

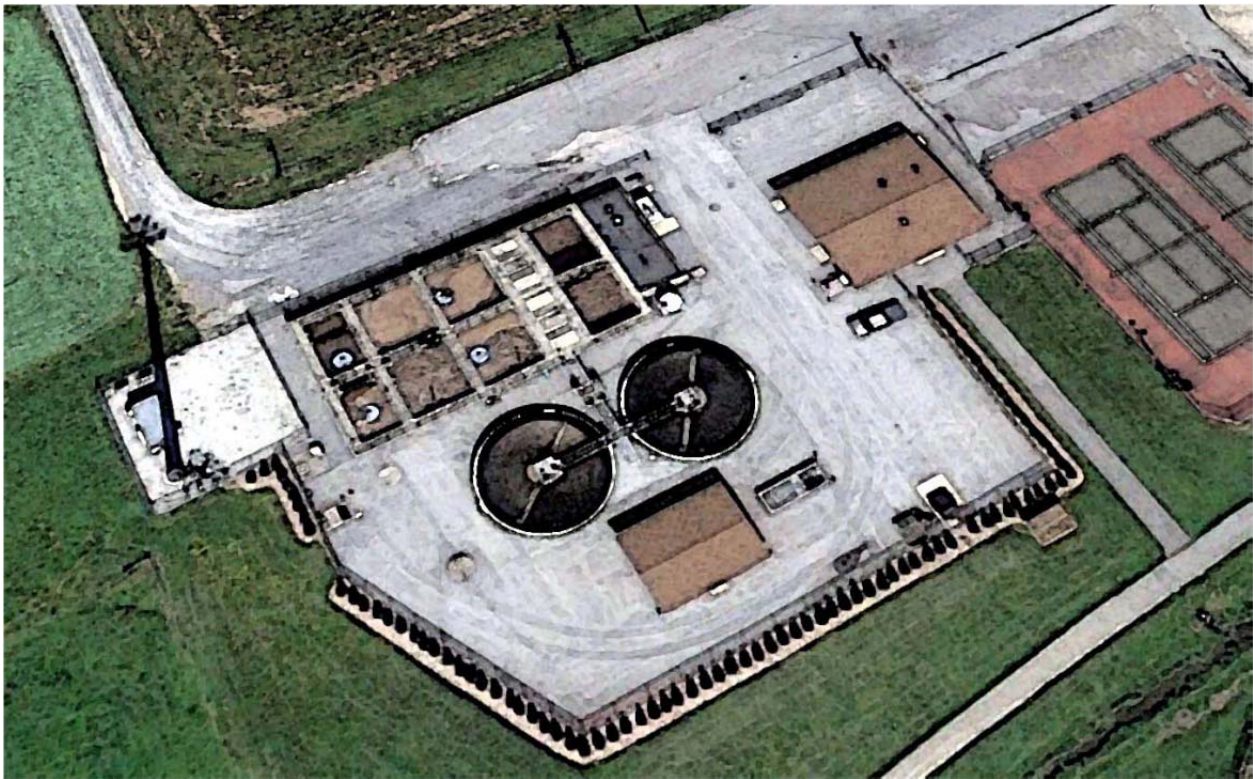
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# WASTEWATER TREATMENT EVALUATION SALISBURY TOWNSHIP'S GAP STP

LANCASTER COUNTY, PA  
NPDES #PA0081574

MARCH through MAY 2015



Bureau of Point and Non-Point Source Management

June 2015

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**Executive Summary:**

The Pennsylvania Department of Environmental Protection (DEP) performed a Wastewater Treatment Evaluation of the Salisbury Township, Lancaster County, Gap Wastewater Treatment Facility (Gap) using onsite instrumentation and a portable wastewater laboratory between March 15 and May 13, 2015. Findings of the evaluation are summarized below. As a result of the evaluation, the DEP's regional water quality enforcement administrators have recommended that a Consent Order and Agreement be entered into between the Commonwealth and Salisbury Township, requiring the latter to have a licensed engineer review the wastewater treatment facility for deficiencies in operation and propose corrective actions that will prevent further degradation of waterways downstream of the plant's effluent discharge.

The findings are summarized as follows:

1. Salisbury Township's Gap WWTF has a headworks which is insufficient to remove inorganic detritus and debris in the raw sewage. This material adversely affects the performance of a finely-tuned BNR treatment process downstream and results in excursions from the facility's discharge limits.
2. Loading to the facility may be inadequate for the operation of advanced biological nutrient removal technology, warranting the use of supplemental carbon to assist the BNR process.
3. In-line, electronic process monitoring equipment specified in the construction documents for the existing facility have either failed due to damage from detritus and/or from insufficient maintenance, or they were never installed to begin with, rendering inoperable the advanced BNR technology provided by the Vendor, Aqua-Aerobics, Inc. Further, the facility lacked an Internet-uplink that would allow Aqua-Aerobics remote access to monitor and trouble-shoot operations at the facility when problems occurred.
4. The WWTF operators do not perform sufficient process monitoring and control of the wastewater treatment and biosolids generation and disposal to achieve the level of performance indicated by the facility's designers. The operators did not properly monitor sludge concentrations in the treatment process or in waste sludge hauling, resulting in
  - a. Inefficient operation of the facility;
  - b. Activated sludge concentrations in excess of the recommended design concentrations for properly operating the facility; and
  - c. Predominance of filamentous organisms that led to deteriorated effluent quality.
5. NPDES Discharge Monitoring Reports (DMR) submitted to DEP may have been deficient due to the lack of dependable analysis results used to determine mass/balance and sludge disposal.
6. Township planning documents for the connection and management of users to the sewer system have not been maintained up-to-date. The Act 537 Plan for the township is fifteen (15) years old, and the most recent projection for growth in the township was dated 2005. The Municipal Wasteload Management (Chapter 94) Reports of the facility have lacked pertinent information on population and system users, which may affect planning, and on precipitation effects to the collection system, which affect hydraulic loading.

Based on the findings in this analysis, the WWTAP staff recommends that

1. An engineering study be commissioned to examine the existing plant headworks to determine if additional preliminary treatment will prevent the accumulation of rags,

debris, and detritus that have been so detrimental to the functioning of downstream process in the facility.

2. The owners and operators implement a Process Monitoring and Control Plan that employs regular on-site analysis of activated sludge properties, incoming waste stream, effluent quality, and biosolids management to effectively operate the facility. This may require equipping the wastewater with the appropriate equipment to do so.
3. The owners and operators establish written Standard Operating Procedures as required for running the facility, including a preventative maintenance program, process monitoring and control, and biosolids management plan.
4. The owners and operators address the damaging effects of comminuted detritus in the facility, including
  - a. Removal of floating and hanging debris from important treatment machinery, including aerators, subsurface mixers, pump throats;
  - b. Removal of detritus-caused obstructions to secondary clarifiers and the service-water pumps and lines; and,
  - c. Employ in their sewer billing letters public relations materials that specifically discourage the flushing of “disposable wipes” and other non-degradable solid wastes into the collection system.
5. Repair, Replace, and Make operational the monitoring equipment required for successful operation of the wastewater treatment system installed during the 2008 upgrade.
6. Revise its service area planning documents to update them and account for changes that affect the hydraulic and organic loading at the treatment facility.

We anticipate that implementation of these recommendations will result in the wastewater treatment process operating as it had been designed to do, with efficiencies and cost-savings that will benefit the facility owner and the service area customers well into the future.

**Narrative:**

The Pennsylvania Department of Environmental Protection (DEP) performed a Wastewater Treatment Evaluation (WTE) of the Salisbury Township, Lancaster County, Gap Wastewater Treatment Facility (Gap) using in-line instrumentation and a portable wastewater laboratory between March 15 and May 13, 2015. DEP staff were notified by members of the US Environmental Protection Agency, Region III, Technical Outreach section (EPA) that the facility required assistance in determining a cause and a cure for filamentous organisms affecting the process that resulted in effluent ammonia and total solids releases exceeding the limits of National Pollutant Discharge Elimination System (NPDES) permit number PA0081574. Messrs. Walter Higgins and James Kern of EPA had previously visited the facility, which had been upgraded to Biological Nutrient Removal (BNR) capability in 2008. The operator of the facility, Mr. Troy Wenger, had reported to them that the facility became difficult to manage following the upgrade. EPA’s technical outreach program provides assistance to wastewater operations within Pennsylvania, Delaware, and Maryland. DEP’s Bureau of Point and Non-point Source Management (BPNSM) runs a similar program called Wastewater Technical Assistance Program (WWTAP) to its permittees, but which is enhanced by the use of instrumentation which allows for continuous monitoring during process optimization..

The WTE evaluates existing operations and practices, followed by small-scale operational changes meant to optimize effluent quality. The purpose for optimizing effluent quality is to reduce nutrients in the final effluent, with an overall goal of improving surface water quality. The WTE was performed by staff of DEP’s Bureau of Point and Non-Point Source Management (BPNSM), Technical Assistance Section.

On arrival, DEP Staff met with then facility operator Troy Wenger, and with his supervisor, township public works director Alex Barra. After a brief discussion of operational issues and DEP’s program, Mr. Neville toured the facility and immediately determined that solids inventory exceeded manufacturer’s recommendations and that said biomass was probably dominantly infected with filamentous organisms. Ammonia-nitrogen present in the effluent were high and had occasionally violated the NPDES permitted limits during the previous winter months. A triple Settleometry test tentatively confirmed the presence of filaments, and on his next visit, DEP Staff confirmed h  
solids and ammonia concentrations. He recommended reducing the solids content through deliberative increases in the wasting rate, and he suggested a dose of 18 gal./day of bleach solution to begin controlling the filaments. Further recommendations would follow over the course of the evaluation.

Settleability Location	Triple Settleometer Test SAR2		
	100%	75:25	50:50
0	1000	1000	1000
5	1000	1000	990
10	1000	1000	970
15	1000	990	950
20	1000	980	920
25	1000	980	880
30	1000	970	850
35	1000	960	820
40	1000	950	790
45	1000	945	765
50	1000	940	740
55	1000	930	725
60	1000	920	710

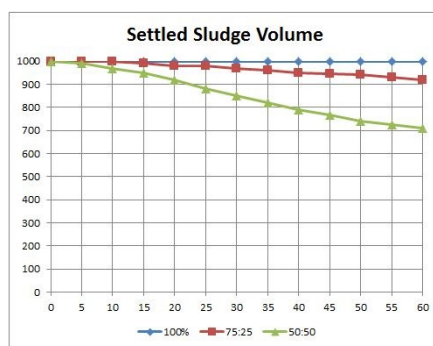


Figure 1: Triple Settleometry Test results, 3/8/15

Salisbury Township is a broad agricultural municipality located in eastern Lancaster County and approximately fifteen miles west of Coatesville, PA. The township owns and operates two wastewater treatment plants, including a small Dutchland Extended Aeration Process near Honey



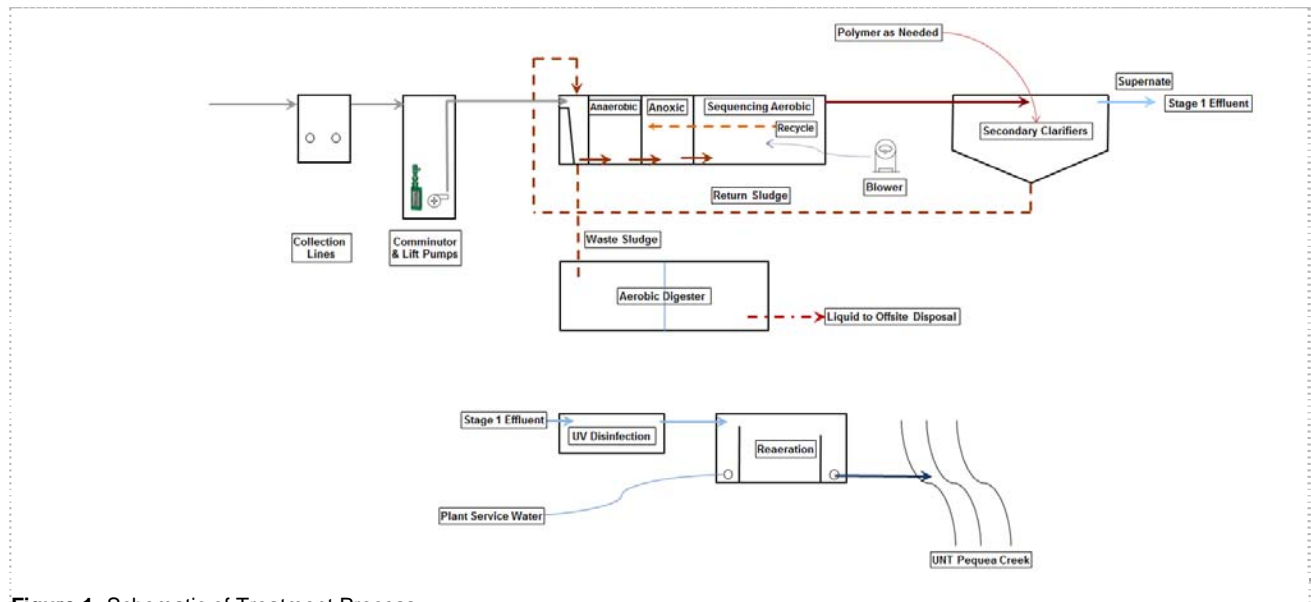
**Figure 2:** Evidence of Poor Settling due to Filamentous Organisms.

Brook, named Rose Hill. Salisbury Township's Gap STP operates under National Pollutant Discharge Elimination System (NPDES) Permit No. PA0081574. The current design flow limit is 0.580 MGD at 1,209 lb./day of organic loading. The treatment plant discharges into a Warm Water Fishery (WWF) in watershed 7-K, an unnamed tributary of Pequea Creek, which is a tributary of the Conestoga River. The outfall is directly adjacent to the treatment plant, and the stream runs through the township's park, where solids losses are immediately visible to the public.

The Salisbury Township Gap STP began life as a Dutchland in-ground vault extended aeration system that eventually reached 100,000 gpd. This plant was supplemented by a 240,000 gpd bilateral Dutchland extended aeration system around 2000, designed with the idea that these collocated facilities would meet the needs of this part of the township. In 2006, with the implementation of the Chesapeake Bay nutrient reduction strategy, DEP proposed new nutrient loading limits which, concurrent with proposals for explosive development, required the Township to upgrade the newer Dutchland plant and demolish the older vault facility.

The existing treatment works consist of the Aqua-Pass Biological Nutrient Removal (BNR) system retrofitted into the two existing Dutchland 120,000 gallon extended aeration reactor tanks. Modifications made during the upgrade included pump systems upgraded to accommodate 580,000 gpd flow, conversion of the existing equalization tank into a 3-phase, in-series system of anaerobic and anoxic reactor tanks whereby solids from two new clarifiers are consolidated anaerobically and mixed with raw wastewater to achieve luxury phosphorus uptake. The two 120,000 gallon aeration tanks were retrofitted with new aerators and with floating subsurface mixers used to maintain substrate contact with carbon and nitrate during an anoxic phase to achieve reduction of oxidized nitrogen to molecular nitrogen. Two 44'-diameter secondary clarifiers replaced four existing ones. Solids from the pre-anoxic tank can be wasted to a two-phase aerobic digester. Clarified effluent is disinfected under ultraviolet (UV) light and re-aerated in a 7,000 gallon balance tank prior to discharge at the approved outfall. Treatment chemicals include the use of proprietary sodium aluminate mixture to aid in flocculation and phosphorus removal. Plant service water is taken from the balance tank and piped throughout the facility to farm taps.

The figure, following, displays a basic treatment diagram for the system:



**Figure 1:** Schematic of Treatment Process

The following table lists critical design criteria for the facility, and a listing of the NPDES Permit requirements may be found in Attachment F.

Parameter	Value
Design Average Daily Flow	0.580 MGD
Maximum Design Flow	1.16 MGD
Average Design BOD5 Loading	1,209 lb./day
Average Design TSS Loading	1,040 lb./day
<b>2014 Annual Average Daily Flow</b>	<b>0.2549 MGD</b>
<b>2014 Organic Loading</b>	<b>473 lb./day</b>
Design Food-to-Mass Ratio	0.094
Design MLSS Concentration	4,000 mg/L
<b>Observed MLSS Concentration</b>	<b>5,500 mg/L</b>
Hydraulic Retention Time	13.6 hours
Solids Retention Time	11.4 days
Estimated Net Sludge Yield	0.74 lb. WAS per lb. BOD5
Estimated WAS Volume	8,249 gpd
<b>Actual WAS Volume</b>	<b>&gt;12,000 gpd</b>
Design O2 per lb. BOD5	1.25 lb.
Design O2 per lb. TKN	4.60
Design Air Delivery	1,283 SCFM @ 7.7 psig
Estimated Power Consumption	644 kW-hr per day
Design MCRT	11.4 days
Design HRT at 0.580 MGD	13.7 hours
Clarifier Surface Overflow Rate (2 @ 44' Diameter)	2.89 gpd/ ft <sup>2</sup> @ max. mo. Flow
Peak hourly SOR	5.78 gpd/ ft <sup>2</sup>
Surface Loading Rate @ 4,000 mg/L TSS	16 lb.-day/ft <sup>2</sup>
Design RAS concentration	10,000 mg/L
Design WAS concentration via Phase Separator	13,000 mg/L

During the late winter months, the facility experienced process upsets due to filamentous bulking combined with ashing of solids later determined to be from maintenance of excessively high solids concentrations. DEP staff deployed in-line process monitoring probes at the anoxic zone and in Staged Aerobic Reactor (SAR) Tank 1 to monitor biological activity, and they installed ammonium and nitrate probes in the final effluent tank to monitor nitrogen. In addition, a portable process monitoring laboratory was set up in the control building to allow evaluators and operators to conduct process monitoring tests on site and to maintain calibration of the in-line probes.

Over the following several weeks, DEP staff conducted process monitoring tests and reported that solids concentrations should be reduced, filamentous organisms should be treated, and efforts should be made to bring the process under control. The plant operator cited time and work assignment issues as factors mitigating against more in-depth process monitoring tests and noted that he continued meeting his monitoring requirements. (These are the required effluent tests for pH and DO, recording of UV intensity, collecting weekly samples for testing at a contract lab, and performing sludge settleability tests and collecting samples for off-site gravimetric solids tests.) Toward the latter part of the data collection period, the operator resigned his position, and the township hired a contract operations firm to maintain the facility.

The new operator immediately began to control the filamentous growth using bleach solution, sought to clear rag obstructions throughout the plant, and had the comminutor removed for service and replacement of its grinding teeth. He pledged to spend at least three hours per day at the facility until its operation was under control and brought in manpower and equipment to help clear detritus from the clarifier influent lines and to get solids concentrations back to manageable levels.

In the final week of the evaluation period, DEP staff and township representatives met to discuss options for implementing improvements to the facility. One of the significant items discussed was having an engineer re-evaluate the need for a more efficient headworks screening system for removal of rags and detritus. Another was to evaluate whether the originally specified monitoring equipment and system automation that had been cut from the planned upgrade should be installed and operated. The engineer would also review current and projected loading to determine if further improvements to capacity, such as flow equalization, should be considered.

**Findings:**

1. The facility was operating under conditions of inadequate sludge wasting, which led to dissolved oxygen deficiency that promoted the dominance of filamentous organisms.
2. Loading to the facility may be inadequate, overall, and specifically inhibiting to the proper operation of a BNR process. Supplemental electron donor carbon sources may be necessary to drive BNR, and nutrient balance or bioremediation (prepared nutrients or bacterial cultures) may be necessary to restore balance and inhibit the dominance of filamentous organisms.
3. The presence of excessive solids and filamentous organisms hinders adequate performance of the secondary clarifiers and results in both ashing of solids and occasional loss of clarifier blanket solids to downstream processes.

4. Further investigation noted that the lack of adequate screening in the plant headworks resulted in accumulation of rags and detritus that damaged downstream equipment and processes, including obstruction of one of the clarifier feed lines, causing imbalance in clarifier operation (and ultimately, solids loss,) and deterioration of aeration diffuser capability.
5. Failure of in-line solids probes due to the presence of rags and detritus may have prevented the Aqua-Aerobics technology from functioning as intended, or the automation specified by the process manufacturer was never implemented in the first place.
6. The WWTF operators do not perform sufficient process monitoring and control of the wastewater treatment and biosolids generation and disposal to achieve the level of performance indicated by the facility's designers. The operators did not properly monitor sludge concentrations in the treatment process or in waste sludge hauling, resulting in
  - a. Inefficient operation of the facility;
  - b. Activated sludge concentrations in excess of the recommended design concentrations for properly operating the facility; and
  - c. Predominance of filamentous organisms that led to deteriorated effluent quality.
7. Manpower coverage may be inadequate for operation of this type of facility, especially during times of biological upset or when preventative maintenance measures are necessary to assure safe and efficient operation.
8. NPDES Discharge Monitoring Reports (DMR) submitted to DEP may have been deficient due to the lack of dependable analysis results used to determine mass/balance and sludge disposal.
9. Township planning documents for the connection and management of users to the sewer system have not been maintained up-to-date. The Act 537 Plan for the township is fifteen (15) years old, and the most recent projection for growth in the township was dated 2005. The Municipal Wasteload Management (Chapter 94) Reports of the facility have lacked pertinent information on population and system users, which may affect planning, and on precipitation effects to the collection system, which affect hydraulic loading influenced by Inflow/Infiltration.

### **Recommendations:**

1. Given the conditions that were present at the outset of the evaluation, and the confirmation of these issues during the field phase of the study, DEP recommended the following:
  - a. Immediately begin to reduce sludge solids concentration within the treatment process to attain the manufacturer's recommended level of solids for adequate treatment of the wastewater. Do not exceed wasting more than 10% of the solids inventory during a single day.
  - b. Immediately take measures to counteract the presence of filamentous organisms:
    - i. Chlorinate the return activated sludge (RAS) appropriately, using 12.5% Sodium hypochlorite solution while monitoring the biology to prevent overdosing.
    - ii. Remove scum layers from the anaerobic and anoxic processes upstream of the SAR tanks, in order to remove existing inoculation reservoirs of filamentous organisms.

- iii. If tenable, employ the use of prepared bacteria to offset the adverse impacts of the necessary chlorination of the biomass.
2. Remove rags and detritus from the treatment system. This entails three significant actions:
  - a. Install temporary measures at the plant headworks to capture and divert much of the rags and insoluble detritus entering the plant;
  - b. Repair the existing comminutor, where teeth are either missing or where there exists insufficient clearance to assure destruction of rags and insoluble detritus;
  - c. Remove rags and detritus from process equipment, including the subsurface aerators, pump impellers, anoxic mixers, clarifier rakes. This activity will be labor intensive and will require process tanks to be alternately emptied and cleaned.
3. Evaluate the facility's headworks with an eye to long-term solution of the rags/detritus issue:
  - a. An engineering study should be pursued to find a treatment technology which adequately removes rags and detritus from the influent wastewater prior to its entry into the SAR treatment process.
  - b. Rags and detritus should be rinsed of soluble BOD prior to disposal in landfill (or incineration) in order to use that BOD to help drive denitrification in anoxic processes.
4. Implement a Process Monitoring and Control Plan that employs regular on-site analysis of activated sludge properties, incoming waste stream, effluent quality, and biosolids management to effectively operate the facility. This may require equipping the laboratory with the appropriate equipment to do so:
  - a. At present, the existing laboratory has only minimal equipment for activated sludge process monitoring and control.
  - b. The evaluator recommended additional analytical testing be done on-site, including regular testing, including but not limited to
    - i. Suspended Solids by gravimetric or volumetric assay;
    - ii. Mixed liquor dissolved oxygen, pH, and alkalinity;
    - iii. Settleability of mixed liquor entering the clarifiers;
    - iv. Regular microscopy of mixed liquor suspended solids;
    - v. In-house testing of effluent nutrients;
    - vi. Waste sludge solids concentration at digesters, following gravity decanting and prior to shipment of liquid waste solids to offsite treatment and disposal.
5. Establish written Standard Operating Procedures as required for running the facility, including a preventative maintenance program, process surveillance, and biosolids management plan;
6. Repair, replace, and make operational the monitoring equipment required for successful operation of the wastewater treatment system installed during the 2008 upgrade;
7. Evaluate and update the existing projections for growth in the treatment facility's service area:
  - a. Capacity projections for the Aqua-Aerobics upgrade were made prior to the 2008 housing industry crash that adversely impacted commercial and residential

development in the township, rendering projected connections and loadings inaccurate.

- b. Inadequate influent loading to a BNR-process treatment facility will affect performance of that facility and may result in degradation of effluent quality. This is especially critical when providing adequate conditions for nitrogen control, where costly supplemental treatment chemicals may be required.
8. The engineer may also need to evaluate manpower coverage to assure the facility is operated thoroughly but efficiently.

These recommendations are made in with the intention to provide the Township with sufficient guidance in assuring efficient treatment of sewage, production of a quality effluent that meets or exceeds the requirements of its NPDES permit, and proper disposal of waste biosolids, with an eye toward assuring community and worker safety while also maintaining economical cost control and oversight.

**Permit Modifications**— Any modifications to the permitted treatment process may require an amendment to the Water Management Permit. If unsure whether a permit modification is necessary, please contact the DEP regional office prior to making any modifications.

**Disclaimers:**

The mention of a particular brand of equipment is in no way an endorsement for any specific company. The Department urges the permittee to research available products and select those which are the most applicable for its situation.

The goal of the Wastewater Technical Evaluation is to reduce nutrients in wastewater plant discharges. This often times involves permittees achieving effluent quality above and beyond any permit requirements.

## Attachment A— WWTAP Participants

### Salisbury Township Gap Wastewater Treatment Facility

#### WWTAP

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## **Attachment B— Equipment Deployed**

### **Digital, Continuously Monitoring Probes**

#### **Laboratory Equipment On-Loan**

The WTE employs several instruments with which to analyze and record data on the operation of the facility. Much of this equipment is the same as that being specified for the operation and maintenance of BNR treatment facilities. Oftentimes, it has been found that BNR facilities requesting assistance of WWTAP have had similar equipment specified by the engineers designing new or upgraded BNR facilities, but much of the instrumentation is either cut from the project in an effort to reduce overall costs, or the equipment that is provided is not sufficiently maintained by operators who are unfamiliar with the technology and the maintenance it requires.

Facility owners may find, following a WTE, that acquisition and implementation of similar monitoring equipment will enhance facility performance. While the Department of Environmental Protection cannot recommend any specific manufacturer or vendor, it does suggest that those facility owners wishing to implement this technology consult with their facility engineers on the proper specification and siting of this equipment.

All new monitoring equipment should be adequately maintained according to its manufacturer's recommendations. This may impose additional work requirements for treatment plant staff and should be accounted for in allocating and scheduling manpower. The Department also recommends that this and any new equipment be tracked using commonly available asset management programs to assure their timely maintenance and replacement.

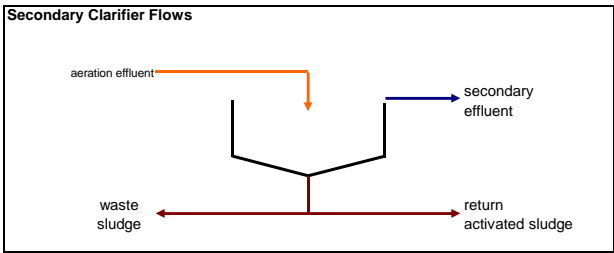
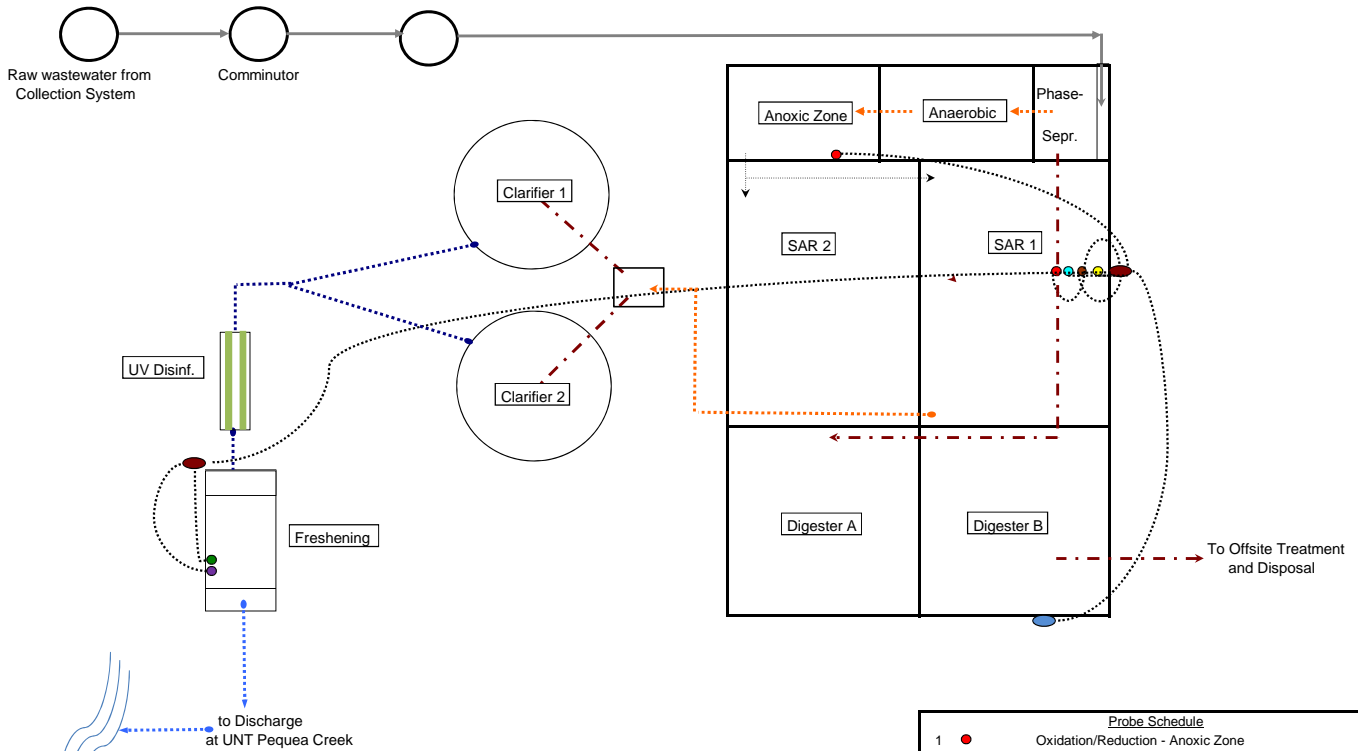
#### **Digital, Continuously Monitoring Probes:**

- 1 – Laptop computer with signal converter
- 2 – SC1000s
- 2 – LDO probes
- 1– pH probe,
- 2 – ORP probes
- 1 – AISE Ammonium Probe
- 1 – Nitrate Probe

#### **Laboratory Equipment On-loan:**

- 1 – Hach HQ40d handheld pH and LDO meter
- 1—Hach BOD dissolved oxygen probe
- 1 – DR2800 spectrophotometer with Environmental QA Lab  
TNTplus test vials for measuring Nitrate-LR, Ammonia-LR, Alkalinity, Phosphorus-  
Total-HR
- 1 – Digital Reactor Block
- 1—Phase-contrast, recording Microscope
- 3—Settleometer Kits
- Laboratory Thermometer, Assorted glassware and sampling equipment

**Salisbury Township Gap WWTF**  
**Salisbury Township, Lancaster County**  
**Treatment Schematic & Instrument Placement**

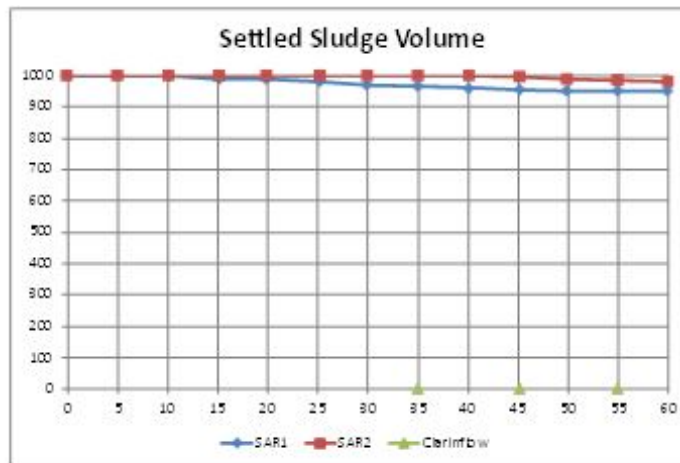


Probe Schedule	
1	Oxidation/Reduction - Anoxic Zone
2	Total Suspended Solids - SAR 2
3	Oxidation/Reduction - SAR 2
4	Dissolved Oxygen - Influent mixture
5	pH - SAR 2
7	Nitrate - Ditch 1 Mixed Liquor
8	Ammonium - Ditch 1 Mixed Liquor
9	SC-1000 Base Controller Unit
10	Data Acquisition Station (in Electrical Room)





Settleability Location	SAR1	SAR2	Clariflow
0	1000	1000	
5	1000	1000	
10	1000	1000	
15	990	1000	
20	990	1000	
25	980	1000	
30	970	1000	
35	965	1000	
40	960	1000	
45	955	995	
50	950	990	
55	950	985	
60	950	980	



Oxygen Uptake Rate: Location	SAR1	SAR2	SARs
0.0	8.60	8.40	
1.0	8.20	7.40	
2.0	7.60	6.60	
3.0	7.20	6.00	
4.0	6.60	5.50	
5.0	6.20	5.00	
6.0	5.70	4.60	
7.0	5.30	4.20	
8.0	5.00	3.80	
9.0	4.60	3.50	
10.0	4.20	3.20	
OUR, mgO2/hr	26.7	28.0	0.0
RR, mgO2-gVSS/hr	6.9	7.0	0.0
slope, -x/y	0.444	0.467	0.000
OUR, mgO2/hr	27	25.8	
RR, mgO2-gVSS/hr	6.75	4.5	

hand calc

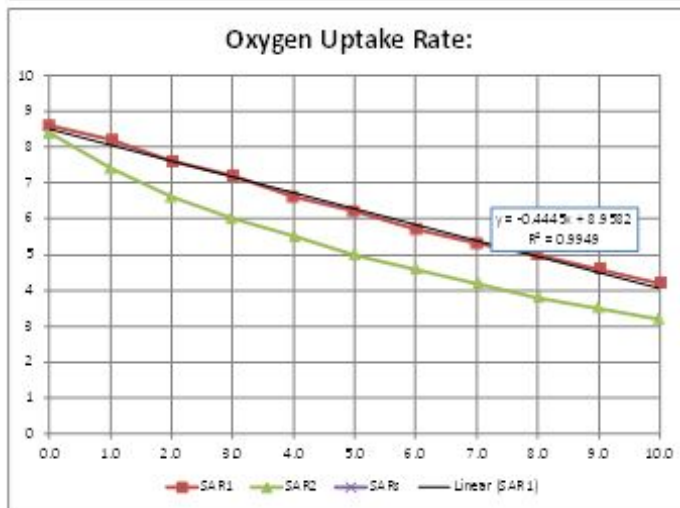


Figure C.2: Example Data from the Automated Process Monitoring Workbook

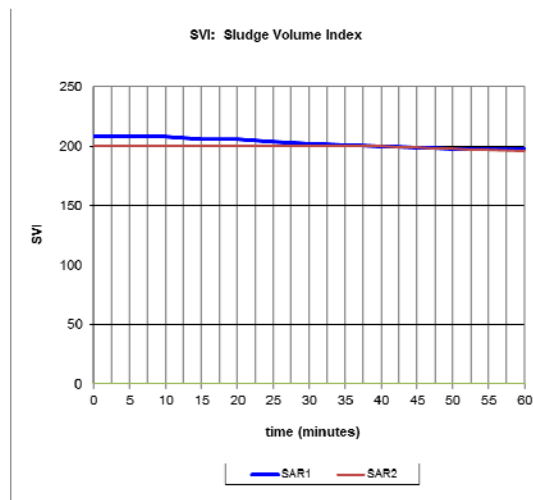
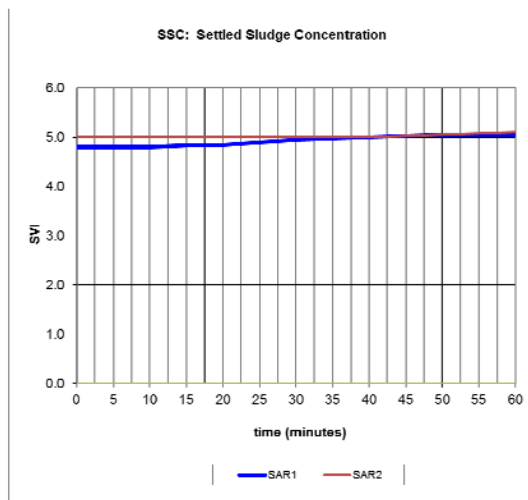


Figure C.3: Example Data from the Automated Process Monitoring Workbook

Location	DO	TempC	pH	TempC
Raw	4.83	12.4	7.85	12.8
Anaerobic	0.23	16.1		
Pre-Anoxic	0.17	13.9		
SAR1	1.21	14.3		
SAR2	0.24	14.5		
Clarifier1	0.13	14.4		
Clarifier2	0.19	14.5		
Post UV	8.97	15.1	7.10	15.0
Outfall001				

Figure C.4: Example Data from the Automated Process Monitoring Workbook

Food=	Flow x BOD	480		
Mass=	Volume x VSS	8,221	F/M total plant =	0.06

Using decimal calculation for AGE:	
AGE=	(Inflow SLU+ Basin SLU) / (Eff SLU + WAS SLU)
	44,440 2,957,423 slu 6,060 160,000 slu/day
	3,001,863 slu pres 166,060 slu/day out
AGE=	18.1 days

Effluent Nutrients:			Dilution	Tube	Under/Over
PO4-P 843	0.46	mg/L P	↑	LR	
NH4-N	0.269	mg/L N	↑	ULR	
NO3-N	0.36	mg/L N	↑	LR	
NO2-N		mg/L N	↑	LR	
TN		mg/L N	↑	--	
ALKALINITY	80	mg/L ALK	↑	sticks	
TRC	NA:	mg/L	↑	---	

<b>Plant Detention time:</b>	
0.427 MG	
0.202 MGD	
2.1 days	
51 hours	

Figure C.5: Example Data from the Automated Process Monitoring Workbook

**Notes:**  
 Weather: rain early, 1", followed by clearing and warm, humid weather  
 Microscope: free swimmers, 2 stalks, no rotifers or higher. Nocardia branching numerous. Spher. natans also seen.

Figure C.6: Example Data from the Automated Process Monitoring Workbook

## Attachment D—Parameter Histograms

The following histograms are representative of the in-line probe output from the DEP's data acquisition system. The technology employed consists of the monitoring features of a Supervisory Control and Data Acquisition (SCADA) system similar to that specified by Aqua-Aerobics when the Aqua-Pass technology was engineered.

The following first page of histograms display probe output for April 13, 2015.

Following the daily histograms is a tabulation of March 2015 Flow and Effluent loading data, combined with histograms and trend charts.

The subsequent pages of histograms display the month-long collation of data during April 2015 and are useful for observing trends.

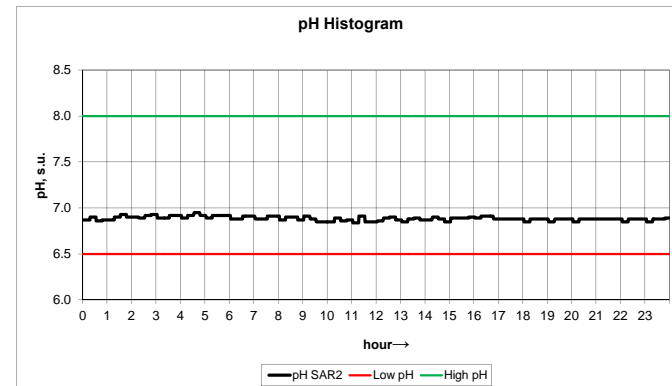
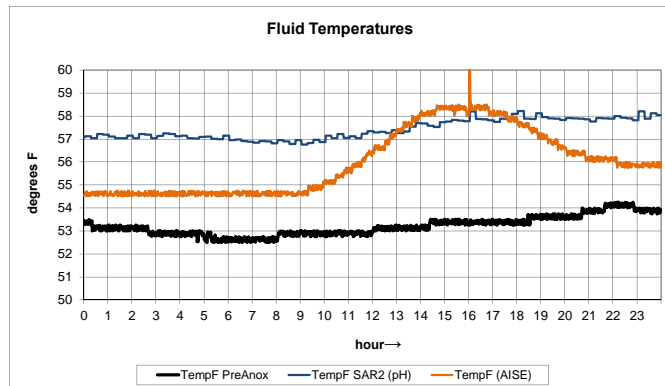
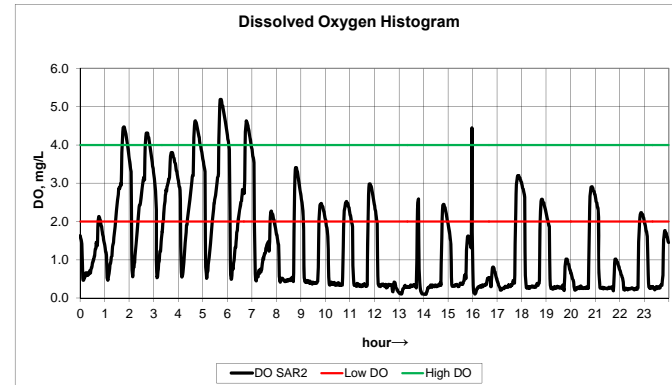
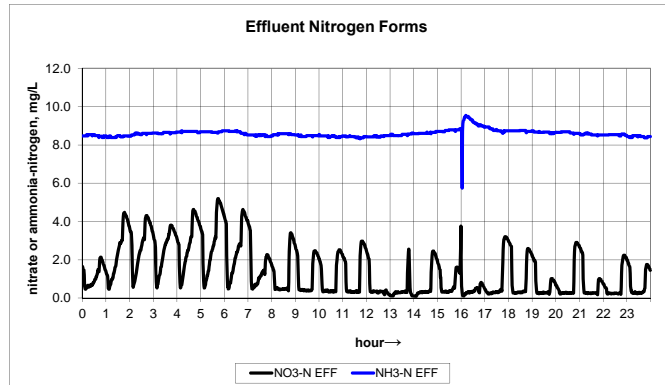
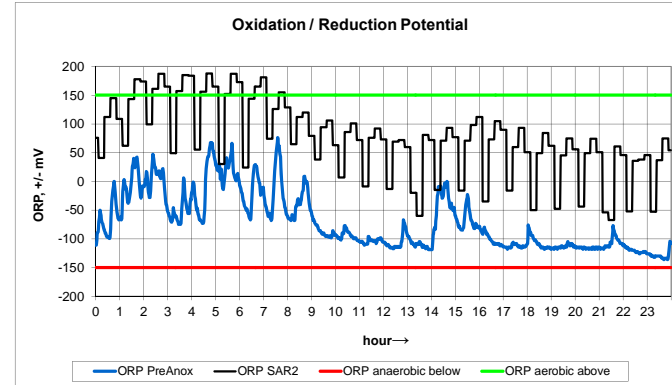
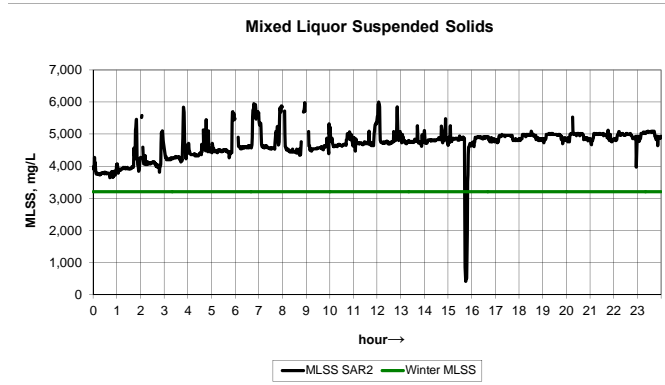
One item that comes to attention is the histogram showing MLSS for early April: The recording is spikey and indistinct. The recorded numbers were generally in the high 5000 mg/L range; however there were significant number of spikes into territory that does not make sense until one corroborates it with the evidence of excessive rags and detritus becoming caught in the probe's self-cleaning mechanism, causing excessively high readings.

The Hach TSS probes installed as part of the original Aqua Aerobics SCADA package have all failed and become irreparably damaged due to this accumulation of comminuted detritus in the process reactors. The experience speaks to the need for a better method of managing rags and detritus in the Salisbury Township Gap STP. A proper headworks screening system would virtually negate this downstream damage to parts of the treatment system, and the probes that may replace these damaged ones will still require regular maintenance once installed.

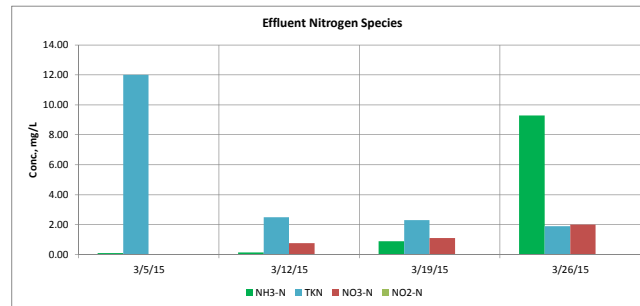
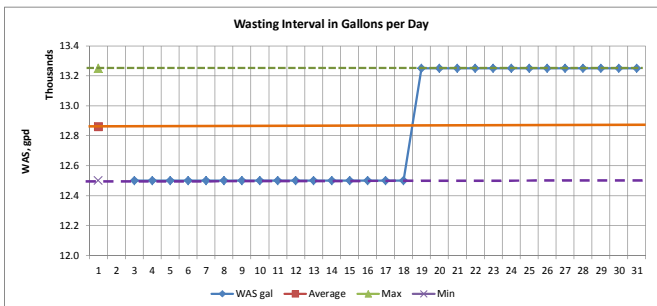
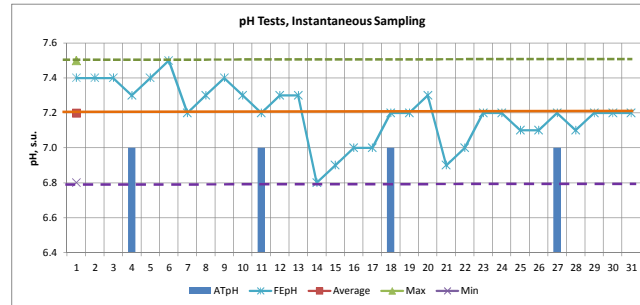
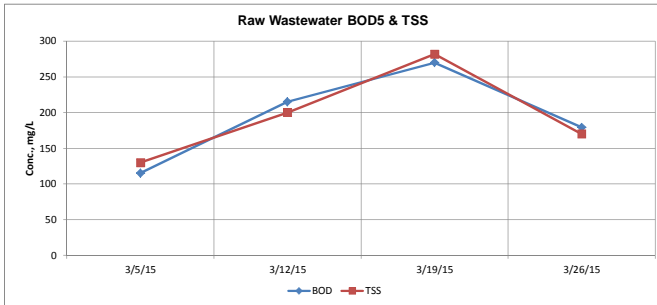
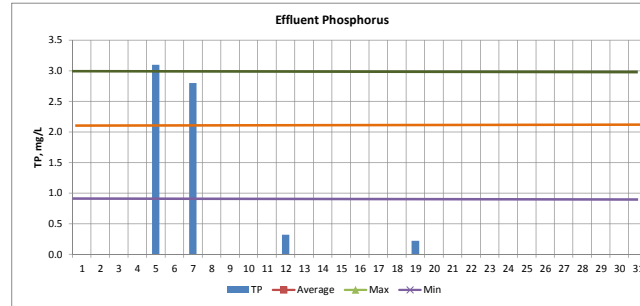
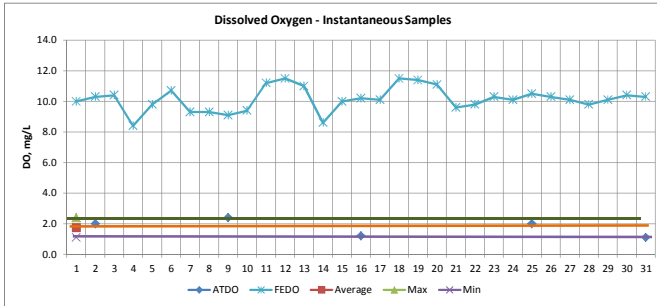
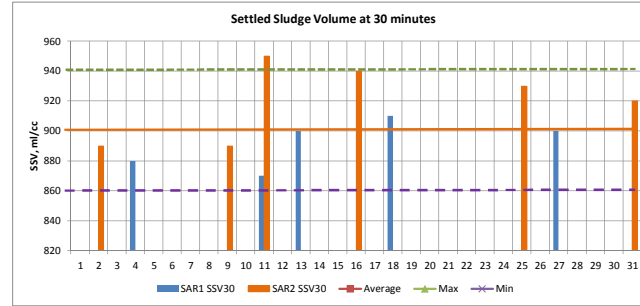
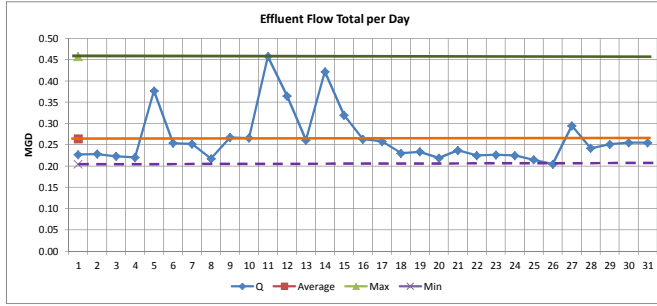
Other trends that are observable in these histograms include process pH remaining below the ideal range for denitrification most of the time. This speaks to the issue of insufficient alkalinity to buffer against the formation of acid during biological nitrification. The micro-organisms that nitrify and denitrify the wastewater are more restricted in the range of pH they tolerate. In this case, pH below the ideal range of 6.8 to 7.5 s.u. speaks to the need for automated delivery of alkalinity, in the form of a metered slurry or as a liquid buffer, such as magnesium hydroxide suspension.

Oxidation / Reduction Probes are quite useful in optimizing BNR processes, because the electric potential of the biomass after dissolved oxygen concentration has fallen to zero allows the operator to determine whether or not truly anoxic conditions exist. The reading is also a barrier against operating the anoxic process under anaerobic conditions, where denitrification is supplanted by reduction of sulfides, production of alcohols, and formation of odor-producing chemicals. The charts showing ORP trends indicate that the anoxic zone tended to maintain good conditions for denitrification, while those in the SAR tended to be on the low end of ideal for nitrification.

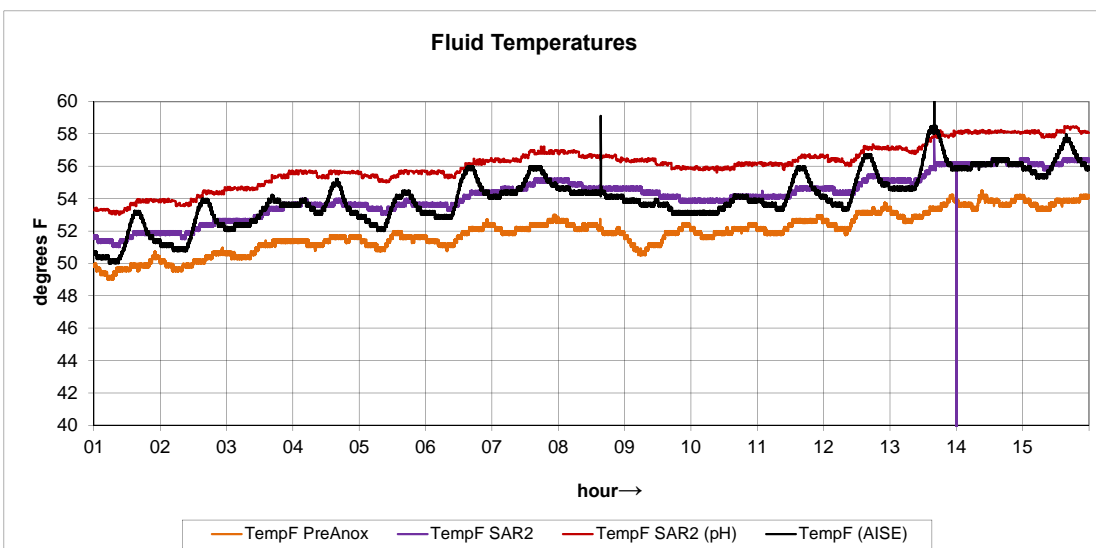
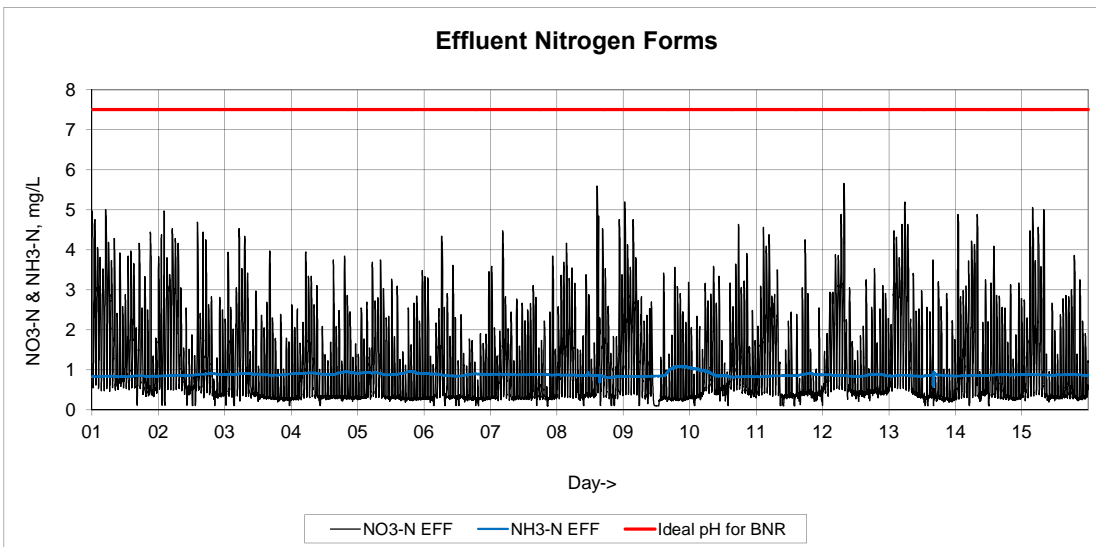
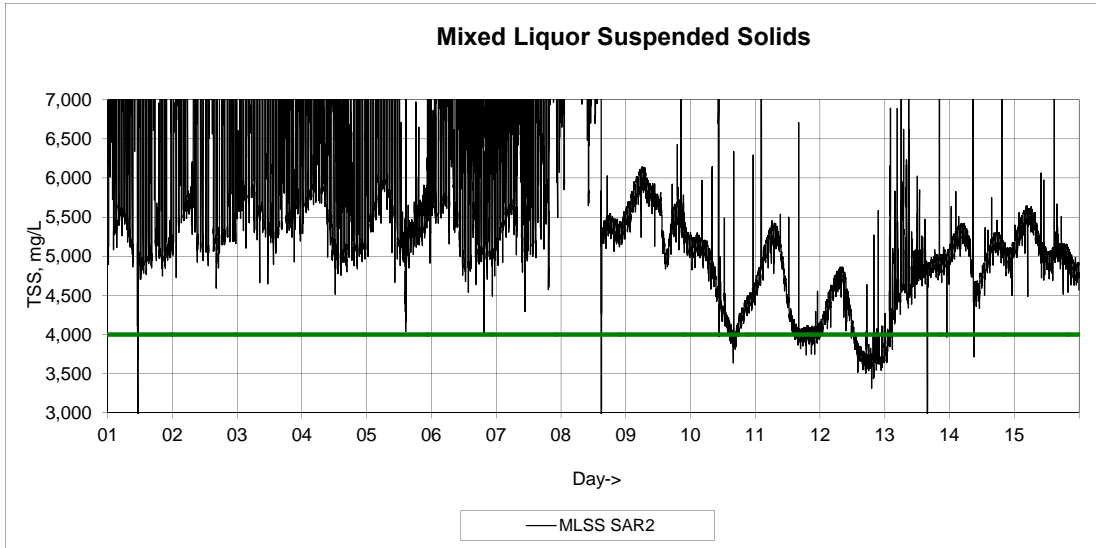
D-2

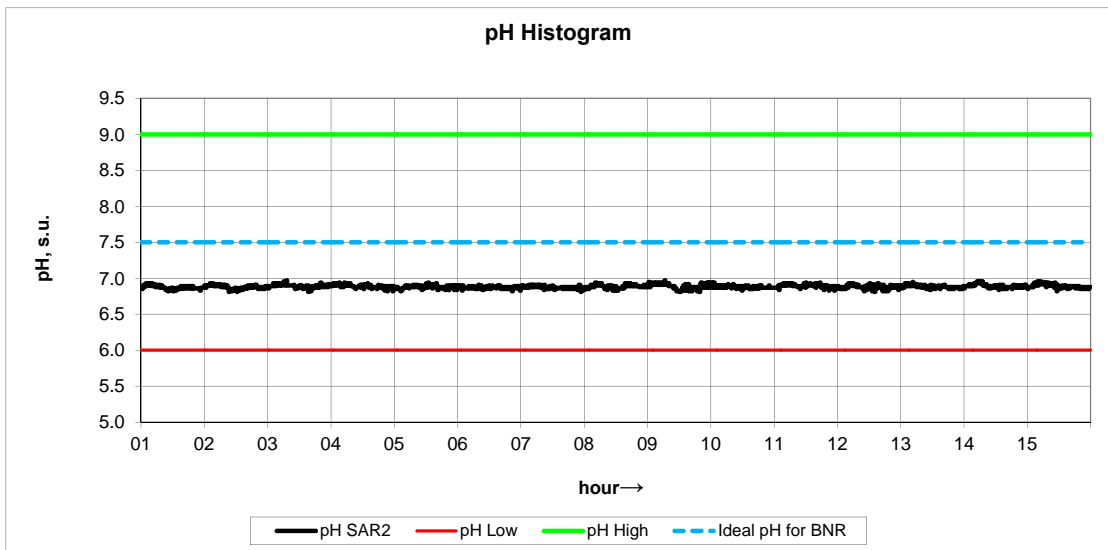
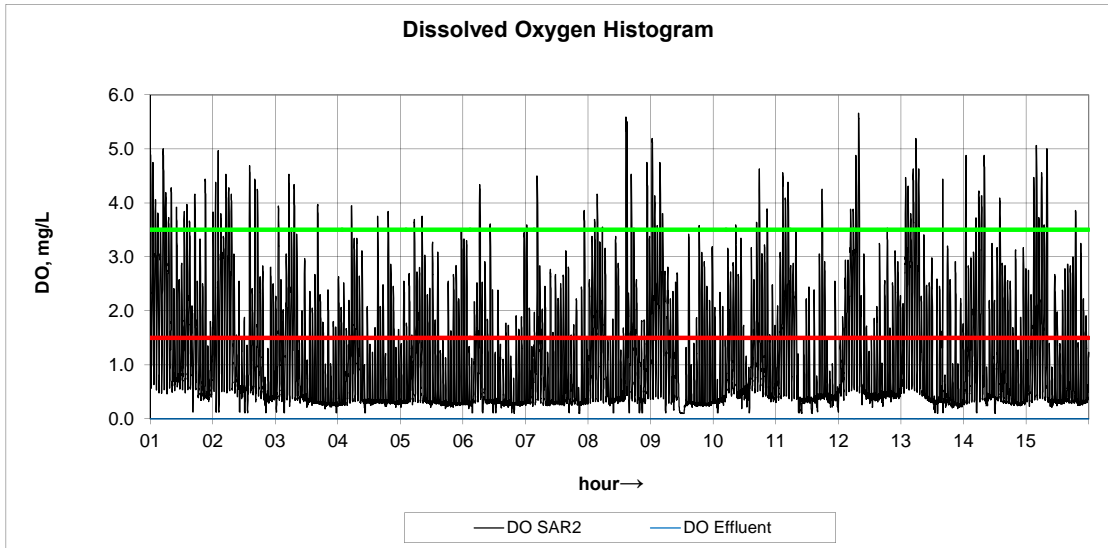
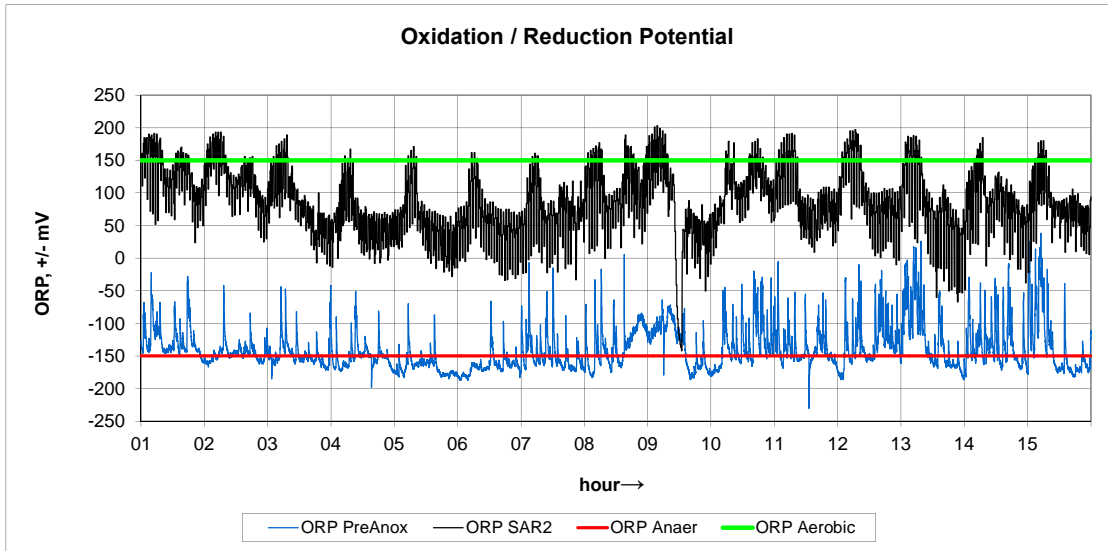


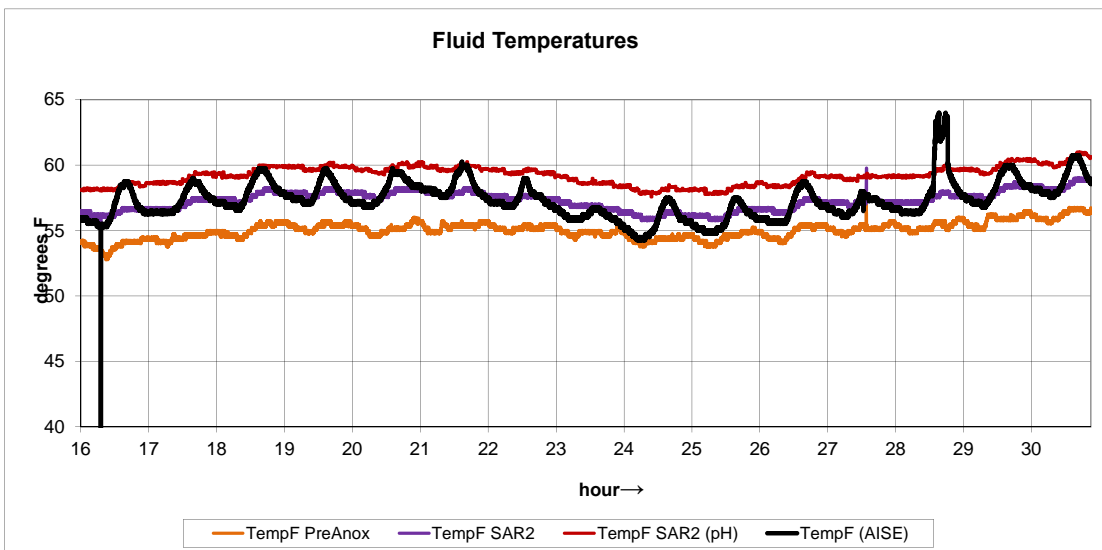
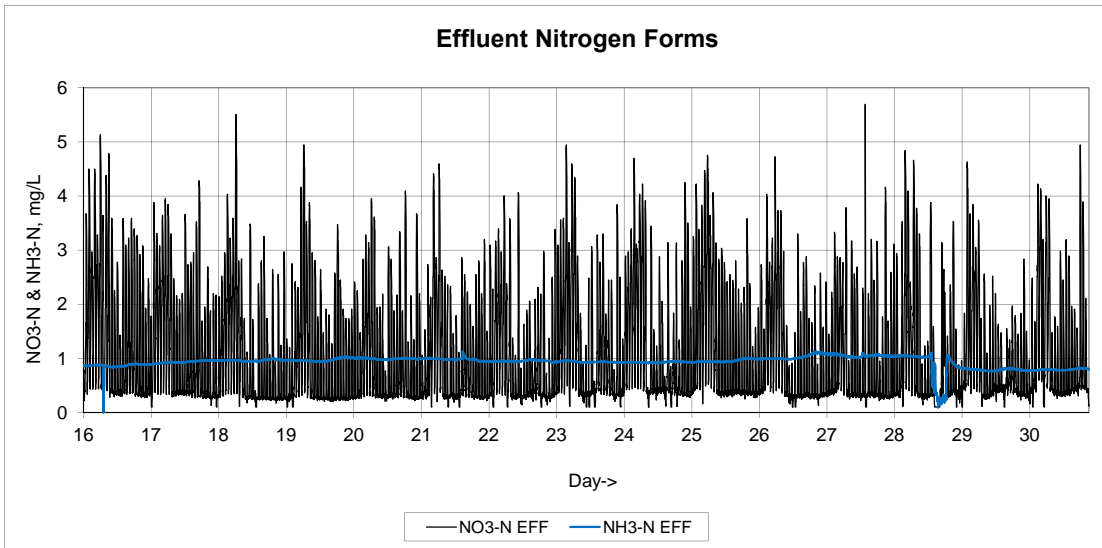
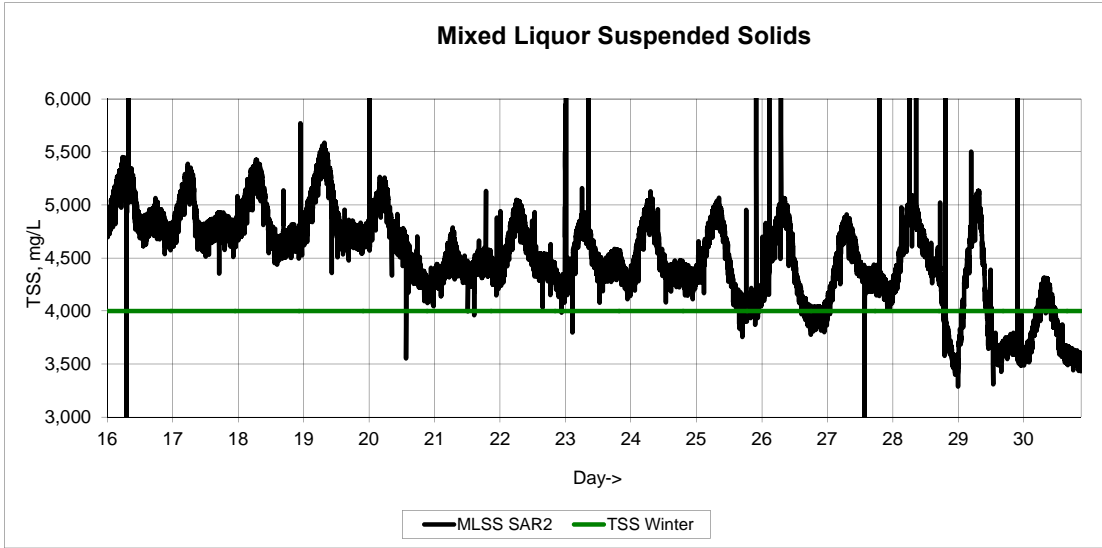


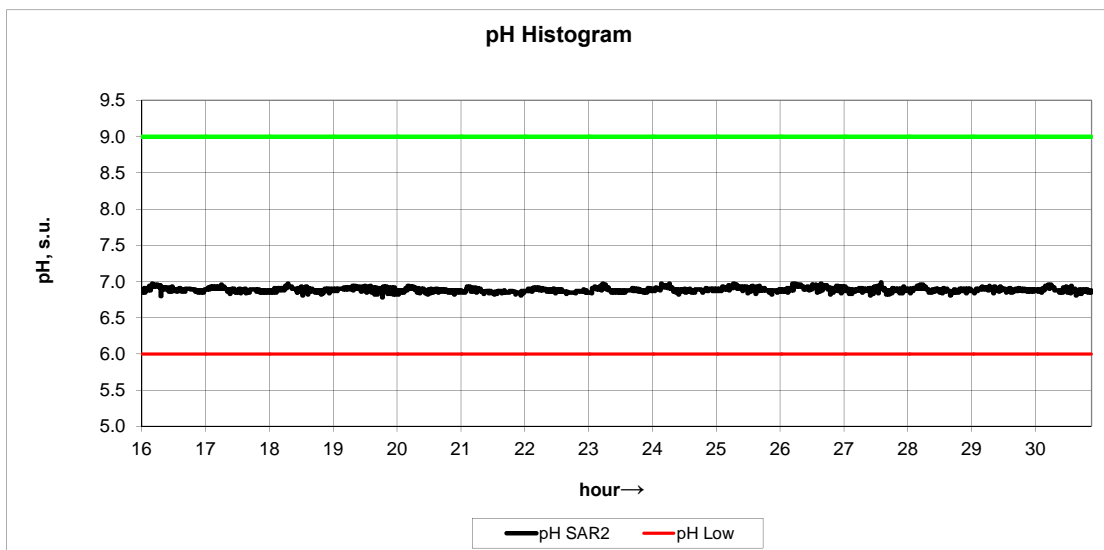
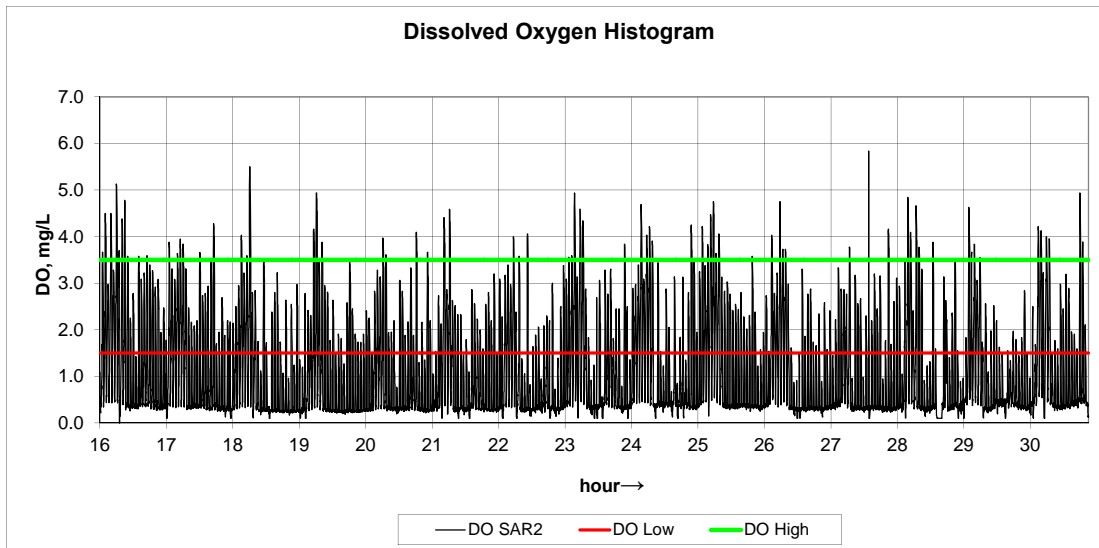
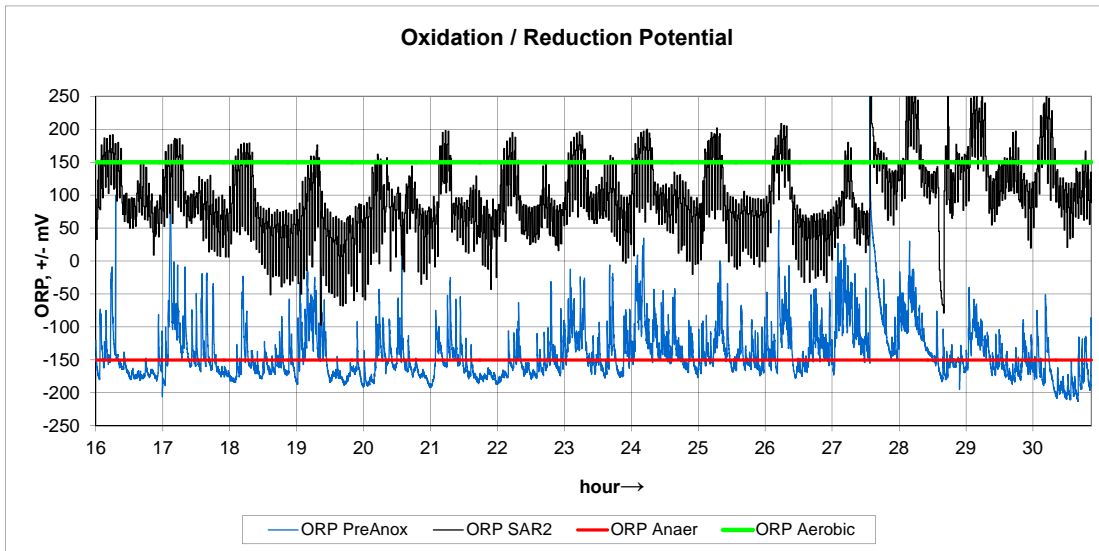


15-day Charts









## Attachment E

### Recommended Process Control Tests, Observations and Calculations

The following is suggested for proper process control. The actual testing and how frequently it is done will be based upon facility circumstances. If unsure, consult the design engineer and state regulatory officials. It is important to do testing on the influent wastewater in order to determine loadings and efficiencies of all treatment units. Influent testing also provides valuable information for chapter 94 reports as well. At a minimum test the influent wastewater each time samples are collected for effluent compliance testing (NPDES Reporting). The operator should also note weather conditions on a daily basis Hi/Lo temperature and amount (if any) precipitation. (This is critical where Inflow/Infiltration affects the collection system flow into the plant.)

The following describes the parameters you should be monitoring (at a minimum) in regard to influent wastewater. Depending on your facility, additional parameters may need to be monitored especially if you facility treats industrial or trucked in waste.

<b>Influent Wastewater Recommended Parameters</b>	
cBOD <sub>5</sub>	24 Hour Composite
Total Suspended Solids (TSS)	24 Hour Composite
Ammonia-Nitrogen (NH <sub>3</sub> -N)	24 Hour Composite
PO <sub>4</sub>	24 Hour Composite
pH	Grab
Temperature	Grab
Alkalinity	Grab
Flow (MGD)	Continuous monitoring
Visual/Aromatic Observations	Document unusual conditions

Following are the monitoring parameters, calculations, and observations for this type of facility. The frequency of these depends on the variability of the waste-stream and other factors. Ideally, a full set of Process Monitoring tests is performed each week for a facility of this size; whenever process adjustments are made, a set of test should follow by a day or two to assure system stability.

<b>Process Monitoring Test</b>	<b>Description / Recommendation</b>
<b>Dissolved Oxygen</b>	Best done with continuous monitoring within the reactor. Calibration of DO sensors should be checked weekly.
<b>Oxidation Reduction Potential (ORP)</b>	Best done with continuous monitoring within the reactor. Very important for anoxic and anaerobic zones.
<b>Nitrate (NO<sub>3</sub>)</b>	Best done with continuous monitoring within the reactor. Occasional grabs (to check calibration) during each cycle. Portable kits similar to TRC test are available for this.
<b>Nitrite (NO<sub>2</sub>)</b>	Can be a grab sample at various intervals. If you are having problems maintaining chlorine residual excess nitrite can be a factor. Nitrite can be associated with incomplete nitrification or incomplete denitrification
<b>Ammonia-Nitrogen (NH<sub>3</sub>-N)</b>	Best done with continuous monitoring within the reactor. Occasional grabs (to check calibration) during each cycle.

<b>MLSS &amp; MLVSS -or- TSS by Centrifuge (Percent-by-Volume)</b>	This test is essential for determining the lbs of solids you have under aeration. The use of a centrifuge spin can provide quick and reasonable estimates of solids under aeration. With an increase in MCRT, the MLVSS should decrease.
<b>Mean Cell Residence Time</b>	MCRT is a calculation. lbs of solids in the system Solids leaving the system (WAS & Effluent)
<b>Food to Microorganism Ratio</b>	F/M is a calculation ( be aware of SWD). FOOD (BOD) coming into system lbs of solids under aeration
<b>Sludge Volume Index (SVI)</b>	SVI is a calculation 30 Minute Settleability Result ml/L MLSS mg/L / 1000
<b>Microscopic Examination</b>	Microscopic observation of the biomass to determine the relative predominance of organisms and to spot troublesome filamentous organisms. Use a count-chart to tally different types of bugs, for comparison to ideal operating conditions.
<b>30 Minute Settleability</b>	To help quantify the amount of sludge in the system and to determine settling characteristics. Must be used in conjunction with MLSS to determine SVI.
<b>Alkalinity</b>	This can be a grab sample, should not drop below 50 mg/l at any point in the system especially for facilities that must nitrify. Some resources note that Alkalinity in mixed liquor should be 180 to 220 mg/L. Would like to see 100 mg/l in effluent after complete nitrification.
<b>pH</b>	This can be done through continuous monitoring or through a grab sample. Alkalinity is more important. Drastic changes in pH will occur when alkalinity has been completely consumed.
<b>Temperature</b>	The temperature will determine how lively your biological activity will be every 10 degree C change in temperature results in biological activity either doubling (warmer temps) or cutting in half (for colder temps).
<b>Oxygen Uptake Rate(OUR)</b>	Useful test for determining the respiration rate of the biomass. Can be used to determine treatability of waste.
<b>Respiration Rate (RR)</b>	Calculated: Divide the OUR by the MLVSS value and multiply by 1000 to get the answer in mg. O <sub>2</sub> per hour per gm. VSS
<b>Amount and concentration of sludge wasted from each SAR</b>	We must be able to quantify the amount of sludge removed from the system in order to maintain a proper mass balance. This may require more attention be paid to each process train as an individual entity.
<b>Recycle flows</b>	Nitrate recycle is critical in BNR. Start with 200% and work upward. This could include flows such as supernatant from aerobic digesters or filtrate from dewatering or thickening activity. These recycle flows can be high in nutrients (phosphorus and nitrogen) as well as BOD.
<b>Waste Sludge Solids &amp; Digester Solids (Total Solids as %)</b>	Critical to solids management is knowing the total solids content of the sludge when it is shipped from the facility. One should not always trust the hauler tests to be accurate. Whenever the viscosity of the sludge changes, that is, after decanting or adding WAS to the digester, use the centrifuge to spin down a sample. Gravimetric analysis (25 ml. sludge into a dish, dried at 100 C overnight and weighed the next day) will give total solids by weight/volume percent.

**Attachment F—NPDES Effluent Discharge Limits**  
Sewage Treatment Plant  
NPDES PA0081574

Discharge Parameter	Effluent Limitations						Monitoring Requirements	
	Mass Units (lbs/day)		Concentrations (mg/L)				Minimum Measurement Frequency	Required Sample Type
	Average	Maximum	Minimum	Monthly Average	Weekly Average	Maximum		
CBOD <sub>5</sub> (05/01 – 10/31) (11/01 – 4/30)	43.9	65.7		20 25	30 40	40 50	1/week	24-hr comp
Suspended Solids	64.7	98.8		30	45	60	1/week	24-hr comp
Ammonia – N (05/01 – 10/31) (11/01 – 04/30)	4.4 13.1			2 6	-- --	4 12	1/week	24-hr comp
Total Phosphorus	4.4			2	--	4	1/week	24-hr comp
Dissolved Oxygen	Minimum of 5.0 at all times							
pH	Within the range of 6 to 9 at all times							
Fecal Coliform 5/1 - 9/30 10/1 - 4/30			200/100 ml as a geometric average, not greater than 1,000/100 ml in more than 10% of the samples tested 2000/100 ml as a geometric average				1/week 1/week	Grab Grab
Net Total Nitrogen	13,150	lb./year	Reported annually for period 10/1 to 9/30					
Net Total Phosphorus	1,643	lb./year	Reported annually for period 10/1 to 9/30					
Ammonia-N	Report	lb./month		Report			1/month	
Kjeldahl-N	Report	lb./month		Report			1/month	
Nitrate-Nitrite N	Report	lb./month		Report			1/month	
Total Nitrogen	Report	lb./month		Report			1/month	
Total Phosphorus	Report	lb./month		Report			1/month	

Table F.1. effluent limitations

## Attachment G—Captioned Photographs



Figure 1: Large mound of rags and detritus removed from SAR



Figure 2: Scum Layer (filamentous organism reservoir) on Pre-Anoxic Tank & Phase Separator



Figure 3: Probe Installation at Effluent Reaeration Tank: Nitrate, Ammonium, & DO Probes



Figure 4: Probe Installation at SAR: pH, TSS, DO, and ORP; Anoxic Tank: ORP



Figure 5: Secondary Clarifier inflow line was clogged by rags and taken out of service.



Figure 6: Evidence of line obstruction at clarifier feed splitter box.



Figure 7: Example of rags accumulating in aerobic digester



Figure 8: Foam buildup in Staged Aerobic Reactor Tank

