

FIVE YEARS OF PHOSPHORUS REMOVAL OPTIMIZATION

WHAT DO WE KNOW?

FOND DU LAC
WTRRF

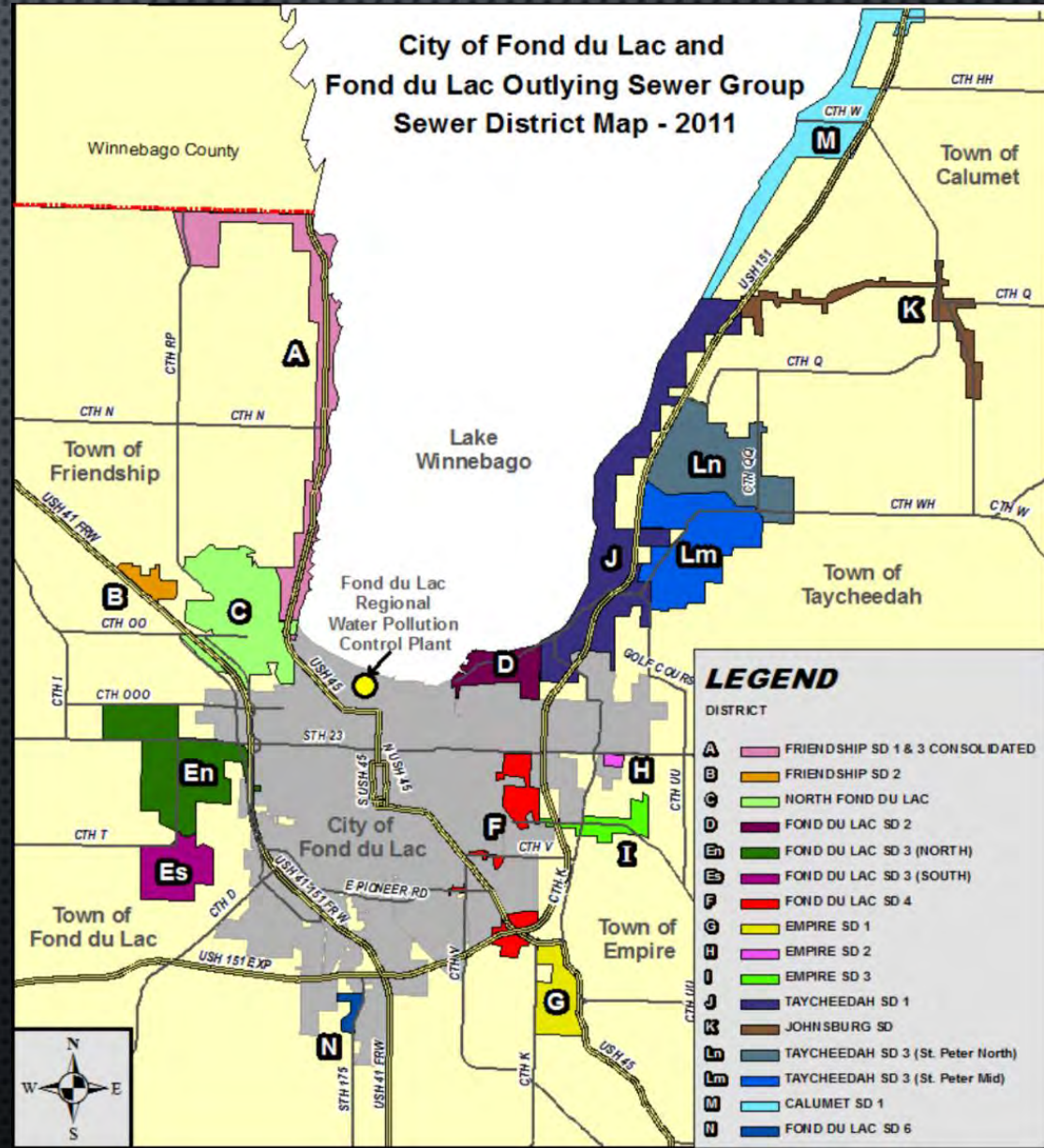
ROADMAP

- BACKGROUND
- GETTING STARTED
- PILOTING
- BPR / CHEMICAL
- FACILITY MASTER PLAN
- WHAT DO WE KNOW?
- ACKNOWLEDGEMENTS



REGIONAL FACILITY

- 18 OUTLYING SEWER GROUPS
- ADDITIONAL 20,000 PEOPLE
- INVOLVED IN SOLVING THE PROBLEM



2008 PLANT UPGRADE

- INFLUENT FINE SCREENS/VORTEX GRIT REMOVAL
- CO-THICKENING PRIMARIES
- CONVENTIONAL MLE ACTIVATED SLUDGE PROCESS – CHEMICAL PHOSPHORUS REMOVAL
- UV DISINFECTION
- TPAD
- CENTRIFUGE DEWATERING



2012
BIOGAS MODIFICATION PROJECT
&
HSW RECEIVING STATION



HISTORICAL OPERATIONS

- 2012 - PRETREATMENT PROGRAM INCLUDED SOURCE REDUCTION FOR PHOSPHORUS
- 2012 - WATER PLANT HALTED USE OF PHOSPHATES FOR IN-LINE TREATMENT ENDED
- OPERATED WITH HIGHER PRIMARY SLUDGE BLANKETS
- OPERATED WITH HIGH D.O. IN ACTIVATED SLUDGE PROCESS
- CHEMICAL PHOSPHORUS REMOVAL ONLY - ALUM – LARGE QUANTITIES
- EXTREME I/I ISSUES
- ONLY REQUIRED TO MEET A 1.0 MG/L TP LIMIT

WHAT WE KNEW

- WOULD RECEIVE A TMDL
- WQBEL: 0.04 MG/L, 3.3 LBS/DAY
- CURRENT LIMIT WAS: 1.0 MG/L – ACHIEVE WITHOUT ISSUE
- 2013 – OPERATIONAL EVALUATION REPORT TO DNR – CANNOT ACHIEVE LIMIT WITHOUT MAJOR UPGRADE
- REQUIRED TO EVALUATE THE FEASIBILITY OF ALTERNATIVES TO MEET THE WQBEL

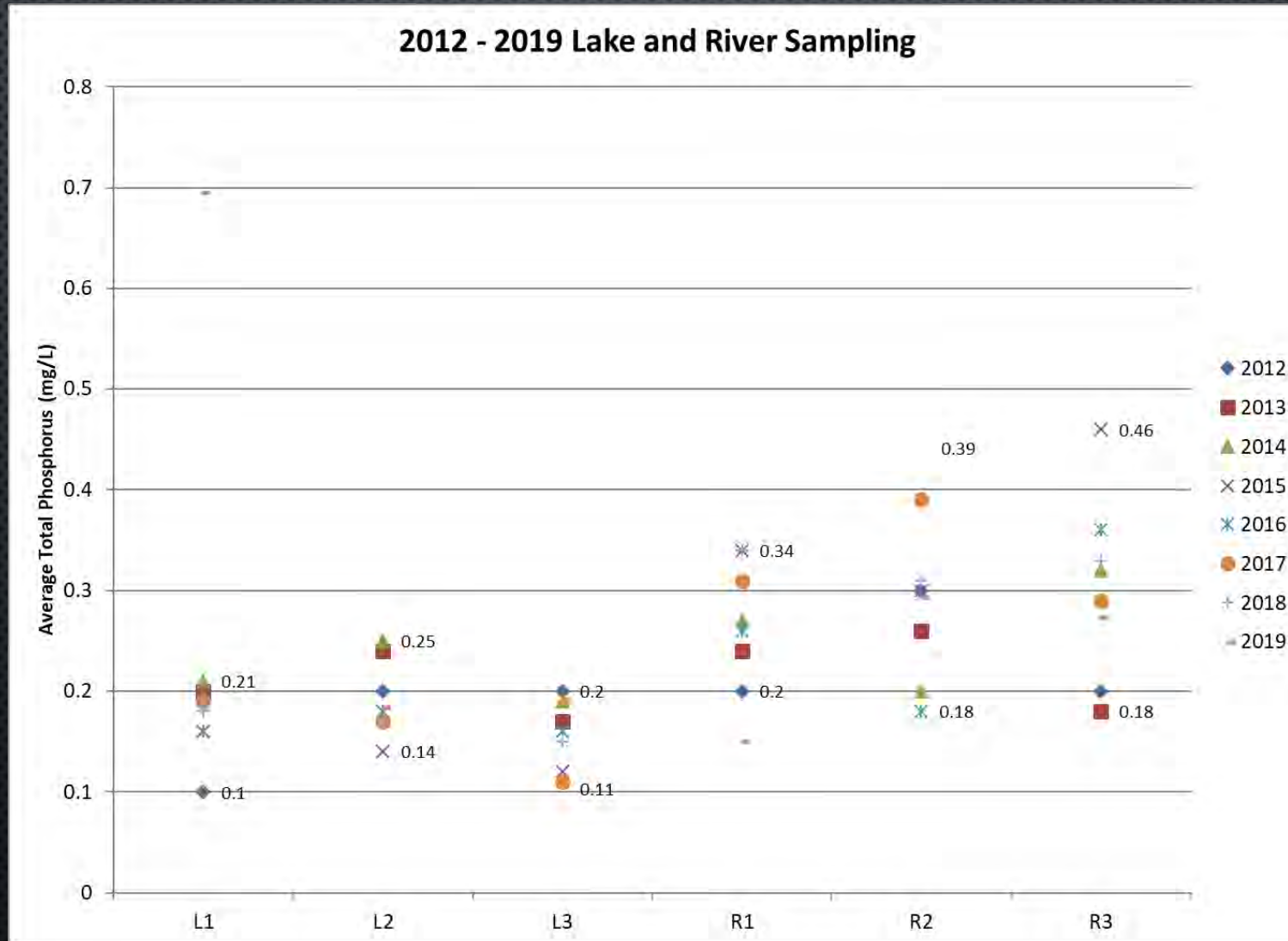
WHAT ARE WE UP AGAINST?

FDL RIVER & LAKE WINNEBAGO

- LARGEST INLAND LAKE - LAKE WINNEBAGO – MAX DEPTH 21 FT.
- HIGH TSS – FDL RIVER
- SUPPLE MARSH DIRECTLY CONNECTED TO LAKE
- LEGACY PHOSPHORUS
- 2012 - SAMPLING/ANALYSIS PERFORMED – 6 SITES



LAKE AND RIVER SAMPLING



2013 CHEMICAL PHOSPHORUS REMOVAL WITH ONLINE ANALYZER



- SUBSTANTIAL CHEMICAL SAVINGS: \$100,000+
- CONTROLLED SAMPLING FREQUENCY
- COMMUNICATES WITH CHEMICAL FEED PUMPS
 - DOSE
 - PACING
- WEEKLY CHECKS TO VERIFY ACCURACY
- ACHIEVE LOWER EFFLUENT TP AND REDUCE CHEMICAL USE
- MINI-LO OP ANALYZER

2013

PILOTING TERTIARY TREATMENT TECHNOLOGIES BALLASTED SETTLING – COMAG



- MAGNETITE
- COULD ACHIEVE 0.04MG/L WITH ALL 3 COAGULANTS (ALUM, FERRIC, AND PAC)
- POLYMER ADDITION
- \$38 MILLION FOR 50MGD PEAK SYSTEM

2014

PHOSPHORUS SPECIATION

- BREAKING PHOSPHORUS DOWN INTO ITS DIFFERENT FRACTIONS
- INSOLUBLE/PARTICULATE, POLYMERIZED, ORGANICALLY BOUND, SOLUBLE NON REACTIVE, ETC
- HELPS UNDERSTAND WHAT FRACTIONS OF PHOSPHORUS ARE AFFECTED MORE BY ONE PROCESS/CHEMICAL THAN ANOTHER — ESSENTIAL FOR REMOVAL
- PIECES OF THE PIE MAKE UP THE WHOLE — NECESSARY TO KNOW FOR ACHIEVING LIMITS



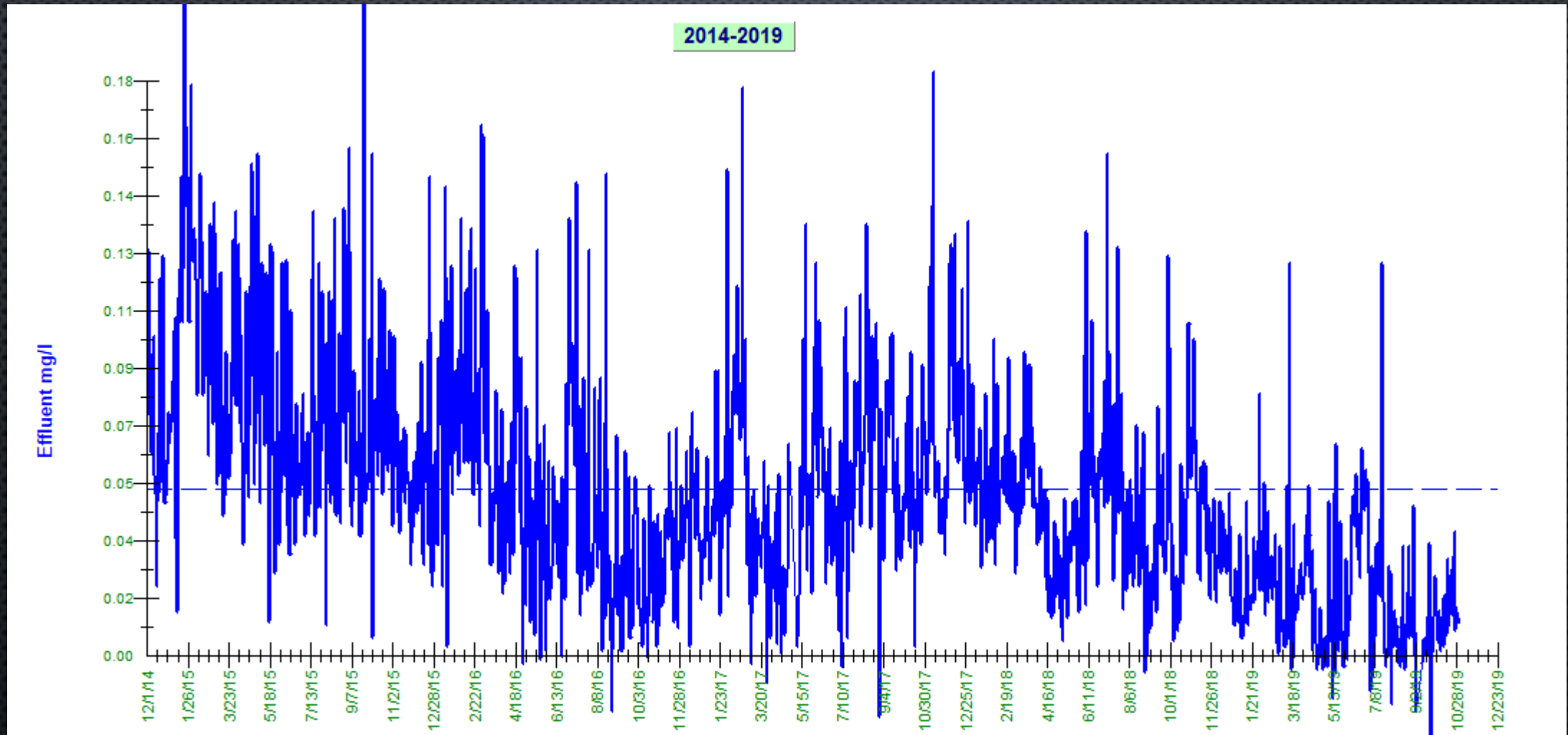
FOND DU LAC WTRRF – CERTIFIED LAB

PHOSPHORUS SPECIATION TESTING

- DEDICATED STAFF
- DILIGENT WORK TO PROVE THE METHOD NEEDED FOR ANALYSIS
- CONFIDENCE IN ACCURACY AND PRECISION

- RESULTS:
 - ABILITY TO DIFFERENTIATE MAIN SOURCES OF SNRP
 - ABLE TO BREAK DOWN PHOSPHORUS TO DETERMINE WHAT FRACTIONS ARE IMPACTED TO DEPICT THE REALITY OF ACHIEVING THE 0.04MG/L LIMIT
 - CONTRACT LAB FOR OTHER COMMUNITIES

SNRP



JAR TESTING

- LAB SCALE PERFORMANCE OF DIFFERENT CHEMICALS TO REMOVE PHOSPHORUS – USED TO DETERMINE FULL SCALE OPERATION AND ESTIMATE USAGE, COST, AND RESULTS
- SPECIFIC DOSAGES AND MIXING TIMES
- ALUM
- PAC
- CERIUM CHLORIDE
- RESULTS SHOWED SORBX WOULD HAVE A LARGE IMPACT ON OUR PHOSPHORUS

BIOLOGICAL PHOSPHORUS REMOVAL

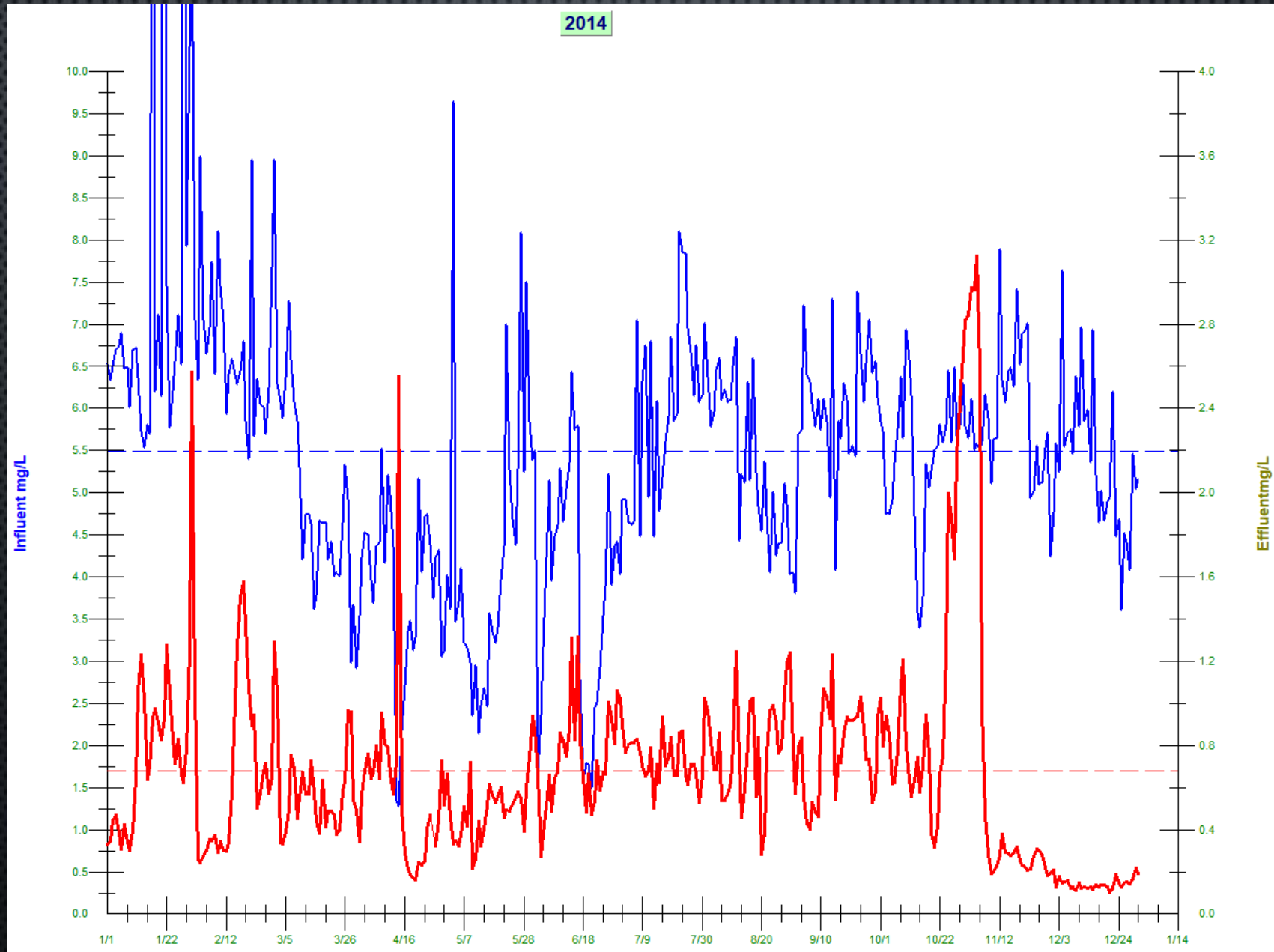
- CHALLENGES

- NOT DESIGNED FOR IT
- NEAR 50% INDUSTRIAL LOAD – INCONSISTENT
- DEWATERING SWINGS

- TRIALS/IMPROVEMENTS

- PROFILING ACTIVATED SLUDGE PROCESS
- NITRATE RECYCLE PUMP ADJUSTMENTS – OFF
- CLARIFIER OFFLINE TO INCREASE LOADINGS TO SECONDARY TREATMENT
- CONDENSE DOWN TO 2 AERATION BASINS
- CYCLE FEED CHANNEL AERATION
- ADD BAFFLE WALL EXTENSIONS
- OPERATE AT LOWER D.O. SETPOINTS

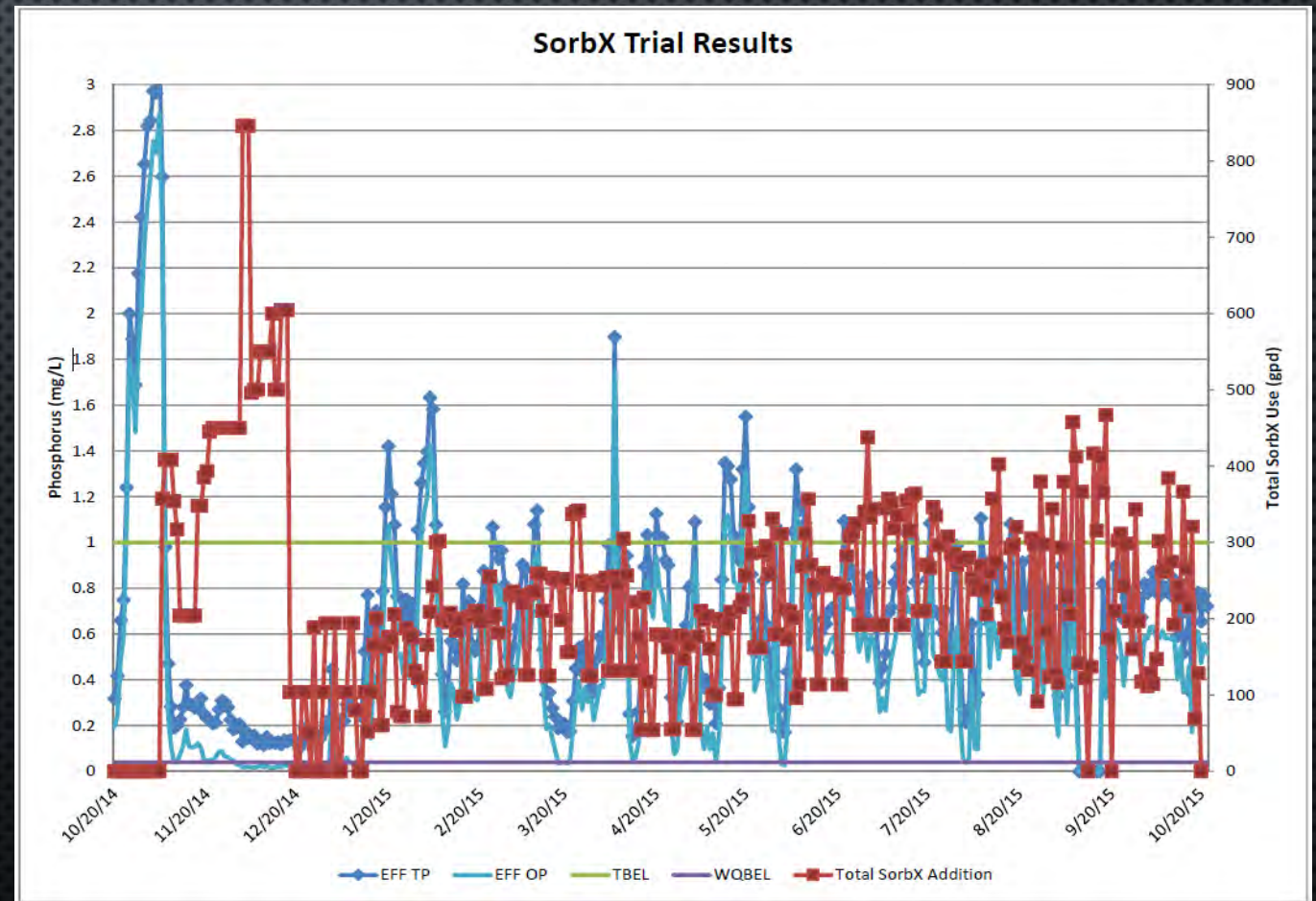
PHOSPHORUS



2015

COAGULANT PILOT

- CERIUM CHLORIDE – 1 YEAR
- UNABLE TO ACHIEVE 0.04MG/L
- 0.12MG/L AT BEST – HIGH CHEMICAL DOSE
- OTHER BENEFITS
 - STRUVITE REMOVAL/REDUCTION
 - 3-4% INCREASE IN CAKE SOLID



FILTRATION

BLUE PRO

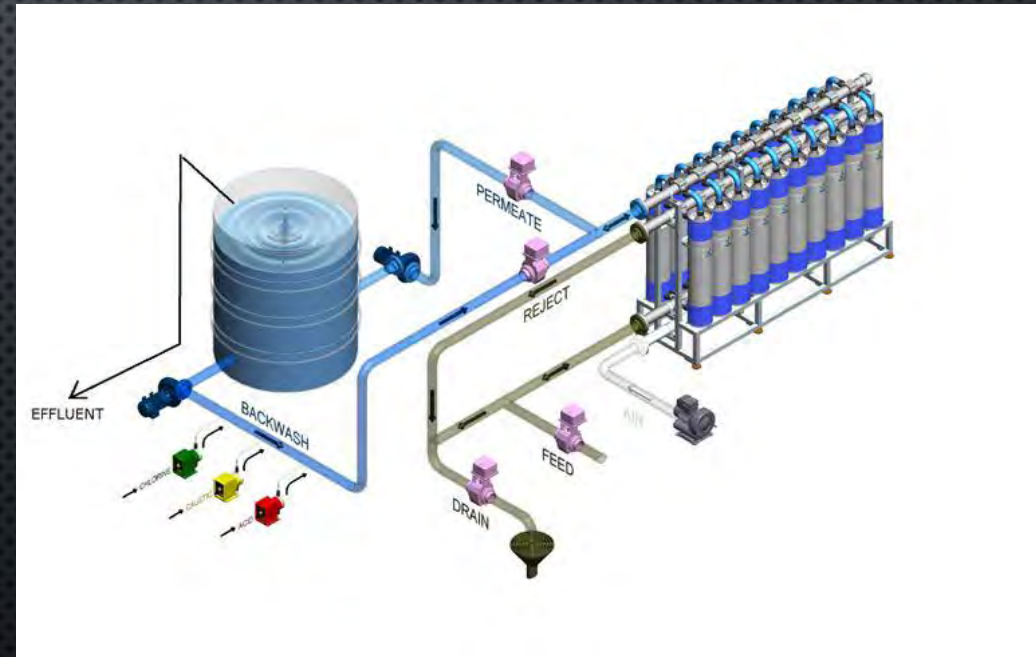
- SAND MEDIA
- DID NOT PILOT – BUDGET/COST OF TECHNOLOGY
- \$70 MILLION FOR 50 MGD PEAK



FILTRATION

OVIVO MEMBRANE TFS

- 2 COAGULANTS – ALUM, CERIUM CHLORIDE
- CERIUM CHLORIDE CREATED ISSUES WITH THE MEMBRANES
- HIGH ALUM QUANTITY NEEDED TO GET NEAR LIMIT
- HIGH SNRP IN PILOT INFLUENT (0.03-0.15MG/L)
- PILOT DID NOT SHOW FAVORABLE RESULTS
- \$109 MILLION FOR 50 MGD PEAK



BALLASTED SETTLING

ACTIFLO

- SAND
- 3 COAGULANTS (FERRIC, ALUM, CERIUM CHLORIDE) ALONG WITH POLYMER
- ONLY FERRIC AND CERIUM CHLORIDE ABLE TO ACHIEVE EFFLUENT LIMIT CONSISTENTLY
- AT TIMES HIGH SNRP IN PILOT INFLUENT (0.03-0.23MG/L)
- \$34 MILLION FOR 50 MGD PEAK



FILTRATION

AQUA AEROBICS – AQUADISK + AQUA ULTRAFILTRATION



- 3 COAGULANTS (ALUM, FERRIC, CERIUM CHLORIDE)
- POLYMER ADDITION
- SNRP IN INFLUENT WAS UP TO 0.1MG/L
- ACHIEVED 0.1MG/L WITH AQUADISK ONLY WITH POLYMER
- ACHIEVED <0.04MG/L CONSISTENTLY WITH THE COMBO (AVG. 0.025MG/L) WITHOUT POLYMER
- \$50 MILLION FOR 50 MGD PEAK

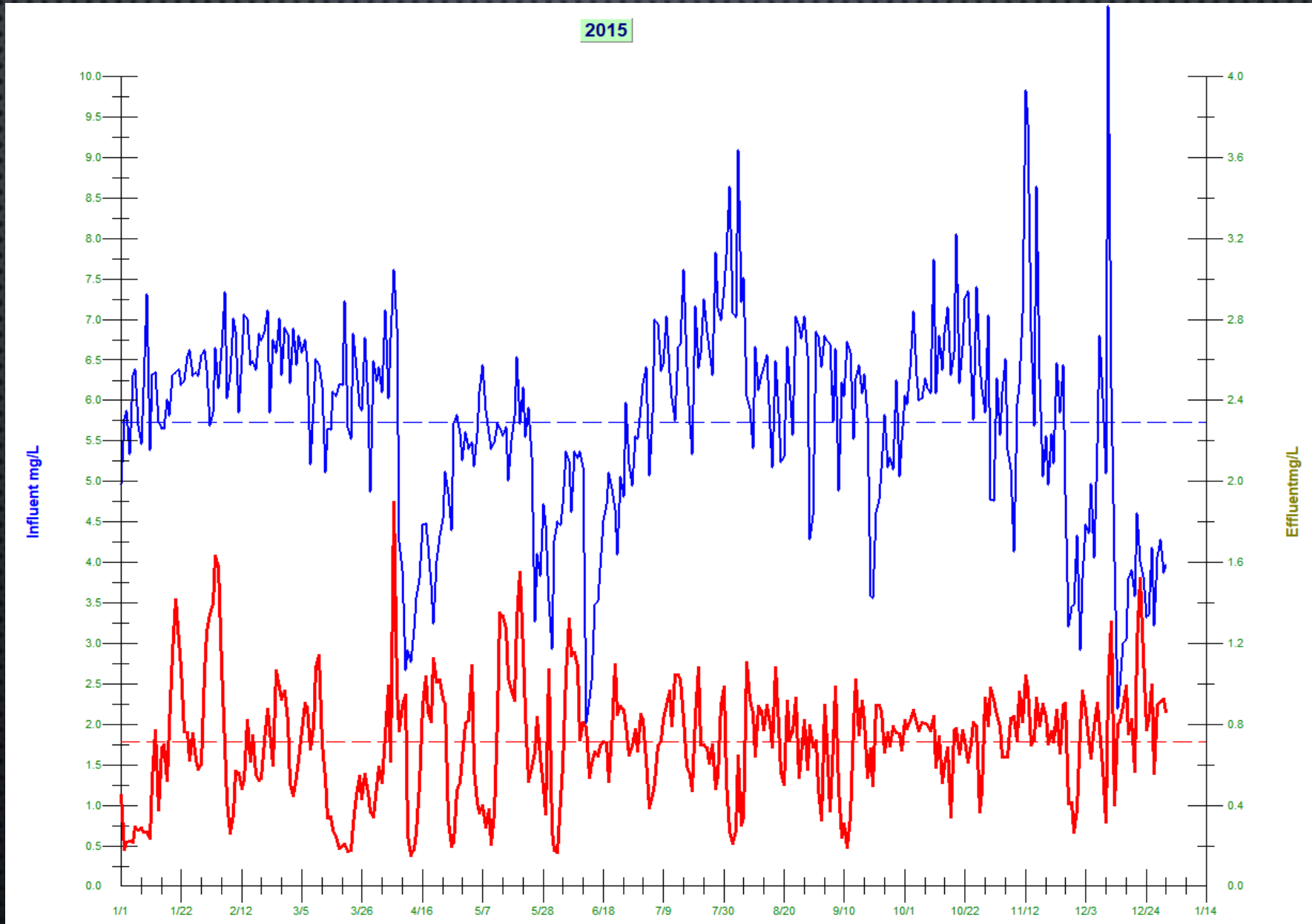


SIDE STREAM NUTRIENT REMOVAL PILOT

- INCREASED CAKE 2-3%
- DECREASED POLYMER DOSE – 3-4 LB/TON
- STRUVITE WAS PRODUCED
- DEMONSTRATED 70-80% OP REMOVAL



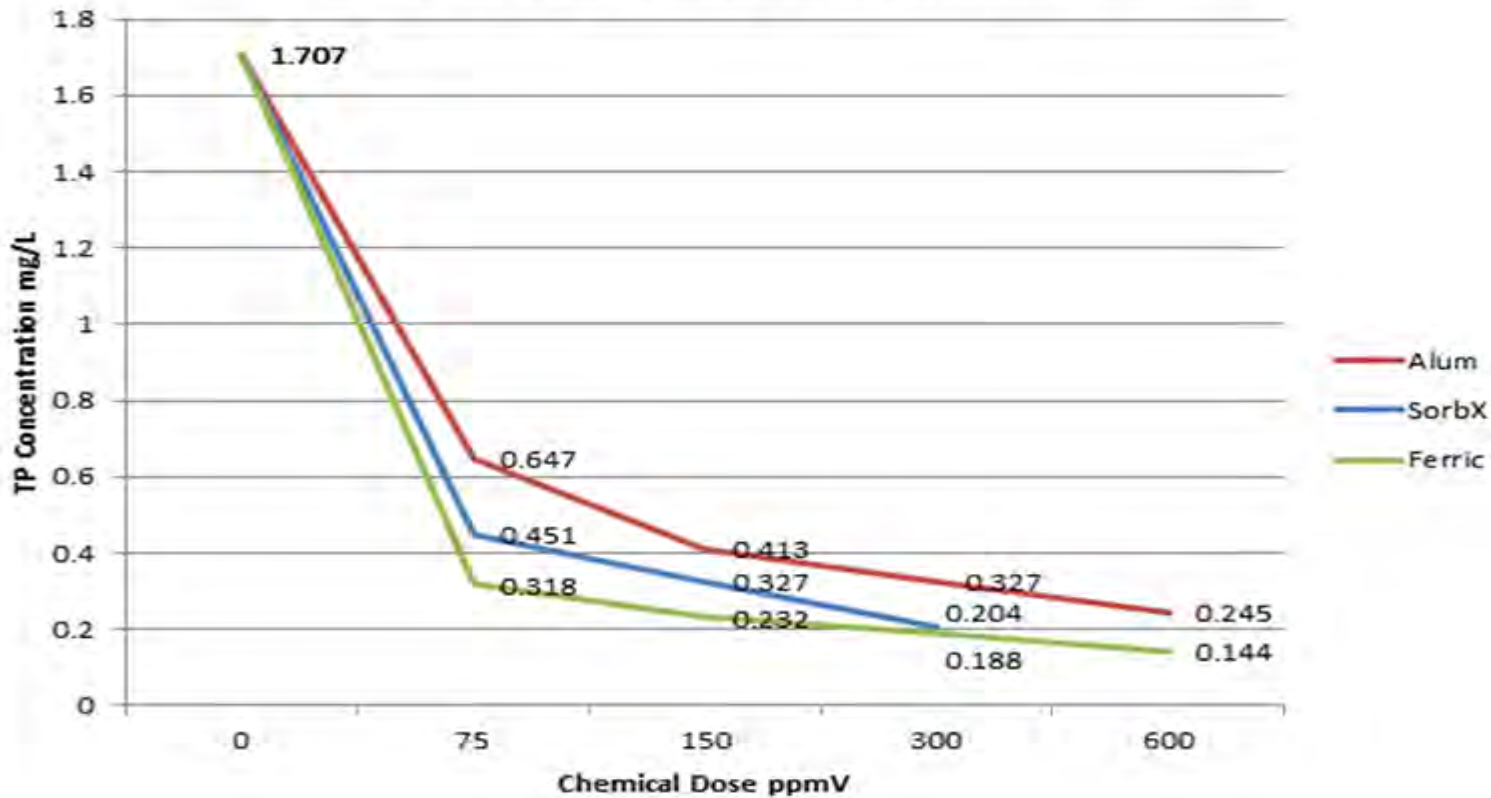
PHOSPHORUS



2016

JAR TESTING

TP Coagulant Comparisons



- COMPARED ALUM & CERIUM CHLORIDE TO FERRIC
- FERRIC DISPLAYED THE BEST RESULTS
- OTHER BENEFITS OF FERRIC
 - DECREASED STRUVITE BUILDUP
 - REDUCED H₂S
- SUMMER 2016 – SWITCHED TO FERRIC

ALGAE BASED TECHNOLOGY

CLEARAS

- NO COAGULATION
- BIOLOGICAL SYSTEM W/CO₂ ADDITION
- AVG. <0.036MG/L
- USES MEMBRANE FILTRATION TO SEPARATE BIOMASS FROM EFFLUENT
- ALGAE BYPRODUCT – REVENUE SOURCE
- \$88 MILLION FOR 50 MGD PEAK



TERTIARY TREATMENT UPDATED COSTS

- REQUESTED PRICING FOR 10 MGD SYSTEMS
 - ACCOUNTS FOR OUR AVG. DESIGN (9.84 MGD)

Alternative	20-Year Present Worth Cost
Advanced TP Removal	
CoMag™	\$ 34,430,000
Blue PRO®	\$ 79,350,000
Ovivo TFS®	\$112,820,000
ACTIFLO	\$ 36,270,000
Aqua-Aerobic DF ¹	\$ 19,490,000
Aqua-Aerobic DF + UF ²	\$ 52,240,000
Clearas Water Recovery	\$ 66,710,000
Watershed AM ³	\$ 19,400,000
WQT ⁴	\$ 18,000,000
Statewide Variance (MDV)	\$ 8,000,000

¹DF = disk filter; unlikely to meet 0.04 mg/L limit alone.

²UF = ultrafiltration (membrane).

³Watershed AM costs do not include monitoring, administration, cost sharing, or grants.

⁴WQT costs do not include modeling, administration, cost sharing, or grants.

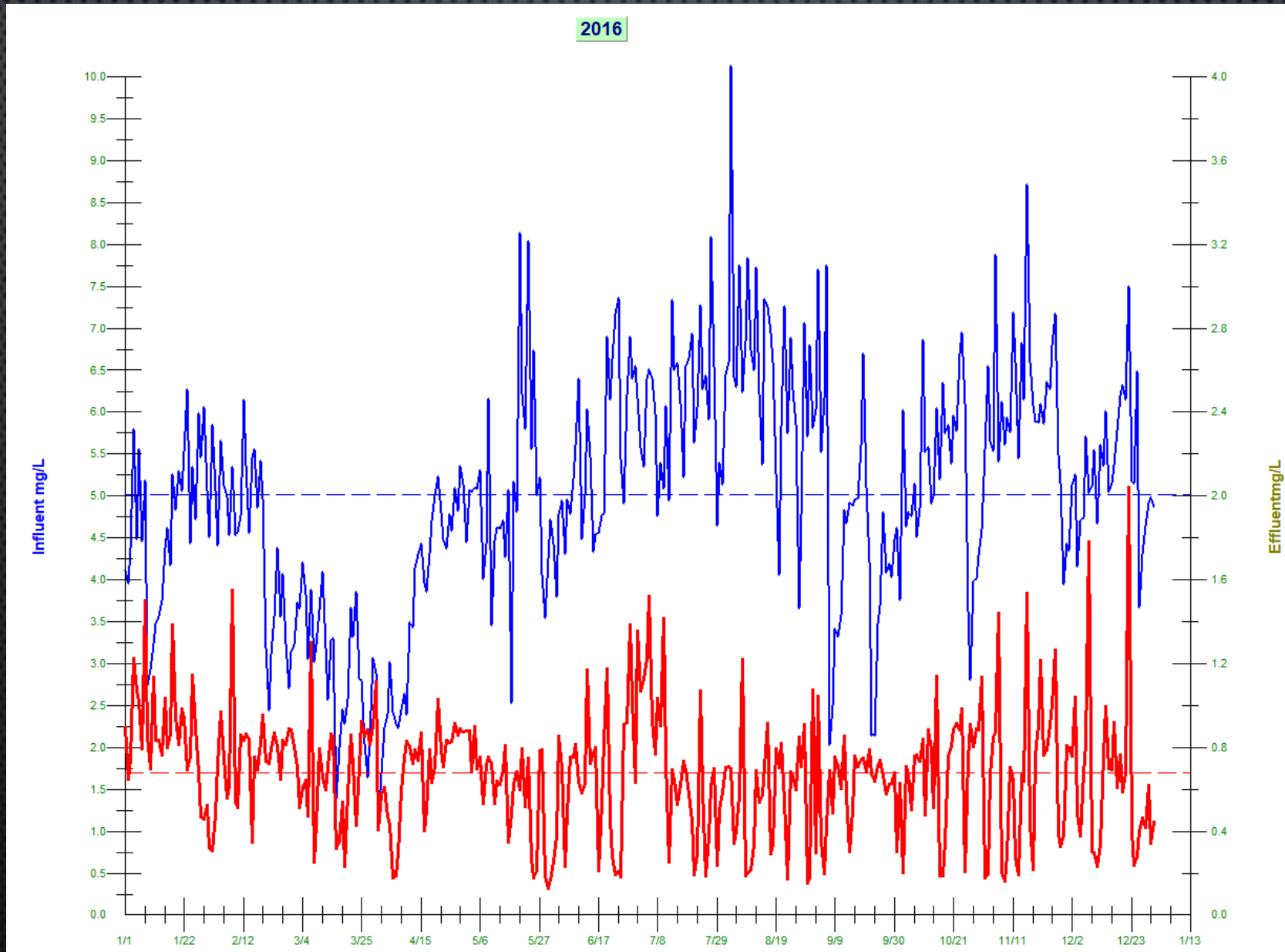
Table 20 Present Worth Cost Comparison for Evaluated WPCP Phosphorus Compliance Alternatives

BIO-P UPDATES

- ROUTE CENTRATE DIRECTLY TO SECONDARY TREATMENT
- PLAYED AROUND MORE WITH MIXING TIMERS IN ANAEROBIC ZONE
- EXTENDED ANAEROBIC ZONE
 - CENTERED NORTH MIXER (PREVIOUS ANOXIC ZONE)
 - REMOVED THE NORTH HALF OF AERATION GRID AT THE HEAD OF AEROBIC ZONE
 - MOVED THE SOUTH MIXER ON THE OTHER SIDE OF THE BAFFLE WALL
- EXPERIMENTED WITH AN ADDITIONAL CARBON SOURCE



PHOSPHORUS



2017

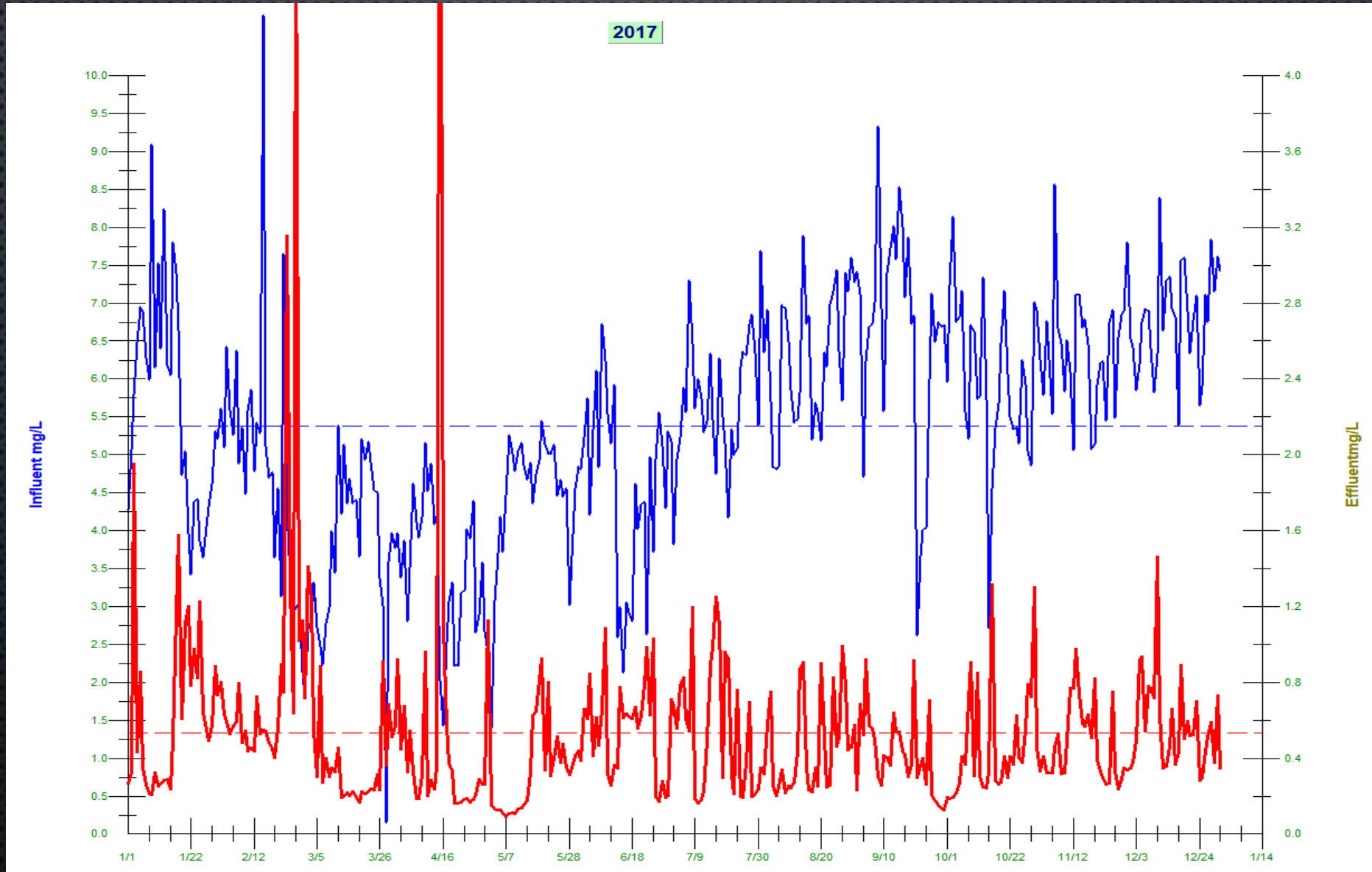
BIO-P

- EVALUATED DIFFERENT CARBON SOURCES
- UTILIZE DIFFERENT CARBON SOURCE FOR BIO-P (LOW SOLIDS/HIGH COD)
- TEMPORARILY PERMANENT INSTALL FOR CARBON SOURCE OFFLOADING AND TRANSFER TO THE BASINS
- QUANTITY OF CARBON SOURCE AVAILABLE INCREASED
- FEEDING TO BASINS INCREASED (2000+GPD)
- BLOCK OFF HOLES IN BAFFLE WALL

PERMIT APPLICATION

- PERMIT EXPIRED 3/31/2018
- NO APPROVED TMDL
 - APPLIED FOR MDV AS A COMPLIANCE OPTION
 - TIMING WAS IMPORTANT

PHOSPHORUS



2018

NEW PERMIT

- 4/1/18
- BEGAN TRACKING FOR THE MDV (9 MONTHS)
 - \$52.02/LB ABOVE A 0.2MG/L UP TO \$640K
- MDV TOTAL
 - \$216,522.89
 - 3 COUNTIES (FDL, WINNEBAGO, CALUMET)

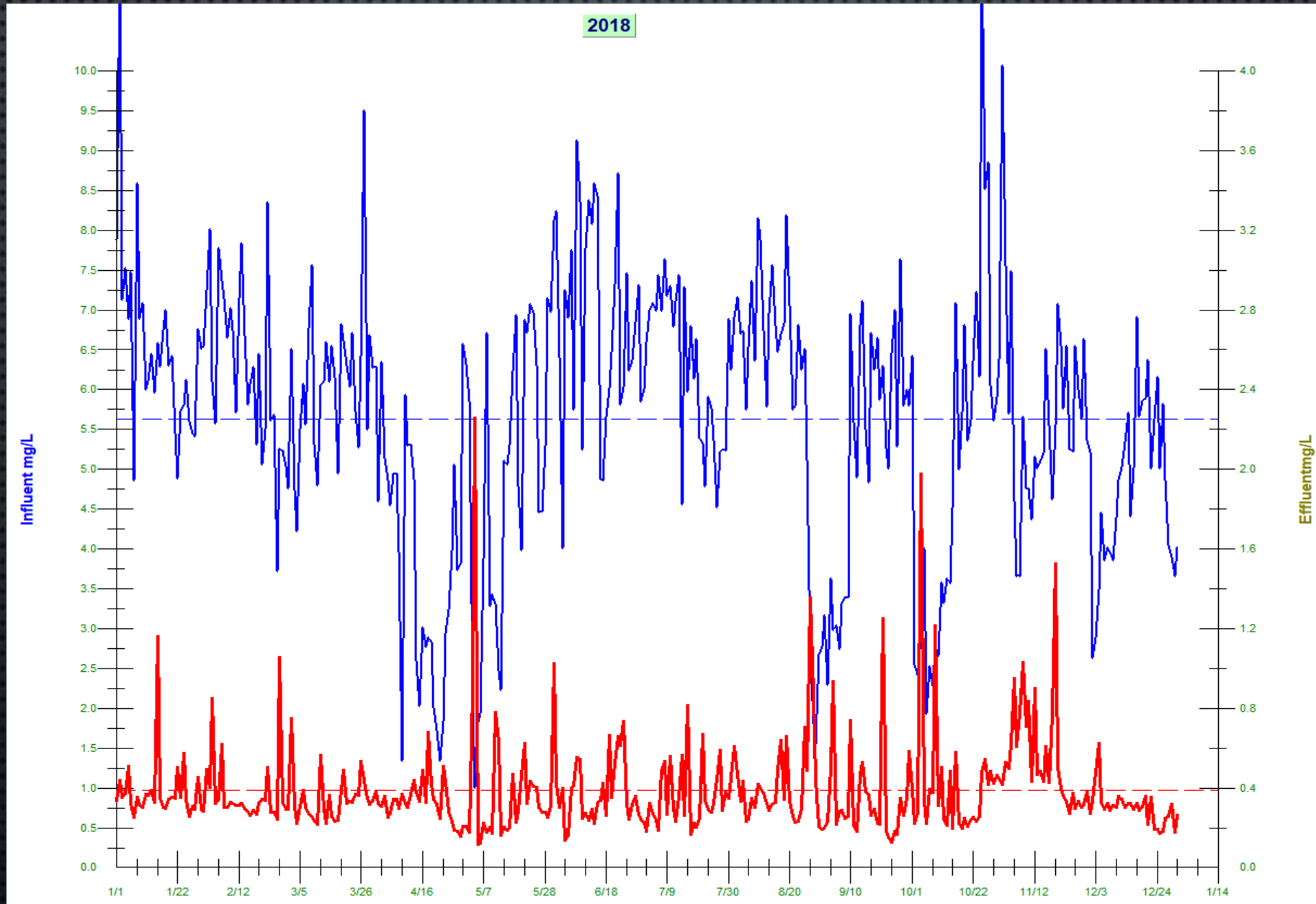
DRAFT WASTE LOAD ALLOCATIONS

- 6 MONTH AVG.
 - 0.19MG/L
 - 17.366LB/DAY
- BETTER, BUT STILL UNABLE TO MEET THOSE LIMITS UNDER CURRENT CONDITIONS

OSCAR SYSTEM

- AMMONIA BASED AERATION CONTROL
 - MINIMUM D.O. – AIR PULSE MODE
 - SNDN – SIMULTANEOUS NIT/DENIT
 - NO NEED FOR NITRATE RECYCLE PUMPS – TRUE ANAEROBIC ZONE
-
- WAS NOT FULLY INSTALLED UNTIL 9/2019

PHOSPHORUS



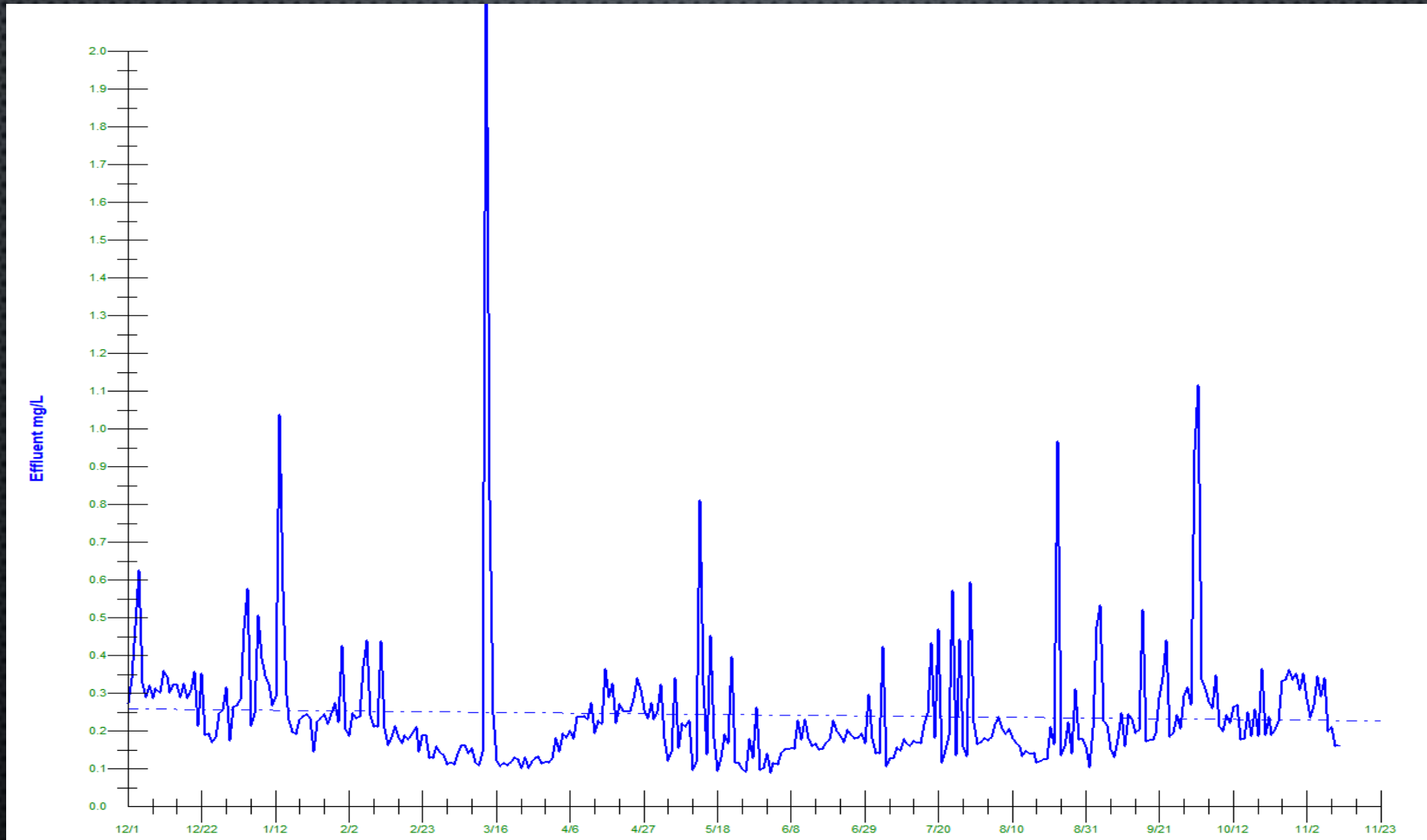
2019

DEAMMONIFICATION



- HSW RECEIVING – LOCAL BUSINESS
- COST AVOIDANCE/POSTPONEMENT OF 4TH AERATION BASIN
- REDUCE MAINSTREAM AMMONIA LOAD BY 35%
 - ENERGY SAVINGS
- MORE CARBON AVAILABLE FOR BIO-P
- LESS NITRATE TO REMOVE

HAS DEAMMONIFICATION IMPACTED PHOSPHORUS REMOVAL?



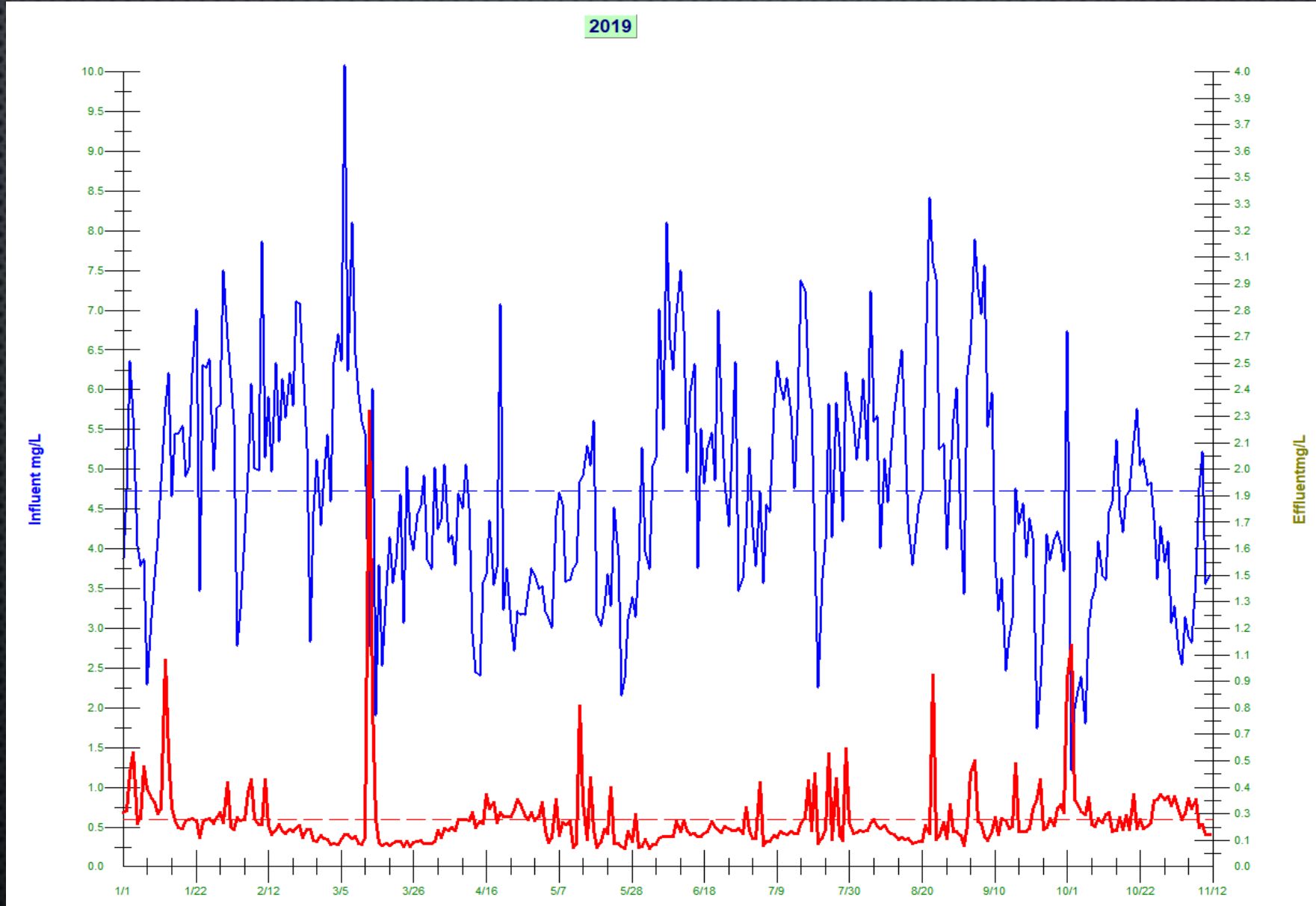
BIO-P

- NEW CARBON SOURCE FEED PUMP
- VOLUME OF SOURCE INCREASED – CONTINUOUS FEEDING
- CLOSED ALL FOUR HOLES AT BOTTOM OF BAFFLE WALL IN ONE TRAIN
- INCREASED THE HEIGHT OF THE BAFFLE WALL ALL THE WAY ACROSS – CASCADE EFFECT
 - ELIMINATES O₂ FROM BACK FEEDING INTO ANAEROBIC ZONE
- EXPERIMENTING WITH DIFFERENT MIXING TIMES

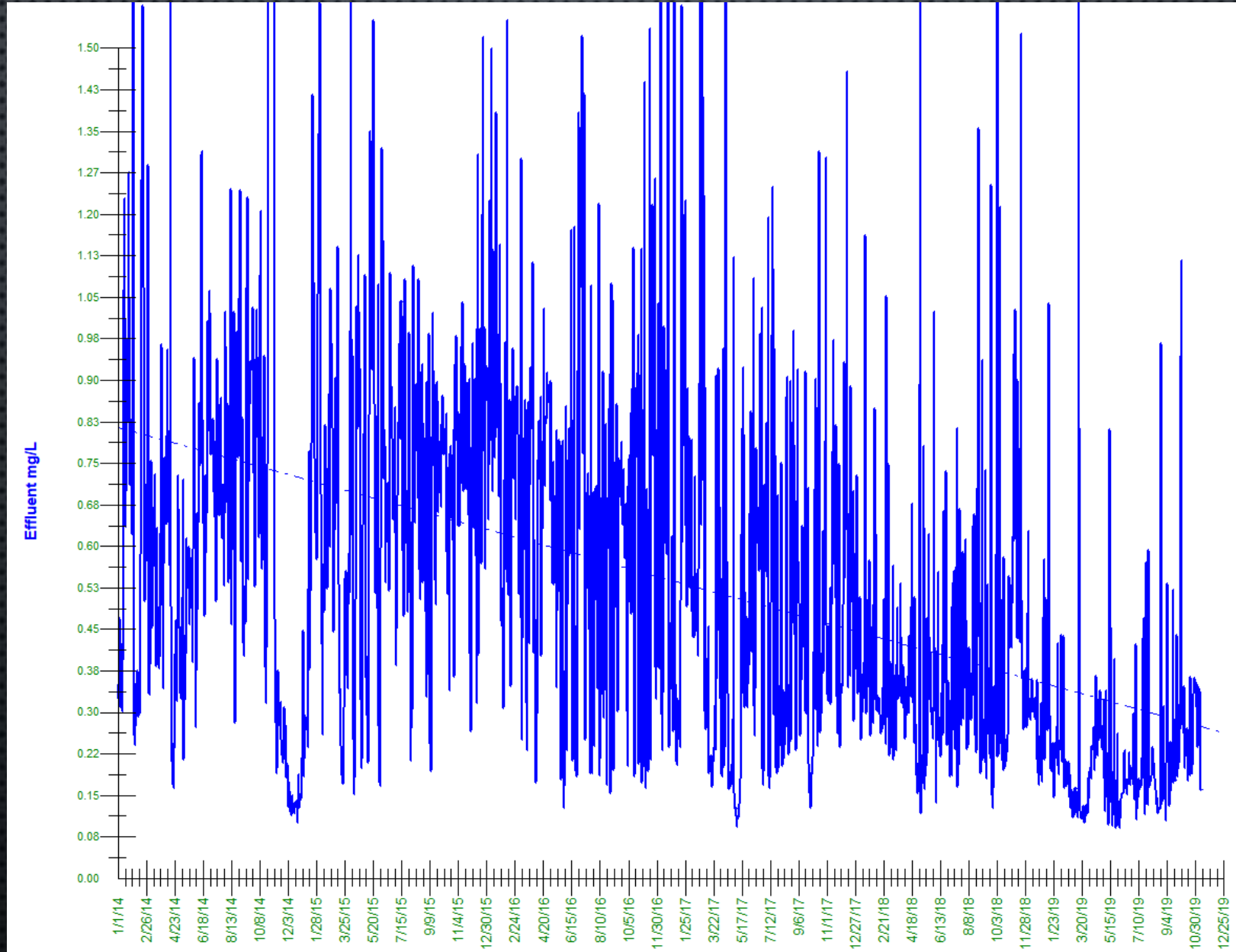


PHOSPHORUS

2019



EFFLUENT PHOSPHORUS



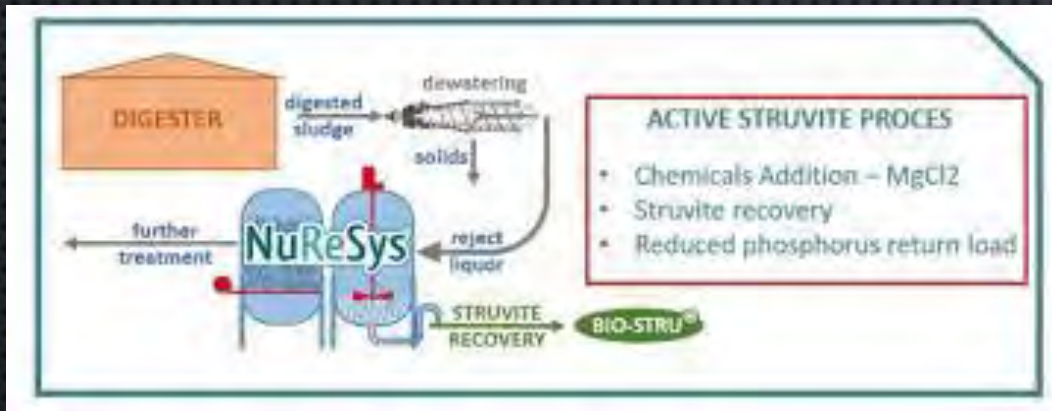
FACILITY MASTER PLAN

- ADDRESSES THE NEXT 15-20 YEARS OF OPERATION
- ADDRESSING PHOSPHORUS IS #1
 - LOOK AT PLANT CAPACITIES
 - I/I
 - BIOSOLIDS
 - BIOGAS
 - NITROGEN
 - PFAS
- CURRENTLY WORKING ON WATERSHED EVALUATION
- PLAN COMPLETION END OF 1ST QTR 2020

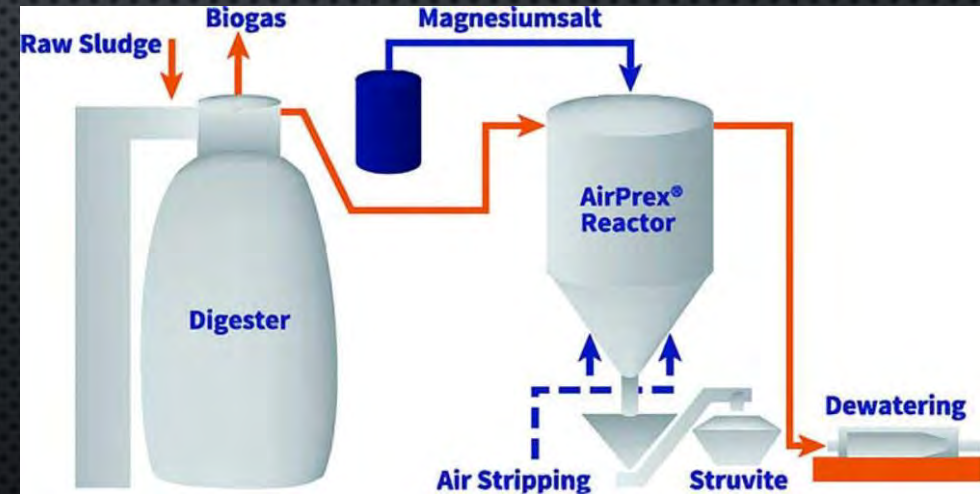
DOWN THE ROAD

STRUVITE SEQUESTRATION: CONSTRUCTION 2020

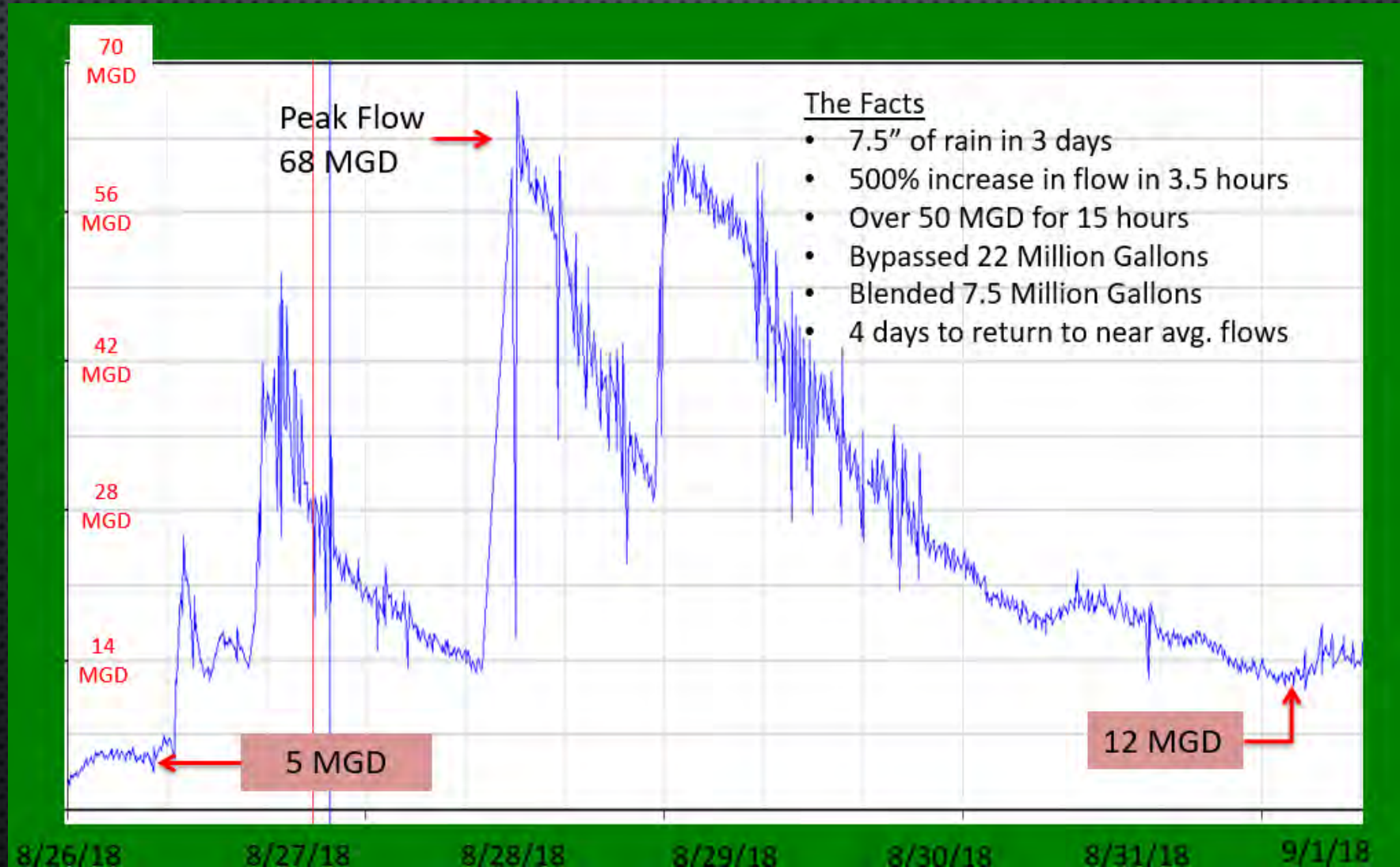
SCHWING/BIOSET NURESYS



CNP AIRPREX



ADDRESSING I/I



WHAT DO WE KNOW NOW?

- THE CAPABILITIES OF OUR LAB AND DESIRE TO UNDERSTAND MORE ABOUT PHOSPHORUS HAS INCREASED OUR UNDERSTANDING OF WHAT IT WILL TAKE TO ACHIEVE FUTURE LIMITS AND AID OTHER COMMUNITIES TOWARDS THAT COMMON GOAL
- MONITORING EQUIPMENT WITH PROPER CONTROL LOGIC CAN BE BIG \$\$ SAVERS
- EVEN WITH DRAFT WLAs WE WILL STILL NEED TO CHOOSE A COMPLIANCE OPTION
- TERTIARY TREATMENT TECHNOLOGIES
 - EXPENSIVE, BUT IT IS IMPROVING
 - CAPABLE OF ACHIEVING THE 0.04MG/L LIMIT
 - PROVIDES PEACE OF MIND THAT LIMIT CAN WILL BE MET
- COAGULANTS
 - JAR TEST/JAR TEST/JAR TEST – CHEAP OPTION TO SEE IF A TRIAL MAKES SENSE
 - CERIUM CHLORIDE FROM A COST STANDPOINT HAS NOT BEEN THE SOLUTION

WHAT DO WE KNOW NOW?

- DEAMMONIFICATION IS WORKING AS DESCRIBED
- STRUVITE SEQUESTRATION SHOULD DECREASE OUR SIDESTREAM OP TO THE MAINSTREAM
- STILL NO APPROVED TMDL— LESS THAN 3.5 YEARS TO PERMIT EXPIRATION

ACKNOWLEDGEMENTS

- FDL WTRRF STAFF
- JEREMY CRAMER
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