The Metropolitan
Water Reclamation District
of Greater Chicago

WELCOME
TO THE SEPTEMBER EDITION
OF THE 2015
M&R SEMINAR SERIES

BEFORE WE BEGIN

- PLEASE SILENCE CELL PHONES OR SMART PHONES
- QUESTION AND ANSWER SESSION WILL FOLLOW PRESENTATION
- PLEASE FILL EVALUATION FORM
- SEMINAR SLIDES WILL BE POSTED ON MWRD WEBSITE (www. MWRD.org: Home Page ⇒ Reports ⇒ M&R Data and Reports ⇒ M&R Seminar Series ⇒ 2015 Seminar Series)
- STREAM VIDEO WILL BE AVAILABLE ON MWRD WEBSITE (www.MWRD.org: Home Page ⇒ MWRDGC RSS Feeds)

Peter Schauer, PE

Current: **Principal Process Engineer , Clean Water Services, Tigard, OR**

Experience: Principal Process Engineer for CWS,

- Heading the Technology Development & Research group for CWS
- Review, planning, testing, and operational support for the CWS 4 wastewater treatment facilities including processes such as biological nutrient removal, WASSTRIP® process, struvite recovery, fermentation, tertiary treatment, ballasted flocculation and sedimentation, etc.

Process engineer within the Water Technologies Group of Black & Veatch

- Wastewater treatment plan upgrades
- WASSTRIP process modeling

Civilian Project Engineer for the Navy

- Conducting R&D on membrane bioreactors for shipboard waste.

Education: M.S., Environmental Engineering, Johns Hopkins University,
B.S., Chemical Engineering, Johns Hopkins University,

Profession: Registered Professional Engineer in Florida

Six Years of Nutrient Recovery at Clean Water Services

Peter Schauer

Clean Water Services

Clean Water Services

Outline

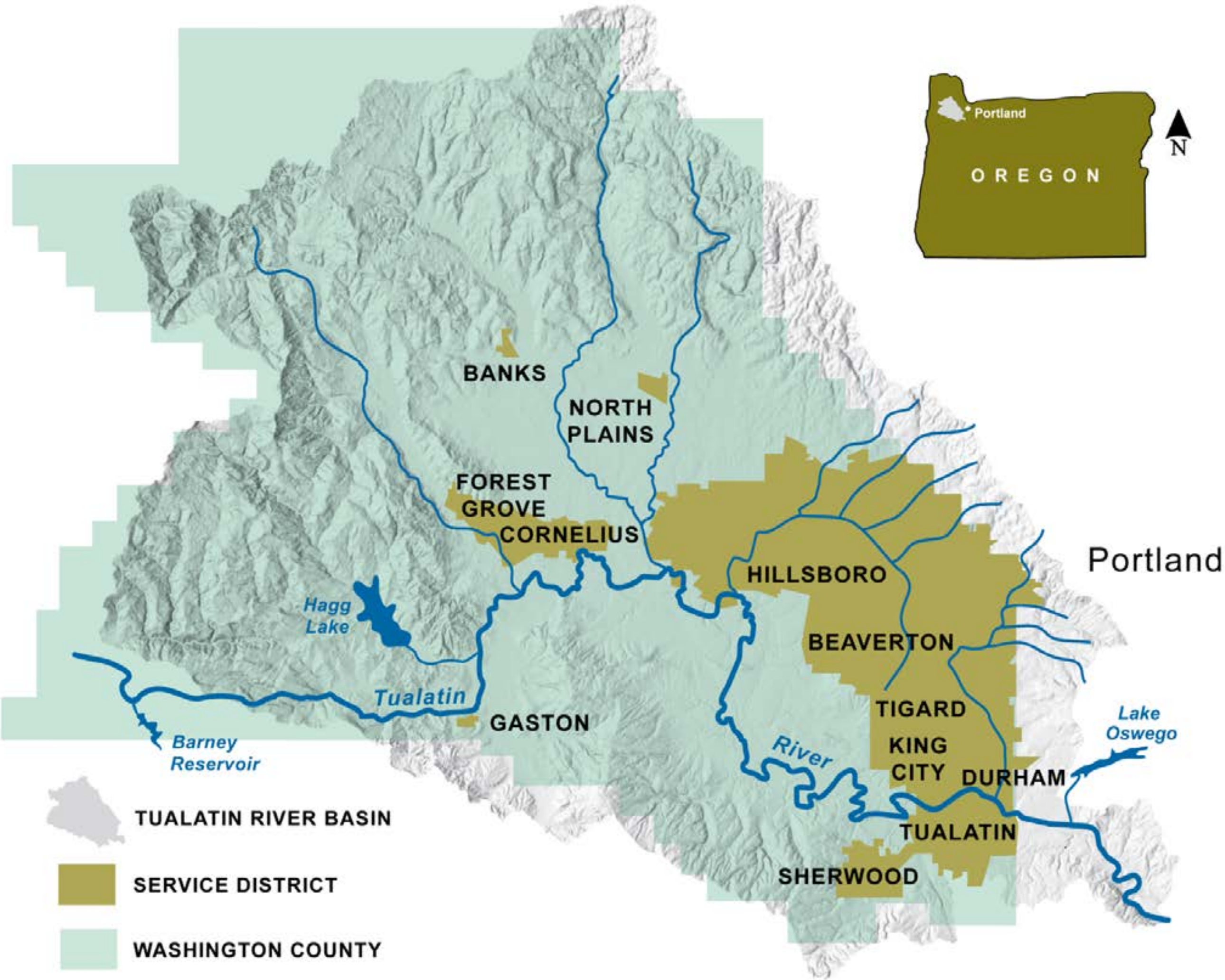
- Background on the District and Facilities
- Phosphorus Removal
- Drivers for Nutrient Recovery
- Nutrient Recovery System Installation
- Drivers for WASSTRIP
- WASSTRIP Learning Curve
- Next Steps

- Established in 1970
- Sanitary sewer and Surface Water Management provider
- Serves over 530,000 customers and industries in urban Washington County, Oregon
- 4 wastewater treatment facilities
- 1,000 miles sanitary and storm sewers and 43 pump stations

Design Ave Dry Weather Flow

Clean Water Services

Clean Water Services



Clean Water Services

Regional Treatment Facilities

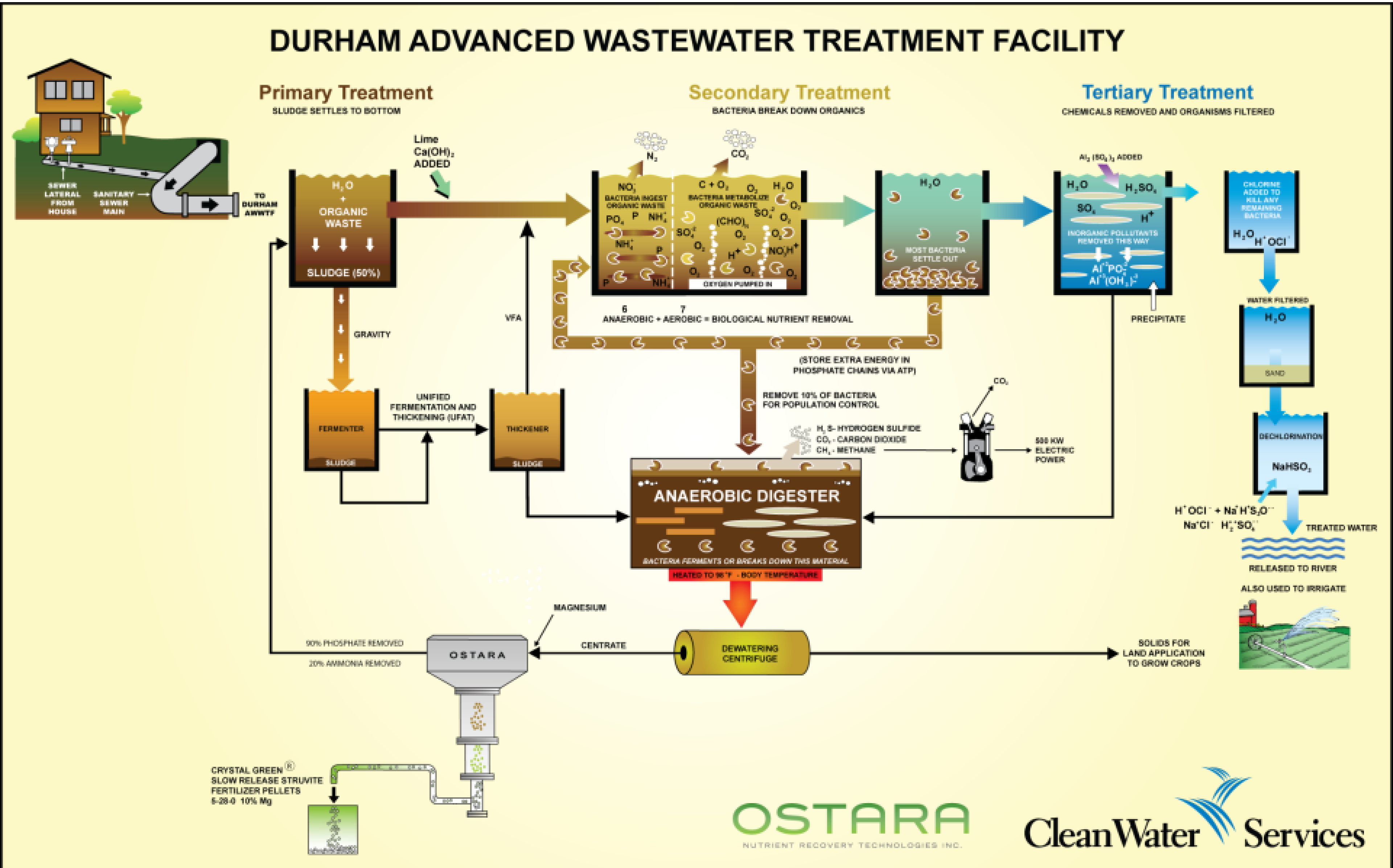
Durham AWWTF
25 mgd

Rock Creek AWWTF
35 mgd

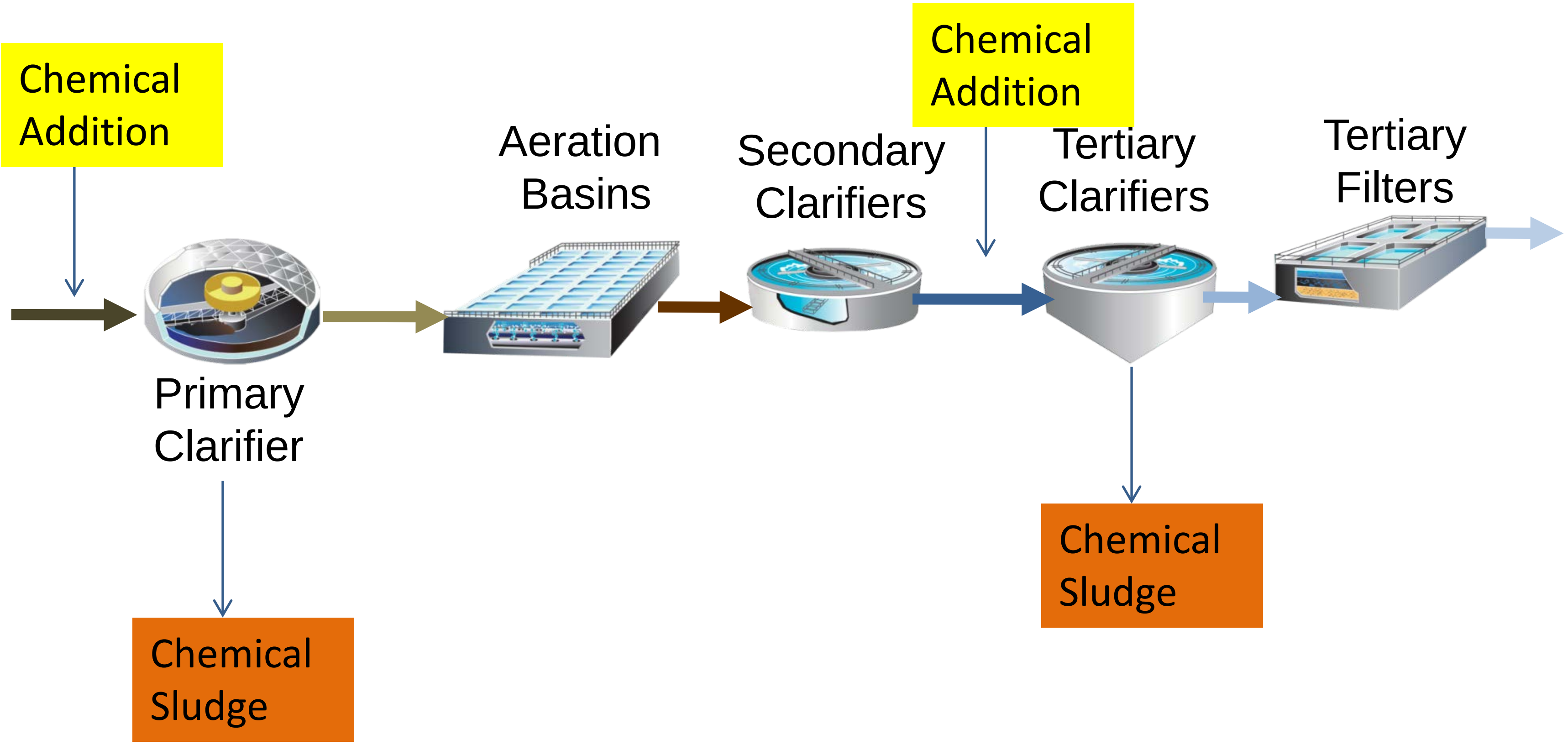
"Summer" Limits

- 0.1 mg/l T-PO4
- Complete nitrification
- 5 mg/l BOD & TSS

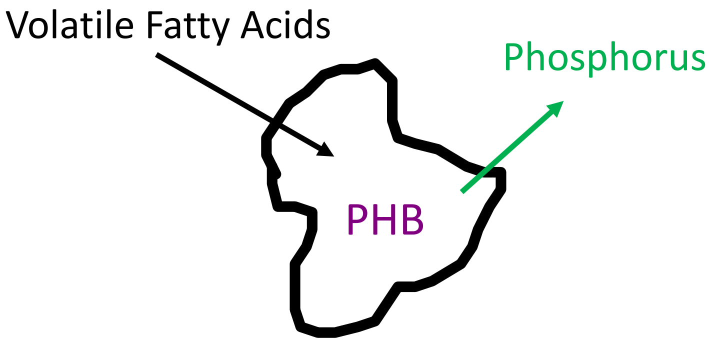
Process Diagram



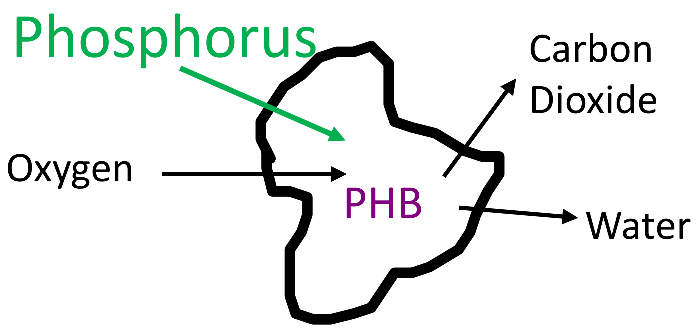
Phosphorus Removal



Overall Biological Phosphorus Removal

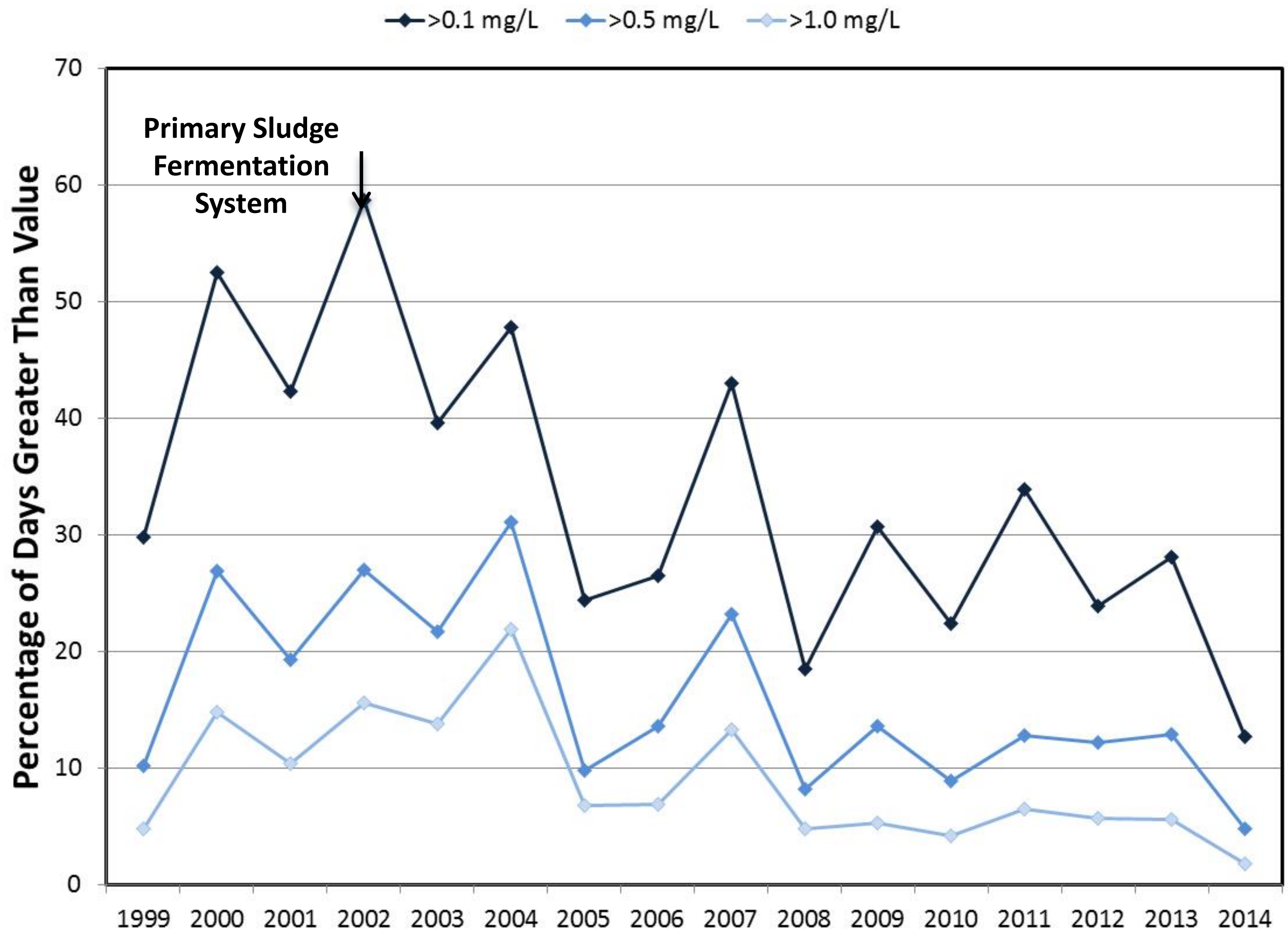


Anaerobic



Aerobic

Efforts to Optimize Bio-P Stability



Clean Water Services

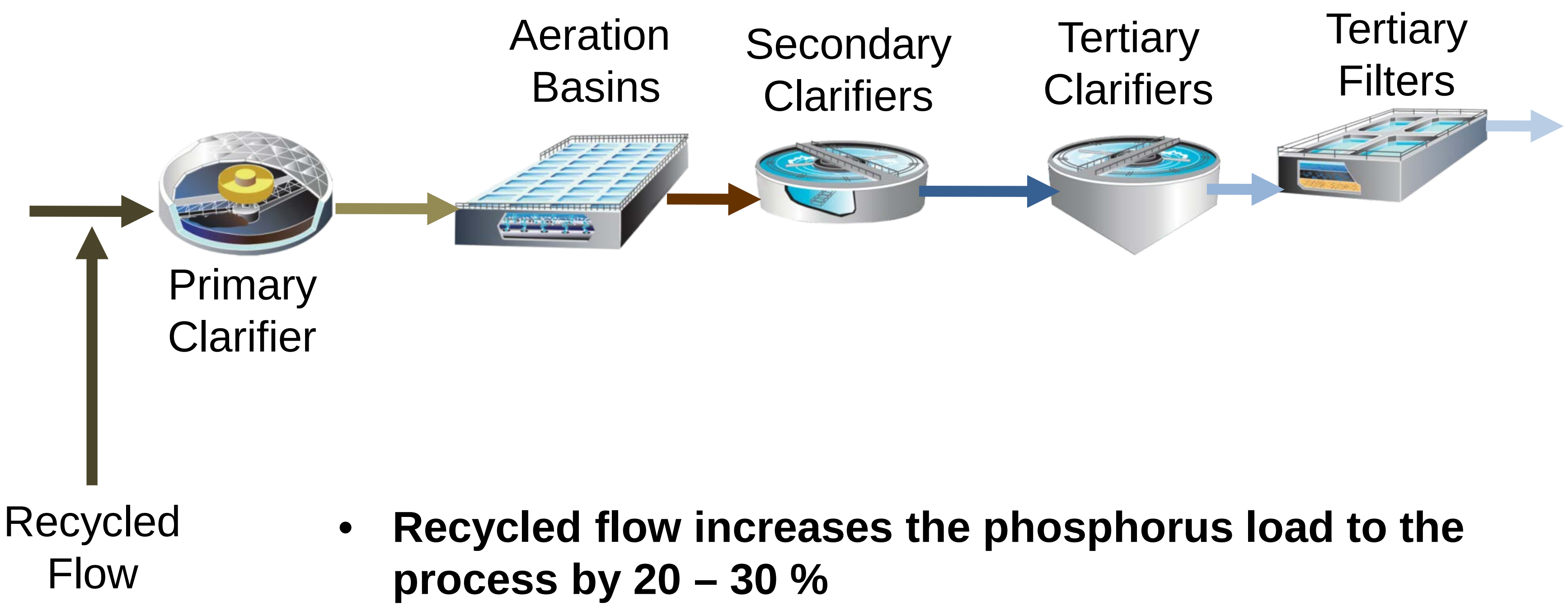
No Good Deed Goes Unpunished => Struvite

Clean Water Services

Struvite Reactions

- $NH_3 + PO_4 + Mg + 6\ H_2O \rightarrow$
  $NH_4PO_4Mg * 6\ H_2O \downarrow$
- 1:1:1 mole ratio NH_3:PO_4:Mg
- Mg usually limiting nutrient
- pH dependent. $CO_2\uparrow$ = pH$\uparrow$ = struvite$\downarrow$

Drivers for Nutrient Recovery



- **Recycled flow increases the phosphorus load to the process by 20 – 30 %**
- **Increased load can lead to process instability**

Benefits of Removing Phosphorus Recycle

- Reduction of recycle phosphorus load
  - Increased process (EBPR) stability
  - Reduction in alum needed
    - Reduction in lime needed
    - Reduction in biosolids dry tonnes
- Struvite revenue

Phosphorus is an "Emerging Issue"

From the June 2009 Scientific American Magazine | 28 comments

Phosphorus Famine: The Threat to Our Food Supply

This underappreciated resource--a key component of fertilizers--is still decades from running out. But we must act now to conserve it, or future agriculture could collapse

By David A. Vaccari

Scientific American – November 2009

From The Times
June 23, 2008

Scientists warn of lack of vital phosphorus as biofuels raise demand

Leo Lewis, Asia Business Correspondent

NEWS SCAN

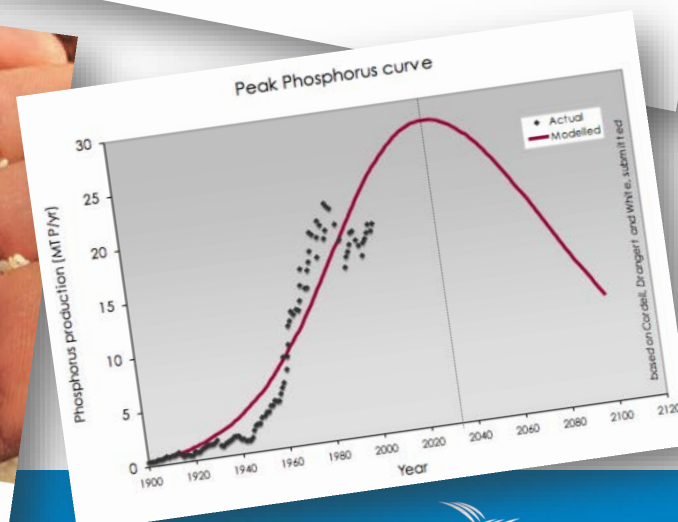
Technology

Sewage's Cash Crop

How flushing the toilet can lead to phosphorus for fertilizers BY KATHERINE TWEED

TUCKED AWAY IN OREGON'S WILLAMETTE VALLEY, THREE MASSIVE metal cones could help address the world's dwindling supply of phosphorus, the crucial ingredient of fertilizers that has made modern agriculture possible. The cones make consistently high-quality, slow-release fertilizer pellets from phosphorus recovered at the Durham Advance Wastewater Treatment Facility, less than 10 miles from downtown Portland. By generating about one ton

WASTEWATER WONDER: Ostara's Crystal Green, a slow-release fertilizer, incorporates phosphorus retrieved from sewage streams.



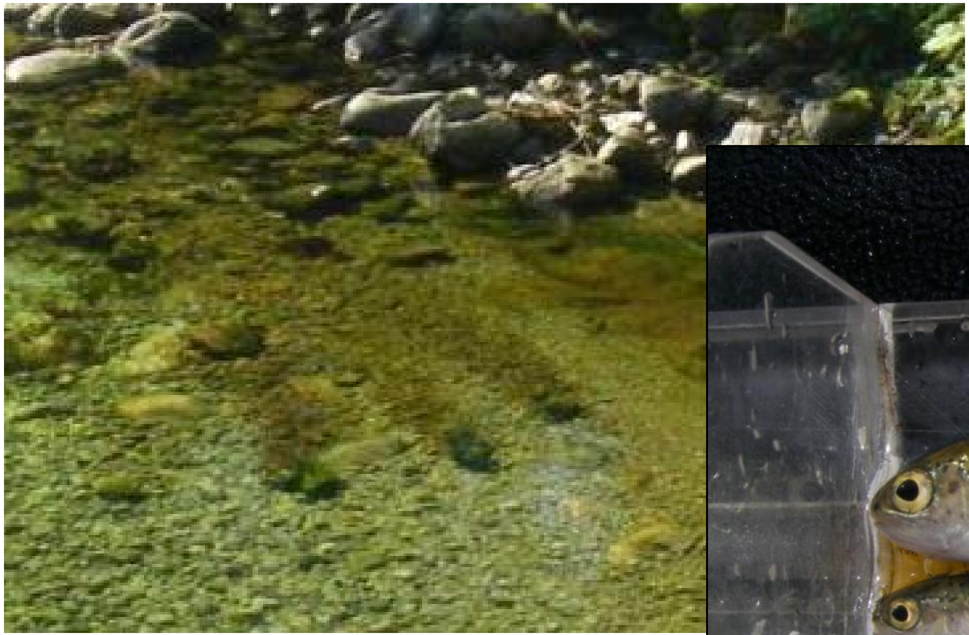
Clean Water Services

Crystal Green®

- 5-28-0 10% Mg fertilizer
- Slow release 6 to 9 months on surface, 3 months in soil, 1 month in a river. Larger prills slower, smaller faster
- Container plants & golf courses and custom blends
- NOT A BIOSOLID. Licensed by Oregon Department of Agriculture as a fertilizer manufacturer. Not waste derived

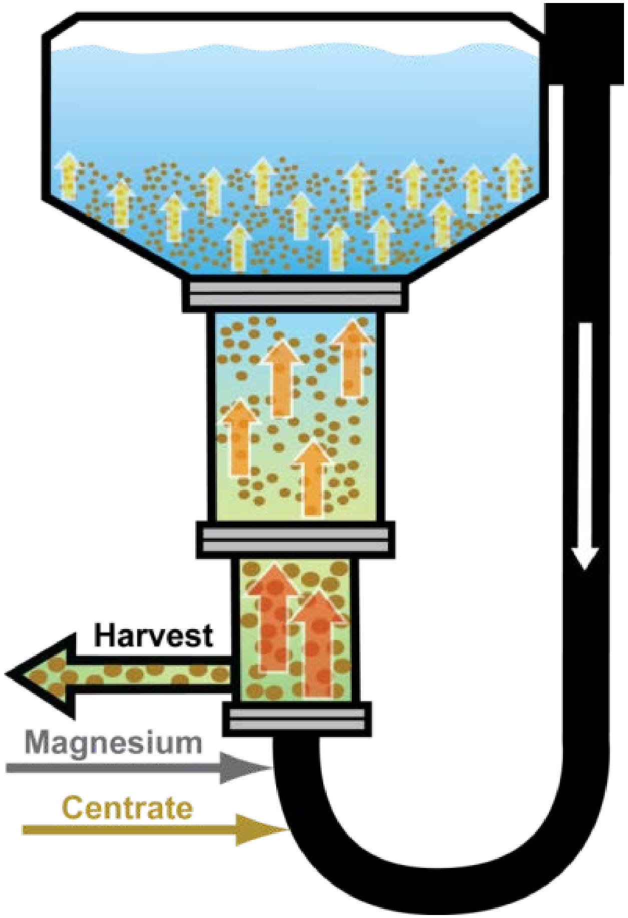
Clean Water Services

Anyone Can Turn Fish into Sewage,
We Turn Sewage into Fish



Durham SRF

3 TON
PEARL 500
OSTARA
PEARL 500
OSTARA



Harvest
Magnesium
Centrate

Water Separation

Water Removal, Drying and Sorting

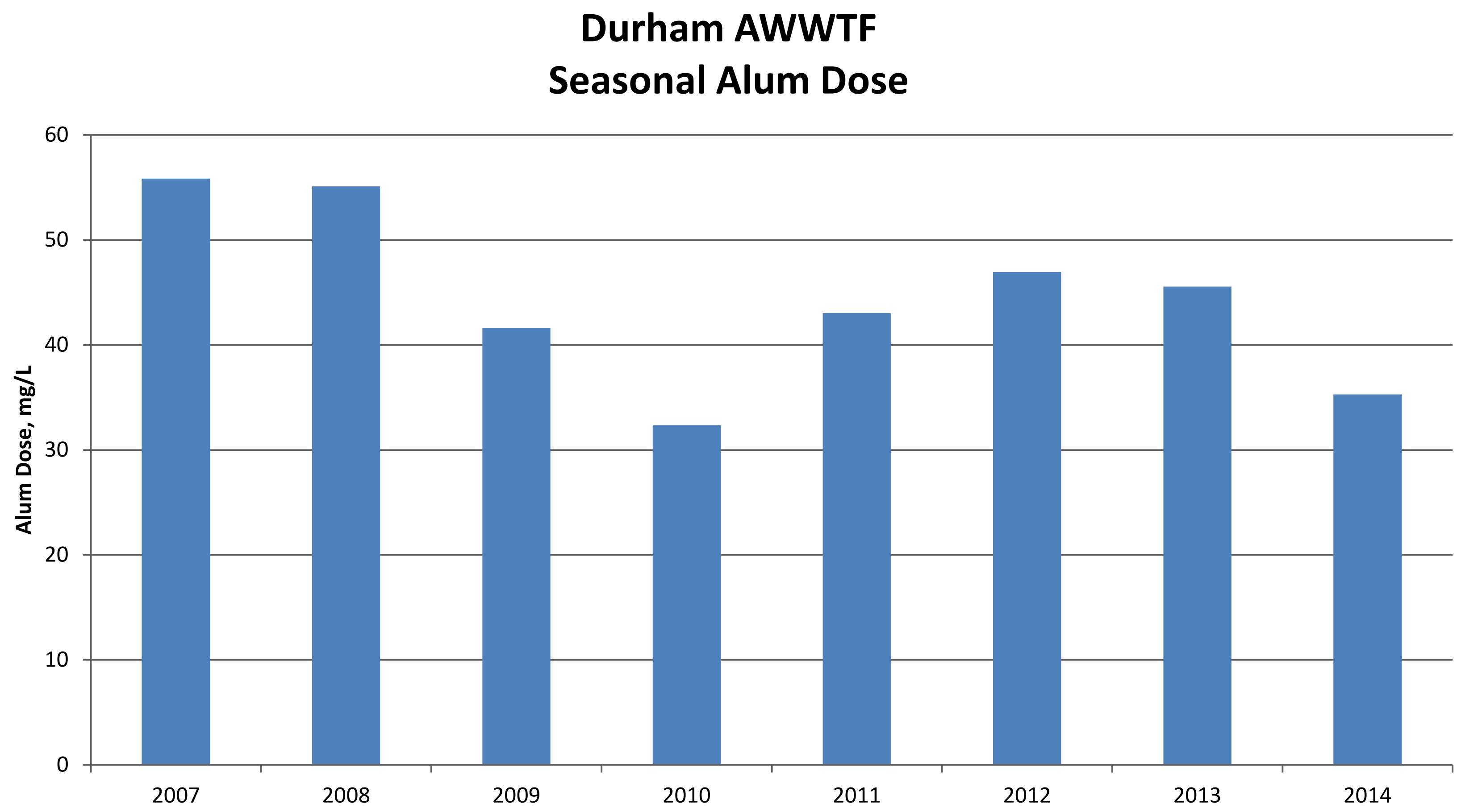
Silos, Bagging and Hoist

On Site Storage

Clean Water Services

Rock Creek NRF

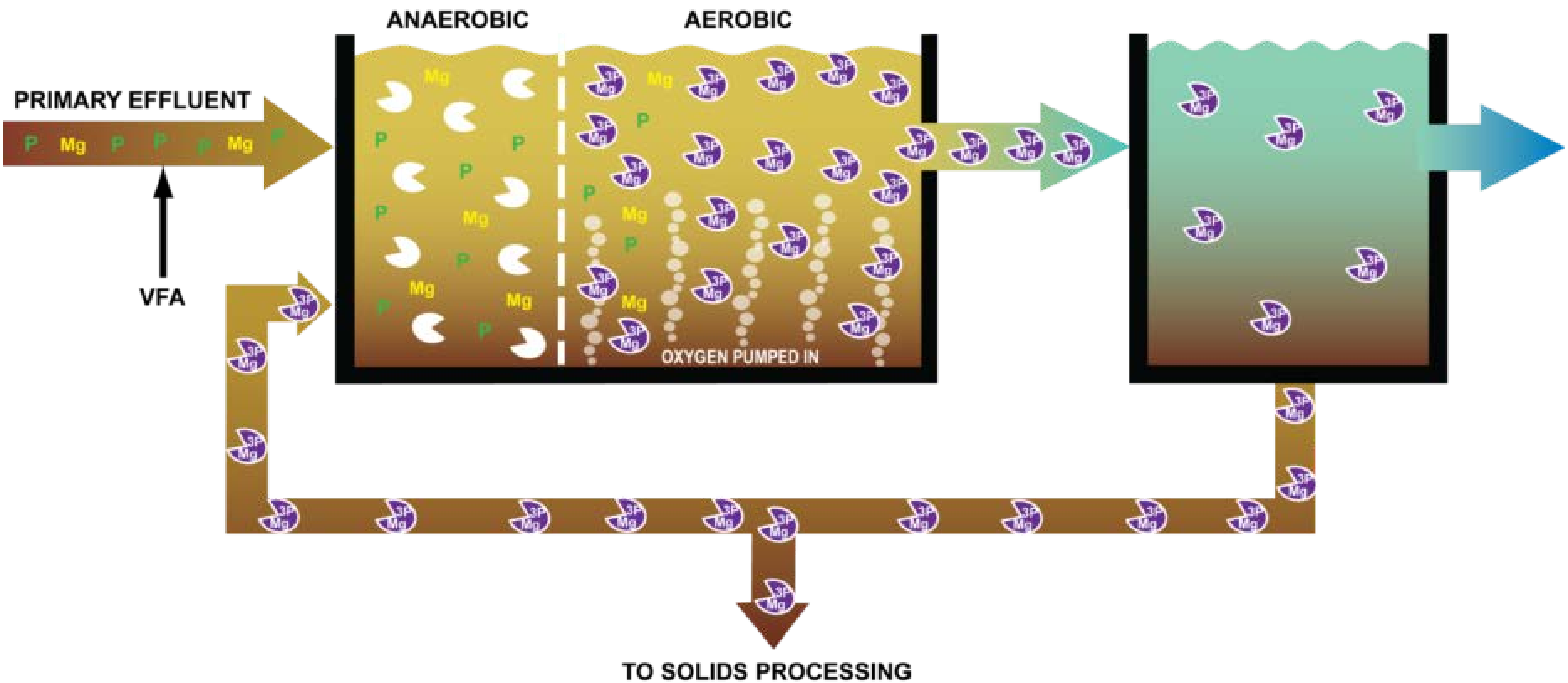
Seasonal Alum Dose



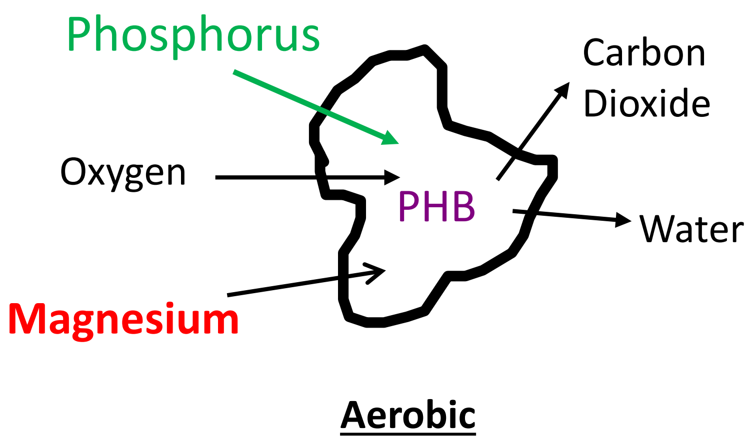
Struvite in the digesters- still an operational issue

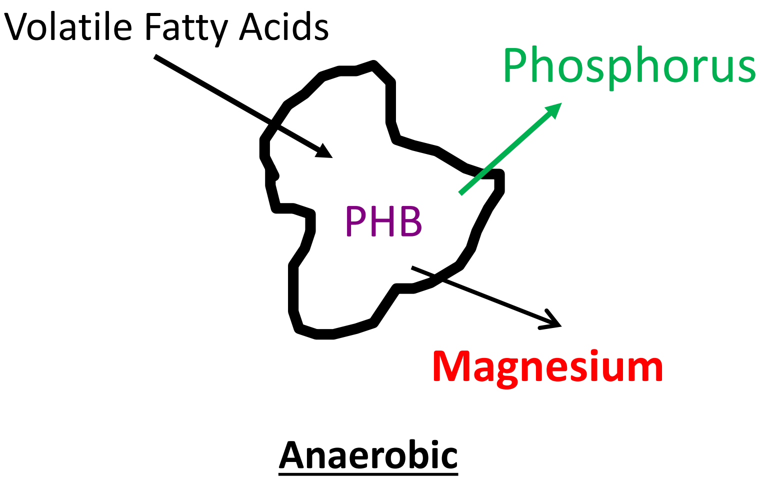
- **Large excess of ammonia and phosphorus exist in the digester**
- **Magnesium is the key to struvite**
- **Struvite is still generated in the digester and piping**
  - **Lost chance to recover P**
  - **Nuisance in digester and piping**

Uptake of P and Mg (& K) in EBPR



Overall Biological Phosphorus Removal





Release - Mg:OP ratio is ~0.3

Struvite - 1:1:1 mole ratio NH_3:PO_4:Mg

Mg usually limiting nutrient

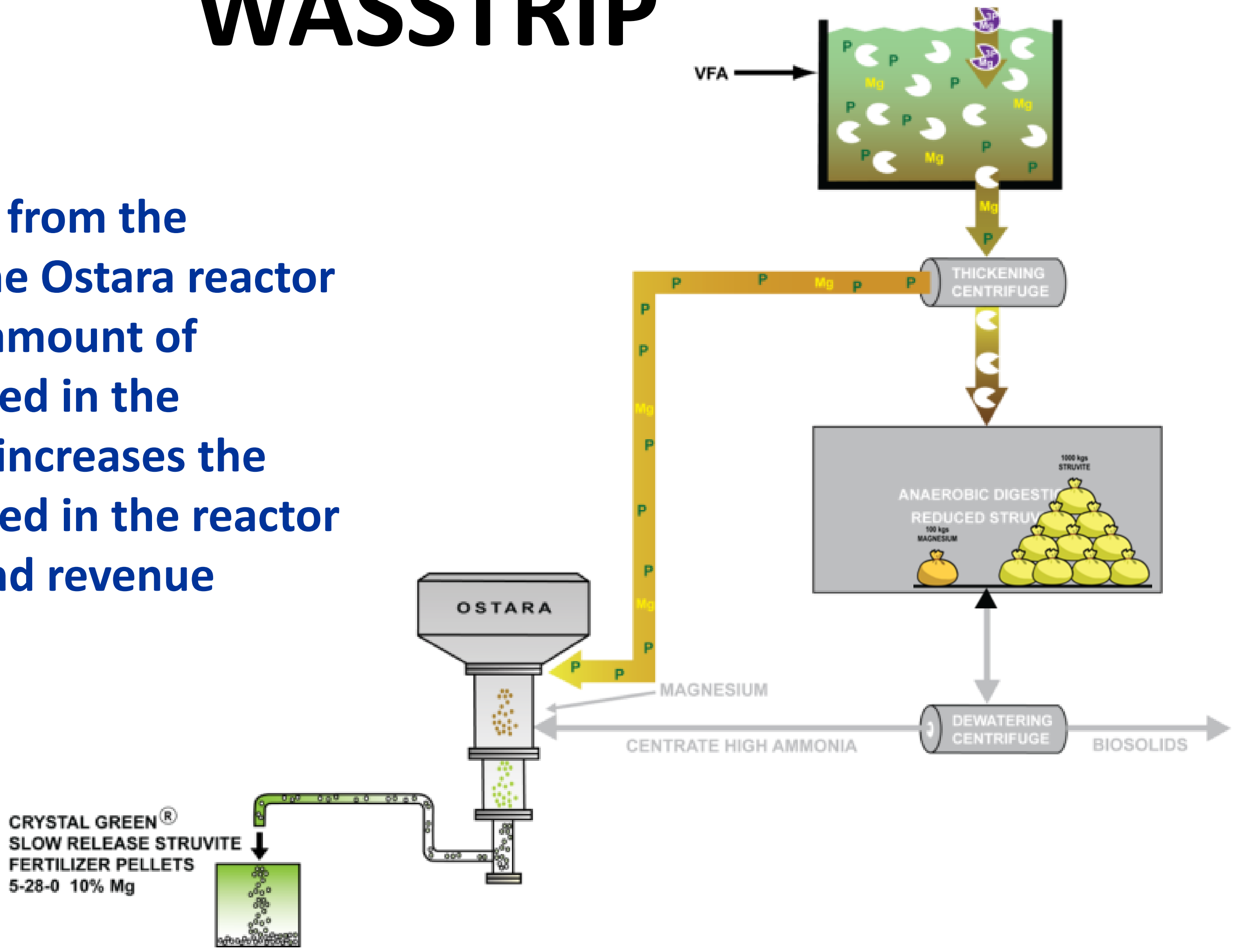
pH dependent. CO_2↑ = pH↑ = struvite↓

Clean Water Services

WASSTRIP

Solution

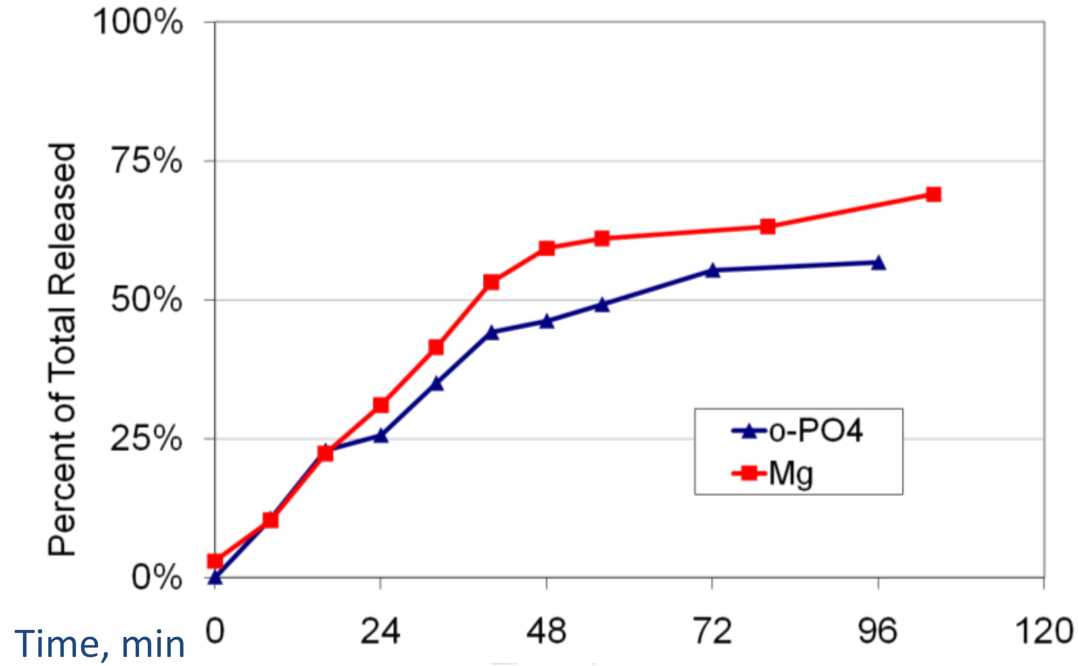
- Diverting Mg from the digester to the Ostara reactor reduces the amount of struvite formed in the digester and increases the struvite formed in the reactor as product and revenue

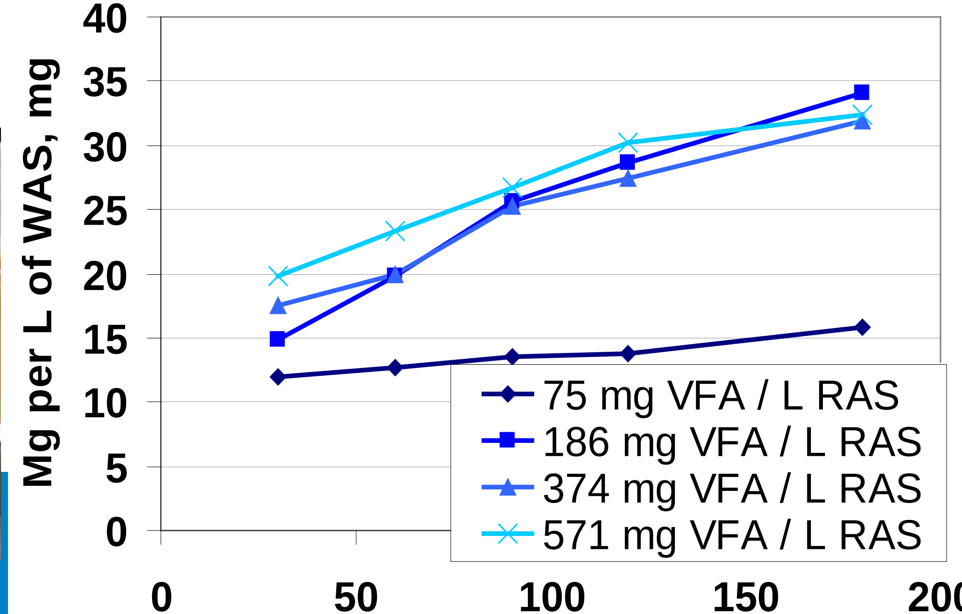


Clean Water Services

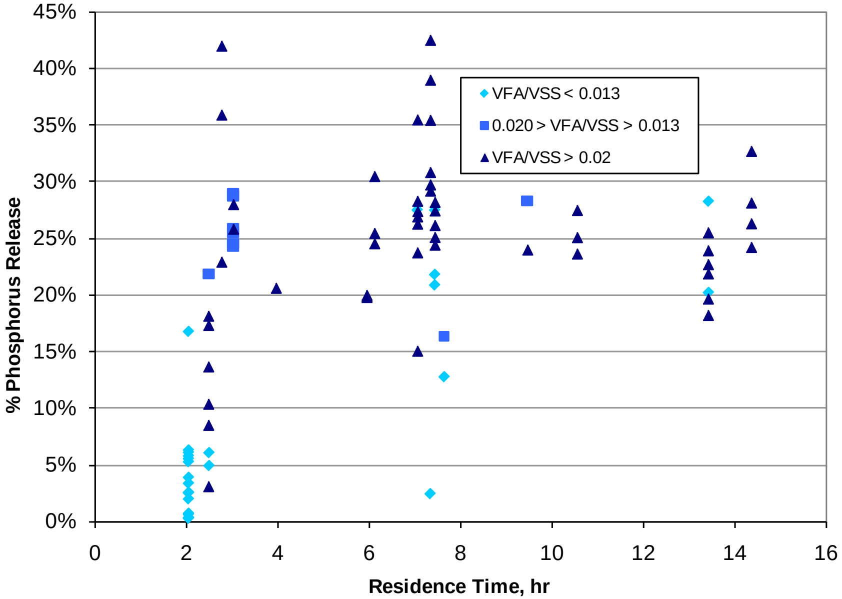
LAB-SCALE RELEASE

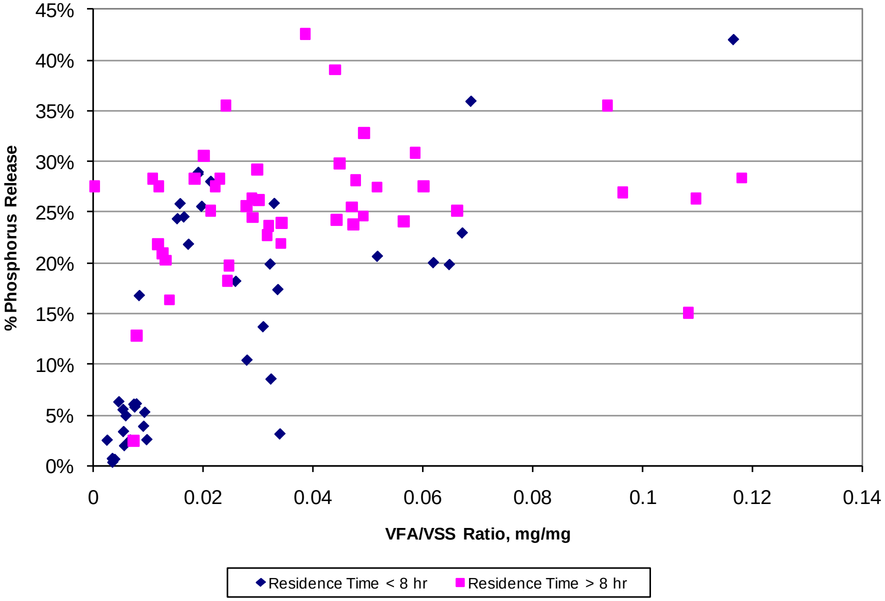
- Release rate for phosphorus is zero-order with respect to VFA concentration
- Mg : P release was consistent





PILOT TEST – OPERATION





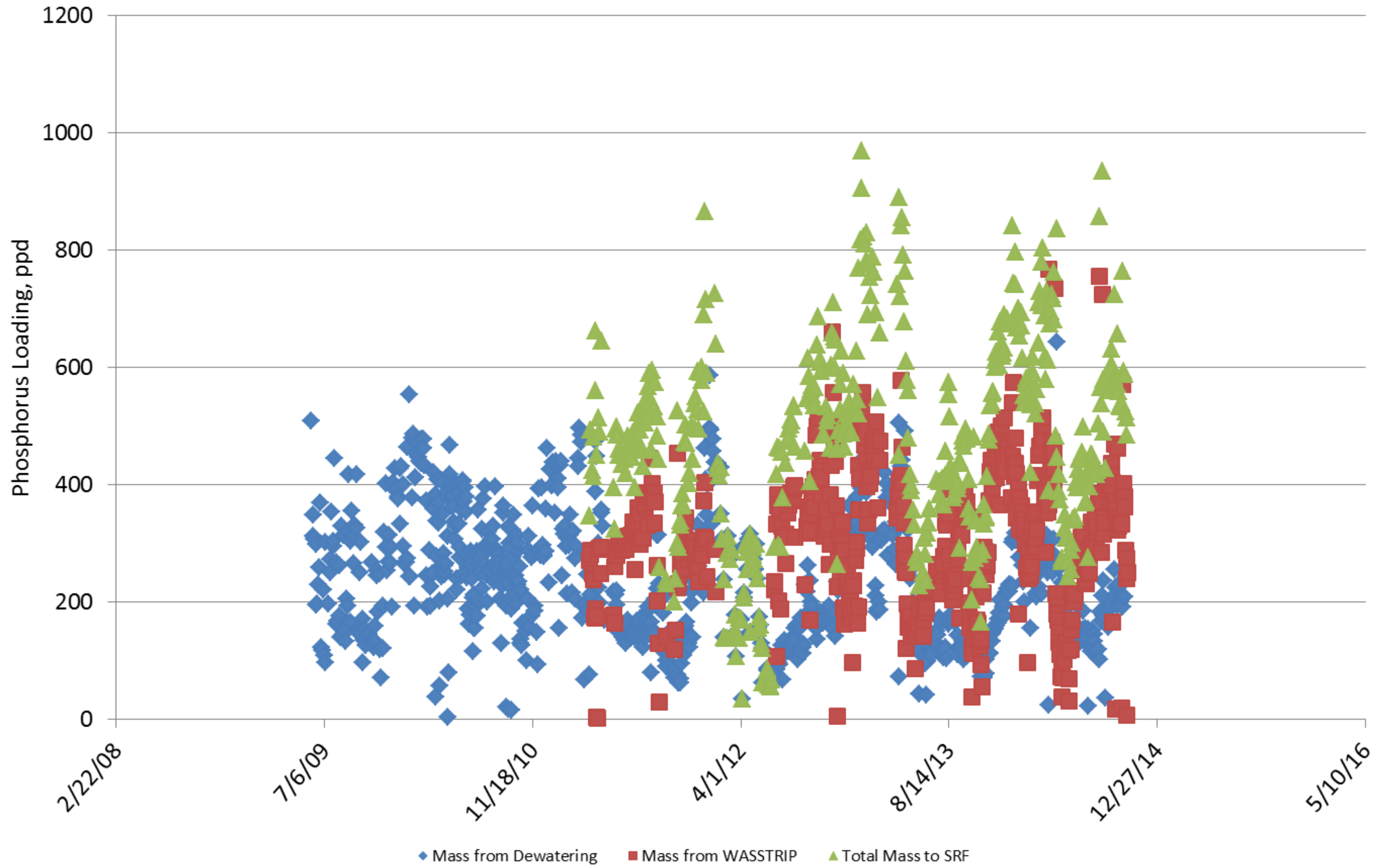
Clean Water Services

WASSTRIP Installation

Clean Water Services

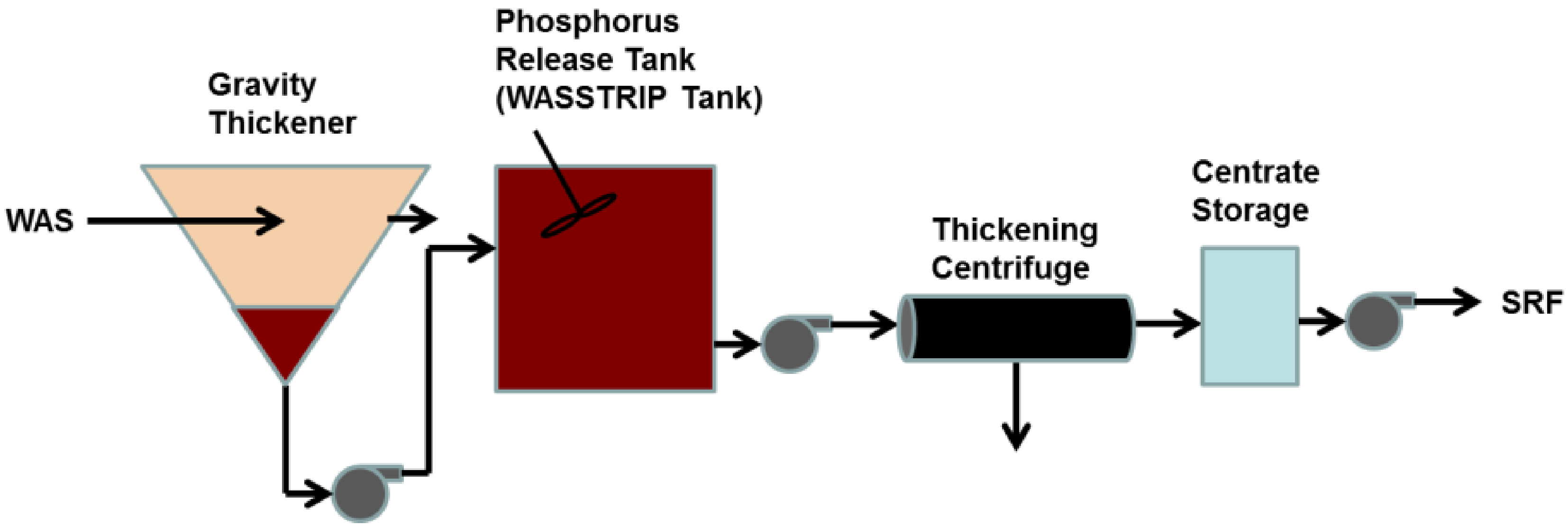
WASSTRIP Installation

Durham AWWTF
Phosphorus Loading to Nutrient Recovery



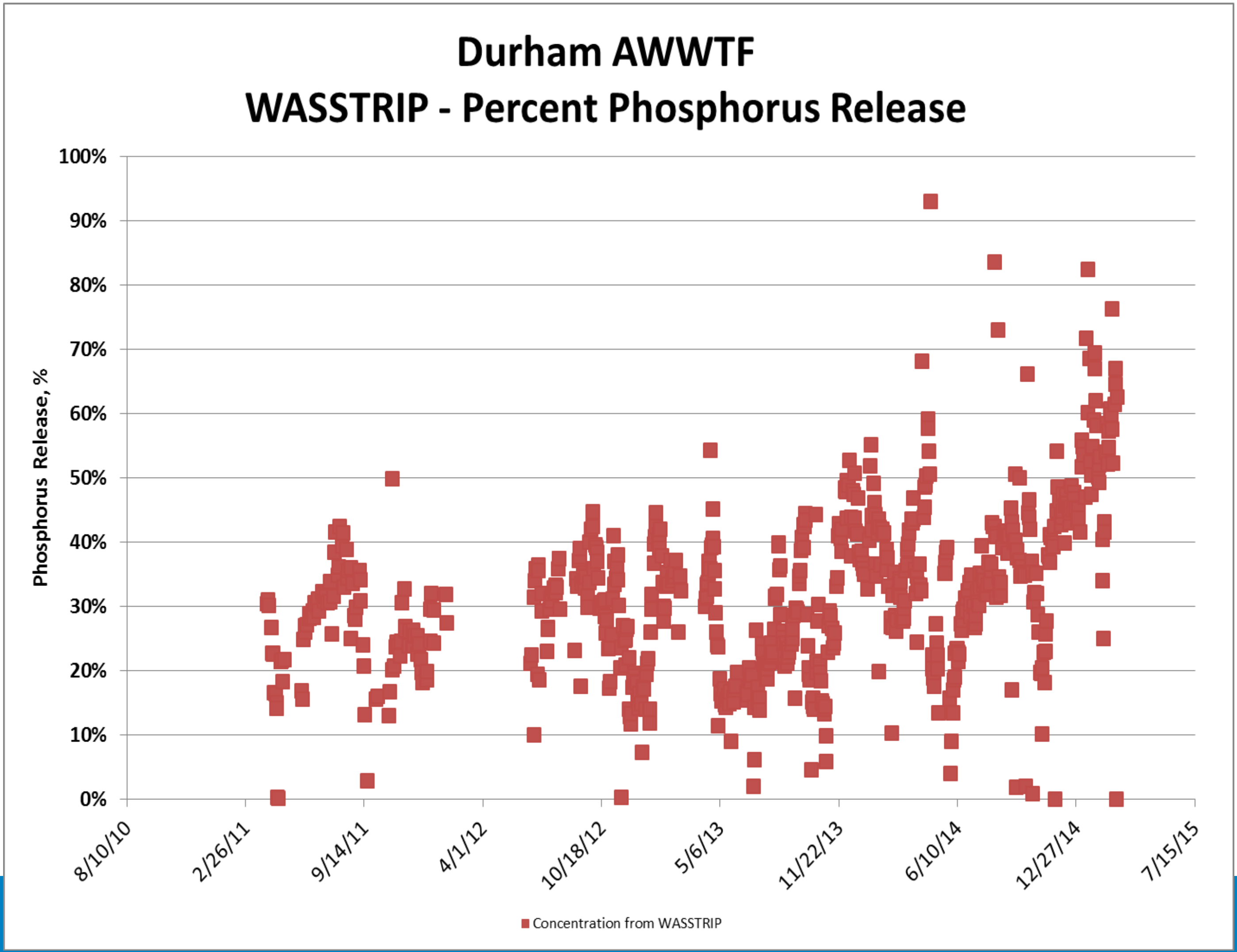
Clean Water Services

WASSTRIP 2.0



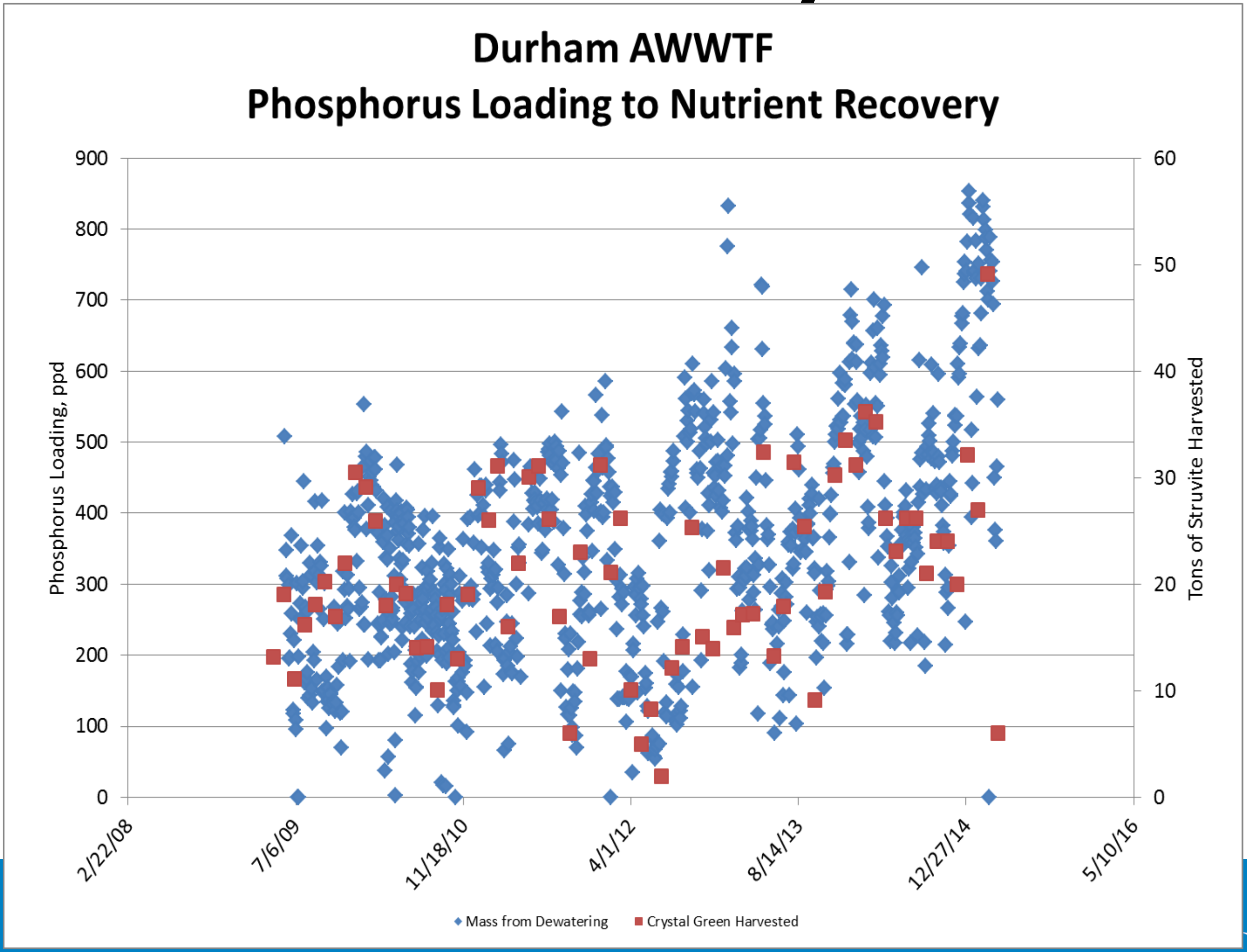
CleanWater Services

Phosphorus Release

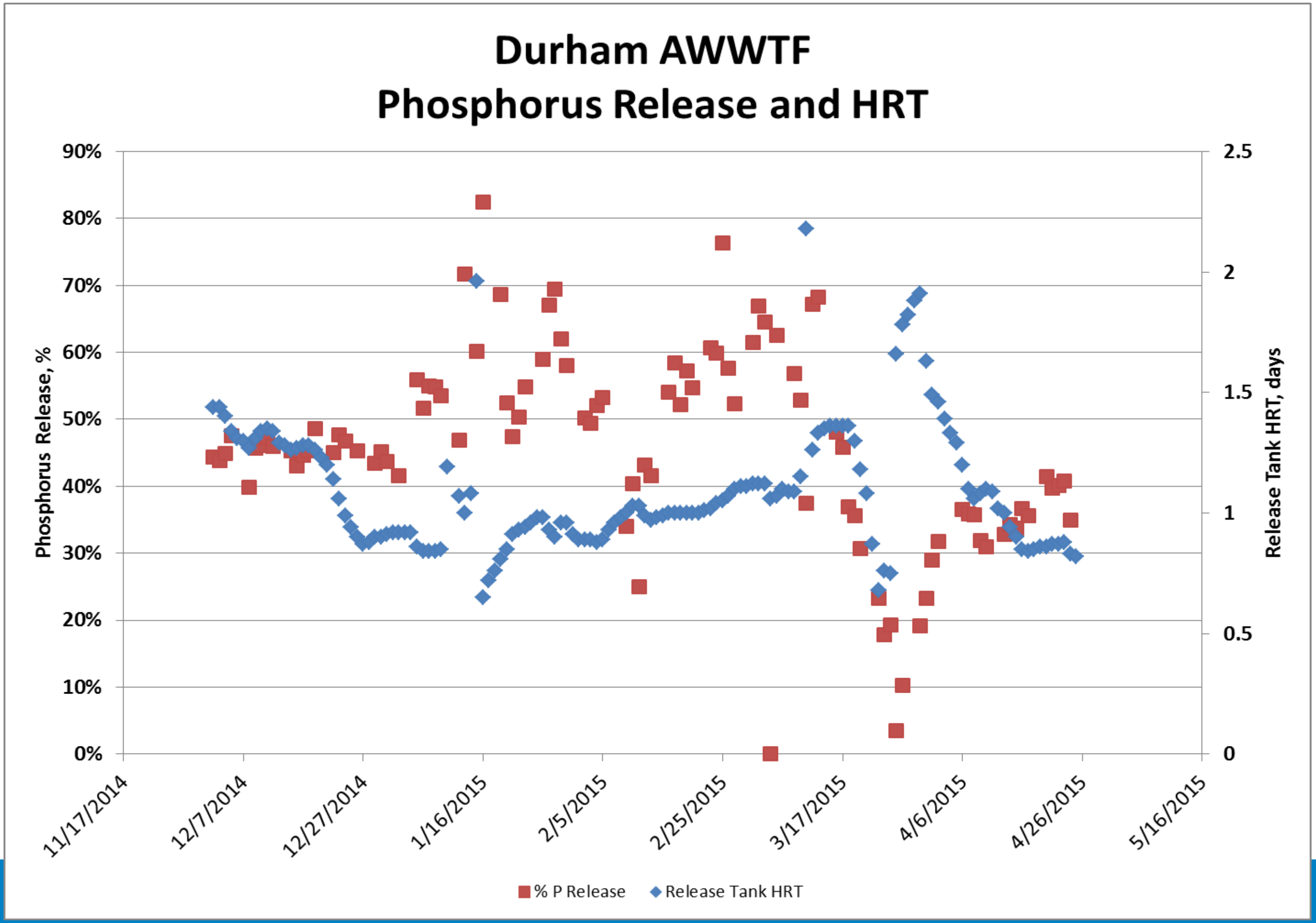


Clean Water Services

Phosphorus Loading to Recovery Facility

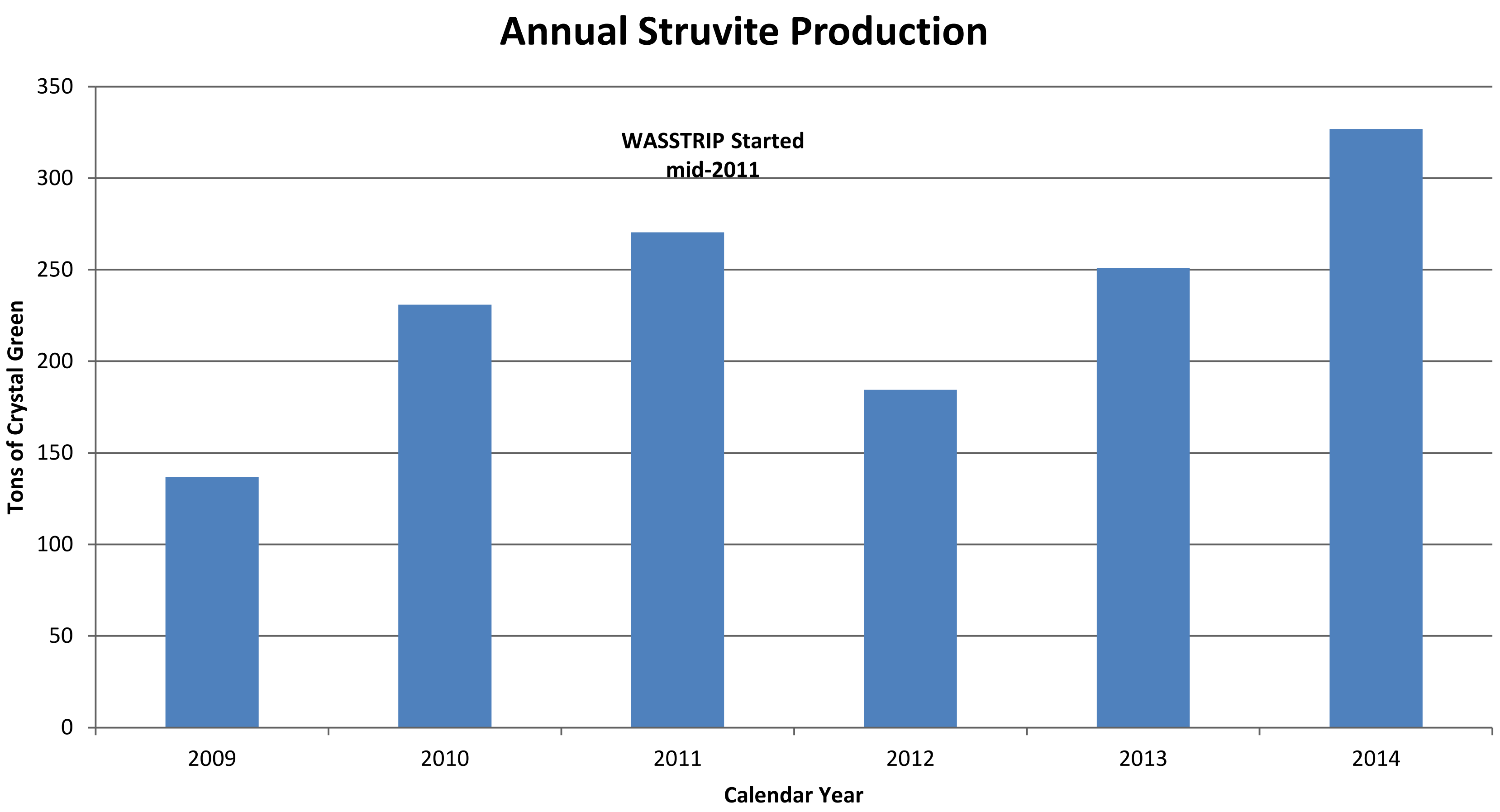


Phosphorus Release & HRT



Clean Water Services

Annual Struvite Production



Clean Water Services

Positive WASSTRIP Impacts

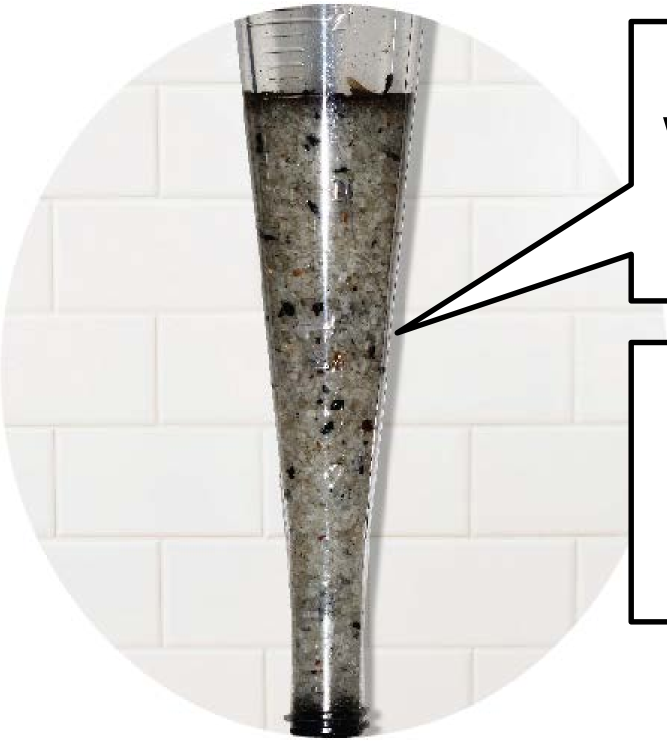
- Decreased struvite production in the digesters/solids process (200 – 800 kg/d)
- Increased beneficial struvite product production

? Decreased phosphorus content in sludge

? Improved dewaterability

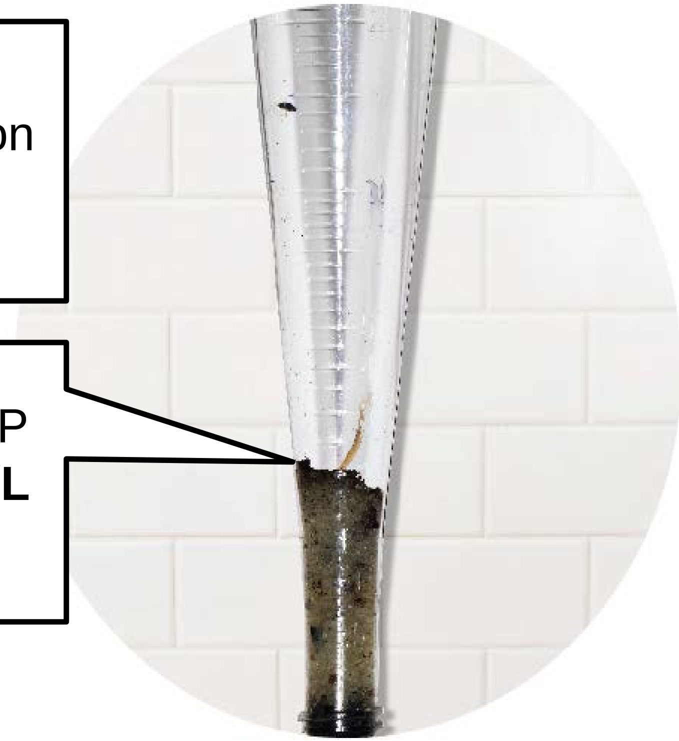
WASSTRIP™ Impact

Imhoff cone with washed sludge shows drastic reduction in digester struvite formation



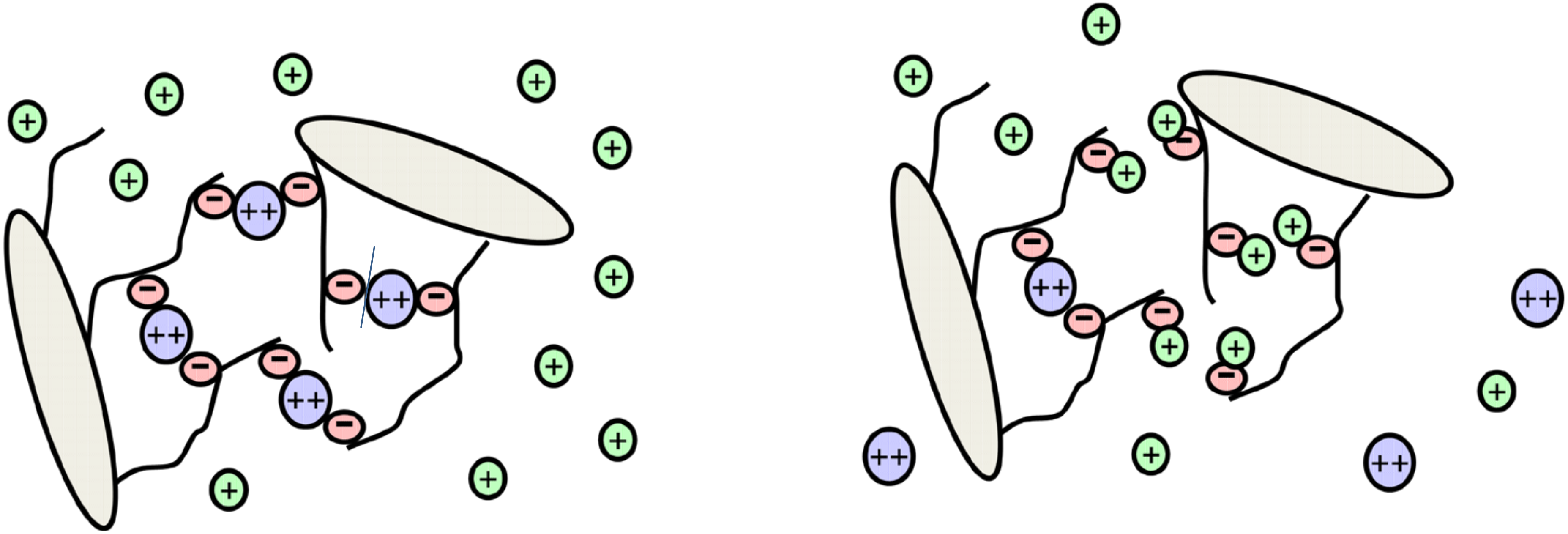
Sludge Sample **prior** to WASSTRIP Implementation with **15 ml/L** of struvite crystals

~60 days **after** WASSTRIP Implementation with **1 ml/L** of struvite crystals



WASSTRIP Impact
Improved Dewaterability

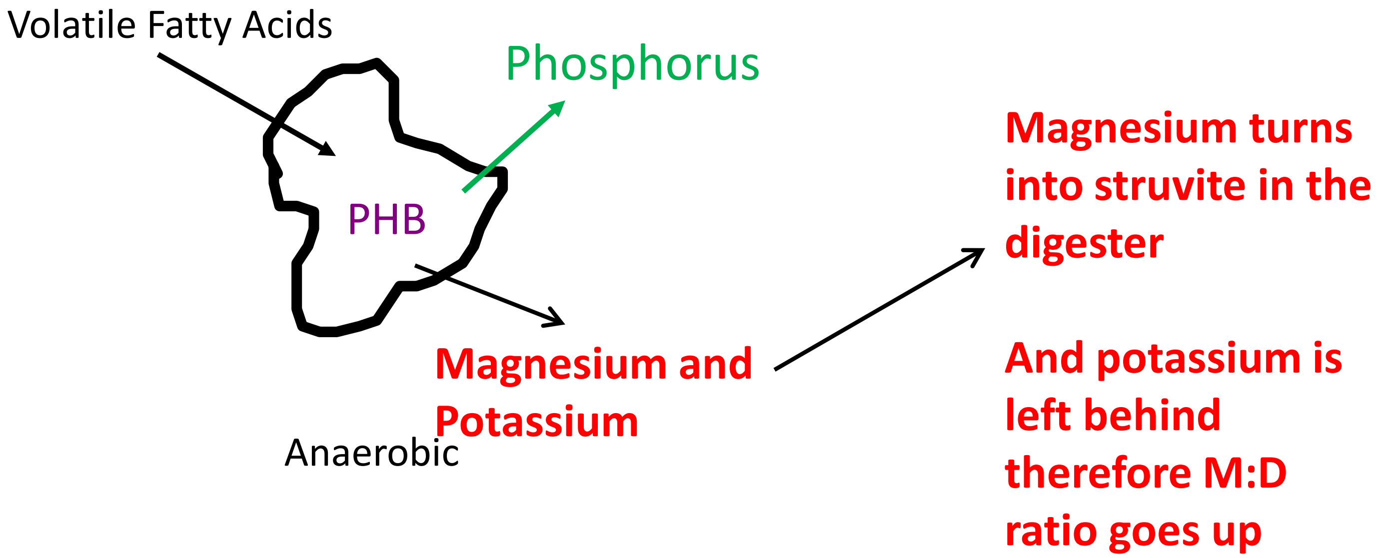
- **One aspect that may impact the dewaterabilty is cation bridging**



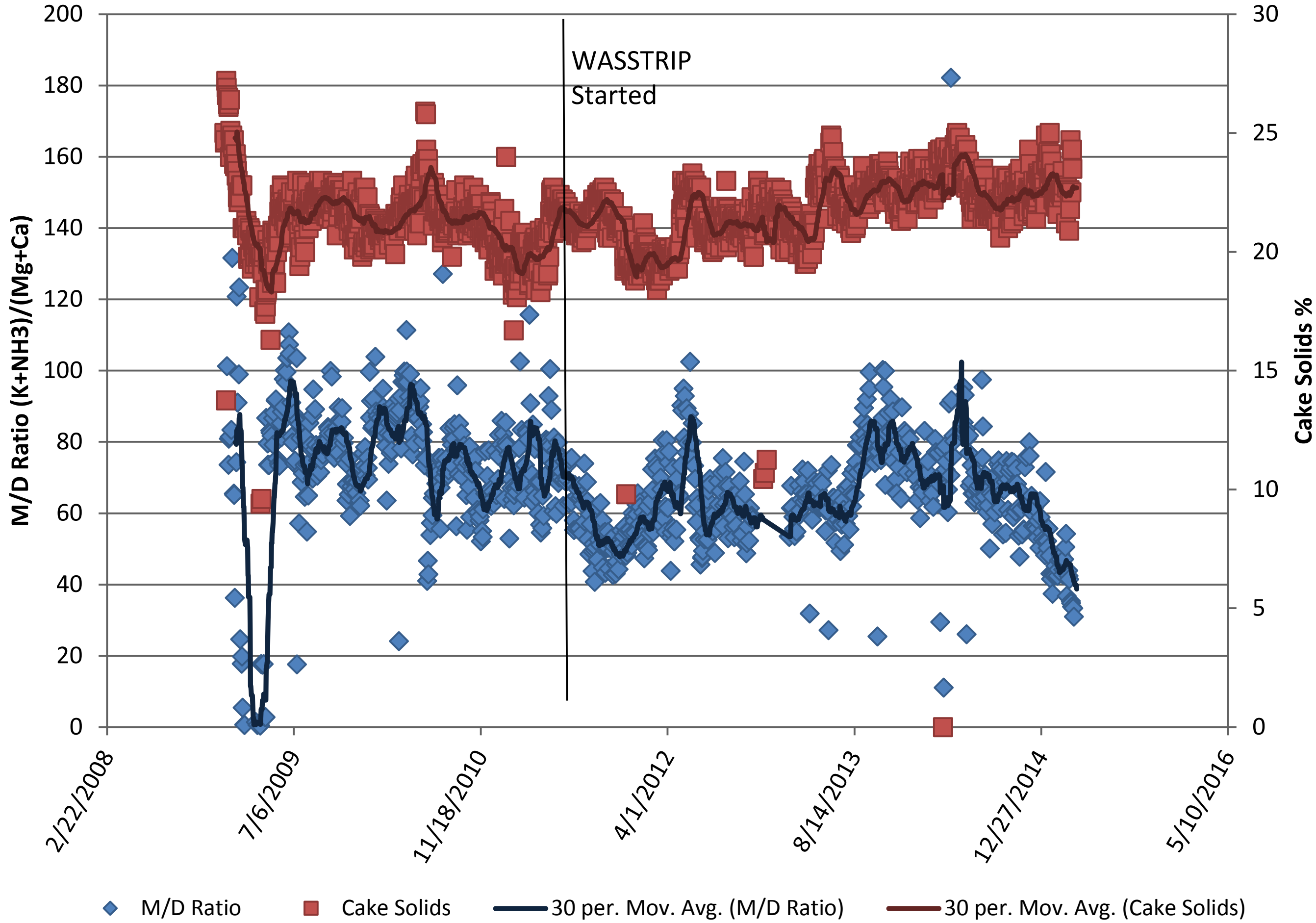
Higgins (2014)

WASSTRIP Impact
Improved Dewaterability

- **Biological Phosphorus Removal can shift the M:D ratio**



Cation Ratio

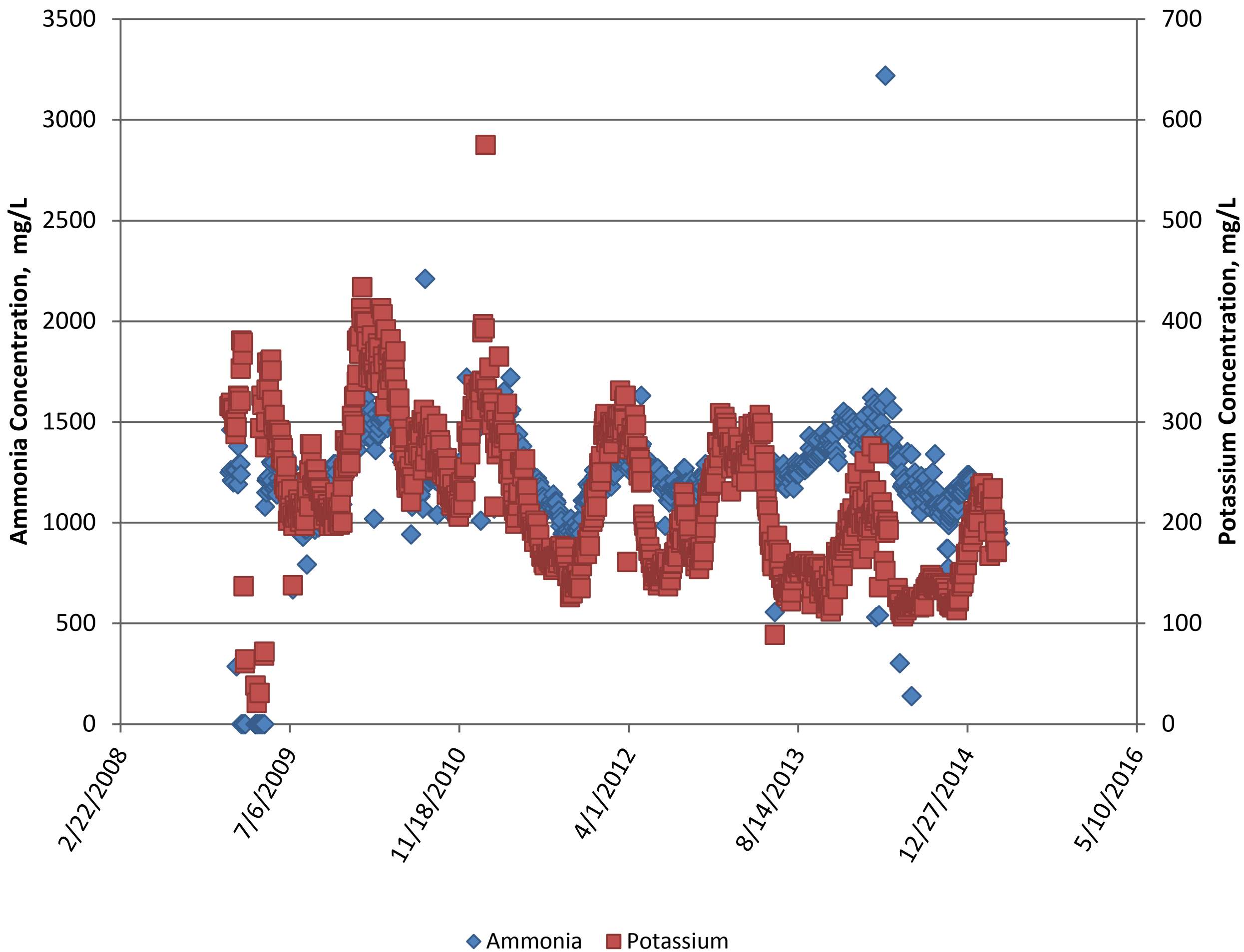


Clean Water Services

Dewatered Cake

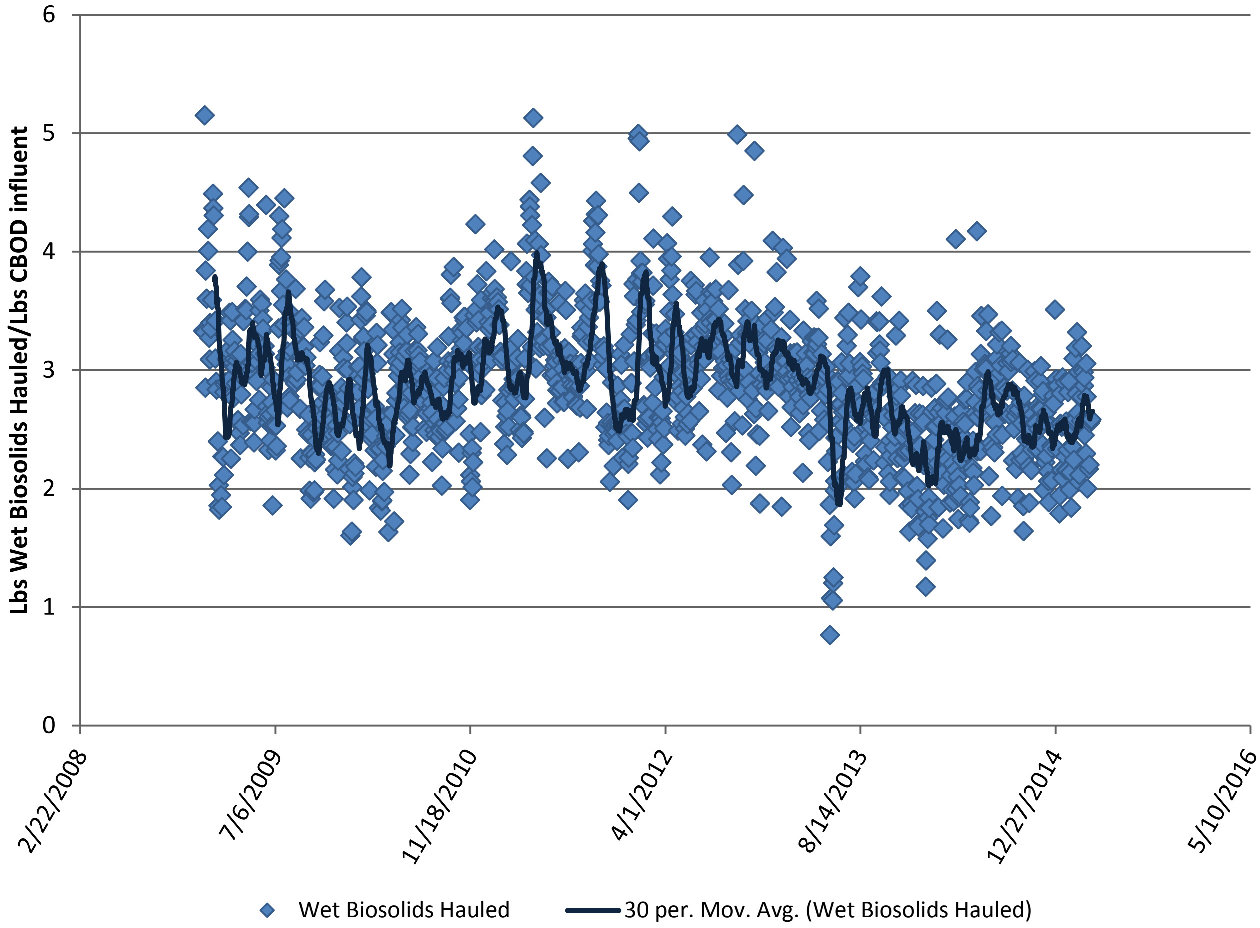
Clean Water Services

Monovalent Cations



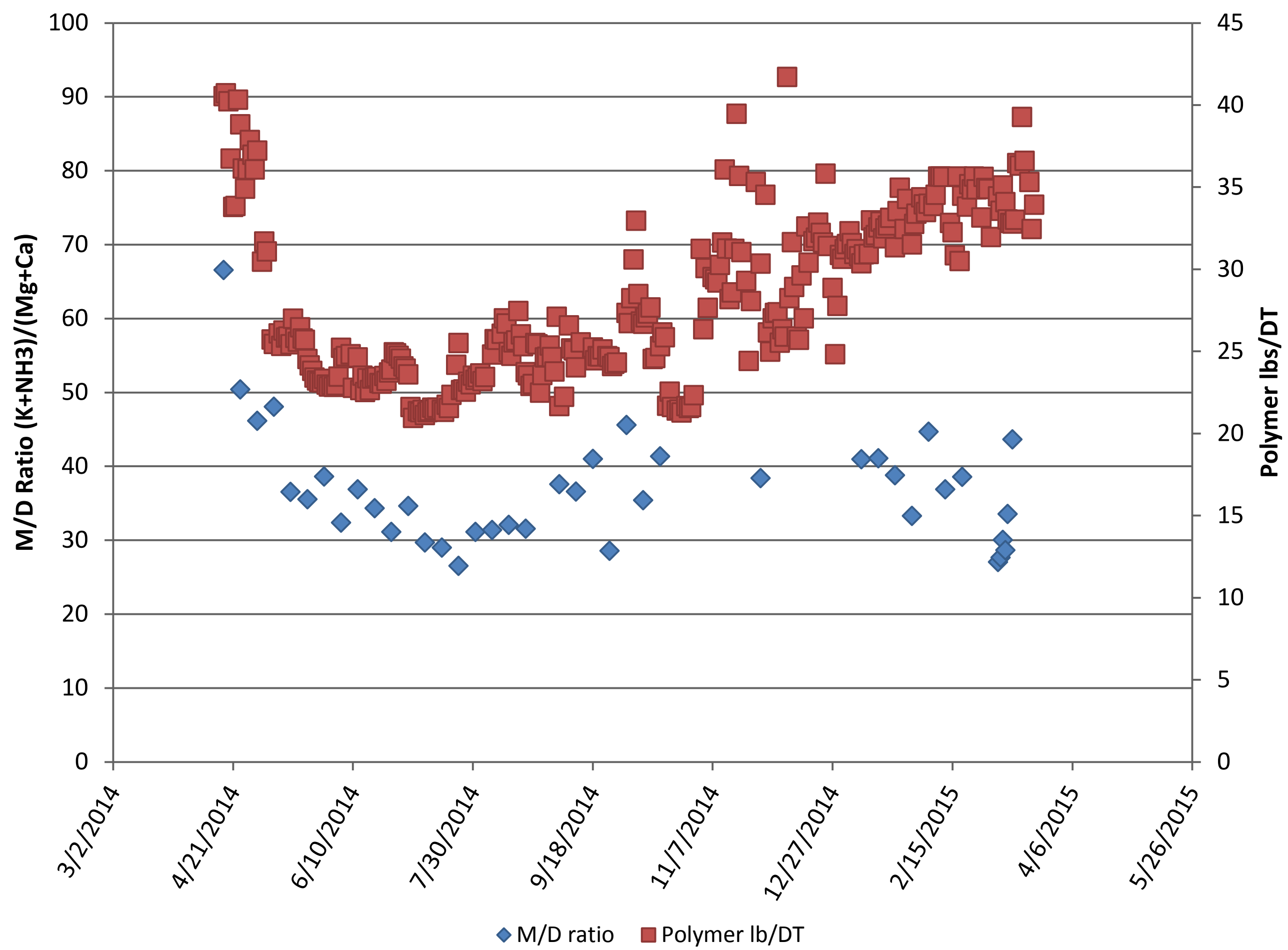
Clean Water Services

Wet Biosolids



Clean Water Services

Polymer Requirements



Clean Water Services

Conclusions

- Reduction in returned phosphorus load improved process stability
- Use of WASSTRIP process increased nutrient recovery
- Shift from nutrient removal to nutrient recovery also caused a shift in the philosophy for operations throughout the year
- Improved dewaterability may occur