



# **Metropolitan Water Reclamation District of Greater Chicago**

**Welcome to the March  
Edition of the 2021  
M&R Seminar Series**

# NOTES FOR SEMINAR ATTENDEES

- All attendees' audio lines have been muted to minimize background noise.
- A question and answer session will follow the presentation.
- Please use the "Chat" feature to ask a question via text to "All Panelists".
- The presentation slides will be posted on the MWRD website after the seminar.
- The ISPE has approved this seminar for one PDH. Certificates will only be issued to participants who attend the entire presentation.

# **Dr. Gayathri Ram Mohan**

Senior Research Scientist

Gwinnett County Department of Water Resources

Lawrenceville, Georgia



Dr. Gayathri Ram Mohan is a Senior Research Scientist with the Gwinnett County Department of Water Resources (GCDWR) which provides water, water reclamation, and stormwater services to nearly 930,000 people. Dr. Ram Mohan has over 10 years of experience in R&D, commissioning and operating pilot scale water and wastewater treatment facilities and leading field process optimization efforts. Dr. Ram Mohan joined GCDWR in 2016 to help support a team of operations and maintenance staff to develop capital projects, optimize existing processes, investigate new technologies, and perform research on a wide variety of advanced and innovative wastewater treatment, water reuse and resource recovery projects. She has published her work in various technical journals, presented at national and international conferences and is also an active member of professional organizations such as GAWP, WEF, and WRF.



# Nutrient Recovery Performance and the Optimization of Biological Phosphorus Removal at the F. Wayne Hill Water Resources Center

Gayathri Ram Mohan, PhD, PE

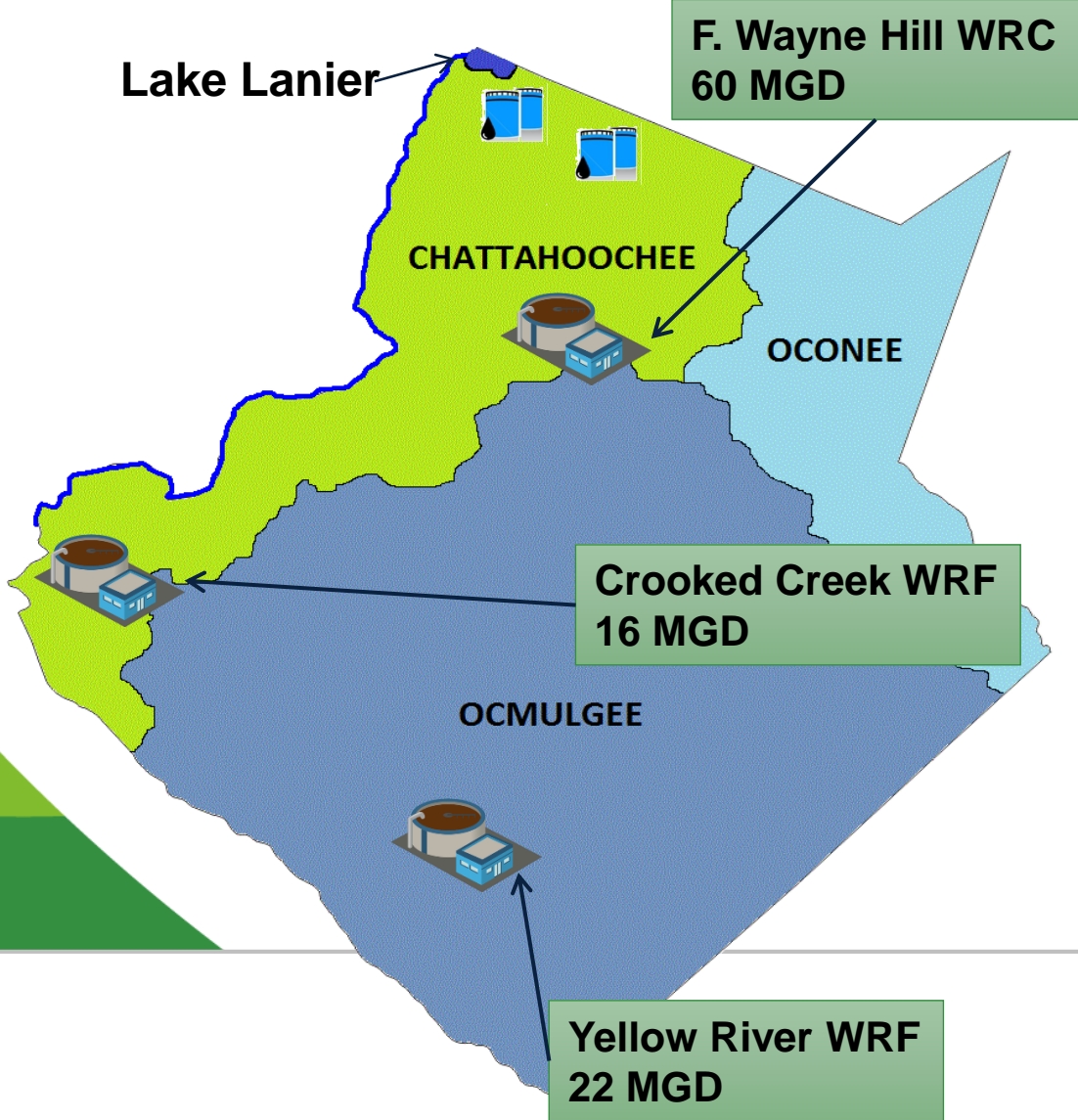
*Scientist, Operations Technical Services*

*Gwinnett County Department of Water Resources*

*Date: 03/26/2021*



# Gwinnett County Water Reclamation Facilities



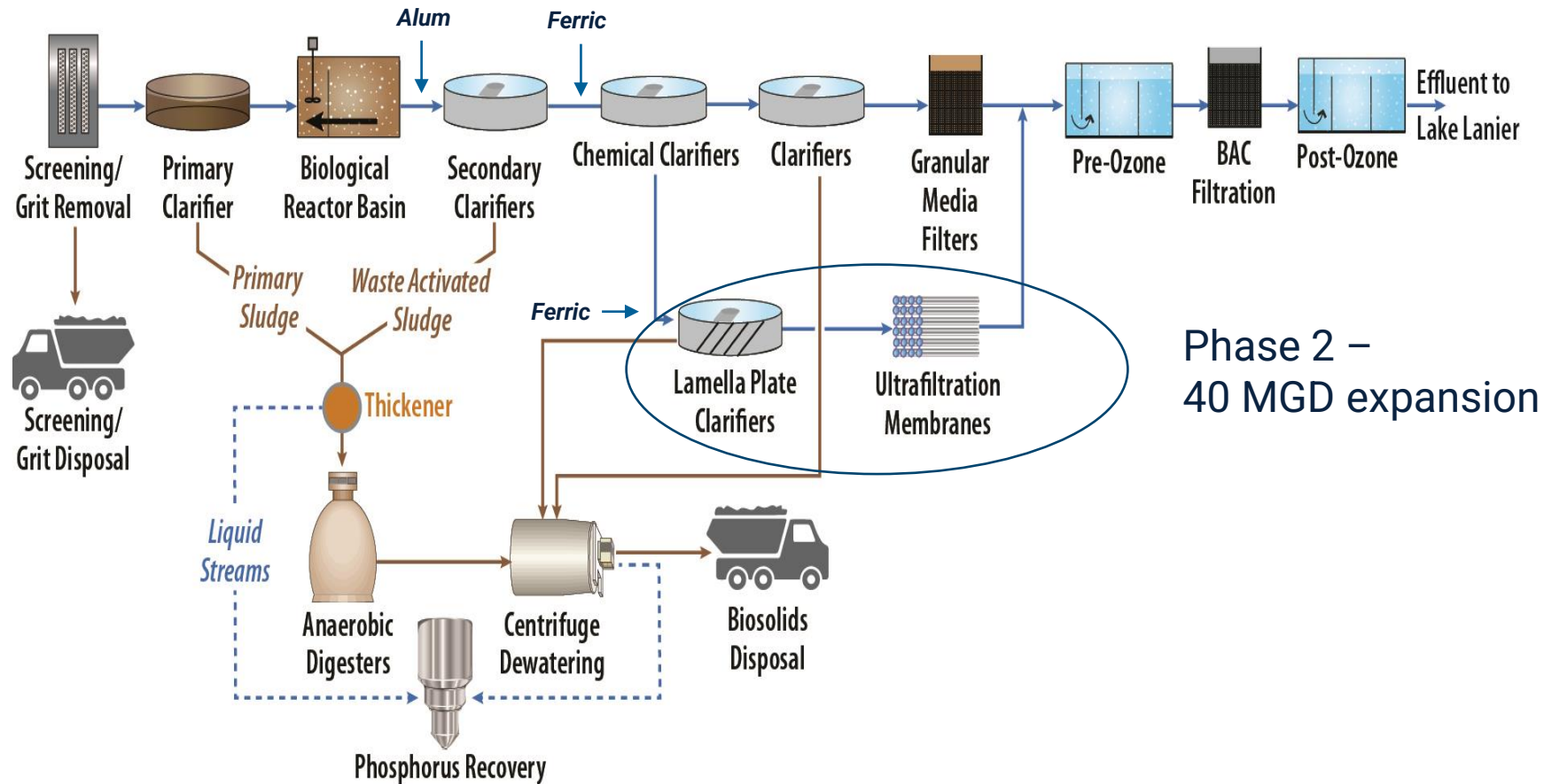


# F. Wayne Hill WRC

- Largest and most advanced of GCDWR facilities – 60 MGD



# F. Wayne Hill WRC Process Flow



Process treatment trains at the F. Wayne Hill Water Resources Center



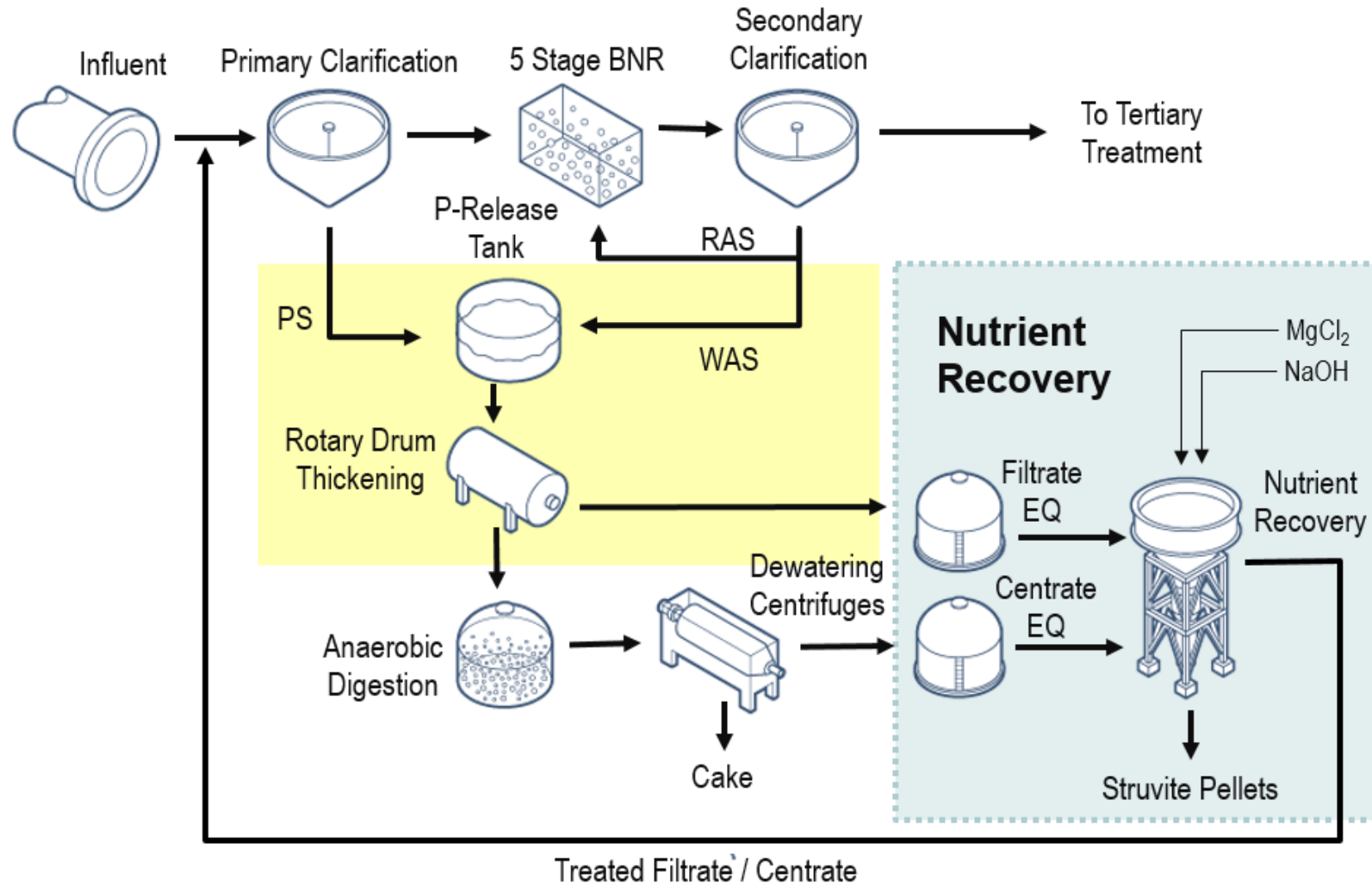
# Nutrient Recovery Facility

- Waste Activated Sludge Stripping to Remove Internal Phosphorus (WASSTRIP)
- Centrate and Filtrate Equalization
- Ostara Reactors and Associated Equipment
  - Two Pearl 2000 reactors





# Process Flow Diagram



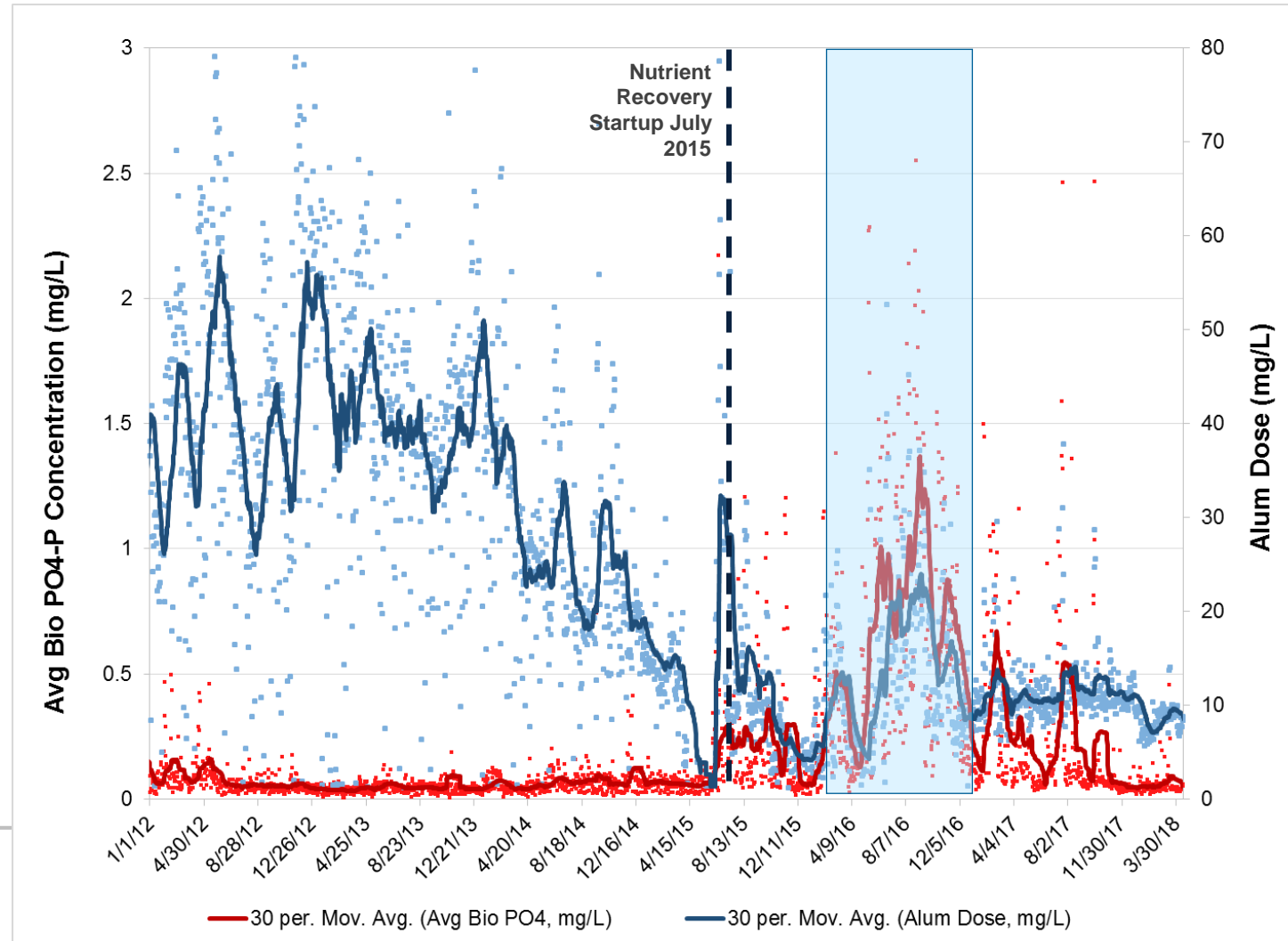


# Historical Enhanced Bio-P Removal (EBPR) Performance



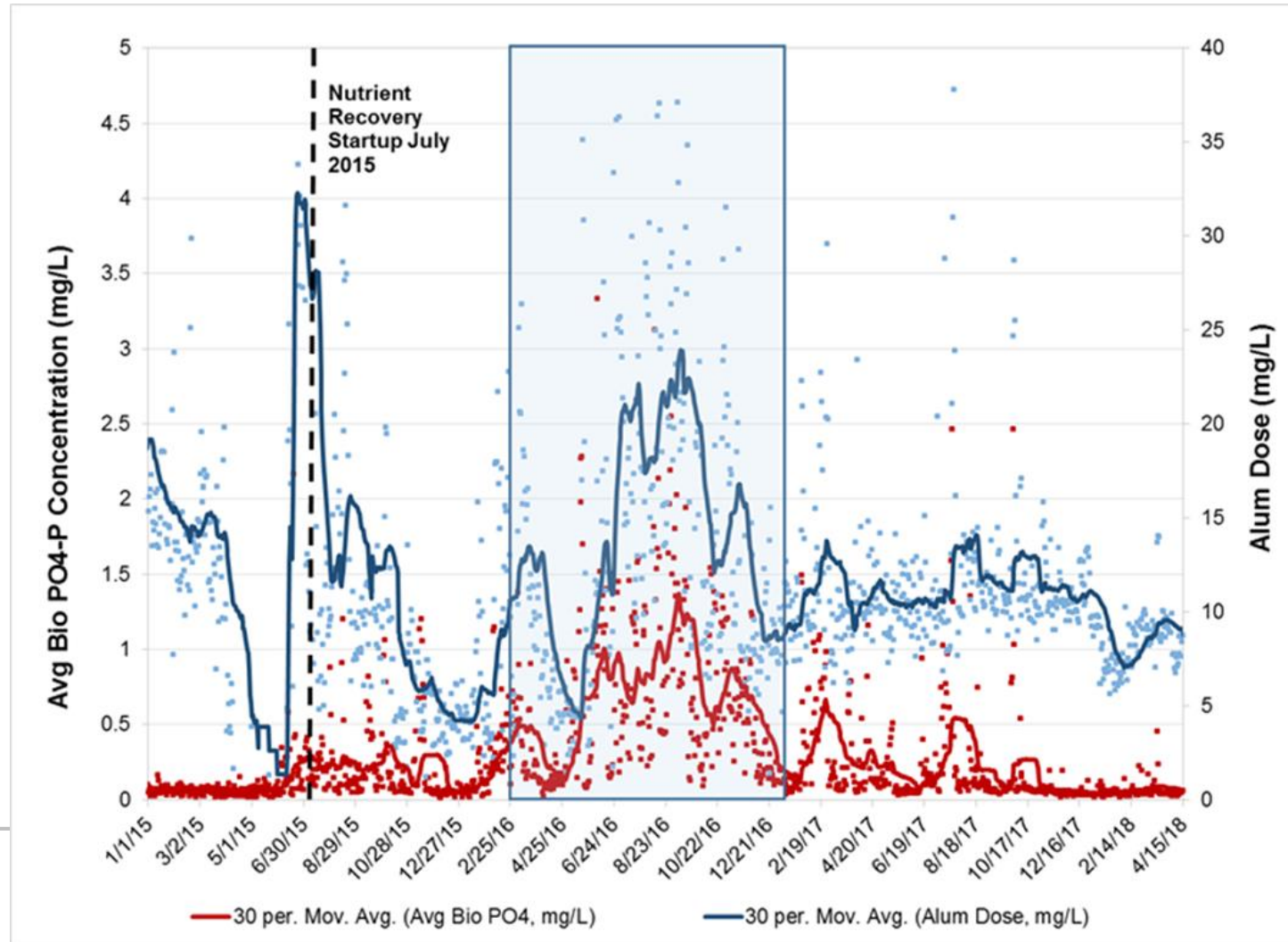
# Historical EBPR Performance

Bioreactor Effluent Ortho-P ( $\text{PO}_4\text{-P}$ ) and Alum Addition



# Historical EBPR Performance

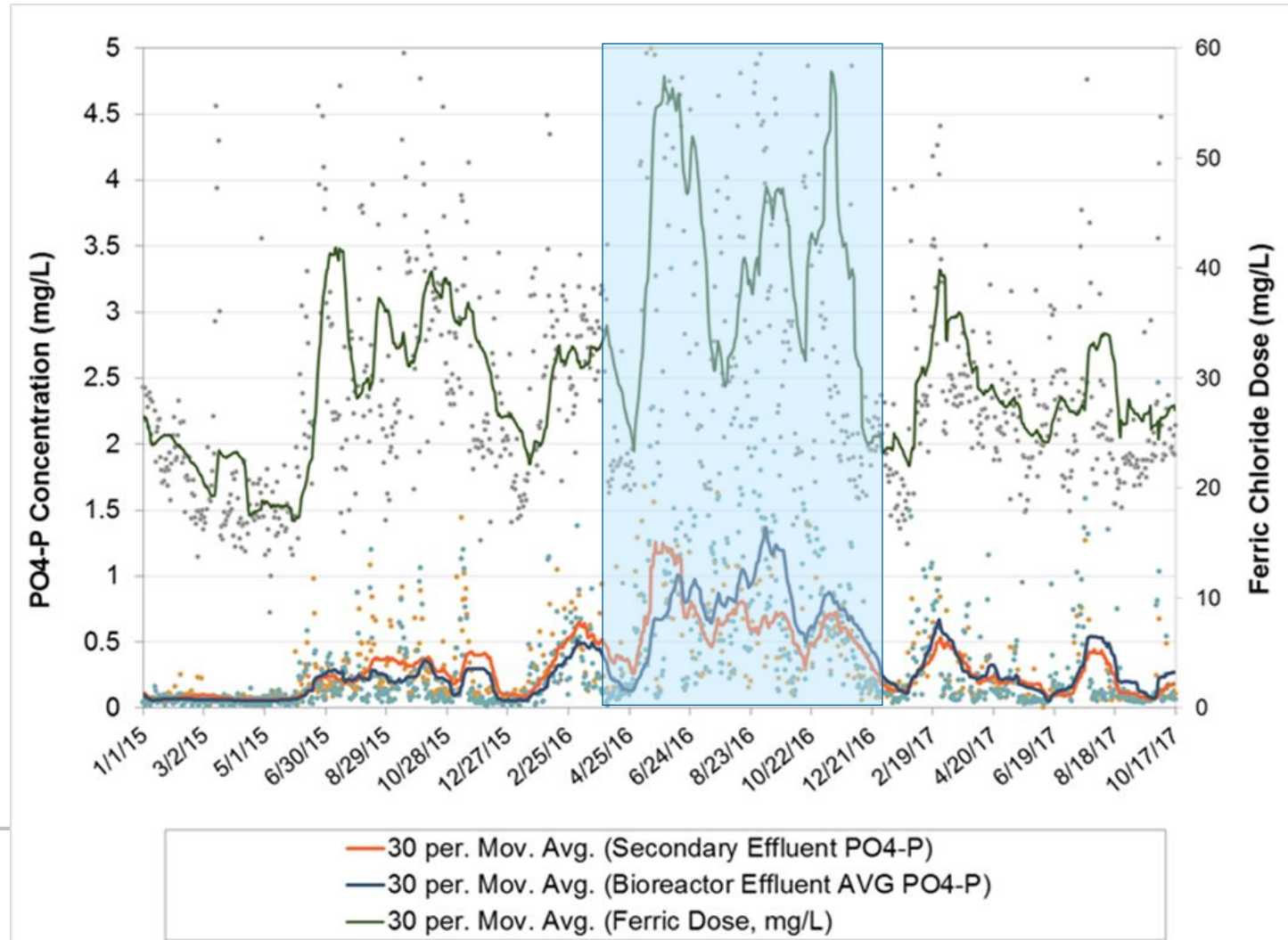
Bioreactor Effluent Ortho-P ( $\text{PO}_4\text{-P}$ ) and Alum Addition





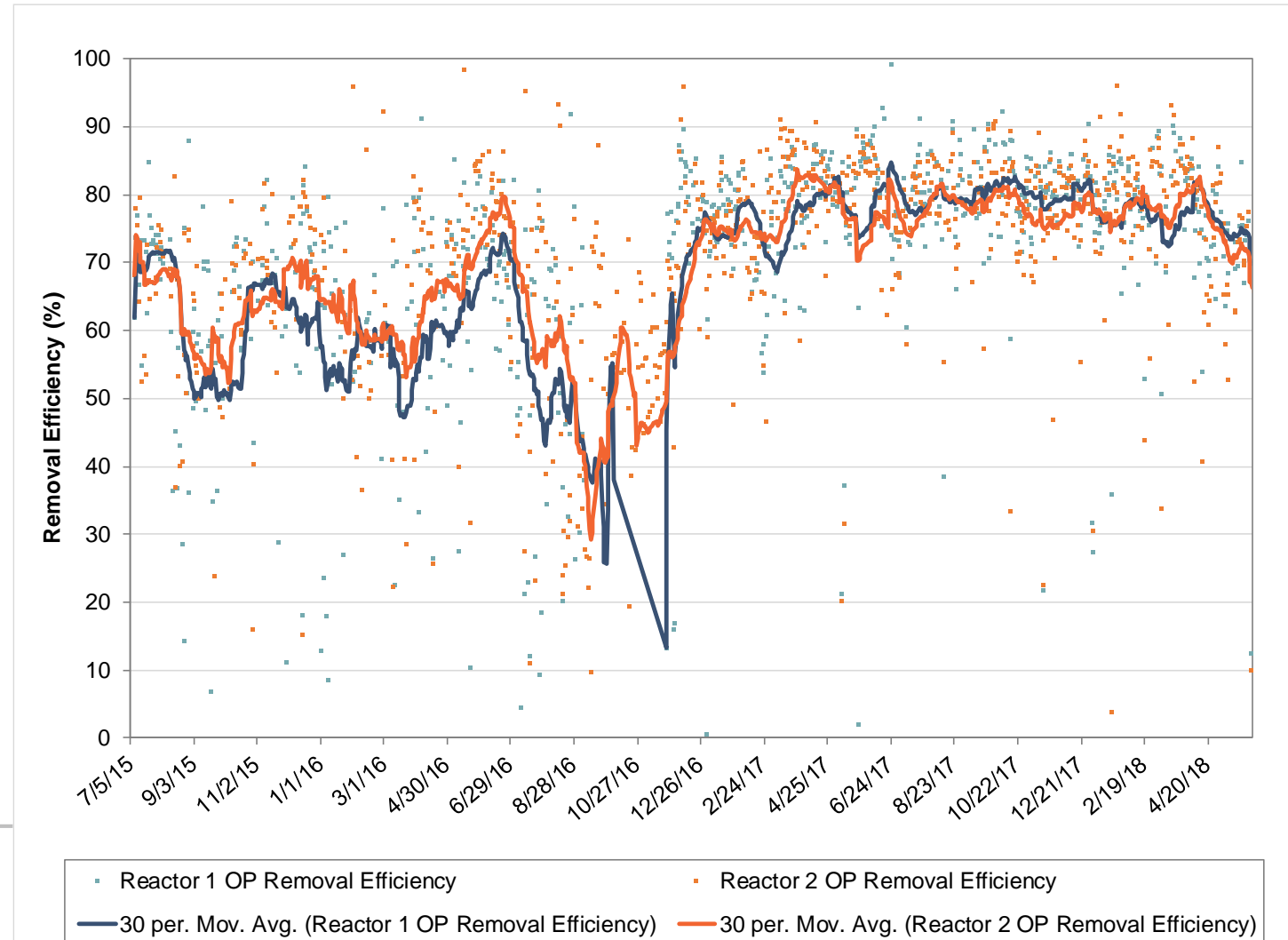
# Historical EBPR Performance

Bioreactor and Secondary Effluent Ortho-P ( $\text{PO}_4\text{-P}$ ) and Ferric Chloride Addition



# Reduced Nutrient Recovery Performance

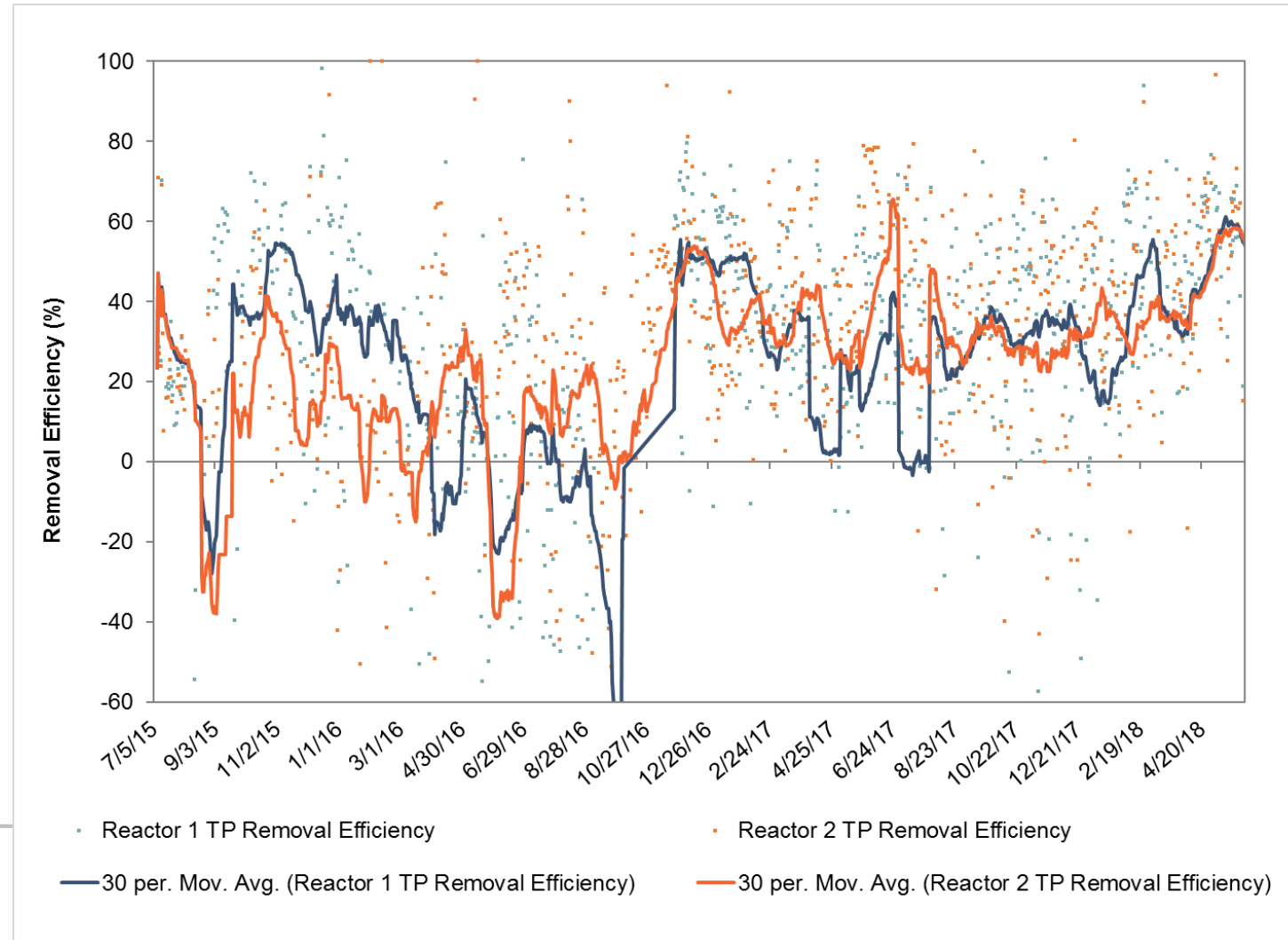
## Ortho-P ( $\text{PO}_4\text{-P}$ ) Removal





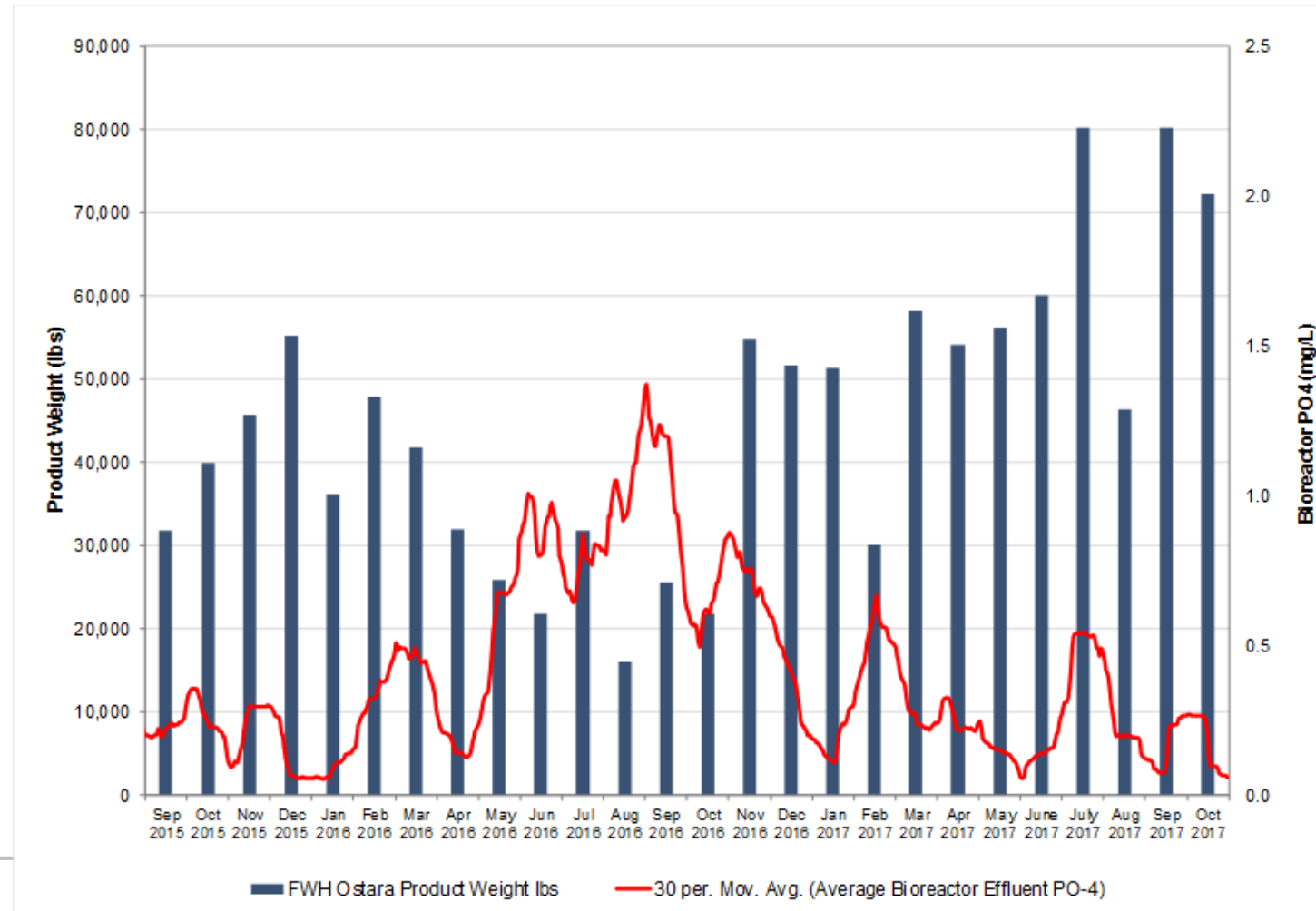
# Reduced Nutrient Recovery Performance

## Total P (TP) Removal



# Nutrient Recovery Performance

## Gross Production and Bioreactor Effluent Ortho-P ( $\text{PO}_4\text{-P}$ )



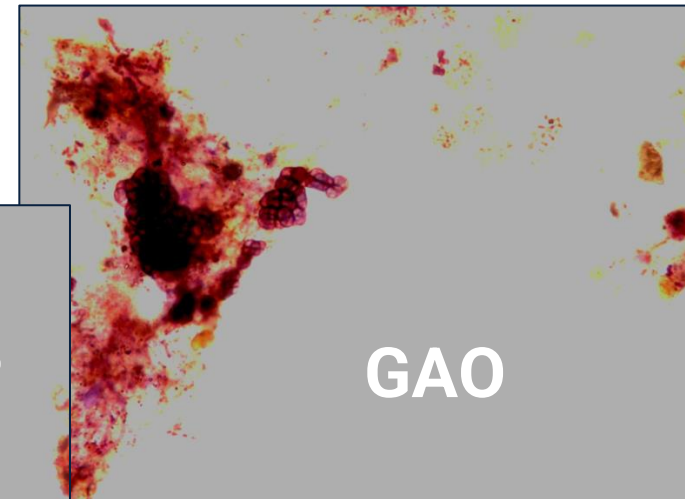
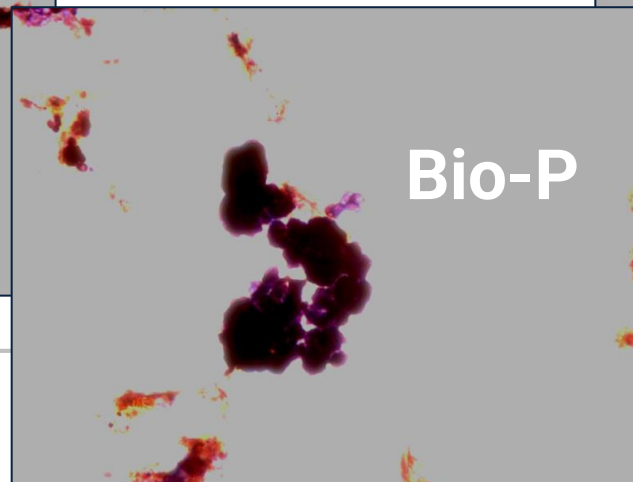
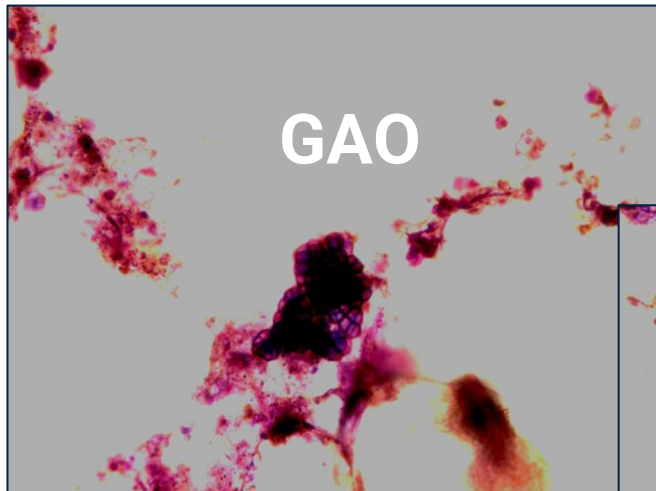
# Nutrient Recovery Performance

Improvements in Performance – 2016 to Present

- More consistent performance since 2016 performance issues
  - Better control of filtrate and centrate TSS
  - Improved control of reactor pH
  - Better control of Mg/P ratio
  - Changes to product harvesting
    - New trigger points and seeding establish
    - Targeting of smaller product
    - Bed depth instrumentation added

# Microscopy of Activated Sludge

- Shift in population of PAOs by GAOs documented in 2016
- Confirmed via microscopic analysis in mid-2016
- GAOs can result in decreased EBPR performance





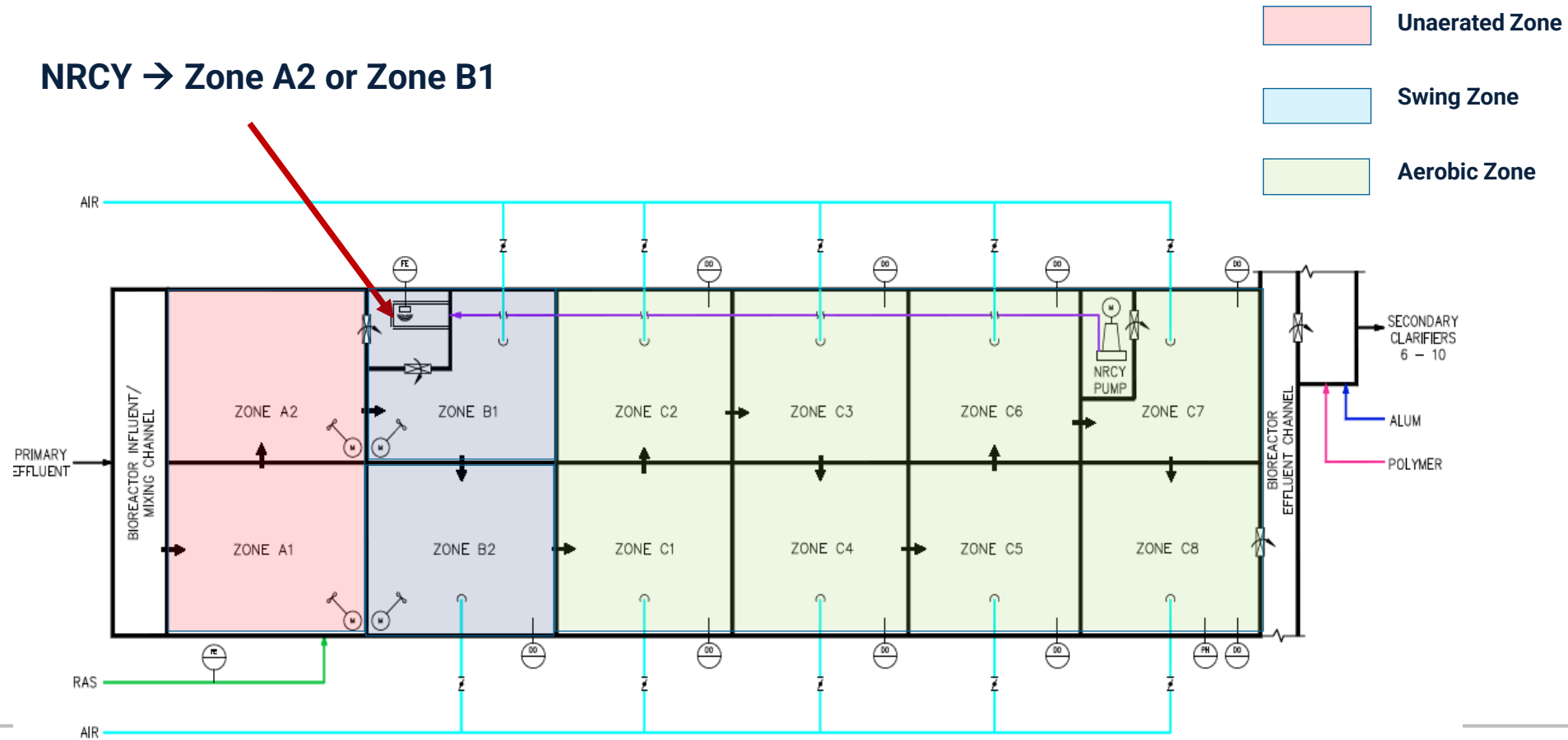
# Optimization of Biological Phosphorus Removal

# Scope of Optimization

- Goals
  - Determine optimal bioreactor configuration for improved bio-P
  - Understand impact of nitrified recycle (NRCY) operation on EBPR performance
  - Reduce reliance on metal salt
- Full-scale bioreactor testing
  - Nitrified recycle (NRCY) on or off
  - NRCY → Zone A2 or B1
  - Zones B1/B2 - unaerated or aerated

# Bioreactor Operational Flexibility

NRCY → Zone A2 or Zone B1



# Field Testing Configurations

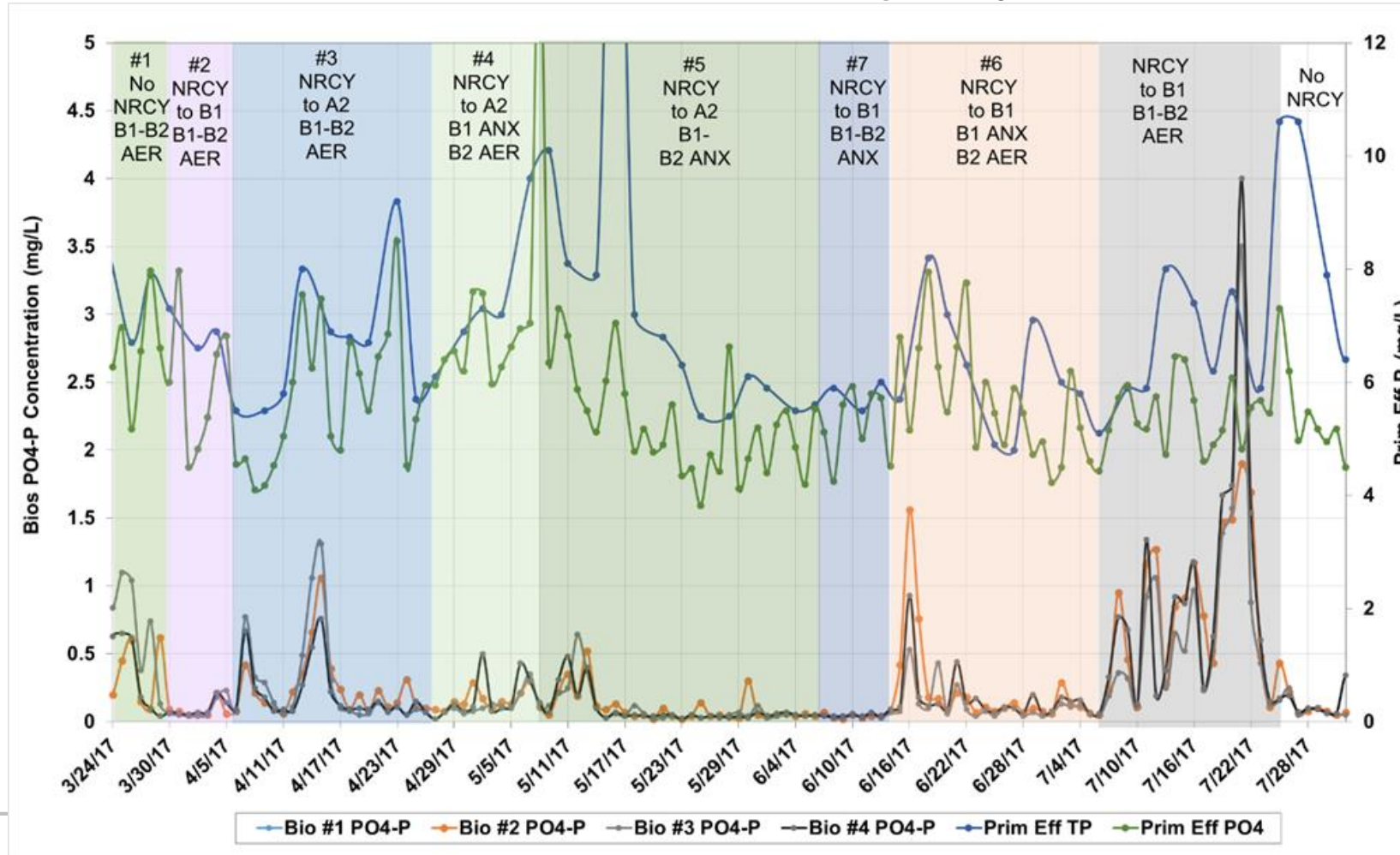
Optimization Configuration	Phase 1 BRBs Evaluated	Phase 2 BRBs Evaluated	NRCY Operation	NRCY Location	Zone B1 Operation	Zone B2 Operation
1	1 and 2	9 and 10	Off	---	Aerobic	Aerobic
2	2 (Test) and 4 (Control)	8 (Test) and 9 (Control)	On	B1	Aerobic	Aerobic
3			On	A2	Aerobic	Aerobic
4			On	A2	Anoxic	Aerobic
5			On	A2	Anoxic	Anoxic
6			On	B1	Anoxic	Aerobic
7			On	B1	Anoxic	Anoxic
8			2 and 3	6 and 8	On	A2



# Optimization Results

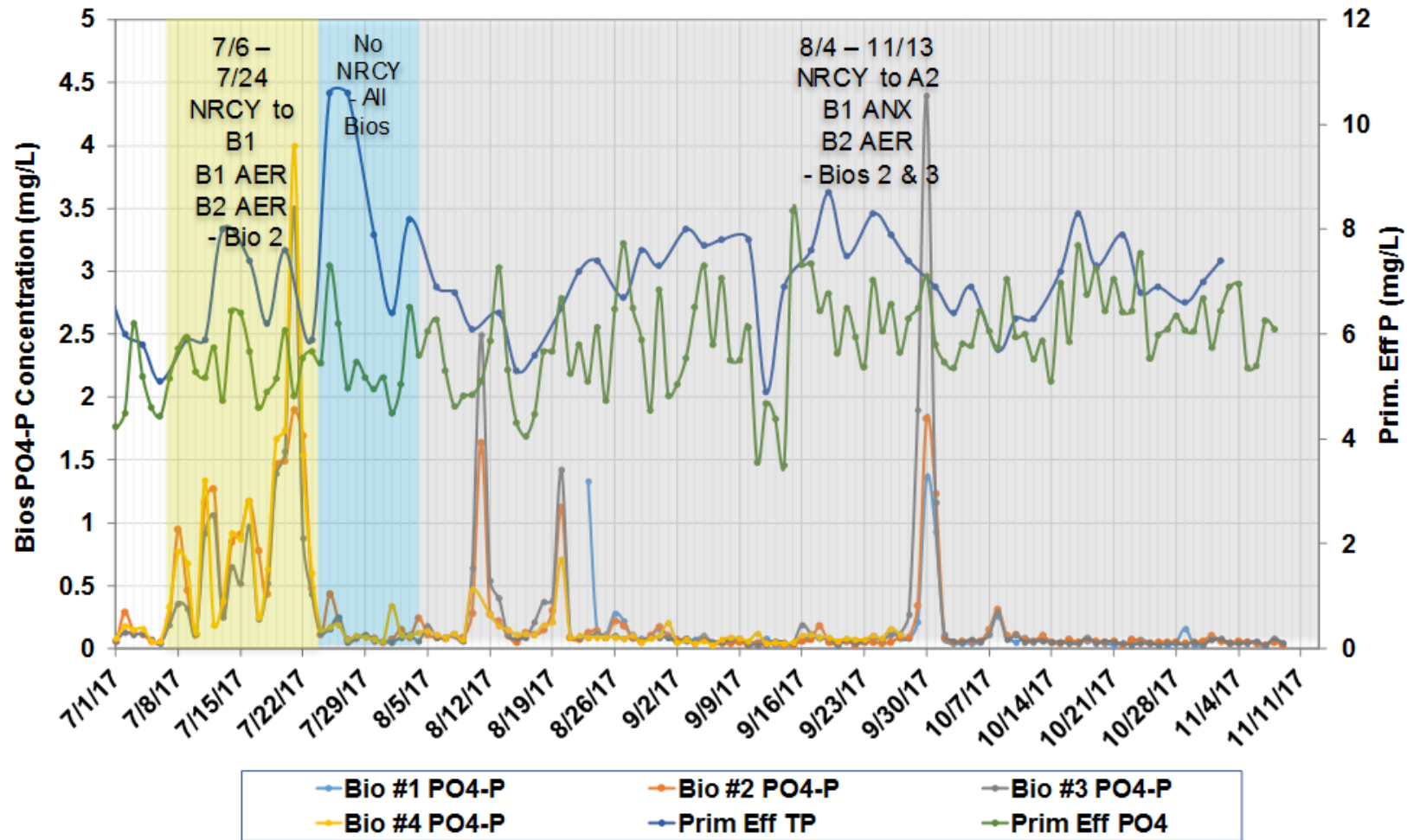
# Bioreactor Effluent PO<sub>4</sub>-P

Phase 1 – March 2017 through July 2017



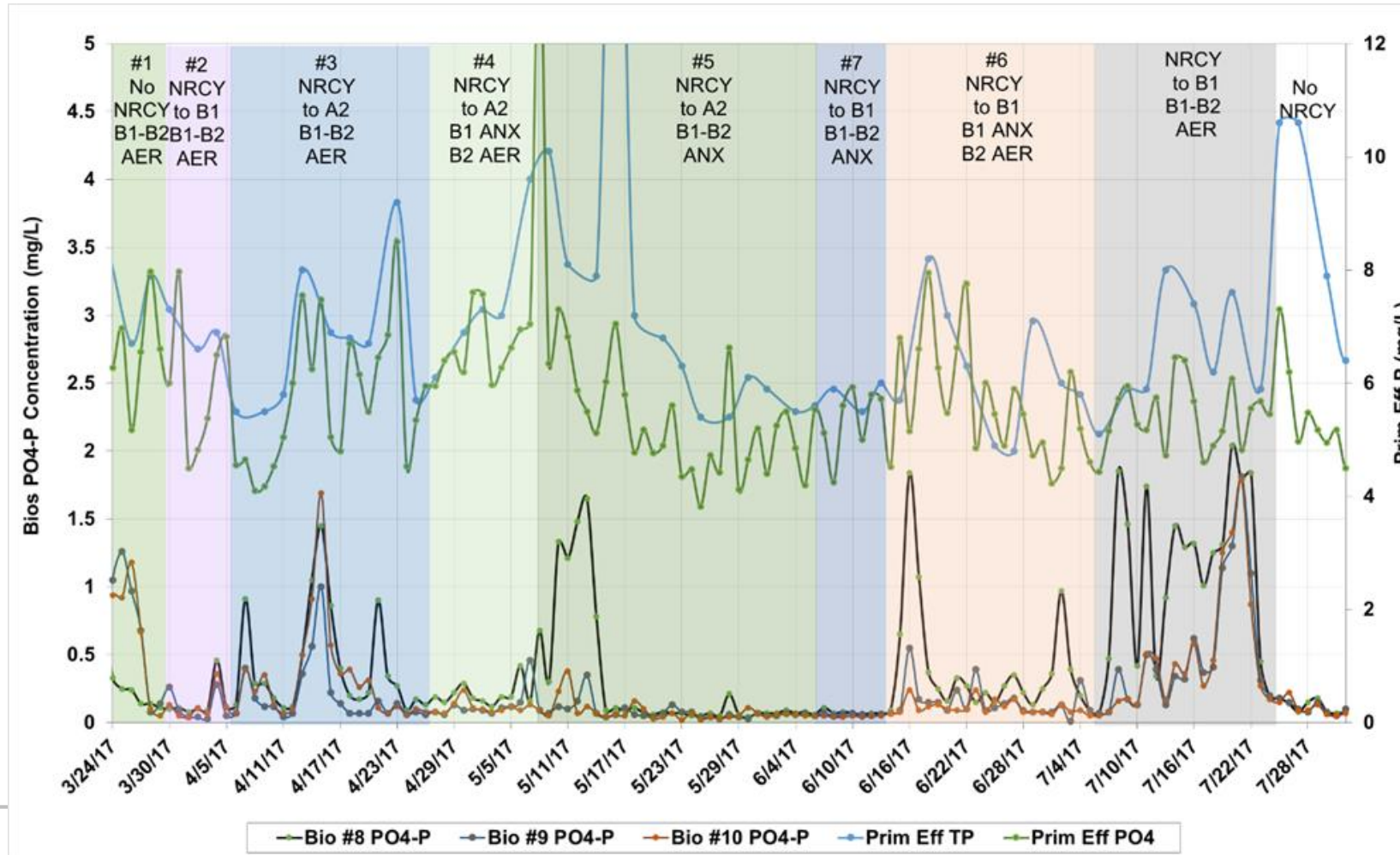
# Bioreactor Effluent PO<sub>4</sub>-P

Phase 1 – July 2017 through November 2017



# Bioreactor Effluent PO<sub>4</sub>-P

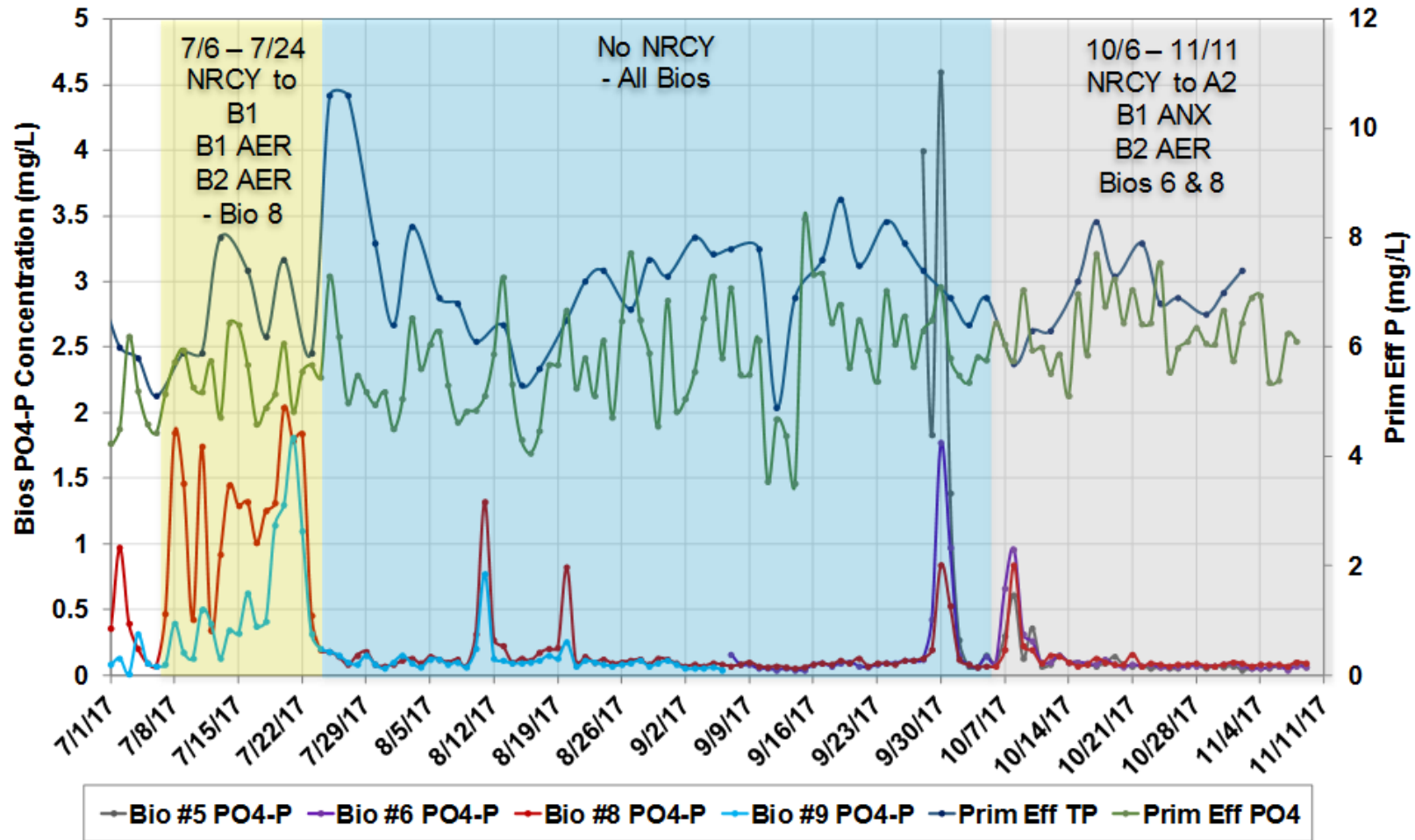
Phase 2 – March 2017 through July 2017





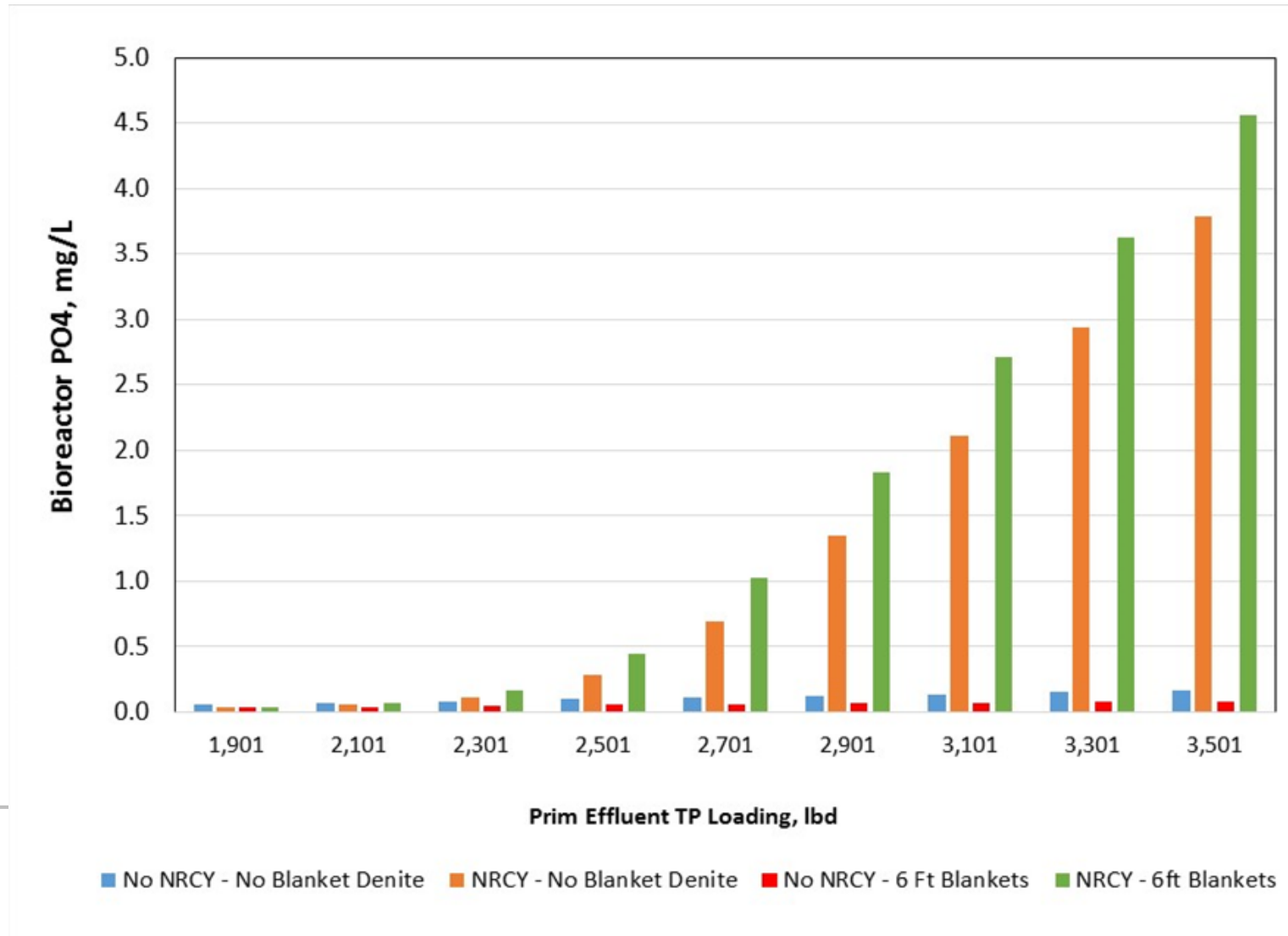
# Bioreactor Effluent PO<sub>4</sub>-P

Phase 2 – July 2017 through November 2017



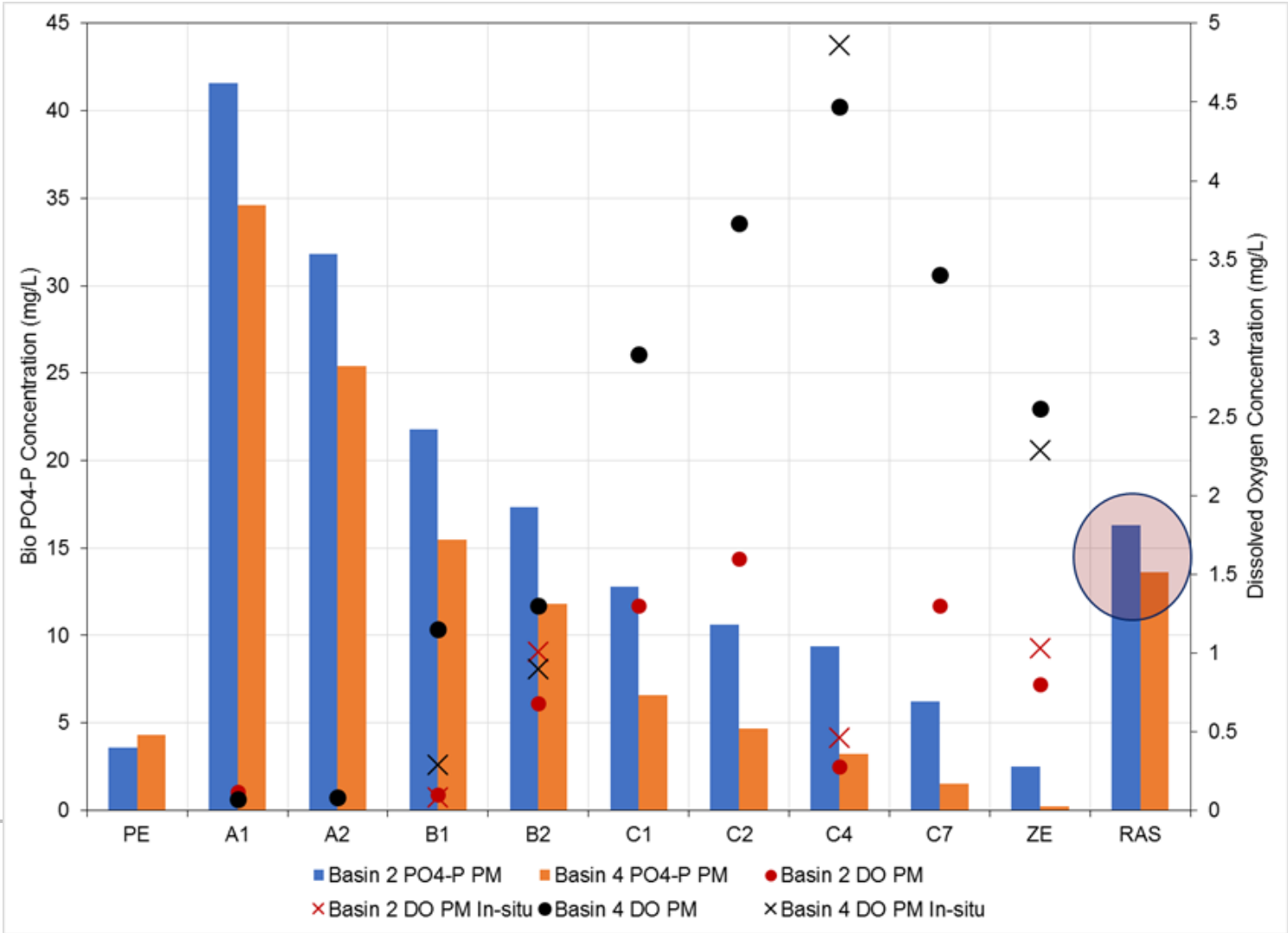
# NRCY Operation and EBPR

## Calibrated Process Model Results



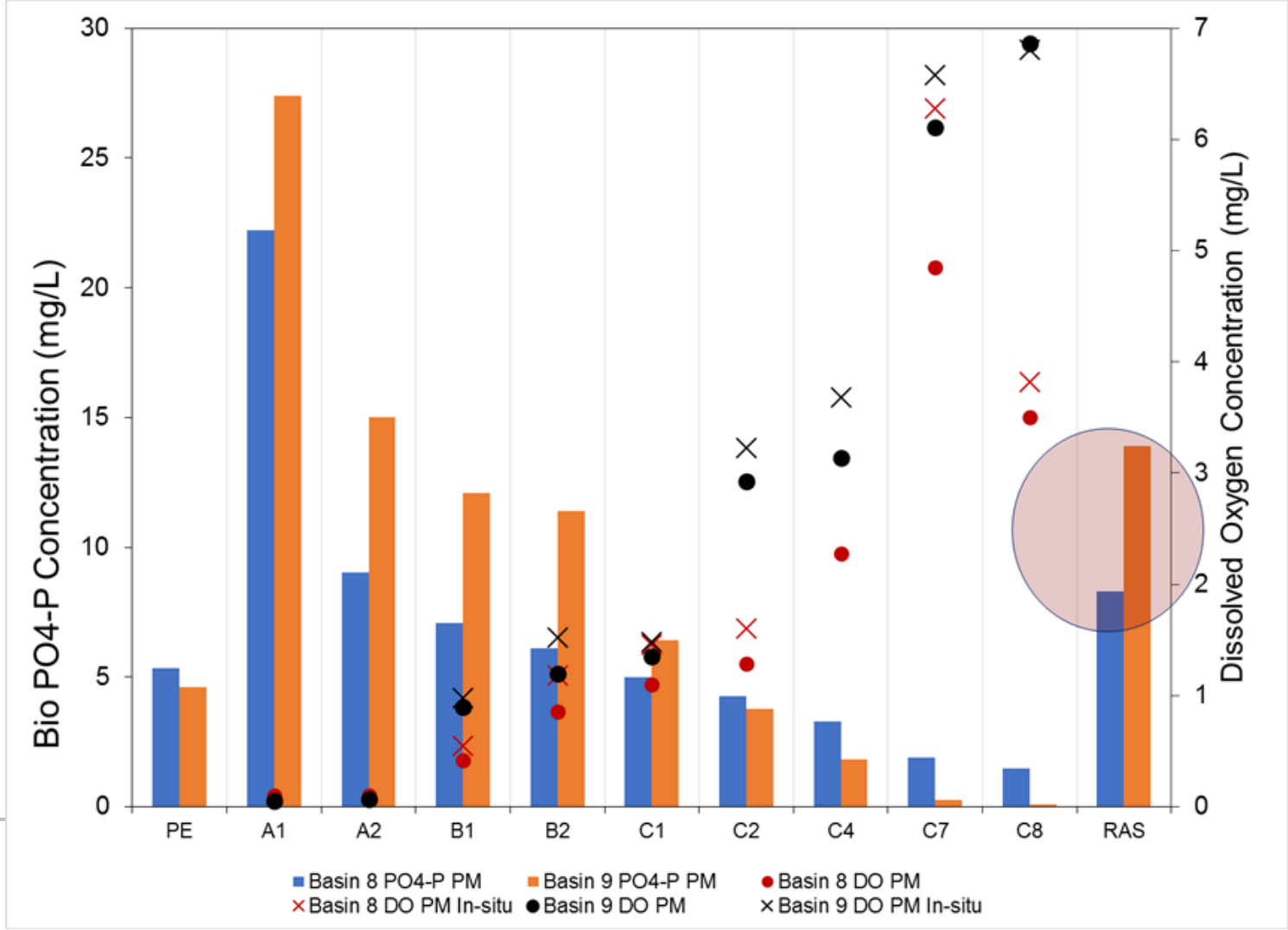
# Secondary Phosphorus Release – Phase 1

## Secondary Clarifier Sludge Blankets



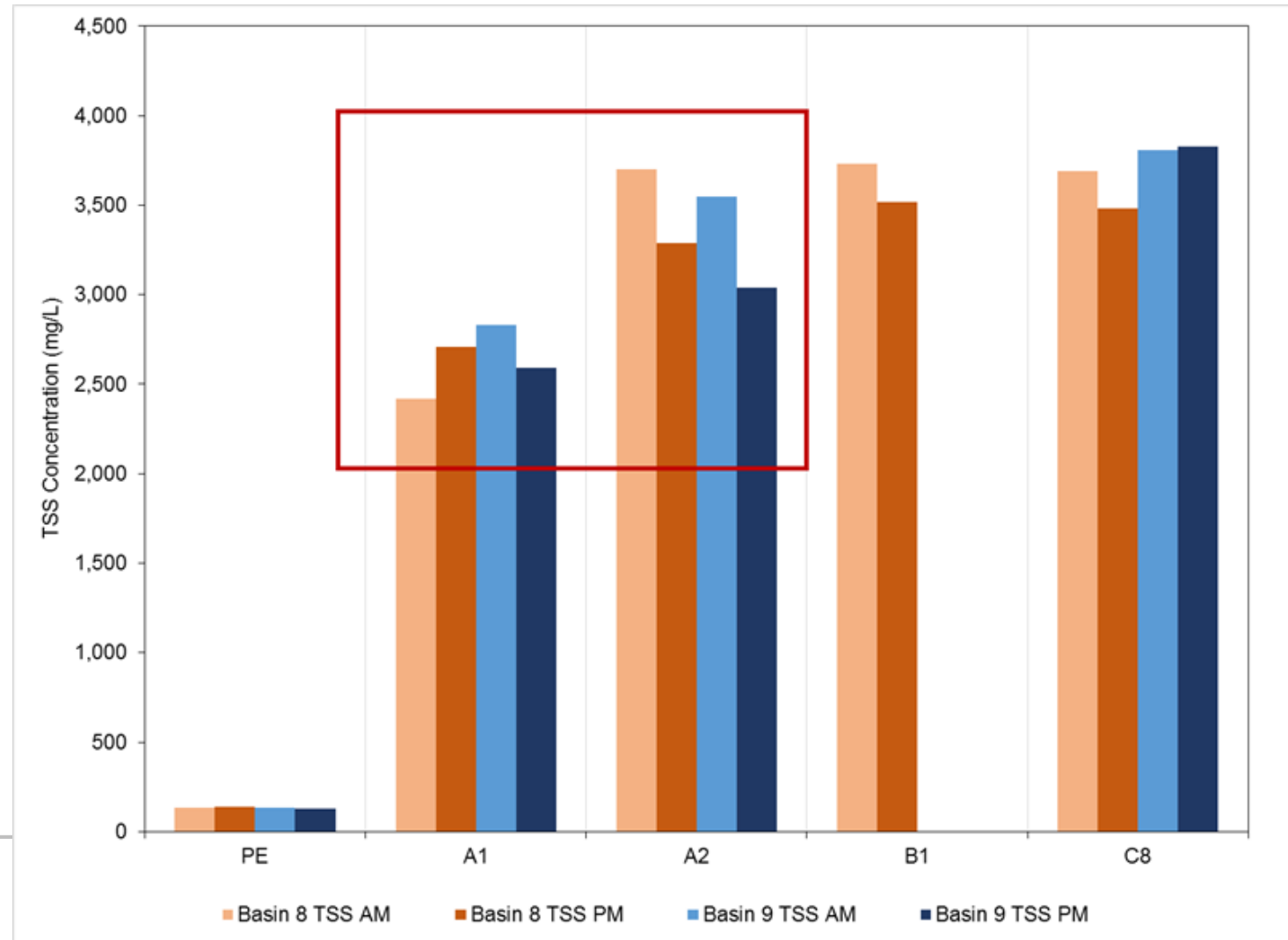
# Secondary Phosphorus Release – Phase 2

## Secondary Clarifier Sludge Blankets



# RAS Short Circuiting

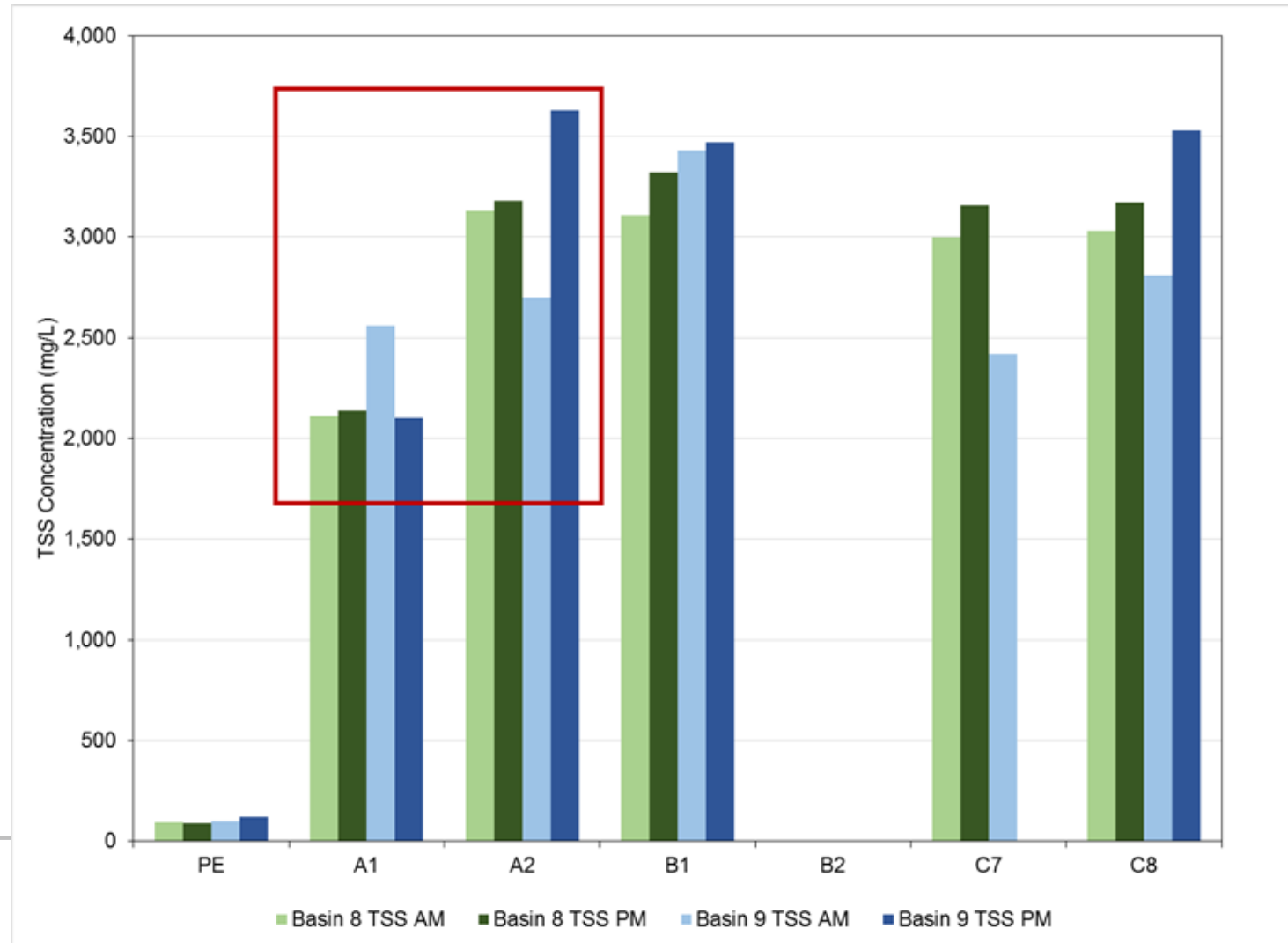
Phase 2 – Zone 1A





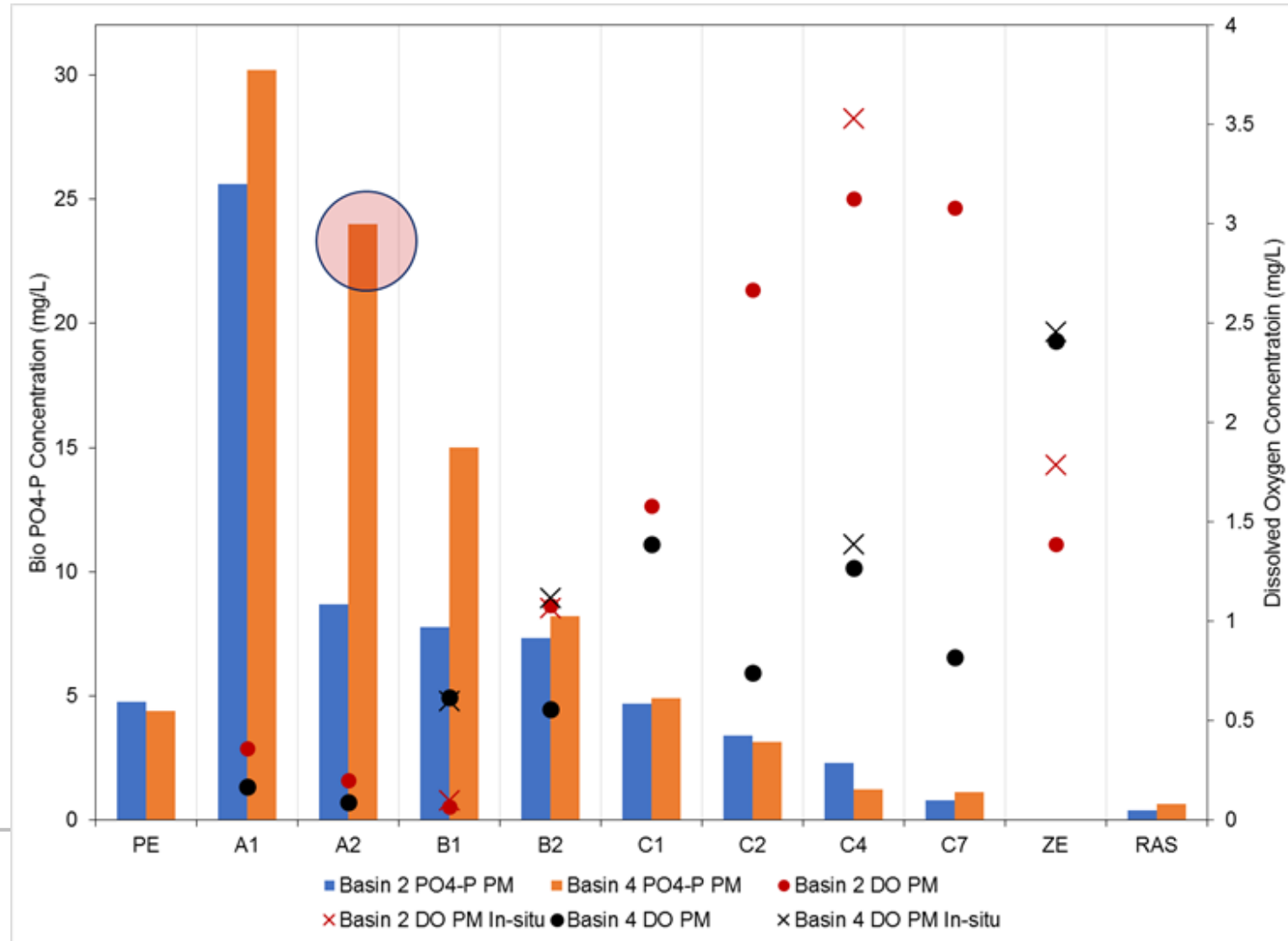
# RAS Short Circuiting

Phase 2 – Zone 1A



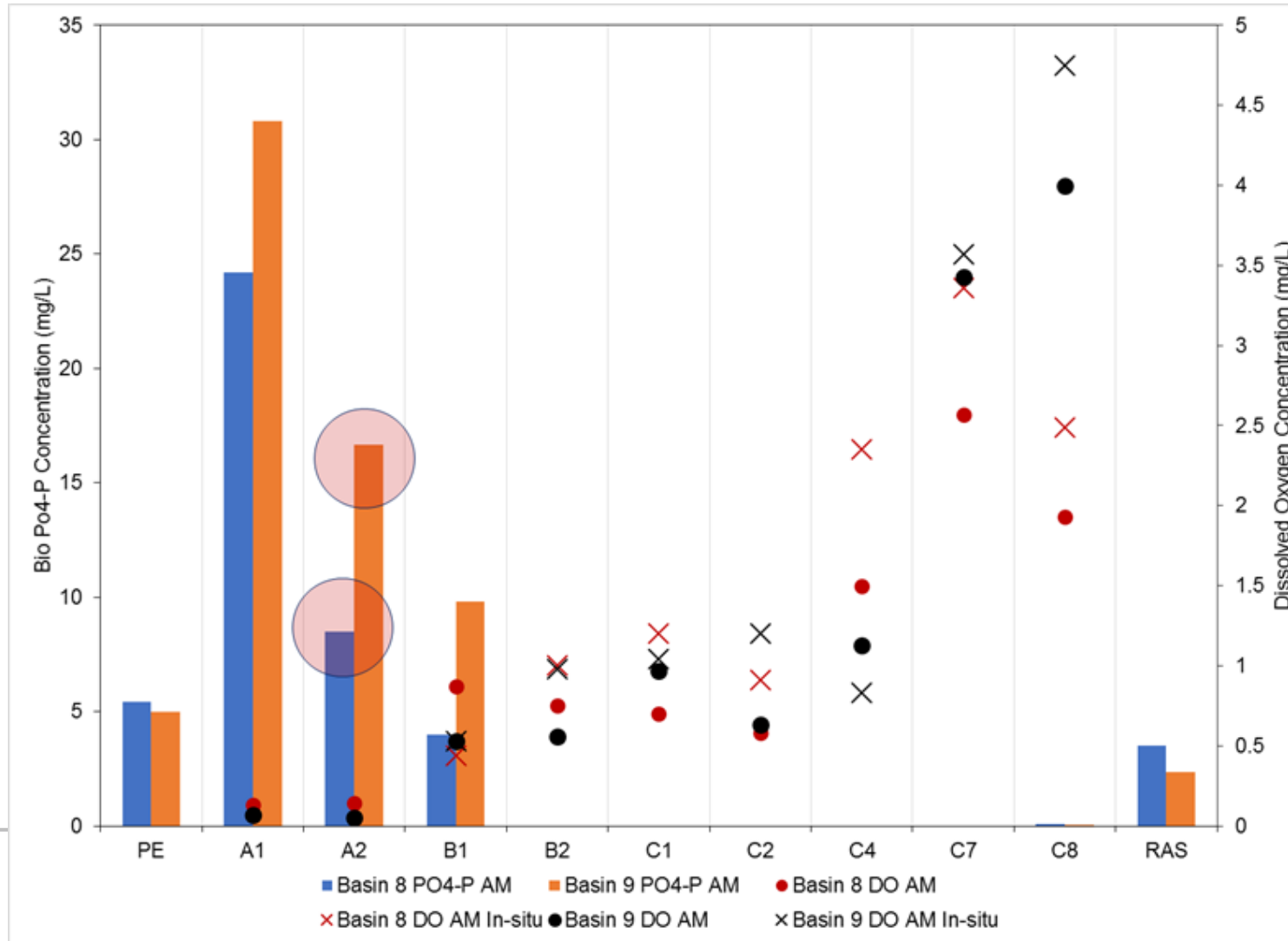
# Back Mixing – Phase 1

From Aerated to Unaerated Zones



# Back Mixing – Phase 2

From Aerated to Un-aerated Zones



# Optimization Conclusions

- Bio-P Performance Tipping Point
  - During normal steady state BRB configuration (NRCY/no NRCY) did not really matter
    - Good VFA/P ratio (Ostara performance), MLSS, pH, DO, low BRB influent nitrate (lower recycle flow), limited P release in secondary clarifier blankets
  - Observed NRCY kinetic inefficiency for rate/level of uptake phosphorus
    - Verified in BioWin model
    - Potential for short circuiting/back-mixing to have greater impact

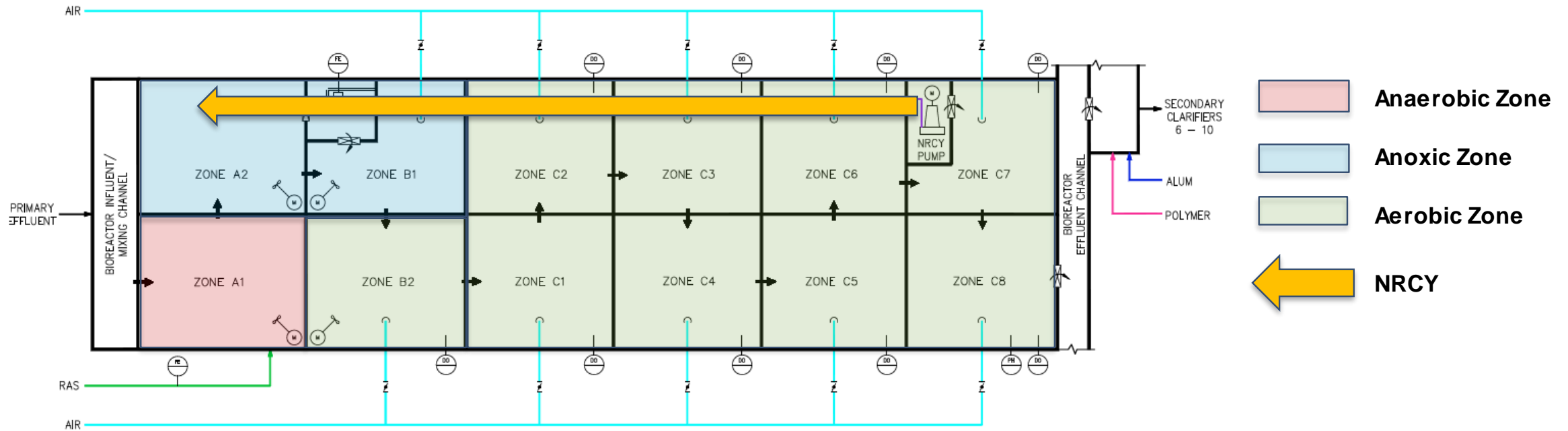
# Optimization Conclusions

- Temporary increase in recycle stream P loading to bioreactors:
  - Increase in BRB influent P leads to increase in Secondary Effluent P
  - Use of NRCY exacerbated EBPR upset conditions
- Secondary Clarifier Blanket Control
  - Reduced control → increase of secondary P release
- Observed RAS short-circuiting of Zone A1 (Phase 2 BRBs) and back mixing of aerated zones to unaerated zones



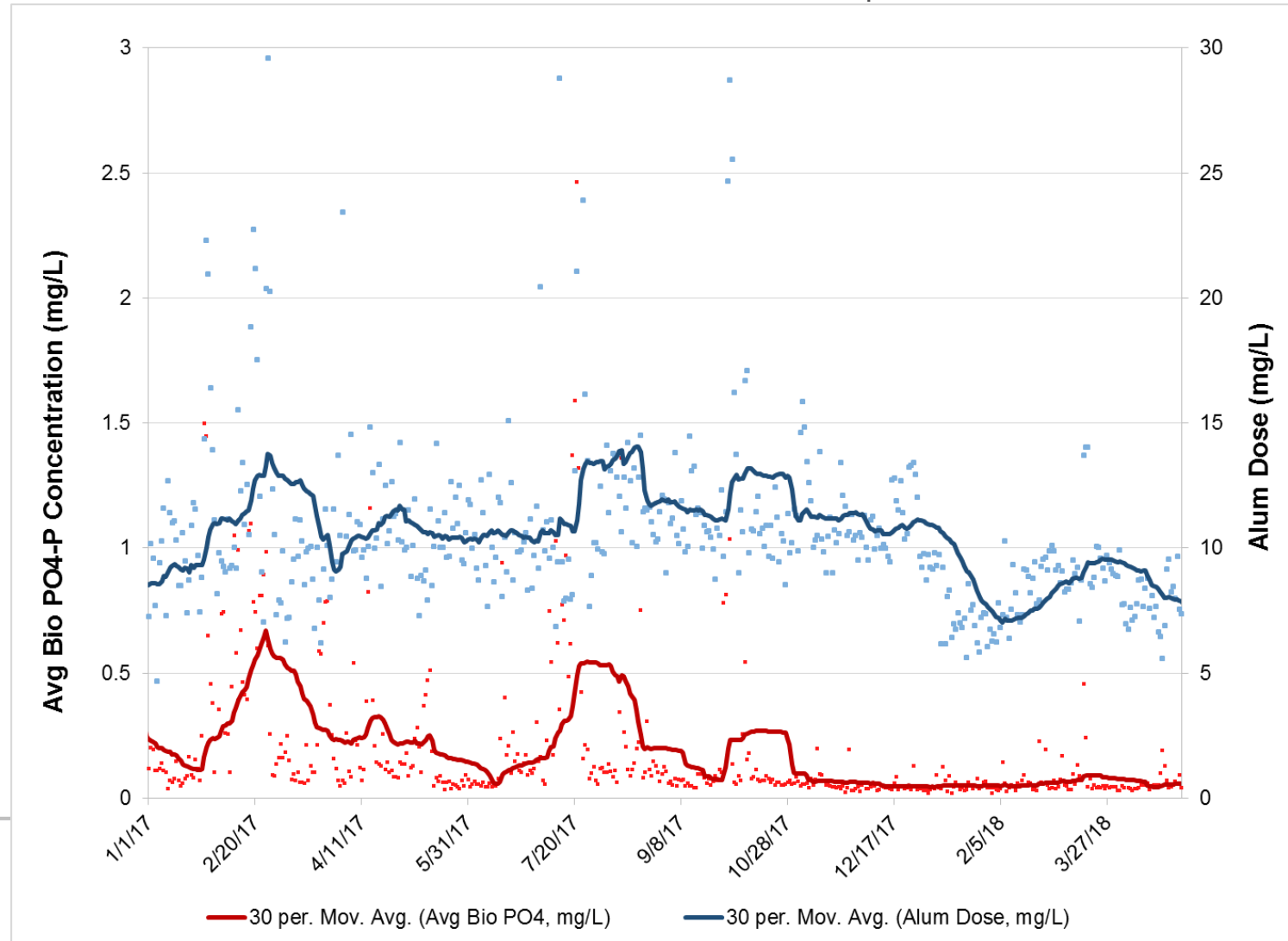
# Optimization Conclusions

- Optimal Bioreactor Configuration



# Performance Improvement

Bioreactor Effluent  $\text{PO}_4\text{-P}$



# Acknowledgements

- GCDWR
  - Justin Garmon
- Hazen and Sawyer
  - Ron Latimer
  - Paul Pitt

# Thank you!

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