Hazen

Real World Sidestream Phosphorus Recovery Performance – Comparison of Operational Performance and Benefits

TEXAS ASSOCIATION OF CLEAN WATER AGENCIES

JANUARY 27, 2023

Introductions

Ana Garcia, PE

- Operations Manager for San Antonio and Corpus Christi offices
- With Hazen since 2007
- Over 15 years of experience in all phases of water and wastewater projects, including master planning, preliminary and detailed design, permitting and bidding, and construction management

Scott Hardy, PE, PMP

- South Central Region Biosolids Practice Leader
- South Central Region Project Management Committee Member
- With Hazen since 2006
- Managed more than 25 wastewater solids process evaluation and design projects.
- Served as project manager and technical advisor the detailed design of nutrient recovery systems

Hazen

Hazen by the Numbers

1951 *Firm Established*
1,440 *Employees*
662 *Professional Engineers*
65 *Innovation Awards in Last 10 Years*
63 *Offices Nationwide*
46 *Texas Professional Engineers*
6 *Texas Offices*

We Are all things water®

Our Areas of Expertise

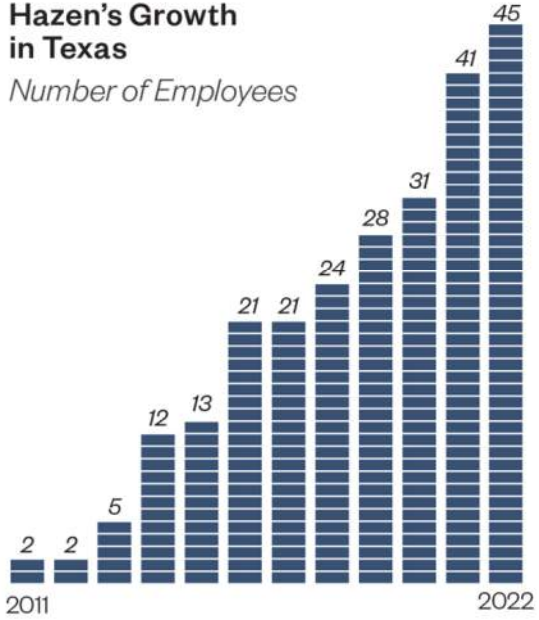
- Wastewater
- Water Resources
- Conveyance
- Economic Analysis
- Hydraulic Modeling
- Reuse
- Construction Management
- Stormwater
- Drinking Water
- Biosolids

Hazen Offices

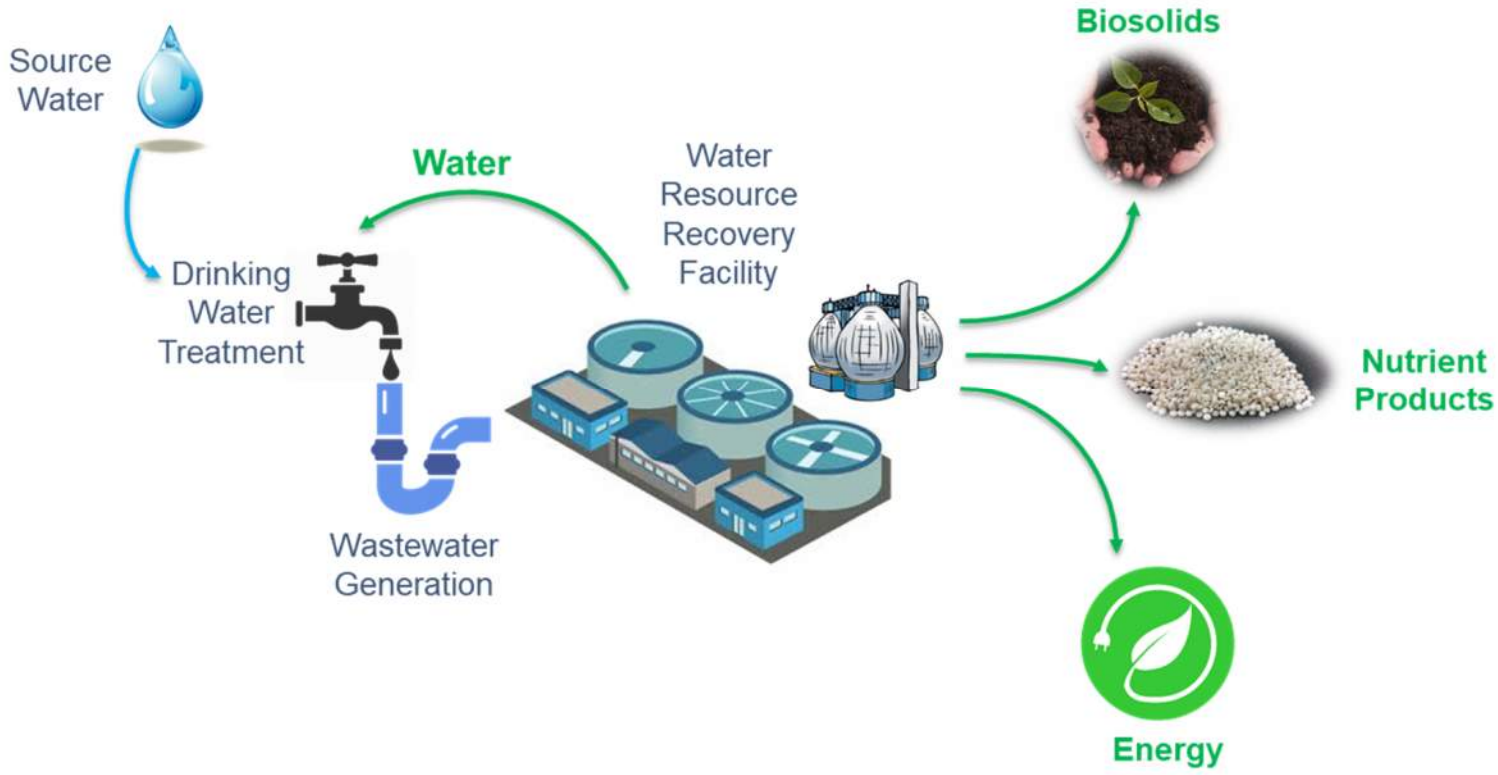
Texas Firm Registration: F-13618

Hazen's Growth in Texas

Number of Employees



Embracing the New Resource Management Paradigm



Trapped Nutrient Resources

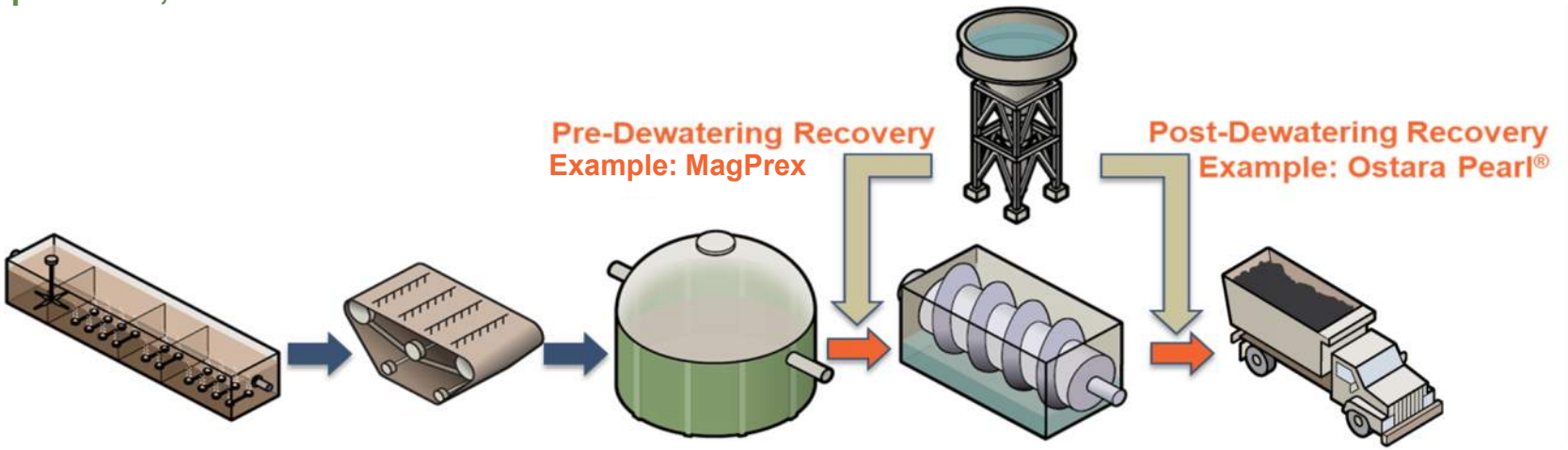
Anaerobic Digestion:

1. Soluble Mg^{2+} present
2. Soluble NH_4^+ and PO_4^{3-} released from biomass
3. CO_2 stripped out of solution
4. pH rises
5. Struvite precipitates

$$Mg^{2+} + NH_4^+ + PO_4^{3-} + 6H_2O \rightarrow \boxed{MgNH_4PO_4} \bullet 6H_2O$$

Converting a Problem to a Resource

Operations, Maintenance & Financial Benefits



- Minimize nuisance scaling
- Reduce pipeline cleaning
- Generate nutrient product
- Reduce chemical costs
- Improve dewatering

- Reduce sludge hauling costs
- Increase treatment capacity
  - Reduce P recycle load
  - Unlock tank/pipeline volume

Case Study #1:

Gwinnet County Department of Water Resources
F Wayne Hill Water Reclamation Facility

Atlanta

F Wayne Hill WRC

- 60 mgd WRRF
- Influent TP ~ 9 mg/L
- 0.08 mg/L TP Effluent Limit
- Bio-P and Chemical Trim for P-removal

Background Struvite & Phosphorus Issues

2009

Replaced Bioxide with $Mg(OH)_2$ for collection system odor control

- Resulted in struvite formation in centrate lines, centrifuges, digester complex
- High soluble Mg content in digester – very low PO_4-P in centrate

2012

Started accepting WAS from 22 mgd Yellow River Bio-P plant

- Increased P load
- Increased recycle P
- Increased struvite formation

Nutrient Recovery Facility:
WASSTRIP® + Ostara Recovery

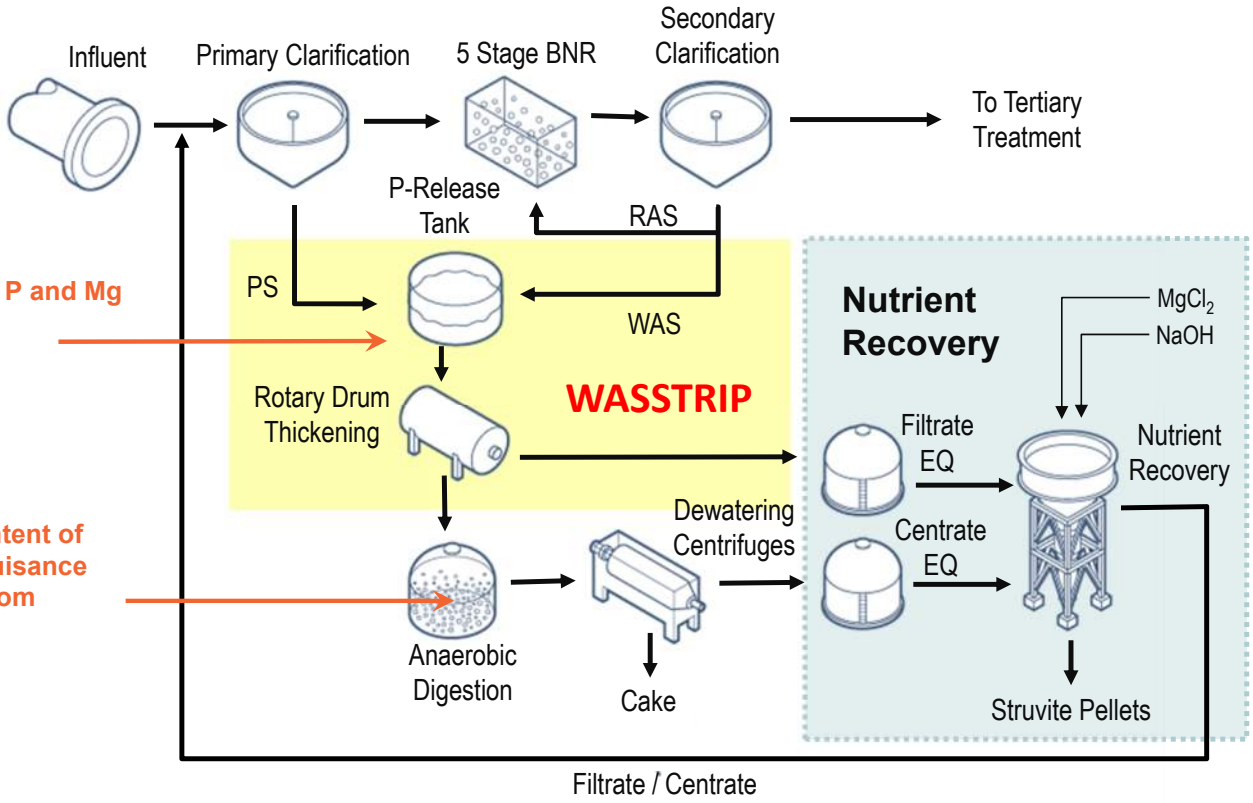
Startup July 2015

How does WASSTRIP® help?

WASSTRIP®

Anaerobic release of P and Mg from sludge

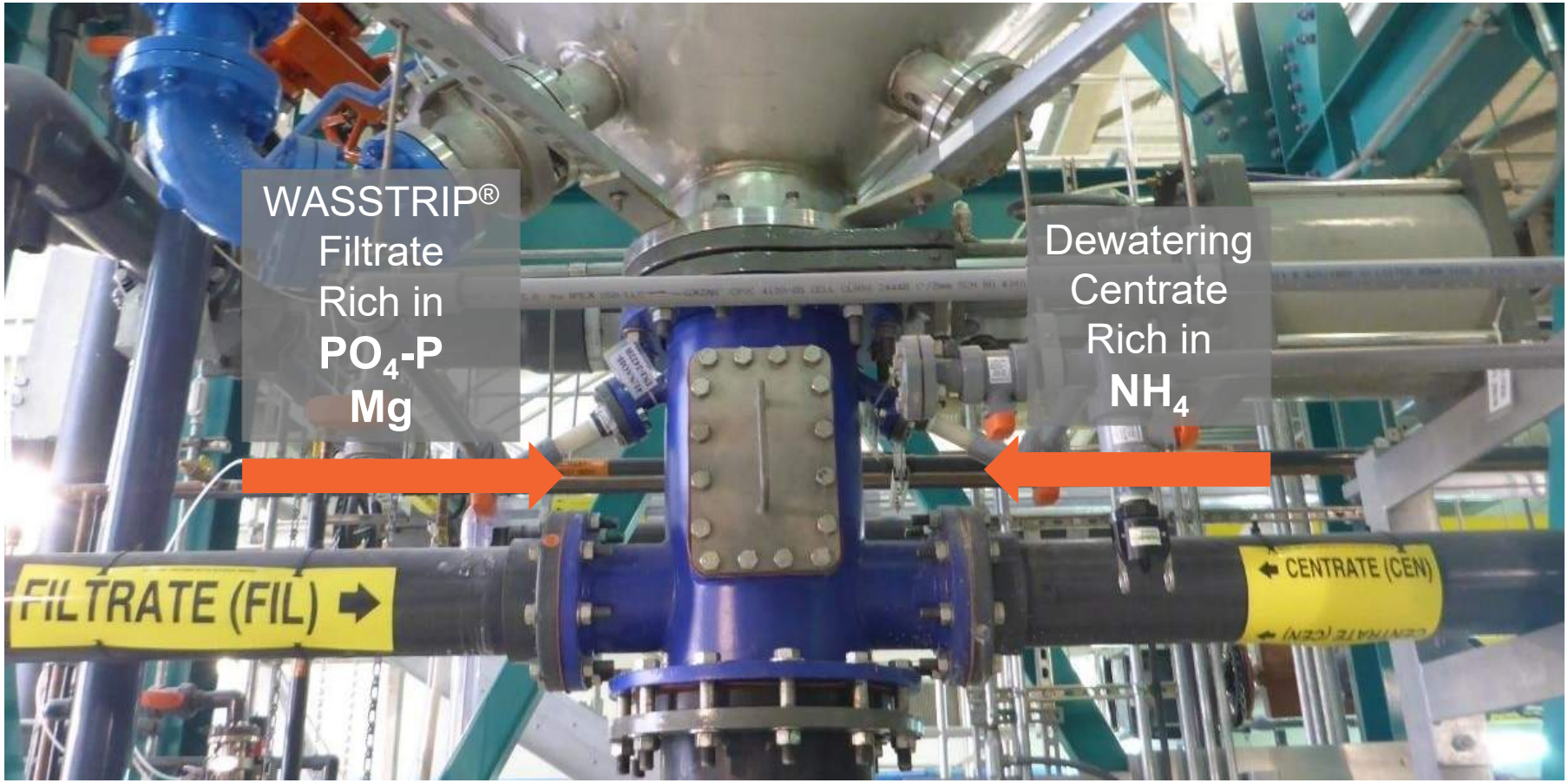
Lower P and Mg content of sludge minimizes nuisance struvite formation from digester onwards



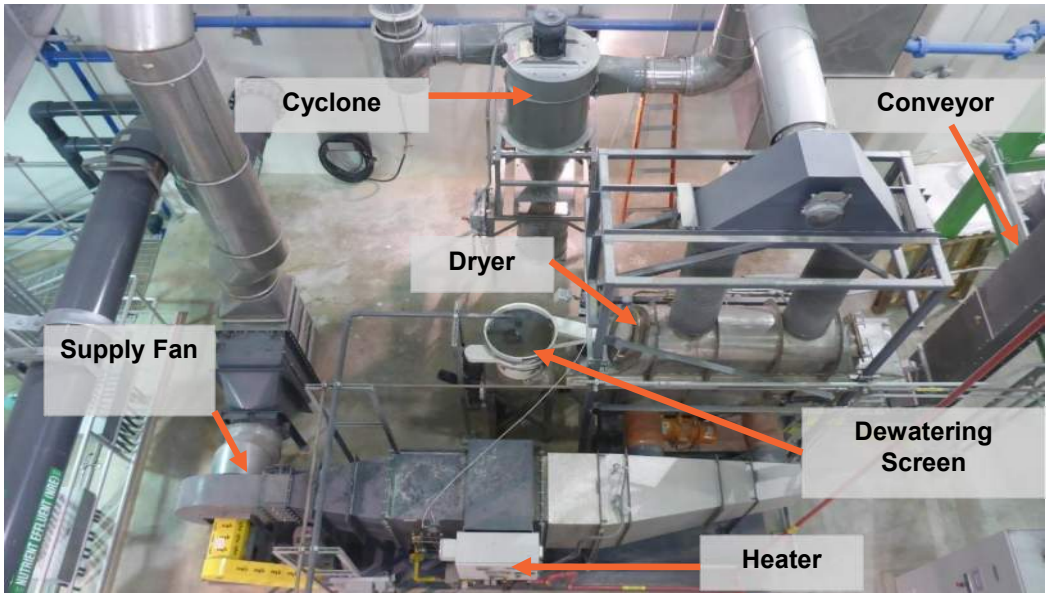
WASSTRIP® Tank

- Inner tank:
  - 98,000 gallons
  - Constant Volume
  - 2 – 4 hr HRT
- Outer tank:
  - 280,000 gallons
  - Elevation Varies
  - < 6 hr HRT

Ostara Reactor Influent



Ostara System

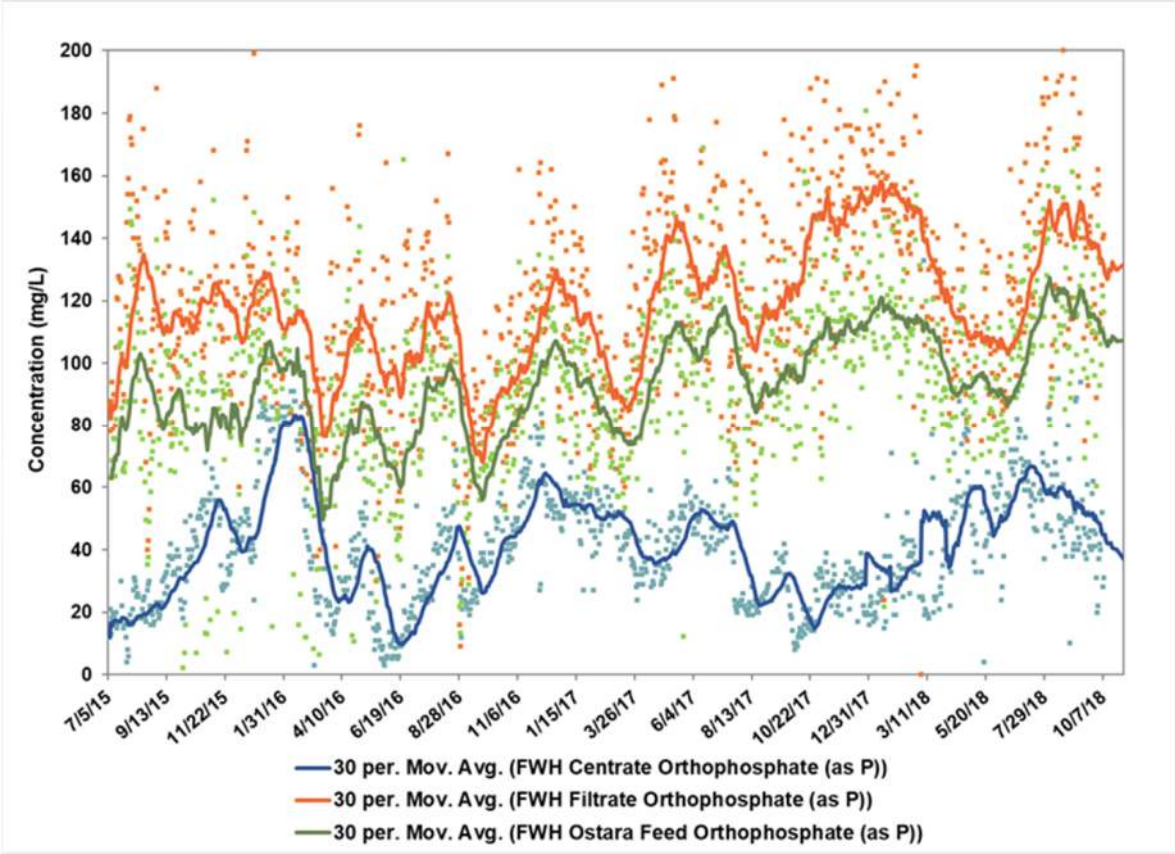


WASSTRIP® Performance Data

Ostara Feed – PO_4-P

Stream	Average PO_4-P (mg/L)
Filtrate	117
Centrate	42
Combined Feed	96

~25% of Influent TP load diverted to recovery avoiding 5,200 lb/d of struvite

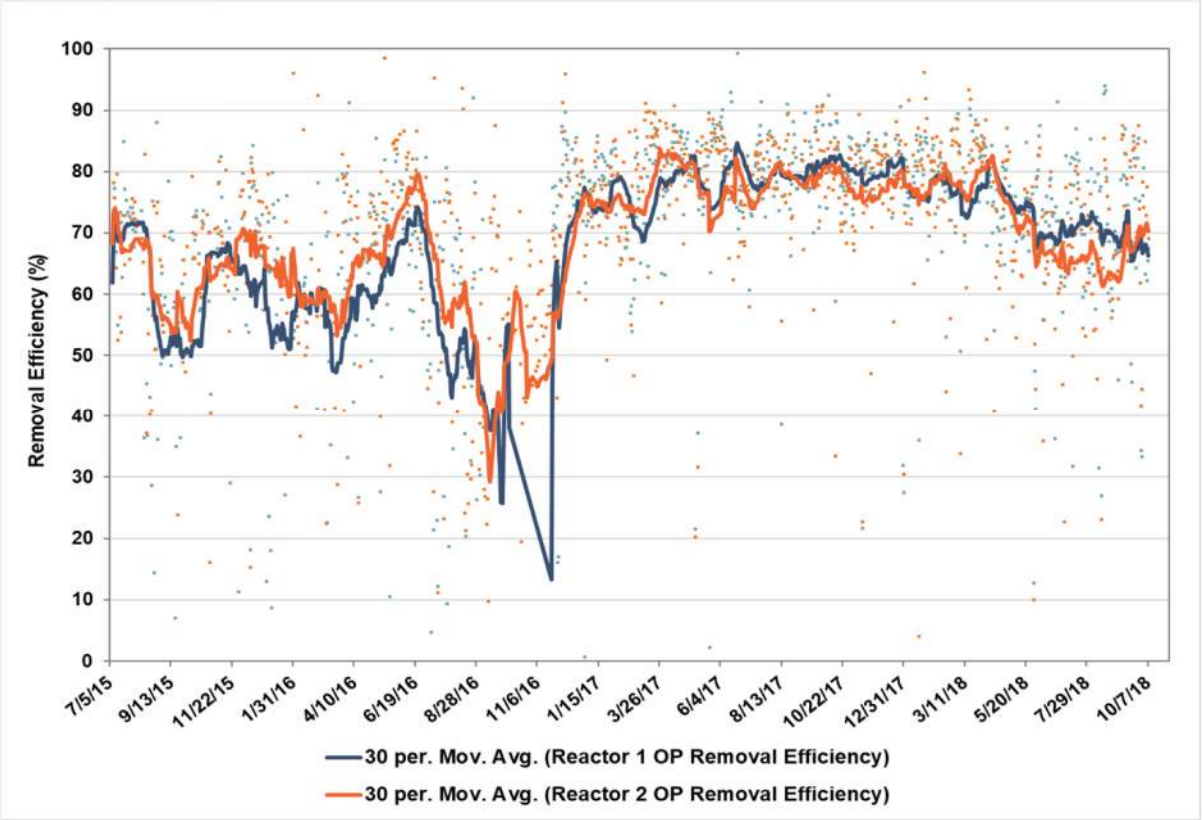


2017 - Ostara PO_4-P Removal & Product Output

2017 Averages:

78% Ortho-P Removal

55,000 lbs product/month



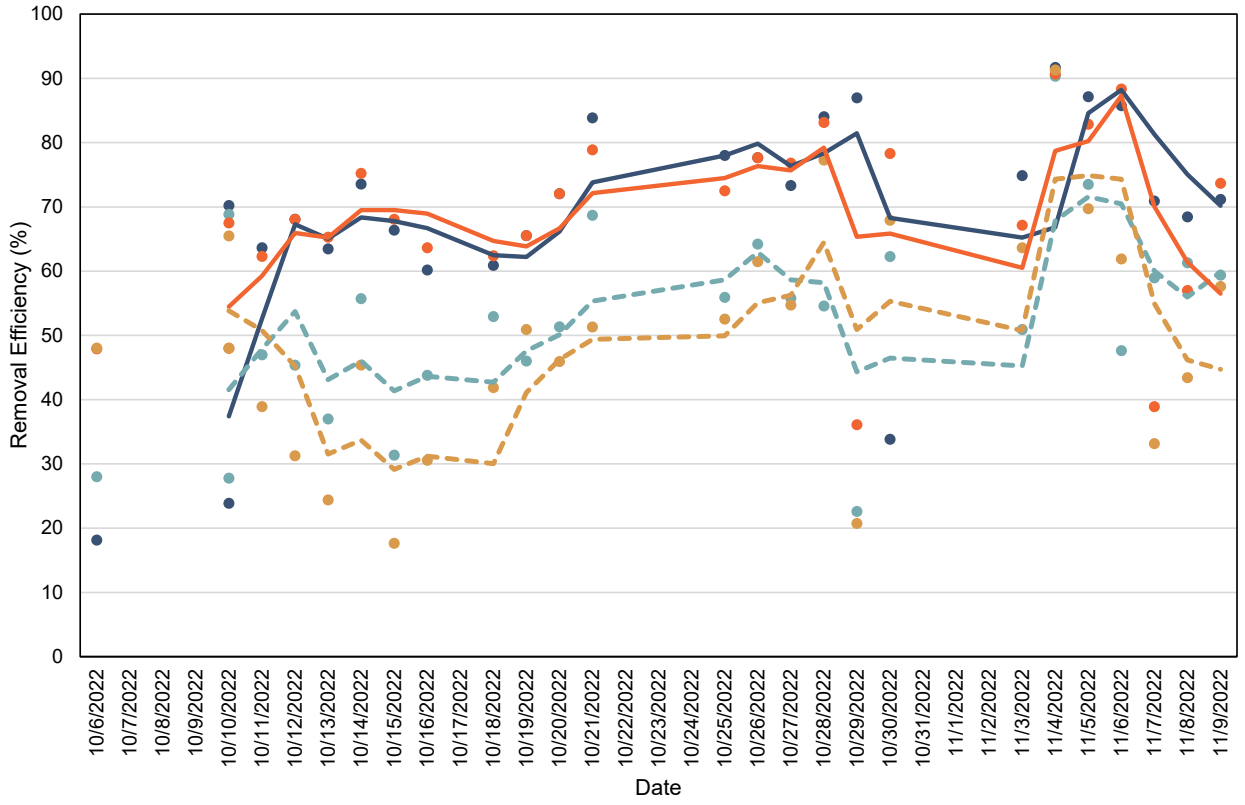
2022 - Ostara PO_4-P Removal & Product Output

Oct. 2022 Averages:

65% Ortho-P Removal

50% Total P Removal

30,000 lbs product/month



Summary

1. Reduced alum use 75%
2. Optimized Bio-P
3. Increased thickened solids
   5.4 → 7.4% TS
4. Increased dewatered solids
   22.2 → 23.7%
5. Decreased dewatering polymer
   38 → 31 active lb/DT
6. No More Struvite Issues
7. Requires Monitoring and Adjustment to Optimize Performance

Case Study #2:

Metro Water Recovery
Robert W. Hite Treatment Facility

Denver

Robert W. Hite Treatment Facility (RWHTF)

- 220 mgd WRRF
- Influent TP ~ 5 mg/L
- Future Effluent TP Limits

Proactive Nutrient Management

Positioning for the future

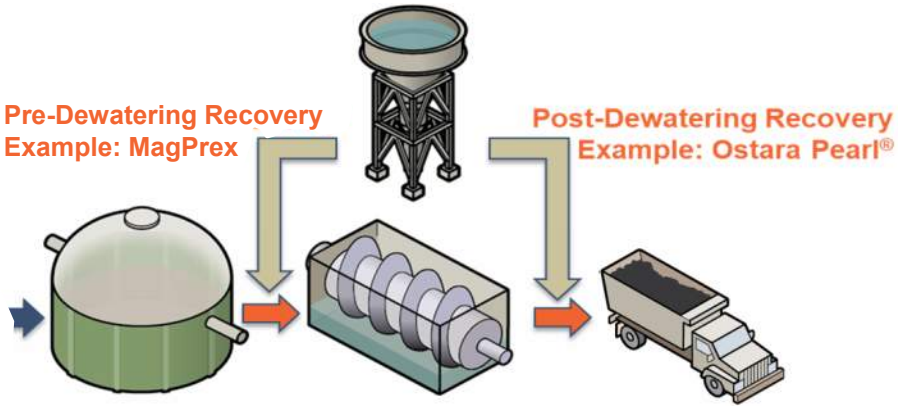
- Meet future nutrient limits (0.1 mg TP/L)

Proactive Nutrient Management

Positioning for the future

- Minimize nuisance struvite
- Minimize sidestream load
- Maximize solids treatment capacity

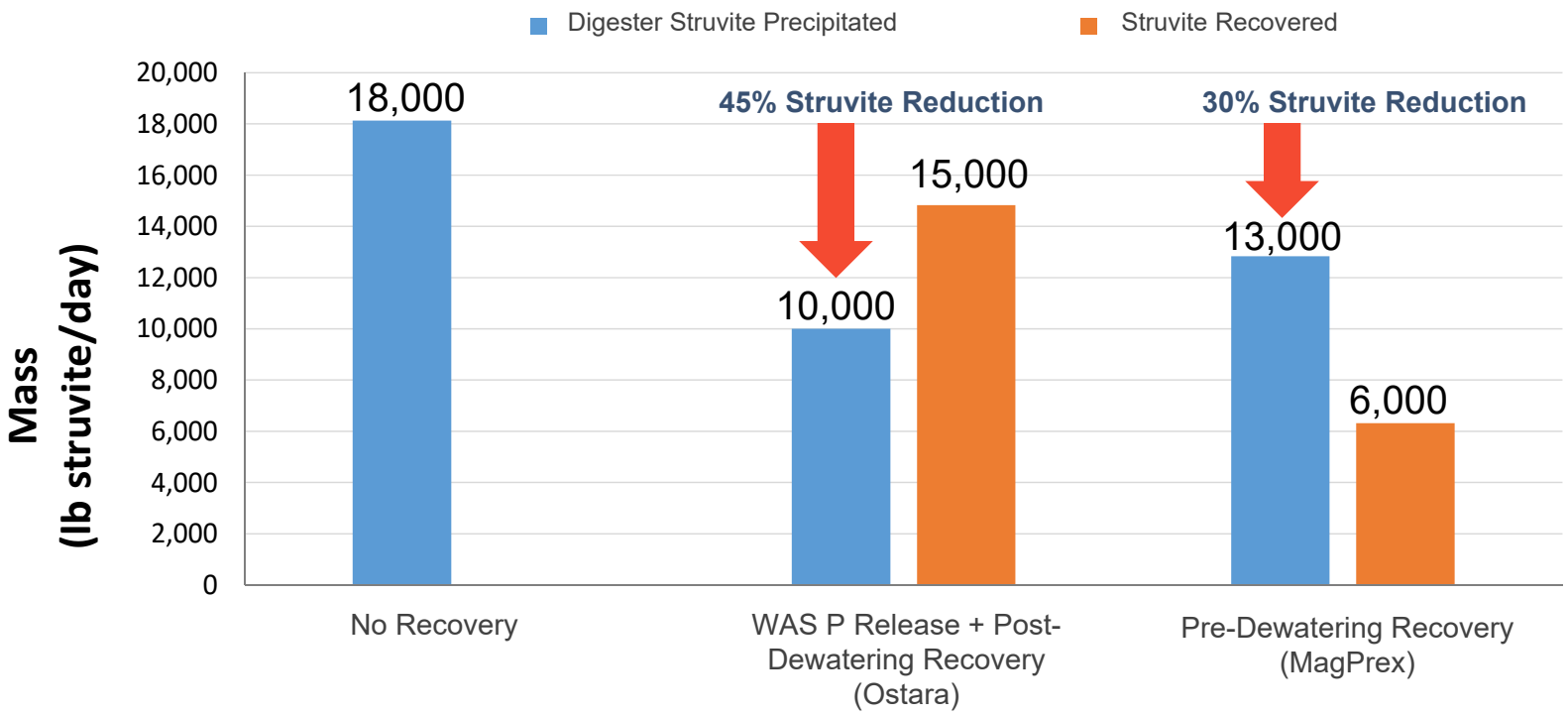
Recovery Technology Evaluation



Driver	Supporting Data
Break Recycle Loop	Pilot (Ostara & MagPrex) WAS P & Mg Release Pilot Modeling
Reduce Biosolids Dewatering Costs	MagPrex Pilot WAS P & Mg Release Pilot
Reduce Struvite Scaling	Modeling
Control Biosolids Phosphorus Loading on Soils	Modeling
Maximize Product Recovery	Pilot (Ostara & MagPrex) Modeling

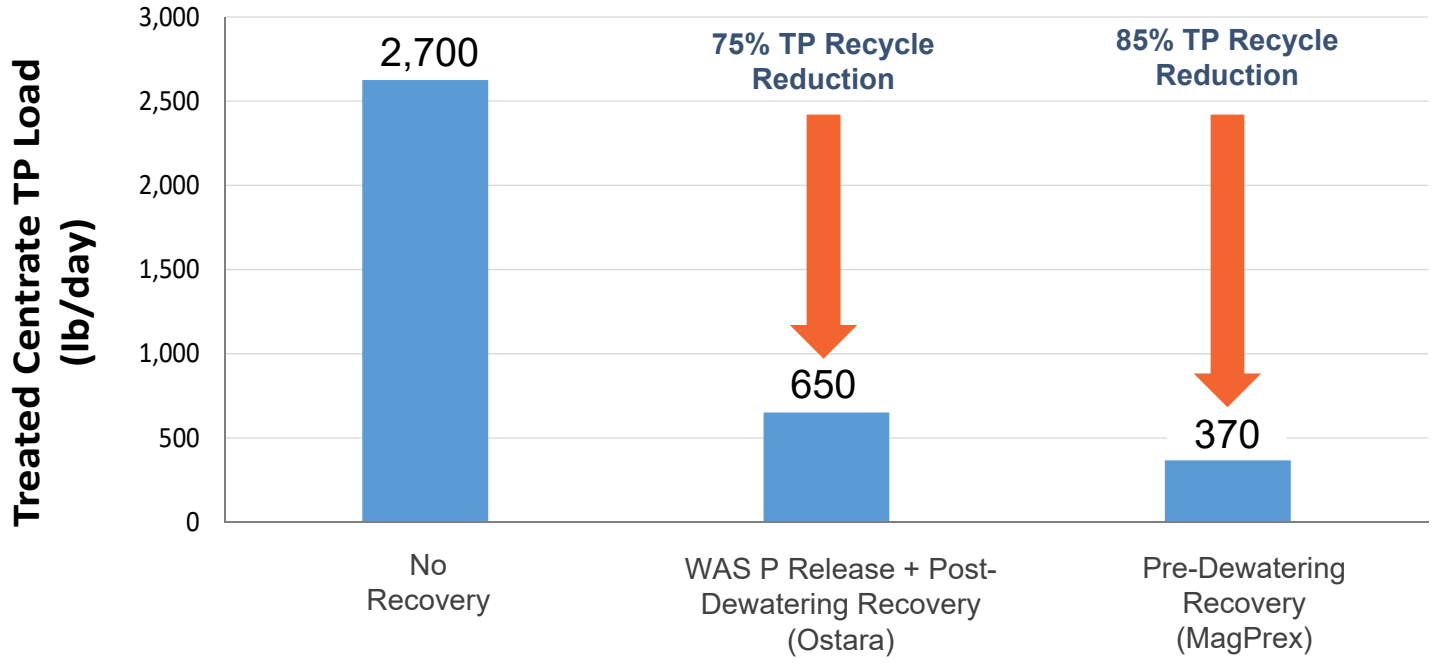
Evaluation Findings

Nuisance and Recovered Struvite



Evaluation Findings

Sidestream Loads

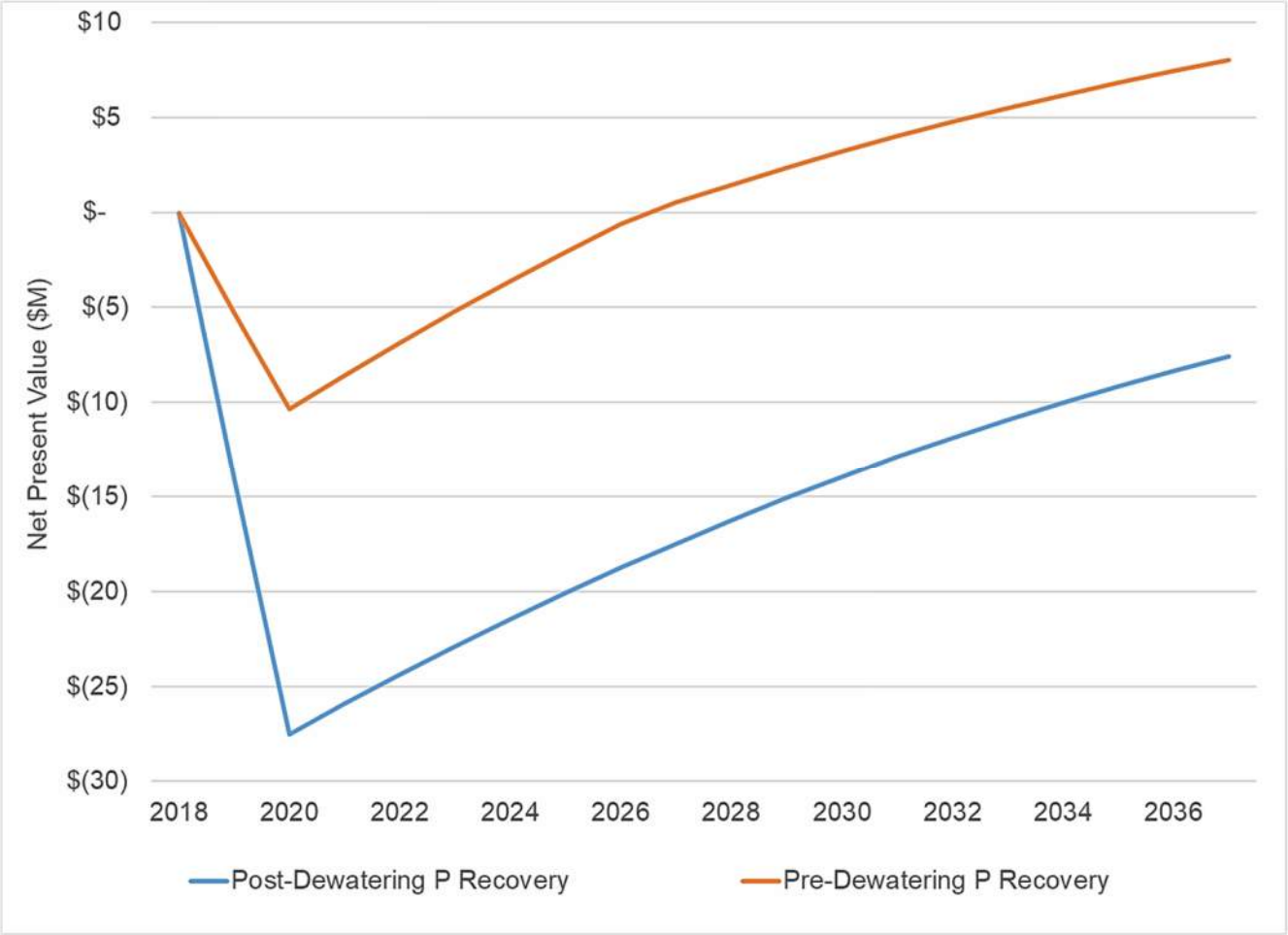


Evaluation Findings

Dewatering Impacts

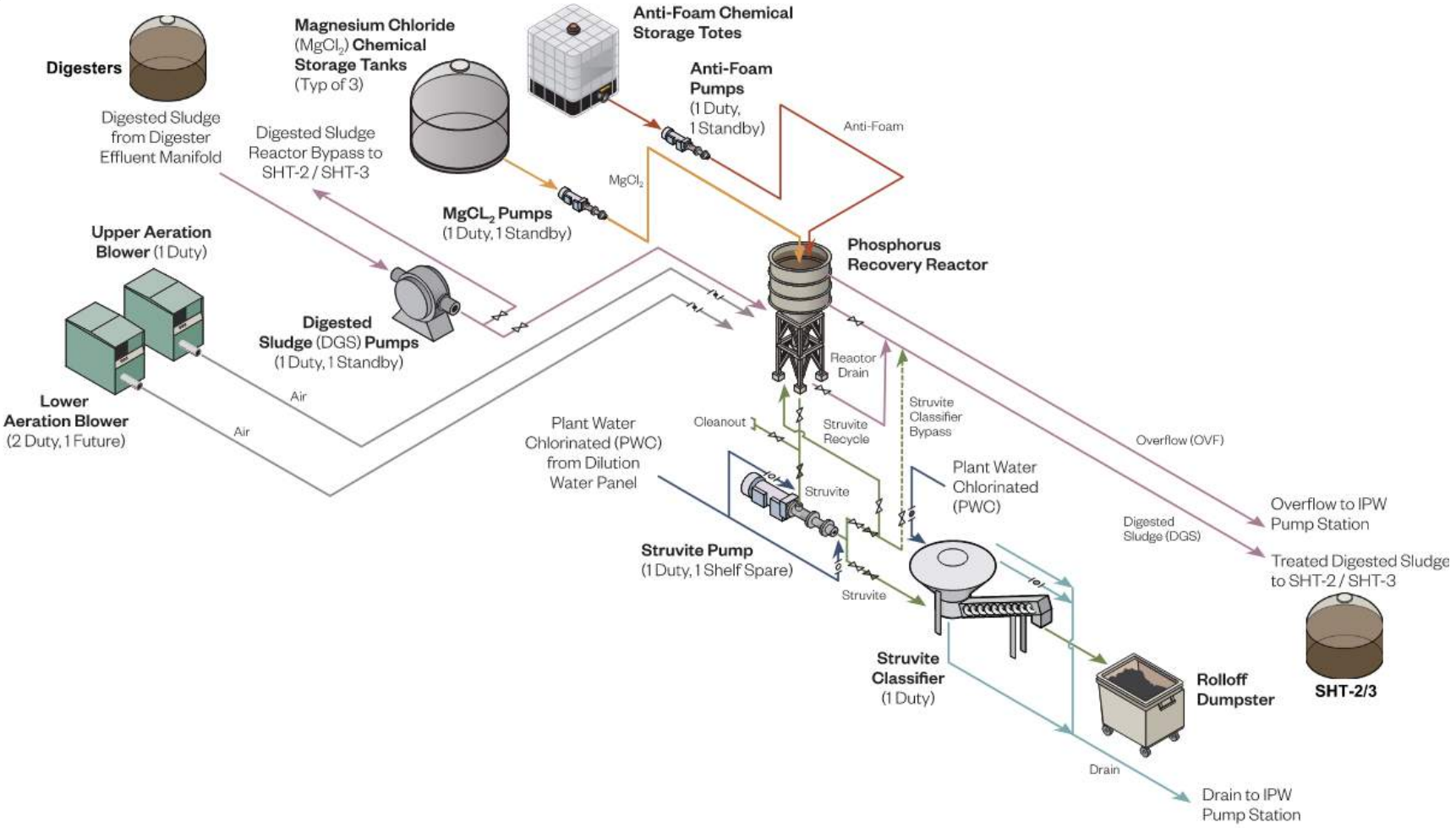
Technology	% Cake TS Increase	% Polymer Reduction
Pre-Dewatering	3.7 - 5.0	14 – 18
WASSTRIP® with Post-Dewatering	0 - 2.0	1.0 - 10

Business Case Evaluation



Pre-Dewatering Recovery with 1 Reactor: $8M 20-Year Net Present Value

MagPrex Process Flow

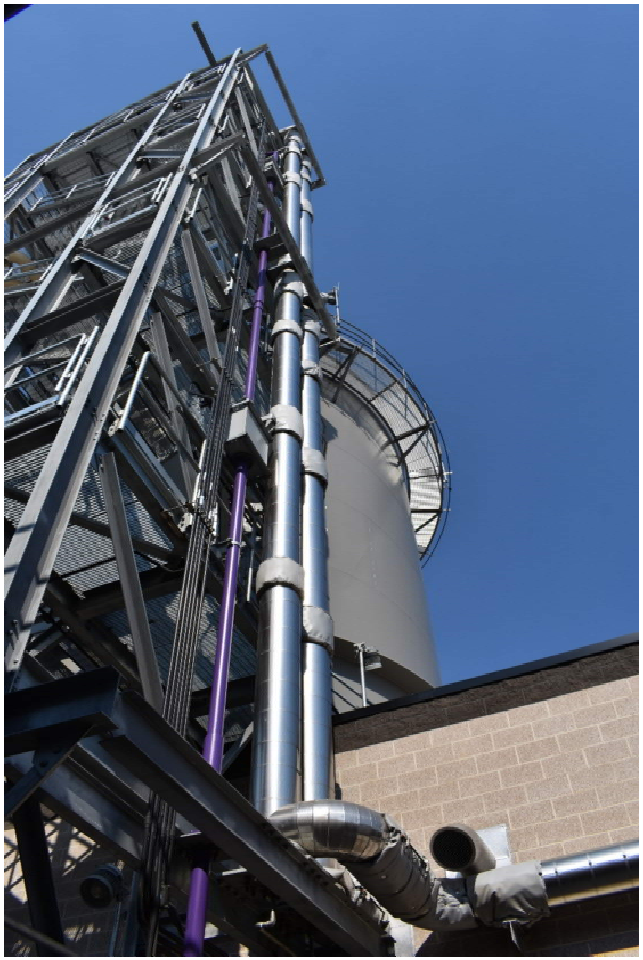


MagPrex Design

Struvite Reactor

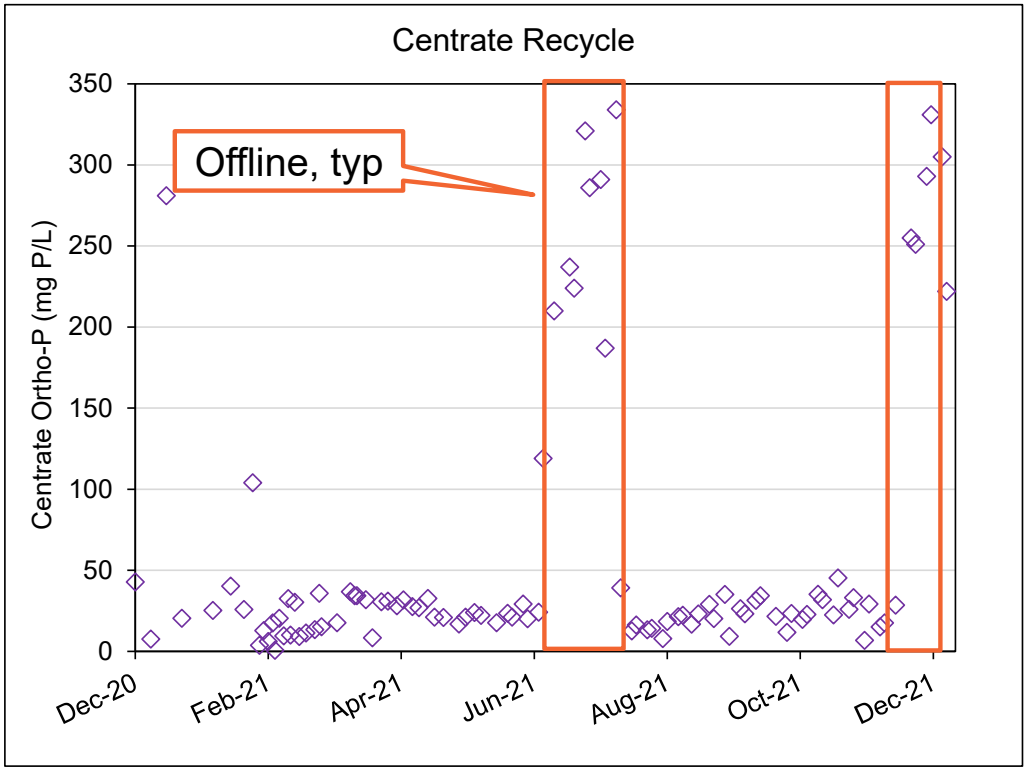
- 40 ft diameter
- 70 ft tall
- 378,000 gallons
- 7 to 10 hour HRT
- Consider installing two smaller reactors to allow cleaning
  - **Metro had space for only one tank**

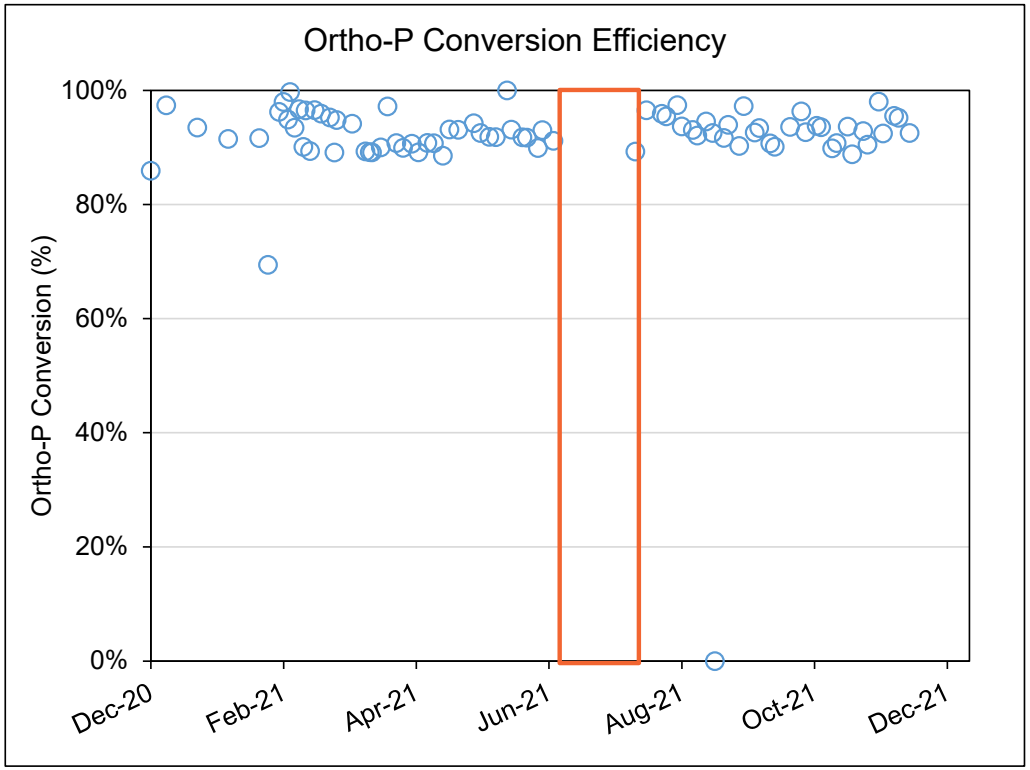
MagPrex System



MagPrex Performance

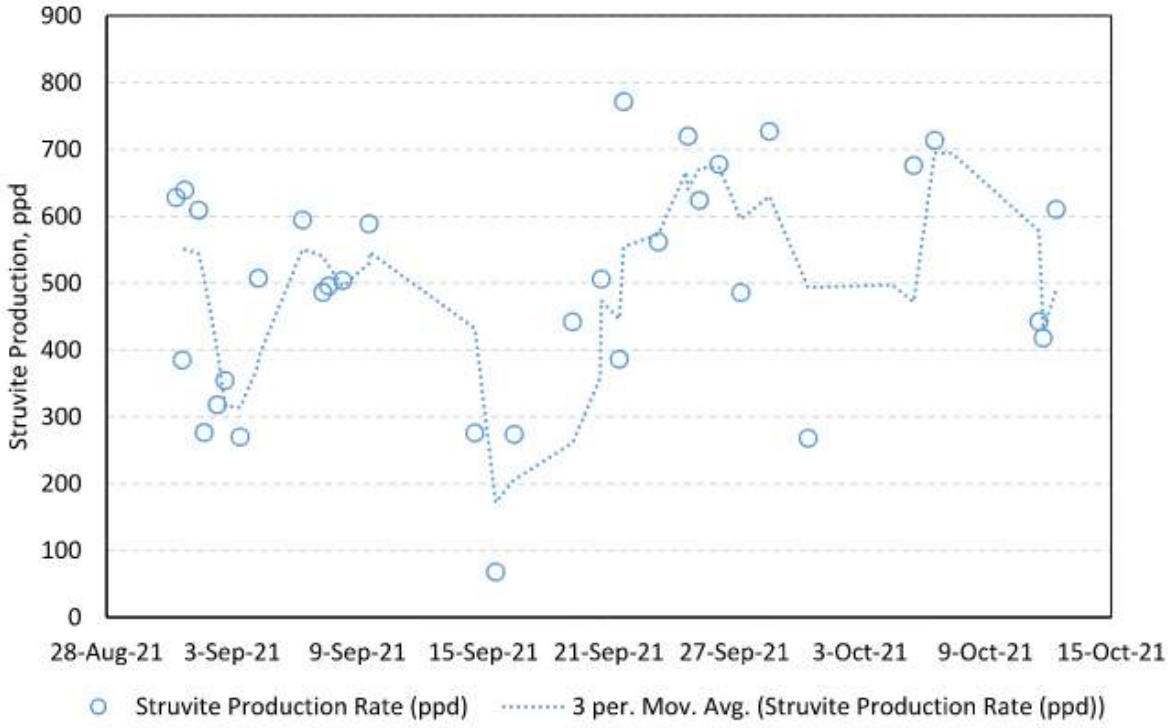
- Ortho-P conversion averaging 90%
  - **334 mg/L TP Feed → 17 mg/L TP Effluent**





MagPrex Performance

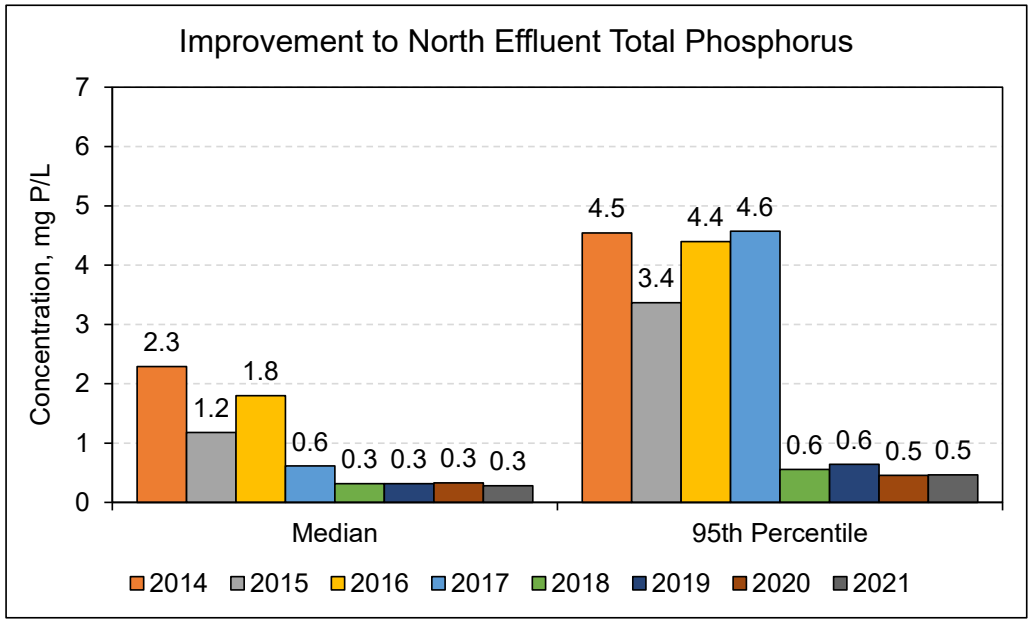
- Struvite Recovery
  - **Currently 500 ppd recovery**

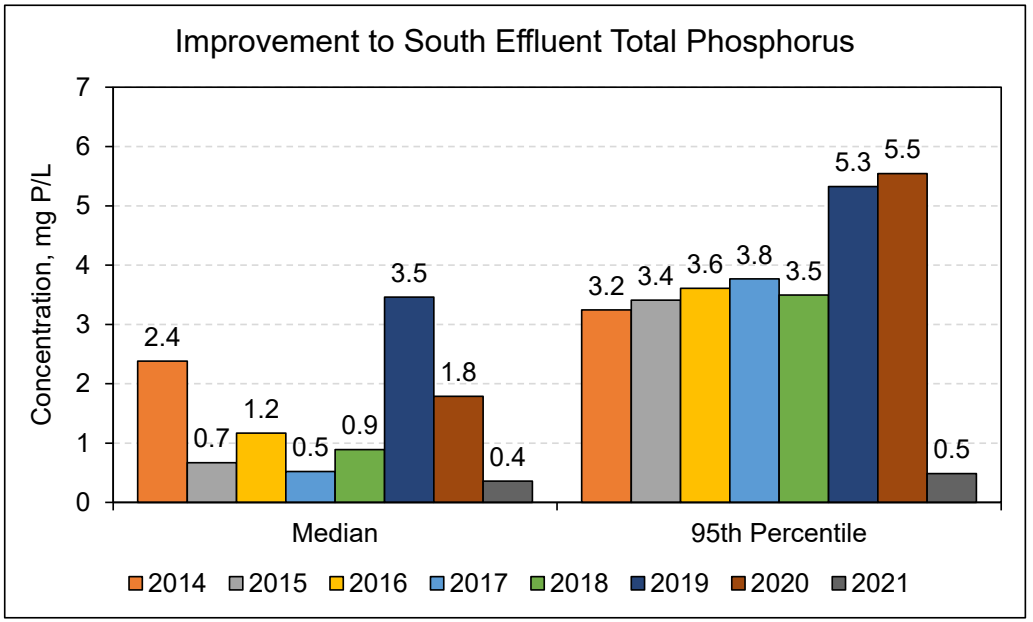


- **Size Distribution: 0.2 to 1.0 mm**

Effluent Impacts

- North Secondary in EBPR mode since March 2019
- South Secondary in EBPR mode since February 2021
- Annual median total phosphorus < 0.4 mg-P/L





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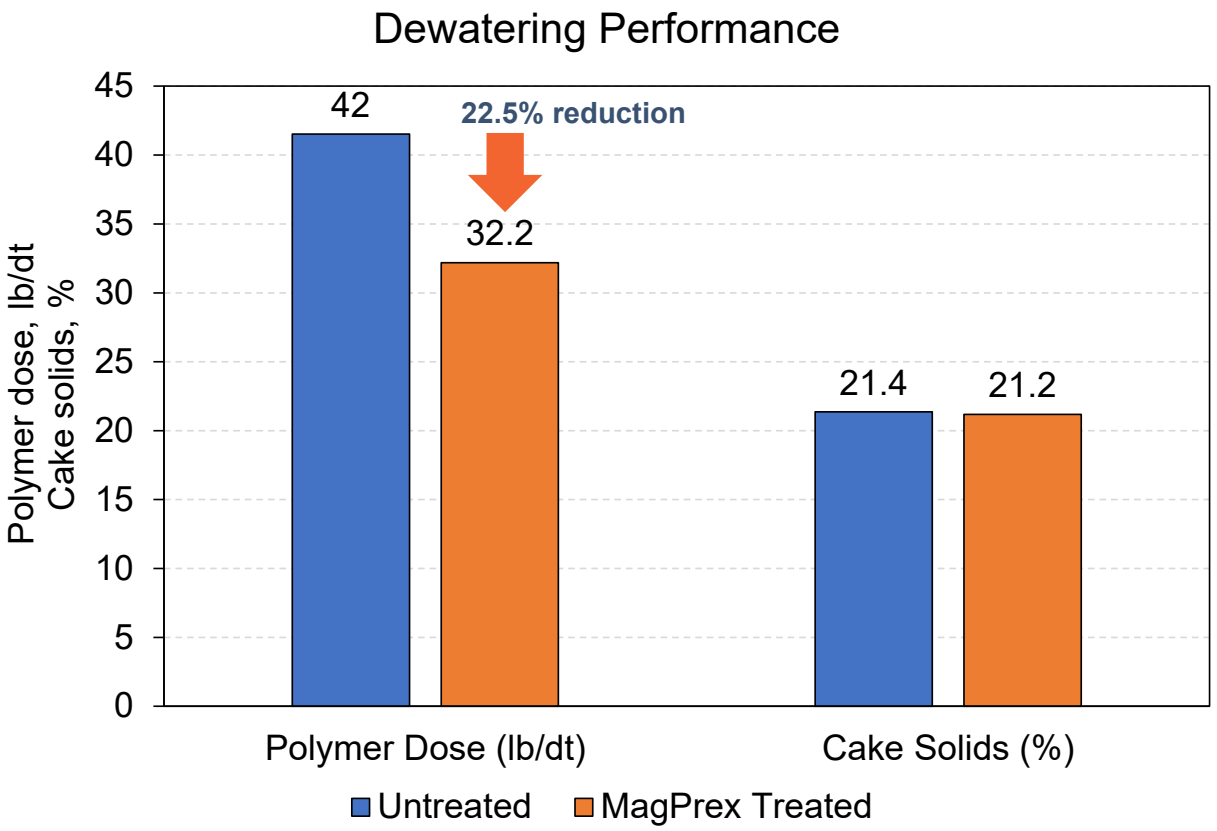


- 22.5% reduction in polymer demand equating to $575K/year savings
- Pilot estimated 15% reduction in polymer
- Pilot estimated 2.5% increase in cake solids – not realized yet…
- New centrifuges coming online soon

Reactor Interior

During Construction

After Months of Operation

Reactor Interior

Technology is developing and improving reliability and maintenance

Lessons Learned

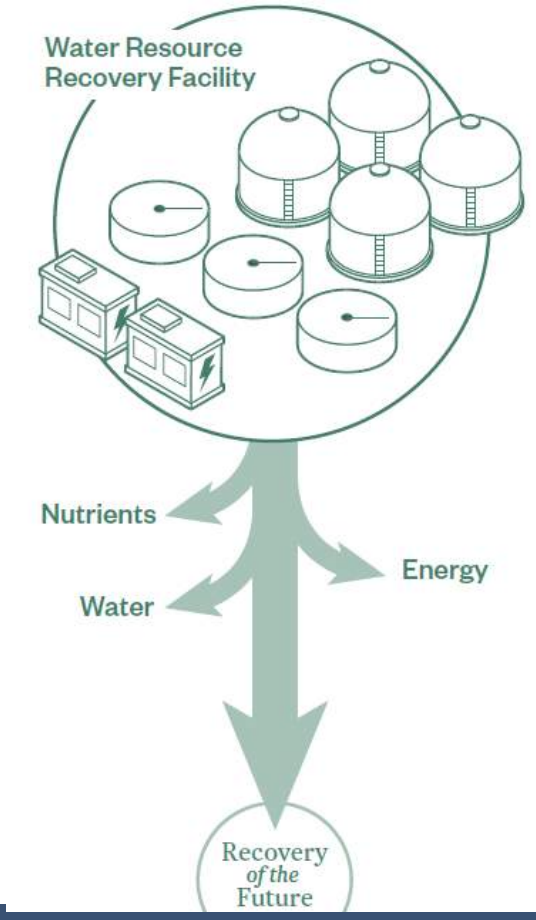
- Ragging issue with diffusers
  - **Influent and Primary Sludge Screening important**
- Change to low-profile vertical diffusers
  - **Horizontal diffuser breaking under rag load**
- Eliminate upper diffusers
  - **Metro turned off upper with no process impacts**
  - **Break from upward lift of lower diffusers and downward force of rags**

Conclusions

Nutrient Recovery is a Viable Treatment Option NOW!

- Operational & Financial Benefits
- Minimize nuisance scaling
- Reduce chemical demand
- Reduce impact of sidestream on mainstream
- Regain lost volume and pumping/treatment capacity
- Reduce in sludge quantity and hauling costs
- Offset costs with product sales
- Two viable technologies depending on desired product

"The resource recovery paradigm considers that most, if not all, materials in wastewater can be recovered and commoditized."
- WE&RF



Acknowledgements

Contacts

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