Metropolitan Water Reclamation District of Greater Chicago

Welcome to the December Edition of the 2020 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.
- Certificates will only be issued to participants who attend the entire presentation.

Beth Vogt, P.E.

Technical Services Director

Fox River Water Reclamation District

Beth Vogt is the Technical Services Director at the Fox River Water Reclamation District in South Elgin, Illinois. Since 2011, she has been responsible for overseeing design and construction projects for the FRWRD's facilities. She is also responsible for overall management of the permitting, pretreatment, engineering, and laboratory staff. Other duties include long range project and budget planning, negotiation of agreements with agency partners, and procurement of equipment and services needed at FRWRD.

Previously Beth worked as a consultant at Greeley and Hansen for 17 years with her final position as the Chicago Office Civil Group Manager. As a consultant, Beth worked on design and construction office management of projects at water and wastewater facilities, including process modeling and analysis, design of preliminary treatment, aeration system improvements, thickening and dewatering systems, equalization basins, and various pumping station improvements. Beth received a bachelor of science in civil and environmental engineering from the University of Wisconsin-Madison and a master of science in civil and environmental engineering from Purdue University. She has been a registered professional engineer in Illinois since 1997.

MWRDGC Seminar Series

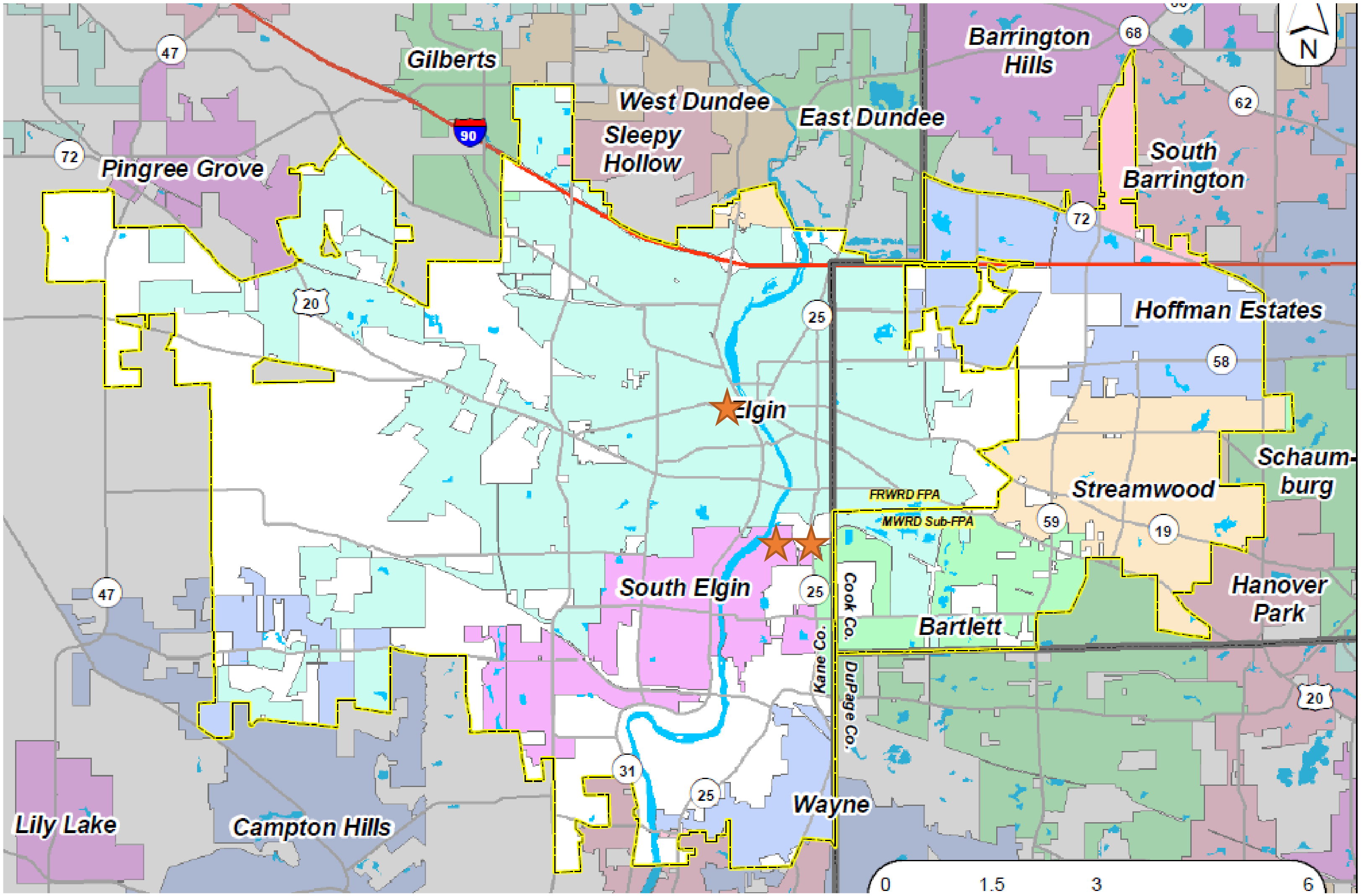
Fox River Water Reclamation District's Efforts on Reducing Phosphorus Discharge Loads

Presented December 11, 2020
Beth Vogt, Technical Services Director, FRWRD

Agenda

- FRWRD Overview
- Phosphorus Removal Project Drivers (FRSG)
- Phosphorus Removal Feasibility Study
- Design Considerations/Issues
- Final Improvements
- Status of Projects
- West Plant BNR Operations
- Questions

FRWRD Overview



FRWRD Overview

- Service: City of Elgin, Village of South Elgin, Poplar Creek Drainage Basin of MWRD, Village of West Dundee, Village of Bartlett and other service agreements
- 37.75 mgd total capacity at 3 plants
  - North WRF – 7.75 mgd
  - ADP WRF – 25 mgd (previously called South or Main)
  - West WRF – 5 mgd
- Approximately 200,000 people served – 81,000 from MWRD area
- All biosolids processing occurs at the ADP WRF
- 14 Pump Stations in the service area; some interceptors and sewers
- 1 CSO discharge point – City of Elgin owns all other CSOs, CSO flow tributary to the ADP WRF

FRWRD and MWRD Agreement

- FRWRD and MWRD entered into an agreement for FRWRD to treat the wastewater from Poplar Creek Drainage Basin in 1974
- IEPA would not allow MWRD to build a new wastewater plant for the area and brokered the arrangement
- MWRD currently owns 9.05 mgd of the 25 mgd capacity at the ADP WRF
- MWRD pays a portion of annual operating costs for the plant as well as contributing to major capital improvement projects
- Portion of contribution depends on whether it is liquid process (36%) or biosolids process (24%)

Project Drivers – FRSG and NPDES Permit Conditions

FRWRD

Fox River Study Group - History

- Formed in 2001
- Members: major WWTP dischargers, municipalities, Kane County, environmental groups, IEPA
- Extensive data collection over 15+ years - steady state model developed
- Negotiated special condition of discharge permits (June 2014)
    - Feasibility study @ 1.0 and 0.5 mg/L, 0.1 mg/L TP and TN = 8-10 mg/L
    - Annual average limit of 1.0 mg/L with implementation schedule
    - USEPA only agreed to 3 year permit term
- FRIP completed in 2015 – Not able to meet WQ standards in any scenarios – additional modeling recommended
- New 5 year permits issued in 2019
    - Additional condition added to meet 0.5 mg/L TP annual geometric mean by 2030
- New dynamic model scenario development underway

2015 FRIP Observations

Scenario	# Days Attaining WQS June - September	% Days Attaining WQS June - September
Baseline	90	74%
WWTP TP = 1.0 mg/L	93	76%
WWTP TP = 0.5 mg/L	96	79%
WWTP TP = 0.1 mg/L	102	84%

FRWRD

FRWRD Feasibility Study

developed by Black & Veatch

ADP WRF

- **Built in 1924 to serve the City of Elgin**
- **Last upgrade 1994 (Biosolids system)**
- **Currently 25.0 mgd, Limited available site area**
- **All biosolids treatment at this plant (high nutrient loading, poor influent characterization)**
- **CSOs tributary to the facility**
- **Provides reliable BOD and ammonia removal**

North WRF

- **Built in 1963 to divert flow from downtown Elgin**
- **Last upgrade 1993**
- **Currently 7.75 mgd Expandable 10.0 mgd**
- **Design peak flow of 22.04 mgd**
- **Much of the tankage is left over from earlier projects and is out of service**
- **Low influent soluble organics**
- **Provides reliable BOD and ammonia removal**

West WRF

- **Built in 1927 for Elgin Mental Health Hospital**
- **Major upgrade/replacement in 2003, BNR – 5 stage Bardenpho Process**
- **Currently 5.0 mgd Expandable to 25.0 mgd**
- **Provides reliable BOD, ammonia, phosphorus and total nitrogen removal**

Existing Plant Capacities

Facility	Current Rated Capacity	Current Capacity		
		Design Average Flow	Average Detention Time	Design BOD Loading Rate (lb/d/1000cf)
ADP WRF	25 mgd	25 mgd	5.2 hrs	43
North WRF	7.75 mgd			
Basins 4 through 12		7.75 mgd	6.7 hrs	42
Basins 8 through 12		6.2 mgd	6.7 hrs	52
West WRF	5.0 mgd	5.4 mgd	12 hrs (6.5 hrs aerobic)	23

- **Noted capacity based on ammonia removal in activated sludge process**
- **IEPA Design BOD loading rate for nitrification is 15 lb/day of BOD per 1,000 cu. ft.**
- **ADP and North WRFs do not have "excess aeration capacity" for Bio-P addition**

Summary of FRWRD Laboratory Data for Study

Most of the data that was used for the Biowin model was operating data that FRWRD routinely measures. These are:

- Temperature
- BOD
- Soluble BOD
- CBOD
- Total suspended solids
- Ammonia
- TKN
- Nitrate
- Total Nitrogen
- Total phosphorus
- Dissolved phosphorus
- COD
- Filtered Flocculated COD
- Readily biodegradable COD
- Alkalinity

This data was provided for 5 years for all three plants on the influent, primary effluent, and final effluent (not every parameter is done at each location). Some of these are done once per week at FRWRD and some are done twice per week.

Intensive sampling performed

Extra Testing for Biowin Model Calibration

- Phosphorus: 84 samples
- TKN: 21 samples
- Ammonia: 21 samples
- Total and volatile suspended solids: 148 samples

FRWRD laboratory performed Jar Testing for Evaluation of Chemical Phosphorus Removal

- pH: 78 samples
- Alkalinity: 26 samples
- Total suspended solids: 26 samples
- Phosphorus: 26 samples

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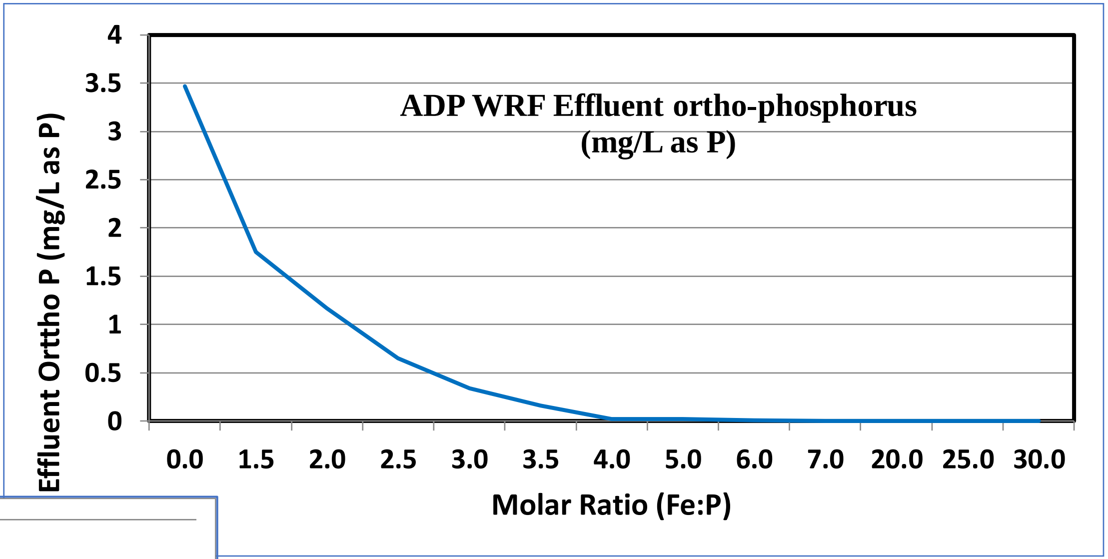
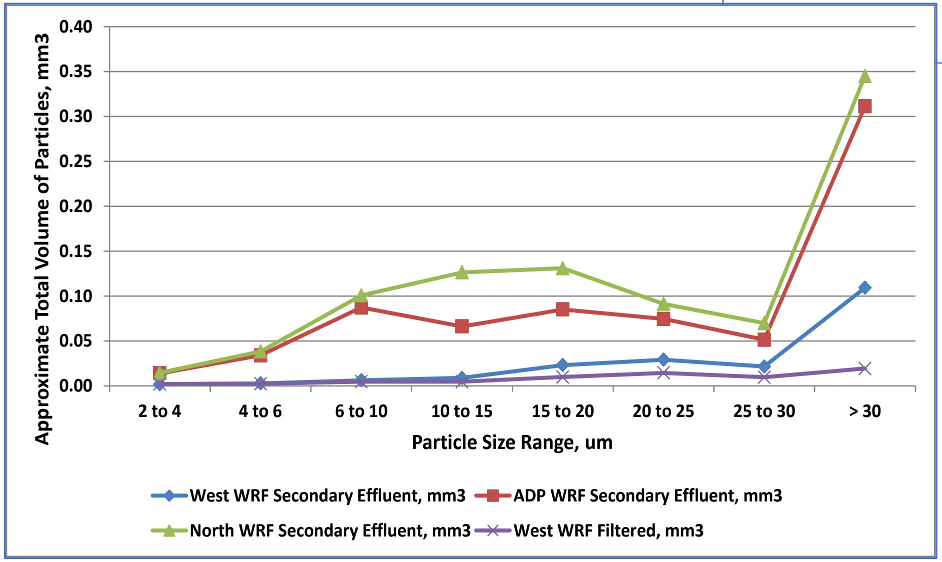
Special Testing by FRWRD

- Chemical phosphorus removal jar testing
- Disk filter bench testing





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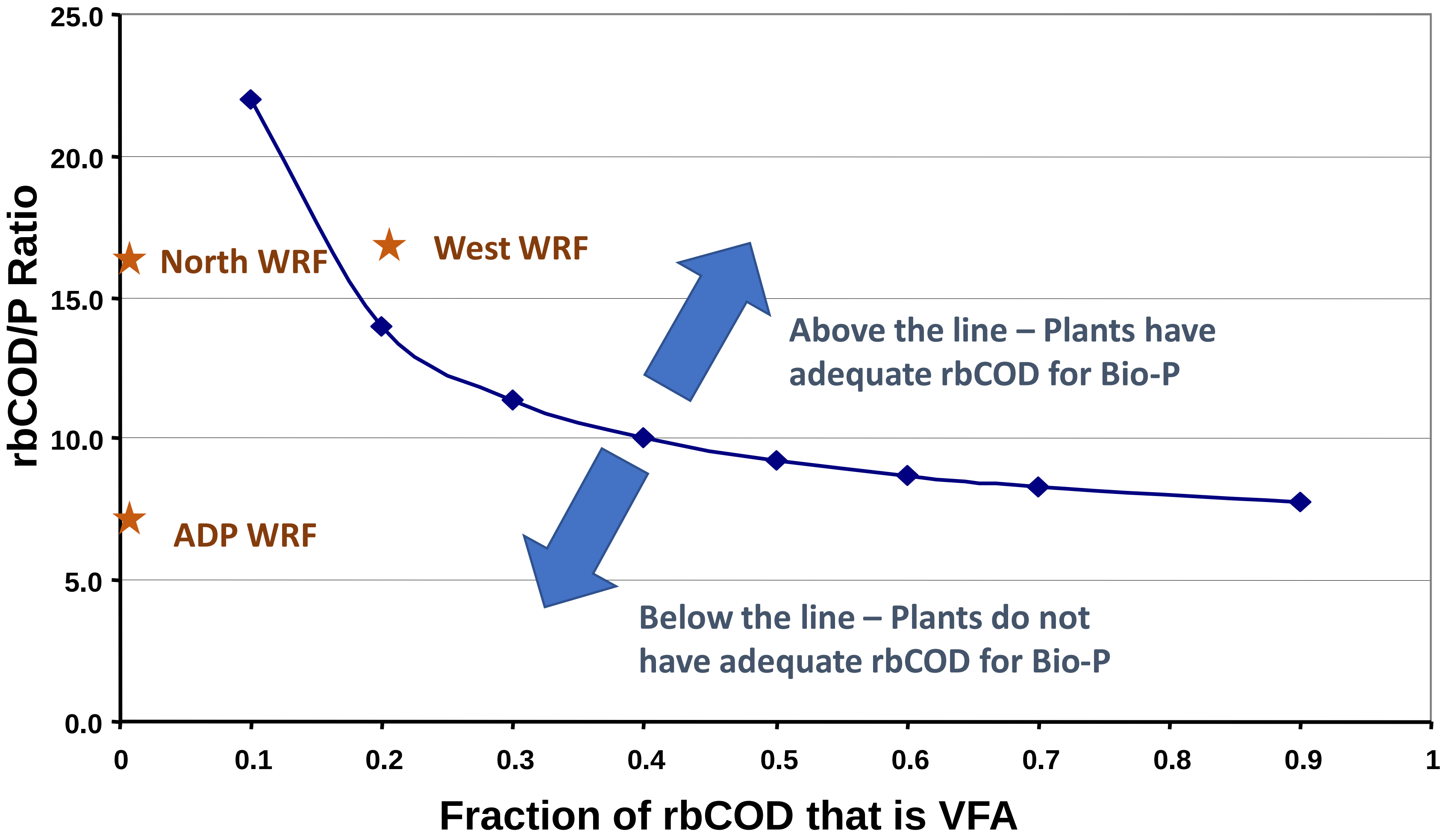
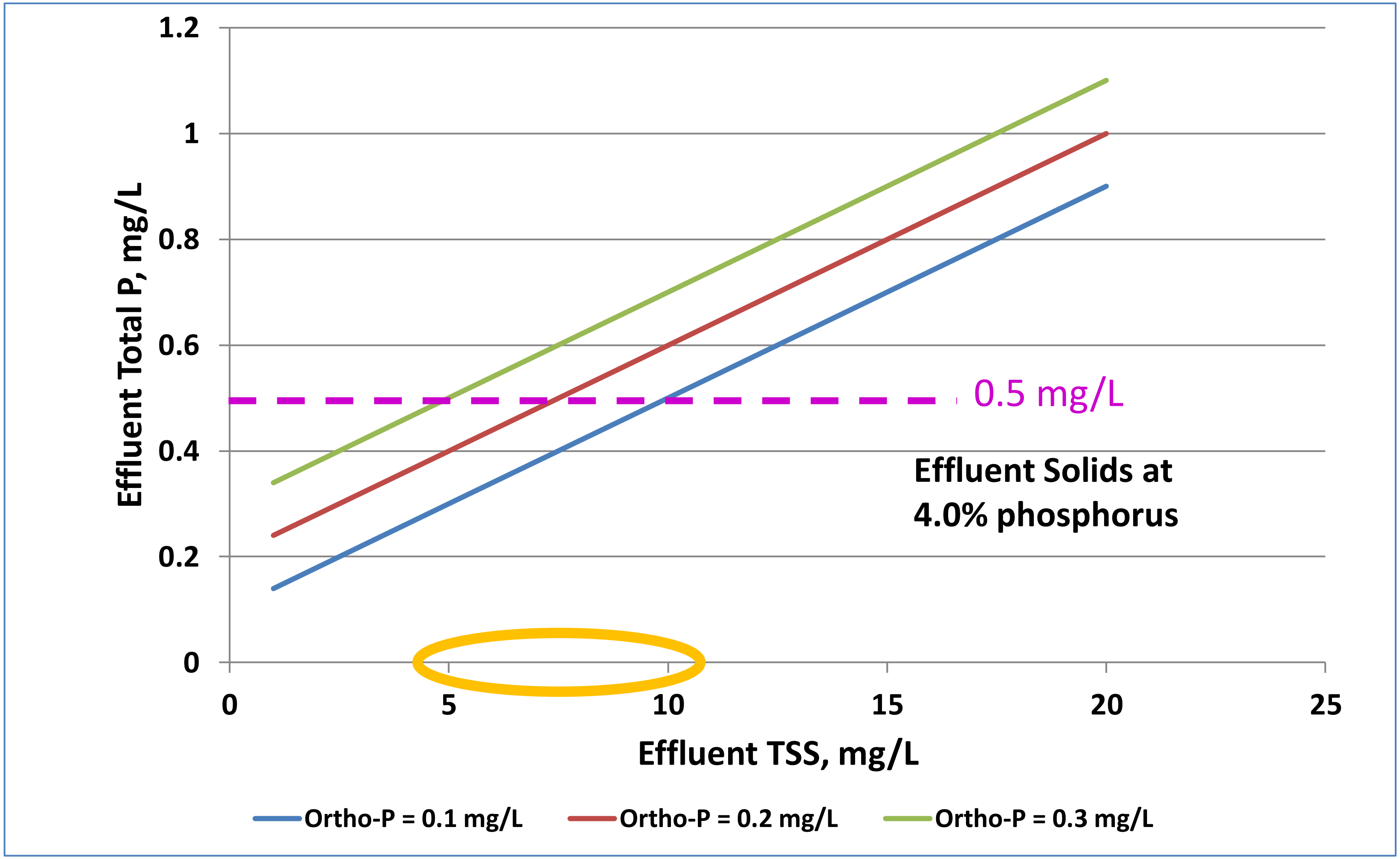
Estimate of VFA and rbCOD Requirements for Biological Phosphorus Removal



Graph from Black & Veatch
Data collected and sent out for lab analysis for VFAs

Can we achieve 0.5 mg/L using Secondary Clarifiers?



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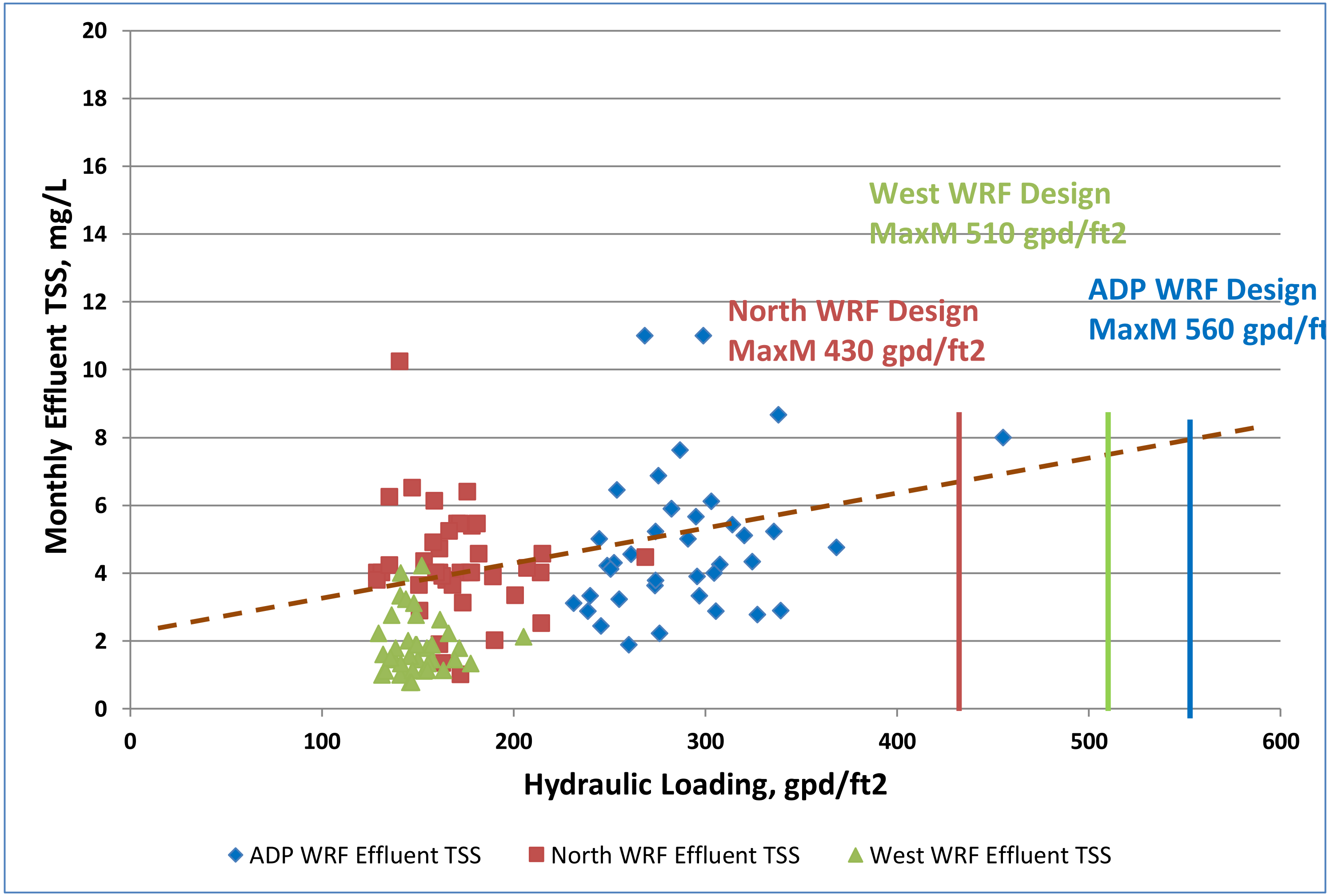

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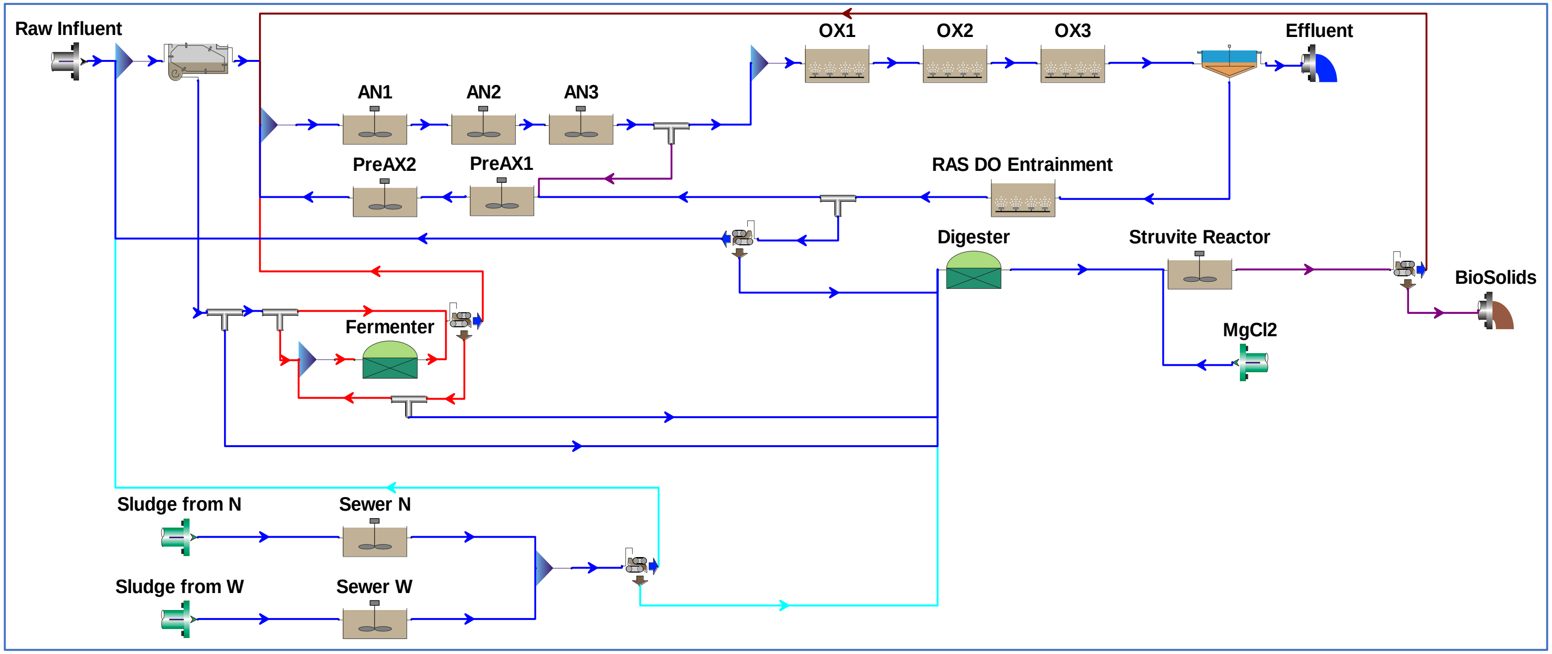
Process Modeling

- Calibration of computer model to current operations
- Use of model to evaluate alternatives



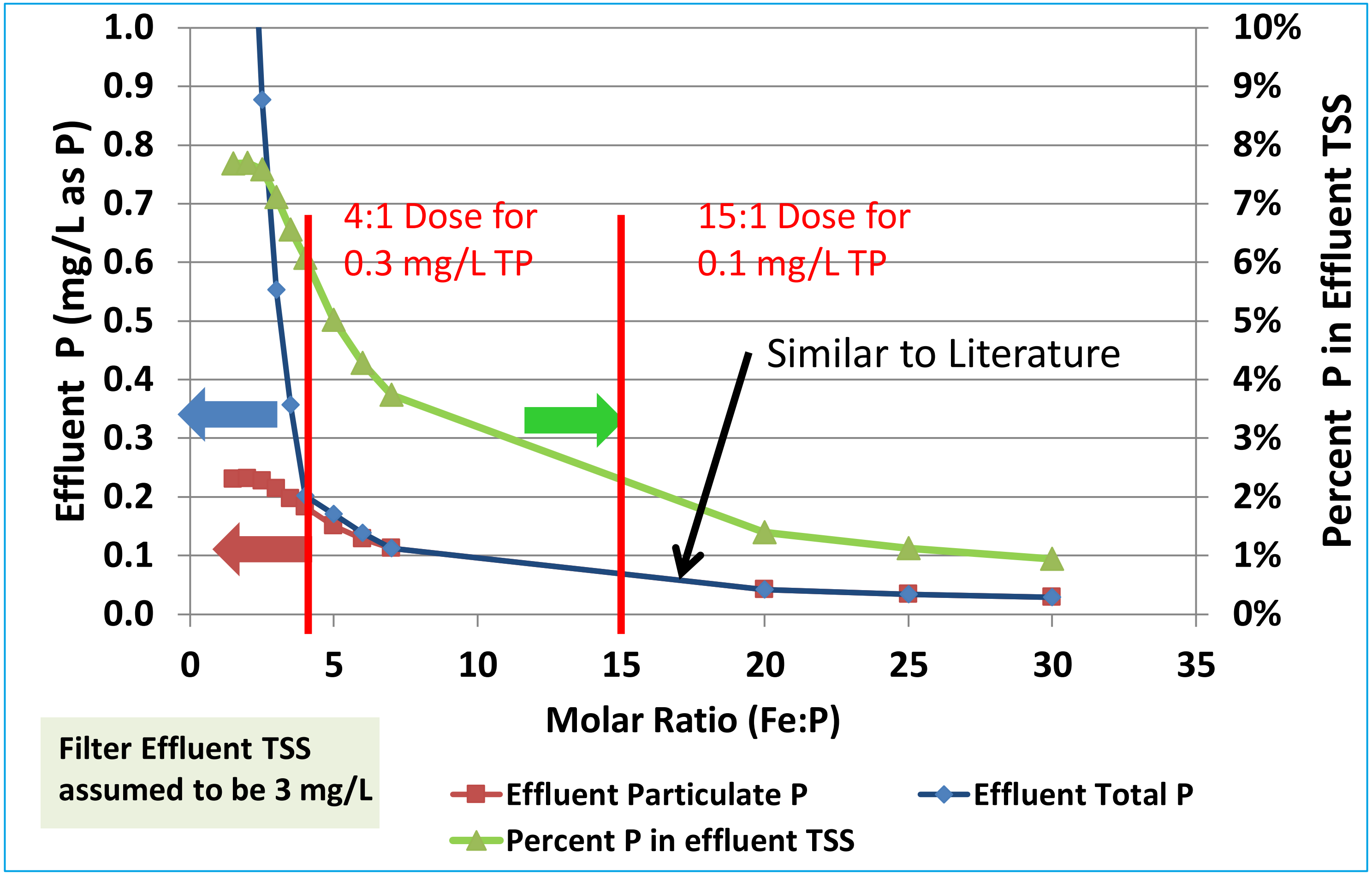
Additional Tankage Required for Biological Phosphorus and Nitrogen Removal

Facility	Current Detention Time at Capacity	Detention Time Required					
		Biological Phosphorus Removal			Full Biological Nutrient Removal (P and N)		
		Additional Hours Required	Total Hours Required	Capacity of Existing Tanks	Additional Hours Required	Total Hours Required	Capacity of Existing Tanks
Pagorski WRF	5.2 hrs	1.5 hrs	6.7 hrs	17.5 mgd	3.5 hrs	8.7 hrs	14.9 mgd
North WRF	6.7 hrs	1.5 hrs	8.2 hrs	6.3 mgd	3.5 hrs	10.2 hrs	5.1 mgd
West WRF	12 hrs	0 hrs	12 hrs	5.6 mgd	0 hrs	12 hrs	5.6 mgd

Note: Information shown is based on modeling of secondary process and displayed as detention time for simplicity

Requires expansion of tankage at ADP and North WRFs to provide phosphorus and nitrogen removal

Effluent TP Depends on Particulate Phosphorus – critical at low eff TP



Short listed alternatives for detailed evaluation

- Phosphorus to 1.0 mg/L
  - Alternative A1: Chem-P at ADP and North WRF, Bio-P at West WRF.
  - Alternative A2: Chem-P at ADP, Bio-P at North and West WRF.
  - Alternative A3: Bio-P at all three WRFs.
- Phosphorus to 0.5 mg/L and 0.3 mg/L
  - Alternative B2 and C2: Disk Filters at all three WRFs
  - Alternative B3 and C3: Depth Filters at all three WRFs
- Phosphorus to 0.1 mg/L
  - Alternative D3: Depth Filters at all three WRFs
  - Alternative D4: Microfilters at all three WRFs
- Nitrogen removal to 8 to 10 mg/L :
  - Alternative N1: West WRF – existing BNR, North WRF - pre-anoxic zone, ADP WRF – Divert PS 31 and Expand to Elgin Box
  - Alternative N3: West WRF – existing BNR, North WRF - pre-anoxic zone, ADP WRF – Retrofit with IFAS with Anoxic Zone

Feasibility Study Costs to Achieve 1.0 mg/L

Alternatives to Achieve 1.0 mg/L TP	Capital Costs	$/mgd	Annual Costs	$/lbP	Net Present Worth
Alt A1 Chem-P at ADP and North WRF, Bio-P at West WRF	$17.5M	$0.46	$3.30 M	$5.26	$53.3 M
Alt A2 Chem-P at ADP, Bio-P at North and West WRF	$24.8M	$0.66	$2.94 M	$4.69	$55.6 M
Alt A3 Bio-P at all three WRFs. Expand on ADP WRF site	$36.5M	$0.97	$0.24 M	$0.39	$35.2 M

Biological P Removal selected for all plants.

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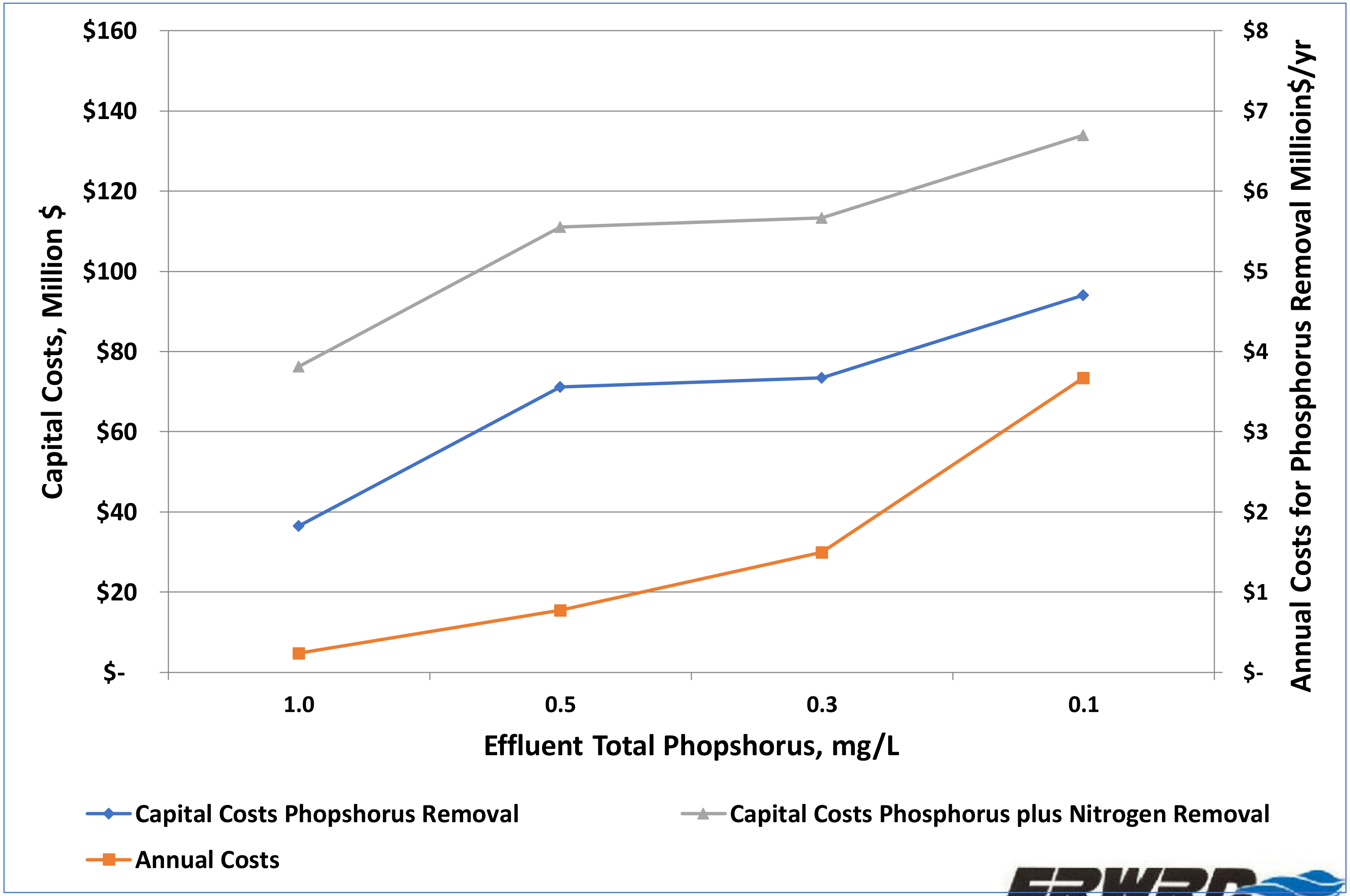
Costs for Phosphorus and Nitrogen Removal



Design Considerations/Issues

Struvite Sequestration Evaluations

Sidestream Struvite Reactor

- Prevent Phosphorus from Returning to Main Treatment Processes
  - Reduce effluent total phosphorus
  - Mitigate impacts to dewatering
  - Reduces struvite scaling of piping
- Evaluate Selected Technologies for Removing Phosphorus in Digested Sludge
  - Technology developed and proven to address impacts to dewatering
  - Simple operation

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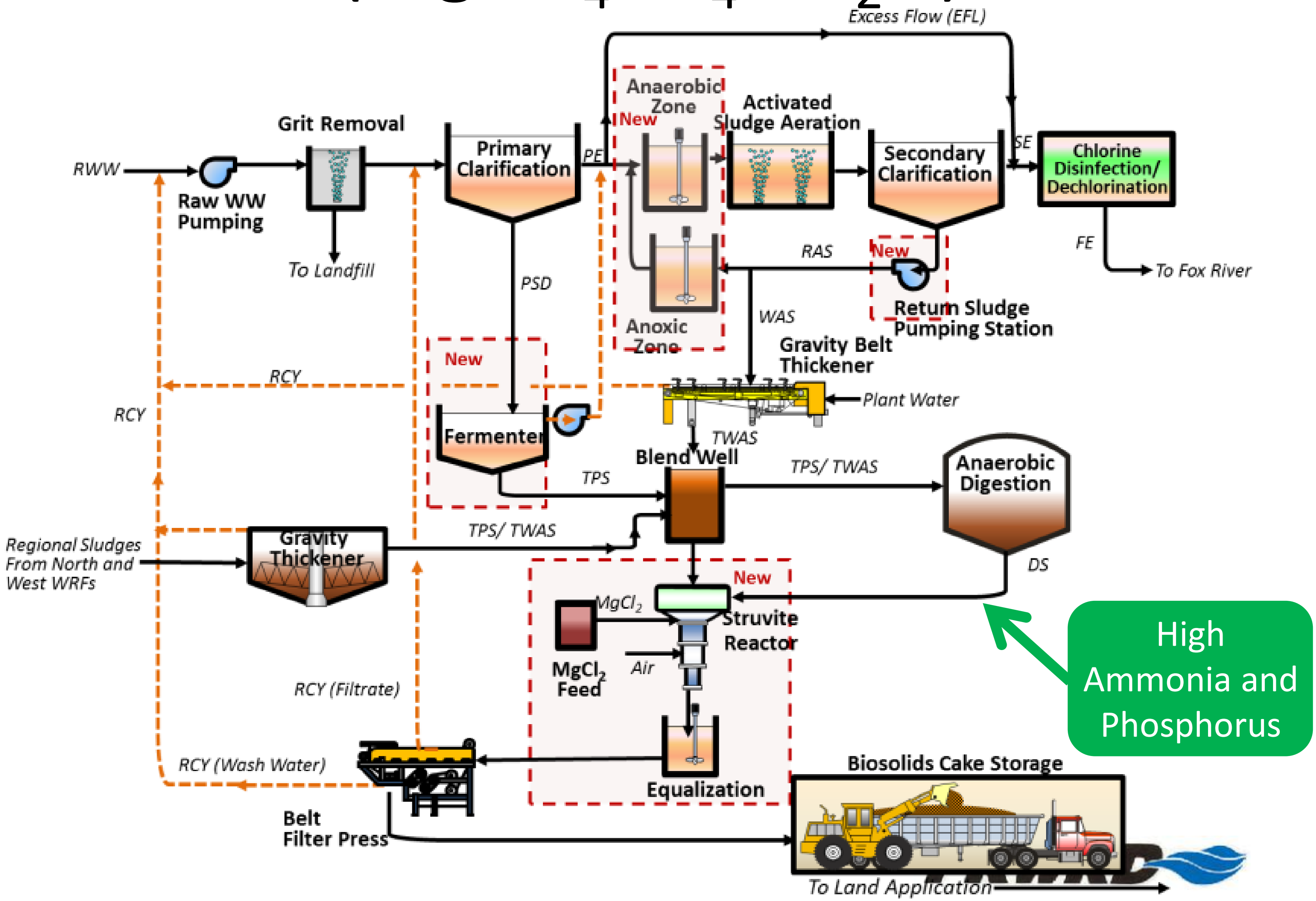
Removing Side Stream Phosphorus as Struvite ($MgNH_4PO_4 \cdot 6H_2O$)



High Ammonia and Phosphorus

Technologies Evaluated

- AirPrex™ (CNP)
- NuReSys™ (Schwing Bioset)
- Multiform Harvest™ (MHI)
- Pearl Process™ (Ostara)

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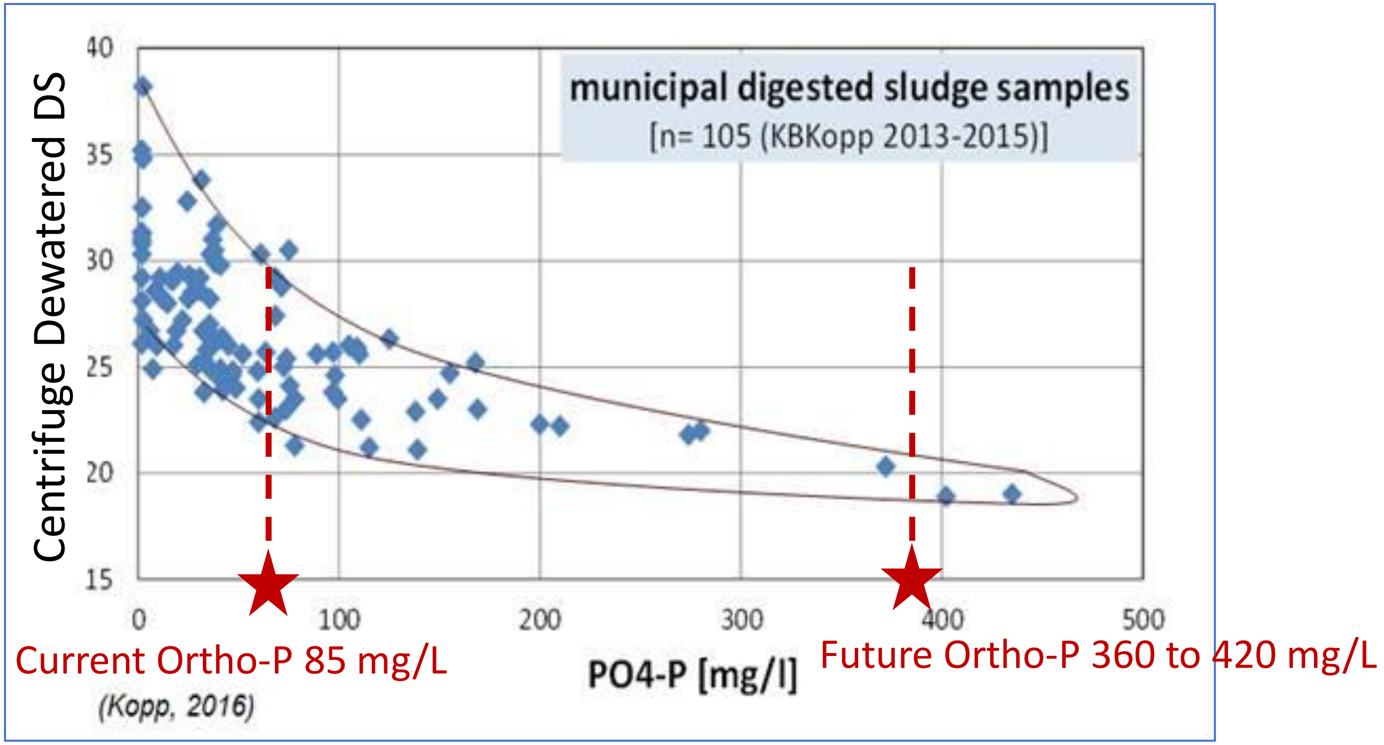
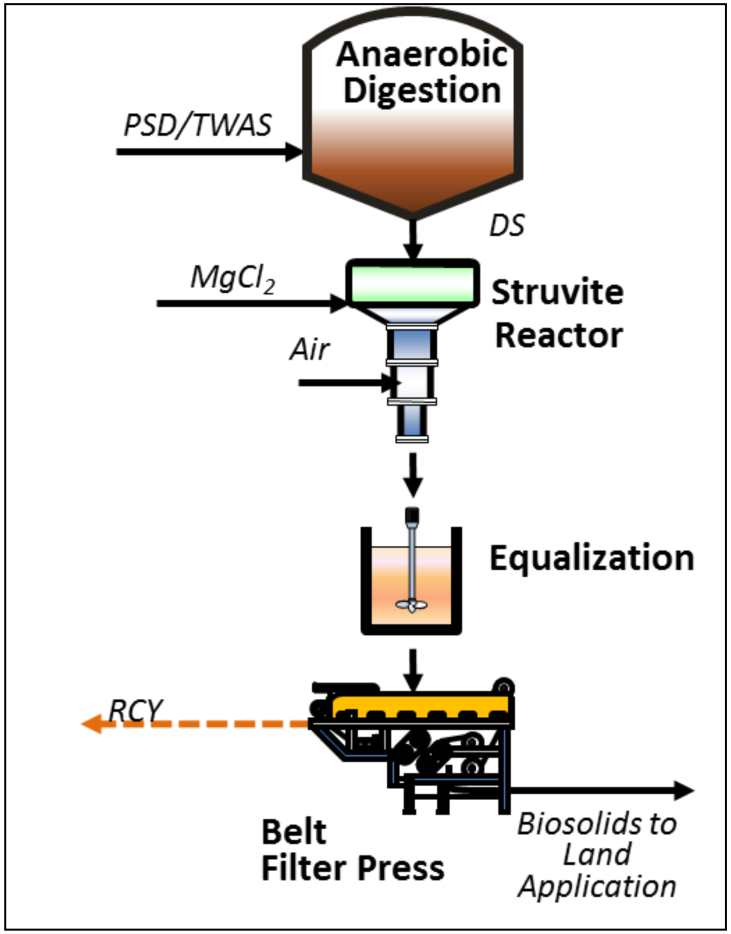
Improve Dewatering

- Reduced phosphate improves dewatering and reduces effluent total phosphorus

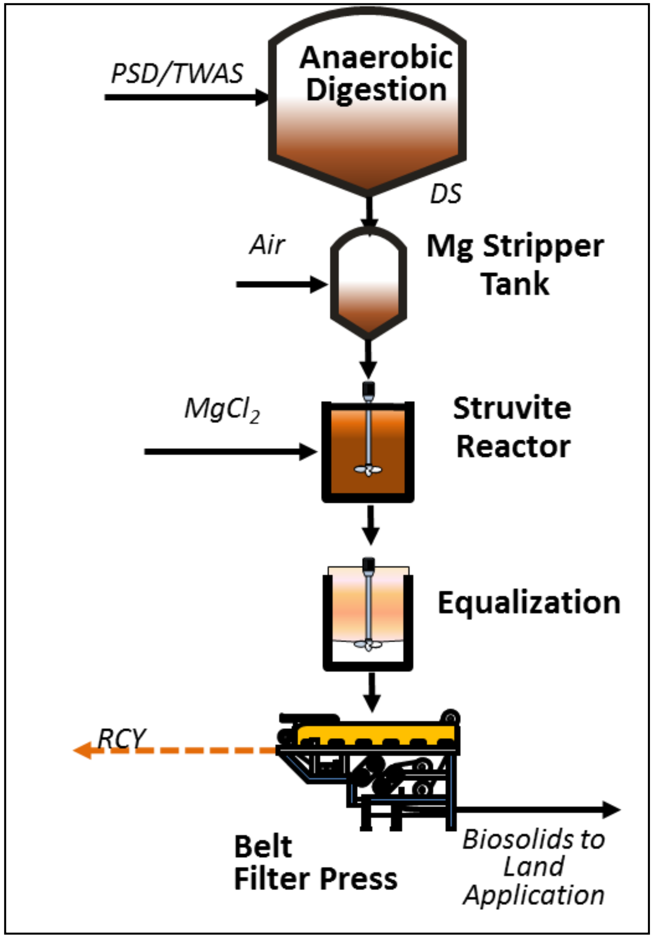


Process Flow Diagrams

AirPrex ™



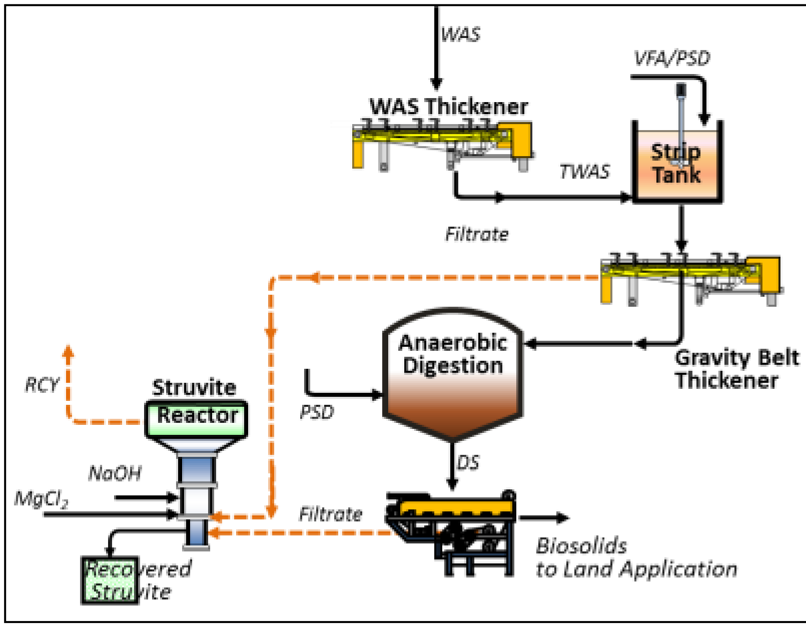
NuReSys ™



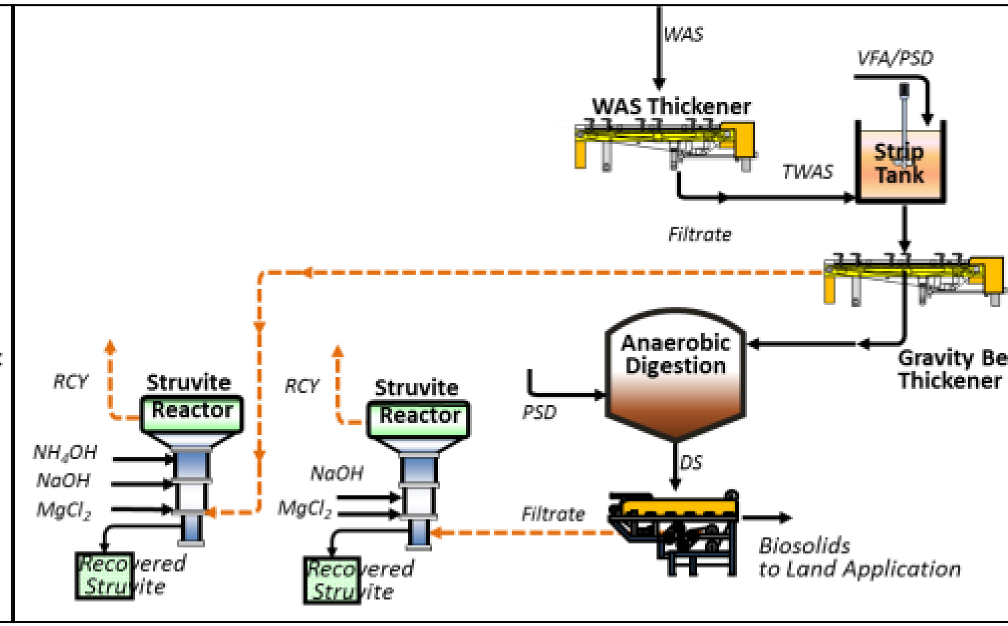
AirPrex and NuReSys can be configured after dewatering, similar to Ostara and Multiform Harvest (next slide)

Process Flow Diagrams

Ostara ™



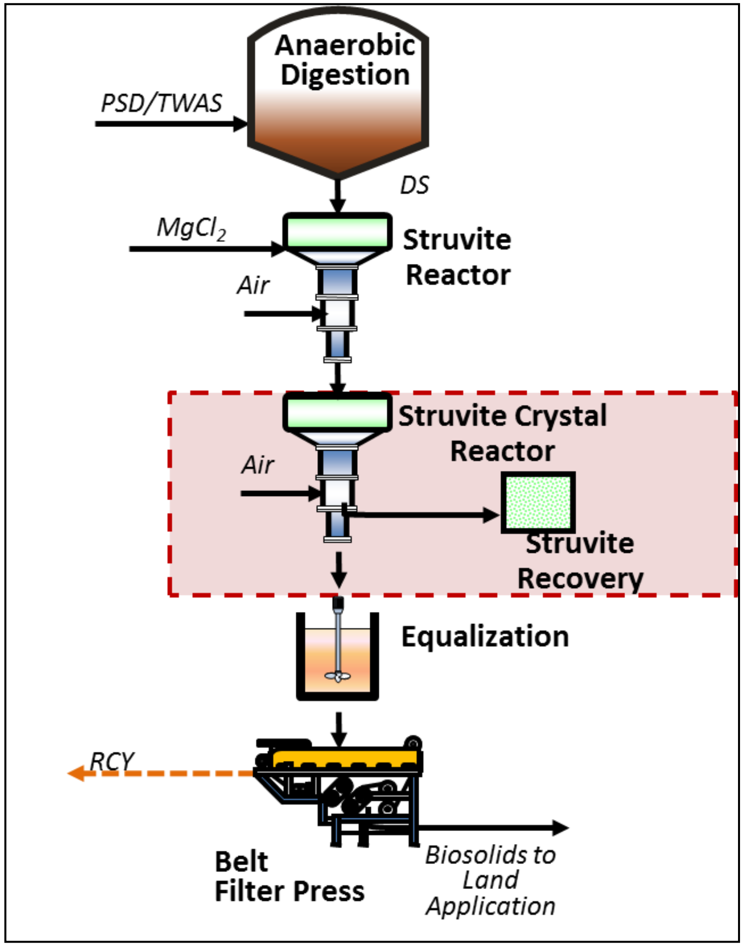
Multiform Harvest ™



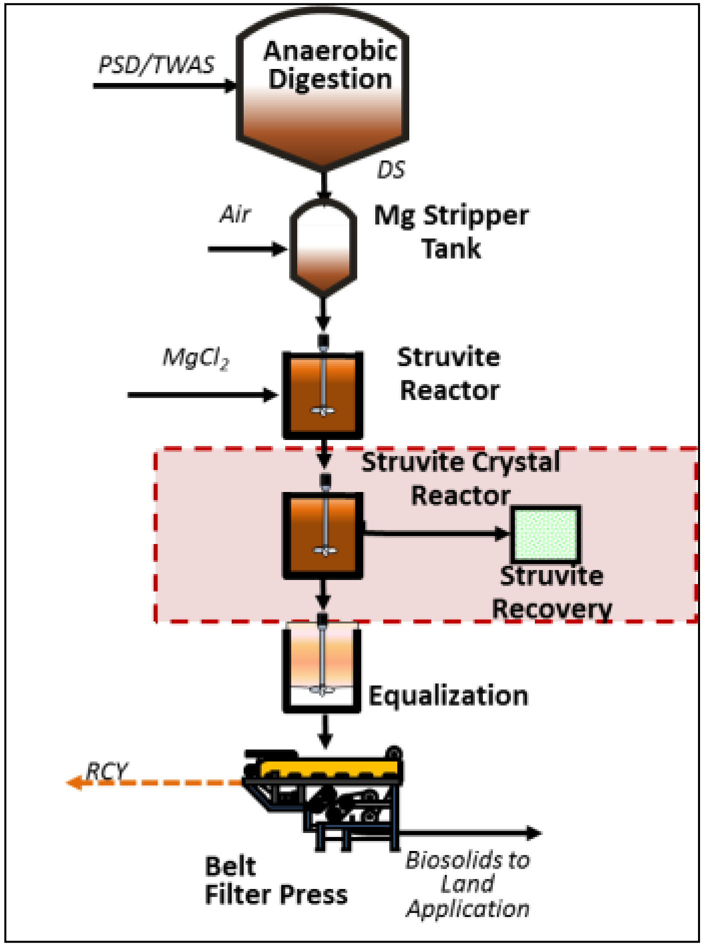
Ostara and Multiform Harvest can be configured without WAS Strip Tank, but will not control struvite scaling

AirPrex and NuReSys with Phosphorus Recovery

AirPrex TM



NuReSys TM



Additional Reactor Volume and Recovery Unit Required for Recovery of Struvite

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Cost Comparison –Preliminary Design

DESCRIPTION	MULTIFORM HARVEST™	OSTARA PEARL™	CNP AIRPREX™	SCHWING NURESYS™
Capital Cost				
Equipment Cost	$1,570,000	$4,650,000	$1,290,000	$992,000
Drum Thickener	$225,000	$225,000	$0	$0
Mixers	$50,000	$50,000	$0	$0
Equipment Installation	$554,000	$1,480,000	$383,000	$282,000
Feed Pumps/Mixing Pumps/ Ferric Feed/Odor Control	$98,000	$98,000	$330,000	$330,000
P-Recovery Building	$1,179,000	$2,773,000	$1,040,000	$1,387,000
P-Release Tanks	$270,000	$270,000	-	-
Equalization Basin	-	-	$875,000	$875,000
Subtotal Total Equipment/ Structural	**$2,920,000**	**$7,270,000**	**$2,280,000**	**$1,920,000**
Elect./I&C/Piping/Site/Contingency/ Engineering				
Total Capital Costs	$11,000,000	$26,612,000	$10,900,000	$10,800,000
O&M Cost				
Magnesium Chloride[1]	$175,000	$175,000	$175,000	$175,000
Sodium Hydroxide[2]	$32,000	$32,000	-	-
Ammonia Hydroxide	$28,000			
Biosolids Disposal Cost Savings	($44,000)	($44,000)	($42,000)	($42,000)
Revenue Generated (fertilizer) [1]	$0 to ($180,000)	($270,000)	-	-
Net Annual O&M Costs [1]	**$11,000 to $191,000**	**($107,000)**	**$133,000**	**$133,000**
Total Present Worth Costs [1]	**$11,100,000 to $13,300,000**	**$25,300,000**	**$12,500,000**	**$12,400,000**

Note:

1. Multiform Harvest estimates revenue at $200 per dry ton, though does not guarantee. Uncertainty in administrative expense associated with marketing product.

Advantages and Disadvantages

Technology	Advantages	Disadvantages
AirPrex ™	• Simple operation, no need for separate WAS Stripping Tank and multiple thickening operation • Able to control struvite scaling, reduce effluent TP and mitigate dewatering issues	• Relatively low phosphorus recovery, if desired (~50%) • Requires equalization prior to dewatering to accommodate dewatering schedule
NuReSys ™	• Simple operation, no need for separate WAS Stripping Tank and multiple thickening operation • Able to control struvite scaling, reduce effluent TP and mitigate dewatering issues	• Relatively low phosphorus recovery, if desired (~50%) • Requires equalization prior to dewatering to accommodate dewatering schedule
Ostara ™	• High phosphorus recovery (85%) • Lowers struvite scaling issues • Product offtake revenue guaranteed	• More complex operation, requiring additional WAS Strip process and multiple WAS thickening operations • High capital costs • Does not improve dewatered solids concentration
Multiform Harvest ™	• High phosphorus recovery (85%) • Lowers struvite scaling issues	• More complex operation, requiring additional WAS Strip process and multiple WAS thickening operations • Does not improve dewatered solids concentration

FRWRD

Detailed Design Issues and Changes

Major Issues Addressed in Detailed Design

- Fitting facilities into the hydraulic gradeline at ADP WRF
  - Extensive hydraulic evaluations including several hydraulic tests onsite to confirm calculations
  - Determined Modified West Bank Process without Johannesburg Option to be implemented (only a portion of PE will go through mixing basins)
- Addressing major increases in project estimated costs
  - Modified West Bank process at both North and ADP
  - Eliminated replacement of ADP RAS PS, building smaller RAS PS just to feed mixing basins
  - Eliminated one fermenter at North

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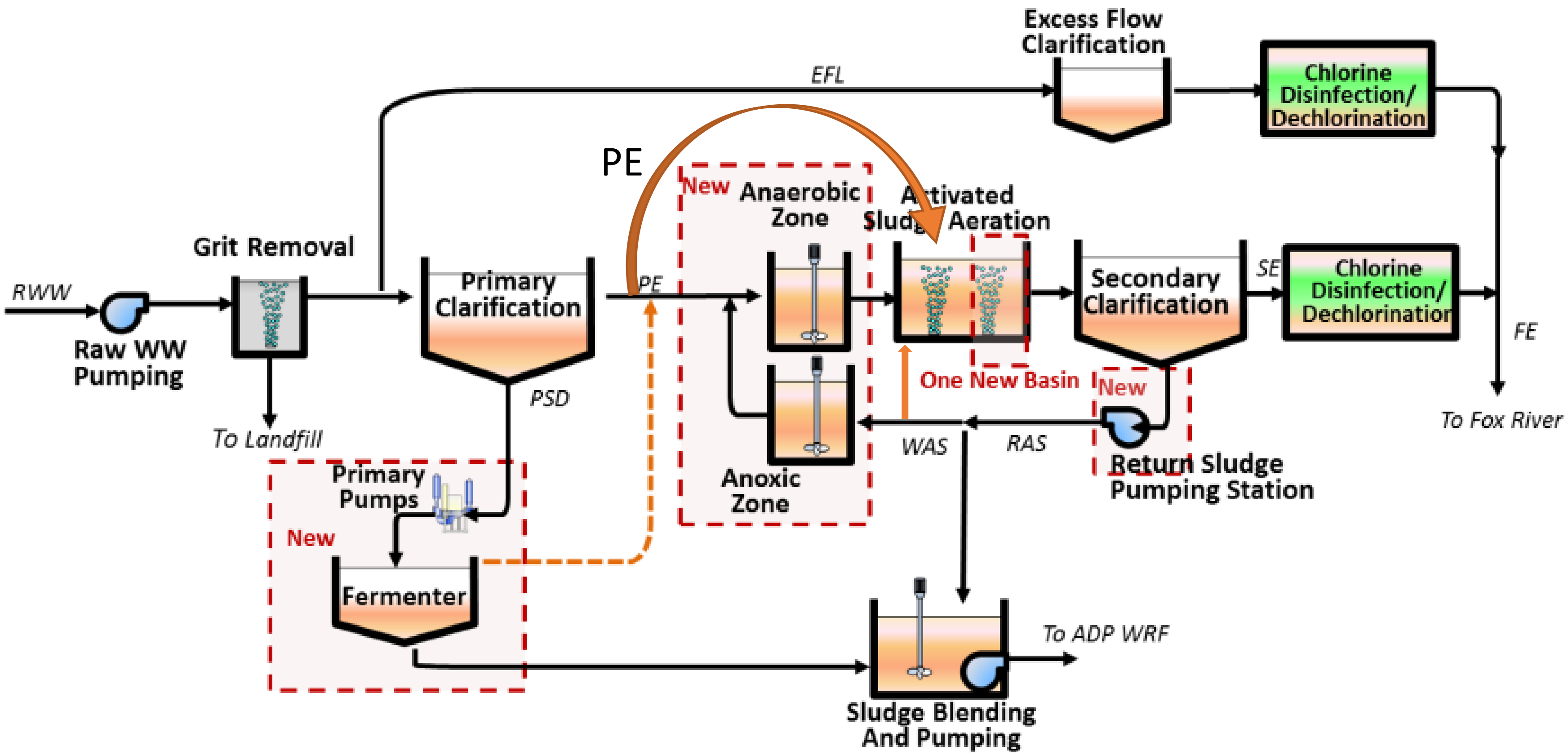
Final Designed Facilities

Major Upgrades to North WRF

- Biological Phosphorus Removal
  - Mixing Basins to select for Bio-P bacteria
  - Fermenter to supplement carbon to mixing basins
  - New primary sludge pumps to control feed to fermenter
- Replace Aged Activated Sludge Basins and Aeration Upgrades
  - Construct new aeration basin
  - Upgrade aeration system to integrate new aeration basin and control DO
- Hydraulic Improvements
  - Modify primary clarifier piping to address poor flow split
  - New clarifier piping/splitter box to address poor flow split
- Replace Return Sludge Pumping Station
  - Address issues with existing pumps
  - Provide return sludge control to improve Bio-P

Process Flow Diagram – North WRF



North Phosphorus

Cost Opinion

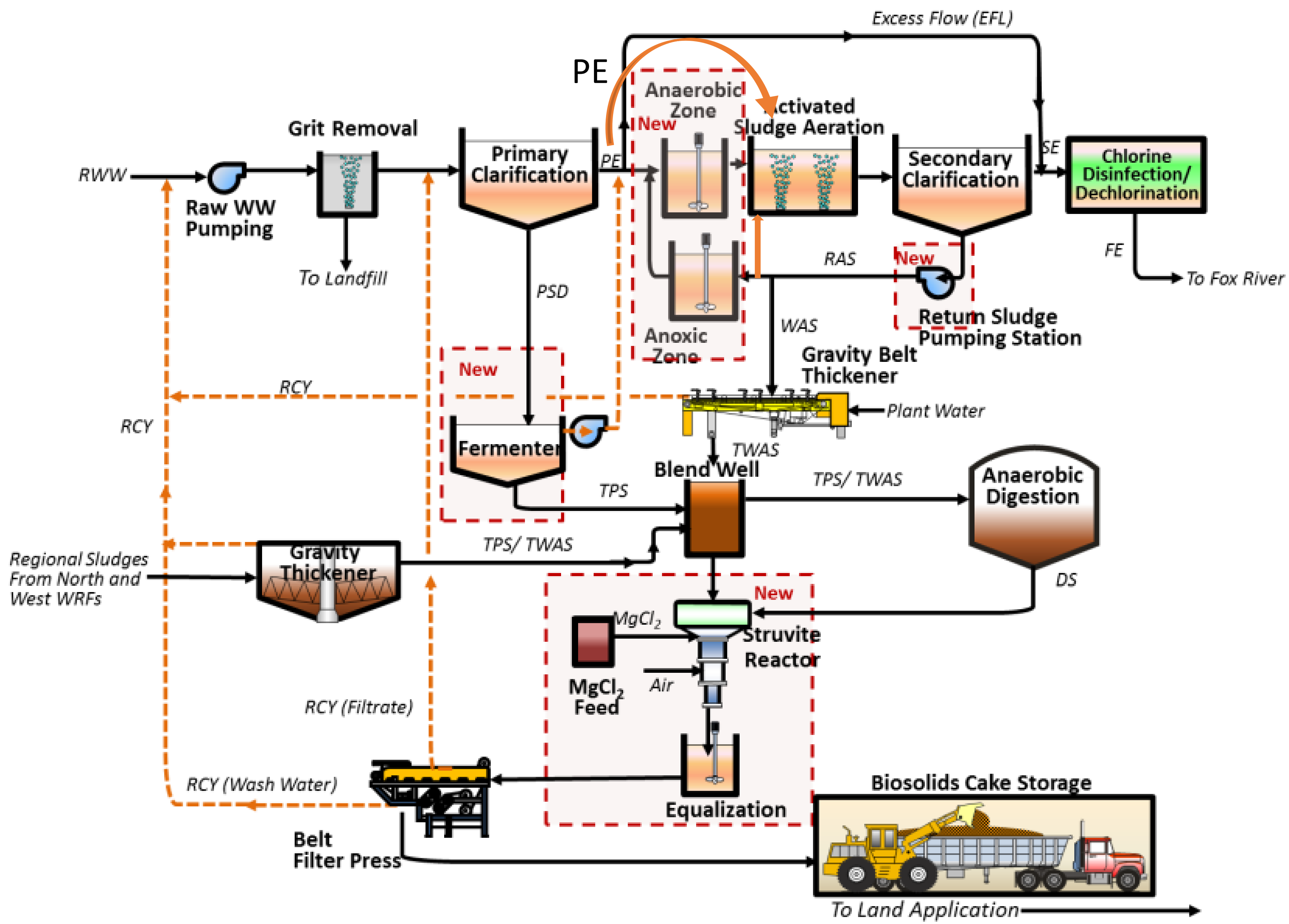
ITEM	ESTIMATED PROJECT COST ANNUAL P LIMIT
Structures	
00 - Sitework	$2,168,000
06 – Return Sludge Pump Station	$2,755,000
08 – Aeration Basin	$2,588,000
10 – Sludge Holding Tank Mixing Pump Station	$644,000
15 – Grit Tank & Primary Sludge Pump Station	$916,000
23 – Blower Building	$1,103,000
25 – Fermenter Control Building	$2,350,000
26 – Mixing Basins	$2,784,000
28 – Odor Control	$550,000
98 – Yard Structures	$861,000
General Requirements	$1,435,000
Totals	
Subtotal	$18,154,000
Inflation to Midpoint of Construction (3%)	$1,106,000
Bonds and Insurances	$289,000
Total Probable Construction Cost (To Midpoint)	**$19,548,000**
Preliminary Design Engineering	$255,000
Detailed Design Engineering	$1,508,000
Estimated Construction Engineering (15%)	$2,932,000
Contingencies (10% of Total Probable Construction Cost)	$1,955,000
Total Probable Project Cost	**$26,199,000**

Major Upgrades to ADP WRF

- Biological Phosphorus Removal
  - Mixing Basins to select for Bio-P bacteria
  - Fermenters to supplement carbon to mixing basins
- Hydraulic Improvements
  - Primary effluent piping upgrades to fit mixing basins in hydraulic profile
- New Smaller RAS and Fermentate Pumping Stations
  - Keep existing RAS PS to feed aeration tanks
  - Provide return sludge control to improve Bio-P and fit in hydraulics
- Cover gravity thickeners and provide odor control
- Struvite Reactor
  - Remove recycled phosphorus to reduce effluent total phosphorus and mitigate dewatering issues
  - New building with sludge equalization tanks and dewatering building modifications

FRWRD

Process Flow Diagram – ADP WRF



ADP Phosphorus: 2 Contracts

Cost Opinion Liquid Facilities

ITEM	ESTIMATED PROJECT COST ANNUAL P LIMIT
Structures	
00 - Sitework	$3,939,000
10 – Thickener Building	$12,000
11 – Gravity Thickener	$725,000
30 – Primary Effluent Metering Flumes	$243,000
31 – Aeration Tanks	$451,000
46 – Blower Control Building	$126,000
52 – Mixing Basins	$4,653,000
53 – Fermenter Control Building	$4,610,000
53 – Odor Control	$488,000
56 – PE/RAS Feed Pump Station	$1,059,000
General Requirements	$1,400,000
Totals	
Subtotal	$17,706,000
Inflation to Midpoint of Construction (3%)	$1,079,000
Bonds and Insurances	$282,000
Total Probable Construction Cost (To Midpoint)	**$19,067,000**
Preliminary Design Engineering	$393,000
Detailed Design Engineering	$1,661,000
Estimated Construction Engineering (15%)	$2,860,000
Contingencies (10% of Total Probable Construction Cost)	$1,907,000
Total Probable Project Cost	**$25,888,000**

Cost Opinion Struvite Facilities

ITEM	ESTIMATED PROJECT COST ANNUAL P LIMIT
Structures	
00 - Sitework	$387,000
20 – Engine Generator Building	$6,000
45 – Sludge Dewatering Building	$678,000
54 – Struvite Building	$4,715,000
55 – Sludge Equalization Tanks	$702,000
56 – Odor Control	$43,000
General Requirements	$588,000
Totals	
Subtotal	$7,119,000
Inflation to Midpoint of Construction (3%)	$323,000
Bonds and Insurances	$112,000
Total Probable Construction Cost (To Midpoint)	**$7,554,000**
Preliminary Design Engineering	$162,000
Detailed Design Engineering	$795,000
Estimated Construction Engineering (15%)	$1,133,000
Contingencies (10% of Total Probable Construction Cost)	$755,000
Total Probable Project Cost	**$10,399,000**

Project Cost Estimates over Time

Project	Feasibility Study Project Cost Est.	Facility Plan Cost Est.	Final Project Cost Est.	As Bid Project Cost
North WRF	$10,980,000	$25,853,000	$26,200,000	$25,952,000
ADP WRF Liquid	$18,845,000	$34,399,000	$25,888,000	$19,372,000
ADP WRF Struvite	$6,084,000	$13,347,000	$10,399,000	$10,248,000
Total	$35,909,000	$73,599,000	$62,487,000	$55,572,000

FRWRD

Current Project Schedules

Project	Expected Construction Completion	Permit Construction Completion	Permit Limit Imposed Date
North WRF	3/17/2021	5/31/2021	8/31/2021
ADP WRF Liquid Processes	11/17/2021	8/31/2022	11/30/2022
ADP WRF Struvite Facilities	3/27/2021	8/31/2021	11/30/2021

FRWRD

Project Status Photos

North WRF – Mixing Basins, Aeration Tank, Splitter Structure

FRWRD

North WRF – Fermentor/Control Bldg and New RAS PS

FRWRD

North WRF Grit Effluent Splitter Structure

ADP WRF Liquid - Fermenters

FRWRD

ADP WRF Liquid – Mixing Basins and Fermentate and RAS PS

ADP WRF Liquid – Gravity Thickener Lining and future covers

FRWRD

ADP WRF Liquid – Aeration Tank MLSS Splitter Box

FRWRD

ADP WRF Struvite Facilities

FRWRD

ADP WRF Struvite Facilities

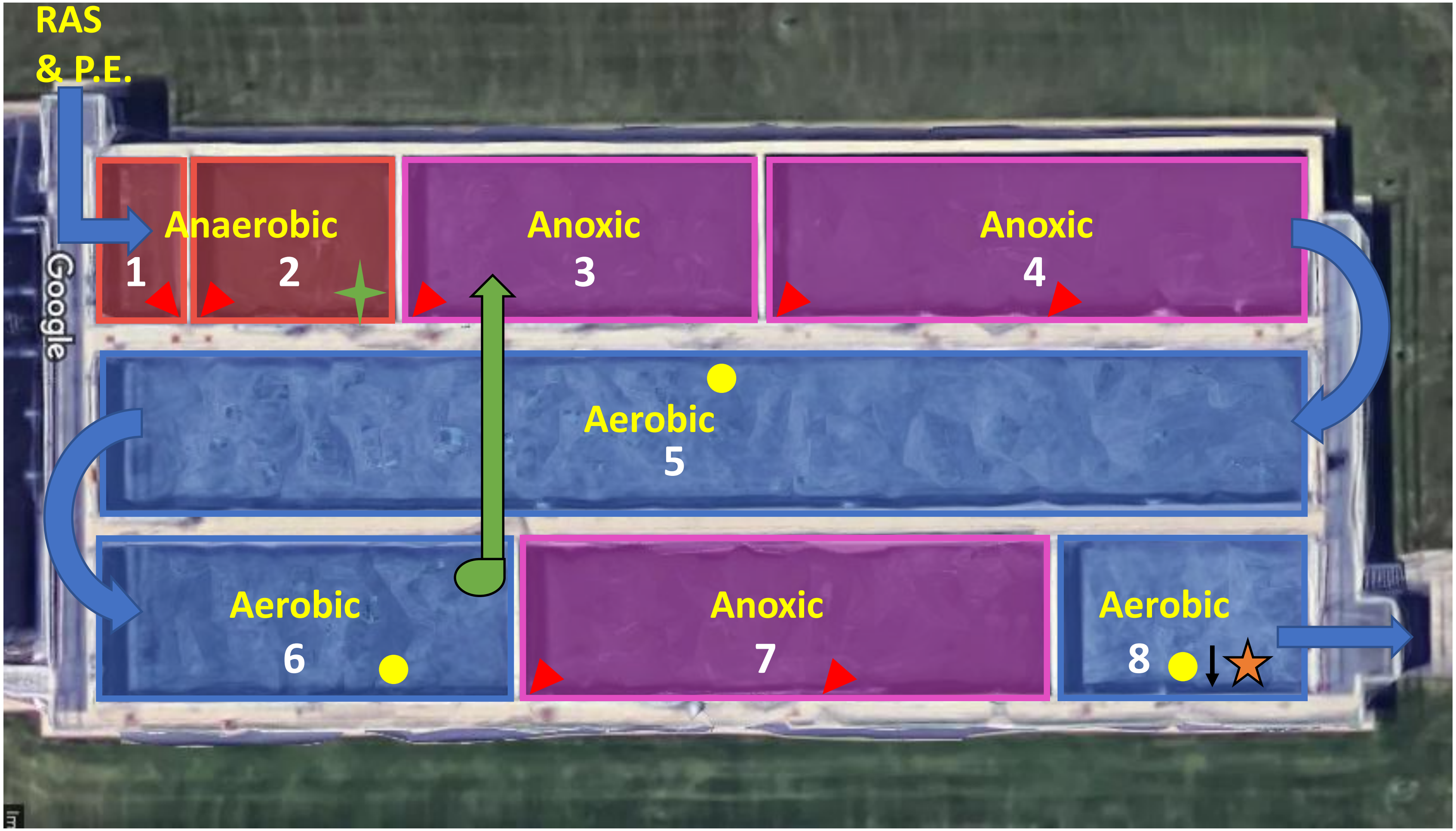
FRWRD

ADP WRF Struvite Facilities

FRWRD

West WRF BNR Operations

5 Stage Bardenpho at West WRF

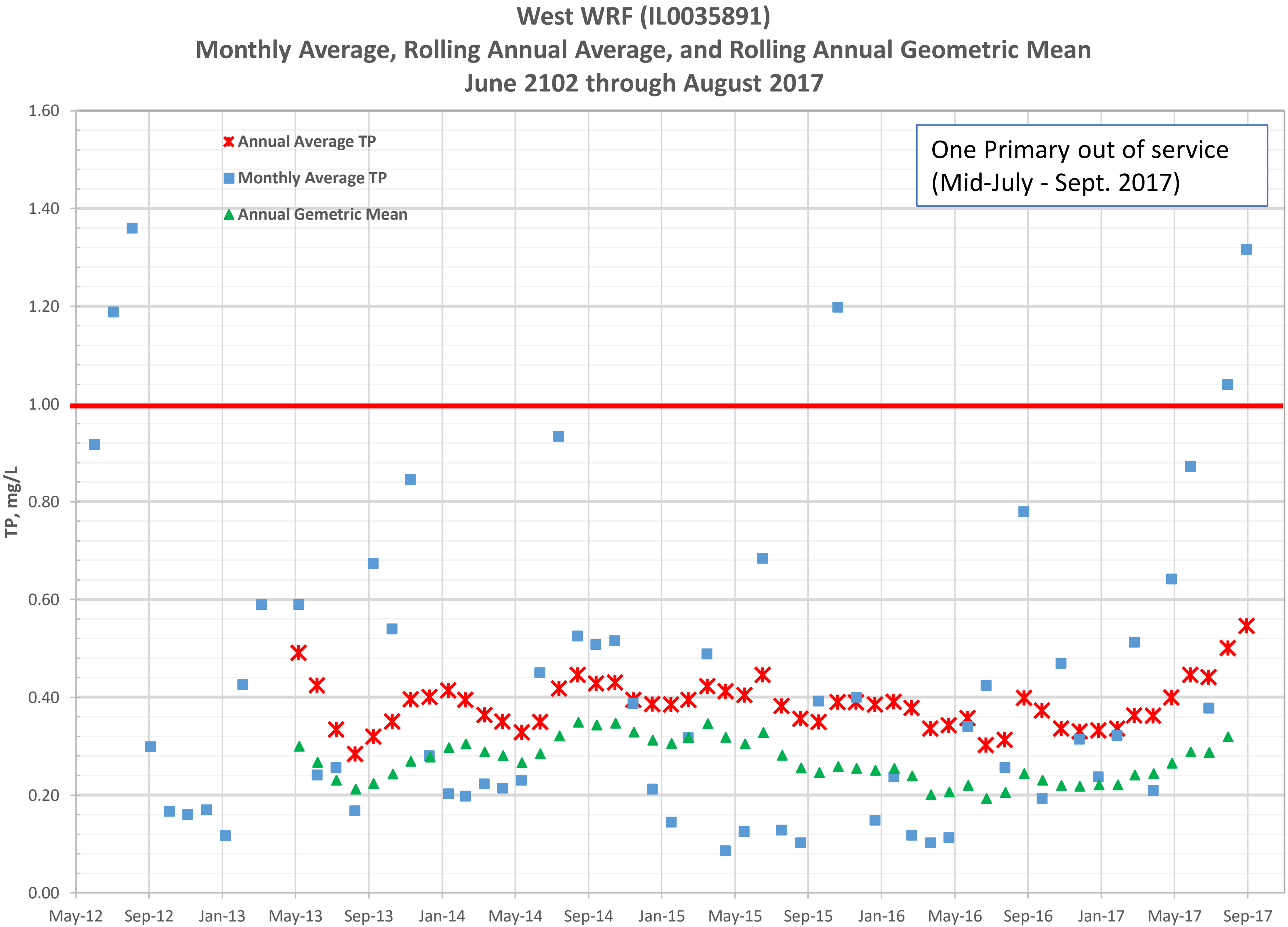


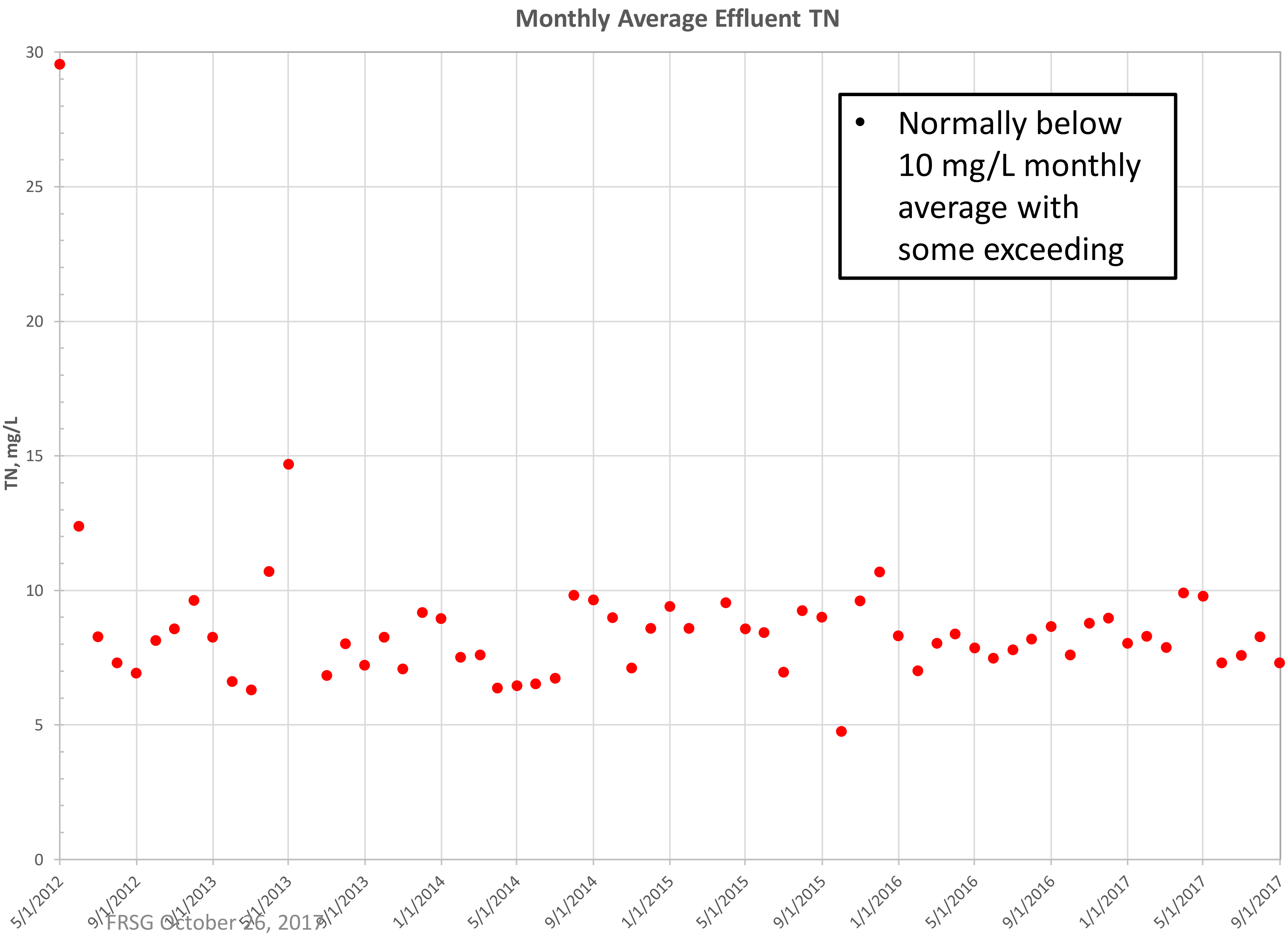
Mixer ORP Probe DO Probe TSS Probe NH3/NOx Probe

Summary of Influent and Effluent 2012 - 2017

Parameter	Influent	Effluent	% Removal
Flow	3.13 mgd	3.13 mgd	
BOD	183 mg/L	1.7 mg/L	99.1
TSS	195 mg/L	1.8 mg/L	99.2
COD	440 mg/L	8.0 mg/L	
TKN	38.5 mg/L	1.5 mg/L	
NOx	<0.2 mg/L	6.6 mg/L	
TN	**38.7 mg/L**	**8.3 mg/L**	**78.6**
TP	**4.5 mg/L**	**0.45 mg/L**	**90.0**

Average Parameters (6/2012 through 9/2017) in BNR mode

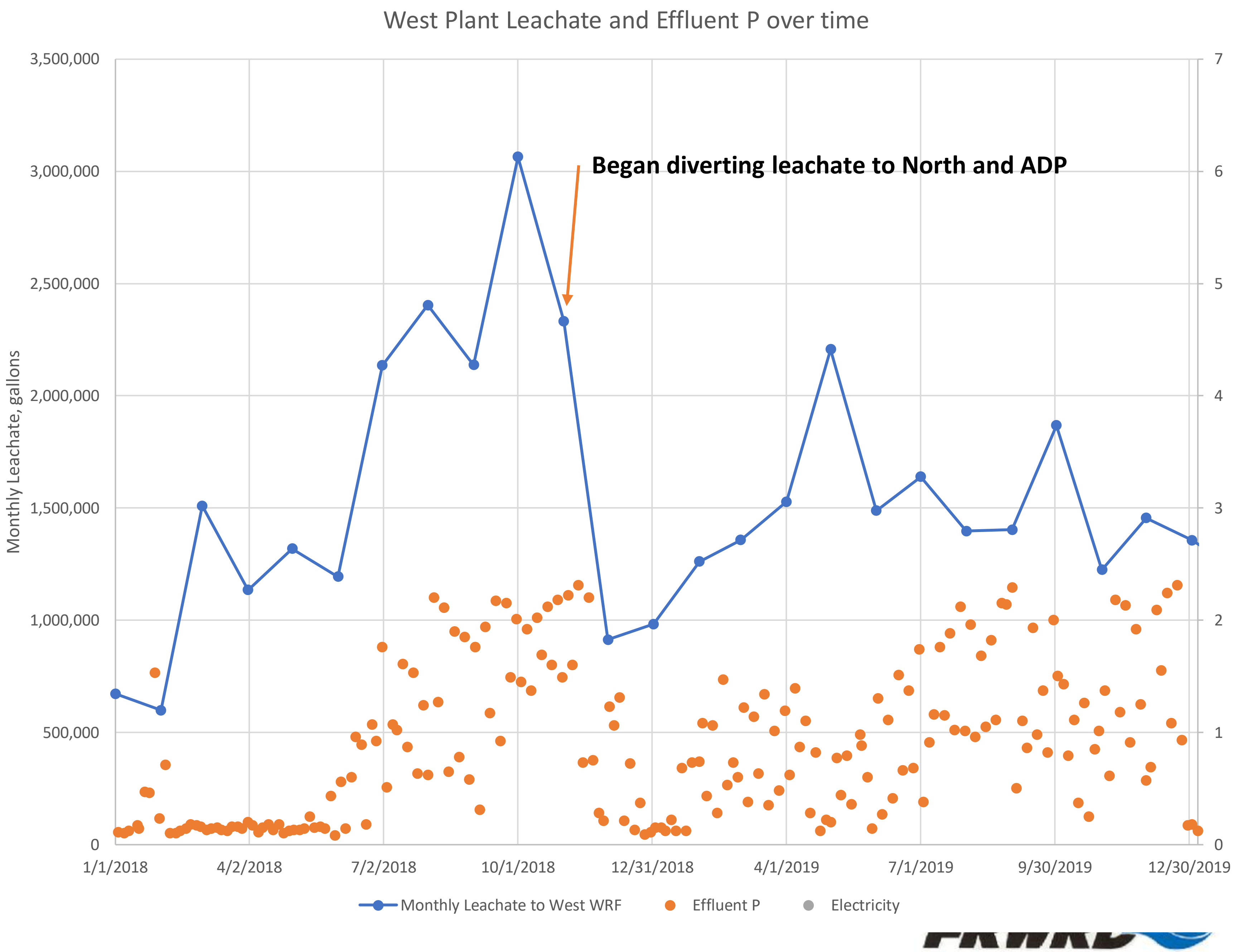

West WRF (IL0035891)
Monthly Average, Rolling Annual Average, and Rolling Annual Geometric Mean
June 2102 through August 2017
Annual Average TP
Monthly Average TP
Annual Gemetric Mean
One Primary out of service
(Mid-July - Sept. 2017)
TP, mg/L
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
May-12
Sep-12
Jan-13
May-13
Sep-13
Jan-14
May-14
Sep-14
Jan-15
May-15
Sep-15
Jan-16
May-16
Sep-16
Jan-17
May-17
Sep-17



Monthly Average Effluent TN
TN, mg/L
30
25
20
15
10
5
0
5/1/2012
9/1/2012
1/1/2013
5/1/2013
9/1/2013
1/1/2014
5/1/2014
9/1/2014
1/1/2015
5/1/2015
9/1/2015
1/1/2016
5/1/2016
9/1/2016
1/1/2017
5/1/2017
9/1/2017
• Normally below 10 mg/L monthly average with some exceeding

Changes since 2017

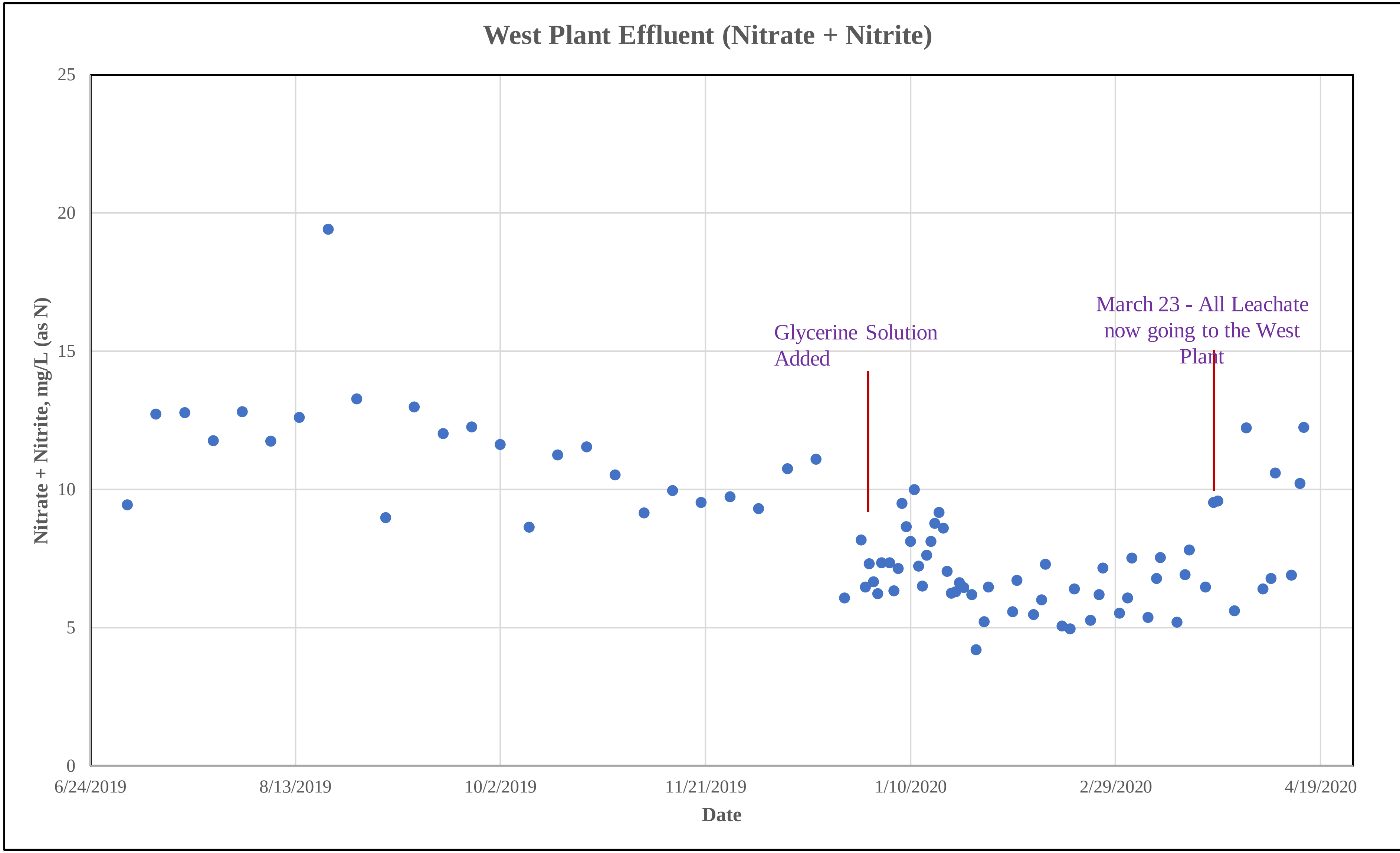
- FRWRD takes landfill leachate from Waste Management at the West WRF
- Normal average loading has been 0.6-1.0 MG per month
- New Manifest Requirements for Leachate went into effect in summer of 2018 – some WWTPs didn't stopped taking it
- Waste Management began bringing leachate from another active landfill
- Monthly leachate load increased to over 2.0 MG per month
- P Removal performance began to suffer
- FRWRD search for a solution began

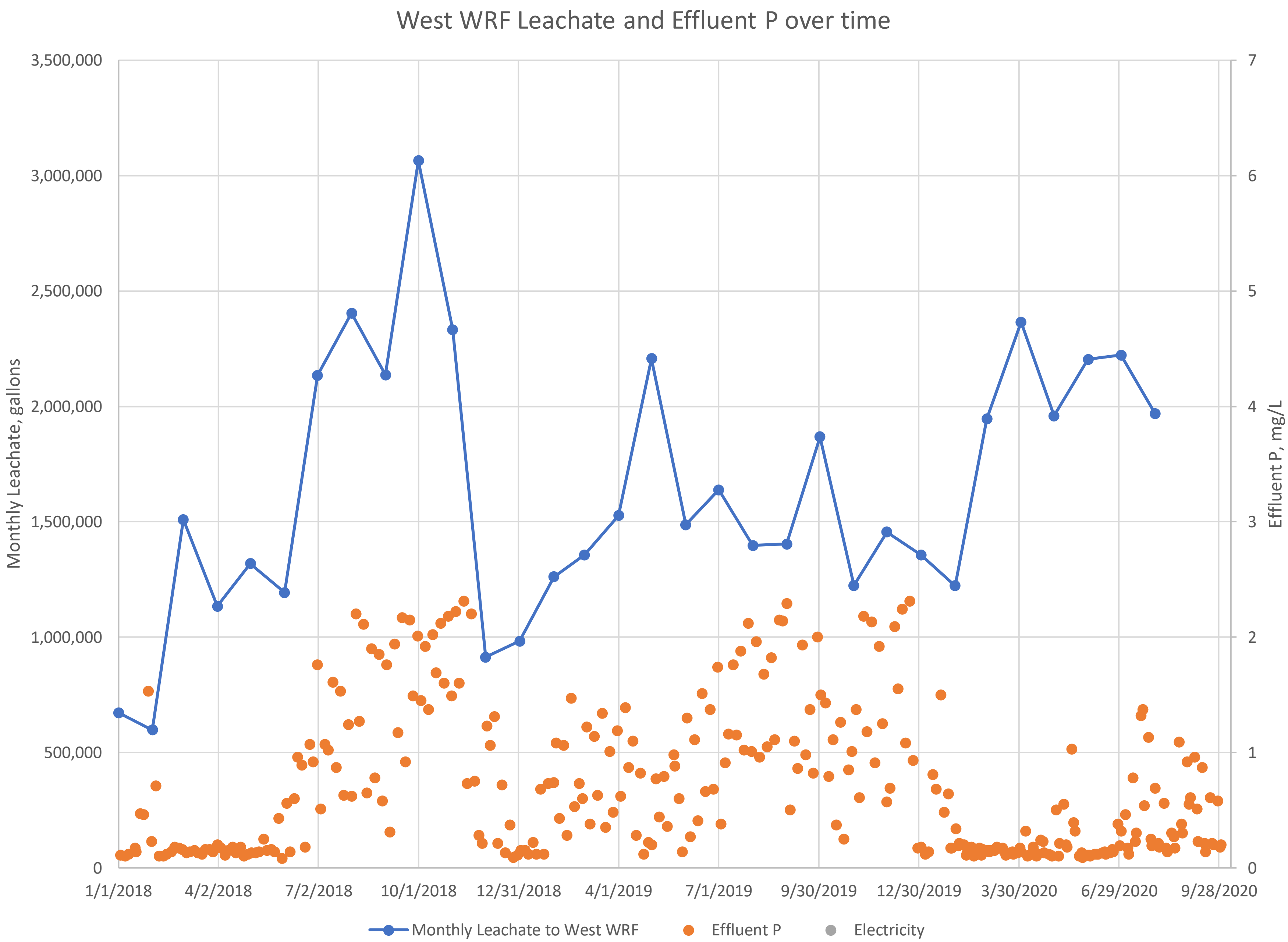

West Plant Leachate and Effluent P over time
Began diverting leachate to North and ADP
Monthly Leachate, gallons
Effluent P, mg/L
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
7
6
5
4
3
2
1
0
1/1/2018
4/2/2018
7/2/2018
10/1/2018
12/31/2018
4/1/2019
7/1/2019
9/30/2019
12/30/2019
Monthly Leachate to West WRF
Effluent P
Electricity

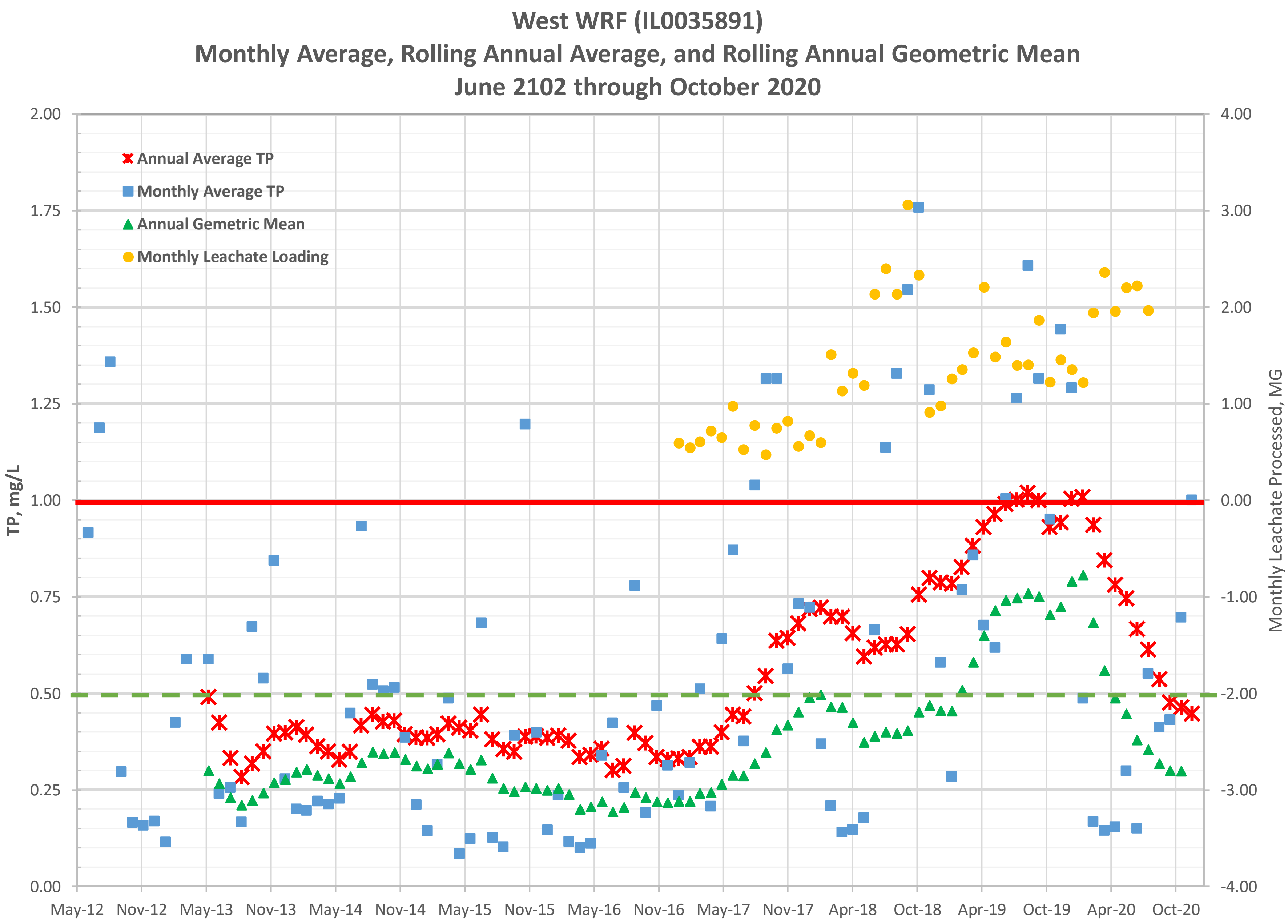
FRWRD decides to try adding Glycerin

- Staff notices that Effluent TN has creeped up to regularly be over 12 mg/L (had normally been below 10 mg/L)
- Anaerobic Zone ORP is generally too high (good performance is at around -600)
- FRWRD staff installs system to pump Micro-C (proprietary glycerin compound) into the second anoxic zone to increase NOx to N2 conversion and thus reduce NOx return with RAS to anaerobic zone
- Performance has greatly improved and leachate loading has been allowed to increase again

FRWRD


West Plant Effluent (Nitrate + Nitrite)
Nitrate + Nitrite, mg/L (as N)
25
20
15
10
5
0
6/24/2019
8/13/2019
10/2/2019
11/21/2019
1/10/2020
2/29/2020
4/19/2020
Date
Glycerine Solution Added
March 23 - All Leachate now going to the West Plant


West WRF Leachate and Effluent P over time
Monthly Leachate, gallons
Effluent P, mg/L
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
7
6
5
4
3
2
1
0
1/1/2018
4/2/2018
7/2/2018
10/1/2018
12/31/2018
4/1/2019
7/1/2019
9/30/2019
12/30/2019
3/30/2020
6/29/2020
9/28/2020
Monthly Leachate to West WRF
Effluent P
Electricity


West WRF (IL0035891)
Monthly Average, Rolling Annual Average, and Rolling Annual Geometric Mean
June 2102 through October 2020
Annual Average TP
Monthly Average TP
Annual Gemetric Mean
Monthly Leachate Loading
TP, mg/L
Monthly Leachate Processed, MG
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
May-12
Nov-12
May-13
Nov-13
May-14
Nov-14
May-15
Nov-15
May-16
Nov-16
May-17
Nov-17
Apr-18
Oct-18
Apr-19
Oct-19
Apr-20
Oct-20

Questions & Discussion