Pilot Partnership for Optimization Pays Off

By Brendan Held

When the Kentucky Division of Compliance Assistance (KDCA) said the U.S. Environmental Protection Agency (EPA) wanted to help the Lawrenceburg water resource reclamation facility (WRRF) reduce nutrient pollution while saving energy costs, superintendent Mitch Hudson admits he was a little skeptical. "We had already gone through two energy audits, mainly looking at equipment upgrades. Most of those recommendations were either impossible from an operational standpoint or came with a 20-year payback. We maybe had a low bar when it came to expectations, but we decided to give it a fair shake."

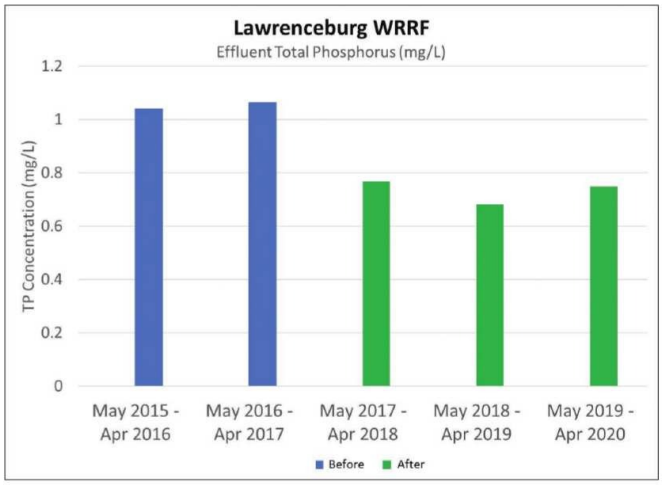
In 2017, Hudson and the chief operator, Jason Ransdell, became part of a group of WRRF professionals in Kentucky that participated in a pilot partnership targeting low or no-cost operational changes to improve nutrient removal and save energy.

The project partners include KDCA, Kentucky Division of Water, Clean Water Professionals of KY & TN, Kentucky Rural Water Association (KRWA), University of Kentucky, University of Memphis, and EPA Region 4. The approach is modeled after a program developed in 2011 by EPA Region 4 and the Tennessee Department of Environment and Conservation.

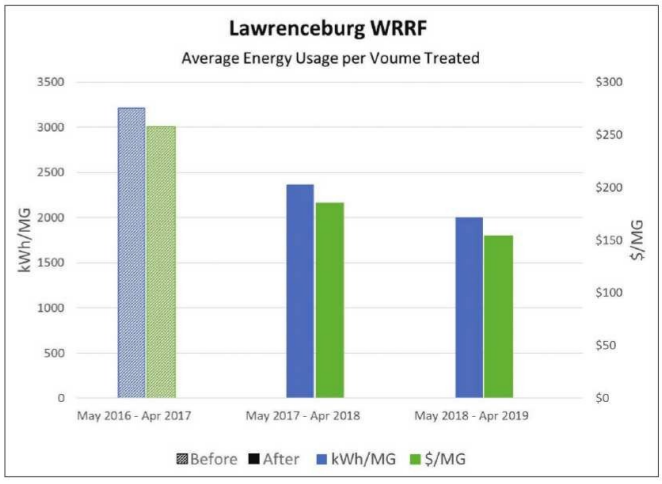
Hudson and Ransdell worked with the project team to model Lawrenceburg's activated sludge process using a free Excel-based tool called Bio-Tiger, developed by Dr. Larry Moore at University of Memphis. The Bio-Tiger model uses readily available treatment parameters and equipment information to develop a steady state model. It can also estimate potential energy savings. The model showed that the aerators in the 3.3 MGD Orbal ditch were supplying about 20% excess oxygen and inhibiting denitrification. Mitch and Jason decided that idling one 75-HP and two 25-HP aerators up to 24 hours/day could be a feasible way to lower the DO concentration in the basin.

It was not a new idea, but Ransdell says the discussion helped move things forward. "There are always those ideas you have where you wonder 'what would happen if...' but are sometimes hesitant to try. Being able to talk to someone like Dr. Moore who has that depth of knowledge gave us some leeway to experiment."

Two years later, that experiment has paid big dividends for Lawrenceburg. Effluent total nitrogen concentrations are down 63%, diverting 18,600 lbs/year from Hammond Creek, equivalent to three dump trucks of urea fertilizer. The WRRF is also discharging 39% less phosphorus, and that's not because they are using more alum. Alum demand also dropped with the new protocol, saving Lawrenceburg $4,500/year.



Meanwhile, the three aerators have mostly stayed off, even as two distilleries contributed to a 25% increase in BOD loading. This saved an estimated 410,000 kWh and $25,000 each year.

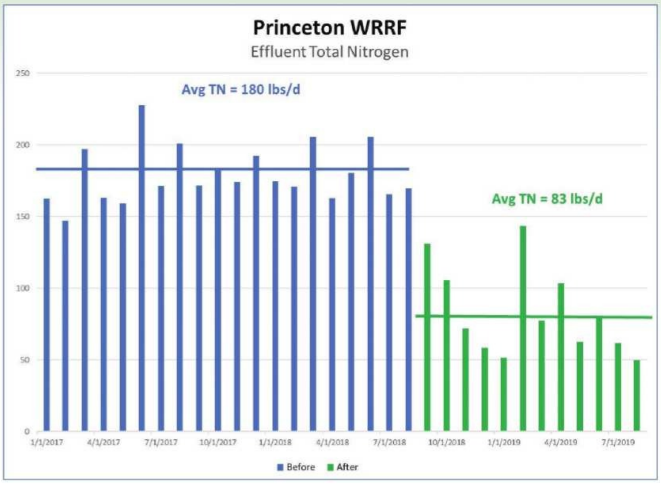


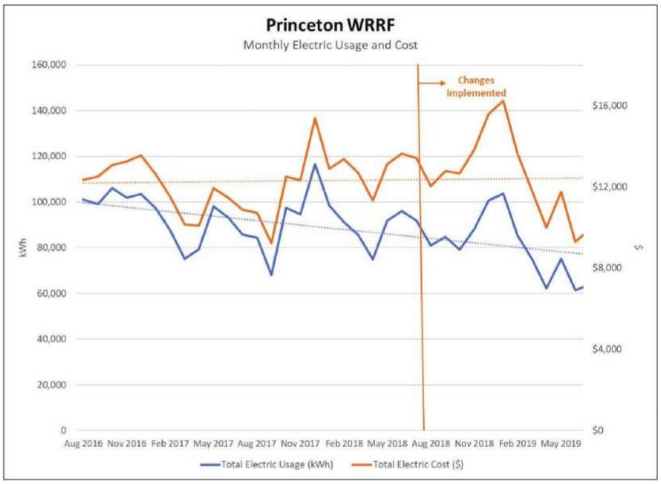
The changes were simple, but Ransdell and Hudson kept good notes of the changes and stayed in touch with regulators. "We appreciated having good communication and reassurance from Kentucky Division of Water. Knowing that they were in the loop made it easier to make gradual changes without the fear of things going haywire," Hudson says. "You need to have the 'want-to' kind of attitude. The types of operators who just do what they're paid to do and nothing else probably won't get very far with optimization. This work represents you."

Lawrenceburg WRRF			
Parameter	Pre-Optimization Baseline	Past 12 months	Units
Average Daily Flow	2.1	2.5	MGD
Influent BOD	205	220	mg/L
BOD loading	3,600	4,500	lb/d
Energy per volume	2,700	1,995	kWh/MG
Energy per lb BOD removed	2.0	1.13	kWh/lb BOD
MLSS	3,600	4,500	mg/L
Effluent BOD	3	3	mg/L
Effluent TSS	4	3	mg/L
Effluent TN	11	4	mg/L
Effluent NH_3	0.2	0.4	mg/L
Effluent TP	1.1	0.67	mg/L

The 'want-to' attitude is in abundance at WRRFs around Kentucky. Princeton and Greenville are two other facilities seeing positive results. At Princeton's 1.57 MGD facility, the Bio-Tiger model showed there was potential to improve denitrification. William Brown, the chief operator, is currently shutting off all rotors in the three oxidation ditches for eight hours each night and running one of two 40-HP rotors in each ditch during the remainder of the day. Effluent total nitrogen has decreased 55%, while effluent TP has decreased by 9% without using additional chemicals. This past year, the WRRF eliminated 30,000 lbs of nitrogen and 300 lbs of phosphorus from being discharged into Eddy Creek, which the Kentucky Division of Water says is impaired for nitrates and phosphorus from agricultural sources.

Meanwhile, the WRRF has reduced electricity usage by 13%. This has allowed their electric bill to remain essentially flat despite a rate increase that saw their cost per kWh jump 17%. The rate increase would have cost $23,000 if consumption remained the same.





Brown says the project has impacted the culture at the plant. "I've turned into my dad, running around and shutting off lights," he says. He also credits his superintendent, James Noel, for placing trust in him to get the job done. "He's given me the latitude to make changes and run the diagnostics I need to get the best from the plant." Noel has been with the plant since high school, working his way up from sweeping floors and cutting grass. For his part, he wants to look for more savings elsewhere. "After what we did here, we want to see what's possible in our drinking water system."

Princeton WRRF			
Parameter	Pre-Optimization Baseline	Past 12 months	Units
Average Daily Flow	1.1	1.1	MGD
Influent BOD	130	166	mg/L
BOD loading	1,140	1,170	lb/d
Energy per volume	3,050	2,200	kWh/MG
Energy per lb BOD removed	2.5	2.0	kWh/lb BOD
MLSS	5,000	4,250	mg/L
Effluent BOD	2.2	2.8	mg/L
Effluent TSS	7.1	6.9	mg/L
Effluent TN	22	9.7	mg/L
Effluent NH_3	0.4	0.3	mg/L
Effluent TP	0.76	0.69	mg/L

In Greenville, superintendent Gary Russ and his team have been eliminating excess aeration and creating anoxic conditions for a short time each day. Operators shut down the two 40-HP blowers from 6 am to 9 am every weekday, allowing for denitrification. The plant operates at high MLSS concentrations during the winter months when freezing conditions make operating the outdoor belt press impractical. There were some initial concerns that the suspended solids would settle and clog the flexible membrane diffusers, but Russ says it hasn't been a problem.

Since beginning the new aeration schedule in August 2018, effluent total nitrogen concentrations have dropped 33% and electrical usage is 13% lower. The average monthly electric bill has decreased from about $4,700 to $3,850. Recent wet weather has meant higher flows and lower BOD loading, causing kWh/MG and kWh/lb BOD efficiency metrics to move in opposite directions.

While Greenville isn't earmarking the savings for anything specific, Russ says they are investing in training and certification for their staff. They also upgraded lighting to high efficiency LED lamps, and hope to improve the belt press to allow winter operation.

Greenville WRRF			
Parameter	Pre-Optimization Baseline	Past 12 months	Units
Average Daily Flow	1.2	1.43	MGD
Influent BOD	122	78	mg/L
BOD loading	1,065	704	lb/d
Energy per volume	1,877	1,388	kWh/MG
Energy per lb BOD removed	2.0	3.1	kWh/lb BOD
MLSS	9,000	3,600	mg/L
Effluent BOD	3	2	mg/L
Effluent TSS	4	3	mg/L
Effluent TN	15	10	mg/L
Effluent NH_3	0.3	0.3	mg/L

While every facility is unique, the design of these WRRFs is not exceptional. Many others may have similar opportunities to save energy and improve nutrient removal. Facilities that have excess treatment capacity, high effluent nitrates, and an aeration system that can operate intermittently or at reduced power might be candidates for optimizing their treatment process to save energy costs while reducing nutrient discharges.

It is possible that these three WRRFs could see future growth that may require their aerators to run more again, which could reduce the long-term benefits of these optimization efforts. But for now at least, these operators are using their ingenuity to pursue what is possible – and reaping the rewards.

KDCA has identified a new group of partner utilities to work with in 2020, and KRWA continues to provide optimization assessments for water resource reclamation facilities across the state. If utilities outside of Kentucky are interested in exploring similar opportunities, they should contact the author at *held.brendan@epa.gov*.

Results Summary			
	Lawrenceburg	Princeton	Greenville
Energy Cost Savings	$25,000/yr	$23,000/yr	$10,000/yr
	16%	15%	18%
Energy Reduction	410,000 kWh/yr	148,800 kWh/yr	110,000 kWh/yr
	22%	13%	13%
TN Reduction	18,600 lbs/yr	30,000 lbs/yr	12,700 lbs/yr
	63%	55%	33%
TP Reduction	1,000 lbs/yr	300 lbs/yr	-
	39%	9%	-
Chemical Cost Savings	$4,500/yr	unknown	-
Chemical Usage	-30%	-50%	-