Treatment Flow Rate

MTFR		Diameter (ft)	Sediment Storage (ft^3)	Effective Treatment Area (ft^2)	Loading Rate (gpm/ft^2)
(cfs)	(gpm)				
0.52	233	3	14.14	7.07	33

2.2 Test Setup

The testing facility is a closed loop, re-circulating system with fine membrane filtration in the recirculation piping from the return to the supply tanks (**Figure 5**). The main piping into and out of the test unit is 10-inch PVC and the calibrated electromagnetic flow meters attached to the supply pumps serve as the primary flow measuring devices.

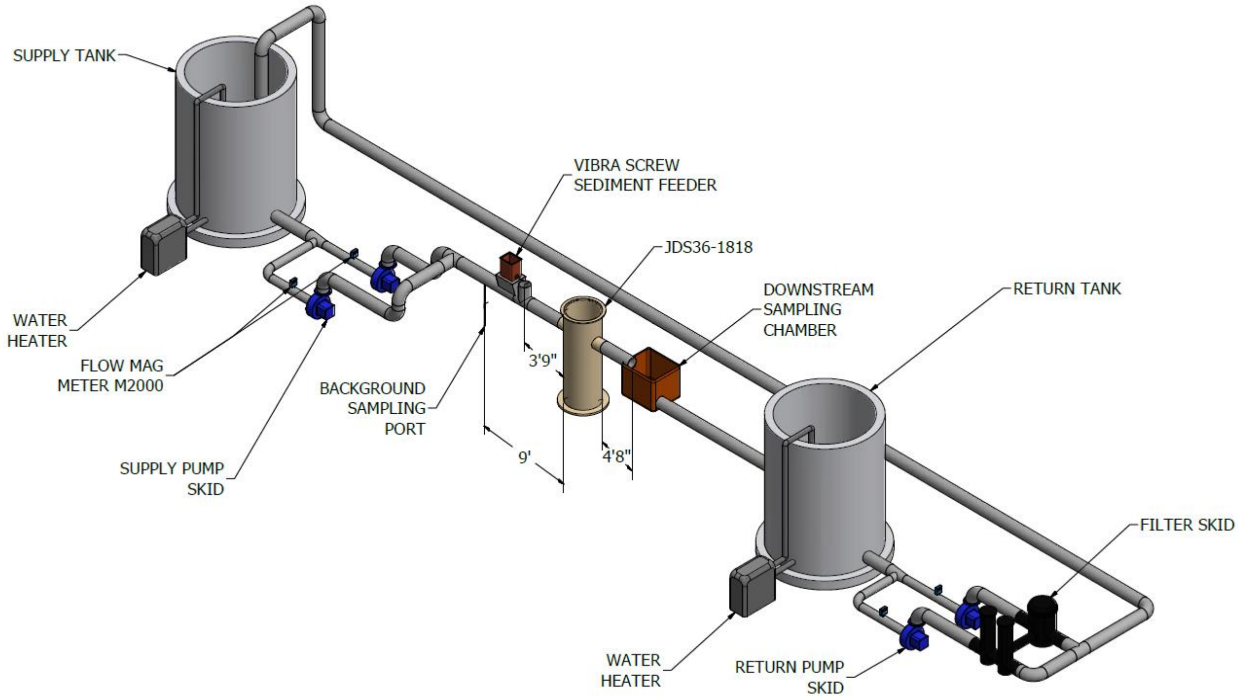

Figure 5 Lab Setup Schematic

Water Flow and Measurement

Flow was pumped from both supply and return tanks using Grundfos Model LC pumps (250 and 700-gpm capacity). Attached to each pump, ModMag M2000 electromagnetic flow meters (**Figure 6**) measured flow throughout the duration of the test which was controlled through a variable frequency drive (VFD). For quality assurance purposes, flow meters were calibrated by Micro Precision Calibration, a 3rd Party entity, using Dynasonics ultrasonic flow meters.

Figure 6 ModMag M2000 Electromagnetic Flow Meters

Sediment Feeding

Test sediment was fed through the crown of a 10-in PVC tee, located 45-in from the JDS unit, using a Vibra-Screw volumetric screw feeder with vibratory hopper. Various screw diameters ranging from ¼-in to ¾-in allowed for the precise addition of sediment during each flow rate tested.

Sediment for each test was pre-measured into individual buckets at a starting weight of 60.000 lbs. and loaded into the hopper of the volumetric screw feeder. During the test, six calibration samples were taken at the injection point at evenly spaced intervals per section 5B of the NJCAT protocol, measured to the nearest milligram. At the end of each test, the feeder was cleaned out and a final sediment weight was measured to three significant figures to determine the total mass into the system during the duration of the test, after subtracting the total weight of the six calibration feed rate samples.

Sample Collection

Flow exited the JDS and entered the downstream sampling chamber in free fall approximately 56-in from the unit (**Figure 7**). Samples were grabbed by hand using wide-mouthed 1-Liters sample bottles in a sweeping motion through the free spilling effluent stream.

Figure 7 Effluent Samples Grabbed from the Effluent Stream

Background water samples were collected in 1-L bottles through a sampling port located 9-feet, upstream from the JDS. The ½-in sampling port was controlled manually through a ball valve (**Figure 8**).

Figure 8 Background Sampling Port

Other Instrumentation and Measurements

Water temperature was taken using a temperature probe at the downstream sampling chamber and recorded with a Campbell Scientific CR3000 Data-Logger.

Test duration and sampling times were recorded using an Extech Instruments stopwatch.

Sediment feed samples were collected in 500-milliliter beakers weighed using a Tree Electronic Precision Balance.

2.3 Test Sediment

As described in the previous section, test sediment was fed through the crown of a 10-in PVC tee, 45-inches upstream from the JDS using a Vibra-Screw volumetric screw feeder with vibratory hopper. Sediment was dropped at centerline through a 10-in pipe connected to the tee. Since the testing facility is outdoors, a windshield was put in place to inhibit wind effects on sediment loading (**Figure 9**).

Figure 9 Vibra Screw Sediment Feeder with Windshield

Appropriate sediment was purchased in bulk from a variety of suppliers and vendors. Jensen blended these sediments to meet the mass gradations requirements explicitly listed in **Table 2** and **Table 3**, set forth by New Jersey Department of Environmental Protection (NJDEP). Sediment batches were prepared for both TSS Removal Efficiency and Scour tests. For Removal Efficiency sediment, the median particle size (d_{50}) of less than 75-microns (µm), was met for all three samples. The d_{50} was approximately 62 µm.

Samples were sent to Lumos & Associates, Sparks, NV, an independent material testing laboratory, for analysis using ASTM D422-63 (Reapproved 2007), "*Standard Test Method for Particle Size Analysis of Soils.*" Results of Particle Size Distribution (PSD) analyses for the Removal Efficiency (RE%) and Scour Testing sediments were plotted against the NJDEP limiting PSD curves and are provided below in **Figure 10** and **Figure 11**, respectively.

Table 2 Test Sediment Particle Size Distribution for Removal Efficiency Test Sediment

NJDEP PSD		Sample 1	Sample 2	Sample 3	Average	NJDEP CONDITION	QA/QC Compliance
SSC EFFLUENT TEST		EFF-PSD1	EFF-PSD2	EFF-PSD3	EFF-PSD$_{avg}$		
Particle Size	Percent	Percent	Percent	Percent	Percent		
1000	100	100	100	100	100	≥ 98%	OK
500	95	96	96	96	96	≥ 93%	OK
250	90	95	95	95	95	≥ 88%	OK
150	75	94	94	94	94	≥ 73%	OK
100	60	78	78	78	78	≥ 58%	OK
75	50	53	53	53	53	≥ 48%	OK
50	45	48	48	48	48	≥ 43%	OK
20	35	38	38	38	38	≥ 33%	OK
8	20	18	18	18	18	≥ 18%	OK
5	10	11	11	11	11	≥ 8%	OK
2	5	4.0	3.5	3.3	3.6	≥ 3%	OK

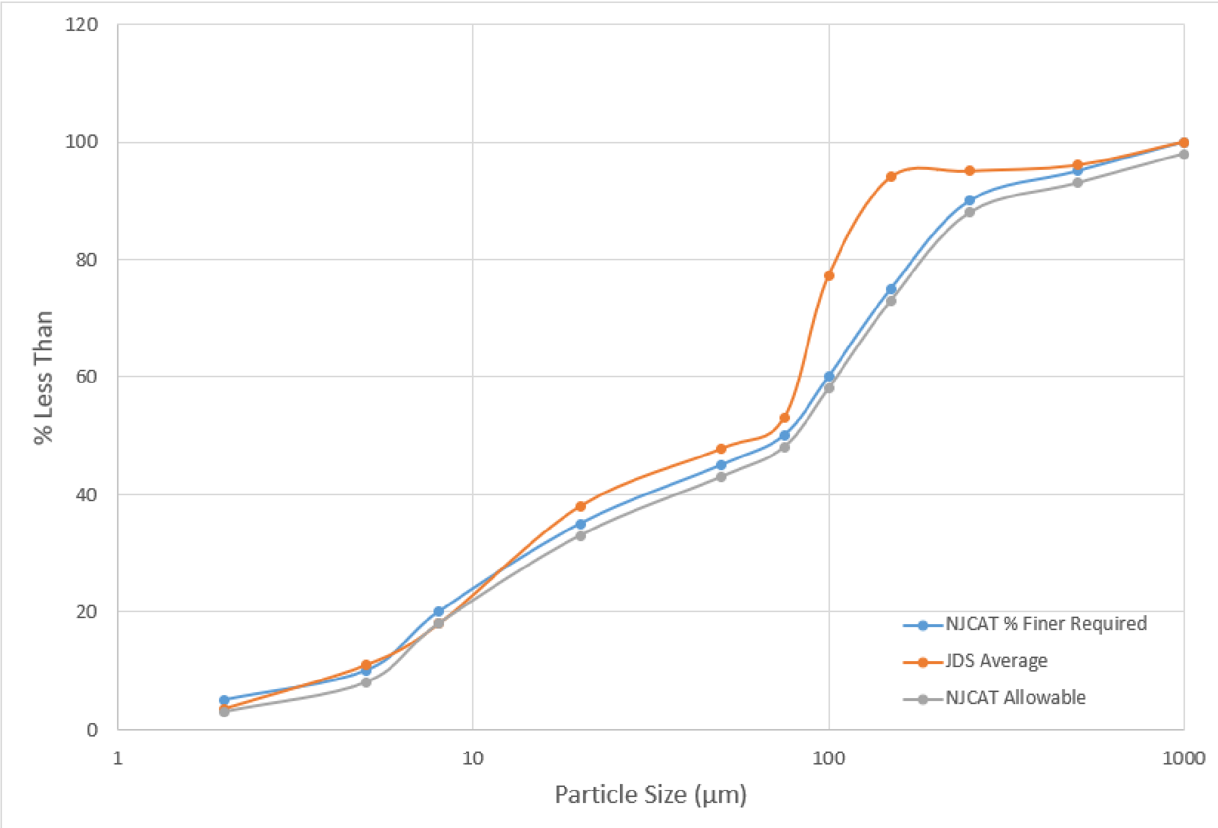

Figure 10 Test Sediment Particle Size Distribution for Removal Efficiency Test Sediment

Table 3 Test Sediment Particle Size Distribution for Scour Test Sediment

NJDEP PSD SCOUR TEST		**Sample 1 SCR-PSD1**	**Sample 2 SCR-PSD2**	**Sample 3 SCR-PSD3**	**Average**	**NJDEP CONDITION**	**QA/QC Compliance**
Particle Size [µm]	**Percent Finer Required [%]**	**Percent Finer [%]**	**Percent Finer [%]**	**Percent Finer [%]**	**Percent Finer [%]**		
1000	100	100	100	100	100	≥ 98%	OK
500	90	96	96	96	96	≥ 88%	OK
250	55	62	64	63	63	≥ 53%	OK
150	40	49	51	51	50	≥ 38%	OK
100	25	26	27	29	27	≥ 23%	OK
75	10	16	17	18	17	≥ 8%	OK
50	0	5.7	6.4	7.2	6.4	≥ 0%	OK

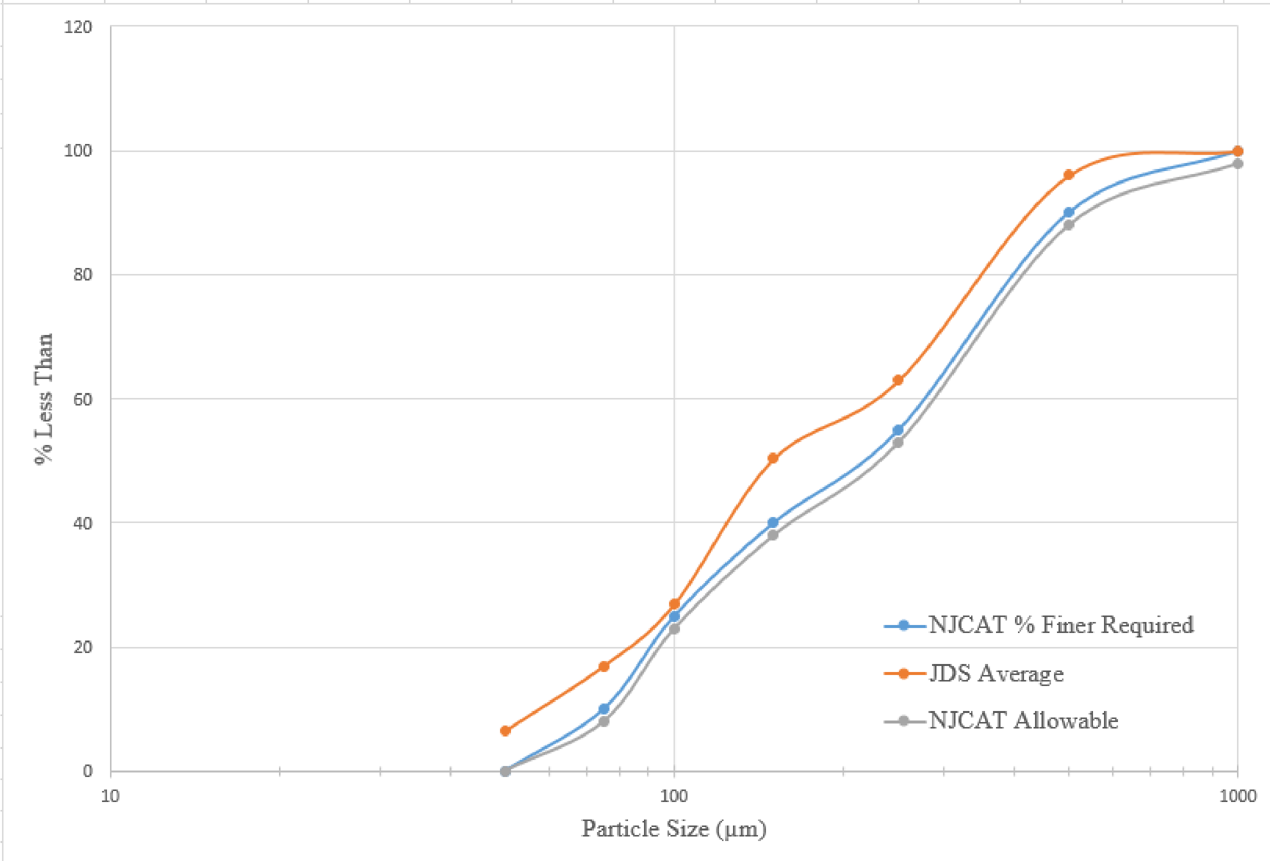

Figure 11 Test Sediment Particle Size Distribution for Scour Test Sediment

2.4 Removal Efficiency Testing Procedure

Removal Efficiency testing was performed in accordance with Section 5 of the *"New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device (January 25, 2013)."* A total of 5 flow rates were tested: 25%, 50%, 75%, 100% and 125% of the Maximum Treatment Flow Rate (MTFR). Upon completion of all five test flows, results were used to calculate the annualized weighted removal efficiency for the JDS36-1818.

An aluminum false floor was installed to simulate 50% sump conditions, with no sediment added prior to testing. The test sediment mass was fed into the flow stream at 45-in upstream of the JDS using the Vibra-Screw 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 concentrations throughout the duration of the removal efficiency testing program.

Six calibration samples were collected at the injection point during each removal efficiency flow rate test. 500-ml beakers were used to collect the samples, which measured a minimum of 0.1-L or until a maximum of one-minute sampling time occurred, whichever came first. The calibration samples were timed at evenly spaced intervals over the total duration of the test for each tested flow rate and timed such that no collection interval exceeded 1 minute in duration. Each calibration sample was collected in a clean 1-liter container over an interval timed to the nearest second. These samples were weighed to the nearest milligram using a calibrated Tree® Model HRB-413 electronic balance. This data was used to confirm that the COV of sediment feed rate was below the limit of 0.10 as required by the protocol.

The average influent TSS concentration used for calculating removal efficiency was calculated using the total mass of the test sediment added during injection divided by the volume of water that flowed through the test unit during injection (**Equation 1**), as required by the protocol. The mass extracted for calibration samples was subtracted from the total mass injected to the system when removal efficiency was subsequently calculated. The volume of water for each test was calculated by multiplying the average flow rate by the time of sediment injection only.

$$\textbf{Average Influent Concentration} = \frac{\text{Total mass added}}{\text{Total volume of water flowing through the MTD during addition of test sediment}}$$

Equation 1 Calculation for Average Influent Sediment Concentration

Background water sampling was taken from a sampling port 9-ft upstream from the JDS. Background samples were taken at every other effluent sample, for a total of 8 background water samples. Where samples were not taken, results were interpolated between previous and subsequent results. Effluent sampling was also done using the grab sampling method. Samples were taken at the downstream sampling chamber approximately 56-inches from the JDS using 1-L bottles.

Effluent grab sampling began after three MTD detention times were allowed to pass. The time interval between samples was 30-seconds however, when the sediment feed was interrupted during feed rate sampling, the following effluent sample was taken after another three MTD detention times had passed. A total of 15 effluent samples, 8 background samples, and 6 sediment samples were collected during the duration of each test. The water temperature was recorded at 60 second intervals.

The background data were plotted on a curve for use in adjusting the effluent samples for background concentration. The JDS36-1818 removal efficiency for each tested flow rate was calculated following **Equation 2**:

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

* Adjusted for background concentration

Equation 2. Equation for Calculating Removal Efficiency

All samples were analyzed by WETLAB-Western Environmental Testing Laboratory, Sparks, Nevada in accordance with ASTM D 3977-97 (re-approval 2007) "Standard Test Methods for Determining Sediment Concentrations in Water Samples."

M2000 electromagnetic flow meters attached to the supply pumps measured flow throughout the duration of each test run. These flows were controlled by the VFD and recorded once per minute by the Data-Logger in order to calculate total water volume and average flow rate during the test. During all test runs, the allowable variation of any of the five test flows was within ±10% of the target flow rate with a COV of less than 0.03.

2.5 Scour Testing Procedure

For minimum conforming scouring testing, there must be 4-inches of scour sediment loaded into the sump with the surface of this scour sediment level with the 50% full level of the JDS unit's sump. Due to damage of the adjustability of the false floor in the sump, it was unable to be lowered the 4-inches below the 50% sump full level following completion of the removal efficiency testing. Thus, 4-inches of scour sediment was loaded on top of the false floor already set at the 50% full sump level for the removal efficiency tests. This 4-inch depth of scour sediment was at a 4-inch level higher than the required 50% level, thus producing a much more conservative condition for scour testing than required by the scour testing protocol. After sediment loading reached the required 4-inches of depth, it was leveled, and the unit was slowly filled with clean water to the level of the inlet and allowed to settle for 93-hours.

Using the VFD, test flow was brought up to the target 200% of the JDS unit's Maximum Treatment Flow Rate (MTFR), of 467-gpm (1.04-cfs) within 5-minutes (min) of beginning the test. Flow rate was measured using M2000 electromagnetic flow meters attached to the supply pumps and recorded once per minute by the CR3000 Data-Logger. Once testing commenced, effluent samples were collected using a 1-L wide-mouthed bottle every 2-mins, while background samples were collected every 4-mins. A total of 15 effluent samples and 8 background samples were collected during the duration of the scour test.

All samples were analyzed by Desert Research Institute (DRI), Reno, Nevada in accordance with ASTM D3977-97 (re-approval 2007) "Standard Test Methods for Determining Sediment Concentrations in Water Samples."

3. Performance Claims

In keeping with the NJCAT verification process, the Jensen Deflective Separator (JDS) performance claims are cited below.

Total Suspended Solids Removal Rate

For the particle size distribution and weighted calculation method specified by the NJDEP HDS MTD protocol, the JDS36-1818 at an MTFR of 0.52 cfs will demonstrate at least 50% TSS removal efficiency.

Maximum Treatment Flow Rate

The MTFR for the JDS36-1818 was demonstrated to be 233 gpm (0.52 cfs) which corresponds to a surface area loading rate of 33.0 gpm/ft^2.

Sediment Storage Depth and Volume

The maximum storage depth for the JDS36-1818 is 24-in, which provides a maximum storage volume of 14.14-ft^3. A sediment storage depth of 12-in, corresponds to a 50% full sump condition (7.07-ft^3).

Effective Treatment Area

The effective treatment area of the JDS models varies with model size, as it corresponds to the surface area of the JDS model diameter. The tested JDS36-1818 model has an effective treatment surface area of 7.07 square feet.

Detention Time and Volume

The detention time of the JDS depends on flow rate and model size. The detention time is calculated by dividing the treatment volume by the flow rate. The treatment volume is defined as the surface area multiplied by the depth between the pipe inverts (which are at the same elevation) and the bottom of the false floor. The tested JDS36-1818 model, at 50% full sump conditions, has a wetted volume of 25.5 ft^3. At the MTFR of 0.52 cfs, the JDS36-1818 has a detention time of 49.5 seconds.

Online or Offline

Based on the results of the Scour Testing as described in Section 4.2, the JDS36-1818 qualifies for online installation.

4. Supporting Documentation

The NJDEP Procedure (NJDEP, 2013a) for obtaining verification of an MTD from NJCAT requires that copies of the 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 Jensen 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.

4.1 Removal Efficiency Testing

In accordance with the NJDEP HDS MTD Protocol, sediment removal efficiency testing was conducted on the JDS36-1818 unit in order to establish the ability of the JDS to remove the specified test sediment at 25%, 50%, 75%, 100% and 125% of the target MTFR with the goal to demonstrate at least 50% annualized weighted sediment removal as defined in the protocol. The target MTFR was 233 gpm (0.52 cfs).

25% MTFR Results

Table 4 Sampling Schedule - 25% MTFR

Detention Time =		198	s
Feed Rate Sampling T =		60	s
Time Between Effluent Sampling =		30	s
Time (min:sec)	**Feed Rate**	**Background**	**Effluent**
0:00	1		
10:54		1	1
11:24			2
11:54	2	2	3
22:48			4
23:18		3	5
23:48	3		6
34:43		4	7
35:13			8
35:43	4	5	9
46:37			10
47:07		6	11
47:37	5		12
58:31		7	13
59:01			14
59:31	6	8	15

Table 5 QA/QC Water Flow Rate and Temperature - 25% MTFR

Test Parameter	Water Flow Rate (gpm)				Maximum Water Temperture (°F)
	Target	Actual	Difference	COV	
	58.35	58.10	-0.431%	0.008	79.53
QA/QC Limit	-	-	±10%	0.03	80
			PASS	PASS	PASS

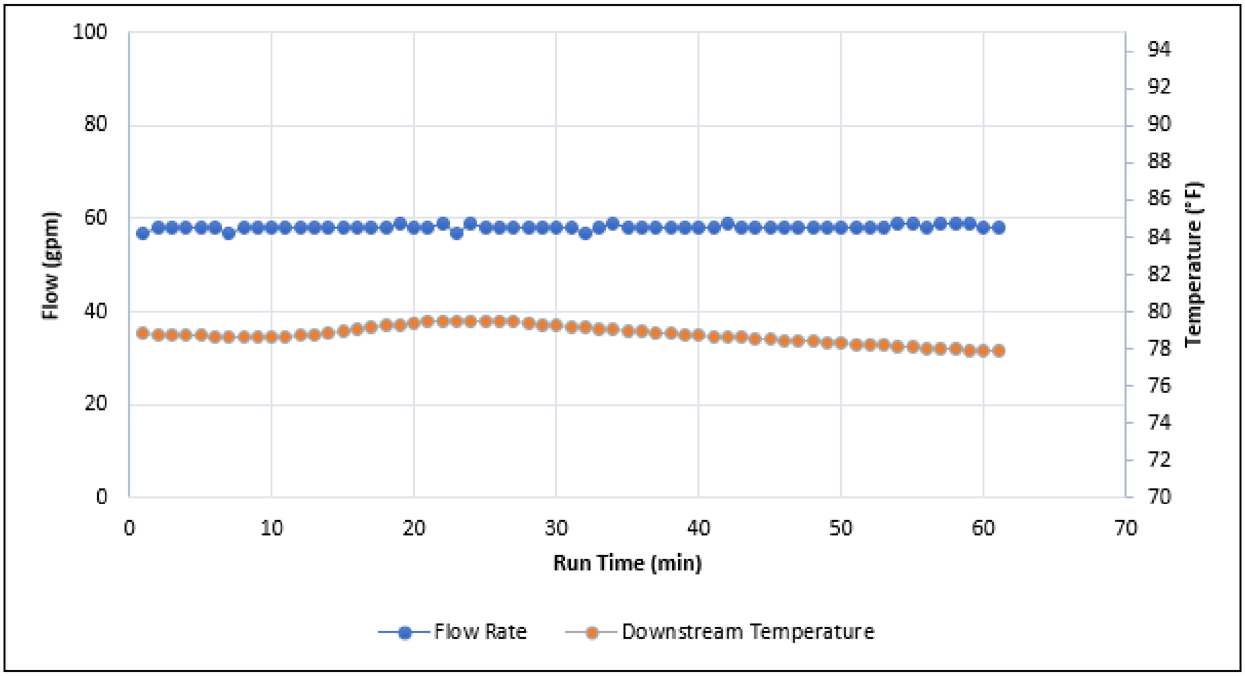

Figure 12 Water Flow Rate and Temperature - 25% MTFR

Table 6 Sediment Feed Rate - 25% MTFR

Sediment Feed Rate (g/min)		Sediment Mass Balance	
Beaker 1	42.514	Weight of Loaded Sediment (lbs)	60.000
Beaker 2	43.641		
Beaker 3	43.720	Weight of Recovered Sediment (lbs)	54.108
Beaker 4	43.424		
Beaker 5	44.281	Mass of Sediment Used (lbs)	5.315
Beaker 6	44.246		
Average	43.638	Volume of Water Through MTD (gal)	3515.9
Total Sample Mass (g)	261.570	Average Influent Concentration (mg/L)	201.1
COV	0.015		
QA/QC Limit	0.10	QA/QC Limit	180-220 mg/L
	PASS		PASS

Table 7 Background Water TSS Concentration - 25% MTFR

Background Water Sample Results			
Sample Number	Sample ID	TSS Concentration (mg/L)[1]	QA / QC C < 20 mg/L
1	BW1-25	71	FAIL
2	BW2-25	3	PASS
3	BW3-25	1	PASS
4	BW4-25	0	PASS
5	BW5-25	0	PASS
6	BW6-25	0	PASS
7	BW7-25	0	PASS
8	BW8-25	0	PASS

1. Refer to callout in 'Excluded Data' immediately following removal efficiency results.

Table 8 Effluent Sample Results and Removal Efficiency - 25% MTFR

Effluent Sample Results				
Sample Number	Sample ID	Effluent Concentration [mg/L]	Related Background Water Concentration[1] [mg/L]	Adjusted Concentration [mg/L]
1	EF1-25	89	0	89
2	EF2-25	87	1.5	86
3	EF3-25	87	3	84
4	EF4-25	93	2	91
5	EF5-25	89	1	88
6	EF6-25	90	0.5	90
7	EF7-25	89	0	89
8	EF8-25	90	0	90
9	EF9-25	91	0	91
10	EF10-25	92	0	92
11	EF11-25	92	0	92
12	EF12-25	92	0	92
13	EF13-25	92	0	92
14	EF14-25	91	0	91
15	EF15-25	93	0	93
Average Adjusted Effluent Concentration (mg/L)				**89.9**
Removal Efficiency (%)				**55.3%**

1. Refer to callout in 'Excluded Data' immediately following removal efficiency results.

50% MTFR Results

Table 9 Sampling Schedule - 50% MTFR

Detention Time =		**99**	**s**
Feed Rate Sampling T =		**60**	**s**
Time Between Effluent Sampling =		**30**	**s**
Time (min:sec)	**Feed Rate**	**Background**	**Effluent**
0:00	1		
5:57		1	1
6:27			2
6:57	2	2	3
12:54			4
13:24		3	5
13:54	3		6
19:52		4	7
20:22			8
20:52	4	5	9
26:49			10
27:19		6	11
27:49	5		12
33:46		7	13
34:16			14
34:46	6	8	15

Table 10 QA/QC Water Flow Rate and Temperature - 50% MTFR

Test Parameter	Water Flow Rate (gpm)				Maximum Water Temperture (°F)
	Target	Actual	Difference	COV	
	116.70	115.24	-1.248%	0.007	78.16
QA/QC Limit	-	-	±10%	0.03	80
			PASS	PASS	PASS

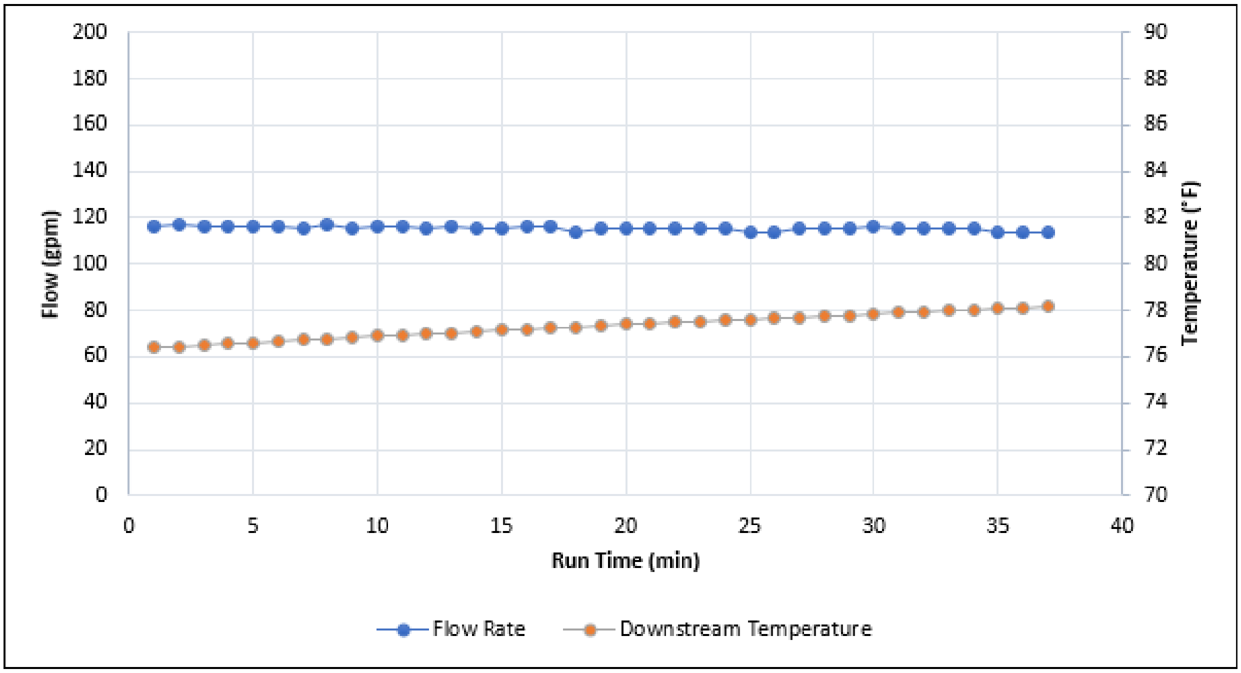

Figure 13 Water Flow Rate and Temperature - 50% MTFR

Table 11 Sediment Feed Rate - 50% MTFR

Sediment Feed Rate (g/min)		Sediment Mass Balance	
Beaker 1	93.401	Weight of Loaded Sediment (lbs)	60.000
Beaker 2	92.537		
Beaker 3	93.528	Weight of Recovered Sediment (lbs)	52.513
Beaker 4	93.796		
Beaker 5	94.179	Mass of Sediment Used (lbs)	6.250
Beaker 6	95.033		
Average	93.746	Volume of Water Through MTD (gal)	4121.9
Total Sample Mass (g)	561.016		
COV	0.009	Average Influent Concentration (mg/L)	218.3
QA/QC Limit	0.10	QA/QC Limit	180-220 mg/L
	PASS		PASS

Table 12 Background Water TSS Concentration - 50% MTFR

Background Water Sample Results			
Sample Number	**Sample ID**	**TSS Concentration (mg/L)**	**QA / QC C < 20 mg/L**
1	BW1-50	6	PASS
2	BW2-50	6	PASS
3	BW3-50	5	PASS
4	BW4-50	4	PASS
5	BW5-50	5	PASS
6	BW6-50	5	PASS
7	BW7-50	6	PASS
8	BW8-50	7	PASS

Table 13 Effluent Sample Results and Removal Efficiency - 50% MTFR

Effluent Sample Results				
Sample Number	**Sample ID**	**Effluent Concentration**	**Related Background Water Concentration**	**Adjusted Concentration**
		[mg/L]	**[mg/L]**	**[mg/L]**
1	EF1-50	108	6	102
2	EF2-50	107	6	101
3	EF3-50	107	6	101
4	EF4-50	108	5.5	103
5	EF5-50	110	5	105
6	EF6-50	110	4.5	106
7	EF7-50	113	4	109
8	EF8-50	112	4.5	108
9	EF9-50	112	5	107
10	EF10-50	113	5	108
11	EF11-50	112	5	107
12	EF12-50	107	5.5	102
13	EF13-50	118	6	112
14	EF14-50	115	6.5	109
15	EF15-50	116	7	109
Average Adjusted Effluent Concentration (mg/L)				**105.8**
Removal Efficiency (%)				**51.6%**

75% MTFR Results

Table 14 Sampling Schedule - 75% MTFR

Detention Time =		**66**	**s**
Feed Rate Sampling T =		**60**	**s**
Time Between Effluent Sampling =		**30**	**s**
Time (min:sec)	**Feed Rate**	**Background**	**Effluent**
0:00	1		
4:18		1	1
4:48			2
5:18	2	2	3
9:36			4
10:06		3	5
10:36	3		6
14:54		4	7
15:24			8
15:54	4	5	9
20:13			10
20:43		6	11
21:13	5		12
25:31		7	13
26:01			14
26:31	6	8	15

Table 15 QA/QC Water Flow Rate and Temperature - 75% MTFR

Test Parameter	Water Flow Rate (gpm)				Maximum Water Temperture (°F)
	Target	Actual	Difference	COV	
	175.04	173.31	-0.988%	0.004	78.89
QA/QC Limit	-	-	±10%	0.03	80
			PASS	PASS	PASS

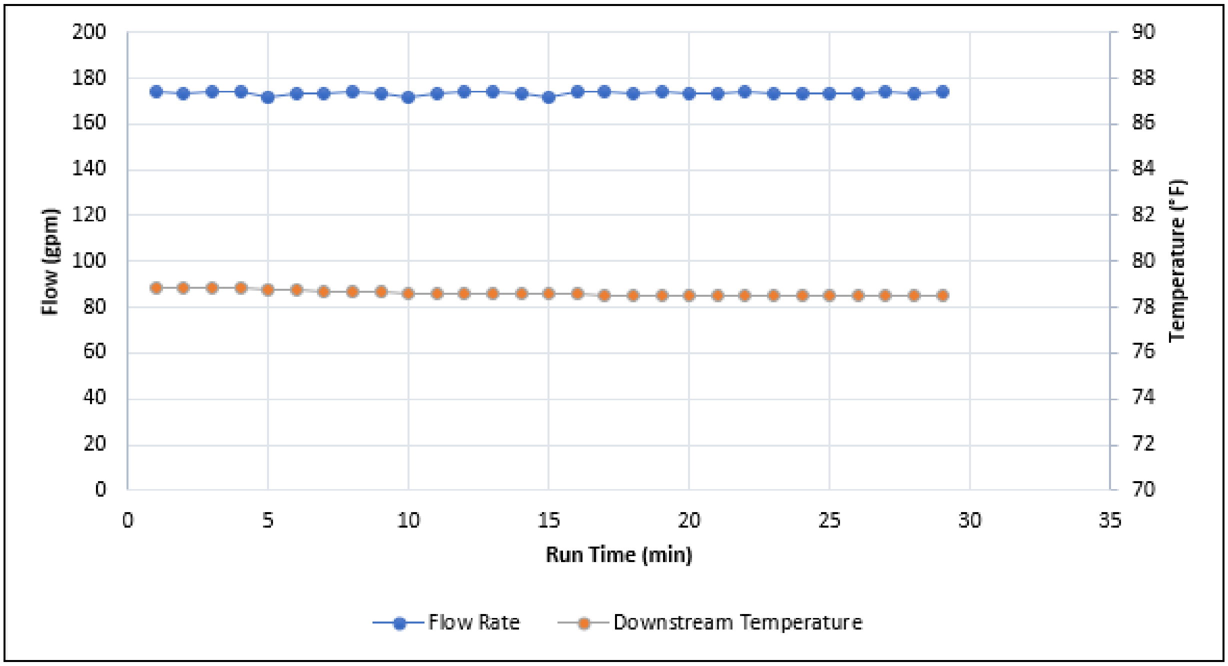

Figure 14 Water Flow Rate and Temperature - 75% MTFR

Table 16 Sediment Feed Rate - 75% MTFR

<table>
<tr><th colspan="2">Sediment Feed Rate (g/min)</th><th colspan="2">Sediment Mass Balance</th></tr>
<tr><td>Beaker 1</td><td>126.194</td><td rowspan="2">Weight of Loaded Sediment (lbs)</td><td rowspan="2">60.000</td></tr>
<tr><td>Beaker 2</td><td>126.972</td></tr>
<tr><td>Beaker 3</td><td>125.513</td><td rowspan="2">Weight of Recovered Sediment (lbs)</td><td rowspan="2">52.406</td></tr>
<tr><td>Beaker 4</td><td>125.004</td></tr>
<tr><td>Beaker 5</td><td>129.353</td><td rowspan="2">Mass of Sediment Used (lbs)</td><td rowspan="2">5.919</td></tr>
<tr><td>Beaker 6</td><td>128.041</td></tr>
<tr><td>Average</td><td>126.846</td><td rowspan="2">Volume of Water Through MTD (gal)</td><td rowspan="2">4768.9</td></tr>
<tr><td rowspan="2">Total Sample Mass (g)</td><td rowspan="2">759.727</td></tr>
<tr><td rowspan="2">Average Influent Concentration (mg/L)</td><td rowspan="2">190.2</td></tr>
<tr><td>COV</td><td>0.013</td></tr>
<tr><td rowspan="2">QA/QC Limit</td><td>0.10</td><td rowspan="2">QA/QC Limit</td><td>180-220 mg/L</td></tr>
<tr><td>PASS</td><td>PASS</td></tr>
</table>

Table 17 Background Water TSS Concentration - 75% MTFR

Background Water Sample Results			
Sample Number	Sample ID	TSS Concentration (mg/L)[2]	QA / QC C < 20 mg/L
1	BW1-75	43	FAIL
2	BW2-75	27	FAIL
3	BW3-75	12	PASS
4	BW4-75	19	PASS
5	BW5-75	13	PASS
6	BW6-75	17	PASS
7	BW7-75	9	PASS
8	BW8-75	16	PASS
2. Refer to callout in 'Excluded Data' immediately following removal efficiency results.			

Table 18 Effluent Sample Results and Removal Efficiency - 75% MTFR

Effluent Sample Results				
Sample Number	Sample ID	Effluent Concentration [mg/L]	Related Background Water Concentration[2] [mg/L]	Adjusted Concentration [mg/L]
1	EF1-75	106	0	106
2	EF2-75	108	0	108
3	EF3-75	114	0	114
4	EF4-75	95	6	89
5	EF5-75	99	12	87
6	EF6-75	104	15.5	89
7	EF7-75	97	19	78
8	EF8-75	111	16	95
9	EF9-75	100	13	87
10	EF10-75	100	15	85
11	EF11-75	102	17	85
12	EF12-75	103	13	90
13	EF13-75	105	9	96
14	EF14-75	106	12.5	94
15	EF15-75	103	16	87
Average Adjusted Effluent Concentration (mg/L)				**92.6**
Removal Efficiency (%)				**51.3%**
2. Refer to callout in 'Excluded Data' immediately following removal efficiency results.				

100% MTFR Results

Table 19 Sampling Schedule - 100% MTFR

Detention Time =		**50**	**s**
Feed Rate Sampling T =		**60**	**s**
Time Between Effluent Sampling =		**30**	**s**
Time (min:sec)	**Feed Rate**	**Background**	**Effluent**
0:00	1		
3:29		1	1
3:59			2
4:29	2	2	3
7:58			4
8:27		3	5
8:57	3		6
12:26		4	7
12:56			8
13:26	4	5	9
16:54			10
17:24		6	11
17:54	5		12
21:23		7	13
21:53			14
22:23	6	8	15

Table 20 QA/QC Water Flow Rate and Temperature - 100% MTFR

Test Parameter	Water Flow Rate (gpm)				Maximum Water Temperture (°F)
	Target	Actual	Difference	COV	
	233.40	232.60	-0.343%	0.004	77.91
QA/QC Limit	-	-	±10%	0.03	80
			PASS	PASS	PASS

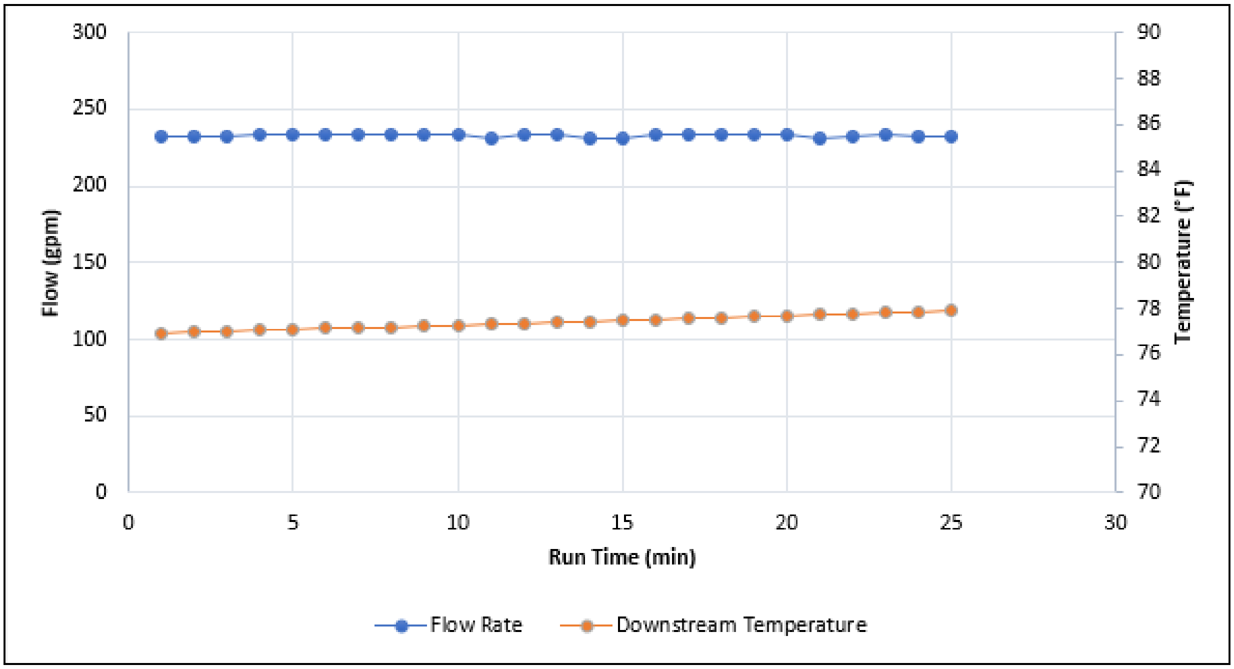

Figure 15 Water Flow Rate and Temperature - 100% MTFR

Table 21 Sediment Feed Rate - 100% MTFR

Sediment Feed Rate (g/min)		Sediment Mass Balance	
Beaker 1	175.743	Weight of Loaded Sediment (lbs)	60.000
Beaker 2	184.957		
Beaker 3	183.266	Weight of Recovered Sediment (lbs)	50.421
Beaker 4	182.155		
Beaker 5	185.412	Mass of Sediment Used (lbs)	7.171
Beaker 6	181.686		
Average	182.203	Volume of Water Through MTD (gal)	5439.0
Total Sample Mass (g)	1092.029		
COV	0.019	Average Influent Concentration (mg/L)	212.5
QA/QC Limit	0.10	QA/QC Limit	180-220 mg/L
	PASS		PASS

Table 22 Background Water TSS Concentration - 100% MTFR

Background Water Sample Results			
Sample Number	**Sample ID**	**TSS Concentration (mg/L)**	**QA / QC** C < 20 mg/L
1	BW1-100	13	PASS
2	BW2-100	11	PASS
3	BW3-100	9	PASS
4	BW4-100	7	PASS
5	BW5-100	7	PASS
6	BW6-100	7	PASS
7	BW7-100	7	PASS
8	BW8-100	7	PASS

Table 23 Effluent Sample Results and Removal Efficiency - 100% MTFR

Effluent Sample Results				
Sample Number	**Sample ID**	**Effluent Concentration**	**Related Background Water Concentration**	**Adjusted Concentration**
		[mg/L]	**[mg/L]**	**[mg/L]**
1	EF1-100	108	13	95
2	EF2-100	110	12	98
3	EF3-100	119	11	108
4	EF4-100	118	10	108
5	EF5-100	109	9	100
6	EF6-100	108	8	100
7	EF7-100	109	7	102
8	EF8-100	104	7	97
9	EF9-100	107	7	100
10	EF10-100	124	7	117
11	EF11-100	110	7	103
12	EF12-100	111	7	104
13	EF13-100	110	7	103
14	EF14-100	119	7	112
15	EF15-100	111	7	104
Average Adjusted Effluent Concentration (mg/L)				**103.4**
Removal Efficiency (%)				**51.3%**

125% MTFR Results

Table 24 Sampling Schedule - 125% MTFR

Detention Time =		**40**	**s**
Feed Rate Sampling T =		**60**	**s**
Time Between Effluent Sampling =		**30**	**s**
Time (min:sec)	**Feed Rate**	**Background**	**Effluent**
0:00	1		
2:58		1	1
3:28			2
3:58	2	2	3
6:57			4
7:27		3	5
7:57	3		6
10:56		4	7
11:26			8
11:56	4	5	9
14:55			10
15:25		6	11
15:55	5		12
18:54		7	13
19:24			14
19:54	6	8	15

Table 25 QA/QC Water Flow Rate and Temperature - 125% MTFR

Test Parameter	Water Flow Rate (gpm)				Maximum Water Temperture (°F)
	Target	Actual	Difference	COV	
	291.74	289.29	-0.841%	0.014	79.35
QA/QC Limit	-	-	±10%	0.03	80
			PASS	PASS	PASS

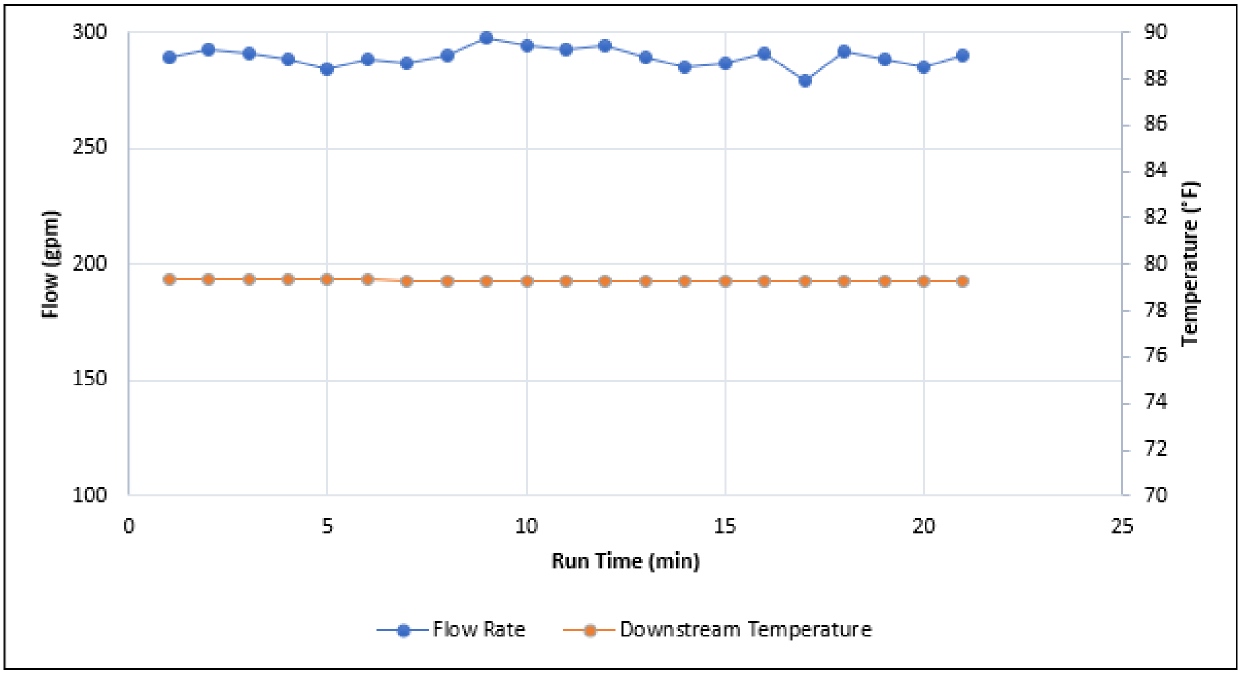

Figure 16 Water Flow Rate and Temperature - 125% MTFR

Table 26 Sediment Feed Rate - 125% MTFR

Sediment Feed Rate (g/min)		Sediment Mass Balance	
Beaker 1	217.895	**Weight of Loaded Sediment (lbs)**	60.000
Beaker 2	213.444		
Beaker 3	214.411	**Weight of Recovered Sediment (lbs)**	49.958
Beaker 4	221.363		
Beaker 5	220.119	**Mass of Sediment Used (lbs)**	7.167
Beaker 6	219.283		
Average	217.753	**Volume of Water Through MTD (gal)**	6046.1
Total Sample Mass (g)	1303.994	**Average Influent Concentration (mg/L)**	199.2
COV	0.015		
QA/QC Limit	0.10	**QA/QC Limit**	180-220 mg/L
	PASS		PASS

Table 27 Background Water TSS Concentration - 125% MTFR

Background Water Sample Results			
Sample Number	Sample ID	TSS Concentration (mg/L)	QA / QC C < 20 mg/L
1	BW1-125	2	PASS
2	BW2-125	2	PASS
3	BW3-125	11	PASS
4	BW4-125	11	PASS
5	BW5-125	10	PASS
6	BW6-125	8	PASS
7	BW7-125	7	PASS
8	BW8-125	7	PASS

Table 28 Effluent Sample Results and Removal Efficiency - 125% MTFR

Effluent Sample Results				
Sample Number	Sample ID	Effluent Concentration	Related Background Water Concentration	Adjusted Concentration
		[mg/L]	[mg/L]	[mg/L]
1	EF1-125	95	2	93
2	EF2-125	116	2	114
3	EF3-125	103	2	101
4	EF4-125	113	6.5	106.5
5	EF5-125	111	11	100
6	EF6-125	110	11	99
7	EF7-125	119	11	108
8	EF8-125	132	10.5	121.5
9	EF9-125	131	10	121
10	EF10-125	121	9	112
11	EF11-125	123	8	115
12	EF12-125	137	7.5	129.5
13	EF13-125	121	7	114
14	EF14-125	130	7	123
15	EF15-125	130	7	123
Average Adjusted Effluent Concentration (mg/L)				**112.0**
Removal Efficiency (%)				**43.8%**

Excluded Data/Results

All data from performance evaluation test runs, including any data excluded from the calculations determining removal rates, must be reported according to Section 5.D of NJDEP HDS Protocol.

[1] During the 25% MTFR test, the first background sample BW1-25, had a 71-mg/L TSS concentration, which was greater than 20-mg/L guideline and therefore replaced with the most conservative value of 0-mg/L.

[2] During the 75% MTFR test, again, the very first TSS background sample and the second background sample, BW1-75 and BW2-75, had TSS concentrations greater than 20-mg/L of TSS and were also replaced in the removal efficiency calculations with the most conservative value of 0-mg/L.

All other test data collected from performance evaluation test runs have been reported.

Annualized Weighted TSS Removal Efficiency

The annualized weighted TSS removal efficiency calculation is shown below in **Table 29** based on the results of the removal efficiency testing.

Table 29 Annualized Weighted Removal Efficiency for the JDS36-1818

%MTFR	Removal Efficiency (%)	Annual Weighting Factor	Weighted Removal Efficiency (%)
25	55.3%	0.25	13.8%
50	51.6%	0.30	15.5%
75	51.3%	0.20	10.3%
100	51.3%	0.15	7.7%
125	43.8%	0.10	4.4%
Annualized Weighted Removal Efficiency			51.6%

4.2 Scour Testing

Scour testing was performed in accordance with Section 4 of the NJDEP Protocol. Since the unit is designed to be installed online, testing was performed at the specified 200% MTFR of 1.04-cfs (467-gpm).

Before testing began, the JDS was cleaned of any remaining sediment from previous testing. The adjustable false floor was damaged and unable to be lowered 4-inches below the 50% sump full level. So, 4-inches of sediment was loaded on top of the false floor, which was already placed at the 50% sump full level. The scour sediment height was checked in several locations using a dipstick and confirmed to be 4-inches above the 50% sump full level. Clean water was then used to fill the unit to the inlet height and allowed to sit for 93-hours.

At the start of the testing, flow rates were gradually increased to the 200% MTFR within the allotted 5-minute period. The clock started after flow passed through the flow meters, but before any water entered the treatment unit. This flow sequence was verified by the third-party observer. Once the clock reached the 5-minute mark, testing began with effluent and background samples taken from the same locations as the Removal Efficiency testing, in accordance with the sampling frequency demonstrated below (**Table 30**).

Table 30 Sampling Schedule - Scour Test

Detention Time (s) =		**25**
Time Between Effluent Sampling (s) =		**120**
Time (min:sec)	**Background**	**Effluent**
0:00		
2:00	1	1
4:00		2
6:00	2	3
8:00		4
10:00	3	5
12:00		6
14:00	4	7
16:00		8
18:00	5	9
20:00		10
22:00	6	11
24:00		12
26:00	7	13
28:00		14
30:00	8	15

Water flow rate and temperature are listed in **Table 31** and shown on **Figure 17.** TSS background and effluent concentrations are shown in **Table 32** and **Table 33.** Adjusted effluent concentration was determined from the following:

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

Table 31 QA/QC Water Flow Rate and Temperature - Scour Test

Test Parameter	Water Flow Rate (gpm)				Maximum Water Temperture (°F)
	Target	Actual	Difference	COV	
	466.78	463.83	-0.632%	0.010	76.95
QA/QC Limit	-	-	±10%	0.03	80
			PASS	PASS	PASS

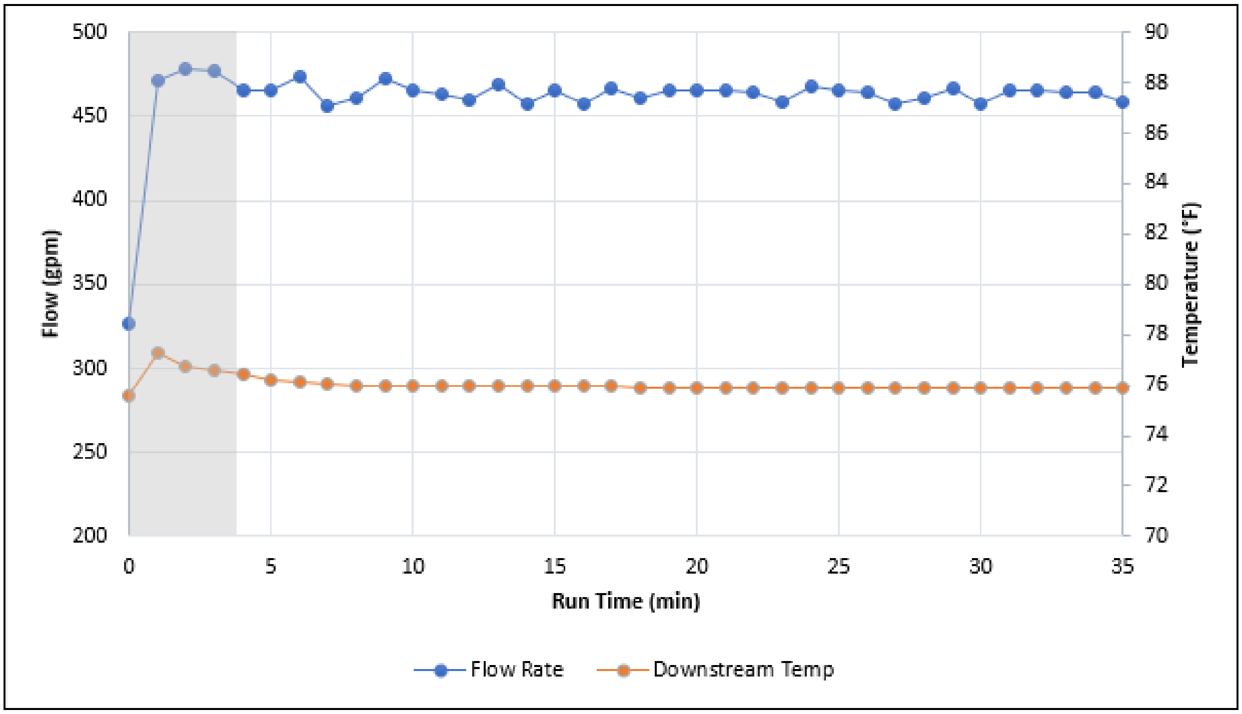

Figure 17 Water Flow Rate and Temperature - Scour Test

Table 32 Background Water TSS Concentration - Scour Test

Background Water Sample Results			
Sample Number	**Sample ID**	**TSS Concentration (mg/L)**	**QA / QC** **C < 20 mg/L**
1	BW1-200	5	PASS
2	BW2-200	5	PASS
3	BW3-200	4	PASS
4	BW4-200	4	PASS
5	BW5-200	3	PASS
6	BW6-200	2	PASS
7	BW7-200	2	PASS
8	BW8-200	1	PASS

Table 33 Effluent Sample Results - Scour Test

Effluent Sample Results				
Sample Number	Sample ID	Effluent Concentration	Related Background Water Concentration	Adjusted Concentration
		[mg/L]	[mg/L]	[mg/L]
1	EF1-200	6	5	1
2	EF2-200	4	5	0
3	EF3-200	5	5	0
4	EF4-200	5	4.5	0.5
5	EF5-200	5	4	1
6	EF6-200	5	4	1
7	EF7-200	4	4	0
8	EF8-200	4	3.5	0.5
9	EF9-200	4	3	1
10	EF10-200	3	2.5	0.5
11	EF11-200	3	2	1
12	EF12-200	3	2	1
13	EF13-200	2	2	0
14	EF14-200	3	1.5	1.5
15	EF15-200	2	1	1
Average Adjusted Effluent Concentration (mg/L)				**0.7**
Removal Efficiency (%)				**PASS**

5. Design Limitations

Each JDS system is evaluated by Jensen and properly designed to meet site-specific conditions such as treatment and bypass flow rates, pipe depth, and load limitations. Jensen provides engineering support to clients on all projects to ensure successful design and installation. All site and/or design constraints are addressed during the design and manufacturing processes.

Soil Characteristics

The system can be used in all soil types. The JDS is pre-assembled and designed to be housed in a precast concrete structure when delivered to the job site. The concrete structure is already designed to meet soil and ground water loading, as well as corrosiveness. For high traffic, railroad, or aircraft loading conditions, use of engineered rock backfill must be determined by the resident engineer. Copies of any geotechnical reports should also be reviewed for each project.

Slope of Drainage Pipe

Pipe slope to the system should follow sewer/septic slope designed guidelines between 0.5% and 10%. Slopes in excess of 10% may cause force momentum concerns and a possible hydraulic jump in the diversion way (offline) or forebay (online) of the inlet. This condition would create a water level higher upstream of the standard weir design for the more typical subcritical flow conditions of storm drain systems. Super critically sloped pipe conditions should be considered in the design phase of the project to best ensure the proper performance of the JDS Unit. JDS unit internals can readily be manufactured from stainless steel to resist force momentum loadings.

Sub-critically sloped storm drain pipelines less than 0.5% could result in sediment accumulation in pipes upstream of the JDS unit for very low flow conditions, but these sediment deposits are typically mobilized into the sump of the JDS units during higher flow events. Since the JDS is typically installed underground, it is not affected by slopes in the finished surface. Jensen is prepared to provide any assistance on design evaluation prior to specification.

Maximum Water Quality Treatment Flow Rate

Maximum treatment flow rate is dependent upon the JDS model size. For the JDS36-1818 used for NJCAT testing, a maximum flow rate of 0.52-cfs (233-gpm), was calculated using a hydraulic loading rate of 33-gpm/ft^2.

Maintenance Requirements

Section 6 of this report details inspection and maintenance requirements for the JDS system. Jensen also provides operation and maintenance guidelines manuals as well as field installation drawings and instruction for each site-specific installation.

The frequency of maintenance is generally a site-specific effort and is a function of the land use activities in the JDS's catchment watershed. In general, maintenance requirements will depend upon the accumulation of trash, debris, and sediments within the system. The cleanout of solids should be done at 50% sump full capacity. For new installations, Jensen recommends the system be checked after every runoff event for the first 30-days and at least once every 30-days during high rainfall seasons.

Driving Head

Driving head or head loss across the unit will also vary depending upon the specific site installation conditions. The JDS design considers the summation of minor losses through the treatment flow path as well as entrance/exit loss through typical manhole or diversion structures. Jensen will provide a table of head losses for all typical JDS units, based off of typical sub-critical sloped pipe conditions for hydraulic and energy grade lines (HGL & EGL), to provide engineers a starting point for determining minimum driving head requirements. Jensen will also join with design engineers to provide site specific HGL & EGL analysis for site-specific applications for peak conveyance and treatment flow rates to ensure the system can achieve the desired treatment and hydraulic conveyance goals of the stormwater management plan.

Installation Limitations

Jensen provides contractors with field installation notes for every JDS installation prior to delivery. Contractors may also request on-site assistance from Jensen engineers or technicians to ensure proper installation. Maximum pick weights are also provided to every contractor to best ensure that the appropriate equipment is used when handling the system.

Configurations

The JDS unit can be installed Online or Offline depending on site specifications. An internal bypass weir allows for the system to be installed Online without the need for an external diversion structure required for the Offline installations.

Loading

All JDS systems are deployed inside precast concrete structures, which are readily designed to handle heavy vehicular traffic, railroad, aircraft, and other live loading conditions including special seismic considerations.

For installations requiring increased capacity to handle the additional stresses generated by force moment loadings from high bypass flow conditions, internal inlets and components can be fabricated from aluminum or stainless steel as opposed to the typical inert, non-corrosive HDPE materials.

Pre-treatment Requirements

The JDS has no pre-treatment requirements as it is an optimal pretreatment unit for stormwater and combined sewer overflow. It is an excellent partner to be used in series before wetlands or other infiltration detention systems.

Depth to Seasonal High-Water Table

Since the JDS is a closed system housed in a concrete structure, connected by existing storm drain lines, high groundwater conditions will not affect the operation of the system. If high groundwater becomes a concern, the concrete structure can be made water tight though additional sealants or coatings. Footings may also be installed at the bottom of the structure to eliminate buoyancy concerns. An anti-floatation ring for the sump is available should it be necessary.

Limitations on Tailwater

Tailwater conditions, caused by tidal forces or increased headwater in downstream infiltration detention systems, are project and site specific and should be addressed in the design of any JDS system installation. Tailwater conditions do have some increase in the amount of driving head necessary for optimal system operation and therefore, should be analyzed by Jensen project engineers to implement the necessary steps in resolving tailwater issues.

6. Maintenance Plan

To ensure the JDS performs at an optimum level, the system must be inspected and maintained at regular intervals. The frequency of maintenance is heavily dependent upon specific site conditions rather than the size of the unit., e.g., catchment areas subject to heavy trash accumulation, unstable soils, or heavy sanding on roadways during winter conditions. Jensen has prepared an Operation and Maintenance Guide, which can be found at: https://www.jensenprecast.com/water-resources/product/hydrodynamic-separators/. The majority of the content of this Operation and Maintenance Guide/manual is reiterated below.

Inspection

Routine inspections are critical to the optimum performance of the JDS system. At a minimum, inspections should take place at least twice per year; however, this may be more frequent depending on site specific conditions.

Inspection Equipment

The following is a list of equipment for the simple and effective inspection of JDS systems:

- Inspection Form (Found in Appendix A of the O&M Guide)
- Flashlight
- Appropriate tools for access and handling of the manhole covers and hatches
- Dipstick or tape measure
- Protective clothing and eye protection

Inspection Steps

Inspections of the internal components can, in most cases, be accomplished through observations from the ground surface. It must be noted that the JDS unit is a confined space environment and only properly trained personnel possessing the necessary safety equipment should enter the unit to perform maintenance or inspection procedures. All necessary pre-inspection steps including traffic control or pedestrian detours must be carried out. Access to the JDS can be reached typically through the manhole cover. When the manhole or hatch has been safely opened the following inspection procedure should begin:

- Record the date, time, and inspector on the day of inspection as well as the job location and model designation.
- Check the inlet and outlet pipes for any unwanted objects or obstructions.
- Observe the inside of the JDS for the level of floatables within the center of the system.
- Check the integrity of the screen for any damage or abrasion.
- Use a tape measure or dipstick to measure the amount of sediment accumulation in the sump.
- If sorbents are used, check for any discoloration.

- Record and photograph any observations in the provided inspection form.
- Finalize the inspection report with the designated manager to determine required maintenance.

Recommendations for Achieving Optimal Performance

New Installations – The condition of the unit should be checked after every major runoff event for the first 30-days. The visual inspection should ascertain that the unit is functioning properly (no blockages or obstructions to inlet and/or separation screen), measuring the amount of solid materials that have accumulated in the sump, the amount of fine sediment accumulated behind the screen, and determining the amount floating trash and debris in the separation chamber. This can be done with a calibrated "dipstick" so that the depth of deposition can be tracked. Schedules for inspections and cleanout should be based on storm events and pollutant accumulation.

Ongoing Operations – During the rainfall season, the unit should be inspected at least once every 30-days. The floatables should be removed and the sump cleaned when it is 50% (12-inches). If floatables accumulate more rapidly than the settleable solids, the floatables should be removed using a vactor truck or dip net before the layer thickness exceeds one to two feet.

Cleanout of the JDS unit at the end of the rainfall season is recommended because of the nature of pollutants collected and the potential for odor generation from the decomposition of material collected and retained. This end of season cleanout will assist in preventing the discharge of pore water from the JDS unit during summer months.

Maintenance

From observations noted during previous inspections, the following items may be indications of necessary maintenance to the JDS system.

- Missing or damaged components.
- Obstruction to the inlet, outlet, or treatment area.
- Excessive accumulation of floatables in the sump chamber, which inhibits or blocks the screen area.
- Accumulation of more than 50%(12-inches) within the bottom of the sump.

The screen assembly is fabricated from ASTM Type 316 stainless steel and fastened with Type 316 stainless steel fasteners that are easily removed and/or replaced with conventional hand tools. Damaged screen assembly should be replaced with the new expanded metal screen assembly placing the expanded apertures in the same orientation as the existing screen section that was removed.

Maintenance Equipment

For proper cleanout, it is recommended the use of a vacuum truck in addition to the basic tools also required for routine inspections.

- Inspection Form (Found in Appendix A of the O&M Guide)
- Flashlight
- Appropriate tools for access to manhole covers and hatches
- Dipstick or tape measure
- Protective clothing and eye protection
- Appropriate safety and certification for confined space
- Vacuum truck with pressure washer attachment

Maintenance Procedures

Cleanout of the JDS unit at the end of a rainfall season is recommended because of the nature of pollutants collected and the potential for odor generation from the decomposition of material collected and retained. This end of season cleanout will assist in preventing the discharge of pore water from the JDS unit during summer months. All safety precautions including traffic and pedestrian detours should be in place before beginning.

- A vactor truck equipped with a pressure washer attachment is typically all that is needed for routine maintenance. The vactor truck will vacuum out all floatables and solids both suspended and stored in the sump. A pressure washer is in place to break up any solids that may be stuck in the sump chamber. Once all contaminants are vacuumed out, taking roughly 30 to 40-minutes for most installations, the vactor truck can be removed from the treatment unit.
- The person conducting maintenance may close-up and replace all access hatches and remove all traffic control.
- All removed debris and pollutants shall be disposed of according to the local municipality.
- Disposal of decant liquid/material should go to a local water treatment plant.
- During maintenance, if any parts need repaired, they can be ordered through the manufacturer.

7. Statements

The following attachments are signed statements from the manufacturer (Jensen Water Resources), the independent third-party observer, the testing laboratories (Lumos Inc., WETLAB, and Desert Research Institute), and NJCAT. These statements are a requirement for the NJCAT verification process.

July 25, 2018

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

Subject: Certification of Compliant Testing

Reference: Jensen Deflective Separation Verification Report

Dear Dr. Magee:

We certify that the Jensen Deflective Separation stormwater treatment unit was tested in accordance with the *New Jersey Department of Environmental Protection (NJDEP), Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device, January 25, 2013.*

Please do not hesitate to call me at either my office: (775) 352-6336, or cell: (408) 427-7571 or email me at wstein@jensenprecast.com if you have any questions regarding our unit testing or any item of the testing verification report.

Sincerely,

Walter L. Stein

Walter Stein, P.E.
Division Manager
Jensen Stormwater BMP/LID Systems
Jensen Precast

A Division of Jensen Precast

JENSENSTORMWATER.COM

Keith E. Dennett, Ph.D., P.E.
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University of Nevada, Reno

February 5, 2019

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

Dear Dr. Magee,

Protocol Compliance Statement

I, Dr. Keith Dennett, Ph.D., P.E., served as a third-party independent observer for testing that was performed by the Jensen Precast Concrete Company on stormwater treatment technologies. All tests were performed at the Jensen Stormwater Testing Facility located at 470 Dunn Circle in Sparks, NV. All testing met or exceeded the standard procedures described in ***Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology, January 25, 2013.***

I was present on-site during all relevant testing. I observed and monitored the testing based on the approved Quality Assurance Project Plan (QAPP) which was prepared in compliance with the standard procedures outlined in the approved QAPP by the New Jersey Corporation for Advanced Technology (NJCAT).

Conflict of Interest Statement

I, Dr. Keith Dennett, Ph.D., P.E., served as a non-biased, independent, third-party observer. I am a full-time faculty member of the Department of Civil and Environmental Engineering at the University of Nevada, Reno (UNR). I declare that I do not have any vested interest in the products that were tested or in any of the affiliated Jensen companies. There is no financial, personal, or professional conflict of interest between me and the Jensen Precast Concrete Company.

If I can provide any additional information, please do not hesitate to contact me by telephone at (775) 784-4056 or by e-mail at kdennett@unr.edu.

Sincerely,

Keith E Dennett

Keith E. Dennett, Ph.D., P.E.
Associate Professor

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

January 7, 2019

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

Dear Mr. Mahon,

Based on my review, evaluation and assessment of the testing conducted on the Jensen Deflective Separator (JDS) a Hydrodynamic Sedimentation (HDS) Manufactured Treatment Device (MTD) from Jensen Stormwater Systems, at their Jensen Precast outdoor facility site in Sparks, Nevada, the requirements of the *New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device (January 25, 2013)* were met or exceeded. Specifically:

Test Sediment Feed

The mean PSD of the Jensen test sediments comply with the PSD criteria established by the NJDEP HDS protocol. The 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 (<75µ); the test sediment d_{50} was approximately 62 microns. The scour test sediment PSD analysis was plotted against the NJDEP removal efficiency test PSD specification and shown to be finer than specified by the protocol.

Removal Efficiency Testing

In accordance with the NJDEP HDS Protocol, removal efficiency testing was executed on the JDS36-1818, a 3 ft. diameter commercially available unit, in order to establish the ability of the Jensen Deflective Separator to remove the specified test sediment at 25%, 50%, 75%, 100% and 125% of the target MTFR. The JDS36-1818 demonstrated 51.6% annualized weighted solids removal as defined in the NJDEP HDS Protocol. The flow rates, feed rates and influent concentration all met the NJDEP HDS test protocol's coefficient of variance requirements and the average background concentration for all five test runs never exceeded 20 mg/L. However, three of the 40 background samples exceeded 20 mg/L. To be conservative when calculating the adjusted effluent concentrations, these three samples were assigned a background concentration of zero.

Scour Testing

In order to demonstrate the ability of the JDS to be used as an online treatment device, scour testing was conducted in accordance with the NJDEP HDS Protocol. The average flow rate during the online scour test was 1.03 cfs, which represents ~200% of the MTFR (MTFR = 0.52 cfs). Background concentrations were 6 mg/L or less throughout the scour testing, which complies with the 20 mg/L maximum background concentration specified by the test protocol. Unadjusted effluent concentrations ranged from 1 mg/L to 5 mg/L. When adjusted for background concentrations, the effluent concentrations range from 0 to 1.5 mg/L with a mean of 0.7 mg/L. These results confirm that the JDS36-1818 meets the criteria for online use.

Maintenance Frequency

The predicted maintenance frequency for all models is 96 months.

Sincerely,

Richard S Magee

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

8. References

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

ASTM D3977-97. *Standard Test Methods for Determining Concentrations in Water Samples.*

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.

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

NJDEP Laboratory Test protocol and Verification Procedure: NJCAT Interpretations, June 2017.

VERIFICATION APPENDIX

Introduction

- Manufacturer – Jensen Water Resources, 521 Dunn Cir, Sparks, NV 89431.
  Phone: (855) 468-5600. Website: https://www.jensenprecast.com/water-resources/

- Jensen Deflective Separator (JDS) MTD – Various sizes found in **Table A-1** and **Table A-2.**

- TSS Removal Rate: 50%

- Online installation

Detailed Specification

- NJDEP sizing tables for the JDS verified models are found in **Table A-1** and **Table A-2**.

- New Jersey requires that the peak flow rate of the NJWQ Design Storm event of 1.25 inch in 2 hours shall be used to determine the appropriate size for the MTD.

- Jensen Water Resources supplies detailed installation and assembly procedures for contractors as well as design support. Jensen Water Resources also offers onsite installation consulting.

- Maximum recommended sediment depth prior to cleanout is 12 inches for all models (50% of sump depth).

- An Operations and Maintenance Guide is provided for each project installation and is available at: https://www.jensenprecast.com/water-resources/product/hydrodynamic-separators/

- According to N.J.A.C. 7:8-5.5, NJDEP stormwater design requirements do not allow a hydrodynamic separator such as the JDS to be used in series with another hydrodynamic separator to achieve an enhanced TSS removal rate.

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

JDS Model	Manhole Internal Diameter (ft)	Maximum Treatment Flow Rate[1] (cfs)	Treatment Area (ft^2)	Hydraulic Loading Rate (gpm/ft^2)	50% Maximum Sediment Storage Volume[2] (ft^3)	Sediment Removal Interval[3] (months)
JDS36-1818	3	0.52	7.07	33.0	7.07	96
JDS48-2424	4	0.92	12.57	33.0	12.57	96
JDS60-2430	5	1.44	19.63	33.0	19.63	96
JDS72-3642	6	2.08	28.27	33.0	28.27	96
JDS84-4248	7	2.83	38.48	33.0	38.48	96
JDS96-4848	8	3.70	50.27	33.0	50.27	96
JDS120-6794	10	5.78	78.54	33.0	78.54	96
JDS144-94102	12	8.32	113.10	33.0	113.10	96

1. Using a tested Hydraulic Loading Rate of 33 gpm/ft^2 with a test sediment d50 of 62 μm and an annualized weighted TSS removal of 50% according to the NJDEP HDS protocol.
2. 50% Maximum Sediment Storage Volume is calculated by the manhole internal area x 1 ft of sediment depth. The sediment sump depth is 2 ft on all units.
3. Sediment Removal Interval is calculated using the equation in Appendix A, Section B of the NJDEP HDS protocol.

Table A-2 Dimensions for Various JDS Models

JDS Model	Manhole Internal Diameter (ft)	Maximum Treatment Flow Rate (cfs)	Total Chamber Depth (ft)	Treatment Chamber Depth[1] (ft)	Aspect Ratio[2] (Depth/Diameter)	Sediment Sump Depth[3] (ft)	Screen Height/Diameter (ft)
JDS36-1818	3	0.52	4.6	3.6	1.2	2.0	1.5/1.5
JDS48-2424	4	0.92	5.7	4.7	1.2	2.0	2/2
JDS60-2430	5	1.44	6.8	5.8	1.2	2.0	2.5/2
JDS72-3642	6	2.08	7.8	6.8	1.1	2.0	3.5/3
JDS84-4248	7	2.83	9.3	8.3	1.2	2.0	4/3.5
JDS96-4848	8	3.70	10.3	9.3	1.2	2.0	4/4
JDS120-6794	10	5.78	12.5	11.5	1.2	2.0	7.8/5.6
JDS144-94102	12	8.32	14.5	13.5	1.1	2.0	8.5/7.8

1. Treatment Chamber Depth is the depth below the invert down to a 50% full sump chamber.
2. The aspect ratio of treatment chamber depth/manhole diameter is 1.2 for the tested model size. A variance of 15% is allowed.
3. JDS uses a 2 ft sump depth to store captured sediment.