



Department of
**Environment &
Conservation**

No-to-Low-Cost Energy Saving Measures: Next Steps for Wastewater Treatment Plants

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So - What is Optimization?

Optimization –

- Operators applying their skills to identify opportunities to use their existing plant structures to achieve:
 - **Greater energy efficiency**
 - **Reduced chemical usage**
 - **Biological nutrient removal**
 - **Better operational control**
- Many plants have all these opportunities



Most Important Reason for Optimization

We work for the public – they pay for your plant and our salaries.

Rate payers want to know that their utilities are doing all that they can to control costs and we owe them that.

Optimization can help improve plant performance and reduce costs.

Plus – its satisfying to see what you can get your plant to do!



WWTP Optimization Goals

- **Greater Energy Efficiency**
 - **WWTPs are energy guzzlers – aeration, pumping, dewatering, disinfection (UV), more pumping.**
 - **Energy is second highest cost of O&M – we are the highest.**
 - **Is turning off the lights at night going to do much? No – but it is a start!**



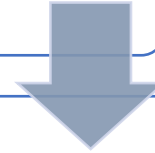
Energy Efficiency – Where To Start

- **KEY STEP – GET YOUR ENERGY BILLS AND START TRACKING ENERGY USE**
- **Hard to manage something you do not measure!**
- **Use Energy Assessment Tool – easy to use and flexible – Excel based on your computer.**
- **Only data you don't already have is monthly energy usage – kWh – and monthly cost.**
- **Energy demand data – kW – also helps if available.**

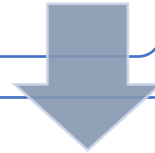


Strategies for Efficiency

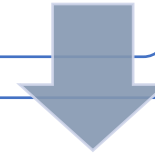
**Process Improvements and
Electric Rate Optimization**



**Improvements to process
monitoring and controls**



**Equipment repair, upgrade,
or replacement**



**On-site energy production:
biogas, solar, biodiesel, etc.**



Read Your Electric Bill

- **Brett Ward – UT Municipal Technical Advisory Service - will go into this in more detail in his presentations.**
- **Look for high usage or demand patterns. Time of day equipment is used can affect cost – a lot!**
- **One plant meter or multiple? Find out what they are metering.**
- **Some plants have more than one meter for the same equipment – double billing has occurred.**



Energy Efficiency Pays Off

- **Top Target – Aeration - 50-60% of total energy use for most WWTPs**
 - **Several ways to control – DO set points, Blower/Aerator speed control, On-Off aeration, timers, others**
 - **SCADA systems should make operator control easy – some do not.**
 - **Important to monitor aeration basin DO – during peak organic load and off-peak.**



SCADA ISSUES

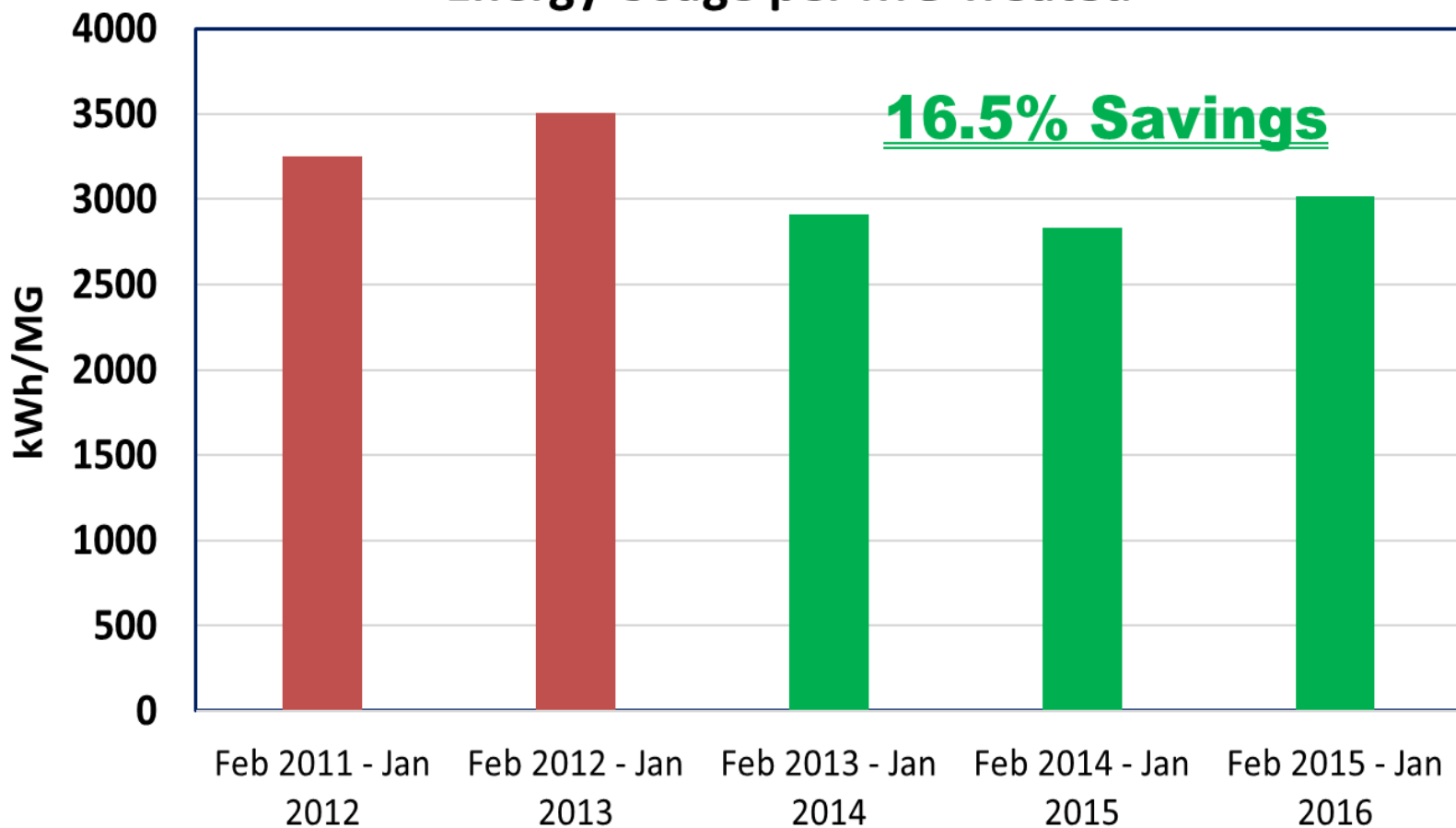
- Some SBR SCADA systems will not permit turning off mixers during aerated periods – rarely need both. **Lawrenceburg, TN** is saving 15,000 kWh/month this way – **over \$1200/month**.
- **Muscle Shoals, AL** operators cannot override SCADA alarms to operate On-Off aeration for anoxic denitrification – saves over 25% energy use - **\$12,000/year** and **reduced TN discharge 33%**. Plan to do more when SCADA can be fixed.

Implementation Cost for both of these examples -- \$0.00



Results – Franklin, TN - AWT Plant – 12 mgd

Franklin TN Water Reclamation Facility Energy Usage per MG Treated



RED bars BEFORE Optimization - GREEN bars AFTER



Franklin, TN – Claude Yates WWTP

- TDEC Energy Team plant assessment visit in October, 2011 with Juan Davis, Plant Superintendent & Mark Hilty, Director-Water Management
- Franklin WWTP – 3 parallel oxidation ditches with anoxic zones – deep bed filter denitrification – UV disinfection
- Effluent limits at time of assessment:

Summer – Winter

■ CBOD	4 mg/l	10 mg/l
■ NH3	0.4 mg/l	1.5 mg/l
■ Total N	5 mg/l	None



Franklin WWTP Assessment Findings

- The ditches had DO set point of 2.0 mg/l – Dr. Moore's plant process model (BioTiger) showed a 1.0 DO set point supplied sufficient oxygen.
- Result -- 300 hp supplemental blower needed for one ditch that normally operated 8 hrs/day was only needed rarely. 300 hp blower reduction saved over 500,000 kWh/year – approx. **\$40,000/year.**
- Lower DO setting in other two ditches allowed plant staff to reduce speed and run time of ditch vertical aerators – saving 600-700,000 kWh/year – **\$50,000/year** – also improved anoxic zones.
- Found and eliminated duplicate electric meter causing double billing – saved **\$40,000/year**
- Implemented on-off aeration for Post Air and BFP belt backwash



Franklin Plant – Bottom Line (so far)

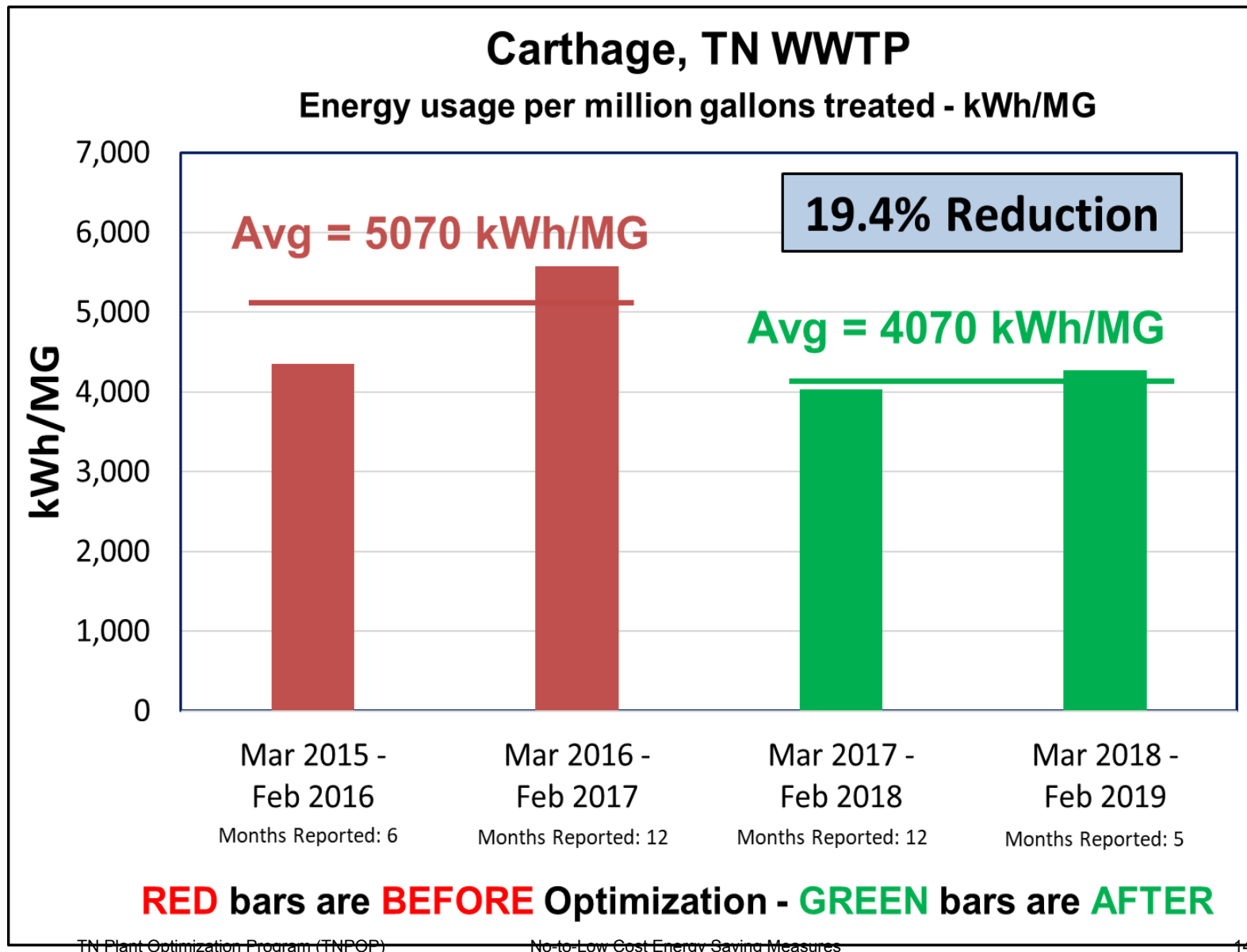


Energy Savings – 1,500,000 kWh/Year

Cost Savings - \$150,000/Year

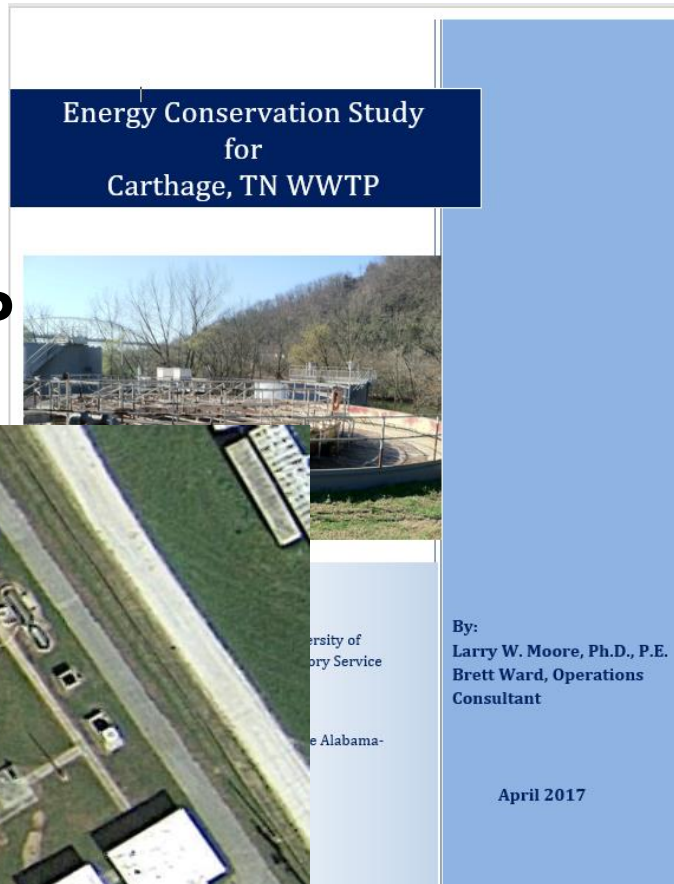
Cost to Implement -- \$0.00

Small Plants – Carthage, TN - 0.63 mgd



What Changed?

Energy Assessment Report for Carthage WWTP



Carthage Assessment Report

- Site visit March 8, 2017 – discussed operations with plant staff
- BioTiger modeled plant operation, determined excess air was being supplied to both aeration basin and aerobic digesters.
- Secondary digester - 25 hp blower running 24/7 except when decanting – plant staff able to reduce run time to 6 hours/day with no problems. Saved approx. 85,000 kWh/year
- Plant staff plans to use some of the savings to by timers and automate the new reduced run time schedule for the digester.



Carthage Results – Bottom Line

- **RESULTS:**

- Energy saving **>7,000 kWh/month – 19%**
- Cost saving almost **\$600/month – 19%**
- During this period Plant loading increased 13% which would have resulted in higher energy use and cost.
- **Cost to Implement -- \$0.00**

Key to results: Plant staff willing to try an operational change.



Carthage Gets a Deserved Shout Out



Case Study: Carthage, TN

August 2018



Staff from the Carthage, TN Wastewater Treatment Plant (WWTP) were invited to participate in the Energy Management initiative of the Tennessee Water and Wastewater Energy Efficiency Partnership, a joint technical assistance program through the U.S. EPA Southeast Regional Office, U.S. Department of Energy, and the Tennessee Department of Environment and Conservation. Representatives from those agencies, the University of Memphis and the University of Tennessee Municipal Technical Advisory Service conducted a site assessment in March 2017.

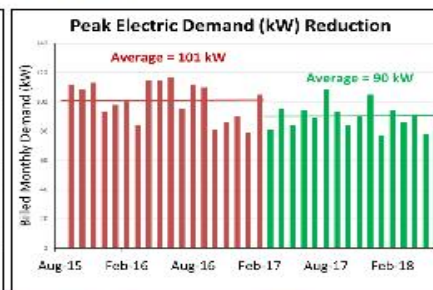
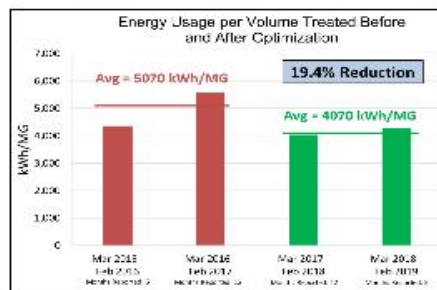
Carthage, a city of approximately 2,300, is nestled in a bend of the Cumberland River, about 50 miles east of Nashville. The WWTP has a design capacity of 625,000 gallons per day (gpd), and currently treats about 330,000 gpd of municipal wastewater. The plant has an annular aeration basin with a final clarifier in the center. Biosolids generated during treatment are further treated in two aerobic digesters, operated in series.



Carthage Wastewater Treatment Plant

Plant staff Steve Key and Ricky Brown met with the team to discuss ways to improve treatment efficiency. The team observed that the solids retention time in the aeration basin and first digester were sufficient to treat the solids, and the aeration to the second digester was redundant. Accordingly, the team recommended reducing the operating time of the aerator in the second digester from constant operation to only six hours per day. Beginning in April 2017, the plant staff has manually adjusted the aerator operation schedule as a part of routine duties. This single change reduced electricity use by 14%, and saved over 7,000 kilowatt-hours (kWh) per month despite a 15% increase in wastewater loading. Staff expects to use some of the savings to purchase and install timers in the near future. The timers will automate this change and manage further reductions. The results achieved at the time of writing are summarized below.

Diligent operator oversight was necessary to implement this recommendation. The project team appreciates the continued efforts of the Carthage operators, and the valuable support of its Mayor and Town Council.



• Annual Energy Savings:	>85,000 kWh/year	• Annual Cost Savings:	>\$7,000/year
• Energy Reduction:	19% kWh/MG	• Cost Reduction:	19% \$/MG
• Peak Electrical Demand:	11% reduction	• Cost to Implement:	\$0

For more information, please contact Ben Bolton at TDEC Office of Energy Programs (ben.bolton@tn.gov)



This material is based upon work supported by the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy (EERE), under Award Number DE-EE0007226.



Elizabethton, TN WWTP Success

- TDEC Energy Team plant visit October 2017 – met city Water Resources General Manager and Facility Manager.
- 3.6 mgd oxidation ditch WWTP with two ditches in series.
- BioTiger model and process analysis showed the aerator run times in the first ditch could be reduced to save energy and create an anoxic zone for denitrification.

Energy savings are occurring even though plant flow and organic load have increased which would have required more energy.



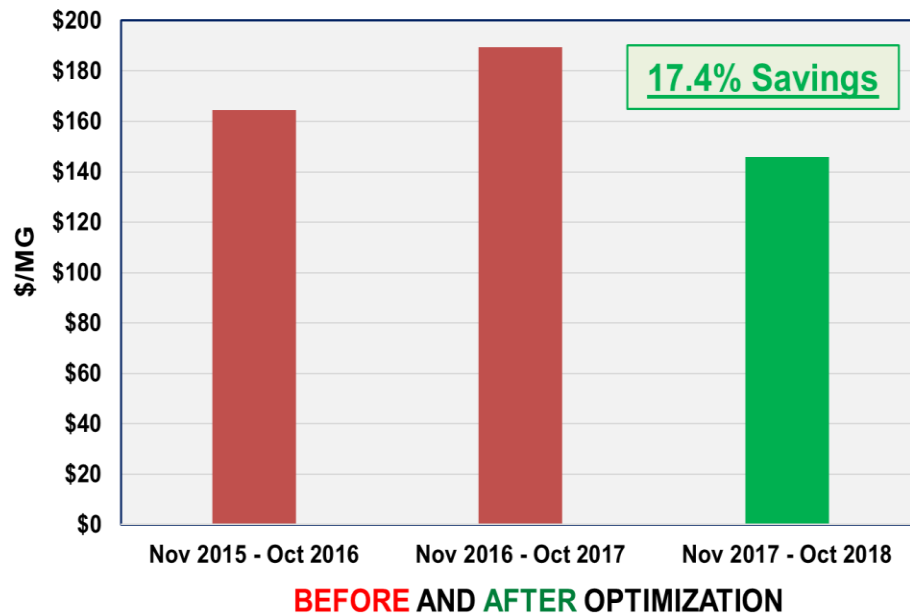
Elizabethton Oxidation Ditch Plant



Elizabethton Bottom Line

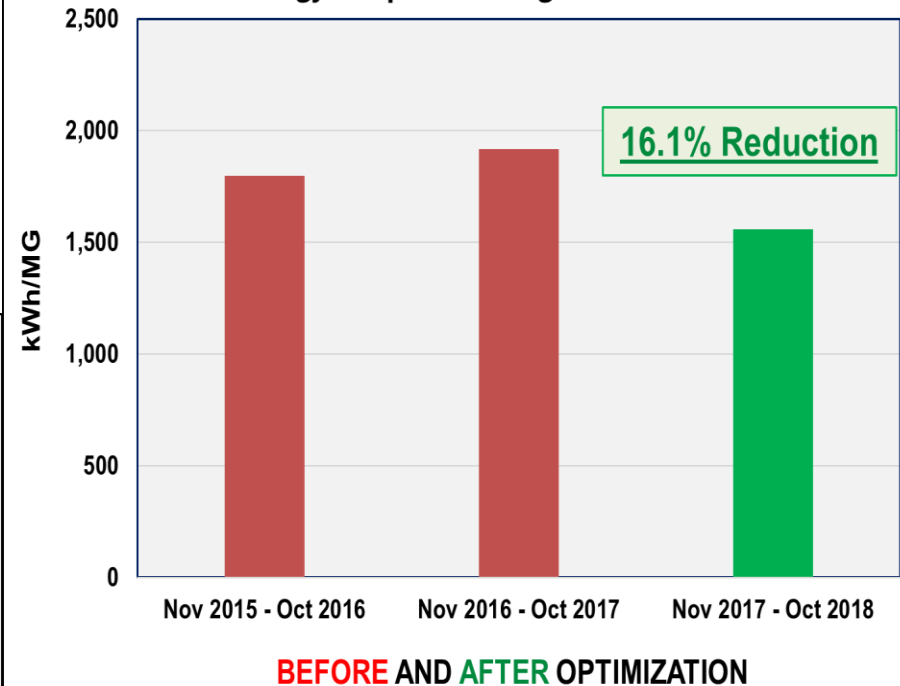
Actual energy cost savings approx. \$9000/year

Elizabethton, TN WWTP
Cost per million gallons treated



Elizabethton, TN WWTP - TN0023515

Energy use per million gallons treated



Costs avoided due to increased flow and load would have been additional \$10,000/year



Church Hill, TN WWTP

- TDEC Energy Team site visit in December, 2016. The WWTP is a 2.5 mgd oxidation ditch with actual flow approx. 0.6 mgd.
- The ditch has 4 X 100 hp aerators running 24/7 at approx. 25% speed.
- Because of the low load on the plant the aerators are supplying excess oxygen. The plant is gradually reducing the run time of the aerators by 4-6 hours and creating an anoxic zone.

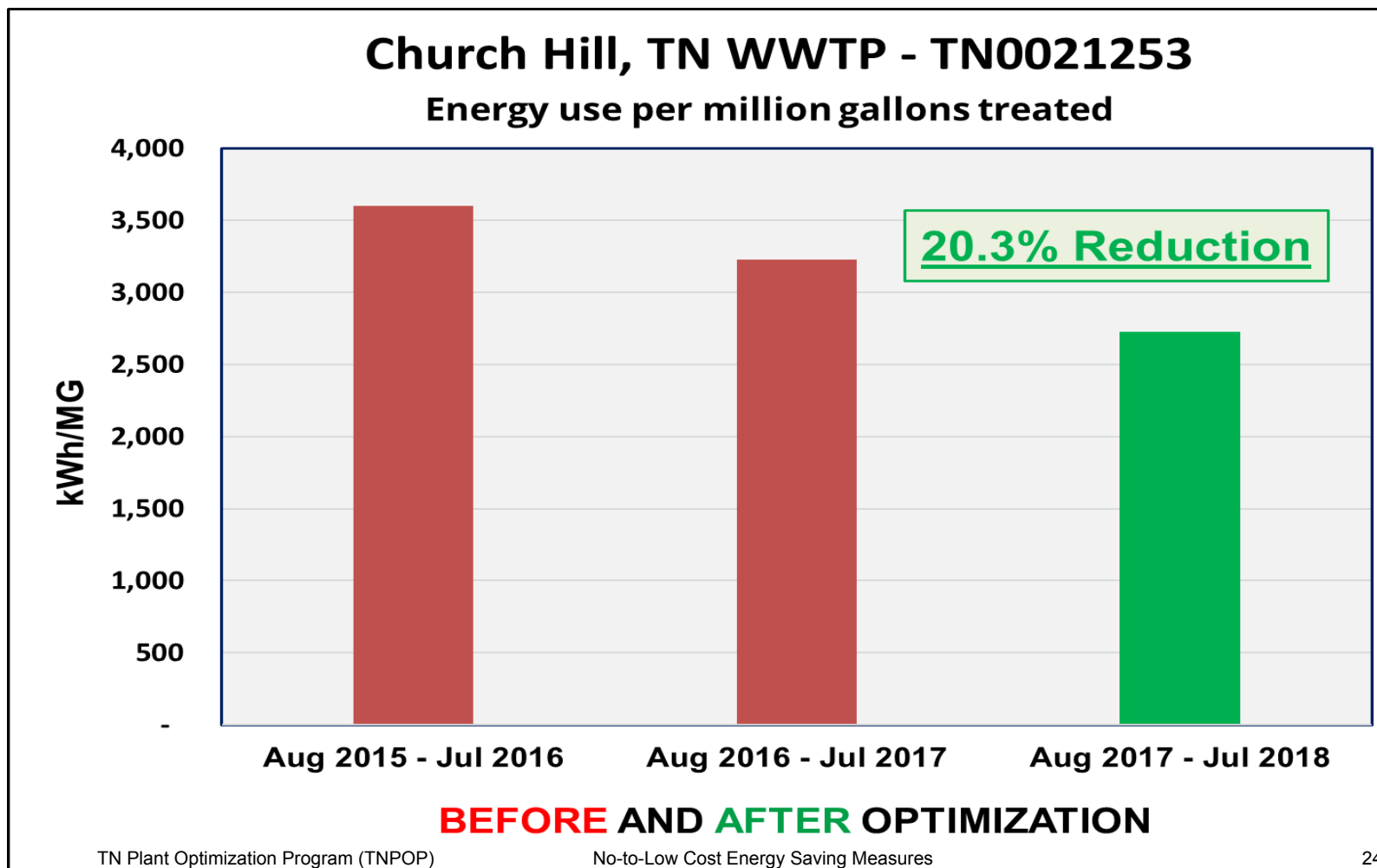


Church Hill Oxidation Ditch Plant



Church Hill Bottom Line - Energy

- Based on limited data the Church Hill energy savings are:



Church Hill TN Discharge Reduction

- **Energy savings – over \$8,000/year**
- The anoxic zone in the Church Hill ditch is allowing denitrification to occur and is reducing the TN discharge from the plant.
- TN discharge reduction over 40% - approx. 20,000 lbs TN/year.
- Plant staff is continuing to evaluate processes for possible additional savings.



What Does This Tell Us

- Energy savings and possible nutrient removal at **low to no cost** to achieve is available at many plants.
- WWTPs often have “low hanging fruit” waiting to be picked – high aeration basin DO – long SRT biosolids with excess aerobic digestion – opportunity for anoxic operation & denitrification

We have resources that can help you find and capture these opportunities.



A Win – Win Opportunity

- **A plant that saves \$20,000/year in energy costs as many plants have done could use those savings to completely pay back a \$370,000 SRF loan over 20 years with NO ADDITIONAL OUT OF POCKET EXPENSE**
- **\$370,000 worth of improvements essentially for FREE**

Those improvements could be for additional energy efficiency measures to pay off the loan even quicker.



Lawrenceburg, TN WWTP

- **3 SBR Reactors with excess aeration capacity – 2 X 350 hp blowers**
- **Presently using one blower at about 30% of its output**
- **One 100 – 150 hp blower would easily provide adequate oxygen – cost for one plus backup about \$150,000 - \$200,000.**

Annual energy cost savings – over \$70,000

Payback less than 3 years



Lawrenceburg Shout Out



Case Study: Lawrenceburg, TN

September 2018



Staff from the Lawrenceburg Utility Systems (LUS) Wastewater Treatment Plant (WWTP) were invited to participate in the Energy Management Initiative of the Tennessee Water and Wastewater Energy Efficiency Partnership, a joint technical assistance program through the U.S. EPA Southeast Regional Office, U.S. Department of Energy, TVA, and the Tennessee Department of Environment and Conservation. A team of representatives from those agencies, the University of Memphis and the University of Tennessee Municipal Technical Advisory Service conducted a site assessment in March 2017. Plant superintendent Lisa Porter met with the team to discuss ways to optimize treatment.

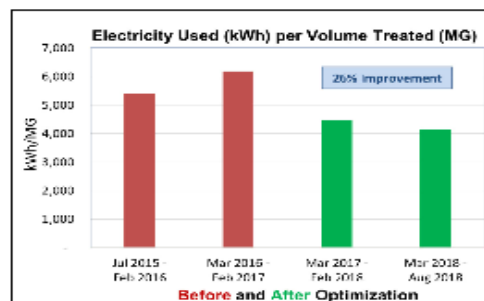
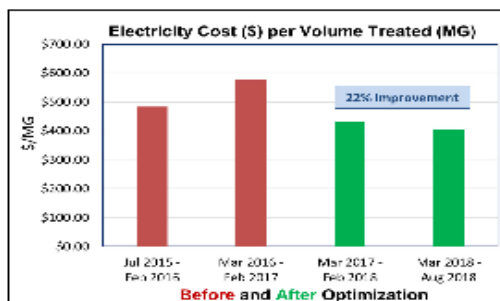


Lawrenceburg Wastewater Treatment Plant

Lawrenceburg, a city of approximately 10,000, is set on Shoal Creek, just 15 miles north of the Alabama state line. The plant is designed to treat 4.5 million gallons per day (mgd), and currently treats about 1.5 mgd of municipal wastewater. It uses three sequencing batch reactors (SBR) aerated with up to two 350-HP centrifugal blowers. Biosolids generated during treatment are processed in aerobic digesters fed by two 40-HP blowers.

The team analyzed the loading to the plant and observed the SBR blowers provided excess aeration but that design constraints of the blowers prohibited full optimization. Additionally, solids loading to the digester indicated that the aerator runtime could be reduced by up to 75%. Following the team's recommendation, the WWTP staff reduced the aeration to the SBRs and digesters. This no-cost change reduced total electric use by 13% and saved 30,000 kilowatt-hours (kWh) per month. During the "after optimization" phase highlighted in the graphs below, the plant's wastewater loading increased 13%, which would have resulted in higher electrical usage without the optimized operation. The results achieved at the time of writing are summarized below.

While no capital was required, diligent operator oversight was necessary to implement this recommendation, and the team appreciates Lisa and her team's continued efforts to optimize their processes.



♦ Annual Energy Savings: >360,000 kWh/year
 ♦ Annual Cost Savings: >\$21,000/year
 ♦ Cost to Implement: \$0

♦ Energy Usage and Cost Reduction: 13% and 8%
 ♦ Influent Loading: 13% Increase
 ♦ Peak Electrical Demand: 3.5% Reduction

For more information, please contact Ben Bolton at TDEC Office of Energy Programs (ben.bolton@tn.gov)



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Do Wastewater Plants Have Money to Burn?



Don't Do This At Your Plant!!



QUESTIONS??

For More Information Contact:

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