
Webinar for North Carolina Wastewater Operators
April 29, 2021
10:00 - 11:45 AM

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Webinar Housekeeping

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• To Ask Questions
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• Other issues? Terry Albrecht (828) 707-2834, talbrecht@wrpnc.org
Energy & Nutrient Optimization of NC Municipal Wastewater Treatment Plants

Biological Nitrogen Removal, Parts 1&2
Activated Sludge, Parts 1&2
Biological Phosphorus Review, Parts 1&2
North Carolina Case Studies, Parts 1&2
Energy Management, Parts 1&2

Today: Wastewater Excellence in North Carolina - an Overview
Introducing a new way of thinking:
Facility upgrades aren’t the only way to get nutrient removal...
Empowered operators achieve amazing results!
Lessons Learned

Biological Nitrogen Removal: 10 mg/L at many (most) activated sludge wwtps
Biological Phosphorus Removal: 1.0 mg/L at many (most) activated sludge wwtps
Many (most) wwtps can reduce their electric bill

Tools are available:

• Bio-Tiger Model
• Nutrient and Energy Assessment Tool
• Nutrient Removal Study Guides
• Course website
• ...and much more

It takes knowledge and courage to transition from PERMIT COMPLIANCE to WASTEWATER EXCELLENCE
Nitrogen
Biological Nitrogen Removal: Convert LIQUID to GAS ...

BOD and TSS Removal: Convert LIQUID to SOLID ...
**Step 1: Convert Ammonia (NH₄) to Nitrate (NO₃)**

Oxygen-rich Aerobic Process
Don’t need BOD for bacteria to grow
Bacteria are sensitive to pH and temperature

**Step 2: Convert Nitrate (NO₃) to Nitrogen Gas (N₂)**

Oxygen-poor Anoxic Process
Do need BOD for bacteria to grow
Bacteria are hardy
Phosphorus Removal: What an Operator needs to know

ONE. Convert soluble phosphorus to TSS (total suspended solids)...
   Biologically
   Chemically

TWO. Remove TSS
Biological Phosphorus Removal

Step 1: prepare “dinner”
VFA (volatile fatty acids) production in anaerobic/fermentive conditions

Step 2: “eat”
Bio-P bugs (PAOs, “phosphate accumulating organisms”) eat VFAs in anaerobic/fermentive conditions ... temporarily releasing more P into the water

Step 3: “breathe” and grow
Bio-P bugs (PAOs) take in almost all of the soluble P in aerobic conditions as they grow and reproduce
First steps for nutrient optimization

• Expand your toolkit for process control sampling
  • Test strips (ammonia, nitrite/nitrate, alkalinity)
  • Spectrophotometer (ammonia, nitrite/nitrate, orthophosphate)
  • Portable DO / ORP meters
  • In-line DO meter
  • Additional in-line instruments (ammonia, orthophosphate ...)

• Manage Regulatory Risk
  • Communication
  • Documentation
  • Ask for help
More on Regulatory Risk...

From Cantor, et al (2021), “Regulators and Utility Managers Agree about Barriers and Opportunities for Innovation in the Municipal Wastewater Sector”
The landscape is changing...

- Some states are requiring optimization as an intermediate step toward nutrient limits
- Other states are offering “safe harbor” letters of support after review of optimization plans, outside of the permitting process
- Any state will require advance communication and strong documentation throughout
Energy Management at Municipal WWTPs

Session Topics:
Organize an Energy Management Program
Energy Vocabulary Literacy
Utility Billing – Understanding your billing
Baseline Data & Tracking (at utility billing level)
Benchmarking
Plant Survey & Evaluations:
Common BMPs for Energy Management
Renewables
OWASA: Energy Management Case Example – Mary Tiger
Resources for Taking the Next Step
Key Takeaways

• Get Familiar with Utility Billing
• Start Tracking Energy Use and Cost Monthly – Make this a KPI!
• Conduct a Plant Assessment for an Energy Balance
• Reach out to Available Resources for Help: Utility, WRP, RWA, Others
• ID Energy Saving Opportunities – Start with no & low cost
• Make your plan!
Resources to take the next step

• Duke Energy: Business Energy Advisors and Large Account Reps
• Dominion Energy: RNG Projects (Lee McElrath, Dominion Energy, NC 828-230-7118)
• Your Local COOP/Municipal Utility Reps
• Your Peer Networks: PWOC-WEF
• Your Consulting Engineers
• State Clean Water Grant Sources: Green Project Reserve
• Advanced Energy: Kitt Butler, kbutler@advancedenergy.org
• Energy Efficiency Assessment Providers:
  • Waste Reduction Partners (serving all of NC)
  • Russ Jordan, Energy Manager, rjordan@wrcnc.org, (828) 251-7477
  • NC Rural Water Association (serving populations <10,000)
  • Natalie Narron, Energy Efficiency Circuit Rider, natalienarron@ncrwa.org, (336) 887-0741
• EPA: Brendan Held & Team Held.Brendan@EPA.gov
Land of Sky’s WRP program provides no-cost energy efficiency and waste assessments.

Clients: Any water/wastewater plant, business or institution in NC.

The Team: 40 staff and volunteer engineers (statewide)

Past energy work with: Asheville Water Resources Department, Town of Salisbury, Town of Boone, Cape Fear Public Utility Authority, Kerr Lake, and others

Results: –past 5 years: 275 clients served, $16.4 million in utility cost savings, 130,000 MWh saved

Initiate a Project: WasteReductionPartners.org or Russ Jordan rjordan@wrpnc.org
Pilot Plant Updates
Reidsville, North Carolina          Population: 14,000          7.5 MGD design flow
Waste Water Treatment Plant
Treatment Process Flow Diagram

Section 2: Treatment Process Flow Diagram
Reidsville’s Action Plan

Phosphorus:
• Already achieving excellent removal, often < 1.0 mg/L
• No additional steps at this time

Nitrogen:
• Effluent currently ~10 mg/L
• After diffuser repairs, consider turning off blowers for 1 hour each morning
• Monitor NH3 and NO3
• Consider additional 1 hour off cycle in the afternoon
• Continue monitoring performance
• Consider additional off cycles up to four 90-min cycles per day
Questions?
Comments?

Scott Bryan
sbryan@ci.Reidsville.nc.us
Eden, North Carolina
Population: 15,000
13.5 MGD design flow
Eden’s Action Plan

Phosphorus:
• Already achieving excellent removal, partially due to alum sludge from WTP
• No additional steps at this time

Nitrogen:
• Effluent currently ~10-12 mg/L
• Continuing cycling off 6 of 12 aerators during peak billing hours
• Increase # of “off” aerators to 9, starting 1 hr/d, increase weekly
• Process control sampling for effluent NH3 and NO3
• Goal is 8 mg/L TN or less
BioTiger Modeling (Summer months)

Assumptions:

- Alum sludge from WTP means higher than normal inert solids
- Average DO concentration throughout basin is less than DO measured at effluent
- Oxygen supply:
  - 12 x 20 HP aerators running for 16.25 hrs/d
  - 6 x 20 HP aerators running for 7.75 hrs/d
  - This is 4830 HP-hr of aeration per day, so, 201 HP over 24 hrs.
- Plant is fully nitrifying, partially denitrifying
- WAS TSS = RAS TSS
BioTiger Modeling (Summer months)

- Assumption:
  - Alum sludge from WTP means higher than normal inert solids
BioTiger Modeling (Summer months)

- Assumptions:
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<td>Energy cost unit ($/kWh)</td>
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BioTiger Modeling (Summer months)

Assumptions:
• Plant is fully nitrifying, partially denitrifying
• WAS TSS = RAS TSS

Analysis:
• O2 supply is within range
• Projected NO3 (w/o any nitrification) is higher than actual NO3
• Will not likely reduce NO3 to 4 mg/L; lower bound of O2 demand unrealistic
• WAS Q ~50% lower than expected – needs further review
BioTiger Modeling (Summer months)

Assumptions:
• WWTP uses ~50% of total electric bill, shared w/ DW Plant

Analysis:
• Aerator electricity use = ~26% of bill, or about 50% of total WWTP
• This seems low for this facility - no aerobic digesters UV disinfection or effluent pumping
Questions? Comments?

Melinda Ward
mward@edenncc.us
Newton, North Carolina          Population: 13,000           MGD design flow
Newton’s Action Plan

Phosphorus:
  • Already achieving excellent removal (<1.0 mg/L avg)
  • No additional steps recommended at this time

Nitrogen:
  • Effluent TN currently ~25 mg/L with low NH3
  • Evaluate VFDs and SCADA upgrade to allow routine on/off cycling of aerators.
  • Start with 90 min off/6 hrs on. Monitor NH3 and NO3, and use ORP to fine tune off cycle
  • Rough estimate of cost savings: $40,000/year
Questions? Comments?

Eric Jones
ejones@newtonnc.gov
Stacy Rowe
srowe@newtonnc.gov
Previous Optimization Efforts

- Successfully proved we can BNR, more work to do to meet expected permit limits
- Air on for only 12 hrs instead of 24 hrs, huge savings
- Saving in pH adjusting chemical costs because denitrification process recovers pH and alkalinity
- We know what is happening in real time and can react accordingly
Asheboro’s Action Plan

Phosphorus:
- Already achieving excellent removal (<1.0 mg/L avg)
- No additional steps recommended at this time
- Long term, consider using intermediate clarifier as side stream fermented

Nitrogen:
- Managing good TN removal using sugar water supplied by cereal manufacturer
- “Reach” goals include routine flooding of trickling filters to eliminate need for off-site carbon
- Consider using intermediate clarifier as side stream fermenter for additional Bio-P
Questions?
Comments?

Mike Wiseman
mwiseman@ci.Asheboro.nc.us
BREAK TIME
Pender County, North Carolina

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Influent Pump Station

Melinda K. Knoerzer Adaptive Ecosystem Process Map
NPDES Permit ID
NC0081736

Effluent To Cape Fear River
A View of the greenhouse and the office and lab inside the greenhouse.
A View of the influent pumping station
A View of the chemical farm, screen and grit station, and the EQ basin.
A View of the Screen and grit station. EQ basin is off camera to the right.
A View of the EQ basin from the screen and grit station (off camera behind).
A View of the MBBR with the EQ basin and the secondary clarifiers in the background. Note the black bio-media in the water. These “bio-balls” provide the surface area for additional bacterial growth. Media pictured below.
A View of the interior of the greenhouse / SFFR
A View of the secondary clarifiers with the digesters background left. And RAS/WAS station behind, and to the right of the clarifiers.
A View of secondary clarifier 2.
A View of secondary clarifier 1 with the MBBR in the background (right).
A View of the Tertiary filters (left) and the UV disinfecting units (right) with the effluent pump and non-potable water stations behind the UV.
A View of the UV station (left), the tertiary filters (background center), the effluent pumping station and NPW system (right).
A View of the aerobic digesters.
A fairly clean overhead view, north is straight up.
Questions?
Comments?

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