



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.

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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

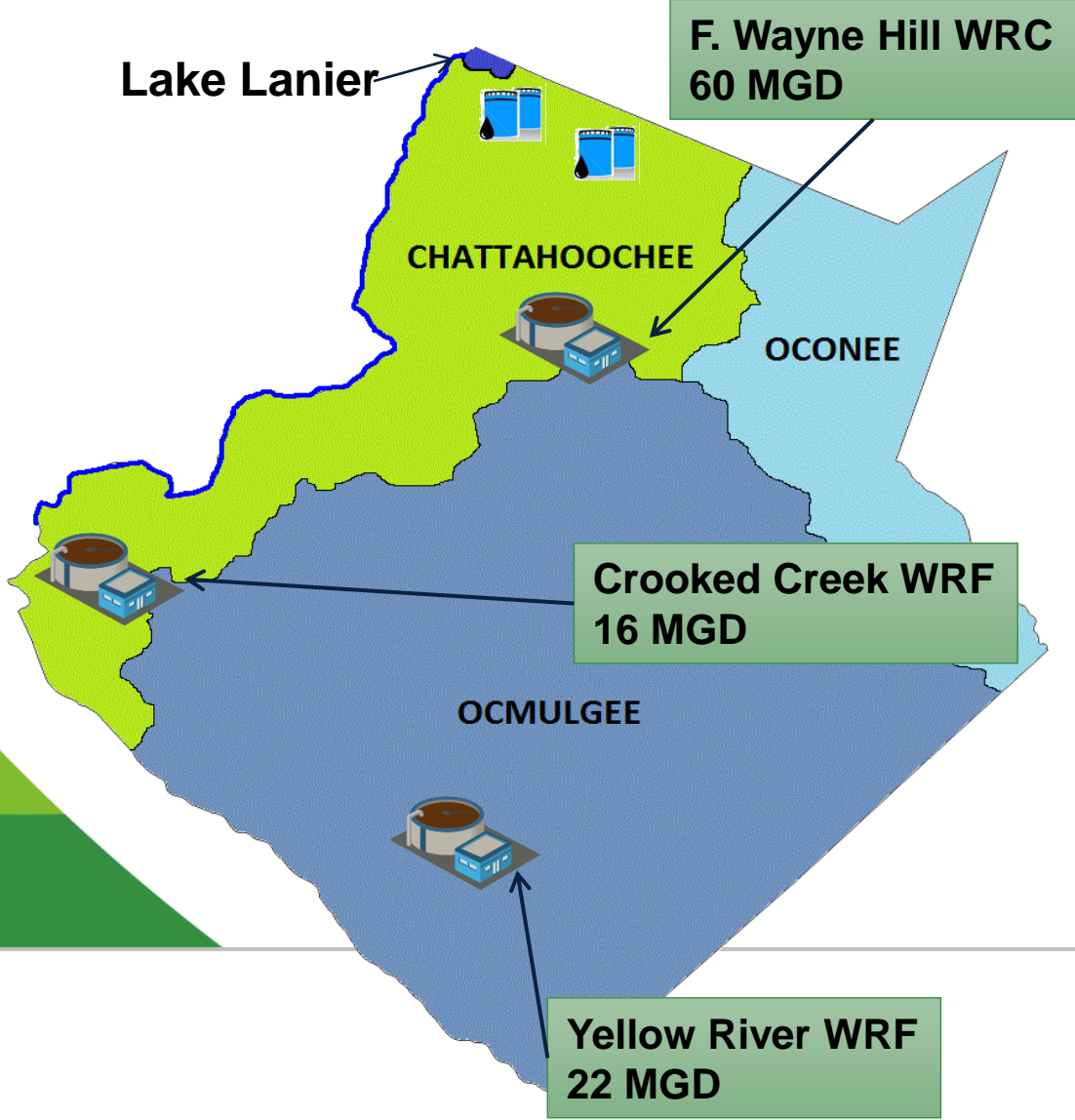
Scientist, Operations Technical Services

Gwinnett County Department of Water Resources

Date: 03/26/2021



Gwinnett County Water Reclamation Facilities

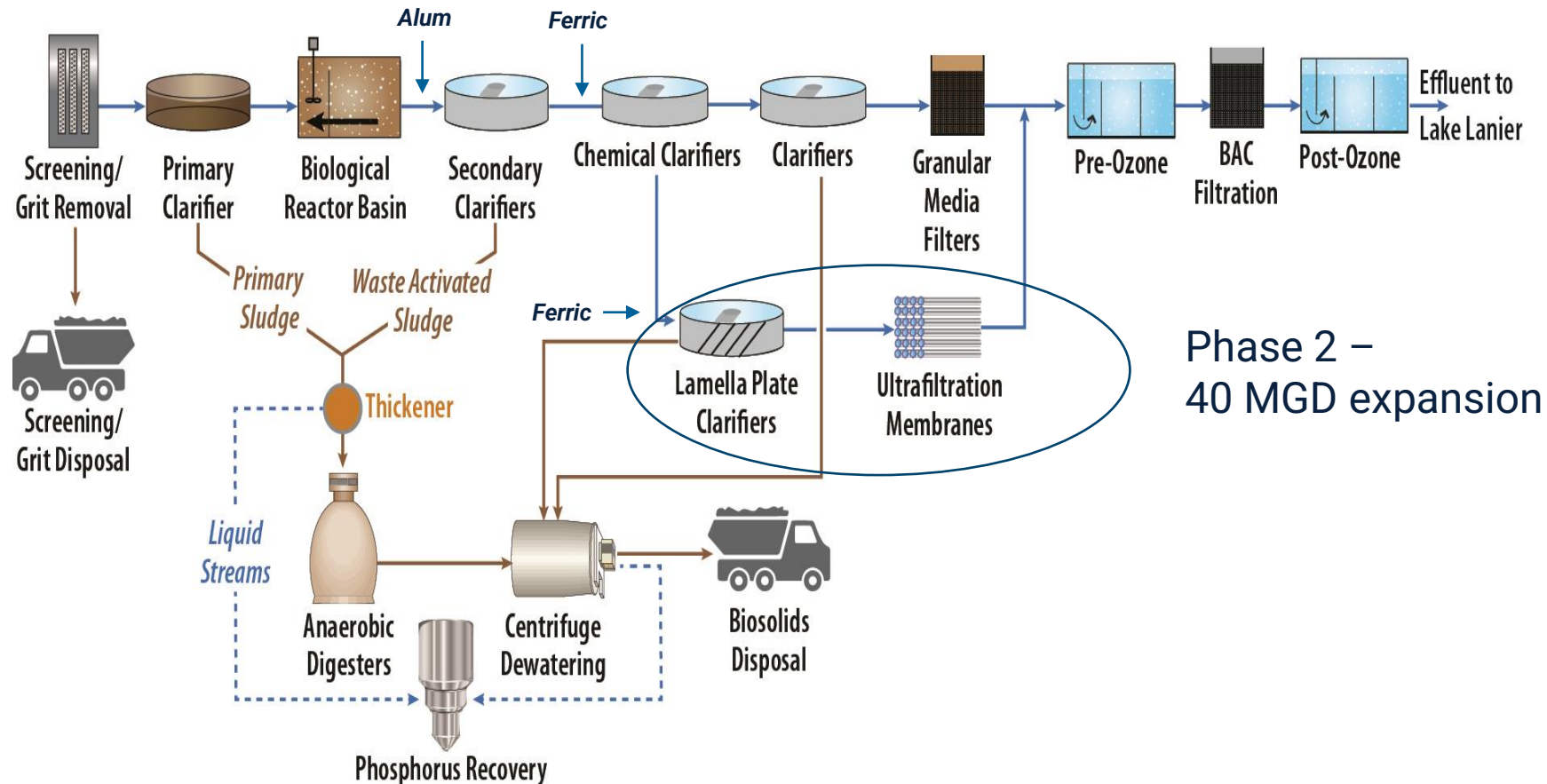


F. Wayne Hill WRC

- Largest and most advanced of GCDWR facilities – 60 MGD



F. Wayne Hill WRC Process Flow



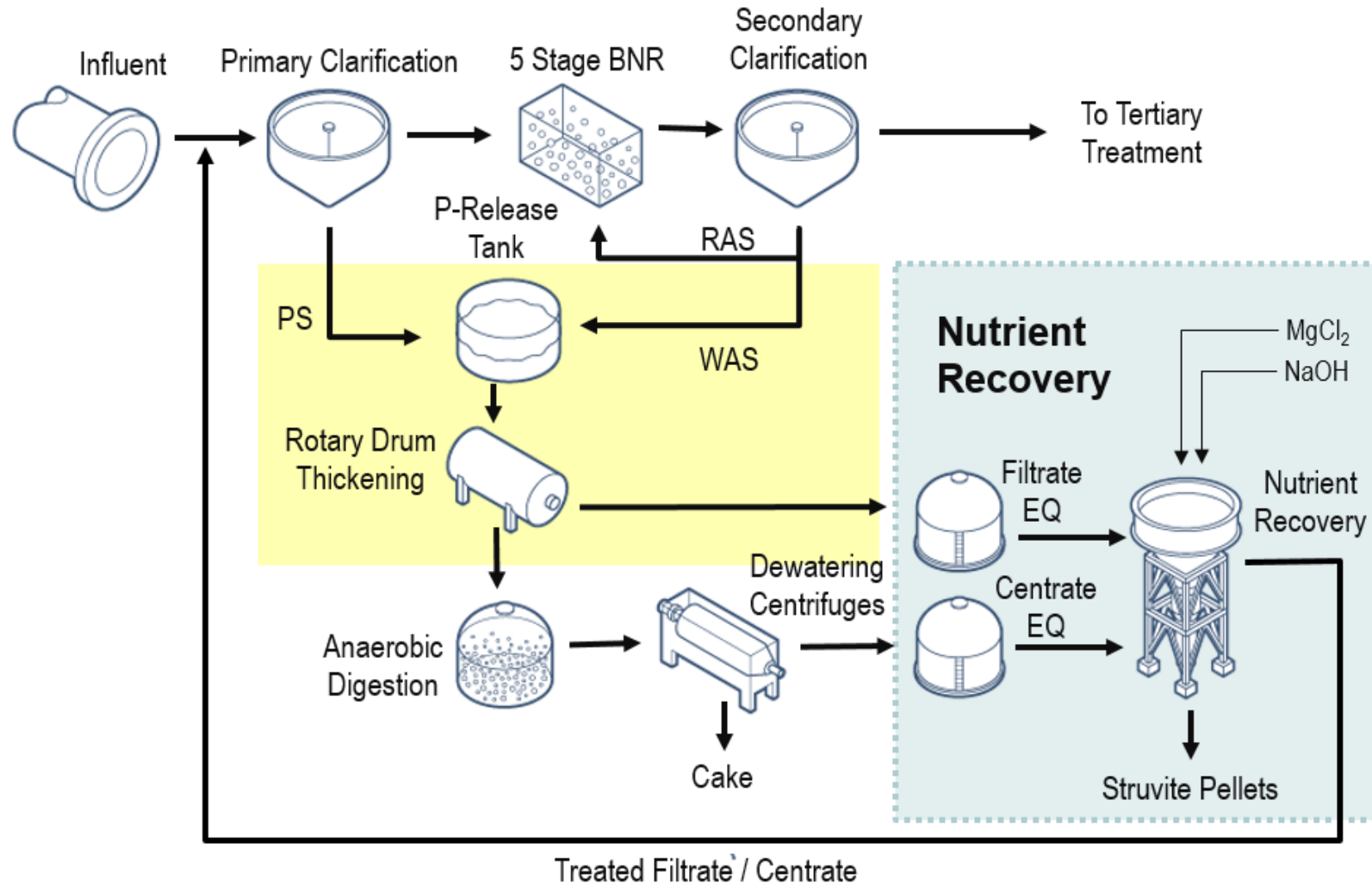
Process treatment trains at the F. Wayne Hill Water Resources Center

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

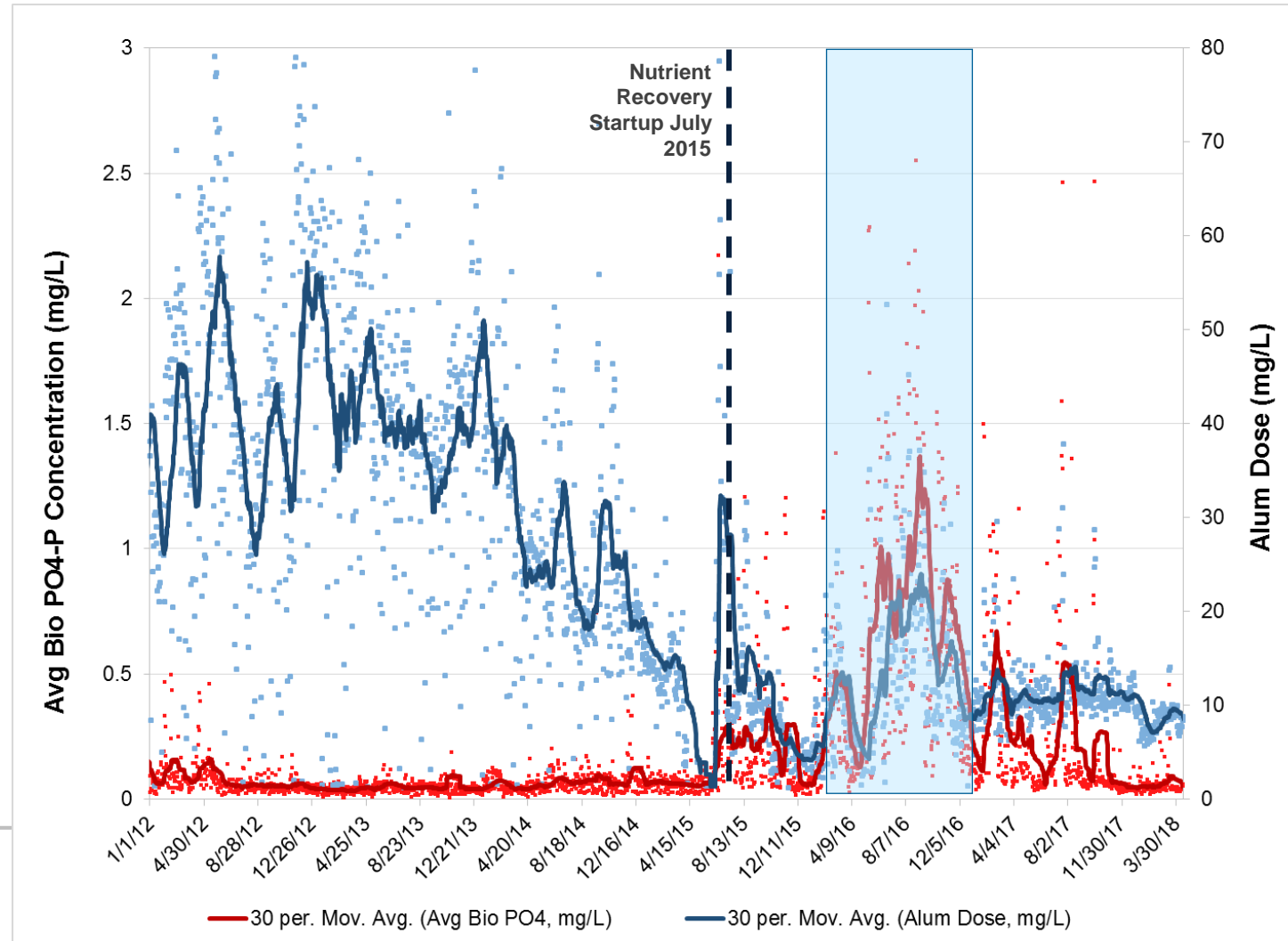




Historical Enhanced Bio-P Removal (EBPR) Performance

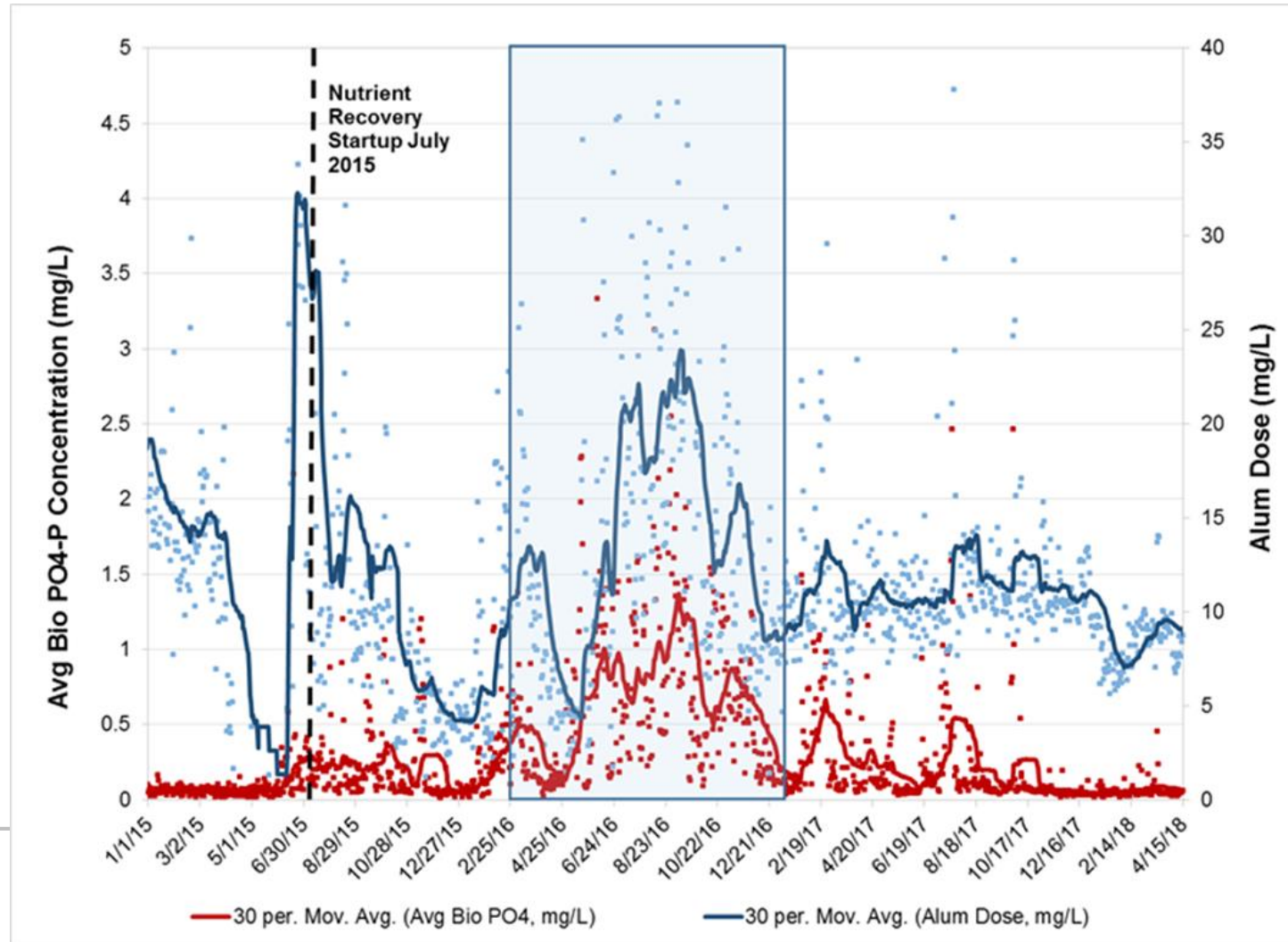
Historical EBPR Performance

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



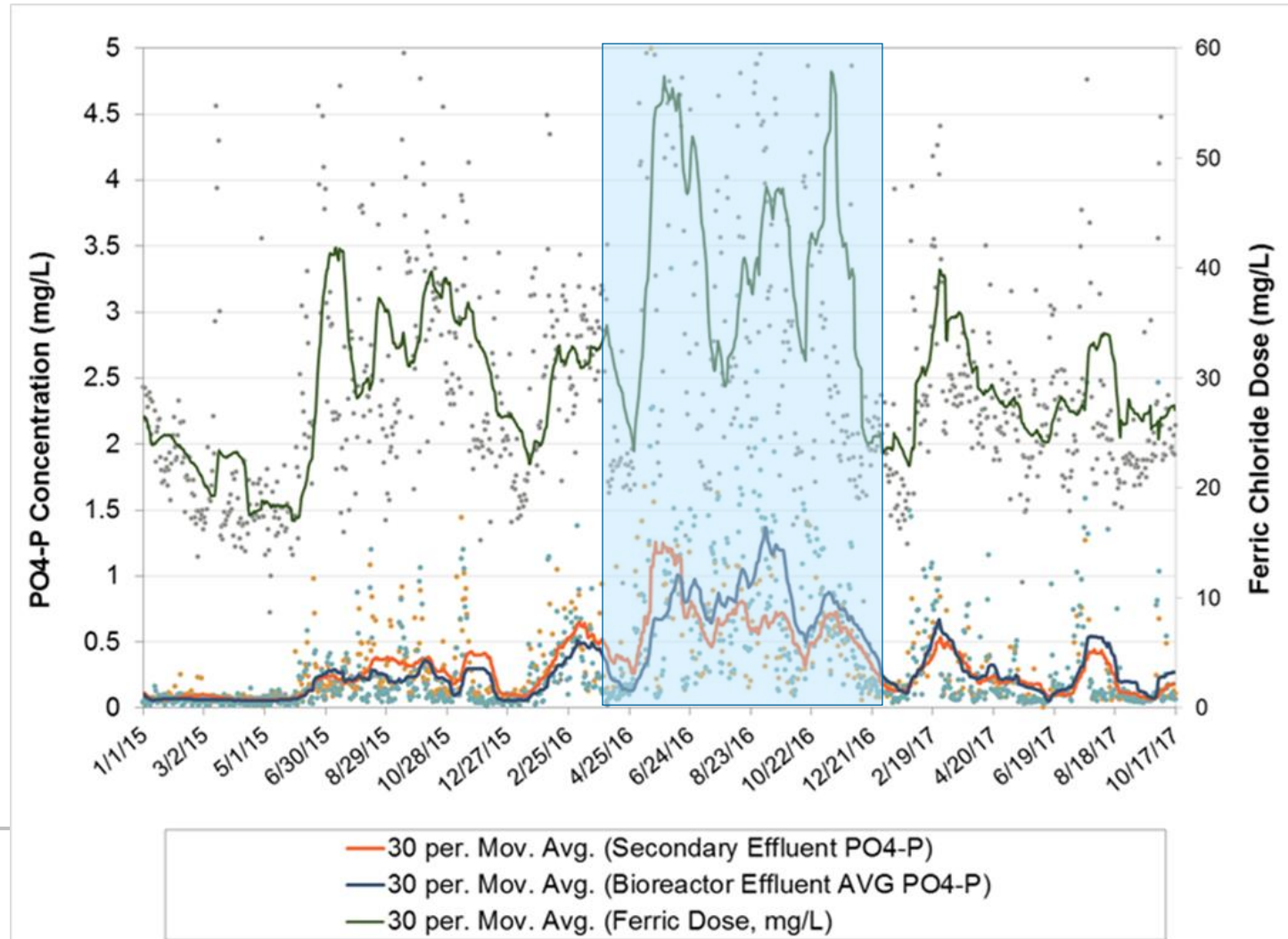
Historical EBPR Performance

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



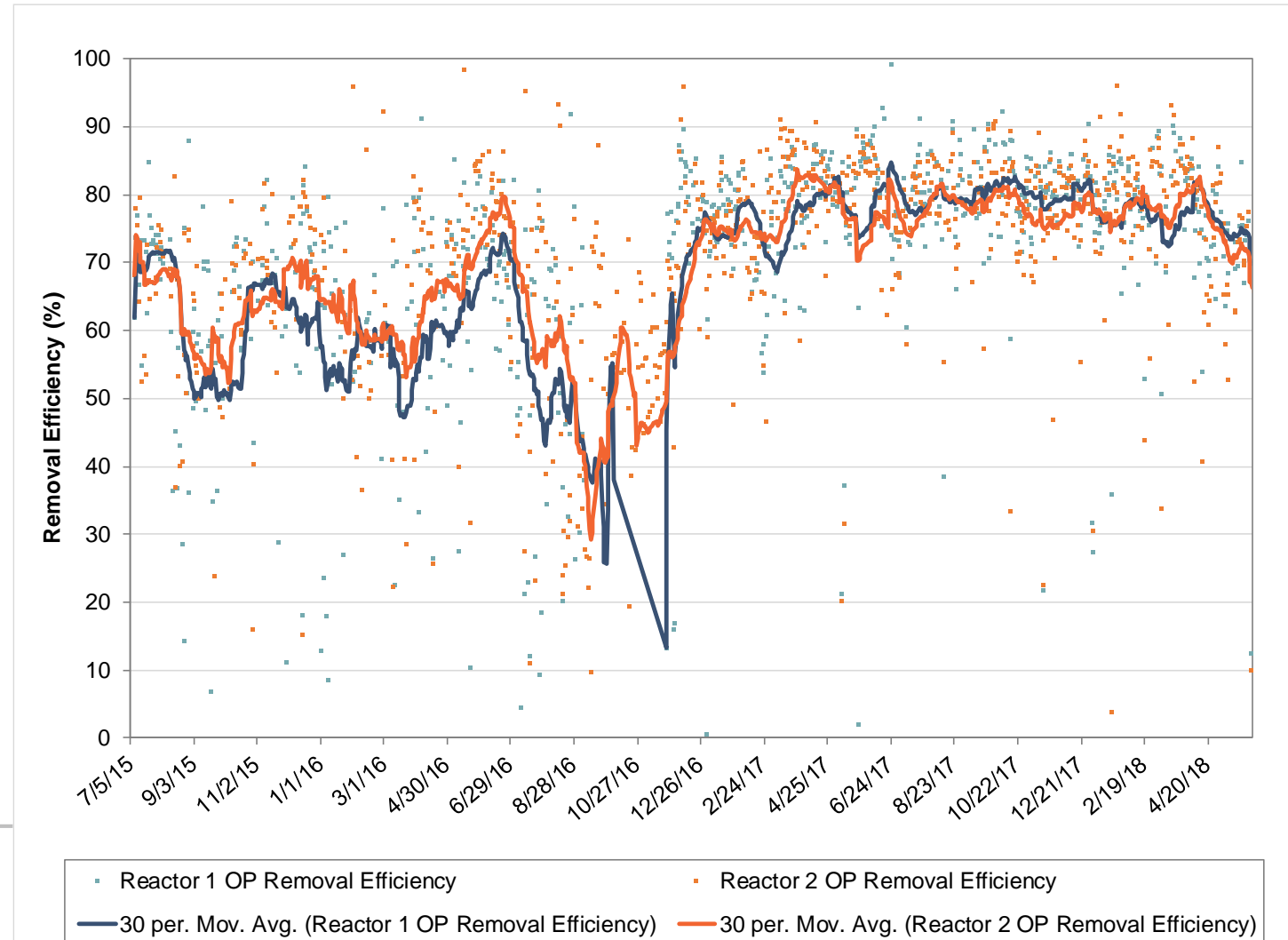
Historical EBPR Performance

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



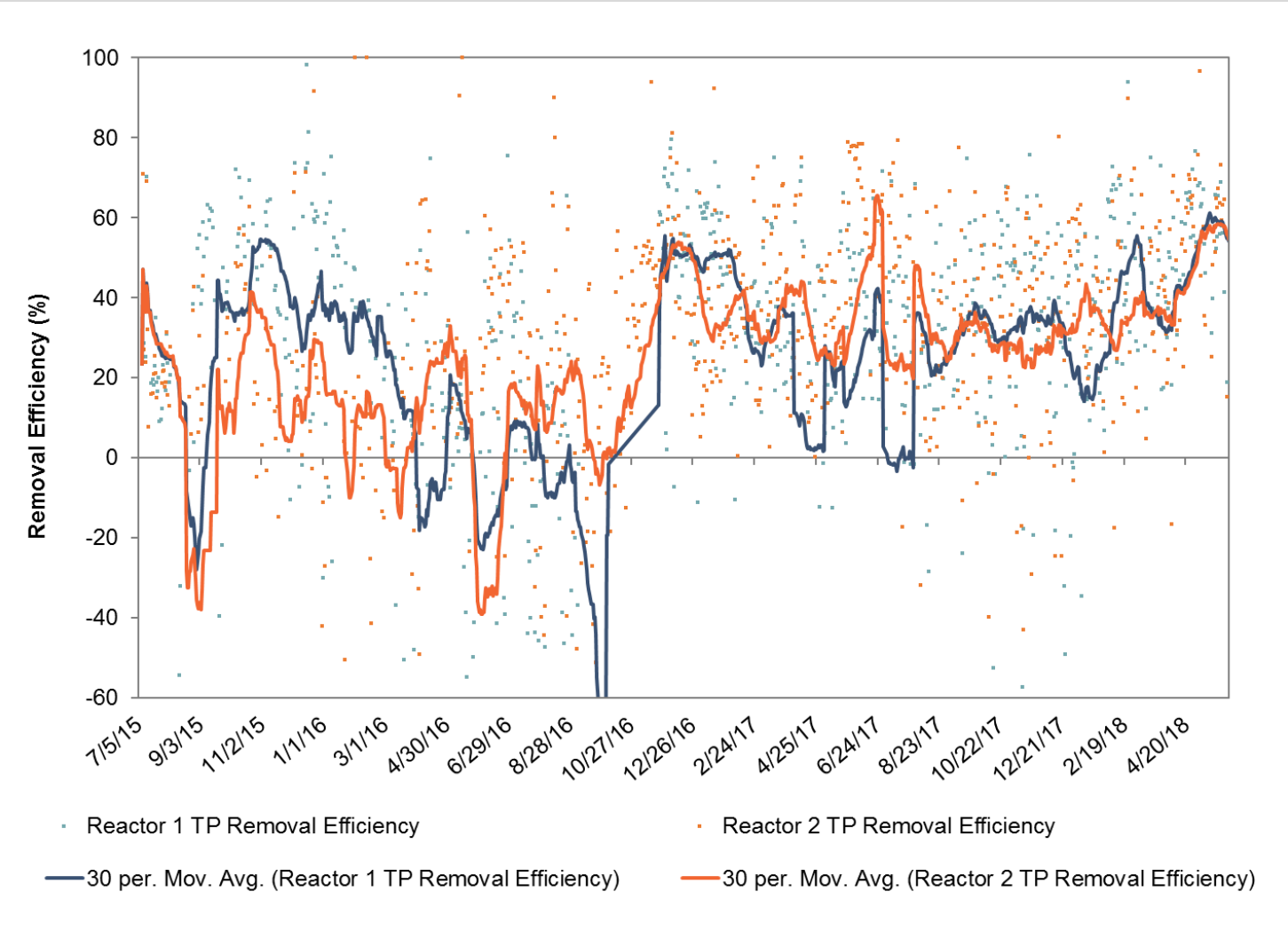
Reduced Nutrient Recovery Performance

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



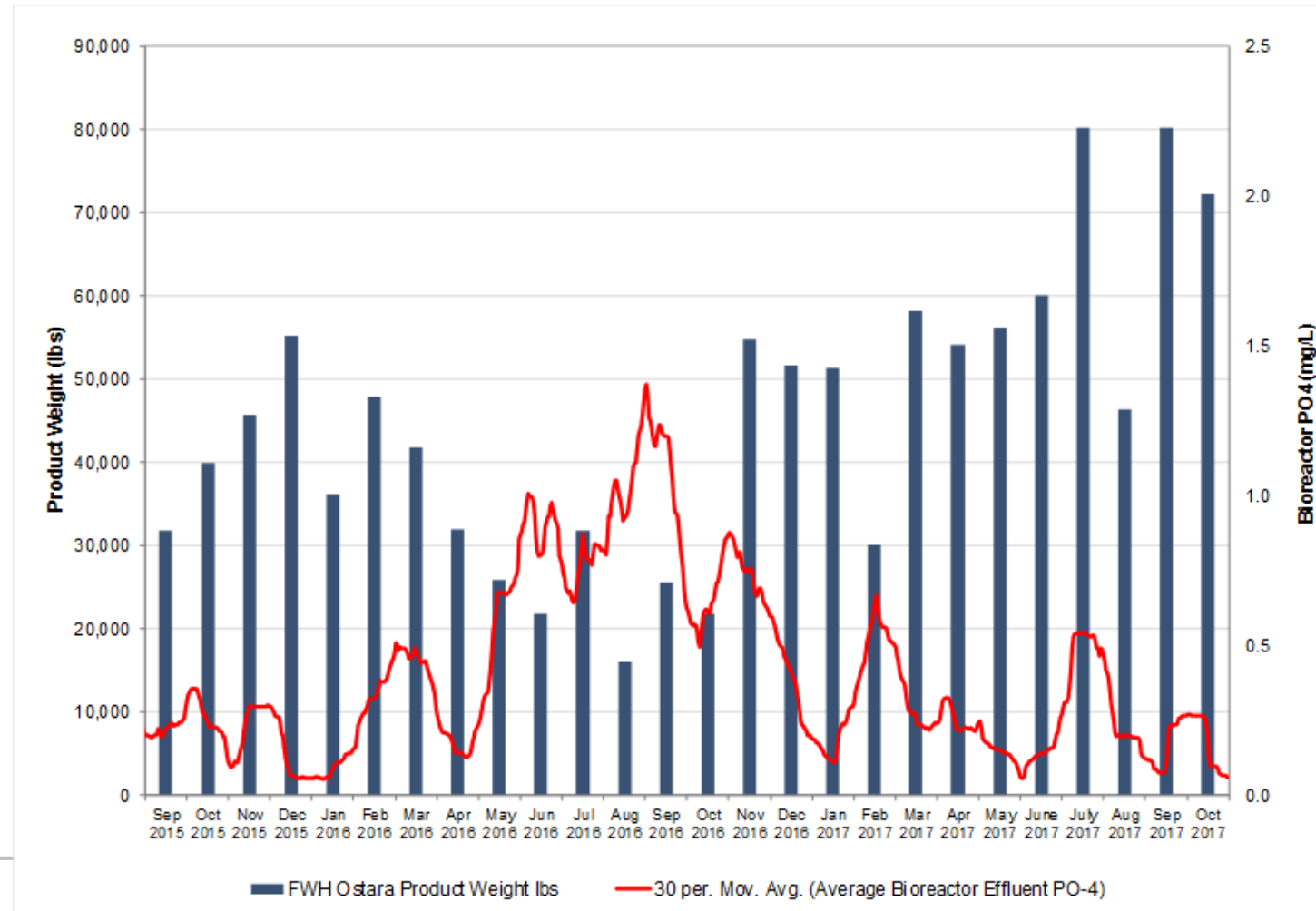
Reduced Nutrient Recovery Performance

Total P (TP) Removal



Nutrient Recovery Performance

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



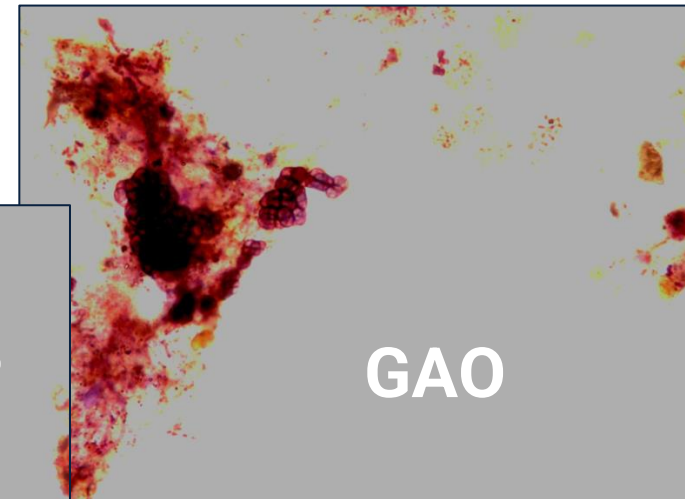
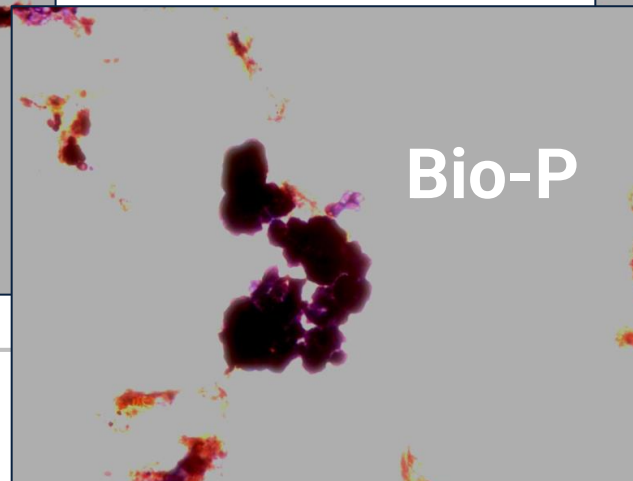
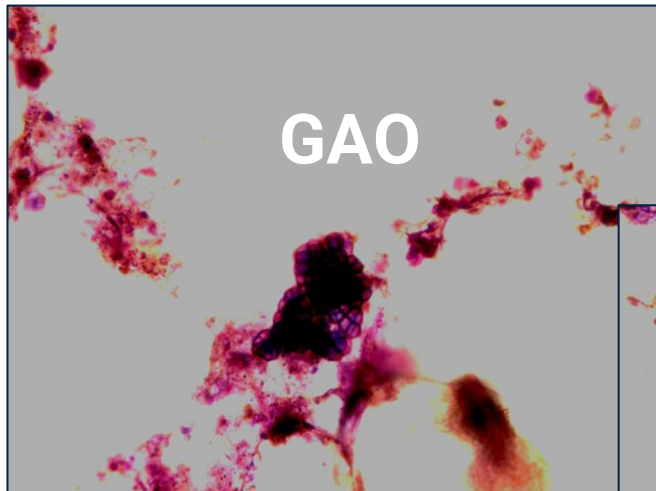
Nutrient Recovery Performance

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



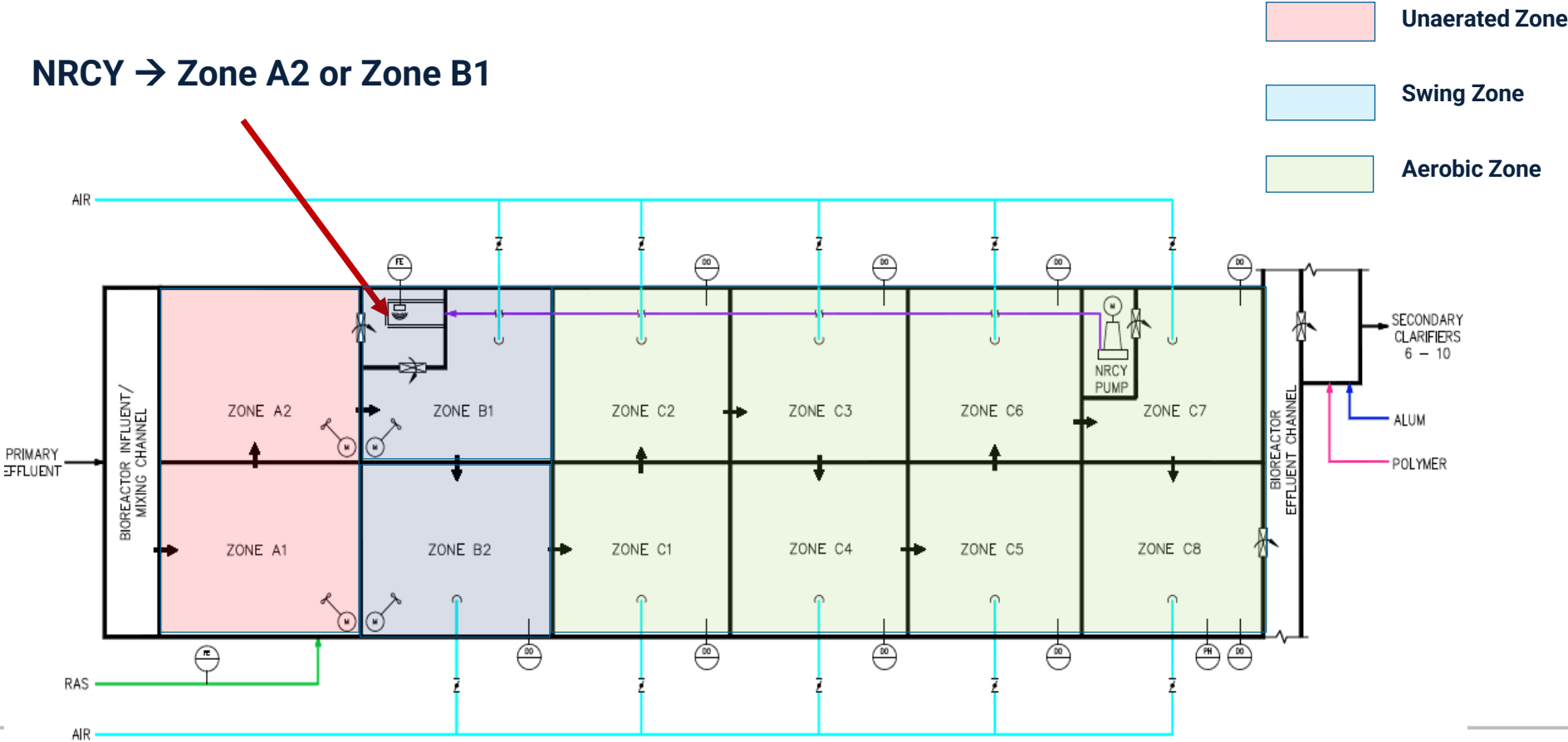
Optimization of Biological Phosphorus Removal

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



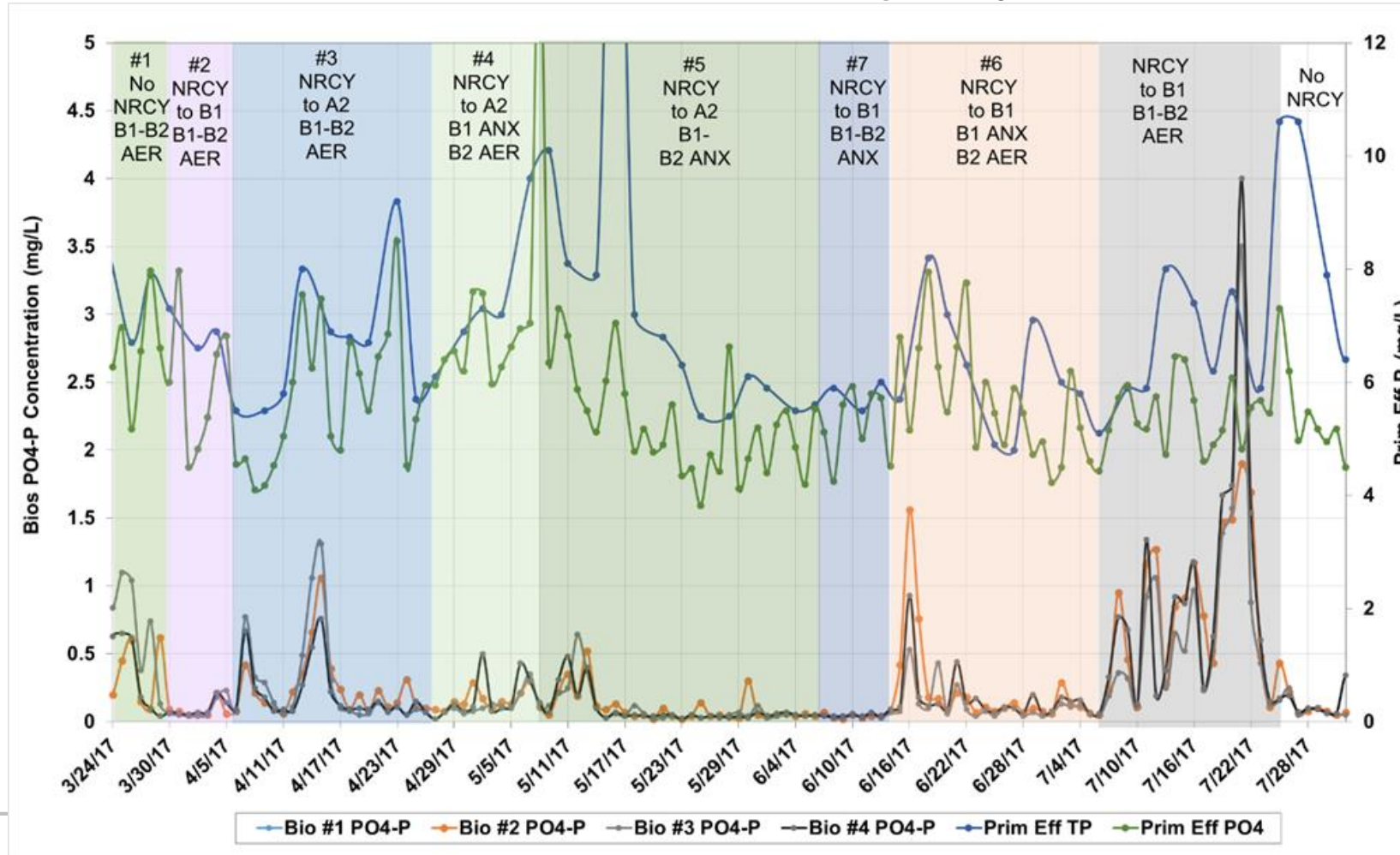
Field Testing Configurations

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

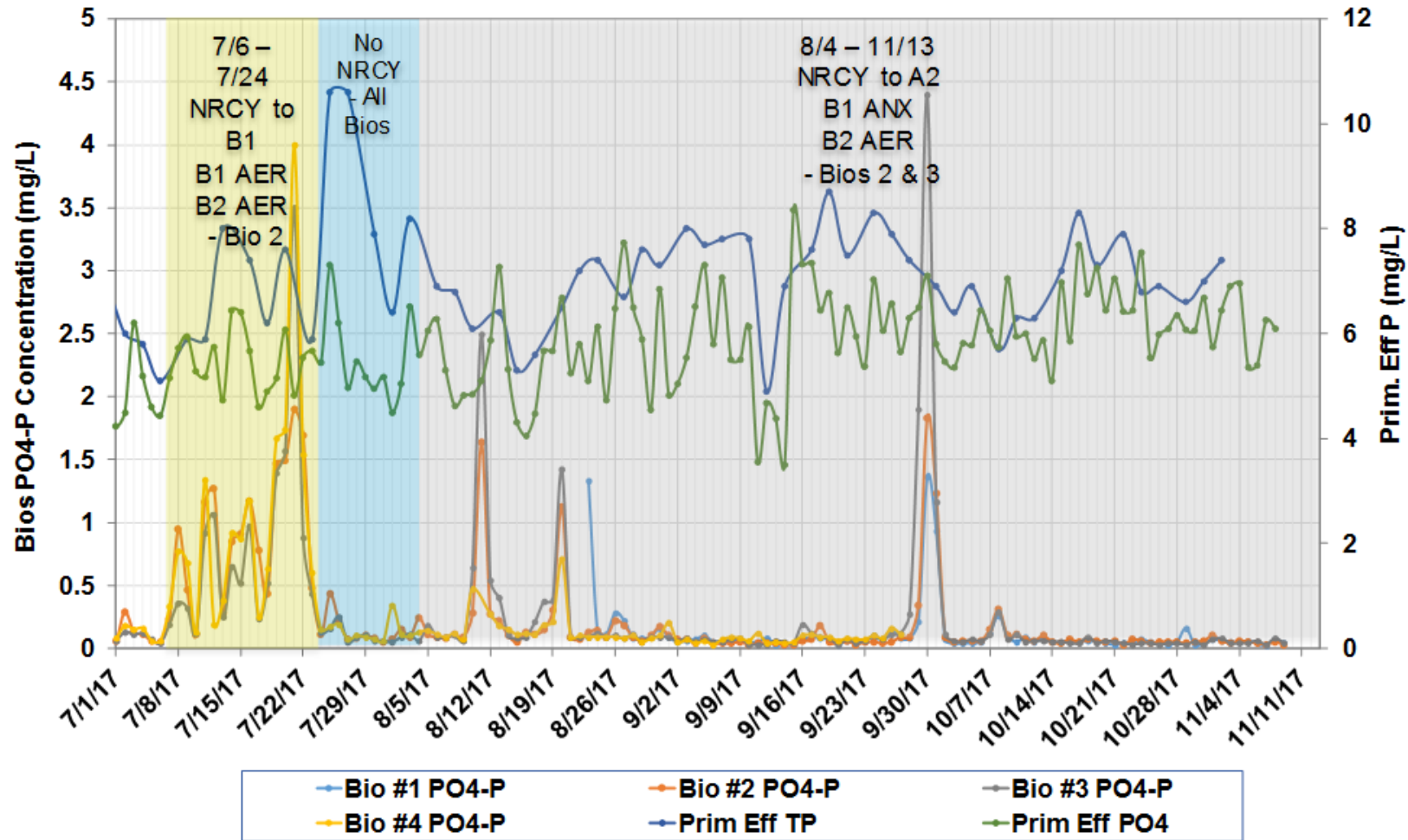
Bioreactor Effluent PO₄-P

Phase 1 – March 2017 through July 2017



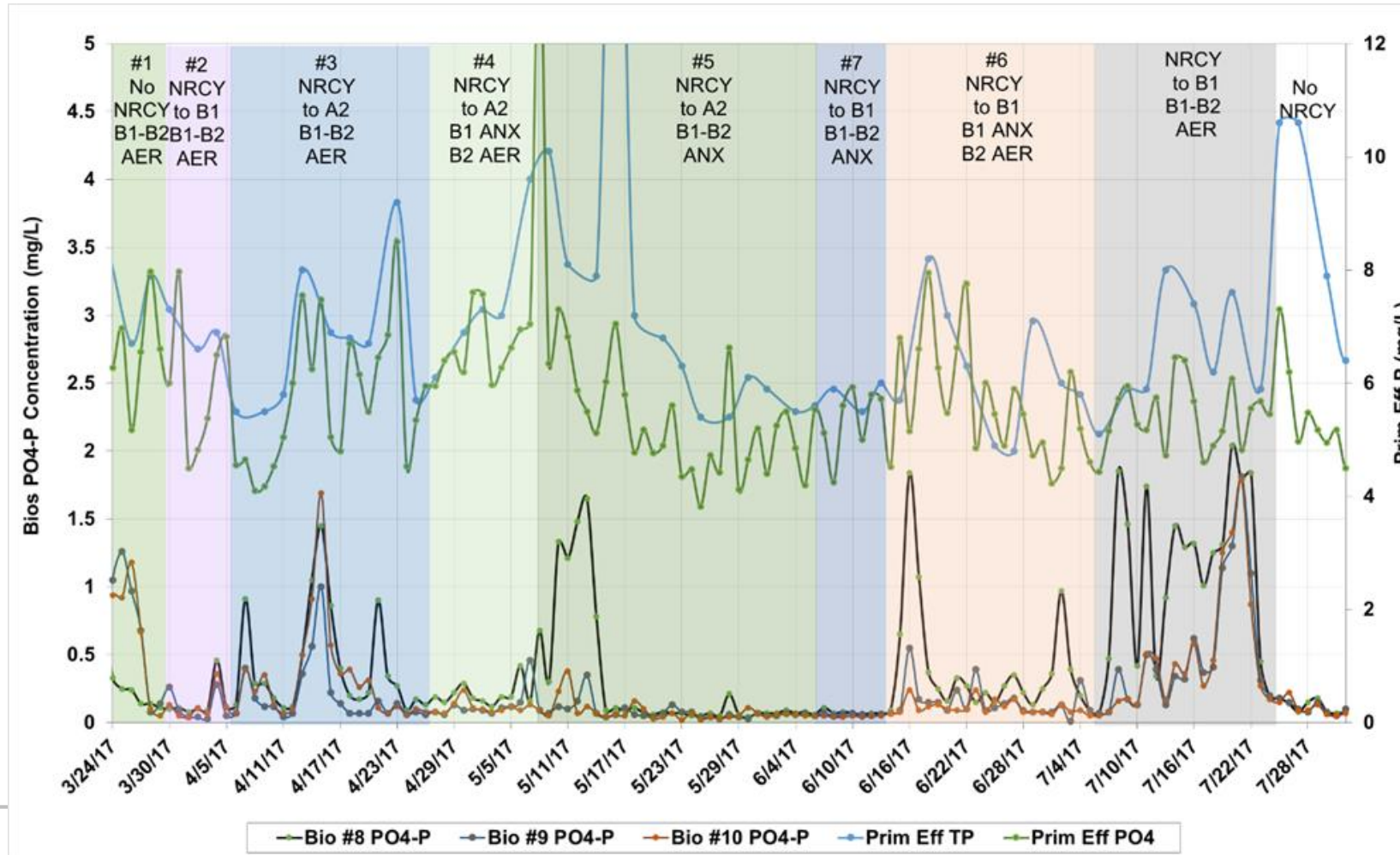
Bioreactor Effluent PO₄-P

Phase 1 – July 2017 through November 2017



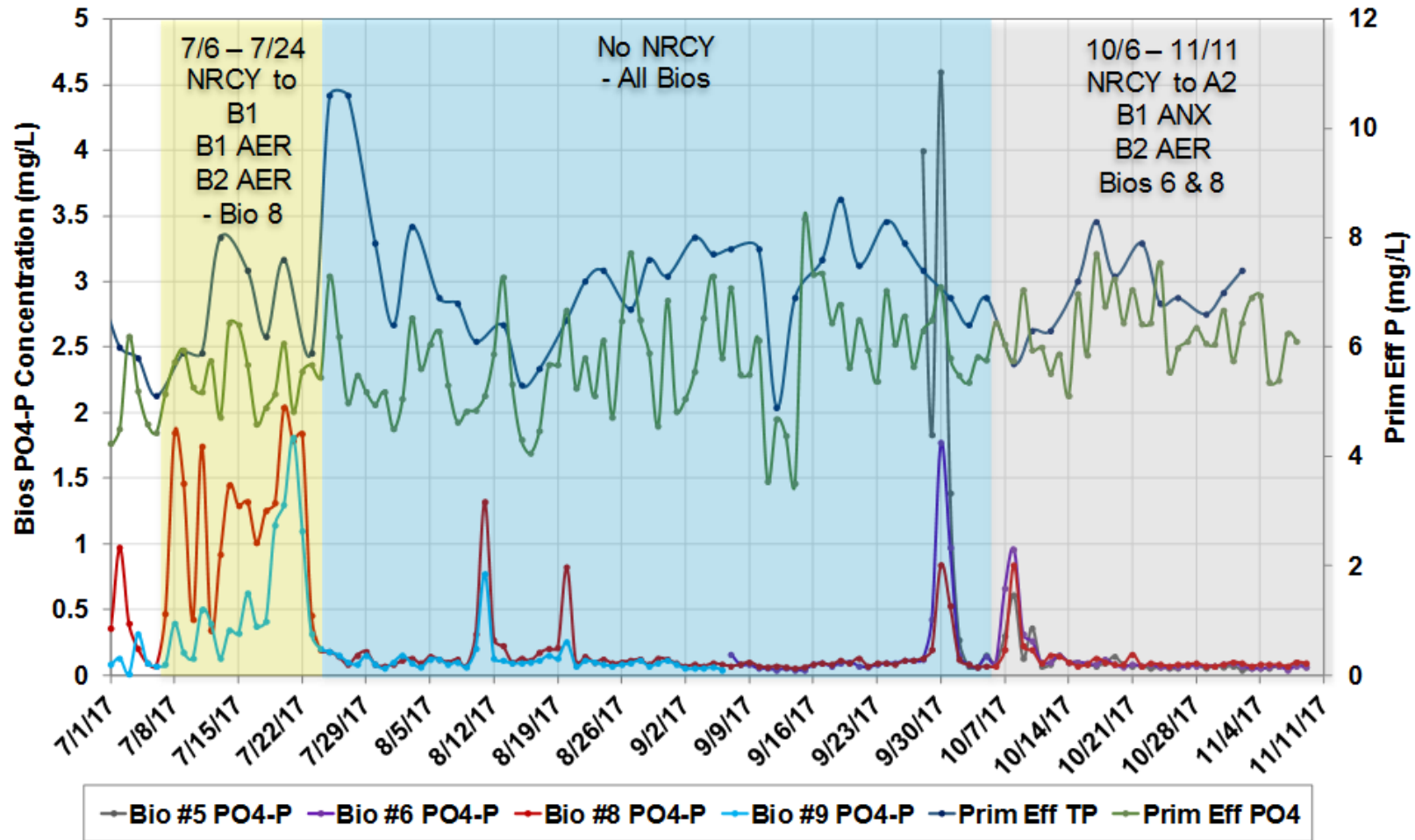
Bioreactor Effluent PO₄-P

Phase 2 – March 2017 through July 2017



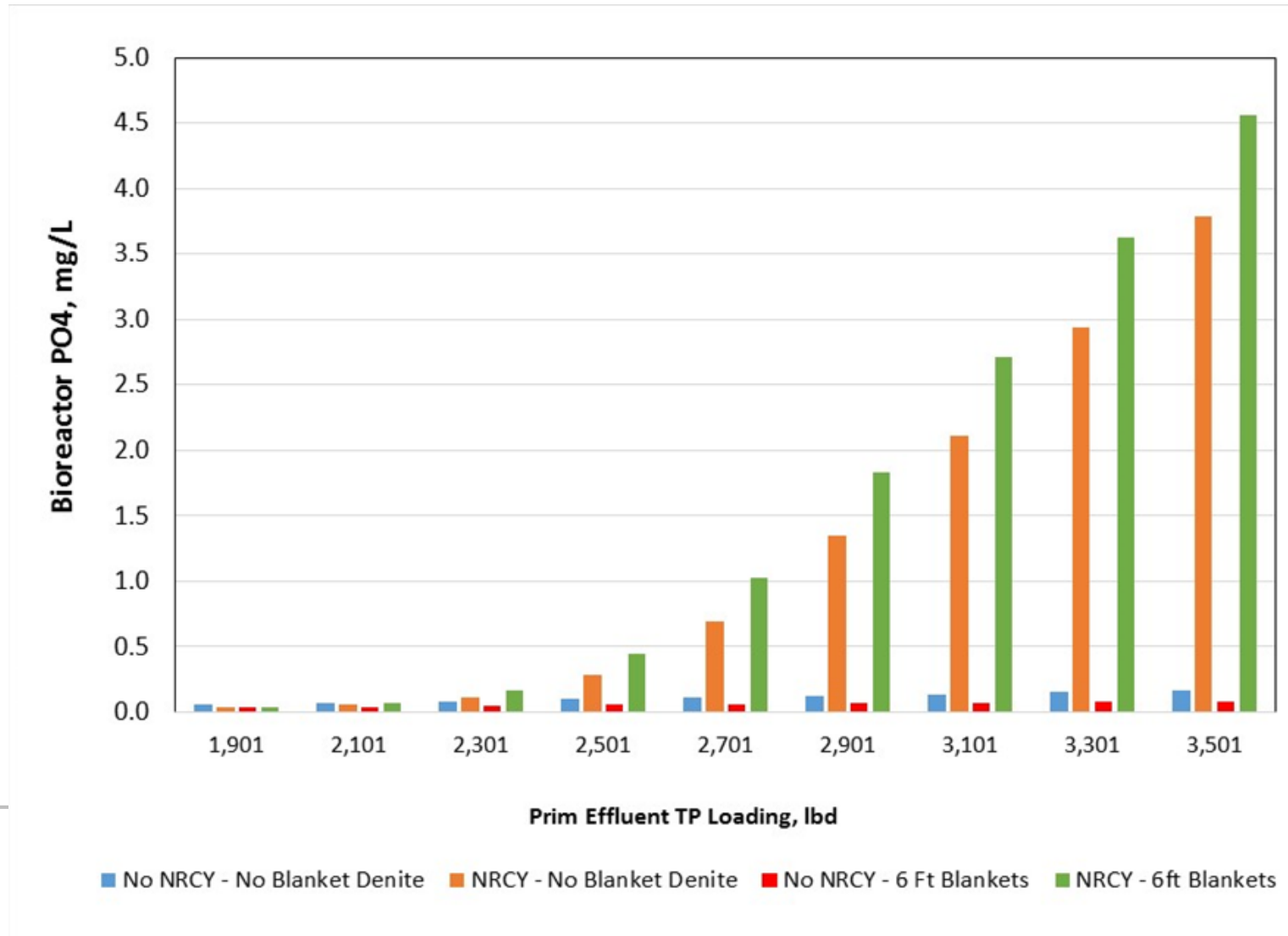
Bioreactor Effluent PO₄-P

Phase 2 – July 2017 through November 2017



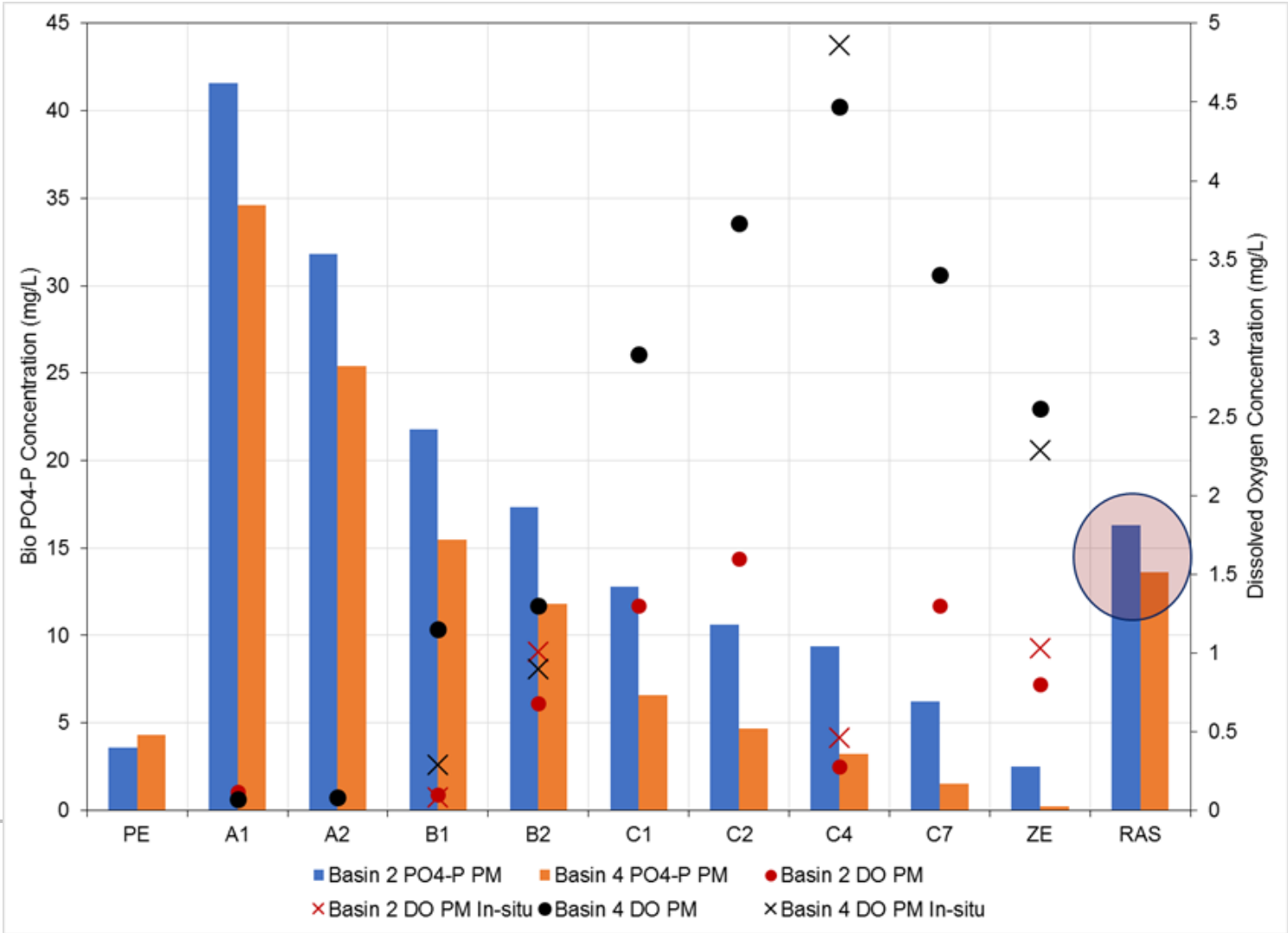
NRCY Operation and EBPR

Calibrated Process Model Results



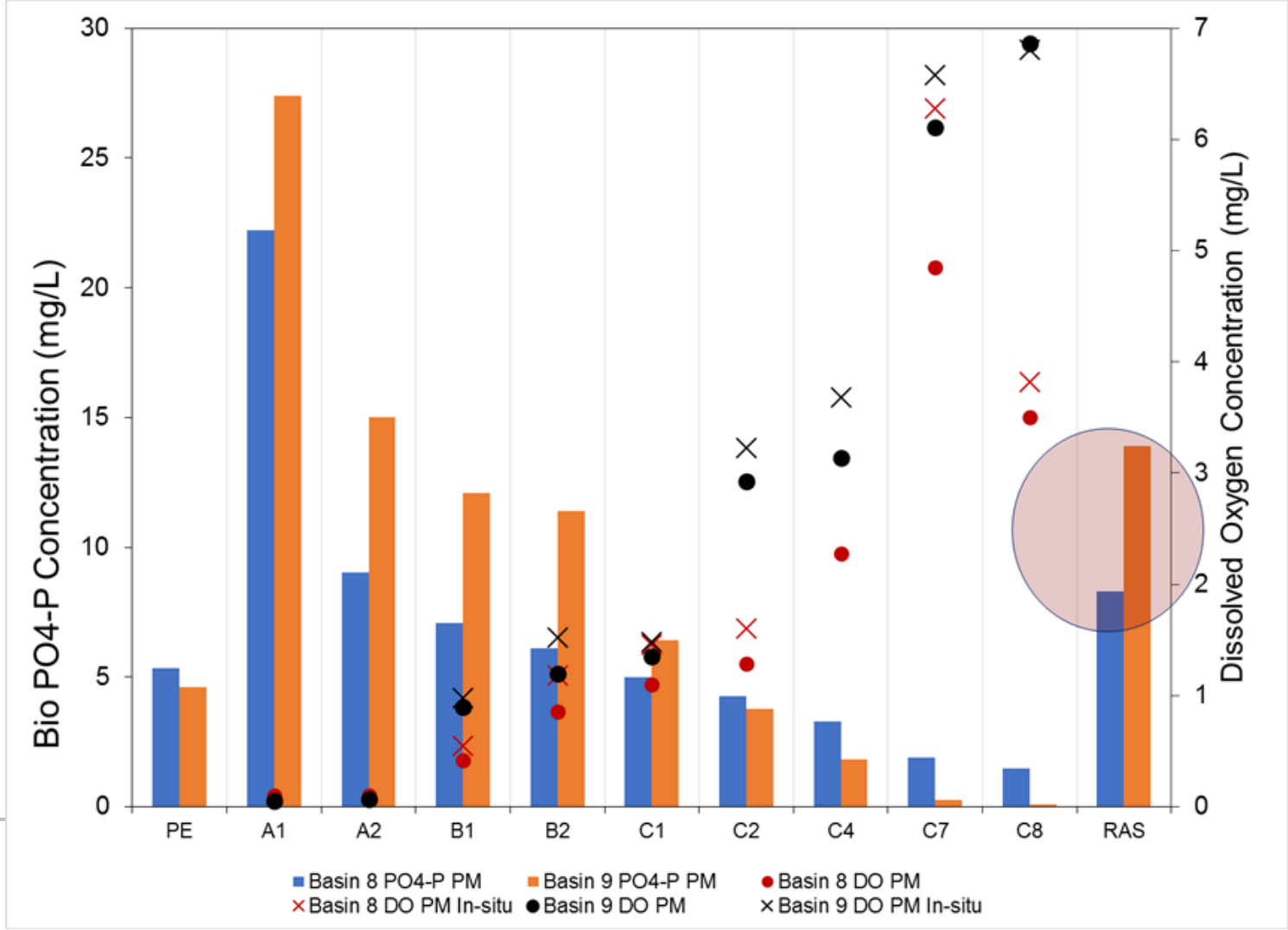
Secondary Phosphorus Release – Phase 1

Secondary Clarifier Sludge Blankets



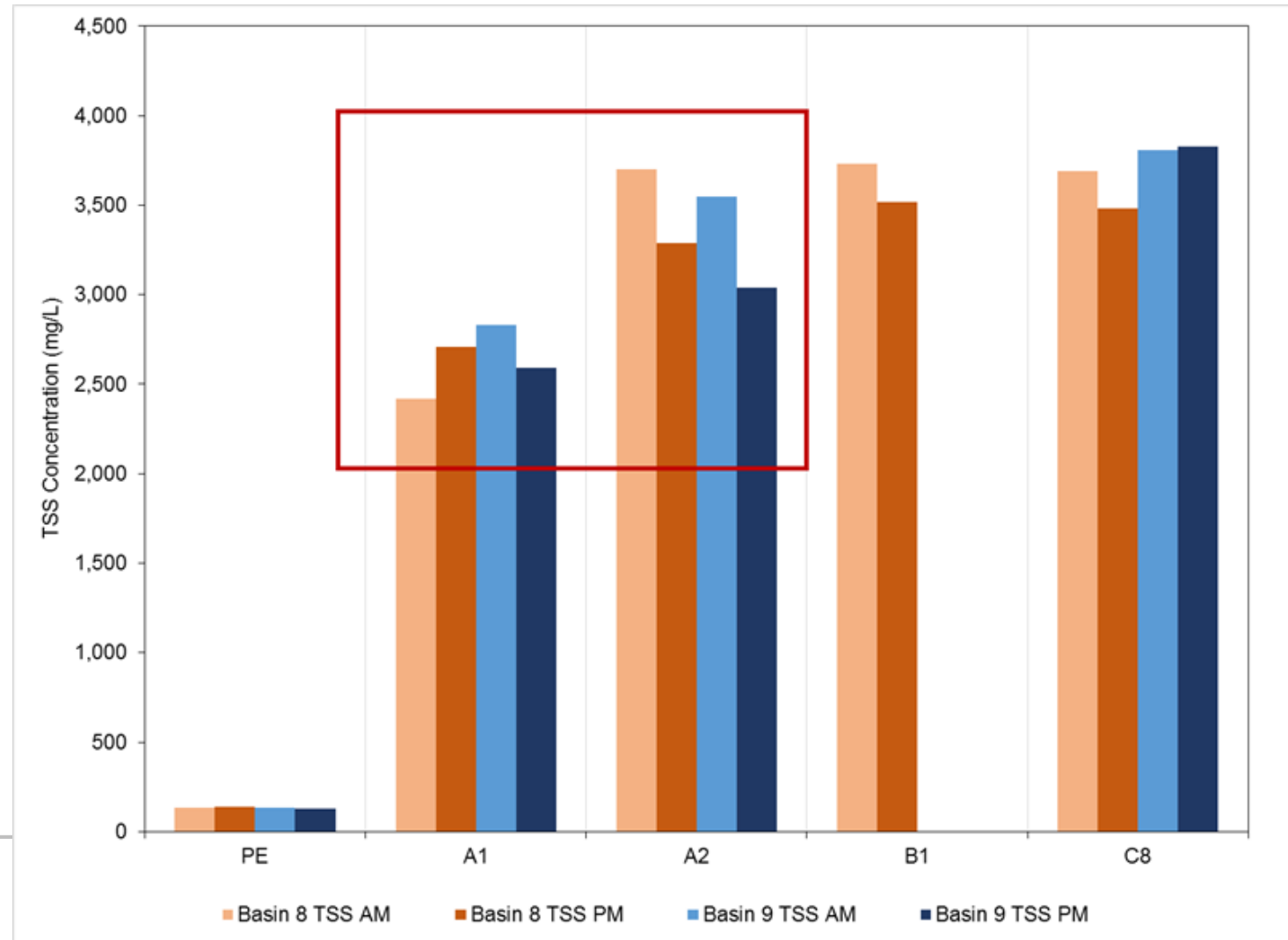
Secondary Phosphorus Release – Phase 2

Secondary Clarifier Sludge Blankets



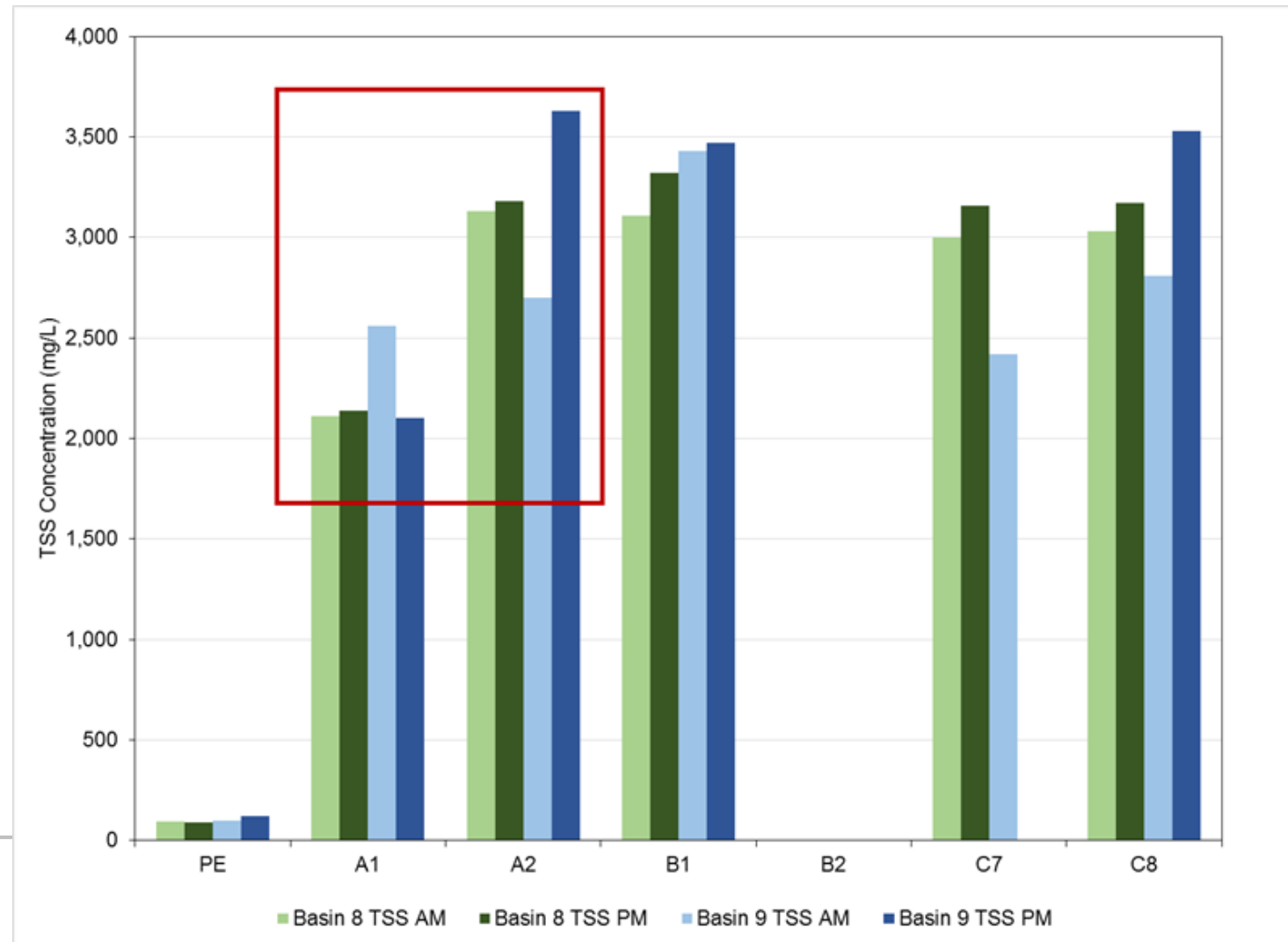
RAS Short Circuiting

Phase 2 – Zone 1A



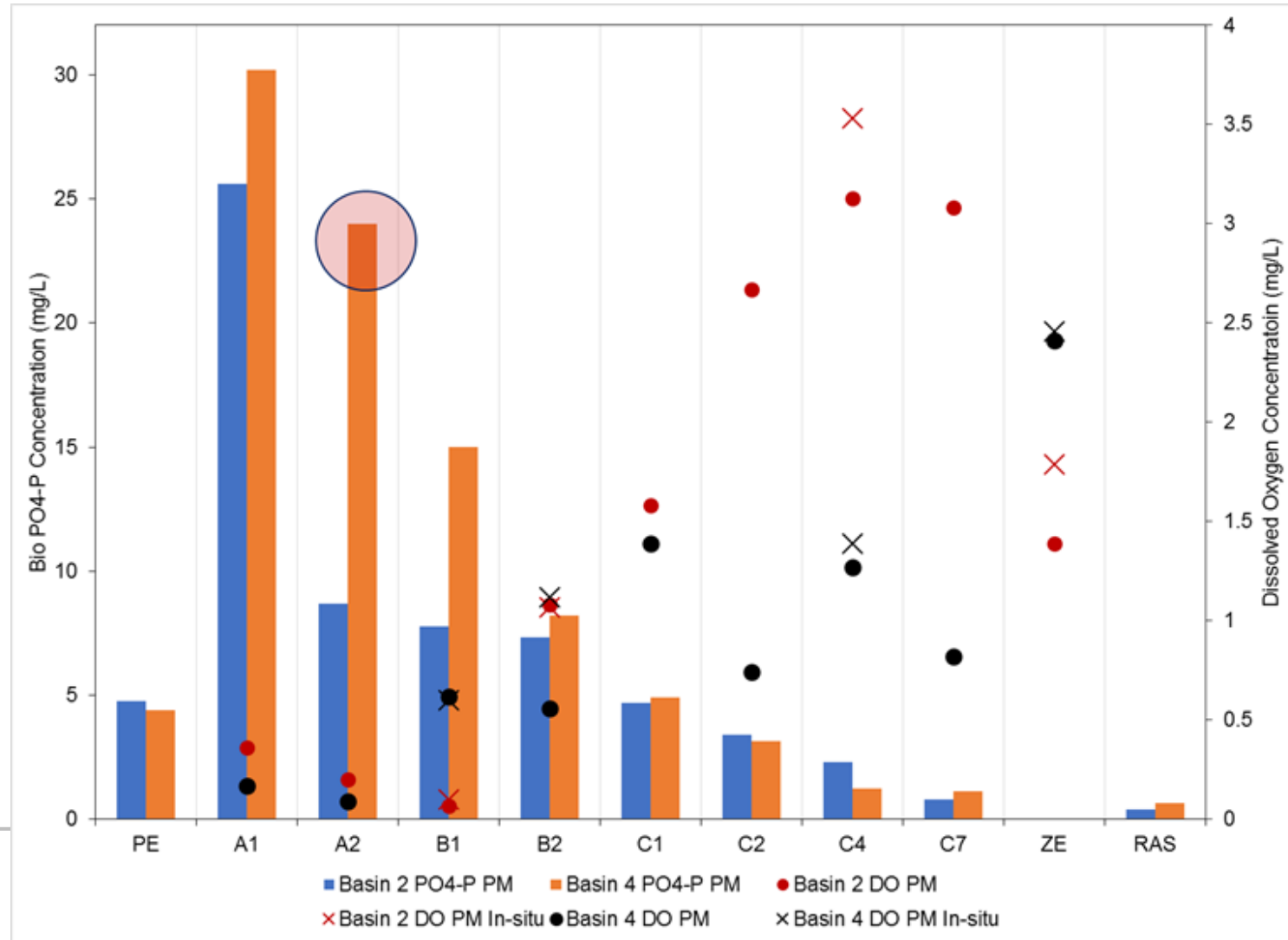
RAS Short Circuiting

Phase 2 – Zone 1A



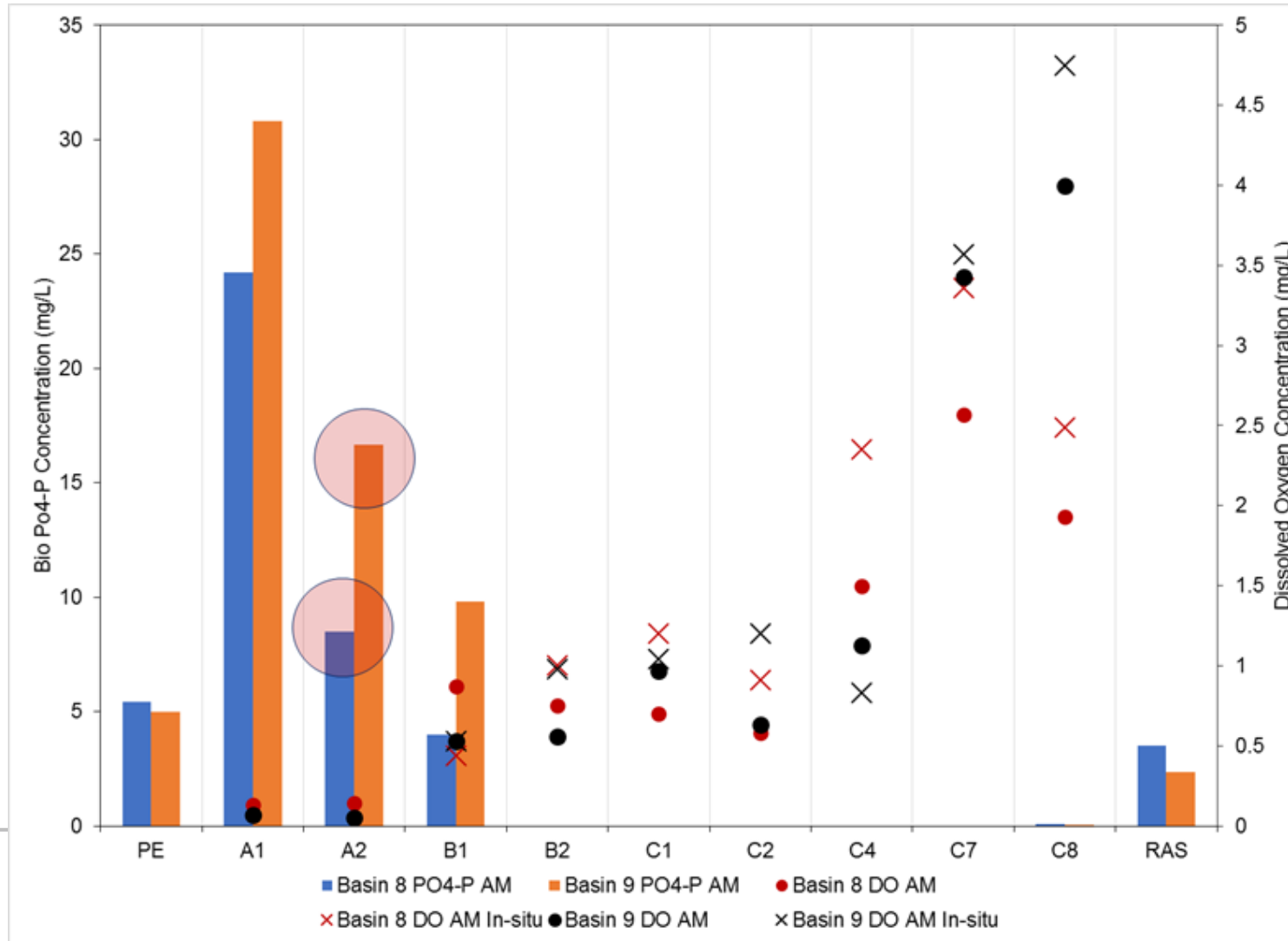
Back Mixing – Phase 1

From Aerated to Un-aerated Zones



Back Mixing – Phase 2

From Aerated to Unaerated Zones



Optimization Conclusions

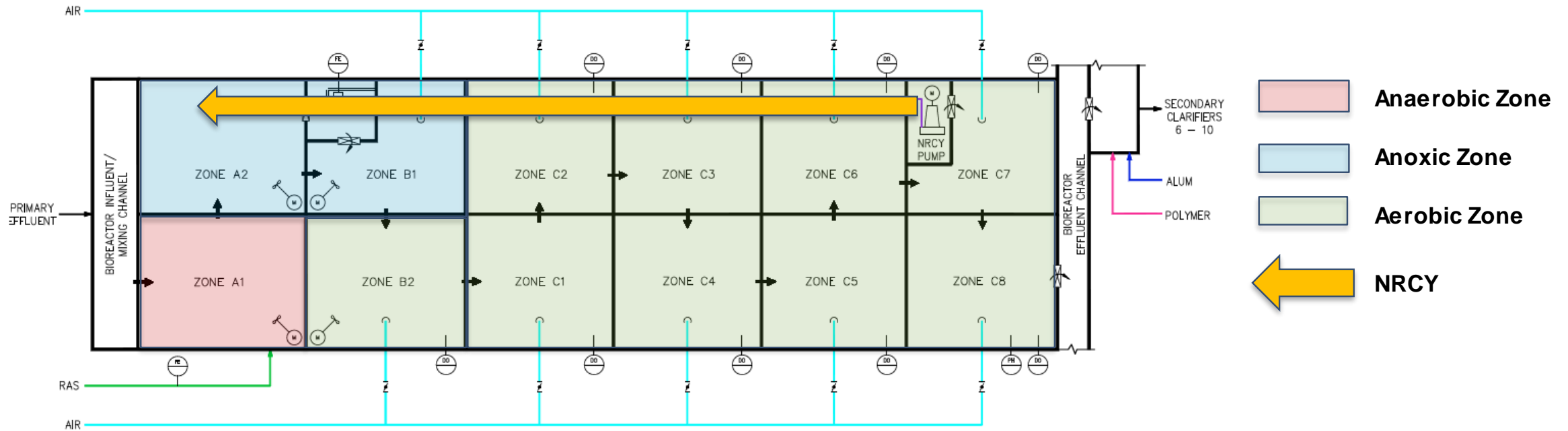
- Bio-P Performance Tipping Point
 - During normal steady state BRB configuration (NRCY/no NRCY) did not really matter
 - Good VFA/P ratio (Ostara performance), MLSS, pH, DO, low BRB influent nitrate (lower recycle flow), limited P release in secondary clarifier blankets
 - Observed NRCY kinetic inefficiency 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

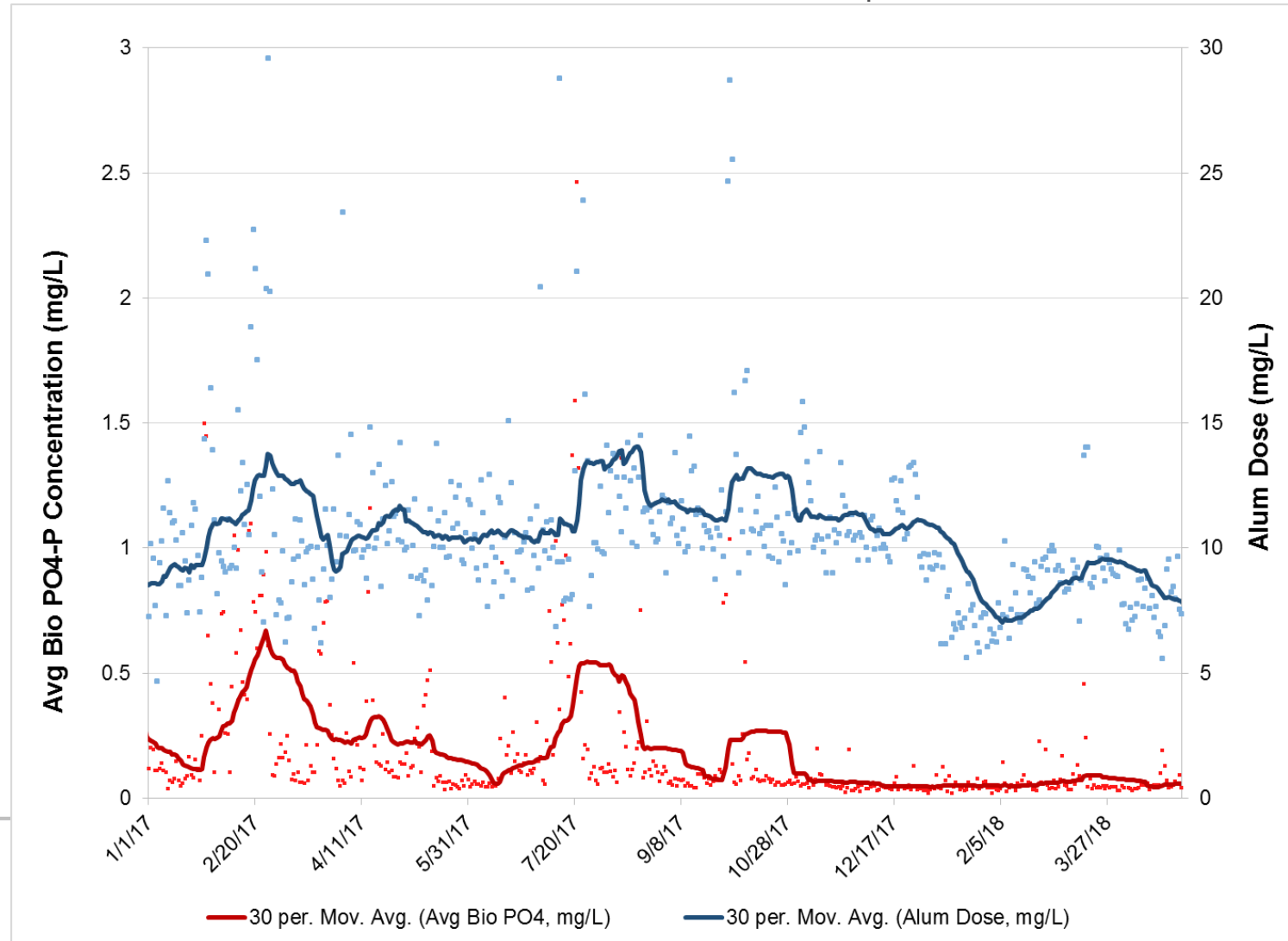
Optimization Conclusions

- Optimal Bioreactor Configuration



Performance Improvement

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



Acknowledgements

- GCDWR
 - Justin Garmon
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 - Paul Pitt

Thank you!

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