June 29, 2017

An Innovative Approach to Retrofitting for Nitrogen Removal

OWEA 2017 TECHNICAL CONFERENCE & EXPO

Innovation

From Wikipedia:

“The application of better solutions that meet new requirements.”

Today's Topics

Nitrogen Removal from Wastewater

- Principles
- Case Studies
  - A: Stabilizing Nitrification in HPO system
  - B: Creating an Anoxic zone
  - C: Denitrifying STEP ww

All case studies presented include an (online) process monitoring component

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Why Nitrogen Removal?

Required by Discharge Permit

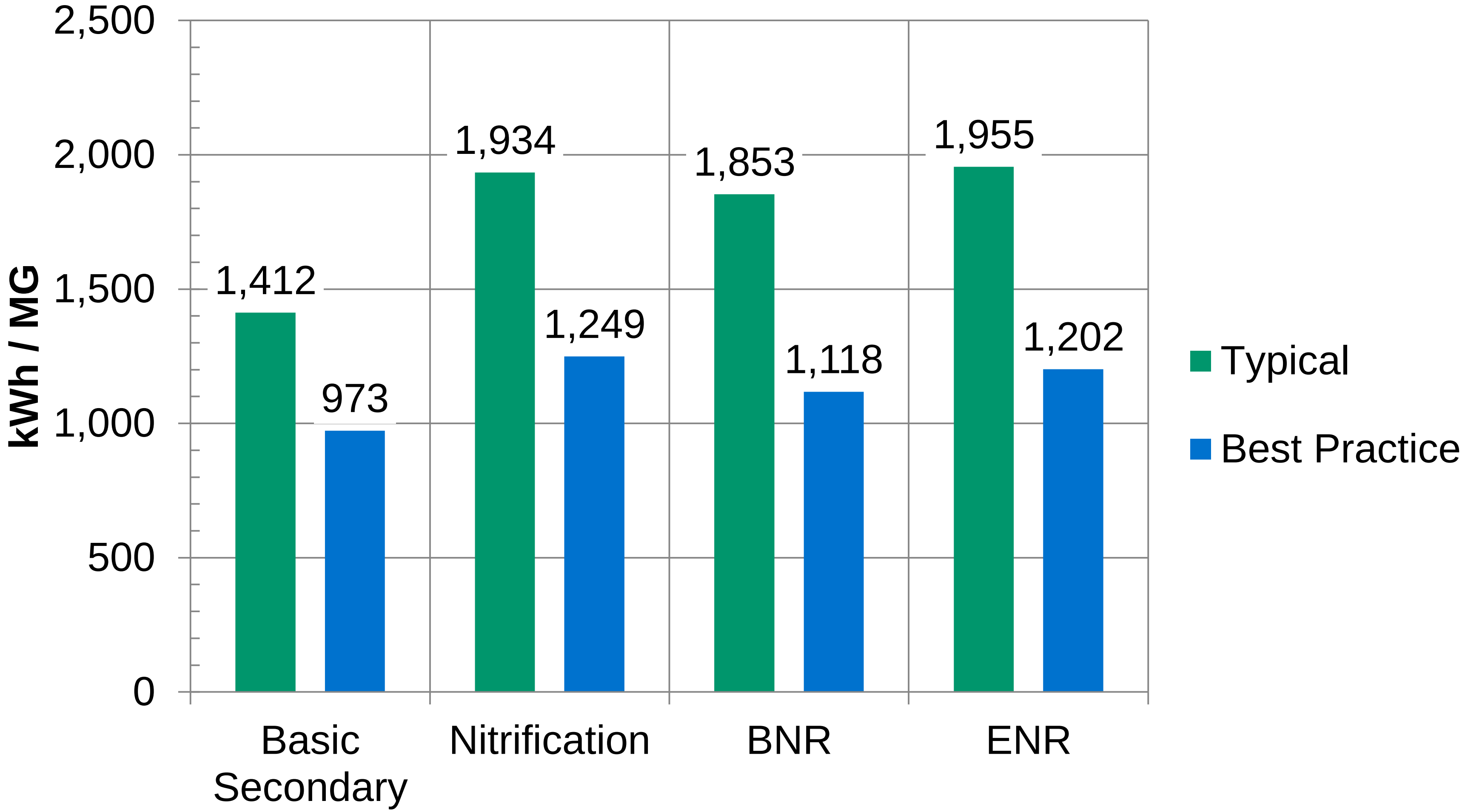
Improve Water Quality (avoid future limit)

Increase Revenue (water quality trading)

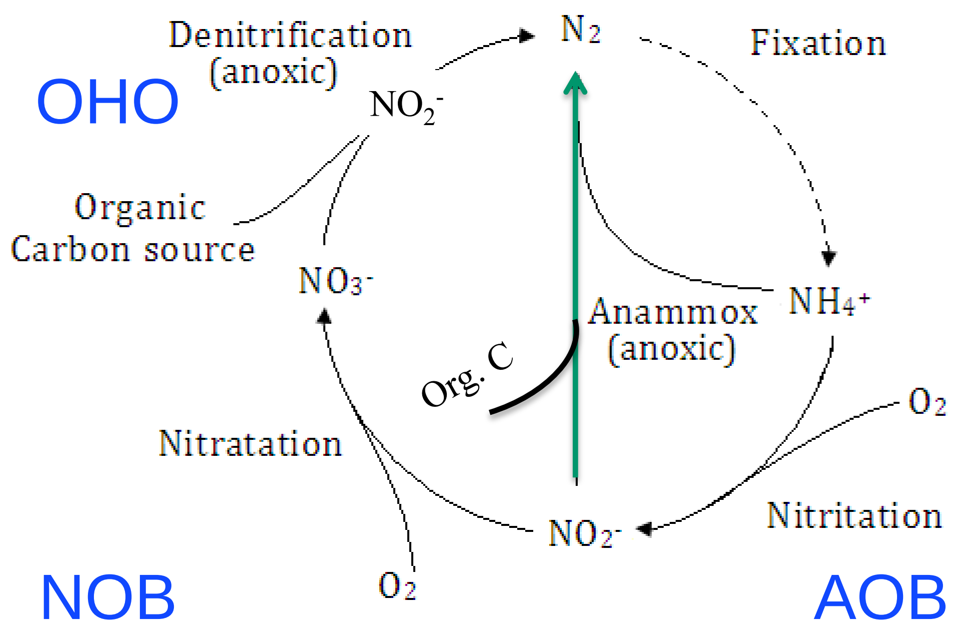
Stabilize Process

Save Energy

Energy Intensity Benchmarking



The Microbiological Nitrogen Cycle



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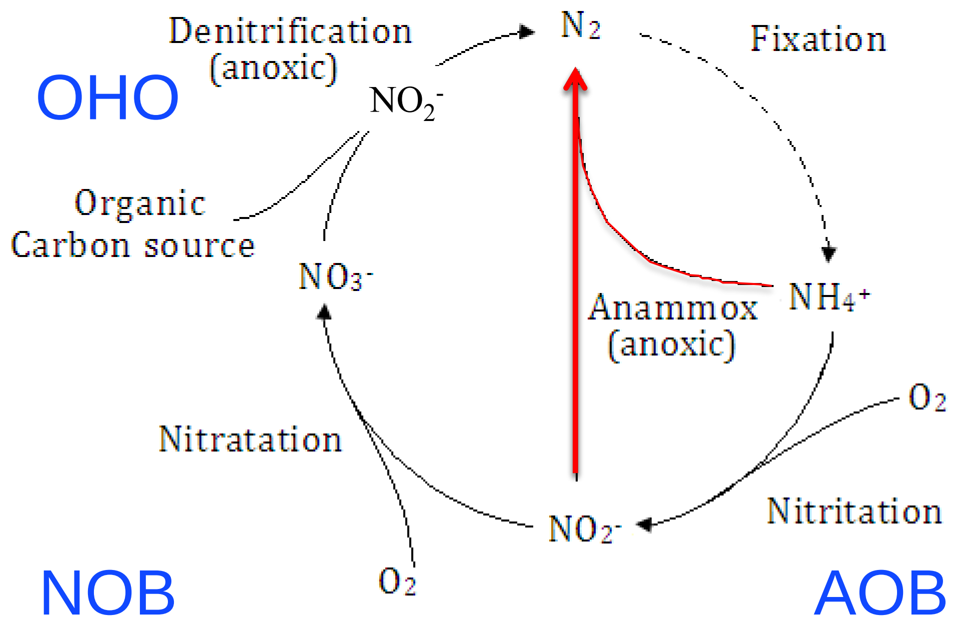

3 Requirements for Biological N Removal

Stable nitrification to generate nitrate ($NH_3 \rightarrow NO_3$)

Anoxic (low DO, low/negative ORP) conditions

Carbon (BOD) for a source of energy

Case Study A – HPO Activated Sludge

Short retention time – conditions change fast

Caustic added to effluent to meet pH requirements

Summer limit: 1.9 mg NH_3-N / L
Winter limit: 5.0 mg NH_3-N / L
(30-day average)

Problems maintaining adequate nitrification, especially in Spring

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Nitrification

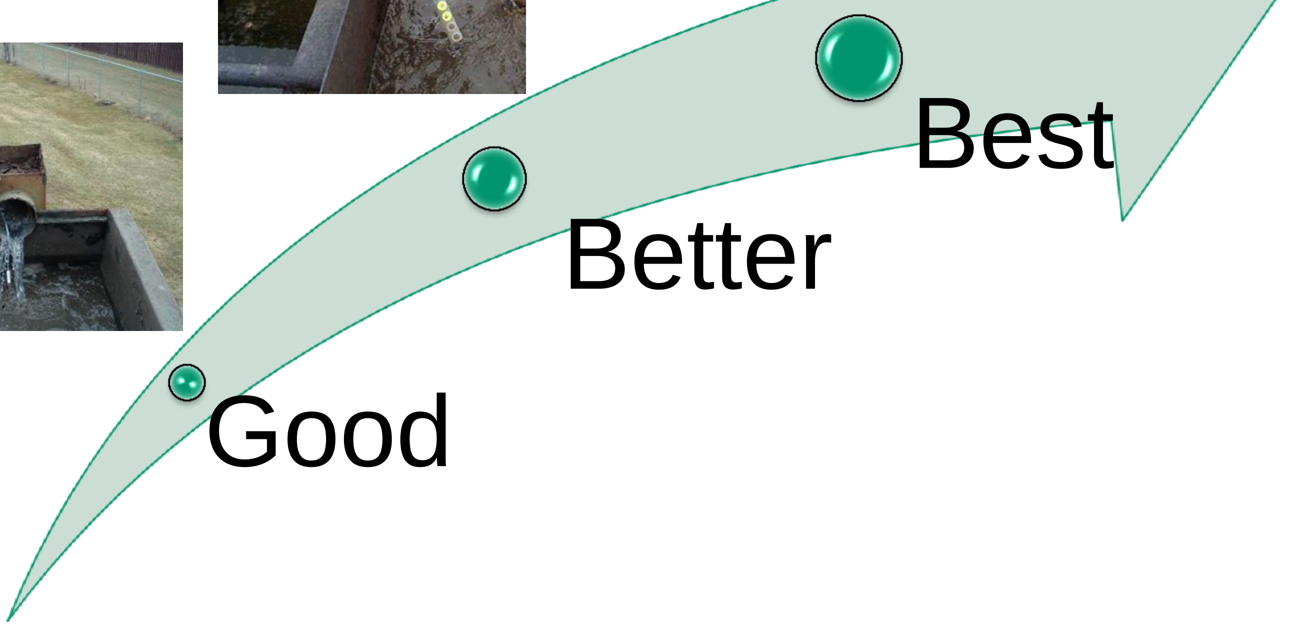
Aeration to provide DO > 1.0

Solids Retention Time > 8 days (depends on temperature)

pH – 6.5 to 8.5 (peak rate is around 7.5)

Usually relatively easy to achieve provided DO, SRT, and pH conditions are maintained within acceptable ranges

Measuring Nitrification

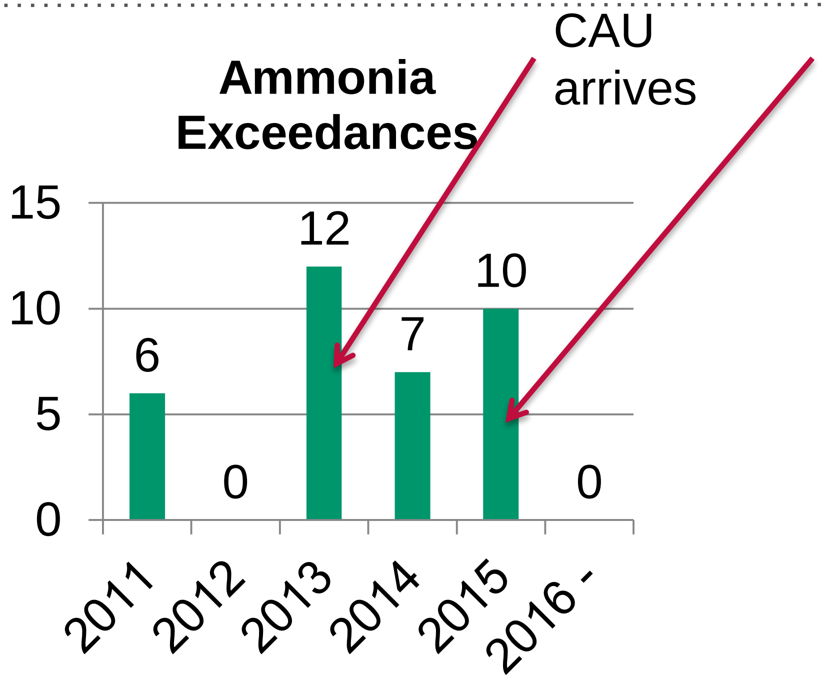


Case Study A – Innovations

Relocated caustic dosing point to upstream from aeration tanks.

Redirected 2nd stage solids to 1st stage.

Installed monitoring system for ammonium, nitrate, and pH.



Case Study B – Extended Aeration Activated Sludge

2 x 1-pass aerated tanks (212 kgal. ea.) – 1 in service for daily flow of 260 kgpd

EQ, Sand filters, chlorine disinfection, post aeration, aerobic sludge storage tanks

New discharge limits: 10 mg TIN / L

Fully aerobic (oxic)

Stable nitrification but not designed for denitrification – no anoxic zones or nitrate recirculation

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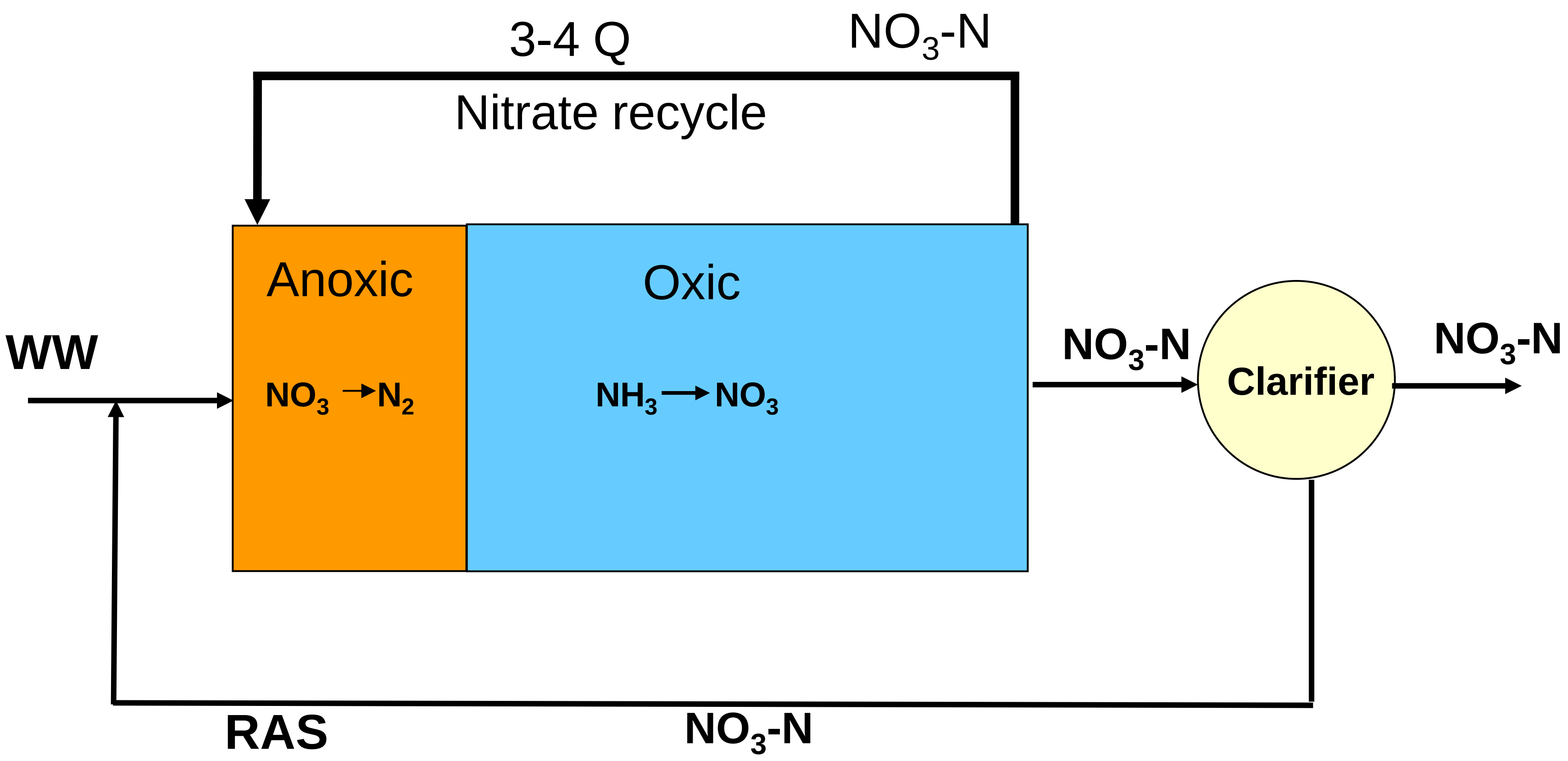
Typical Denitrification Flow Sheet



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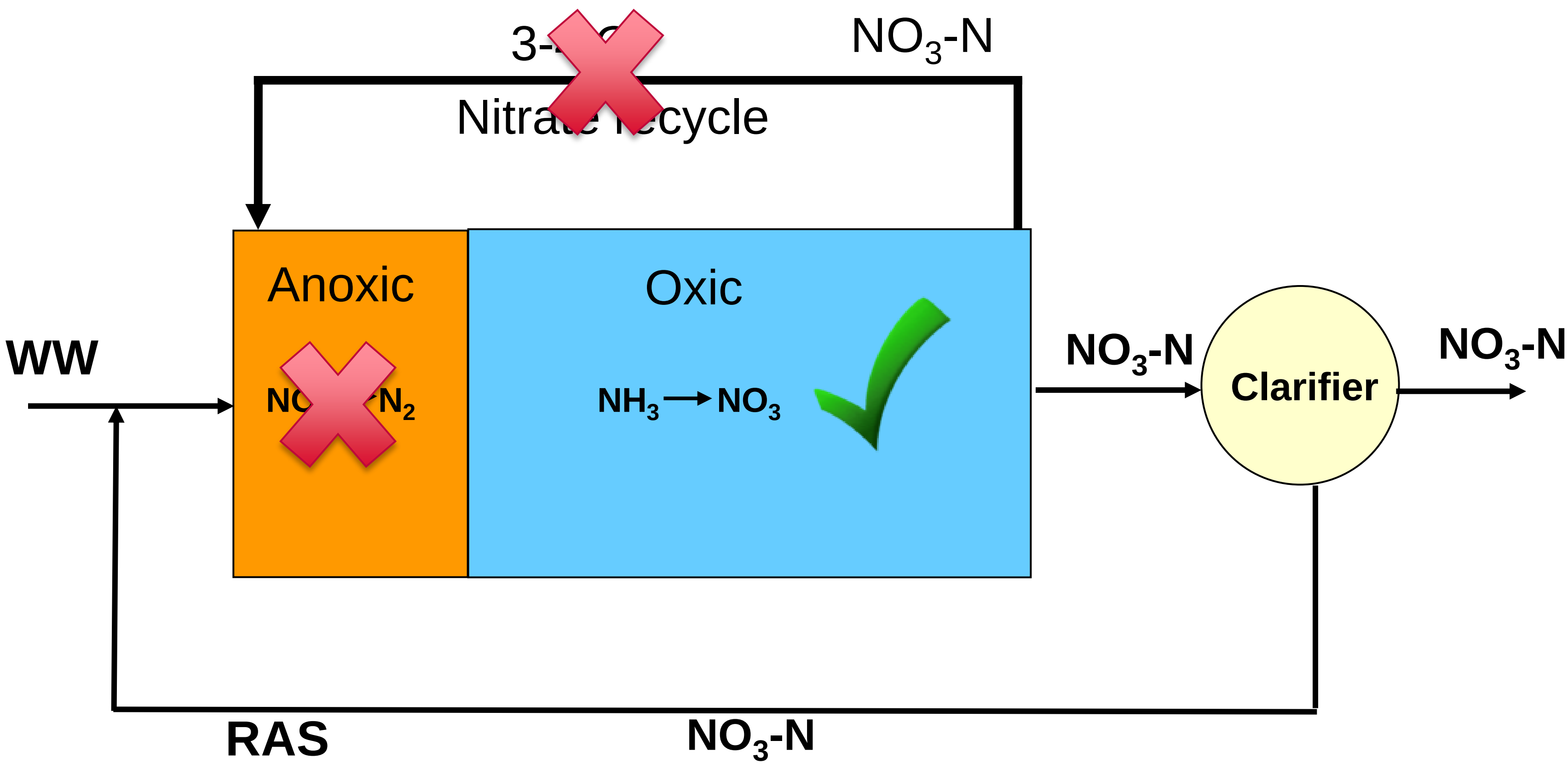

Case Study B – Innovations

Convert EQ tank to anoxic zone?

Convert 1 of 2 aerated tanks to anoxic zone?

Build anoxic zone into existing online aeration tank?

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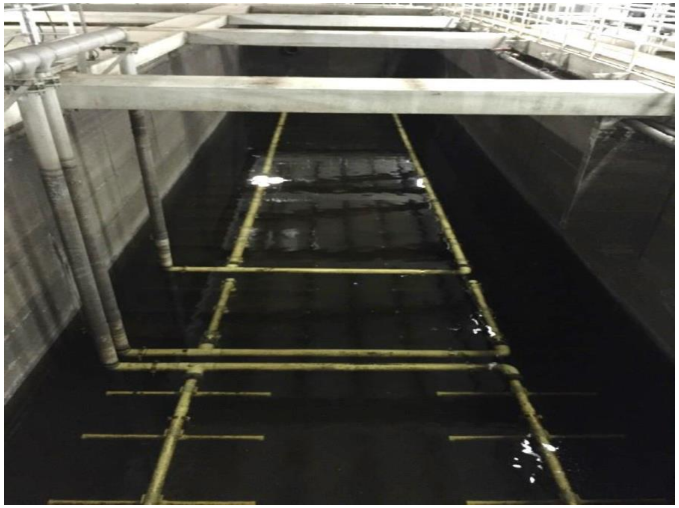
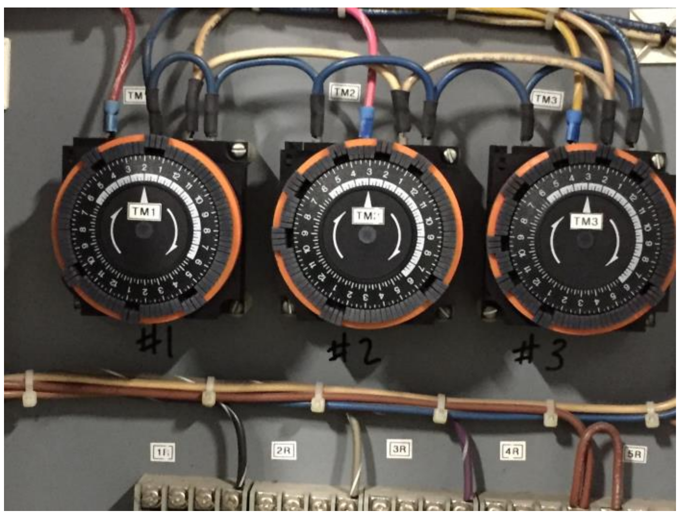


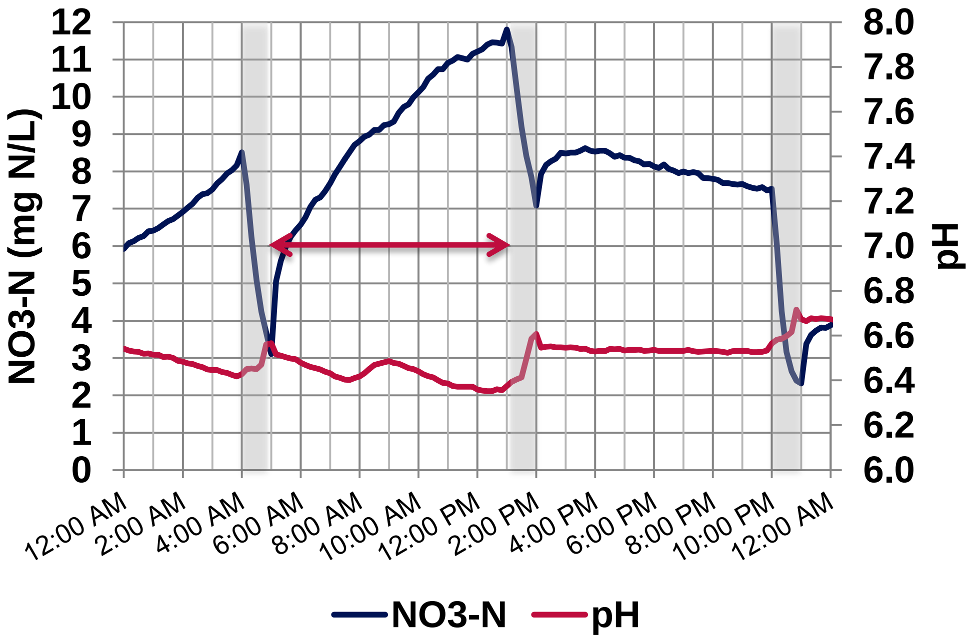
Case Study B – Nitrate Recirculation?

No nitrate recirculation

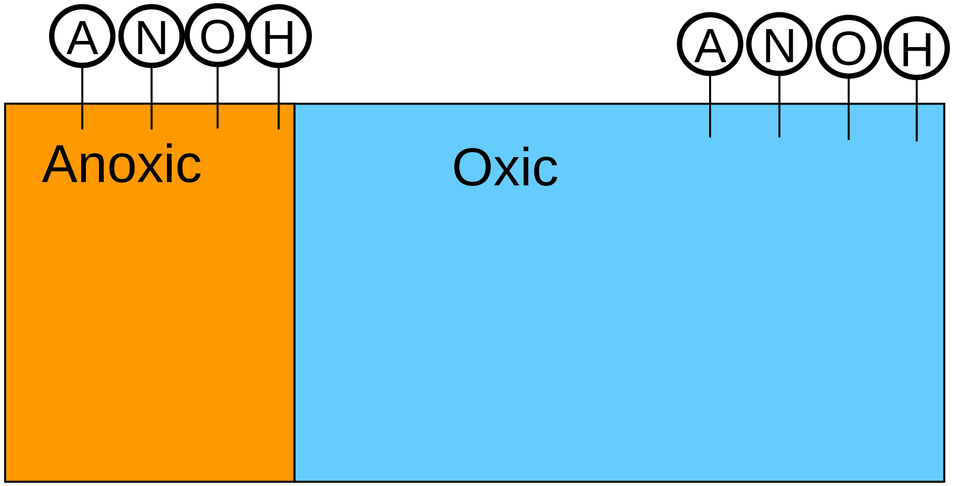
Instead: Intermittent aeration of oxic zone for increased denitrification
Lead blower "off" 3 x / day

2 blowers operated continuously for nitrification of peak morning load





Case Study B - Process Monitoring System

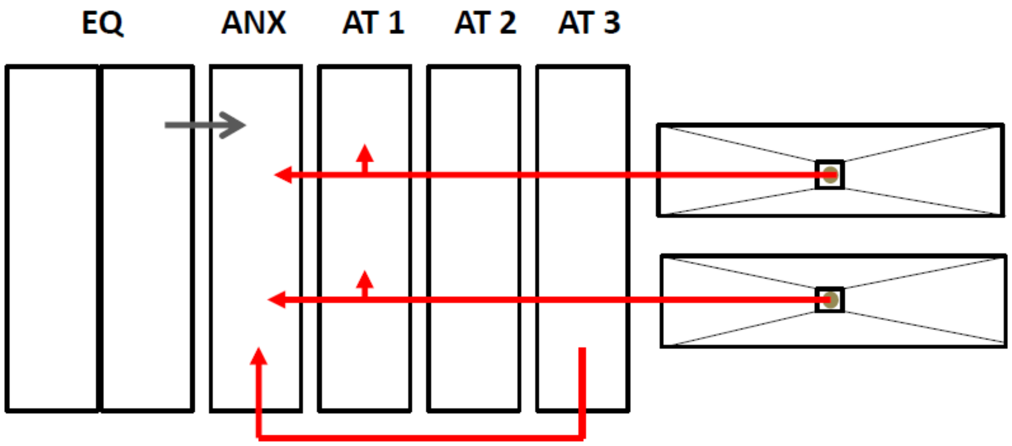


Case Study C: STEP system

WWTP on new housing development / early in build-out

Nitrate recycle system but no external carbon

Nitrates in effluent exceed limits / nitrification stable



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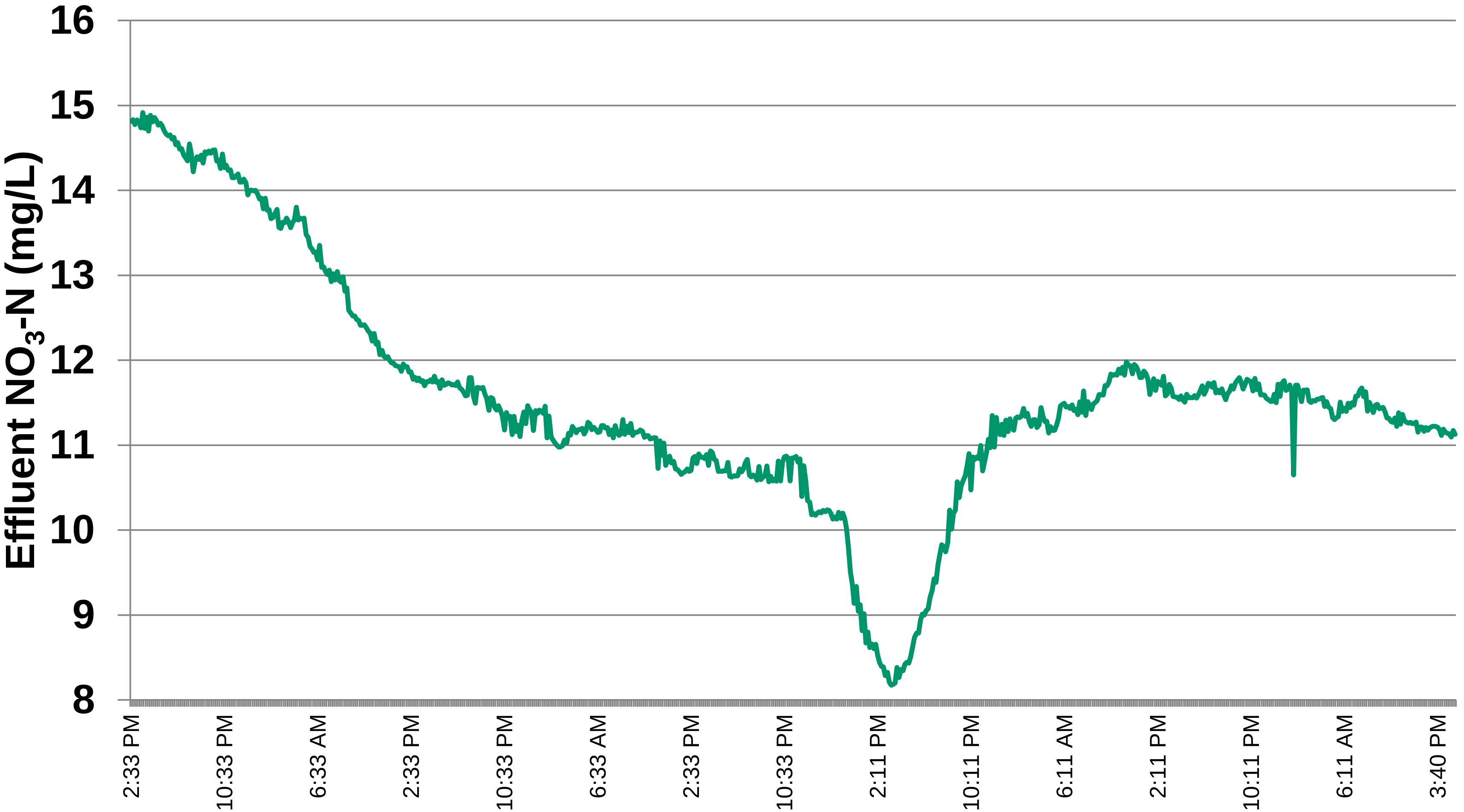
Troubleshooting Denitrification

Oxic / effluent	Anoxic	Condition	Remedy
Low NO_3	Low NO_3	DN not limited	None as long as nitrification is stable
High NO_3	Low NO_3	Nitrate limited	Increase nitrate recycle
High NO_3	High NO_3	Carbon limited	Increase carbon dosing

Case Study C

	Oxic NO_3	Anoxic NO_3	Nitrate Recycle Rate	Anoxic Volume	Carbon
Initial	16.4	15.6	100%	1 x	N/A
Stop nitrate recycle pump	10.6	5.1	0%	1 x	N/A
Resume nitrate recycle / add anoxic volume	7.0	3.9?	15 / 75	2x	N/A
New nitrate method	14.1	7.3			
Add mixer to 2nd anoxic zone	22.2	10.8			

Case Study C: Optical Nitrate Probe



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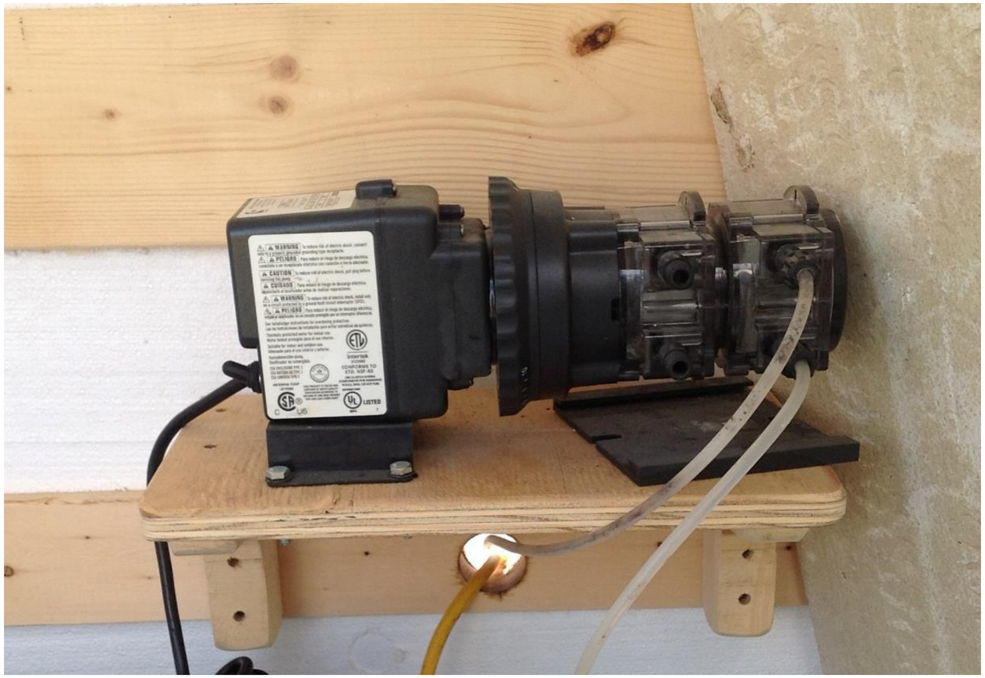
Case Study C – Simple Carbon Dosing System

Peristaltic pump – off the shelf

Gycerin – safe alternative to methanol



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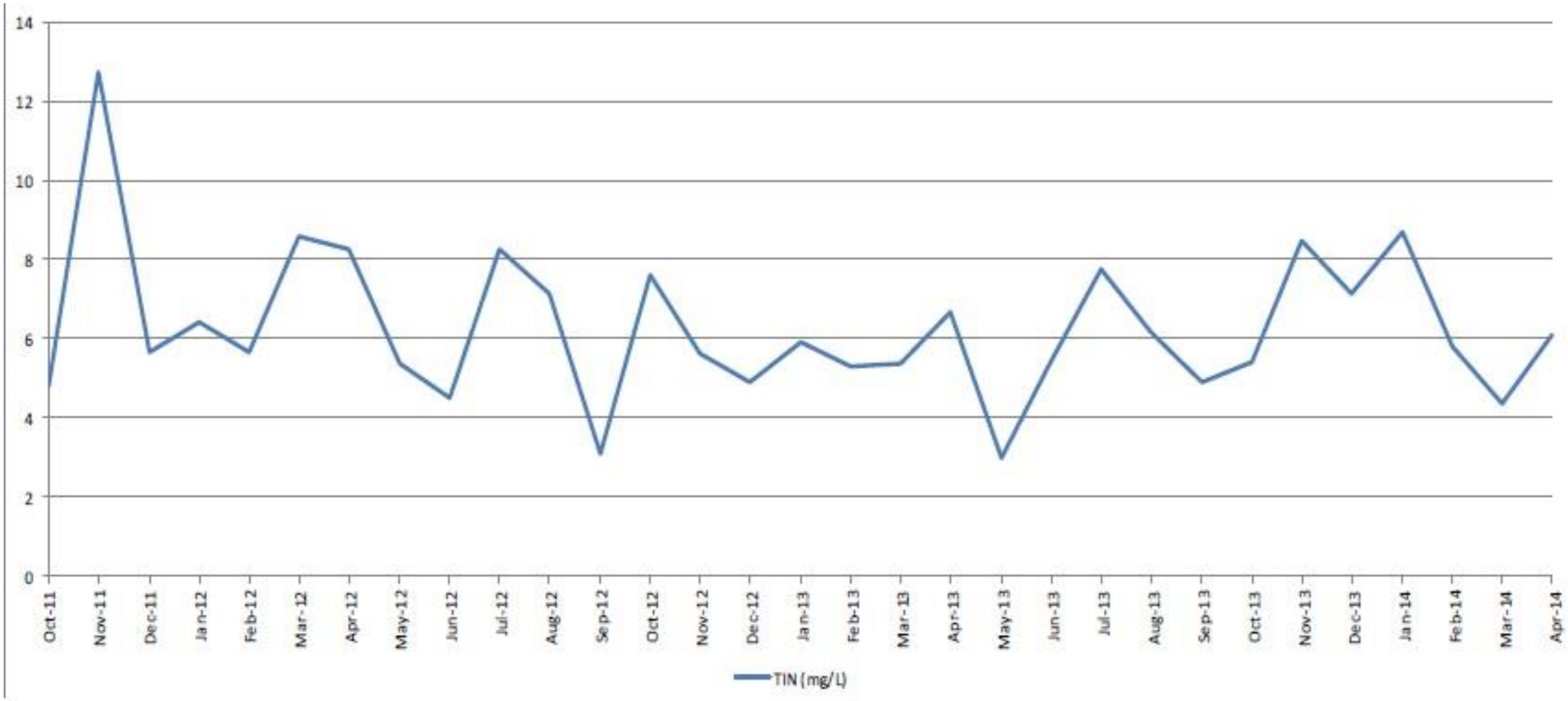
Add mixer to 2nd anoxic zone	22.2	10.8			
Add carbon dosing system	10.1	0.7			

Case Study C – Effluent Monthly Total Inorganic Nitrogen (TIN)



Summary

Innovation to provide N removal requires an understanding of the biology to cultivate and enrich critical populations.

Innovation includes modifications to existing equipment, developing new ways to operate, or creating new systems from off-the-shelf materials and equipment.

Online process monitoring is valuable for understanding what is limiting treatment performance and quickly evaluating viability of solutions.

Case Study A: HPO system – modified chemical dosing point and implemented new solids recirculation to stabilize nitrification.

Case Study B: Extended Aeration – constructed new zone, operational modification to aeration to create anoxic conditions.

Case Study C: STEP system influent – optimized nitrate recirculation, added carbon dosing system to stabilize denitrification.

Acknowledgments

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Delaware County RSD Wastewater Facility Operations Department

Questions?