



UrbanUtilities

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# Enhanced In-Digester Struvite Phosphorus Recovery – Putting the “E” in Circular Economy

# Welcome





# Enhanced In-Digester Struvite Phosphorus Recovery

→ Putting the “E” in Circular Economy

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# Acknowledgement & respect

GHD acknowledges Aboriginal and Torres Strait Islander peoples as the Traditional Custodians of the land, water and sky throughout Australia on which we do business. We recognise their strength, diversity, resilience and deep connections to Country. We pay our respects to Elders of the past, present and future, as they hold the memories, knowledges and spirit of Australia. GHD is committed to learning from Aboriginal and Torres Strait Islander peoples in the work we do.



# Introduction

## Luggage Point WWTP:

- 133 ML/d ADWF
- 800,000 EP

## Initiated to solve struvite/MAP blockages:

- Digested sludge transfer pipework
- Centrate pumps and pipework causing dewatering bottleneck / significant downtime
- Fortnightly maintenance to clear blockages
- Maintenance activities safety
- Centrifuge bowl abrasion wear?

## Options considered:

- Reduced digested sludge pH
- Ferrous dosing
- Anti-scalant dosing
- Centrate dilution
- Centrate struvite precipitation
- Digested sludge struvite precipitation





# High Maintenance Effort/Cost

- Jet rodding, manual cleaning of centrate pumps, acid cleans
- Intensive fortnightly activities

Work Order Type	(Multiple Items)				
Row Labels		Sum of Actual Material Costs	Sum of Actual Other Costs	Sum of Actual Resource Cost	Sum of Actual Total Costs
ST018-PU_-0450-101 Centrifuge Filtrate Pump 1		8,790	82,766	15,772	107,329
ST18 - Dewatering filtrate pumps		-	-	-	-
ST18 Cen 2 not pumping centrate		-	1,165	287	1,453
ST18 Cent filtrate pump 1 not pumping		-	-	-	-
ST18 Cent Filtrate pumps blocked Peter V		285	6,254	1,613	8,152
ST18 Cent. filtrate pump 1 not pumping		-	1,199	259	1,458
ST18 Centrate pumps blocked centrifuge		-	3,108	450	3,558
ST18 Centrifuge Filtrate pump blocked		-	841	254	1,095
ST18 Centrifuge filtrate pumps fault.		-	1,518	283	1,801
ST18 centrifuge filtrate pumps faulting		-	35,072	3,190	38,262
ST18 centrifuge filtrate pumps tire coup		-	1,251	415	1,666
ST18 Centrifuge filtrate pumps tripping		3,233	1,339	345	4,916
ST18 - FILTRATE PUMP		-	2,257	528	2,785
ST18 Filtrate pump 1 coupling broken		-	313	216	529
ST18 filtrate pump 1 thermal overload		218	618	121	956
ST18 Filtrate pumps 1/2 blocked Phil D.		-	584	147	730
ST18 Filtrate pumps blocked Bob H.Called		-	646	732	1,377
ST18-Centrifuge filtrate pump		2,847	14,933	3,101	20,881
ST18Centrifuge Filtrate pump blocked		1,531	3,658	837	6,026
ST18-FILTRATE PUMP 1 NOT PUMPING		-	539	610	1,149
ST018-PU_-0450-102 Centrifuge Filtrate Pump 2		8,678	36,400	9,339	54,417
Centrate pumps blocked att Glen		-	635	154	788
Filtrate pump 2 refurb requested by Tom		-	-	-	-
ST018- filtrate pump #2 thermal overload		4,818	2,476	759	8,053
ST18 Centrifuge filtrate 2 not pumping		-	998	321	1,318
ST18 CENTRIFUGE FILTRATE PUMP #2		-	992	306	1,298
ST18 CENTRIFUGE FILTRATE PUMP #2 BLOCKED		-	998	321	1,318
ST18 centrifuge filtrate pump 2 blocked		2,931	7,154	1,319	11,405
ST18 centrifuge filtrate pump 2 siezed		502	2,833	596	3,930
ST18 filtrate pump 2 blockage		-	2,739	885	3,624
ST18 filtrate pump 2 cable requires atte		-	597	182	779
ST18 Filtrate pump 2 fault callout Gavin		427	10,061	2,750	13,238
ST18,Filtrate pumps require Acid Clean		-	643	199	842
ST18-centrifuge filtrate pump 2 loes s		-	4,064	881	4,946
ST18-filtrate pump 2 continually running		-	2,209	668	2,877
<b>Grand Total</b>		<b>17,468</b>	<b>119,166</b>	<b>25,112</b>	<b>161,745</b>





# Struvite / MAP Formation



- Precipitates whenever activities of  $\text{Mg}^{2+}$ ,  $\text{NH}_4^+$ ,  $\text{PO}_4^{3-}$  exceed solubility constant
- Depends on pH → Higher pH = greater precipitation potential
- Anaerobic digestion of BNR WAS releases high concentrations of  $\text{NH}_4^+$ ,  $\text{PO}_4^{3-}$ ,  $\text{Mg}^{2+}$
- Pressure drop in pumps, pump suction and pipe bends causes  $\text{CO}_2$  stripping, raising pH



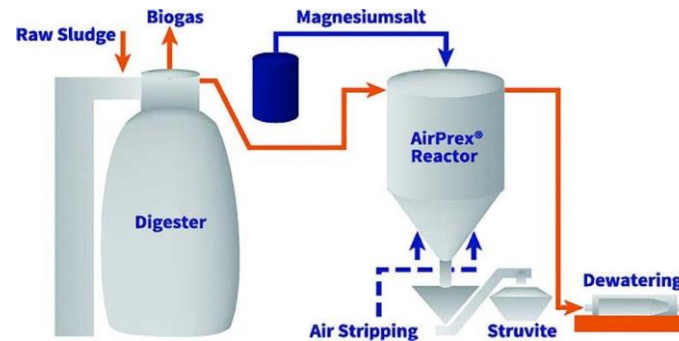
# Phosphorus Recovery with Struvite Crystallisation

## Why recover phosphorus?

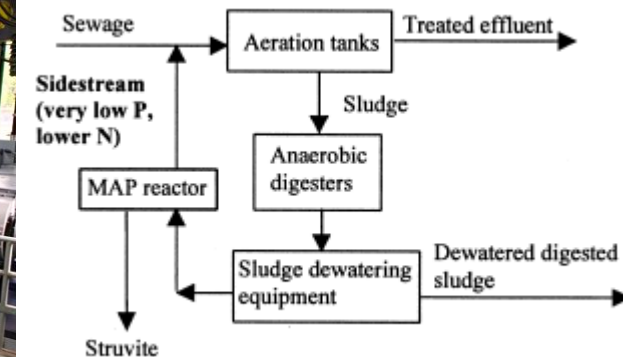
- Growth limiting nutrient
- Increased demand and limited reserves
- Discharge to environment causes severe eutrophication and loss of resource

## Struvite crystallisation processes

- Side-stream CSTR or fluidised bed reactor
  - CSTR: Phospaq, Anphos, NuReSys
  - FBR: Ostara/Pearl, Phosnix
- Sludge-stream
  - Airprex (CSTR with crystal separation / settling)
- Significant infrastructure & operational costs



Source: [www.tpomag.com](http://www.tpomag.com)



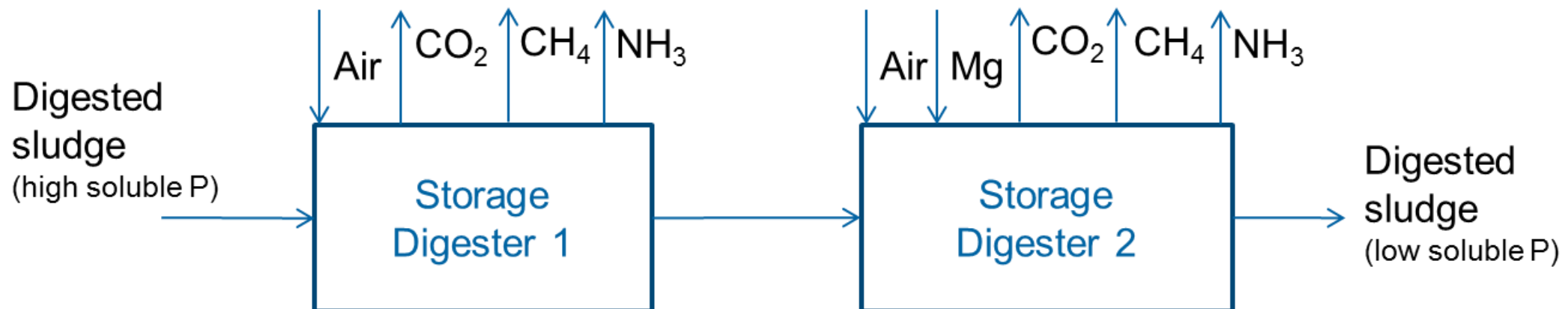
Source: Münch & Barr, 2011



# In-Digester Struvite Recovery

- Series digested sludge flow
  - from Storage Digester 1 to 2
- Storage Digester 1: Air mixing & strip  $\text{CO}_2$ 
  - Raise pH
  - Minimise  $\text{MgCO}_3$  formation
- Storage Digester 2: MHL dosing & air mixing
  - Raise pH further
  - Crystallise struvite further
  - Reduce sludge phosphate concentration

- ✓ Low cost infrastructure / implementation solution
- ✓ Reduces phosphate to very low levels in digested sludge and throughout sludge stream
- ✓ Minimises struvite formation potential throughout
- ✓ Phosphorus retained in the biosolids product
- ✓ Phosphorus in Struvite is bio-available
- ✓ WWTP effluent P (& N) reduction
- ✓ Improved sludge dewaterability
- ✗ Struvite / phosphorus is not separated from biosolids





# MHL Dosing Design Basis

- Low centrate Mg supports observations that significant struvite formed prior to centrifuges
- Problematic struvite still forming with Mg ~ 5 mg/L
- Struvite precipitation potential decreased by dropping soluble P concentration
  - Target < 20 mg-P/L
- Centrate data prior to MHL dosing:

Parameter	Units	Average
Magnesium	mg/L	5
Ammonia	mg N/L	930
Soluble Phosphorus	mg P/L	195
pH		7.9





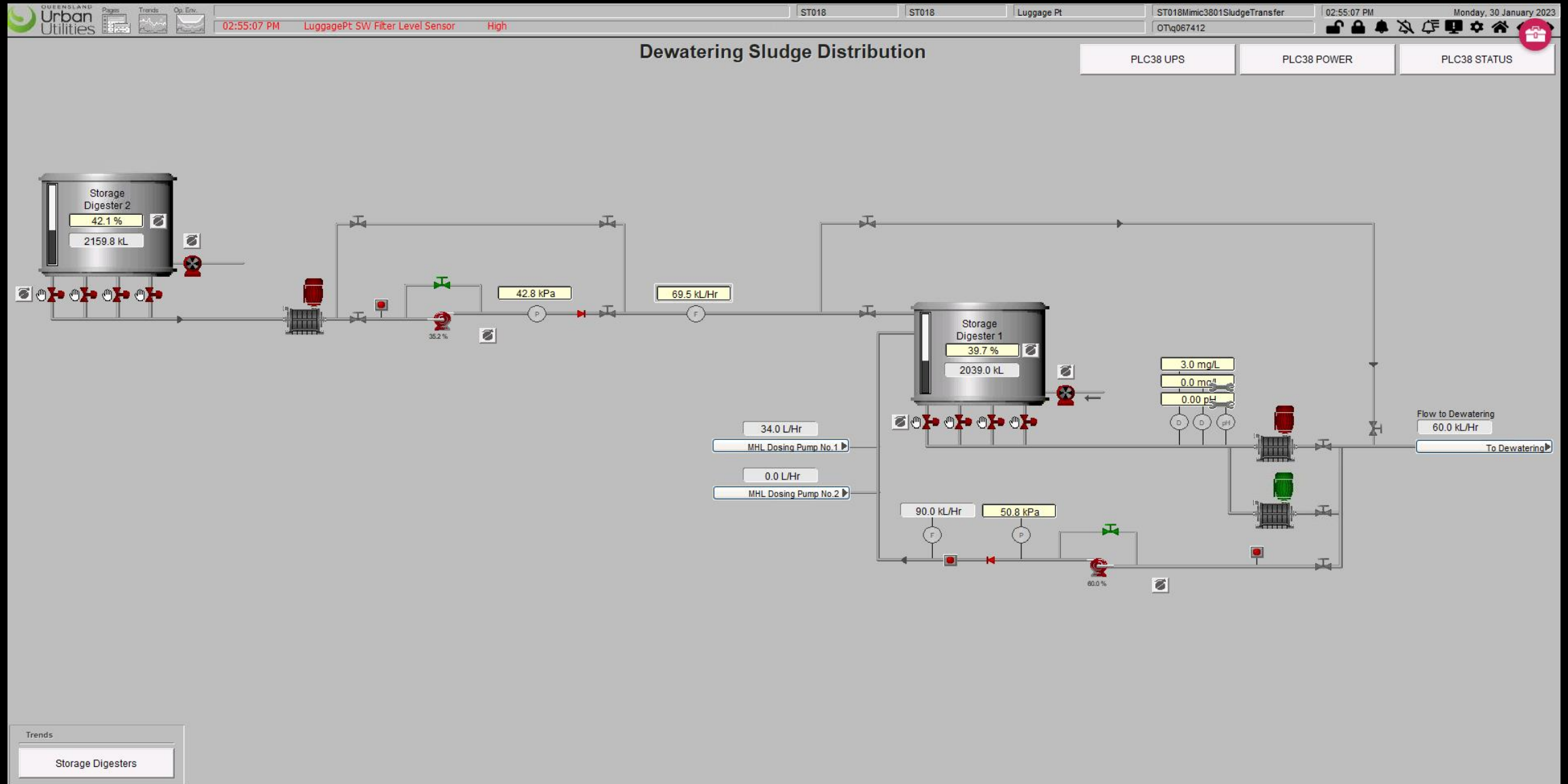
# MHL Storage & Dosing

- Simple bulk storage tanks & dosing pumps
- No recirculation or tank mixing
- MHL supply makes a difference:
  - Current supply is very low maintenance
  - No blockages
  - Effective P removal
- MHL dosed to sludge recirculation line on Storage Digester 2





# Digested Sludge MHL Dosing PFD





**→ Implementation Results**



# **NO** struvite related blockages or maintenance

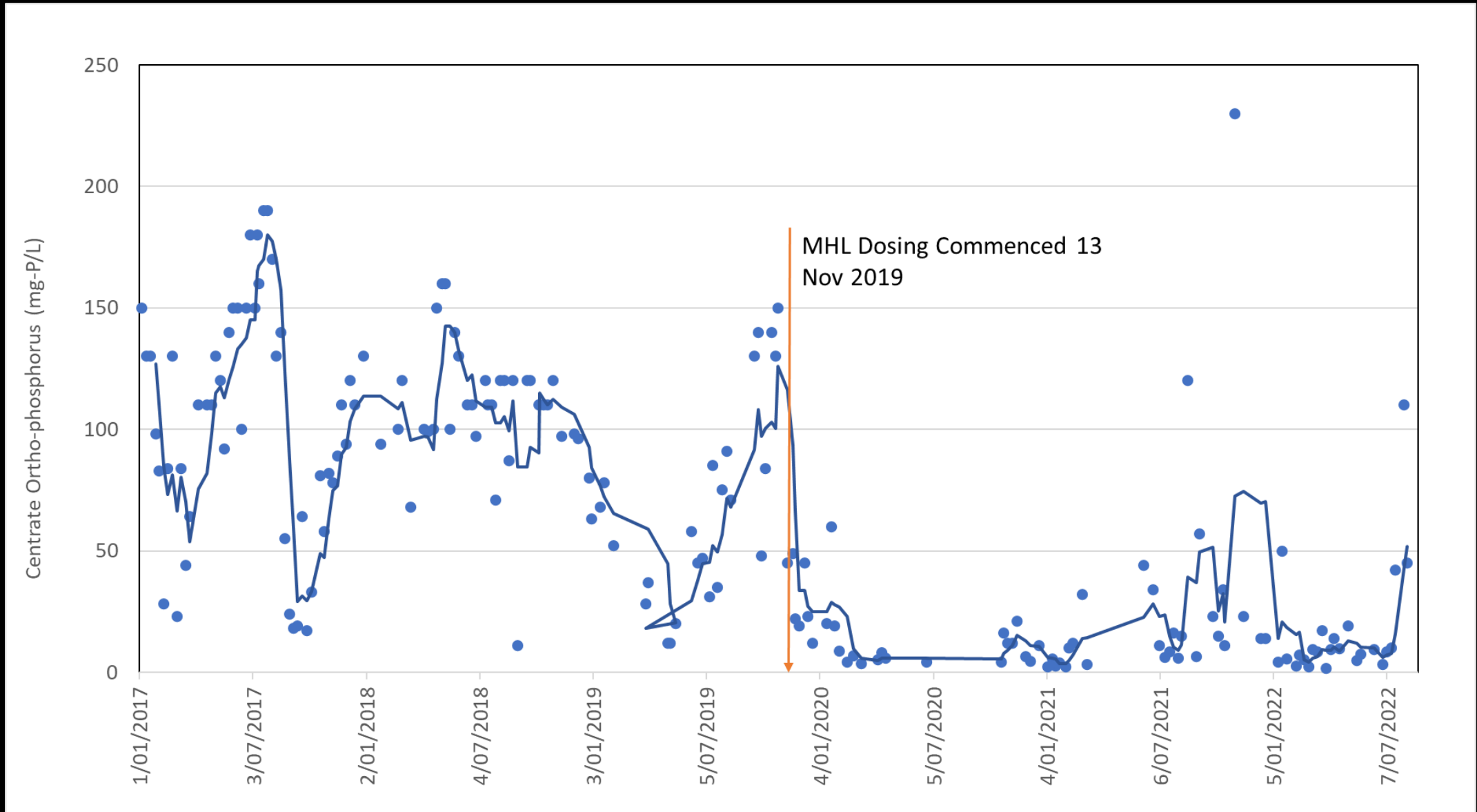
- pipelines or
- pumps

Other measures that contributed:

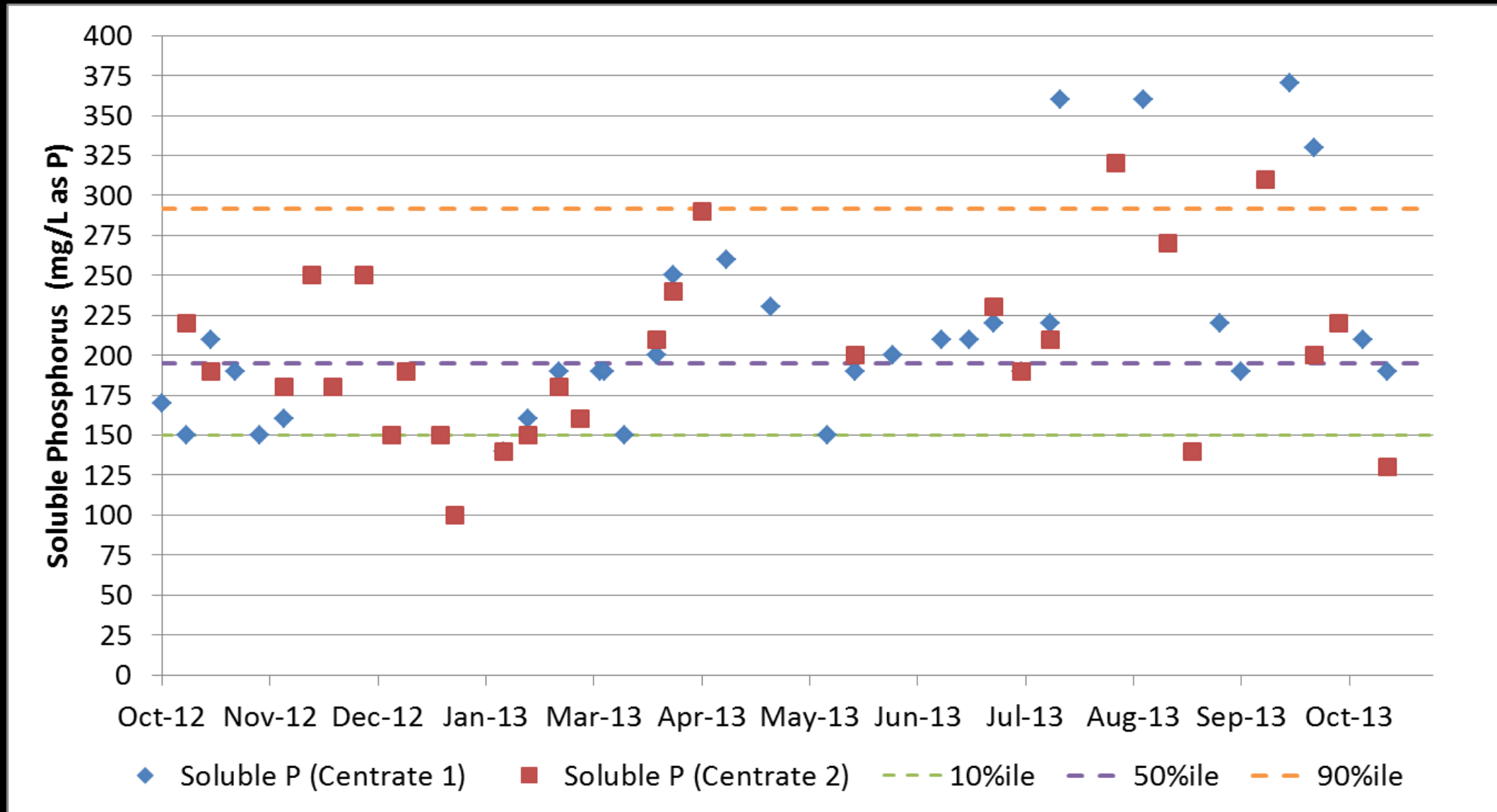
- Removal of sharp bends in pipework
- Removed long suction pipes for pumps
- Centrate pumps changed to PD type



# Centrate Soluble Phosphorus Reduction

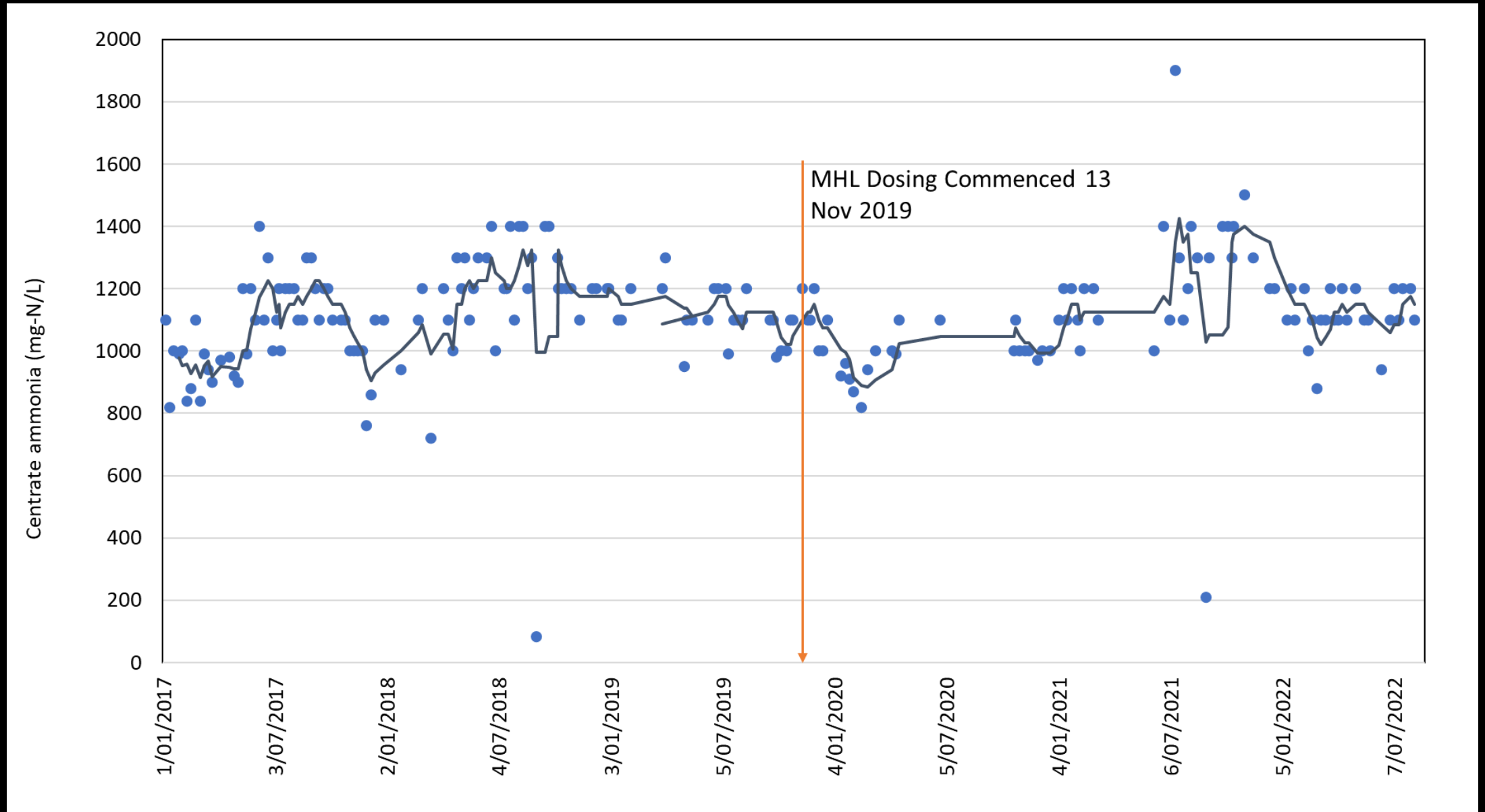


# Centrate Soluble Phosphorus Prior to MHL & Fe Dosing

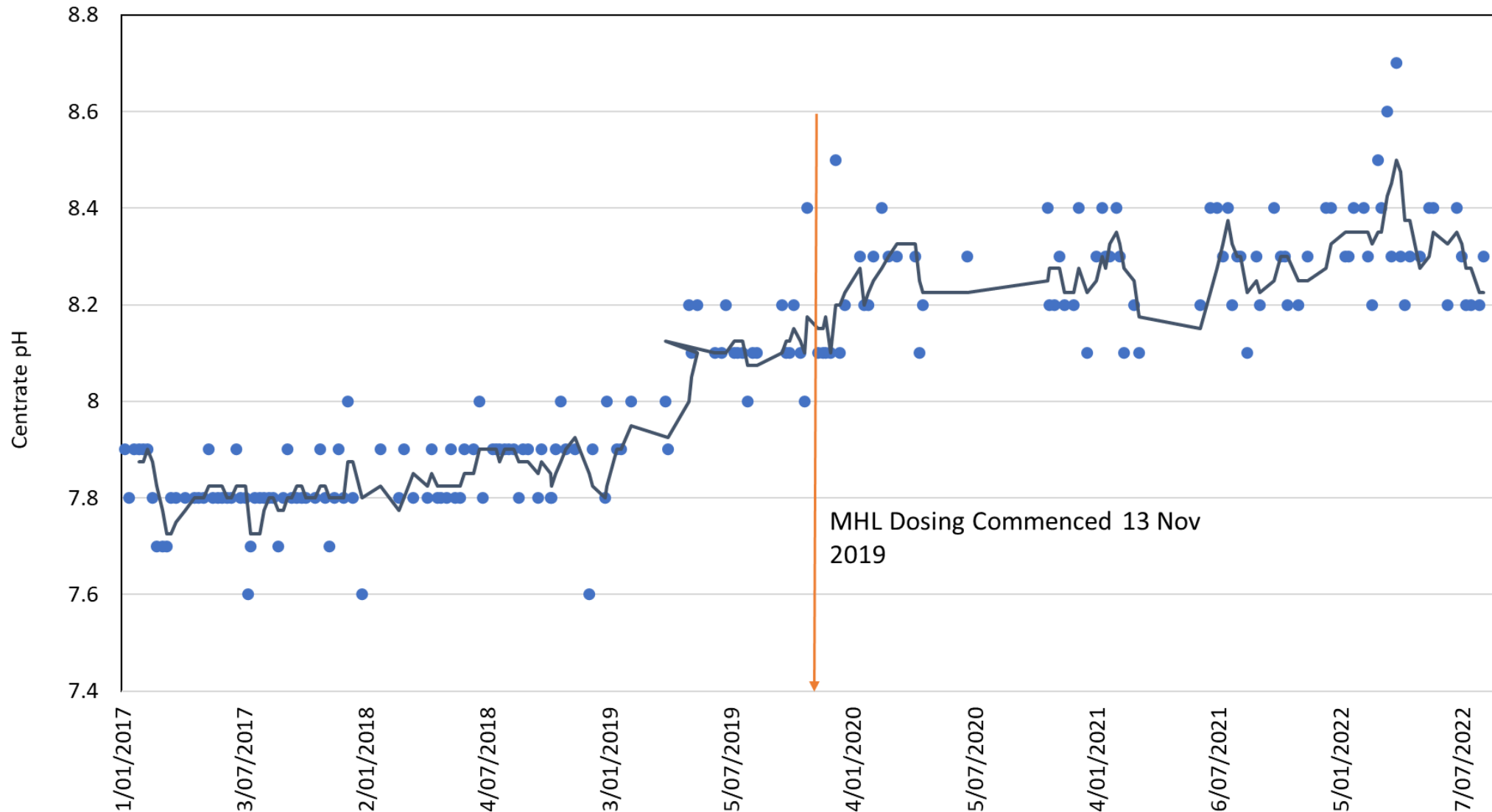




# Centrate Ammonia “Reduction”

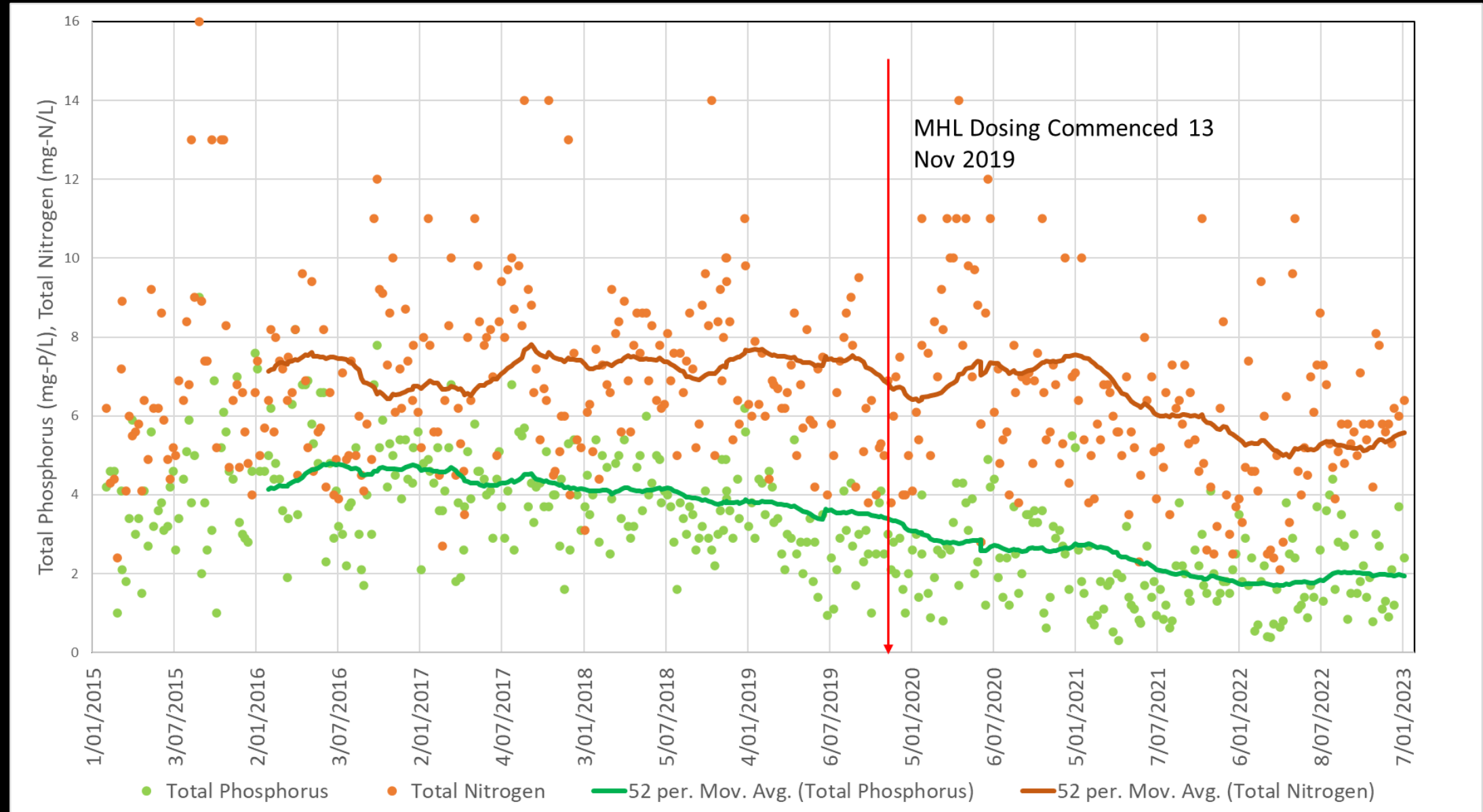


# Centrate pH Change





# Luggage Pt WWTP Effluent Total P & N



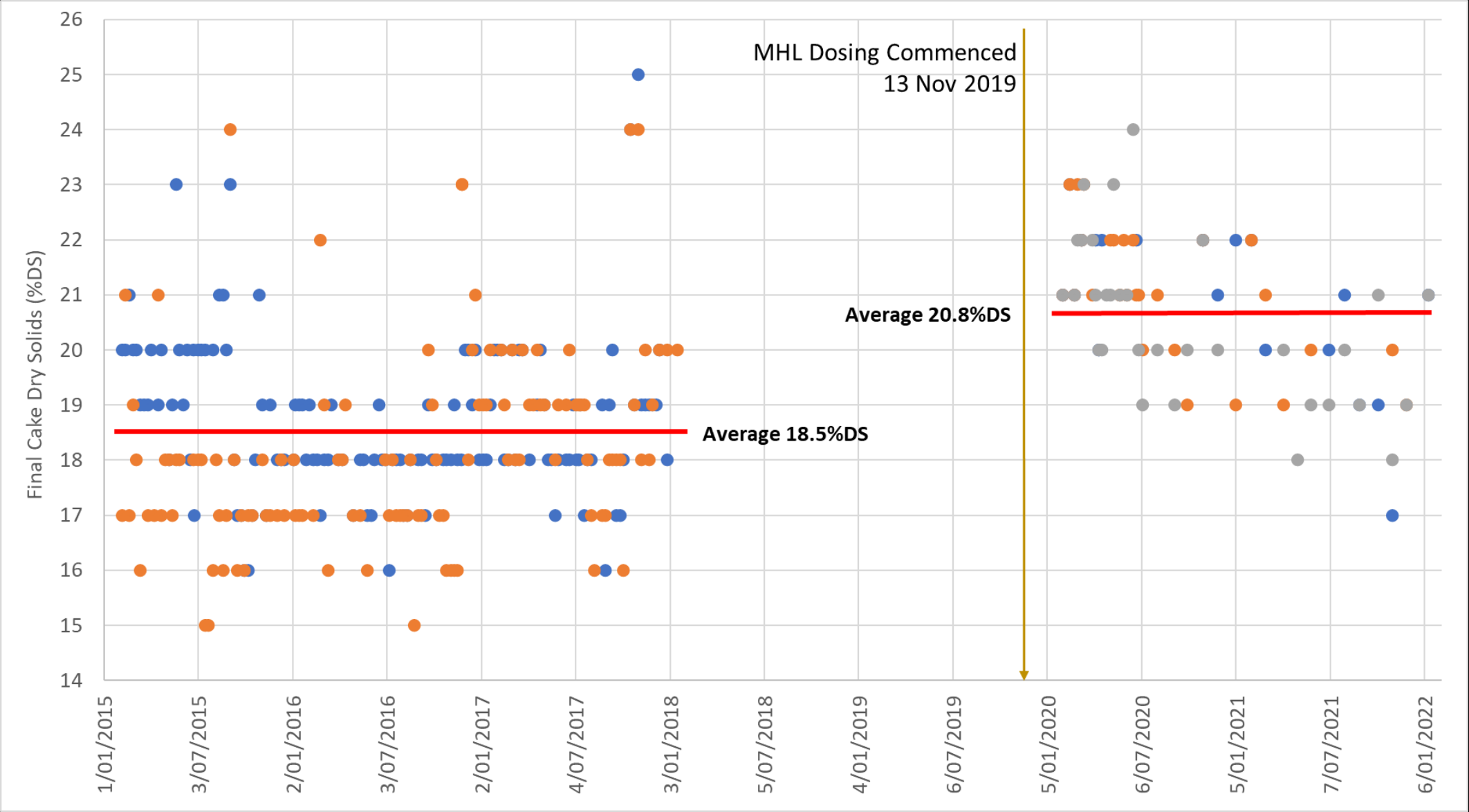
# Effluent Phosphorus Reduction

- Struvite/MHL removes about 170 - 250 kg-P/day
  - Equivalent to 1.3 – 2 mg-P/L in effluent
- Ferrous chloride dosing to primary digesters
  - Targeting H<sub>2</sub>S reduction in biogas for Cogen
  - Maximum impact would be 15% of P reduction
- Limited impact on centrate nitrogen return
  - Anammox centrate removal efficient / cost effective





# Luggage Pt WWTP Dewatered Cake Dry Solids





# Operational Parameters



- MHL dose rate = 34 L/h
- Molar dosage (Mg:P) = 1.6
- Airflow rate = 1000 m<sup>3</sup>/h/digester
- Digester HRT (each) = 30 hours





**\* Thank You**