JENNER AREA JOINT SEWER AUTHORITY STP
BOSWELL, SOMERSET COUNTY, PENNSYLVANIA

NPDES # PA0042749

WASTEWATER TREATMENT EVALUATION

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pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION
WASTEWATER TECHNICAL ASSISTANCE PROGRAM

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Executive Summary:

Jenner Area Joint Sewer Authority (JAJSA) owns and operates a sewage treatment plant (STP) in Boswell Borough in Somerset County, Pennsylvania. The treatment plant employs two package secondary treatment units normally operated in contact/stabilization mode. Design flow and organic loading are 0.8 MGD annual average daily flow (AADF) and 1,360 lb/day, respectively. The treatment facility serves the communities of Jennerstown and surrounding boroughs and townships. The collection system has ten pumping stations. The receiving stream is Quemahoning Creek.

The JAJSA STP recently was assessed civil fines and penalties for effluent quality violations. In a period from December 2015 through August 2017 there were eleven fecal coliform and five ammonia-nitrogen exceedances. The violations were chiefly due to the inability of the antiquated contact/stabilization wastewater treatment facility to reduce effluent ammonia levels. At this facility, high flows and inadequate detention times resulted in partial nitrification (nitrite ion were combining with chlorine disinfectant used to kill fecal coliform bacteria to produce chemically inert compounds (HCl or NaOH, depending on the chlorine source.) The short detention time of contact/stabilization systems generally does not permit the formation of sufficient population of Nitrobacter to convert nitrite to nitrate.

During frequent regional inspections of the facility, DEP technical assistance staff from Ebensburg evaluated the operation and recommended that use of longer detention time (conversion from contact/stabilization to conventional aeration) would achieve nitrification of ammonia waste and put an end to nitrite lock in the disinfection system, provided that sufficient alkalinity is maintained within the reactors. During June, the facility operators began converting one of two reactors for conventional aeration. They did this by holing the dividing walls among the three outer ring tanks, contact, stabilization, and sludge holding. They relocated the raw wastewater influent to be closer to the return activated sludge line. This action produced lower ammonium in the effluent, and addition of magnesium hydroxide provided alkalinity to control process pH to keep it favorable for nitrification.

DEP staff from Harrisburg installed in-line instrumentation to monitor several treatment parameters, beginning in late June. As the summer progressed, the system was improved by monitoring treatment parameters. Several grinder pumps were installed into the reactor so that operators could provide mixing during anoxic periods, when aeration was deactivated. The anoxic period provided for denitrification in the reactor space instead of at the clarifiers. This improved effluent quality by reducing total nitrogen and clarifier solids loss.

The project terminated in October with both reactors having been successfully converted from contact/stabilization to biological nitrogen removal.

Summary of Findings:

Generally, the facility was operating well by the late summer and early autumn. Addition of hydroxide alkalinity improved the performance of BNR by controlling acid formation and reducing the incidence of nitrite formation that had interfered with chlorine disinfection. However, imprecise control of solids and aeration did cause high coliform counts in August. At the close of the project, nitrification and denitrification appeared to be functioning optimally.

Lack of long-term solids control due to the reduction of sludge holding space, combined with the obsolescence of the coarse-bubble aeration grid, and inclusion of air-lift return sludge pumps all reduced the effectiveness of BNR at this facility, resulting in occasional continued fecal coliform test results exceeding summertime imax limit. This problem may be easily resolved by implementing the recommendations for further process control.

Operational staff was motivated and well-versed in maintenance of the facility, but the basics of biological nutrient removal were relatively new to them. Ongoing cross-training is recommended to assure multiplicity of skills and team depth. In particular, staff should become practiced in process monitoring tests required to maintain and optimize biological nutrient removal. Many of these tests were demonstrated during the evaluation, and there are ample sources for staff training available in response to licensees' continuing education requirements.

Recommendations:

The following recommendations are suggested for maintaining improved process control for nitrogen reduction at this facility:

1. Assure that the facility engineer submit the necessary application for Water Management Part II permit amendment to record the process modifications constructed during the summer, including both conversion of the reactors from contact/stabilization to conventional and the addition of Magnesium hydroxide as an alkalinity supplement.
2. Have the facility engineer evaluate the new requirements for sludge holding or aerobic digester space, and proceed with ensuring permanent changes to the process.
3. We were informed by the operators that the first phase of reconstruction at this facility would include replacement of the existing headworks with rotary fine screening of rags and detritus. This should move forward, as comminuted detritus and rags in the downstream treatment units have caused pump failures and aeration inefficiencies.
4. Continue the alkalinity adjustment through the use of magnesium hydroxide to the treatment units. Where exclusive use of magnesium hydroxide may challenge the operating budget, a combination of alkalinity supplements such as sodium hydroxide for bulk control and magnesium hydroxide for polishing may be more cost-effective. The facility's engineer should evaluate this.
5. Solids concentrations in the two treatment units should be no more than 2,500 mg/L during warm weather months. Problems controlling solids were attributed to lack of digester space after the conversion of Unit 1 to conventional aeration; replacing the lost digester capacity should be considered sooner than later.
6. The present system employs air lift pumps to transfer RAS from the clarifier to the biological reactors. During anoxic mixing periods, these pumps do not run, allowing sludge to accumulate. Consider using mechanical pumps to provide better control of RAS.
7. Use of continuous monitoring DO probes to control aeration blower function would reduce excess aeration and provide for energy savings.
8. Continuous monitoring probes for Oxidation/Reduction Potential would permit fine-tuning of the oxic/anoxic cycling that is presently controlled exclusively through use of electric timers. ORP probes allow the operators to seek and maintain an optimized period of anoxic mixing, where denitrification occurs, without sacrificing the nitrification.
9. To maintain balanced alkalinity addition, installation of continually-monitoring pH probes in the treatment units is recommended. The operators should monitor mixed liquor pH frequently in order to maintain adequate alkalinity buffering; up to using the pH probes to control the alkalinity feed system. Denitrification requires that mixed liquor pH remain above 7.0 s.u. and, ideally, at or above 7.5 s.u.
10. The secondary clarifiers may experience short-circuiting. Consider having the facility's consulting engineer evaluate the use of baffles or modifying the weirs and launders.
11. Biological nitrogen removal will requires that the operators conduct more robust process monitoring tests, including regular analyses for mixed liquor alkalinity, and nitrogen forms such as ammonium, nitrite, and nitrate at various points throughout the process. The operators already employ gravimetric analysis for solids and volatile solids, and they titrate for alkalinity. A summary of recommended process monitoring tests and their frequencies is included as Attachment D. Enhanced process monitoring may require the purchase of additional laboratory equipment and test materials.
12. In order to control slug loads at this facility, the owners and operators may wish to consult with US EPA Region III (Philadelphia) pretreatment staff to determine what options short of a full-scale pretreatment program may be applied to the problem contributor. In the interim, a meeting between JAJSA and the suspected source may aide in identifying the problem and lead to resolution.
13. Review of operational data suggested that sludge production was 123% of expected. It is suggested that a more robust solids inventory be maintained by regularly monitoring the sludge wasting volumes, solids concentrations of the digester, and sludge press throughput, as total solids by weight and by press run production volume.

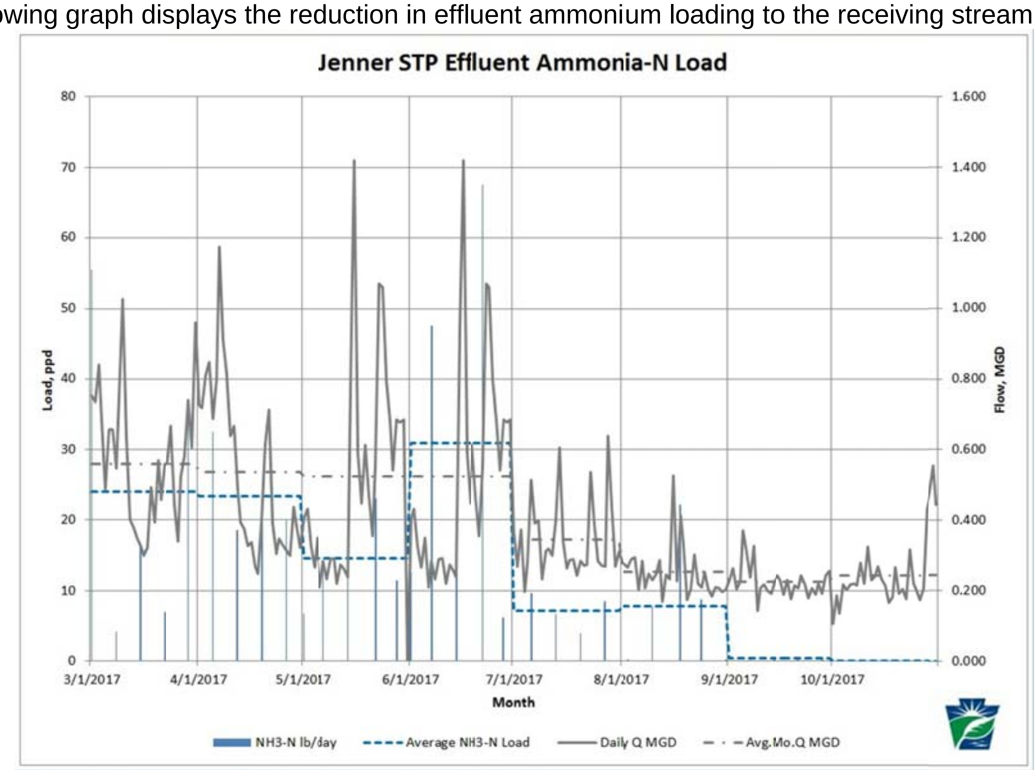
14. Begin using data management tools to enact electronic recordkeeping. Many of the bench forms and logs are hand-written on loose paper. Laboratory calibrations and measurements should be written in blue ink in bound notebooks, and laboratory results should be maintained and processed in electronic spreadsheets. DEP staff can offer assistance in upgrading these skills.
15. Continue to pursue cross-training of facility staff in the operation and maintenance of the plant. This cross training should include not only facilities operation and maintenance, but also both laboratory and digitized recordkeeping. It is important to understand that operating a nitrification or biological nutrient removal (BNR) facility will be more technically complicated than running the existing facility.

Background and Discussion:

The Jenner Area Joint Sewer Authority's Sewage Treatment Plant (STP) consists chiefly of two identical, self-contained steel contact/stabilization units constructed in the early 1970s. Each unit has an inner ring clarifier surrounding by an outer ring partitioned into three spaces for contact, stabilization, and sludge holding.

In June 2017, the operators converted one of the two process units to conventional treatment space, eliminating a sludge holding tank on that side and opening walls among three tanks. A referral for instrumentation was made to Bureau of Clean Water's wastewater technical assistance program (WWTAP), and DEP staff also recommended that JAJSA consider supplementing process alkalinity in the form of magnesium hydroxide [$Mg(OH)_2$] to its treatment units. Probes were installed in the process units and at the effluent metering station, and monitoring began on June 28 and continued until October 18. During this time, one operational conventional treatment unit received 60% of the raw flow, and the remaining contact / stabilization unit received 40%, initially. Recorded data showed ammonium reductions in the clarifier effluent from the conventional side. Next, the remaining reactor was converted to conventional aeration, but the sludge holding space was retained pending future construction of a stand-alone aerobic digester. Conversion of both processes to conventional aeration yielded significantly reduced effluent ammonia, and addition of timed anoxic mixing cycles further reduced process nitrate, resulting in overall reductions of Total Nitrogen at this facility.

The following graph displays the reduction in effluent ammonium loading to the receiving stream.



Jenner Effluent Ammonia-N Load decreases to nearly nothing after both reactors have been converted.

During July and August, when one of two reactors was operating in conventional mode, the ammonium loading was approximately halved from previous times. In September and October, with both reactors converted and with denitrification occurring, the ammonium loading dropped to nearly nothing.

Daily flow during the evaluation period averaged 0.276 MGD, with a daily maximum of 0.687 MGD.[1] Hydraulic loading generally tapers off during the warm weather season, resulting in diminished I/I in the collection system. During the evaluation, there were two or three slug loads coming from a contributing industry, which caused wide pH swings and inhibited biological growth. JAJSA has no industrial pretreatment program. Establishing one would be highly complicated and then difficult to operate on top of the main treatment plant and its ten pump stations. Therefore, JAJSA operators and owners should consider measures short of a fully developed pretreatment program in order to have the offending source mitigate its contribution to JAJSA's treatment stream. It could be as simple as a meeting between the utility and the industry, perhaps in the presence of the authority solicitor, to work out a plan; otherwise, stricter legal conditions may apply. DEP staff recommended JAJSA consult with the EPA Region III's pretreatment staff for some initial ideas to pursue. It would be better settled amicably out of court than at a legal proceeding.

During the WTE, the operators employed magnesium hydroxide feed system to provide supplemental hydroxide alkalinity to counteract acid formation during nitrification. The temporary system consists of one 220-gallon tote drum and two LMI metering pumps, each feeding chemical to the secondary inflow splitter. It is anticipated that a permanent installation may include a single above-ground storage tank (AST) in control building, with appropriate enclosure, at such time as permanent modifications to the secondary treatment units are completed.

DEP's instrumentation chiefly focused on the secondary treatment units, where four probes were installed into the modified treatment unit one (conventional aeration) and three probes installed into the second unit, using it initially as a test control. These included Dissolved Oxygen (DO), pH/temperature, Oxidation/Reduction Potential (ORP), and Total Suspended Solids (TSS) probes. Also, probes for ammonium (NH4-N) and nitrate (NO3-N) were placed in the clarifier portion of the first unit, initially, and then moved to the discharge end of the disinfection system after both secondary units had been converted for nitrification. Data was incorporated into workbooks for charting and analysis by DEP staff in Harrisburg.

In addition to the continuously-monitoring equipment, DEP staff also deployed a portable wastewater monitoring laboratory consisting chiefly of a solids centrifuge, settleometers, a microscope, and a spectrophotometer. DEP staff also instructed the chief operator in the frequent use of this equipment for process monitoring and control purposes. Both of the current operators and two laborers[2] spent a day in a tutorial on process monitoring and control that heavily referenced the Activated Sludge Manual of Practice (MOP-9,) but since the operators had already been using the gold standard gravimetric test for solids, use of the centrifuge for solids inventory during the Evaluation was discontinued.) Operators later purchased more modern standard equipment for Settleometry/Sludge Volume Index and for pH tests. With this report, in the attachments, is provided a listing of the DEP portable laboratory equipment, as requested, for reference in their planned replacement of older equipment.

The evaluation followed the serial conversion of the two secondary units. Unit 1 had been in the process of being converted for conventional aeration/nitrification when the inline probes were deployed, so background data was generated from Unit 2 and from facility operational records (effluent water quality.) While operators adjusted the alkalinity dosing to steady-state concentrations, Unit 2 continued to provide background data for comparison. Finally, after both units had been converted, and inflow had been split

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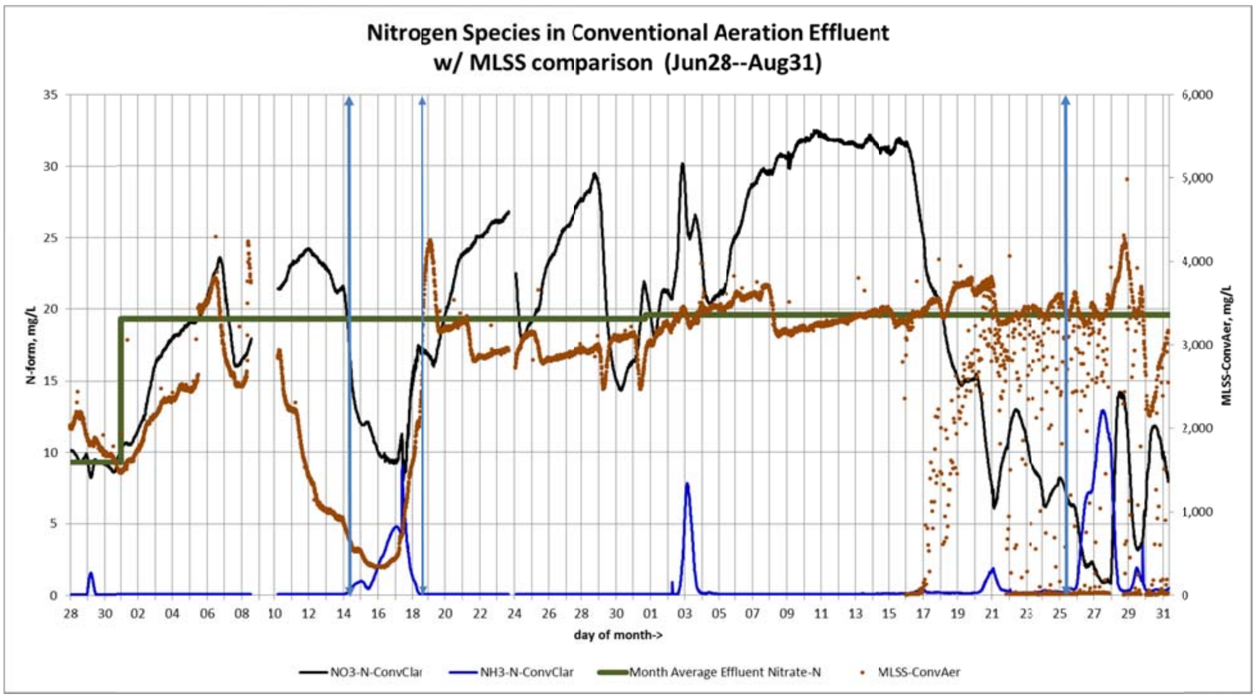
[1] Records in WMS from March through October 2017 were evaluated for baseline flow and loading. Jenner Area STP typically experiences severe I/I during the wet weather months: between March and June, there were 17 days where flow exceeded the 0.80 MGD rating; afterward, there were none. (This occurs in the presence of a working equalization / surge buffer tank.) The maximum flow for the entire period was 1.4 MGD, occurring twice.

[2] Laborers, who will likely assume operational responsibilities when licensed and after the current operators reach their retirement ages.

in a way to accommodate for the detention time differences between the two units, the NH4-N and NO3-N probes were redeployed to the final effluent to record optimized qualities.

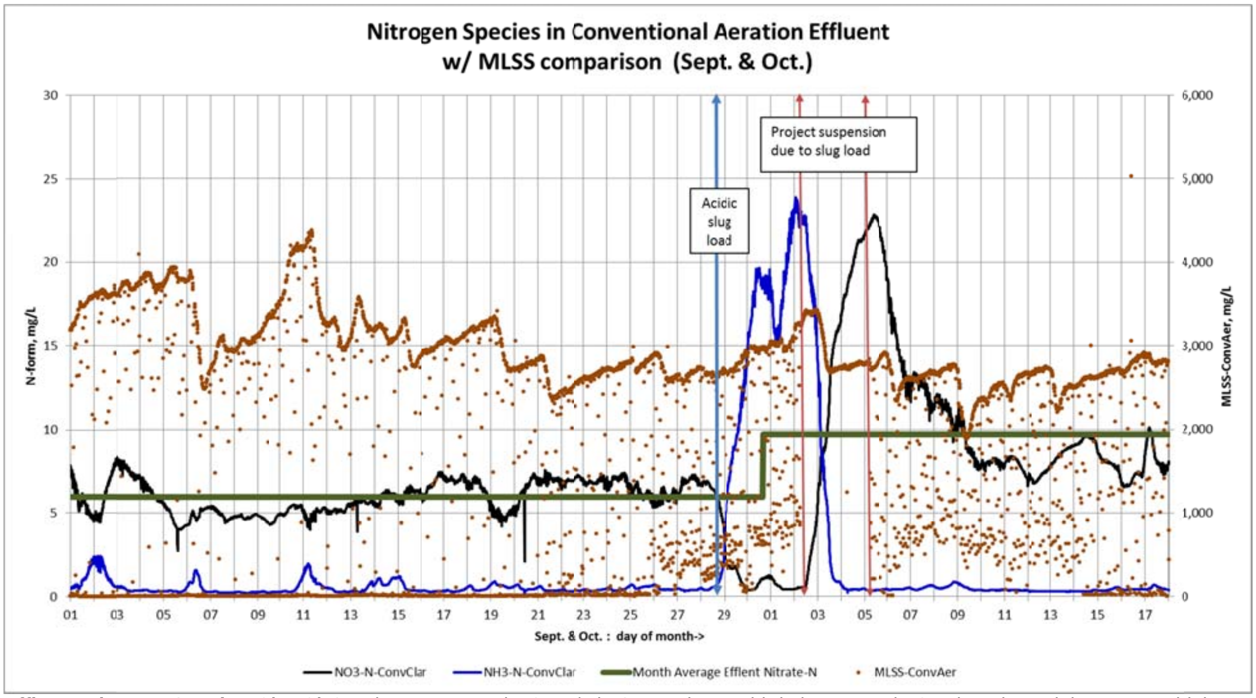
The two charts, below, display effluent ammonium and nitrate concentrations along with Unit 1 mixed liquor suspended solids (MLSS.) Generally, nitrate concentrations were reduced as pH stabilized through alkalinity addition. From June 28 through July 17, Unit 1 returned to service as conventional aeration. Nitrate concentration at the Unit 1 clarifier prior to the second week of July had been all over the board, but then nitrate formation peaked at 32.5 mg/L on August 17. At this time, the "stars aligned" with complete nitrification, optimal water temperature, ideal pH, high process alkalinity (due to $Mg(OH)_2$ addition.) On August 18, the operators began cycling the aeration blowers to allow for brief anoxic periods, and the nitrate concentration dropped as low as 6.4 mg/L on August 25, after which a plant upset resulted in an ammonium spike, followed by another recovery.



Effluent nitrogen species 6/28—8/31: Two upsets occurred during this period, one pH related; the second probably due to sustained low DO in the reactor.

In September and October, with both reactors running in conventional aeration mode with aeration cycling saw effluent nitrate concentrations drop to an average of 5.9 mg/L for September and 9.7 mg/L for October. In either case, the concentrations met a target value of 10 mg/L for the month, similar to the Delaware River Basic Commission's target value in southeastern Pennsylvania. There are presently no nitrate or total nitrogen limits for facilities in western Pennsylvania discharging into the Ohio River Basin.

A plant upset at the start of October skewed the nitrogen numbers higher, initially, but with recovery the effluent nitrogen numbers appeared to be recovering. Of note, aeration cycling with anoxic mixing during this time period saw deterioration of ammonium-nitrogen concentration when compared to August. The likely causes of this were sustained high mixed liquor suspended solids (MLSS) which caused chronic low DO concentrations in the reactors. The operators attributed high MLSS to the lack of sludge holding capacity. It will be critical, moving forward, to restore adequate aerobic digester capacity by building a free-standing digester at the facility. The tentative improvements schedule for JAJSA may have to be adjusted to prioritize this replacement.

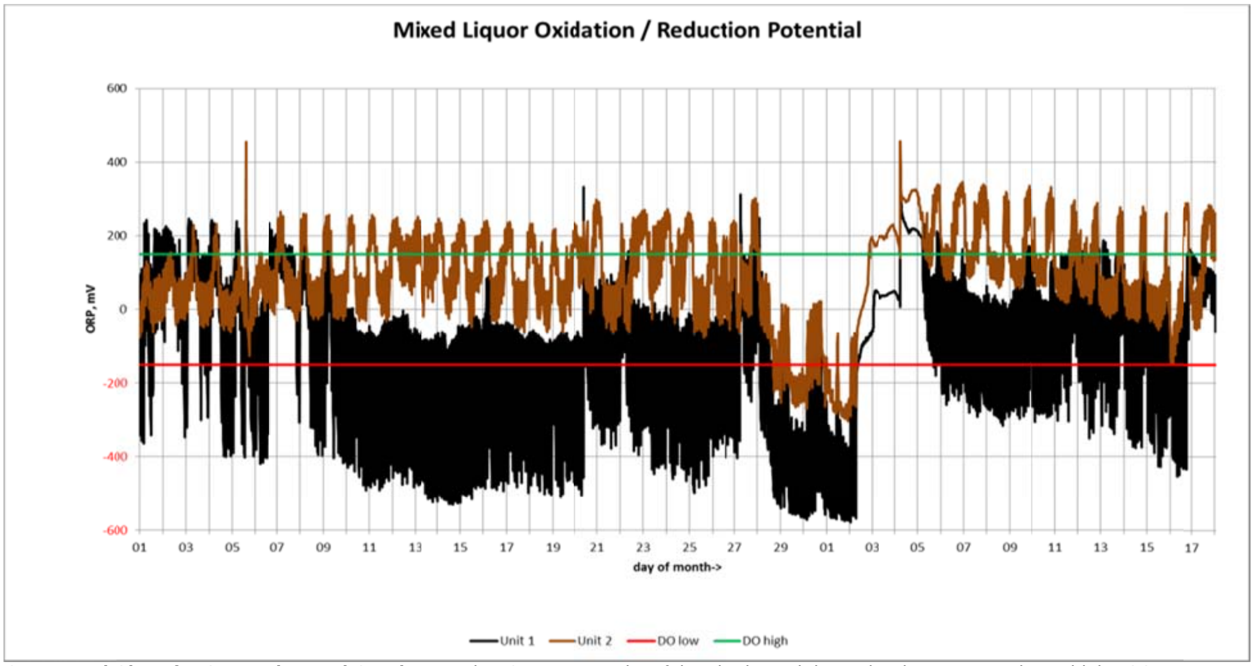


Effluent Nitrogen Species, 9/1-10/18: Nitrate averaged 5.9 mg/L in September; a third plant upset in October skewed the average higher, to 9.7 mg/L. Ammonium-N deteriorated somewhat as operators experimented with cycle times.

A key factor making this pilot study successful was the operators' use of submersible trash or grinder pumps to provide for anoxic mixing during denitrification cycles. There were some delays in sourcing and installing the pumps, during which time the anoxic cycle consisted only of mixing at the flow interfaces of return sludge, influent wastewater, and mixed liquor. The currents established within the tanks provided some denitrification but not enough for successful nutrient removal which, for the sake of this evaluation was set at nitrate concentrations below ten milligrams per liter (10 mg/L) with concurrent ammonium concentrations below 3 milligrams per liter (3 mg/L.) In the absence of quantitative analysis for nitrite-nitrogen, the combination of low NH4-N and NO3-N concentrations was taken to infer the relative absence of nitrite-nitrogen.

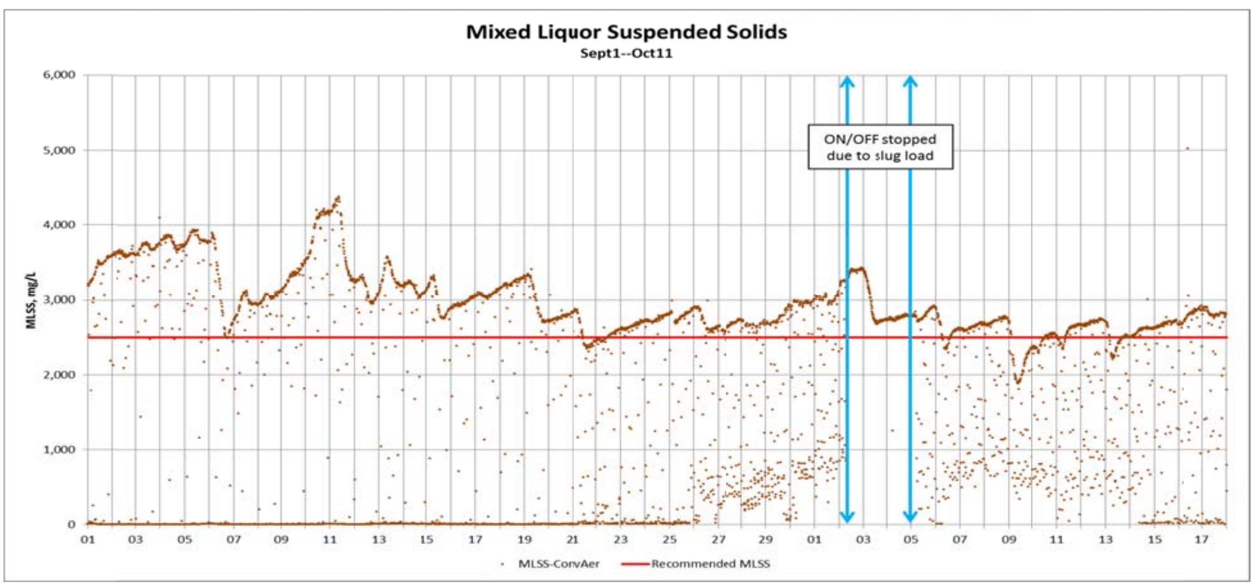
Facilities attempting to optimize biological nutrient removal (BNR) often find it very useful to monitor Oxidation/Reduction Potential (ORP) measurements of the mixed liquor. The defined operating range for nitrification is generally above + 150 millivolts (mV,) a relative collective, net-surface charge on the bacteria under aerobic conditions. Denitrification generally occurs during anoxic cycles, when ORP is between +150 and -150 mV. If ORP drops below -150 mV for long, anaerobic conditions may occur, where aerobic bacteria begin to die and sulfides, methane, and various organic acids and intermediates are formed, all adverse for activated sludge treatment. Prolonged periods of anaerobic-range ORP indicated inadequacies of the aging aeration system, with its difficult-to-adjust air valves and its coarse-bubble diffusers. Generally, one unit operated well only at the expense of the other, and valve adjustments proved to be very labor-intensive.

In order for anoxic conditions to be optimized, DO must approach 0 mg/L, after which ORP measurement becomes more useful in optimizing denitrification. ORP provides measurements of the net effective charge on the biomass. In fully oxidized sludges, it ranges from 150 mV to 400 mV; in anoxic, denitrifying sludges, it ranges between 150 mV and -150 mV. Below -150 mV, the mixed liquor becomes septic, where anaerobic bacteria convert complex chemicals to simple ones that include hydrogen sulfide and methane gas, organic acids, alcohols, ketones, and esters, all of which are poor for effluent quality.

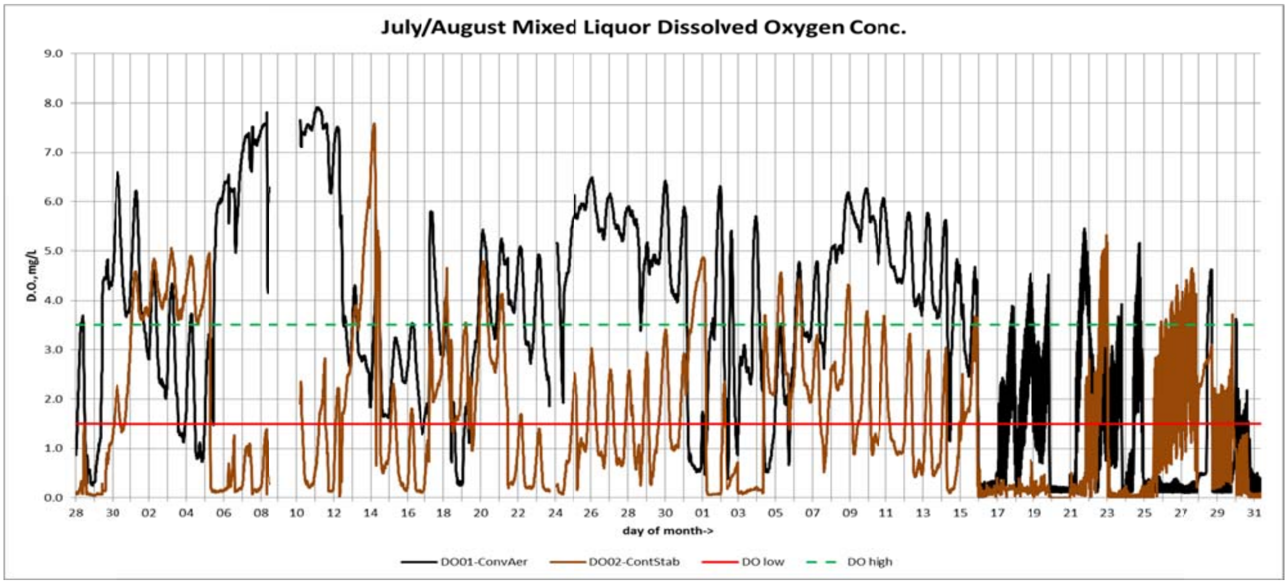


ORP Trend Chart for September and October: Unit 1 ORP spent a lot of time in the red due to inadequate aeration & high TSS.

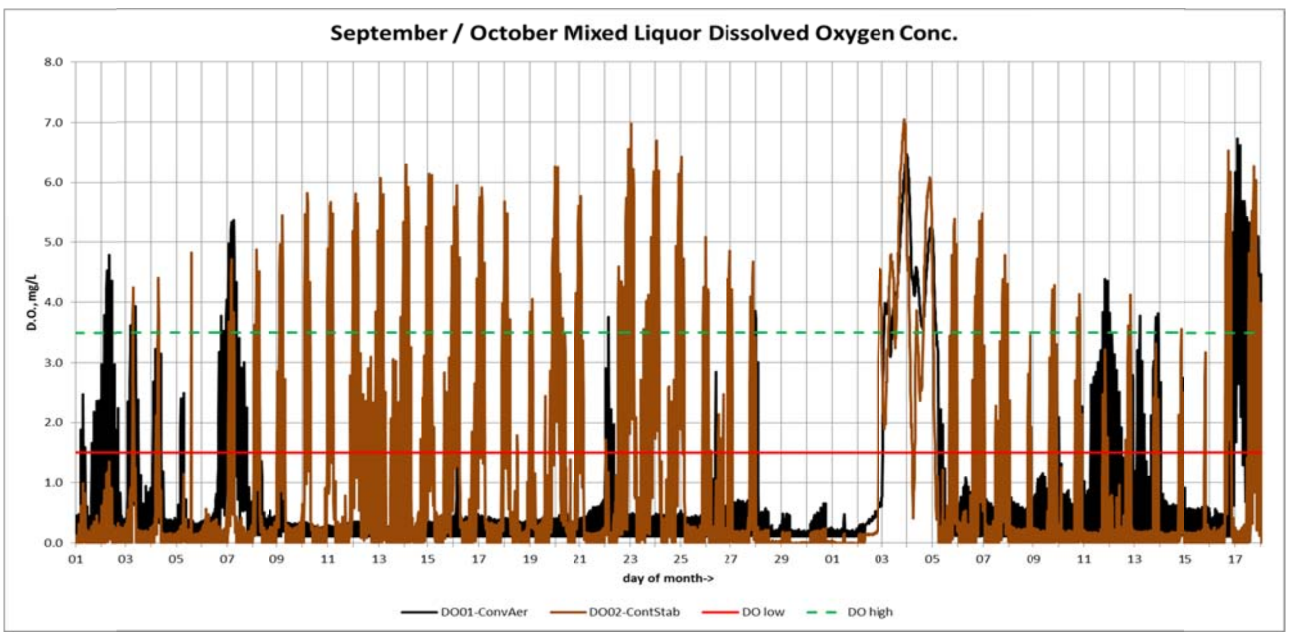
Mixed liquor suspended solids generally ran high during the evaluation, due to the sludge-management difficulties afforded by halving the available sludge holding volume. Operators had to continually transfer solids in order to maintain equilibrium, but the MLSS concentrations remained well above that recommended for summer-season operations. This accounted for some of the difficulties in maintaining sufficient DO concentration and in avoiding prolonged anaerobic conditions.



MLSS dissolved oxygen (DO,) where oxic range is between 1.5 and 3.5 mg/L: Generally, there hasn't been much fine control of DO at this facility, due to the coarse-bubble mixers and clunky hand valves for imprecisely controlling the various air lines. For most of July and half of August, the DO was relatively uncontrolled. With the implementation of timed oxic /anoxic periods, DO control was slightly better, but this was more of a function of DO saturation of the mixed liquor by blowers running at 100% capacity than it had been due to manual control.

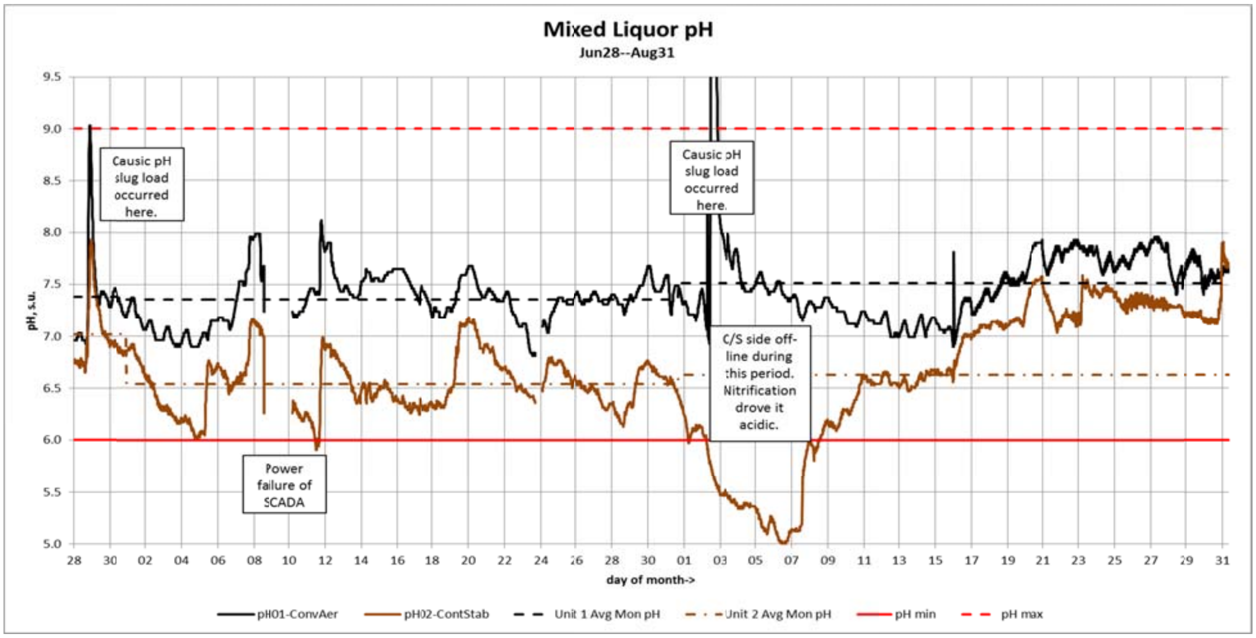


During late August and September, the DO record showed breaks for anoxic periods, but any DO above 3.5 mg/L is considered to represent wasted energy. This may be mitigated by planned improvements to the aeration system, with blower output regulated by DO control feedback to variable speed drives on the PD blowers. It is equally important for the system to provide sufficient aeration recovery for the mixed liquor following anoxic periods. Operators reported that they regularly “robbed Peter to pay Paul” when they shifted aeration capacity between Units one and two to maximize treatment efficiency with available equipment. Insufficiently aerated mixed liquor can lead to problems treating the waste, not the least of which are found when filamentous organisms become dominant.



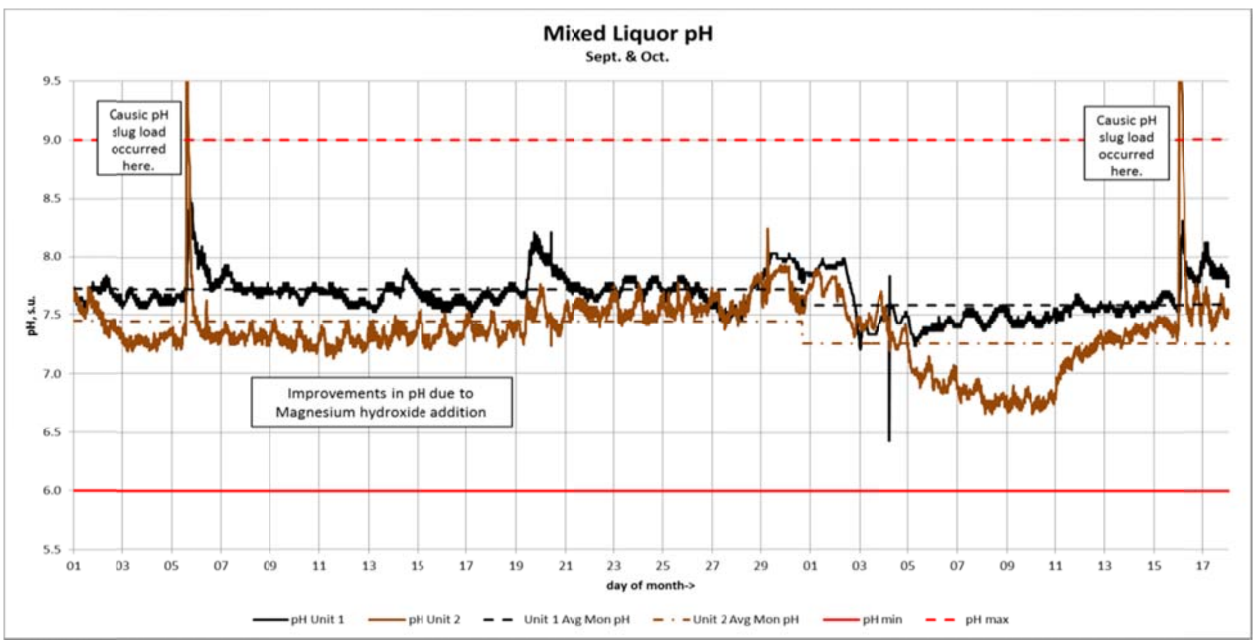
Nitrification of ammonia wastes occurs under strictly aerobic conditions, above the red line.

The pH chart for July/August, below, shows a contrast between Unit 1 in conventional mode, with $Mg(OH)_2$ addition, and Unit 2 in contact/stabilization mode, without. The contact stabilization pH was generally too low to promote good nitrification.



Mixed Liquor pH in August, prior to and at the beginning of $Mg(OH)_2$ addition

The chart below shows the mixed liquor pH measured during August and September. MLSS pH became stable with the addition of $Mg(OH)_2$ alkalinity, reducing the inhibitory effects of acid produced by nitrifying bacteria during the oxic periods, allowing denitrification to be optimized. pH of the converted reactors was optimally higher due to alkalinity supplementation.



Mixed Liquor pH in September, after adjusting $Mg(OH)_2$ feed rate

Acknowledgements:
DEP WWTAP thanks the Chief Operator, facility staff, and the Jenner Area Joint Sewer Authority for the opportunity to demonstrate BNR process optimization at the JAJSA treatment facility.

ATTACHMENT A: EVALUATION TEAM

--for the Jenner Area Sewer Authority		
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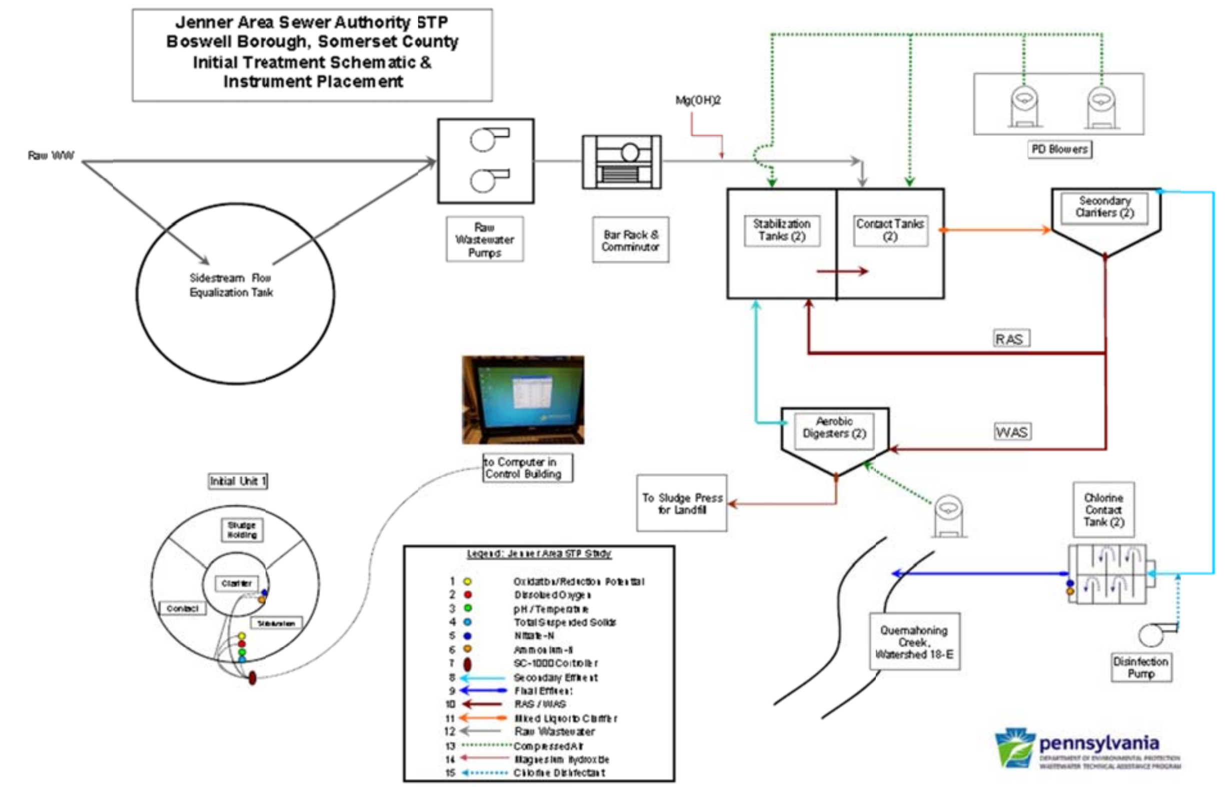
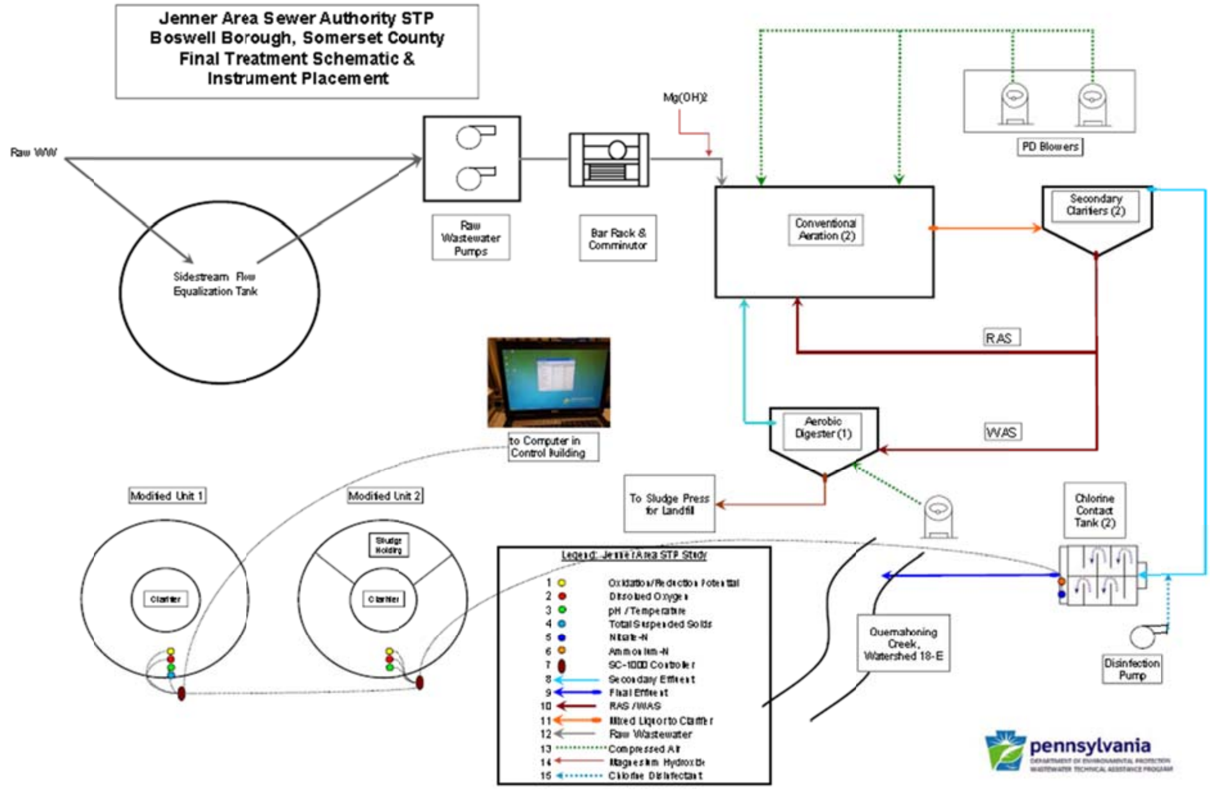
ATTACHMENT B: TREATMENT SCHEMATIC



Ancillary processes include the following:

- Flow Equalization Tank (for stormwater surge attenuation)
- Comminutor and Bypass Bar Screen
- Effluent disinfection system employing chlorine gas in 150-lb. cylinders, with associated chlorine contact tanks
- Service water pump and distribution system
- Effluent flow metering installation
- Solids handling system consisting of
    - Existing Aerobic Digester / Sludge Holding Tank in Unit 2
    - 1-meter Filter-Belt Sludge Press
    - Disposal to Permitted Landfill (Mostoller's, Somerset County, MLF-187)
- Process Control Laboratory
- Emergency Generator
- Maintenance Garage and Workshop

Following modifications, where contact/stabilization was fully converted to convention aeration, the schematic changed to the following:



ATTACHMENT C: EFFLUENT VIOLATIONS BETWEEN MAY 2015 AND AUGUST 2017

Effluent Violations, May 2015 through September 2017

Date			Permit		Reported		Sampling	Sample	Sampling
Event Start	Event End	Parameter	Limit	Type	Value	Unit	Point	Type	Frequency
5/1/2015	5/31/2015	NH3	12.0	8-hr Composite	13.0		001	8-Hr Composite	1/week
5/1/2015	5/31/2015	Fecal Coliform	1,000	Instantaneous Maximum	14,136	CF/100ml	001	Grab	1/week
7/1/2015	7/31/2015	Fecal Coliform	1,000	Instantaneous Maximum	24,196	CF/100ml	001	Grab	1/week
7/1/2015	7/31/2015	Fecal Coliform	200	Monthly Average	710	CF/100ml	001	Grab	1/week
12/1/2015	12/31/2015	Fecal Coliform	10,000	Instantaneous Maximum	12,223	CF/100ml	001	Grab	1/week
2/1/2016	2/29/2016	Fecal Coliform	10,000	Instantaneous Maximum	10,849	CF/100ml	001	Grab	1/week
5/1/2016	5/31/2016	Fecal Coliform	1,000	Instantaneous Maximum	2,787	CF/100ml	001	Grab	1/week
6/1/2016	6/30/2016	NH3	12.0	Weekly Average	13	MG/L	001	8-Hr Composite	1/week
7/1/2016	7/31/2016	NH3	12.0	Weekly Average	16	MG/L	001	8-Hr Composite	1/week
5/1/2017	5/31/2017	Fecal	200	Geometric Mean	2,910	CF/100ml	001	Grab	1/week
5/1/2017	5/31/2017	Fecal	1,000	Instantaneous Maximum	68,670	CF/100ml	001	Grab	1/week
6/1/2017	6/30/2017	Ammonia-Nitrogen	8	Average Monthly	10.0	MG/L	001	8-Hr Composite	1/week
6/1/2017	6/30/2017	Ammonia-Nitrogen	12	Weekly Average	20.0	MG/L	001	8-Hr Composite	1/week
6/1/2017	6/30/2017	Fecal	1,000	Instantaneous Maximum	29,090	CF/100ml	001	Grab	1/week
7/1/2017	7/31/2017	Fecal	1,000	Instantaneous Maximum	2,617	CF/100ml	001	Grab	1/week
8/1/2017	8/31/2017	Fecal	1,000	Instantaneous Maximum	18,252	CF/100ml	001	Grab	1/week

Table C: Past Effluent Violations likely based on incomplete nitrification (nitrite-lock)

ATTACHMENT D: RECOMMENDED PROCESS MONITORING TESTS

PROCESS CONTROL TESTS FOR DOMESTIC WASTEWATER TREATMENT FACILITIES

Activated Sludge Facility: Conventional, Complete Mix, Step Feed, or Extended Air
Less than and including 1.0 MGD (Page1 of 1)

SAMPLE PARAMETER	SAMPLE LOCATION	SAMPLE TYPE	3/WEEK	1/WEEK	2/MONTH
Raw Influent*					
BOD_5 and/or COD	Influent	Grab			X
TSS/VSS, NH_3-N, and pH	Influent	Grab			X
* Frequency of sampling may need to be increased or decreased depending on plant size or conditions.					
Aeration Basin					
MLSS/MLVSS (or centrifuge, with correlated data from periodic MLVSS values)	RAS line and effluent	Grab			X
Dissolved oxygen	Effluent	In situ		X	
Settleability (SV30)	Effluent	Grab	X		
pH	Effluent	Grab		X	
Microscopic examination	Effluent	Grab			X
Computation of SVI, F/M ratio, sludge age, and/or MCRT, as desired	Effluent	—	As data collected		
Secondary Clarifier					
Sludge blanket depth	As appropriate	In situ		X	
Final Effluent					
Parameters, sample types, and frequencies as required by permits.					

The table reproduced above lists suggested sampling frequencies for facilities of capacity up to 1.0 MGD. This represents the minimum monitoring requirements; however, experience suggests that process monitoring tests be performed more frequently when a facility is experiencing any changes. These changes include any process changes made by the operators and any changes due to unavoidable circumstances, such as slug loading or equipment service interruptions. Generally, the higher the level of treatment, the more process control testing is necessary. For example, denitrification operations require additional process monitoring when compared to nitrification operations.

The facility employs the gravimetric solids test, which is the gold standard for solids testing. The DEP portable laboratory included a solids-by-volume centrifuge test that was unnecessary at JAJSA. The centrifuge test does in 15 minute what otherwise takes up to four hours. If used, centrifuge solids tests are done daily and are backed up with gravimetric solids tests at least twice per week in order to maintain centrifuge calibration (Weight-to-Concentration Ratio, or WCR.) Microscopy, Settleability, and water chemistry should be done on the mixed liquor at least twice per week until the operators have reasonable understanding of a 4-season set of reference data to which they may refer in future years. Whenever process or treatment methods change, the test data set would need to be reproduced. Also, whenever the facility experiences plant upset conditions more frequent process-monitoring and control testing should be performed by the operators, until conditions stabilize.

Process Monitoring testing is often not the same as those performed by contract laboratories in that approved test methods are not utilized. Compliance testing refers to those analyses used by certified laboratories for reporting parameters required by the NPDES permit. Over the years, many small treatment facilities began to contract compliance testing to certified environmental laboratories. This eased the burden on operators, and it saved the facility owner the cost of maintaining certification of its own laboratory. However, over time, many facilities ceased to perform regular process monitoring tests, as well. It is important for operators to know the condition of their facilities, the sludge solids inventory, and the qualities of the treatment solids (i.e., quantity and quality of “bugs”) to effectively optimize operations.

Thus DEP’s WWTAP has adopted the process monitoring tests recommended by US-EPA and the professional trade organization, Water Environment Federation (WEF.) These tests include the following:

- Centrifuge solids test: percent volume/volume measurement of activated sludge solids for activated sludge-type plants: Calculations stemming from this data include solids inventory (expressed as “sludge units” (SLU).)
- Clarifier blanket level: a core-sampling of the clarifier contents provides a proportional quantity of mixed liquor and supernatant that can be used for developing awareness of how much mixed liquor is detained in the effluent clarifier, representing part of the overall sludge inventory.
- Settleometry test: 30- and 60- minute activated sludge settling rates in wide half-gallon or 1-liter, calibrated vessels: Settled sludge volume (SSV) is expressed in standard 30-minute intervals and used to calculate Settled Sludge Concentration (SSC) which is a qualitative measure of how well the activated sludge settles in the clarifier, mimicking clarifier performance in terms of supernatant quality as well.
- Oxygen Uptake Rate (a.k.a. Soluble Oxygen Uptake Rate): By measuring the rate of dissolved oxygen depletion in a sample of mixed liquor, one may demonstrate the relative effect of BOD loading on the biomass, how quickly this material will be metabolized by the activated sludge organisms. Expressed in “milligrams Oxygen per hour,” when mixed liquor volatile suspended solids concentration is known or can be extrapolated, then one may determine the actual Respiration Rate, in mg. Oxygen per hour per gram of activated sludge. OUR and RR are also useful for comparing the relative health of the biomass under toxic conditions, should there be undesirable contaminants in the raw wastewater, or anoxic conditions, should the aeration be insufficient to treat the incoming waste load using the available amount of oxygen.
- Raw Wastewater and Effluent Chemical Oxygen Demand (COD): an analog of the 5-day Biochemical Oxygen Demand test, COD can be determined in about three hours and give operators a quick assessment of relative strength of wastewater and/or the amount of material remaining in treated effluent, thereby providing an analog of treatment efficiency.
- Nutrient Tests: A portable wastewater laboratory provided during the WTE consists of materials for conducting various colorimetric analyses for nutrients such as ammonia-nitrogen, nitrite, nitrate, Kjeldahl nitrogen, phosphorus, etc. to determine whether the facility is removing or treating nutrients. For process monitoring purposes, nutrient test strips provide ample, low-cost, low-trouble test results. They are available in most supplier catalogs (USA Blue Book, Hach, Grainger, et al.)
- Various other tests included in the portable wastewater laboratory include alkalinity testing (the buffering capacity of the mixed liquor or the clarified supernatant,) chlorides, sulfides, halogens such as Total Residual Chlorine and Free Chlorine, and metals including aluminum and iron, known contaminants to downstream aquatic life.

The objective of all this testing is to develop a unique profile for the facility useful in developing operations trends, showing conditions that become predictive of how the facility responds to various beneficial or adverse conditions that could affect effluent quality and treatment efficiency. Once sufficient data exists, operators should have a cogent understanding of how the facility responds to process adjustments and what they must do to maintain it in good condition.

Typically, operators should determine an overall treatment strategy for their facility, using standard industry calculations for:

- Food to Mass Ratio (F/M)
- Mean Cell Residence Time (MCRT)
- Sludge Age or Dynamic Sludge Age

These values can be determined using the equipment described above. These calculations provide set-points unique to the facility that can be adjusted either through changes in sludge wasting rates or aeration capacity, assuming that the concentration of waste in the wastewater is a variable that operators cannot control.

ATTACHMENT E: RECORD PHOTOGRAPHS

Unit 1 Reactor Conversion

Unit 2 Reactor in C/S Mode

Disinfection Contact Tanks

Secondary Splitter Box, w/ Mg(OH)2 feed to both units

Influent channel w/ 24-hr Composite Sampler on loan

SC controller & Sensor Probes at Unit 1

Data Acquisition and Portable Wastewater Lab

Unusual Brown Influent during high-pH Slug Load

Staging the Unit 2 Conversion

Temporary WAS line, Unit 1 to Unit 2 Sludge Holding

Rigging / Power for Anoxic Grinder Pump, Unit 1

Final Effluent NH4 & NO3 Probes & Composite Sampler