Nutrient and Energy Optimization Study
Cowan, Tennessee
Wastewater Treatment Plant
July 2021

Tennessee Association of Utility Districts

with funding from the **Tennessee Department of Environmental Conservation**
and support from **CleanWaterOps**, **UT- Municipal Technical Advisory Service**
and the **City of Cowan**

Introduction

Tennessee Plant Optimization Program (TN POP) assists water and wastewater utilities in achieving energy efficiency and nutrient optimization through low-and-no-cost measures. TN POP is a free program operated by the Tennessee Department of Environment and Conservation (TDEC), Division of Water Resources (DWR). The program provides resources to support water and wastewater operators in achieving optimization in energy use and nutrient removal for their facilities through low-and-no-cost measures.

Acknowledgements

The following study was made possible through funding from Tennessee Department of Environment and Conservation (TDEC), Division of Water Resources (DWR) with an TDEC/SRF/TAUD contract. Special ***Thank You*** to the Cowan Board of Public Utilities Board of Alderman, Cowan's Mayor Joyce Brown, Cowan Utility Manager Kenny Henshaw, Cowan Chief Plant Operator Nic Willis, Grant Weaver of CleanWaterOps, TDEC's Karina Bynum and Brett Ward of UT- Municipal Technical Advisory Service (MTAS).

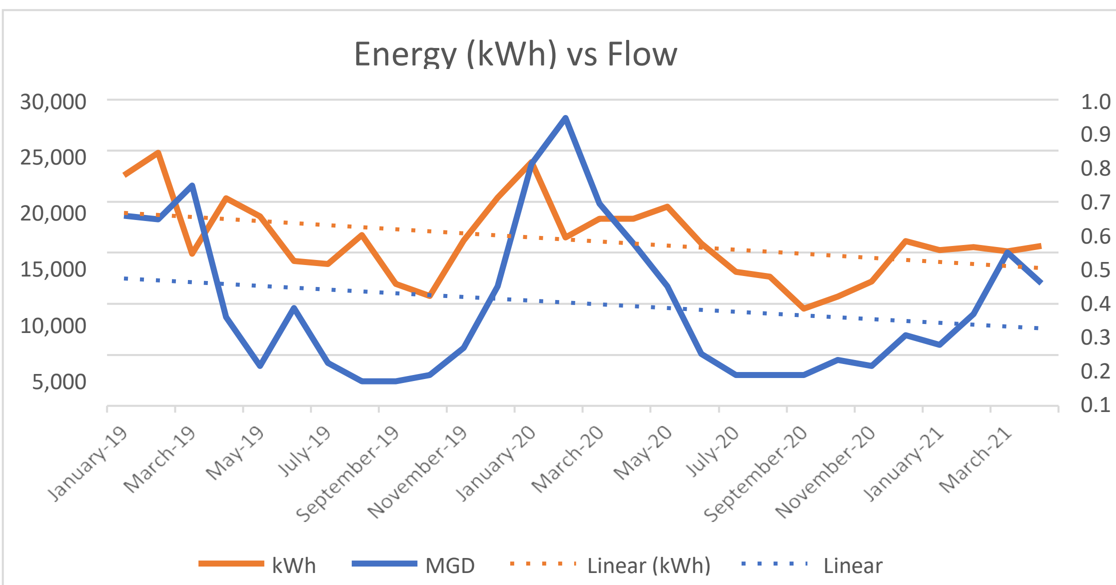
2020 Cowan, Tennessee Nutrient and Energy Optimization Study

Executive Summary

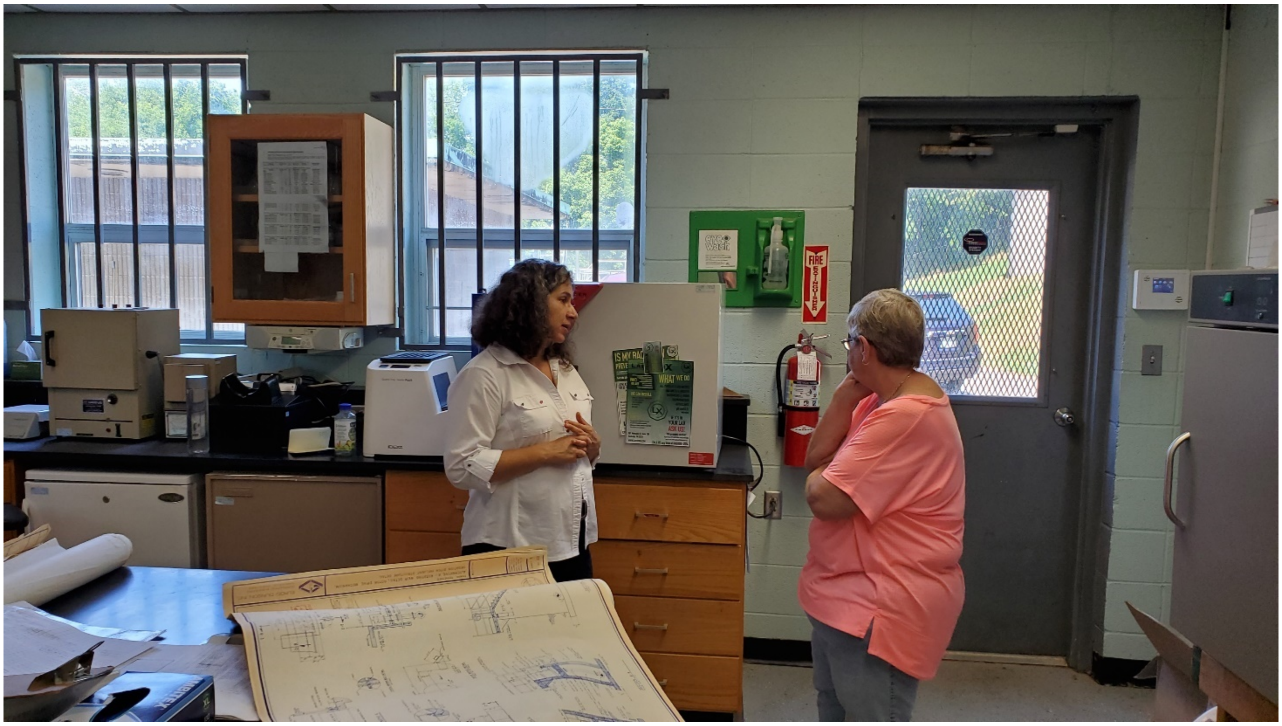
Creative changes to the day-to-day operation of the Cowan municipal wastewater treatment facilities have reduced the discharge of nitrogen from the Cowan municipal wastewater treatment plant by more than 50%. A smaller, but noticeable, improvement in phosphorus removal has also been achieved.

2020 Data	Cowan Effluent (average)			
	Nitrogen		Phosphorus	
	mg/L	lb/day	mg/L	lb/day
Before (Jun-Aug 2020)	18.1	19.3	2.7	2.9
After (Sep-Dec 2020)	7.6	8.4	2.2	2.4
Change (mg/L)	10.5	10.9	0.5	0.5
Change (Percent)	58%	57%	20%	16%

The changes appear to have reduced electrical usage, too. However, as shown in the table below and discussed in more detail in Appendix 2, more information is needed to draw firm conclusions on the magnitude of the electrical savings, if any.



Because conventional funding sources have proven inadequate to Cowan's needs, treatment facilities are badly in need of repair: overflowing screen, multiple needed repairs and replacements. To repair its wastewater treatment facilities sufficiently to support community development while protecting and enhancing the environment, Cowan must be creative. Two strategies are recommended. One, invest the money saved on electricity in equipment that will give city personnel the laboratory and office equipment and supplies necessary for them to do their day-to- day work. Two, partner with a problem-solver who can make what are now unaffordable engineering fixes into affordable wastewater treatment solutions. First, however, Cowan's actual electrical costs need to be better understood. Only time will allow this to happen.



TDEC's Karina Bynum and City of Cowan's Mayor, Joyce Brown discuss the TNPOP program and the infrastructure needs of the plant and collection system.

Recommended lab and office supplies

- Laptop computer, printer, and docking station including keyboard, monitor, and speakers
- Cell phone for 24/7 emergency contact and response
- Internet and cell phone service
- Spectrophotometer, pipettes and vials for testing phosphate, ammonia, and nitrate
- Portable dissolved oxygen (DO) and oxygen reduction potential (ORP) meters and probes
- Test strips for testing ammonia, nitrite/nitrate and alkalinity

A conventional engineering and funding approach to fixing broken equipment and otherwise making the Cowan wastewater treatment facility function effectively has proven unaffordable. In lieu of chasing funds to finance what is estimated to be a two-million-dollar facility upgrade, Cowan needs to identify and implement a far less costly solution. This can only be done by working with a creative problem-solving team to develop affordable non-traditional solutions to the needs listed below.

Immediate and long-term needs

- Eliminate spillage from the influent screen while improving influent screening
- Rehabilitate/modernize oxidation ditch rotor motors and drives
- Repair oxidation ditch effluent weir
- Balance flow through the oxidation ditch effluent / clarifier influent splitter box
- Modernize equipment electronics and controls, including SCADA
- Develop an effective, affordable sludge handling strategy
- Lab/Office Roof Repairs

As one example of the creative thinking necessary to provide Cowan with practical, cost-effective solutions, consider sludge handling. The conventional approach is to install thickening and dewatering equipment. The equipment is expensive and operating it is labor intensive. An alternative is to contract with a neighboring municipality to process Cowan's sludge. Should such an arrangement be made, Cowan could hire a private septic tank pumper to truck the material off-site. At best, Cowan's facilities can be modified at little expense to accommodate this strategy. At worst, new thickening (but not dewatering) equipment will be required.

Facilities Description

The Cowan wastewater treatment facility (permit number TN0021644) serves 742 customers. There are 17.55 miles of sewer collection lines including 750 manholes. The wastewater treatment facility is located at 300 Looney Street, Cowan, TN.

The treatment facility's design flow is 0.4 MGD (million gallons per day). On most days, Cowan's wastewater flow is less than 200,000 gallons per day and, at times, less than 100,000 GPD. However, because the facility periodically processes flows of 1.0 MGD or more, the last 3 years average daily flow is 0.36 MGD. Flow surges due to infiltration and inflow (I&I) is an issue. Based on 2019 annual average daily flow of 0.305 MGD and 7-day Average Daily Dry Weather Flow of 0.07 MGD, the average daily influent I/I flow is 77%. This data was generated from the Tennessee Division of Water Resources SRF Infrastructure Scorecard, Wastewater I/I assessment tool.

Cowan wastewater treatment facilities brief description.

After passing through an influent flow meter, wastewater is pumped to an elevated stationary screening device by the plant's influent lift station. After screening, influent flows into a Lakeside carousel oxidation ditch with two horizontal shaft rotors. Bacteria rich wastewater leaving the ditch passes over an adjustable weir to a splitter box that diverts flow to the two secondary clarifiers. Flow exiting the clarifiers passes through a tertiary clarifier. A chlorine bleach solution is added to the wastewater flow as it enters the tertiary clarifier such that the tertiary clarifier is used as a chlorine contact chamber for disinfection. From the tertiary clarifier the treated wastewater passes through a post-aeration tank prior to discharge to Boiling Fork Creek.

The sludge that settles in the secondary clarifiers is pumped back into the oxidation ditch as return activated sludge (RAS). Waste sludge is pumped to an aerobic digester. The digester is routinely decanted by turning off the air, allowing the solids to settle, and gravity flowing the supernate to the influent lift station. Digested sludge is periodically dewatered using the facilities wedge wire drying beds. A polymer is added to sludge withdrawn from the digester and piped to one of two active drying beds. Dewatered sludge is removed from the drying beds by skid loader and transported to the community landfill by dump truck.

Notwithstanding the fact that the treatment facility has historically performed well as measured by BOD, TSS, and ammonia, several deficiencies plague operations and inhibit plant staff from optimizing treatment performance. These deficiencies are discussed below.

Influent screen. The stationary influent screen routinely plugs. To contain the overflow, a diversion chute was fabricated and installed such that the overflow is directed back to the influent lift station. At best, this is a temporary fix – one that needs to be resolved. At worst, the "fix" does little more than create an endless repumping of influent.

Aged electrical equipment. The oxidation ditch motors and drives are not energy efficient. Their replacement will provide energy savings and more reliable operations.

Aged mechanical equipment. The oxidation ditch effluent weir – once adjustable – is frozen in place. Unevenly. As a result, the majority of the flow exiting the oxidation ditch is diverted to one of the two parallel secondary clarifiers while the other clarifier receives little flow. The weir needs to be aligned so that the splitter box can be properly operated to equally divert flow.

Limited instrumentation/process control equipment. The facility's laboratory is poorly equipped: no spectrophotometer, no portable ORP. There is no computer, no Internet service, and no municipally provided cell phone. There are no in-line instruments, no SCADA (supervisory control and data acquisition) system. There should be.

Inadequate solids handling. The wedge wire drying beds routinely plug, as wedge wire drying beds are prone to do. With limited sludge dewatering capability, the aerobic digester becomes full and staff is unable to waste sludge from the oxidation ditch. This results in unacceptably high mixed liquor suspended solids (MLSS) concentration of 5000 to 6000 mg/L; a MLSS concentration of 2500-3000 mg/L is preferable. A better method of sludge handling is needed: thickening, dewatering, and disposal.

Aging infrastructure. The lab/office roof leaks. The re-aeration chamber is covered with a tarp to minimize algal growth. Permanent repairs to both are called for.

Wastewater Treatment Plant characteristics

Single Lakeside Oxidation Ditch with a design capacity of 0.4 MGD.
The Oxidation Ditch has a volume of 470,000 gallons
The Oxidation Ditch is equipped with two 25 hp motors, fixed-speed drives, and horizontal shaft aerators
Each of the two Secondary Clarifiers has a volume of 53,000 gallons
The Tertiary Polishing Clarifier has a volume of 72,000 gallons
Average Year-round Influent flow: 0.36 MGD (Based on 3 years data)
Average Year-round Influent Ammonia (NH_3): 20 mg/L, 60 lbs/day
Average Year-round Effluent Ammonia (NH_3): 0.05 mg/L, 0.18 lbs/day, TKN 0.13 mg/l
Average Year-round Influent BOD: 126 mg/L, 378 lbs/day
Average Year-round Effluent BOD: 2.2 mg/L, 6.42 lbs/day
Effluent pH; 6.80 s.u.
Influent Alkalinity: 150+ mg/L
Effluent Alkalinity: 80+ mg/L

Operating Process Control Parameters:
Average MLSS (mixed liquor suspended solids): 5000 mg/L
Average MLVSS (mixed liquor volatile suspended solids): 4000 mg/L

Optimization Approach

***Grant Weaver of CleanWaterOps and TDEC's Karina Bynum during the initial visit observations*.**

TAUD assembled a team of experts to evaluate Cowan's wastewater treatment plant facilities and recommend changes in day-to-day operations to optimize nitrogen and phosphorus treatment. The team included TAUD's wastewater expert Dewayne Culpepper, TAUD's energy conservation specialist Michael Keeton, and wastewater optimization expert Grant Weaver of CleanWaterOps. The team had the full support of Cowan Mayor/Utilities Board Chair Joyce Brown, Cowan Utility Manager Kenny Henshaw, Cowan Chief Operator Nic Willis, and TDEC's Karina Bynum.

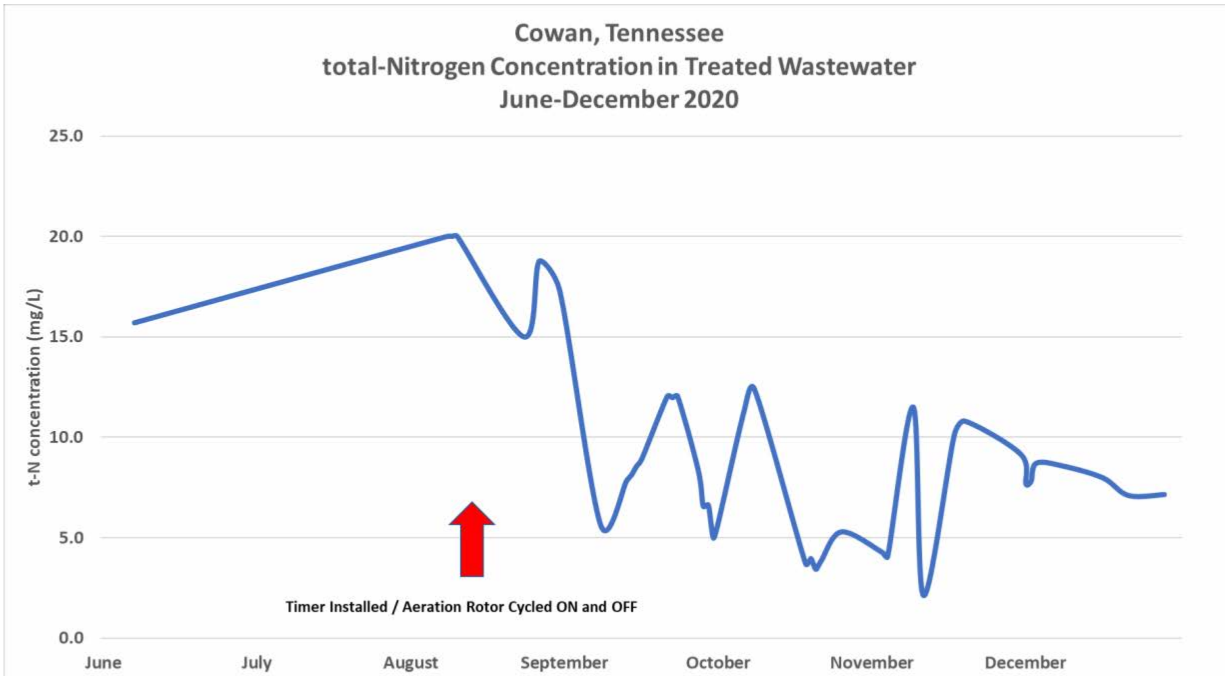
In advance of a June 25, 2020 Cowan site visit involving the entire team, TAUD's Dewayne Culpepper made five plant visits (4/14/20, 5/7/20, 5/27/20, 6/2/20 and 6/10/20), compiled historical data on the Cowan treatment facility, collected additional samples, trained Cowan staff on TDEC's data entry system, assembled an extensive assortment of laboratory testing equipment and supplies, calibrated lab testing equipment, and delivered, set-up, and trained Cowan staff in the use of the lab equipment.

Sampling protocols and an optimization strategy were developed during the June 25 site visit and refined during the subsequent months. The fact that city staff historically operated the plant well – effluent BOD and TSS averaging less than 5 mg/L and effluent ammonia-nitrogen averaging less than 0.1 mg/L – the team was able to focus immediately on optimizing nitrogen removal with work on phosphorus removal to be initiated after nitrogen removal was becoming optimized. The team's optimization strategies are discussed below.

Nitrogen Removal

Optimizing nitrogen removal required maintaining the excellent ammonia-nitrogen conversion to nitrate-nitrogen while boosting nitrate-nitrogen conversion to nitrogen gas by strengthening anoxic (oxygen-poor) conditions. The first step in this journey was one of changing rotor use. Instead of routinely operating the aeration rotor immediately downstream of the influent channel, the team suggested turning that rotor off and instead operating the rotor at the opposite side of the ditch. The thinking being better nitrate removal would result from the introduction of organic-rich raw wastewater into a low oxygen zone. Given the short horizontal distance between where influent enters the oxidation ditch and where effluent from the ditch exits, there was a concern that short-circuiting might occur. This concern was resolved by collecting a sample of wastewater exiting the ditch after both rotors had been off for three hours, letting the sample settle, and testing the supernate for BOD. The sample showed very little BOD, documenting an absence of short-circuiting.

The plan, therefore, was to create aerobic conditions by operating one rotor long enough to complete the conversion of ammonia-nitrogen to nitrate-nitrogen followed by long enough, strong enough, anoxic conditions to support the conversion nitrate-nitrogen to nitrogen gas. A graph illustrating the results follows.



First, however, the team wanted to confirm that the ammonia-nitrogen concentration would not unacceptably spike during air-off cycles. To test this, samples of wastewater exiting the oxidation ditch were collected every thirty minutes for a period of three hours after both rotors were turned off. Ammonia did not rise unacceptably, and the trials began in earnest.

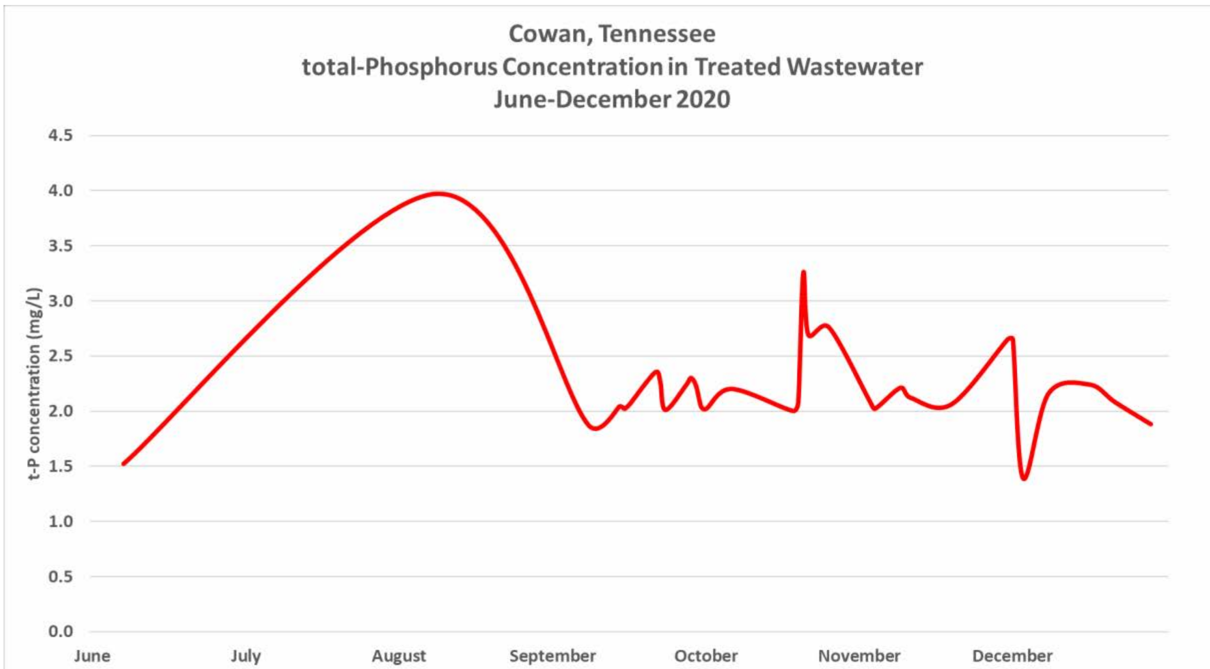
The city simplified the trials for the team by purchasing and installing timers on both aeration rotors. Without the timers, it would have been necessary to manually turn on and turn off the rotors, making night and weekend operations very difficult.

With timers installed, the rotor immediately downstream of the influent channel remained off for 22 hours a day, coming on only twice per day for a period of one hour to resuspend any material that may have settled to the bottom of the tank in the vicinity of the aeration rotor. The far rotor was programmed to operate ON for 2 hours and OFF for one hour with the twice per day operation of the near rotor timed so both rotors would run during the twice per day one hour resuspension cycles. In short order, the timing of the far rotor was changed to 3 hours ON and 2 hours OFF. Then, to 3½ hours ON and 2½ hours OFF. Frequent ammonia and nitrate samples were collected to confirm conditions. Before optimization, the total-nitrogen concentration averaged over 23 mg/L and a pounds per day discharge of 26.4. By study's end, effluent total-nitrogen was averaging less than 8 mg/L (8.4 pounds per day), a 67% improvement.

Phosphorus Removal

With nitrogen removal dialed in, the team began developing options for optimizing biological phosphorus removal. Two strategies were considered: (i) operating the aerobic digester as a side-stream fermenter and (ii) driving the bottom of the oxidation ditch sufficiently anaerobic to serve as a mainstream fermenter. As these options were being discussed, a troubling finding emerged: low pH. Fortunately, the pH meter that was showing a low effluent pH was found to be defective and the oxidation ditch pH was confirmed to consistently be above a pH of 6.8, the lower limit necessary for sustaining biological phosphorus removal.

A graph showing phosphorus concentrations throughout the study follow.



On 10/26/20, ORP was measured in two depths at seven locations around the ditch. Measurements were taken 2-feet below the surface and 1-foot above the bottom of the ditch. Testing was performed while the one operational rotor was on. As expected, the ORP readings downstream of the rotor (+225/+250) were measurably higher than the readings distant from the rotor (+110/+130). Even greater variations in ORP readings were observed surface to bottom, a difference of as much as 300 mV from +225/+240/+250 at the surface and -150/-154/-150 at the bottom of the ditch. These readings indicate that the right conditions exist to support mainstream biological phosphorus removal: aerobic enough at the surface to support phosphorus uptake while sufficiently septic at the bottom of the ditch to support volatile fatty acid (VFA) production and uptake by the bacteria that provide biological phosphorus removal.

Phosphorus removing bacteria can take time to populate a wastewater facility. Perhaps because too little time passed before study end, “before” and “after” phosphorus testing failed to document improvements in phosphorus removal. Prior to the study, the effluent total-phosphorus concentration was typically 2.7 mg/L, 2.9 pounds per day. At study’s end, it was averaging 2.2 mg/L, 2.4 pounds per day.

Particularly during warm weather, soluble phosphorus can be removed from the wastewater only to be released back into solution in overly large clarifiers. If not for the tremendous fluctuations in flow experienced by Cowan, it would be advisable to utilize only one of the two secondary clarifiers to minimize the phosphorus release. However, given that the flow can increase by ten- fold following a heavy rain, it is not practical to consider this operational strategy until I&I is controlled.

Energy Savings

As discussed in the Electrical Energy Evaluation (Appendix 2), electrical usage appears directly related to flow. The long-term trend on both is slowly downward until August 2020 and energy usage has stabilized beginning in December 2020. This may be related to influent pumps that are out of service during this time. Electrical demand was fairly constant throughout the study.

Unfortunately, during the time of September 2020 to April 2021, energy efficiency worsened form 1500 kWh/MG to 1800kWh/MG. This probably relates to the fact that most energy usage is fixed no matter what the flow is, and it is the nature of the calculations during high flow that show high efficiency. After a longer time of tracking usage, this should change.

The city should consider a “soft start” type of motor controller. Starting and stopping old equipment repeatedly will accelerate failure.

Influent screening overflows during high flow contributes to double pumping of influent sewage costing more money and wear and tear on pumps.

As with most old gravity sewer systems, Cowan has an inflow and infiltration problem. Pumping and treating inflow and infiltration of groundwater and stormwater wastes energy, money and shortens the life of the plant. The city is encouraged to begin an in-house inflow and infiltration location and repair program. Often this type of work easily locates large and easily repaired leaks.

Investigate the low power factor. Check all three phase motors for voltage and current balance. The age of the big motors could also be a factor. Consider upgrading to premium efficiency motors and soft starts for the ditch rotors. Somewhere within the facility wiring there is a step- down transformer that because of age, may contribute to the low power factor. Duck River Electric Coop may have access to TVA’s Comprehensive Services. A full plant evaluation can be done through this program and generally there is no charge.

Lighting can contribute to low power factors. Any lights with transformers such as fluorescent, or “high bay” lights have these. There are easy conversions to LED available for most fluorescent lights.

Data

Little historical nutrient data exist. Commercial laboratory testing is expensive. Therefore, TAUD (Tennessee Association of Utility Districts) purchased all required HACH TNT reagents, Tensette pipets and HACH IntelliCAL Rugged DO and ORP probes. TAUD staff borrowed the rest of the required equipment from TDEC (Tennessee Department of Environment and Conservation) TNPOP equipment loan program to perform in-house testing. A "before" assessment was made to quantify the nitrogen and phosphorus concentrations before optimization. Throughout the study, wastewater samples were collected and testing was performed in-house for process control purposes. These data have been compiled and are attached as an Appendix to this report.

Commercial laboratory testing differs from the in-house testing as described below. Commercial laboratory testing for total-nitrogen is the sum of TKN (total Kjeldahl Nitrogen) and Nitrite/Nitrate testing performing using EPA approved testing protocols. The in-house nitrogen testing reported in the Appendix was done using an EPA approved Hach spectrophotometer and EPA approved Hach TNT test vials. In-house testing was for nitrate-nitrogen only, making the results some 1-3 mg/L lower than laboratory testing. The in-house testing of phosphorus was for orthophosphate, not total phosphorus as was the commercial lab testing. Given Cowan's low effluent TSS (total suspended solids), the difference in the commercial lab EPA approved testing of total-phosphorus and the in-house EPA approved testing of orthophosphate was likely less than 0.1 or 0.2 mg/L, insignificant to the results.

Appendices

The following information is provided as Appendices to this report: water quality data, discharge permit data, electrical energy evaluation, and progress reports.

Appendix 1: Water Quality Data

The following Data was compiled from Cowan’s 2016 -2020 Monthly Operation Reports. All information from the Cowan MOR’s was transferred to Tennessee Water Resources Bulk EMOR system to generate the reports for this report.

Cowan, Tennessee

Date	Flow		Nitrogen					Phosphorus				
	Influent	Effluent	Influent		Effluent		Percent	Influent		Effluent		Percent
	MGD	MGD	mg/L	lb/day	mg/L	lb/day	Removal	mg/L	lb/day	mg/L	lb/day	Removal
2/10/2015	0.17	0.18			7.2	10.8				1.0	1.5	
5/11/2015	0.08	0.12			96.0	96.1				1.2	1.2	
8/5/2015	0.07	0.11			23.0	21.1				3.1	2.8	
12/8/2015	0.56	0.56			6.5	30.2				0.8	3.9	
2/10/2016	0.27	0.28			8.9	20.8				0.7	1.7	
5/11/2016	0.13	0.15			26.5	33.2				1.9	2.4	
June 2016					14.1					1.9		
8/10/2016	0.07	0.09			31.8	23.9				3.4	2.5	
11/8/2016	0.08	0.08			35.8	23.9				2.9	2.0	
2/7/2017	0.17	0.17			19.3	27.4				1.9	2.7	
6/10/2020	0.20	0.20	25.9	43.2	15.7	26.2	39%	4.5	7.5	1.5	2.5	66%
8/10/2020	0.08	0.10			20.0	16.7				4.0	3.3	
8/11/2020	0.07	0.09			20.0	15.0						
8/12/2020	0.07	0.09			20.0	15.0						
8/25/2020	0.08	0.14			15.0	17.5						
8/28/2020	0.09	0.12			18.8	18.8						
9/1/2020	0.15	0.18			17.3	26.0						
9/9/2020	0.08	0.10			5.6	4.7				1.9	1.6	
9/14/2020	0.14	0.14			7.8	9.1						
9/15/2020	0.08	0.09			8.1	6.1				2.0	1.5	
9/16/2020	0.09	0.09			8.6	6.4				2.0	1.5	
9/17/2020	0.09	0.11			8.9	8.2				2.1	1.9	
9/22/2020	0.08	0.08			12.0	8.0				2.4	1.6	
9/23/2020	0.17	0.13			12.0	13.0				2.3	2.5	
9/24/2020	0.10	0.13			12.0	13.1				2.0	2.2	
9/28/2020	0.10	0.11			8.4	7.7				2.2	2.0	
9/29/2020	0.13	0.16			6.6	8.8				2.3	3.1	
9/30/2020	0.14	0.15			6.6	8.3				2.2	2.8	
10/1/2020	0.10	0.12			5.0	5.0				2.0	2.0	
10/2/2020	0.09	0.12			5.8	5.8				2.0	2.0	
10/7/2020	0.18	0.14			11.3	13.2				2.2	2.6	
10/9/2020	0.09	0.10			12.4	10.3						
10/19/2020	0.09	0.10			3.7	3.1				2.0	1.7	
10/20/2020	0.10	0.12			4.0	4.0				2.1	2.1	
10/21/2020	0.10	0.12			3.4	3.4				3.3	3.3	
10/22/2020	0.11	0.11			3.8	3.5				2.7	2.5	
10/26/2020	0.12	0.12			5.3	5.3				2.8	2.8	
11/3/2020	0.16	0.14			4.3	5.0				2.1	2.4	
11/4/2020	0.14	0.12			4.1	4.1				2.0	2.0	
11/9/2020	0.13	0.12			11.5	11.5				2.2	2.2	
11/11/2020	0.11	0.11			2.1	1.9				2.1	1.9	
11/17/2020	0.11	0.11			10.1	9.3						
11/19/2020	0.10	0.10			10.8	9.0				2.1	1.7	
11/30/2020	0.17	0.16			9.2	12.2				2.7	3.5	
12/1/2020	0.19	0.16			7.7	10.2				2.7	3.5	
12/2/2020	0.16	0.16			7.8	10.4						
12/3/2020	0.15	0.15			8.7	10.9				1.4	1.7	
12/8/2020	0.17	0.16			8.6	11.4				2.2	2.9	
12/16/2020	0.29	0.29			8.0	19.3				2.2	5.4	
12/21/2020	0.19	0.17			7.1	10.1				2.1	2.9	
12/28/2020	0.26	0.22			7.2	13.1				1.9	3.4	

Appendix 2: Discharge Permit

Tennessee Water Resources Permit information site:

https://dataviewers.tdec.tn.gov/pls/enf_reports/f?p=9034:34051::::34051:P34051_PERMIT_NUMBER:TN0021644

Appendix 3: Electrical Energy Evaluation

City of Cowan June 2021
Wastewater Treatment Plant
2021 Electrical Energy Evaluation

Brett Ward, Utility Operations Consultant
UT- Municipal Technical Advisory Service

The City of Cowan, Tennessee operates a 0.4 MGD secondary treatment plant which discharges treated effluent to Boiling Fork Creek. Electric usage and plant operating data were provided for the time period January 2019 to April 2021.

The Cowan plant consists of influent flow measurement, influent pumping, static influent screening, a two-rotor oxidation ditch, two final clarifiers, chlorine contact chamber, and post aeration with flow measurement. Additionally, there are return/waste activated pumps and an aerobic digester with wedge wire drying beds. The plant operates in substantial compliance but does, as do most all Tennessee plants, struggle with high flow during times of rainfall.

Energy Usage Evaluation

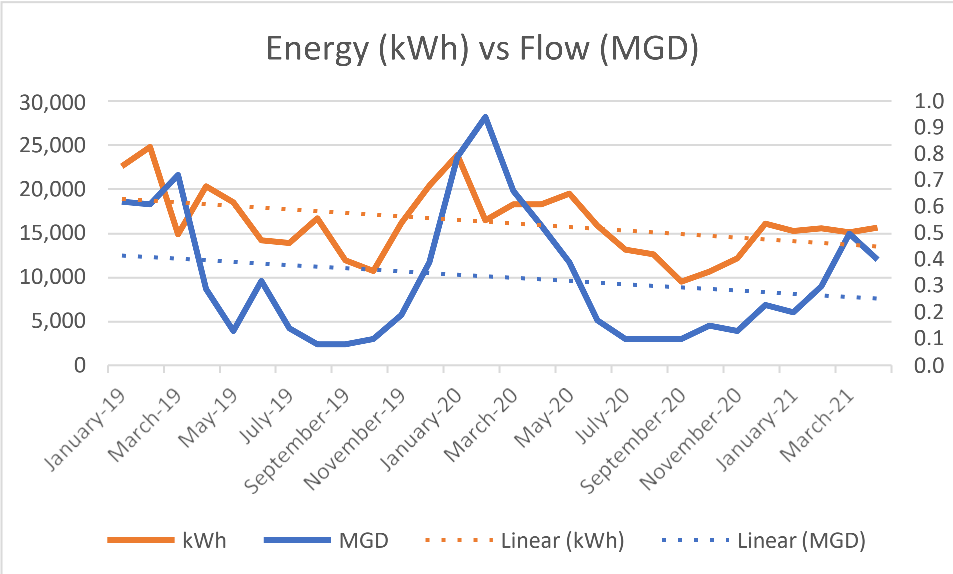
The traditional plant operations were generally energy efficient. Energy usage per million gallons of sewage treated for the initial time of January 2019 through August of 2020 was 1504 kWh/MG. This is in the lower end of sixteen plants previously evaluated during the EPA-TDEC-MTAS-UM Energy Initiative. Of those plants evaluated, the lowest value was 1079 kWh/MG and the second most efficient plant used 1502 kWh/MG. The highest value was 5619 kWh/MG. The Cowan plant starts this program with a good record. During this initial time, January 2019 to August 2020, plant effluent ammonia averaged very low, generally less than 0.1 mg/L and effluent nitrate was 17 mg/L but there were only two nitrate test values.

Beginning August 2020, personnel from the Tennessee Association of Utility Districts began working with the Cowan plant staff. Oxidation ditch rotors had timers installed and an off/on operation strategy was begun. On June 14, 2021, this cycle was 3.5 hours "ON" and 2.5 hours "OFF" for one rotor. The other rotor is operated for one hour at 12:00 am and pm. The impact of this off/on strategy on effluent quality has been substantial. Effluent nitrate is down to an average of 5.89 mg/L, but this has been a steady, stair-step decline to a level of 0.43 mg/L in June 2021. It must be noted that effluent ammonia has increased during this time, but only to an average of 0.35 mg/L.

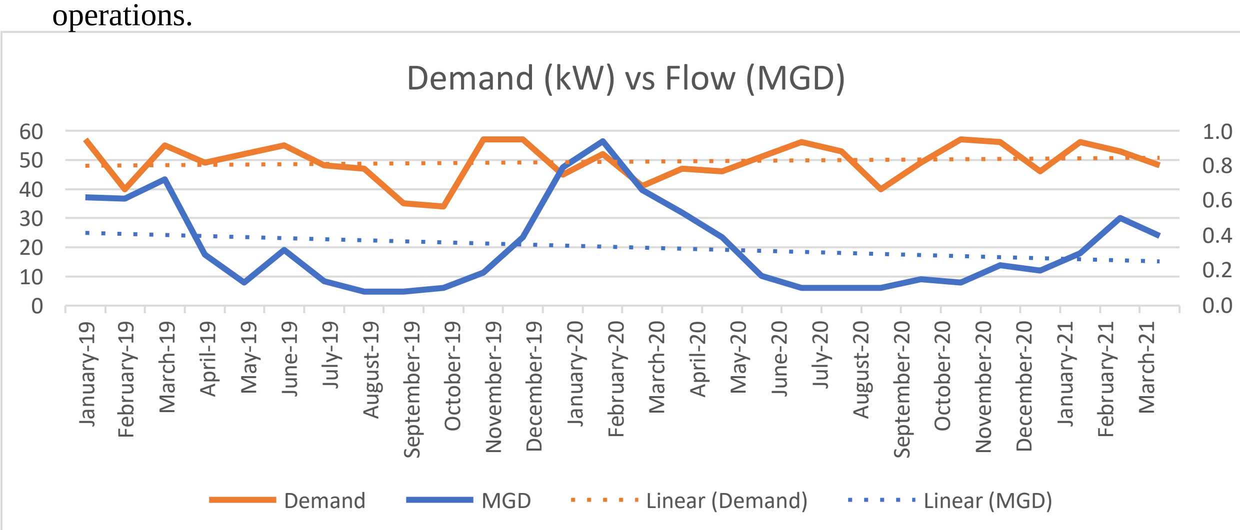
Digester operations are already quite efficient. The aerobic digester is aerated about 6 hours per day. Because the sludge is ultimately disposed of by landfilling, only a minimum of air is needed for odor control. The current sludge disposal method is by landfilling after drying and storage on the drying beds. This is a very energy efficient method but very labor intensive.

It would generally appear that energy usage is directly related to flow. The long-term trend on both is slowly downward until August 2020 and energy usage has stabilized beginning in December 2020. This may be related to influent pumps that are out of service during this time. Unfortunately, during the time of September 2020 to April 2021 energy efficiency got worse. Energy usage increased to 1800 kWh/MG. This probably relates to the fact that most energy usage is fixed no matter what the flow is, and it is the nature of the calculations during high flow that show high efficiency. After a longer time of tracking usage, this should change.

See the graph below, Energy vs Flow. The gaps between the lines represent times of poor efficiency where energy usage does not fall to the extent that flow does. Months where the graphs touch or cross represent very efficient months.



Commercial electric meters also track energy demand. Though increasing very gradually the Cowan plant has a very stable demand over the entire time. This indicates constant plant operations.



Another factor of commercial electric meters is the calculation of power factor. Within the TVA power system, a user will be assessed penalties if the power factor drops below 85%. The Cowan power factor is 70% but average penalties are only about $130 per month. These costs are buried within the demand charges, so they are not easily located. The Duck River Electric Coop may assist Cowan with correcting this condition.

Performance Summary

Before August 2020

1504 kWh/MG
1.5 kWh/ lbs BOD
removed Effluent NO_3 ~
17 mg/L Effluent NH_3 ~
0.01 mg/L

After August 2020

1797 kWh/MG
1.86 kWh/ lbs BOD
removed Effluent NO_3
~ 5.9 mg/L Effluent
NH_3 ~ 0.4 mg/L

Summary

There is simply not enough operating data spanning the normal variation of flow and loading at this plant to make good conclusions about the operational changes that have been made. Energy usage is down as is total energy cost over the entire 27 months of data provided but energy efficiency had gotten worse. The effluent total nitrogen values are down and are without reservation a result of the off/on aeration. Conclusions about energy usage are more problematic.

Recommendation

- Continue to operate the oxidation ditch rotors in the off/on mode but monitor this process closely especially in the upcoming summer weather. If ammonia increases, more aeration time will be needed. This off/on operational strategy is used widely across the state especially with oxidation ditches. Ditches generally always fully nitrify and forcing them to denitrify, the purpose of the off cycle, had several benefits. This saves energy, reduces nitrate and lowers total nitrogen discharges to streams, selects against filamentous bacteria, produces slightly less sludge to waste, and can prevent pH drops. But there is a down-side. Starting and stopping old equipment repeatedly will accelerate failure. The city should consider a "soft start" type of motor controller.

- Continue the minimal aeration time in the aerobic digester.

- The influent screening facility is deplorable. It was poorly designed, cannot be properly operated, is extraordinarily and unavoidably dirty, and at times of high flow contributes to double pumping of influent sewage. This unit should be replaced with a "very fine" drum screen of adequate capacity.

- As with most old gravity sewer systems, Cowan has an inflow and infiltration problem. Pumping and treating groundwater and stormwater wastes energy, money and shortens the life of the plant. The City is encouraged to begin an in-house inflow and infiltration location and repair program. Often this type of work easily locates large and easily repaired leaks.

- Investigate the low power factor. Check all three phase motors for voltage and current balance. The age of the big motors could also be a factor. Consider upgrading to premium efficiency motors and soft starts for the ditch rotors. Somewhere within the facility wiring there is a step- down transformer that because of age, may contribute to the low power factor. Duck River Electric Coop may have access to TVA's Comprehensive Services. A full plant evaluation can be done through this program and generally there is no charge.

- Lighting can contribute to low power factors. Any lights with transformers such as fluorescent, or "high bay" lights have these. There are easy conversions to LED available for most fluorescent lights.

Appendix 4: Progress Reports

The following information is a day-to-day activity report to document progress of the TNPOP program efforts.

Cowan Board of Public Utilities TNPOP Program Progress Report Summary

The City of Cowan's Mayor, Mrs. Joyce Brown, Board & Alderman and Wastewater Treatment Plant Chief Operator, Nic Willis, are fully engaged in optimizing the Cowan treatment plant for both, nutrient removal and energy. Mr. Willis is applying the knowledge gained from the TNPOP Professional Training Materials, Grant Weaver with CleanWaterOps and TAUD staff.

After the first on-site visit on April 14, 2020, all historical data was completed on new e-MOR, Energy assessment completed, laboratory analysis equipment and regents were provided, and training completed for analysis on several optimization parameters. This was accomplished with a total of 4 on-site visits.

On June 25th, the official TNPOP Cowan Optimization initial visit was conducted on-site with Grant Weaver, Karina Bynum, Cowan Mayor Joyce Brown, and Operator, Nic Willis. During the meeting, all involved evaluated the TNPOP program, and the evaluation of process to develop optimization plan.

Since June 25th, there has been constant communication with all parties involved and numerous onsite visits. The Cowan Board of Utilities invested in electronic timers and installed them to control the aeration rotors saving energy and lowering the Total Nitrogen (TN). Both rotors only run a total 14 hours per day which has reduced the energy usage. A Plan of action was implemented to run the process to lower Nitrates, TN and TP. Nitrates have been reduced from >20.0 mg/L down to < 4.0 mg/L, TN has been reduced from >20 to < 4.0 and Total Phosphorus (TP) has been reduced from 4.0 to <1.50.

A SRF score card has been completed on 10/26/2020. A system needs item list has been developed on 11/17/2020.

A virtual meeting was held on 01/04/2021, to discuss the TNPOP program optimization results and the aging wastewater plant critical infrastructure needs with Cowan officials, Consulting engineer, Grant Weaver, State Officials and TAUD. During the meeting, the TNPOP optimization program results for nutrient reduction & energy savings were reviewed as well as future infrastructure upgrade needs, and different funding avenues were discussed.

On June 14, 2021, – Bret Ward (MTAS), Micheal Keeton, Nic Willis and I met on-site and reviewed the plant biological process, electrical grid of the plant, pumps, motors, reviewed all electric usage data and current laboratory data. After reviewing the data, it was determined that the plant is performing wonderfully, and more efficient solids disposal handling equipment is needed and would enhance the optimization of Total Phosphorus removal to meet our goals. During the first quarter of 2021, three effluent scans of TP and TN were analyzed by a contract lab with reported results for an average TP of 1.46 mg/L and an average TN of 3.97 mg/L.

It was also noted to optimize energy consumption, the age of the big motors could be a factor. Consider upgrading to premium efficiency motors and soft starts for the ditch rotors. Somewhere within the facility wiring there is a step- down transformer that because of age, may contribute to the low power factor.

In conclusion, the TNPOP optimization program has shown nice improvements in nutrient reduction and energy usage (but offset by demand charges) promoting a more efficient operating plant and a wonderful, treated effluent for the environment to enjoy. Data supporting nutrient removal optimization improvements is documented and energy optimization data will need more time and information to draw a firm conclusions on the magnitude of the electrical savings, if any.

TNPOP Program Progress Report - Cowan Board of Public Utilities

Utility Information
Cowan Board of Public Utilities
Mayor: Ms. Joyce Brown
P.O. Box 338
301 E. Cumberland Street
Cowan TN 37318
(931) 967-7318
cowanwater@comcast.net

Utility Manager
Kenny Henshaw
(931) 967-1922
cowanwater@comcast.net

WWTP Operator Information:
Nic Willis - Chief Plant Operator - Grade III Certification
P.O. Box 338
301 E. Cumberland Street
Cowan TN 37318
931-308-8880 cell
nicwillis1985@yahoo.com

WWTP Plant Information
Cowan STP – Permit #TN0021644
742 Wastewater Customers.
17.55 miles of sewer collection lines.
750 Manholes
The City of Cowan is authorized to discharge treated municipal wastewater from Outfall 001 to the Boiling Fork Creek at mile 13.4. Discharge 001 consists of municipal wastewater from a treatment facility with a design capacity of 0.4 MGD. The Permit is attached that shows all permit required parameters, monitoring and limits.

Tennessee Water Resources Permit information site:

https://dataviewers.tdec.tn.gov/pls/enf_reports/f?p=9034:34051::::34051:P34051_PERMIT_NUMBER:TN0021644

The WWTP plant's physical location is:
300 Looney St.
Cowan TN 37318
35.157420, -86.020827

Wastewater Treatment Plant characteristics
Single Lakeside Oxidation Ditch with a design capacity of 0.4 MGD.
Ditch has two 25 hp rotary aerators and ditch is followed 2 clarifiers the followed by a polishing clarifier.
0xidation Ditch has a volume of 0.470 MG
Each Clarifier had a volume of 0.056 MG
Average Year-round Influent flow: 0.36 MGD (Based on 3 years data)
7-day average low flow is 0.07 MGD (BASE LINE FLOW)
2020 Annual Average Influent I/I flow is 0.235 MGD resulting in percent I/I of 77%
Average Year-round Influent Ammonia NH_3: 20 mg/L, 60 lbs/day - TKN ? mg/l (estimate) 40 mg/l
Average Year-round Effluent Ammonia NH_3: 0.05 mg/L, 0.18 lbs/day, TKN 0.13 mg/l
Average Year-round Influent BOD: 126 mg/L, 378 lbs/day
Average Year-round Effluent BOD: 2.2 mg/L, 6.42 lbs/day

Average 2019 -2020 winter wastewater parameters (November – April):
Average Influent Flow: 0.58 MGD ; Max flow: 1.65 MGD
Influent BOD: 118.0 mg/L; Effluent BOD: 2.3 mg/L
Influent TSS : 125 mg/L ; Effluent TSS : 3.2 mg/L
Influent pH ; NA s.u.; Effluent pH ; 6.80 s.u.
Effluent Ammonia: 0.07 mg/L

Average 2019 summer wastewater parameters (May – October):
Average Influent flow: 0.14MGD; Max flow: 1.22 MGD; Min flow: 0.06 MGD
Influent BOD: 133mg/L; Effluent BOD: 1.98 mg/L
Influent TSS : 144mg/L ; Effluent TSS : 3.06 mg/L
Influent pH ; NA s.u.; Effluent pH ; 6.83 s.u.

Operating Process Control Parameters:
Average MLSS: 5000 Average, MLVSS : 4000, Volatile Solids Content : 80%
Influent Alkalinity: >150, Effluent Alkalinity: >80

2020 Cowan TNPOP / TAUD Report of Activities Daily Log

April 13 - Contact Aerial Wessel-Fuss on Cowan Emor build

April 14 – Initial On-site visit to Cowan. Introducing the TNPOP program to Mayor and Operators. Gathering data for optimization and implementing new Emor and Training on Emor.

April 17 – TNPOP - Home Office- State contract TPOP COWAN transferring historical data (2015 - 2020) to bulk eMOR. Purchasing equipment for state contract and acquiring equipment from state for contract

April 20 - TNPOP - Home Office- State contract TPOP Cowa, transferring historical data (2015 - 2020) to bulk e MOR.

April 27 - State optimization contract TNPOP - Cowan data entry to Bulk EMOR System

May 7 – Travel to Cowan. State optimization contract TNPOP - On-site Training, Cowan data entry to Bulk EMOR System and submittal training.

May 18 - Home Office - Researching and gathering reagents, laboratory supplies and analytical test strips for TNPOP Wastewater analysis. - Watching TNPOP Program Training Modules.

May 19 – Contacted Grant Weaver. Building TNPOP Lab Reagent list with Grant Weaver for USA Blue Book order.

May 20 - Modified TNPOP REAGENT Order List. Sent to Brent. Reviewed method procedures for each reagent

May 22 - State Score Card Review, State Contract Meeting, Review of State lab equipment and reagent order to conduct testing. Reviewed testing methods.

May 27 - Travel to Cowan. On- site visit - State optimization contract TNPOP - Cowan , Training Modules and lab evaluation.

May 27 - Coordinating with TDEC on lab equipment pick up.

May 28 - Travel to Shelbyville to meet TDEC - Dewitt Logston to recieve TNPOP Laboratory Equipment

May 29 – Home Office - TNPOP - Coordinating agendas with Grant Weaver, Harriman, Cowan and Karina Bynum - TDEC for the month of June on- site visits

June 1 – Home Office - TNPOP equipment evaluation, and calibration. Reviewing TNPOP Training modules.

June 2 - Travel to Cowan - On-site visit for TNPOP LAB EQUIPMENT and Chemistries delivery, set up and training. Provided Continued EMOR Training

June 4 - Home Office - reviewing TNPOP Program, contract and Grant Weaver past TNPOP reports. Emailed Grant, Harriman and Cowan agendas for June on-site meetings. Booked Rooms

June 8 - State Optimization Contract - TNPOP update report sent to Karina and prep for TNPOP Visits to Cowan and Harriman

June 10 - Travel to Cowan's WWTP, On - site visit ,TNPOP, Lab equipment set up and training to use equipment.

June 22 - State Contract- TNPOP, Training Received from Training Modules, Emailed All TNPOP participants on upcoming on-site visits

June 25 - State contract TPOP Cowan On-site Initial Visit with Grant Weaver, Karina, Cowan Mayor and Management for evaluation of process and to develop optimization plan. (See Detailed Observations, Recommendations and Comments page for plan.)

June 26 - State Contract - TNPOP - Home Office- Developing a Progress Reporting system for Activities on TNPOP On-site visits for Cowan and Harriman.

June 29 – Received Grant Weaver's email concerning Initial on-site report of observations and initial recommendations for developing the process sampling and monitoring plan and nutrient optimization strategy.

July 1 – Conducted conference call with Grant Weaver, Michael Keeton and Dewayne Culpepper reviewing Grant Weavers initial on-site report. Drafting Harriman and Cowan profile. operating parameters, process monitoring and nutrient optimization plan. Also, Cowan's Nic Willis submitted data for Grant Weaver's request on sampling for ammonia and BOD exiting the ditch.

July 2 - Drafting Harriman and Cowan profile. operating parameters, process monitoring and nutrient optimization plan (continued)

July 6 – On-site visit to review and implement monitoring plan and nutrient optimization strategy.

July 24 – Called Nic to schedule on- site visit for July 27th. Also checked on status of installing timers. Timers on order and will be installed when received.

July 27 – On-site visit. TAUD purchased and delivered to Nic a 0.1 – 1.0 HACH Tennsetter for the TNT laboratory test. Reviewed Laboratory test results for Nitrite, Nitrate, Ph, Alkalinity and Ammonia (Nh3). Average results of each:
Influent Alkalinity (>150 mg/L), Effluent Alkalinity (80 mg/l), Effluent Nitrite (<0.3 mg/L), Effluent Nitrate (>23 mg/L), Influent PH (6.8 s.u.) and Effluent PH (6.7 s.u.). Emailed Grant with results.

August 7 – Called Nic to check on Timers to control aerators and Nic stated that they have the timer and waiting on electrician to do the installation.

August 17 – Nic called to confirm that the timers have been installed. We had a conference call with Grant and preceded with the game plan of one rotor operating 2 hours on and 1 hour off, with the second rotor operating 1 hour on every twelve hours (during the same time with the other rotor to move the blanket).

August 31 – Called Nic to check how the Nitrates were doing in the effluent of Ditch and Nitrates have decreased from 28 mg/L to 15 mg/L with Ammonia <0.2 mg/L. I called Grant with the update and he said to now run the one aerator 3 hours on and 2 hours off.

September 1 – Called Nic and told him the new plan to run the one aerator, 3 hours on and 2 hours off. Nic confirmed and said he would make the Change.

September 9 – On-site visit. After plant process ran for one-week, Nic performed analysis on ammonia as N, nitrites, nitrates, and orthophosphate on final effluent. The results looked great!
Ammonia as N = <0.03, Nitrite = <0.1, Nitrate = 5.9, Orthophosphate = 1.87 (down from 3.99). Had a conference call between Nic, Grant and Dewayne discussing results and Grant suggested new game plan of one rotor operating 3.5 hours on and 2.5 hours off, with the second rotor operating 1 hour on every twelve hours (during the same time with the other rotor to move the blanket). The intention of the new process control change is to see if the nitrate could be reduced even further. Nic agreed to adjust the timer to reflect the change.

September 25 – Called Nic and discussed plant process and laboratory analysis. TP and TN have inched up slightly due to High MLVSS and dewatering of digested sludge in digestor to make space to waste more biosolids to lower the MLVSS.

September 26- Called Grant to let him know the status of the plant operations and TP and TN. Grant agreed that high MLVSS and dewatering of sludge had an impact TN and TP removal rates and to keep the plant running as planned to see if the TP and TN removal improves.

October 26 – On site visit. Reviewed plant process and laboratory results for TP and TN. Called Grant Weaver and discussed data. Also, performed ORP analysis on plotted out sampling points around the Oxidation ditch. Emailed Grant and Nic the ORP results and discussed findings. Grant responded that ORP findings looked good.

October 28 – Karina Bynum requested EMOR'S from Cowan for the last 6 months and I sent them to her.

November 3 – Karina need TP AND TN results for the past 6 months.

November 4 – Nic sent a excel report with TP and TN results for the last 6 months

November 5 – Contacted Karina concerning reports and developing a Summary report.

November 6 – Submitted a progress report and summary report to Brent and Karina.

November 10 – TDEC SRF State Contract Virtual Meeting – Score card and TNPOP reports.

November 17 – Cowan virtual meeting discussing nutrient removal and Developed "Wish List" of Items and cost estimates.

December 1 – On-site visit. Reviewed laboratory data with Nic and reviewed process control of plant.

December 2 through 15 – updating Cowan bulk eMOR with new data for final reports, updating TNPOP progress reports. Researched data and contacted vendors on infrastructure replacement to generate report for wish list.

December 16 – Cowan virtual meeting with Grant, Karina, Nic to complete Cowan wastewater treatment plant infrastructure wish list. During the meeting, Karina planned to have a meeting set up with Mayor, Alton Heathcoat (Engineer), Lorie Fisher (grant writer), Grant Weaver, Nic Willis, Kenny Henshaw to discuss results of plant optimization and what funding might be pursued.

2021 Cowan TNPOP/TAUD Report of Activities to Date Daily Log

January 4 – Virtual Meeting with Cowan Mayor, Alton Heathcoat (Engineer), Lorie Fisher (grant writer), Grant Weaver, Nic Willis, Kenny Henshaw to discuss results of plant optimization and what funding might be pursued.

January 8 – Virtual meeting with Karina, Grant Weaver and Dewayne Culpepper to discuss funding meeting and TNPOP Program final reports and recommendations for Cowan.

January 11 – Updating bulk EMOR data to prepare submit to Grant Weaver for TNPOP final report. Updated progress reports.

January 22 – Virtual meeting with Karina, Grant Weaver, Micheal Keeton and Dewayne Culpepper to discuss TNPOP Program final reports for energy optimization.

February 26 - Virtual meeting with Karina, Grant Weaver, Micheal Keeton and Dewayne Culpepper to discuss TNPOP Program final reports for energy optimization.

March 12 - Virtual meeting with Karina, Grant Weaver, Micheal Keeton and Dewayne Culpepper to discuss TNPOP Program final reports for energy optimization.

March 26 - Virtual meeting with Karina, Grant Weaver, Micheal Keeton and Dewayne Culpepper to discuss TNPOP Program final reports for energy optimization.

April 23 - Virtual meeting with Karina, Grant Weaver, Micheal Keeton, Brent Ogles and Dewayne Culpepper to discuss TNPOP Program final reports for energy optimization.

May 17- Emailed Brett Ward on setting up meeting at Cowan WWTP to discuss TNPOP energy optimization and on-site tour of the plant. Date would be set once electric data from Duck River Electric was received,

June 3 – Micheal Keeton notified me that he has all data from the electric utility and Bret Ward has confirmed to meet us on-site at the Cowan WWTP June 14, 2021. Called Nic to let him know and he plans to be there.

June 14 – Bret Ward, Micheal, Nic and I met on-site and reviewed the plant biological process and electrical grid of the plant, pumps and motors, reviewed all electric usage data and current laboratory data. In house TNT nitrate test was performed with a result of 0.43 mg/L. Also. during the permit renewal process there were 3 scans on effluent parameters:

Date	TP	TN
4/20/21 -	1.42	4.85
4/21/21 -	1.28	4.83
4/27/21 -	1.67	2.24

Detailed Observations, Recommendations and Comments from Email Correspondences

Cowan Initial Visit 06/25/2020 – Grant Weaver's Report

Dewayne & Mike (w/copy to Brent & Karina),

As we discussed while at the Cowan wwtp, our first objective is to dial-in total nitrogen removal.
After this is accomplished, we can work on phosphorus removal.

A first draft discussion of our "plan" follows.
Dewayne, when you return from vacation, I'd enjoy discussing with you.
And, editing it to fix my mistakes and include Mike and your recommendations.

We calculated that the oxidation ditch provides a hydraulic retention time of approximately five days.
(Cowan's flow averages 80,000 GPD, the ditch has a capacity of approximately 400,000 gallons.)
For nitrogen removal, we agreed on a strategy that replicates how the Harriman staff is operating their oxidation ditch.
Harriman's ditch is routinely producing an effluent with a total-N of 2-4 mg/L.

The concept for Cowan being … cycle aeration rotors on long enough for ammonia conversion to nitrate and off long enough for nitrate conversion to nitrogen gas.
As-is, Cowan produces an effluent that is very low in ammonia (generally non-detect) and TKN (the latest effluent TKN sample was non-detect).
Cowan's effluent is also low in TSS.

As-is, Cowan operates with one of two aerators running continuously: generally, rotor #1.
While at the plant, we recommended operated with rotor #2, not #1.
Our thinking being …
With rotor #1 off, the influent will enter the ditch into a low-oxygen zone and thereby enhance nitrate removal.
As-is, the influent enters an aerobic zone.
We did talk about periodically operating rotor #1 in lieu of, or in addition to, rotor #2 to resuspend any material that may settle near rotor #1 … for example, run rotor #1 once per day.

Our recommendations follow.

1. First, confirm that influent will not short-circuit to the secondary clarifiers when both rotors are off.
To determine if short-circuiting will happen:
   a. turn both aeration rotors off for three hours
   b. then, collect a grab sample of mixed liquor exiting the ditch / entering the secondary clarifier inlet distribution box
   c. allow MLSS to settle sufficiently to provide enough supernatant for BOD test
   d. perform BOD test

If the BOD is 10 mg/L or less, the influent is not short-circuiting and Cowan can operate with both rotors off without issue.

If the BOD is greater than 10 mg/L, repeat the test to confirm it is an issue.
If an issue, work on removing the baffle underneath rotor #1, the rotor nearest the influent channel
2. While the rotor is off for the BOD test described above, collect ammonia grab samples every 30 minutes and perform in-house testing.
Collect ammonia samples from the same location as the BOD sample.
Let the sample settle and pull of supernatant for ammonia testing.
Write down the results.

Provided that the influent is not short-circuiting to the secondary clarifiers …
The goal is to manipulate the rotor operations such that:
a. ammonia removal is maintained by having enough rotor-on time
b. nitrate removal is achieved by implementing enough rotor-off time
To do this, you and I will need to support Nick ____________ in making and monitoring the impact of the operational changes discussed below.

Operational changes
Begin by switching rotors so that rotor #2 is operational and #1 is idle.
Turn off the in-service rotor #2 for an hour in the morning and an hour in the afternoon.
Run rotor #2 all weekend.
Routinely – once per day (?) – run both rotors for an hour to resuspend debris.

When timers are installed, keep rotor #1 off and turn off rotor #2 for one hour every six hours.
Keep a daily log with the day's operational settings – that is write down when each rotor is on and off.

As long as the ammonia remains low, increase the off time by 30-minute intervals.
Once the nitrate concentration drops to less than 5 mg/L, pause.
Let's then review and evaluate… and, come up with a plan on how to proceed.

Testing/Monitoring
Daily collect an "effluent" grab sample – let's talk about what works best for "effluent" testing.
a. test for ammonia
b. test for nitrate
c. record the results on a calendar or log sheet

Short-term mechanical fixes
Install timers on both rotors with the capability to (at a minimum) adjust the on/off cycles of each in 15-minute increments.
Remove the rotor baffles, with priority given to rotor #1.

Mid to Long-term mechanical fixes (we should create a wish-list and prioritize it as the summer progresses … and, give a copy to Cowan as we gain more familiarity with the plant)
For now, the list includes …

Office computer and Internet access
Employer provided cell phone
Lab equipment
Pipettes
Pipette tips
Spectrophotometer

Portable DO and ORP probes
In-line instrumentation
Energy efficient changes
Soft-start equipment for rotors and ???
Modifications to / replacement of influent screen

Something we didn't discuss: install baffles/stops on the ditch outlet / secondary clarifier inlet distribution box.
Doing so will balance the flow rate to the two clarifiers and thereby minimize washout during high flows.
Dewayne, when you return from vacation, we can discuss over the phone.

Grant

Cowan follow up visit 07/07/2020 – Grant Weaver's Process Control Adjustments Report

***Grant was given an update on the initial visit process sampling plan 06/25/2020 and the following information was determined from the results of several parameter data points.

From: Dewayne Culpepper <DewayneCulpepper@taud.org>
Sent: Wednesday, July 1, 2020 2:25 PM
To: Grant Weaver <g.weaver@cleanwaterops.com>
Subject: Cowan Ammonia testing at Oxidation Ditch Effluent

Grant,
Nic Willis from Cowan sent this to me just about 1 hour ago. This is the little experiment on the Ditch effluent for Ammonia as N and BOD.

Hey just an FYI I tested Ammonia hourly during the 3 hour off
1hr = 0.329mg/l
2hr = 1.59 mg/l
3 hr = 4.02 mg/l but there was almost no sludge at the 3 hour mark

Ditch Effluent BOD < 3.0

Dewayne T. Culpepper
Tennessee Association of Utility Districts (TAUD) Senior Wastewater Specialist
Cell (931) 607- 6981
Office (615) 896-9022
E-mail: dewayneculpepper@taud.org
Web: taud.org

Dewayne,

I'm good with those numbers.
When that comes in, Nic can begin manually turning the air OFF for an hour in the AM and another hour in the PM.
After a week or so of that, OFF two hours in AM and PM.

Meanwhile, the City needs to get timers on the rotors.
But you know all of this…Grant

Cowan on-site visit 07/27/2020 – Laboratory Process Report Email to Grant.

Hi Grant,

I visited the Cowan WWTP today and reviewed the plant characteristics and the laboratory data that Nic has been performing for the past 3 weeks. First of all, the timers for the brush aerators are not installed due to a back order with USA Bluebook. Nic said that they should arrive this week and installed ASAP. The air off for two hours in the morning and afternoon has been done somewhat but not consistent from day to day due to Nic having to cover for employees that took vacation. Nic had to do double duty and run the utility while the superintendent was off. The aerators had no air on – air off during the weekend. So, until we get the timers installed there will be erratic lab results. I few things that I found out after reviewing Nic's lab results on the influent and effluent: Average results of each:

Influent Alkalinity (>150 mg/L), Effluent Alkalinity (80 mg/l), Effluent Ammonia (<0.1) Effluent Nitrite (<0.3 mg/L), Effluent Nitrate (>23 mg/L), Influent PH (6.8 s.u.) and Effluent PH (6.7 s.u.).

Also, Nic has not been able to waste from the digestor to the drying beds due to a valve that has broken. They are getting that repaired soon. The MLSS in the Ditch is 5000 – 6000 mg/l.

Another thing that was discovered during my visit was the Water Plants finished water PH is 6.65 when we tested it out of the faucet….they thought it was 7.1 – 7.2 and we think they have a bad ph probe at the water plant. If the water leaving the water plant was a 7.1 – 7.3 with the influent Alkalinity to the wastewater plat at 150, this would be better conditions for process control to remove Phosphorus… right?

Please give me a call when you can tomorrow to talk about Cowan. Also, I will be at Harriman tomorrow morning. Call anytime,

Thanks,

Dewayne T. Culpepper

Cowan Conference Call on 8/17/2020 – Rotor Timers Installed! Initial Start of Process Control Plan.

August 17 – Nic called to confirm that the timers have been installed. We had a conference call with Grant and preceded with the game plan of one rotor operating 2 hours on and 1 hour off, with the second rotor operating 1 hour on every twelve hours (during the same time with the other rotor to move the blanket).

Cowan Call on 9/01/2020 – Change of Process Control Plan.

Called Nic (08/31) to check how the Nitrates were doing in the effluent of Ditch. Nitrates have decreased from 28 mg/L to 15 mg/L with Ammonia <0.2 mg/L. I called Grant with the update and he said to now run the one aerator 3 hours on and 2 hours off with the second rotor operating 1 hour on every twelve hours (during the same time with the other rotor to move the blanket). Called Nic and told him the new plan to run the one aerator, 3 hours on and 2 hours off. Nic confirmed and said he would make the Change.

Cowan on-site visit 09/09/2020 – Laboratory Analysis Results and Correspondence with Grant.

After plant process ran for one-week, Nic performed analysis on ammonia as N, nitrites, nitrates, and orthophosphate on final effluent. The results looked great!

Ammonia as N = <0.03, Nitrite = <0.1, Nitrate = 5.9, Orthophosphate = 1.87 (down from 3.99). Had a conference call between Nic, Grant and Dewayne discussing results and Grant suggested new game plan and emailed the plan to all as follows:

<u>Grant wrote:</u>
Nic,
Congrats and THANK YOU VERY MUCH for the excellent work!
I'm thinking we might squeeze a bit more nitrogen removal by extending the air-OFF cycle.
And, maybe, get some more biological phosphorus removal.
As we discussed on the phone today, I suggest changing the cycles such that the rotor by the influent operates ON for 3½ hours and OFF for 2½ hours.
This isn't a big change from the 3 hours ON and 2 hours OFF you were running.
And, as you have been doing, periodically run the far rotor to resuspend solids that accumulate in that part of the ditch.
I believe you are running it ON for 1 hour and 11 hours OFF.
Grant

Cowan on-site visit 10/26/2020 – Laboratory Analysis Results, ORP analysis and Correspondence with Grant.

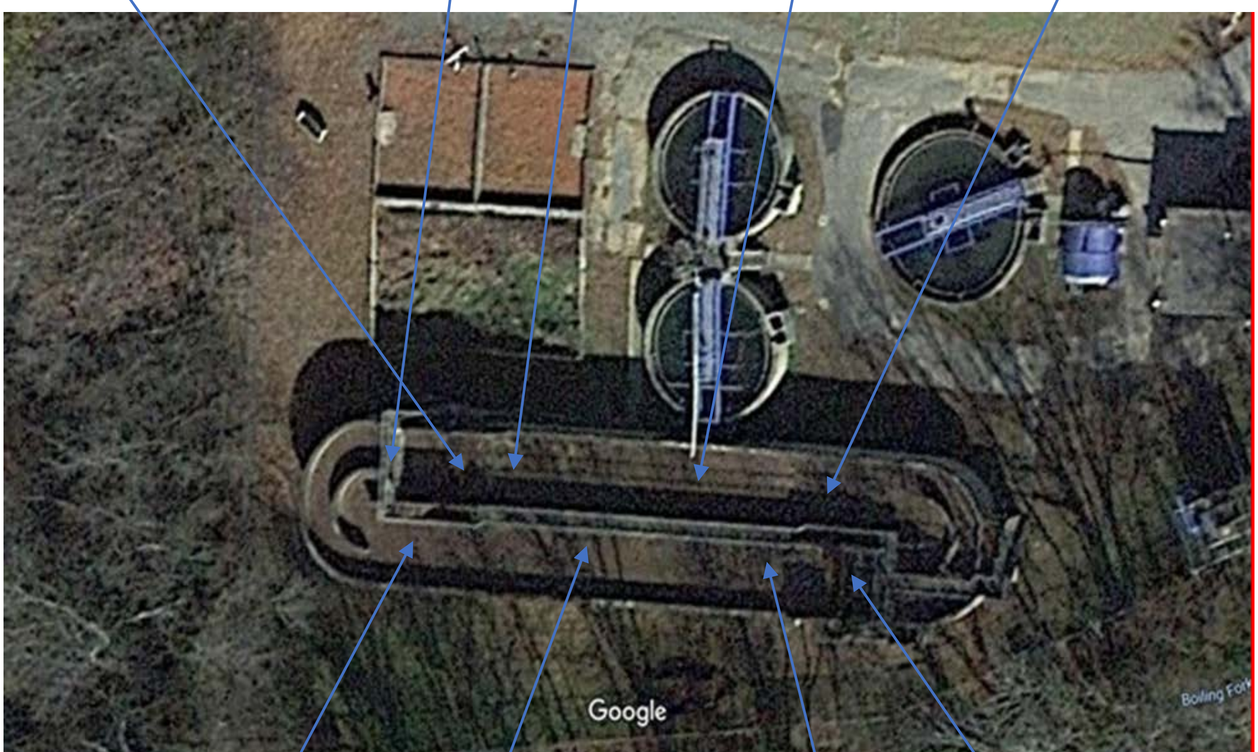
On site visit. Reviewed plant process and laboratory results for TP and TN. Called Grant Weaver and discussed data. Also, performed ORP analysis on plotted out sampling points around the Oxidation ditch. Emailed Grant and Nic the ORP results and discussed findings. Grant responded that ORP findings looked good.

ORP Readings Top : before rotor +110 after rotor +225 mid way +250 +250 (2 FT FROM SURFACE

ORP Readings Bottom: before rotor +100 after rotor -154 mid way -150 -140 (1 FOOT FROM BOTT

Flow Direction

ROTOR – Runs 3.5 hours and Off 2.5 hours



ROTOR - Runs 1 hour/12 hours

Top +160

Bottom -150

Mid way +240

Mid way -150

After rotor +130

After rotor +130

Cowan 11/01 - 11/17/2020 – Correspondence with Grant on Cowan infrastructure needs list to both sustain the operation of an optimize plant and replacement of aged infrastructure assets.

Dewayne,

Karina would like us to …
(a) put together a "Cowan needs list" totaling something on the order of $500,000 and
(b) develop an estimate of the annual cost savings that Cowan is (will) realize because of the optimization work.

We have a couple months to put this together, more, I suspect, if we need it.
After which, Karina will twist TDEC arms to develop a grant/loan package that will get Nic and the City of Cowan what they need at an out-of-pocket cost of zero.
That is, she'll create a grant/loan package that has an annual debt servicing cost that is equal to the annual electrical (and, if any, other) savings.

(a) During my initial site visit, the four of us (you, Mike, Nic and me) came up with the following "needs list," a good place to start.

Office computer and Internet access
Employer provided cell phone
Lab equipment
    Pipettes
    Pipette tips
    Spectrophotometer
    Portable DO and ORP probes
In-line instrumentation
Energy efficient changes
Soft-start equipment for rotors and ???
Modifications to / replacement of influent screen

(b) To lock down the annual savings, we'll need Mike Keeton to crank numbers to come up with the electrical savings associated with cycling the rotors on and off versus running them both all the time.
I did some quick math assuming both rotors used to run all the time versus now (one rotor runs 12 hours a day and both rotors run 1 hour a day).
Guessing at the rotor Hp (40 HP) and guessing at Cowan's cost of electricity ($0.12/KWH), I came up with an annual savings of almost $45,000!
If so, this would pay the debt service on an $800,000+ zero interest 20-year loan!
And, that is without any grant money.
(Maybe we should come up with $1,000,000 of needs!)

When convenient for you, let's talk about this.
After which, maybe I should meet you and Mike at the plant in order to work on the "needs list."

What do you think?

Grant

Grant Weaver, PE & Wastewater Operator
President

The Water Planet Company

Mid to Long-term mechanical fixes (we should create a wish-list and prioritize it as the summer progresses … and, give a copy to Cowan as we gain more familiarity with the plant)
For now, the list includes …

Building and Laboratory Improvements

SCADA

Office Lap Top computer, Soft ware and Internet access

Employer provided cell phone

Lab equipment

- Pipettes – HACH Tensette
- Pipette tips
- Spectrophotometer
- Portable DO and ORP probes
- TNT Reagents

New Roof on Building

Wastewater Plant Improvements

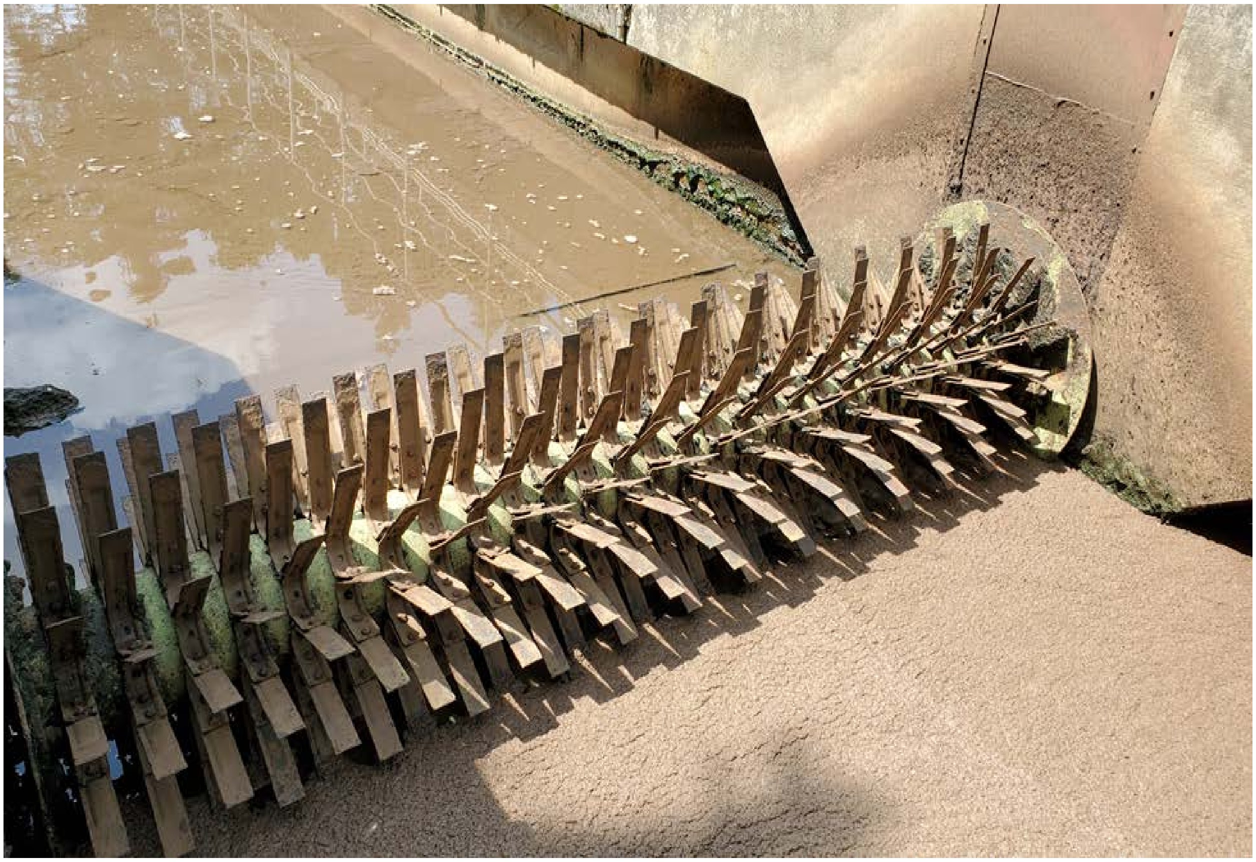
Modifications to / replacement of influent screen (Drum Screen)

SCADA connected In-line instrumentation – to control aerators

New Rotors, Motors and gearboxes with the soft starts

Install baffles/stops on the ditch outlet / secondary clarifier inlet distribution box. (Doing so will balance the flow rate to the two clarifiers and thereby minimize washout during high flows.)

Small Sludge dewatering press



November 17 – Cowan Virtual Meeting discussing nutrient removal and "Wish List" of Items and cost estimates. Attendance: Nic, Grant, Karina and Culpepper

During the meeting, A list of items was reviewed. Task were assigned to get an accurate cost estimate on each item. Each item was giving a priority.

Cowan Infrastructure Needs

Savings estimate 17NOV20 - high
$50,000 annual savings (about 1/3 of the energy bill cut) - in 20 years = $1M @ 0% interest
Score card – I/I cost - $516,365 cost of treatment

Cost estimate 17NOV20
High priority upgrade: $500,000
Complete upgrade: $ 2,000,000

Tasks 17NOV20 due 18DEC20
Karina - Heathcoat – contact Angela and Paula to intercept the project

Karina – get more info how to use this list to get on PRL, ECD and RD include
Dewayne – get better estimates on brush replacement and solids processing
Michael – get better information on energy savings
Grant – green components – justification

Mid to Long-term mechanical fixes (we should create a wish-list and prioritize it as the summer progresses … and, give a copy to Cowan as we gain more familiarity with the plant)
For now, the list includes …

Building and Laboratory Improvements

Medium - SCADA – inline ORP, DO, Ammonia, Nitrate, (Phosphorus), connected to aerators - $100, 000

High - Office Lap Top computer, Software and Internet access, printer, scanner, cell phone - $8,000

High - Facility structural fixes, including splitter box, roof $150,000 Install baffles/stops on the ditch outlet / secondary clarifier inlet distribution box. (Doing so will balance the flow rate to the two clarifiers and thereby minimize washout during high flows.) – need control level of ditches, splitter box to clarifiers. Need to level the splitter box weir, ditch solids clean up, old TF tank rehab?

High - Lab equipment - $20,000

Pipettes – HACH Tensette
Pipette tips
Spectrophotometer
Portable DO and ORP probes
TNT Reagents

Wastewater Plant Improvements

High - Modifications to / replacement of influent screen (Drum Screen) – rotating drum ($150,000) – piping is ready – low maintenance, automatic cleaning

Medium - New Rotors, Motors and gearboxes with the soft starts – major rehab – labor, materials, engineering – get better number, estimate ($500, 000)

- Rotor for aeration, other used for mixed. Can possibly do just one brush aerator and use submersible mixer for mixing.

SOLIDS HANDLING

Medium - Small Sludge dewatering press – wet weather limited, solids stored in plant for the winter, drying bed! - Oliver Springs and cost – ($700,000) look into it. Screw press (Ferwin) Collierville- not Shelton Rd., North West?

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Filtrate from sludge press – send to???? Sludge holding tank not to head of plant? Press less more often? Storage and bleed in?

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Implementation:

December 16, 2020 – Cowan Virtual Meeting discussing nutrient removal and "Wish List" of Items and cost estimates. Attendance: Nic, Grant, Karina and Culpepper

Cowan virtual meeting with Grant, Karina, Nic to complete Cowan wastewater treatment plant infrastructure wish list. During the meeting, Karina planned to have a meeting set up with Mayor, Alton Heathcoat (Engineer), Lorie Fisher (grant writer), Grant Weaver, Nic Willis, Kenny Henshaw to discuss results of plant optimization and what funding might be pursued.

January 4, 2021 – Cowan Virtual Meeting with Cowan Officials, Engineer, TDEC to discussing discuss results of plant optimization, aging infrastructure needs and what funding might be pursued.

Virtual Meeting with Cowan Mayor, Alton Heathcoat (Engineer), Lorie Fisher (grant writer), Grant Weaver, Nic Willis, Kenny Henshaw to discuss results of plant optimization and what funding might be pursued. The TNPOP Optimization of Nutrients was successfully demonstrated along with potential energy savings.

January 4, 2021 – Cowan Virtual Meeting Results and Comments

Funding is limited and will have most likely be done in stages or through long term loan and grant options to replace critical infrastructure.
The Mayor does realize the fact that the plant needs the items on the list and the infrastructure will have to be updated within the next few years.
Today we had a meeting with Cowan and one of the most important information is the energy savings from TNPOP. Review of the past bills and split out the energy costs to show total usage and charges, and demand charges. Also need to look if there are any power factor penalties assessed. A comparison to the months that the aeration was adjusted for Nitrogen removal will document savings. Energy savings can be used for upgrades to the infrastructure to help pay the loan.

June 14, 2021: On -site Meeting with Brett Ward (MTAS) Concerning Energy Report and Review of Plant Data since Initiating TNPOP

June 14, 2021 – Bret Ward, Micheal, Nic and I met on-site and reviewed the plant biological process and electrical grid of the plant, pumps and motors, reviewed all electric usage data and current laboratory data. In house TNT nitrate test was performed with a result of 0.43 mg/L. Also. during the permit renewal process there were 3 scans on effluent parameters:

Date	TP	TN
4/20/21 -	1.42	4.85
4/21/21 -	1.28	4.83
4/27/21 -	1.67	2.24