# How's Brockton Doing? 2 Years of Process Optimization to Achieve 3 mg/L TN

## Brockton, Massachusetts – Advanced Water Reclamation Facility

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CDM Smith

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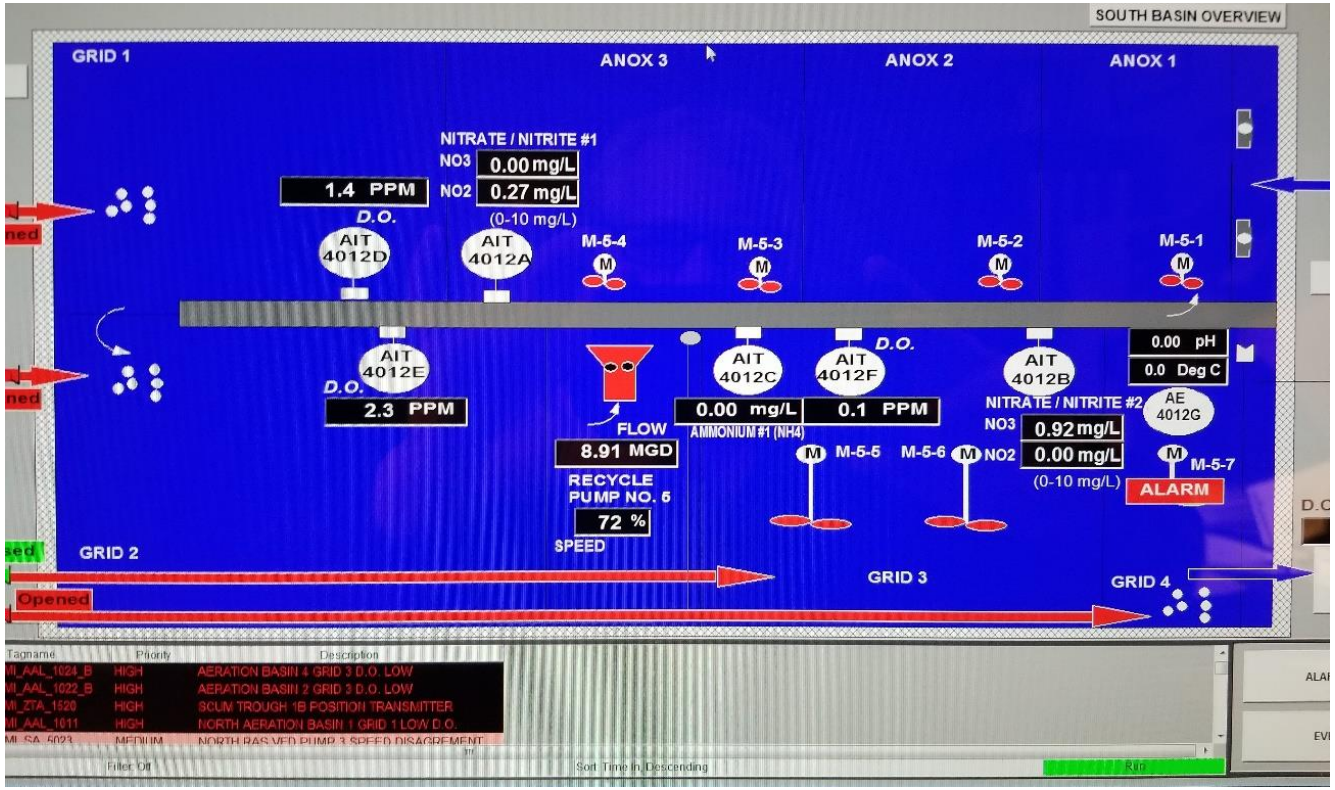
2023 Annual Conference & Exhibit
January 22-25 | Boston

# Topics

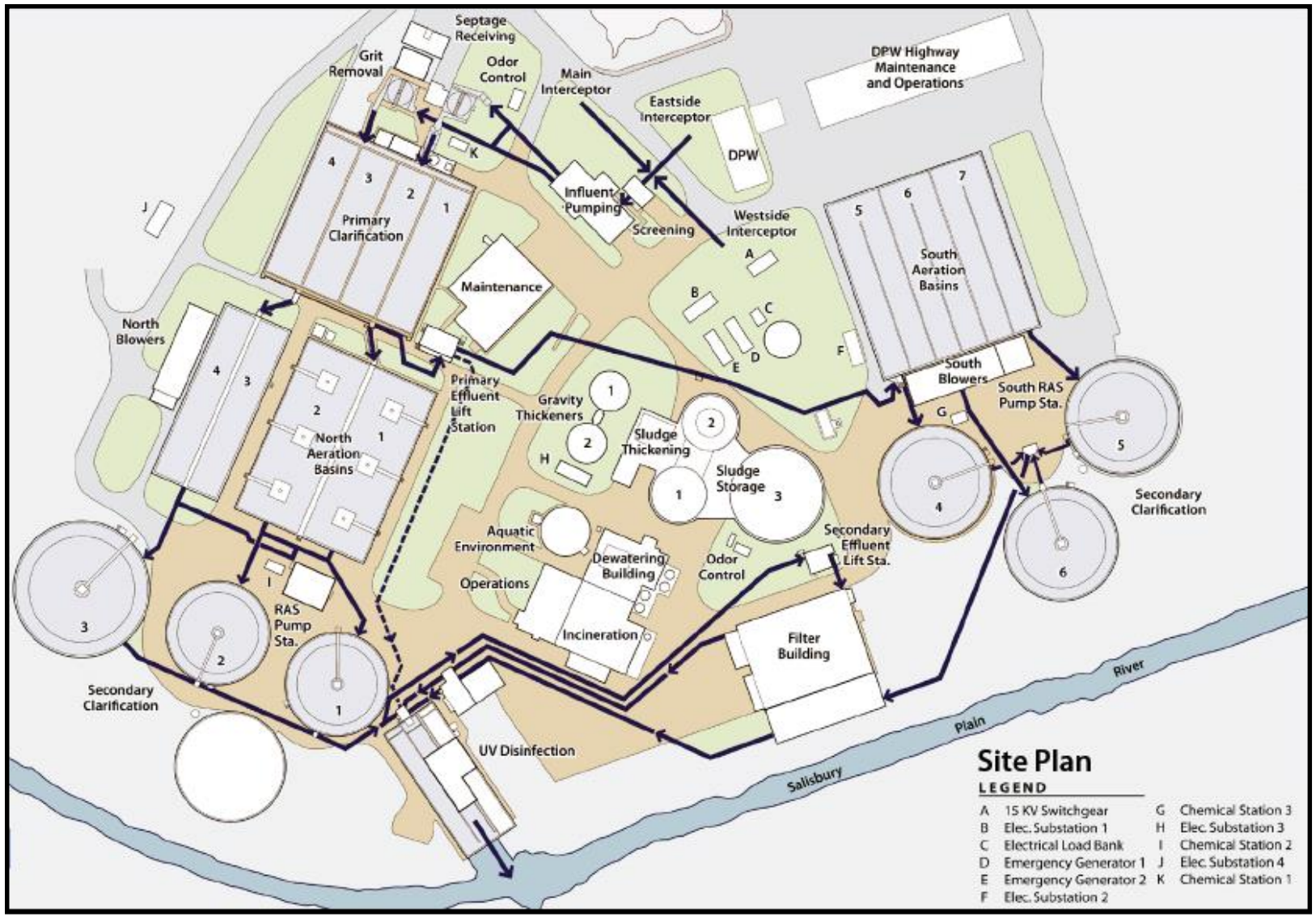
- Background/history
- BNR upgrade/configurations
- Performance Summary
  - Effluent quality
  - rDON
- On-Line instrumentation and Optimization



# Brockton AWRF

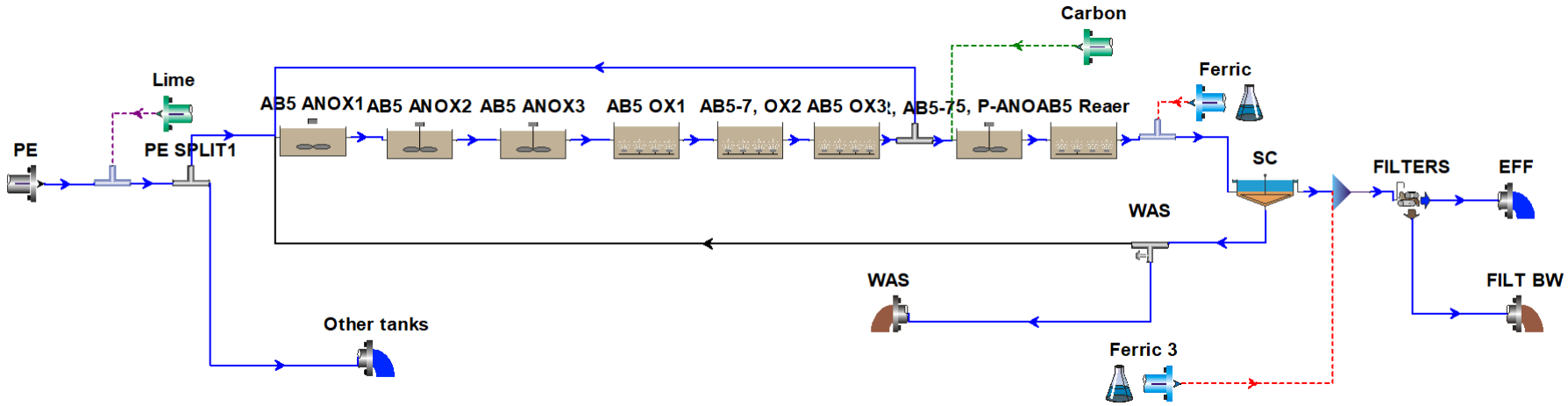
- City population <100,000
- Activated sludge late 1960s
- Expansion early 1980s (2-stage process)
  - 18 mgd average annual flow
  - 36 mgd max day flow
  - 60 mgd peak
- Upgrade in mid 2000s (nutrient removal)
  - Expansion to 20.5 mgd
  - N removal to 5.5 mg/L TN (MLE)
  - Chemical P removal to 0.2 mg/L
    - AquaDiamond cloth filters

# Brockton AWRF

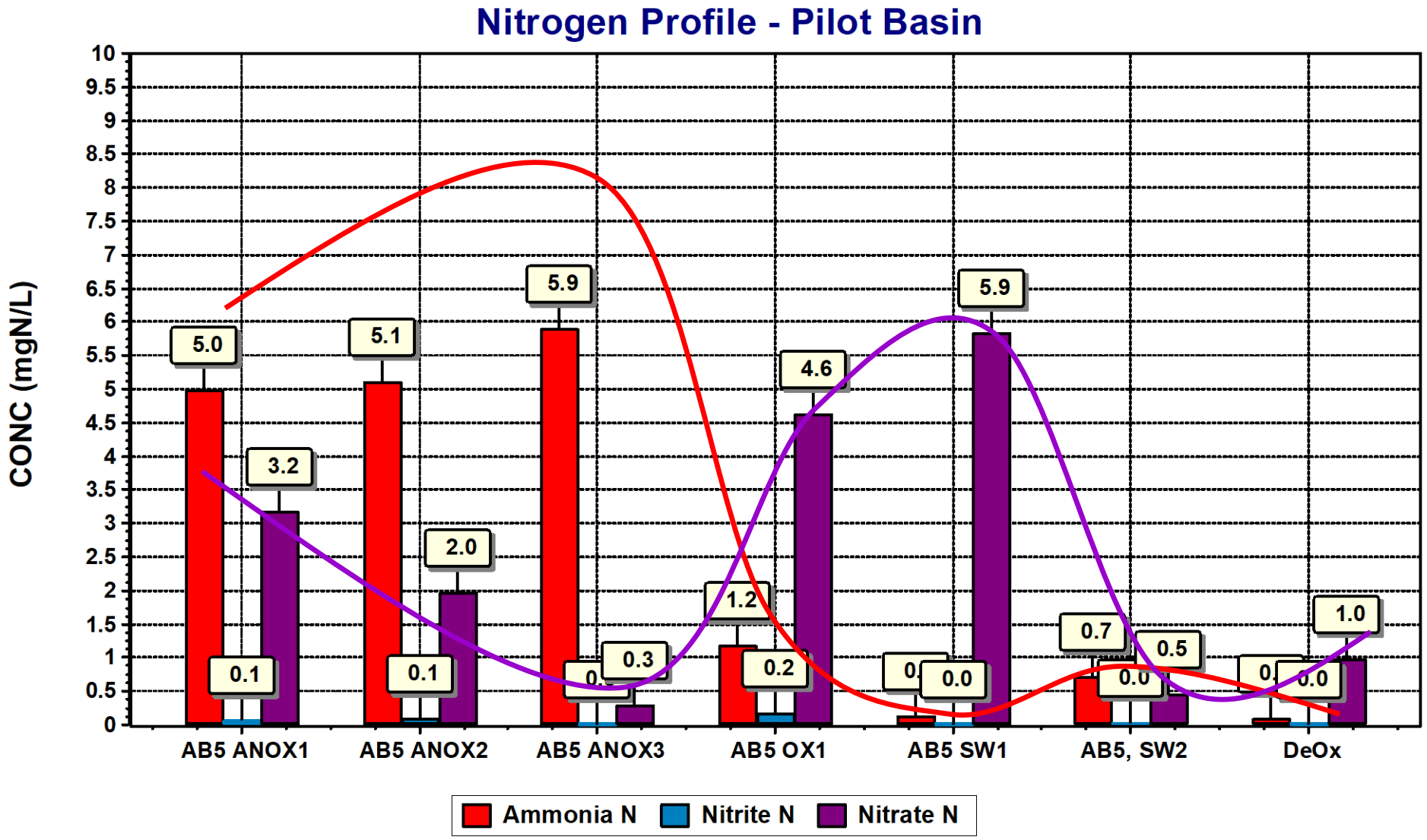


# 3 mg/L TN Pending…?

- Around 2012-2013 Brockton anticipated that at some point that a TN limit might be included in NPDES permit
- 3 mg/L a possibility?
- Conceptual evaluation of alternatives
  - Option 1: Achieve 3 mg/L TN with existing (modified) processes
  - Option 2: Add tertiary denitrification (at cost of $10Ms)
  - Process evaluation determined that Option 1 could work – but would be challenging
  - Piloting conducted to verify possible performance

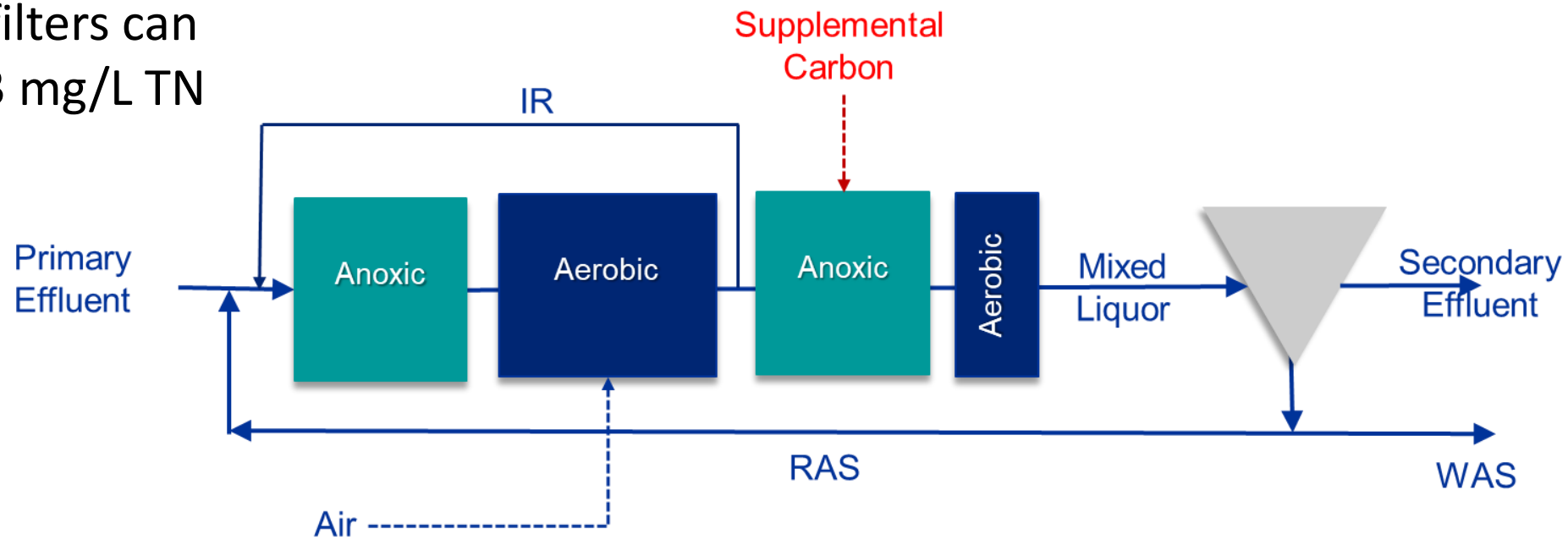


# Process Model Predicted Nitrogen Profile



# Piloting

- One of AWRF's treatment trains modified
- Confirmed that 4-stage Bardenpho followed by effluent filters can achieve 3 mg/L TN





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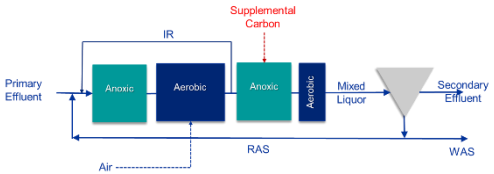
# 2 Years of Pilot Nitrogen Removal Performance

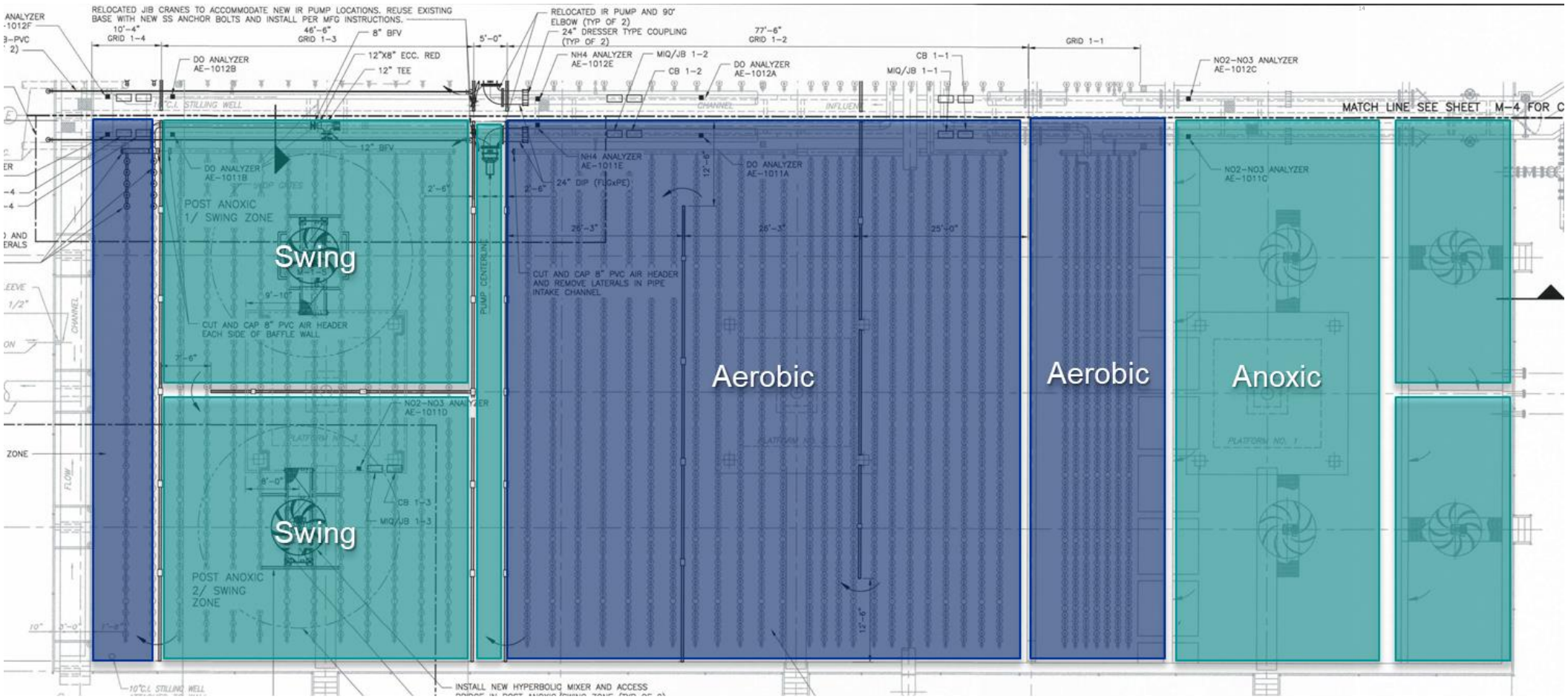
| Parameter | Average | Maximum |
|---|---|---|
| $NH_3$-N | 0.12 mg/L | 0.31 mg/L |
| $NO_2$-N | 0.011 mg/L | 0.020 mg/L |
| $NO_3$-N | 1.16 mg/L | 2.91 mg/L |
| TIN | 1.29 mg/L | 3.1 mg/L |

# NPDES Limits (2017 Renewal)

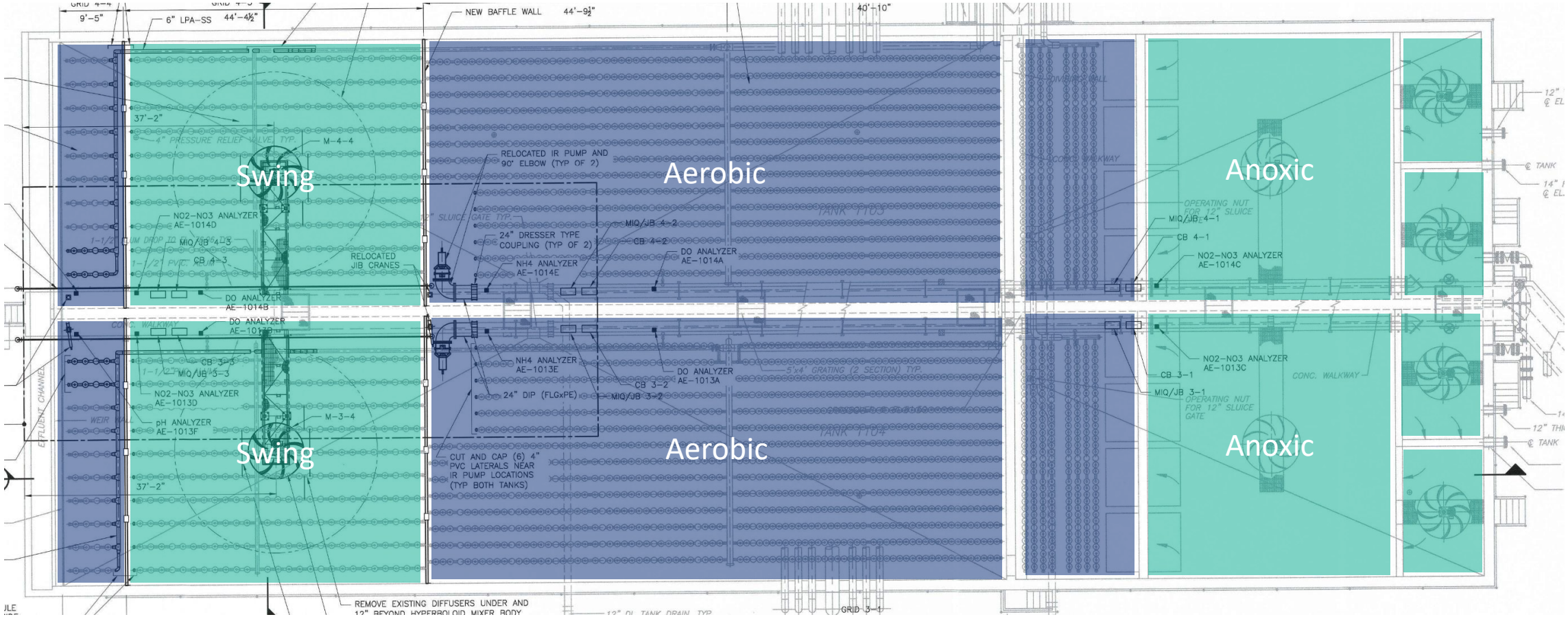
| | Average Monthly | Average Weekly | Maximum Daily |
|---|---|---|---|
| CBOD5 (5/1 – 10/31) | 5 mg/L | 8 mg/L | 15 mg/L |
| CBOD5 (11/1 – 4/30) | 15 mg/L | 25 mg/L | 30 mg/L |
| TSS (5/1 – 10/31) | 5 mg/L | 8 mg/L | 15 mg/L |
| TSS (11/1 – 4/30) | 15 mg/L | 25 mg/L | 30 mg/L |
| Total phosphorus (4/1 – 10/31) | 0.101 mg/L | -- | -- |
| Total phosphorus (9/1 – 3/31) | 1.0 mg/L | -- | -- |
| Ammonia-nitrogen (6/1 – 10/31) | 1 mg/L | 1 mg/L | 1.5 mg/L |
| Ammonia-nitrogen (11/1 – 11/30) | 6.3 mg/L | -- | -- |
| Ammonia-nitrogen (12/1 – 4/30) | 9.5 mg/L | -- | -- |
| Ammonia-nitrogen (5/1 – 5/31) | 3.2 mg/L | -- | -- |
| Total nitrogen (5/1 – 10/31) | 450 lbs/day (seasonal average) | | |

# Aeration Basin No. 1 Process Layout (No. 2 Similar)

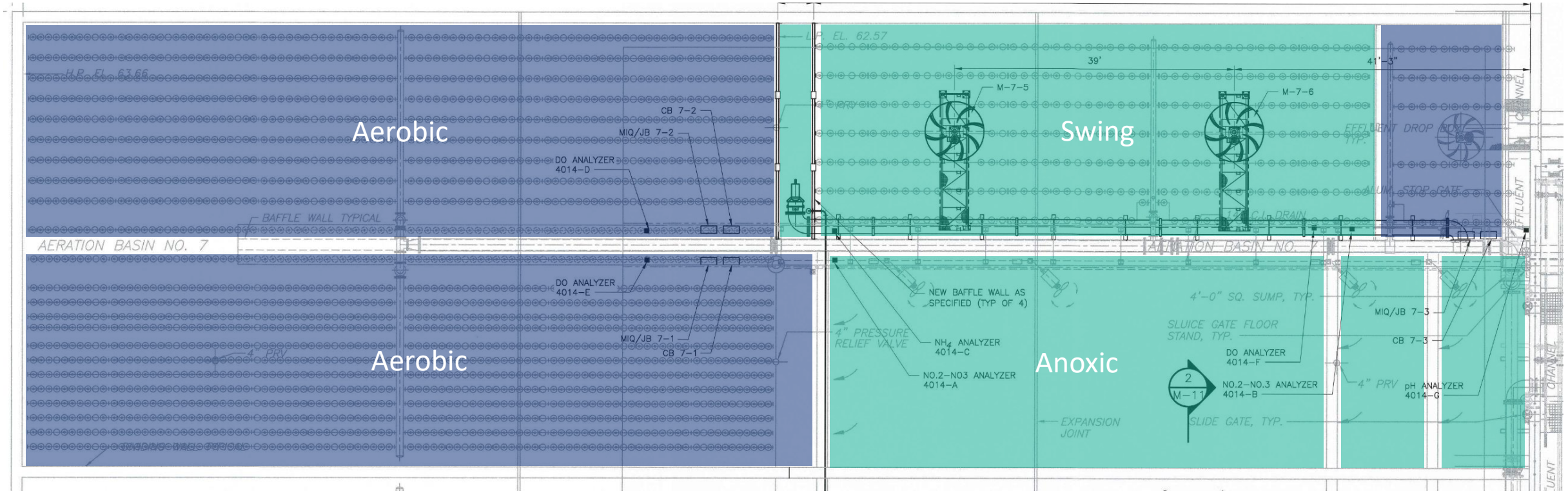


# Aeration Basin Nos. 3 and 4 Process Layout

# Aeration Basin No. 7 Process Layout (Nos. 5 and 6 similar)

# Basin Modifications

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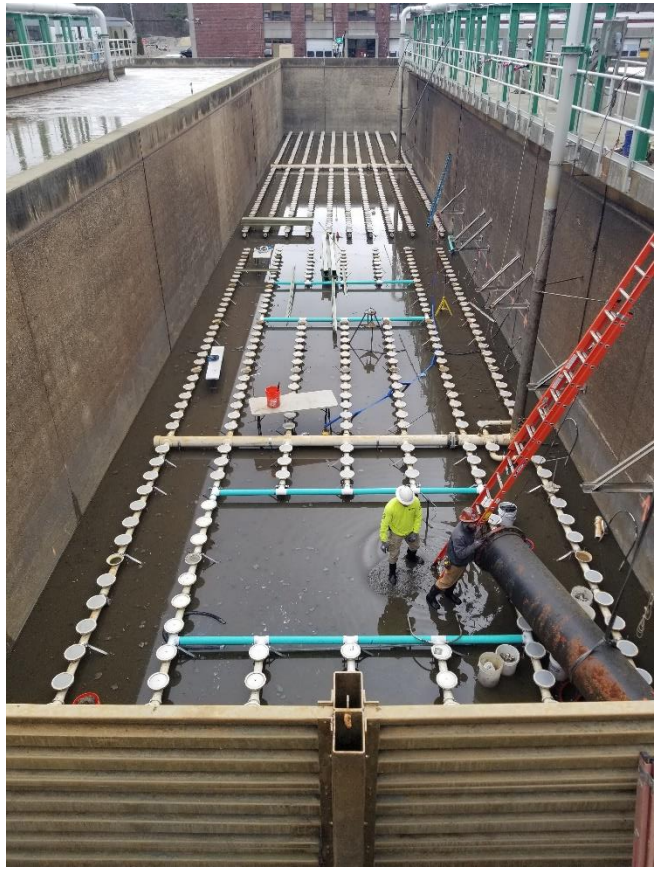
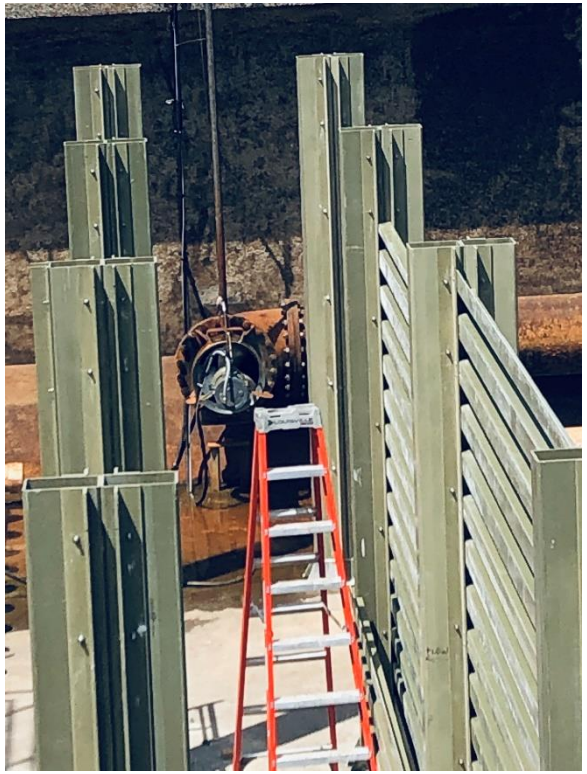
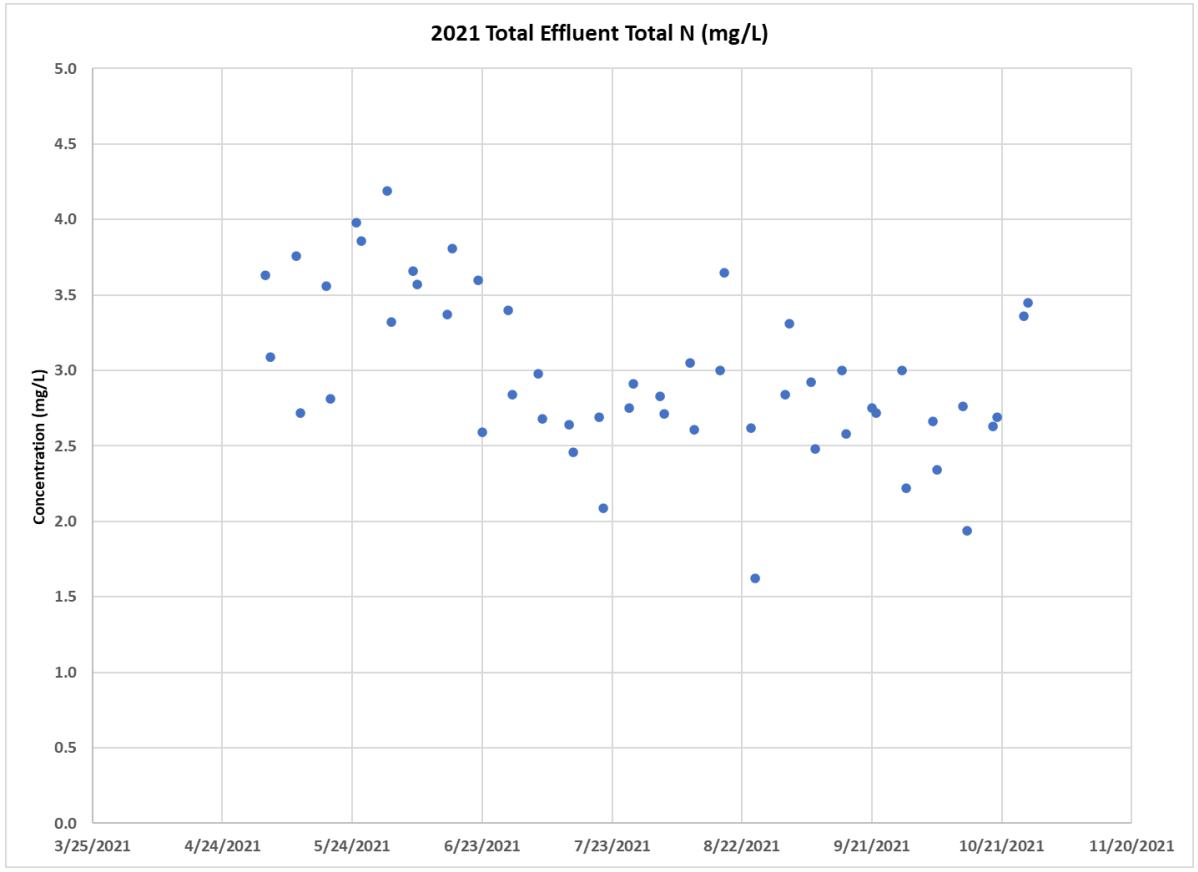
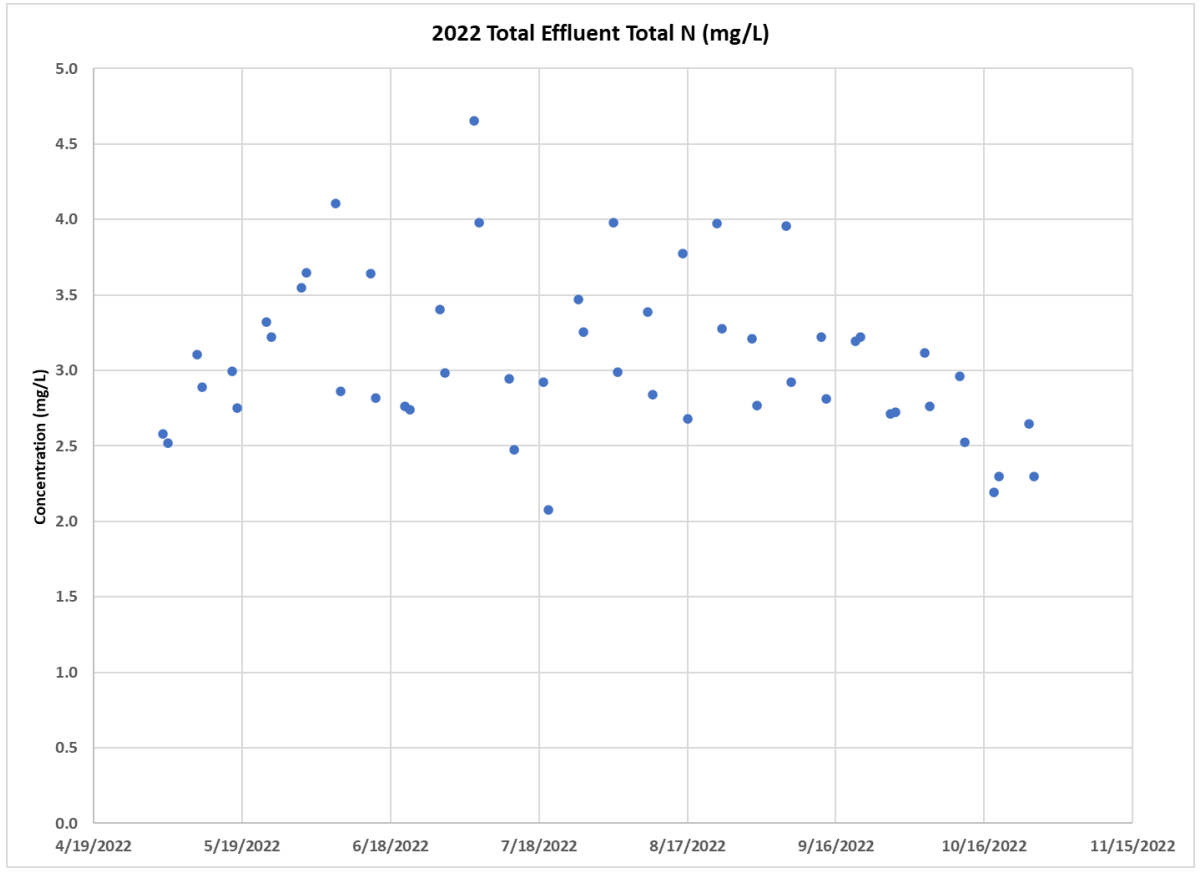


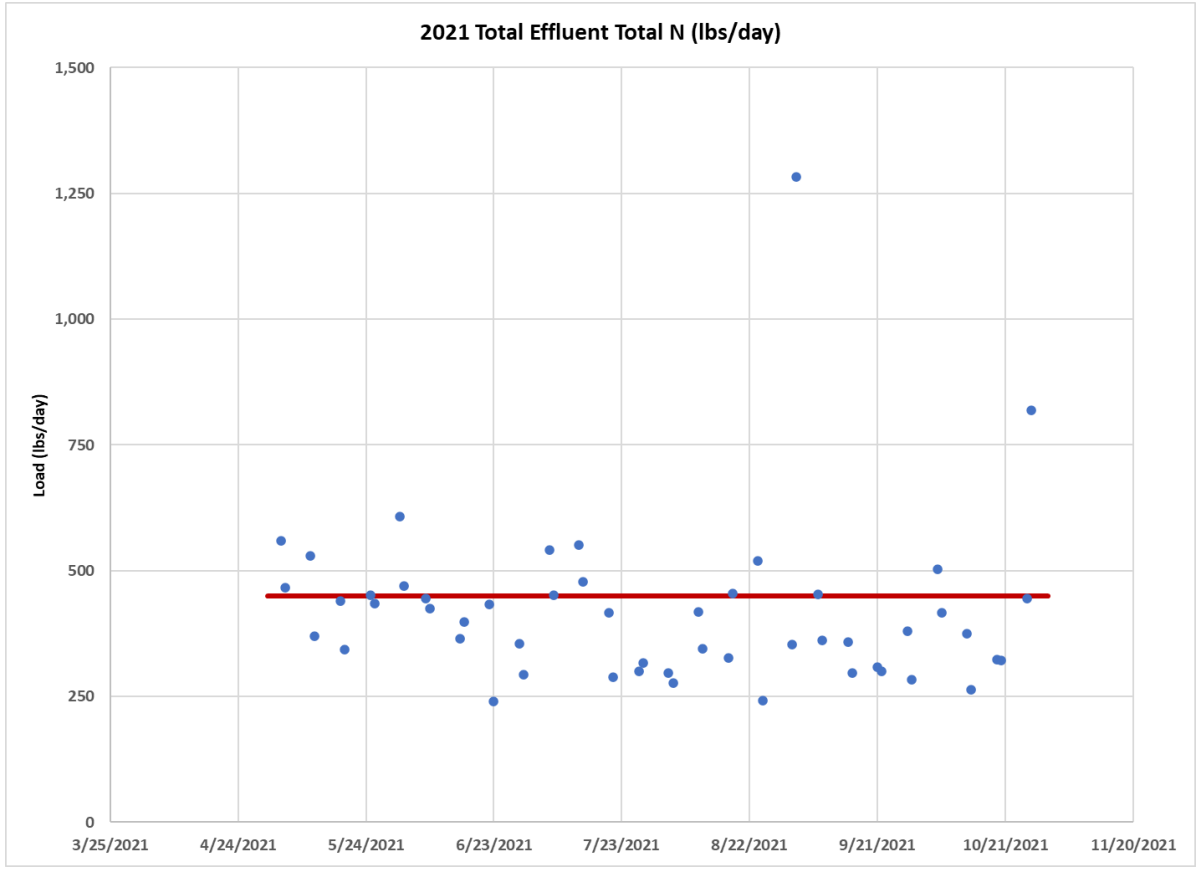


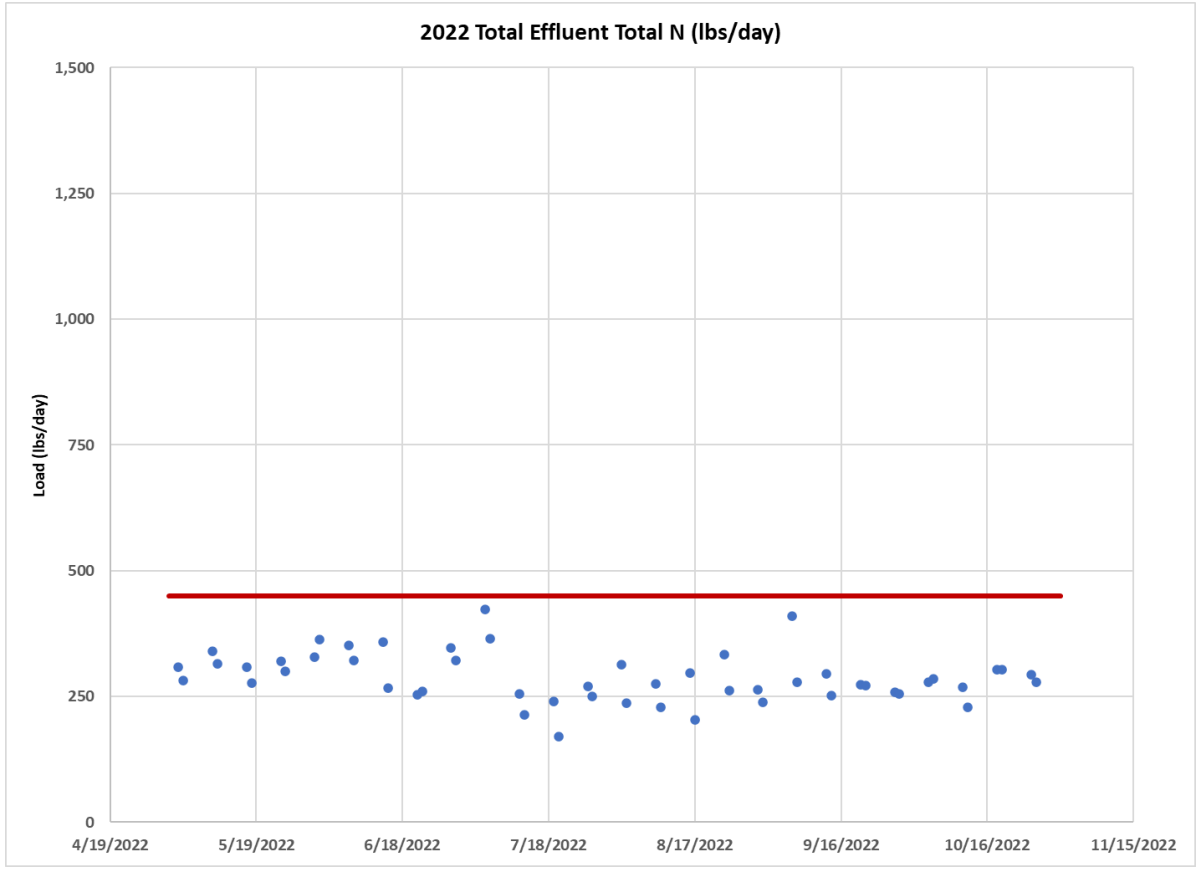
# Effluent TN Concentrations



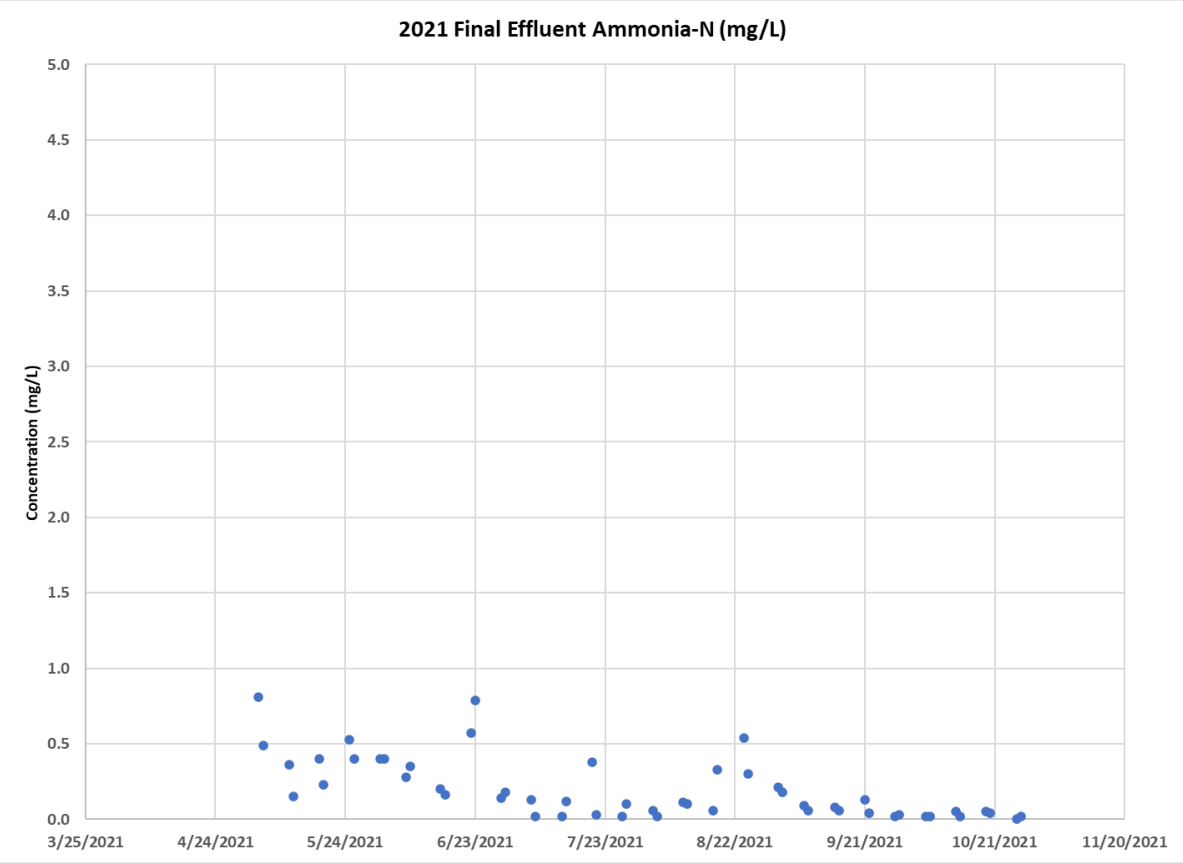



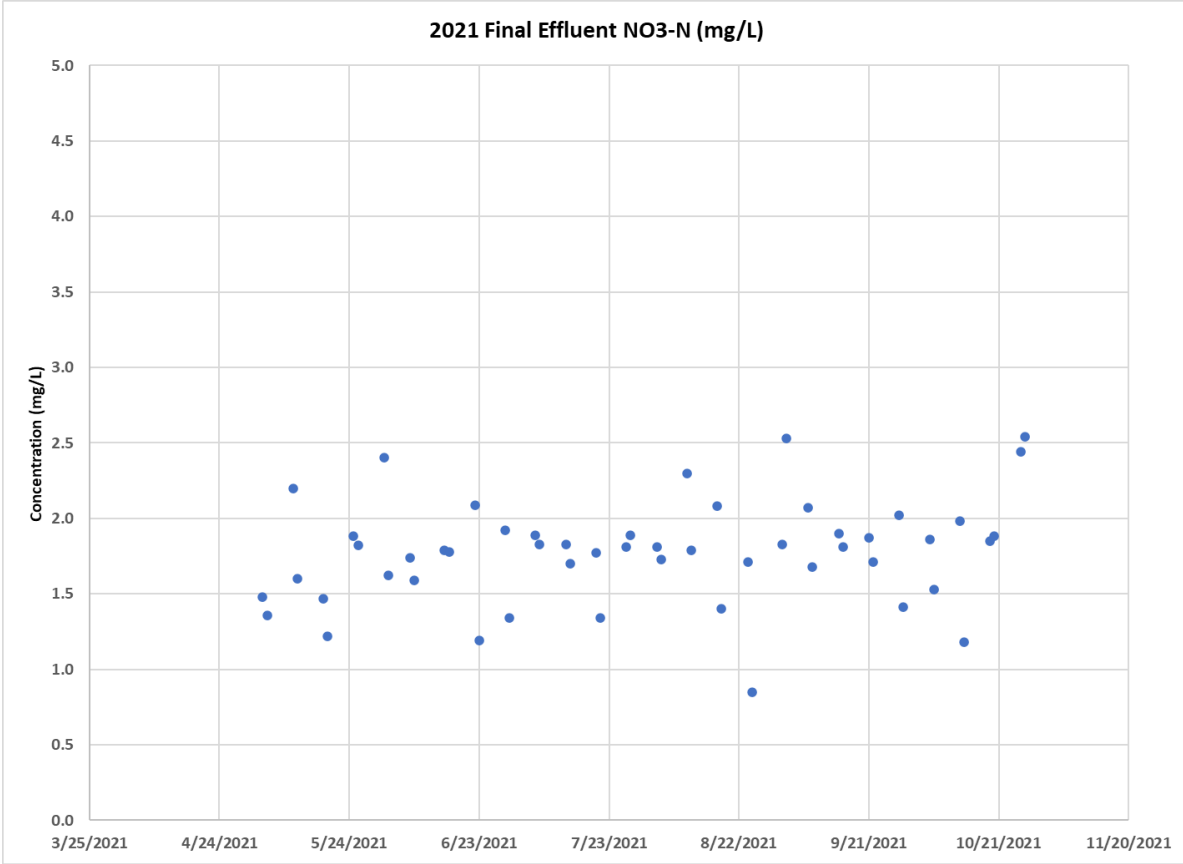
# Effluent TN Loads



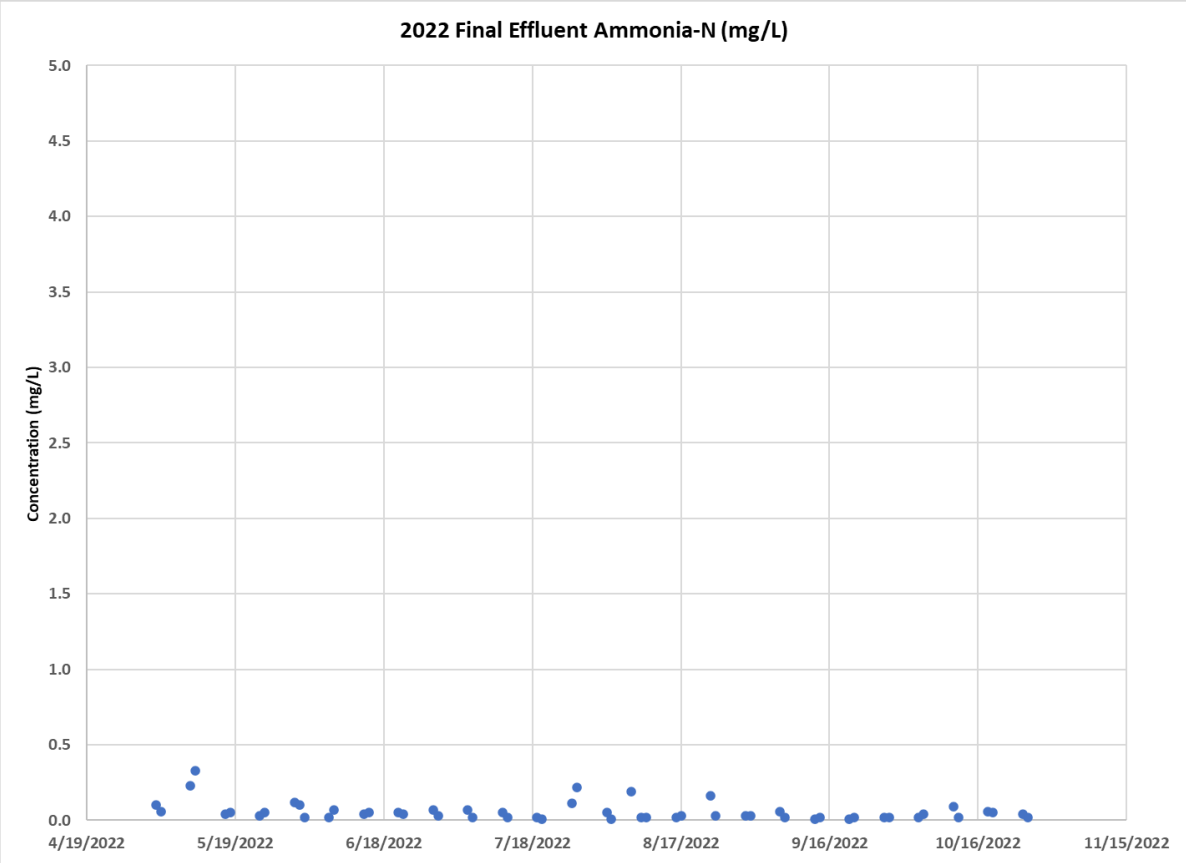



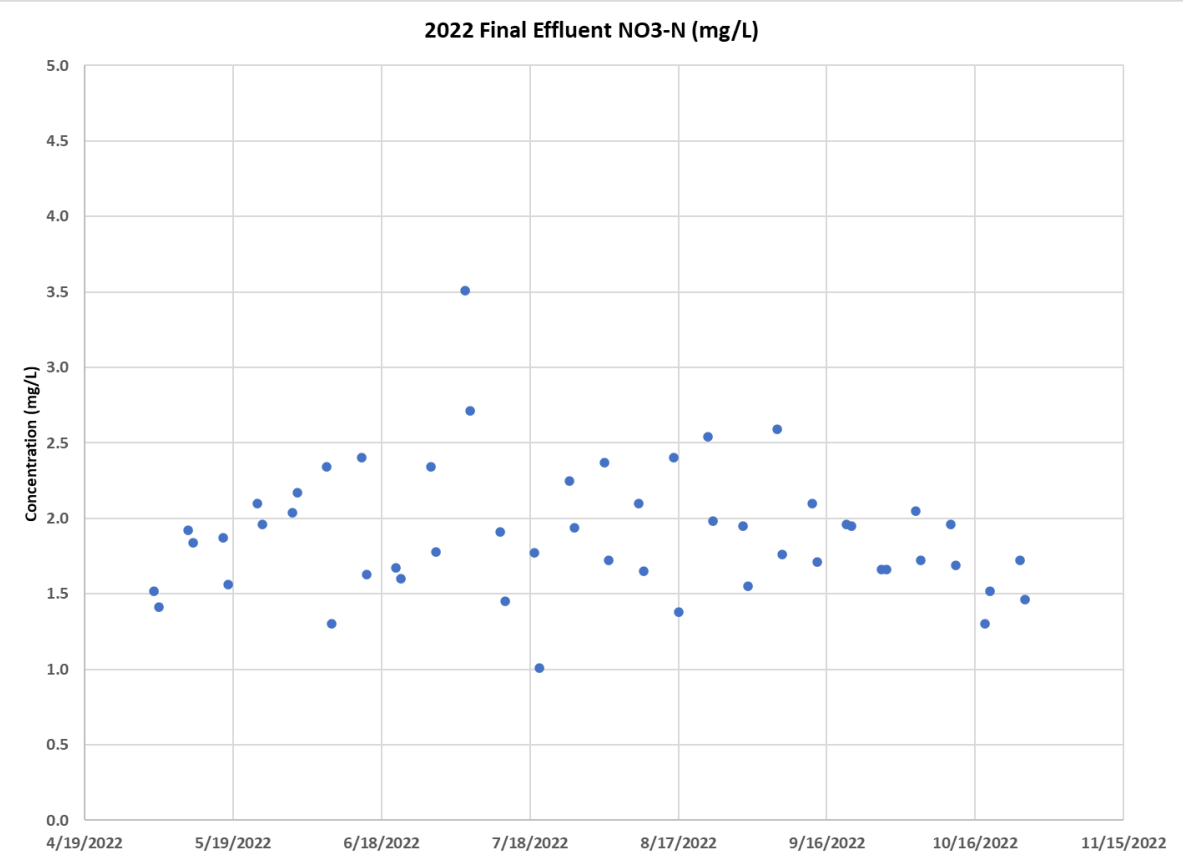
# 2021 Effluent Ammonia and Nitrate



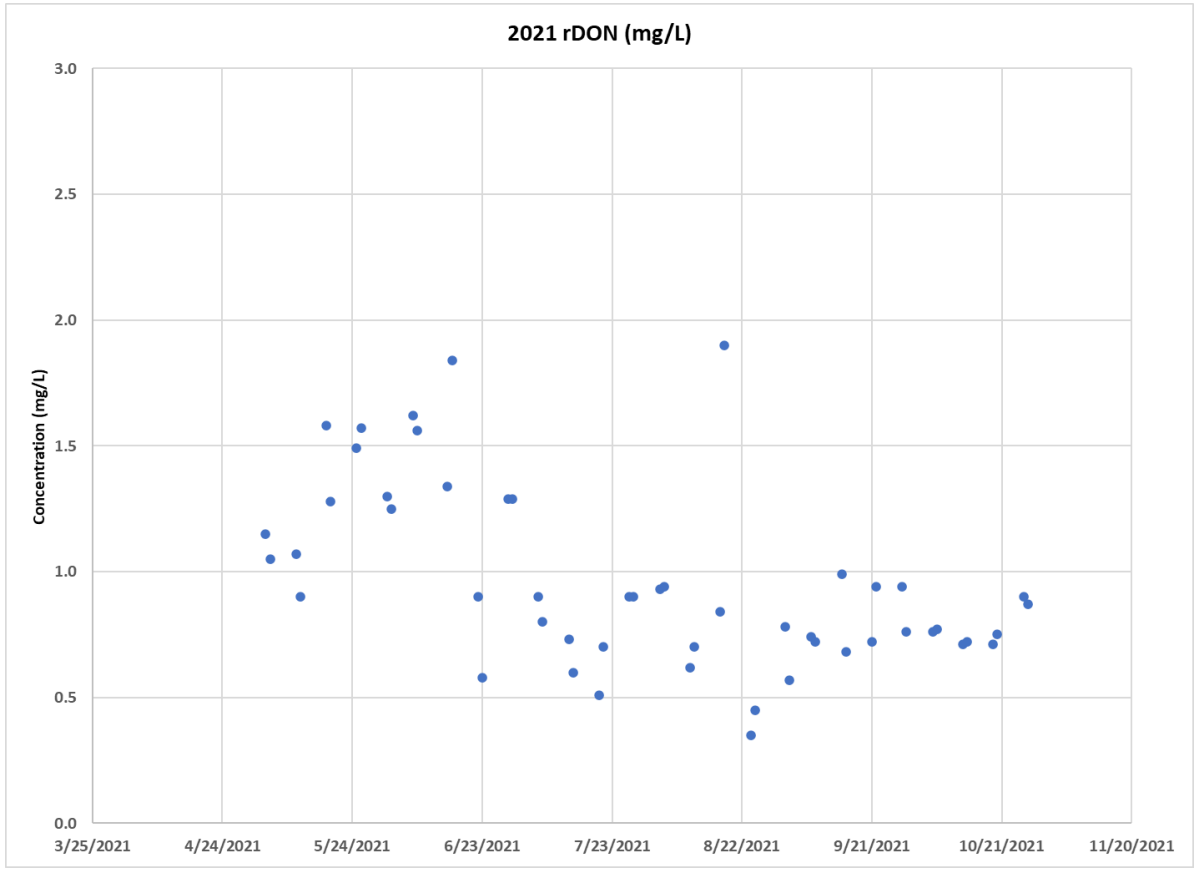



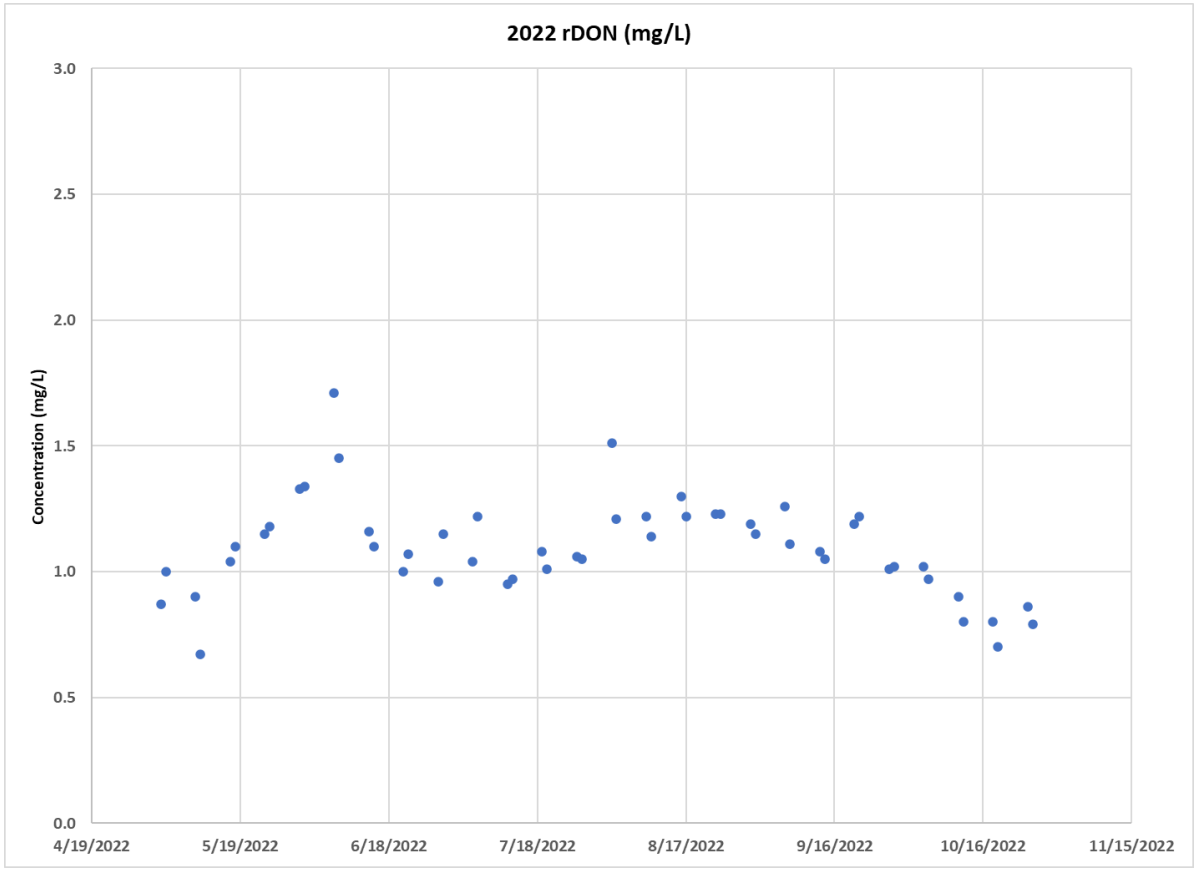
# 2022 Effluent Ammonia and Nitrate



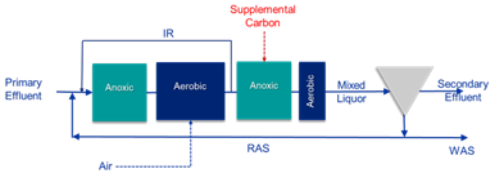



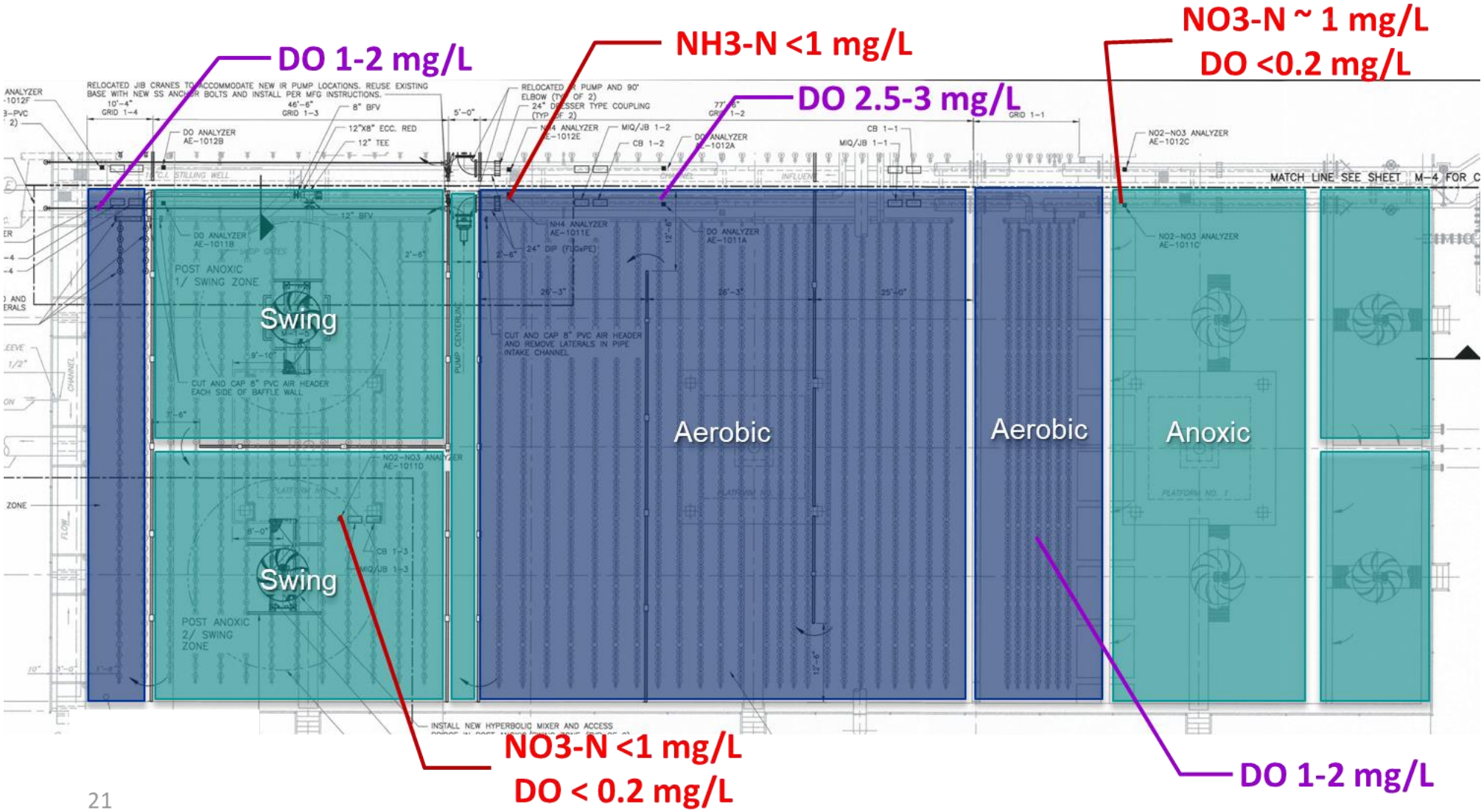
# Effluent rDON Concentrations



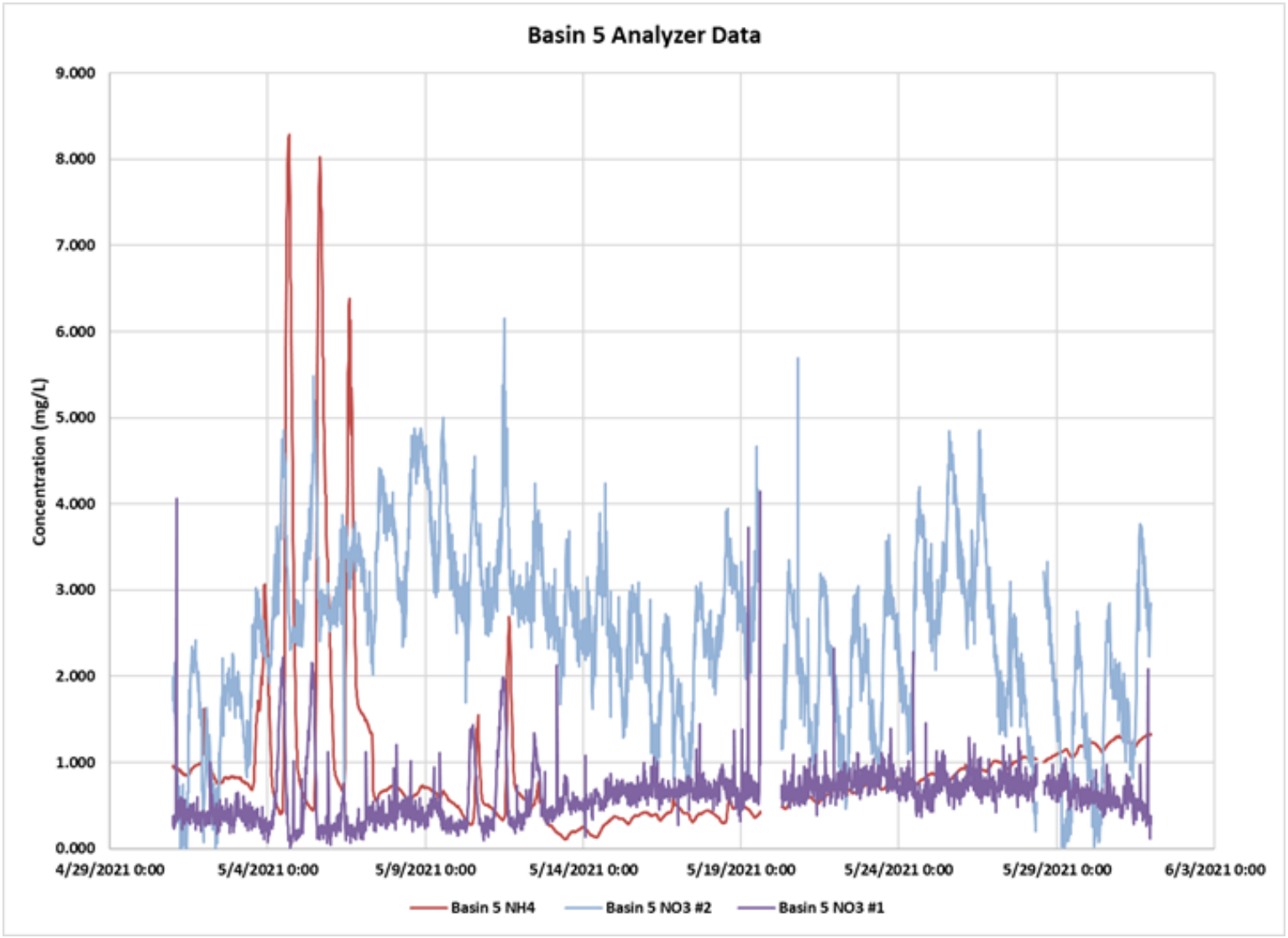



# Aeration Basin No. 1 Anticipated Performance

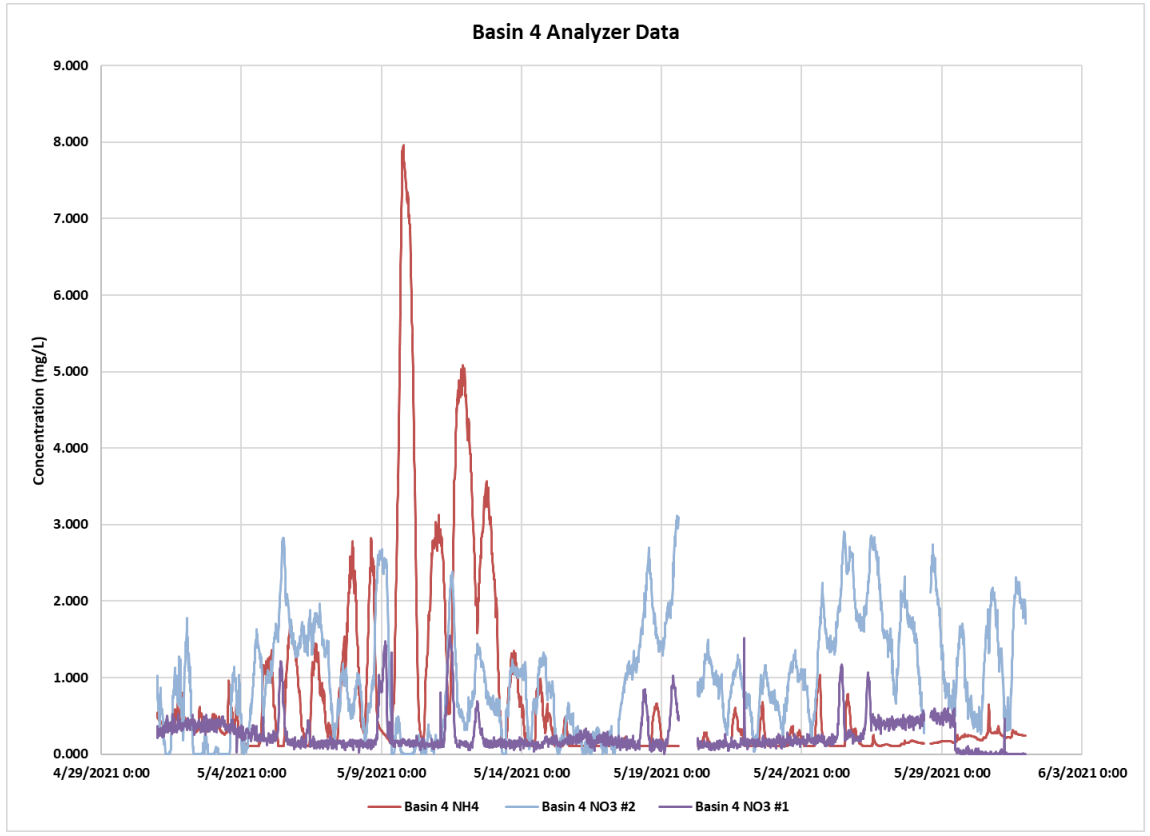


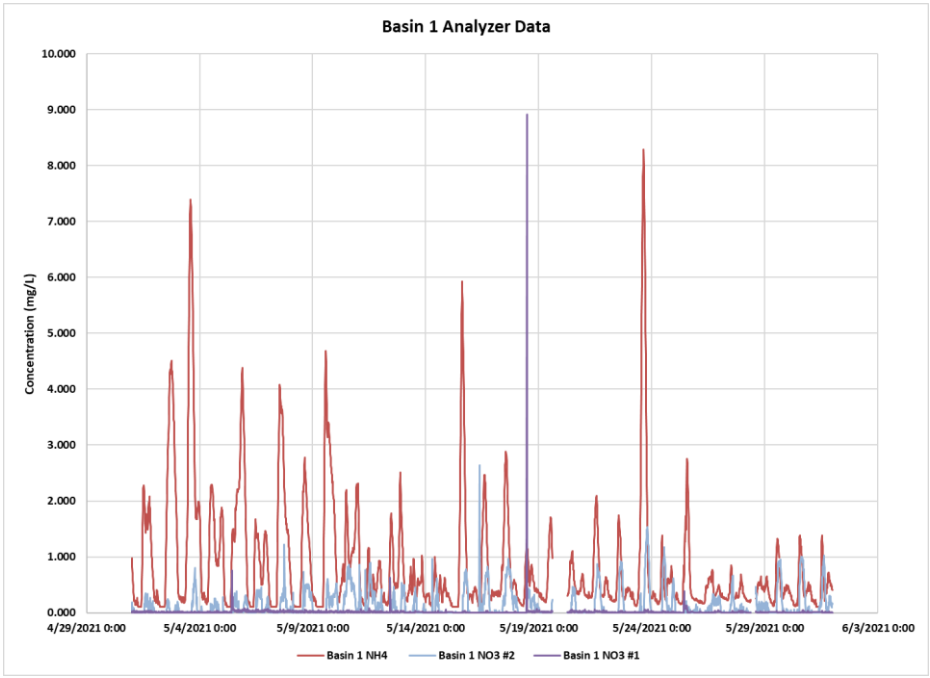



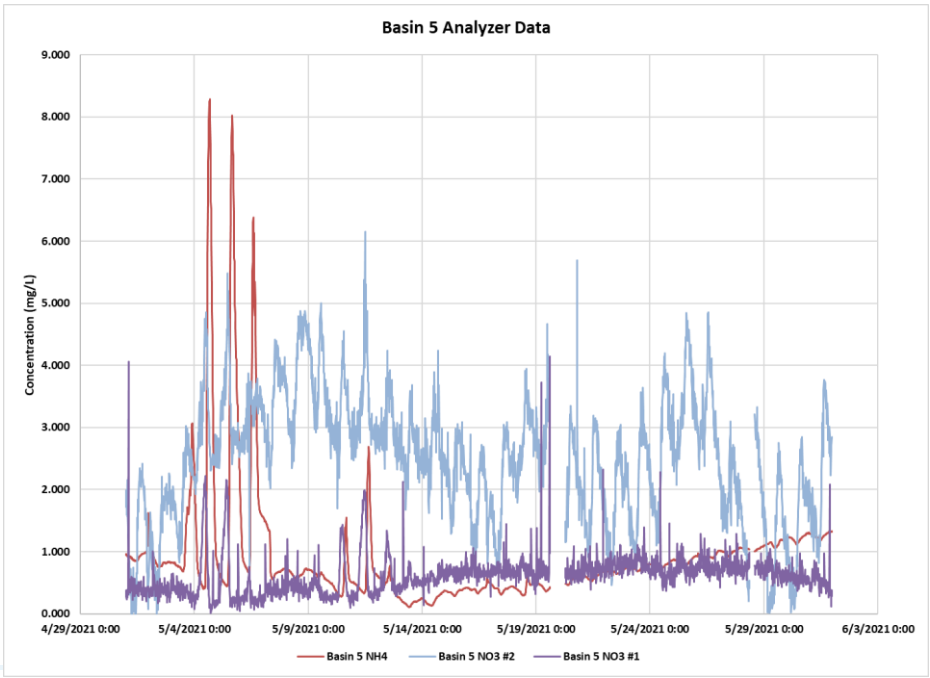
# Analyzer Data



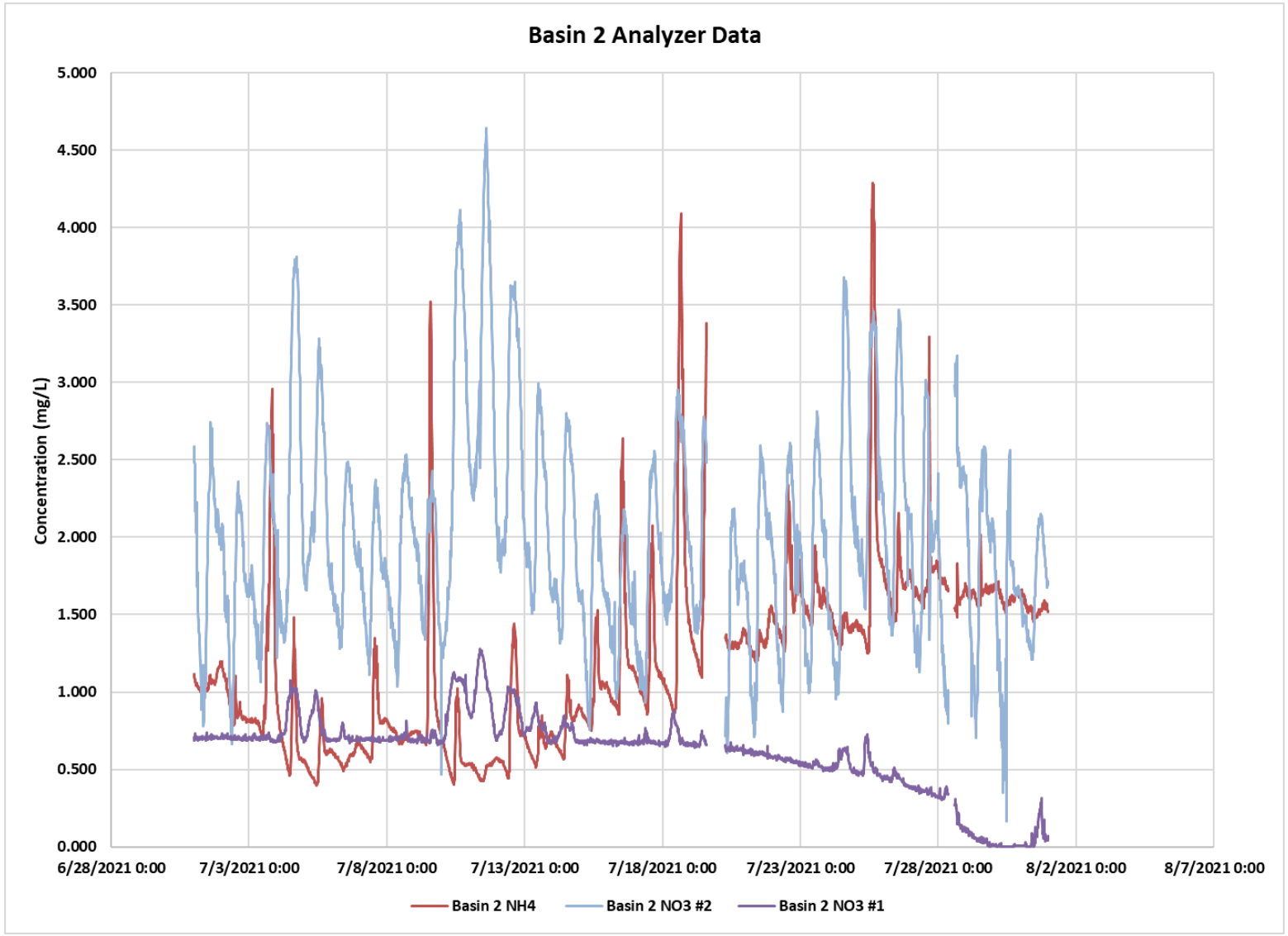
# May 2021 Observations



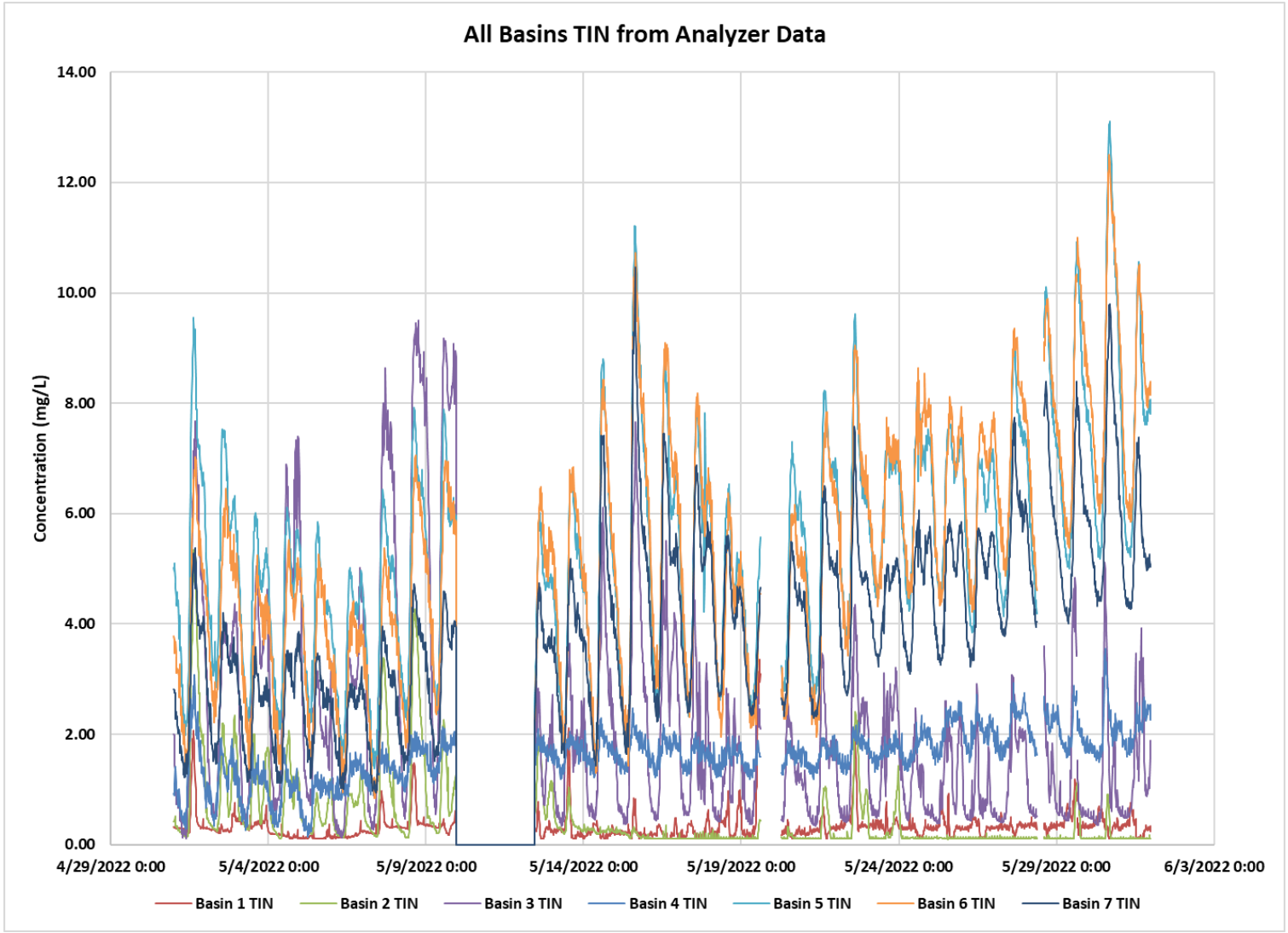



# July 2021, Basin 3: Nitrification and IR rate

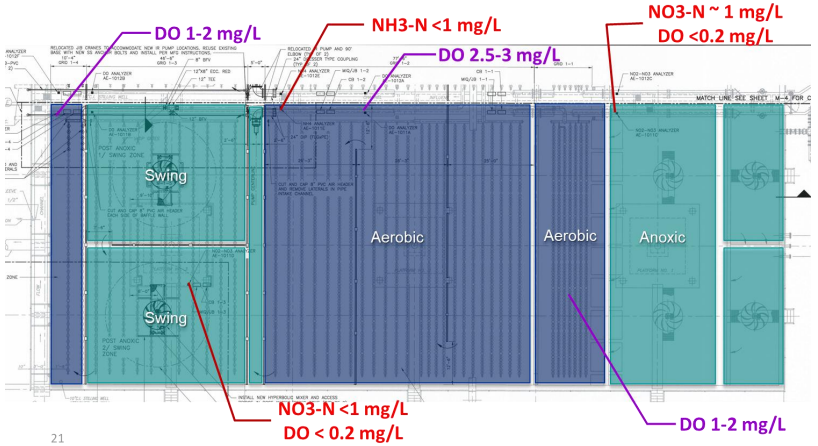


# May 2022 – TIN Comparison

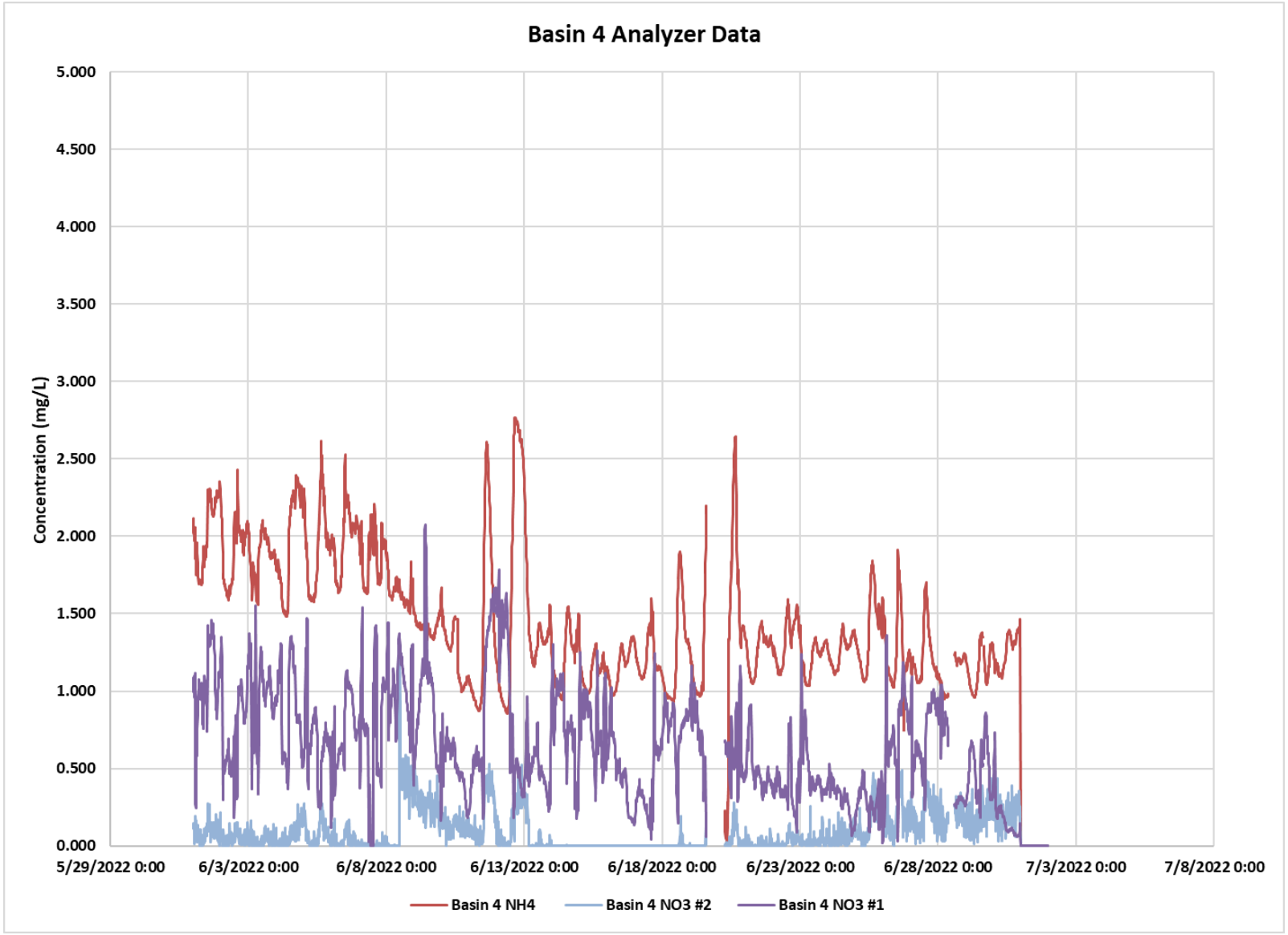


# ABAC – Ammonia-Based Aeration Control

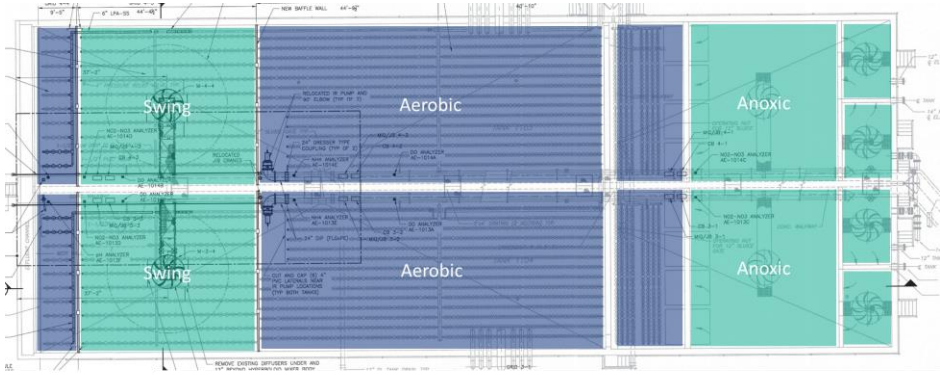
- Installed in northern system (basins 1-4)
- Operational April 21; ammonia setpoint of 0.5 mg/L in aerobic zone
- Moved sensor to middle of zone; ammonia setpoint 1.0 mg/L
- Increased setpoint to 1.3 mg/L in 2022

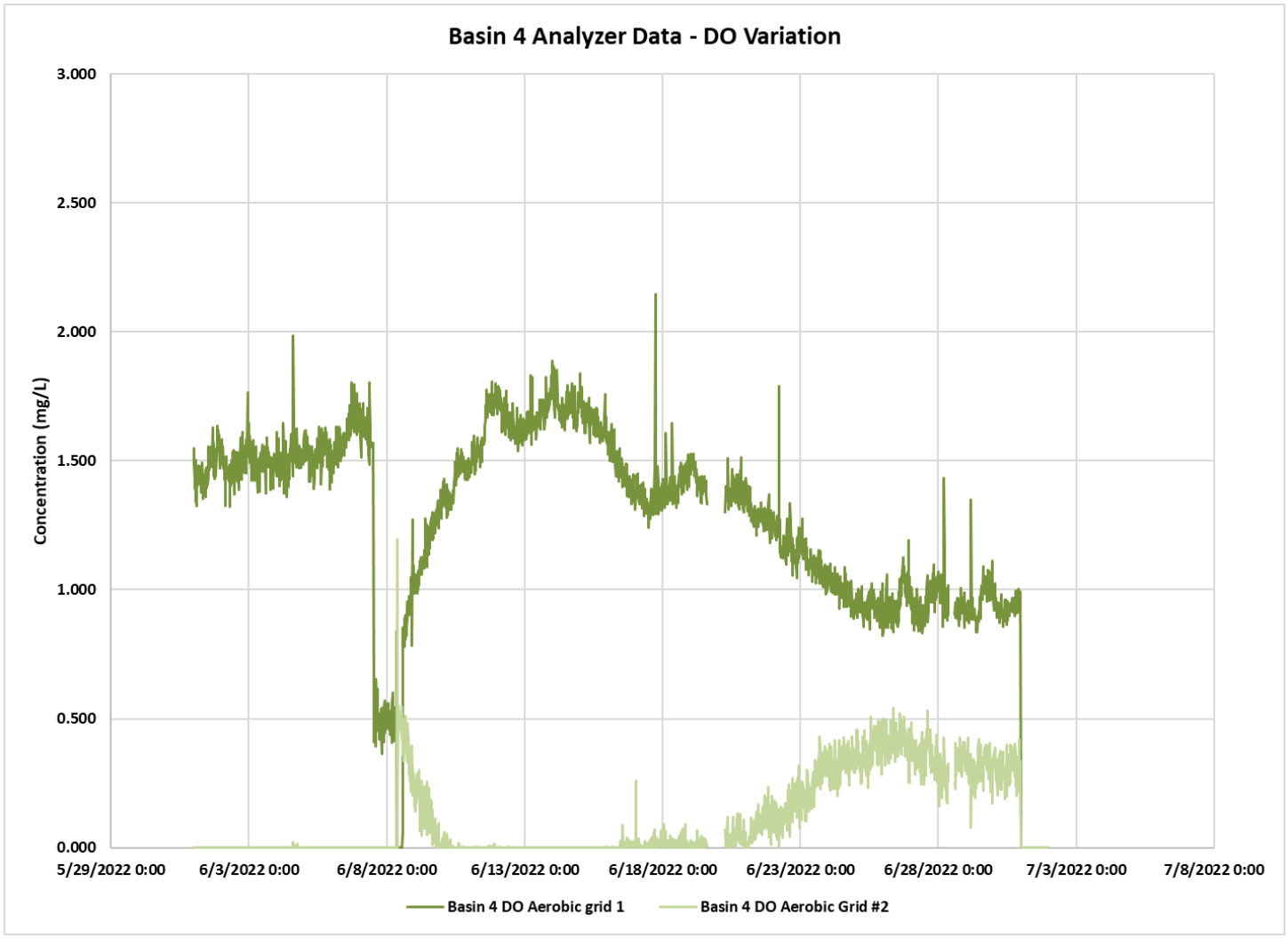



# June 2022 – ABAC Performance



# June 2022 – ABAC Performance



# Conclusions

- Process performance has demonstrated that the Brockton AWRF can achieve 3 mg/L TN without tertiary denitrification
- Not easily!
  - Diligent operation
  - Significant investment in instrumentation (initial and ongoing)
  - High-performing effluent filters to remove particulate TKN
  - rDON is a potential issue
- Supplemental carbon still available
- ABAC system is providing benefit

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