WASTEWATER TREATMENT EVALUATION
CAMPBELLTOWN EAST STP

SOUTH LONDONDERRY TOWNSHIP, LEBANON COUNTY, PA
NPDES #PA0087700

AUGUST-SEPTEMBER 2015

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION
WASTEWATER TECHNICAL ASSISTANCE PROGRAM

Bureau of Point and Non-Point Source Management

December 2015

Executive Summary

At the request of South Londonderry Township Municipal Authority's (SLTMA) manager, DEP staff from the Bureau of Point and Non-point Source Management (BPNSM) met with owners and operators of the Campbelltown East sewage treatment plant (STP) to discuss potential for reduction of energy consumption and effluent nutrients through process modifications. At the time, concerns were also expressed regarding possible annual nutrient limits, receiving stream TMDL, and community development would require additions and capital improvements to the facility. DEP staff installed in-line probes and supplemental laboratory equipment at the STP to collect data that would be used to make recommendations regarding process modifications that could, if enacted, reduce the owners' electrical cost while also limiting nutrient discharges to the receiving stream. Data collection would be repeated post-project to confirm benefits. This report covers the initial data collection and bases its recommendations on same, with the benefit of having studied similar facilities.

The Municipal Authority owns and operates four wastewater treatment plants within its borders, a main treatment facility located in Campbelltown, two small facilities located in the communities of Lawn and Colebrook, and the Campbelltown East STP which is located within an industrial park east of the Lebanon County Municipal Airport. This facility permitted under NPDES Permit No. PA-0087700 for 0.210 million gallons per day (MGD) and 490 lb/day organic loading. In 2014, the average daily flow had been 0.140 MGD with an annual average loading of 290 lb/day. The facility is not currently overloaded, and unused capacity at Campbelltown East STP is mostly reserved for future tenants of the Airport Industrial Park.

DEP staff installed several recording instruments throughout the facility from August 21 through October 6, 2015. Time graphs of recorded data are appended as Attachment 6. They also installed a power logging computer on the electrical motor for Number 2 aeration blower to record baseline data for future comparison purposes. A summary of probes and locations in included as Attachment 2; in addition, the power logger report is included as Attachment 4.

During the evaluation, the superintendent raised the question of what benefit would justify modifying a facility, already in permit compliance, for BNR in the absence of a permit requirement (such as additional limits) to do so. Aside from the environmental benefits of removing nitrogen forms from the plant effluent and the receiving stream, which this study will not quantify, BNR modifications with control feedback have been shown to reduce energy consumption by approximately one third, while also reducing the amount of alkalinity supplement that is required to achieve effective nitrification (nitrification being a permit requirement.) Improvements may pay for themselves within one or two permit cycles without creating unduly burdensome maintenance requirements. As a practical matter, few would consider excluding process and treatment improvements from any contemplated capacity upgrades.

Recommendations:

1. The initial study provided baseline data for energy consumption. DEP staff estimates that the facility could reduce its energy consumption by about thirty (30%) overall by enacting such simple process modifications as intermittent aeration, provided that the current aeration system (blowers, diffusers) are modernized to accommodate direct dissolved oxygen control (limiting DO to a range from 1.5 to 3.5 mg/L during oxic phases.
2. Efficient nitrification of organic and inorganic nitrogen in the waste stream requires supplemental alkalinity be added to maintain sufficient buffering capacity (>=100 mg/L) for complete treatment. Chemical amendment includes the use of magnesium hydroxide

(magnesia,) which is highly efficient and safe, albeit expensive, as well as carbonate/bicarbonate salts, or soda ash which is the least safe for handling.

3. The recommended pH for nitrogen oxidation and removal is between 7.0 and 8.0 s.u. South Londonderry Township already benefits from a predominantly limestone lithography, such that alkalinity may not be an issue here.
4. Biological nitrogen removal can be accomplished within the existing footprint, but projected increases in flow and loading will eventually warrant facility upgrades or diversion of influent to other treatment facilities in the Township.
5. Biological nitrogen removal using intermittent aeration would require addition of anoxic mixers to the secondary treatment system. A short-term solution to this is to employ small submersible grinder pumps having angled discharges, to keep the denitrifying bacteria in contact with aqueous nitrate and influent carbon during the anoxic period.
6. Flow equalization tank works best when there is sufficient impounded raw wastewater to attenuate fluctuations in loading and water chemistry; therefore, it is suggested that a tolerable working level be maintained there, with sufficient precaution against potential malodors, to assure attenuation of hydraulic and organic loading.
7. The Township's consulting engineers should be engaged to evaluate treatment options, as budget and growth-projections permit, and any plan to expand the facility or to replace obsolete equipment should consider both energy efficiency and biological nutrient reduction. The facility's existing footprint is amenable to more than a single treatment strategy, including but not limited to intermittent aeration in a conventional activated sludge footprint, re-engineering existing process units to accommodate alternative treatment strategies such as batch reaction, modified Ludzack-Ettinger (MLE,) Bardenpho, and others.

Background:

South Londonderry Township, located in Lebanon County, owns and operates three wastewater treatment facilities located in population centers of this mostly agricultural region. Population centers are located along primary and secondary state roads traversing the northern part of the township, centered on the villages of Campbelltown and Lawn. The township is adjacent to rapidly suburbanizing communities of Hershey and Palmyra, experiencing development pressures itself, as well.

One of the three treatment facilities is the Campbelltown East sewage treatment plant (STP,) a conventional activated sludge treatment facility built east of the county airport within an industrial park that has developed in the time since the STP began operating in 2001. The facility is rated for 0.210 MGD and an organic loading of 495 lb/day. In 2014, the average flow was 0.140 MGD, and the organic loading was 293 lb/day. Organic loading was a 50% increase over that of the previous year. Three-month average daily hydraulic flow was 0.432 MGD. The maximum-month organic loading that year had been 444 lb/day. There were 27 new EDU[1] added in 2014, with a projection of 15 EDU/year over the next five years. No new EDU were assigned in 2014, as additional capacity at Campbelltown East STP is reserved under agreements.

The facility's NPDES permit currently lists an annual limit for total phosphorus (TP) as 974 lb/yr. In the recent annual report, the facility generated 327 lb for the period, well below the limit. Phosphate is treated conventionally. There is presently no limit for total nitrogen (TP), although the facility has "monitor and report" requirements. For the recent annual period, the facility discharged a theoretical 17,958 lb. TN/yr., although this calculation was qualified most months with a "<" sign, indicating that many of the test results upon which this calculation had been based, especially that for nitrite-nitrogen, had been reported as "non-detect." The annualized limit on ammonia-nitrogen is 105 lb/yr. Using Chesapeake Bay calculations, one might expect a TN limit of 3,836 lb/yr. The facility generates TN in excess of this limit, mostly as fully-oxidized nitrate-nitrogen.

At the time of the evaluation, the facility was having its copper limit reevaluated. Testing demonstrated that the copper limit could safely be removed from the permit requirements.

In addition, the facility's headworks was being improved to replace obsolete comminutor with rotary fine-screening for trash and detritus. This is intended to reduce the maintenance required to clear comminuted rags and "disposable wipes" from pumps, valves, and diffusers, which also makes the facility more amenable to instrument-based controls and to the subsurface anoxic mixers that would be required for biological nutrient removal (BNR.)

In addition to the new headworks, the STP consists of an equalization tank and a pair of prefabricated, parallel secondary treatment trains that each include an aeration zone and integral hopper-style secondary clarifiers. Solids treatment consists of a aerobic digester followed by four on-site reed beds or disposal at two agricultural sites, or to a processor, pursuant to general permit PAG 08-3583.

During the summer of 2015, DEP staff met with the plant owner and operators concerning potential energy reduction methods that would reduce facility electrical costs. The savings

[1] An EDU is conservatively estimated at 235 gpd. Typically, the value is 250 gpd representing 2 ½ persons per household. Industrial park future development is expected to be a major contributor to Campbelltown East STP.

would mainly occur as a result of promoting biological nutrient removal (BNR) from activated sludge mixed liquor through equipment modernizations that would provide for finer process control of aeration dissolved oxygen residual. At the time, the facility was experiencing reduced aeration capability in one of the two trains, due to the lingering presence of rags and detritus clinging to the subsurface aerators.

Prior to the modernization of the headworks, the facility employed a comminutor to macerate trash and detritus in the raw wastewater flow; however, with increasing use of so-called "flushable" cleaning supplies, the accumulation of indigestible fiber strands within downstream processes became enough of a problem so as to interfere with adequate aeration of the biosolids. Headworks replacement controlled this problem, but each aeration tank had to be shut down and thoroughly cleaned of the accumulated material. It had been thought that this alone would improve the dissolved oxygen residual, but this had not been observed.

Wastewater Technical Evaluation:

On August 21, 2015, DEP staff installed process monitoring equipment to record various water and sludge quality conditions on a 24/7 basis for background data and to use in recommending process adjustments that could benefit the Township by reducing energy and maintenance costs over time. The equipment consisted of a mini-SCADA system of Hach chemical and IR/UV probes to collect data over a period of about six-to-eight weeks. Among those parameters tested are:

- Dissolved Oxygen residual
- pH and Temperature
- Total Suspended Solids
- Oxidation / Reduction Potential
- Ammonia-nitrogen
- Nitrate-nitrogen
- Biochemical Oxygen Demand

Data was produced by the digital probes and recorded on a notebook computer for transfer and graphing using a combination of readily available office software.

Over the course of the study, DEP staff would visit the facility twice per week to download data and to maintain and recalibrate the equipment, as needed. Some additional bench tests were employed to further characterize the process. Also, a 30-day power consumption profile of one of the main aeration blowers was done. The recorded power consumption of the PD blower may be useful as a benchmark for future power savings that may result in energy rebates or rate reductions.

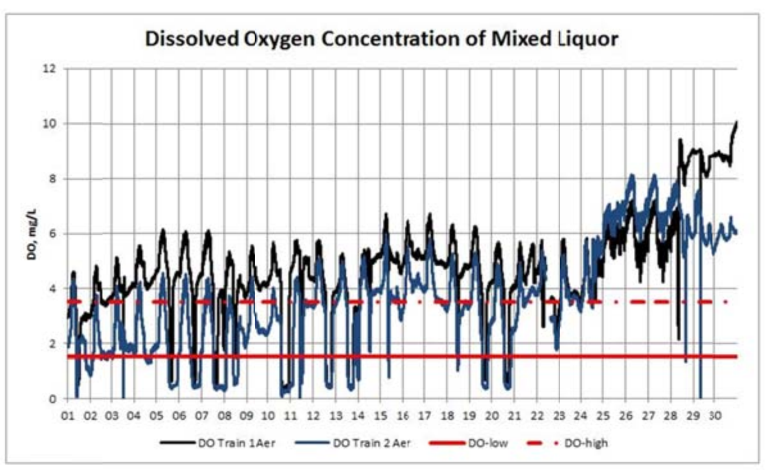


Figure 1: DO Residuals in Aeration Tanks

Generally, it was found that dissolved oxygen in the aeration tanks sometimes exceeded that necessary for treatment of the waste. As depicted in the accompanying chart, any DO above 4.0 mg/L in the aeration tanks can be considered "wasted energy," because activated sludge requires DO levels between 1.5 and 4.0 mg/L to completely nitrify most ammonia wastes. Where DO residual falls below 1.0 mg/L, there is an increased risk of incomplete treatment of wastes, resulting in potential NPDES permit violations for fecal coliform due to incomplete nitrification, where nitrite combines with chlorine and neutralizing its disinfectant power.

Plant operators noted that Train 2 typically held lower concentrations of DO than Train 1. It had been reasoned that this was due to the presence of detritus on the aerators; however, following cleaning of the worst of the detritus, DO had not appreciably improved. Other possible reasons for the disparity may be the increased distance from the PD blowers and the need for pressure adjustments.

Figure 2 displays a time graph of the effluent nitrate-nitrogen concentration for September 2015. Of note, on a new nitrate probe that had been bench calibrated, the nitrate values pegged at 52 mg/L. Increased nitrate concentration may be a characteristic of groundwater I/I entering the collection system. Regardless, to achieve total nitrogen concentrations envisioned by the Chesapeake Bay nutrient-reduction strategy, there would have to be a five-fold decrease in the effluent nitrate-nitrogen.

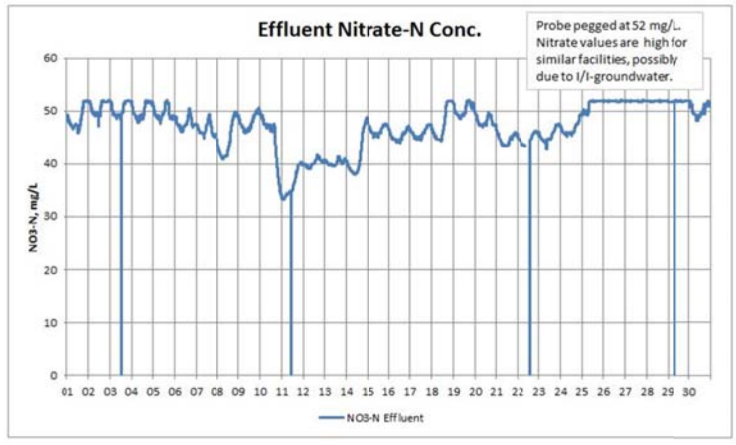


Figure 2: Effluent Nitrate Concentration

For the same period, pH time charts show that pH of the mixed liquor tends to reside at the low end of acceptable range for nitrification to be truly efficient, indicating perhaps a lack of consistently sufficient process alkalinity (as $CaCO_3$.) Since most effluent TKN and nitrite-nitrogen test results were consistently below detection limits, most of the facility TN emission has been as nitrate-nitrogen, indicating that nitrification is virtually complete.

Monitoring and Testing:

The operators add polyaluminum chloride to precipitate phosphorus, and total phosphorus residual has not been a problem at the facility. DEP staff employed an environmental field lab spectrophotometer to colorimetrically test for phosphorus, with the results being generally in concurrence with the operators' own bench tests. Total phosphorus was not part of the study.

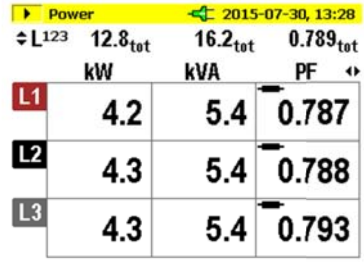
Other bench tests occasionally performed included those for settled sludge volume, oxygen uptake rate, microscopy, and various colorimetry used to check calibration ranges on the electronic probes and monitor process adjustments.

Intermittent "ON/OFF" Aeration for Process Denitrification:

At present, the Township could attempt intermittent aeration , because the existing aeration blowers are not equipped to prevent hard-starts that cause high peak electrical loads and probably cause belt-slippage and damage to motor controls. The WWTAP is willing to assist the Township in developing such treatment strategies and in documenting improvements to total nitrogen reduction and energy consumption if and when blower improvements are made.

Energy Evaluation:

A preliminary record of the existing motors was made using a Fluke Power Logger that was connected to one of two blower motors for a period of thirty days. The purpose was to set a baseline against which future improvements could be compared. The figure at right shows the general power consumption for the blower motor as 12.8 kW with a power factor of 0.789, which is typical.



An evaluation of the existing blower motor showed that it consumed approximately 130 kW/day for continuous aeration on a 24/7/265 basis. The facility has four positive displacement (PD) blowers dating from original construction. The blowers are considered “hard start” and have significant initial amp draw when starting. This precluded DEP from attempting intermittent aeration for BNR. However, at other facilities, DEP has found that a general thirty percent (30%) reduction of electrical consumption is achieved when the aeration system is run intermittently to achieve denitrification. A simple calculation of reduced power consumption by this blower motor shows that at use 70% of the day, the 60 hp motor would consume:

- 91.3 kW/day for 16 hr., 48 min. per day for intermittent aeration, 38.7 kW/day reduction over continuous operation.
- If electrical cost is seven cents per kilowatt-hour, there would be a $2.71 per day savings that equates to $988.79 savings per year, one blower operating.

A copy of the automatically generated power logger report is included in Attachment 4, following. As expected the power quality in this industrial park is excellent, and there were no anomalies discovered during the evaluation.

Should the blowers be upgraded or altered, DEP staff proposed, a second energy evaluation could be performed which may produce evidence that could be used by SLTMA to negotiate better rates for its power or obtain energy rebates from the power utility.

Disclaimers:

This document is not intended to serve as an engineering evaluation of a particular wastewater system. Facility managers must work with their consulting engineers to proceed with any interim adaptations or planned upgrades. The DEP regional office is to be notified of any temporary process modifications, and a Water Management Part II Permit Amendment is required for any permanent changes, including alternative BNR practices.

The mention of a particular brand of equipment is in no way an endorsement for any specific company. The Department urges the permitee to research available products and select those which are the most applicable for its situation. The goal of the Wastewater Treatment Evaluation is to reduce nutrients in wastewater plant discharges. This often times involves permittees achieving effluent quality above and beyond any permit requirements.

ATTACHMENTS

1. Evaluation Team
2. Process diagram
3. NPDES Limits
4. Energy Report: 60 hp blower motor
5. Record Photographs
6. Example Graphs and Charts from WTE

ATTACHMENT 1

Pennsylvania Dept. of Environmental Protection

Marc Austin Neville, Water Prgm. Spec. (WPS)
PA DEP BPNSM
Rachel Carson State Office Bldg.
POB 8774
Harrisburg, PA 17105
tel. (717) 772-4019
eml. mneville@pa.gov

Thomas Brown, WPS
PA DEP BPNSM
Cambria Office
286 Industrial Park Road
Ebensburg, PA 15931
tel. (814) 472-1878
eml. thbrown@pa.gov

Campbelltown East STP

Scott Galbraith, Director of Public Works
South Londonderry Township
27 West Market Street
Palmyra, PA 17078-8736
tel. (717) 838-5556
eml. scott@slondtwp.com

Samuel M. Blauch Jr.
South Londonderry Township
27 West Market Street
Palmyra, PA 17078-8736
tel. (717) 838-5556

ATTACHMENT 2: EQUIPMENT PLACEMENT SCHEMATIC

This illustration shows the probe placement for the evaluation. Train 1 had probes for:

- pH / Temperature
- Dissolved Oxygen
- Oxidation / Reduction Potential
- Total Suspended Solids

Train 2 had a DO probe; the Influent Splitter Box had a BOD/UVAS probe; and the discharge end of the Chlorine Contact Tank (baffled for ultrasonic flowmeter) had probes for:

- Ammonium-nitrogen
- Nitrate-nitrogen

ATTACHMENT 3

Campbelltown East STP NPDES PA0087700 Permit Limits

Parameter	Effluent Limitations						Monitoring Requirements	
	Mass Units (lbs/day) (1)		Concentrations (mg/L)				Minimum (2) Measurement Frequency	Required Sample Type
	Average Monthly	Daily Maximum	Minimum	Average Monthly	Weekly Average	Instant. Maximum		
Flow (MGD)	Report	Report	XXX	XXX	XXX	XXX	Continuous	Measured
pH (S.U.)	XXX	XXX	6.0	XXX	XXX	9.0	1/day	Grab
Dissolved Oxygen	XXX	XXX	5.0	XXX	XXX	XXX	1/day	Grab
Total Residual Chlorine	XXX	XXX	XXX	0.12	XXX	0.40	1/day	Grab
CBOD5	43	70 Wkly Avg	XXX	25	40	50	1/week	24-Hr Composite
BOD5 Raw Sewage Influent	Report	Report	XXX	Report	XXX	XXX	1/week	24-Hr Composite
Total Suspended Solids	52	78 Wkly Avg	XXX	30	45	60	1/week	24-Hr Composite
Total Suspended Solids Raw Sewage Influent	Report	Report	XXX	Report	XXX	XXX	1/week	24-Hr Composite
Fecal Coliform (CFU/100 ml) May 1 - Sep 30	XXX	XXX	XXX	200 Geo Mean	XXX	1,000	1/week	Grab
Fecal Coliform (CFU/100 ml) Oct 1 - Apr 30	XXX	XXX	XXX	2,000 Geo Mean	XXX	10,000	1/week	Grab
Ammonia-Nitrogen May 1 - Oct 31	4.4	XXX	XXX	2.5	XXX	5.0	1/week	24-Hr Composite
Ammonia-Nitrogen Nov 1 - Apr 30	13.1	XXX	XXX	7.5	XXX	15	1/week	24-Hr Composite
Total Phosphorus	3.5	XXX	XXX	2.0	XXX	4.0	1/week	24-Hr Composite
Total Phosphorus	XXX	Report Total Annual	XXX	XXX	XXX	XXX	1/month	Calculation
Total Phosphorus	XXX	974 Total Annual	XXX	XXX	XXX	XXX	1/year	Calculation
Kjeldahl---N	Report Total Mo	XXX	XXX	Report	XXX	XXX	1/month	24-Hr Composite
Nitrate-Nitrite as N	Report Total Mo	XXX	XXX	Report	XXX	XXX	1/month	24-Hr Composite
Total Nitrogen	Report Total Mo	XXX	XXX	Report	XXX	XXX	1/month	Calculation

ATTACHMENT 4: POWER LOGGER REPORT

(Note: Data files are available separately)

Campbelltown East Blower # 2 Sept 2015 Power, Volts, &, Amps

280 volts avg.
19.4 amps avg.
5.4 kW avg.
130 kW/day for continuous aeration
91.3 kW/day for 16 hr., 48 min. per day for intermittent aeration
38.7 kW/day reduction
$2.71 per day savings at .07 per kWh
$988.79 savings per year, one blower operating

Instrument Information

Model Number	FLUKE 1735
Serial Number	S133033363B6
Firmware Revision	V01.09

Software Information

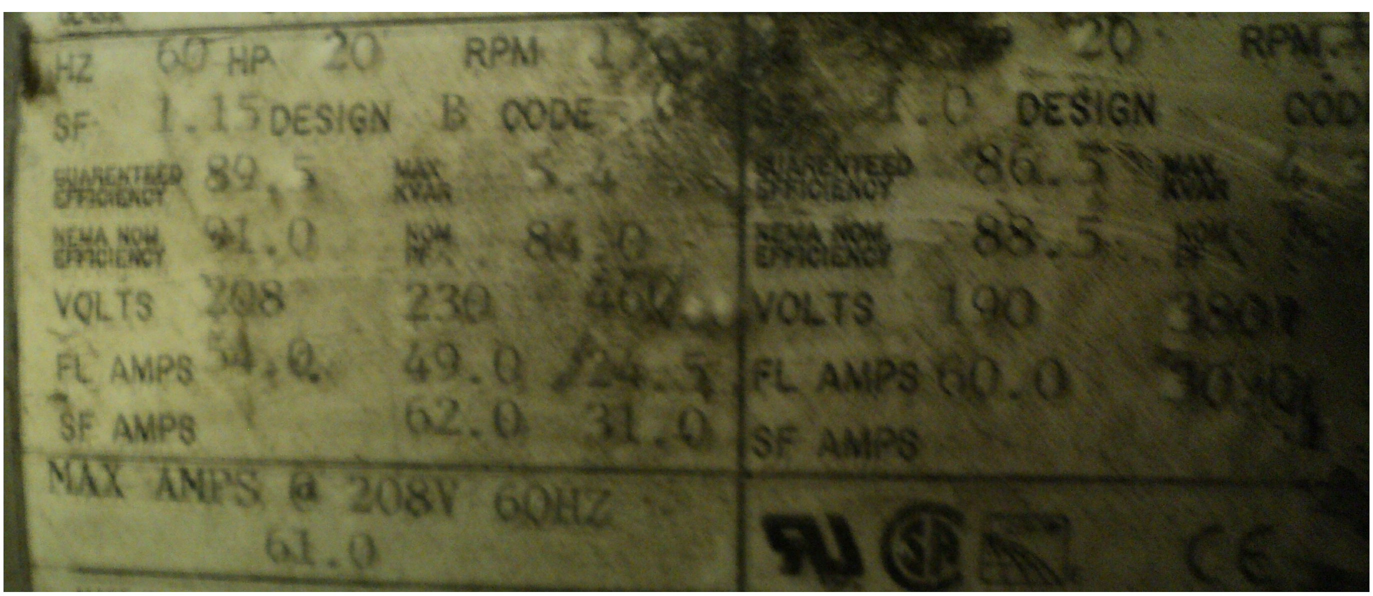
Power Log Version	4.0.2
FLUKE 345 DLL Version	11.20.2006
FLUKE 430 DLL Version	1.8.0.0
FLUKE 430-II DLL Version	1.0.0.19

General Information

Recording location Campbelltown East Blower 2

Client S. Londonderry Twp., Lebanon County

Notes
PA0087700
3 phase 460 V
FL 24.5 amp
SF 31.0 amp
1.15
60 hp
1765 rpm



Measurement Summary

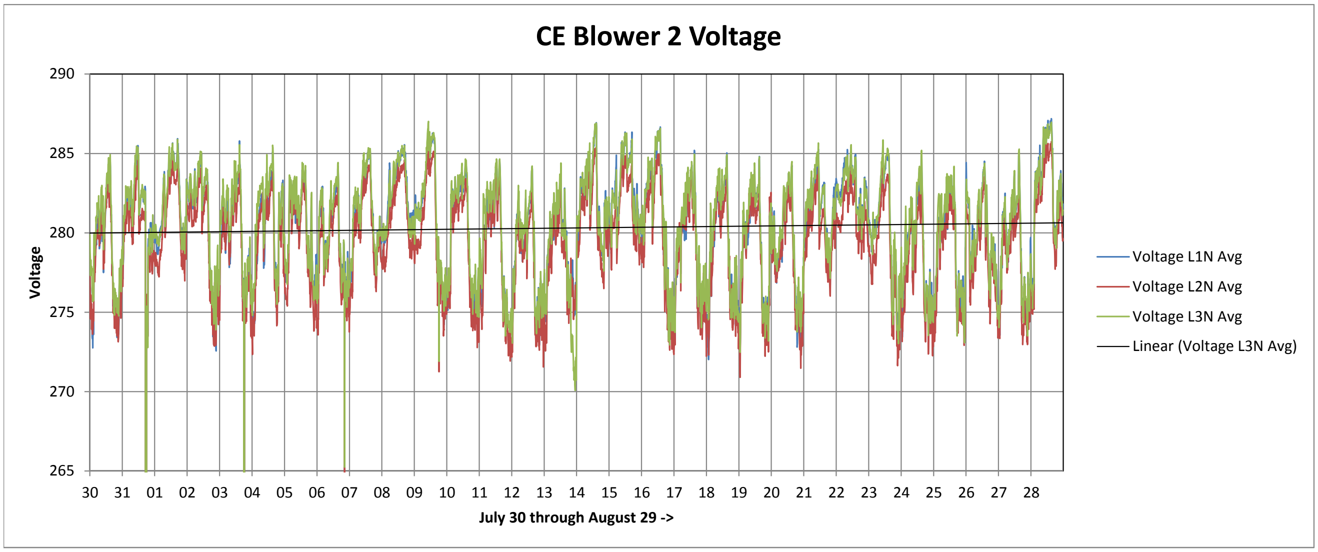
Application mode	N/A
First recording	7/30/2015 1:38:41 PM
Last recording	8/29/2015 1:18:41 PM
Recording interval	0h 10m 0s 0msec
Nominal Voltage	480 V
Nominal Current	51 A
Nominal Frequency	60 Hz

Recording Summary

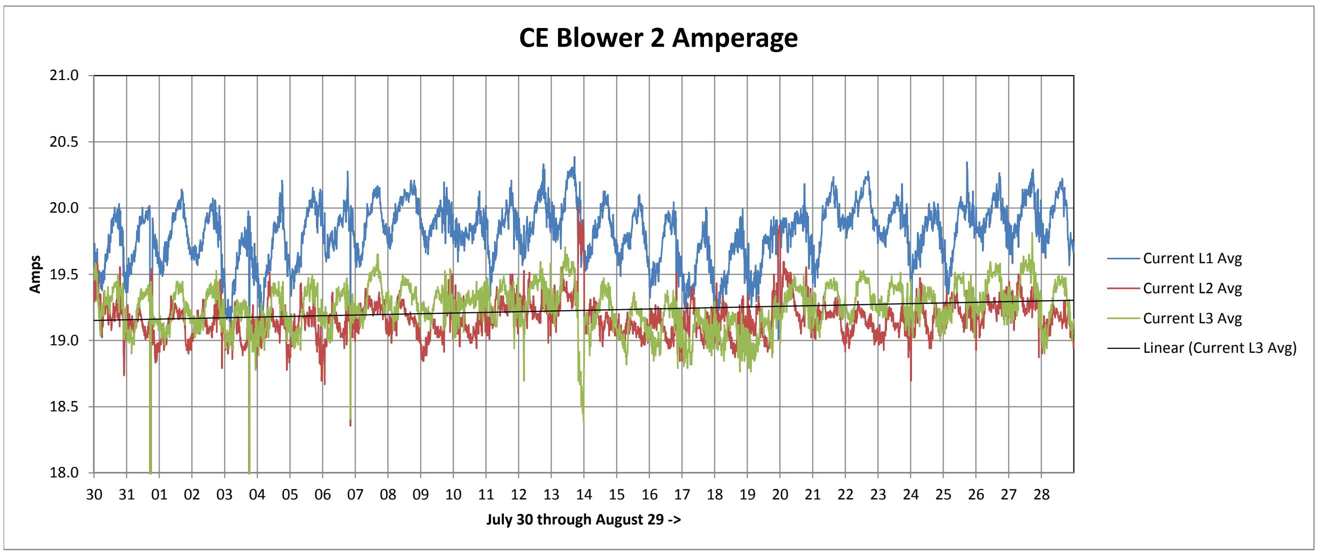
RMS recordings	4319
DC recordings	0
Frequency recordings	4319
Unbalance recordings	0
Harmonic recordings	0
Power harmonic recordings	0
Power recordings	4319
Power unbalance recordings	0
Energy recordings	4319
Energy losses recordings	0
Flicker recordings	0
Mains signaling recordings	0

Events Summary

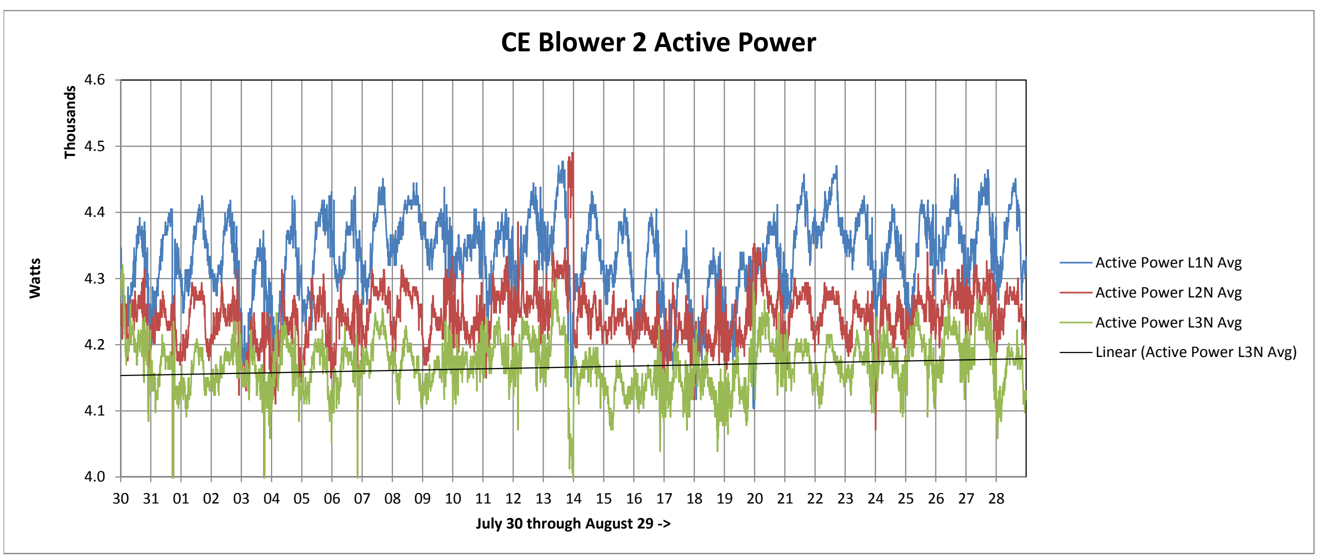
Dips	0
Swells	0
Transients	0
Interruptions	0
Voltage profiles	0
Rapid voltage changes	0
Screens	27
Waveforms	0
Intervals without measurements	0
Inrush current graphics	0
Wave events	0
RMS events	0



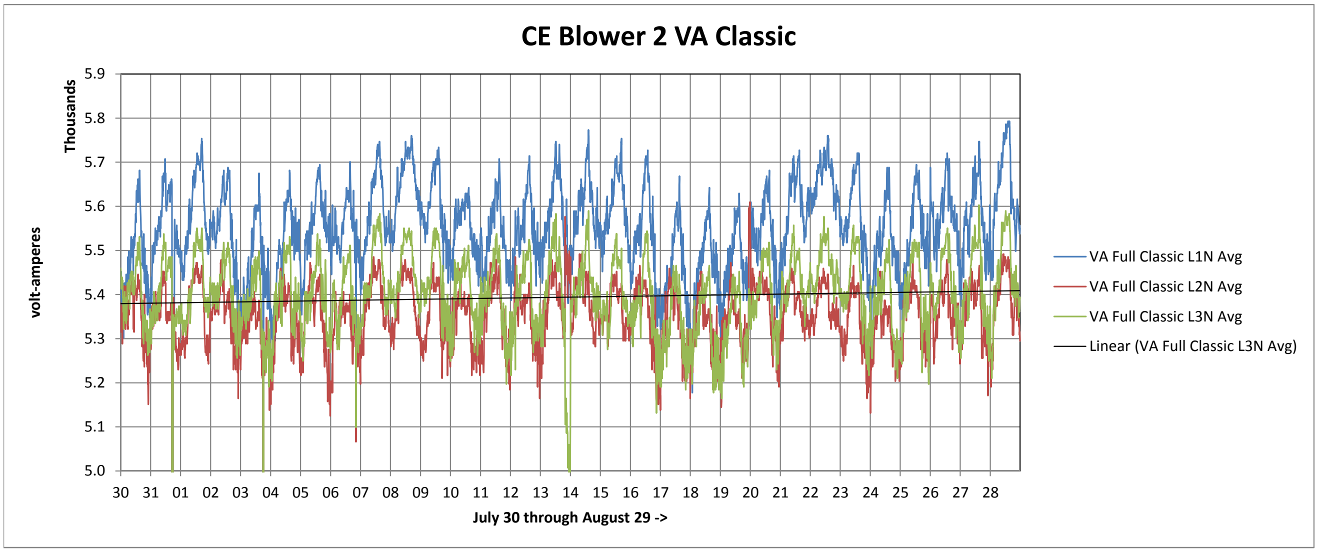
CE Blower 2 Voltage
Voltage
290
285
280
275
270
265
30 31 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
July 30 through August 29 ->
Voltage L1N Avg
Voltage L2N Avg
Voltage L3N Avg
Linear (Voltage L3N Avg)

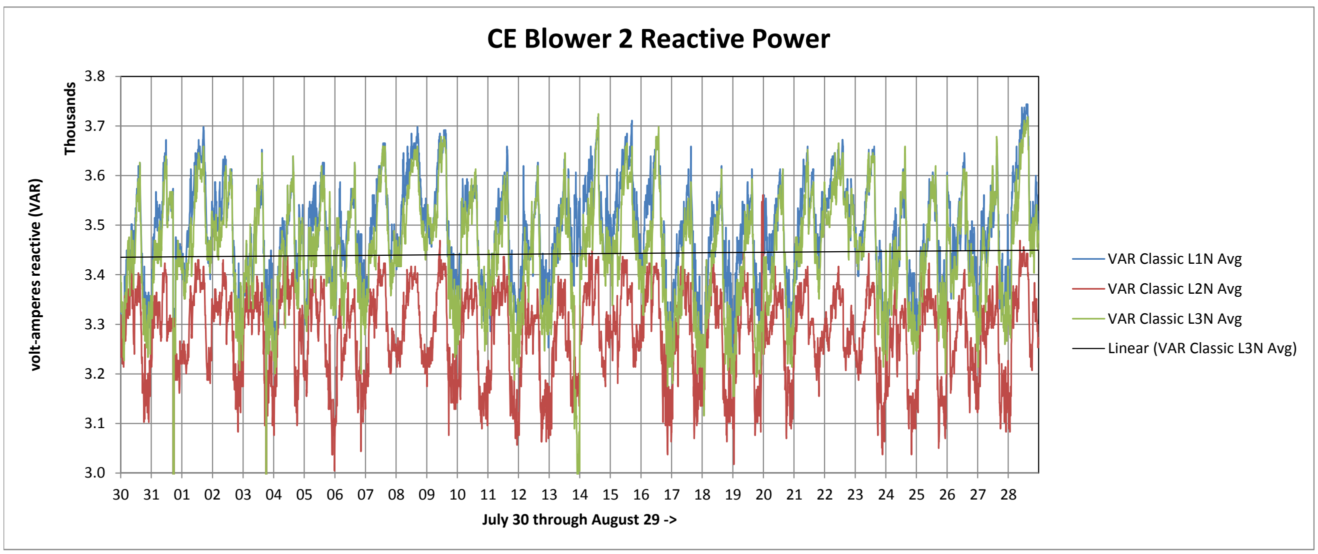


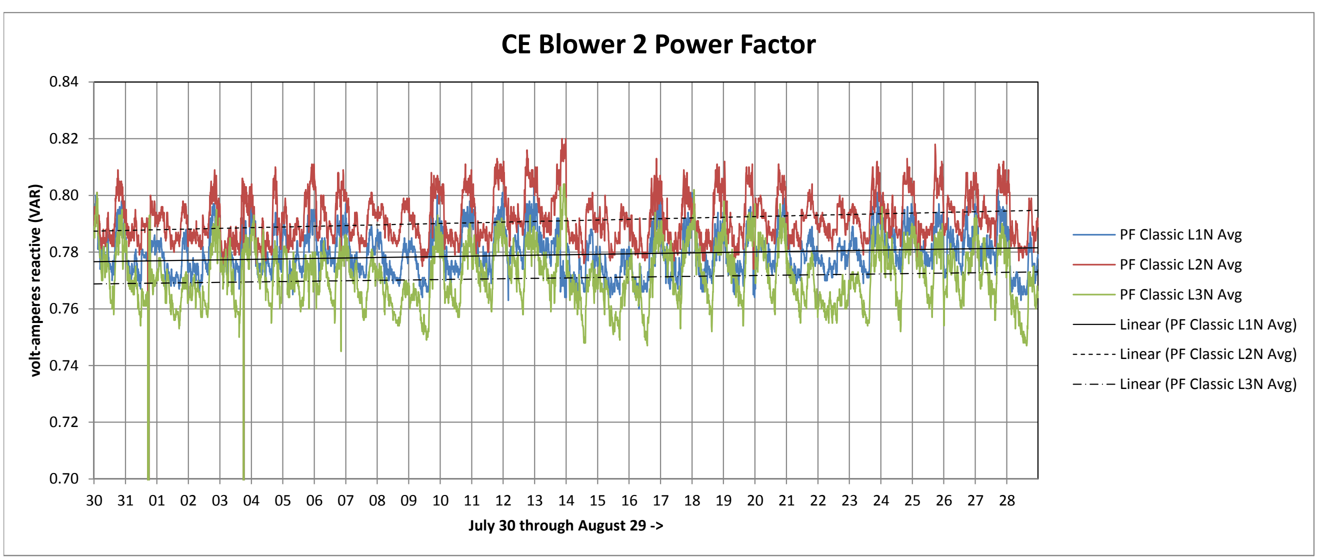
CE Blower 2 Amperage
Amps
21.0
20.5
20.0
19.5
19.0
18.5
18.0
30 31 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
July 30 through August 29 ->
Current L1 Avg
Current L2 Avg
Current L3 Avg
Linear (Current L3 Avg)



CE Blower 2 Active Power
Watts
Thousands
4.6
4.5
4.4
4.3
4.2
4.1
4.0
30 31 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
July 30 through August 29 ->
Active Power L1N Avg
Active Power L2N Avg
Active Power L3N Avg
Linear (Active Power L3N Avg)


CE Blower 2 VA Classic
Thousands
volt-amperes
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5.0
30 31 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
July 30 through August 29 ->
VA Full Classic L1N Avg
VA Full Classic L2N Avg
VA Full Classic L3N Avg
Linear (VA Full Classic L3N Avg)


CE Blower 2 Reactive Power
Thousands
volt-amperes reactive (VAR)
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3.0
30 31 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
July 30 through August 29 ->
VAR Classic L1N Avg
VAR Classic L2N Avg
VAR Classic L3N Avg
Linear (VAR Classic L3N Avg)


CE Blower 2 Power Factor
volt-amperes reactive (VAR)
0.84
0.82
0.80
0.78
0.76
0.74
0.72
0.70
30 31 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
July 30 through August 29 ->
PF Classic L1N Avg
PF Classic L2N Avg
PF Classic L3N Avg
Linear (PF Classic L1N Avg)
Linear (PF Classic L2N Avg)
Linear (PF Classic L3N Avg)

ATTACHMENT 5: PHOTOGRAPHS

Influent Lift Station & Sampler in Background

New Fine-screening Facility

Control Building and Equalization Tank

Equalization Tank

Treatment Units and Digester

Aeration Tank with Clarifier in Foreground

RAS / Scupper Disch. / Influent

Digester Tank

Blower Room

PD Blower with 60 h.p. Motor

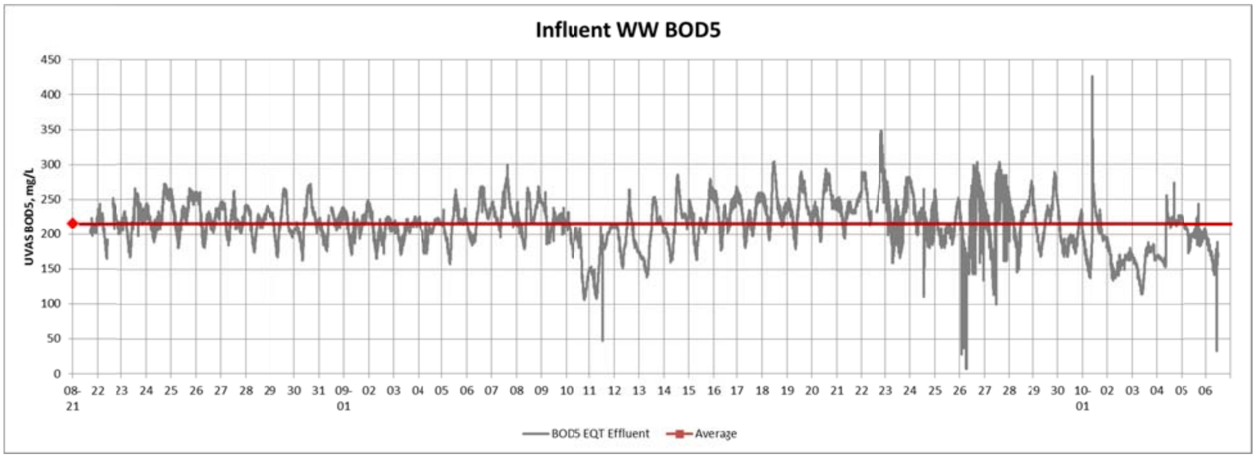
Chlorine Contact Tank w/ solids baffle

Effluent Sampler

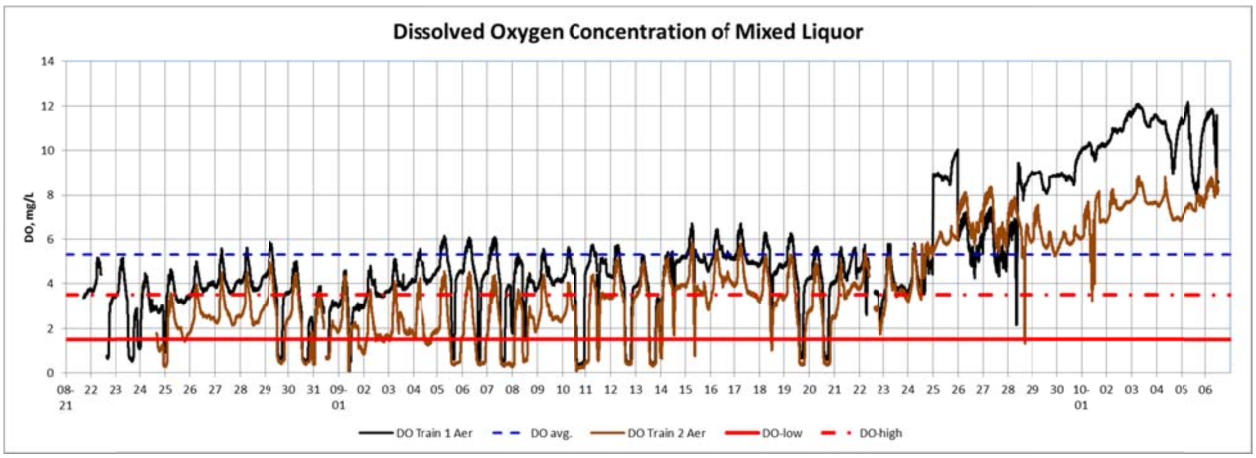
Aerobic Digester

Reed Beds

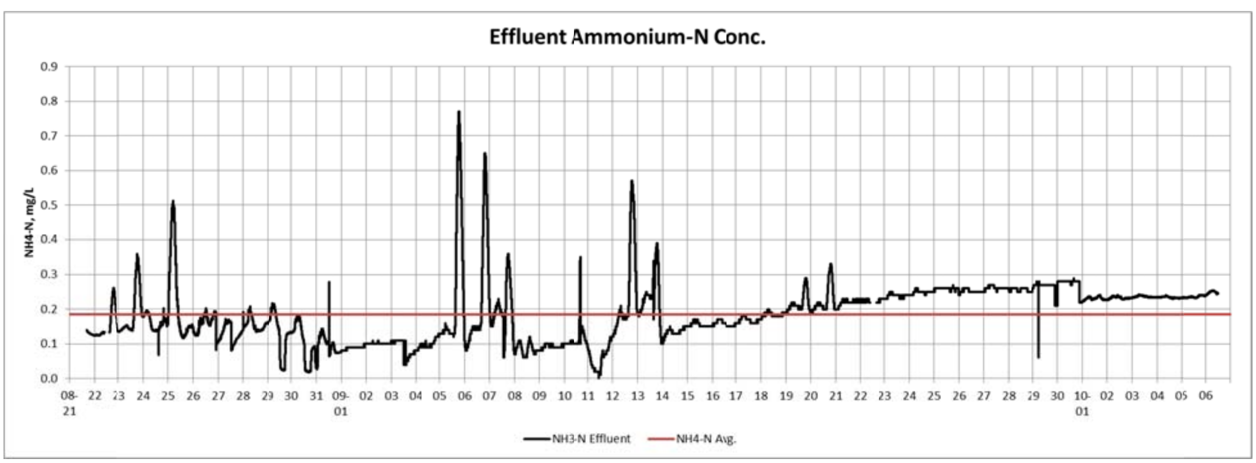
ATTACHMENT 6: EXAMPLE DATA CHARTS



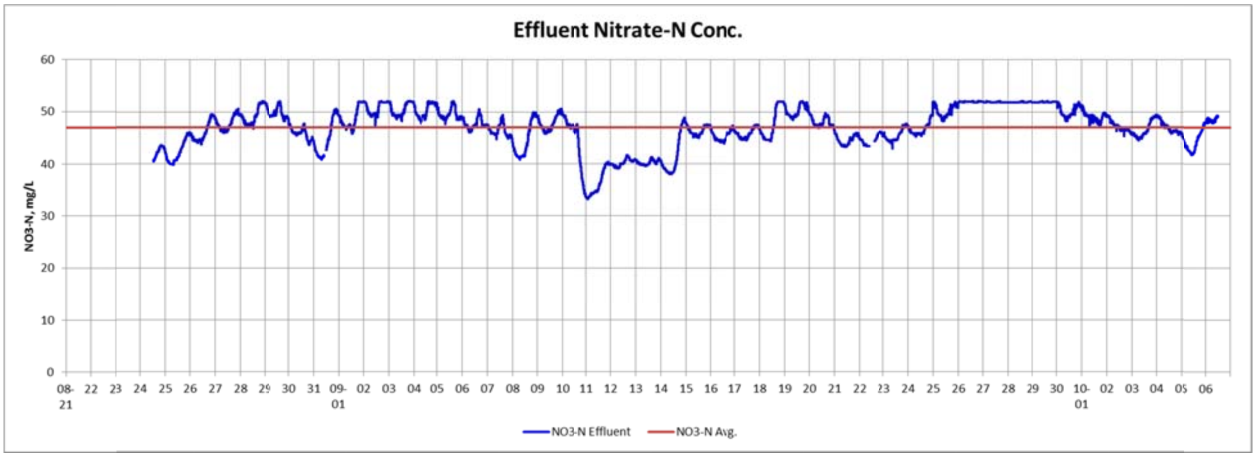
Influent BOD_5, measured by ultraviolet spectroscope probe located in the influent splitter box, showed an average BOD_5 at the splitter box of 216 mg/L, which is in line with literature values for domestic wastewater. Lower values represent dilution at the equalization tank following rain events.



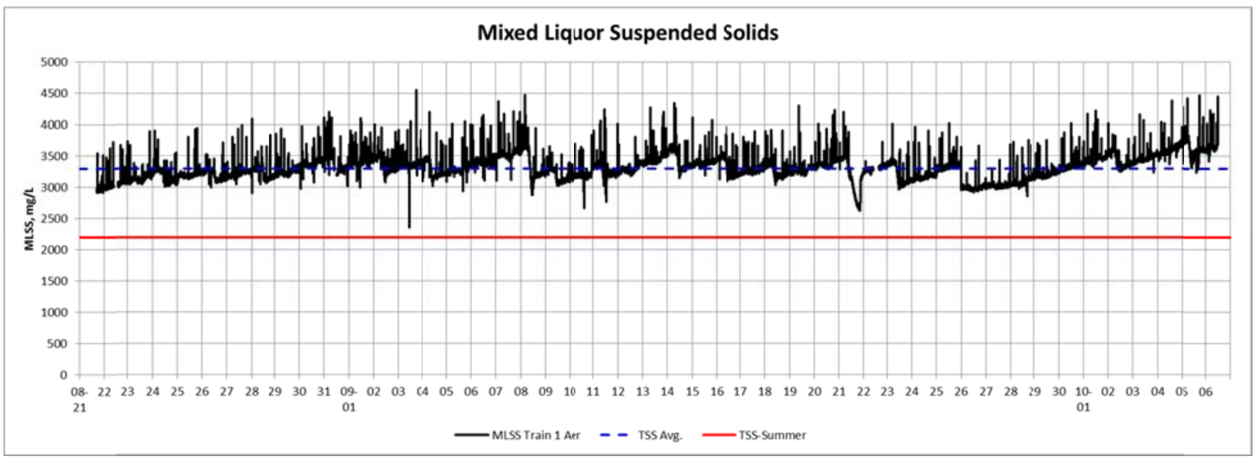
Dissolved oxygen concentrations in the aeration tanks, where the average DO was above the recommended maximum for nitrification. DO values above the range of 3.5 mg/L to 4.0 mg/L (especially at right) represent wasted electrical energy. This may be mitigated through the use of variable speed drives on the PD (positive displacement) blowers, controlled by DO probes located in the aeration tanks. Such DO control becomes especially important when denitrification is considered.



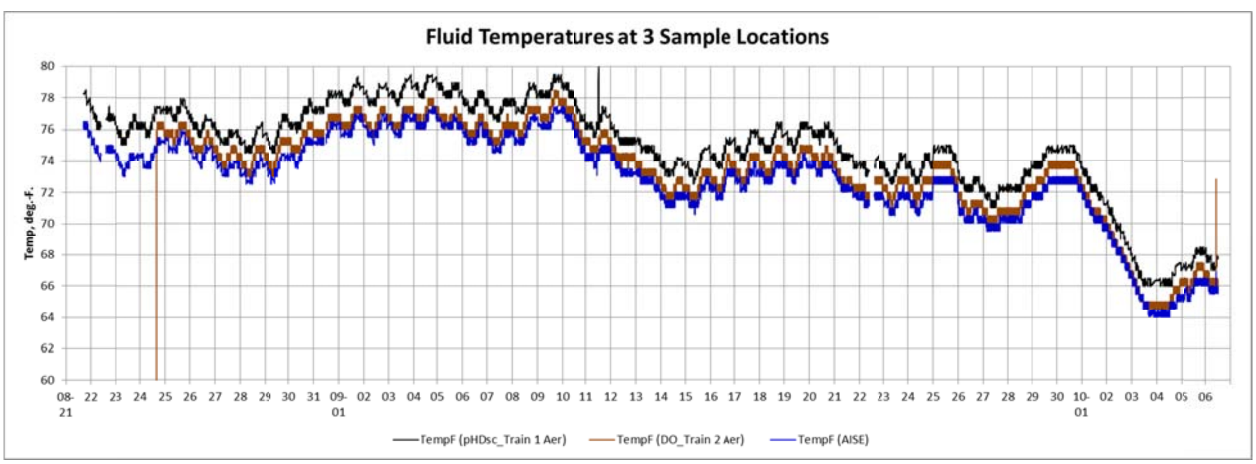
Effluent ammonium concentrations, measured at the discharge end (effluent sampling point) of the chorine contact tank. Note that all concentrations are below 0.8 mg/L, with an average of 0.2 mg/L.



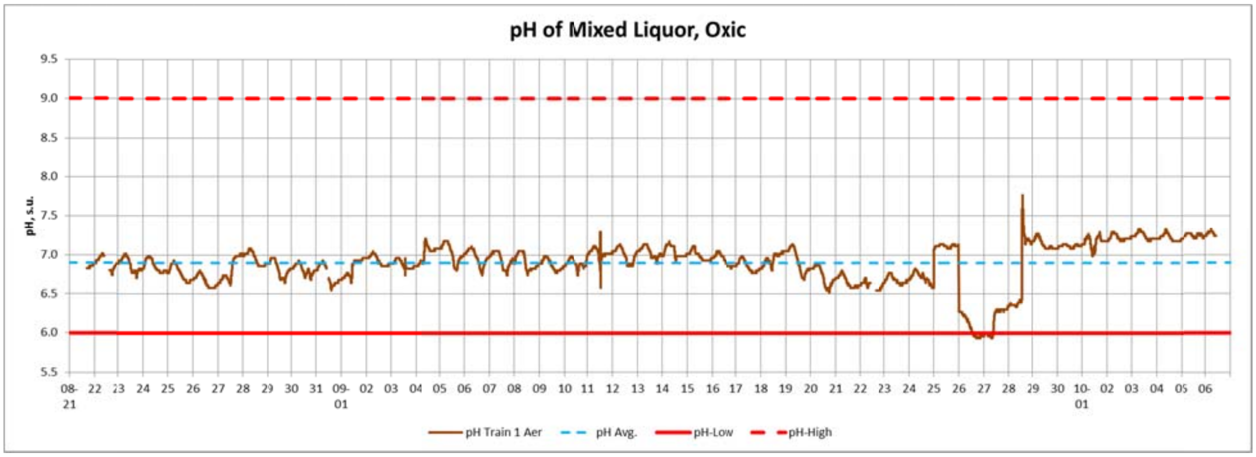
Effluent nitrate concentrations, measured at the effluent sampling point, showed an average of 47 mg/L, which is high for most wastewater treatment effluents. The operators reported that this may be due to groundwater influences. The average NO2-NO3 concentrations in the Aug-Sept DMRs was 55.4 mg/L for 8/21 through 10/6, and nitrite would have been almost negligible due to such low effluent ammonium concentrations.



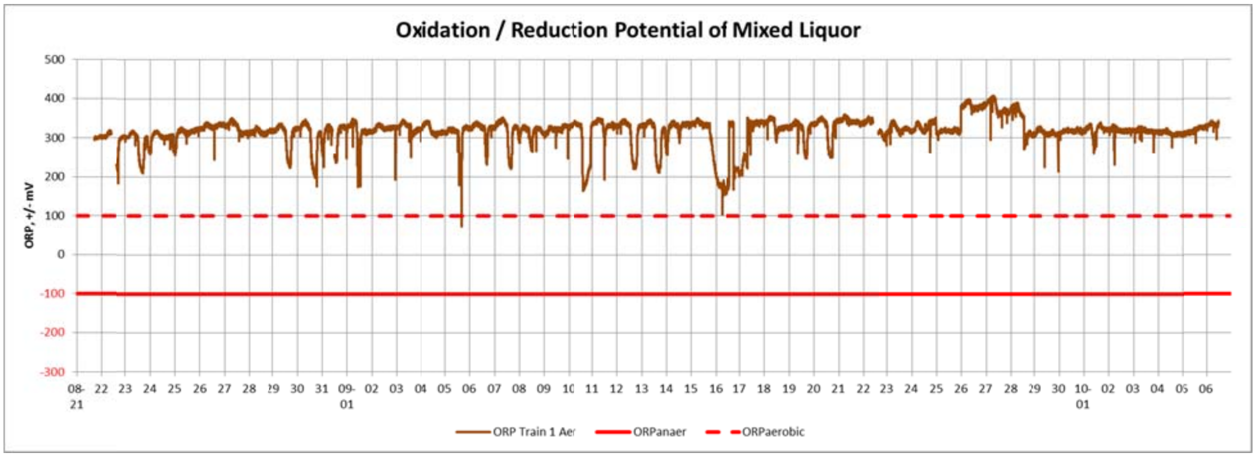
Solids inventory was higher than expected for warm-weather operations; however, this did not interfere with DO residuals and probably benefitted nitrification. Period average was close to 3,300 mg/L. Lab records for 2015 showed similar values, averaging 3,200 to 3,600 mg/L.



Fluid temperatures for late summer into early autumn reflected the weather. The transition between warm weather and cold weather seasons can present problems in activated sludge processes, as growth rates slow and different bacterial populations compete for dominance. However, no problems occurred during the early transition. For cold weather, sludge concentrations are usually increased to make up for the slower metabolic rates.



Mixed liquor pH in Train 1 averaged 6.9 s.u. for the period nearly neutral. For denitrification, the recommended pH range is between 7 and 8 s.u., ideally 7.5 to 7.8. Not an issue here, but pH lower than 7.0 may indicate need for additional alkalinity to enhance buffering capacity.



ORP proved to be the least useful measurement in this evaluation, because this is not a BNR facility, and with high DO residuals and low ammonia-nitrogen, nitrification could be considered complete. The typical ORP range for denitrification is between +100 and -100 mV. ORP is a very useful parameter indicating denitrification, as it shows what is happening after DO has reached 0 mg/L.