3-ENGINEERING, LLC
WATER MANAGEMENT SOLUTIONS

Fuji Clean CEN-Series Performance Submitted For Virginia Department of Health TL-3 Listing

FujiClean USA™ LLC
Toward Clean Water…

Submitted By

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FUJI CLEAN CEN-SERIES
FINAL REPORT FOR TL-3 LISTING

November 15, 2018

Summary

This report is submitted in accordance with the Virginia Department of Health (VDH) Memorandum of Understanding (MOU) signed with Fuji Clean USA, LLC, (Fuji Clean) dated September 5, 2017. The report provides sampling results of 22 Fuji Clean CEN-Series units in support of TL-3 listing in accordance with VDH regulations. Using a spreadsheet provided by VDH staff and developed in conformance with the analysis, the Upper 99 Percent Confidence Interval of Log-Transformed Data Converted Back to Native Units is 7.1 mg/L for BOD and 4.6 mg/L for TSS. Both values support are less than 10 mg/L and thus support the application. The report recommends that the Fuji Clean CEN-Series be listed as providing TL-3 treatment.

Sampling Program Details

The report contains sampling data from both Virginia and Maryland. Maryland requires 24-hour composite samples while Virginia allows grab samples. Sampling began in Maryland and was recognized under a MOU (Memorandum of Understanding) signed with "Chesapeake Bay States" (states whose watersheds discharge to the Chesapeake Bay). Sampling began in Virginia soon after under a separate MOU with the Virginia Department of Health (VDH). Initially, only Virginia sampling was recognized for the purposes of this report. Fuji Clean requested of the VDH and was granted a variance to include Maryland sampling. The variance was reasonable because both states experience the same climate, sampling in both states adhere to the same the sampling requirements and limitations, Virginia is a party to the Chesapeake Bay States MOU, and the same third-party laboratory conducts all sampling and analysis.

Two Excel spreadsheets are provided with the report. The first spreadsheet was developed and provided by the VDH. This spreadsheet is set-up to generate the results required in the MOU. The second spreadsheet contains details about each site including addresses, system model, estimated flow, sampling results, notes, and other details either required by or of interest to the VDH. All chain-of-custody and sampling reports are provided separately.

Maryland and Virginia have different sampling requirements. Maryland does not recognize influent sampling results, so influent sampling was conducted for jurisdictions other than Maryland. One Maryland sampling event was blank because of a mechanical

error. This should not cause an issue because influent parameters are provided for all other sampling events. Both BOD and cBOD results are provided, too.
Locations were selected based on their availability and conformance to the MOU: Sites were generally within the proximity of a Fuji Clean dealer. Virginia sites were generally along the I-81and I-66 corridors. Maryland sites were located in two northeastern counties. All sampling sites are full-time residential occupancies having daily flows less than 1,000 gpd. The specific addresses of the sampling sites is provided in the Excel spreadsheet of the Log-Transformed Data.

Installation details varied with the soil and site limitations. For example, Virginia sites ranged form enhanced flow to dripline irrigation designs. Maryland sites typically were gravity dispersal. Sites were generally for new construction. The southernmost site was in Louisa County.

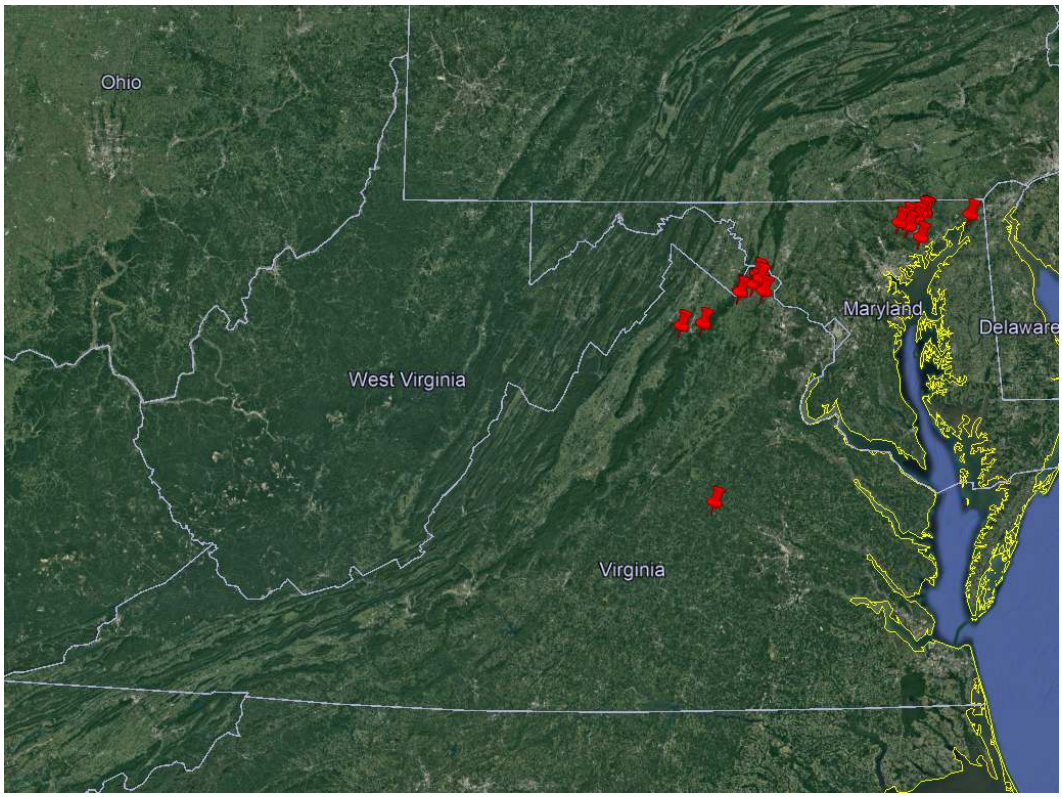


Figure 1—Sampling Locations

All systems were under operation and maintenance agreements with authorized maintenance entities. The Maryland maintenance is Dwayne C. Jones Contracting, Inc., of Jarrettsville, MD. The Virginia maintenance entity is McKim Septic & Pumping of Purcellville, VA. Each maintenance entity maintained its systems in accordance with

applicable regulations and Fuji Clean instructions. Inspection reports are provided in the attached electronic files. Dwayne C. Jones and Austin Echols are the Maryland and Virginia maintenance entity representatives, respectively.

Microbac Laboratories collected and analyzed all samples. Microbac laboratories are accredited and/or certified under applicable Maryland and Virginia regulations. Properly credentialed staff collected and transported samples in accordance with applicable practices. Field measurements were taken with calibrated equipment, and analyses were conducted in accordance with applicable analysis protocols. The Virginia contact is Caliesha Scott, who manages the Richmond office. Chain of custody and chemical analysis report forms are attached and provide details related to the analysis methods.

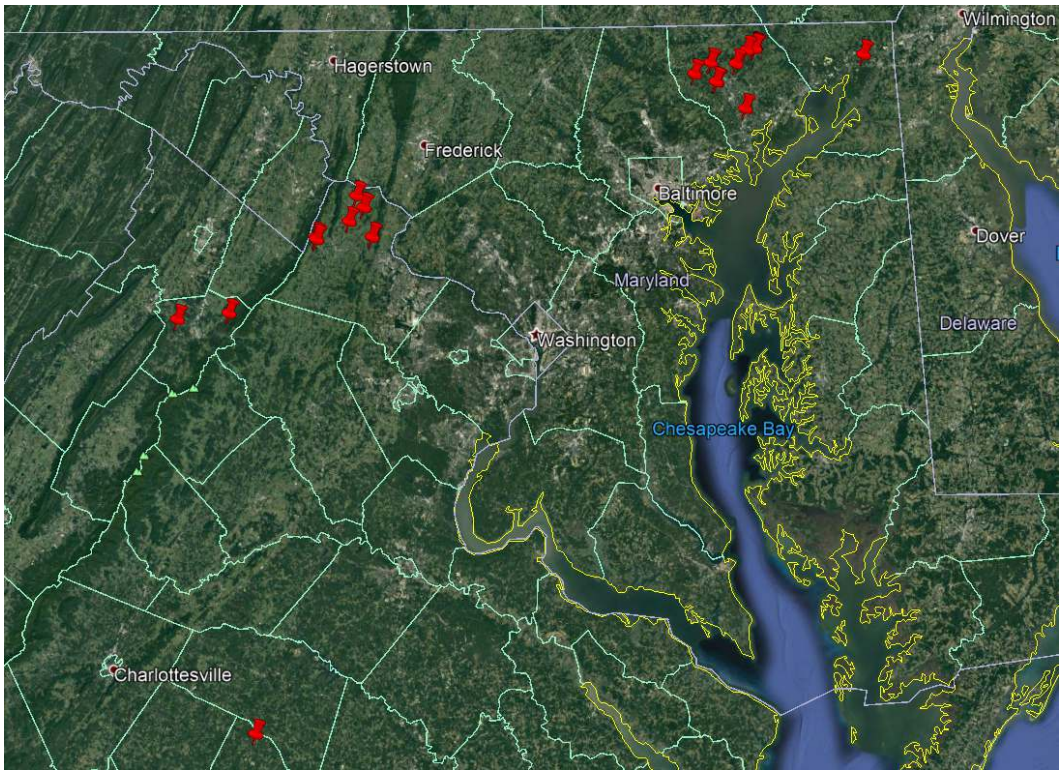


Figure 2—Sampling Location Detail

All sampling was conducted using a standardized method and equipment. All Fuji Clean CEN-Series models contain both inlet and outlet baffle walls. A 12-inch long sampling tube was connected to the tank side of the baffle and a vacuum drawn to bring the wastewater directly to the sampling container. Regardless of whether the sample was a 24-hour composite or instantaneous grab sample, the composite sampler was used to collect the influent and effluent samples.

Flow data was unavailable though occupancy information is. Sites are served by wells, and onsite wastewater treatment systems that include pumps either were on demand-dosing or incorporated mechanical timers. Regardless, none of the systems showed signs of excess flow. Occupancy ranged from two-to-five persons, so typical daily flow is estimated to range from 100 gpd at the low side to 250 gpd at the high side. The range yields an average daily flow of 175 gpd. Typical flow for dwellings connected to metered water connections is 190 gpd.

Dwelling size ranged from two-to-four bedrooms, so Fuji Clean CEN5 and CEN7 models were selected. Units were monitored after start-up, and formal sampling began approximately three-to-six months afterword—when normal operation was confirmed. In one case, the contents had to be pumped and the system re-started because someone had added introduced excessive chlorine to the wastewater.

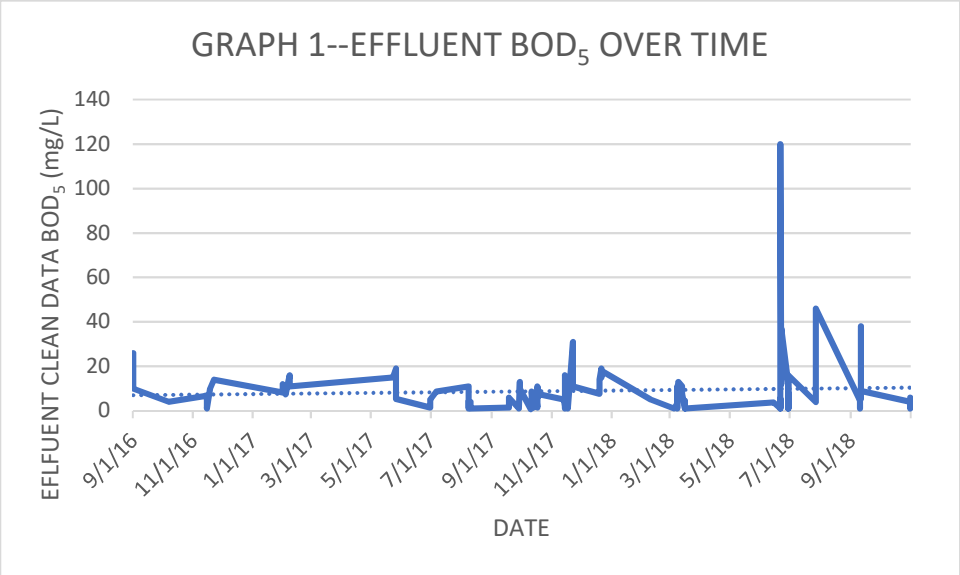
Results and Analysis

The results are shown below and demonstrate compliance with the limits for TL-3 effluent quality. The data is based on a total of 105 samples taken from 22 sites. Each site has a minimum of four samples. Several sites have five or more samples; one site has seven samples. All data was included including a couple of samples that appeared to be erroneous. The erroneous data resulted in higher averages but not sufficiently high to affect the outcome. An effluent BOD_5 result of 120 mg/L was traced to owner abuse the day before sampling. The owner is involved in dog rescue efforts and cares for a number of doges. He had cleaned up after the dogs just prior to sampling.

Table1—BOD and TSS Results for Log-Transformed Data

	BOD_5 (mg/L	TSS (mg/L)
Count (N) =	22	22
Degrees of Freedom (N-1) =	21	21
Mean =	1.59	1.22
Std Dev =	0.70	0.57
Std Err =	0.15	0.12
Upper 99% T (1-tailed) =	2.52	2.52
Upper 99% T Conf Int =	1.96	1.53
Upper 99% T Conf Int =	7.1	4.6
NOTE: Background Color Indicates Value Type	Native Values	
	Log-Transformed Values	

Graphs of the data visualize the performance. Graph 1 displays effluent BOD_5 chronologically for all 105 samples. The graph includes a trendline of performance. The data reflects consistent performance documented by the trendline. The lone high value resulted from the owner washing large amounts of dog wastes the day before sampling; the data is sufficiently robust to absorb the high value. The VDH Upper 99 Percent confidence value is 7.1 mg/L.



Graph 2 displays the effluent TSS chronologically for all 105 samples. The graph also reflects consistent results with a consistent trendline. The VDH Upper 99 Percent confidence value is 4.6 mg/L.

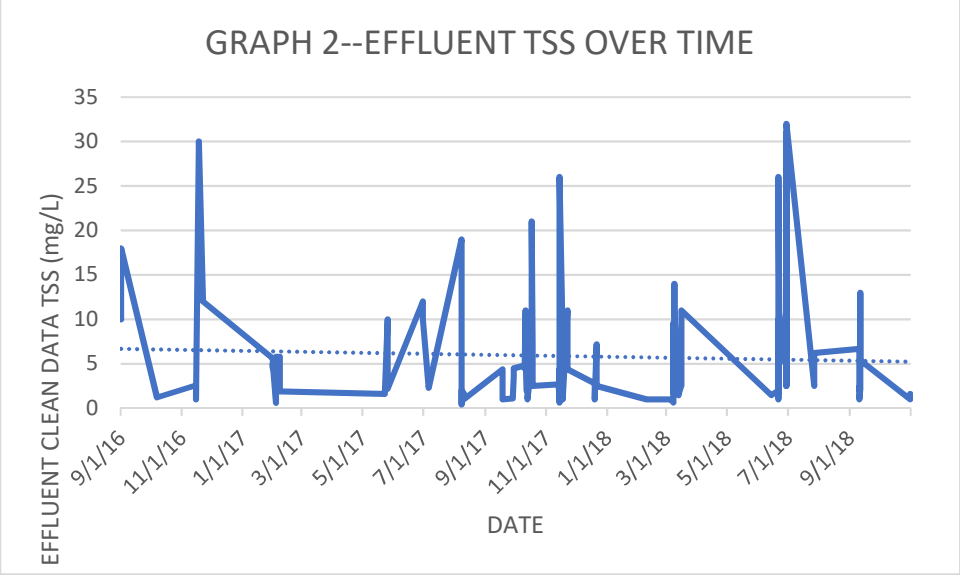
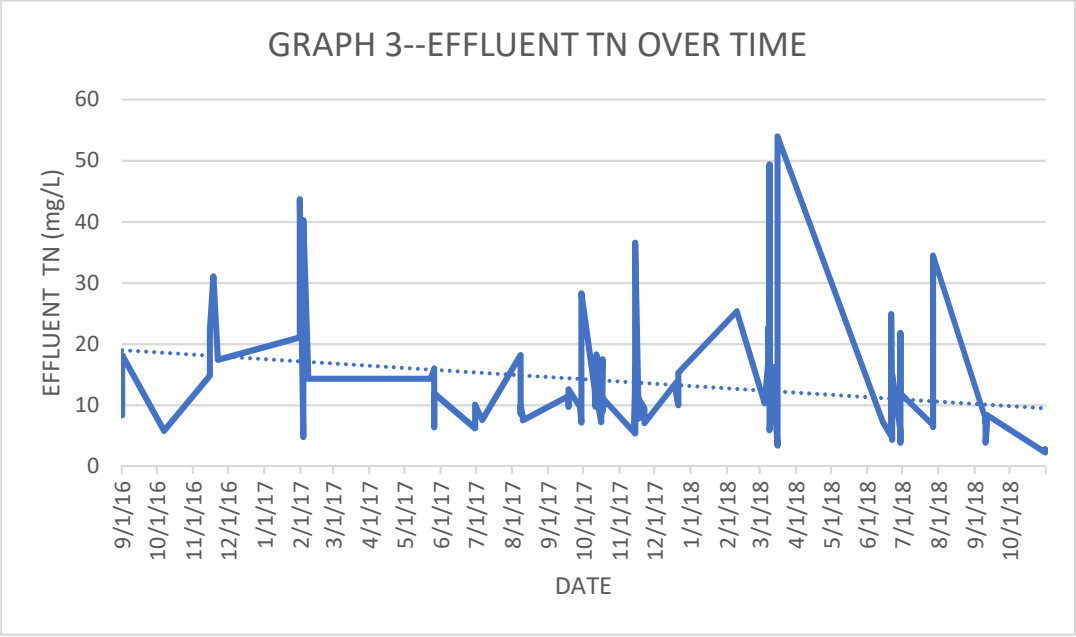


Chart 3 is the Effluent TN (Total Nitrogen) for all samples. The average Effluent TN is 13.4 mg/L for 105 samples. The standard deviation is 9.6 mg/L. TN sampling is not required for TL-3 listing, and the Fuji Clean CEN-Series already has certification under NSF/ANSI Standard 245. Regardless, some jurisdictions such as North Carolina, Austin, Texas, and Florida accept data from other jurisdictions as a part of their approval processes.



The data was re-sorted and the associated probability with each data point calculated to develop normal distribution graphs. The graphs visualize the data to allow its consistency to be observed rather than inferred. Shown in Table 2 are the averages and standard deviations calculated to develop Graphs 4 through 6. Recall that "Clean Data" refers to data transformed as a result of a "<-sign" (less than) in front a data point. Under the VDH reporting requirements, the value itself can be divided in half when the <-sign appears in the report. None of the TN data points has <-signs before them, but the data is presented in Table 2 for ease of comparison.

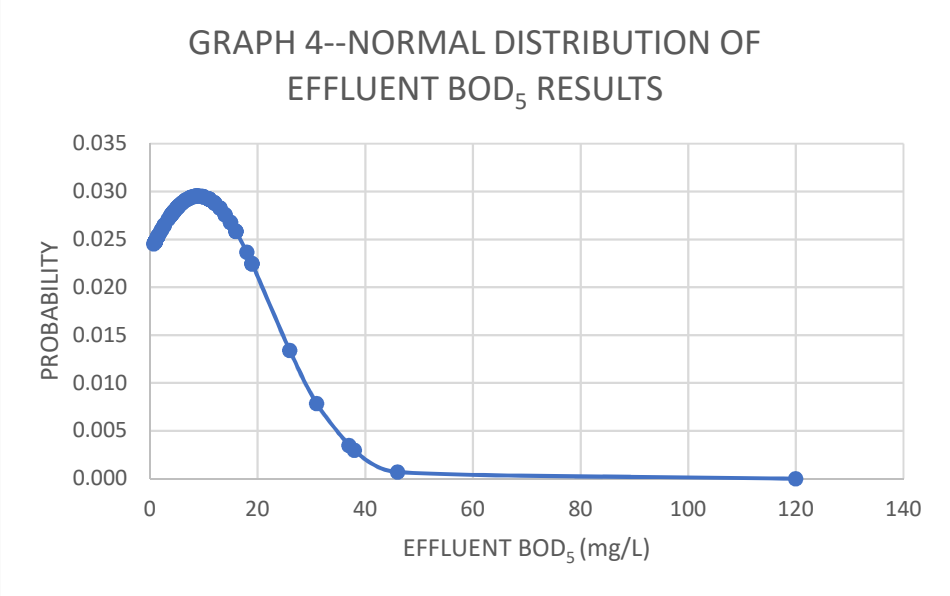
TABLE 2—CALCULATIONS BASED ON CLEAN DATA EFFLUENT VALUES (mg/L)

ITEM	TN	BOD_5	TSS
AVERAGE	13.4	9.0	5.8
STD DEV	9.6	13.5	6.7
COUNT	105	105	105

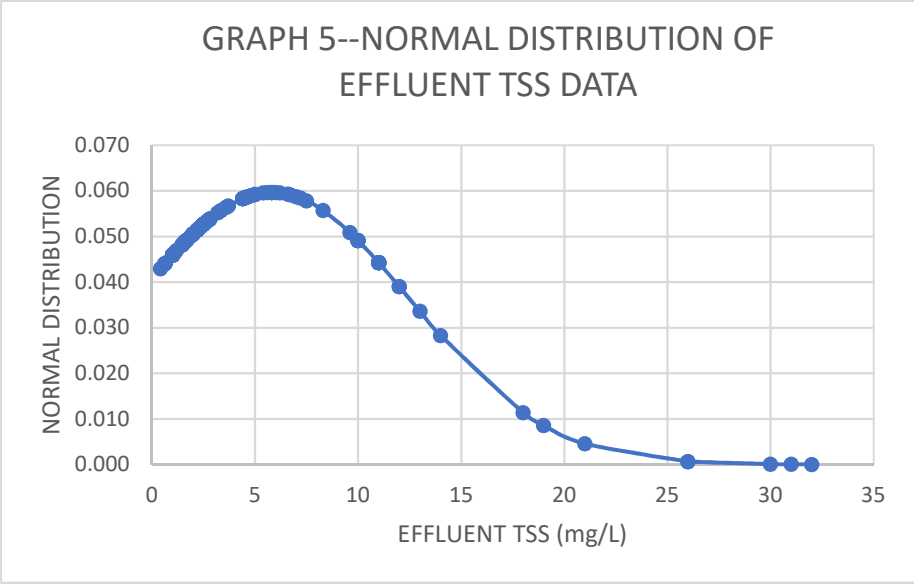
The graphs are necessarily one-sided because values cannot below 0; the typical lower limit for these tests is 2 mg/L unless special procedures are in place. An Excel spreadsheet is provided for

the calculations and resulting graphs. Also note that the values include a time-dependent element. Improved performance is expected as system mature. This improved performance is a result of mixed liquor maturation. Intended performance can be observed

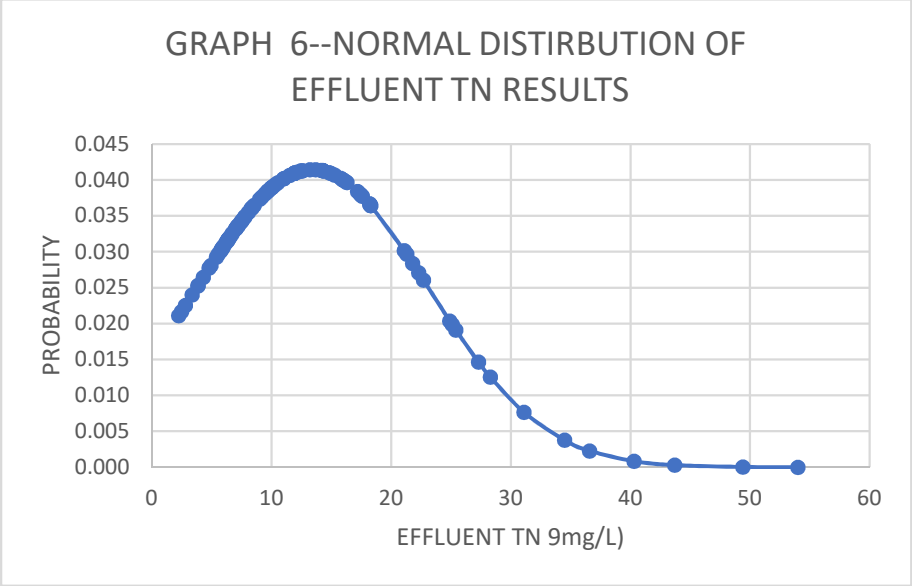
The Clean Data Effluent BOD_5 shows a tight distribution with just a few trailing values. So many values below 9 mg/L are present so as to preclude the observation of any single value. As noted, the 120 mg/L value was a result of owner abuse the day prior to sampling.



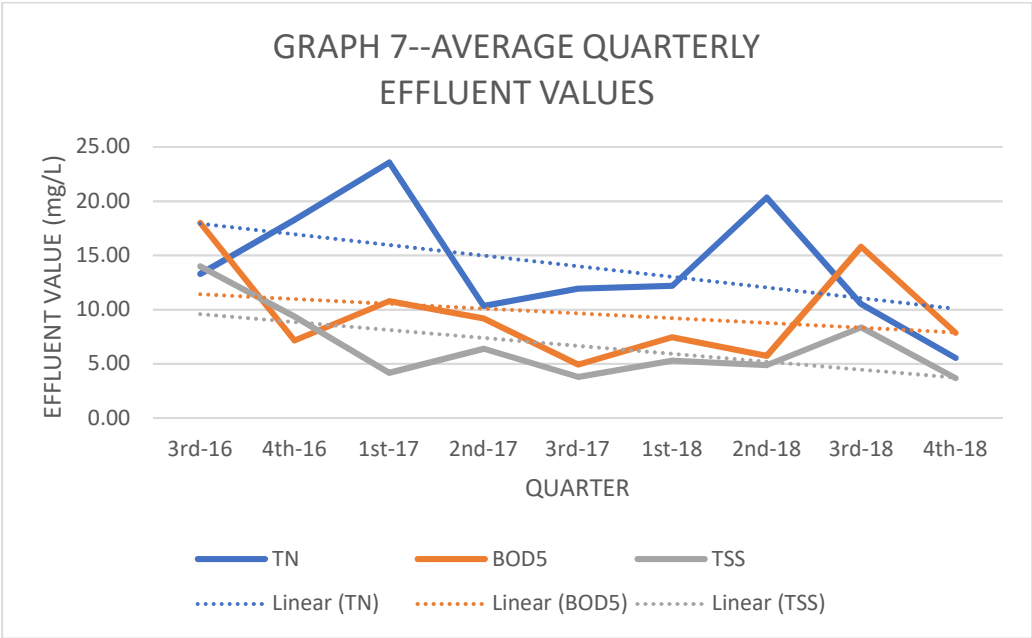
The effluent TSS exhibits a similar distribution over a smaller range. Again, the prevalence of values below the mean makes observation of individual points impossible.



Graph 6, which is a distribution of Effluent TN values, is not required and provided to demonstrate the robustness of the nitrogen-removal capabilities of the models.



Graph 7 is presented to examine performance through the year. Again, two trends are observed. First, the Effluent BOD_5 and TSS demonstrate improvement except during the third quarter of 2018. This unexpected result is the result of owner abuse, as noted. This result does not affect the outcome with regard to TL-3 listing. Overall, BOD_5 and TSS performance is increasing as systems age.



The second trend are the higher Effluent TN results during colder months. Higher values are expected because of cooler tank temperatures. Higher TN values can be addressed by providing insulation or heating to raise water temperature. Overall, the TN performance is increasing as the systems age.

Maintenance

Typical operational issues were observed during the course of the sampling. Re-sampling was conducted if the issue resulted in unrepresentative results or delayed if the matter was temporary. For example, an air hose was observed to have broken and resulted in impeded operation. The airline was repaired and the unit resampled. Occasionally, high oil and grease was encountered. A couple of analyses seemed incorrect and were questioned. Notes were made of unusual conditions and results.

Assessment

VDH staff should expect that Fuji Clean CEN-Series perform consistent with TL-3 effluent quality and their NSF/ANSI Standards 40 and 245 certifications. Overall, VDH staff should expect that Fuji Clean units will produce an effluent having a BOD_5 and TSS less than or equal to 10 mg/L. Staff should also expect an effluent TN in the range of 15 mg/L. All three values represent superior performance.

VDH staff should expect that Fuji Clean CEN-Series units can be maintained easily and need little maintenance effort when the units are installed, operated, and maintained in accordance with the manufacturer's design, installation, operation, and maintenance requirements, recommendations, limits, and prohibitions. Maintenance events were infrequent and required little effort to repair. One system was found to have been poisoned before sampling began. This unit was pumped and put back into service. The resultant sampling has been successful.

FC #	Test Site No.	Test Site Name	Model	Bedrooms	Occupancy	Est. Flow (GPD)	Sample Date	Lab Report
VA-01	1	150 Deane Rd, Toms Brook, VA	CEN-5	3	2	120	9/18/17	17I0842
							11/14/17	17K0753
							3/8/18	18C0489
							6/21/18	18F1131
VA-02	2	35430 Snooty Fox Rd., Round Hill, VA	CEN-10	5	4	200	9/18/17	17I0843
							11/14/17	17K0754
							3/8/18	18C0486
							6/21/18	18F1134
VA-03	3	35571 Sunny Ridge Rd, Round Hill, VA	CEN-10	5	3	175	9/18/17	17I0844
							11/14/17	17K0755
							3/8/18	18C0485
							6/21/18	18F1135
VA-04	4	11924 Purcell Rd, Lovettsville, VA	CEN-5	3	2	120	10/16/17	17I0883
							11/14/17	17K0758
							3/9/18	18C0490
							6/22/18	18F1139
							9/10/18	18I0504
VA-05	5	16028 Waterford Crest Place, Paeonian Springs, VA	CEN-10	5	5	250	9/29/17	17I1386
							11/14/17	17K0757
							3/9/18	18C0493
							6/21/18	18F1136
VA-08	6	4621 Walton Rd, Louisa, VA	CEN-5	3	4	200	9/28/17	17I0839
							11/13/17	17I0840
							3/5/18	H8C0013
							6/14/18	H8C0207
VA-09	7	38719 Morrisonville Rd., Lovettsville, VA	CEN-7	4	4	175	9/29/17	17I1385
							11/14/17	17K0756
							3/9/18	18C0492
							6/22/18	18F1138
VA-12	8	3325 Howellsville Rd, Front Royal, VA	CEN-5	3	2	120	3/8/18	18C0487
							6/21/18	18F1133
							9/10/18	18I0502
							10/31/18	H8J0037
VA-10	9	75 Mitchell Dr, Strasburg, VA	CEN-5	3	2	120	3/8/18	18C0488
							6/21/18	18F1132
							9/10/18	18I0503
							10/31/18	H8J0035
VA-14	10	13046 April Circ, Lovettsville, VA	CEN-5	3	3	1150	3/9/18	18C0491
							6/21/18	18F1137
							9/10/18	18I0505
							10/31/18	H8J0036
MD-01	11	1715 Castleton Rd, Darlington, MD	CEN-5	3	3	150	9/1/16	16H1838
							11/15/16	16K0913
							2/3/17	17B0391
							5/26/17	17E1489
							10/10/17	17J0646
MD-02	12	161 Antego Dr, Elkton, MD	CEN-5	3	2	120	8/10/17	17H0679
							10/18/17	17J1048
							12/21/17	17L0854
							3/16/18	18C0929
							6/29/18	18F1529
MD-03	13	1241 Baldwin Mill Rd, Jarrettsville, MD	CEN-5	3	5	250	10/7/16	16J0466
							1/31/17	17A1523
							6/30/17	17F1630
							10/12/17	17J0648
							11/17/17	17K0860
							9/11/18	18I0571

FC #	Test Site No.	Test Site Name	Model	Bedrooms	Occupancy	Est. Flow (GPD)	Sample Date	Lab Report
MD-05	14	1711 Castleton Rd, Darlington, MD	CEN-5	3	2	120	9/1/16	16H1837
							11/15/16	16K0912
							2/3/17	17B0389
							5/26/17	17E1488
							8/8/17	17H0676
							10/10/17	17J0645
MD-07	15	3135 Copenhaver Rd, Street, MD	CEN-5	3	3	150	1/31/17	17B0162
							5/23/17	17E1264
							8/8/17	17H0678
							10/17/17	17J1047
							12/21/17	17L0852
MD-08	16	1719 Castleton Rd, Darlington, MD	CEN-5	3	3	150	2/7/17	17B0519
							5/26/17	17E1490
							8/8/17	17H0677
							10/11/17	17J0647
MD-09	17	3530 Scarboro Rd, Street, MD	CEN-5	3	4	200	11/18/16	16K0972
							2/7/17	17B0520
							10/18/17	17J1049
							11/22/17	17K0862
							3/16/18	18C0927
							6/29/18	18F1527
							9/11/18	18I0571
MD-10	18	538 West Ln, Bel Air, MD	CEN-5	3	4	200	11/22/16	16K1221
							1/31/17	17A1525
							7/6/17	17G0200
							10/13/17	17J0651
							11/22/17	17K0863
							6/29/18	18F1524
MD-11	19	410 Rockspring Church Rd, Forest Hill, MD	CEN-5	3	2	120	11/17/17	17K0861
							2/9/18	18B0505
							3/13/18	18C0757
							6/29/18	18F1525
							7/27/18	18G1328
MD-12	20	3236 Sudath Ln, Jarrettsville, MD	CEN-5	3	3	150	8/10/17	17H0680
							10/13/17	17J0650
							12/19/17	17L0851
							6/29/18	18F1526
							7/27/18	18G1327
MD-13	21	1723 Castleton Rd, Darlington, MD	CEN-5	3	4	150	10/11/17	17J0652
							12/21/17	17L0853
							3/16/18	18C0928
							6/29/18	18F1528
							7/27/18	18G1329
MD-14	22	400 Rockspring Church Rd, Forest Hill, MD	CEN-5	3	2	120	6/30/17	17F1628
							10/17/17	17J1046
							12/19/17	17L0850
							3/13/18	18C0756
							9/11/18	18I0572