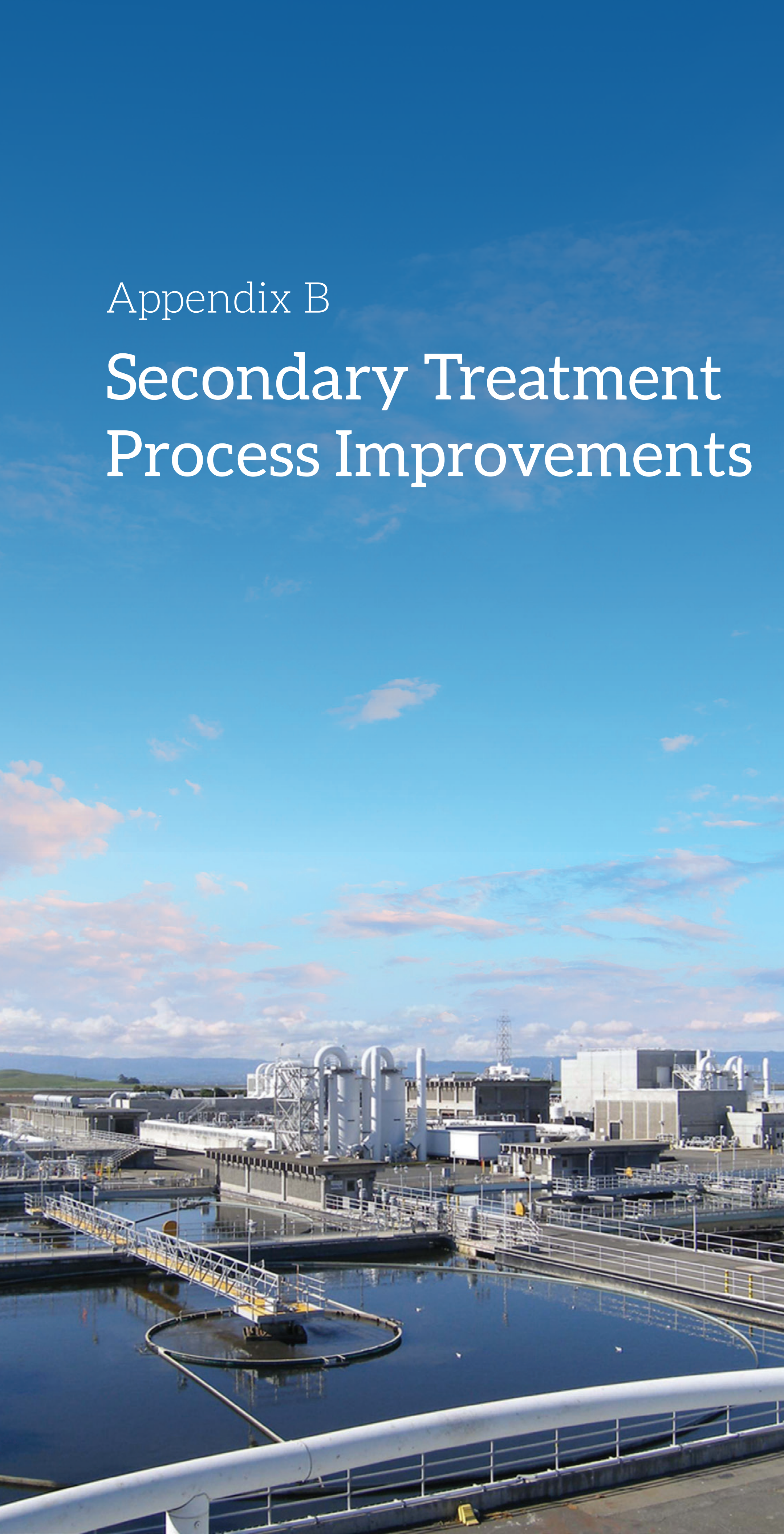

Appendix B

Secondary Treatment Process Improvements

B

Union Sanitary District’s
Enhanced Treatment and Site Upgrade Program

August 2019

To: Union Sanitary District: Curtis Bosick, PE, and Raymond Chau, PE

From: Hazen: Paul Pitt, PE, and Irene Chu, PE

Reviewed By: Hazen: Marc Solomon, PE

Re: Secondary Treatment Process Improvements Final Report

Secondary Treatment Process Improvements

Final Report

Revision No.	Date	Description	Author	Reviewed
1	4/29/2019	Draft Report for Review	I. Chu, P. Pitt	R. Latimer A. Griborio J. Rohrbacher M. Solomon
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3	5/31/2019	Draft Report for District Review	I. Chu	District
4	7/11/2019	Final Report with District Comments	I. Chu	M. Solomon P. Pitt
5	8/15/2019	Final Report with District Second Round of Comments	I. Chu	M. Solomon

Table of Contents

List of Appendices

1. Historical Data Analysis
2. Assumptions / Scenarios Document
3. BioWin™ Sampling Results
4. BioWin™ Model Calibration
5. Clarifier Field Testing
6. Clarifier Model Calibration Results
7. Comprehend Phase Workshop Presentation and Minutes
8. Explore Phase Workshop Presentation
9. District Notes
10. Converge Phase Workshop Presentation and Minutes
11. Cost Estimate
12. Follow-up Converge Phase Workshop Presentation

List of Tables

List of Figures

Hazen

List of Abbreviations

Abbreviation	**Meaning**
AA	Average Annual
AACE	American Association of Cost Engineers
AAF	Average Annual Flow
ADWF	Average Dry Weather Flow
AWWTP	Alvarado Wastewater Treatment Plant
BACWA	Bay Area Clean Water Association
BNR	Biological Nutrient Removal
C	Celsius
CAS	Conventional Activated Sludge
cBOD	Carbonaceous Biochemical Oxygen Demand
CCT	Chlorine Contact Tank
CFD	Computational Fluid Dynamics
COD	Chemical Oxygen Demand

Conc	Concentration
d	Day
EBDA	East Bay Dischargers Authority
EBRPD	East Bay Regional Park District
EQ	Equalization
ft	Foot
gfd	Gallons per Square Foot per Day
gpd	Gallons per Day
lbs	Pounds
lbs/d	Pounds per Day
lbsN/d	Pounds per Day of Nitrogen
lbsP/d	Pounds per Day of Phosphorus
M	Million
mgd	Million Gallons per Day
mg/L	Milligram per Liter
MBR	Membrane Bioreactor
MG	Million Gallons
ML	Mixed Liquor
MLE	Modified Ludzack Ettinger
MLSS	Mixed Liquor Suspended Solids
MM	Maximum 30-day
MW	Maximum 7-day
NH_3-N	Ammonia
NO_3-N	Nitrate
NO_2-N	Nitrite
NRCY	Nitrified Recycle
NTP	Notice to Proceed
OAC	Old Alameda Creek
P	Phosphorus
PE	Primary Effluent
PF	Peaking Factor
PFD	Process Flow Diagram
PO_4-P	Orthophosphate
RAS	Return Activated Sludge
sf	Square Foot
SOR	Surface Overflow Rate
SLR	Solids Loading Rate
SE	Secondary Effluent
SRT	Solids Retention Time
SSCAR	Solids System Capacity Assessment Report

SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SWAS	Surface Waste Activated Sludge
TIN	Total Inorganic Nitrogen
TKN	Total Kjeldahl Nitrogen
TMDL	Total maximum daily limit
TN	Total Nitrogen
TP	Total Phosphorus
TRC	Total Residual Chlorine
TSS	Total Suspended Solids
USD	Union Sanitary District
WAS	Waste Activated Sludge
WW	Wet weather

1. Introduction

The Union Sanitary District (District) owns and operates the Alvarado Wastewater Treatment Plant (AWWTP), a conventional activated sludge (CAS) plant. The AWWTP has an average dry weather flow (ADWF) of 23-mgd and is permitted through the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) to discharge 33-mgd ADWF to the East Bay Dischargers Authority (EBDA) common outfall. Under peak flow conditions the plant may discharge an average of 42.9-mgd over a 24-hour period to the EBDA outfall and up to 20-mgd to the Hayward Marsh.

1.1 Process Description

Raw wastewater from the Irvington, Newark and Alvarado pump stations combines in the headworks building where it is measured and screened. Flow from the headworks is split by Control Box 1 to six square primary clarifiers (Primary Clarifiers 1-4 in the west and Primary Clarifiers 5 and 6 in the east). Primary Effluent (PE) is combined and distributed to the secondary treatment system by Control Box 2. PE from Control Box 2 is pumped by Primary Effluent Lift Station 1 (east) and 2 (west). Pumped PE is combined with Return Activated Sludge (RAS) just downstream of each lift station, and the MLSS is distributed to each aeration basin. The aeration effluent MLSS from the Aeration Basins 1-4 (east) and Aeration Basins 5-7 (west) are combined at Control Box 4 and subsequently split for distribution to the six square secondary clarifiers. Secondary Clarifiers 1-4 (west) are 90-ft in (inscribed) diameter and Secondary Clarifiers 5 and 6 are 120-ft in (inscribed) diameter. Effluent from the clarifiers is combined and disinfected in the chlorine contact tanks. Chlorinated effluent passes through polishing screens and is pumped via the EBDA pump station.

Effluent from the EBDA pump station is conveyed through the EBDA force main. A valve box on site allows pumped flow to be diverted to Old Alameda Creek (OAC) in certain discharge situations. The District discharges to Old Alameda Creek during annual testing of the emergency system but has not discharged in an emergency capacity since the 1990's. Downstream of the valve box, flow can be diverted from the EBDA force main at a location off-site to the Hayward Marsh. Flow to Hayward Marsh is dechlorinated in the line to the Marsh. Flow conveyed to the EBDA outfall is dechlorinated at EBDA facilities.

1.2 Drivers for Project

The District has initiated the Enhanced Treatment and Site Upgrade Program to address several issues at the plant. The drivers for the project include:

1. Capacity Improvements
2. Wet Weather Effluent Discharge
3. Aging Infrastructure
4. Synergy with Future Nutrient Removal

1.2.1 Capacity Improvements

In 2017, the District performed a capacity analysis of the existing liquid treatment system to determine if the Alvarado WWTP has capacity to treat the permitted flow of 33-mgd. It was concluded that the WWTP is at capacity at current ADWF and cannot reliably treat peak hour flows due to poor settling of the activated sludge.

1.2.2 Wet Weather Effluent Discharge

The Hayward Marsh, owned and operated by the East Bay Regional Park District (EBRPD), receives and further polishes, AWWTP plant effluent that is not discharged to the EBDA outfall. During dry weather, approximately 2.6-mgd of AWWTP effluent is pumped to Hayward Marsh as a fresh water source for the Marsh. During wet weather, AWWTP can discharge up to 42.9-mgd, daily average flow total; flows greater than this are diverted to the Hayward Marsh. EBRPD has decided to imminently convert the Hayward Marsh to a recreational facility. As such, the District needs a wet weather effluent discharge alternative to the Hayward Marsh.

1.2.3 Aging Infrastructure

In addition to the capacity, effluent, and nutrient removal drivers, the AWWTP is also facing aging infrastructure drivers. While upgrades to the various systems have been completed, major infrastructure repairs are still required. A structural evaluation completed in 2013 noted that the east aeration basin covers need repair. Several of the buildings at the AWWTP need significant seismic repairs. The <u>Enhanced Treatment and Site Upgrade Project</u> affords the District the opportunity to address these aging infrastructure drivers while addressing the capacity and effluent disposal needs.

1.2.4 Synergy with Future Nutrient Removal

The District is currently permitted to discharge to Old Alameda Creek if flow to EBDA and the Hayward Marsh is maximized. With the future loss of the Hayward Marsh as a secondary discharge point, the District is interested in permitting the Old Alameda Creek discharge point to discharge effluent flows greater than 42.9-mgd. Initial discussions with SFBRWQCB indicated that the Board may permit more frequent discharge to Old Alameda Creek if the District achieves some level of nutrient removal at AWWTP. While the degree of nutrient removal required for discharge to Old Alameda Creek is currently being evaluated, nutrient removal has been accommodated for in the <u>Enhanced Treatment and Site Upgrade Program</u>.

The District wishes to address the immediate drivers (capacity, effluent disposal and aging infrastructure), while preparing for potential future nutrient regulations such as BACWA (Bay Area Clean Water Association) Level 2 standards. The District understands that planning for future nutrient removal while developing the <u>Enhanced Treatment and Site Upgrade Program</u> will minimize stranded assets.

1.3 Context of other Projects

The Secondary Treatment Process Improvements described in this report are a subset of the Enhanced Treatment and Site Upgrade Program. The improvements have been developed in context of several ongoing or recently completed studies and projects. These include the following:

- The overall Enhanced Treatment and Site Upgrade Program
- Standby Power Generation System Project
- Primary Digester No. 7 Project
- Odor Control Alternatives Study
- Plant Solids System/ Capacity Assessment Report (SSCAR)

Where appropriate this analysis utilized and or built upon the information from these reports.

1.4 Purpose of this Document

The purpose of this report is to document the approach, assumptions and analysis to derive the best value solution for the District. This report will summarize the recommended project elements, sequencing and AACE Class IV level estimate of probable construction cost.

2. Approach

The following section describes the approach to arriving at the best-value solution for the Secondary Treatment Process Improvements to address the near-term and long-term drivers.

2.1 Historical Data Analysis

Five years of plant data were analyzed to develop the current influent flows, loads and peaking factors at the plant. Statistical analysis was performed to remove outliers from the calculations. Current flows and loads were escalated to develop design flows and loads. The current and design flows and loads are summarized in **Section 4 – Assumptions** and in **Appendix 2.**

Ten years of historical data was analyzed to understand plant performance. Loads, mass balances, and process calculations were performed. This data is summarized in **Section 3 – Historical Data and Special Sampling** and presented in detail in **Appendix 1.**

2.2 Process Modeling Tools

A whole plant process model and two computational fluid dynamics (CFD) models of the secondary clarifiers were used to evaluate alternatives for the Secondary Treatment Process Improvements.

2.2.1 Process Modeling

A BioWin™ version 4.1 process model of the Alvarado Wastewater Treatment Plant was developed for District as part of the Plant Solids System/Capacity Assessment Report. The process model was updated to BioWin™ version 5.3 as part of this Secondary Treatment Process Improvements analysis. A calibration check was performed during the update. The calibration check is presented in **Appendix 4**.

To support the process model calibration, special sampling was performed to supplement the routine process samples taken historically. This data is summarized in **Section 3 – Historical Data and Sampling** and presented in **Appendix 3. Figure 2-1** shows the updated process model flow sheet.

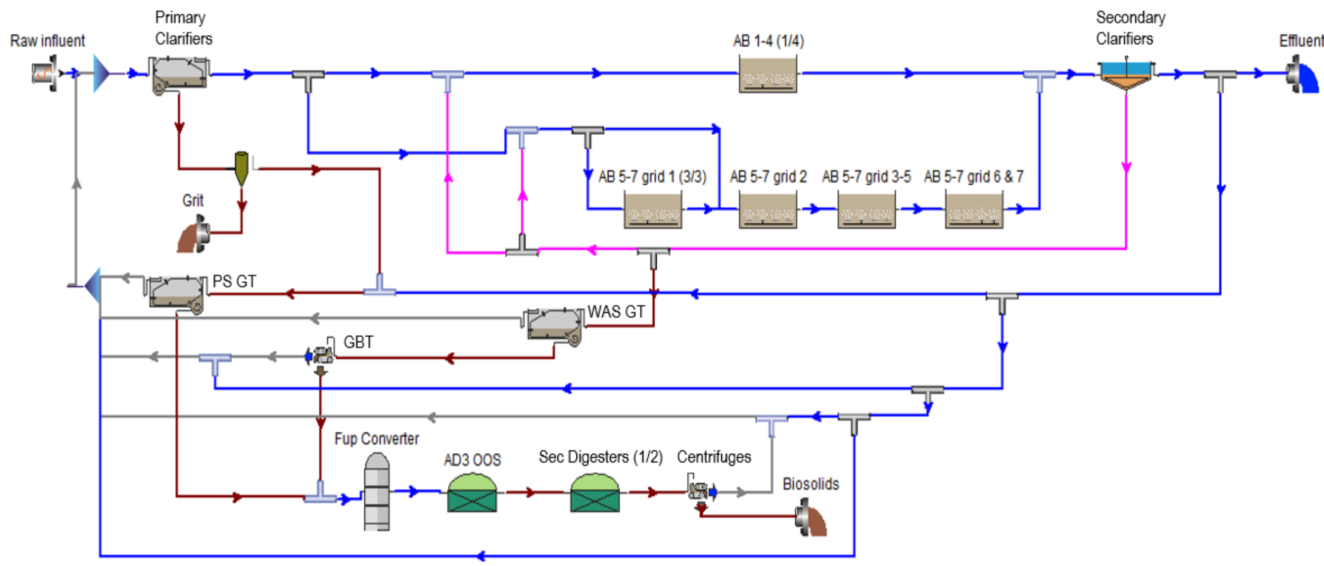


Figure 2-1 AWWTP Process Model

2.2.2 Computational Fluid Dynamic Modeling

Both a two-dimensional (2Dc) model and three-dimensional (3D) CFD model were used as part of this analysis. The 2Dc CFD model used in this project was developed at the University of New Orleans (McCorquodale et al. 2005, Griborio and McCorquodale 2006) while the 3D model was developed by Hazen (Griborio 2017). The models were customized to the dimensions and characteristics of the Alvarado WWTP secondary clarifiers. The governing equations for the model are based on the following principals: (1) continuity or conservation of fluid volume; (2) conservation of momentum; (3) conservation of mass of solids; (4) conservation of thermal energy; (5) modified mixing length turbulence closure scheme; (6) non-Newtonian flow related to the solids ratio; (7) flocculation due to the rate of dissipation of turbulent kinetic energy, velocity gradients, differential settling and filtration; and (8) discrete, zone compression settling.

To support model development extensive field testing, including clarifier stress testing, was performed at the Alvarado WWTP. This data is summarized in **Section 3 – Historical Data and Special Sampling** and presented in detail in **Appendix 5.** Model calibration to this field data is presented in **Appendix 6**. Note that since the AWWTP has two different types of clarifiers two models were developed for calibration.

2.3 Phased Approach

As the District is balancing near-term and long-term needs, a phased or programmatic approach to the Secondary Treatment Process Improvements has the potential to attenuate capital improvements over time. The benefits of implementing a phased approach is that later phases can be implemented when needed, preventing overbuilding. This is particularly useful for the District as timing of near-term drivers are well-defined, but the scope and timing of long-term drivers are not. Therefore, developing a trigger-based program optimizes capital expenditure for the District.

Table 2-1 Timing of Near-Term and Long-Term Needs

Need	Estimated Timing
Capacity	Presently
Aging Infrastructure	Presently
Discharge to Old Alameda Creek	1-2 Years
Nutrient Standards (BACWA Level 2)	15-20 years
Buildout Capacity (average annual flow = 33-mgd)	~30 years
More Stringent Nutrient Standards (BACWA Level 3)	~30+ years

Meeting the BACWA Level 2 nutrient standards was defined as a reasonable long-term goal for the program. The infrastructure to meet BACWA Level 2 standards for 2040 flows and loads is defined as Phase II presented in detail in **Section 6 – Long-term Solution Options**.

Adequate space was also identified to address potential future needs for more stringent nutrient standards (i.e. BACWA Level 3) for an annual average flow of 33-mgd (buildout conditions). **Section 6** documents, at a high level, a Phase III project to meet BACWA Level 3 standards for buildout conditions. This infrastructure is considered conservative place holder. It is recommended that as the analysis for and the definition of a Phase III project be revisited as technologies change, the standards become better defined, or as loading conditions warrant.

A subset of the long-term Phase II capital project, was defined for immediate implementation to address near-term needs; this was defined as Phase I. The potential Phase I and Phase II projects are discussed in **Section 7**. **Figure 2-2** illustrates the approach of defining a reasonable long-term solution (Phase II), working backwards to meet near-term goals (Phase I), and having a conservative place holder for potential needs in the far future (Phase III). Note that for this analysis costs were determined for Phase I (near-term) and Phase II (BACWA Level 2 standards for 2040 Loads) projects but not Phase III (BACWA Level 3 standards for buildout conditions). Costs are detailed in **Section 8 – Estimate of Probable Costs**.

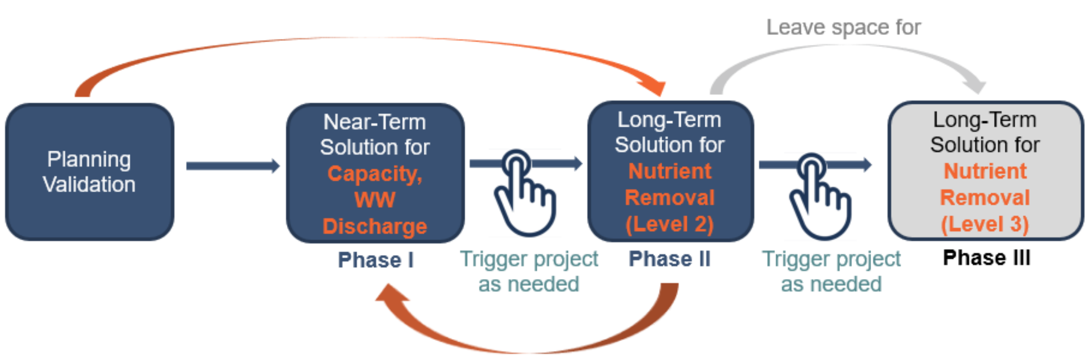


Figure 2-2 Trigger-Based Approach

3. Historical Data and Special Sampling

Ten years of historical data was analyzed to understand plant performance. Loads, mass balances, and process calculations were performed. Key parameters are summarized in this section and presented in **Appendix 1.**

Two plant specific models were developed to conduct the analysis of the AWWTP, the process model and the CFD models (2D and 3D). To support the process model calibration, special sampling was performed to supplement the routine process samples taken historically. To support the CFD model development extensive field testing, including clarifier stress testing, was performed. Key parameters are summarized in this section and presented in detail in **Appendix 3** and **Appendix 5** for the process model sampling and clarifier field testing respectively.

3.1 Historical Data Analysis

3.1.1 Influent Flows and Loads

Total plant flow may be calculated two ways at the AWWTP:

1. EBDA flow meter
2. Total influent flow as the sum of east and west partial flumes located at the headworks

The District has the noted that the EBDA flow meter is considered to be more accurate estimate of total plant flow measurement. This flowmeter was used in the analysis presented in this report. **Figure 3-1** shows the average daily EBDA Flow from 2008 to 2018.

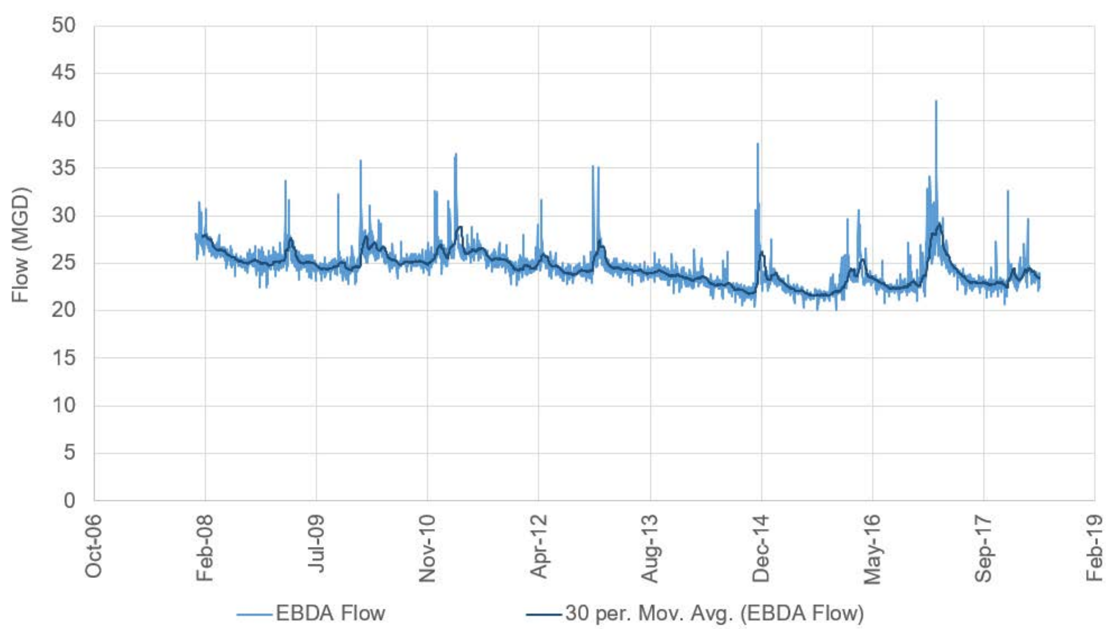


Figure 3-1 Historical Plant Flow

The average daily flow for this period was 24.4-mgd. Influent flows have remained relatively constant with a decrease from 2012 to 2014. **Figure 3-2** to **Figure 3-5** present unsorted historical influent concentration and load calculated based on the EBDA flowmeter data.

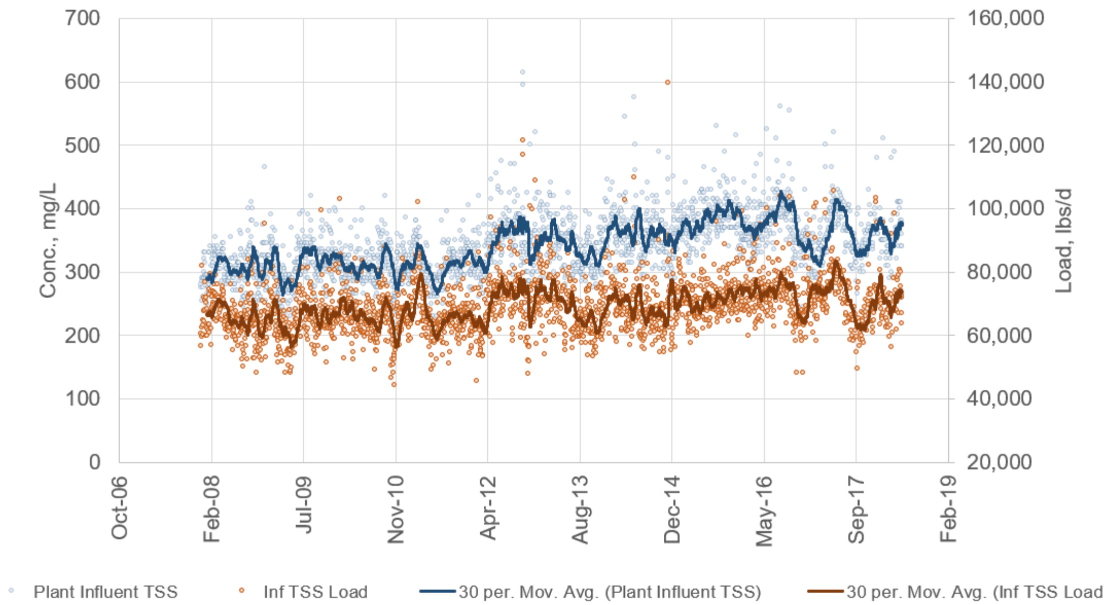


Figure 3-2 Historical Influent TSS Concentration and Load

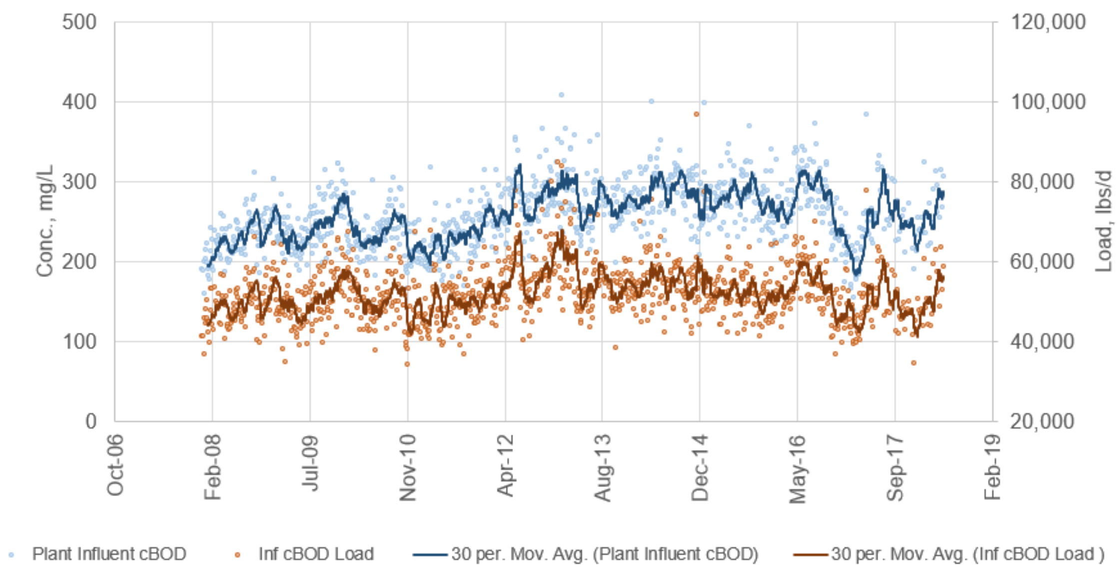


Figure 3-3 Historical Influent cBOD Concentration and Load

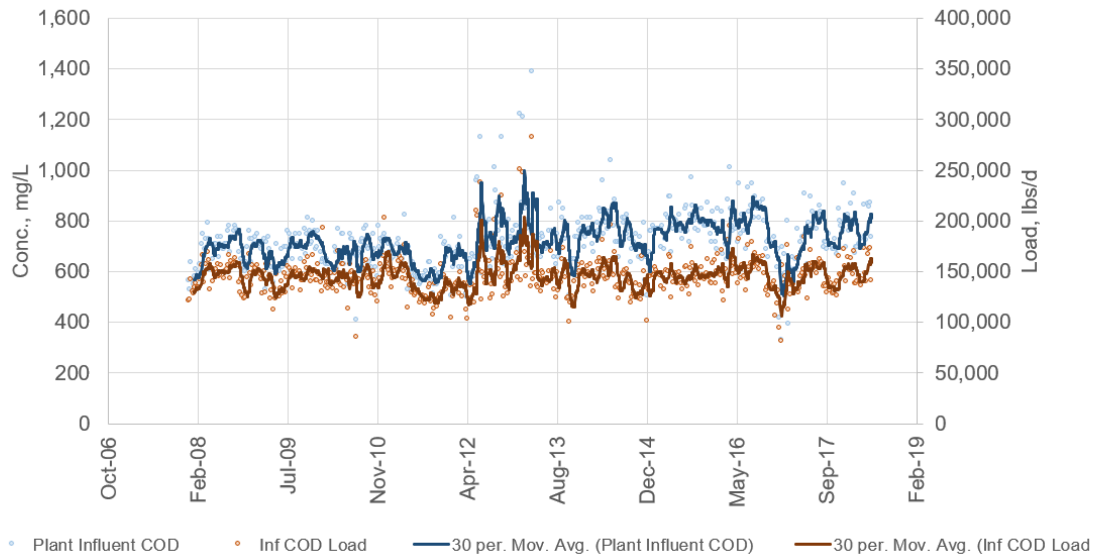


Figure 3-4 Historical Influent COD Concentration and Load

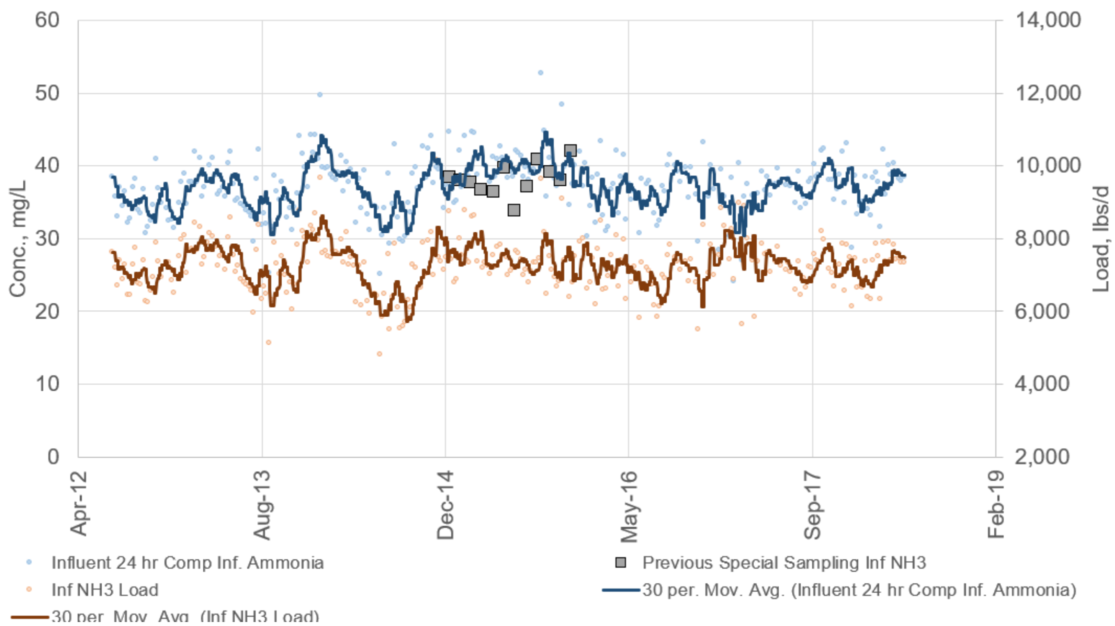


Figure 3-5 Historical Influent Ammonia Concentration and Load

While the data shows a slight increase in concentration and load from 2008 to 2012 for influent TSS, cBOD, and COD, the data shows relatively stable loads from 2012 – present. The limited influent ammonia also shows relatively stable loads from 2013 – present.

3.1.2 Sludge Settling Characteristics and MLSS

Due to the configuration of the aeration basins, the AWWTP typically operates with a high sludge volume index. **Figure 3-6** shows the historical SVI at the plant and **Table 3-1** summarizes the percentile data for SVI. The average SVI from 2008-2018 is 250 mL/g with the 90th percentile greater than 400 ml/g. The relatively high SVI at the plant has caused difficulties with settling at the plant. To address excessively high SVIs and improve settling, the plant at times applies hypochlorite to the RAS.

Table 3-1 Historical Sludge Volume Index Summary (2008-2018)

Percentile	SVI (mL/g)
50th	250
90th	404
95th	494
Flows >28-mgd	270

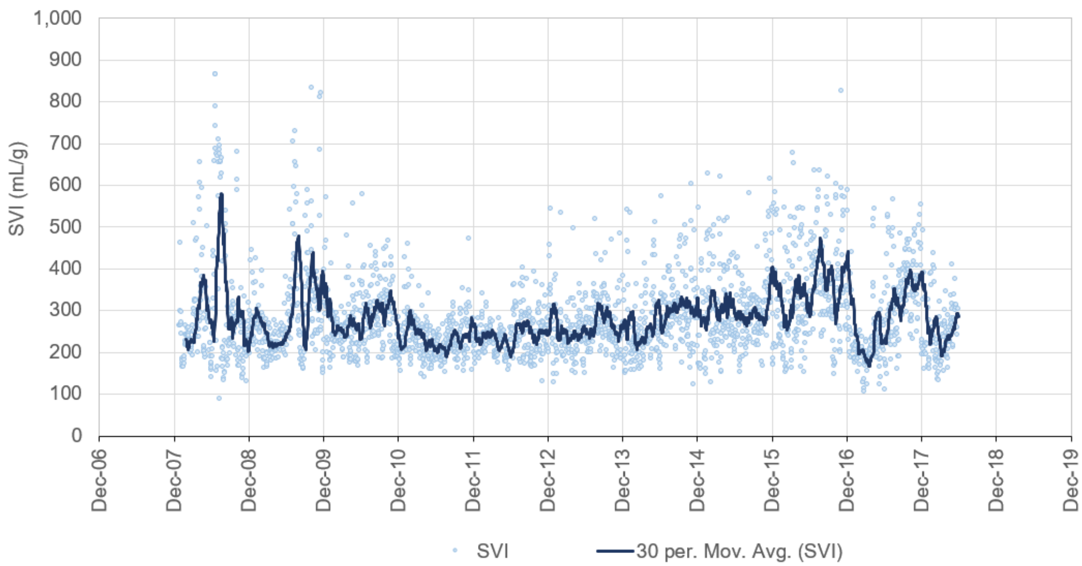


Figure 3-6 Historical Sludge Volume Index

Recently (2013-2018) the plant has operated with an average MLSS of around 1,300 ml/g (ranging between 1,200 mg/L and 1,500 mg/L) to maintain an aerobic SRT ~1.2 days for carbon removal. **Figure 3-7** shows the historical MLSS. While the MLSS results in a relatively low solids loading rate to the secondary clarifiers (7-10 lbs/d/sf on average), the relatively high SVI at the plant has caused difficulties maintaining effluent quality during storm events and effectively decreased the secondary capacity of the plant.

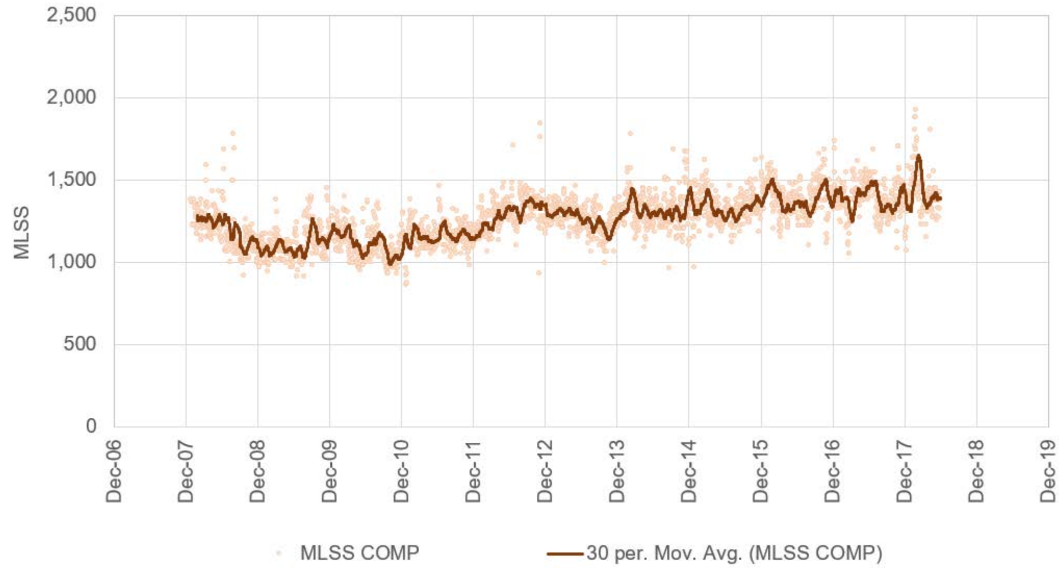


Figure 3-7 Historical MLSS

Despite the high historical SVI, the plant has maintained effluent quality and met effluent standards. **Figure 3-8** and **Figure 3-9** show the AWWTP historical effluent TSS and BOD respectively.

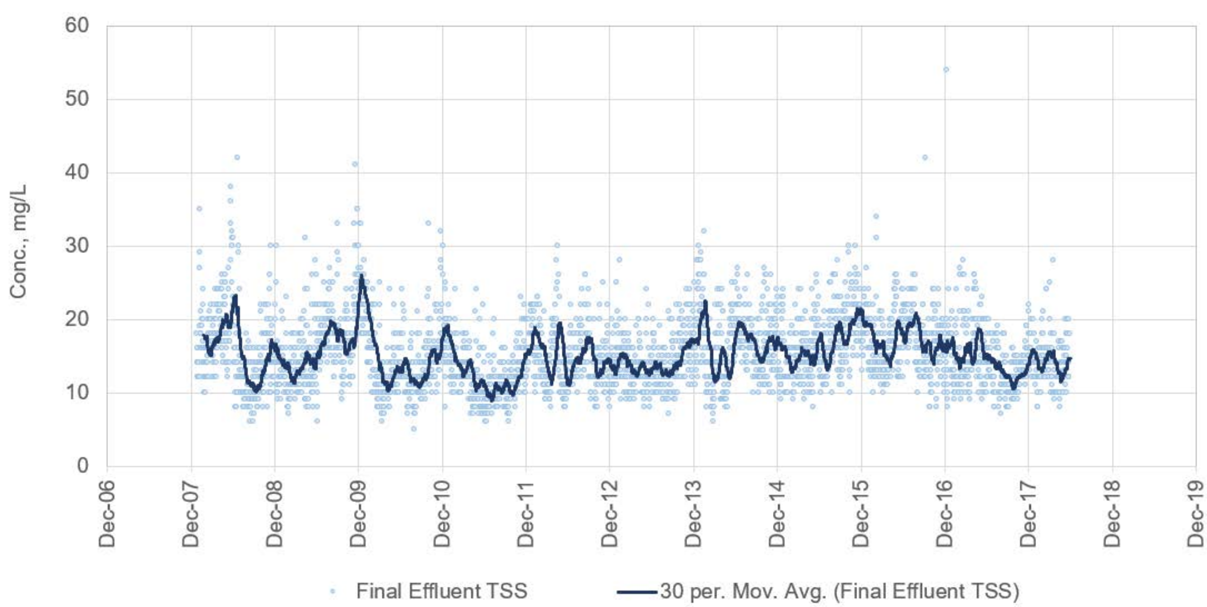


Figure 3-8 Historical Effluent TSS

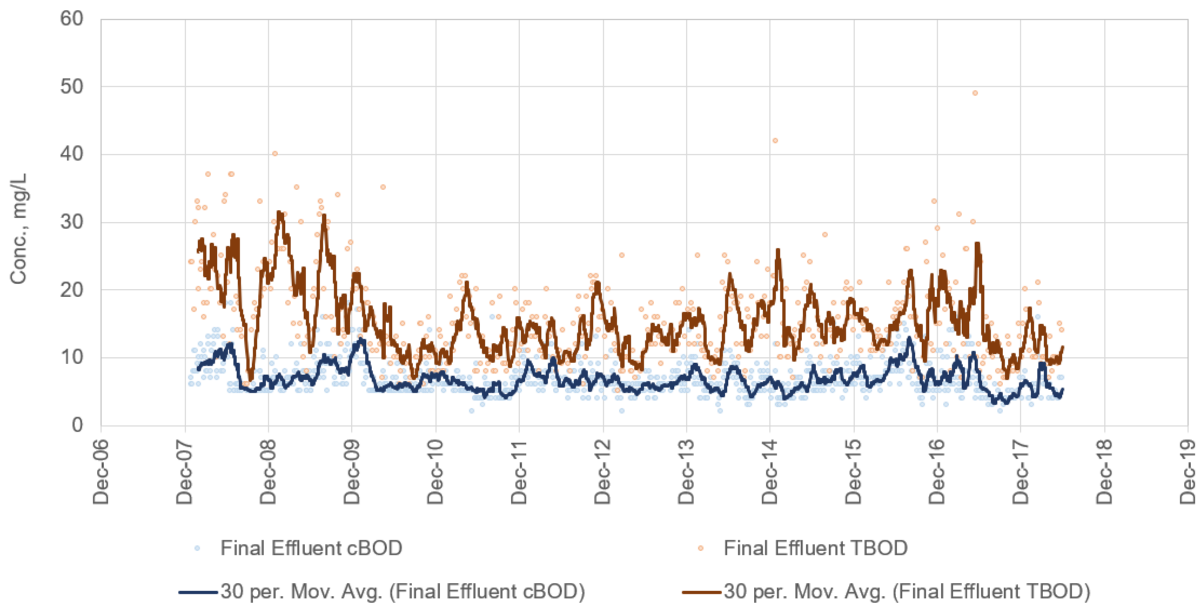


Figure 3-9 Historical Effluent BOD

The plant had a few instances with high effluent TSS, greater than 30 mg/L, and high effluent cBOD, greater than 25 mg/L. The monthly and weekly averages during these instances met permit standards. As noted in **Section 1** a driver for this project is to address capacity issues at the plant.

3.2 Special Sampling for Process Modeling

Special sampling to support the calibration of the whole plant process model was preformed from August 7 to August 13, 2018. The sampling included composite sampling, diurnal sampling and nutrient profiles (grab sampling). Key information is presented below.

3.2.1 Wastewater Influent

Influent composite samples were analyzed for BOD, cBOD, TSS, VSS, TKN, NH_3-N, TP, and PO_4-P. The average of the special sampling is presented in **Table 3-2.** Where comparisons can be made to historical data, the special sampling data matched well with historical averages. This indicates that the special sampling results are of good quality.

Table 3-2 Influent Composite Sampling Results

Percentile	Sampling Average	Historical Average
BOD_5, mg/L	262	NA
$cBOD_5$, mg/L	226	257
COD, mg/L	737	721
TSS, mg/L	332	341
VSS, mg/L	304	NA
TKN, mg/L	54	53
NH_3-N, mg/L	37	37
TP, mg/L	6.9	6.9
PO_4-P, mg/L	3.1	NA[1]

[1] Sampling conducted in 2016 to support the HDR watershed permit reporting included soluble reactive phosphate. This data was not included in this average.

The influent ammonia to TKN ratio was found to be 0.68. The COD to TP ratio was found to be 108 (mg/L COD)/(mgP/L). These ratios were used to develop influent nutrient loads based on historical data COD and ammonia data.

3.2.2 Wastewater Effluent

Effluent composite samples were analyzed for cBOD, COD, TSS, TKN, NH_3-N, and TP. **Table 3-3** shows the effluent composite special sampling results.

Table 3-3 Effluent Composite Sampling Results

Percentile	Sampling Average	Historical Average
COD, mg/L	48	51
TSS, mg/L	13	16
NH_3-N, mgN/L	40	39
TKN, mgN/L	44	46
TP, mgP/L	3.2	2.6

The special sampling results showed excellent agreement with historical average. The data shows there is not nitrification at the plant.

3.3 Clarifier Field Testing for Development of CFD Models

Clarifier field testing to support the calibration CFD model development was conducted from August 20 to August 24, 2018. The conditions of the testing are summarized in **Table 3-4**. On Day 3 and 4 of testing, clarifiers were gradually taken out of service to increase the surface overflow rate (SOR). On Day 3 a peak hour SOR of 1,350 gpd/sf was achieved by isolating east clarifiers. On Day 4 a peak hour SOR of 1,100 gpd/sf was achieved by isolating west clarifiers. Throughout testing the sludge volume index was between 250 and 400 mL/g.

Table 3-4 Clarifier Stress Testing Conditions

Parameter	Units	Day 1	Day 2	Day 3	Day 4	Avg.
MLSS	mg/L	1,030	1,100	940	900	1,000
SVI	mL/g	285	255	300	380	305
SLR	ppd/ft^2	6.9	7.2	9.7	8.5	8.0
RAS Rate	%	38%	37%	37%	37%	37%
Avg. SOR	gpd/ft^2	610	590	1,000	870	--
Max. SOR	gpd/ft^2			1,350	1,100	

A summary of clarifier performance during testing is presented in **Table 3-5**. Testing showed that the east clarifiers preformed more poorly than the west clarifiers. Clarifier 6 was pushed to failure on Day 4 causing the test to end at noon. The dynamic performance of the clarifiers during the testing was used for calibration and validation of the CFD models. **Figure 3-10** shows Clarifier 6 during stress testing.

Table 3-5 Clarifier Stress Testing Results

Parameter	Units	Day 1	Day 2	Day 3	Day 4	Avg.
C1	mg/L	13	11	11		12
C2	mg/L	11	11	11	15	12
C3	mg/L	9	10	12	17	12
C4	mg/L	11	10	12		11
ESS West	mg/L	11	11	11	16	12
C5	mg/L	15	12	14	17	15
C6	mg/L	16	14	18	31	22
ESS East	mg/L	16	16	16	24	18

Figure 3-10 Observed Loss of Solids at Clarifier 6 During Stress Testing

During testing it was found that Clarifiers 5 and 6 had leaking RAS seals. The amount of leakage during testing is not known. The clarifier RAS seals were fixed subsequent to testing in September and October of 2018.

4. Assumptions

The following section describes the assumptions used to frame analysis of the Secondary Treatment Process Improvements analysis.

4.1 Current Flows and Loads

A statistical analysis was performed on five years of plant historical data (June 2013 – May 2018) to determine flow and load peaking factors. For annual average (AA) peaking factors, data greater than two standard deviations were excluded from the calculation. For minimum day, maximum month, maximum 30-day (MM), maximum 7-day (MW), and maximum day (MD) values, data greater than three standard deviations were excluded from the calculations. Where appropriate, peaking factors were adjusted to account for drought years.

1. Current peaking factors for the daily effluent flow for the Alvarado WWTP are presented in **Table 4-1.**

Table 4-1 AWWTP Flows and Flow Peaking Factors

Flow Criteria	Historical	
	Flow (mgd)	Peaking Factor
Minimum Day	20.6	0.88
Average Annual	23.4	1.00
Maximum Month	25.8	1.10
Maximum 30-Day	25.9	1.11
Maximum 7-Day	28.5	1.22
Maximum Day	33.9	1.45

Annual average and maximum 30-day flows were used in this analysis. The maximum 30-day flow peaking factor was adjusted to 1.15 after excluding drought years from the average. This results in a more conservative maximum 30-day influent flow.

2. Current peaking factors derived from historical data for influent cBOD, TSS, COD, NH_3-N flow for the Alvarado WWTP are presented in **Table 4-2**.

Table 4-2 AWWTP Historical Average Load and Peaking Factors

Criteria	cBOD		TSS		COD		NH_3-N	
	Load (lbs/d)	PF	Load (lbs/d)	PF	Load (lbs/d)	PF	Load (lbs/d)	PF
Minimum Day	38,700	0.73	53,200	0.75	111,000	0.76	5,560	0.77
Average Annual	52,600	1.00	70,500	1.00	146,000	1.00	7,240	1.00
Maximum Month	59,200	1.13	76,800	1.09	159,000	1.09	7,920	1.09
Maximum 30-Day	60,500	1.15	78,900	1.12	166,000	1.13	8,190	1.13
Maximum 7-Day	66,900	1.27	89,100	1.26	166,000	1.13	7,670	1.06
Maximum Day	75,400	1.43	107,000	1.51	181,000	1.24	9,230	1.27

While the table shows the peaking factors derived from historical data, for this analysis, a 1.15 maximum 30-day peaking factor was used for cBOD, TSS, COD and NH_3-N.

4.2 Influent Nutrient Loads

The District is not required to and therefore does not typically sample influent Total Kjeldahl Nitrogen (TKN) or total phosphorus (TP). To estimate these influent loads, ratios observed during special sampling were used to develop influent loads. Note that while sampling for TKN was conducted in 2016 to support the HDR watershed permit, the ammonia to TKN ratio from special sampling was used to estimate TKN loads. **Table 4-3** summarized the estimated influent loads and ratios observed in special sampling.

Table 4-3 AWWTP Estimated Influent Nutrient Loads

	Load (lbs/d)	Note
Influent TKN	10,650	Special Sampling NH_3-N/TKN ratio= 0.68
Influent TP	1,350	Special Sampling COD/TP ratio= 108

4.3 Growth Assumptions

For consistency with other planning studies (Enhanced Treatment & Site Upgrade Program and Plant Solids System/Capacity Assessment Report), the following assumptions were used for growth.

- Assumption on growth for loads: 1% per year up to the design horizon.
- Assumption on growth for flows: 1% per year up to the design horizon.

4.4 Influent Hydrograph

The hydrograph used for modeling was based on observed hourly influent flow during the February 20, 2017 storm event. The hydrograph has been modified by the District to estimate actual plant flows if storage in the upstream sewers and discharge to Old Alameda Creek are not available. The adjusted peak hour (PH) flow during this storm was 64.7-mgd. **Figure 4-1** shows the adjusted hydrograph. The base flow of this hydrograph will be escalated by 1% per year according to the assumed flow increase. **Table 4-4** summarizes the peak hour flows for the two chosen design horizons and buildout conditions. When the average annual flow is 33-mgd, the peak hour flow will be 74.4-mgd. The Capacity Testing Program noted a hydraulic capacity of 85-mgd; however, this did not account for safety factors or process standards. The Plant Solids System/Capacity Assessment Report estimates a similar future peak hour flow for the plant of 72.3-mgd.

Table 4-4 AWWTP Peak Hour Flow

	Peak Hour (mgd)
Current	64.7
2028	67.1
2040	70.4
Buildout (AA flow = 33-mgd)	74.4

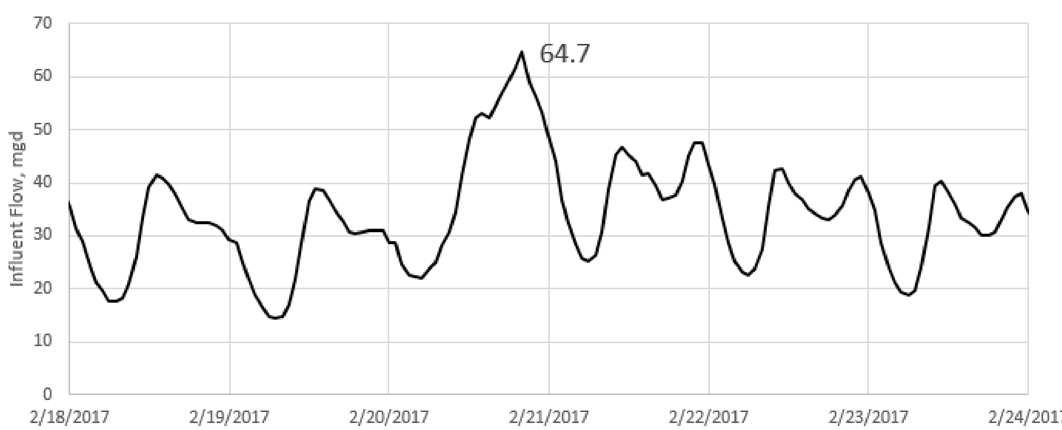


Figure 4-1 Influent Flow if Old Alameda Creek and Collection System Storage Eliminated

4.5 Design Horizons

As described in **Section 2** a trigger-based approach will be used to define the capital improvement program, split into Phase I and Phase II. A 2028 design horizon will be used to define Phase I. A 2040 design horizon will be used to define Phase II. The annual average and maximum month flows and loads for the 2028 and 2040 design horizon are presented in **Table 4-5**.

Table 4-5 Design Flows and Loads

		Current		2028		2040	
	Unit	AA	MM	AA	MM	AA	MM
Flow	mgd	23.4	26.9	25.8	29.7	29.1	33.5
Peak Flow	mgd	64.7	64.7	67.1	67.1	70.4	70.4
COD	lbs/d	146,000	167,900	161,300	185,500	181,700	209,000
BOD	lbs/d	52,600	60,500	58,100	66,800	65,500	75,300
TSS	lbs/d	70,500	81,100	77,900	89,600	87,800	100,900
TKN	lbs/d	10,650	12,240	11,800	13,500	13,250	15,240
NH_3-H	lbs/d	7,200	8,300	8,000	9,200	9,010	10,360
TP	lbs/d	1,350	1,560	1,490	1,720	1,680	1,940

4.6 Temperature

The District is not required to and therefore does not typically monitor wastewater temperature. Temperature from monthly grab samples from 2010 – 2015 showed the lowest recorded temperature was 16^{o}C. For this analysis the minimum week temperature is assumed to be 16^{o}C. The District has recently (as of October 2018) been recording plant influent temperature with an in-situ probe. The minimum temperature observed was 19^{o}C. If the minimum temperature is greater than the assumed minimum week temperature, effluent water quality will be better than the modeled water quality.

4.7 Effluent Standards

The plant currently has secondary standards for cBOD and TSS. These standards are summarized in **Table 4-6**.

4.7.1 Current Secondary Standards

Table 4-6 Current Effluent Standards

	Monthly	Weekly
cBOD, mg/L	25	40
TSS, mg/L	30	45

4.7.2 Potential Standards Negotiated for Old Alameda Creek Discharge

With the expected elimination of the AWWTP second discharge option, the Hayward Marsh, the District is currently discussing an alternative of discharging flows greater than 42.9-mgd to the Old Alameda Creek. While standards for Old Alameda Creek discharge are not yet defined, an average 15% TN removal over the year was used as an initial target for analysis. **Table 4-7** summarizes the assumed standards required for Old Alameda Creek.

Table 4-7 Assumed Old Almeda Creek Effluent Standards

Discharge point	Old Alameda Creek	Comment
Flows, mgd	0-22 mgd	> 43-mgd; year-round discharge
cBOD, mg/L	10	
TSS, mg/L	15	
TN, % removal	15	Annual load reduction
Ammonia, mg/L	2	Assuming no daily / weekly limit. BACWA monthly limit was assumed.

4.7.3 Potential Year-round Nutrient Standards

Nutrient limitations are not currently required for discharge to San Francisco Bay but are expected to be in place within the next two permit cycles. The draft administrative watershed permit that will be effective July 2019, requires dischargers to the San Francisco Bay to monitor and report nutrient levels in plant effluent. It is expected that the next permit cycle will introduce effluent nutrient load caps (capped at current loads plus an additional 10% to account for growth) with reductions in the following permit cycle.

Currently the level of nutrient removal that will be required when the limits are in place is not known. The Bay Area Clean Water Agency (BACWA) defined two levels of nutrient removal that were assumed for the Nutrient Reduction Study (June 2018) these are presented in **Table 4-8**. For this study, it is assumed that the District will need to comply with Level 2 nutrient standards by 2040. While Level 3 standards are not expected to be in place for many years, and are not the focus of this study, layouts and sizing were developed for these standards to ensure that space was available within the plant footprint to accommodate processes to meet these standards.

Table 4-8 BACWA Nutrient Reduction Study Effluent Standards

	NH_3-N mgN/L	TN mgN/L	TP mgP/L
Level 2	2	15	1
Level 3	2	6	0.3

These standards might be applied as a total maximum daily limit (TMDL), seasonally or monthly. For this analysis, the Level 2 standard was assumed to be a monthly average standard. Facilities were sized to meet this standard during the coldest month.

4.8 Wet Weather and Redundancy Operation

The District currently operates all secondary clarifiers during wet weather, but not all aeration basins. For future conditions, to maintain required aerobic solids retention times (SRTs) and reduce solids loading rates (SLRs) to the secondary clarifiers, it is assumed that all aeration basins and secondary clarifiers will be online during storm events.

Redundancy conditions were defined as one aeration basin or one secondary clarifier out of service during dry weather operation. The water quality for these redundancy scenarios was checked for each design horizon, 2028 and 2040 as well as current conditions. These scenarios are defined in **Table 4-9**.

Table 4-9 Wet Weather and Redundancy Operation

	Secondary Clarifier Redundancy	Aeration Basin Redundancy	Wet Weather
Flow, mgd	AA	AA	Design Hydrograph
Load, lbs/d	MM	MM	MM
Aeration Basin	All in service	Largest unit out of service	All in service
Secondary Clarifier	Largest unit out of service	All in service	All in service

5. Model Scenarios

The District considered two technologies for the Secondary Treatment Process Improvements a membrane bioreactor (MBR) system and a conventional activated sludge (CAS) system. The calibrated process model and CFD models were used to size the secondary treatment process to meet BACWA Level 2 standards for 2040 loads. This **Section 5** summarizes the key modeling results for the MBR and CAS options under several conditions as listed in **Table 5-1**.

Infrastructure upgrades to achieve this effluent quality and conceptual layouts are described in **Section 6**. The infrastructure for the CAS option can be phased as a function of future design requirements and these phasing options are described in **Section 7**. **Section 7** also describes the predicted performance of these interim conditions.

Table 5-1 Model Flow and Load Scenarios

Parameter	Abbreviation	Load Condition	Flow Condition
Average Annual	AA	AA	AA
Maximum Month	MM	MM	MM
Maximum Load, Annual Average Flow	MML-AAF	MM	AA
Aeration Basin Redundancy	1AB OOS	AA	AA
Secondary Clarifier Redundancy[1]	1SC OOS	AA	AA

[1]CAS option only

Table 5-2 summarizes the concentration and loads for each of the scenarios listed in **Table 5-1**.

Table 5-2 2040 Model Influent Flow, Loads and Concentrations

Parameter	AA		MM		MML-AAF		Redundancy - 1 AB OOS		Redundancy - 1 SC OOS[1]	
Flow, mgd	29		33		29		29		29	
Temp., °C	16		16		16		16		16	
	lbs/d	mg/L	lbs/d	mg/L	lbs/d	mg/L	lbs/d	mg/L	lbs/d	mg/L
cBOD[2]	77,000	270	88,500	270	88,500	310	77,000	270	77,000	270
COD	182,000	749	209,000	749	209,000	861	182,000	749	182,000	749
TSS[3]	85,500	362	98,000	362	98,000	416	85,500	362	85,500	362
TKN	13,300	55	15,300	55	15,300	63	13,300	55	13,300	55
NH_3	9,000	37	10,400	37	10,400	43	9,000	37	9,000	37
TP	1,690	6.9	1,940	6.9	1,940	8.0	1,690	6.9	1,690	6.9

[1]CAS option only
[2]Note that the model prediction for cBOD was 8% greater than the escalated historical "true BOD" (cBOD/0.84). This is considered acceptable given the COD match.
[3]Note that the model prediction for TSS is 2% higher than the escalated historical TSS load. This is considered acceptable.

5.1 MBR BACWA Level 2 2040 Modeling Results

The BACWA Nutrient Reduction Study (June 2018) recommended that the District adopt an MBR technology to achieve the BACWA Level 2 standards. The MBR would replace the clarifiers as solids separation technology. A process flow diagram of how the MBR would fit at the AWWTP is presented in **Figure 5-1**. Flow from the existing primary clarifiers would be combined into one primary effluent line that would lead to a central PE pump station where it is pumped up to fine screens. After the PE is screened it is distributed to the east (4.1 MG) and west aeration basins (proposed 4 basins totaling 4.4 MG) operated in an anoxic – oxic configuration (specific details on the aeration basin configurations is provided in **Section 6**). RAS from the MBR facility is delivered to each aeration basin by a RAS force main. MLSS from both basins is combined in a central MLSS junction box where it is conveyed to the new MBR facility. Permeate from the MBR facility is disinfected at the new effluent facilities that can accommodate flows to EBDA and OAC.

During wet weather PE can be equalized in the new PE equalization basin. The PE EQ pump station will drain the 2.5 MG PE EQ tank back to the fine screens for screening and distribution to the aeration basins.

Figure 5-2 shows the process model flow sheet. The process modeling for MBR sizing is summarized in **Table 5-3.** Key features include MBR tanks, increased RAS flow, and a RAS deoxygenation zone.

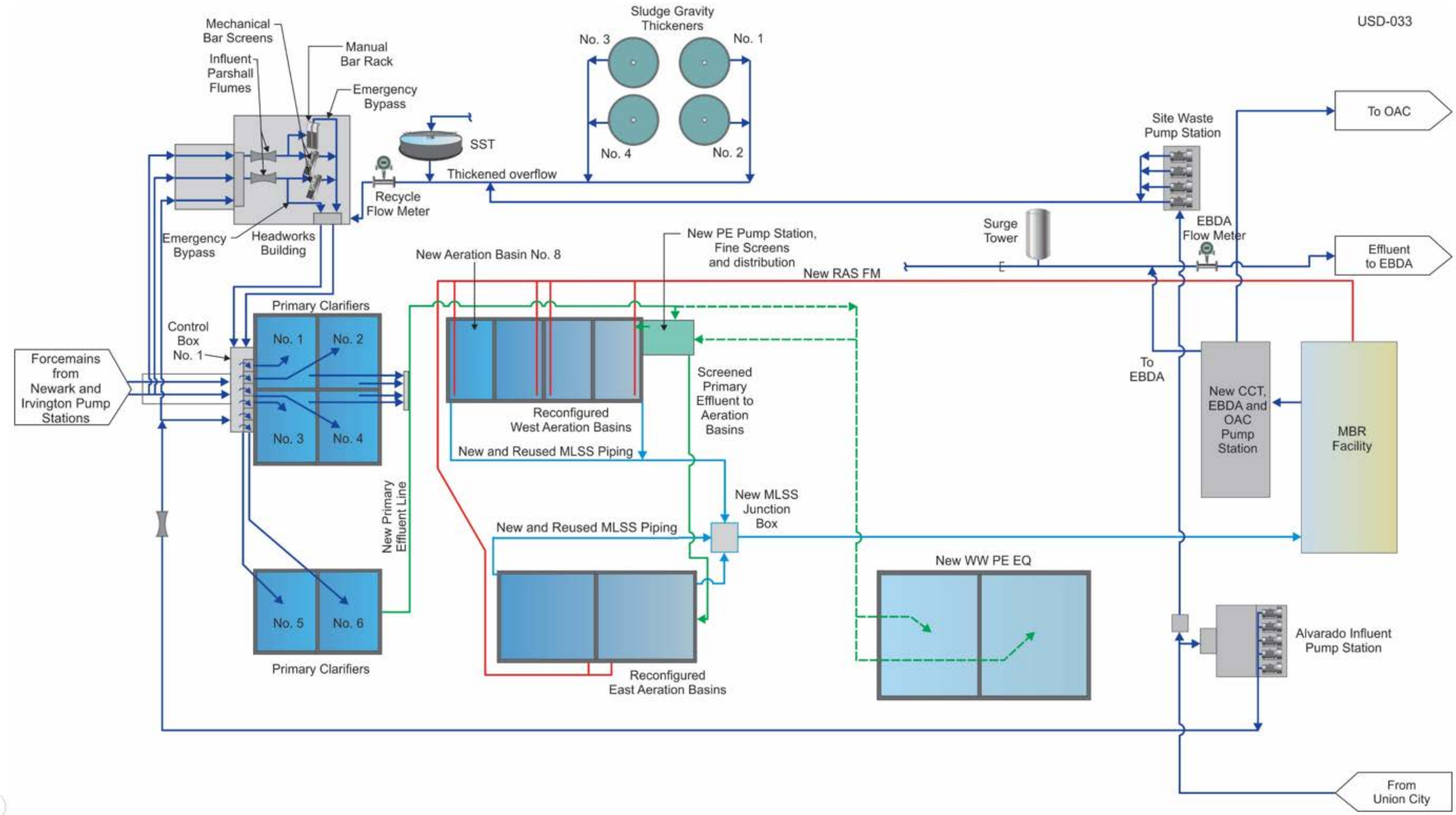


Figure 5-1 MBR BACWA Level 2 Process Flow Diagram

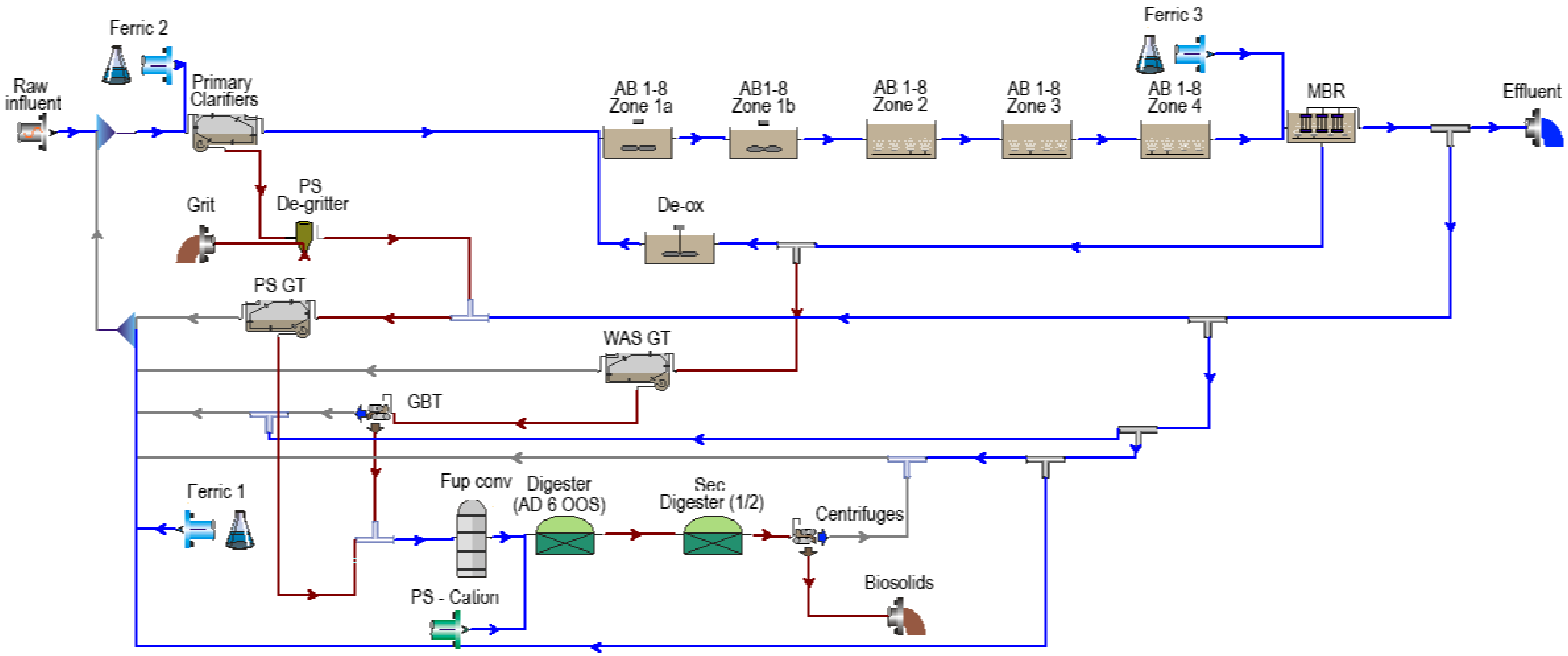


Figure 5-2 MBR Process Model

Table 5-3 MBR 2040 Load Model Results

	Parameter	Units	AA	MM	MML-AAF	Redundancy - 1 AB OOS
Aeration	AB in service	#	8	8	8	7
	MLSS	mg/L	7,300	7,700	7,700	8,000
	SRT	d	13	13	13	13
	Aerobic SRT	d	8	8	8	8
MBR Tanks	Trains in Service	#	9	9	9	8
	Total Cassettes	#	162	162	162	144
	Surface Area	Msf	3.10	3.1	3.1	2.7
	Design Flux	gsf	12.5	14.5	12.5	12.5
	Actual Flux	gsf	9.3	10.7	9.3	10.5
	RAS Ratio	%	400	400	400	400
WAS	WAS flow	mgd	0.47	0.48	0.48	0.43
	WAS conc	mg/L	9,200	9,000	9,800	10,100
	WAS Load	lbs/d	36,000	39,200	39,300	36,200
Secondary Effluent[1]	cBOD	mg/L	1	1	1	<1
	TSS	mg/L	0	0	0	<1
	TN	mgN/L	~11-12	~11-12	~12	~11-12
	NH_3	mgN/L	<0.5	<0.5	<0.5	<0.5
	NO_3	mgN/L	~9-10	~9-10	~9-10	~9-10
	NO_2	mgN/L	~0	~0	~0	~0
	TIN	mgN/L	~9-10	~9-10	~9-10	~9-10
	TP	mgP/L	<1	<1	<1	<1
	PO_4-P	mgP/L	<1	<1	<1	<1

[1] Average of Dynamic Modeling Results

5.2 CAS BACWA Level 2 2040 Modeling Results

The CAS option utilizes the same technology that exists at the AWWTP but converts the process from carbon removal to biological nutrient removal. **Figure 5-3** shows the proposed process flow diagram. To do this, additional aeration basin volume is proposed, and increased clarifier capacity is required. Similar to the MBR option, primary effluent is combined in one primary effluent line that leads to a central PE pump station. Pumped PE is distributed to three sets of aeration basins, AB 1-4 (4.1 MG), AB 5-8 (4.4 MG) and AB 9-12 (4.4 MG) operated in a Modified Ludzack Ettinger (MLE) configuration (specific details on the aeration basin configurations are provided in **Section 6**). PE is further distributed to the individual tanks by a common channel. RAS from the central RAS pump station is delivered to each aeration basin by a RAS force main. MLSS from all basins is combined in a central MLSS junction box where it is conveyed to the new MLSS splitter box. The splitter box feeds the four new circular clarifiers. Effluent is disinfected at the new effluent facilities that can accommodate flows to EBDA and OAC.

For the CAS option, there are two wet weather strategies that will help the AWWTP maintain BNR operation during wet weather, PE equalization and step-feed operation. During wet weather PE can be equalized in the new PE equalization basin. The PE EQ pump station will drain the 2.5 MG PE EQ tank back to the PE pump station for distribution to the aeration basins. The second strategy, step-feed operation, can be triggered when influent flow exceeds a trigger point (i.e. 45-mgd). In this mode, most (i.e. 100 – 75%) of the PE flow is diverted half way down the aeration basins to reduce solids loading to the secondary clarifiers and preserve the nitrifier population in the upfront zones. **Section 6** shows the step feed point for each aeration basin configuration.

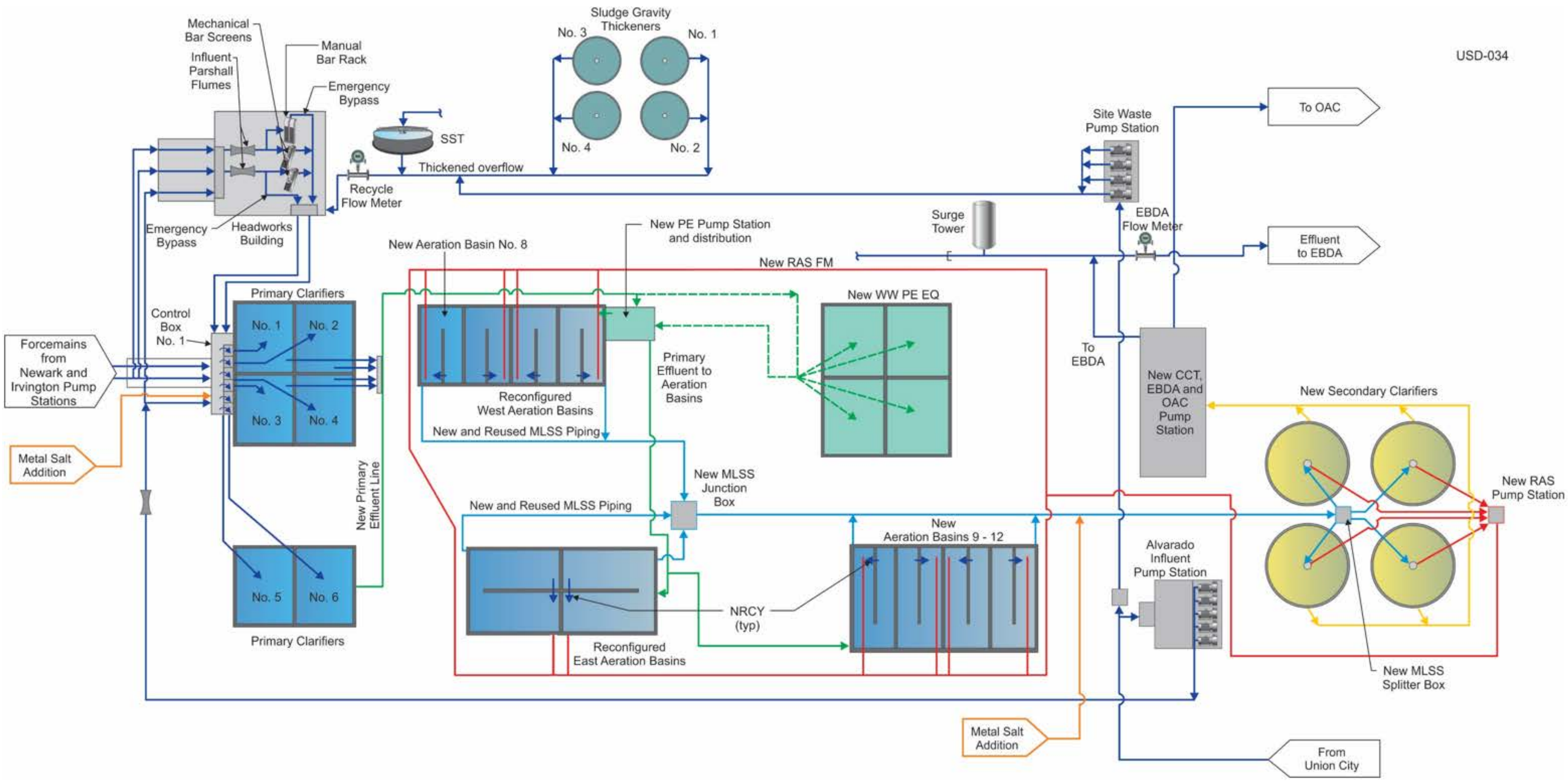


Figure 5-3 CAS BACWA Level 2 Process Flow Diagram

The CAS option process model results are presented in **Table 5-4** for 2040 AA, MM, MML-AAF, and redundancy scenarios. Loads and redundancy assumptions are documented in a memorandum attached in the **Appendix 2**. While wet weather simulations were dynamic, the conditions during step feed operation are presented in the **Table 5-4**.

Table 5-4 CAS 2040 Model Results

	Parameter	Units	AA	MM	MML-AAF	WW-MM[1]	Redundancy - 1 AB OOS	Redundancy - 1 SC OOS
Aeration	AB in service	#	10	10	10	10	9	10
	MLSS zone 2	mg/L	3,100	3,600	3,600	5,000	3,600	3,100
	MLSS zone 4	mg/L	3,100	3,600	3,600	2,700	3,600	3,100
	SRT	d	~10	~10	~10	~10-13	~8	~10
	Aerobic SRT	d	~6.5	~6.5	~6.5	~6.5-8	~5.6	~6.5
Secondary Clarification	Number	#	4	4	4	4	4	3
	Surface Area	sf	75,500	75,500	75,500	75,500	75,500	56,600
	Volume	MG	10	10	10	10	10	8
	SOR	gpd/sf	415	475	415	810	415	550
	SLR	lbs/d/sf	18	23	18	18	20	24
	SVI	mL/g	110	110	110	110	110	110
	RAS Ratio	%	64	64	64	64	64	64
WAS	WAS flow	mgd	0.55	0.55	0.55	0.55	0.55	0.55
	WAS conc	mg/L	8,000	9,100	9,100	9,000	9,100	8,000
	WAS Load	lbs/d	38,000	43,000	43,000	43,000	35,000	34,000
Secondary Effluent	cBOD	mg/L	<10	<10	<10	<10	<10	<10
	TSS	mg/L	<15	<15	<15	<15	<15	<15
	TN	mgN/L	~12	~13-14	~13-14	~14	~13	~12
	NH_3	mgN/L	~1	~1	~1	<2	~2	~1
	NO_3	mgN/L	~9	~9-10	~9-10	~7-10	~9	~9
	NO_2	mgN/L	<0.5	<0.5	<0.5	<1	<0.5	<0.5
	TIN	mgN/L	~9	~9-10	~9-10	~7-10	~9	~9
	TP	mgP/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	PO_4-P	mgP/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

[1] MLSS during step feed operation

Figure 5-4 shows the CAS option process model flow sheet. Key features include step-feed operation, flexible selector zones and nitrified recycle (NRCY).

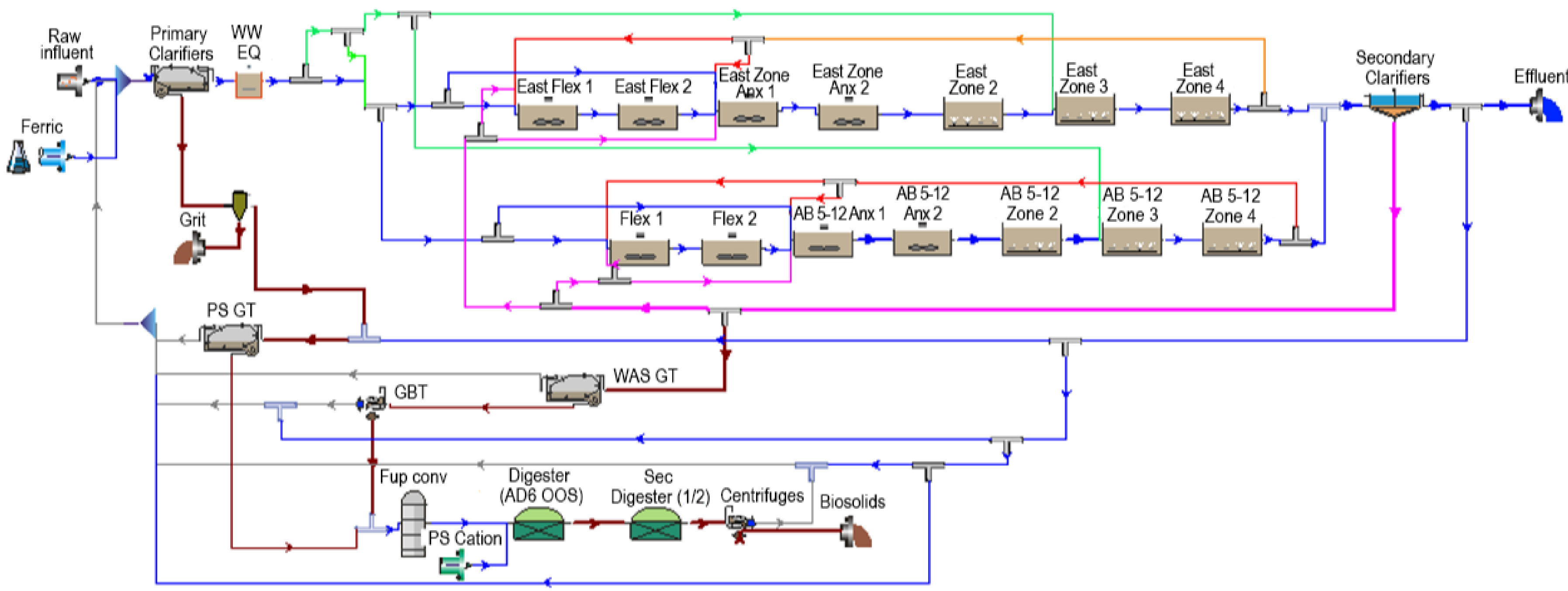


Figure 5-4 CAS Process Model

5.2.1 New Circular Secondary Clarifier Sizing

Based on process modeling, the clarifiers will need to pass 2,700 mg/L when the plant is operating in step-feed operation during a storm event (70.4-mgd for a 2040 storm and 61-mgd for an equalized 2040 storm). Surface overflow rate (SOR) and solids loading rate (SLR) were checked at critical clarifier loading conditions. Based on these conditions and the availability of space, clarifier diameter was maximized to a diameter of 155 ft. These conditions are summarized in **Table 5-5**.

Table 5-5 Clarifier Loading Conditions

Parameter	Effluent Flow	RAS Flow	MLSS	SVI	Clari-fiers online	Surface Area	SOR	SLR
	mgd	mgd	mg/L	mL/g	#	sf	gpd/sf	lb/d/sf
AA	29.1	14.6	3,100	110	4	75,500	390	15
AA – SC Redundancy	29.1	14.6	3,100	110	3	56,600	510	20
MM	33.5	16.8	3,600	110	4	75,500	440	20
MM – SC Redundancy	33.5	16.8	3,600	110	3	56,600	590	27
Max Day	42.2	21.1	3,600	110	4	75,500	560	25
WW – PH EQ[1]	61	30.5	2,700	110	4	75,500	810	-

[1]Note that step-feed and PE equalization triggers may be optimized.

5.3 Summary of Process Volumes

The process volume required to achieve BACWA Level 2 standards for both MBR and CAS for 2040 loads were developed using the calibrated process model. These volumes are summarized in **Table 5-6** for the MBR, and **Table 5-7** for the CAS option. CFD modeling was used to size the secondary clarifiers and ensure the ability to pass site-specific conditions as defined in **Table 5-5.**

Table 5-6 MBR Option Process Volume Requirements

Zone	MBR Process Volume, mg
Total Volume	8.5
Existing Volume	7.4
Total New Volume	1.1
Total Ras Deoxygenation Volume	0.5
Total Anoxic Volume	2.8
Total Aerobic Volume	5.2

Table 5-7 CAS Option Process Volumes Requirements

Zone	CAS Process Volume, mg
Total Volume	12.9
Existing Volume	7.4
Total New Volume	5.5
Flex Zone Volume	0.5
Total Anoxic volume	3.1
Total Aerobic Volume	9.3
Secondary Clarifier, sf	75,500

6. Long-term Solution Options

As detailed in **Section 5 – Model Scenarios**, the District is considering a CAS and MBR option for the Secondary Treatment Process Improvements. This **Section 6 – Long-term Solution Options** details the infrastructure to meet the BACWA Level 2 standards for 2040 flows and loads for both the CAS and MBR Options. As noted in **Section 2 – Approach**, a high-level description of a Phase III project to meet BACWA Level 3 standards for buildout conditions was also defined; this is also described in this section. Infrastructure common to both MBR and CAS long-term solutions is detailed in this section and includes effluent facilities, sidestream treatment, and metal salt addition for chemical phosphorus removal. This section presents the long-term scope as listed below:

- 6.1. MBR Long-term Options
  - 6.1.1. MBR Phase II Option
  - 6.1.2. MBR Phase III Option
- 6.2. CAS Long-term Options
  - 6.1.3. CAS Phase II Option
  - 6.1.4. CAS Phase III Option
- 6.3. Effluent Facilities
- 6.4. Sidestream Treatment
- 6.5. Chemical Phosphorus Removal

6.1 Membrane Bioreactor Long-term Options

6.1.1 MBR Option Phase II Scope

This section details the infrastructure required to implement BACWA Level 2 standards for the 2040 flows and loads conditions with MBR technology.

6.1.1.1 Process Volume and Aeration Basin Configuration

The total required process volume to treat 2040 flows and loads with the MBR technology was determined to be 8.5 MG. This includes RAS de-oxygenation zones, anoxic zones and aerobic zones. This volume can be achieved with the existing aeration volume of 7.4 MG and the construction of Aeration Basin 8. **Table 6-1** summarizes the process volume and zone volumes required for the treatment of 2040 flows and loads to BACWA Level 2 standards with MBR system.

Table 6-1 MBR Option Process Volumes

Zone	Volume, MG
Total Volume	8.5
Existing Volume	7.4
New Volume	1.1
Total RAS Deoxygenation Volume	0.5
Total Anoxic volume	2.8
Total Aerobic Volume	5.2

Figure 6-1 and **Figure 6-2** show process configuration for the east and west aeration basins for an MBR solution. Key retrofits for the east aeration basin modifications include:

- Combination of AB 1 and 2 into one basin
- Combination of AB 3 and 4 into one basin
- Reuse of the existing PE channel
- Segregated RAS flow and a RAS de-oxygenation zone
- Reuse of the existing east MLSS channel for a surface wasting channel
- Reuse of the existing west MLSS channel for MLSS
- Baffles and mixing to create the deoxygenation zones
- Baffles and mixing to create the anoxic zones

Key features for the west aeration basin modifications and new Aeration Basin 8 include:

- Reuse of the existing PE channel at the west of the basin
- Construction of Aeration Basin 8 on the south side of Aeration Basin 5 (at current location of Lift Station 2 and Control Box 2)
- Flipping the configuration of Aeration Basin 6
- Reuse of the MLSS channel
- Baffles and mixing to create the deoxygenation zones
- Baffles and mixing to create the anoxic zones

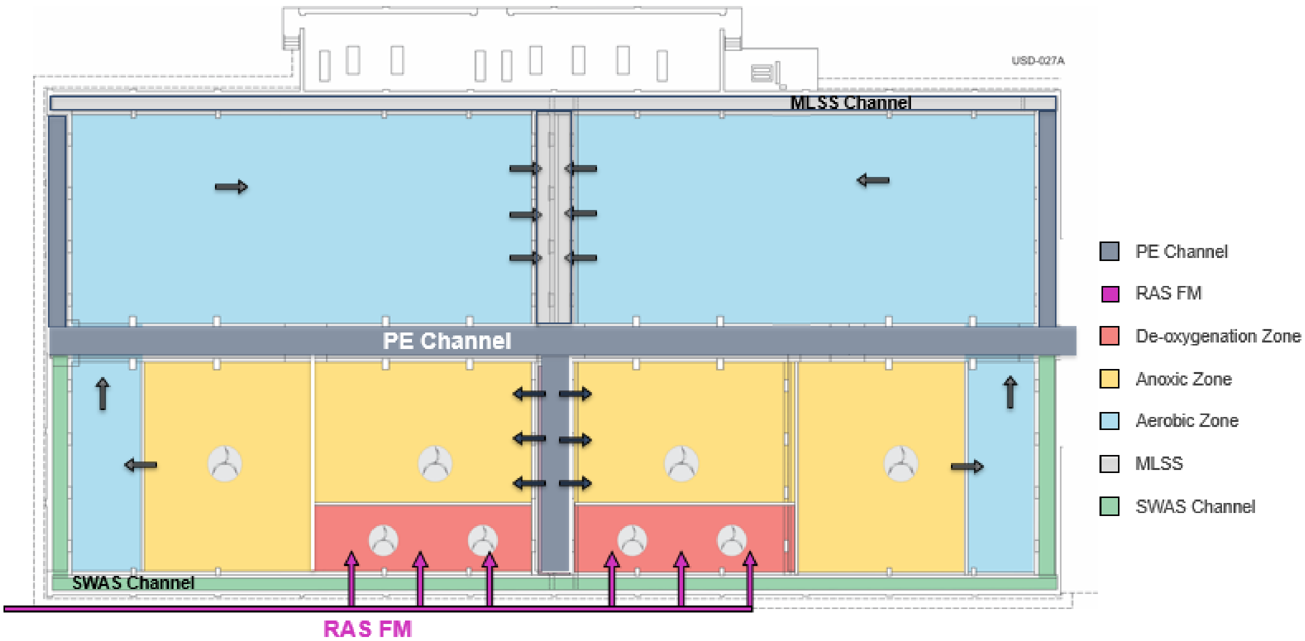


Figure 6-1 MBR East Aeration Basin Process Schematic

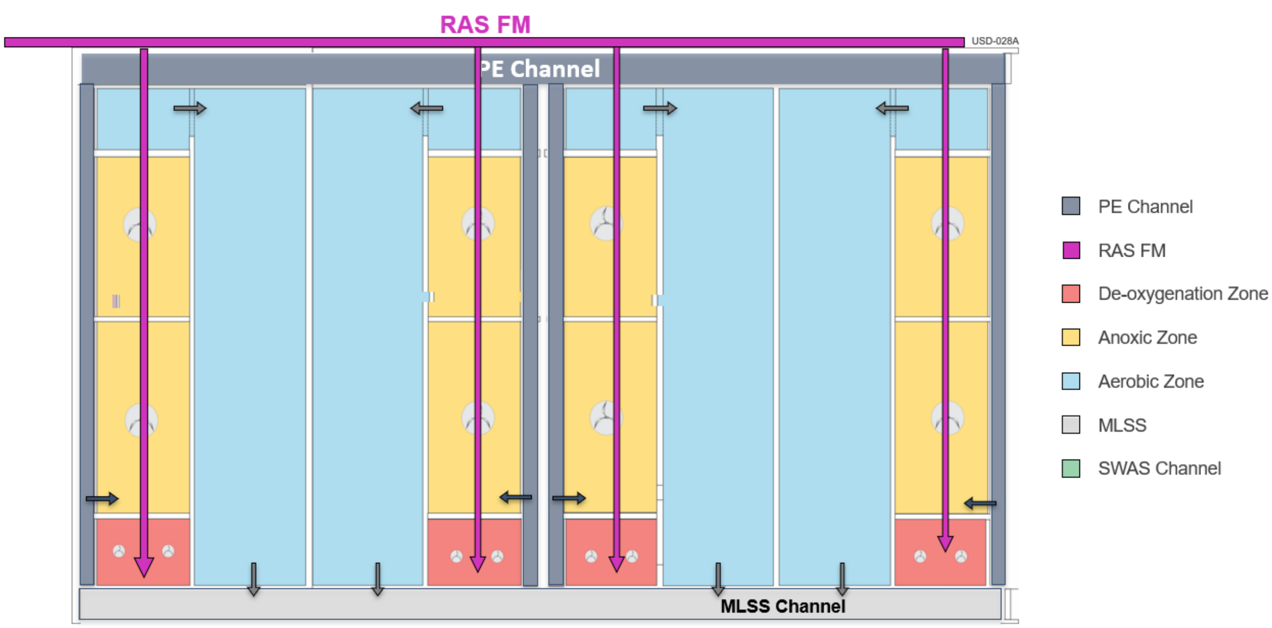


Figure 6-2 MBR West Aeration Basin Process Schematic

6.1.1.2 Process Aeration

The minimum, average and maximum diurnal airflows required for the aeration basin were determined for annual average, maximum 30-day, maximum 7-day, and max day loads. These airflows were calculated for scenarios with and without centrate treatment. Airflows without centrate treatment were used to size the blower facilities. **Table 6-2** summarizes the required process airflows for these conditions.

Table 6-2 2040 Process Air Requirements for MBR Option

Condition	Load Condition	DO, mg/L	Minimum Diurnal Airflow, scfm	Average Diurnal Airflow, scfm	Maximum Diurnal Airflow, scfm
MBR Process air without Centrate Treatment	AA	2	10,400	32,900	55,200[1]
	MM	2	11,900	38,400	61,500[1]
	MW	1	12,000	39,200	
	MD	0.5	14,600	48,100	
MBR Process air with Centrate Treatment	AA	2	8,900	31,500	52,100[1]
	MM	2	10,200	36,800	58,300[1]
	MW	1	10,300	37,600	
	MD	0.5	12,600	46,300	

[1] DO of 1 mg/L assumed for these conditions

A Neuros NX700 blower can deliver approximately 13,000 scfm at maximum temperature, humidity and minimum inlet pressure conditions. The system will require five NX700 blowers to deliver maximum diurnal airflow for maximum month loads. For an n+1 redundancy six blowers are required. It is proposed that the new blowers be centrally located in a new facility north of the existing Aeration Basins 5-7.

6.1.1.3 Intermediate Pump Station and Fine Screens

Primary effluent fine screening will be required to prevent damage to the membranes. The head available between the primary clarifier weirs and the Lift Station 1 and 2 wet wells is not great enough to fit fine screens and screened PE distribution. It is proposed that:

- A new centralized intermediate pump station is provided to replace existing Lift Station 1 and Lift Station 2
- Pumped PE flows through new ¼-inch fine screens
- Screened PE is split downstream of the fine screens for distribution to the aeration basins.

The fine screen and intermediate pump station will be located in the area immediately north of Aeration Basins 5 – 7, in the footprint future Aeration Basin 8 as proposed by the 1993 upgrade. (Under this project, Aeration Basin 8 will be located south of Aeration Basin 5 where the existing

CB2 and Lift Station 2 are located; see **Figure 6-4.**) The area is approximately 70' wide (N-S) and 100' long (E-W) with an additional 50' of height upon demolition of the existing odor control towers. Primary effluent would be routed west of existing Aeration Tanks 5 - 7 and tie into the proposed intermediate PS wet well.

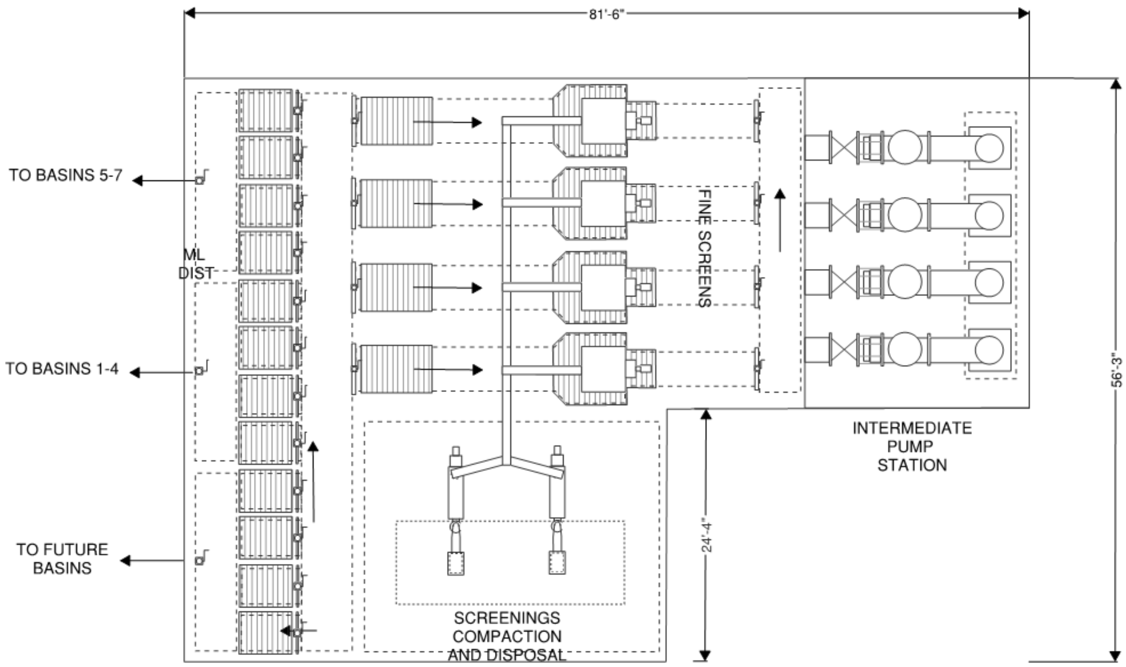


Figure 6-3 Intermediate Pump Station and Fine Screens Layout

6.1.1.4 Membrane Bioreactors Tanks

The membrane tanks were sized for appropriate average annual, maximum month and peak flow flux rates. A Suez (GE-Zenon) cut sheet was used as the basis of design for the MBR facility. **Table 6-3** summarizes the design conditions for the proposed MBR facility.

Table 6-3 MBR Facility Design Conditions

Design Parameter	Units	AADF	Max Month	Peak Hour
Flow	mgd	29.1	33.5	60.0[1]
Design Flux	gfd	12.5	14.5	29.0
Cassettes	#	144	144	144
Resulting Membrane Tanks	#	8	8	8
Cassettes per Tank	#	18	18	18
Resulting Flux	gfd	10.5	12.1	21.7
Resulting Flux (1 OOS)	gfd	12.0	13.8	24.8

[1] Assuming 2.5MG of EQ

6.1.1.5 MBR Option Phase II Site Layout

Figure 6-4 shows the proposed MBR Phase II Layout. Key features include

- Modified Aeration Basin 1-4
- Modified Aeration Basin 5-7
- New Aeration Basin 8 south of existing Aeration Basin 5-7
- New 60-inch PE line to centrally located Intermediate Pump Station routed to the west of existing Aeration Basin 5-7
- New intermediate pump station and fine screen facility
- New blower facility north of existing Aeration Basin 5-7
- PE distribution piping to the east and west aeration basins
- New 2.5 MG equalization basin
- New MLSS junction box and reuse of the existing 60-inch line to the MBR tanks
- New MBR facility that includes:
    - 9 Membrane tanks (cassettes installed in 8 tanks)
    - Clean in place chemicals
    - Scour blowers
    - Permeate pumps
    - Note that the location of the MBR tanks was agreed upon in the December 2018 Charrette. The option to phase MBR construction over the existing Secondary Clarifier location was eliminated due to concerns over plant operation during construction.
- New effluent facility

6.1.2 MBR Option Phase III Infrastructure and Layout

As noted in **Section 2 – Approach**, this analysis identified place holder process volumes and facilities to meet BACWA Level 3 standards for buildout conditions. For the MBR option this Phase III project has been identified as:

- New Aeration Basin 9 and 10 (2.2 MG)
- Carbon addition facilities for further denitrification
- Additional membrane cassettes to meet increased flows

It is recommended that as the analysis for and the definition of this Phase III project be revisited as technologies change, the standards are become more defined, or as loading conditions warrant. **Figure 6-5** shows the MBR option Phase III Layout.

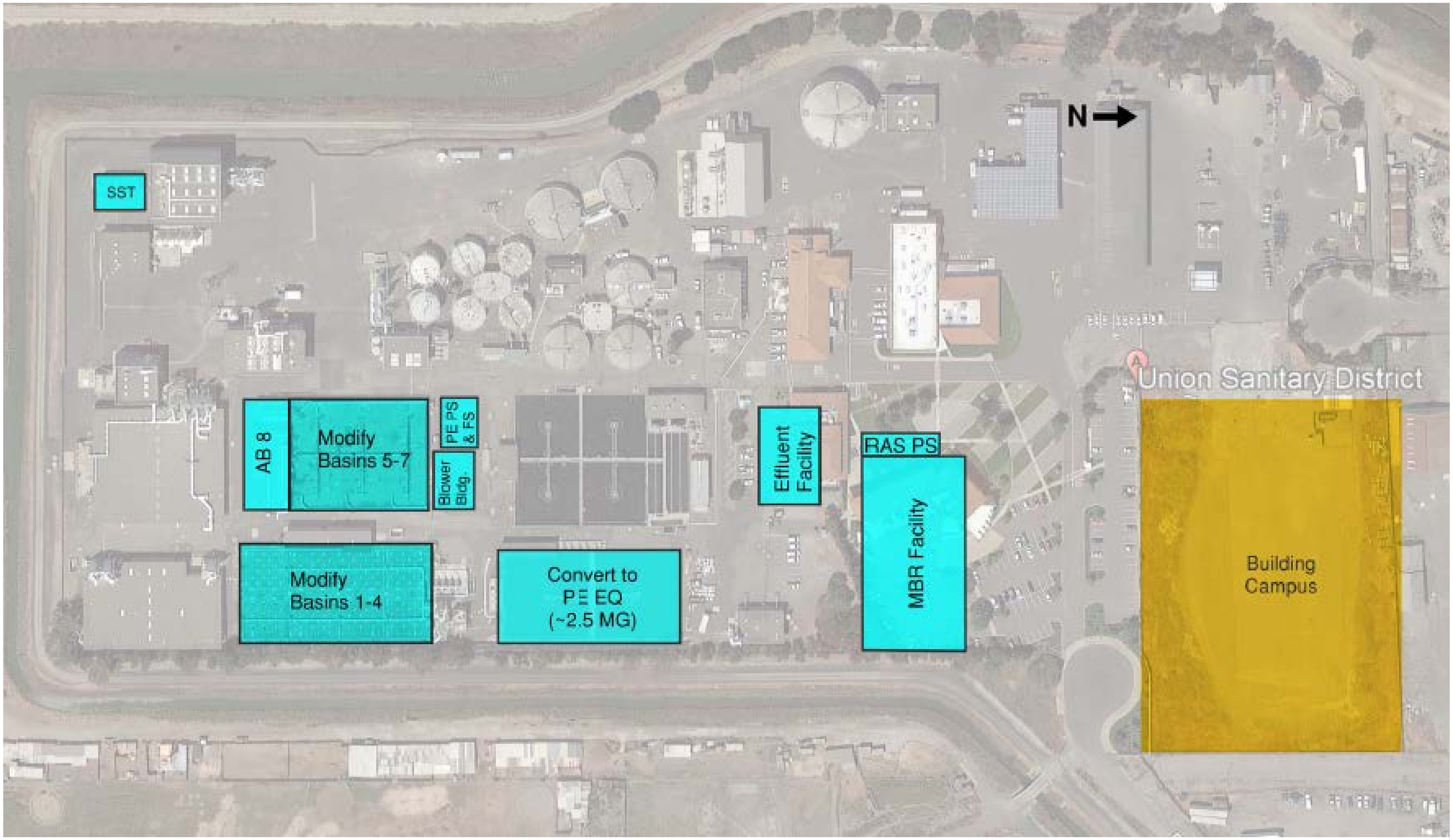


Figure 6-4 MBR Option Phase II Layout

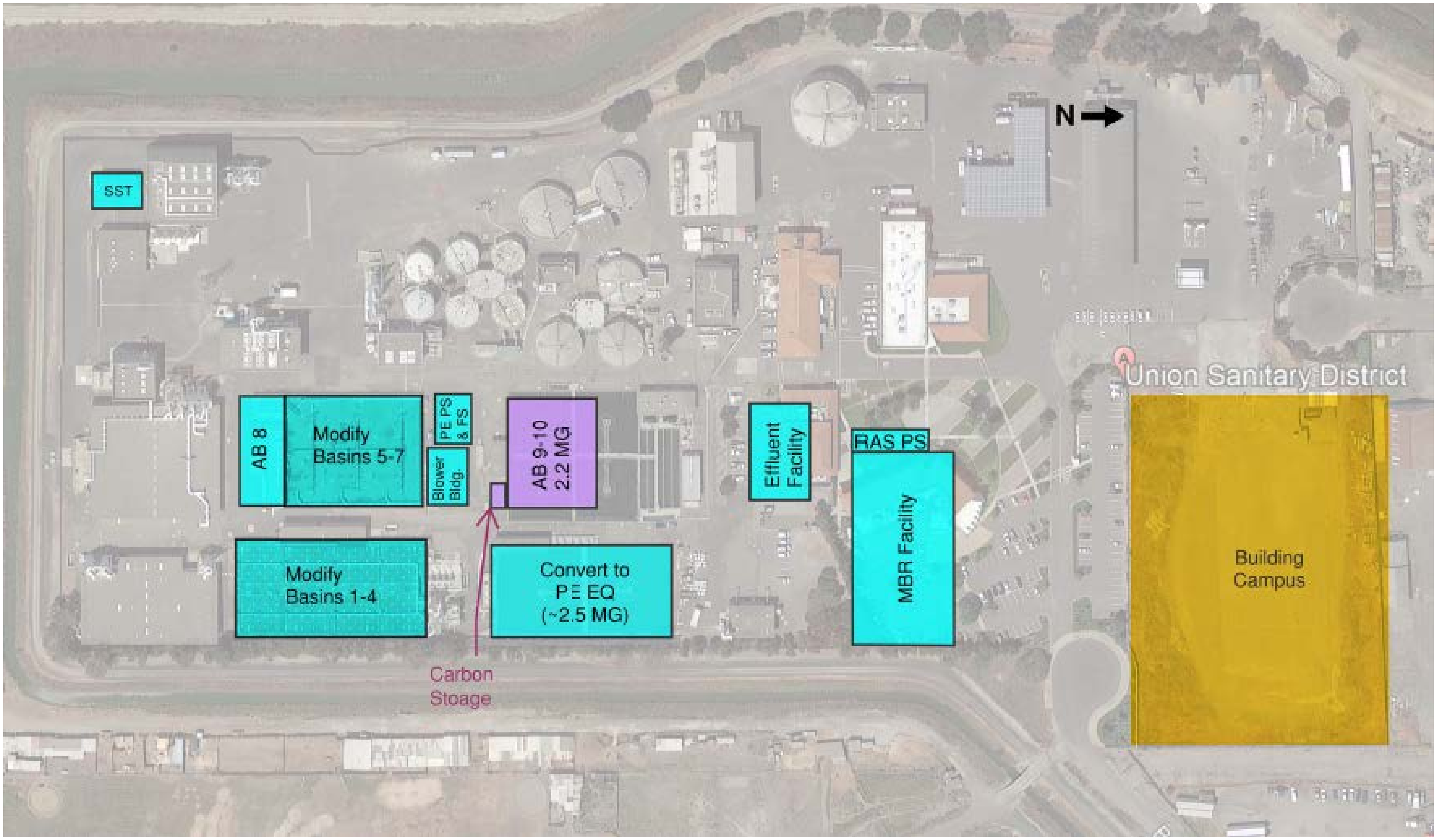


Figure 6-5 MBR Option Phase III Conceptual Layout

6.2 Conventional Activated Sludge Long-term Option

6.2.1 CAS Option Phase II Scope

6.2.1.1 CAS Option Process Volume and Aeration Basin Configuration

The total required process volume to treat 2040 flows and loads with the CAS technology was determined to be 12.9 MG. This includes flexible zones for RAS conditioning, anoxic zones, and aerobic zones. This volume can be achieved with the existing volume and the construction of new Aeration Basin 8 adjacent to the existing west aeration basins and new Aeration Basins 9-12. **Table 6-4** summarizes the process volume and zone volumes required for the treatment of 2040 flows and loads to BACWA Level 2 standards with a conventional activated sludge system.

Table 6-4 CAS Option Process Volumes

Zone	Volume, MG
Total Volume	12.9
Existing Volume	7.4
New Volume	5.5
Flex Zone	0.5
Total Anoxic Volume	3.1
Total Aerobic Volume	9.3

Figure 6-6 and **Figure 6-7** show the process configuration for the east and west aeration basins for a CAS solution. Key retrofits for the east aeration basin modifications include:

- Combination of AB 1 and 2 into one basin
- Combination of AB 3 and 4 into one basin
- Reuse of the existing PE channel
- Segregated RAS into the RAS de-oxygenation zone
- Reuse of the existing east MLSS channel for a surface wasting channel
- Reuse of the existing west MLSS channel for MLSS
- Baffles and mixing to create the deoxygenation zones
- Baffles and mixing to create the anoxic zones

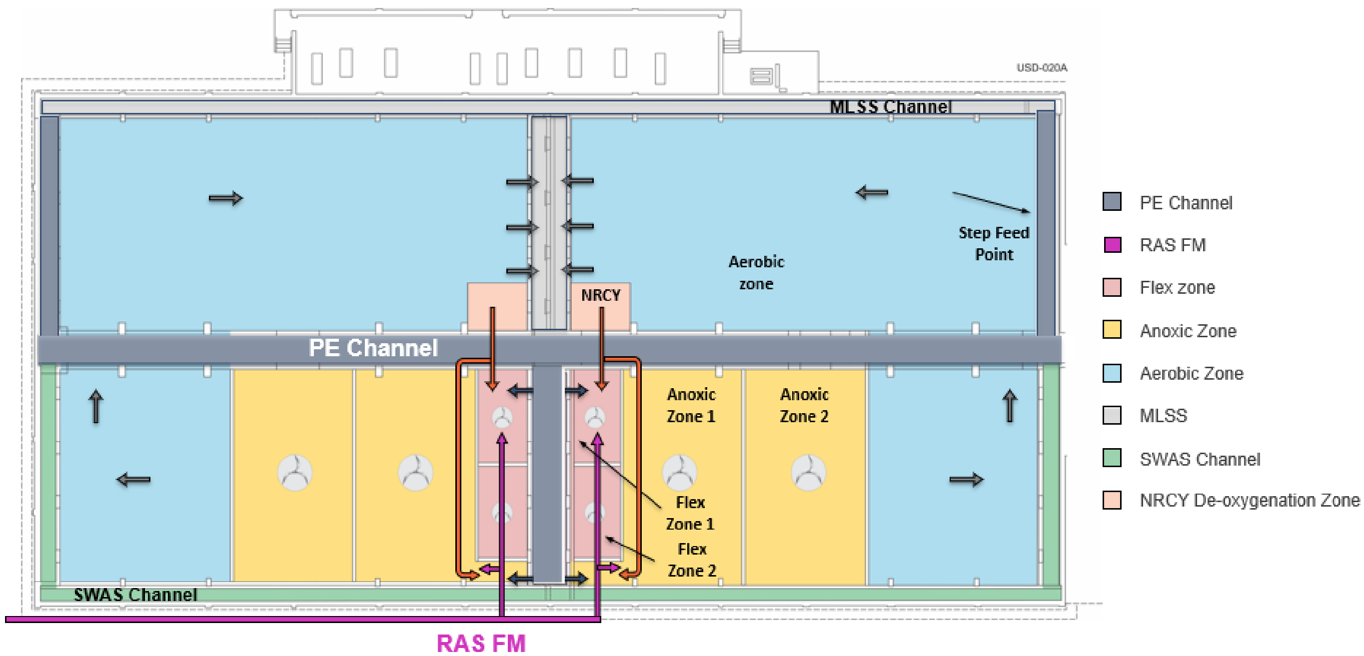


Figure 6-6 CAS East Aeration Basin Process Schematic

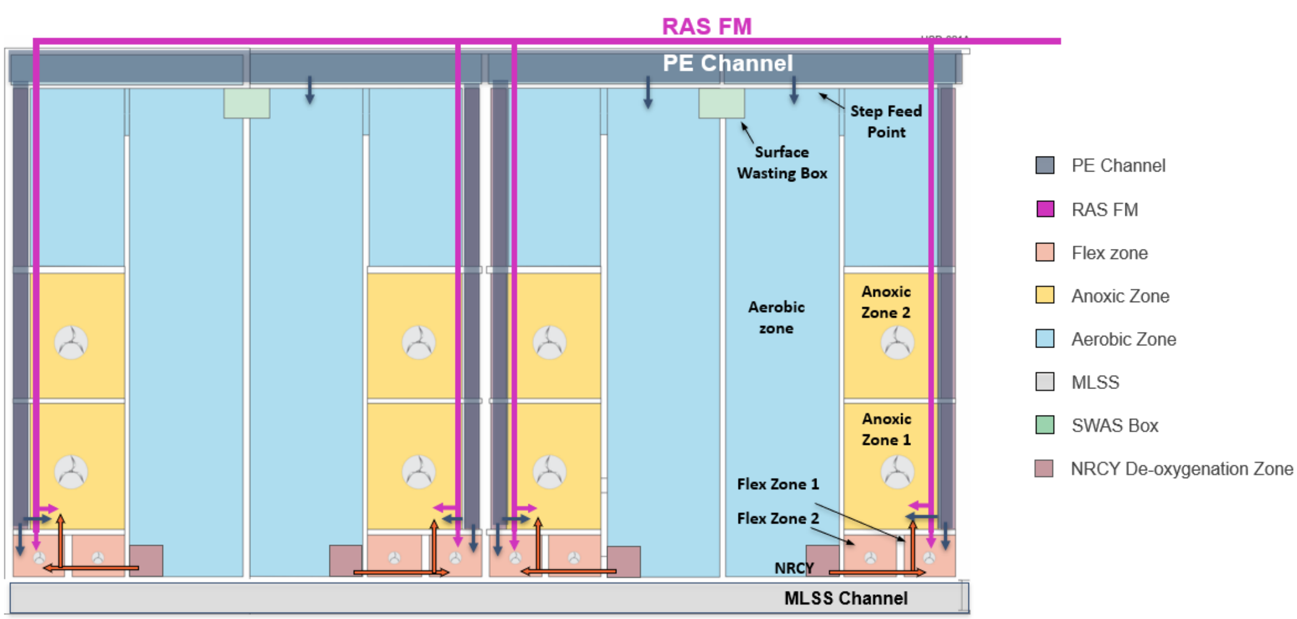


Figure 6-7 CAS West Aeration Basin Process Schematic

Key features for the west aeration basin modifications and new Aeration Basins 8-12 include:

- Reuse of the existing PE channel at the west of the basin
- Construction of Aeration Basin 8 on the south side of Aeration Basin 5
- Flipping the configuration of Aeration Basin 6
- Reuse of the MLSS channel
- Baffles and mixing to create the deoxygenation zones
- Baffles and mixing to create the anoxic zones

6.2.1.2 Process Aeration

The minimum, average and maximum diurnal airflows required for the aeration basin were determined for annual average, maximum 30-day, maximum 7-day and max day loads. These airflows were calculated for scenarios with and without centrate treatment. Airflows without centrate treatment were used to size the blower facilities. **Table 6-5** summarizes the required process airflows for these conditions.

Table 6-5 2040 Process Air Requirements for CAS Option

Condition	Load Condition	DO, mg/L	Minimum Diurnal Airflow, scfm	Average Diurnal Airflow, scfm	Maximum Diurnal Airflow, scfm
CAS Process air without Centrate Treatment	AA	2	7,100	23,900	40,000[1]
	MM	2	8,100	28,000	44,700[1]
	MW	1	8,200	28,500	
	MD	0.5	9,900	34,900	
CAS Process air with Centrate Treatment	AA	2	6,500	22,900	37,500[1]
	MM	2	7,400	26,700	41,900[1]
	MW	1	7,500	27,400	
	MD	0.5	9,200	33,700	

[1] DO of 1mg/L assumed for these conditions

A Neuros NX700 blower can deliver approximately 13,000 scfm at maximum temperature, humidity and minimum inlet pressure conditions. The system will require four NX700 blowers to deliver maximum diurnal airflow for maximum month loads. For an n+1 redundancy five blowers are required. It is proposed that the new blowers be centrally located in a new facility north of the existing Aeration Basins 5-7.

6.2.1.3 Intermediate Pump Station

To accommodate the 5.5 MG of new aeration basin volume additional primary effluent distribution lines and a new lift station will be needed. As Control Box 2 is a congested flow control structure, and routing of a new PE line to Aeration Basins 9-12 would be difficult, a centralized primary effluent intermediate pump station and splitter box is proposed.

- A new intermediate pump station is provided to replace existing Lift Station 1 and 2 at a central location.
- Pumped PE is split just downstream for distribution to the aeration basins.

The intermediate pump station will be located in the area immediately north of Aeration Basins 5 – 7, in the footprint of the future Aeration Basin 8 as proposed in the 1993 upgrade. (Under this project, Aeration Basin 8 will be located south of Aeration Basin 5 where the existing CB2 and Lift Station 2 are located; see **Figure 6-8**.) The area is approximately 70' wide (N-S) and 100' long (E-W) with an additional 50' of height upon demolition of the existing odor control towers. Primary effluent would be routed west of existing Aeration Tanks 5 - 7 and tie into the proposed intermediate PS wet well.

6.2.1.4 Secondary Clarifiers

New clarifiers and a combination of new and modified secondary clarifiers were considered to provide more secondary clarification capacity for the AWWTP. Through the planning process in this analysis, it was decided that new clarifiers would be provided to meet the BACWA Level 2 standards for 2040 flows and loads. **Table 6-6** documents the decisions made by the District during the planning phases of this project.

Table 6-6 CAS Clarifier Layout Options

CAS Clarifier Layout Option	Decision	Reasoning
Split Plant Option: Existing plant and separate new plant	Eliminated	Increases operational complexity too significantly
New and Modified Clarifiers: Combined MLSS sent to modified and new clarifiers	Eliminated	Provides the most redundancy but is most difficult to construct and operationally complex
All New Clarifiers: All new clarifiers where the existing administration buildings is currently located	Selected	This will be the simplest to operate and most reliable technology

Four new circular clarifiers will be planned for in the location north of the existing clarifiers where the administration building is currently located. The clarifier characteristics are summarized in **Table 6-7**.

Table 6-7 New Clarifier Characteristics

Parameter	Unit	Value
Number	-	4
Diameter, ft	ft	155
Sidewater Depth	ft	18
Center well	ft	38
Center well depth	ft	7.5
Energy Dissipating Inlet	-	Yes
Sludge collection		Towbro

6.2.1.5 Return Activated Sludge

A new centralized RAS pump station will have the following features:

- One pump per clarifier connected directly to the RAS line
- A flow meter on each RAS line will control the RAS pump speed for the corresponding pump
- One redundant pump per pair of clarifiers
- The RAS pumps will have the capacity to pump 100% of forward flow at maximum month conditions with all secondary clarifiers in service. This will also provide a 50% RAS rate during wet weather.

6.2.1.6 CAS Option Site Layout

Figure 6-8 shows the proposed CAS layout. Key features include

- Modified Aeration Basin 1-4
- Modified Aeration Basin 5-7
- New Aeration Basin 8 south of existing Aeration Basin 5-7
- New Aeration Basins 9-12 north of existing East Aeration Basins
- New 60-inch PE line to centrally located intermediate pump station routed to the west of existing Aeration Basin 5-7
- New intermediate pump station
- New blower facility North of existing Aeration Basin 5-7

- PE distribution piping to the existing and new aeration basins
- New 2.5 MG PE equalization basin
- New MLSS junction box and reuse of the existing 60-inch line to the new MLSS distribution box
- New MLSS distribution box
- Four new circular clarifiers with sludge suction header
- Centralized RAS station
- New RAS force main
- New individual RAS line (with flow meter and control valve) from force main to each aeration basin
- New 72-inch effluent line to new effluent facility
- New effluent facility.

6.2.2 CAS Option Phase III Infrastructure and Layout

As noted in **Section 2 – Approach**, this analysis identified place holder process volumes and facilities to meet BACWA Level 3 standards for buildout conditions. For the CAS option this Phase III project has been identified as:

- Demolition of PE EQ installed in Phase I
- New Aeration Basin 13-16, 4.9 MG (at location of Phase I PE EQ)
- Carbon addition facilities for further denitrification
- Disk filters to meet low TP requirements

Figure 6-9 shows the CAS option Phase III Layout. It is recommended that the District secure offsite PE equalization basin to replace the onsite PE EQ that will be eliminated as part of Phase III prior to its elimination. This potential offsite PE equalization tank is not shown on the site plan in **Figure 6-9**, but the District has identified a potential location adjacent to the AWWTP. It is recommended that as the analysis for and the definition of this Phase III project be revisited as technologies change, the standards become more defined, or as loading conditions warrant.

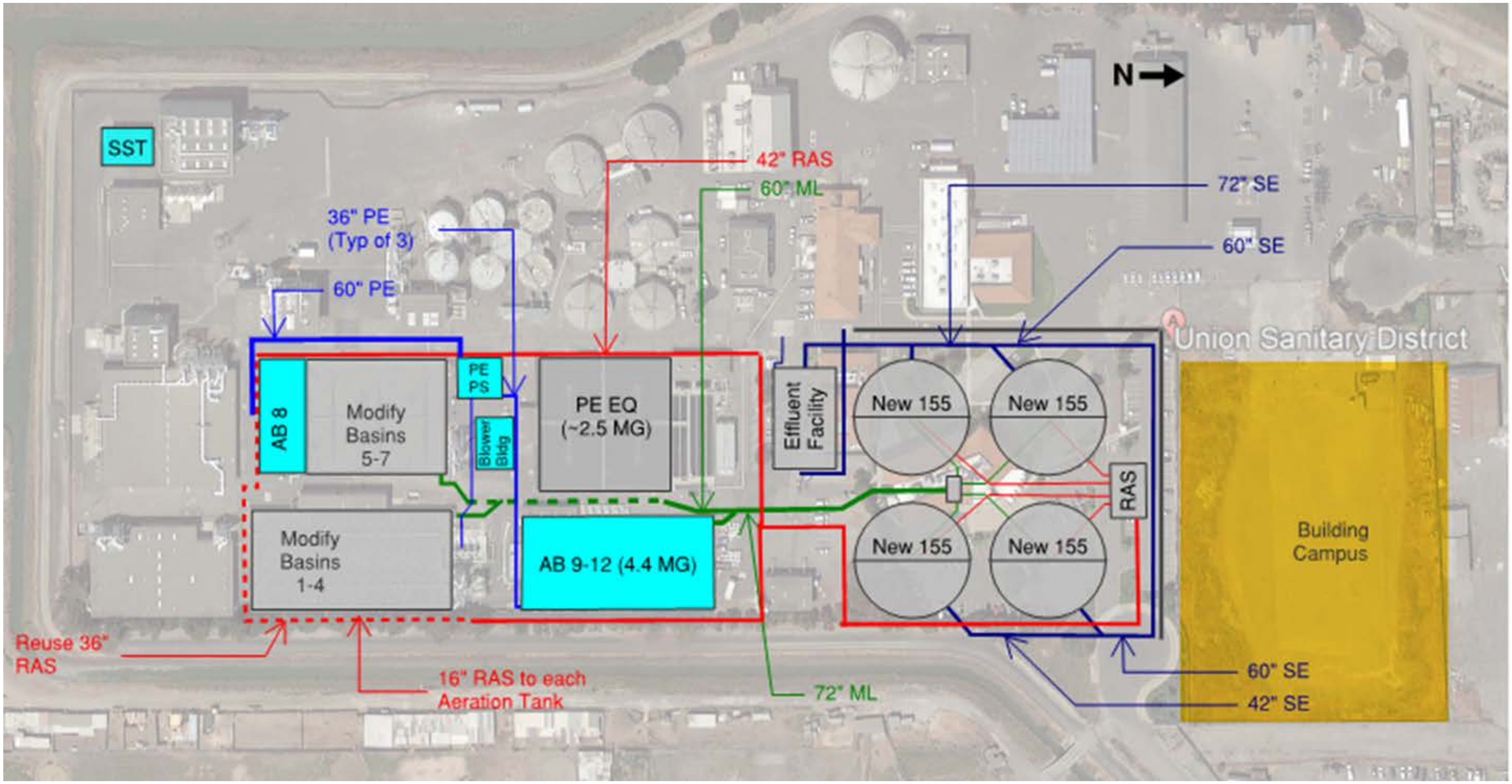


Figure 6-8 CAS Option Phase II Layout

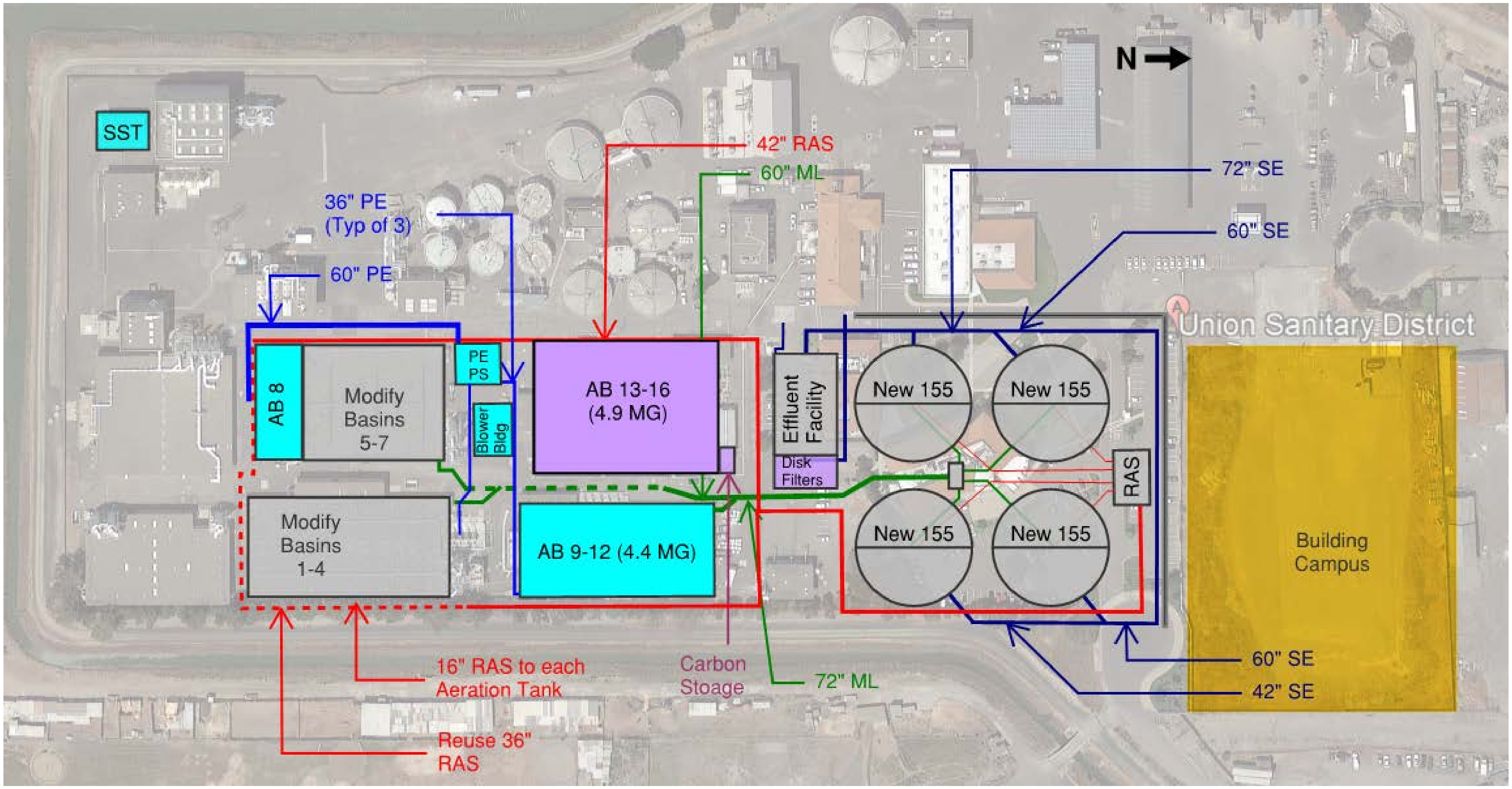


Figure 6-9 CAS Option Phase III Conceptual Layout

6.3 Effluent Facilities

The District currently has the ability to discharge to Old Alameda Creek for emergency purposes only. Unlike normal flow conditions, when flow is discharged to the EBDA force main and dechlorinated offsite, the District is responsible for dechlorinating any flow that goes to Old Alameda Creek to a TRC of 0.0 mg/L. The District does not currently have efficient dechlorination facilities and must recirculate flow to the head of the plant until it is confirmed that the TRC requirement is met. The process is very cumbersome and operationally complex and reduces capacity during wet weather. New dechlorination facilities are therefore included in the upgrade of the plant.

The existing plant has a hydraulic bottleneck between the final clarifiers and the chlorine contact tanks. This hydraulic bottleneck is caused by a shallow free surface port in the existing flash mix basin that accounts for significant head loss during peak events, limiting final clarifier effluent prior to submergence of final clarifier weirs. Plant staff have also noted that the existing chlorine contact tanks are in poor condition with gates that are inoperable, reducing operational flexibility. A condition assessment of the existing chlorine contact tanks was not performed as part of this analysis; however, visual observations confirm the District's experience. To address the hydraulic bottleneck and to provide a more reliable facility, a new chlorination facility was assumed for both the MBR and CAS options.

The EBDA pump station located at the AWWTP is owned by EBDA and operated by the District. The EBDA pump station is at the end of its useful life. The District wishes to include a new EBDA pump station as part of the effluent facilities upgrade.

The new effluent facility configuration is shown in Figure 6-10 and will include the following features:

- New flash mixing for chlorination
- New CCT that can be configured in direct or in a serpentine layout
- New EBDA Pump station
- New flash mixing for dechlorination
- New dechlorination contact basin (sized for either thiosulfate or sodium bisulfite)
- New Old Alameda Creek pump station
- New elevated discharge box to limit tidal impacts to pumping
- New sample location for TRC confirmation

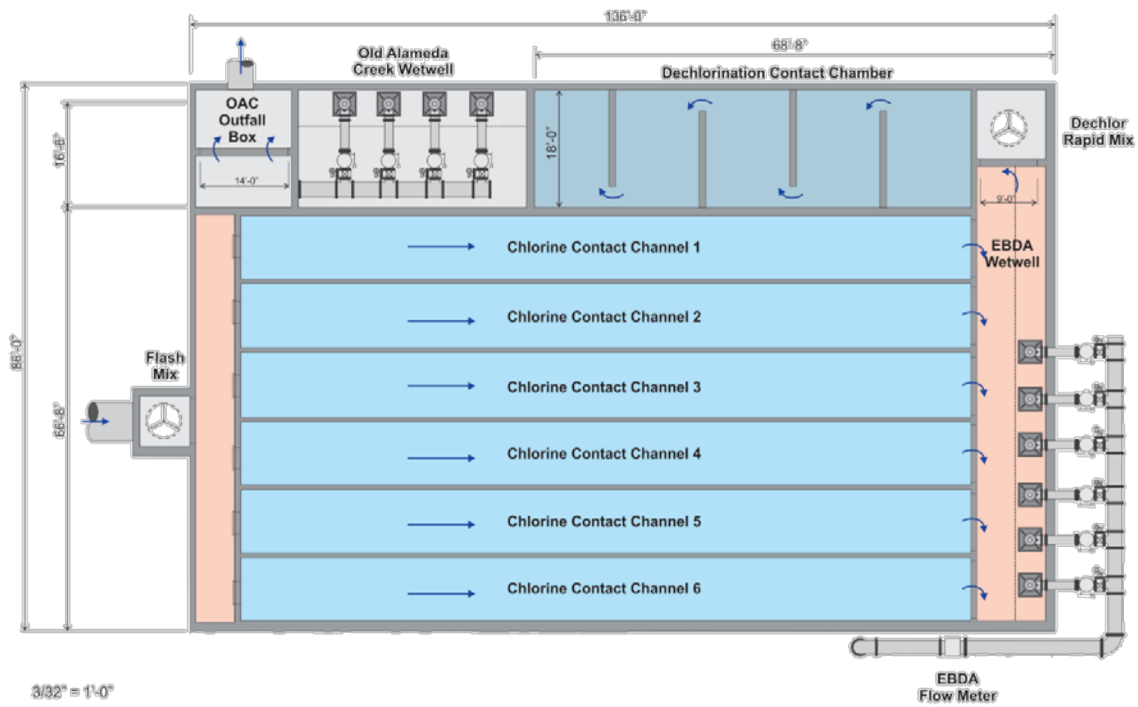


Figure 6-10 New Effluent Facility

6.4 Sidestream Treatment Facility

As summarized in **Section 5 – Modeling Scenarios**, sidestream deammonification is required to meet BACWA Level 2 standards for the for 2040 loads. The District recently piloted an ANITA™ mox system. The system was considered in sizing the facility. The sidestream facility has the following features and would be located near the dewatering building in the southwest corner of the plant:

- Centrate equalization
- A 0.37 MG reactor
- Electrical room
- Chemical room

6.5 Chemical Phosphorus Removal

The BACWA Level 2 standards includes a total phosphorus limit (TP < 1 mg/L) for discharge to the San Francisco Bay. While the volume required for biological phosphorus removal was determined, the District decided that chemical phosphorus removal should be assumed for this analysis. Chemical phosphorus removal would be accomplished by metal salt addition to centrate and MLSS. Two small dosing stations were included in the scope for both the CAS and MBR options. Chemical phosphorus removal will require approximately 1,000 gpd/d of metal salt addition.

7. CAS Phasing Options

As described in **Section 2 – Approach**, once the long-term layout was developed, there are opportunities to phase the project and spread out capital investment over time. This is mainly a feature of the CAS solution where a trigger based on the future requirements can be developed.

There are three main CAS phasing options have the same nutrient removal infrastructure in 2040 but are packaged into near-term (Phase I) and long-term (Phase II) solutions differently; the Phase I and Phase II is presented in **Figure 7-1**.

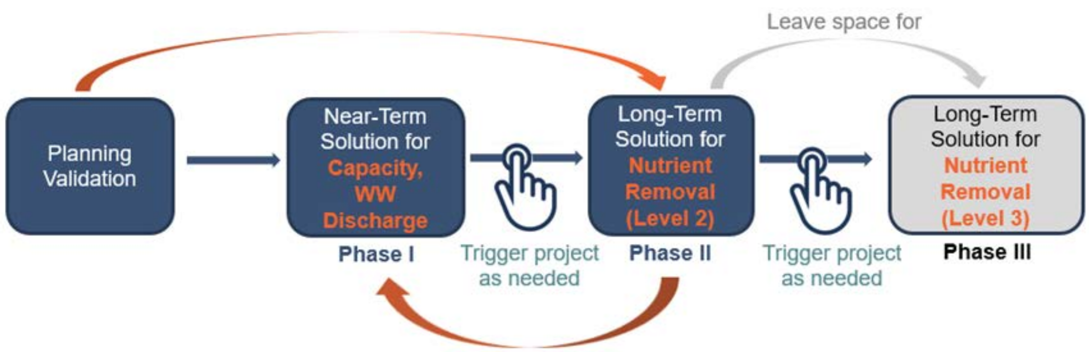


Figure 7-1 Trigger-Based Phasing of Near-term and Long-term Solutions

The three CAS phasing options were developed to achieve a specific objective in the near-term with Phase I. The differences in Phase I objectives are summarized in **Table 7-1**. These options result in the same long-term nutrient removal infrastructure (at the end of Phase II) as presented in **Section 6**. However, there are different intermediate projects to help achieve near-term objectives.

Table 7-1 CAS Phasing Options

Phase	CAS Option 1 – Clarifier Modifications and Limited Seasonal BNR	CAS Option 2 – New Clarifiers Early and Year-round BNR	CAS Option 3 – No Old Alameda Creek Discharge
Phase I: Near-term Objectives	• Increase capacity • Earliest creek discharge with limited BNR	• Increase capacity • Potential discharge to Old Alameda Creek through year-round nutrient removal	• Increase capacity • Avoid creek discharge
Additional intermediate scope over CAS Option presented in **Section 6.2**	• Near-term Clarifier Modifications • Disk Filters		• Secondary Effluent Equalization Basin

For each phasing option, the following is described in this **Section 7- CAS Phasing Options**:

1. Phase I Scope
2. Phase I Effluent Water Quality
3. Phase II Remaining Scope
4. Phase I and Phase II Layouts
5. Option Summary - Benefits and Considerations

For each of the three phasing options, the intermediate design horizon of 2028 was used to determine the water quality after Phase I. These flows and loads are presented in **Table 7-2**. The wet weather hydrograph was escalated to 2028 conditions and resulted in a peak hour flow of 67.1-mgd.

Table 7-2 2028 Model Influent Flow, Loads and Concentrations

Parameter	AA		MM		MML-AAF		Redundancy - 1 AB OOS		Redundancy - 1 SC OOS[1]	
Flow, mgd	26		30		26		26		26	
	lbs/d	mg/L	lbs/d	mg/L	lbs/d	mg/L	lbs/d	mg/L	lbs/d	mg/L
cBOD	68,300	270	78,500	270	78,500	310	68,300	270	68,300	270
COD	161,400	749	185,600	749	185,600	861	161,400	749	161,400	749
TSS	75,900	362	87,300	362	87,300	416	75,900	362	75,900	362
TKN	11,800	55	13,500	55	13,500	63	11,800	55	11,800	55
NH_3	8,000	37	9,200	37	9,200	43	8,000	37	8,000	37
TP	1,500	6.9	1,700	6.9	1,700	8.0	1,500	6.9	1,500	6.9

[1]CAS option only

7.1 CAS Option 1 – Clarifier Modifications and Limited Seasonal BNR

7.1.1 CAS Option 1 – Phase I Scope and Process Flow Diagram

As noted in **Table 7-1**, CAS Option 1 – Clarifier Modifications and Limited Seasonal BNR Phase I achieves the objectives of increasing plant capacity and provides limited seasonal BNR for discharge to Old Alameda Creek. **Table 7-3** summarizes the scope for CAS Option 1 - Clarifier Modifications and Limited Seasonal BNR for Phase I and Phase II.

Table 7-3 CAS Option 1 – Clarifier Modifications and Limited Seasonal BNR Scope

	CAS Option 1 – Clarifier Modifications and Limited Seasonal BNR	Note
Phase I – Capacity Scope	Aeration Basin Modifications	No new AB volume. Layouts as described in **Section 6.2.1.1**
	Secondary Clarifier Modifications	New as described in **Section 7.1.1.1**
Phase I – Creek Discharge Scope	Sidestream Treatment	As described in **Section 6.4**
	Disk Filters	New as described in **Section 7.1.1.2**
	Chlorination/Dechlorination Facilities	As described in **Section 6.3**
	EBDA and OAC Pump Station	As described in **Section 6.3**
	EBDA FM re-route	As described in **Section 6.3**
Phase II Scope	Intermediate Pump Station	As described in **Section 6.2**
	2.5 MG of PE equalization	As described in **Section 6.2**
	New Aeration Basin Volume (5.5 MG)	As described in **Section 6.2**
	Blowers and Blower Building	As described in **Section 6.2**
	New Secondary Clarifiers	As described in **Section 6.2.1.3**
	Chemical P Removal	As described in **Section 6.5**

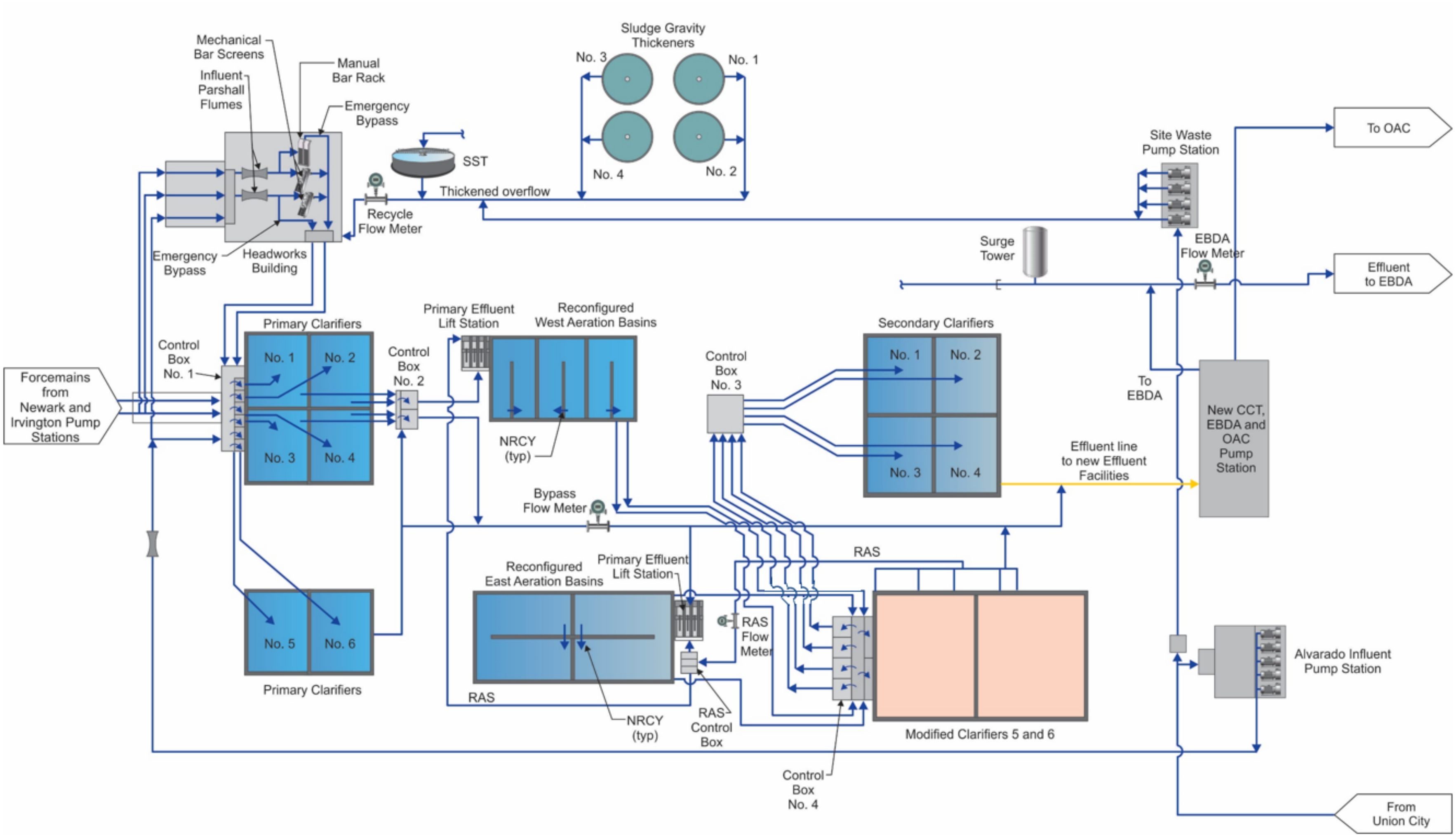


Figure 7-2 CAS Option 1 Phase 1 PFD

7.1.1.1 Secondary Clarifier Modifications

CAS Option 1 increases plant capacity in Phase I through aeration basin modifications as described in **Section 6.2.1** and secondary clarifier modifications. Secondary clarifier field testing identified modifications to clarifier internals that could improve existing Secondary Clarifiers 5 and 6 performance. Secondary Clarifiers 1-4 performed well during field testing and modifications to improve performance are not recommended. Subsequent to clarifier field testing, the RAS seals for Clarifiers 5 and 6 were replaced in September and October of 2018. Additional modifications to Secondary Clarifier 5 and 6 include the following and are illustrated in **Figure 7-3**.

- Corner fillets
- Energy dissipating inlet
- Replacement of existing daft tube mechanism with sludge suction header

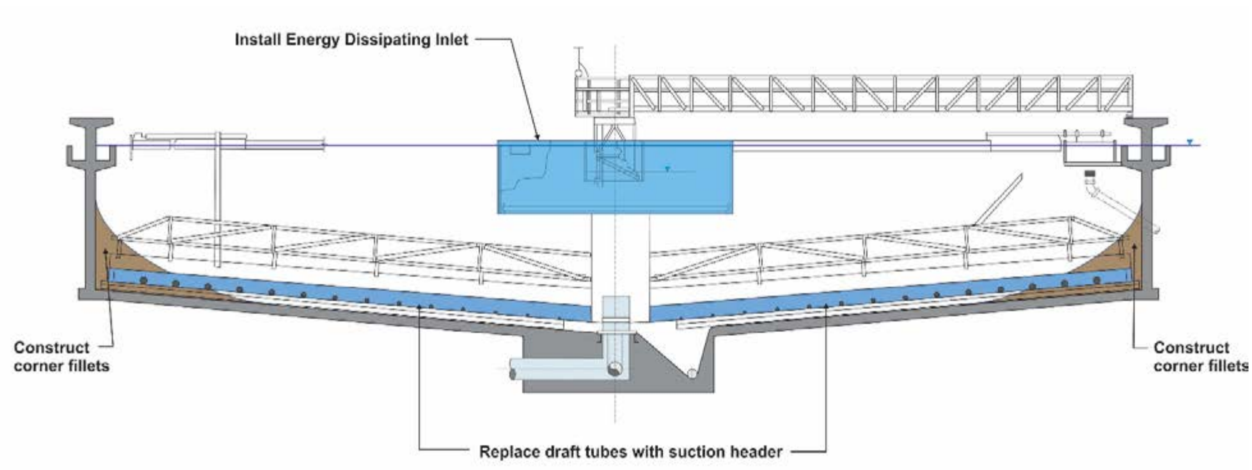


Figure 7-3 CAS Option 1 – Secondary Clarifier 5 and 6 Modifications

- **Enhancement:** The plant currently does not have effective RAS control from Secondary Clarifier 5 and 6 and has poor RAS control for Secondary Clarifiers 1-4. An enhancement to CAS Option 1 Phase I would be to provide either RAS control for Secondary Clarifier 5 and 6 or improved RAS control for all clarifiers via expansion of the existing RAS pump station or a new RAS pump station.

7.1.1.2 Phase I Creek Discharge

Old Alameda Creek discharge may have more stringent TSS and cBOD standards in the future. Per **Section 4** it was assumed that discharge to Old Alameda Creek would require a TSS less than15 mg/L. Disk filters were chosen to further treat flow that is discharged to the Creek. This results in two effluent qualities, normal effluent water quality discharged through the EBDA force main and improved effluent quality discharged to the Old Alameda Creek.

To optimize disk filter performance, it is proposed that some flow always be sent through the disk filters. During dry weather these two flows, filtered through disk filters and not treated with disk filters, will be combined and discharged through the EBDA force main. Once the plant effluent flows are greater than 42.9-mgd, the better effluent quality will be segregated through a passive system, dechlorinated and discharged to Old Alameda Creek.

7.1.2 CAS Option 1 – Effluent Water Quality

While TN reduction to achieve creek discharge is currently being discussed with the regional board, Phase I can achieve around 15% annual TN removal through sidestream treatment and seasonal BNR:

- Sidestream treatment will reduce centrate nitrogen load by 80-90%. This is approximately a 10% effluent TN load reduction.
- Seasonal BNR provides additional TN load reduction during the warmest months, June – August. Averaging three months of BNR operation with SST and nine months of just SST with carbon removal operation results in a total TN reduction of around 15%.

7.1.2.1 Process Modeling Results

Process modeling was conducted to determine nutrient removal after the completion of CAS Option 1 Clarifier Modifications and Limited Seasonal BNR - Phase I. These results are presented in **Table 7-4.**

Table 7-4 CAS Option 1 – Phase I Summer BNR Operation Modeling Results

	Parameter	Units	AA	MM	MML-AAF
Influent	Temperature	°C	20	20	20
Aeration	AB in service	#	5	5	5
	MLSS zone 2	mg/L	2,700	3,000	3,000
	SRT	d	5.3	5.3	5.3
	Aerobic SRT	d	3.5	3.5	3.5
Secondary Clarification	Number	#	6	6	6
	Surface Area	sf	48,000	48,000	48,000
	Volume	MG	5	5	5
	SOR	gpd/sf	540	625	540
	SLR	lbs/d/sf	18	24	20
	SVI	mL/g	110	110	110
	RAS Ratio	%	50%	50%	50%
WAS	WAS flow	mgd	0.4	0.5	0.5
	WAS conc	mg/L	9,200	10,000	10,000
	WAS Load	lbs/d	35,000	39,000	39,000
Secondary Effluent[1]	cBOD	mg/L	<10	<10	<10
	TSS	mg/L	<15	<15	<15
	TN	mgN/L	<15	<15	<16
	NH_3	mgN/L	~1-2	~1-2	~1-2
	NO_3	mgN/L	~10-11	~10-11	~10-12
	NO_2	mgN/L	<0.5	<0.5	<0.5
	TIN	mgN/L	~10-12	~10-12	~10-12
	TP	mgP/L	~3	~3	~3
	PO_4-P	mgP/L	~2.5	~2.5	~2.5

Process modeling shows that with these Phase I improvements, nutrient removal can be achieved during the summer months for annual average loads. With modified clarifiers and improved SVI, the clarifiers can sustain a MLSS of 2,700 mg/L during dry weather. This allows the facility to operate in BNR mode during the warmer months. It is not recommended that the plant operate in BNR mode during cold weather as the modified clarifiers will not be able to sustain higher MLSS required for nitrification in cold weather. A comparison of effluent qualities for BNR operation and carbon removal operation is presented in **Table 7-5**.

Table 7-5 CAS Option 1 – Phase I BNR and CAS Effluent Quality Comparison

Operation	Units	BNR	Carbon Removal
Conditions	-	MML-AAF	MML-AAF
Temperature	^oC	>20	16
Aerobic SRT	D	3.5	1.5
cBOD	mg/L	<10	<10
TSS	mg/L	<15	<15
TN	mgN/L	<16	~47
NH_3	mgN/L	~1-2	~45
TP	mgP/L	~3	~2

With these Phase I improvements, the plant should operate in carbon removal mode during wet weather as the modified clarifiers will not be able to sustain peak flows at MLSS required for BNR operation (even with step feed operation). **Figure 7-4** shows effluent water quality during wet weather after CAS Option 1 Phase I is completed. Note that with the disk filters installed in Phase I, effluent TSS is below 15 mg/L throughout the storm event.

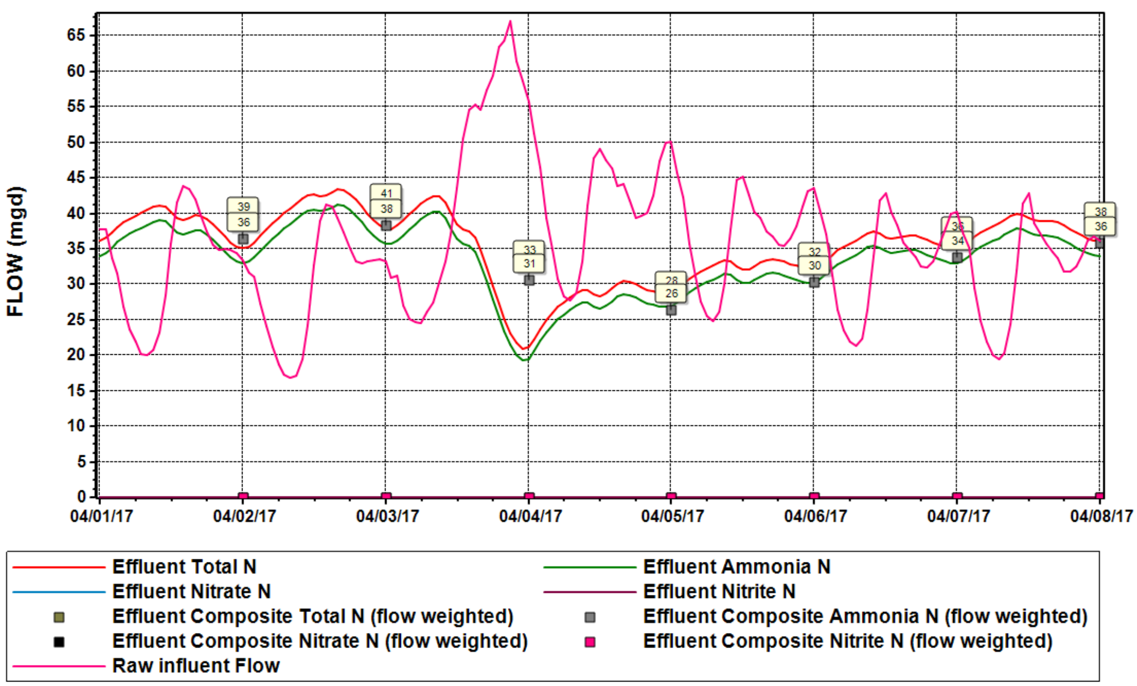


Figure 7-4 CAS Option 1 – Phase I Wet Weather Effluent Nitrogen

7.1.3 CAS Option 1 – Phase II Scope

The remaining scope items not constructed in Phase I will be constructed as part of Phase II as listed in **Table 7-3**. Phase II will be triggered when the facility expects to meet BACWA Level 2 standards.

7.1.4 CAS Option 1 – Phase I and II Layouts

A site plan showing the AWWTP after CAS Option 1 – Clarifier Modifications and Limited Seasonal BNR Phase I is completed is shown in **Figure 7-5**.

A site plan showing the AWWTP after CAS Option 1 – Clarifier Modifications and Limited Seasonal BNR Phase II is completed is shown in **Figure 7-6**. Note that only the blue shaded infrastructure is constructed under Phase II, grey shaded infrastructure is installed as part of Phase I.

Both site plans show the location of the proposed new building campus facility. Campus details have been developed in parallel to this study as part of the Enhanced Treatment & Site Upgrade Program.

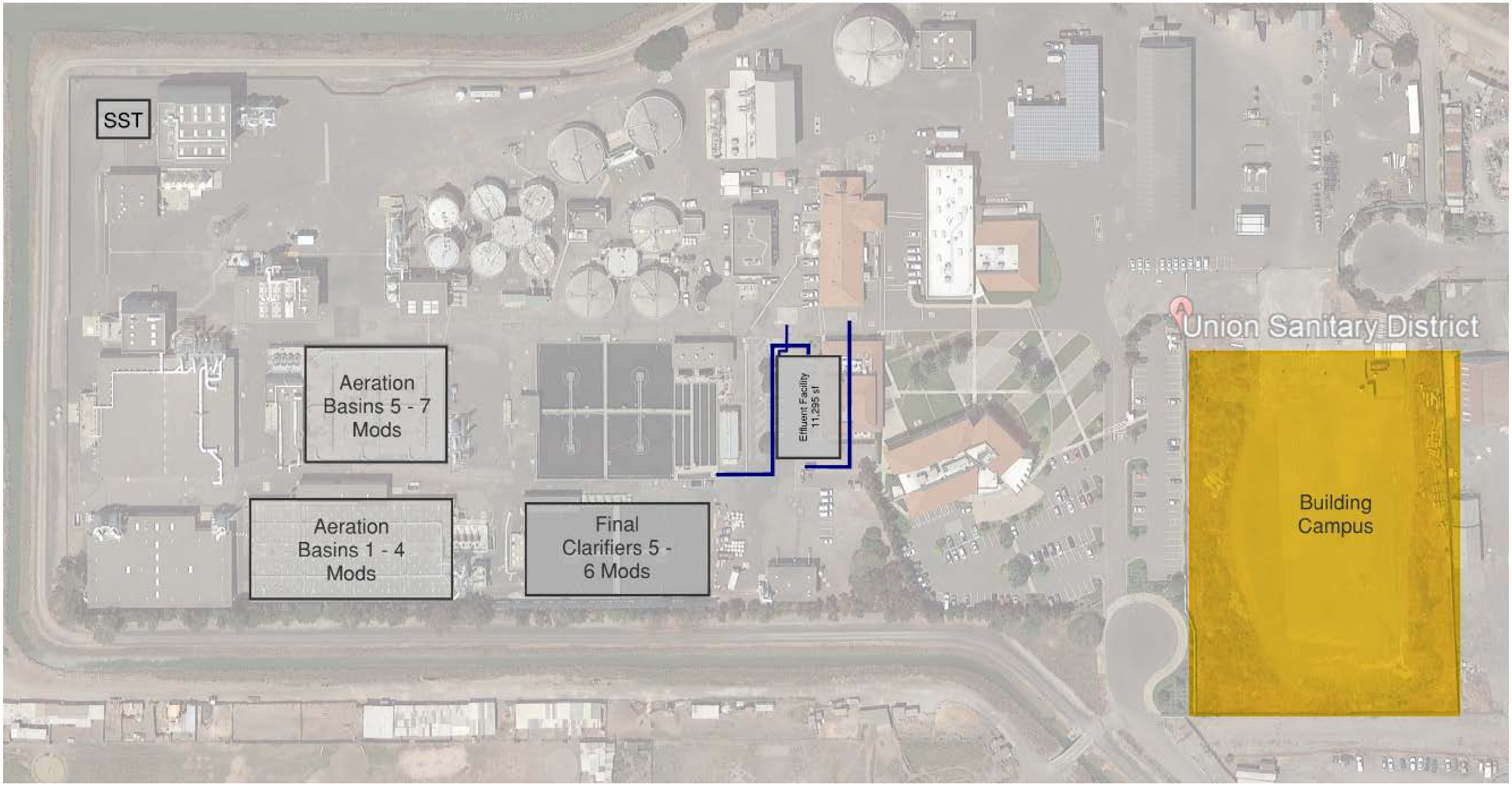


Figure 7-5 CAS Option 1 – Clarifier Modifications and Limited Seasonal BNR Phase I

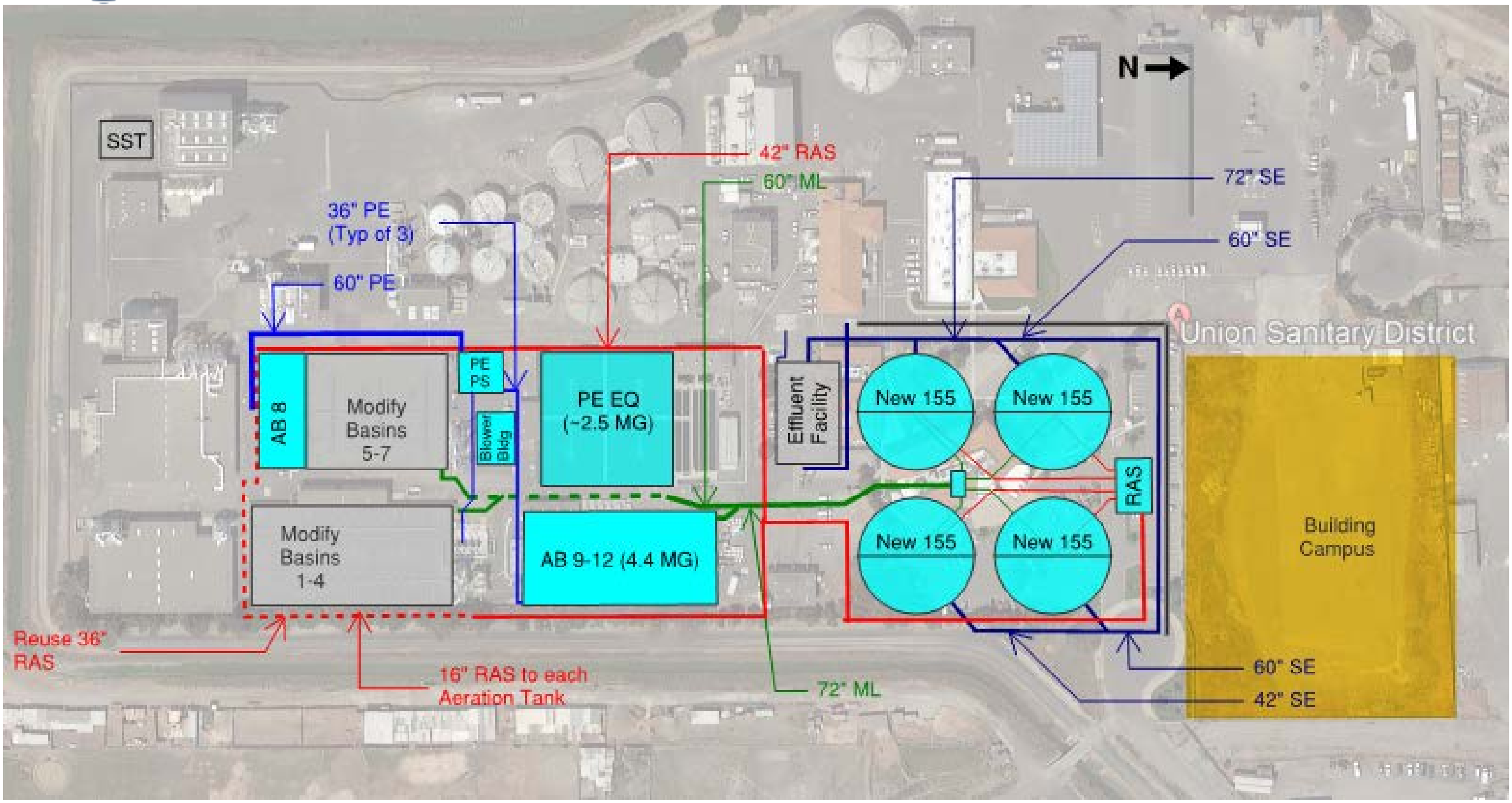


Figure 7-6 CAS Option 1 – Clarifier Modifications and Limited Seasonal BNR Phase II

*Note that Phase I scope is shown in grey and Phase II scope is shown in blue.

7.1.5 CAS Option 1 – Benefits and Considerations

There are several benefits to the phasing in CAS Option 1 – Clarifier Modifications and Limited Seasonal BNR.

1. Improved clarification over current operation
2. Achieves creek discharge
    - Limited seasonal BNR can be achieved with aeration basin modifications and clarifier modifications
    - Sidestream treatment can be constructed simultaneously
    - Effluent facility can be constructed simultaneously
3. This option delays most capital expenditures to Phase II

There are several considerations to the phasing in CAS Option 1 – Clarifier Modifications and Limited Seasonal BNR. These are:

1. Only achieves limited seasonal BNR
2. Invests in disk filters that will be of limited benefit once the new clarifiers are constructed
3. Invests in clarifier modifications that will not be needed after the new clarifiers are constructed
4. Less reliable clarifier performance in the interim period (after Phase I is completed but before Phase II is completed)
5. Needs sidestream treatment in Phase I
6. Operational complexity with two water qualities

7.2 CAS Option 2 – New Clarifiers Early and Year-round BNR

7.2.1 CAS Option 2 – Phase I Scope and Process Flow Diagram

As noted in **Table 7-1**, CAS Option 2 – New Clarifiers Early and Year-round BNR Phase I achieves the objectives of increasing plant capacity and potential discharge to Old Alameda Creek through year-round nutrient removal. **Table 7-6** summarizes the scope for CAS Option 2 - New Clarifiers Early and Year-round BNR for Phase I and Phase II. **Figure 7-7** shows the process flow diagram for this configuration.

Table 7-6 CAS Option 2 – New Clarifiers Early and Year-round BNR Scope

Phase	CAS Option 2 – New Clarifiers Early and Year-round BNR	Note
Phase I – Capacity Scope	Aeration Basin Modifications	No new AB volume. Layouts as described in **Section 6.2.1.1**
	New Secondary Clarifiers	As described in **Section 6.2.1.4**
Phase I – Creek Discharge Scope	PE Equalization (2.5 MG)	As described in **Section 6.2**
	Chlorination/Dechlorination Facilities	As described in **Section 6.3**
	EBDA Pump Station	As described in **Section 6.3**
	EBDA FM re-route	As described in **Section 6.3**
Phase II Scope	Intermediate Pump Station	As described in **Section 6.2**
	New Aeration Basin Volume (5.5 MG)	As described in **Section 6.2**
	Blower and Blower Building	As described in **Section 6.2**
	Chemical P Removal	As described in **Section 6.5**
	New Sidestream Treatment	As described in **Section 6.4**

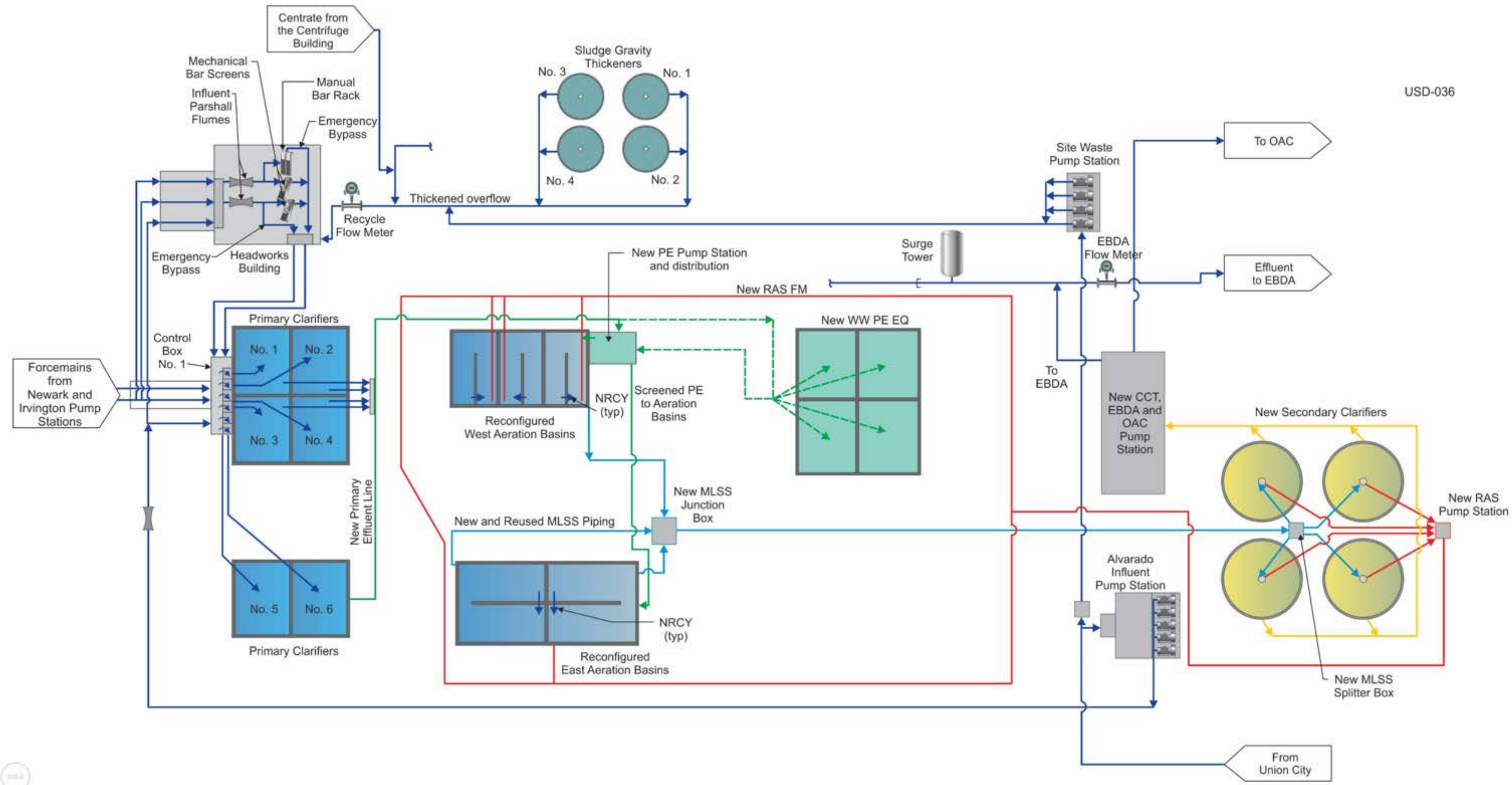


Figure 7-7 CAS Option 2 Phase I PFD

7.2.2 CAS Option 2 – Effluent Water Quality

Phase I accomplishes improved effluent quality through year-round BNR. The aeration basin modifications described in **Section 6.2.1.1** coupled with the new modern clarifiers will provide the District with the capability to operate in BNR mode year-round because:

- The RAS system associated with the new modern clarifiers allows for step feed operation during wet weather.
- The PE equalization shaves peaks during wet weather.
- The new clarifiers can handle wet weather at the higher solids loading required for BNR
- Year -round BNR operation can achieve approximately 50% effluent TN load reduction for the year. It also achieves significant ammonia removal in wet weather.

To meet the stringent TSS standards (TSS<15 mg/L) for creek discharge during wet weather while maintaining solids inventory for BNR, the District will utilize several features in CAS Option 2 Phase I:

- PE equalization to shave off peak flow during storm events
- Step feed operation to off load solids loading to the secondary clarifiers
- Modern clarifiers with more total surface area and improved RAS control.

7.2.2.1 CAS Option 2 – New Clarifiers Early and Year-round BNR – Nutrient Removal

Process modeling was conducted to determine nutrient removal after the completion of CAS Option 2 Phase I. These results are presented in **Table 7-7.**

Table 7-7 CAS Option 2 – Phase I BNR Operation Modeling Results

	Parameter	Units	AA	MM	MML-AAF	Redundancy - 1 AB OOS[1]	Redundancy - 1 SC OOS
Influent	Temperature	^oC	16	16	16	20	16
Aeration	AB in service	#	5	5	5	4	5
	MLSS	mg/L	3,400	3,800	3,800	3,800	3,400
	SRT	d	5.3	5.3	5.3	4.5	5.3
	Aerobic SRT	d	4.5	4.5	4.5	4.0	4.5
New Secondary Clarifiers	Number	#	4	4	4	4	3
	Surface Area	sf	75,500	75,500	75,500	75,500	56,600
	Volume	MG	10	10	10	10	8
	SOR	gpd/sf	378	430	379	372	504
	SLR	lbs/d/sf	18	21	19	20	23
	SVI	mL/g	110	110	110	110	110
	RAS Ratio	%	50%	50%	50%	50%	50%
WAS	WAS flow	mgd	0.4	0.4	0.4	0.4	0.4
	WAS conc	mg/L	10,500	11,400	11,400	12,000	10,200
	WAS Load	lbs/d	33,000	38,000	38,000	37,000	33,000
Secondary Effluent	cBOD	mg/L	<10	<10	<10	<10	<10
	TSS	mg/L	<15	<15	<15	<15	<15
	TN	mgN/L	<18	<18	~19	<18	<18
	NH_3-N	mgN/L	<2	~2.5	~3	~3.5	<2
	NO_3-N	mgN/L	~11-12	~12	~14.5	~11	~11-12
	NO_2-N	mgN/L	~0.5	~0.5	~0.5	~1	~0.5
	TIN	mgN/L	~12-13	~12-13	~15	~12	~12-13
	TP	mgP/L	~3-4	~3-4	~3-4	~3-4	~3-4
	PO_4-P	mgP/L	~3	~3	~3.5	~3	~3

[1]Largest AB out of service

If BNR operation is needed it is not recommended to take an aeration basin out of service during colder months as it will reduce the aerobic SRT significantly. Also note that these models were run without diurnal PE equalization as a conservative assumption. Note that modeling results presented in **Table 7-7** for AA, MM and MML-AAF are for worst case conditions, coldest temperatures. These models show ammonia breakthrough for the coldest month. During the coldest months there is a potential to optimize the system by using the swing zone aerobically to increase the aerobic SRT and reduce ammonia breakthrough.

Table 7-8 shows the expected effluent quality for other temperatures and **Figure 7-8** shows the TN reduction over the year. These model results show up to 50 % TN load reduction over a typical year.

Table 7-8 CAS Option 2 – Phase I BNR Operation Modeling Results Throughout the Year

Parameter	Units	Temperature, °C				
		16	18	20	22	24
Load Condition	-	MM	MM	MM	MM	MM
Flow Condition	-	AA	AA	AA	AA	AA
Flow	mgd	26	26	26	26	26
AB Volume in service	mg	7.4	7.4	7.4	7.4	7.4
Swing Volume	-	Aerobic	Aerobic	Anoxic	Anoxic	Anoxic
New Secondary Clarifier SA	sf	75,500	75,500	75,500	75,500	75,500
SVI	mL/g	110	110	110	110	110
SRT	d	4.8	4.8	4	4	4
MLSS	mg/L	3,800	3,800	3,600	3,600	3,550
TN	mgN/L	~19	<19	<16	~15	~15
NH_3-N	mgN/L	~3	<2	<2	<1	<1
NO_3-N	mgN/L	~14.5	~15	~9-11	~10-12	~10-12
NO_2-N	mgN/L	~0.5	~0.5	~0.5	<0.5	<0.5
TIN	mgN/L	~15	<15.5	~10-11	~10-12	~10-12

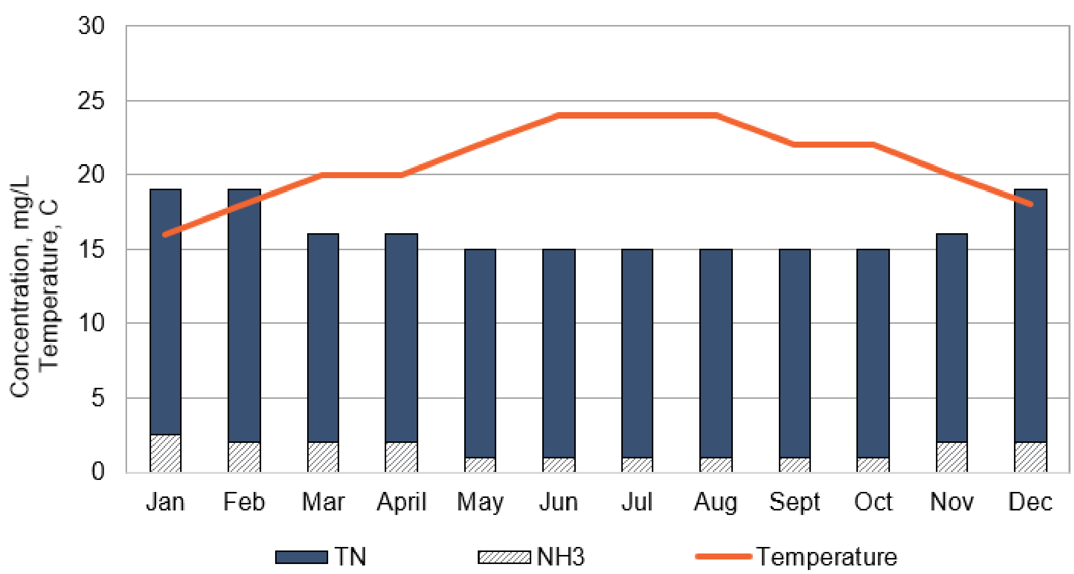


Figure 7-8 CAS Option 2 – Phase I TN Reduction

During storm events, step feed operation reduces the MLSS from 3,600 mg/L to 2,700 mg/L. This solids loading rate reduction, PE equalization, and the modern clarifier technology allow the facility to achieve effluent TSS less than 15 mg/L during storm events. **Figure 7-9** and **Figure 7-10** show the simulated effluent TSS and effluent nitrogen during the design storm after CAS 2 Phase I is completed, respectively. Note that the SOR in **Figure 7-10** is based on the clarifier effluent flow after equalization.

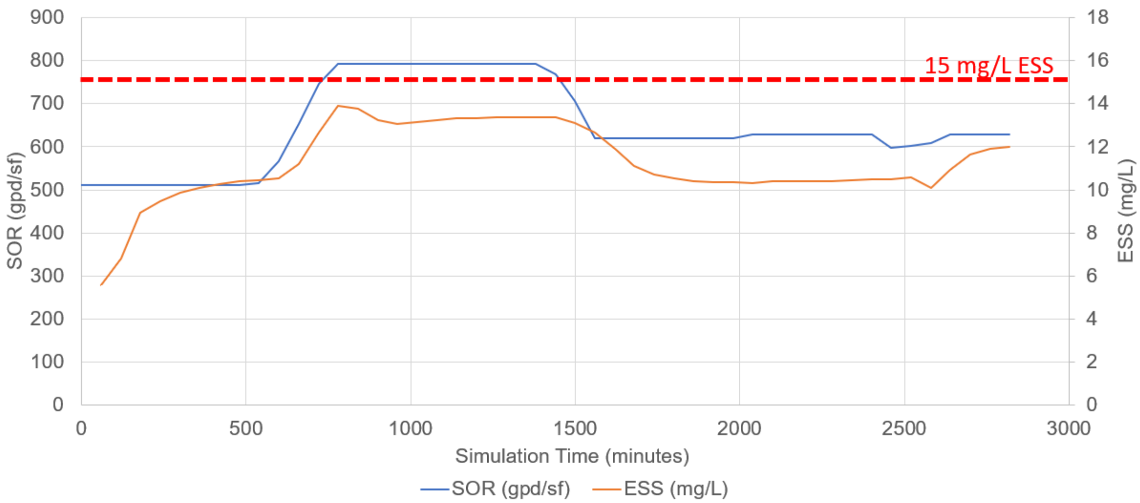


Figure 7-9 CAS Option 2 – Phase I Wet Weather Effluent TSS

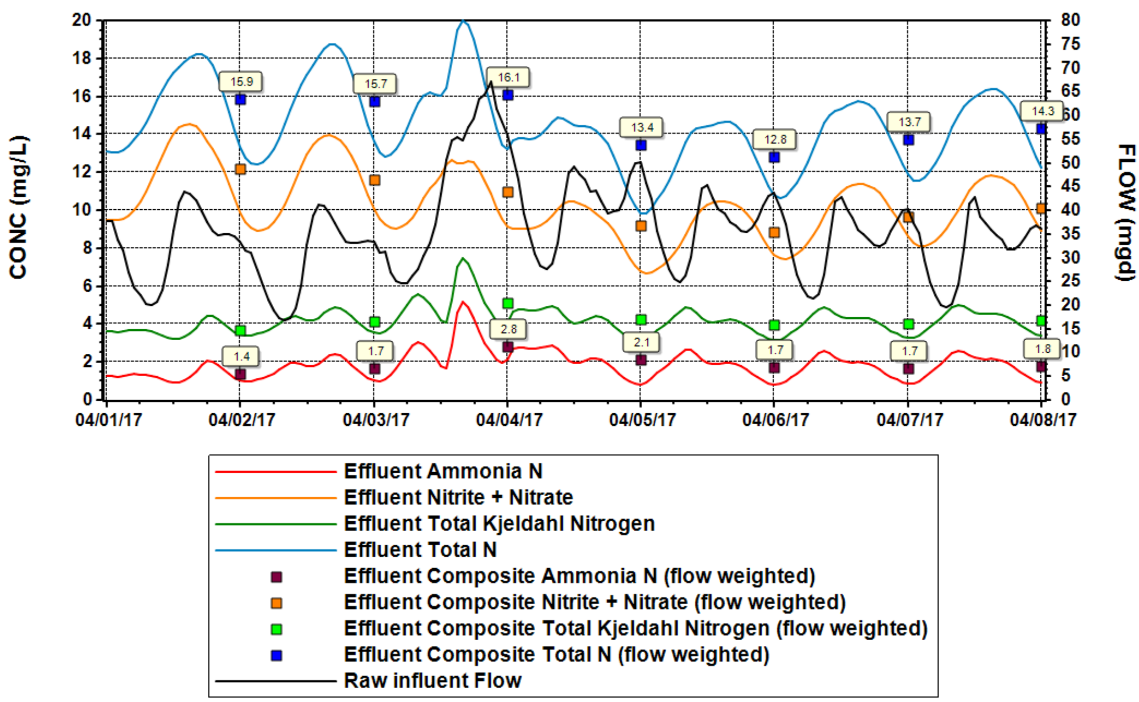


Figure 7-10 CAS Option 2 – Phase I Wet Weather Effluent Nitrogen

7.2.3 CAS Option 2 – Phase II Scope

The remaining scope items not constructed in Phase I will be constructed as part of Phase II as listed in **Table 7-6**. Phase II will be triggered when the facility expects to be required to meet BACWA Level 2 standards year-round or if loading increases such that ammonia breakthrough occurs in cold weather.

7.2.4 CAS Option 2 – Phase I and II Layouts

A site plan showing the AWWTP after CAS Option 2 – New Clarifiers Early and Year-round BNR Phase I is completed is shown in **Figure 7-11**. A site plan showing the AWWTP after CAS Option 2 – New Clarifiers Early and Year-round BNR Phase II is completed is shown in **Figure 7-12**. Only the blue shaded infrastructure is constructed under Phase II, grey shaded infrastructure is installed as part of Phase I.

7.2.5 CAS Option 2 – Benefits and Considerations

There are several benefits to the phasing in CAS Option 2 – New Clarifiers Early and Year-round BNR. These are:

1. Achieves Year-round BNR (Note: Not BACWA Level 2 standards)
2. Sidestream treatment is not required in Phase I, saving capital expenditures
3. Achieves greatest yearly mass TN removal (approximately 50%)
4. Does not have stranded assets associated with disk filters
5. Does not have stranded assets associated with clarifier modifications
6. New RAS control after Phase I is completed
7. Frees up 2.5 MG of volume for PE EQ in Phase I

One important consideration to the phasing of CAS Option 2, is the requirement to relocate the administrative and control building. For other options (CAS Option 1 and CAS Option 3) this activity must occur before Phase II, affording the District more flexibility in design and construction of the new building campus. For this option the buildings must be done in Phase I to accommodate the new clarifiers.

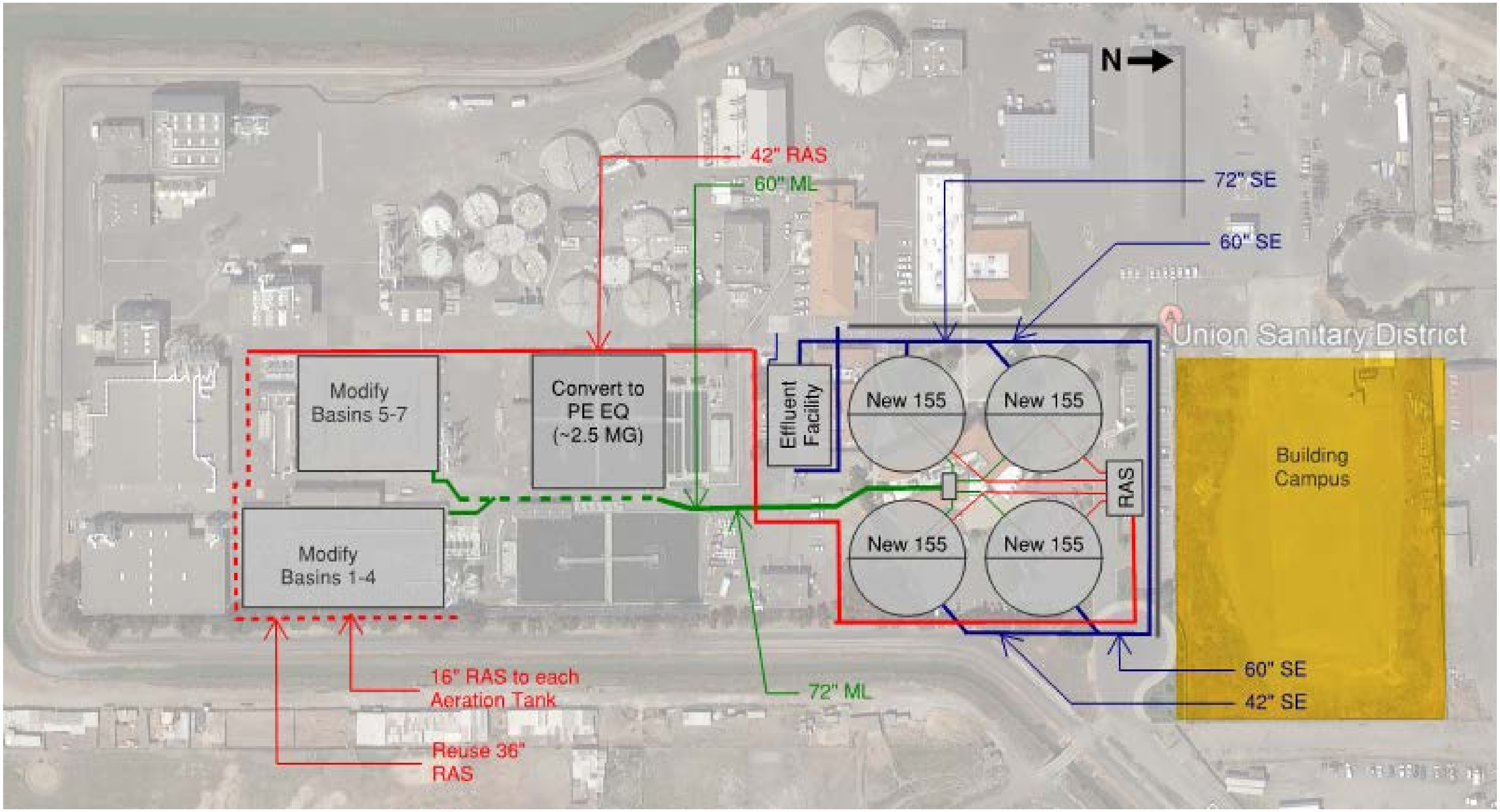


Figure 7-11 CAS Option 2 – New Clarifiers Early and Year-round BNR Phase I

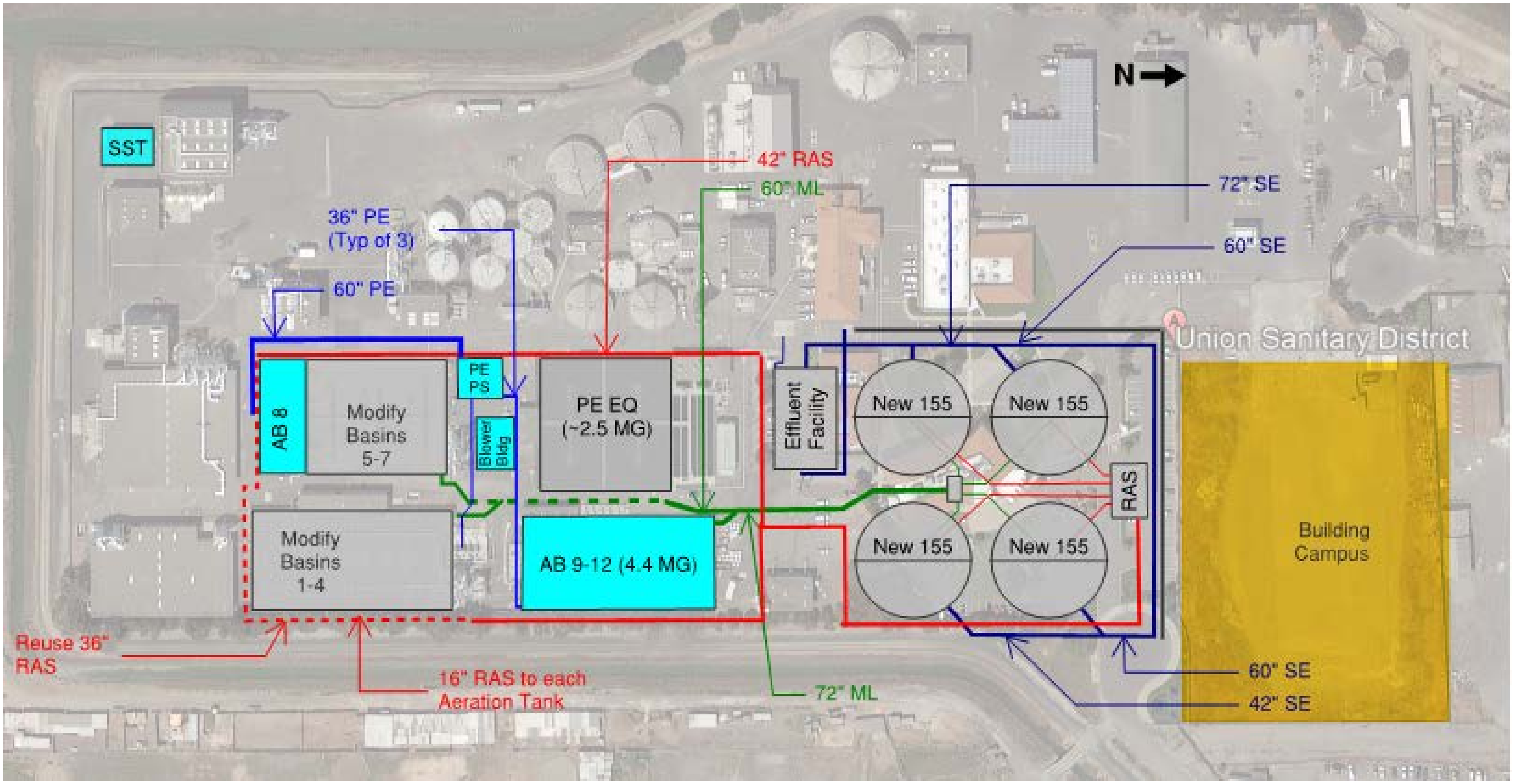


Figure 7-12 CAS Option 2 – New Clarifiers Early and Year-round BNR Phase II

*Note that Phase I scope is shown in grey and Phase II scope is shown in blue.

7.3 CAS Option 3 – No Old Alameda Creek Discharge

7.3.1 CAS Option 3 – Phase I Scope and Process Flow Diagram

As noted in **Table 7-1**, CAS Option 3 – No Old Alameda Creek Discharge Phase I achieves the objectives of increasing plant capacity and avoiding discharge to Old Alameda Creek. **Table 7-9** summarizes the scope for CAS Option 3 - No Old Alameda Creek Discharge for Phase I and Phase II. **Figure 7-13** shows the process flow diagram for this configuration.

Table 7-9 CAS Option 3 – No Old Alameda Creek Discharge Scope

Phase	CAS Option 3 – No Old Alameda Creek Discharge	Note
Phase I – Capacity Scope	Aeration Basin Modifications	No new AB volume. Layouts as described in **Section 6.2.1**
	New Secondary Clarifiers	As described in **Section 6.2.1.4**
Phase I – Creek Avoidance	New Effluent Storage	As described in **7.3.1.1**
Phase II Scope	Intermediate Pump Station	As described in **Section 6.2**
	PE EQ (2.5 MG)	As described in **Section 6.2**
	New Aeration Basin Volume (5.5 MG)	As described in **Section 6.2**
	Blower and Blower Building	As described in **Section 6.2**
	Chemical P Removal	As described in **Section 6.2**
	New Sidestream Treatment	As described in **Section 6.4**
	Chlorination Facilities	As described in **Section 6.3**
	EBDA Pump Station	As described in **Section 6.3**
	EBDA FM re-route	As described in **Section 6.3**

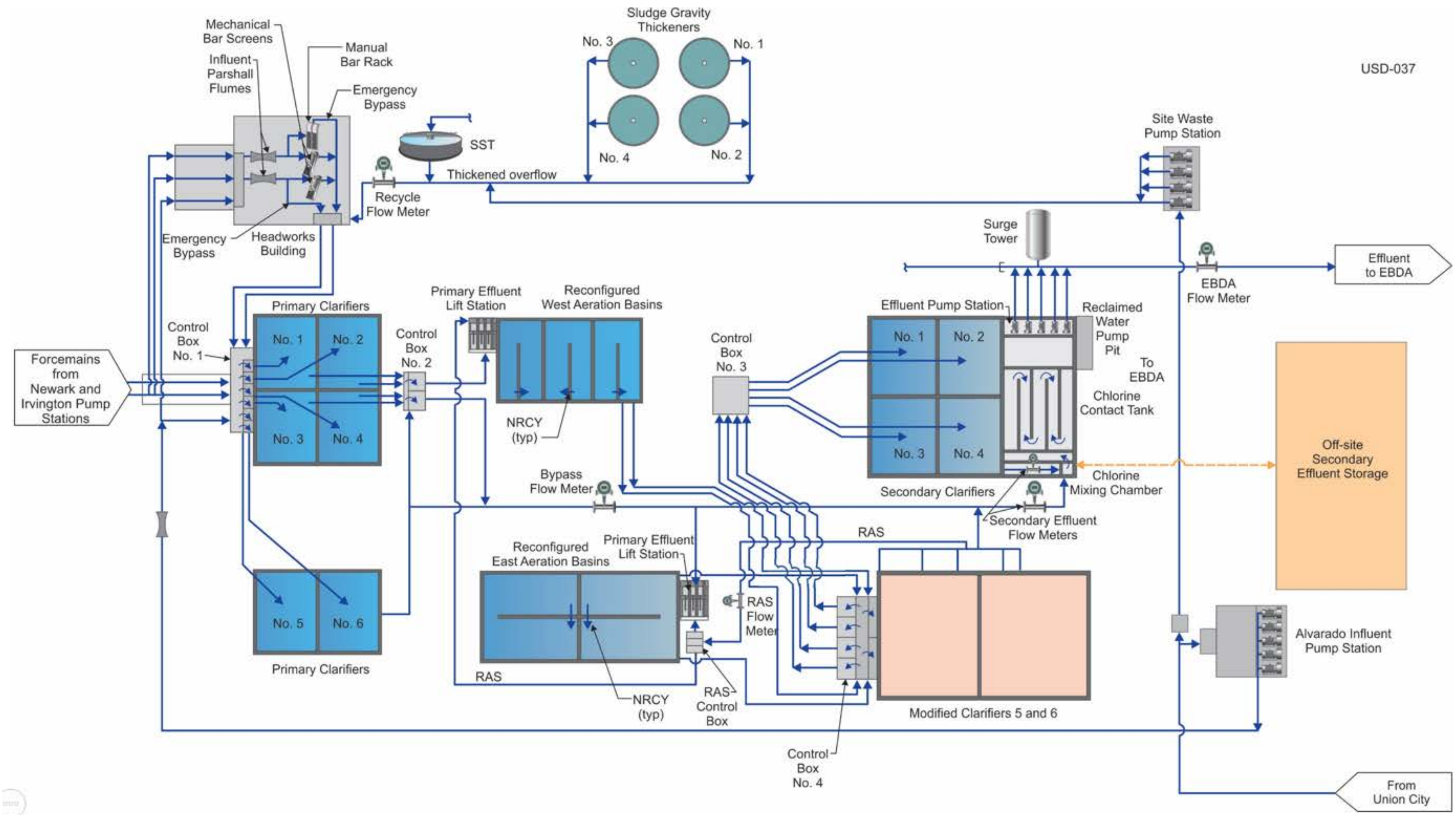


Figure 7-13 CAS Option 3 Phase I PFD

7.3.1.1 Secondary Effluent Equalization Basin

To limit effluent flows to 42.9-mgd, the maximum that can be discharged through the EBDA facility, an effluent storage facility is required. An initial analysis was conducted on actual plant effluent hourly flows from 2011 – May 2017. Hourly flows were escalated to 2040 flows (based on 1% per year escalation per **Section 4 - Assumptions**) and wet weather seasons were modeled to show the volume to be diverted to maintain a maximum secondary effluent flow of 42.9-mgd. Assuming that flows greater than 42.9-mgd are stored, this results in a minimum of 20 MG for 2040. Assuming the existing 8-mgd of emergency creek discharge is available, and additional free board, a 15 MG storage facility was planned for. Per discussions with the District, the effluent storage facility could include the following:

- Purchase a 17-acre land parcel adjacent to the AWWTP (east)
- Mitigation costs are approximately $1M per acre of acquired land
- No covers as stored flow would be secondary effluent
- Pumping and metering
- Extensive permitting and environmental documentation

7.3.2 CAS Option 3 – Effluent Water Quality

This option avoids discharge to the creek entirely and is not subject to the potential negotiations of a total TN load reduction of 15%. A part of this option the District will have modified aeration basins and modified secondary clarifiers in Phase I. The District could perform limited seasonal BNR similar to CAS Option 1. For process modeling results see **Section 7.1.2.1.**

7.3.3 CAS Option 3 – Phase II Scope

The remaining scope items not constructed in Phase I will be constructed as part of Phase II as listed in **Table 7-9.** Phase II will be triggered when the facility expects to be required to meet BACWA Level 2 standards year-round.

7.3.4 CAS Option 3 – Phase I and II Layouts

A site plan showing the AWWTP after CAS Option 3 – No Old Alameda Creek Discharge Phase I is completed is shown in **Figure 7-14**. A site plan showing the AWWTP after CAS Option 3 – No Old Alameda Creek Discharge Phase II is completed is shown in **Figure 7-15.** Note that only the blue shaded infrastructure is constructed under Phase II, the grey shaded infrastructure is constructed as part of Phase I.

7.3.5 CAS Option 3 – Benefits and Considerations

There are several benefits to the phasing in CAS Option 3 – No Old Alameda Creek Discharge. These are:

1. The secondary effluent storage system is relatively simple to operate. It would simplify operations during wet weather as flows greater than the EBDA capacity are passively diverted to the secondary effluent storage system. These flows are then drained where there is capacity it the EBDA system
2. The secondary effluent storage can also be used for off spec water
3. Can shave daily peak flow in DW to reduce effluent pumping costs (however it will increase daily maintenance)
4. Potentially less cash flow required depending on remediation requirements
5. EQ provides flexibility for future construction sequencing

There are several considerations to the phasing in CAS Option 3 – No Old Alameda Creek Discharge. These are:

1. Permitting and environmental documentation to acquire and use the adjacent land to construct a secondary effluent storage facility is risky and could take considerable time. The permitting and environmental process for this may take several years.
2. Land acquisition may also be risky as it involves additional parties to negotiate with.
3. This option does not provide synergy with future nutrient removal. While the basin modifications are required as listed in **Section 6**, the construction of the secondary effluent storage facility does not advance the ability of the plant to perform nutrient removal. Significant investment will need to be made as part of CAS Option 3 Phase II.

Figure 7-14 CAS Option 3 – No Old Alameda Creek Discharge Phase I

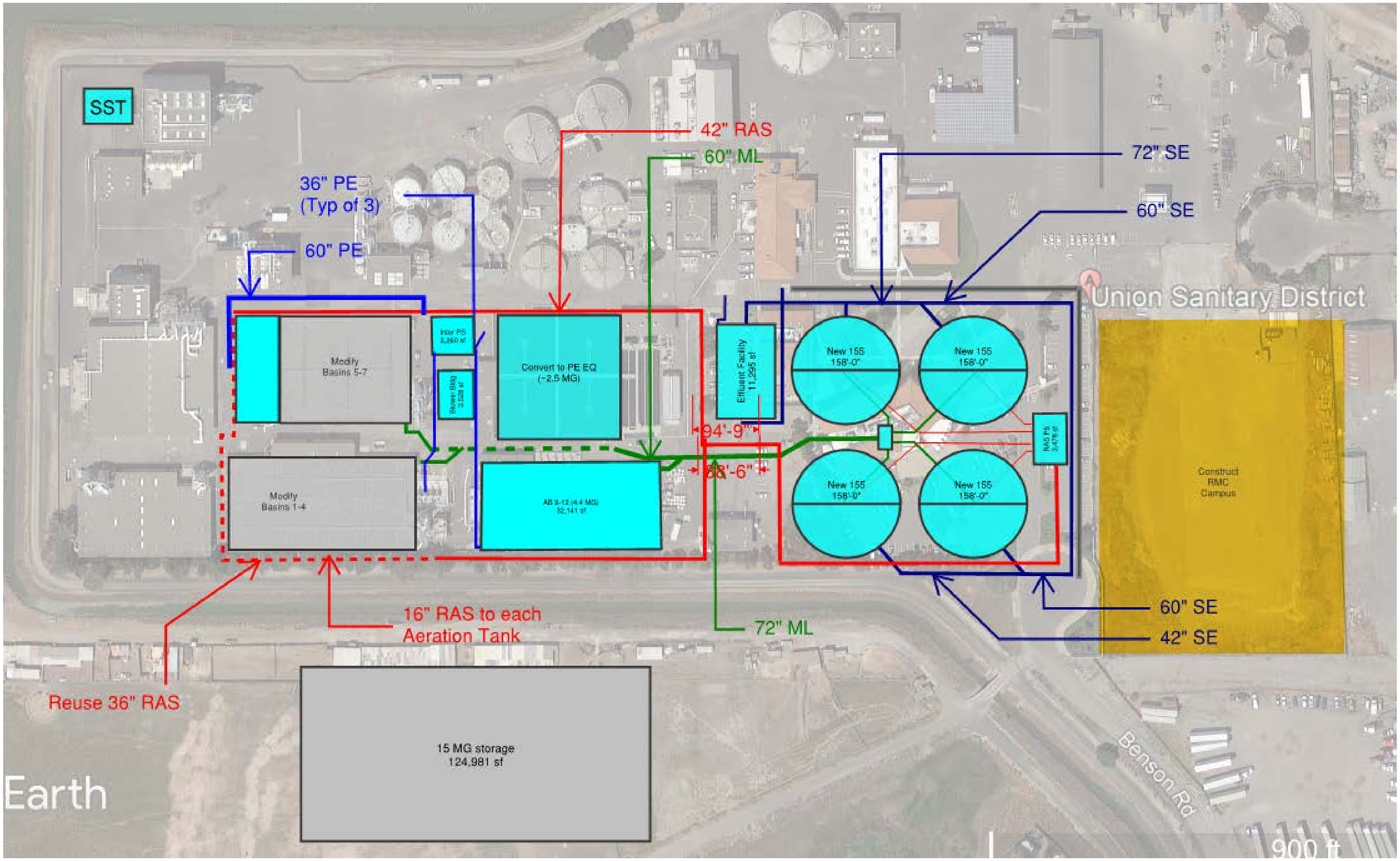


Figure 7-15 CAS Option 3 – No Old Alameda Creek Discharge Phase II

*Note that Phase I scope is shown in grey and Phase II scope is shown in blue.

7.4 CAS Phasing Options Summary

The phasing options were designed to achieve different specific objectives in Phase I as noted in **Table 7-1**. Each has benefits and considerations as summarized in **Table 7-10**.

Table 7-10 Summary of Benefits and Considerations for each CAS Option

Phase	CAS Option 1 Clarifier Modifications and Limited Seasonal BNR	CAS Option 2 New Early Clarifiers and Year-round BNR	CAS Option 3 No Old Alameda Creek Discharge
Phase I	• Aeration Basin Modifications • Secondary Clarifier modifications • Disk Filters • New[1] Chlorine Contact Channels • New[1] Dechlorination Facility • New[1] Effluent Pump Station • Move EBDA Force Main • Sidestream Treatment	• 2.5 MG of PE Equalization • Aeration Basin Modifications • New Secondary Clarifiers • New[1] Chlorine Contact Channels • New[1] Dechlorination Facility • New[1] Effluent Pump Station • Move EBDA Force Main	• Aeration Basin Modifications • Secondary Clarifier Modifications • Secondary Effluent Equalization
Phase II	• PE Pump Station • 2.5 MG of PE Equalization • New AB Vol. (5.5 MG) • Blowers and Blower Building • New Secondary Clarifiers • Chemical P Removal	• PE Pump Station • New AB Vol. (5.5 MG) • Blowers and Blower Building • Sidestream Treatment • Chemical P Removal	• PE Pump Station • 2.5 MG of PE Equalization • New AB Vol. (5.5 MG) • Blowers and Blower Building • New Secondary Clarifiers • Move EBDA Force Main • Sidestream Treatment • Chemical P Removal

Phase	CAS Option 1 Clarifier Modifications and Limited Seasonal BNR	CAS Option 2 New Early Clarifiers and Year-round BNR	CAS Option 3 No Old Alameda Creek Discharge
PROS	• Achieves seasonal BNR (3 months) quickly to get to creek with a gap of 2 years • Achieves improved clarification performance (over current)	• Year round BNR[2] • No sidestream treatment required in Phase I • Greatest TN removal until more stringent standards imposed • No stranded disk filters • No Clarifier modifications • Better clarifier performance • New RAS control in Phase I • 2.5 MG available for PE EQ	• Simplified operation during wet weather • Storage provides flexibility for off spec water during dry weather • Can shave daily peak flow in DW to reduce effluent pumping costs • Potentially cash flow required depending on remediation requirements • EQ provides flexibility for future construction MOPO
CONS	• Only achieves seasonal BNR • Stranded assets in disk filters • Stranded assets in clarifier modifications • Less reliable clarifier performance until Phase II • Need sidestream treatment • O&M complexities due to two effluent qualities	• Need to move buildings delays getting to the creek by two additional years over CAS Option 1	• Permitting and environmental process poses additional risk • Land acquisition and restoration requirement poses additional risk • Option does not provide synergy with future nutrient removal

[1]Conservative place holder for costs. Better use of existing infrastructure is pending condition assessment of the existing CCTs

[2]Achieves year-round BNR but not BACWA level 2 standards during coldest months

8. Estimate of Probable Costs

An American Association of Cost Engineers (AACE) estimate of probable costs was developed to determine project costs for each of the secondary treatment options and the individual packages. These cost estimates are summarized in this section and are detailed in **Appendix 11.**

The cost estimates developed for this planning phase project can be considered between a Class 3 and Class 4 estimate given the level of detail that has been defined for the options. **Table 8-1** summarizes the cost estimate classifications and the accuracy of each classification.

Table 8-1 AACE Cost Estimate Classifications

Estimate Level	Project Level	Basis	Accuracy
Class 5 – Factored Estimate	Conceptual / Screening	Similar	-50% to +100%
Class 4 – Equipment Factored Estimate	Study / Feasibility	Parametric model / Major Equipment	-30% to + 50%
Class 3 – Budgetary Cost Estimate	Budget Authorization	Semi-detailed Unit Costs	-20% to + 30%
Class 2 – Control Budget Estimate	Budget / Bid Estimate	Detailed Take-offs	-15% to + 20%
Class 1 – Detailed Estimate	Definitive Estimate	Material Take-offs	-10% to + 15%

8.1 Assumptions

Several assumptions were made to develop the project costs including Division 1, contractor overhead and profit, subcontractor mark up, escalation, bonding and insurance, contingency and market conditions. These values were selected based on experience and knowledge of local conditions. The current market conditions, a “hot” construction market, were also considered. These values were slightly relaxed for future construction as it was assumed that the current construction market will “cool down” to normal conditions. The cost assumptions are summarized in **Table 8-2**.

Table 8-2 Cost Assumptions for Secondary Treatment Process Improvements Project

	Typical Values, %	Assumption, %	Note
Division 1	8-20	15	
Overhead	10-20	10	
Profit	10-18	15	
Subcontractor Markup	2.5-7	5	
Escalation	2-5	4	Annual
Bonding / Insurance	2-6	3	
Contingency	25-50	30	For study or predesign
Market Conditions	Varies		Robust market
TOTAL		82	

8.2 Operation & Maintenance Cost Assumptions

Operations and Maintenance costs were only calculated for processes that were affected by the secondary treatment options. These were:

- Intermediate pump station (primary effluent pumping)
- Primary effluent equalization pumping
- Process air demand
- Aeration mixing demand
- Nitrified recycle pumping demand
- Clarifier mechanism
- RAS pumping
- WAS pumping
- SWAS pumping
- Chlorination flash mixing
- Disk filtration
- Dechlorination flash mixing
- EBDA pump station
- Old Alameda Creek pump station
- MBR facility demand and membrane replacement
- Sidestream treatment
- Chemical addition for phosphorus removal
- Operation personnel

O&M costs were calculated as additional O&M over current O&M costs. Where appropriate if there was no change assumed, this was noted. For intermittent costs, i.e. pumping to Old Alameda Creek, a percentage of time was assumed as summarized in **Table 8-3**.

Table 8-3 Intermittent Process Usage Assumptions

Intermittent Process	% of time	Note
Primary Effluent Equalization	4%	Wet weather only
SWAS pumping	17%	10 minutes an hour
Old Alameda Creek Pump Station	8%	Estimated % of time greater than 43-mgd

8.3 MBR Costs

The MBR option is estimated to have a capital cost of approximately $390M. This covers all project elements as detailed in **Table 8-4**.

Table 8-4 MBR Project Costs[2]

Scope Item	Costs, $M
PE Pump Station/ Fine Screens and Blower Building	44
Aeration Basin Modifications	40
Effluent Facilities	25
MBR Facilities	250
Plant Equalization and Storage	15
Sidestream Treatment	16
Total Capital Costs	390
Total Project Costs[1]	505
Annual O&M Costs	8.5

[1] 30% for Engineering, CM, Legal and Administrative
[2] Excludes campus building costs

8.4 CAS Option 1 – Modified Clarifiers and Limited Seasonal BNR Project Costs

The CAS Option 1 is estimated to have a capital cost of approximately $265M. This covers all project elements as detailed in **Table 8-5**.

Table 8-5 CAS Option 1 – Clarifier Modifications and Limited Seasonal BNR Phase I and II Project Costs[2]

Scope Item	Costs, $M
Phase I	
Existing Aeration Basin Modifications	27
Existing Secondary Clarifier Modifications	13
New Effluent Facility (CCT, De-Chlor) EBDA PS, OAC PS, Disk filters	38
New Sidestream Treatment	14
Phase I Subtotal Capital Costs	92
Phase II	
New Intermediate Pump Station and Blower Building	33
New PE Equalization Facility	9
New Aeration Basin 8	11
New Aeration Basin Volume (4.4 MG)	50
New Secondary Clarifiers	70
Phase II Subtotal Capital Costs	173
Total Capital Costs	265
Total Project[1] Costs	345
Annual O&M Costs	4.6

[1]30% for Engineering, CM, Legal and Administrative

[2] Excludes campus building costs

8.5 CAS Option 2 – New Clarifiers Early and Year-round BNR Project Costs

The CAS Option 2 is estimated to have a capital cost of approximately $250M. This covers all project elements as detailed in **Table 8-6**.

Table 8-6 CAS Option 2 – New Clarifiers Early and Year-round BNR Phase I and II Project Costs[2]

Scope Item	Costs, $M
Phase I	
Existing Aeration Basin Modifications	33
New Effluent Facility (CCT, De-Chlor) EBDA PS, OAC PS	32
New Secondary Clarifiers	69
New PE Equalization Facility	11
Phase I Subtotal Capital Costs	145
Phase II	
New Intermediate Pump Station and Blower Building	31
Aeration Basin 8	11
New Aeration Basin Volume 9-12 (4.4 MG)	46
Sidestream Treatment	16
Phase II Subtotal Capital Costs	105
Total Capital Costs	250
Total Project[1] Costs	320
Annual O&M Costs	4.6

[1]30% for Engineering, CM, Legal and Administrative

[2]Excludes campus building costs

8.6 CAS Option 3 – No Old Alameda Creek Discharge Project Costs

The CAS Option 3 is estimated to have a capital cost of approximately $280M. This covers all project elements as detailed in **Table 8-7**.

Table 8-7 CAS Option 3 – No Old Alameda Creek Discharge Phase I and II Project Costs[2]

Scope Item	Costs, $M
Phase I	
Existing Aeration Basin Modifications	23
Existing Secondary Clarifier Modifications	37
Secondary Equalization	69
Phase I Subtotal Capital Costs	98
Phase II	
New Intermediate Pump Station and Blower Building	30
New PE Equalization Facility	8
New Aeration Basin 8	11
New Aeration Basin Volume (4.4 MG)	46
New Secondary Clarifiers	65
New Effluent Facility (CCT, De-Chlor) EBDA PS, OAC PS	3
Sidestream Treatment	16
Phase II Subtotal Capital Costs	180
Total Capital Costs	280
Total Project[1] Costs	360
Annual O&M Costs	4.6

[1]30% for Engineering, CM, Legal and Administrative
[2]Excludes campus building costs

8.7 Project Cost Comparison

The project and O&M costs were combined to determine the net present value (NPV) of the options. These are summarized in **Table 8-8**. For all CAS Options the O&M costs per year were assumed to be similar. Note that the campus building costs were not included in the total project costs or NPV calculations. The campus building project was identified, scoped (planning level) and justified as part of the Enhanced Treatment & Site Upgrade Program; as the project was recommended for reasons outside of this project, the costs are not part of this analysis. The costs are associated with this project and listed in **Table 8-8** for reference.

Table 8-8 Project Cost Comparison Summary

Scope Item	MBR Option	CAS Option 1 Clarifier Modifications and Limited Seasonal BNR	CAS Option 2 New Clarifiers Early and Year-round BNR	CAS Option 3 No Old Alameda Creek Discharge
Phase I Project Costs[1,3]	505	120	190	128
Phase II Project Costs[1,3]	-	225	135	233
Total Project Cost[3]	505	345	320	360
20 Year NPV O&M costs[3]	145	50	50	25
NPV[3]	650	395	370	385
Campus Building Costs[2,3]	66	66	66	66

[1]Project Costs include 30% for Engineering, CM, Legal and Administrative
[2] From ETSU Program Analysis
[3]Costs are in 2019 dollars.

Table 8-8 shows that both the Project and O&M costs associated with the MBR option are significantly more costly than any of the CAS options that can be phased. As CAS Option 2 has the least stranded assets it has the most favorable net present value.

The annual capital expenditures for each option were plotted to illustrate the lifecycle expenditures over time. **Figure 8-1** and **Figure 8-2** show the lifecycle expenditures over time for the MBR and CAS options, respectively.

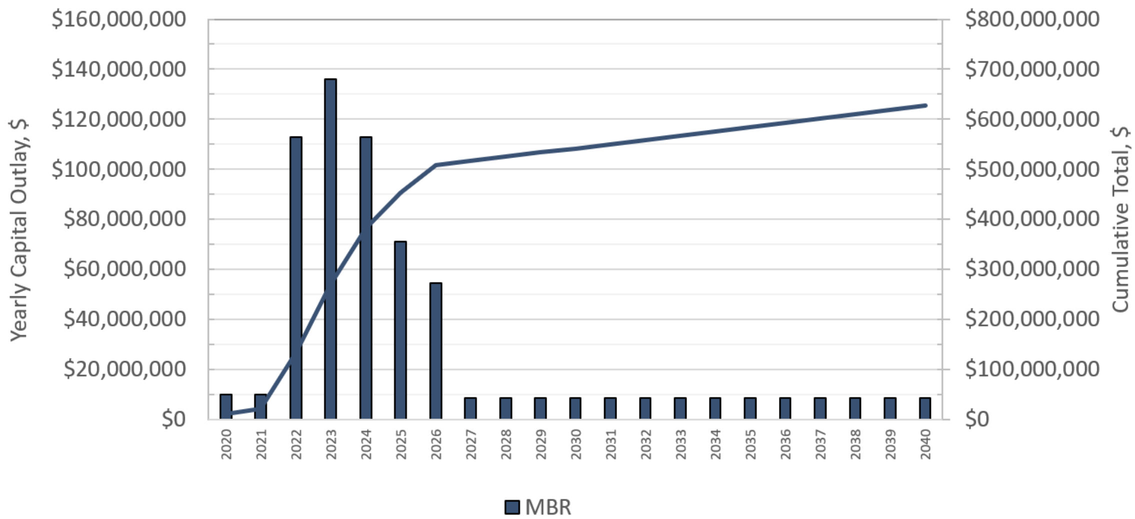


Figure 8-1 MBR Option Lifecycle Expenditures Over Time

It can be seen that the MBR project would require significant immediate investment as it cannot be phased. Furthermore, the overall cost of the MBR results in a cumulative total capital outlay (in 2040) of over $650M while the most expensive CAS option is less than $400M.

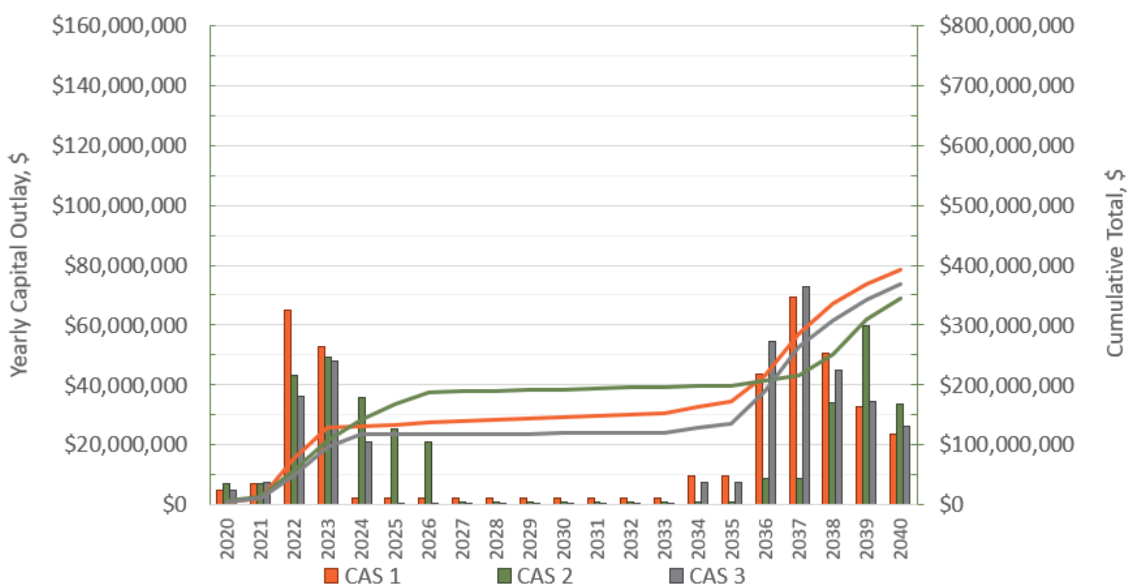


Figure 8-2 CAS Options Lifecycle Expenditures Over Time

9. Best Value Solution

9.1 Process Technology

The District considered two technologies for the Secondary Treatment Process Improvements. The benefits, considerations, and costs of these options are summarized in **Table 9-1**.

Table 9-1 MBR and CAS Technology Summary

	MBR	CAS
Benefits	• Excellent effluent quality • Compact technology • No settling sludge issues • Flexibility to produce recycled water	• Lower Capital Costs • Lower O&M Costs • Phasing Options spread capital expenditures out over time • Flexibility for wet weather peaks • Familiar technology
Considerations	• High Capital Costs • High O&M Costs • No phasing options • Wet weather peak flow issues • New technology / training	• Space requirements
Total Project Costs[1]	\$505M	\$320-345M

[1]Excludes Campus Building Costs

Due to the costs of the project and the ability to achieve the same standards with the CAS technology, the District decided to consider a CAS solution for the Secondary Treatment Process Improvements.

9.2 CAS Phasing Options

The District considered three CAS phasing options for the Secondary Treatment Process Improvements. The benefits and considerations and costs of these options are summarized in **Table 9-2.**

Table 9-2 CAS Phasing Options Summary

	CAS Option 1 – Clarifier Modifications and Limited Seasonal BNR	CAS Option 2 – New Clarifiers Early Year-round BNR	CAS Option 3 – No Old Alameda Creek Discharge
Benefits	• Achieves seasonal BNR (3 months) quickly to get to creek with a gap of 2 years • Achieves improved clarification performance (over current)	• Year round BNR2 • No sidestream treatment required in Phase I • Greatest TN removal until more stringent standards imposed • No stranded disk filters • No clarifier modifications • Better clarifier performance • New RAS control in Phase I • 2.5 MG available for PE EQ	• Simplified operation during wet weather • Storage provides flexibility for off spec water during dry weather • Can shave daily peak flow in DW to reduce effluent pumping costs • Potentially less cash flow required depending on remediation requirements • EQ provides flexibility for future construction sequencing
Considerations	• Only achieves seasonal BNR • Stranded assets in disk filters • Stranded assets in clarifier modifications • Less reliable clarifier performance until Phase II • Need sidestream treatment • O&M complexities due to two effluent qualities	• Need to move buildings delays getting to the creek by two additional years over CAS Option 1	• Permitting and environmental process poses additional risk • Land acquisition and restoration requirement poses additional risk • Option does not provide synergy with future nutrient removal
Total Project Costs[2]	$345M	$320M	$360M

[1]Achieves year-round BNR but not BACWA level 2 standards during coldest months

[2]Excludes Building Campus Costs

Given the risks and time associated with permitting a secondary effluent equalization basin, the District decided to eliminate CAS Option 3 – No Old Alameda Creek Discharge from further consideration. Both CAS Option 1 – Clarifier Modifications and Limited Seasonal BNR and CAS Option 2 – New Clarifiers Early and Year-Round BNR achieve capacity improvements and the potential for creek discharge (pending discussions with SFBRWQCB). **Table 9-3** summarizes the water quality difference between CAS Option 1 and CAS Option 2.

Table 9-3 CAS Option 1 and Option 2 Nutrient Removal Potential Summary

	CAS Option 1 – Clarifier Modifications and Limited Seasonal BNR	CAS Option 2 – New Clarifiers Early Year-round BNR
Design	June 2019	June 2019
Construction Start	Mar 2021	Mar 2021
Construction Completion	May 2024	July 2025
Gap between Potential Hayward Marsh ending and Phase I Completion	~2 years	~4 years
Annual Mass TN Reduction Achieved, %	20%	50%
Years of BNR	8 years	6 Years
Annual loads of TN removed 10 years after Hayward Marsh ends, %-yr	1.6	3
Ammonia discharge to Creek	Not mitigated (seasonal BNR)	BNR during wet weather

Since CAS Option 2 has fewer stranded assets, better effluent quality, more reliable technology, and a lower cost, the preferred option is CAS Option 2.

9.3 Preferred Alternative – Sequencing

The District would like to execute the project quickly given the imminent closure of the Hayward Marsh. **Figure 9-1** shows the estimated project schedule for CAS Option 2 – Phase I from the beginning of design, October 2019 to construction completion July 2026.

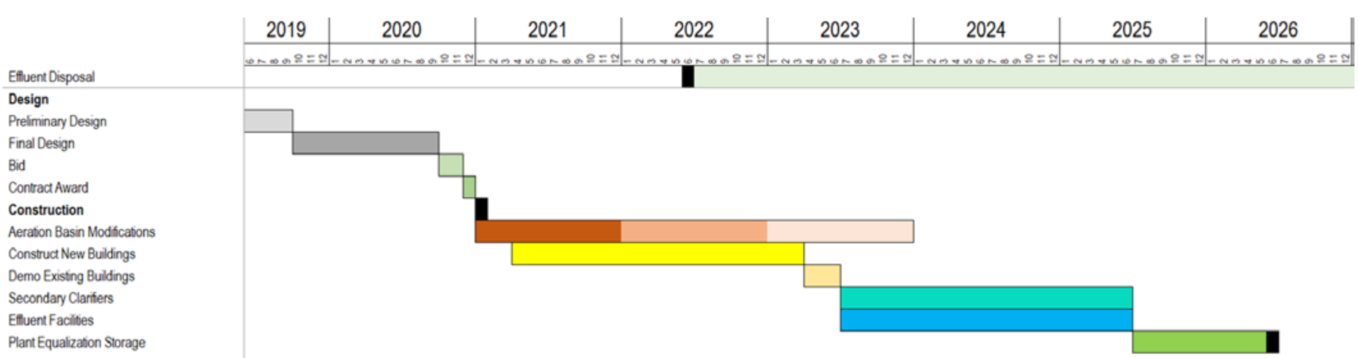


Figure 9-1 CAS Option 2 - Phase I Estimated Construction Schedule

Appendix 1. Historical Data Analysis

The data used in the analysis of historical data are summarized below in tables and figures.

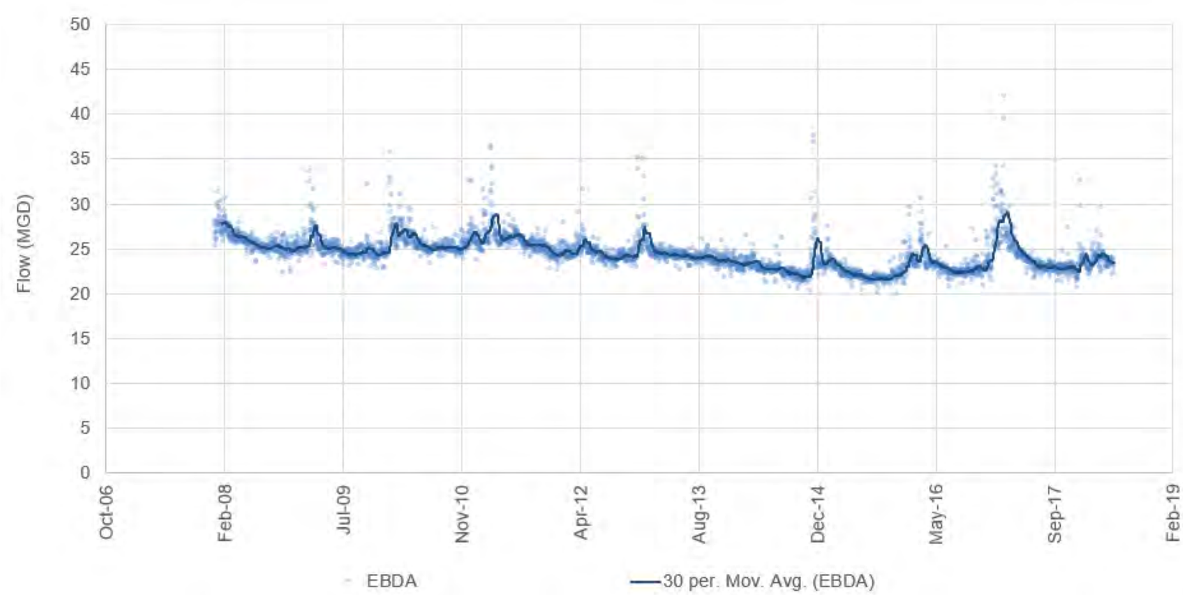


Figure 1-1: Influent Flow

Table 1-1: Historical Influent Flow

Year	Flow (MGD)
2013	24.2
2014	23.0
2015	22.3
2016	23.3
2017	24.4
2018	23.9

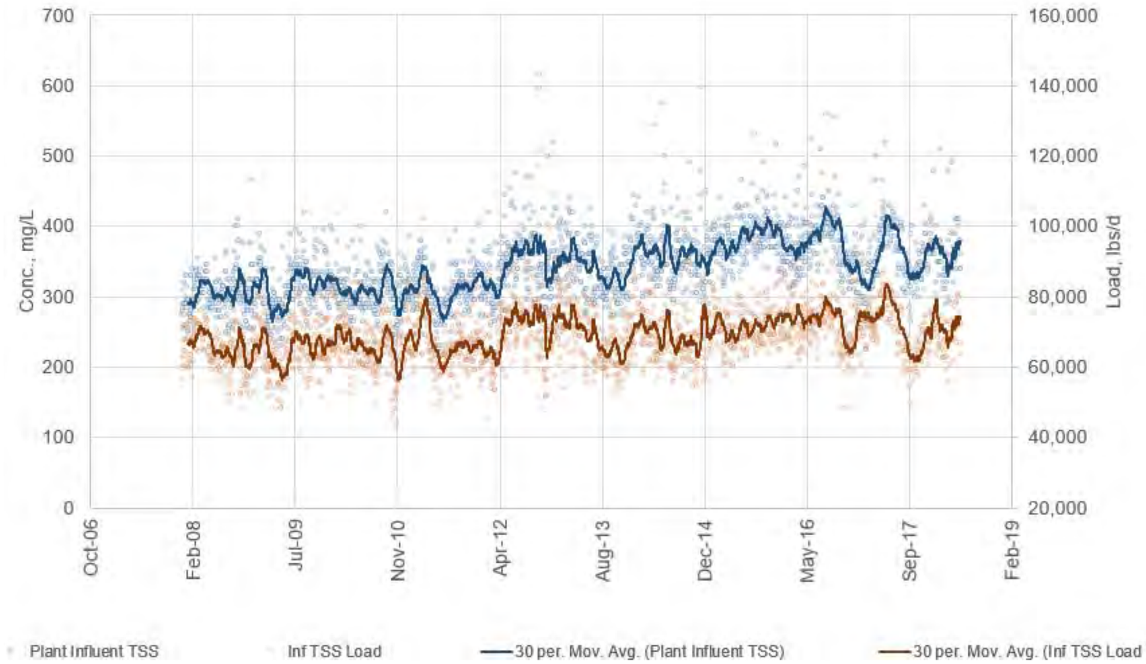


Figure 1-2: Influent Total Suspended Solids Loads and Concentrations

Table 1-2: Historical Influent TSS Data

Year	Concentration (mg/L)	Load (lbs/day)
2013	341	68,655
2014	361	69,464
2015	384	71,465
2016	377	72,988
2017	355	72,743
2018	350	72,579

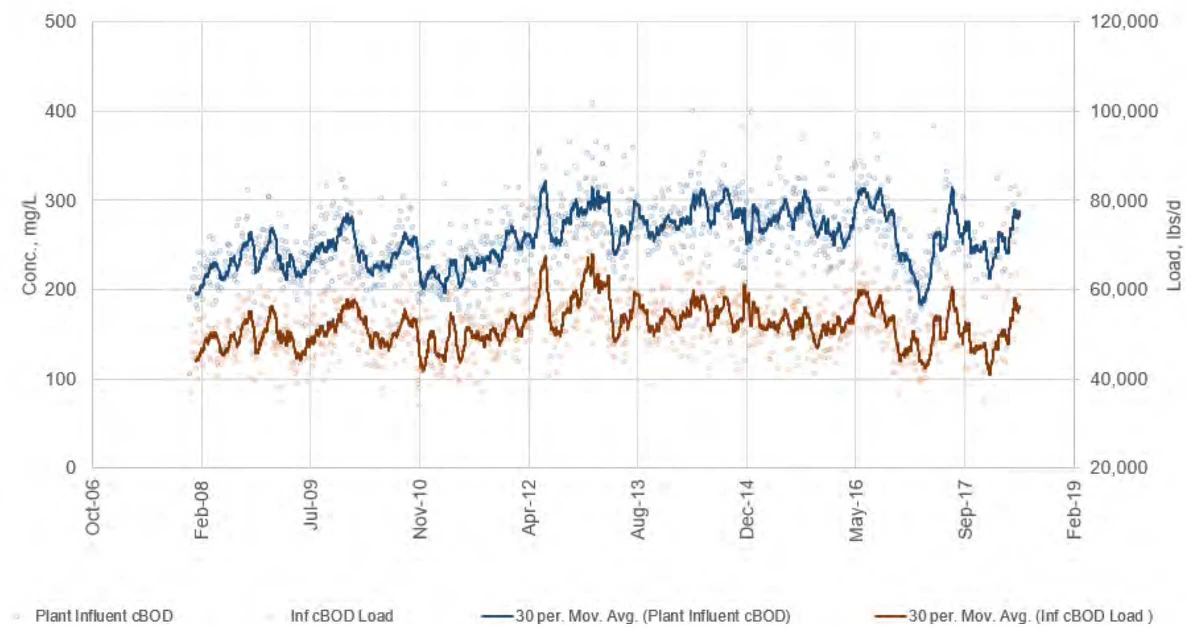


Figure 1-3: Influent Carbonaceous Biological Oxygen Demand

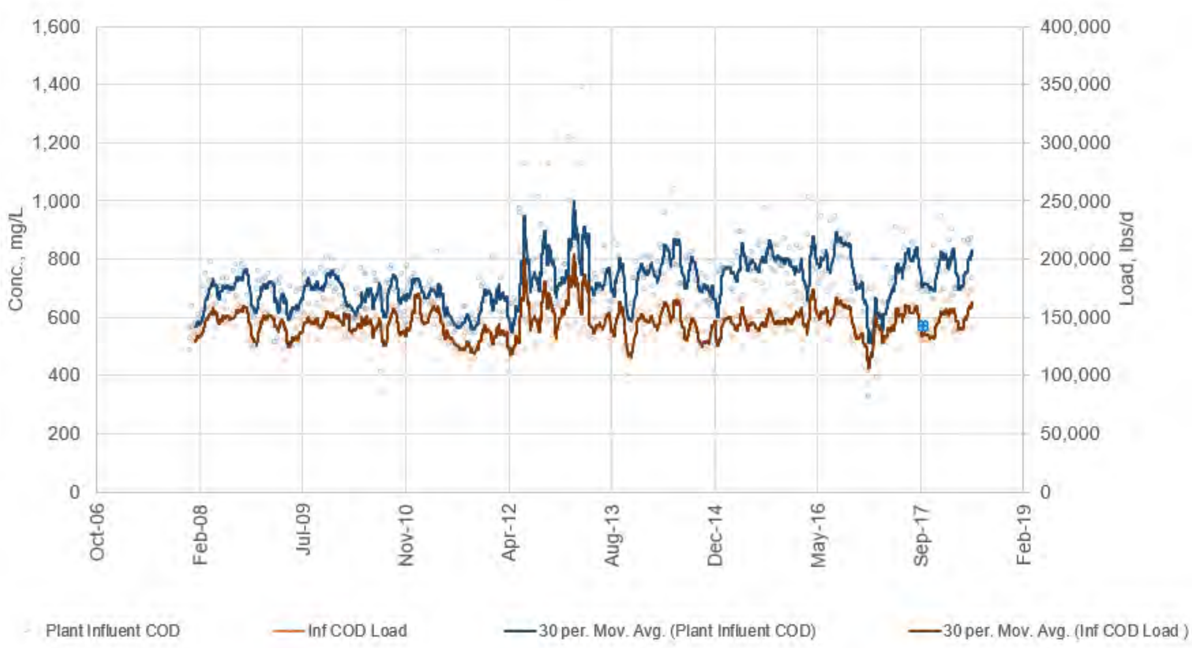


Figure 1-4: Influent Chemical Oxygen Demand

Table 1-3: Historical Influent COD and cBOD

Year	Concentration (mg/L)	Load (lbs/day)	Concentrati on (mg/L)	Load (lbs/day)
2013	751	151,415	276	55,449
2014	752	143,882	287	55,057
2015	786	145,919	282	52,163
2016	778	149,992	275	52,990
2017	711	142,695	239	48,943
2018	762	151,567	259	51,427

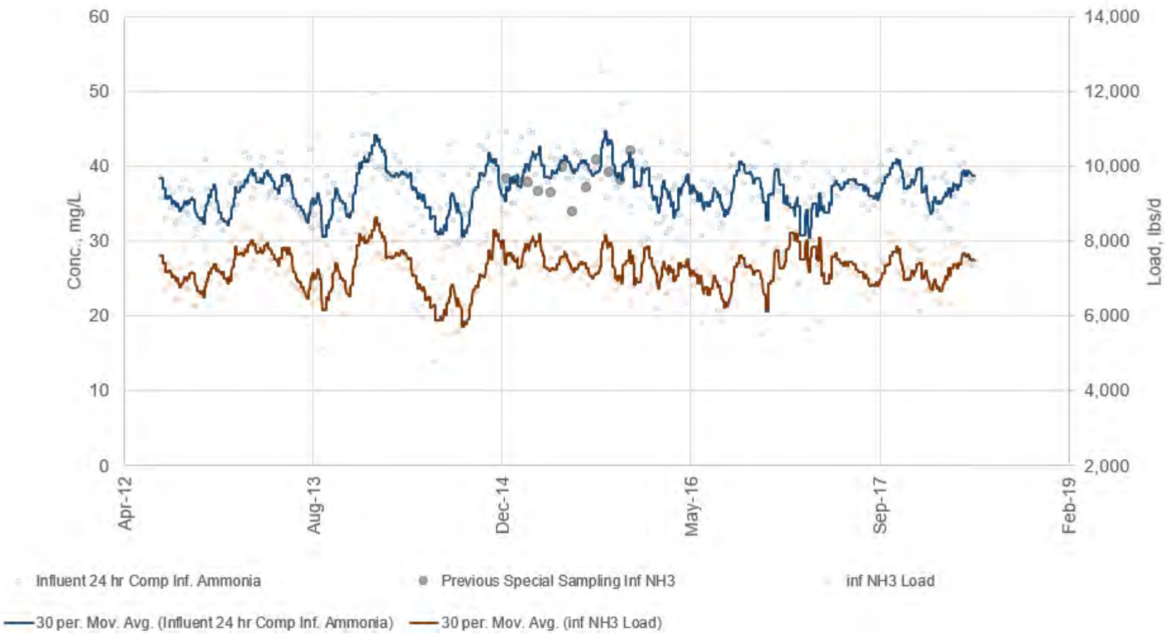


Figure 1-5: Influent Ammonia Load and Concentration

Table 1-4: Historical Influent Ammonia

Year	Concentration (mg/L)	Load (lbs/day)
2013	37	7,359
2014	37	7,121
2015	40	7,473
2016	37	7,080
2017	37	7,386
2018	37	7,188

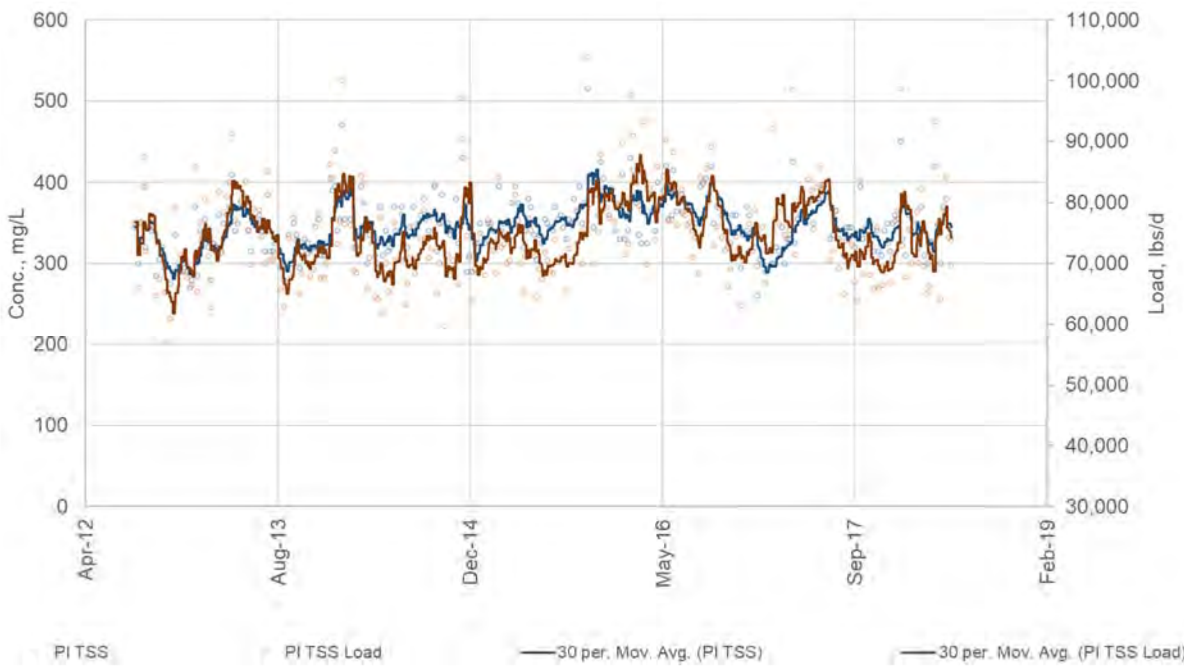


Figure 1-6: Primary Influent Total Suspended Solids Load and Concentration

Figure 1-7: Primary Influent Carbonaceous Biological Oxygen Demand

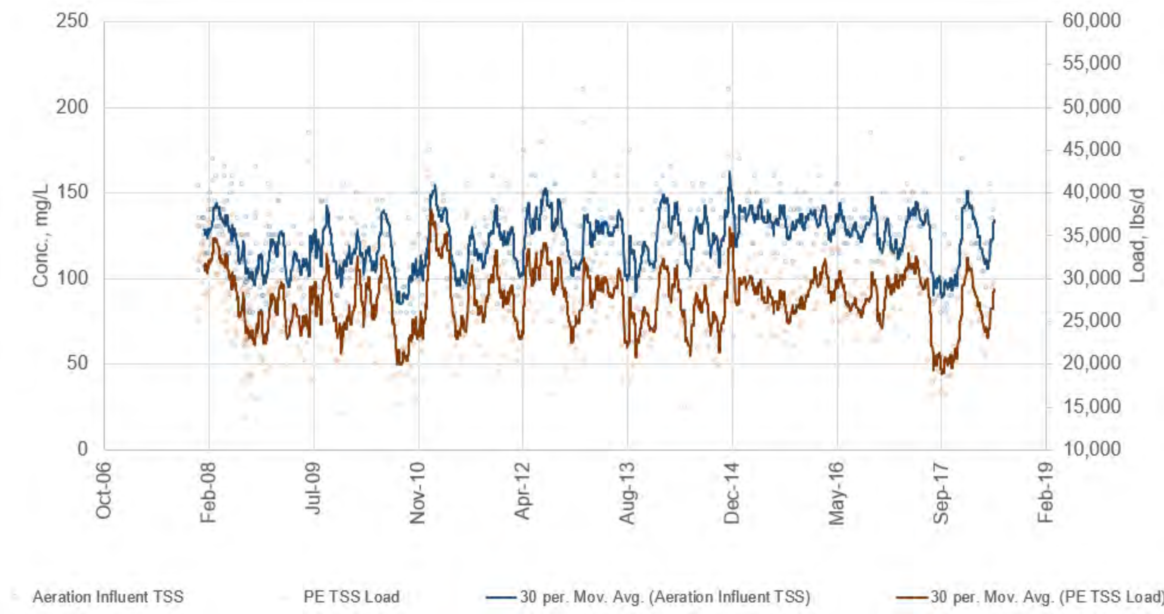


Figure 1-8: Primary Effluent Total Suspended Solids

Table 1-5: Historical Primary Effluent TSS

Year	Concentration (mg/L)	Load (lbs/day)	Percent Removal (%)
2013	122	27,187	64
2014	130	27,543	63
2015	135	27,897	62
2016	131	28,281	64
2017	118	26,437	65
2018	116	27,558	64

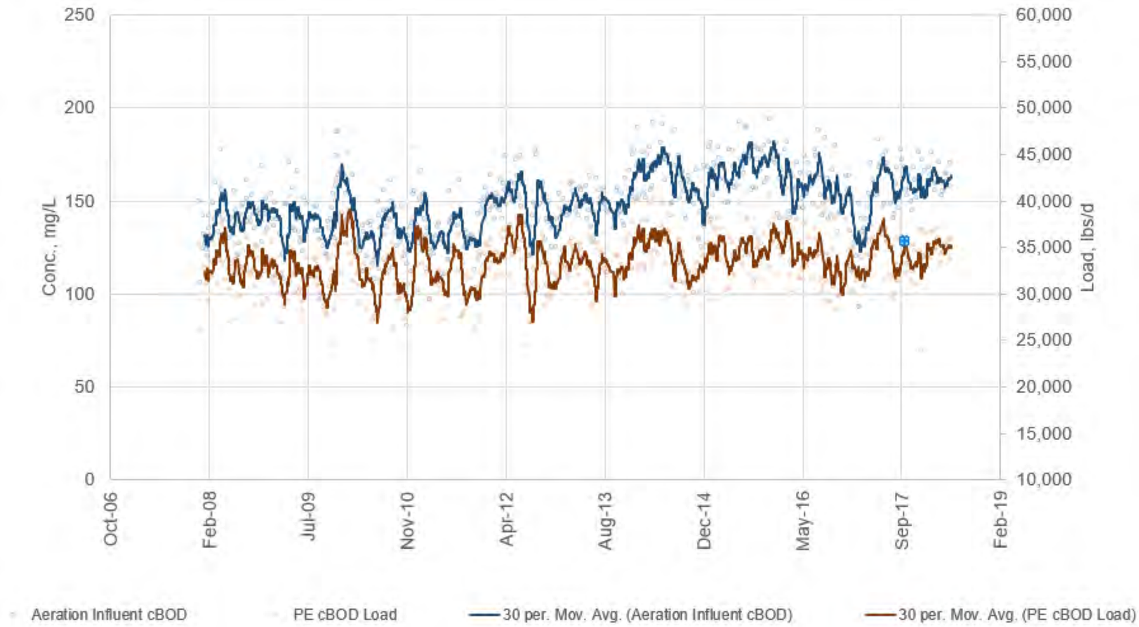


Figure 1-9: Primary Effluent Carbonaceous Biological Oxygen Demand

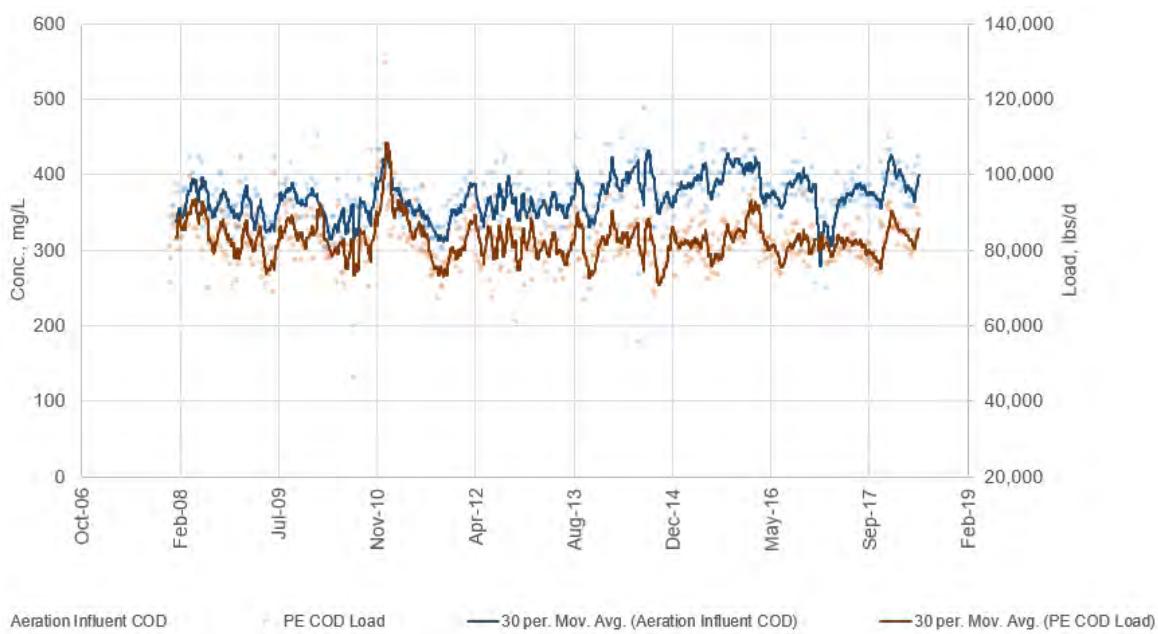


Figure 1-10: Primary Effluent Chemical Oxygen Demand

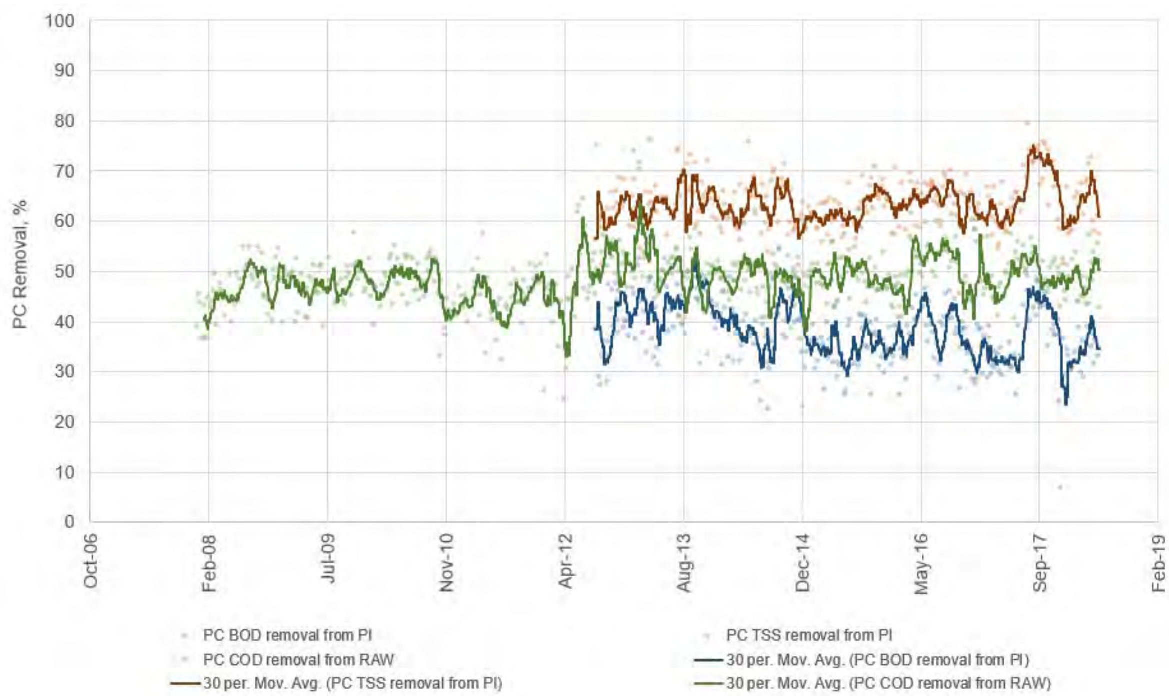


Figure 1-12: Primary Clarifier Removal

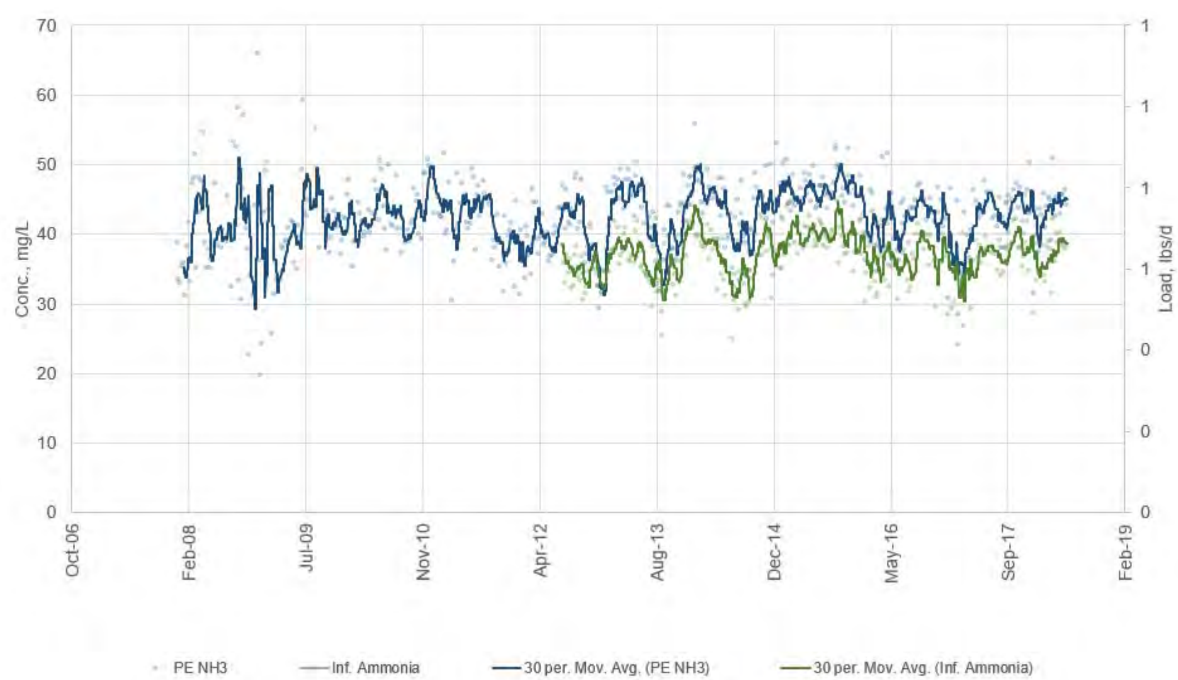


Figure 1-11: Primary Effluent Ammonia

Table 1-6: Historical Primary Effluent NH_3-N

Year	Raw NH_3-N Concentration (mg/L)	PE NH_3-N Concentration (mg/L)
2013	37	42
2014	37	44
2015	40	47
2016	37	42
2017	37	42
2018	37	43

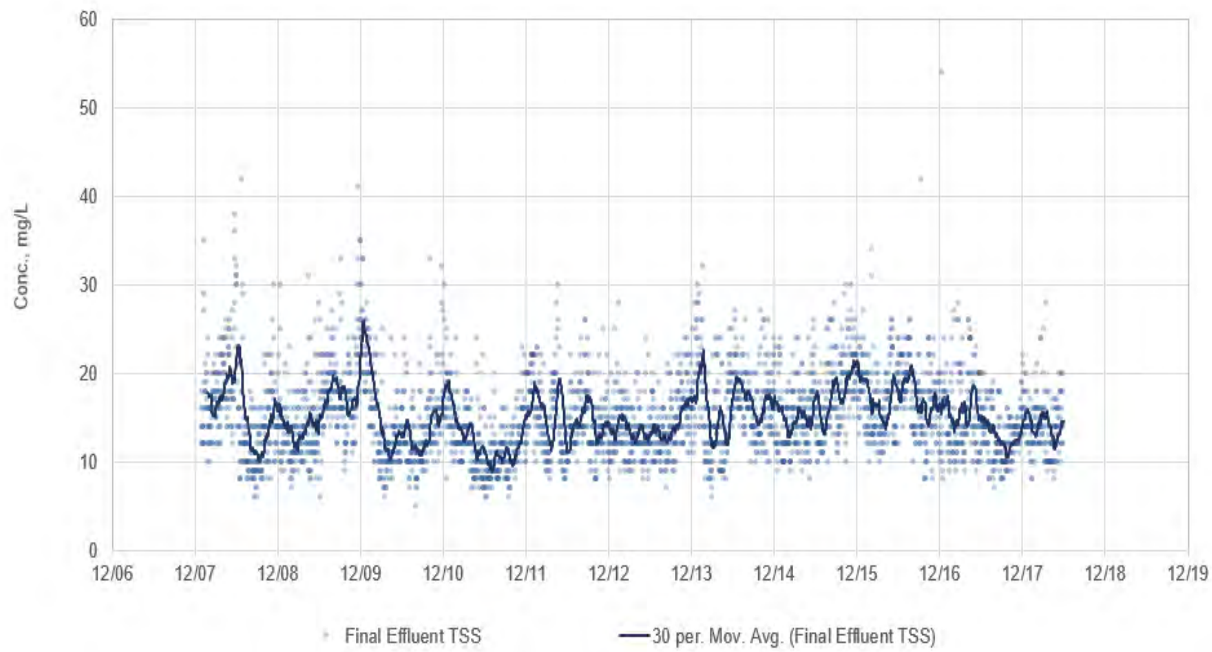


Figure 1-14: Final Effluent Total Suspended Solids

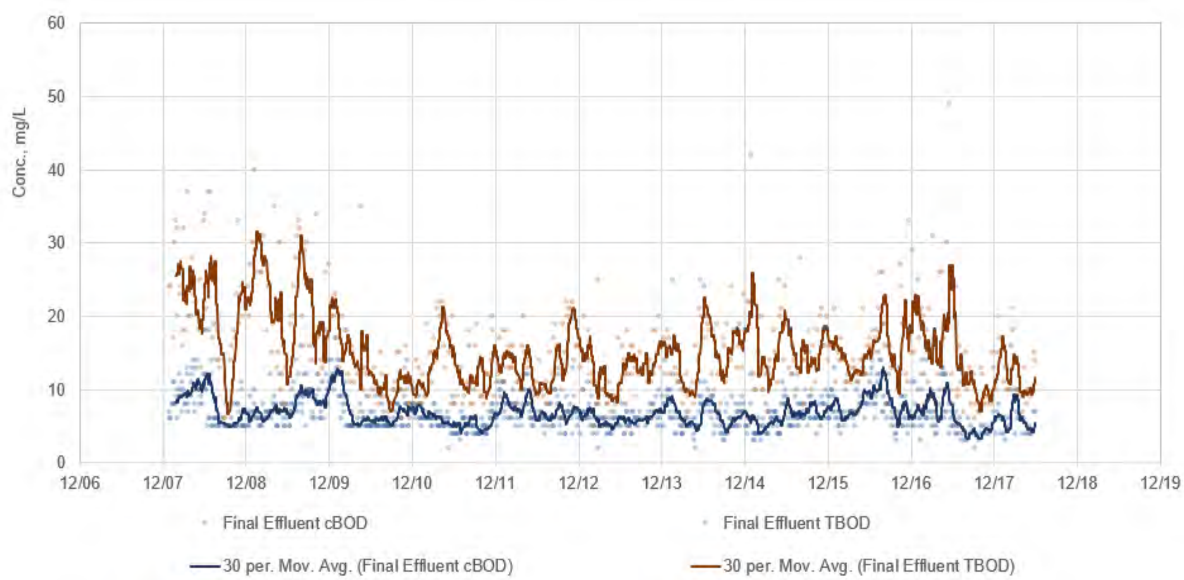


Figure 1-13: Final Effluent cBOD and TBOD

Figure 1-16: Final Effluent COD Concentration

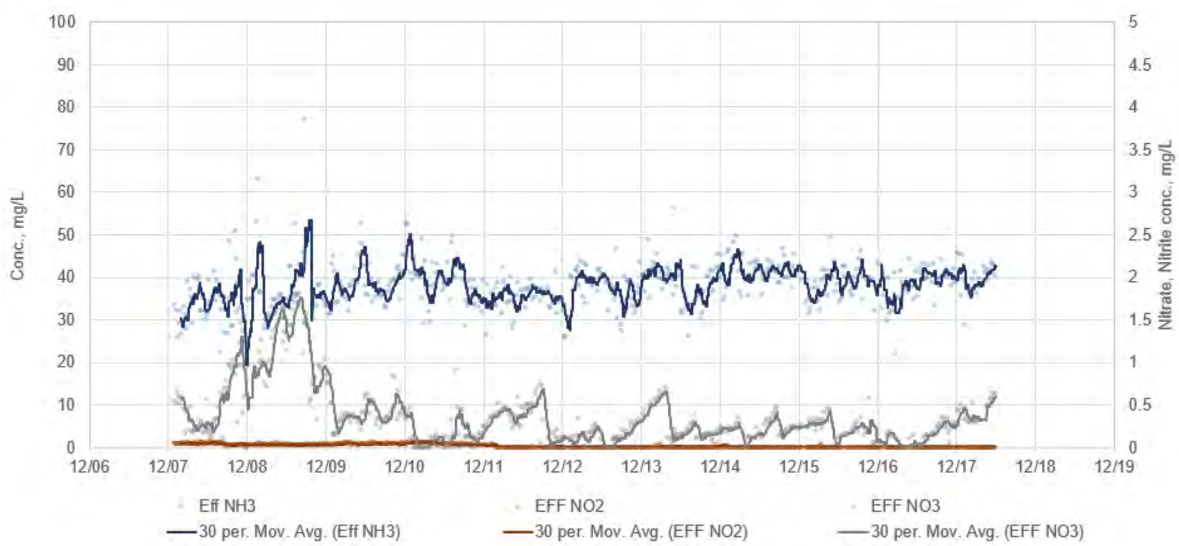


Figure 1-15: Final Effluent Nitrogen Concentration

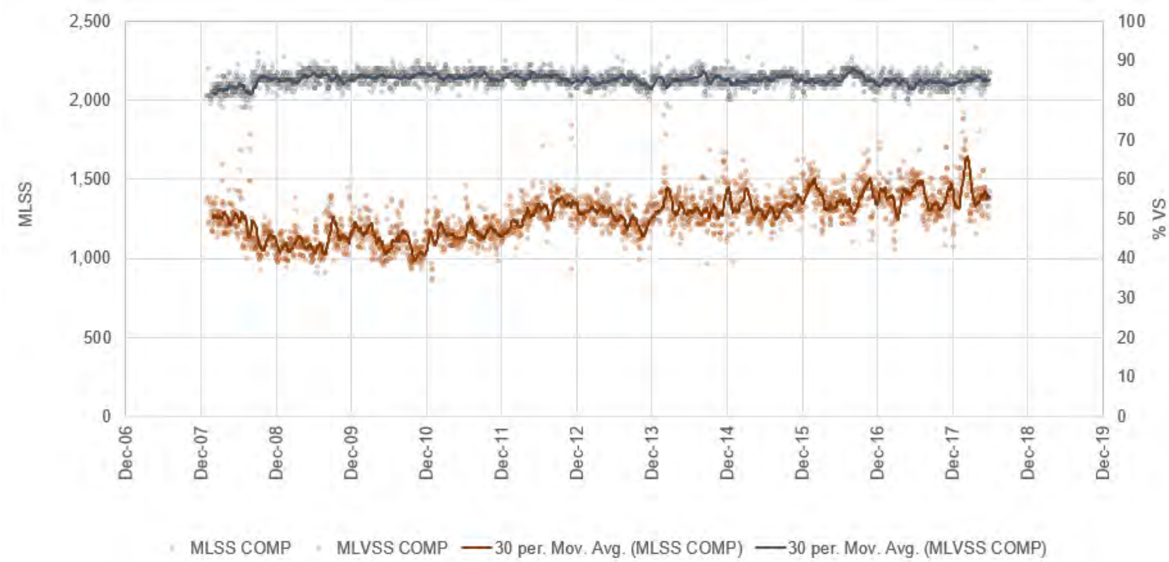


Figure 1-18: Mixed Liquor Suspended Solids

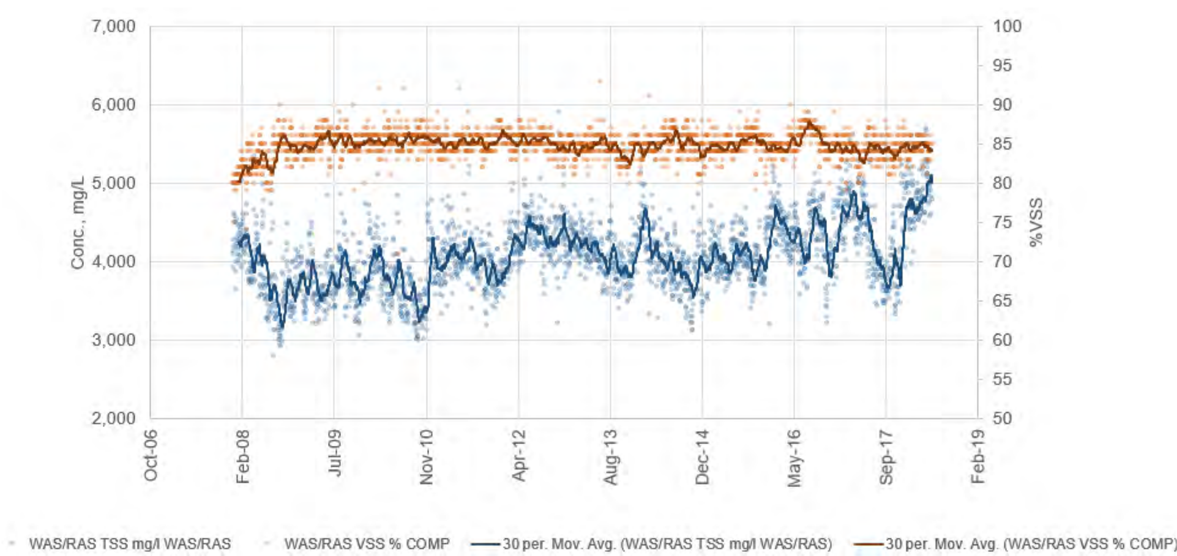


Figure 1-17: WAS / RAS Concentrations

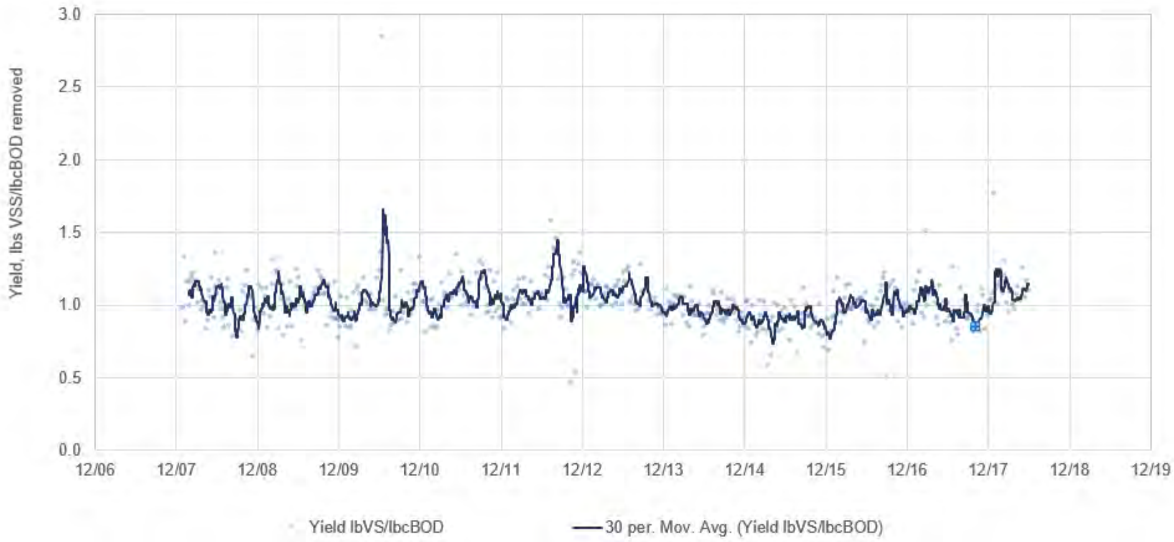


Figure 1-20: Yield VS/BOD

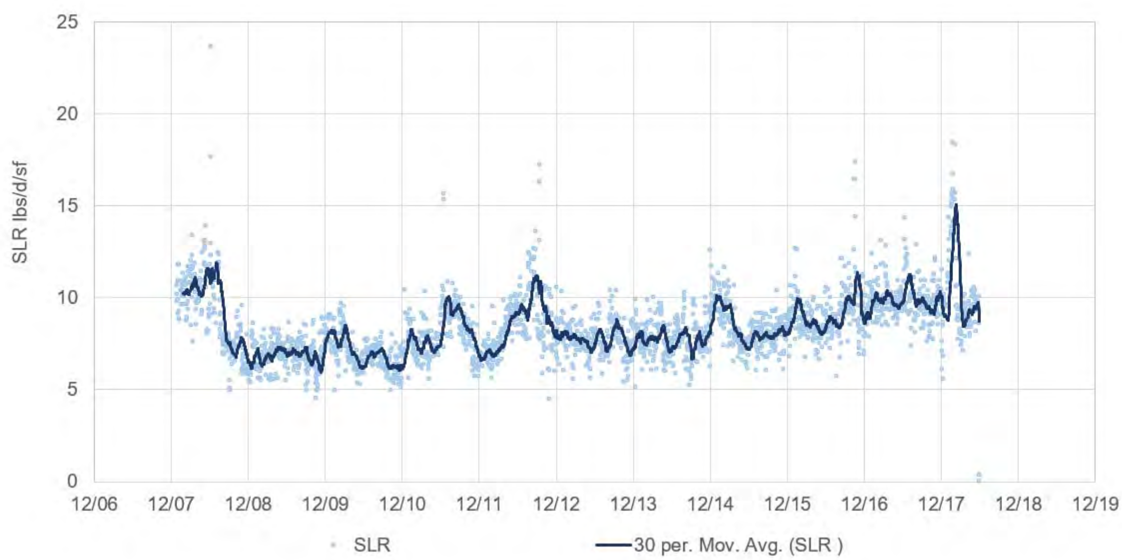


Figure 1-19: Solids Loading Rate

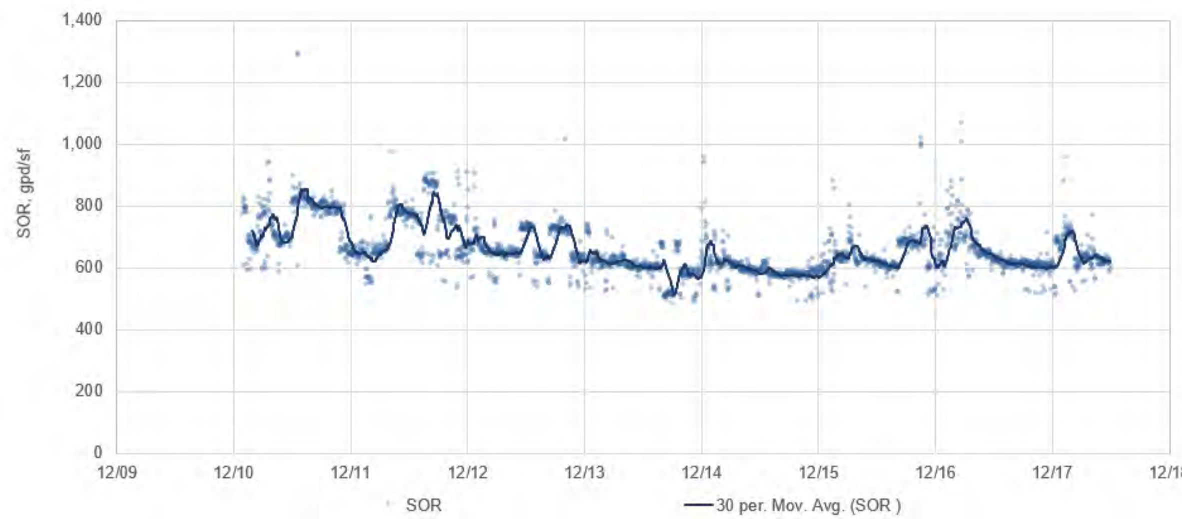


Figure 1-21: Surface Overflow Rate

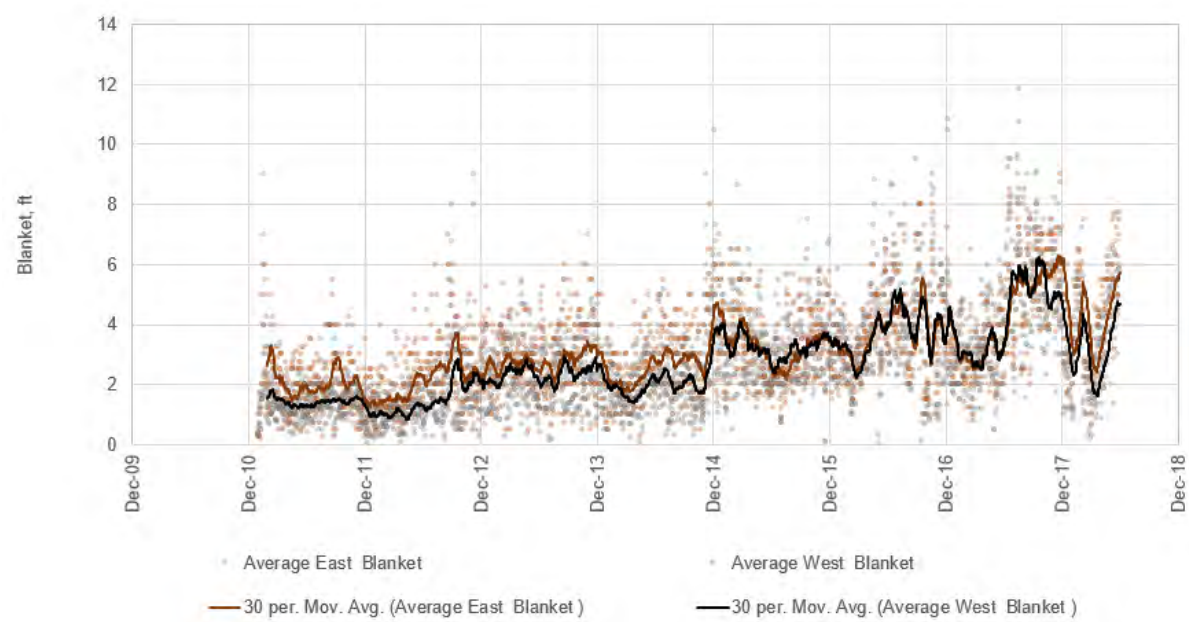


Figure 1-22: Secondary Clarifier Sludge Blanket

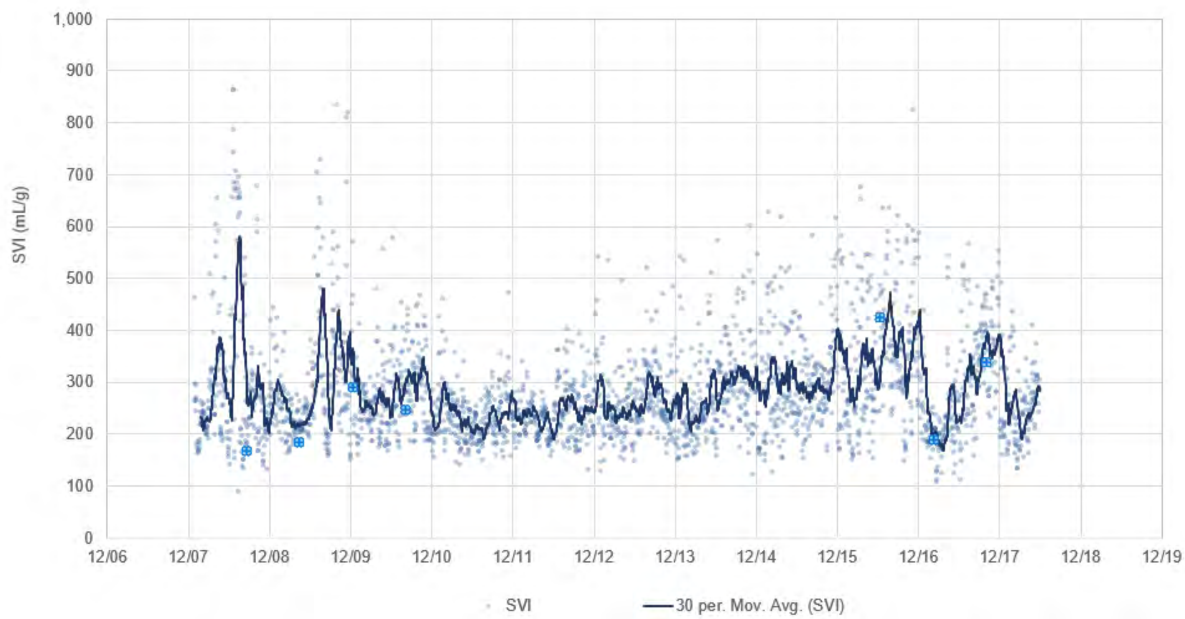


Figure 1-23: Sludge Volume Index

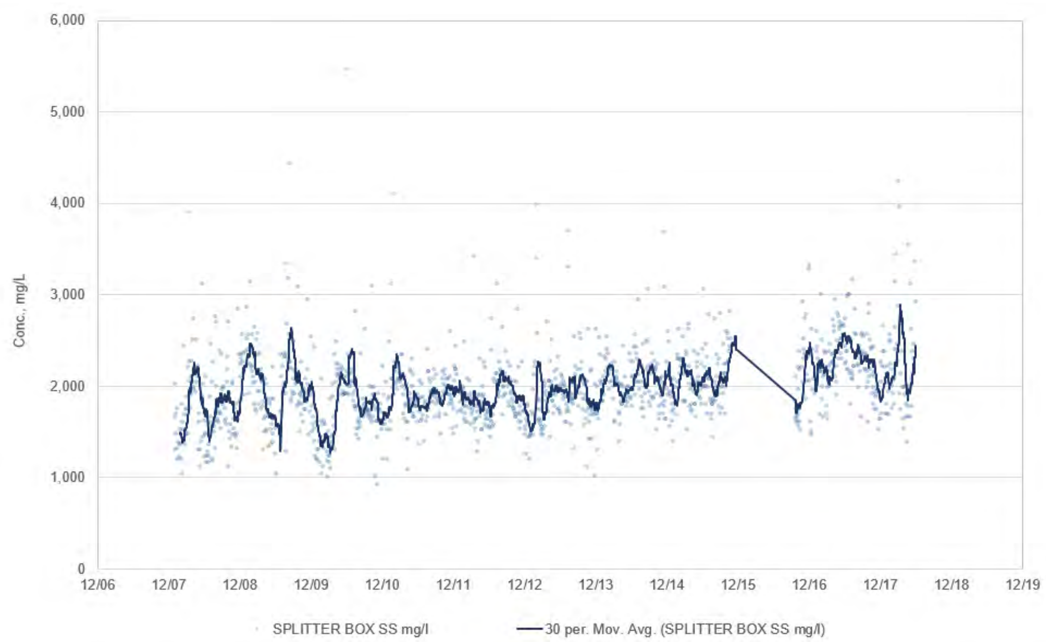


Figure 1-24: Primary Sludge Gravity Thickener Influent

Table 1-7: Historical TPS

Year	Concentration, % TS	Load (lbs/day)
2013	5.84	41,613
2014	5.70	37,547
2015	5.73	41,751
2016	5.29	46,091
2017	5.77	45,970
2018	5.72	48,094

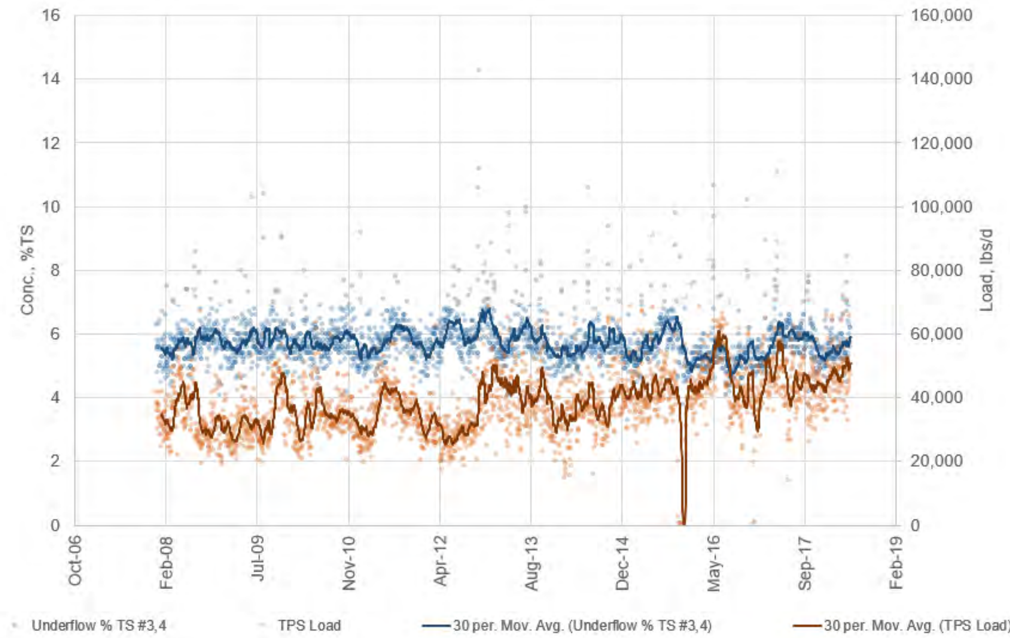


Figure 1-25: TPS Load and Concentration

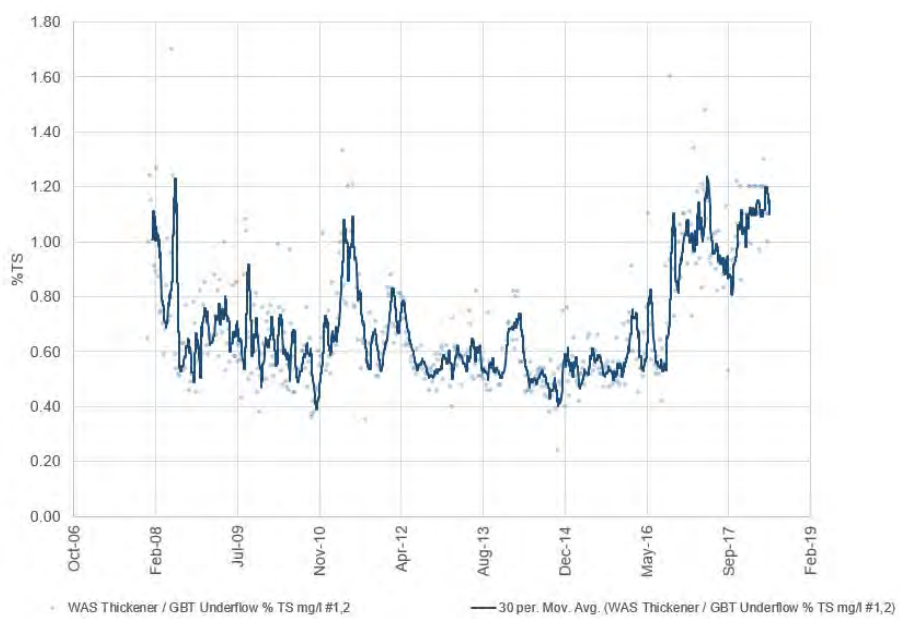


Figure 1-26: PWAS Total Suspended Solids

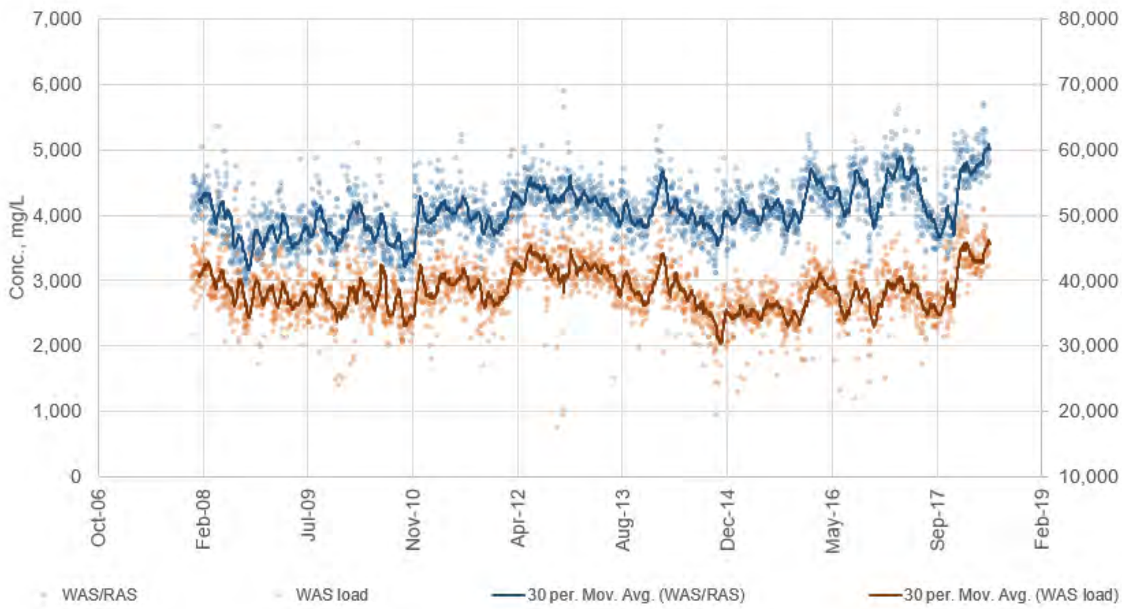


Figure 1-28: Waste Activated Sludge Load and Concentration

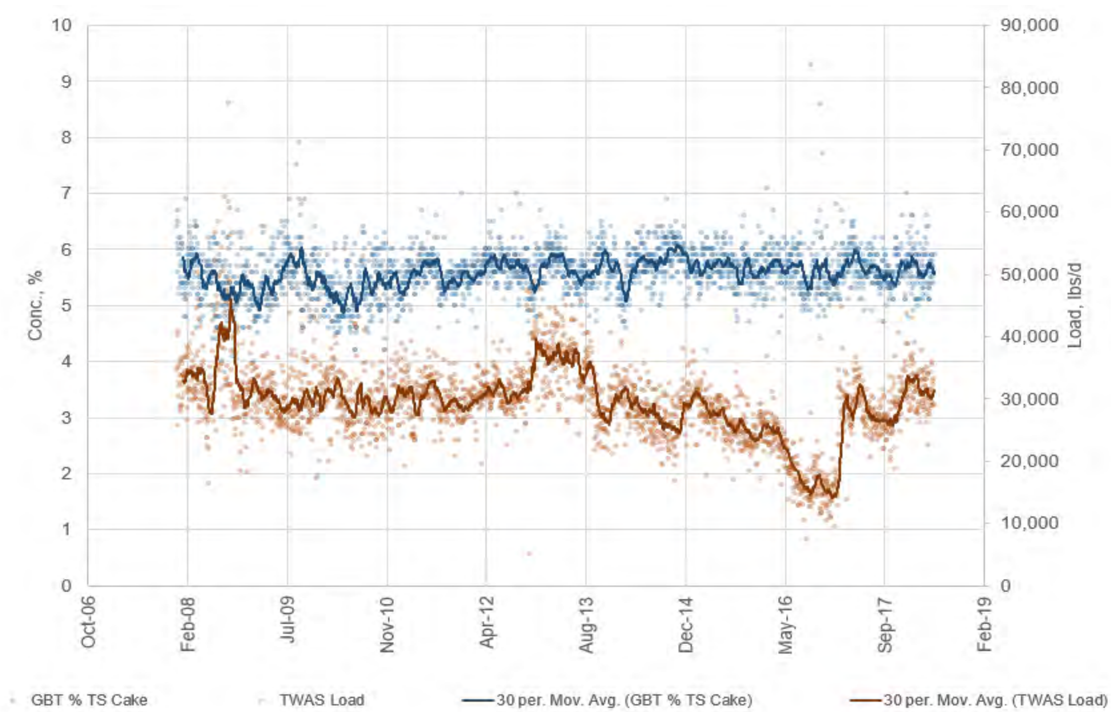


Figure 1-27: TWAS Percent Total Solids and Loading

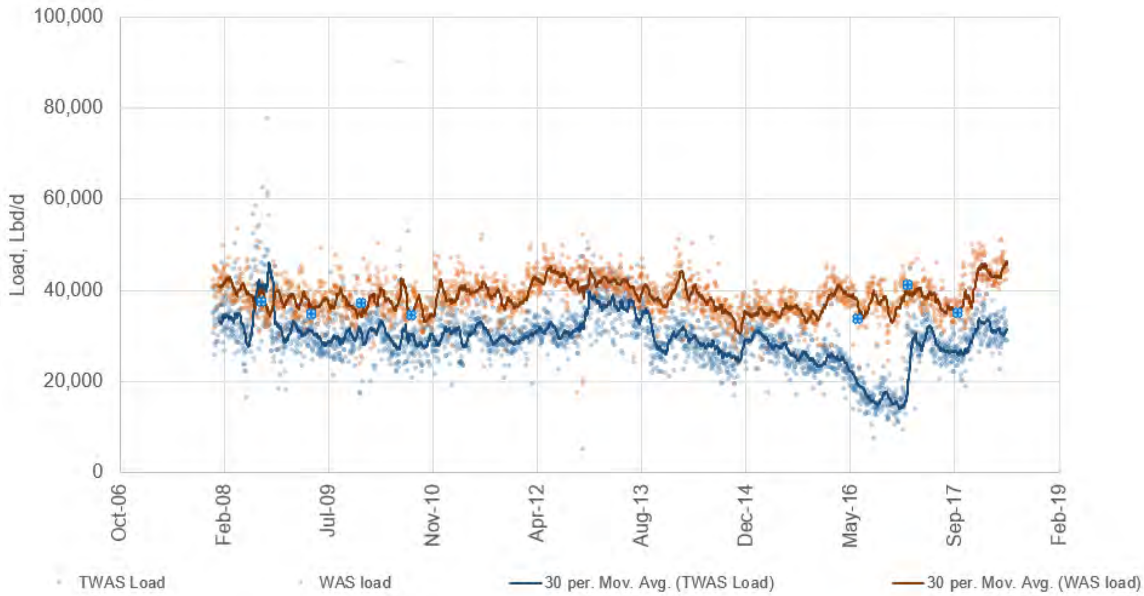


Figure 1-29: WAS vs TWAS Sludge Loading Comparison[1]

[1]TWAS flow from 2016-2017 was found to be reporting values lower than actual conditions

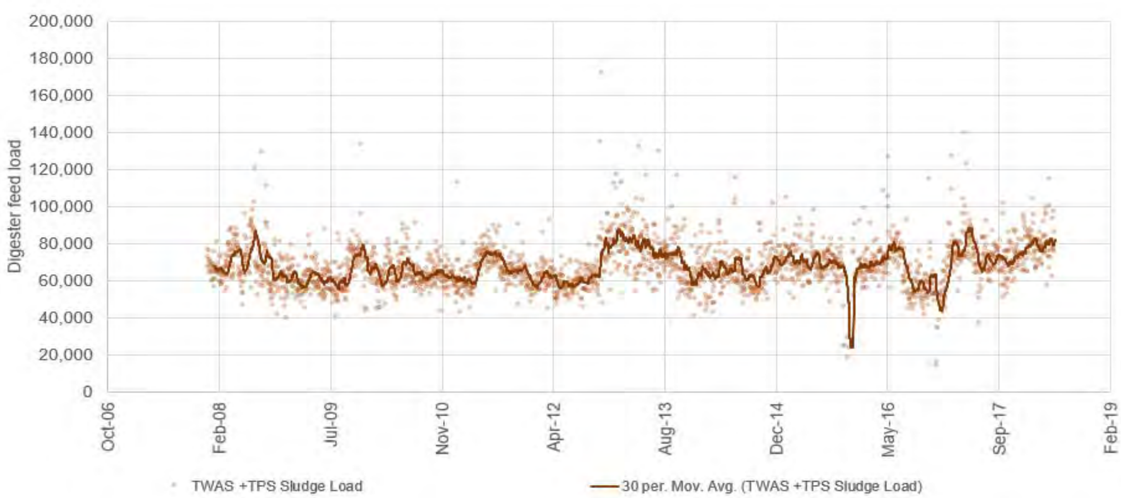


Figure 1-30: TWAS + TPS Load[1]

[1]TPS flow data is thought to have interference due to scum

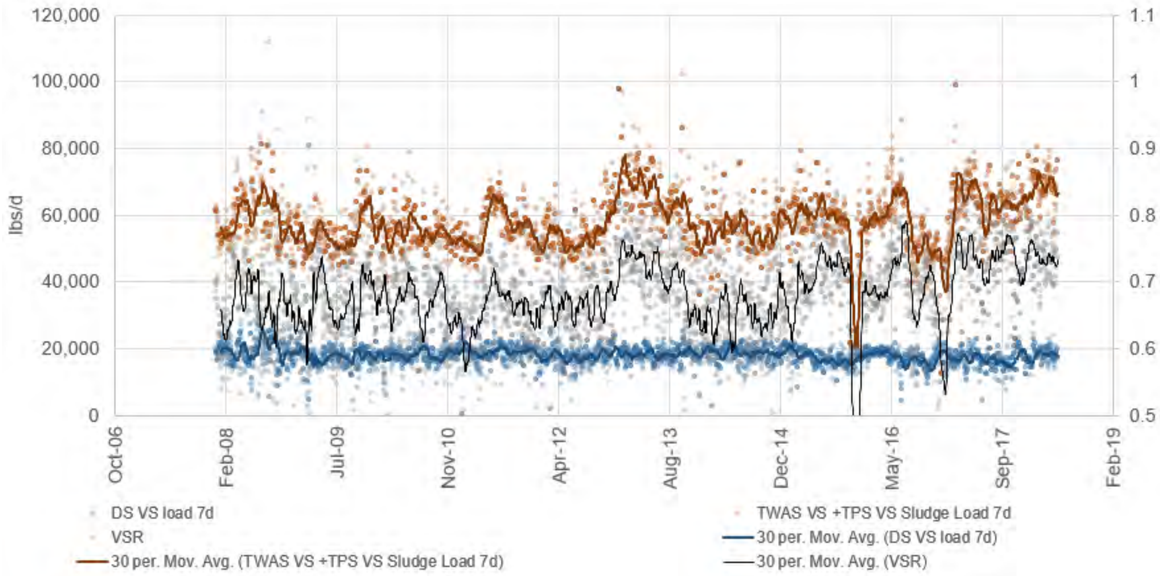


Figure 1-31: Digester Volatile Solids Load and Volatile Solids Reduction

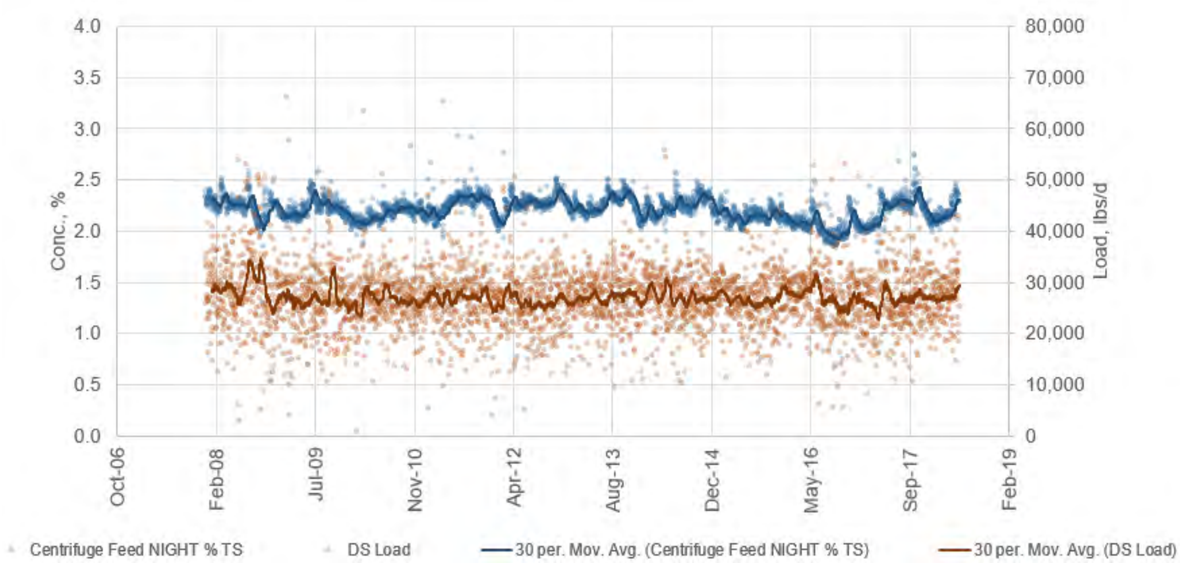


Figure 1-32: Digester Sludge Load and Concentration

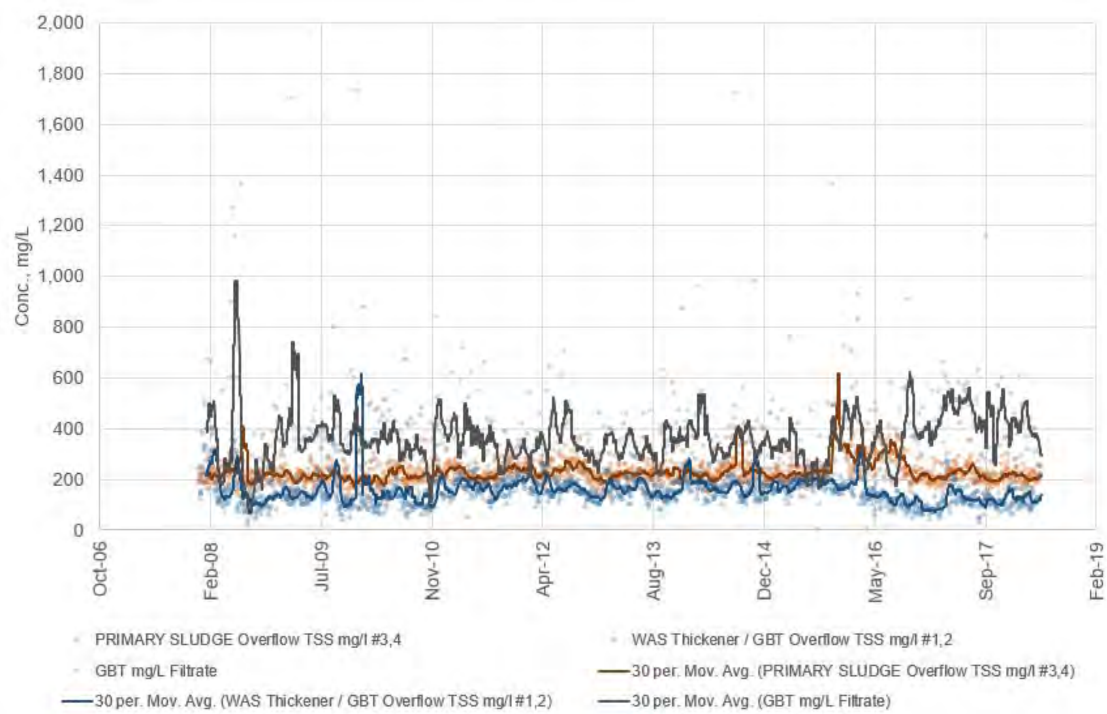


Figure 1-33: Gravity Thickener Overflow

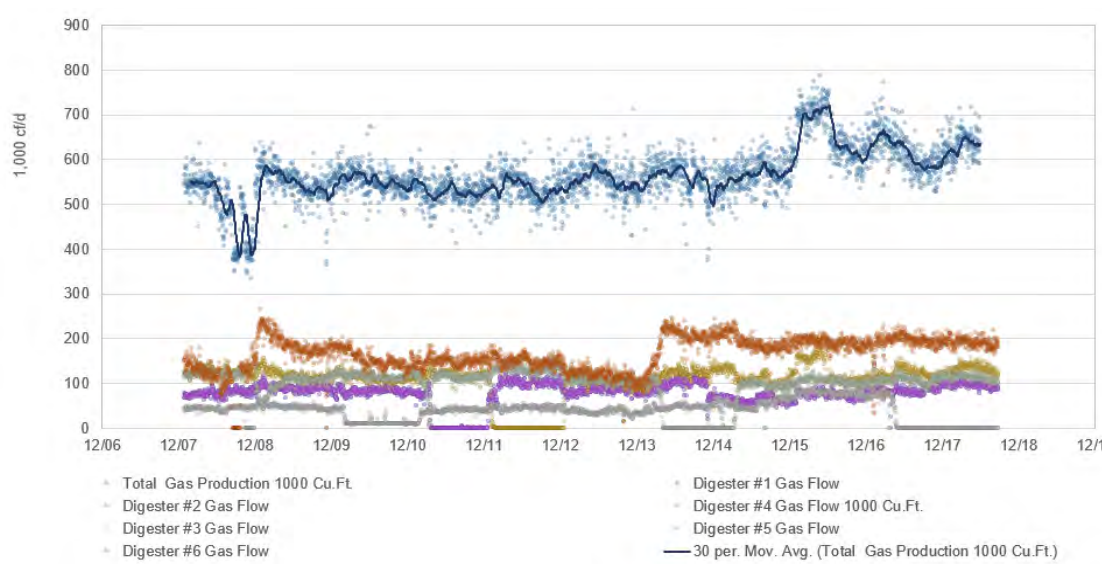


Figure 1-34: Digester Gas Flow[1]

[1]Gas flow data is suspect

Appendix 2. October 4, 2018 Assumptions Document

Hazen *Memorandum*

October 4, 2018

To: Curtis Bosick

From: Paul Pitt, Irene Chu

Reviewed: Marc Solomon

Re: Secondary Treatment Process Improvements: Modeling Assumptions

The purpose of this document is to define modeling assumptions for three secondary system capacity scenarios for the Union Sanitary District (USD) Alvarado Wastewater Treatment Plant (WWTP, Alvarado WWTP). The three scenarios are:

- Scenario 1: Capacity of the existing secondary system under historical SVI conditions
- Scenario 1a: Capacity of the existing secondary system under improved SVI conditions due to collection system calcium nitrate addition (if proven).
- Scenario 2a: Capacity of the secondary system with near term improvements (flexible selector, aeration basin upgrades and step feed) with the selector operating anaerobically.
- Scenario 2b: Nutrient removal capability with near term improvements (flexible selector, aeration basin upgrades and step feed) with the selector operating seasonally between anoxic and anaerobic conditions.
- Scenario 3: Secondary system improvements to achieve Level 2 nutrient removal standards.
- Scenario 4: MBR optimum sizing to achieve Level 2 nutrient removal standards

1. Historical Flows and Loads

a. Current Flows

The current peaking factors for effluent flow for the Alvarado WWTP are detailed below. The analysis is based on data from June 2013 to May 2018.

USD WWTP
Flows and Flow Peaking Factors

Flow Criteria	Historical	
	Flow (MGD)	Peaking Factor
Minimum Day	20.64	0.88
Average Annual	23.38	1.00
Maximum Month	25.80	1.10
Maximum 30-Day	26.89*	1.15*
Maximum 7-Day	28.49	1.22
Maximum Day	33.88	1.45

Job no

* The maximum 30-Day peaking factor was adjusted to 1.15 after excluding drought years from the average. This results in a more conservative Maximum 30-Day influent flow.

b. Current Loads

The current loads and peaking factors for influent cBOD and TSS for the Alvarado WWTP are detailed below. The analysis is based on data from June 2013 to May 2018.

Criteria	cBOD		TSS		COD		NH_3-N	
	Load (Lbs/d)	PF	Load (Lbs/d)	PF	Load (Lbs/d)	PF	Load (Lbs/d)	PF
Minimum Day	38,700	0.73	53,200	0.75	111,000	0.76	5,560	0.77
Average Annual	52,600	1.00	70,500	1.00	146,000	1.00	7,240	1.00
Maximum Month	59,200	1.13	76,800	1.09	159,000	1.09	7,920	1.09
Maximum 30-Day	60,500	1.15	78,900	1.12	166,000	1.13	8,190	1.13
Maximum 7-Day	66,900	1.27	89,100	1.26	166,000	1.13	7,670	1.06
Maximum Day	75,400	1.43	107,000	1.51	181,000	1.24	9,230	1.27

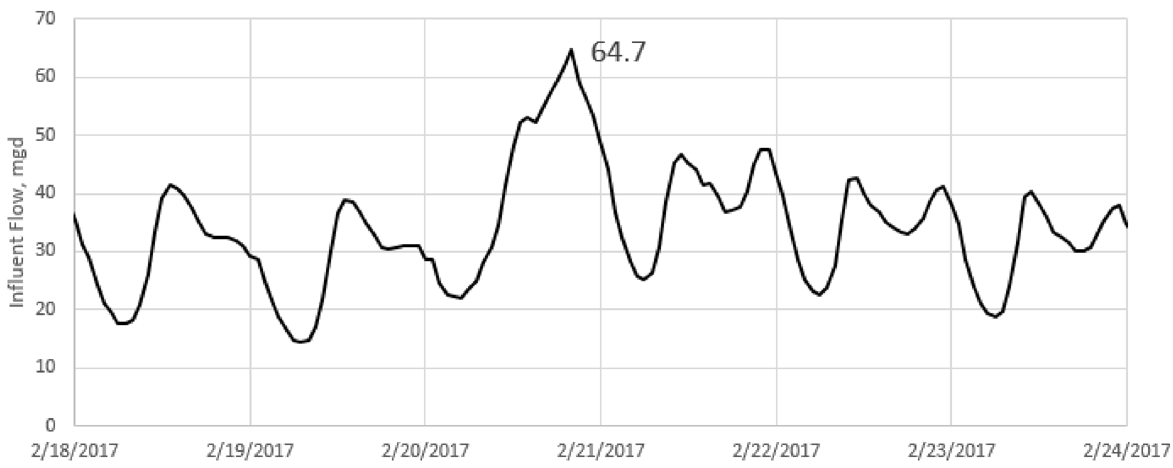
*For scenarios a 1.15 Maximum 30-Day peaking factor was used for cBOD, TSS, COD, and NH_3-N

c. Growth Assumptions

Assumption on growth for loads = 1% per year up to the design horizon.
Assumption on growth for flows = 1% per year up to the design horizon.

d. Hydrograph

The hydrograph used for modeling will be based on actually observed plant flow during the February 20, 2017 storm event. The hydrograph has been modified to estimate actual plant flows if storage in the upstream sewers and discharge to Old Alameda Creek are not available. The peak hour flow rate during this storm was 64.7 mgd. The base flow of this hydrograph will be escalated by 1% per year according to the assumed growth %.



2. Scenario 1: Capacity of the existing secondary system

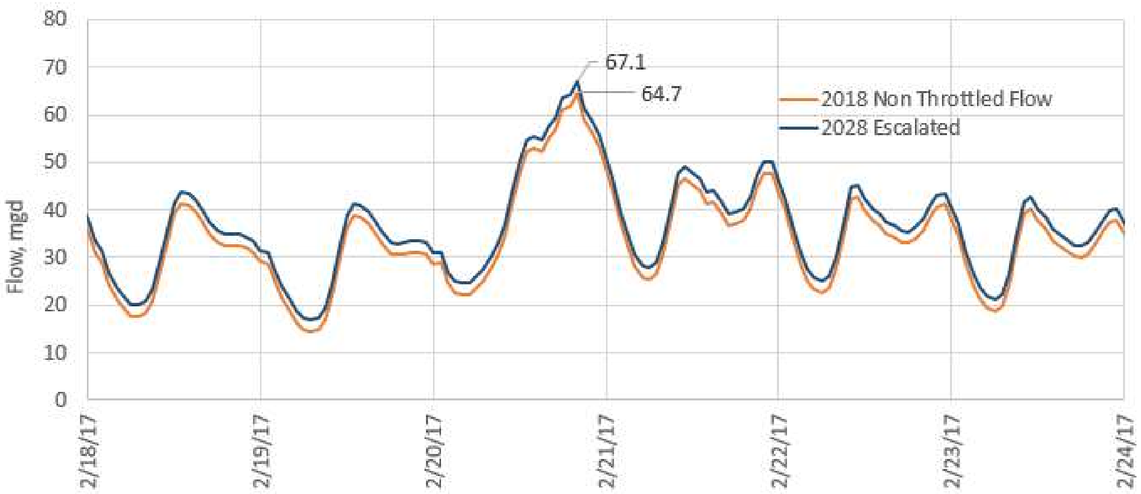
- This scenario assumes no new infrastructure.

a. Flows and Loads

	2018		2028		Note
	AA	MM	AA	MM	
Flow, mgd	23.4	26.9	25.8	29.7	1% increase/yr
Peak Flow, mgd	64.7	64.7	67.1	67.1	Base flow increases 1% / yr
COD, lbs/d	146,000	167,900	161,300	185,500	1%/yr load increase, Max 30 Day PF = 1.15
BOD, lbs/d	52,600	60,490	58,100	66,800	1%/yr load increase, Max 30 Day PF = 1.15
TSS, lbs/d	70,500	81,075	77,900	89,600	1%/yr load increase, Max 30 Day PF = 1.15
TKN, lbs/d	10,647	12,244	11,800	13,500	Special Sampling NH_3-N/TKN ratio= 0.68
NH_3-H, lbs/d	7,240	8,326	8,000	9,200	1%/yr load increase, Max 30 Day PF = 1.15
TP, lbs/d	1,352	1,555	1,490	1,720	Special Sampling COD/TP ratio= 108
	2018		2028		
	AA	MM	AA	MM	2028 MM load AA Concentrations
COD, mg/L	749	749	749	749	861
BOD, mg/L	270	270	270	270	310
TSS, mg/L	362	362	362	362	416
TKN, mg/L	55	55	55	55	63
NH_3-H, mg/L	37	37	37	37	43
TP, mg/L	6.9	6.9	6.9	6.9	8.0

b. Wet Weather

Hydrograph with peak flow of 67.1 mgd in 2028.



c. Effluent Standards

Current secondary standards.

	Monthly	Weekly
cBOD, mg/L	25	40
TSS, mg/L	30	45

d. SVI

	SVI (ml/gm)
Percentile	2008-2018
50th	250
75th	310
90th	404
95th	494
99th	672
Flows >28 mgd	270

e. Modeling Scenarios

	Dry Weather	Wet Weather	Redundancy
Load	MM	MM	AA
Flow	DW	Wet Weather Hydrograph	DW
PC TSS removal, %	63	63	63
Basin in service	All Basins in Service	All Basins in Service	1AB/1 SC out of service
SRT, d	~1.5	~1.5	~1.5
MLSS, mg/L	TBD	TBD	TBD
SVI percentile	90^{th}	75^{th}	75^{th}

3. Scenario 2a – Capacity of the secondary system with flexible selector in anaerobic mode, aeration basin upgrades and step feed

a. Flows and Loads

	2018		2028		Note
	AA	MM	AA	MM	
Flow, mgd	23.4	26.9	25.8	29.7	1% increase/yr
Peak Flow, mgd	64.7	64.7	67.1	67.1	Base flow increases 1% / yr
COD, lbs/d	146,000	167,900	161,300	185,500	1%/yr load increase, Max 30 Day PF = 1.15
BOD, lbs/d	52,600	60,500	58,100	66,800	1%/yr load increase, Max 30 Day PF = 1.15
TSS, lbs/d	70,500	81,100	77,900	89,600	1%/yr load increase, Max 30 Day PF = 1.15
TKN, lbs/d	10,650	12,240	11,800	13,500	Special Sampling NH_3-N/TKN ratio= 0.68
NH_3-H, lbs/d	7,240	8,330	8,000	9,200	1%/yr load increase, Max 30 Day PF = 1.15
TP, lbs/d	1,350	1,560	1,490	1,720	Special Sampling COD/TP ratio= 108
	2018		2028		
	AA	MM	AA	MM	2028 MM load AA Concentrations
COD, mg/L	749	749	749	749	861
BOD, mg/L	270	270	270	270	310
TSS, mg/L	362	362	362	362	416
TKN, mg/L	55	55	55	55	63
NH_3-H, mg/L	37	37	37	37	43
TP, mg/L	6.9	6.9	6.9	6.9	8.0

*Assumed implementation of nutrient limits in 2028 per ETSU.

b. Wet weather

Hydrograph with peak flow of 67.1 mgd in 2028. Refer to hydrograph presented for **Scenario 1**. Assumes ability to step feed has been implemented.

c. Standards

Current secondary standards.

	Monthly	Weekly
cBOD, mg/L	25	40
TSS, mg/L	30	45

d. Temperature

Currently verifying plant temperature data. The Solids System Capacity Analysis (SSCAR) assumed the minimum cold weather temperature to be 16^{o}C and the maximum warm weather temperature to be 27^{o}C.

	Winter	Spring	Summer	Fall
Months	Dec – Feb	Mar – May	Jun – Aug	Sept – Nov
Temperature, ^{o}C	16	20	27	22

e. Modeling Scenarios

	Dry weather	Wet weather	Redundancy During summer
Load	MM	MM	AA
PC TSS removal, %	63	63	63
Temperature, ^{o}C	16	16	20
Basins in service	ALL	ALL	1AB/1SC OOS
Selector operation	Anaerobic	Anaerobic	Anaerobic
Step feed	No	Yes	Possible
SRT, d	1-2	1-2	1-2
MLSS, mg/L	TBD	TBD	TBD
SVI (ml/gm)	110	110	110

4. Scenario 2b – Nutrient Removal Capability of secondary system with flexible selector in anoxic mode, aeration basin upgrades and step feed

a. Flows and Loads

	2018		2028		Note
	AA	MM	AA	MM	
Flow, mgd	23.4	26.9	25.8	29.7	1% increase/yr
Peak Flow, mgd	64.7	64.7	67.1	67.1	Base flow increases 1% / yr
COD, lbs/d	146,000	167,900	161,300	185,500	1%/yr load increase, Max 30 Day PF = 1.15
BOD, lbs/d	52,600	60,500	58,100	66,800	1%/yr load increase, Max 30 Day PF = 1.15
TSS, lbs/d	70,500	81,100	77,900	89,600	1%/yr load increase, Max 30 Day PF = 1.15
TKN, lbs/d	10,650	12,240	11,800	13,500	Special Sampling NH_3-N/TKN ratio= 0.68
NH_3-H, lbs/d	7,240	8,330	8,000	9,200	1%/yr load increase, Max 30 Day PF = 1.15
TP, lbs/d	1,350	1,560	1,490	1,720	Special Sampling COD/TP ratio= 108
	2018		2028		
	AA	MM	AA	MM	2028 MM load AA Concentrations
COD, mg/L	749	749	749	749	861
BOD, mg/L	270	270	270	270	310
TSS, mg/L	362	362	362	362	416
TKN, mg/L	55	55	55	55	63
NH_3-H, mg/L	37	37	37	37	43
TP, mg/L	6.9	6.9	6.9	6.9	8.0

*Assumed implementation of nutrient limits in 2028 per ETSU.

b. Wet weather

Hydrograph with peak flow of of 67.1 mgd in 2028. Refer to hydrograph presented for **Scenario 1**. Assumes ability to step feed has been implemented.

c. Standards

Current secondary standards.

	Monthly	Weekly
cBOD, mg/L	25	40
TSS, mg/L	30	45

Modeling results on expected nutrient performance will be presented.

d. Temperature

Currently verifying plant temperature data. The Solids System Capacity Analysis (SSCAR) assumed the minimum cold weather temperature to be 16ºC and the maximum warm weather temperature to be 27ºC.

	Winter	Spring	Summer	Fall
Months	Dec – Feb	Mar – May	Jun – Aug	Sept – Nov
Temperature, ºC	16	20	27	23

e. Modeling Scenarios

Recommend anaerobic selector for wet weather October 15 – March 15 (see scenario 2a wet weather) as discussed in workshop. The rest of the year, the selector may be operated in an anoxic mode to perform some nutrient removal and gain experience with BNR operation

	BNR operation			Redundancy
	Dry season March 16 – October 14			During dry weather
Temperature	20	23	27	20
Load	MM	MM	MM	AA
PC TSS removal, %	63	63	63	63
Temperature, ºC	20	27	22	20
Basins in service	ALL	ALL	ALL	1AB/1SC OOS
Selector operation	Anoxic	Anoxic	Anoxic	Anoxic
Step feed	No	No	No	Possible
SRT, d	TBD	TBD	TBD	TBD
MLSS, mg/L	TBD	TBD	TBD	TBD
SVI (ml/gm)	130	130	130	130

5. Scenario 3: Secondary system improvements to achieve Level 2 nutrient requirements

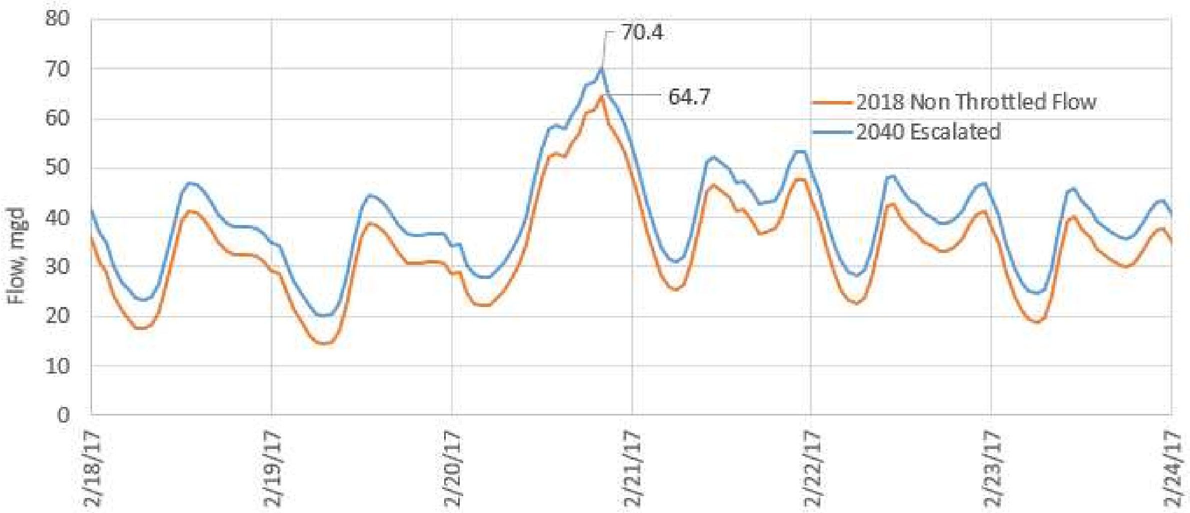
a. Flows and Loads

2040 Design horizon

	2018		2040		Note
	AA	MM	AA	MM	
Flow, mgd	23.4	26.9	29.1	33.5	1% increase/yr
Peak Flow, mgd	64.7	64.7	70.4	70.4	Base flow increases 1% / yr
COD, lbs/d	146,000	167,900	181,700	209,000	1%/yr load increase, Max 30 Day PF = 1.15
BOD, lbs/d	52,600	60,500	65,500	75,300	1%/yr load increase, Max 30 Day PF = 1.15
TSS, lbs/d	70,500	81,100	87,800	100,900	1%/yr load increase, Max 30 Day PF = 1.15
TKN, lbs/d	10,650	12,240	13,250	15,240	Special Sampling NH_3-N/TKN ratio= 0.68
NH_3-H, lbs/d	7,240	8,330	9,010	10,360	1%/yr load increase, Max 30 Day PF = 1.15
TP, lbs/d	1,350	1,560	1,680	1,940	Special Sampling COD/TP ratio= 108
	2018		2040		
	AA	MM	AA	MM	2040 MM load AA Concentrations
COD, mg/L	749	749	749	749	861
BOD, mg/L	270	270	270	270	310
TSS, mg/L	362	362	362	362	416
TKN, mg/L	55	55	55	55	63
NH_3-H, mg/L	37	37	37	37	43
TP, mg/L	6.9	6.9	6.9	6.9	8.0

b. Wet weather

Hydrograph with peak flow of 70.4 mgd. Implementation of step feed.



c. Standards

Assume Level 2 nutrient requirements. It is assumed that the nutrient standards will be applied monthly. Design temperature will be the minimum month value of 16ºC.

	NH_3-N mg/L	TN, mg/L	TP, mg/L
Level 2	2	15	1

The District is interested in discharging up to 43-mgd to the EBDA outfall and then flows above 43-mgd would be discharged to Old Alameda Creek. Discussions with the regional board indicate that discharges to the Old Alameda Creek may be subject to stricter cBOD and TSS standards as noted below.

Discharge point	Old Alameda Creek	Comment
Flows, mgd	0-22 mgd	> 43 mgd; negotiating year round discharge
cBOD, mg/L	10	
TSS, mg/L	15	
TN, mg/L	15	Assumed per 9/18 meeting
Ammonia, mg/L	2	Assuming no daily / weekly limit per 9/18 meeting. BACWA monthly limit was assumed.

d. Temperature

Currently looking into plant temperature data. Solids System Capacity Analysis (SSCAR) assumed the minimum cold weather temperature to be 16ºC. A sensitivity analysis on temperature impacts for the required infrastructure will be performed assumings 16 ºC and 18 ºC minimum monthly conditions.

e. Modeling Scenarios

	Normal	Wet Weather	Redundancy
Load	MM	MM	AA
PC TSS removal, %	63	63	63
Temperature, ºC	16	16	20
Basins in service	ALL	ALL	1AB/1SC OOS
Selector operation	Anoxic	Anoxic	Anoxic
Step Feed	No	Yes	Possible
SRT, d	6-7	6-7	6-7
MLSS, mg/L	TBD	TBD	TBD
SVI (ml/gm)	150	150	150

6. Scenario 4: Membrane Bioreactor to achieve Level 2 Standards

a. Flows and Loads

2040 Design horizon

	2018		2040		Note
	AA	MM	AA	MM	
Flow, mgd	23.4	26.9	29.1	33.5	1% increase/yr
Peak Flow, mgd	64.7	64.7	70.4	70.4	Base flow increases 1% / yr
COD, lbs/d	146,000	167,900	181,700	209,000	1%/yr load increase, Max 30 Day PF = 1.15
BOD, lbs/d	52,600	60,500	65,500	75,300	1%/yr load increase, Max 30 Day PF = 1.15
TSS, lbs/d	70,500	81,100	87,800	100,900	1%/yr load increase, Max 30 Day PF = 1.15
TKN, lbs/d	10,650	12,240	13,250	15,240	Special Sampling NH_3-N/TKN ratio= 0.68
NH_3-H, lbs/d	7,240	8,330	9,010	10,360	1%/yr load increase, Max 30 Day PF = 1.15
TP, lbs/d	1,350	1,560	1,680	1,940	Special Sampling COD/TP ratio= 108
	2018		2040		
	AA	MM	AA	MM	2040 MM load AA Concentrations
COD, mg/L	749	749	749	749	861
BOD, mg/L	270	270	270	270	310
TSS, mg/L	362	362	362	362	416
TKN, mg/L	55	55	55	55	63
NH_3-H, mg/L	37	37	37	37	43
TP, mg/L	6.9	6.9	6.9	6.9	8.0

b. Wet weather

Hydrograph with peak flow of 70.4 mgd. Refer to hydrograph presented in **Scenario 3**.

c. Standards

Assume Level 2 nutrient requirements. It is assumed that the nutrient standards will be applied monthly. Design temperature will be the minimum month value of 16ºC.

	NH_3-N mg/L	TN, mg/L	TP, mg/L
Level 2	2	15	1

The District is interested in discharging up to 43-mgd to the EBDA outfall and then flows above 43-mgd would be discharged to Old Alameda Creek. Discussions with the regional board indicate that discharges to the Old Alameda Creek may be subject to stricter cBOD and TSS standards as noted below.

Discharge point	Old Alameda Creek	Comment
Flows, mgd	0-22 mgd	> 43 mgd; negotiating year round discharge
cBOD, mg/L	10	
TSS, mg/L	15	
TN, mg/L	15	Assumed per 9/18 meeting
Ammonia, mg/L	2	Assuming no daily / weekly limit per 9/18 meeting. BACWA monthly limit was assumed.

d. Temperature

Currently looking into plant temperature data. Solids System Capacity Analysis (SSCAR) assumed the minimum cold weather temperature to be 16°C.

a. Modeling Scenarios

	Normal	Wet Weather	Redundancy
Load	MM	MM	AA
PC TSS removal, %	63	63	63
Temperature, °C	16	16	20
Basins in service	ALL	ALL	1AB/1 MBR module OOS
Selector operation	Anoxic	Anoxic	Anoxic
MLSS, mg/L	8,000	8,000	8,000

Appendix 3. BioWin® Sampling Results

Table 3-1: Influent Composite Sampling Results (Unfiltered)

Parameter	8/7/2018	8/8/2018	8/9/2018	8/10/2018	8/13/2018	Sampling Average	Historical Average
BOD_5, mg/L	193	297	295	264	262	262	--
$cBOD_5$, mg/L	201	219	223	223	265	226	257
COD, mg/L	802	724	743	676	742	737	721
TSS, mg/L	320	330	340	310	360	332	341
VSS, mg/L	300	300	310	290	320	304	--
TKN, mg/L	53.0	54.0	57.0	52.0	54.0	54.0	52.8
NH_3-N, mg/L	37.0	37.0	38.0	37.0	35.0	36.8	37
TP, mg/L	6.8	7.2	7.0	6.7	6.6	6.9	6.9
PO_4-P, mg/L	2.6	4.3	2.9	3.0	2.8	3.1	--

Table 3-2: Influent Composite Ratios

Influent Composite Ratios	Sampling Average	Historical Data	Typical Range
COD:$cBOD_5$	3.3	2.8	2.1 – 3.0
COD:BOD_5	2.8	--	1.8 – 2.5
$cBOD_5$:BOD_5	0.86	--	0.8 – 0.9
Soluble COD Fraction	0.38	--	0.3 – 0.5
Particulate/Colloidal COD	0.62	--	0.5 – 0.7
VSS:TSS	0.92	--	0.8 – 0.9
Particulate COD:VSS	1.52	--	1.3 – 1.9
NH_3-N:TKN	0.68	0.72	0.6 – 0.8
$cBOD_5$:TKN	4.2	5.3	4 – 8
$cBOD_5$:TP	33	43	20 – 50
PO_4-P:TP	0.45	--	0.4 – 0.8

Table 3-3: CB2 (Primary Effluent) Composite Sampling Results (Unfiltered)

Parameter	8/7/2018	8/8/2018	8/9/2018	8/10/2018	8/13/2018	Sampling Average	Historical Average
BOD_5, mg/L	161	158	157	173	200	170	--
$cBOD_5$, mg/L	141	130	126	147	174	144	150
COD, mg/L	430	379	367	398	433	401	370
TSS, mg/L	110	100	95	115	145	113	122
VSS, mg/L	99	90	90	110	115	101	--
TKN, mg/L	54.0	56.0	57.0	55.0	59.0	56.2	--
NH_3-N, mg/L	44.0	46.0	44.0	44.0	46.0	44.8	42.4
TP, mg/L	6.7	3.3	7.1	6.9	6.8	6.2	--
PO_4-P, mg/L	3.3	3.9	4.0	4.1	3.8	3.8	--

Table 3-4: CB2 (Primary Effluent) Composite Ratios

Primary Effluent Composite Ratios	Sampling Average	Historical Data	Typical Range
COD:$cBOD_5$	2.8	2.5	2.1 – 3.0
COD:BOD_5	2.4	--	1.8 – 2.5
$cBOD_5$:BOD_5	0.85	--	0.8 – 0.9
Soluble COD Fraction	0.49	--	0.3 – 0.5
Particulate/Colloidal COD	0.45	--	0.5 – 0.7
VSS:TSS	0.90	--	0.8 – 0.9
Particulate COD:VSS	1.39	--	1.3 – 1.9
NH_3-N:TKN	0.80	0.84	0.6 – 0.8
$cBOD_5$:TKN	2.6	3.1	4 – 8
$cBOD_5$:TP	26	--	20 – 50
PO_4-P:TP	0.62	--	0.4 – 0.8

Table 3-5: Effluent Composite Sampling Results (Unfiltered)

Parameter	8/7/2018	8/8/2018	8/9/2018	8/10/2018	8/13/2018	Sampling Average	Historical Average
$cBOD_5$, mg/L	--	--	--	--	--	--	6.1
COD, mg/L	52	45	44	48	53	48	51
TSS, mg/L	13	10	10	14	16	13	16
NH_3-N, mg/L	39	40	41	40	40	40	39
TKN, mg/L	43	45	44	45	44	44	46
TP, mg/L	3.1	2.8	3.3	3.6	3.2	3.2	2.6

Table 3-6: Recycle and Sludge Summary

Location	%TS	%VS	TKN (mg/L)	TP (mg/L)	TSS (mg/L)	Historical %TS	Historical TSS (mg/L)
PS	0.3	54	--	--	--	--	--
Degritted PS	0.2	48	--	--	--	--	--
TPS	5.9	89	--	--	--	5.7	--
WAS	0.4	71	--	--	--	0.7	--
PWAS	1.1	81	--	--	--	--	--
TWAS	5.6	86	--	--	--	5.6	--
Centrifuge Feed	2.2	71	--	--	--	--	--
Dewatered Cake	24.1	72	--	--	--	24.5	--
PS Thickener Overflow	--	--	60	9	210	--	160
WAS Thickener Overflow	--	--	49	14	107	--	--
GBT Filtrate	--	--	83	26	430	--	366
Centrate	--	--	1,867	113	300	--	200

Table 3-1 Ammonia Profile

	8/9/2018 10:00	8/9/2018 14:00	8/12/2018 10:00	8/12/2018 14:00
INF	45.9	40.4	45.8	44.2
CB1	47.2	41	43.4	46
CB2	46.4	45	46	48.8
AerWestH69	54	46	47	49.2
AerWestH68	52.6	42.6	48.4	44
AerWestH123	26.1	45.8	46.4	42.4
AerWestH55	50.6	45.8	48	46.6
AerWestT57eff	54.6	45	50.2	42.4
AerEastT1mid	50.4	45.4	49.6	43.4
AerEastT1end	52	46.4	47.4	43.2
SEC EFF	46.1	46.6	46.8	43.4
EFF	25.4	49.6	44.6	46.2
RAS	55.4	48.2	36.6	39.2
PS Overf	46.6	46.8	38.2	44.8
WAS Overf	50.2	50.2	43.4	49.6
GBT FILTRATE	50.6	51.2	48	49.8

Table 3-2 Orthophosphate Profile

	8/9/2018 10:00	8/9/2018 14:00	8/12/2018 10:00	8/12/2018 14:00
INF	3.88	3.94	2.85	3.35
CB1	4.2	4.32	2.58	3.64
CB2	4.7	5	3.69	3.76
AerWestH69	3.95	4.8	2.80	3.17
AerWestH68	3.85	4.32	2.80	1.23
AerWestH123	2.68	2.74	1.70	1.85
AerWestH55	1.99	1.98	1.02	1.44
AerWestT57eff	1.84	1.54	0.84	1.41
AerEastT1mid	2.07	2.25	1.33	1.54
AerEastT1end	2.13	2	1.24	1.43
SEC EFF	2.74	3.54	0.79	2.32
EFF	2.67	3.52	1.54	2.27
RAS	6.72	9.01	3.52	4.65
PS Overf	5.23	5.82	3.52	0.27
WAS Overf	10	11.2	10.12	6.67
GBT FILTRATE	27.6	23	16.43	21.11

Appendix 4. Biowin Model Calibration

Table 4-1 Steady State Calibration Results

Parameter	Reported	Steady State Simulation	Avg. Dynamic Simulation
Primary Effluent TSS, mg/L	126	121	120
Primary Effluent BOD_5, mg/L	161 (192*)	199	198
Primary Effluent NH_3-N, mg/L	43	47	-
Basin MLSS, mg/L	1,290	1,330	1,330
Basin MLVSS, mg/L	1,090	1,180	1,170
RAS/WAS MLSS, mg/L	4,360	4,410	4,480
RAS/WAS MLVSS, mg/L	3,660	3,890	3,940
Effluent TSS, mg/L	14	13	13
Effluent BOD, mg/L	11	9	9
Effluent COD, mg/L	50	51	51
Effluent NH3-N, mg/L	40	39	39
Thickened Primary Sludge, lb/d	45,600	48,900	48,700
WAS, lb/d	40,200	39,100	39,500
Thickened WAS, lb/d	29,300	31,600	31,600
Digester Feed Total Solids, lb/d	74,900	80,500	80,300
Digester Feed Volatile Solids, lb/d	65,500	71,900	-
Centrifuge Feed Total Solids, lb/d	26,900	32,300	32,000
Centrifuge Feed Volatile Solids, lb/d	17,300	24,900	-
Dewatered Cake Solids, lb/d	26,700	31,000	30,800
Digester VSR, %	73%	65%	-
Digester Gas Production, CF/day[1]	610,000	700,000	-
Digester Gas CF/lb Volatile Solids	12.7	15.0	

[1] Digester gas flowmeter was found to be faulty

Appendix 5. Clarifier Stress Testing Data

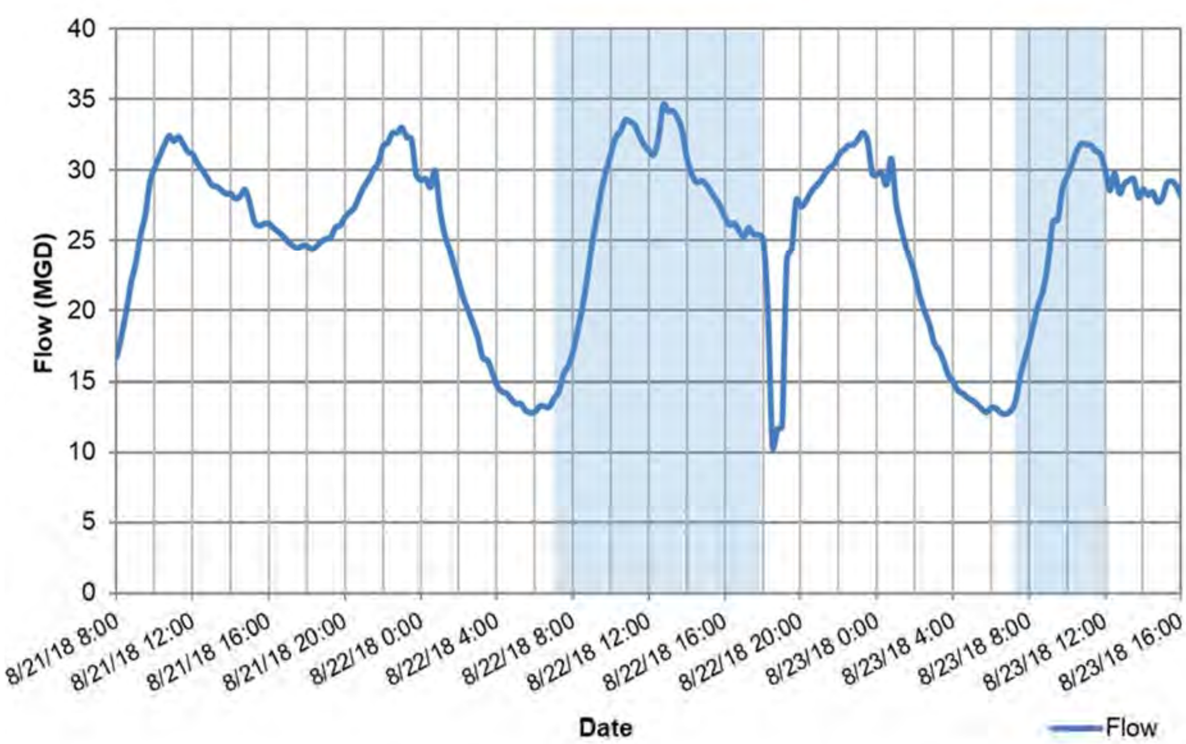


Figure 5-1: Plant Flow During Clarifier Field Testing

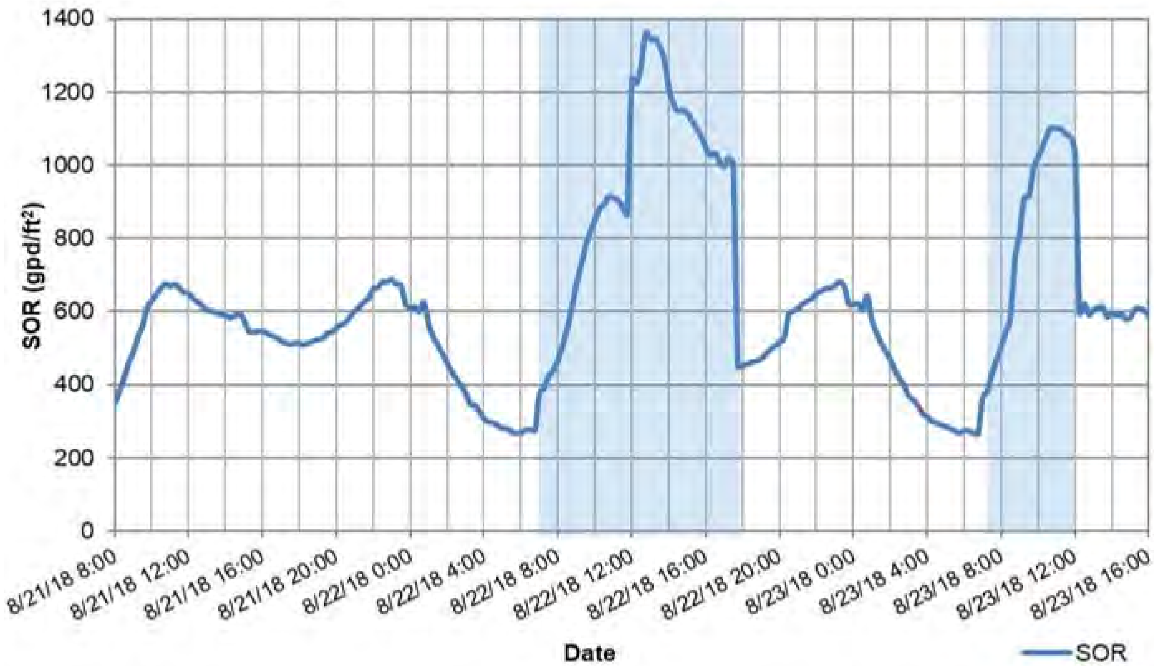


Figure 5-2: Surface Overflow Rate during Clarifier Field Testing

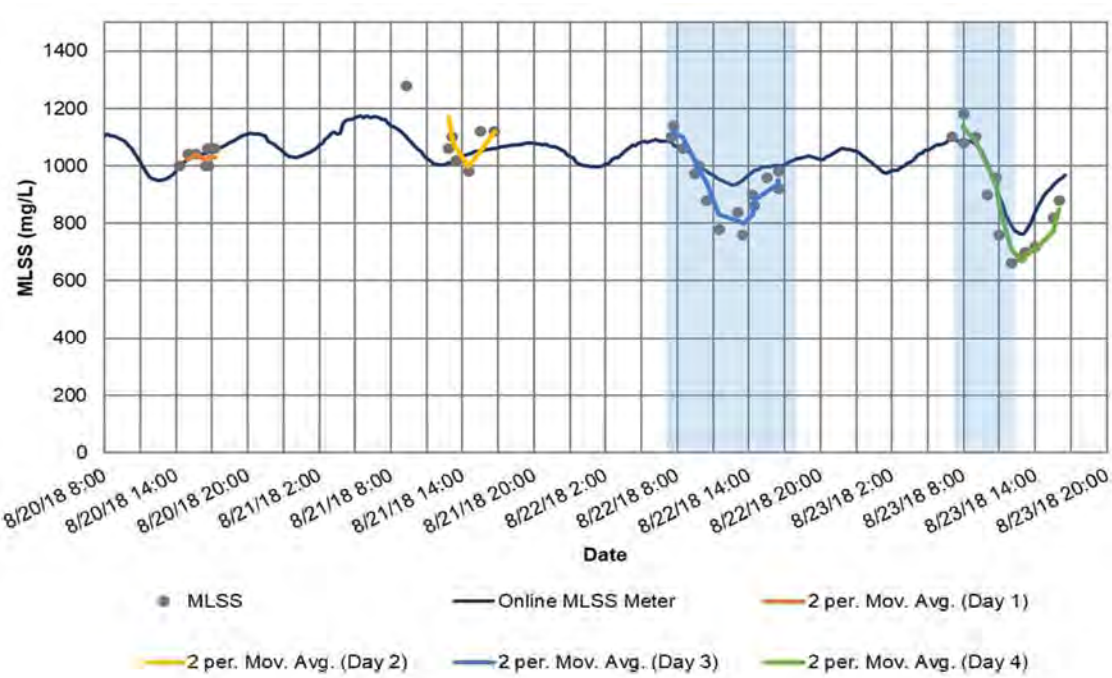


Figure 55-3: Mixed Liquor Suspended Solids during Clarifier Stress Testing

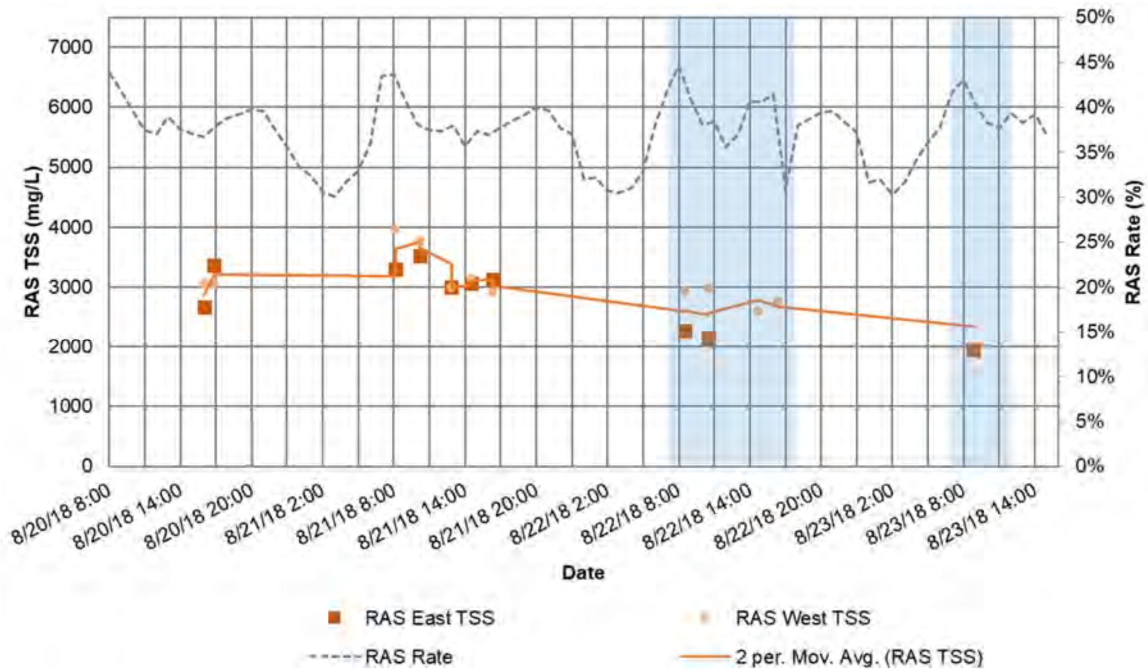


Figure 5-4: RAS TSS and RAS Rate during Clarifier Stress Testing

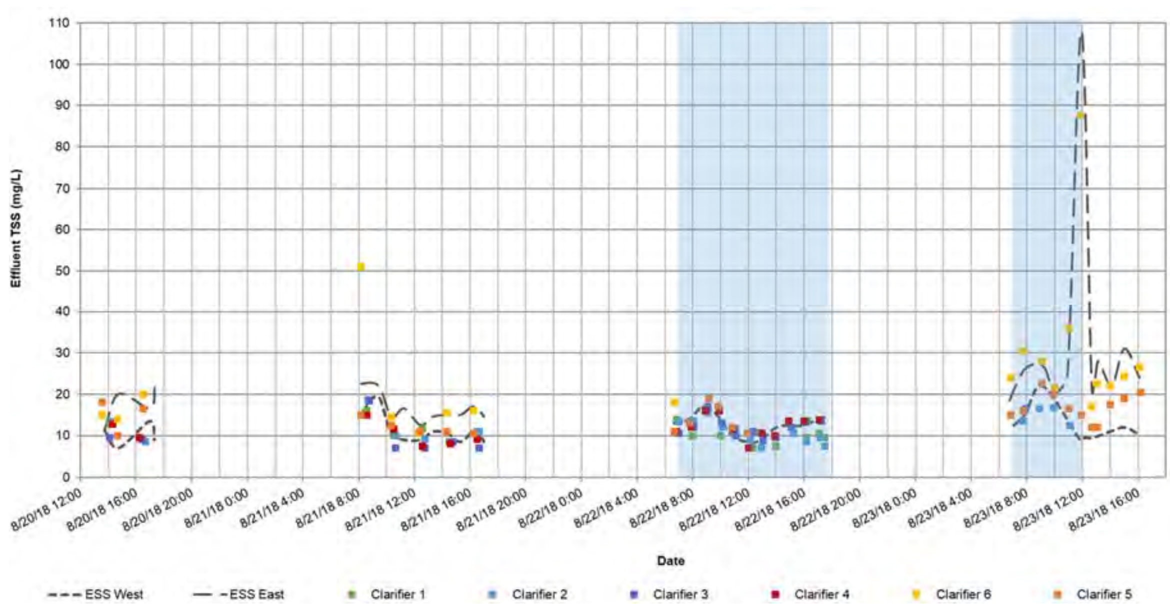


Figure 5-5: Effluent TSS during Day 1 of Clarifier Field Testing

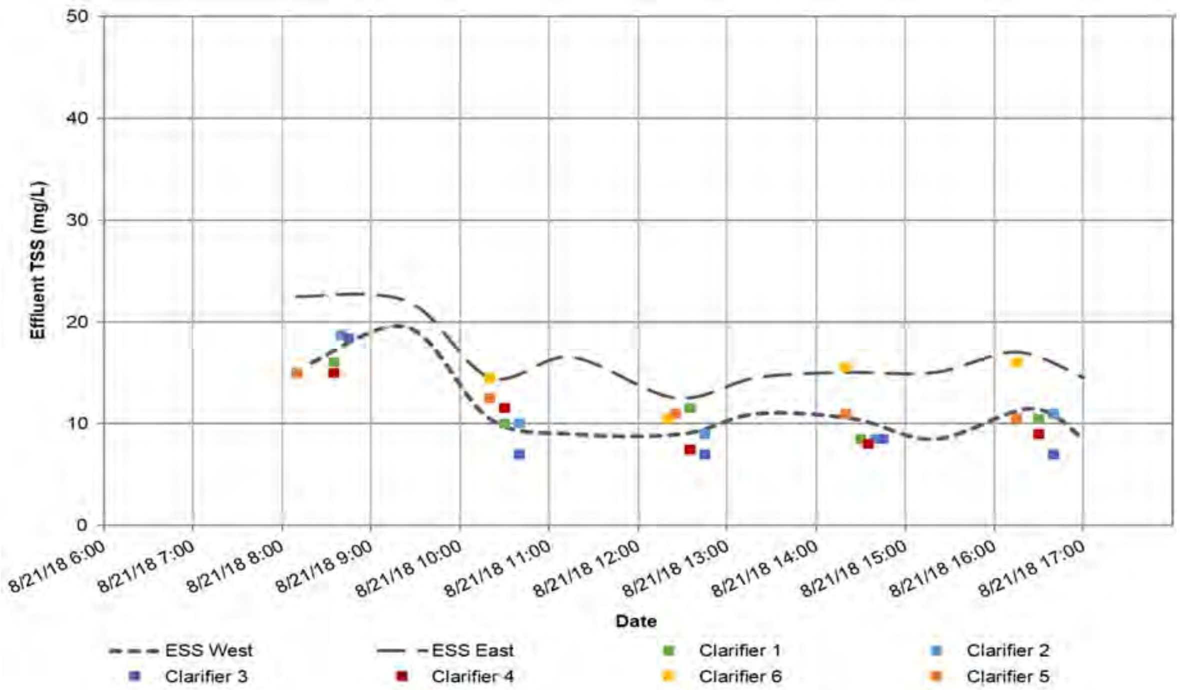


Figure 5-6: Effluent TSS during Day 2 of Clarifier Field Testing

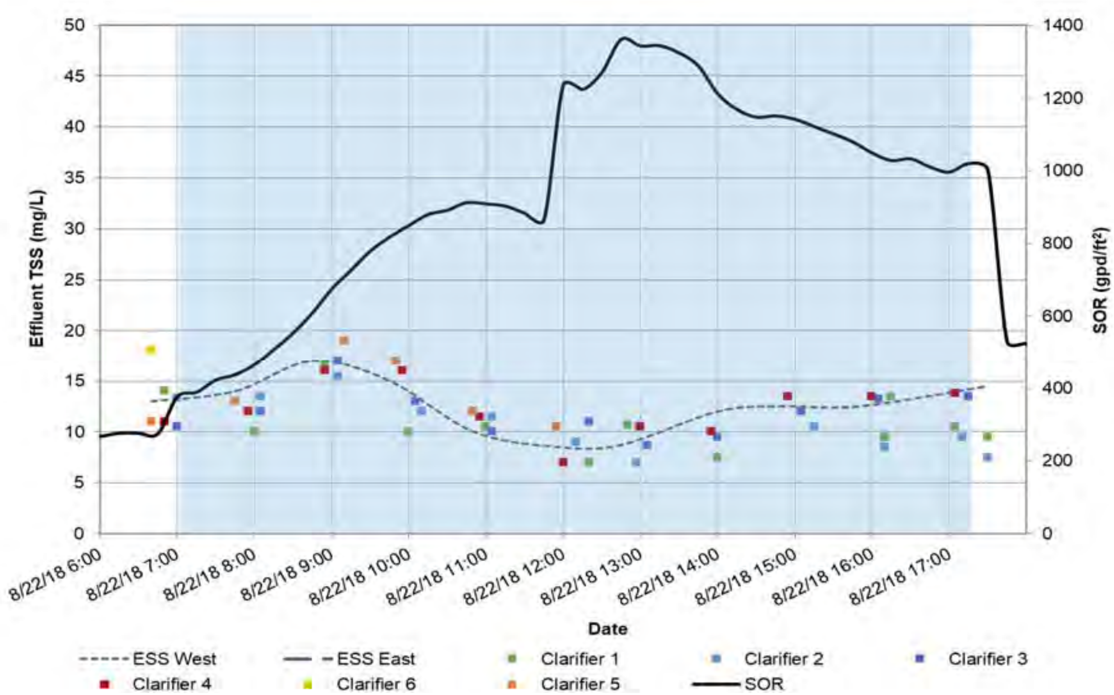


Figure 5-7: Effluent TSS and SOR during Day 3 of Clarifier Field Testing

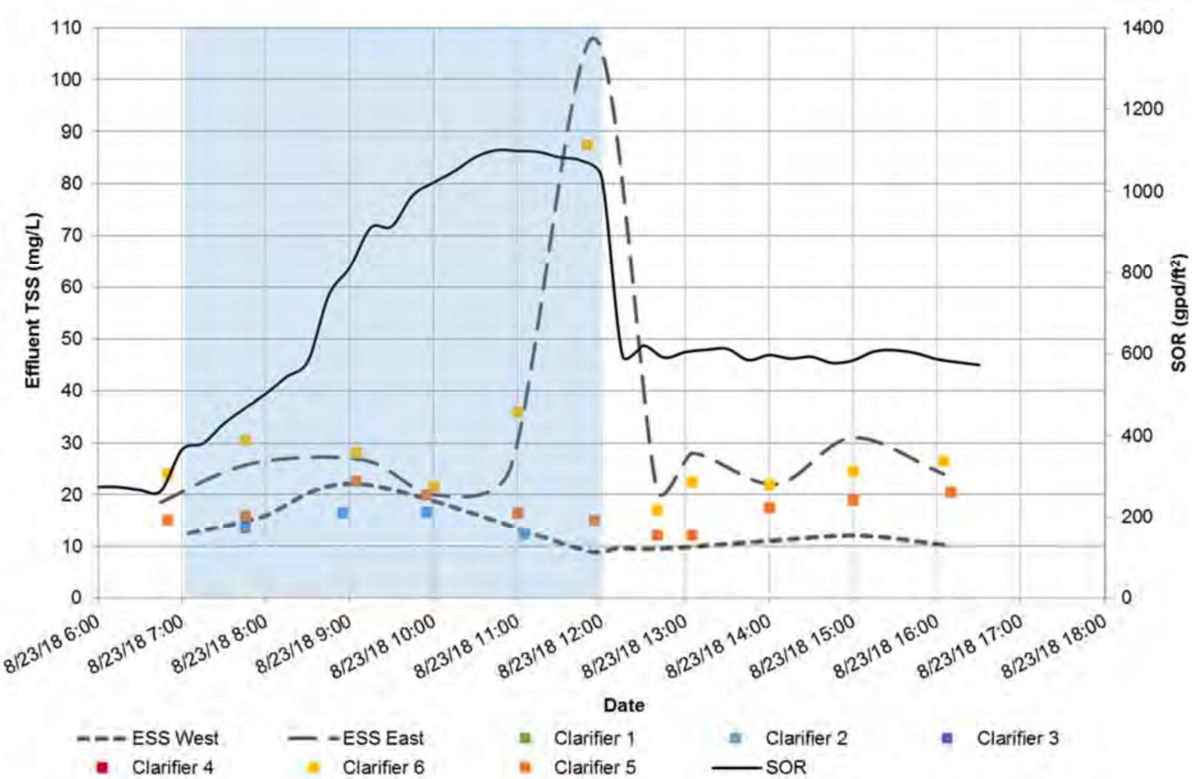


Figure 5-8: Effluent TSS and SOR during Day 4 of Clarifier Field Testing

Table 5-1 Clarifier Stress Testing Conditions

Parameter	Units	Day 1	Day 2	Day 3	Day 4	Average
MLSS	mg/L	1030	1100	940	890	990
SVI	mL/g	285	255	300	380	305
SLR	ppd/ft^2	6.9	7.2	9.7	7.3	7.8
RAS Rate	%	38	37	37	37	37
Average SOR	gpd/ft^2	680	680	1000	870	--
Max. SOR PH SOR	gpd/ft^2			1360 1340	1100 1100	

Appendix 6. CFD Model Calibration

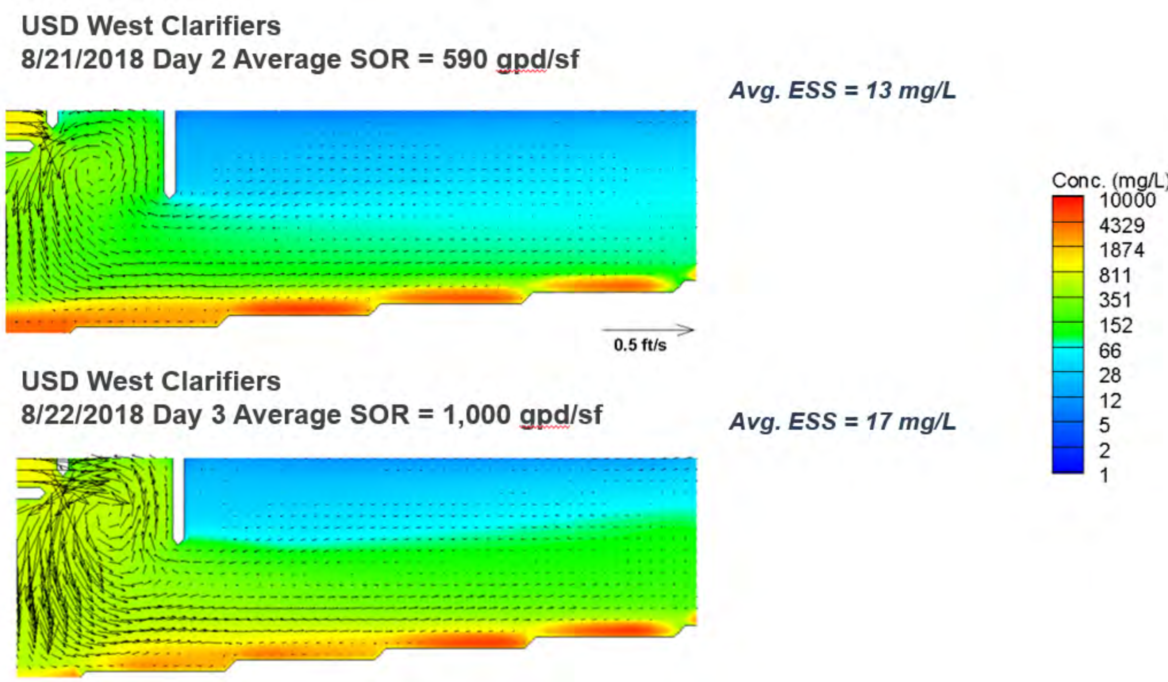


Figure 6-1 West Clarifier Calibration Results

Table 6-1 Steady State Calibration Results

West	SOR (gpd/sf)	SLR (ppd/sf)	MLSS (mg/L)	ESS (mg/L)		RAS (mg/L)		Blanket Depth (ft)		Blanket+ Dispersed Depth (ft)	
Time Period				Field	Model	Field	Model	Field	Model	Field	Model
Day 2 - Baseline	590	7.6	1,090	11	13	3,200	3,500	1	1	3	5
Day 3 - Stress Testing	1,000	9.5	920	13	17	2,210	3,400	2	2	6	7

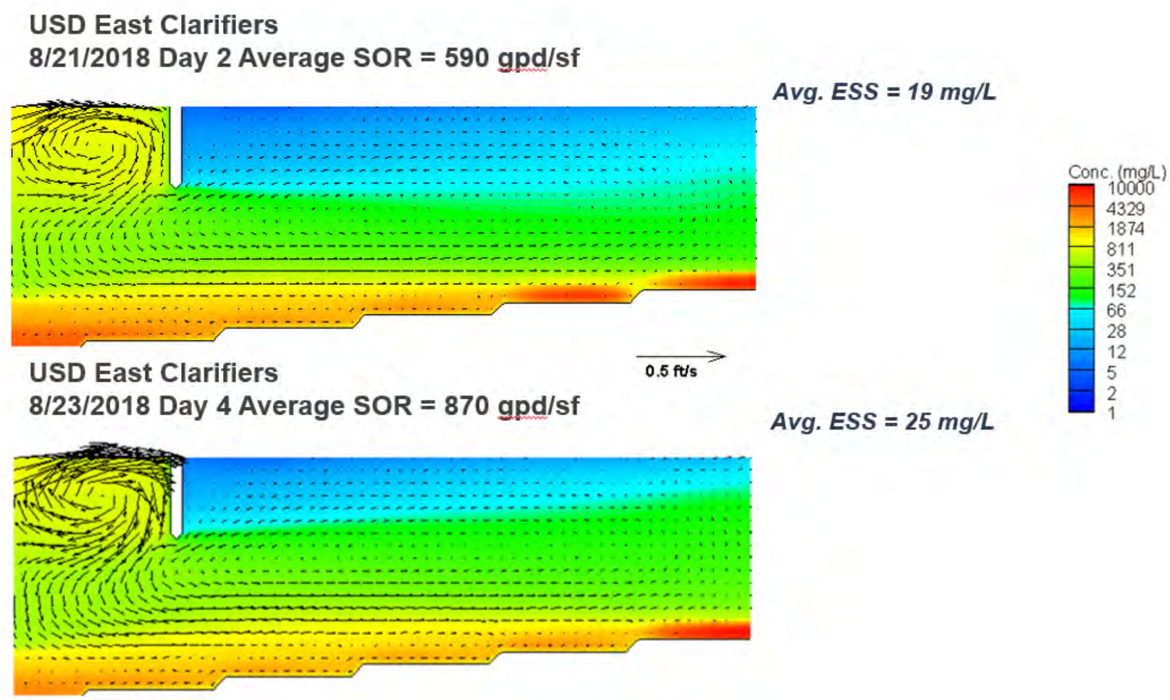


Figure 6-2 East Clarifier Calibration Results

Table 6-2 Steady State Calibration Results

West	SOR (gpd/sf)	SLR (ppd/sf)	MLSS (mg/L)	ESS (mg/L)		RAS (mg/L)		Blanket Depth (ft)		Blanket+ Dispersed Depth (ft)	
Time Period				Field	Model	Field	Model	Field	Model	Field	Model
Day 2 - Baseline	590	7.6	1,090	16	19	3,200	3,500	2	2	4	5
Day 3 - Stress Testing	870	7.2	900	25	25	ND	3,050	2	2	8	7

Appendix 7. Comprehend Phase Workshop Presentation and Minutes

Hazen

Secondary Treatment Upgrade Project – Comprehend Workshop

September 18, 2018

Agenda

Topic		Duration
1.	Introduction/Timeline	8:30 – 8:40
2.	Goals/Executive Summary	8:40 – 9:00
3.	Historical Data Review	9:00 – 9:20
4.	BioWin™ Special Sampling Results/Analysis	9:20 – 9:50
	BREAK	9:50 – 10:00
5.	BioWin™ Model Calibration/Validation	10:00 – 10:25
6.	Filament Analysis	10:25 – 10:45
7.	Secondary Clarifier Stress Testing Results	10:45 – 11:15
8.	CFD Modeling	11:15 – 11:45
9.	What's Coming	11:45 – 12:15
10.	Action Items/Next Steps	12:15 – 12:30

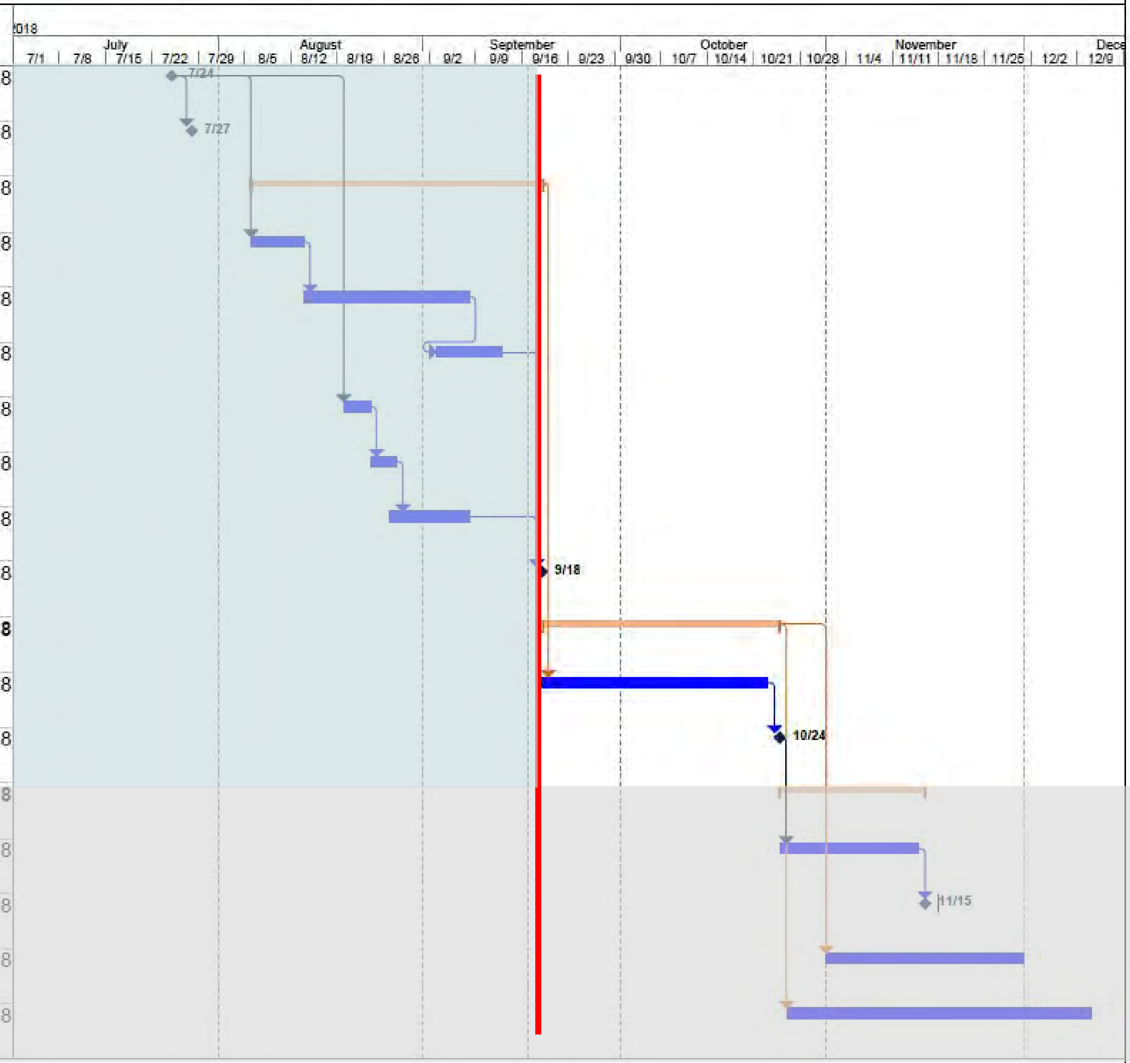
Comprehend Workshop – Agenda note

- A lot of great work from the district and staff to gather information to go into this presentation. Thank You!
- Would like to highlight key points from sampling and historical data
- Save time for modeling initial sneak peak
- Core team members are available to discuss data details

Hazen

Union Sanitary District
Secondary Treatment Upgrade Project - Phase 1

ID	Task Name	Start	Finish
1	Notice to Proceed	7/24/18	7/24/18
2	Kick Off Meeting	7/27/18	7/27/18
3	**Comprehend Phase**	8/6/18	9/18/18
4	Biowin Sampling	8/6/18	8/13/18
5	Biowin Sample Analysis	8/14/18	9/7/18
6	Biowin Model Development	9/3/18	9/12/18
7	Clarifier Stress Testing	8/20/18	8/23/18
8	Stress Testing Sample Analysis	8/24/18	8/27/18
9	CFD Model Development	8/27/18	9/7/18
10	Comprehend Workshop	9/18/18	9/18/18
11	**Explore Phase**	**9/19/18**	**10/24/18**
12	Optimization	9/19/18	10/22/18
13	Explore Workshop	10/24/18	10/24/18
14	**Converge Phase**	**10/25/18**	**11/15/18**
15	Integration with Master Plan and Road Maps	10/25/18	11/14/18
16	Converge Workshop	11/15/18	11/15/18
17	Additional Follow-Up Work Based upon District Review	11/1/18	11/30/18
18	Reporting	10/26/18	12/10/18



Project Status Update

- ✓ Biowin sampling
- ✓ Plant data during biowin sampling
- ✓ Stress testing
- ✓ Lab analysis
- ✓ Biowin Model
- ✓ CFD Model
- ✓ Assumptions defined (August 20)

Goals/ Executive Summary

Executive Summary

Paul Pitt

Comprehend Phase Scope

- Identify goals and boundary conditions (assumptions)
- Review historical data
- Flows and Loads development
- Special sampling
- Biowin calibration
- CFD model development
- Filament Analysis

ES - Historical Data Review

- Excellent sampling and analysis by USD staff
- Influent ratios make sense and are consistent with expected values for municipal wastewater
- Observed yield and sludge production data makes sense
- Overall good quality data that we have confidence in and can use to calibrate process model

ES – Biowin Special Sampling

- Special sampling results correspond to historical averages
- $COD:BOD_5$ (2.8) higher than typical (1.8 – 2.5)
- $cBOD_5:TKN$ (4.2) at lower end of typical range (4 – 8)
- NH_3-N:TKN (0.68) within typical range (0.6 – 0.8)
- PO_4-P:TP ratio (0.36) slightly below typical range (0.4 – 0.8)
- Gathered critical data on weekday and weekend diurnal pattern

ES – Biowin Model Development

- Increased rbCOD (improves nutrient removal)
- Increased inert particulate COD (increases solids production
- Annual daily dynamic and steady state models calibrate well to existing data
- We have confidence that the model will accurately predict nitrogen removal and solids production

Filament Analysis Summary

- Analysis were consistent
- Confirmed Type 021N was dominant filament with no sulfur granules
- Not much chlorine damage observed despite dosage
- Some bio-P population variable

Secondary Clarifier Field Testing and Model Calibration

- Clarifier field testing conducted from 8/20 to 8/23/2018
  - Stress testing of West and East clarifiers
  - Comprehensive array of tests and evaluations
  - Lab data consistent with field observations
- West clarifiers (Clarifiers 1-4) outperformed the East Clarifiers
  - Sustained overflow rates > 1,000 gpd/ft^2 but with high blankets.
  - Solids loading rate was low ~ 10 ppd/ft^2
  - SVI ~ 300 mL/g

Secondary Clarifier Field Testing and Model Calibration (cont.)

- East clarifiers (Clarifiers 5-6) failed under slightly lower loading conditions
  - Overflow rates > 900 gpd/ft^2
  - Solids loading rate ~ 8 ppd/ft^2
  - SVI ~ 380 mL/g
- East clarifiers presents poor hydrodynamics and excess turbulence
  - Draft tube configuration
  - No EDI
  - Corners
  - Leaking seal in Clarifier 6 further impacting Performance

Secondary Clarifier Field Testing and Model Calibration (cont.)

- East clarifiers presents poor hydrodynamics and excess turbulence
  - Draft tube configuration
  - No EDI
  - Corners
  - Leaking seal in Clarifier 6 further impacting Performance

Secondary Clarifier Field Testing and Model Calibration (cont.)

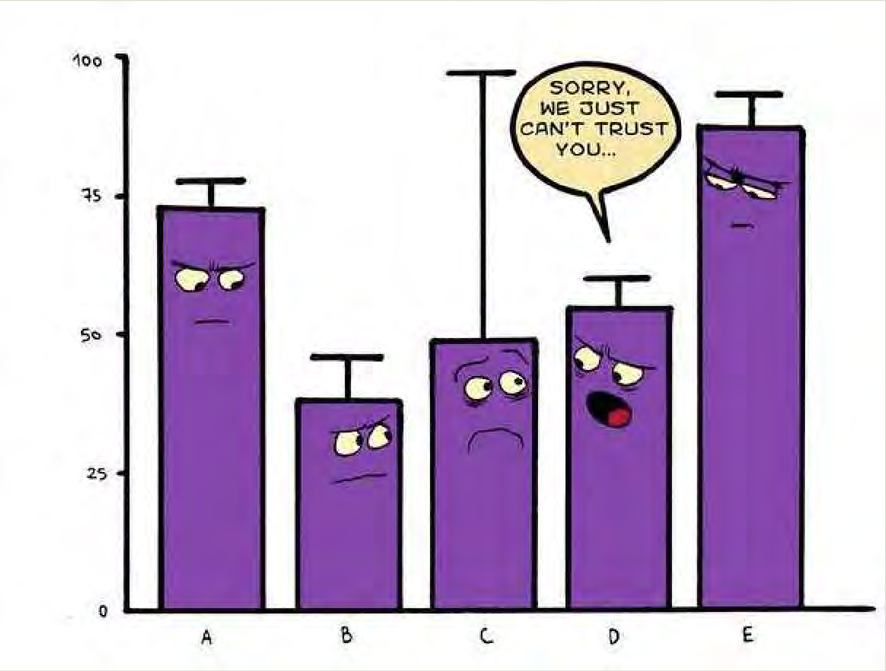
- Two dimensional (2D) models calibrated for East and West clarifiers
  - Good match between observed and predicted effluent TSS, RAS TSS and sludge blankets
  - Three-dimensional (3D) models will be used for verification of selected alternatives

ES – What's Next

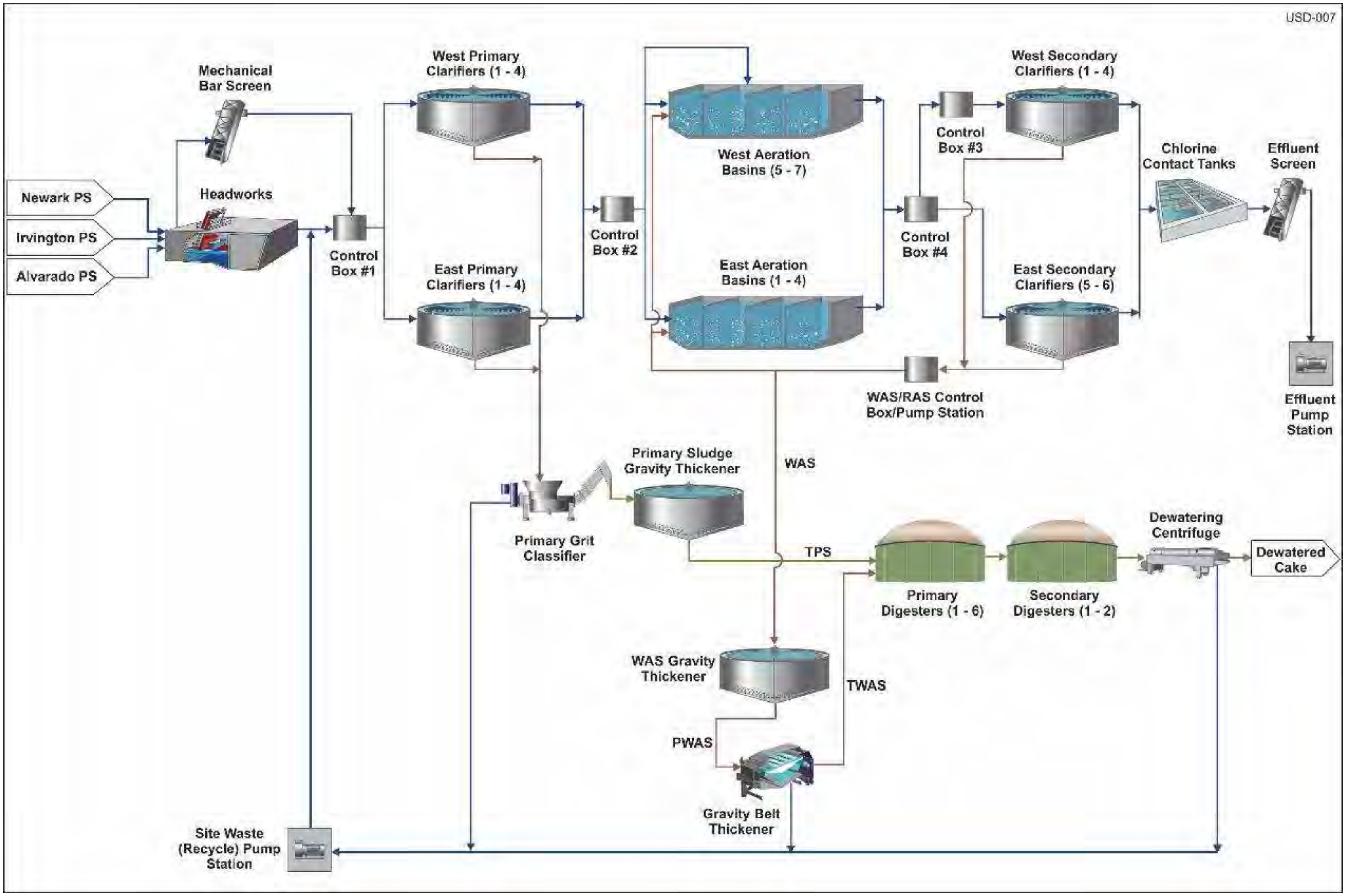
- Initial sizing for 2040 Level 2 BNR
  - Hazen - 14.6 Mgal (7 Mgal additional)
  - Master plan – 30 Mgal (22.4 Mgal additional)
- Significant diurnal flow/loading from previous work
  - Refine based on our sampling results
- Supplemental sampling and historical data show poorer COD/N ratio in primary effluent than previous model
  - Confirm and evaluate impacts/alternatives to address
  - Sensitivity of required volume vs temperature and nutrient requirements
- Link with clarifier CFD model, verify optimum MLSS/clarifier size/aeration volume

Historical Data Review

Irene W. Chu

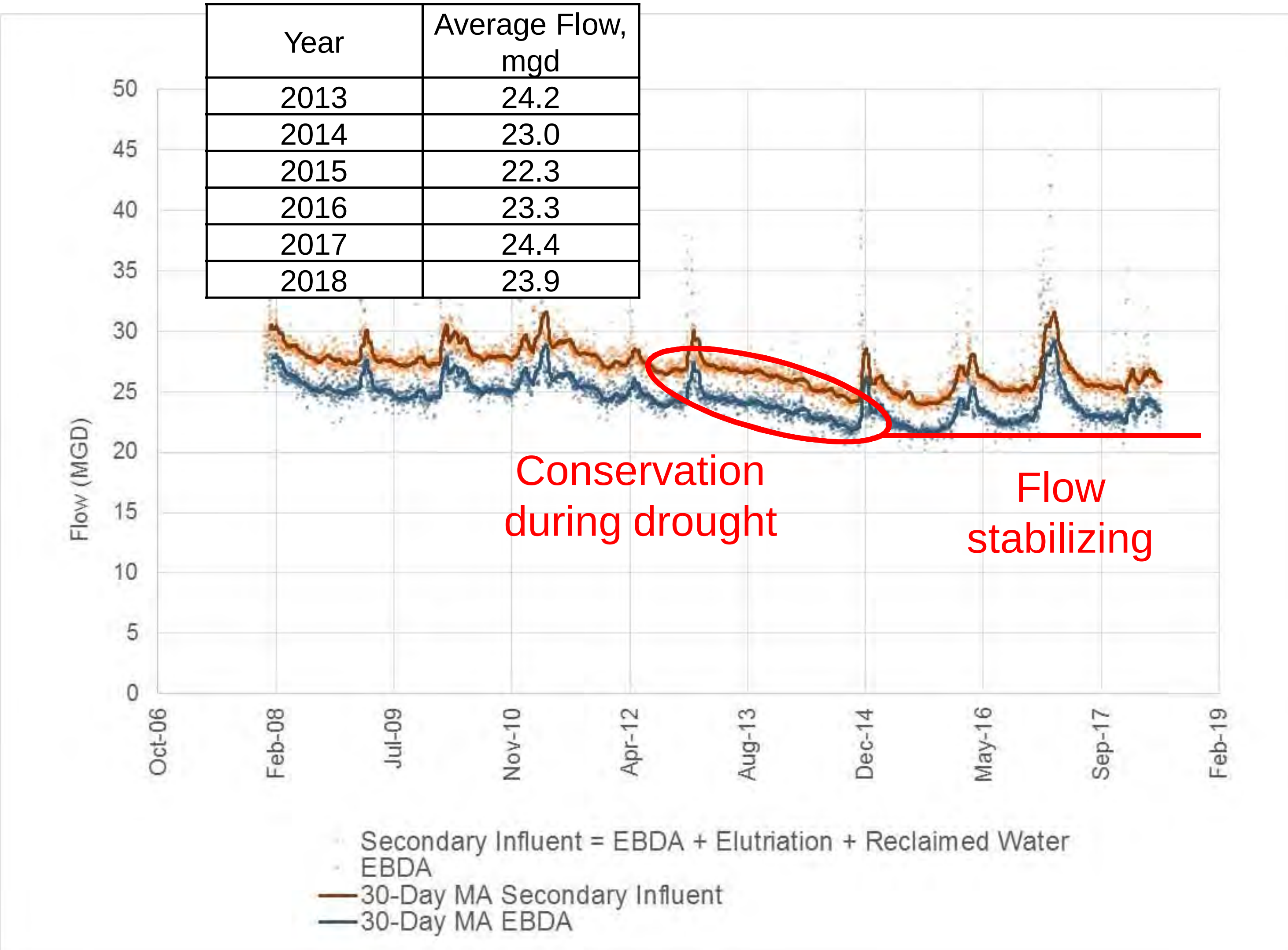


USD Process Flow Diagram



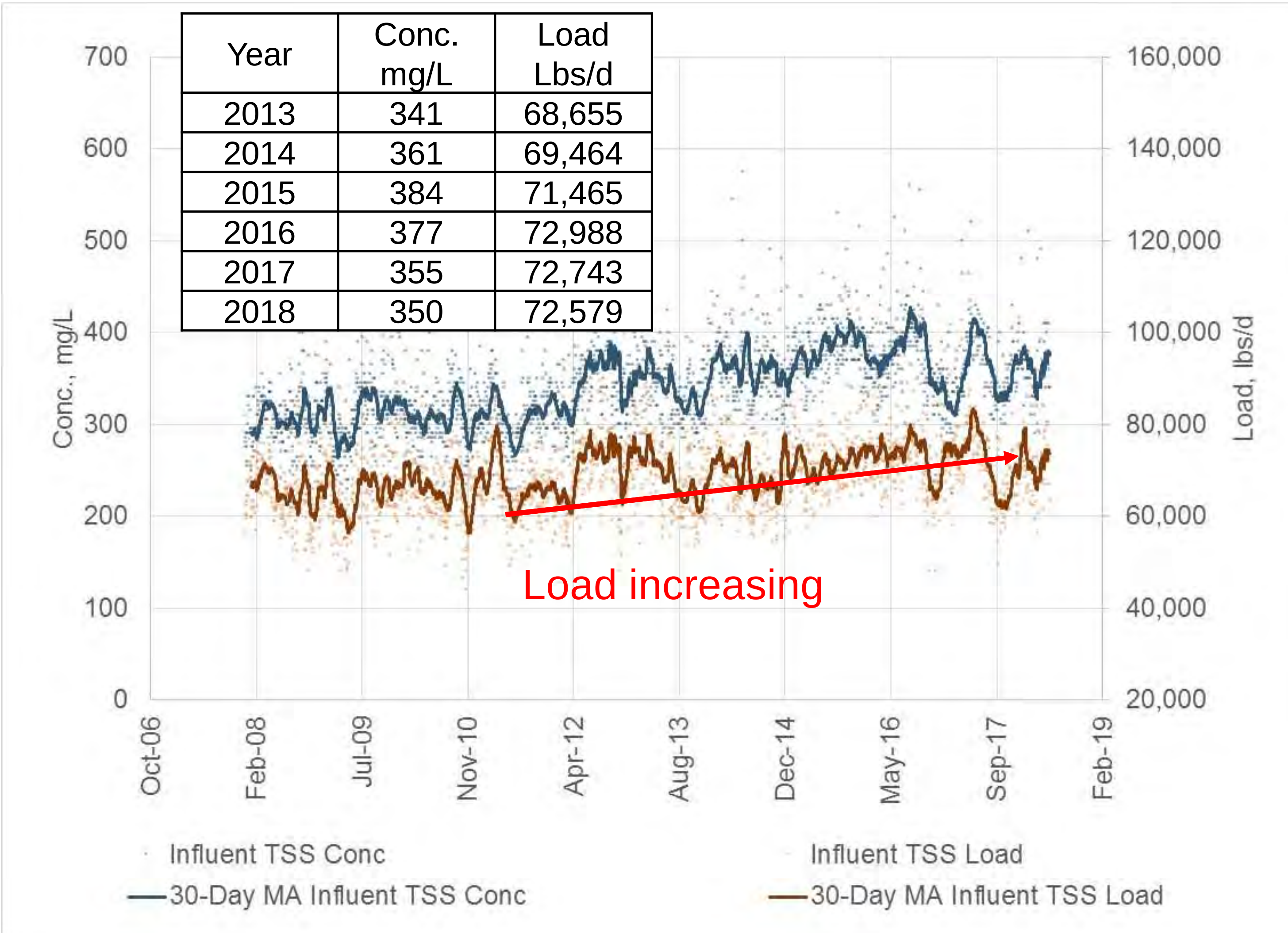
Historical Data Review – Influent Flow

Year	Average Flow, mgd
2013	24.2
2014	23.0
2015	22.3
2016	23.3
2017	24.4
2018	23.9



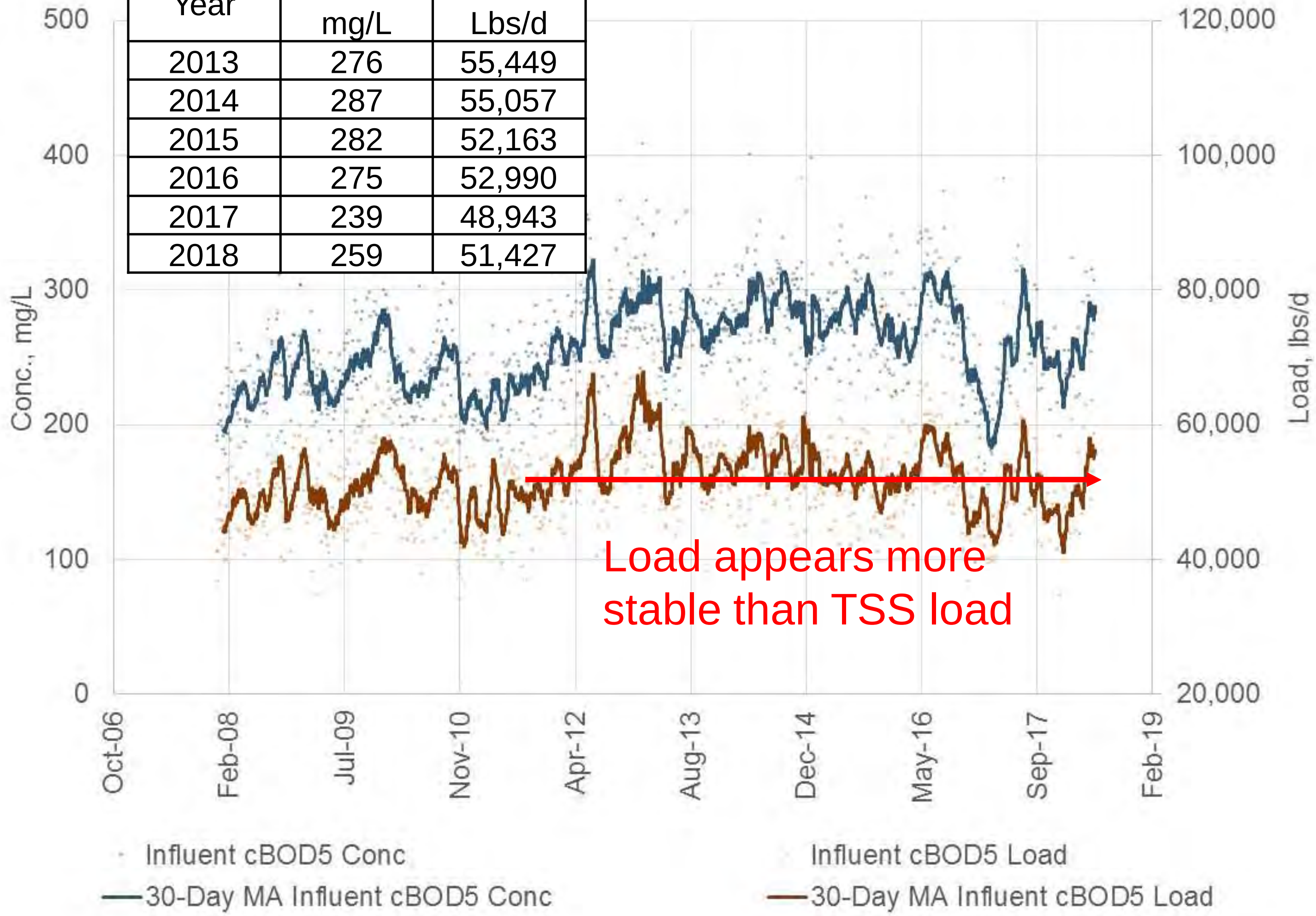
Historical Data Review – Influent TSS

Year	Conc. mg/L	Load Lbs/d
2013	341	68,655
2014	361	69,464
2015	384	71,465
2016	377	72,988
2017	355	72,743
2018	350	72,579



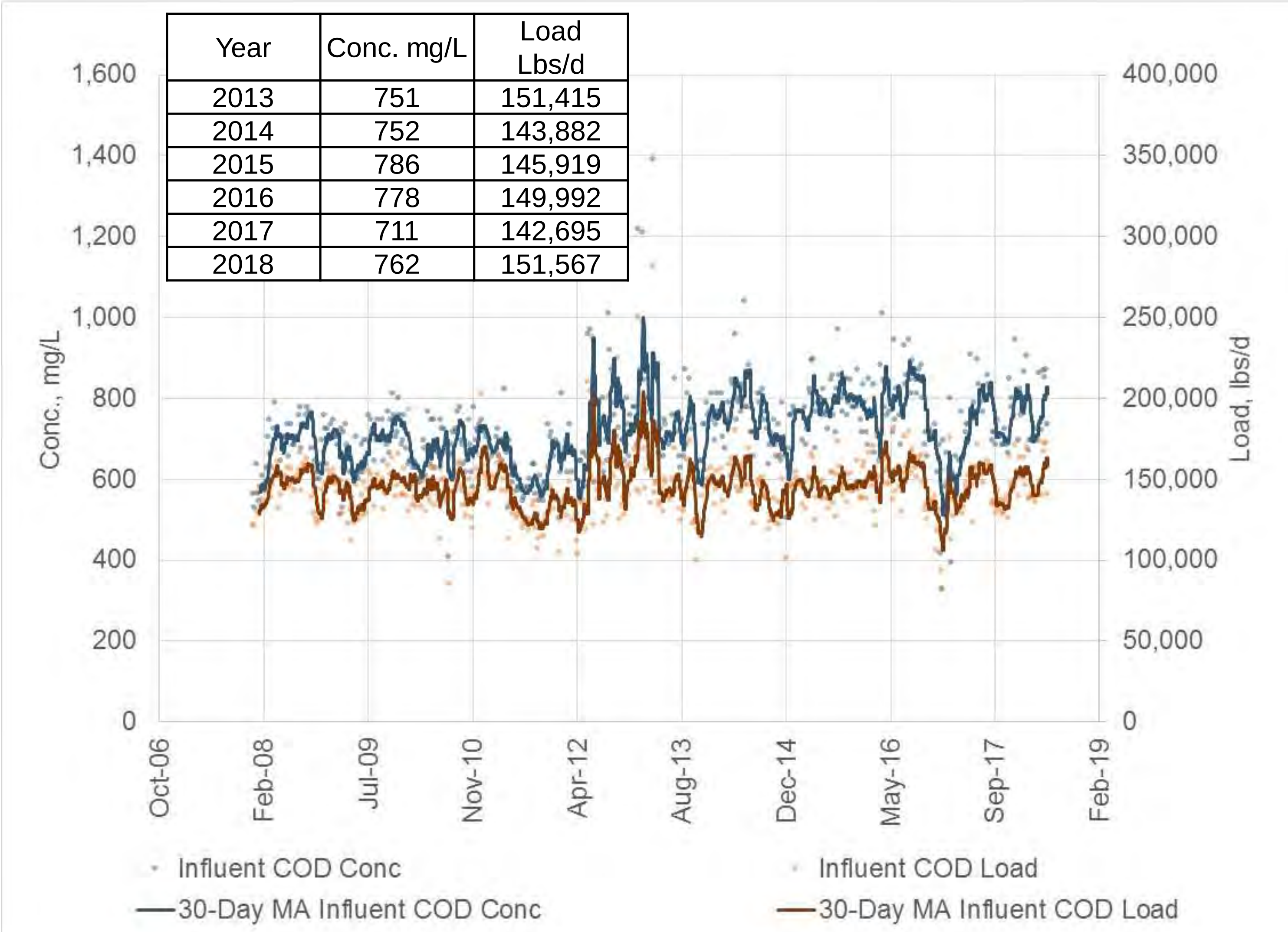
Historical Data Review – Influent $cBOD_5$

Year	Conc. mg/L	Load Lbs/d
2013	276	55,449
2014	287	55,057
2015	282	52,163
2016	275	52,990
2017	239	48,943
2018	259	51,427



Historical Data Review – Influent COD

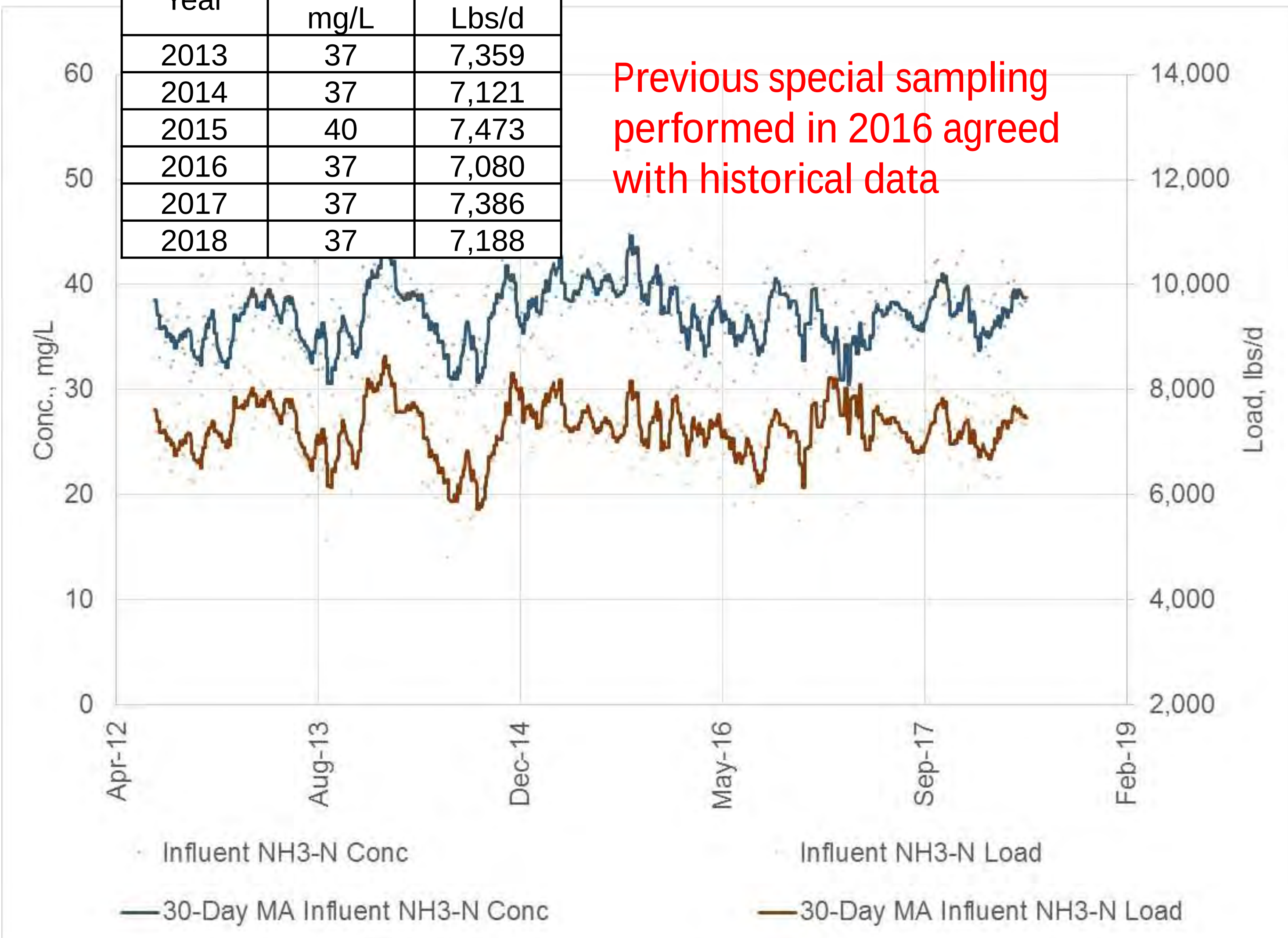
Year	Conc. mg/L	Load Lbs/d
2013	751	151,415
2014	752	143,882
2015	786	145,919
2016	778	149,992
2017	711	142,695
2018	762	151,567



Historical Data Review – Influent Ammonia

Year	Conc. mg/L	Load Lbs/d
2013	37	7,359
2014	37	7,121
2015	40	7,473
2016	37	7,080
2017	37	7,386
2018	37	7,188

Previous special sampling performed in 2016 agreed with historical data



Historical Data Review – Loads and PF

(Jun-13 to May-18 Data)

Flow Criteria	Flow (MGD)	PF
Minimum Day	20.6	0.88
Average Annual	23.4	1.00
Maximum Month	25.8	1.10
Maximum 30-Day	25.9	1.11
Maximum 7-Day	28.5	1.22
Maximum Day	33.9	1.45

Load peaking factors are consistent and typical for municipal wastewater

Typically designed around max-30 day loads

Criteria	$cBOD_5$		COD		TSS		NH_3-N	
	Load ppd	PF	Load ppd	PF	Load ppd	PF	Load ppd	PF
Minimum Day	38,700	0.73	111,000	0.76	53,200	0.75	5,560	0.77
Average Annual	52,600	1.00	146,000	1.00	70,500	1.00	7,240	1.00
Maximum Month	59,200	1.13	159,000	1.09	76,800	1.09	7,920	1.09
Maximum 30-Day	60,500	1.15	166,000	1.13	78,900	1.12	8,190	1.13
Maximum 7-Day	66,900	1.27	ND	ND	89,100	1.26	ND	ND
Maximum Day	75,400	1.43	181,000	1.24	107,000	1.51	9,230	1.27

Historical Data Review

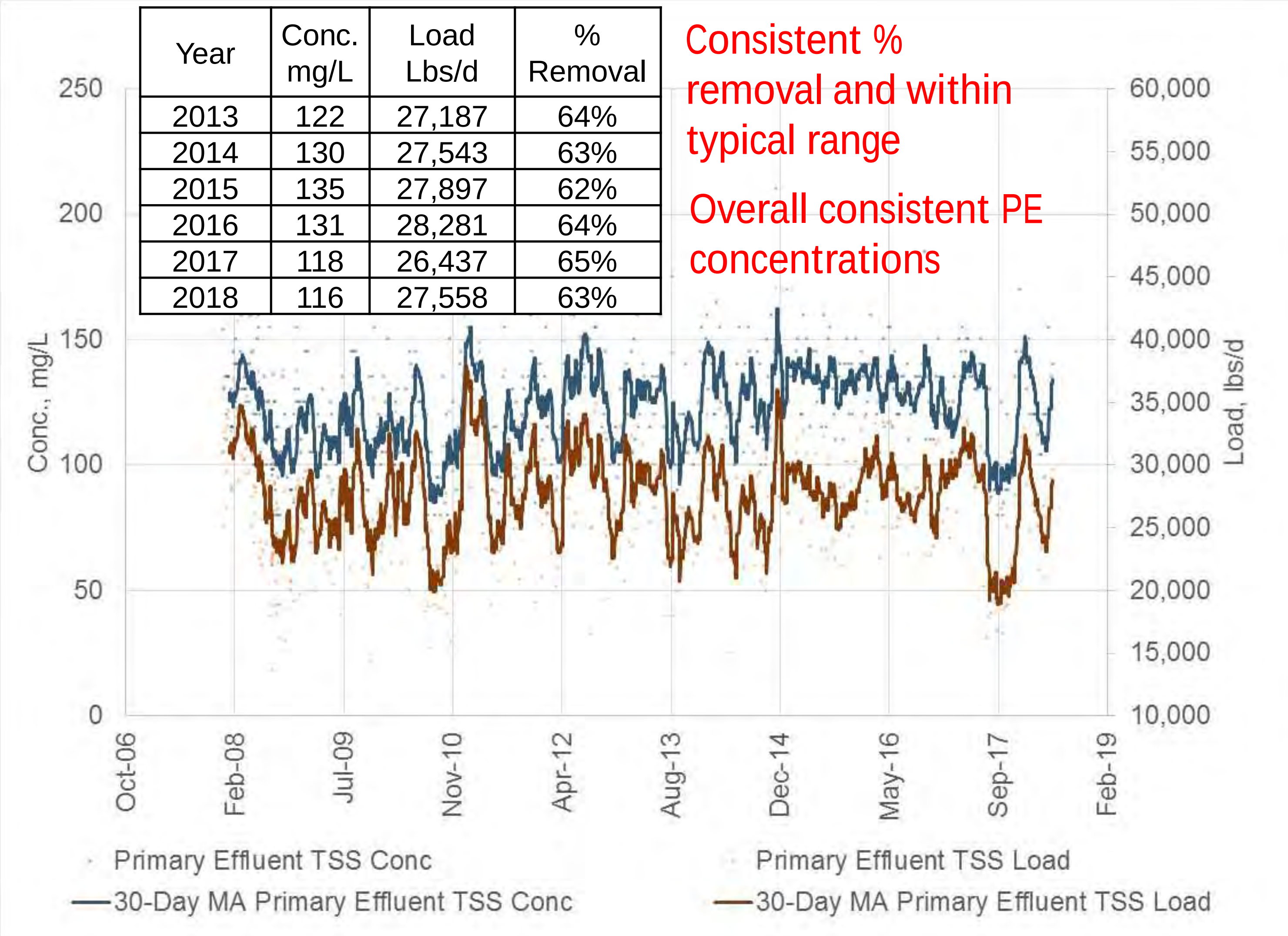
- Influent flows decreased over drought period likely due to conservation
- Recent years flow has stabilized
- TSS concentrations and load showed slight increase
- $cBOD_5$ and NH_3-N concentration and loads were stable
- For scenarios we assumed 1% load increase / year

Historical Data Review – PE TSS

Year	Conc. mg/L	Load Lbs/d	% Removal
2013	122	27,187	64%
2014	130	27,543	63%
2015	135	27,897	62%
2016	131	28,281	64%
2017	118	26,437	65%
2018	116	27,558	63%

Consistent % removal and within typical range

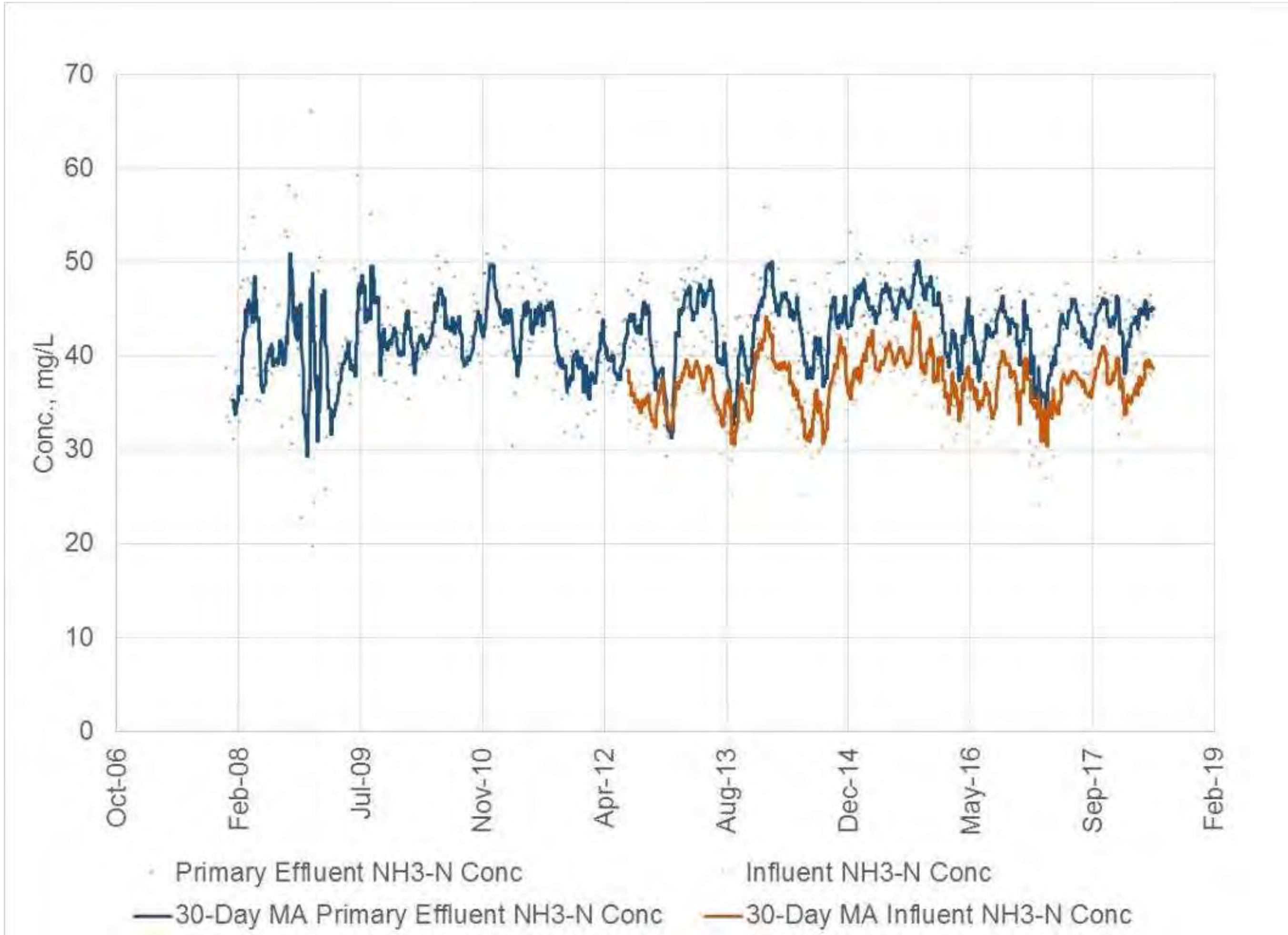
Overall consistent PE concentrations



Historical Data Review – PE NH_3-N

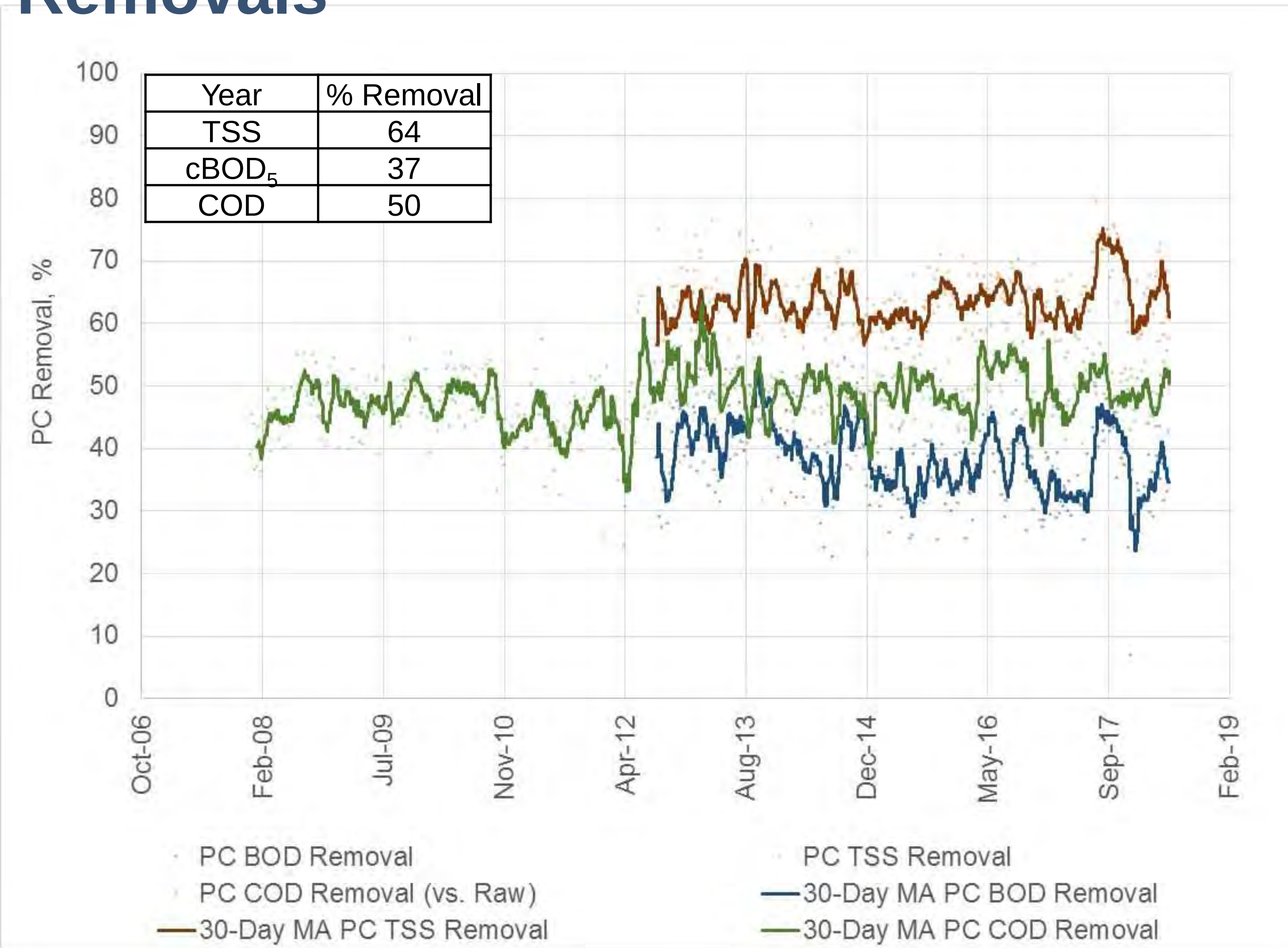
Year	Raw NH_3-N Conc. mg/L	PE NH_3-N Conc. mg/L
2013	37	42
2014	37	44
2015	40	47
2016	37	42
2017	37	42
2018	37	43

15% increase in NH_3-N across PC due to recycle load



Historical Data Review – Primary Clarifier Removals

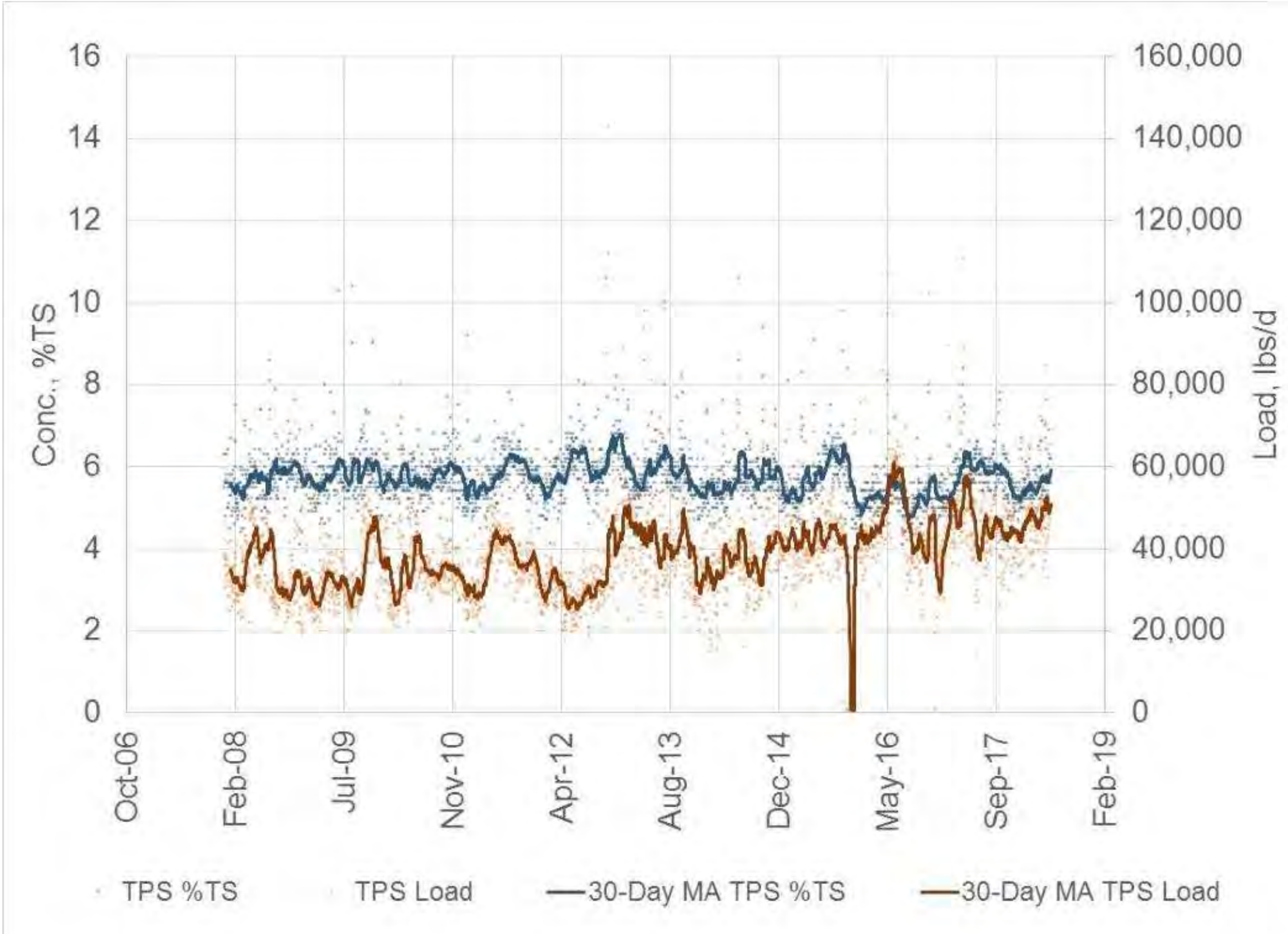
Year	% Removal
TSS	64
$cBOD_5$	37
COD	50



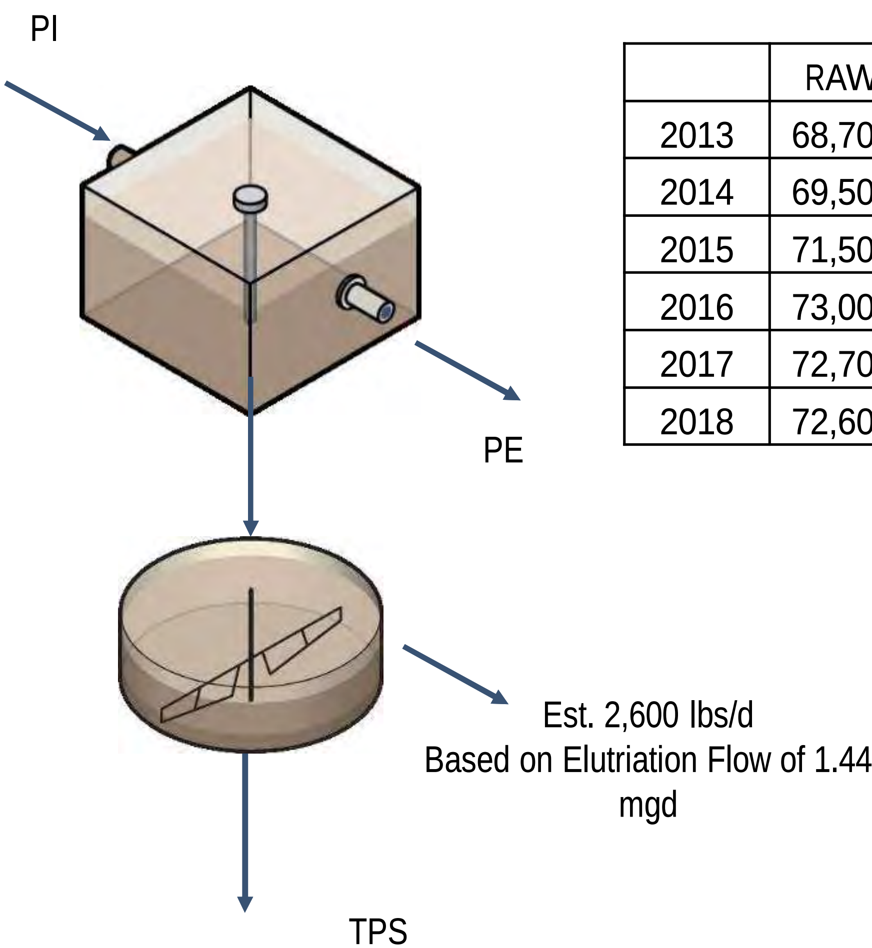
Historical Data Review – TPS

Year	Conc, % TS	Load Lbs/d
2013	5.84	41,613
2014	5.70	37,547
2015	5.73	41,751
2016	5.29	46,091
2017	5.77	45,970
2018	5.72	48,094

Concentration is consistent, however load increases.



Historical Data Review – Primary Clarifier Mass Balance



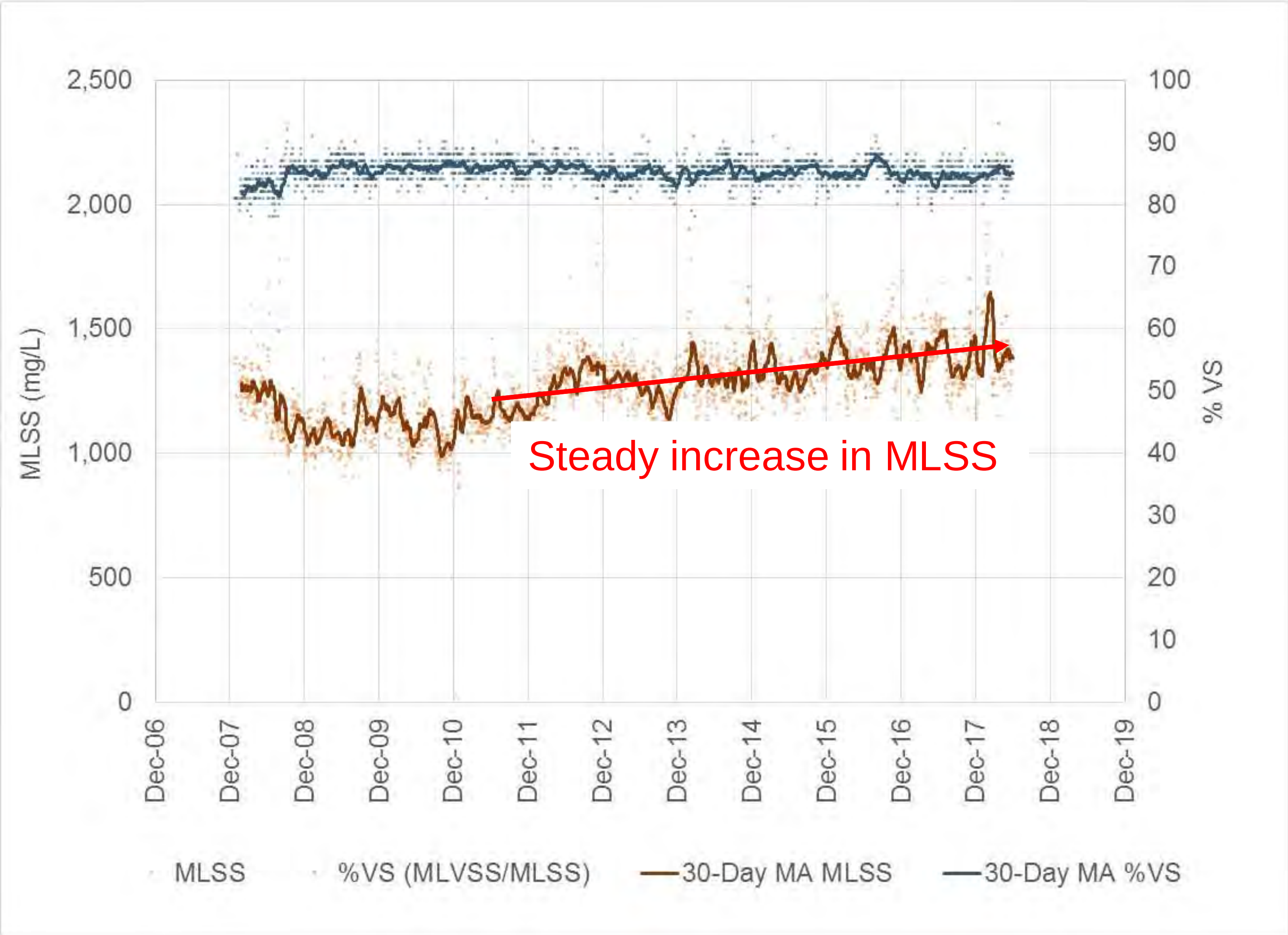
	RAW	PI	PE	TPS	PS GTO	OUT	Out/in
2013	68,700	74,300	27,200	41,600	2,600	71,400	96%
2014	69,500	73,600	27,500	37,500	2,600	67,600	92%
2015	71,500	74,100	27,900	41,800	2,600	72,300	98%
2016	73,000	78,500	28,300	46,100	2,600	77,000	98%
2017	72,700	75,200	26,400	46,000	2,600	75,000	100%
2018	72,600	75,600	27,600	48,100	2,600	78,300	104%

Great agreement based on our understanding of flow

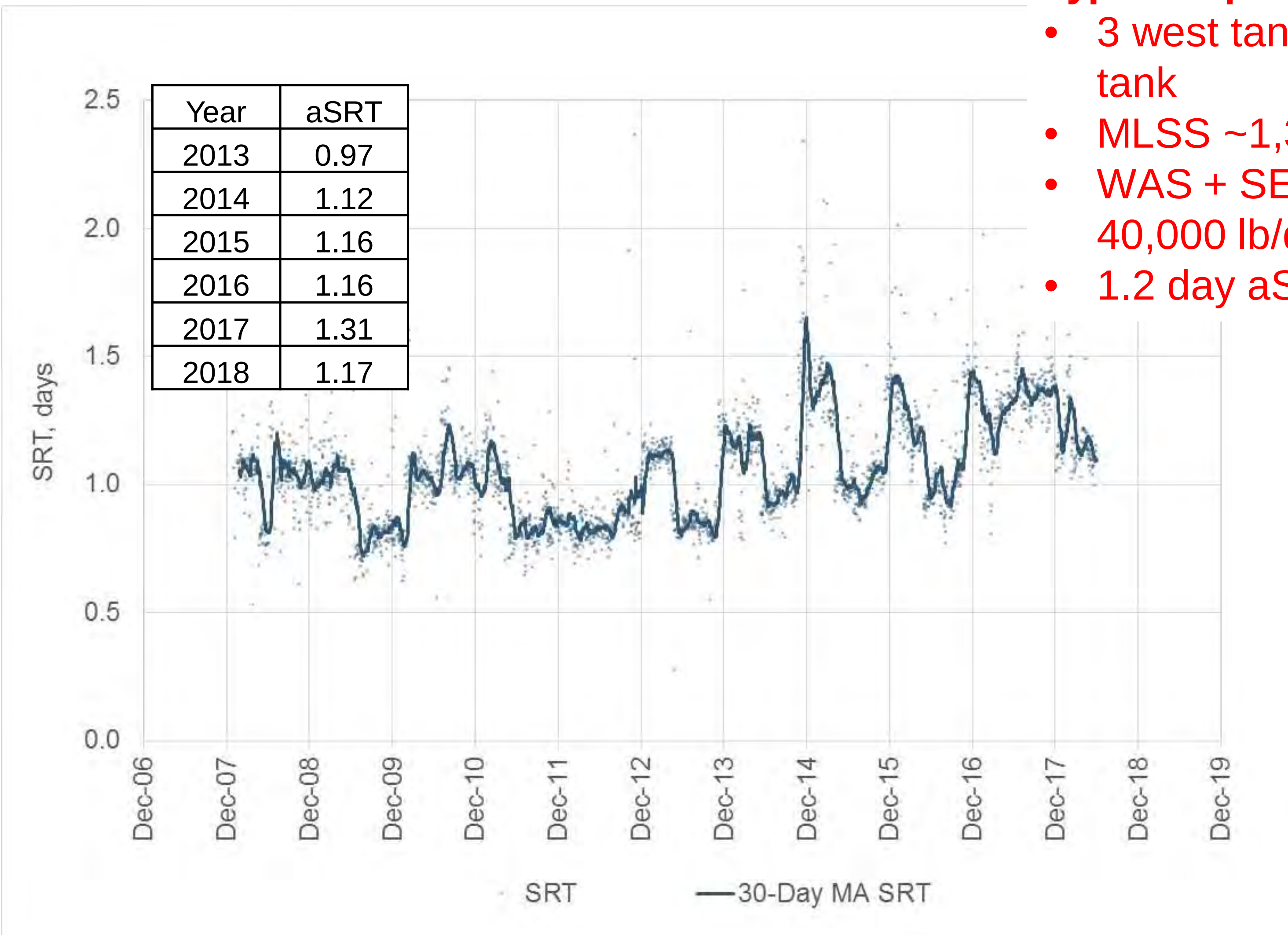
Historical Data Review – Primary Summary

- Consistent removal across primary clarifier
  - Excellent closure around primary clarifier/PS GT
  - TSS removal 64%
  - $cBOD_5$ 37%, COD 50%
  - Typical for municipal utilities
- Excellent mass balance closure around the primary clarifier + PS gravity thickener
- Recycles increase NH_3-N
  - 16% increase in concentration
  - 29% increase in load

Historical Data Review – MLSS



Historical Data Review – aSRT



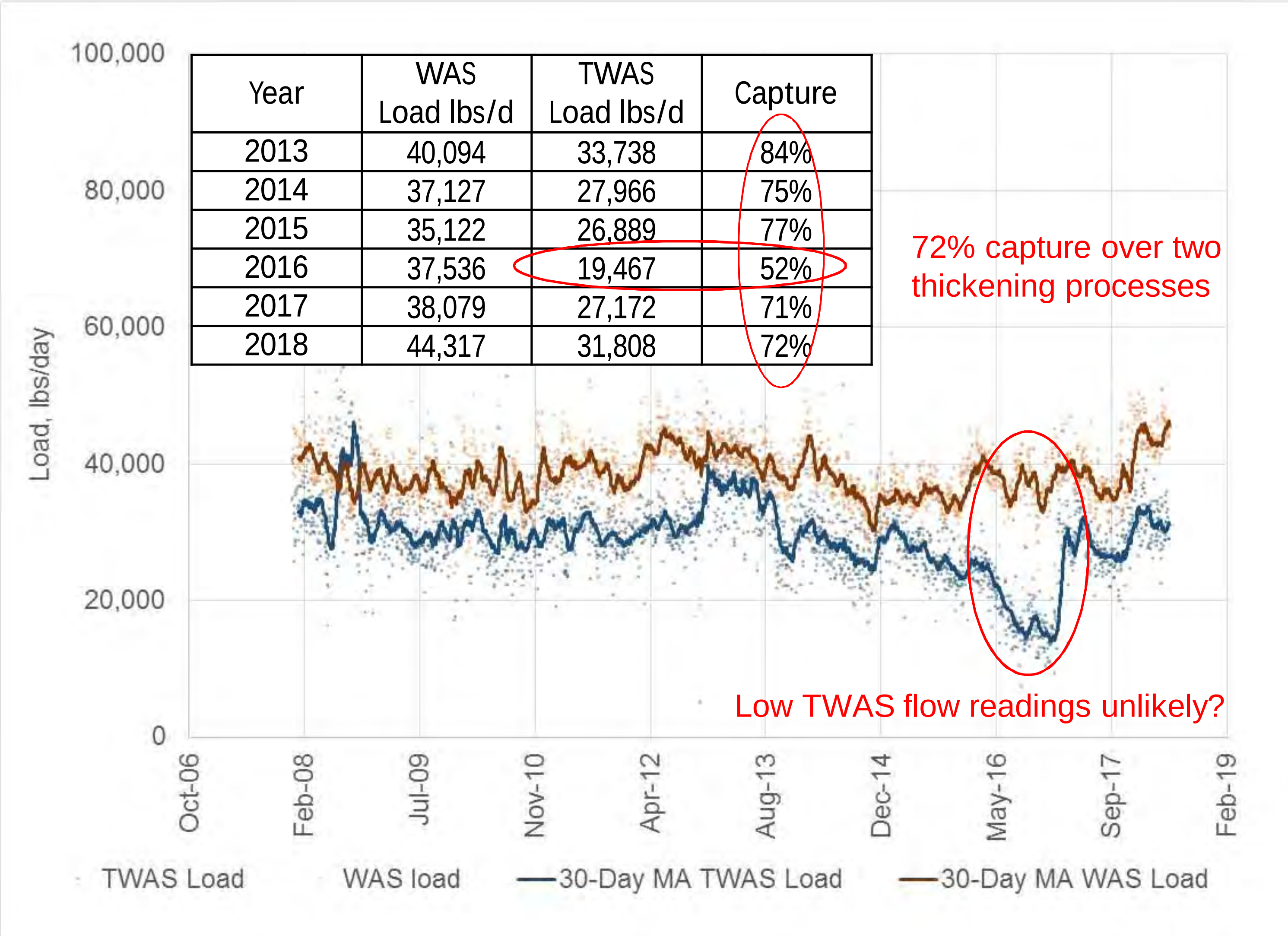
Year	aSRT
2013	0.97
2014	1.12
2015	1.16
2016	1.16
2017	1.31
2018	1.17

Typical operation:

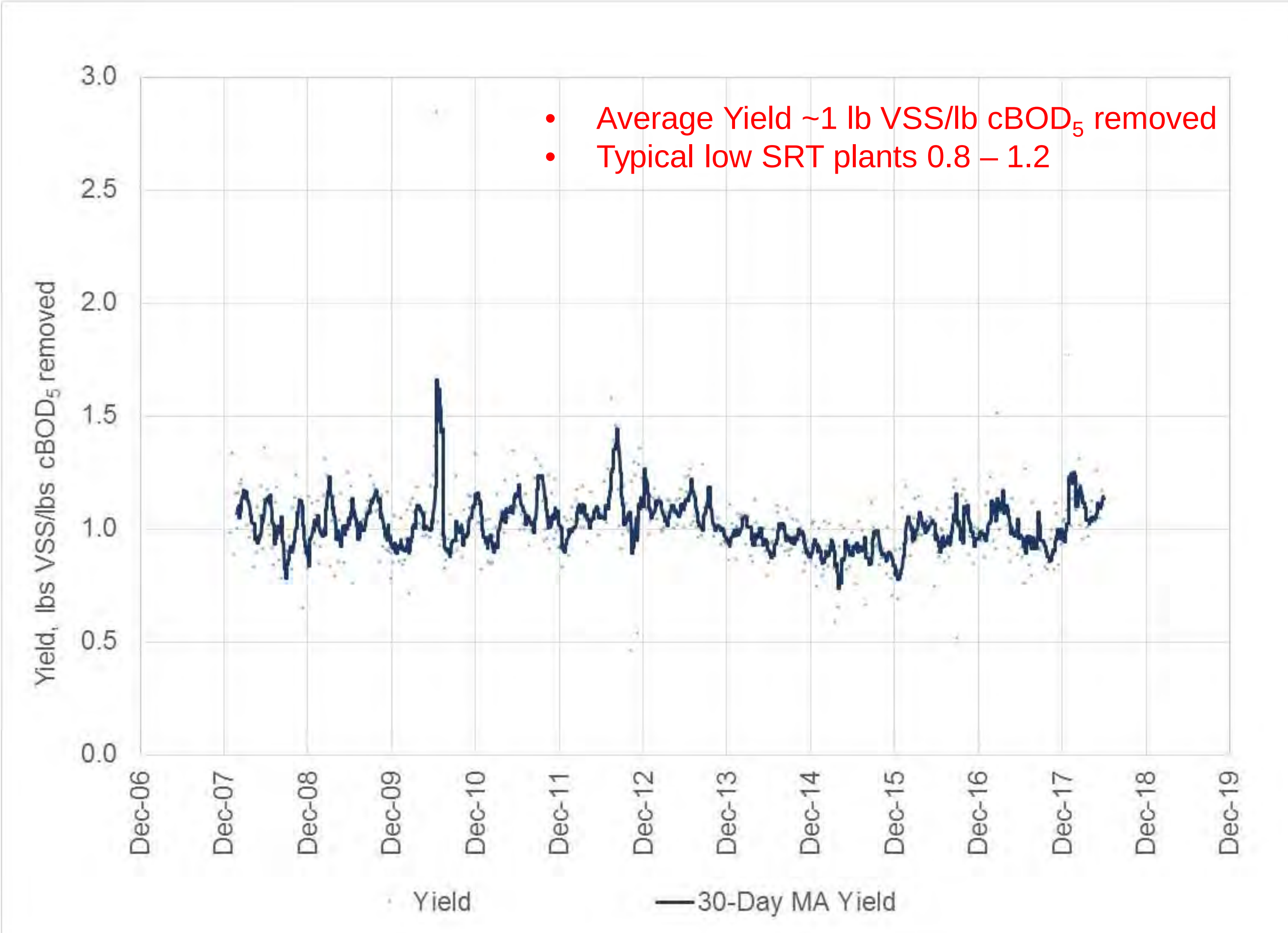
- 3 west tanks, 1 east tank
- MLSS ~1,300 mg/L
- WAS + SE load ~ 40,000 lb/day
- 1.2 day aSRT

Historical Data Review – Sludge Production

Year	WAS Load lbs/d	TWAS Load lbs/d	Capture
2013	40,094	33,738	84%
2014	37,127	27,966	75%
2015	35,122	26,889	77%
2016	37,536	19,467	52%
2017	38,079	27,172	71%
2018	44,317	31,808	72%



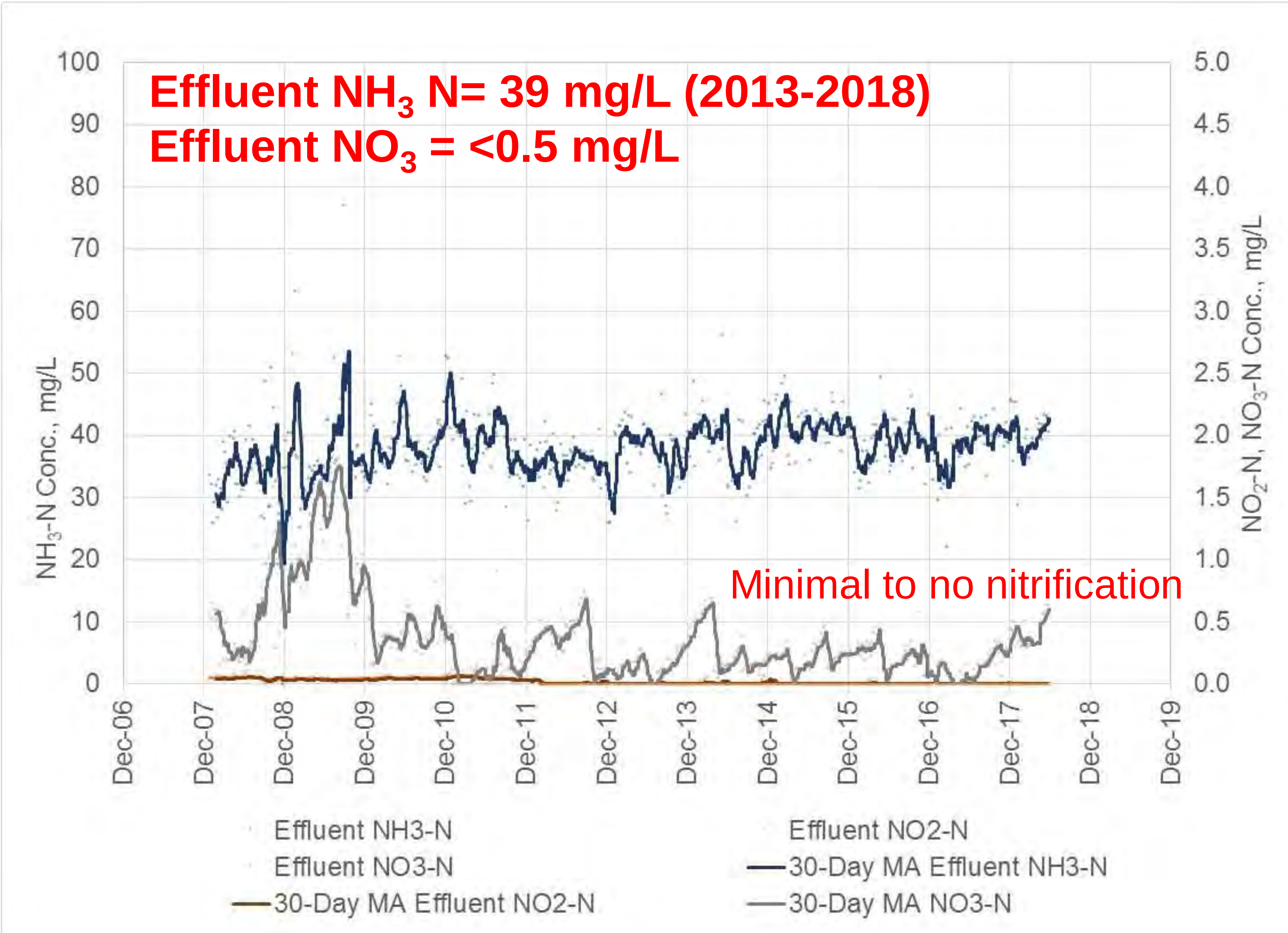
Historical Data Review – Yield



Historical Data Review – Secondary Process Review

- MLSS showed slight increase over the period
- Accommodate increase in load to the secondary system
- aSRT has been overall has been consistent over the last 5 years
- Observed yield based on WAS VSS load is consistent with low SRT plants
- Overall great quality data that we can use to calibrate process model

Historical Data Review – Effluent Nutrients



Historical Data Review – Effluent Summary

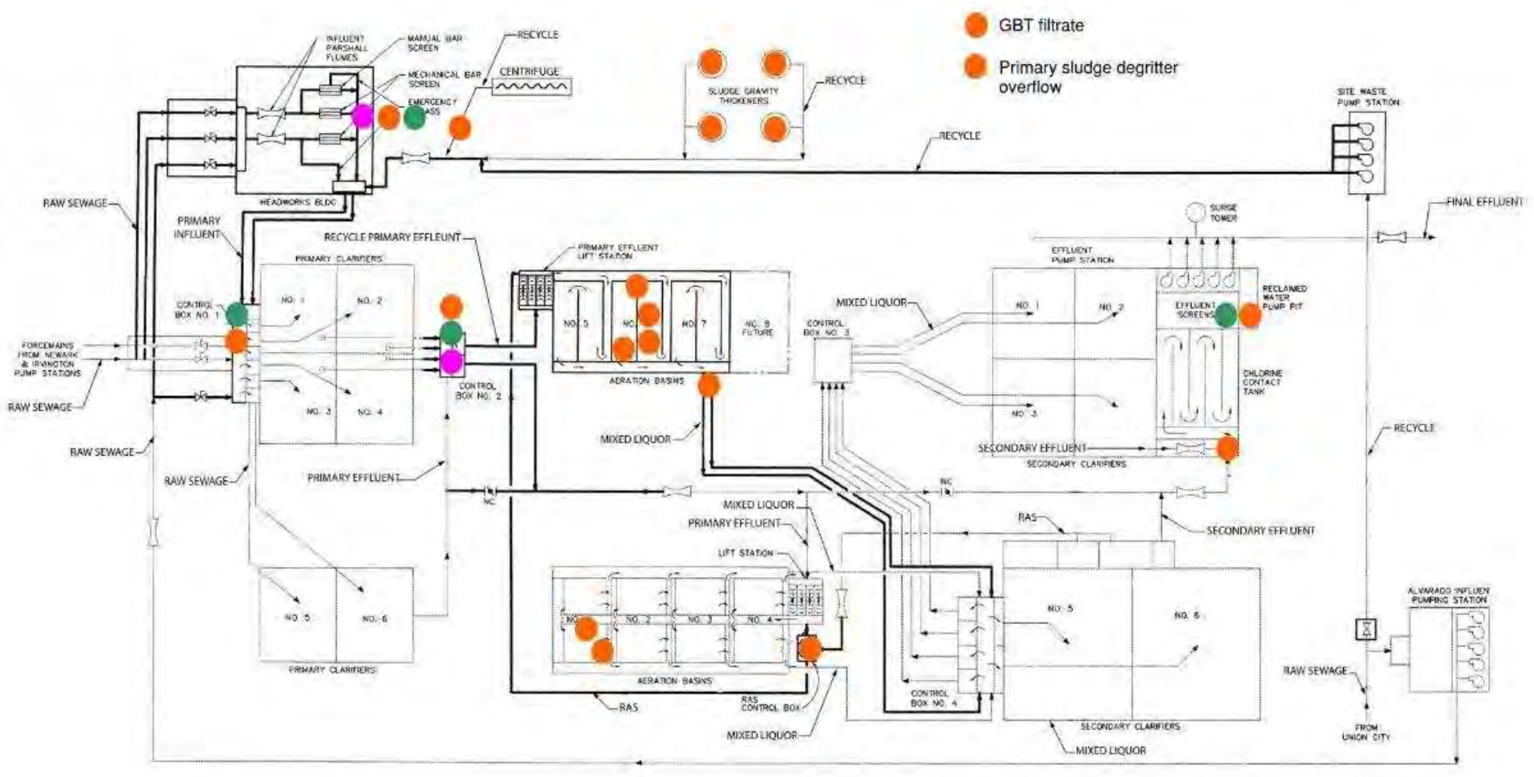
	Final Effluent, mg/L
TSS	15
$cBOD_5$	6.6
BOD_5	14
COD	51
NH_3	43
NO_3	<0.5

- On average effluent TSS well within limits
- No NH_3-N removal through secondary system
- Effluent COD~50 mg/L

BioWin™ Process Model Special Sampling Results/Analysis

Joe Rohrbacher / Irene W. Chu

Special Sampling Diagram



Composite sample locations

Grab sample locations

Diurnal sample locations

Summary of Effort

Measure	Number
Days of Sampling	**6**
Samples Collected and Filtered	**1,203**
Samples Analyzed by District Lab	**457**
Samples Analyzed by Hazen	**300**
Samples Analyzed by Caltest	**446**

Special sampling was a huge effort and a huge thanks to District staff for the help and hospitality

Influent Composite Sampling Results (Unfiltered)

Parameter	8/7/2018	8/8/2018	8/9/2018	8/10/2018	8/13/2018	Sampling Average	Historical Average
BOD_5, mg/L	193[1]	297	295	264	262	262	ND
$cBOD_5$, mg/L	201	219	223	223	265	226	257
COD, mg/L	802	724	743	676	742	737	721
TSS, mg/L	320	330	340	310	360	332	341
VSS, mg/L	300	300	310	290	320	304	ND
TKN, mg/L	53.0	54.0	57.0	52.0	54.0	54.0	52.8
NH_3-N, mg/L	37.0	37.0	38.0	37.0	35.0	36.8	37
TP, mg/L	6.8	7.2	7.0	6.7	6.6	6.9	6.9
PO_4-P, mg/L	2.6	4.3	2.9	3.0	2.8	3.1	ND

[1]Excluded from average value and fractions

Consistent results that agree with historical data

Influent Composite Ratios

	Sampling Average	Historical Data	Typical Range
$COD:cBOD_5$	3.3	2.8	2.1 – 3.0
$COD:BOD_5$	2.8	ND	1.8 – 2.5
$cBOD_5:BOD_5$	0.86	ND	0.8 – 0.9
Soluble COD fraction	0.38	ND	0.3 – 0.5
Particulate/Colloidal COD	0.62	ND	0.5 – 0.7
VSS:TSS	0.92	ND	0.8 – 0.9
Particulate COD:VSS	1.52	ND	1.3 – 1.9
NH_3-N:TKN	0.68	0.72	0.6 – 0.8
$cBOD_5$:TKN	4.2	5.3	4 – 8
$cBOD_5$:TP	33	43	20 – 50
PO_4-P:TP	0.45	ND	0.4 – 0.8

$COD:cBOD_5$ slightly higher

$COD:BOD_5$ slightly high

NH_3-N:TKN agrees

$cBOD_5$:TKN lower end of typical range

CB2 (Primary Effluent) Composite Sampling Results (Unfiltered)

Parameter	8/7/2018	8/8/2018	8/9/2018	8/10/2018	8/13/2018	Sampling Average	Historical Average
BOD_5, mg/L	161	158	157	173	200	170	ND
$cBOD_5$, mg/L	141	130	126	147	174	144	150
COD, mg/L	430	379	367	398	433	401	370
TSS, mg/L	110	100	95	115	145	113	122
VSS, mg/L	99	90	90	110	115	101	ND
TKN, mg/L	54.0	56.0	57.0	55.0	59.0	56.2	ND
NH_3-N, mg/L	44.0	46.0	44.0	44.0	46.0	44.8	42.4
TP, mg/L	6.7	3.3	7.1	6.9	6.8	6.2	ND
PO_4-P, mg/L	3.3	3.9	4.0	4.1	3.8	3.8	ND

CB2 (Primary Effluent) Composite Ratios

	Sampling Average	Historical Data	Typical Range
$COD:cBOD_5$	2.8	2.5	2.1 – 3.0
$COD:BOD_5$	2.4	ND	1.8 – 2.5
$cBOD_5:BOD_5$	0.85	ND	0.8 – 0.9
Soluble COD fraction	0.49	ND	0.3 – 0.5
Particulate/Colloidal COD	0.45	ND	0.5 – 0.7
VSS:TSS	0.90	ND	0.8 – 0.9
Particulate COD:VSS	1.39	ND	1.3 – 1.9
NH_3-N:TKN	0.80	0.84	0.6 – 0.8
$cBOD_5$:TKN	2.6	3.1	4 – 8
$cBOD_5$:TP	26	ND	20 – 50
PO_4-P:TP	0.62	ND	0.4 – 0.8

$COD:cBOD_5$ slightly higher

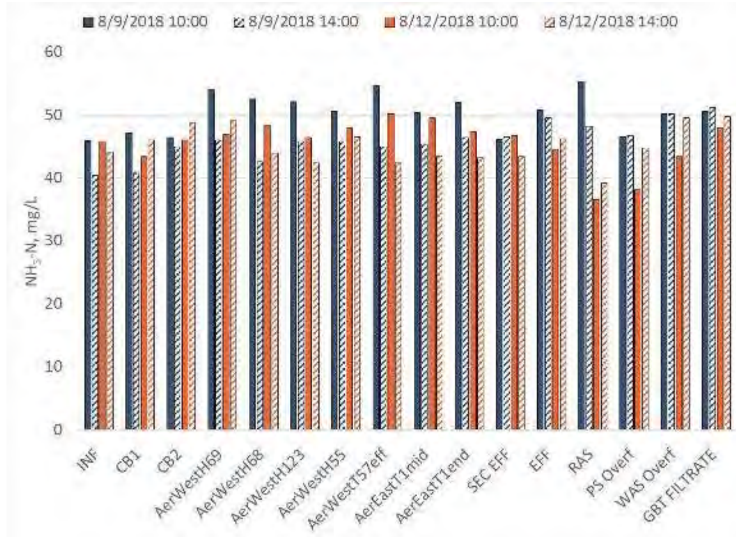
Effluent Composite Sampling Results (Unfiltered)

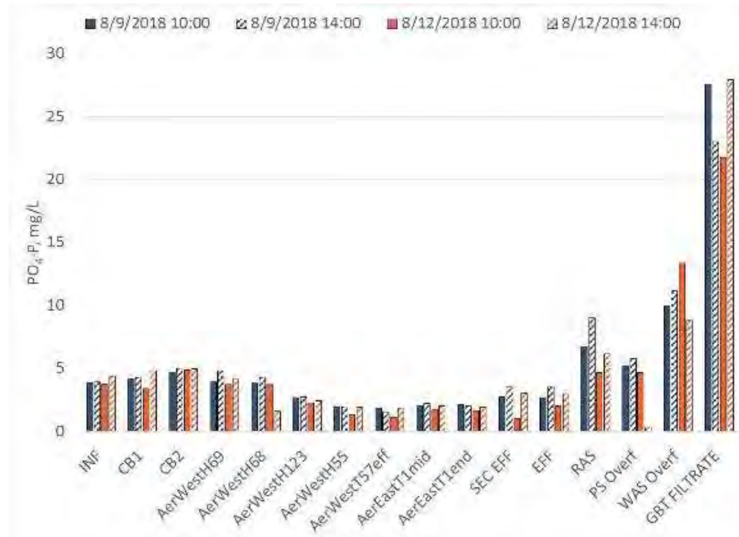
	8/7	8/8	8/9	8/10	8/13	Sampling Average	Historical Data*
$cBOD_5$ (mg/L)							6.1
COD (mg/L)	52	45	44	48	53	48	51
TSS (mg/L)	13	10	10	14	16	13	16
NH_3-N (mgN/L)	39	40	41	40	40	40	39
TKN (mg/L)	43	45	44	45	44	44	46
TP (mgP/L)	3.1	2.8	3.3	3.6	3.2	3.2	2.6

Great agreement

Summary of Profile Test Findings

- No nitrification in aeration basins as expected
- P-uptake across aeration tanks. P-release in RAS and solids handling processes





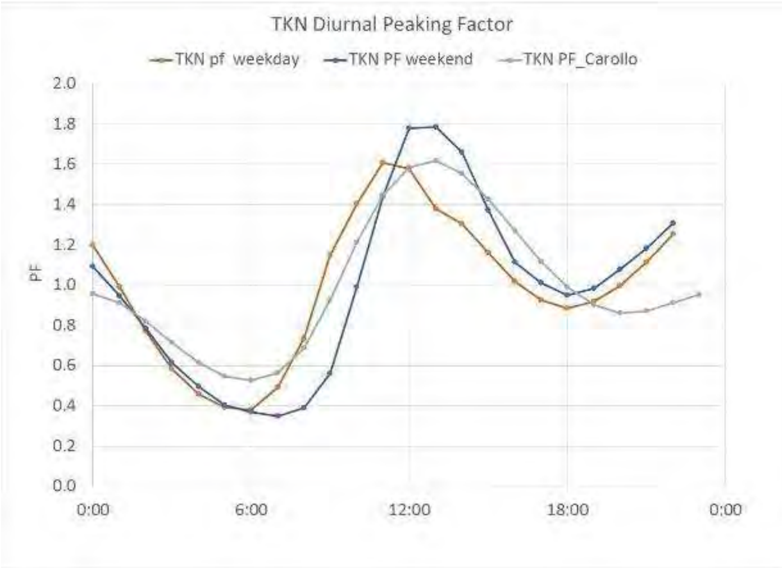
RECYCLE and SLUDGE Summary

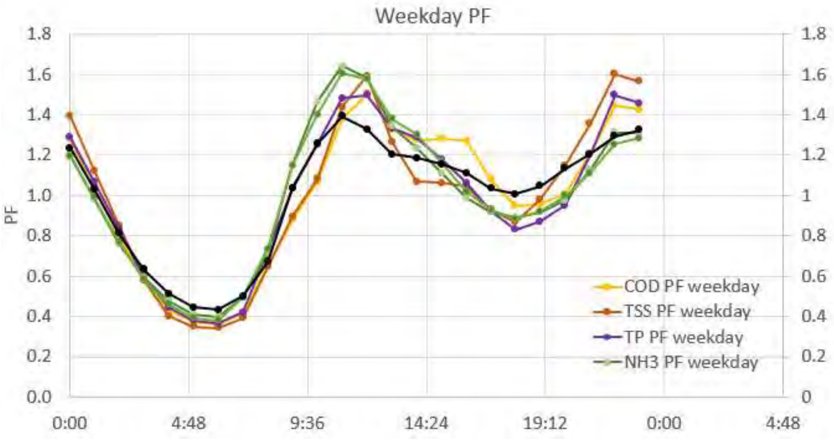
Location	%TS	%VS	TKN (mg/L)	TP (mg/L)	TSS (mg/L)	Historical %TS	Historical TSS (mg/L)
PS	0.3	54				ND	ND
Degritted PS	0.2	48				ND	ND
TPS	5.9	89				5.7	
WAS	0.4	71				0.7	ND
PWAS	1.1	81				ND	ND
TWAS	5.6	86				5.6	ND
Centrifuge Feed	2.2	71				ND	ND
Dewatered Cake	24.1	72				24.5	ND
PS Thickener Overflow			60	9	210	ND	160
WAS Thickener Overflow			49	14	107	ND	ND
GBT Filtrate			83	26	430	ND	366
Centrate			1,867	113	300	ND	200

Agreement with historical values

Diurnal Sampling Findings

- Variations from pattern in previous model
- Weekend PFs are slightly higher than weekday and follow a later schedule
- $cBOD_5$ and TKN load PFs follow similar trends
- PE peaking factors less pronounced than influent
- Diurnal pattern important for ammonia breakthrough during wet weather





Summary of Influent Characteristic Findings

- Special sampling results correspond to historical averages
- $COD:BOD_5$ (2.8) higher than typical (2.1 – 2.2)
- $cBOD_5:TKN$ (4.2) at lower end of typical range (4 – 8)
- NH_3-N:TKN (0.68) within typical range (0.6 – 0.8)
- PO_4-P:TP ratio (0.36) slightly below typical range (0.4 – 0.8)

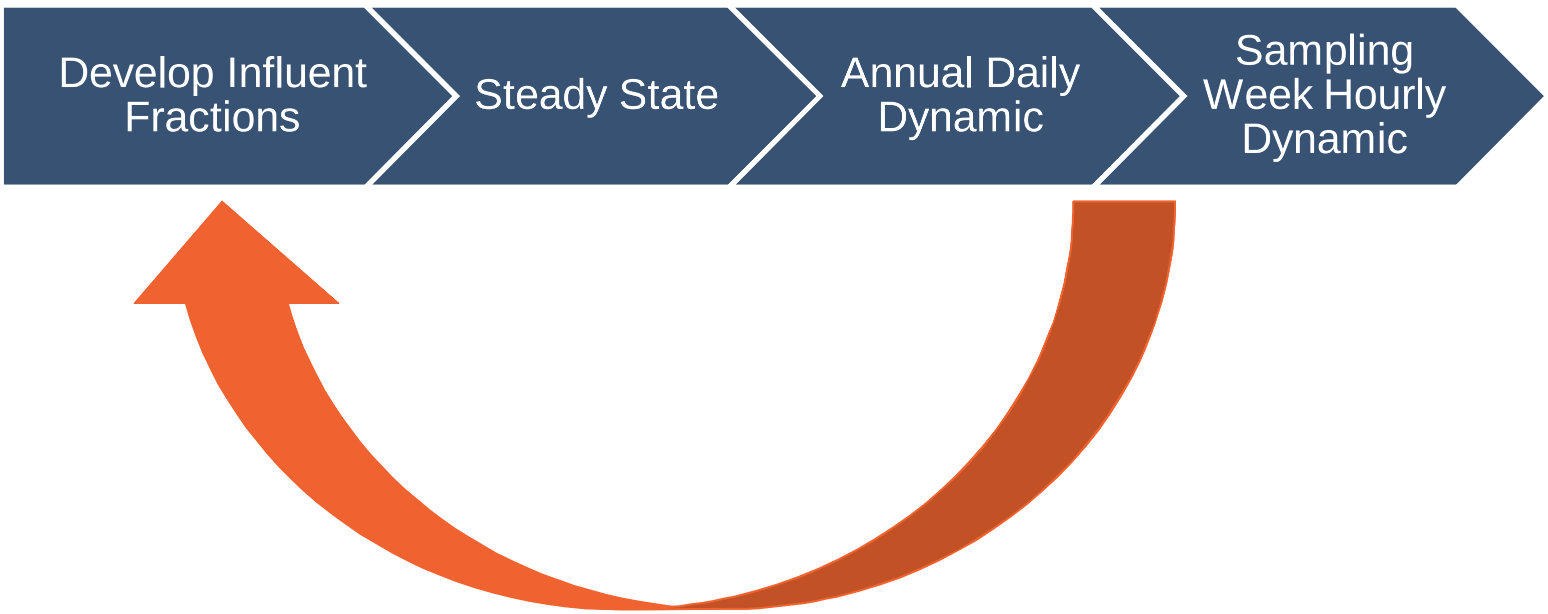
Break

10 min

BioWin Process Model Calibration/Validation

Joe Rohrbacher

BioWin Model Calibration Process

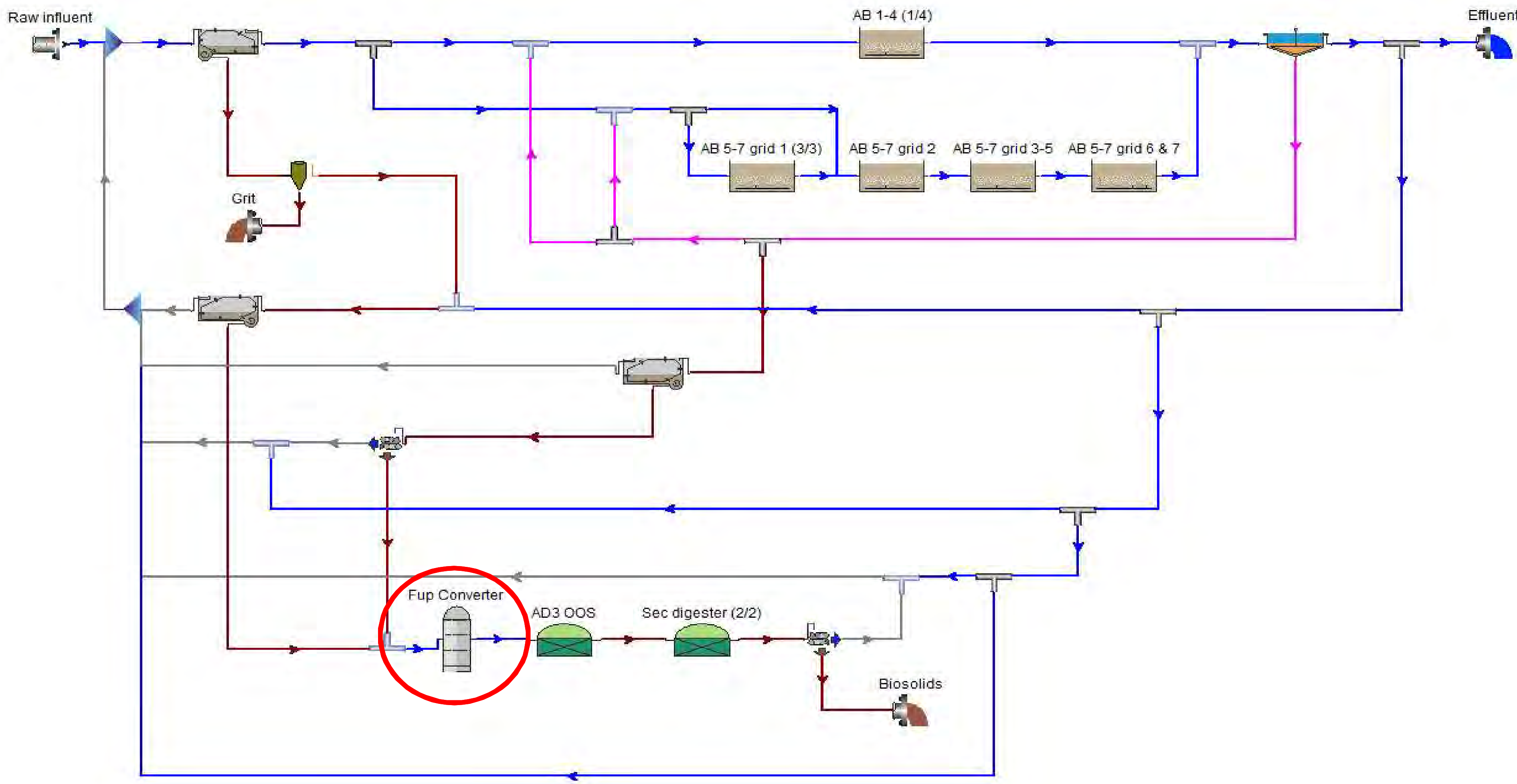


Influent Wastewater Fractions are Key to Proper Model Calibration

Symbol	Description	BioWin Default Raw	Previous Model	Revised Model	Typical Observed Range
Fbs	Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.16	0.16	**0.21**	0.09 – 0.26
Fac	Acetate [gCOD/g of readily biodegradable COD]	0.15	0.30	**0.15**	0.1-0.4
Fxsp	Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.75	0.80	**0.83**	0.50 – 0.90
Fus	Unbiodegradable soluble [gCOD/g of total COD]	0.05	0.03	**0.04**	0.02 – 0.11
Fup	Unbiodegradable particulate [gCOD/g of total COD]	0.13	0.10	**0.26**	0.15 -0.28
Fna	Ammonia [gNH_3-N/gTKN]	0.66	0.66	**0.70**	0.30 – 0.78
Fnox	Particulate organic nitrogen [gN/g Organic N]	0.50	0.50	**0.60**	0.50 -0.90
Fnus	Soluble unbiodegradable TKN [gN/gTKN]	0.02	0.02	**0.02**	0.00 – 0.06
FupN	N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.035	0.035	**0.035**	-
Fpo4	Phosphate [gPO_4-P/gTP]	0.50	0.50	**0.36**	0.20 – 0.80
FupP	P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.011	0.011	**0.015**	-
Fzbh	OHO COD fraction [gCOD/g of Total COD]	0.02	0.02	**0.02**	-

Influent Fractions Impact Solids Production and Nutrient Removal Potential

Revised Biowin Configuration



The Model Matched Reported Primary Effluent and MLSS Concentrations

	Reported June-17 to May-18	Steady State Simulation	Average Dynamic Simulation
Primary Effluent TSS, mg/L	126	121	120
Primary Effluent BOD_5, mg/L	161 (192*)	199	198
Primary Effluent NH_3-N, mg/L	43	47	-
Basin MLSS, mg/L	1,290	1,330	1,330
Basin MLVSS, mg/L	1,090	1,180	1,170
RAS/WAS MLSS, mg/L	4,360	4,410	4,480
RAS/WAS MLVSS, mg/L	3,660	3,890	3,940

*Estimated BOD_5

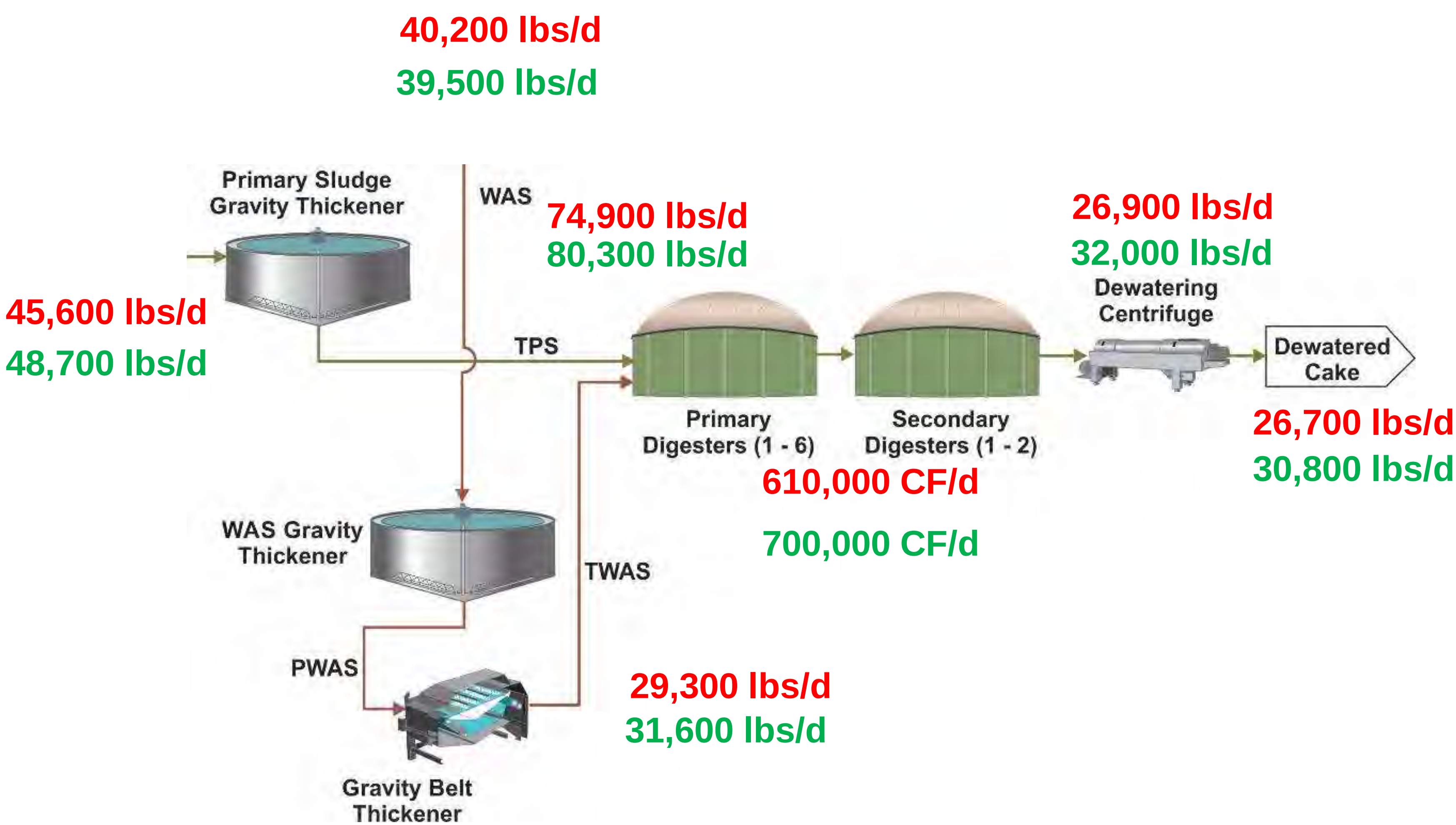
The Model Matched Reported Secondary Effluent Concentrations

	Reported	Steady State Simulation	Average Dynamic Simulation
Effluent TSS, mg/L	14	13	13
Effluent BOD, mg/L	11	9	9
Effluent COD, mg/L	50	51	51
Effluent NH_3-N, mg/L	40	39	39
Effluent NO_3-N, mg/L	0.3	0.0	0.0

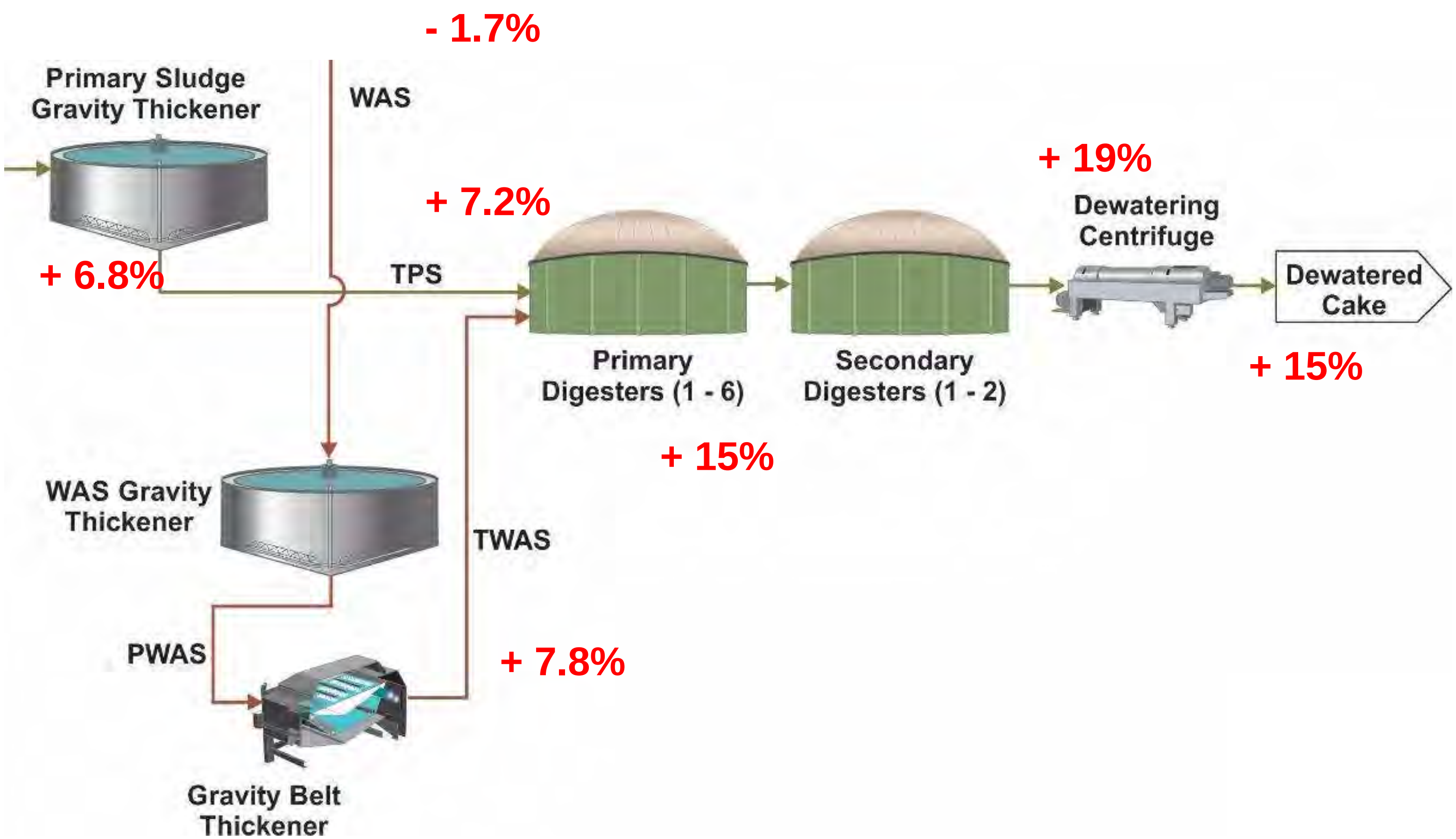
The Model Matched Reported Solids Production prior to Digestion, but Overpredicted Digested Solids and Gas Production

	Reported	Steady State Simulation	Avg. Dynamic Simulation
Thickened Primary Sludge, lb/d	45,600	48,900	48,700
WAS, lb/d	40,200	39,100	39,500
Thickened WAS, lb/d	29,300	31,600	31,600
Digester Feed Total Solids, lb/d	74,900	80,500	80,300
Digester Feed Volatile Solids, lb/d	65,500	71,900	-
Centrifuge Feed Total Solids, lb/d	26,900	32,300	32,000
Centrifuge Feed Volatile Solids, lb/d	17,300	24,900	-
Dewatered Cake Solids, lb/d	26,700	31,000	30,800
Digester VSR, %	73%	65%	-
Digester Gas Production, CF/day	610,000	700,000	-
Digester Gas CF/lb Volatile Solids	12.7	15.0	

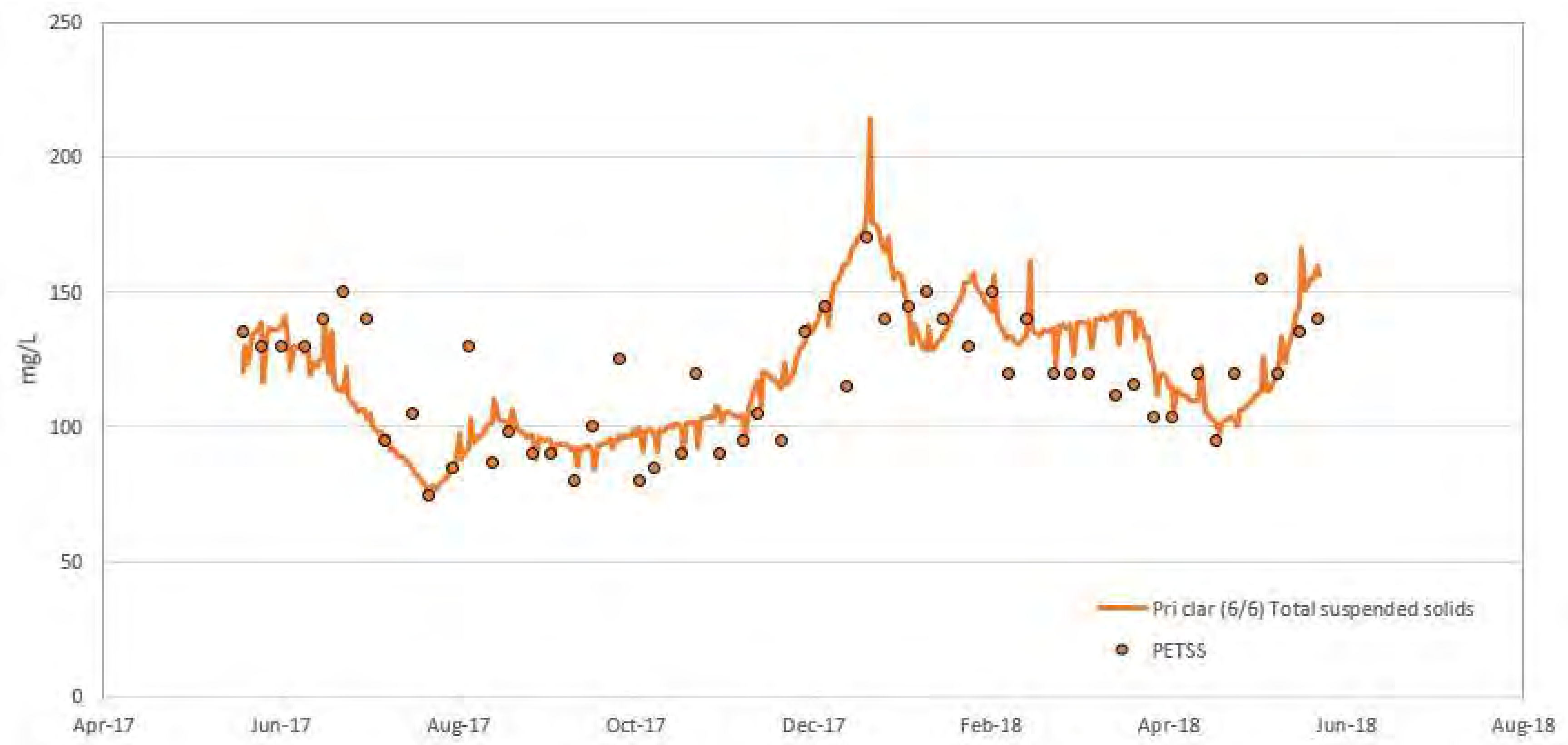
Solids Processing Balance



Solids Processing Balance



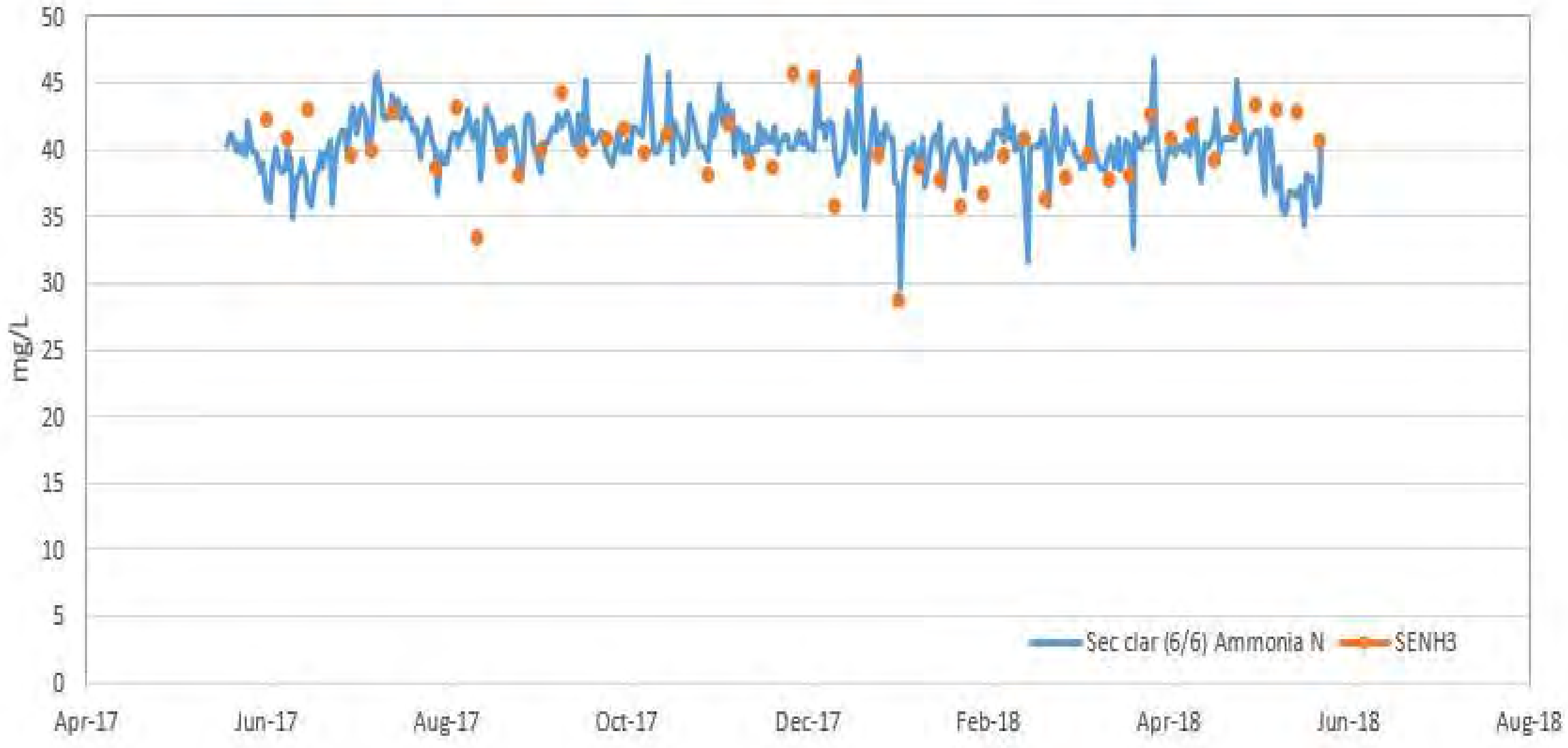
Annual Dynamic Model - Primary Effluent TSS



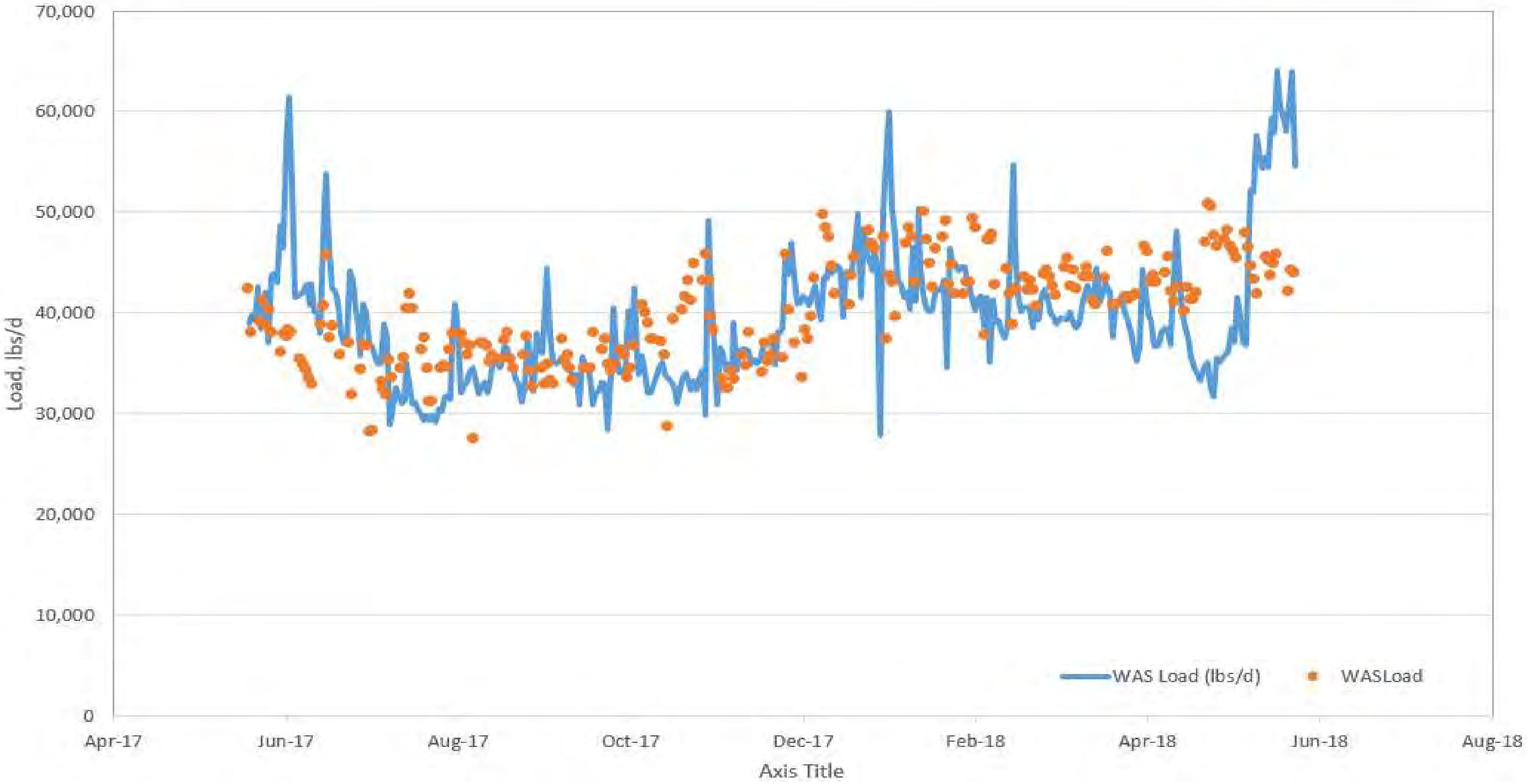
Annual Dynamic Model - Primary Effluent COD

Annual Dynamic Model – MLSS Concentration

Annual Dynamic Model – Effluent Ammonia Concentration

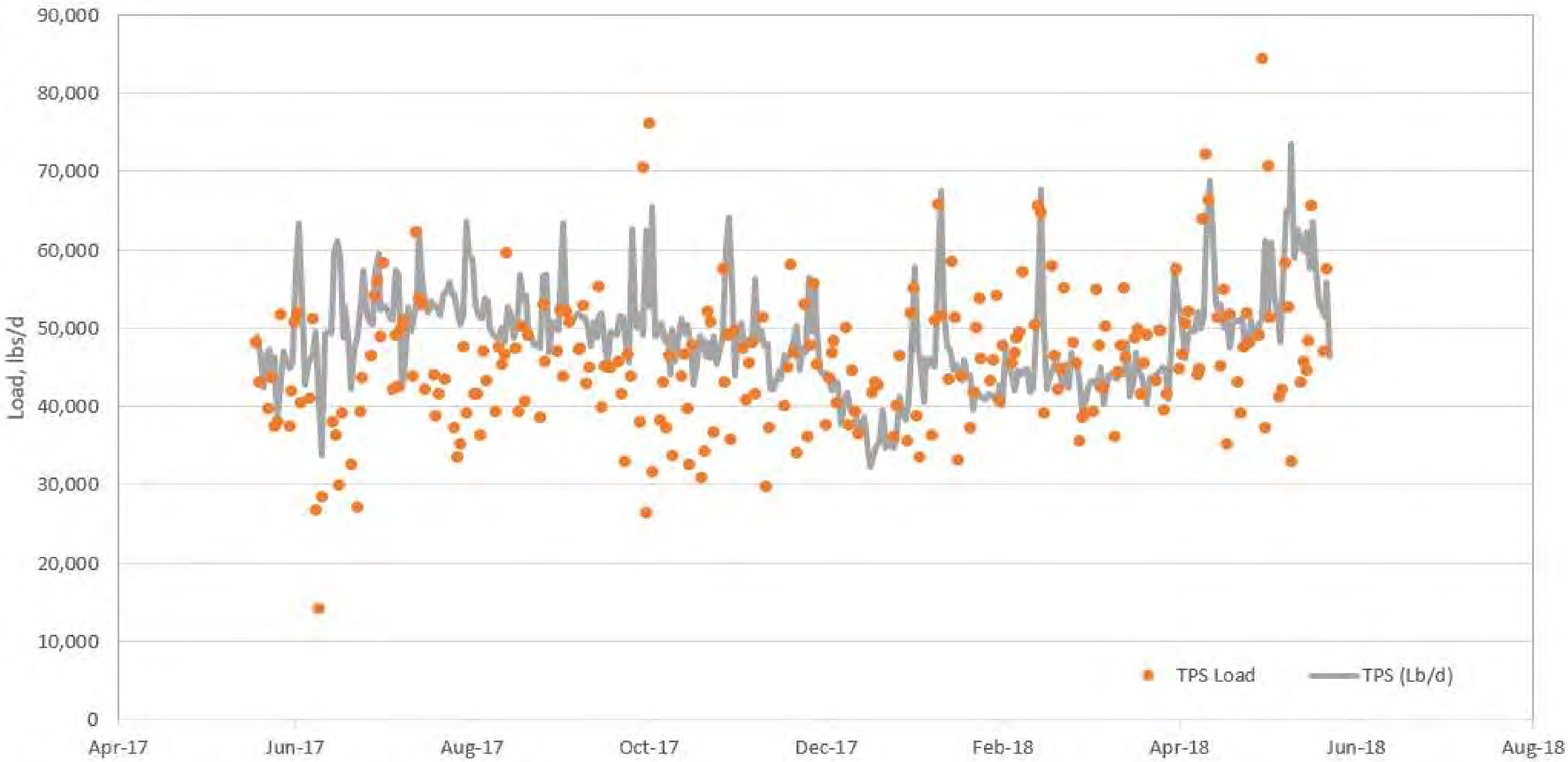


Annual Dynamic Model – WAS Load



Hazen

Annual Dynamic Model – Thickened Primary Sludge Load

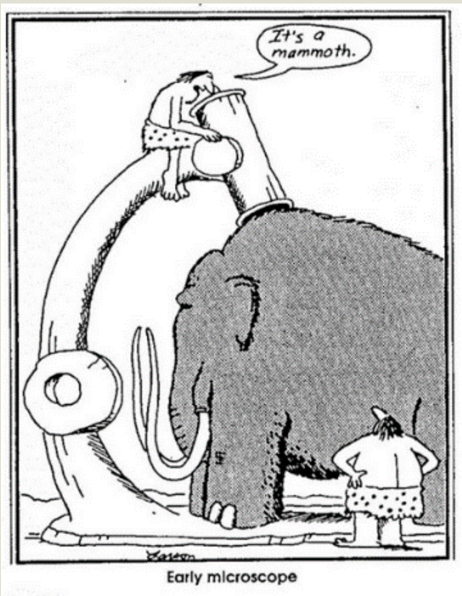


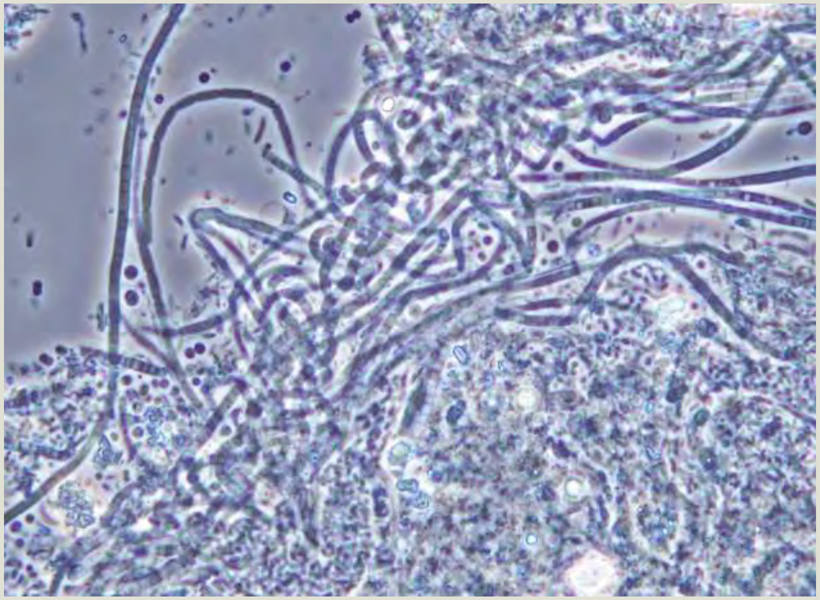
Overall Model Calibration Conclusions

- Special sampling data indicates increased rbCOD & inert particulate COD
- Steady state and year-long dynamic simulations produced excellent correlation to reported data
- Solids predictions matched very well prior to digestion
  - Model predicts greater digested solids and dewatered cake
  - Model predicts greater digester gas production
- The Biowin model will accurately represent evaluated alternatives

Filament Analysis

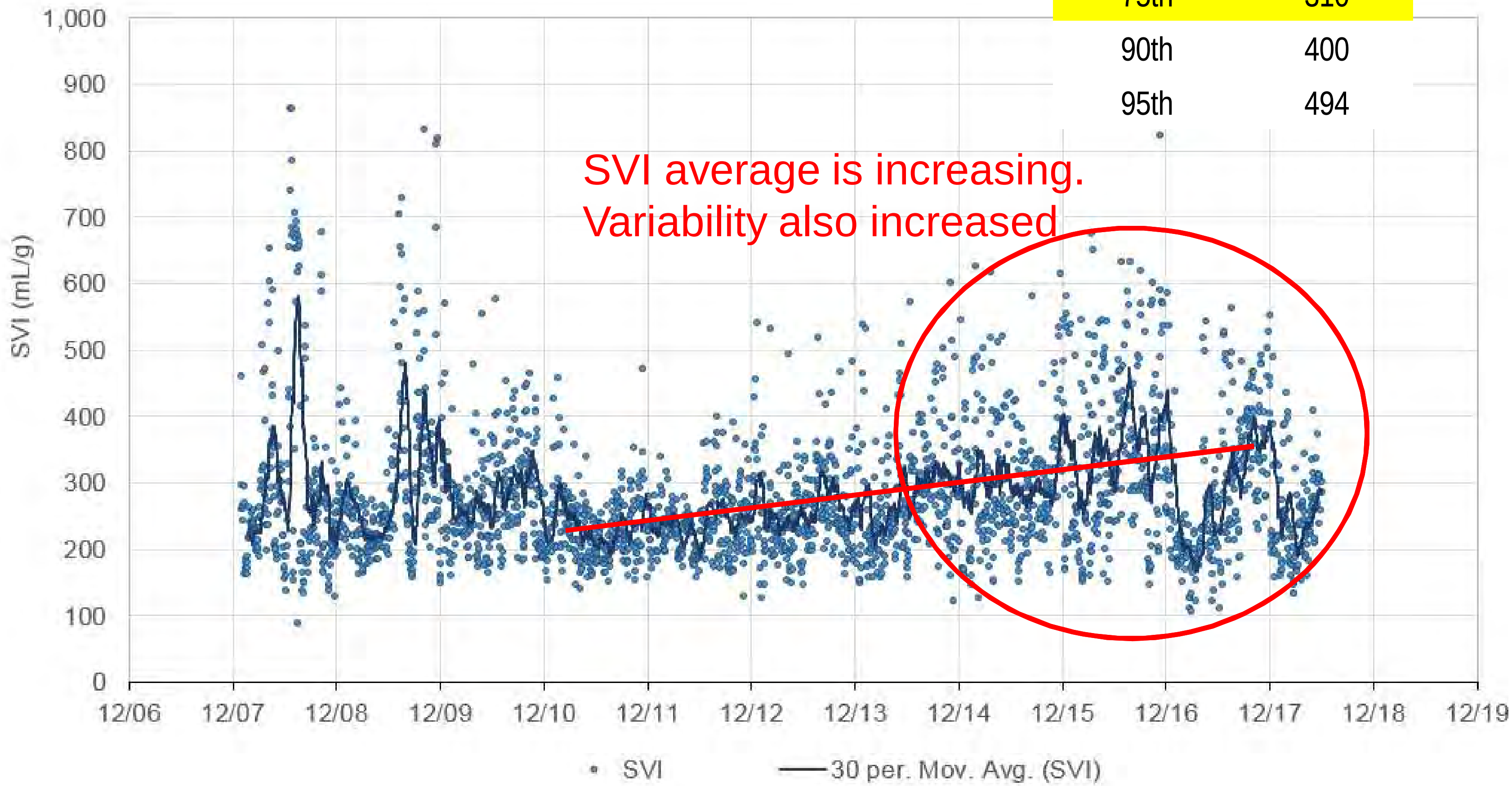
Paul Pitt





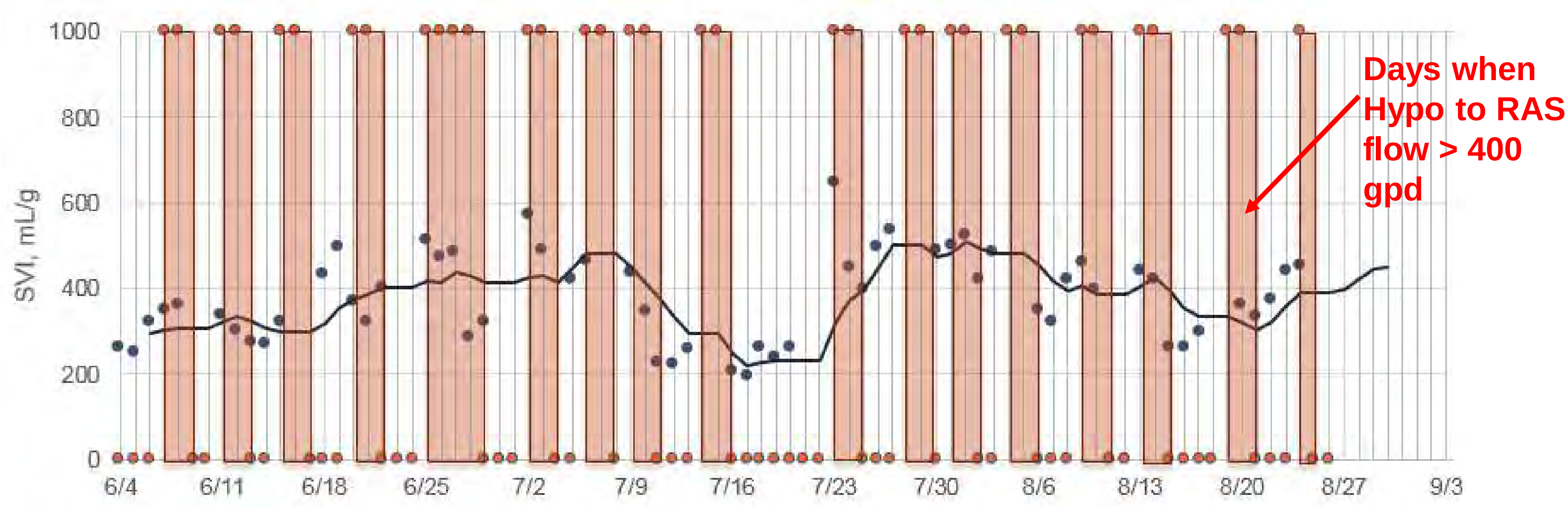
Historical Data Review – SVI

	2008-2018
50th	250
75th	310
90th	400
95th	494



Filament Analysis – Recent SVI

- Hypo to RAS ~ twice a week for 36 hours (typical for summer operation)
- Higher SVI due West AB maintenance (more east AB in service)

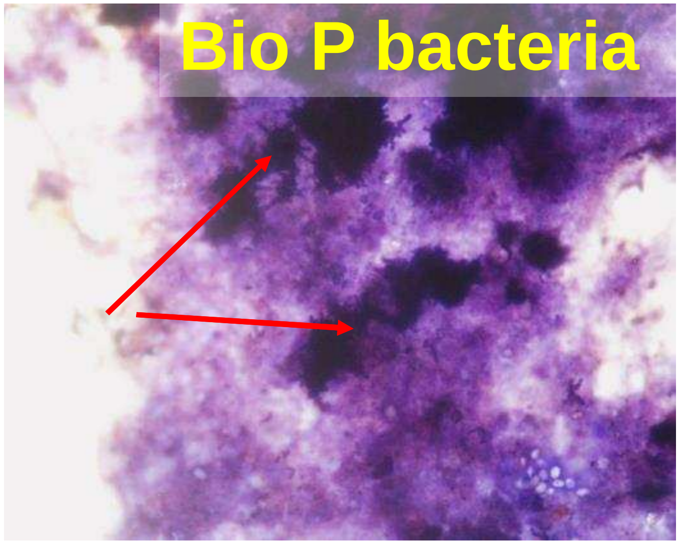


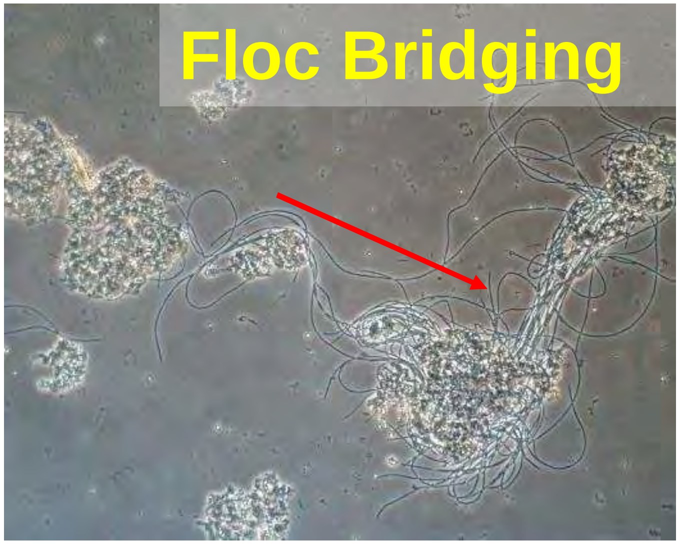
Filament Analysis

Samples taken:

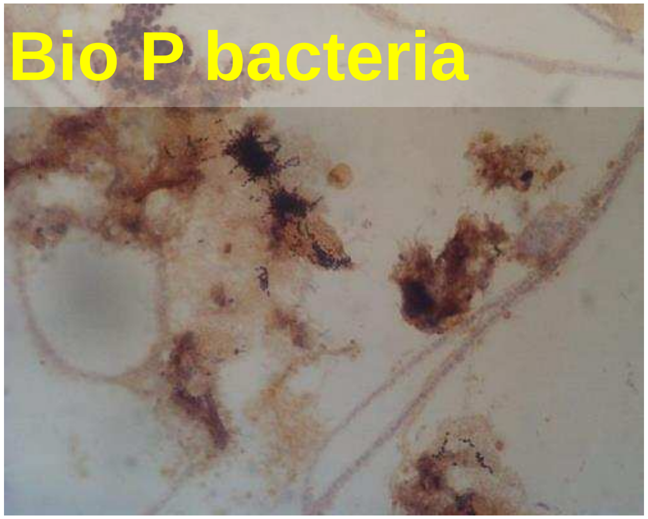
- 8/11/2018
- 8/23/2018
- 9/6/2018

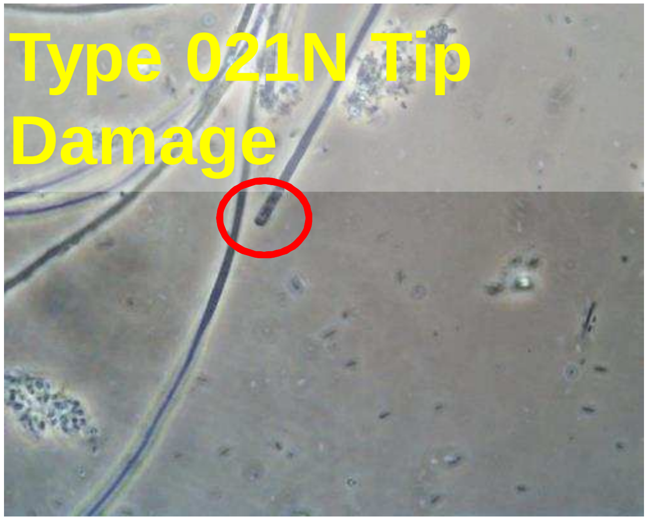
USD Sample 8-11-2018



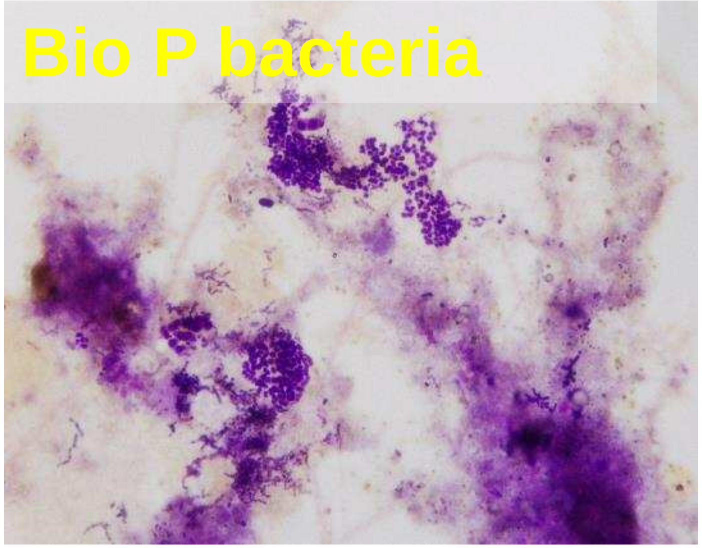


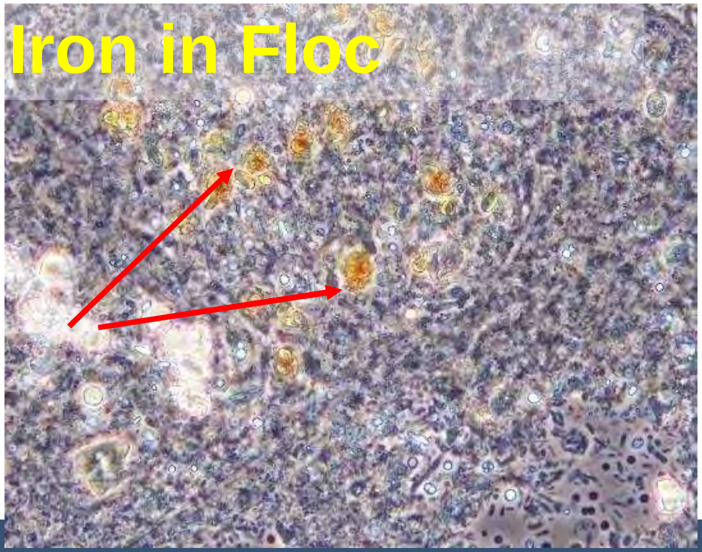
USD Sample 8-23-2018





USD Sample 9-8-18





Hypo to RAS Dose

Parameter	Value	Unit
Total AB Volume	4.35	MG
MLSS	1,150	mg/L
AB Inventory	41,700	lbs
RAS	3,460	mg/L
Blanket TSS	2,300	mg/L
West Blanket	4.4	ft
East Blanket	5.8	ft
Secondary clarifier Blanket Inventory	44,400	lbs
Total Inventory	86,200	lbs
Hypo (12%) daily flow	1,200	gpd
Cl_2 mass	1440	lb Cl_2
Dose	**16.7**	lb Cl2/1000 lb MLSS

Hypo to RAS Dose – Typical Doses

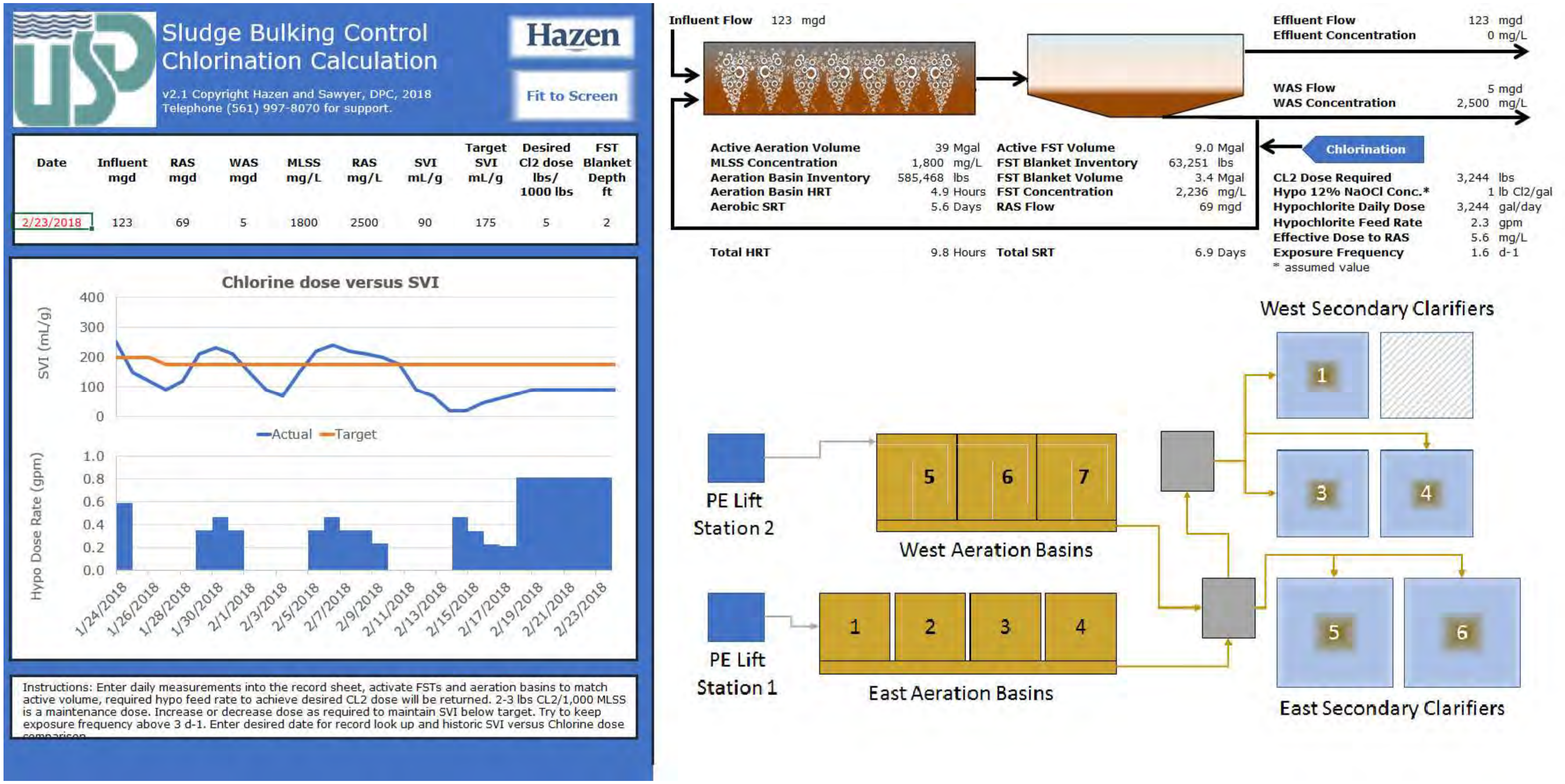
	Dose lb Cl2/1000 lb MLSS
Maintenance Dose	2-3
Moderate Dose	5-6
High Dose	>10
USD Dose	**16.7**

Hypo to RAS Dose – Frequency of Exposure

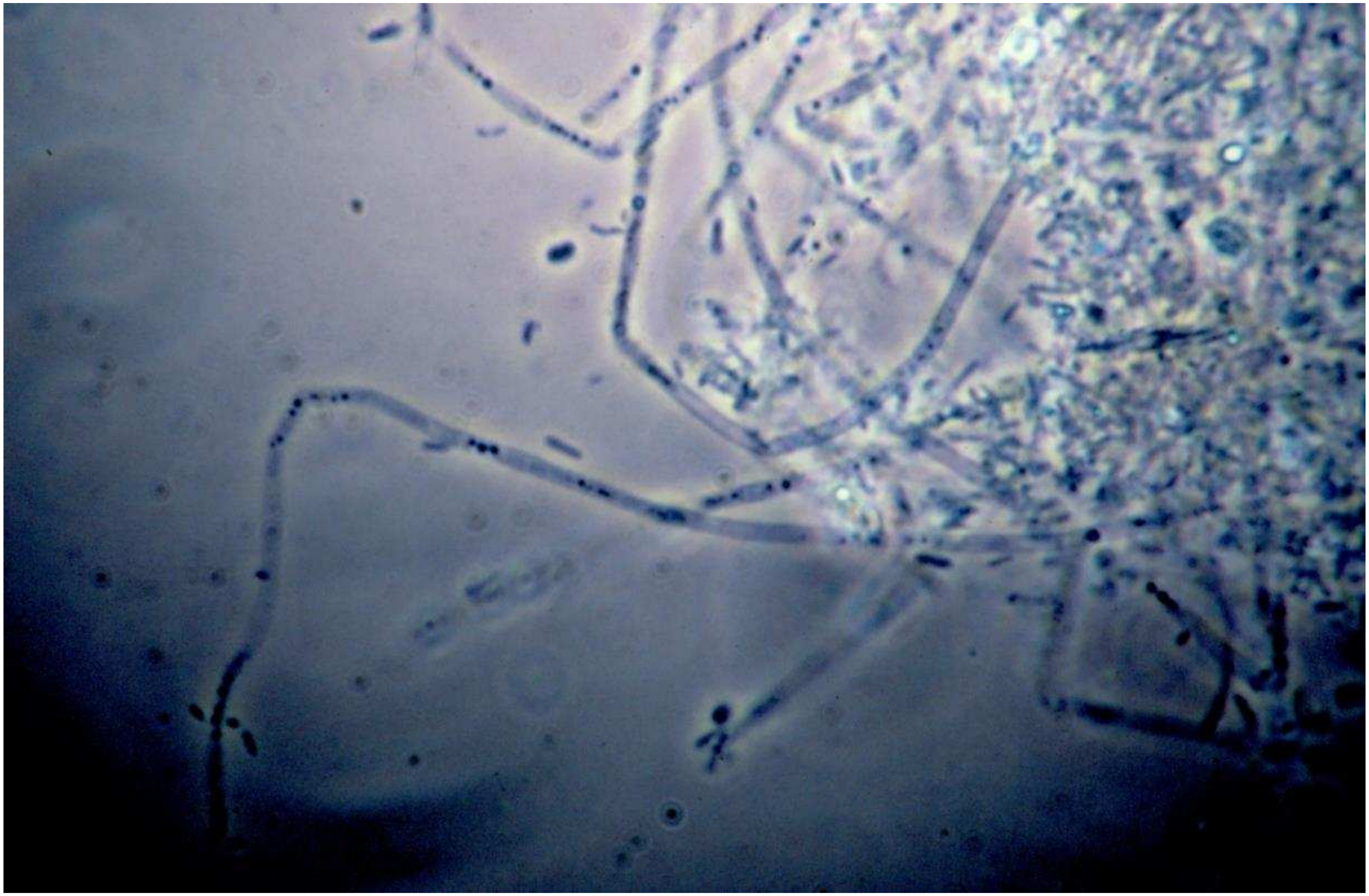
Parameter	Value	Unit
RAS Flow	9.37	mgd
RAS	3,460	mg/L
RAS Load	270,000	Lbs/d
Total Inventory	86,200	lbs
Frequency	3.1	1/d

Typical frequency of exposure >3d

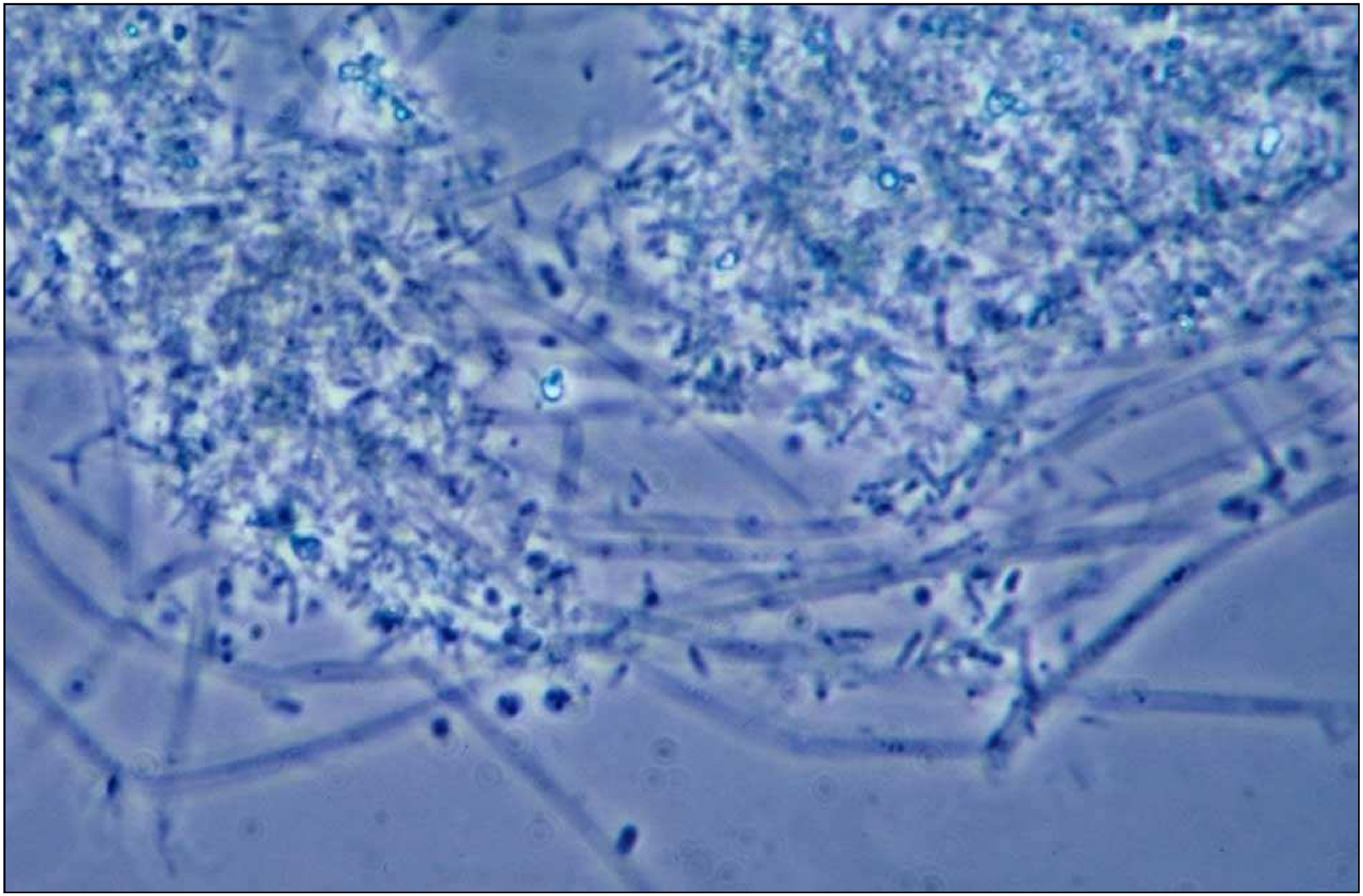
RAS Chlorination tool



Moderate Cl_2 Damage



Heavy Cl_2 damage



Filament Analysis Summary

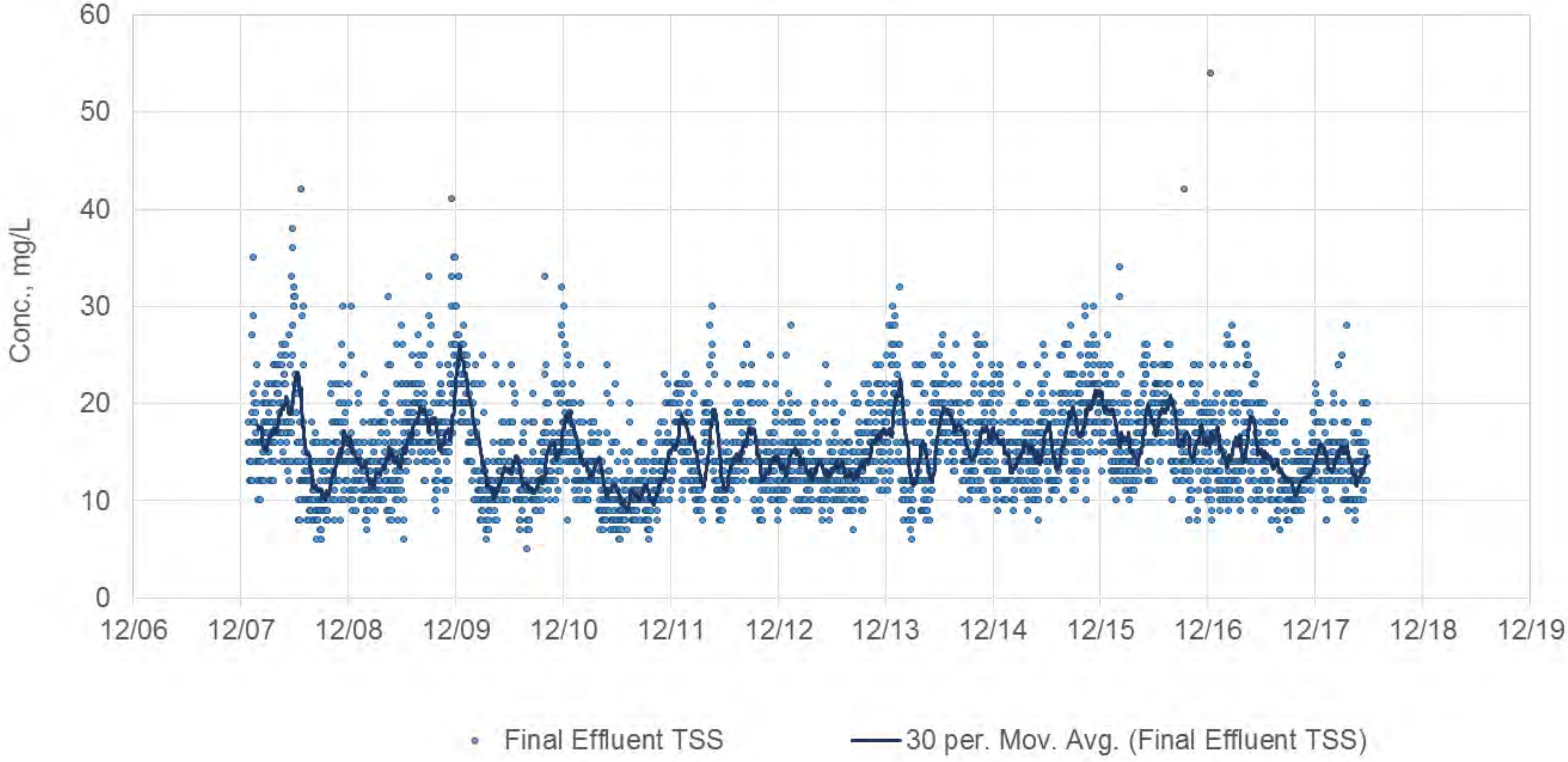
- Analysis were consistent
- Confirmed Type 021N was dominant filament with no sulfur granules
- Not much chlorine damage observed despite dosage
- Some bio-P population variable

Secondary Clarifier Stress Testing Results

Alonso Griborio / Irene W. Chu

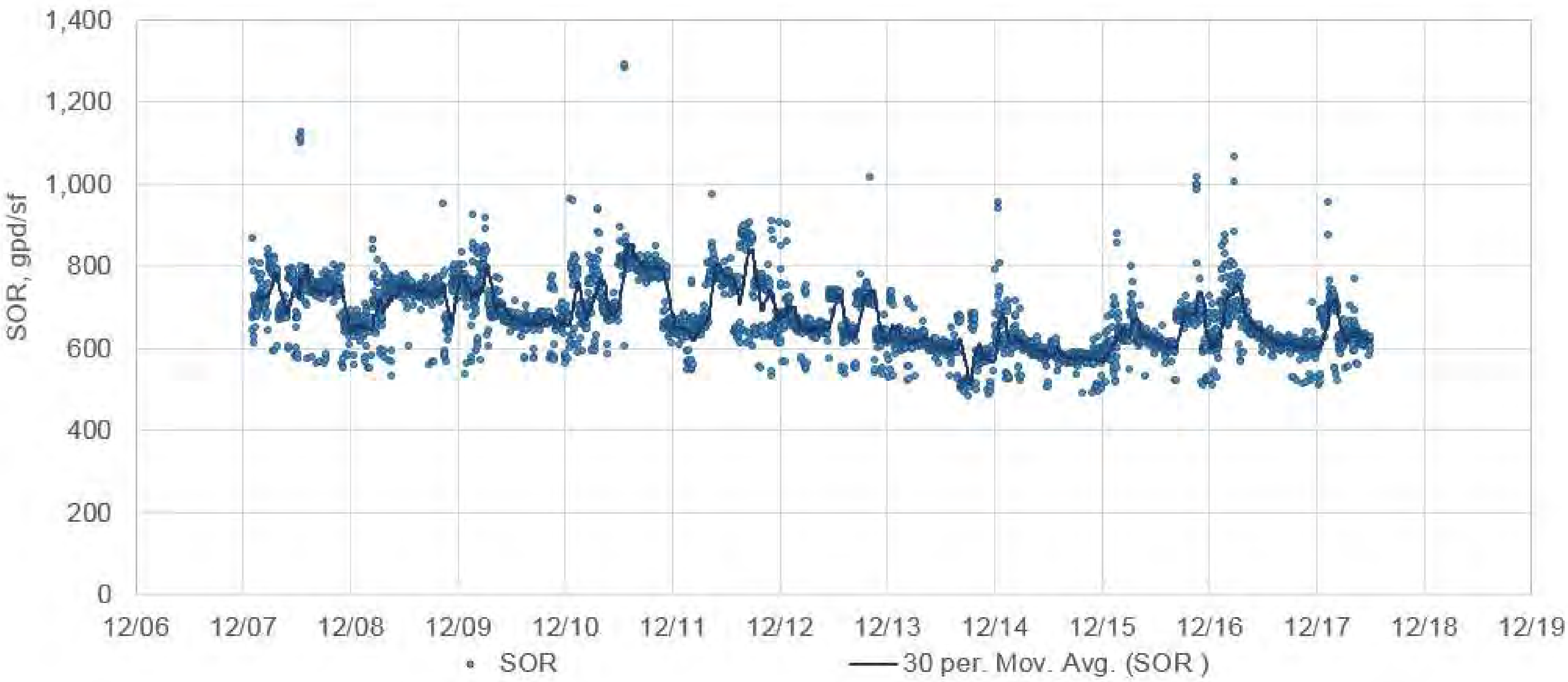
Historical Data Review – Effluent TSS

Year	2013	2014	2015	2016	2017	2018
Eff TSS (mg/L)	15	16	17	17	14	14



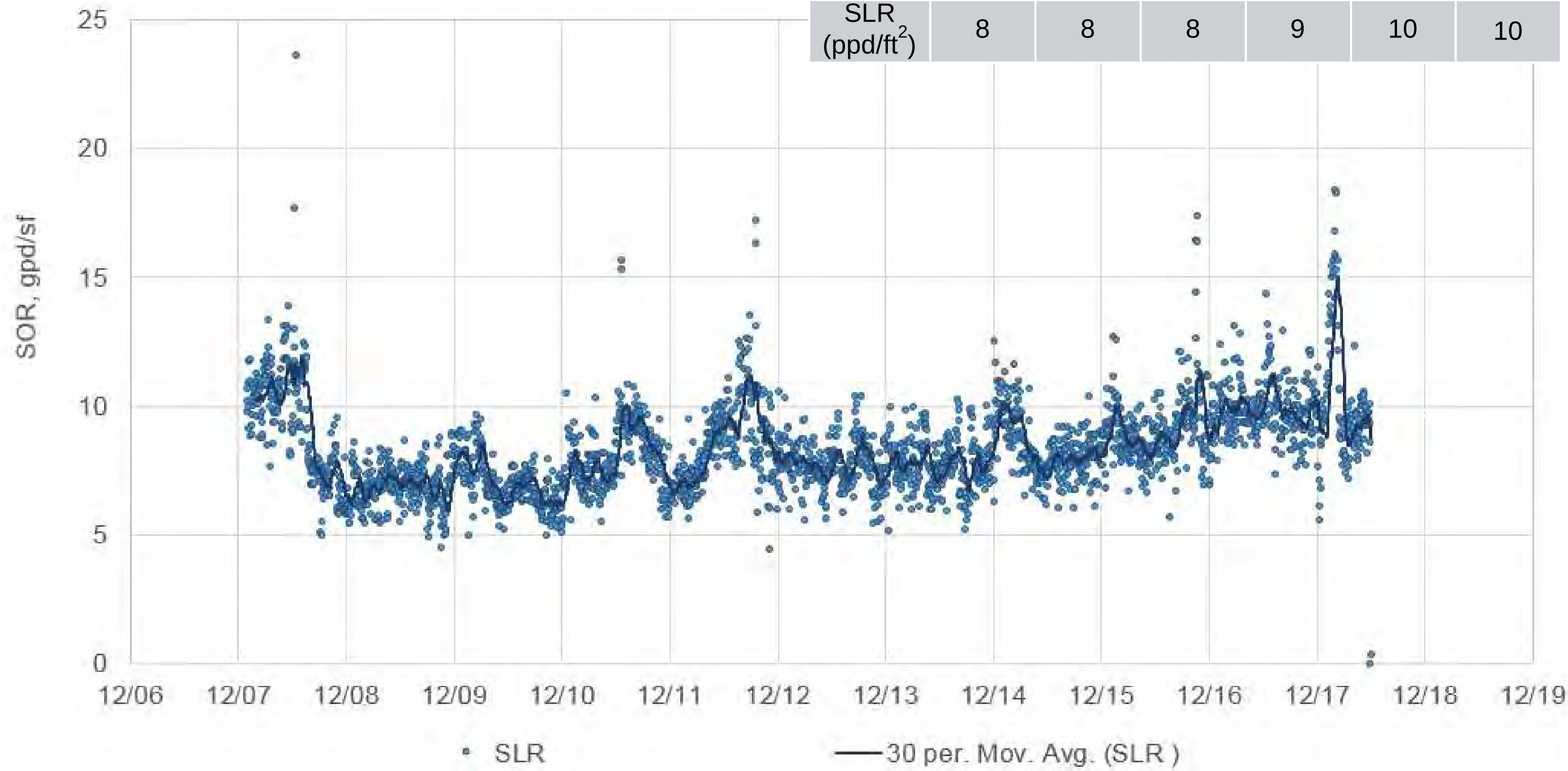
Historical Data Review – SOR

Year	2013	2014	2015	2016	2017	2018
SOR (gpd/ft^2)	670	600	590	640	650	650



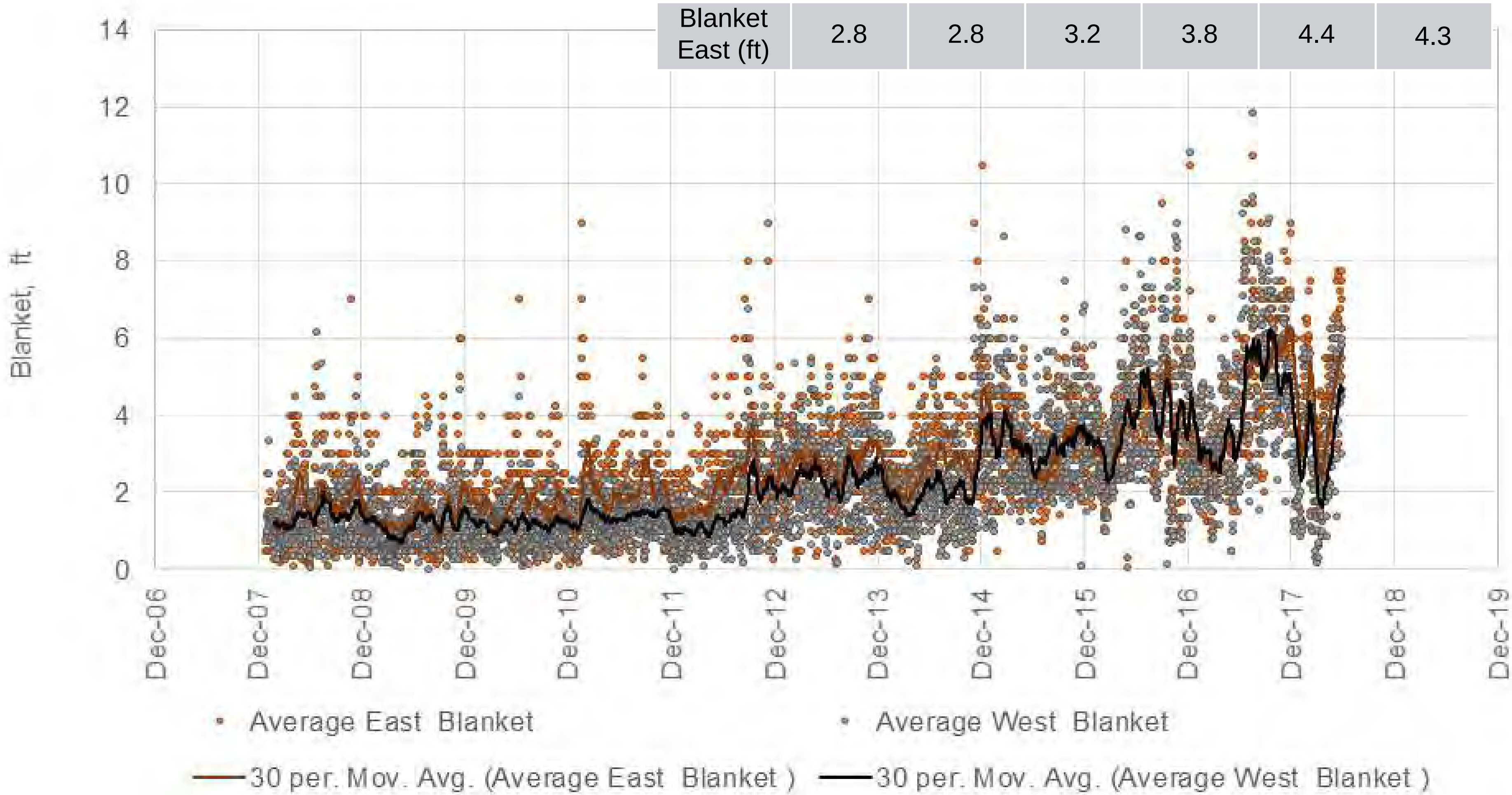
Historical Data Review – SLR

Year	2013	2014	2015	2016	2017	2018
SLR (ppd/ft^2)	8	8	8	9	10	10

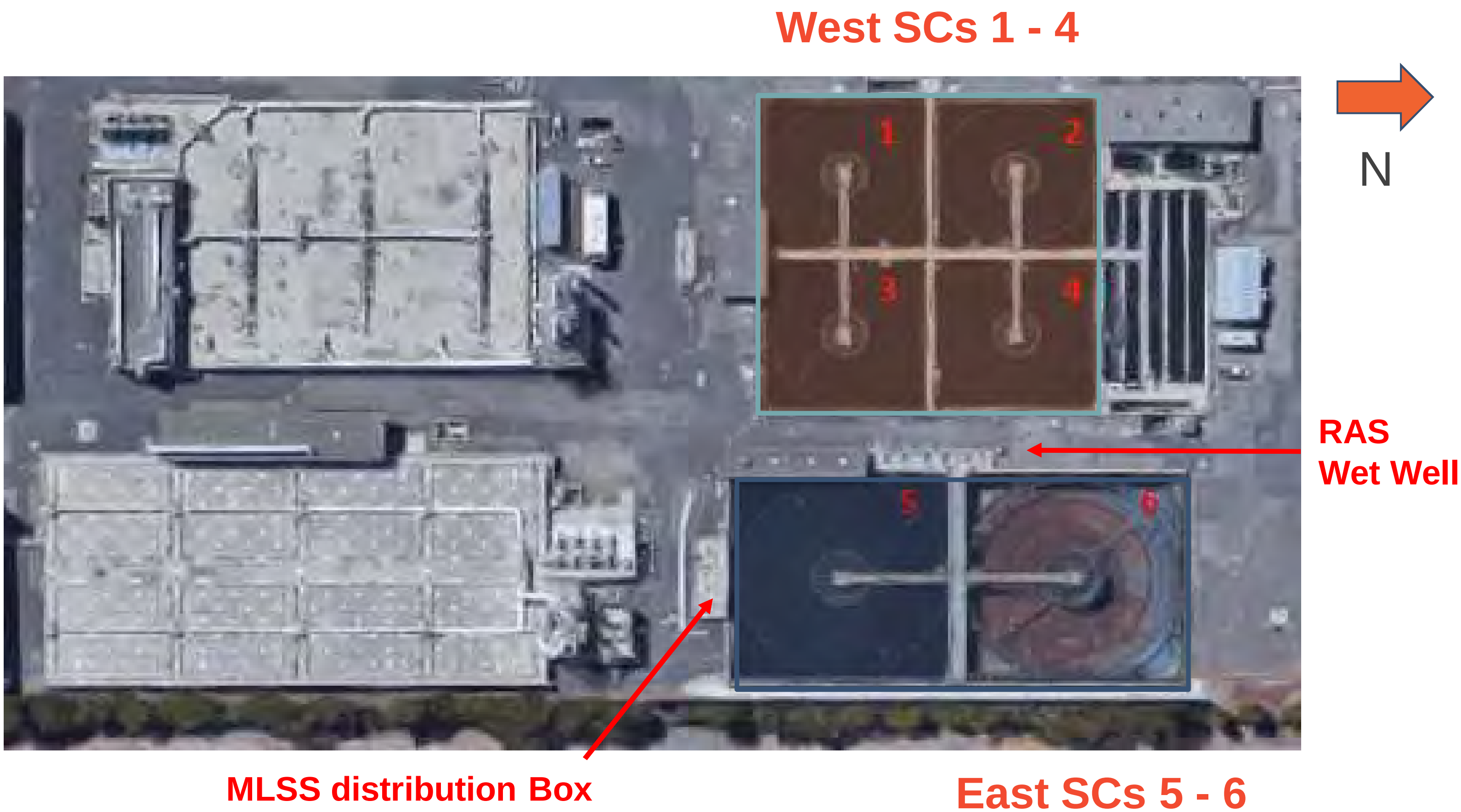


Historical Data Review – Blankets

Year	2013	2014	2015	2016	2017	2018
Blanket East (ft)	2.8	2.8	3.2	3.8	4.4	4.3



USD Secondary Clarifiers Configuration



USD Secondary Clarifiers Configuration

Parameter	Secondary Clarifiers 1-4	Secondary Clarifiers 5-6
Number of Tanks / Tank Nos.	4	2
Diameter	90-ft	120-ft
Surface Area (per clarifier)	8,100 sf (total) 6,390 sf (embedded circle) 25,450 sf – 4 Units	14,400 sf (total) 11,300 sf (embedded circle) 22,600 sf – 2 units
Nominal SWD	12-ft	13-ft
Bottom Slope	8.3% (1:12)	8.3% (1:12)
Collector Mechanism	Suction Header	Draft tube/organ pipe
Hopper Location	N/A	N/A
Launder Type	Inboard, Overhung on Wall	Inboard, Overhung on Wall
Density Current Baffle	No	Only SC 6
Inlet Center Column Diameter	42-inch	42-inch (assumed)
Energy Dissipating Inlet	Yes	No
Center Well Type	Standard	Standard
Center Well Diameter (d)	24-feet	30-feet
d/D (%)	27%	25%
Center Well Depth	6-feet	7-feet
Corners	Concrete Fillet (1:2 slope)	Corner Raking Mechanism

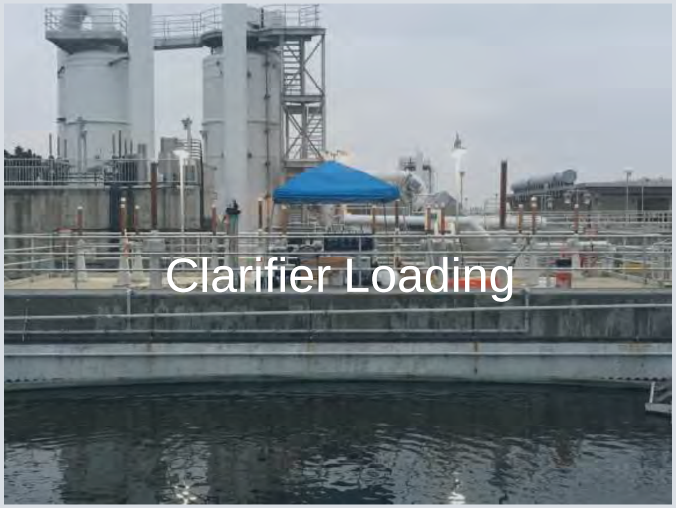
West SCs 1 - 4

East SCs 5 - 6

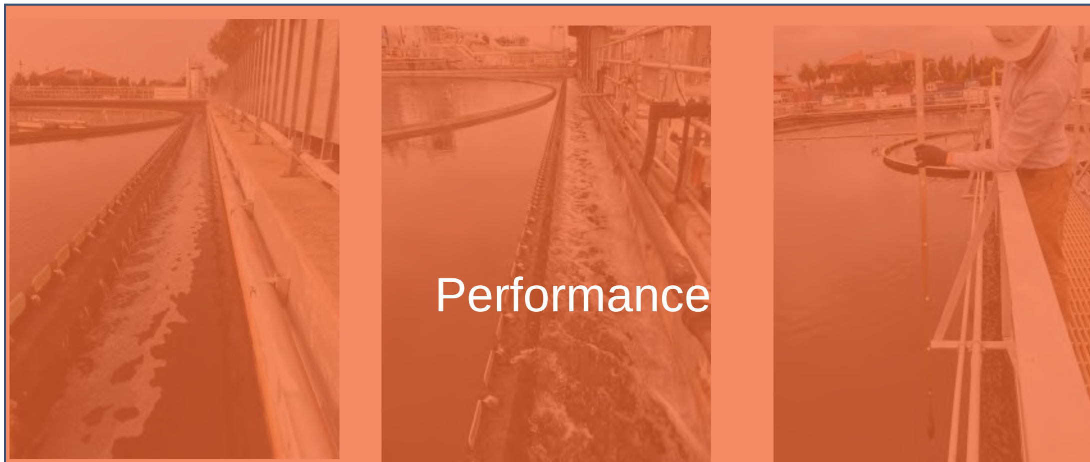
Clarifier field testing conducted over four consecutive days

- Day 1 8/20/2018 – Equipment Setup and Initial Characterization
- Day 2 8/21/2018 – Baseline Testing
- Day 3 8/22/2018 – Stress Testing West Side
- Day 4 8/23/2018 – Stress Testing East Side

A comprehensive array of tests and evaluations was conducted…



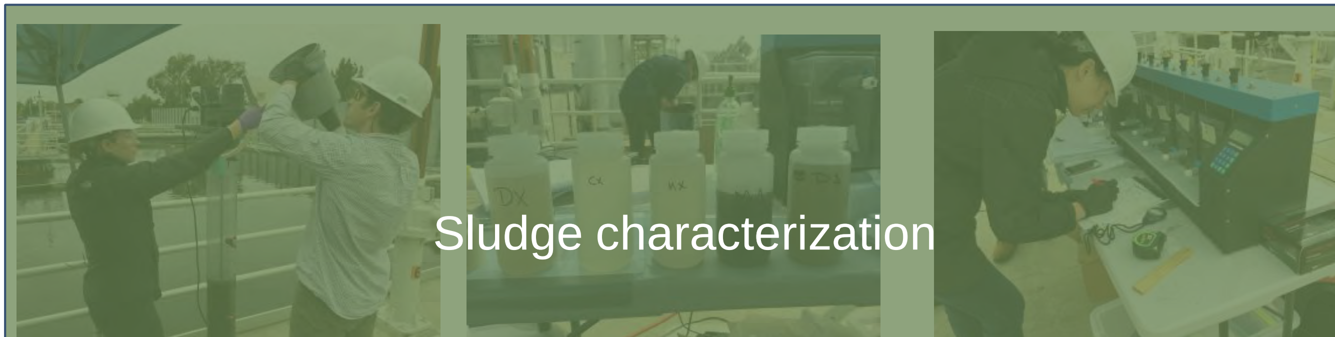
Influent and effluent flows and MLSS



Clarifier effluent TSS / Turbidity

Sludge blanket depth and profiles

RAS flow and RAS TSS



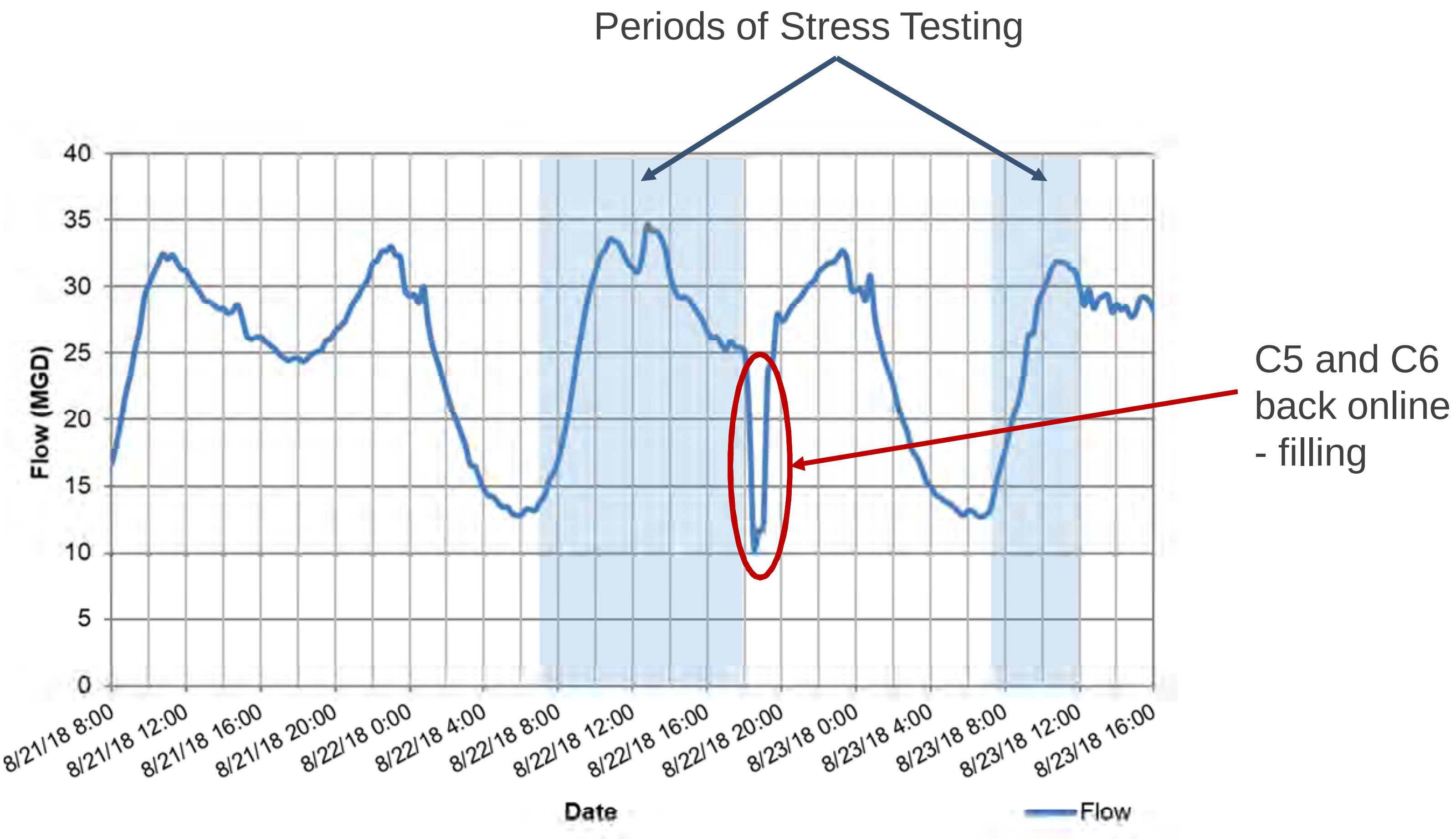
Settling properties
Settling column/SVIs

Discrete settling

Flocculation parameters
FSS/DD

Plant Flow during Clarifier Field Testing

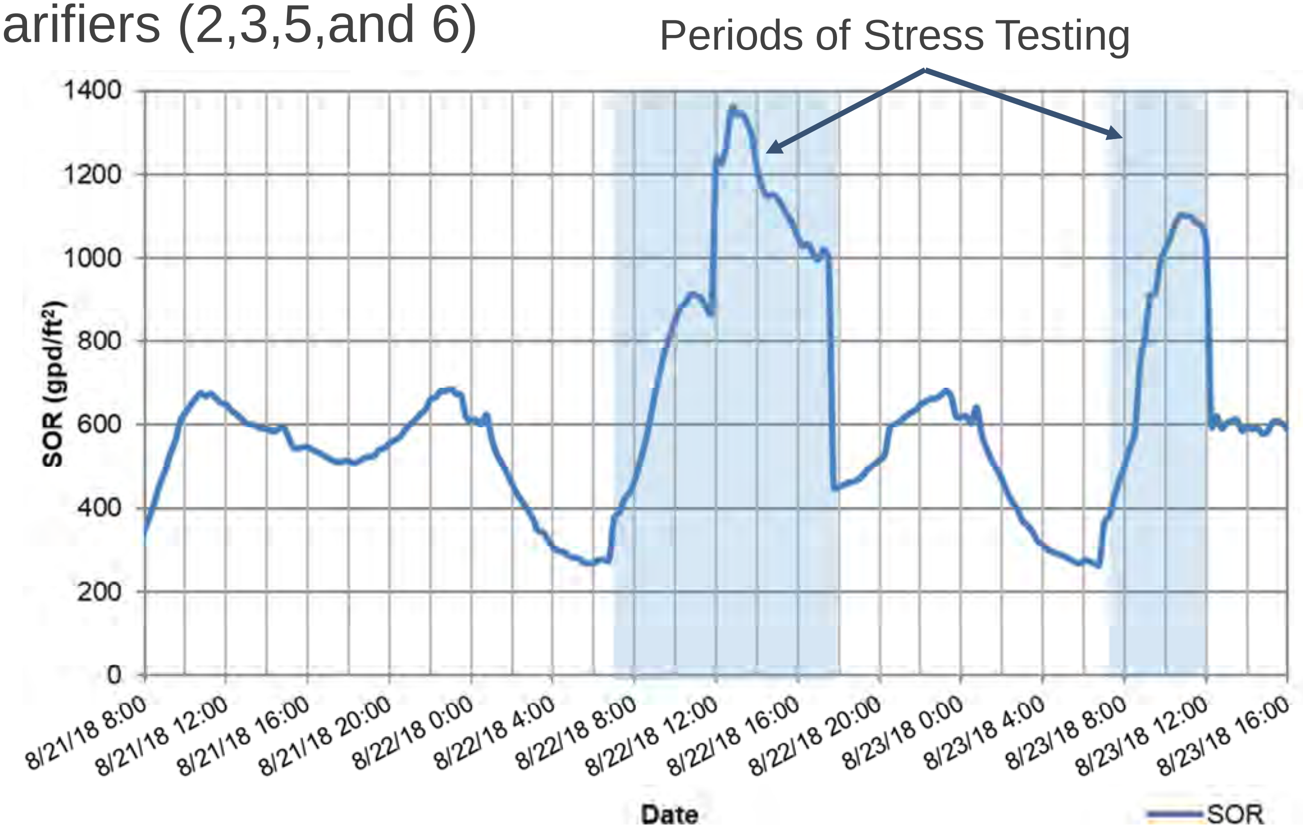
Calculated as the sum of EBDA Effluent Flow, reclaimed water, and elutriation flow



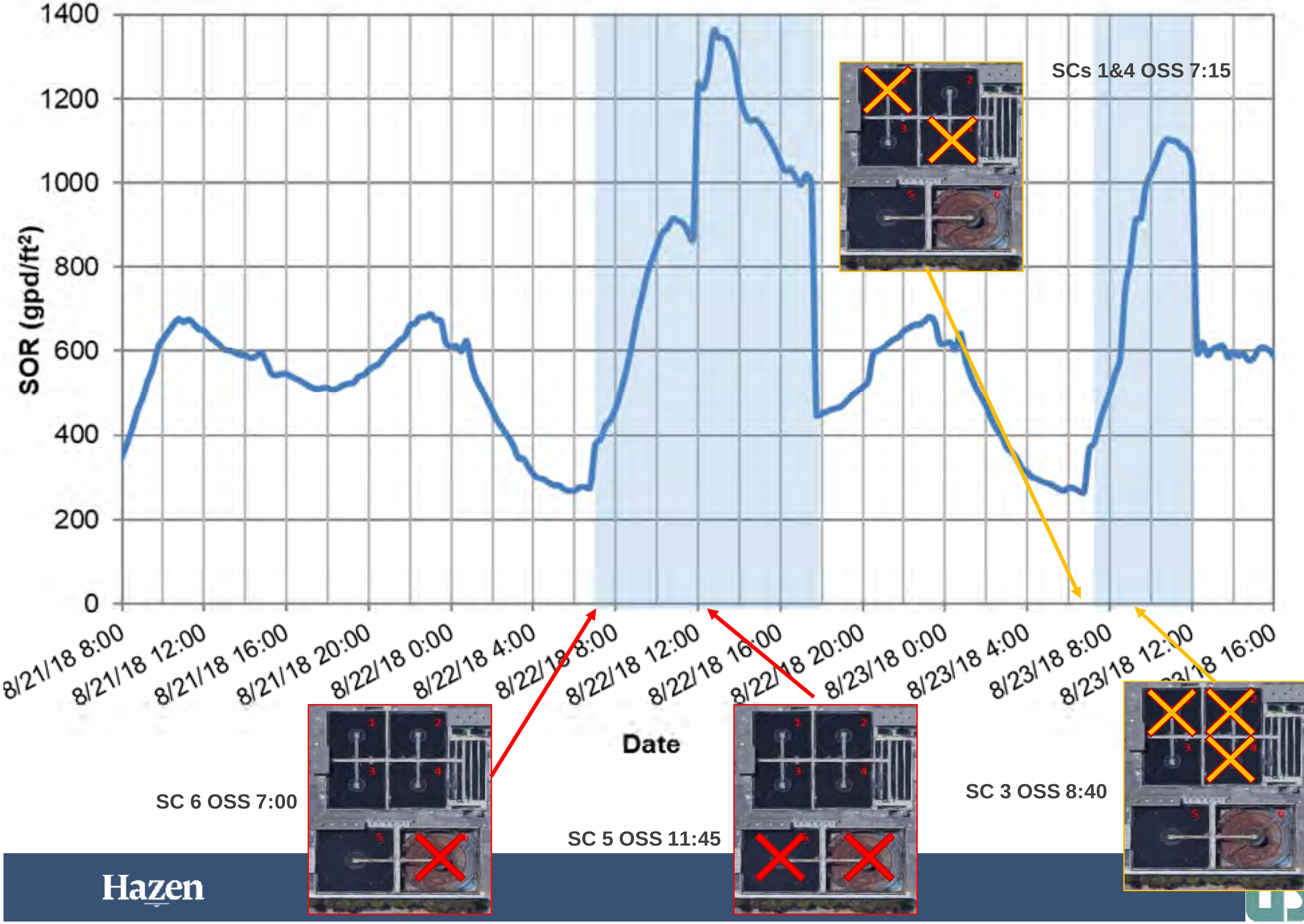
Clarifier Field Testing – Surface Overflow Rate (SOR)

- Assumed equal flow distribution to clarifiers
- Peak SOR > 1300 gpd/ft^2 on Day 3 (to Clarifiers 1-4)
- Peak SOR approx. 1100 gpd/ft^2 on Day 4 (to Clarifiers (2,3,5,and 6)

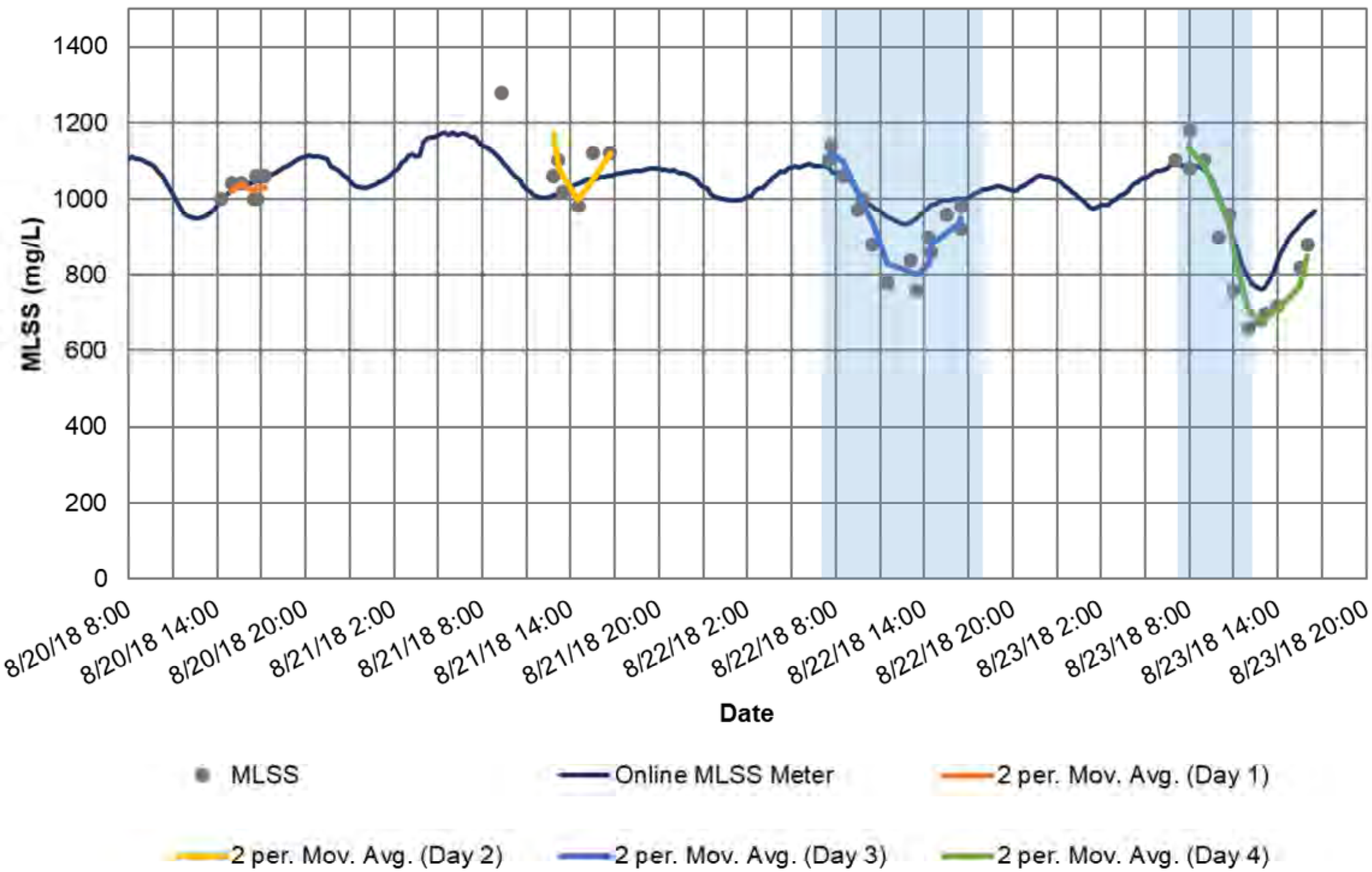
SOR	
1000	48.1
1,100	52.9
1,300	62.5



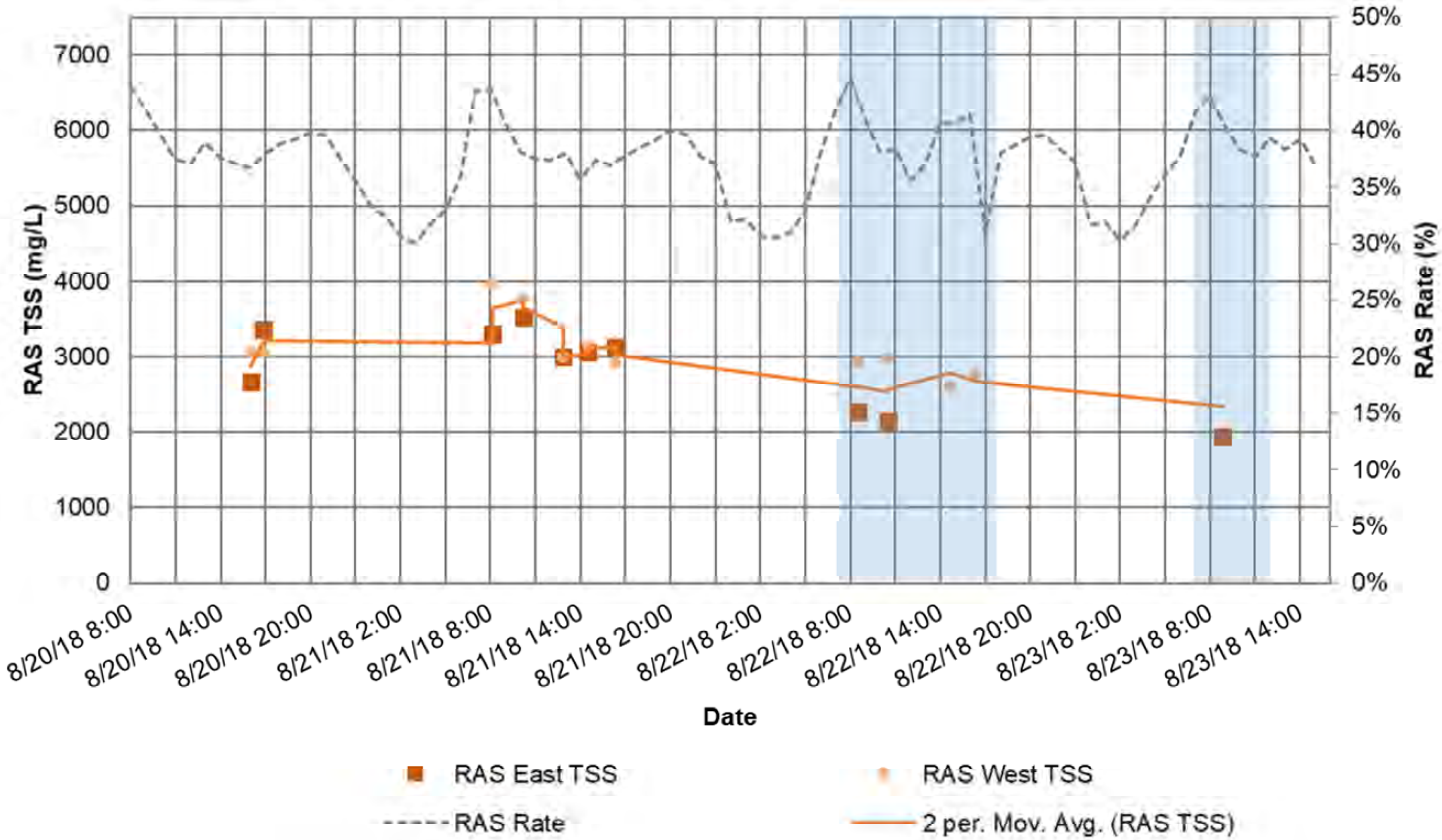
Clarifier Field Testing – Surface Overflow Rate (SOR)



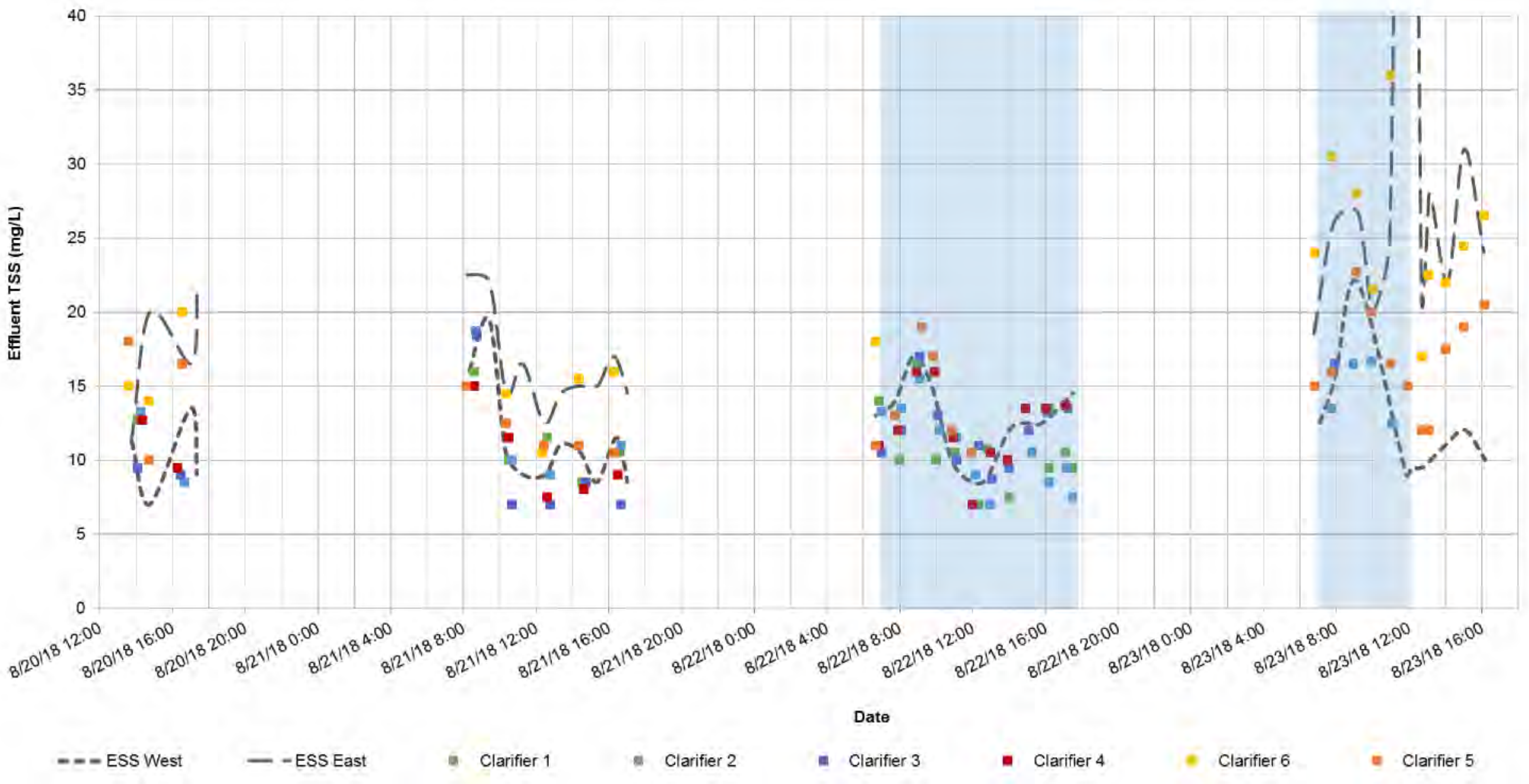
Clarifier Stress Testing - MLSS



Clarifier Stress Testing - RAS TSS and RAS Rate

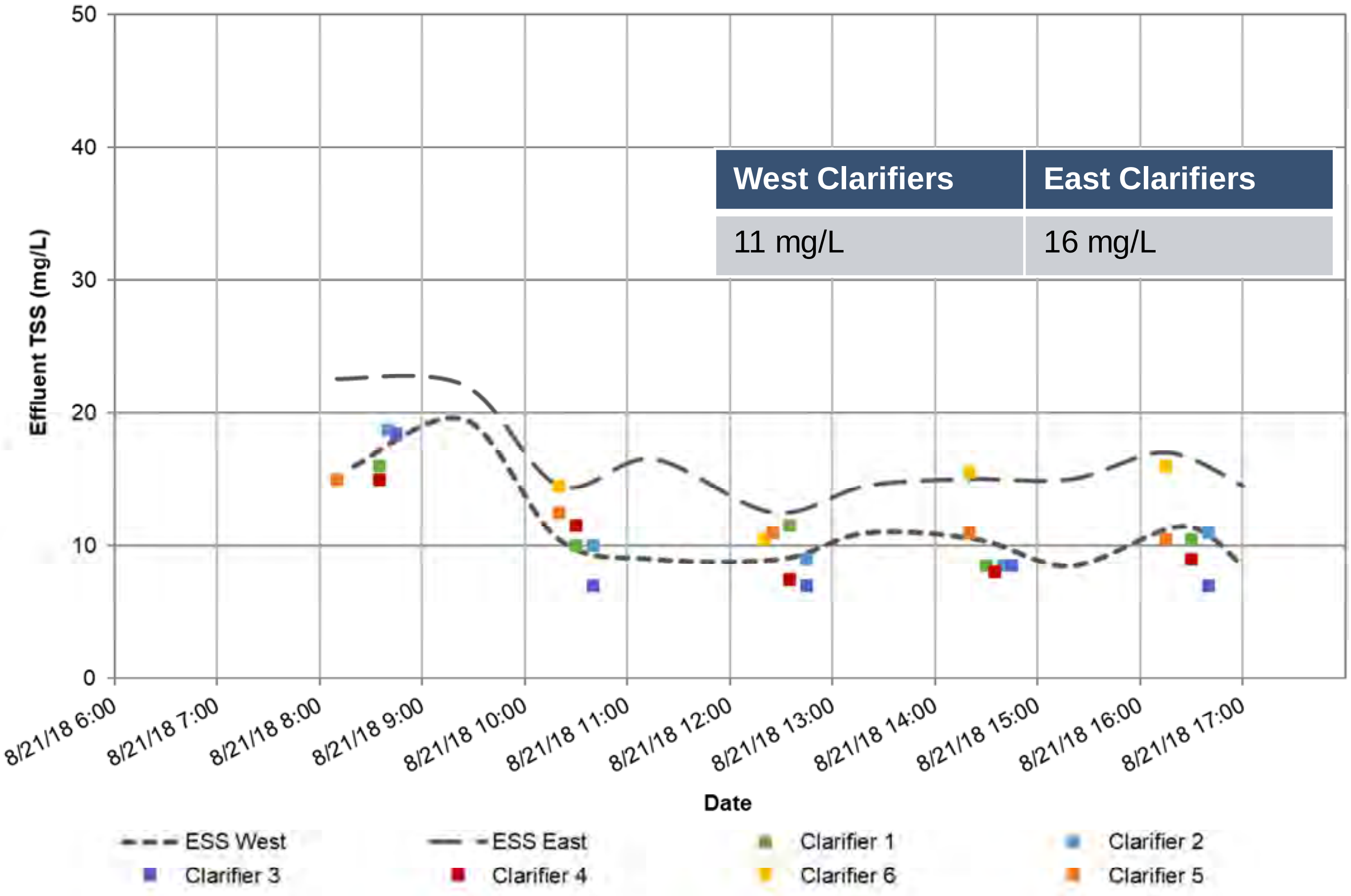


Clarifier Field Testing – ESS



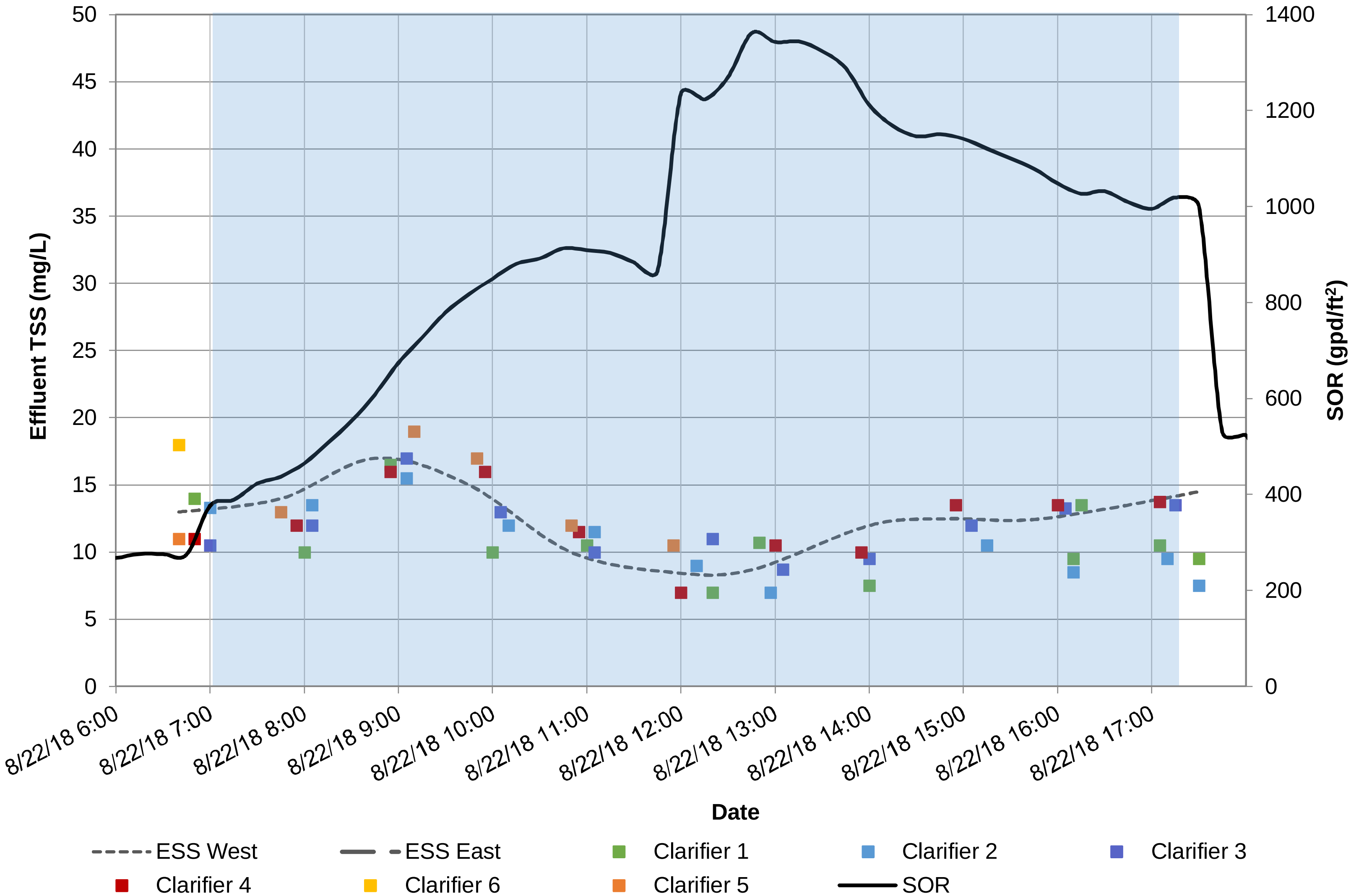
Clarifier Field Testing – ESS – Day 2

Normal operation

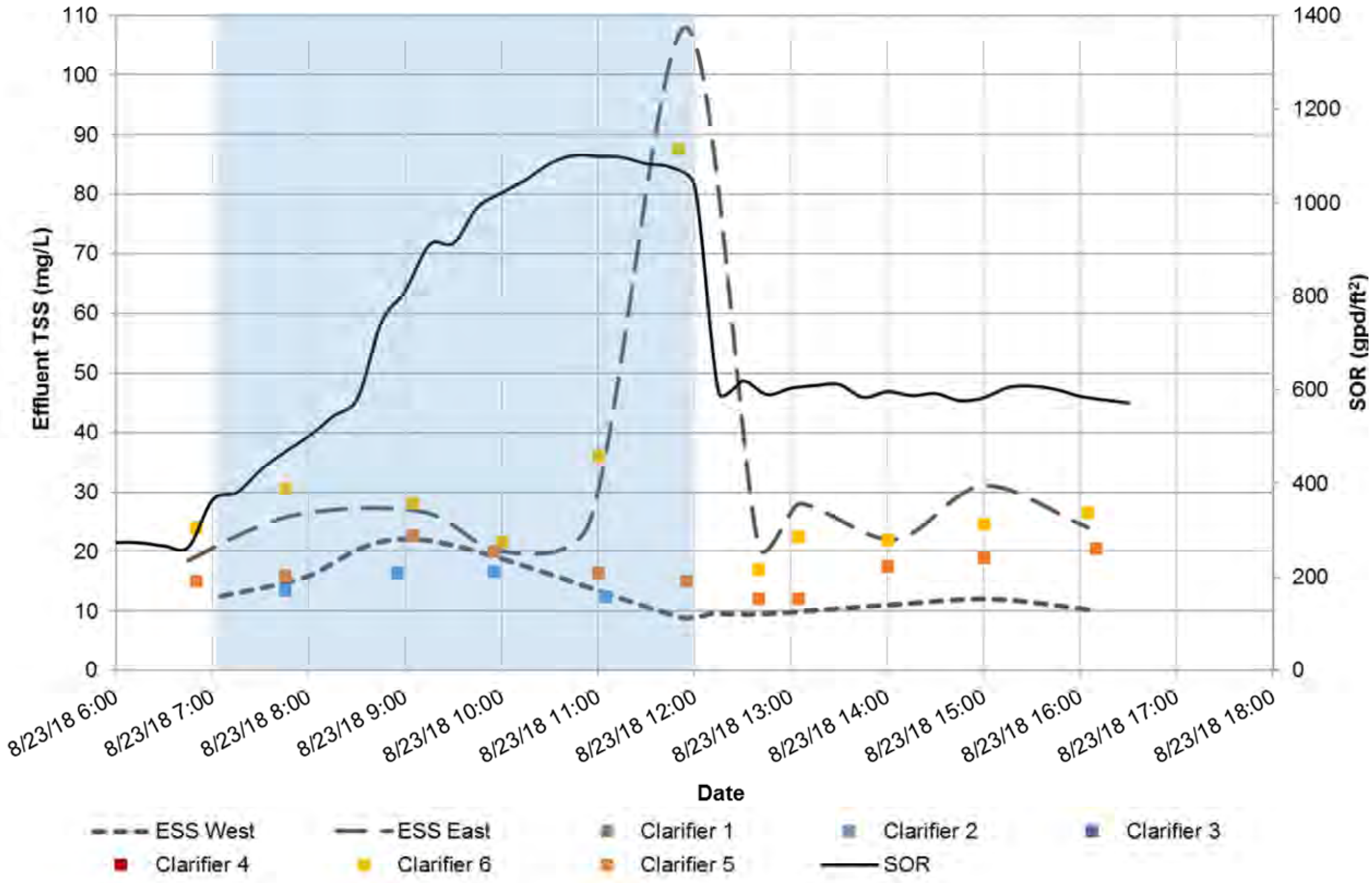


West Clarifiers	East Clarifiers
11 mg/L	16 mg/L

Clarifier Field Testing – ESS – Day 3



Clarifier Field Testing – ESS – Day 4



Clarifier Stress Testing – Summary

- Mixed Liquor Suspended Solids
- Sludge Volume Index
- Solids Loading Rate
- RAS Rate
- Surface Overflow Rate

Parameter	Units	Day 1	Day 2	Day 3	Day 4	Avg.
MLSS	mg/L	1030	1100	940	900	**1,000**
SVI	mL/g	285	255	300	380	**305**
SLR	ppd/ft^2	6.9	7.2	9.7	8.5	**8**
RAS Rate	%	38%	37%	37%	37%	**37%**
Avg. SOR	gpd/ft^2	610	590	1,000	870	**--**
Max. SOR PH SOR	gpd/ft^2			1,360 1,340	1,100 1,100	--

Clarifier Stress Testing – ESS

- Effluent TSS units - mg/L

Clarifier	Day 1	Day 2	Day 3	Day 4	Avg.
West Secondary Clarifiers					
C1	13	11	11		**12**
C2	11	11	11	15	**12**
C3	9	10	12	17	**12**
C4	11	10	12		**11**
ESS West	11	11	11	16	**12**
Average C1-C4	10	11	13	12	**12**
East Secondary Clarifiers					
C5	15	12	14	17	**15**
C6	16	14	18	31	**22**
ESS East	16	16	16	24	**18**
Average C5-C6	13	13	16	25	**18**

Blanket Measurements

Sludge blankets measured every hour

Both sludge blanket and dispersed layer noted

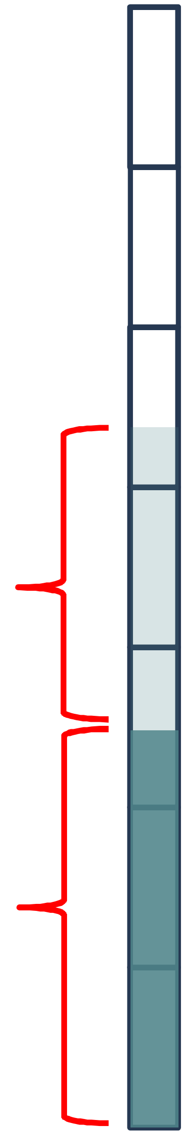
Reading =

2.5 ft blanket +

1 ft dispersed

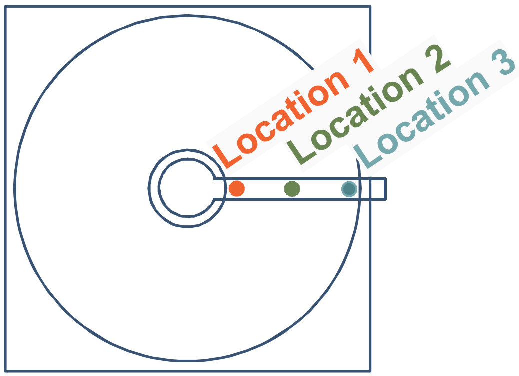
Dispersed Layer (Typically ~ 1,000 to 100 mg/L)

Sludge Blanket (Typically > 1,000mg/L)

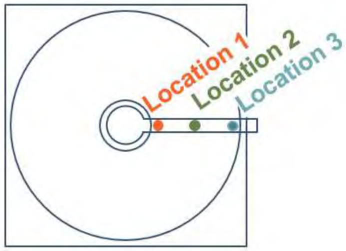


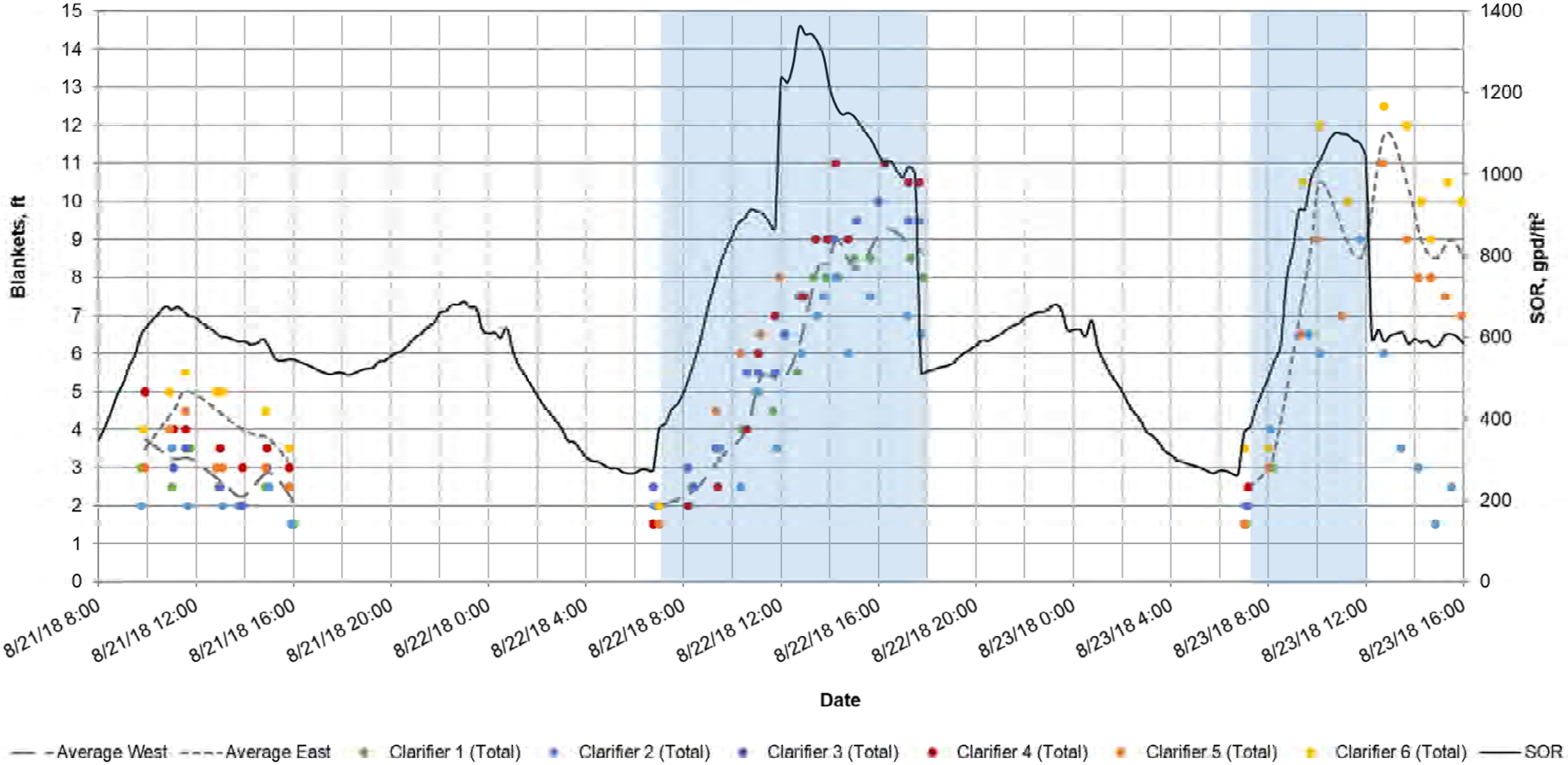
Blanket Measurements

- Blankets Measured at three locations
- Location 2 is the typical blanket measurement location
- Clarifiers 3 and 5 also have a TSS meter that estimates blanket depth

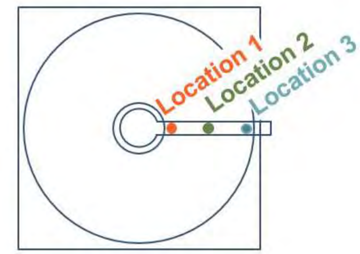


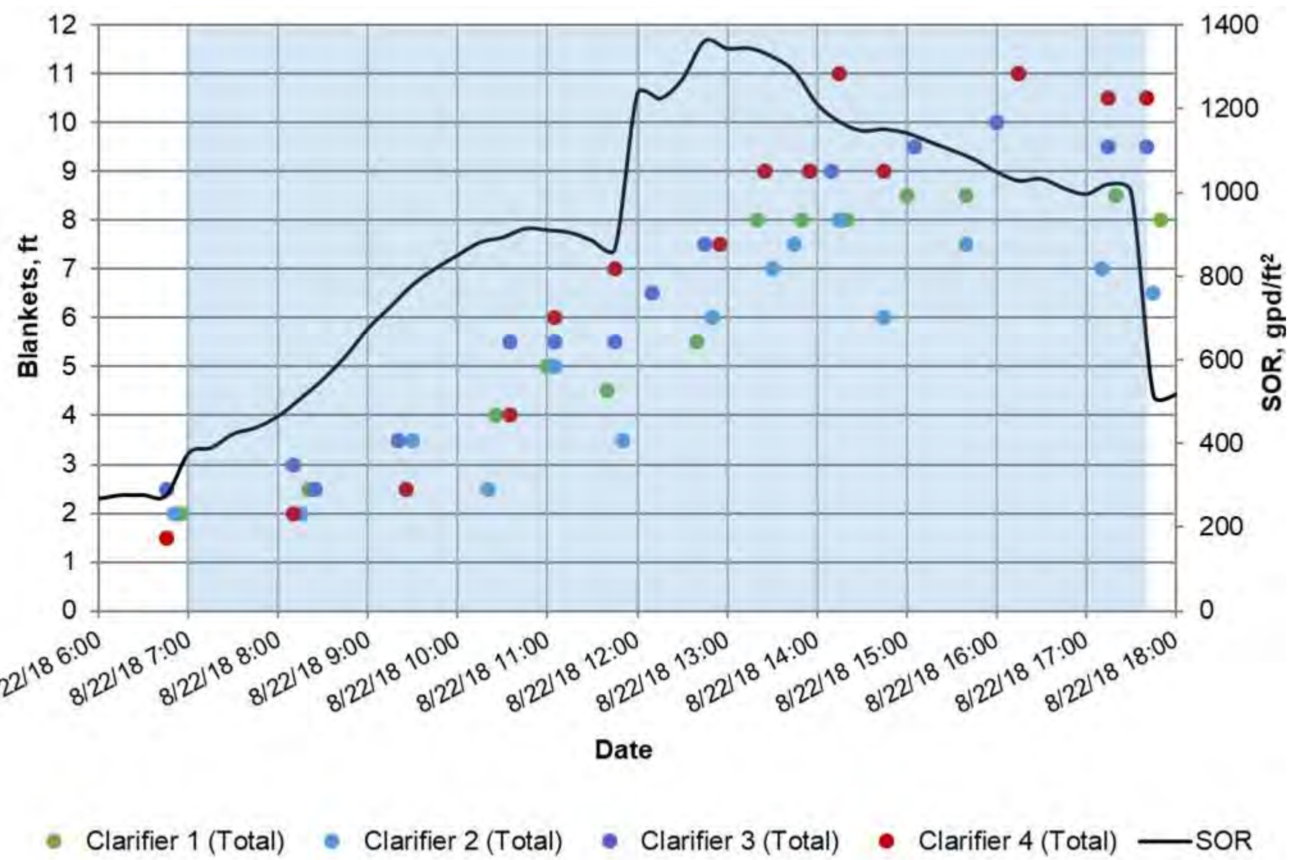
Blanket Measurements – All Clarifiers (C1-C6)



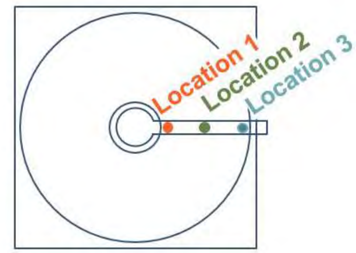


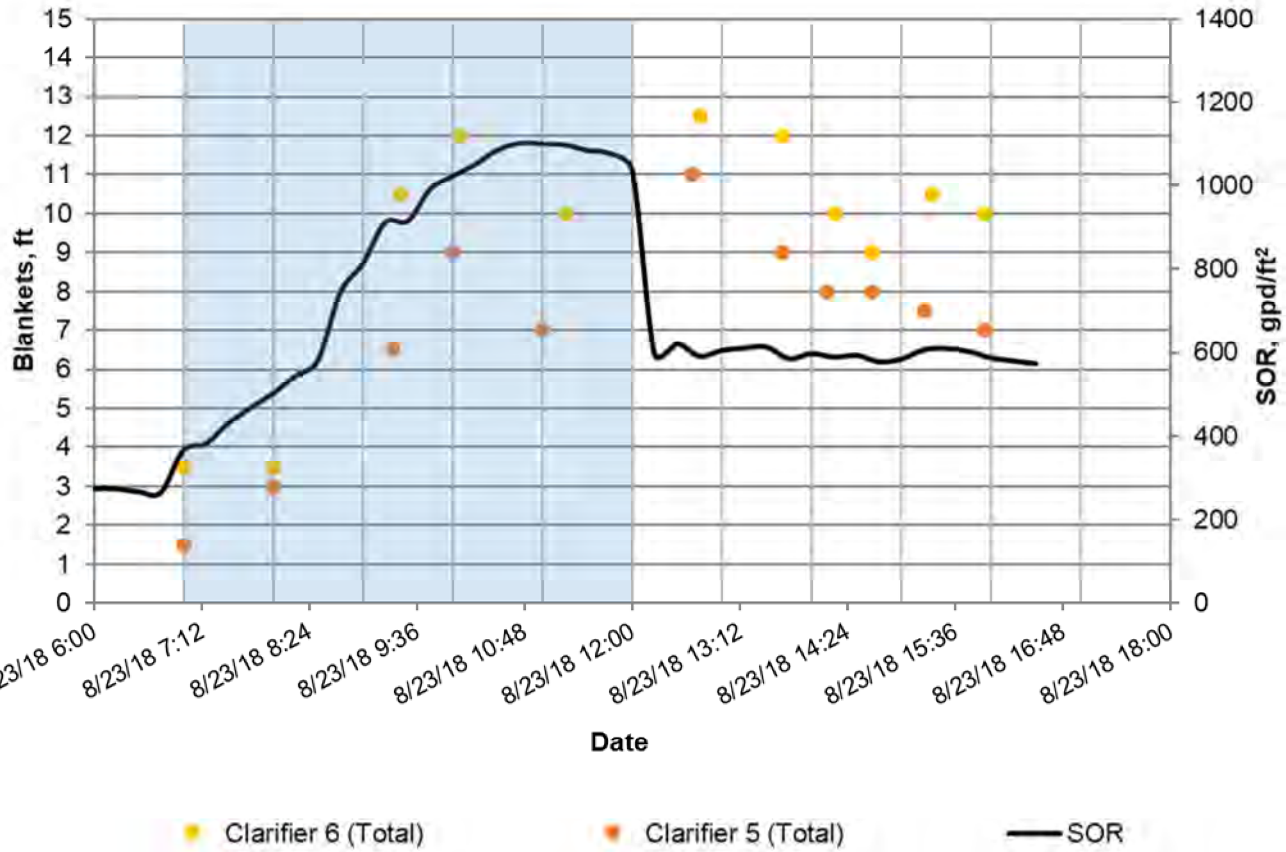
Blanket Measurements – West Clarifiers (C1-C4) – Day 3



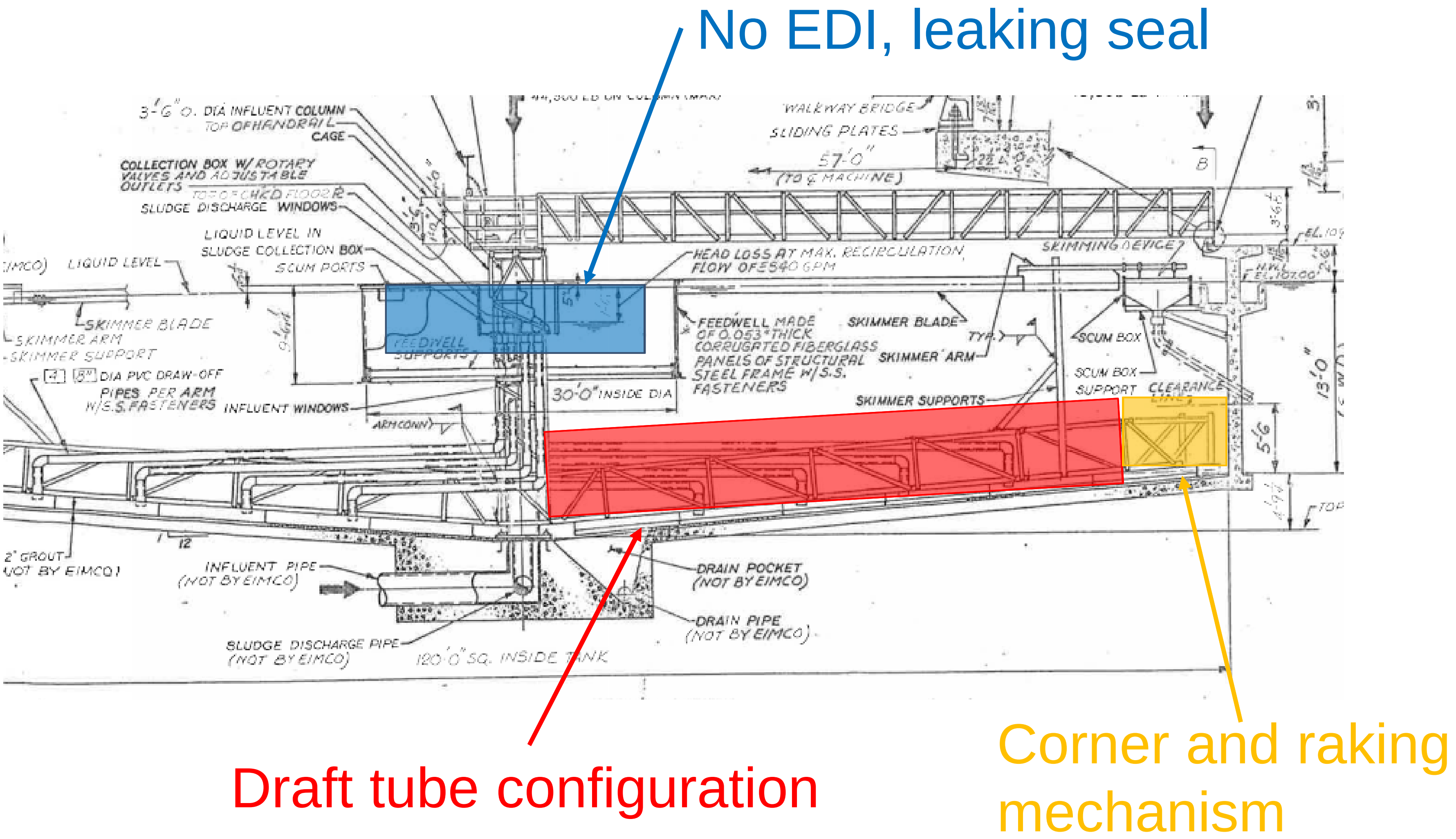


Blanket Measurements –
East Clarifiers (C5 and C6) – Day 4

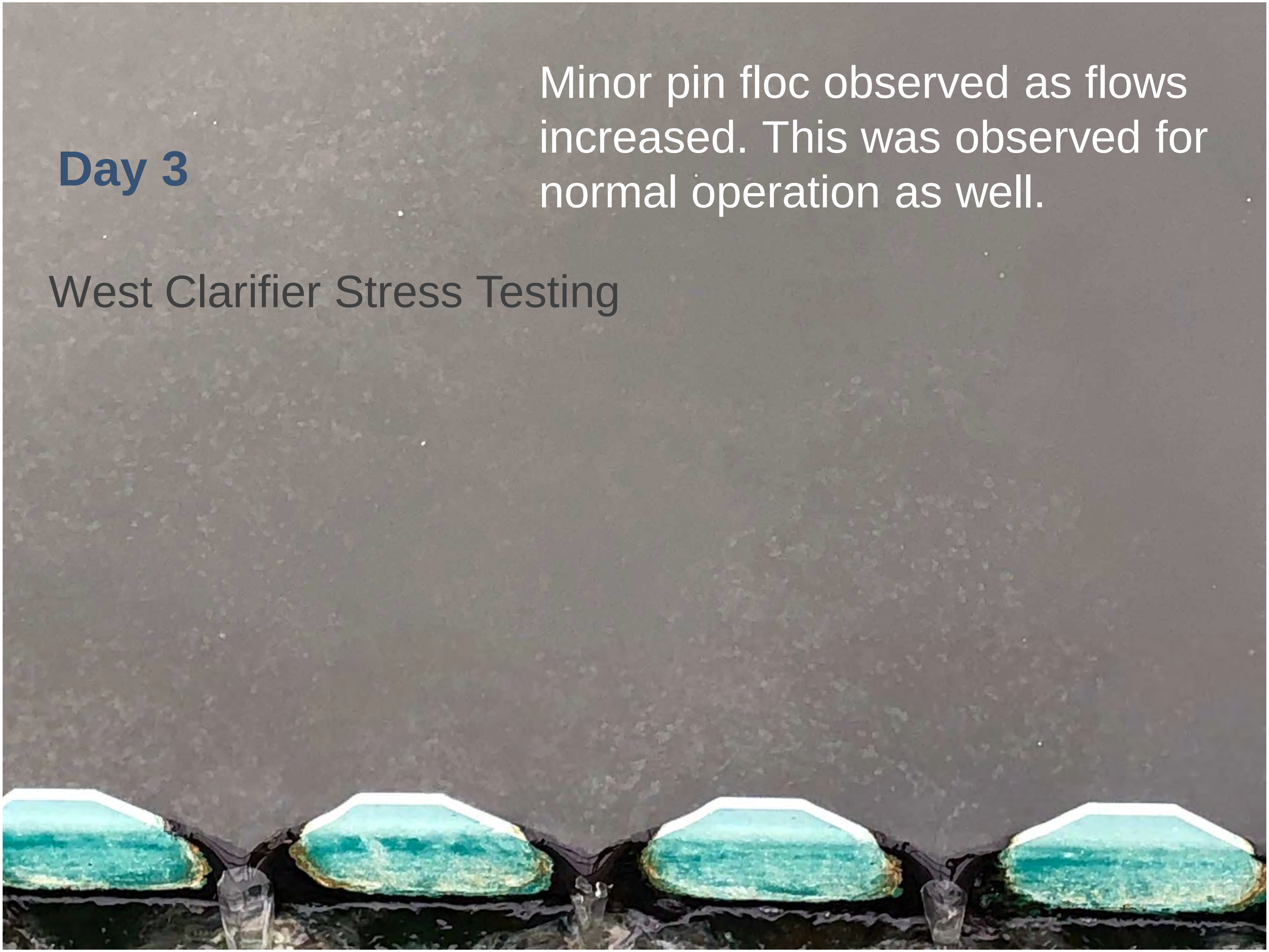




Secondary Clarifiers 5 and 6



10 am - Minor pin floc observed in the morning as flows increased
Day 2
Normal Operation

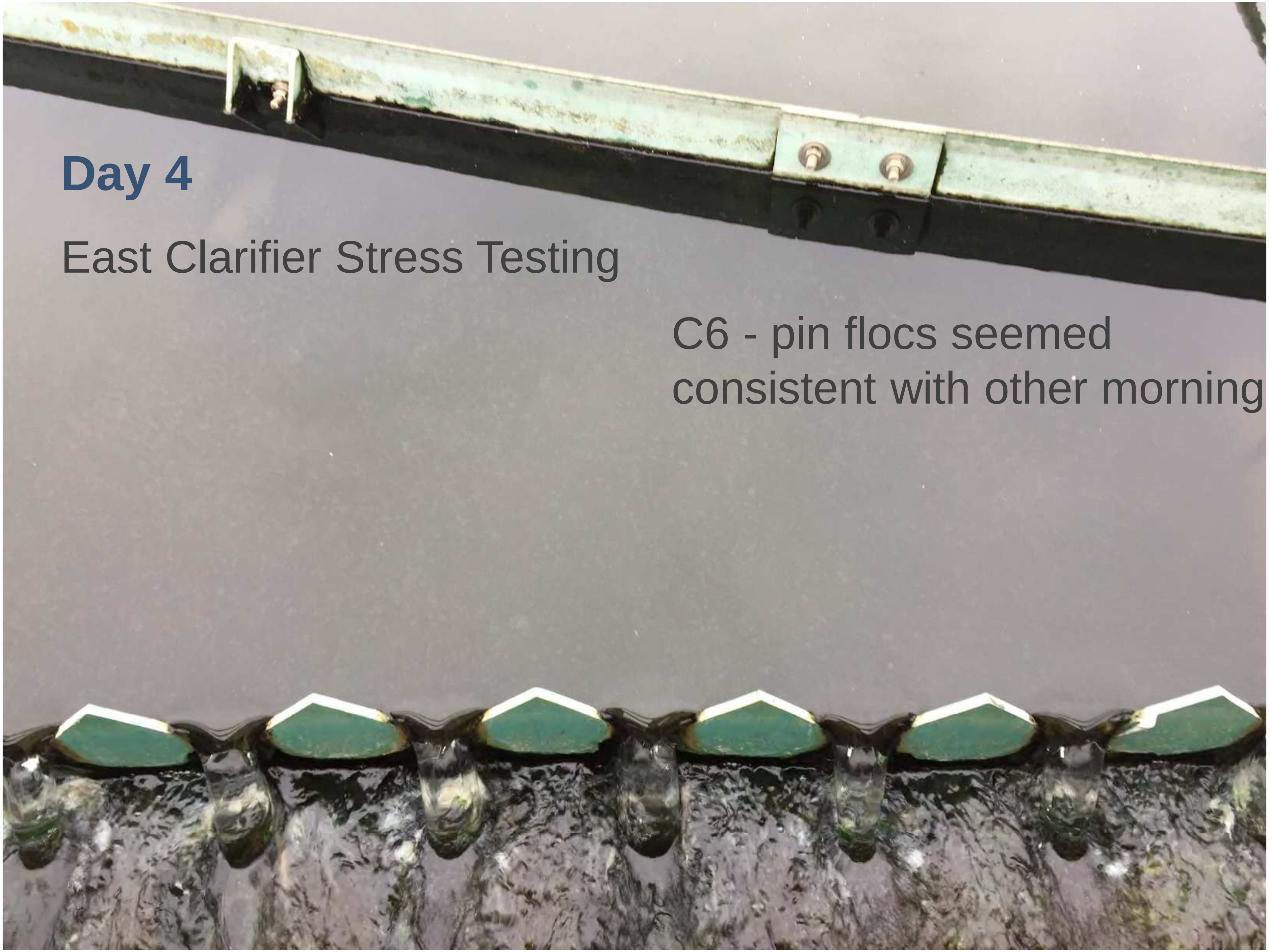

Day 3
Minor pin floc observed as flows increased. This was observed for normal operation as well.
West Clarifier Stress Testing


Day 3
High flows at C3.
Downstream weir
subsequently removed


Day 3
Plume on C4

Day 4

East Clarifier Stress Testing



C6 - pin flocs seemed consistent with other morning

Clarifier 6

Blankets high near the weir at approximately 11:00 on Day 4 (8/23)


C6-loss of solids
observed at~
11:45

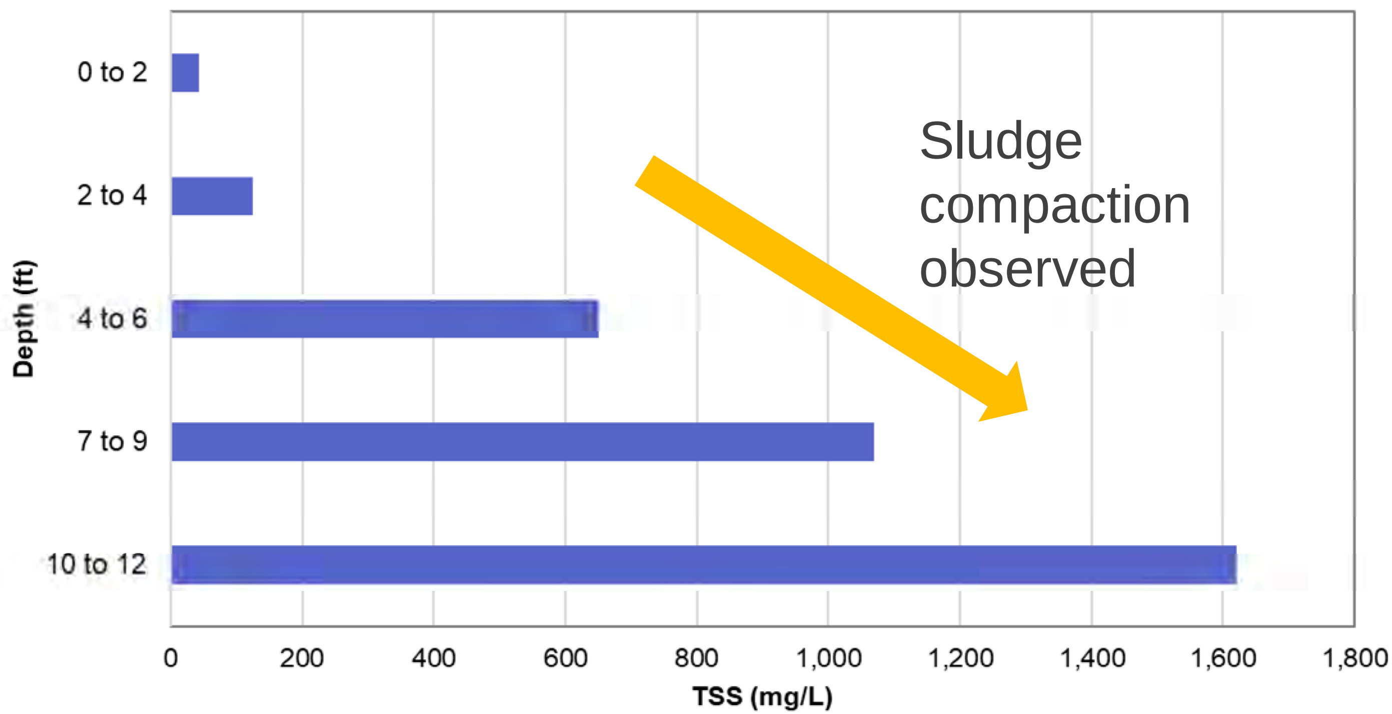

Plumes near C6 Baffle


C5 still cloudy
around 1:30pm

Profiles

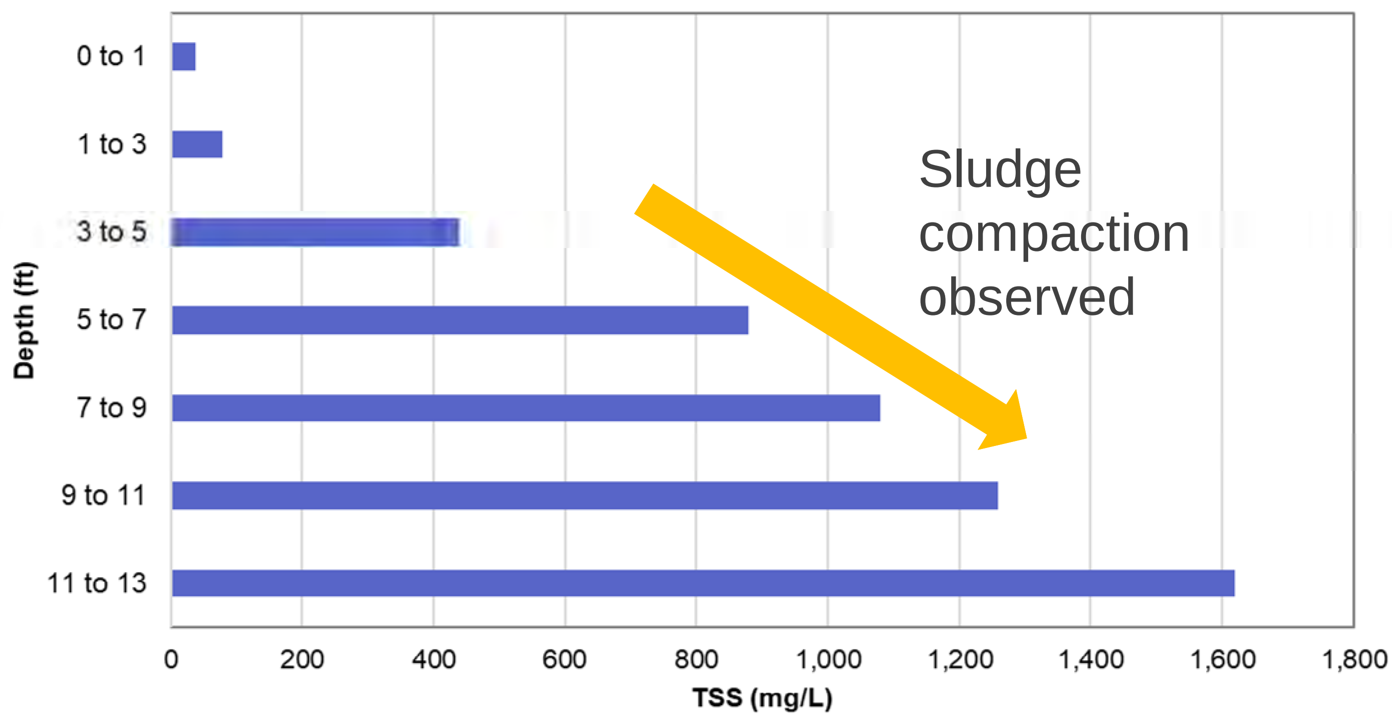
Clarifier 3 TSS Profile – Day 3 at 2:15 PM

- SOR = 1,170 gpd/sf
- Blanket was measured as 4 ft + 5 ft (at 2:10 pm)
- Meter read 7.5 ft + 0 ft (at 2:10 pm)



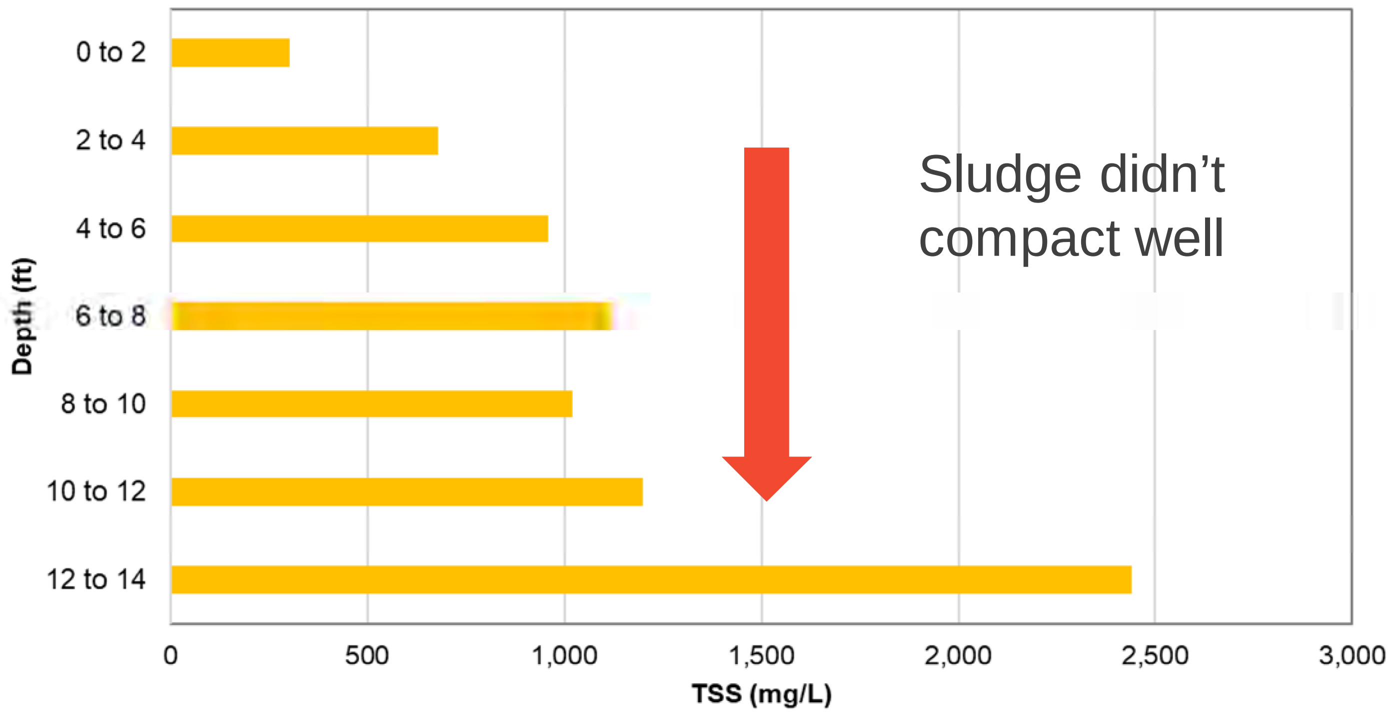
Clarifier 3 TSS Profile – Day 3 at 4:30 PM

- SOR = 1,030 gpd/sf
- Blanket was measured as 2 ft + 8 ft (taken at 4:00 PM)
- Meter read 8.5 ft + 0 ft (taken at 4:00 PM)

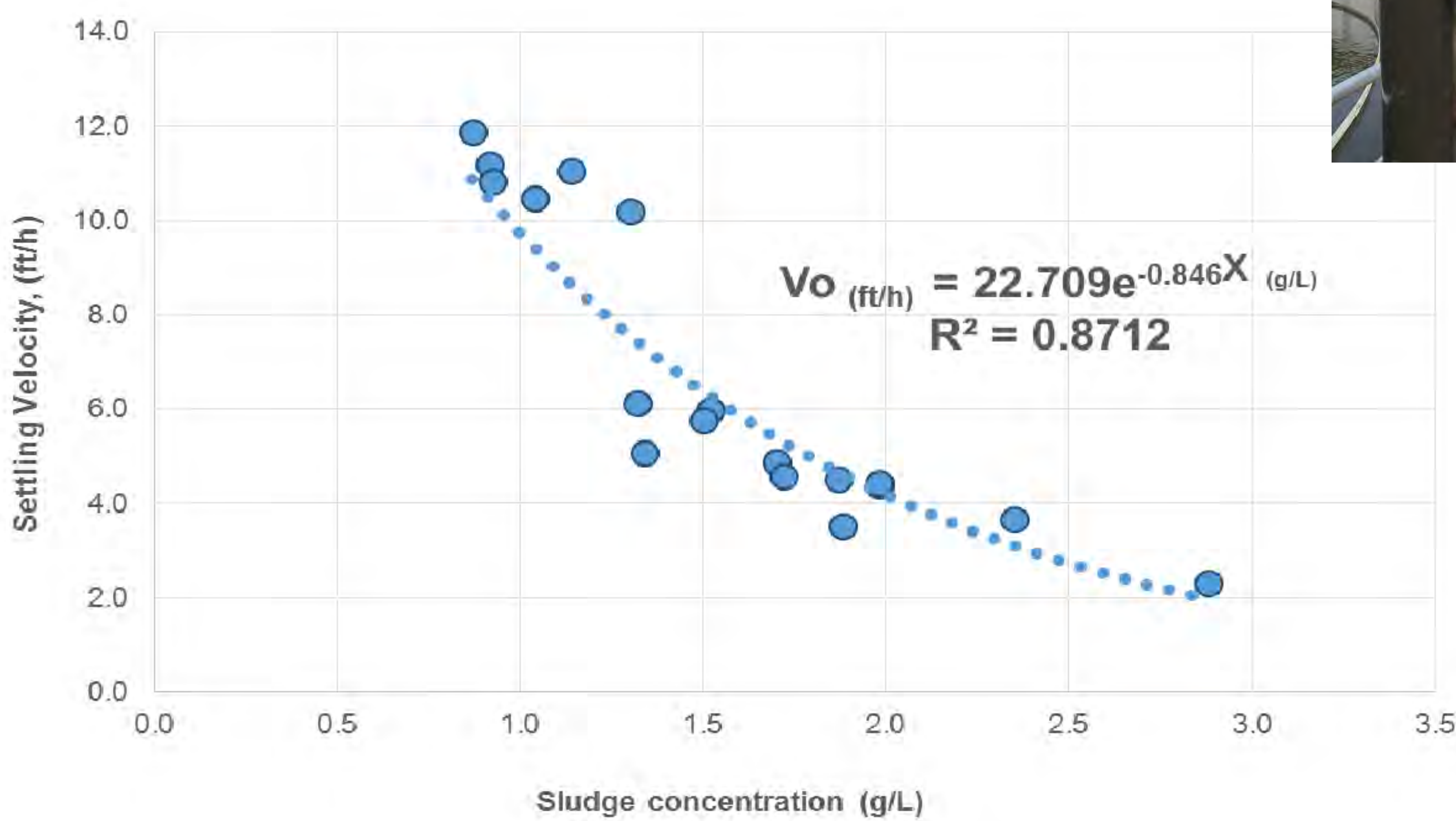


Clarifier 6 TSS Profile – Day 4 at 11:50 AM

- SOR = 1,080 gpd/sf
- Blanket was measured as 2 ft + 8 ft (taken at 11:15 AM)

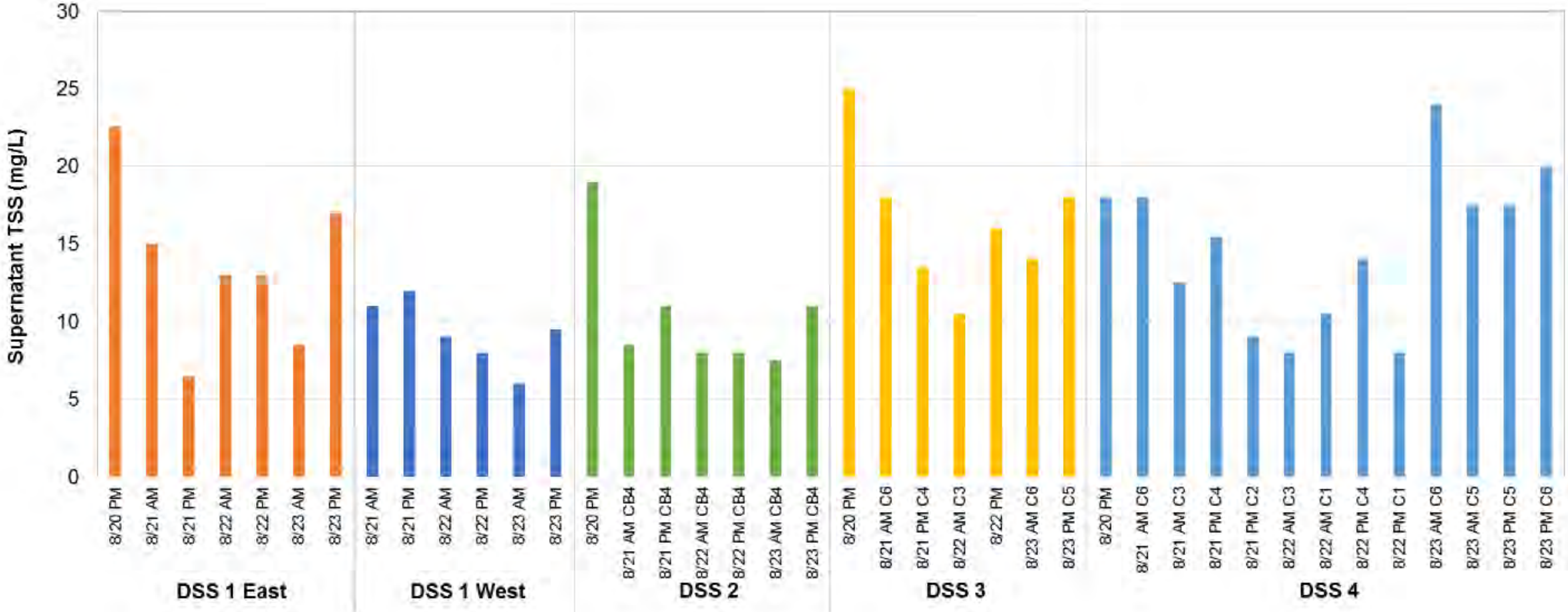


Clarifier Field Testing – Zone Settling



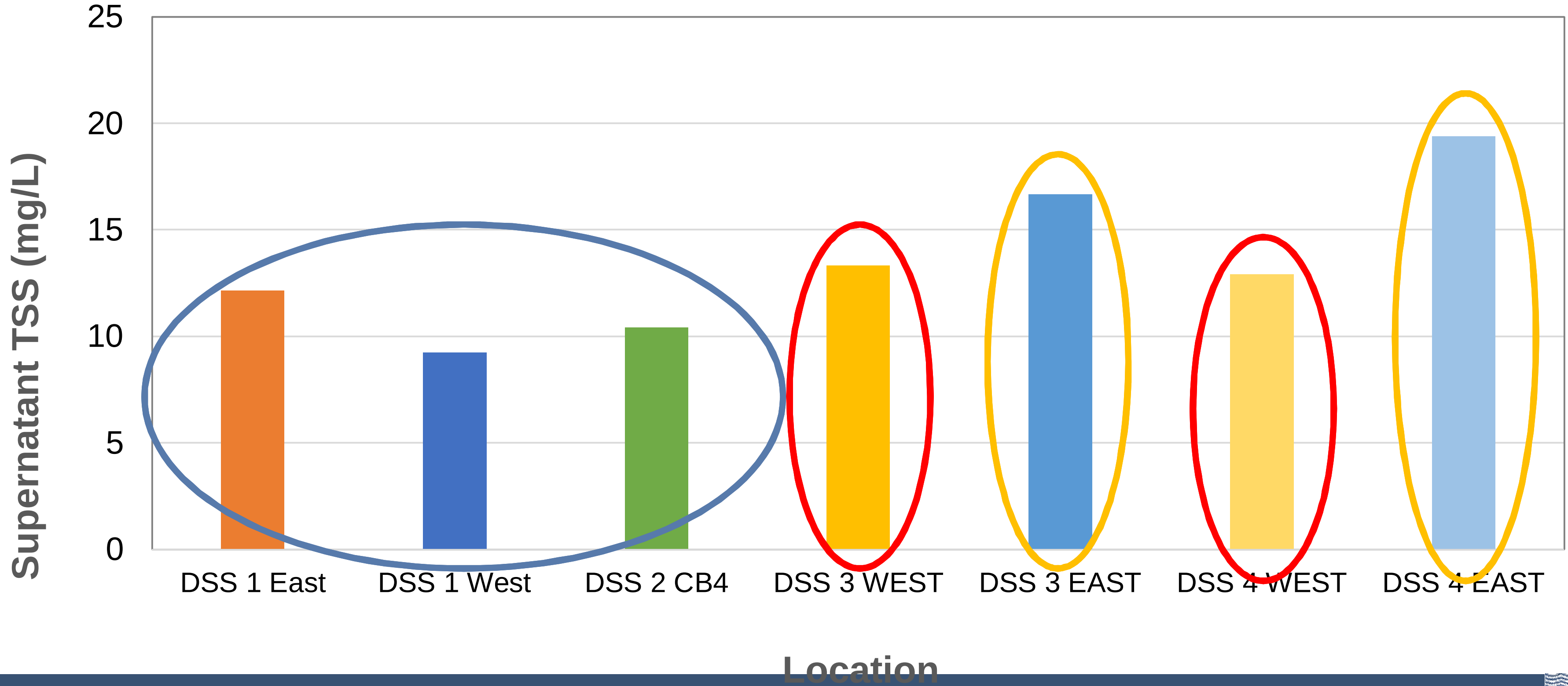
Clarifier Field Testing – DSS Results

- DSS 1 Downstream end ABs
- DSS 2 CB4
- DSS 3 Clarifier center well
- DSS 4 Clarifier effluent



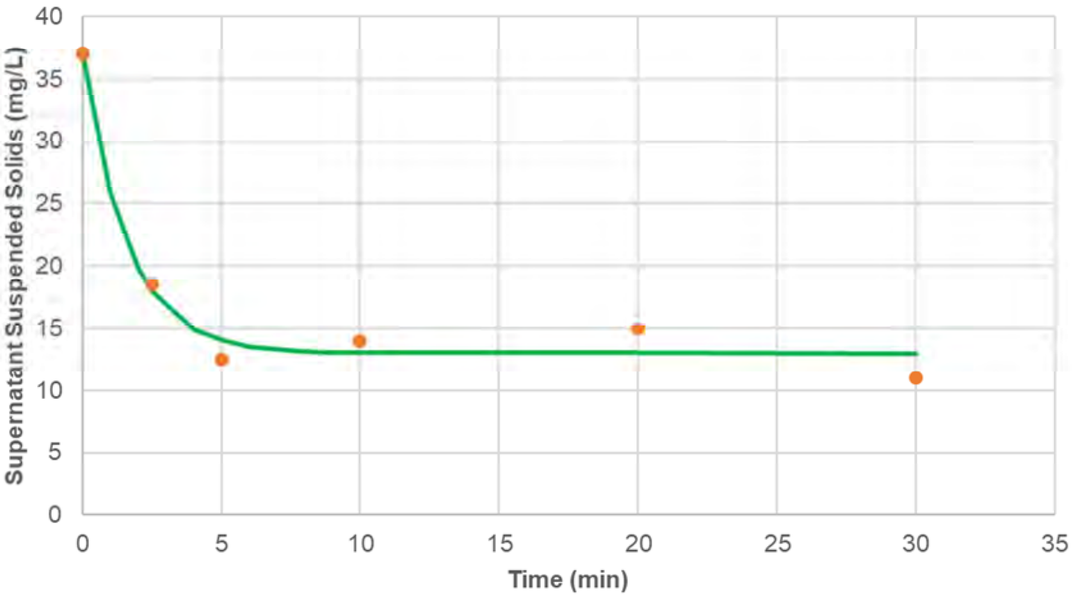
Clarifier Field Testing – DSS Results

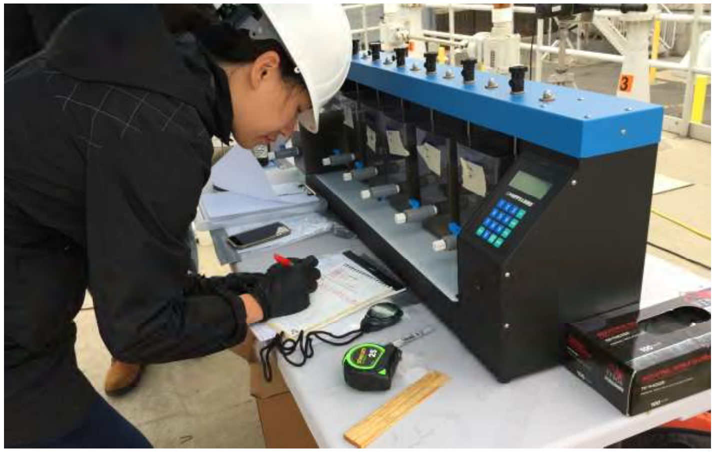
- DSS 1 Downstream end ABs
- DSS 2 CB4
- DSS 3 Clarifier center well
- DSS 4 Clarifier effluent



Clarifier Field Testing – Flocculation Results

- Decreasing TSS in supernatant with increasing flocculation time
  - $K_a = 7.32 \times 10^{-5}$ L/g SS
  - $K_b = 2.07 \times 10^{-8}$ s
- Example Plot for 8/21/18 (Day 2) at 8:30 AM





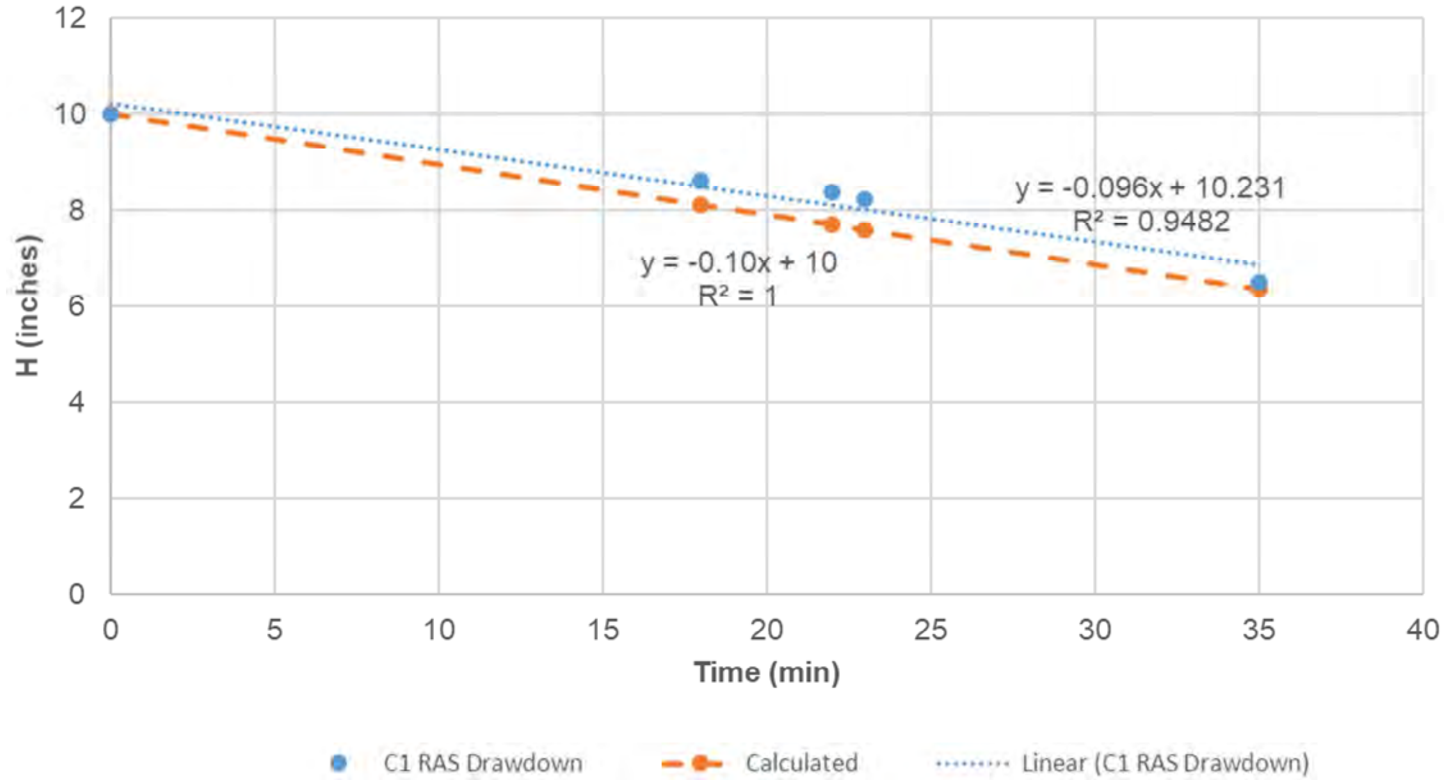
RAS Drawdown

- Measure the change in height ΔH over time
- Calculate $\frac{\Delta H}{\Delta t}$ and compare it to expected values
- Done for Clarifiers 3 and 4 on Day 4

Clarifier Field Testing – C4 RAS Drawdown

- $\left(\frac{\Delta H}{\Delta t}\right)_{measured}$ = 0.096 in/min = 11.5 ft/day
- $\left(\frac{\Delta H}{\Delta t}\right)_{calculated}$ = 0.10 in/min = 12 ft/day

} 4% difference



Secondary Clarifier Field Testing and Model Calibration

- Clarifier field testing conducted from 8/20 to 8/23/2018
  - Stress testing of West and East clarifiers
  - Comprehensive array of tests and evaluations
  - Lab data consistent with field observations
- West clarifiers (Clarifiers 1-4) outperformed the East Clarifiers
  - Sustained overflow rates > 1,000 gpd/ft^2 but with high blankets.
  - Solids loading rate was low ~ 10 ppd/ft^2
  - SVI ~ 300 mL/g

Secondary Clarifier Field Testing and Model Calibration (cont.)

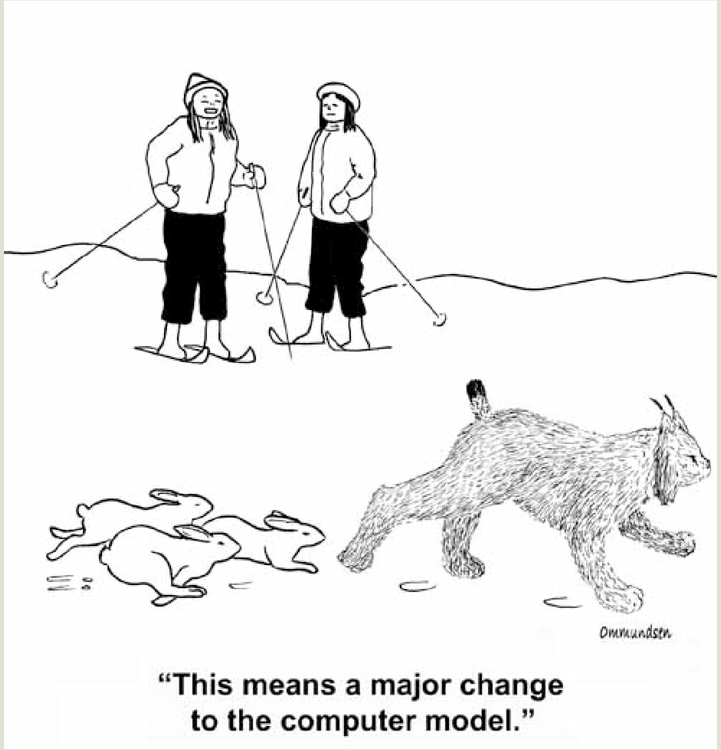
- East clarifiers failed under slightly lower loading conditions
  - Overflow rates > 900 gpd/ft^2
  - Solids loading rate ~ 8 ppd/ft^2
  - SVI ~ 380 mL/g
- East clarifiers presents poor hydrodynamics and excess turbulence
  - Draft tube configuration
  - No EDI
  - Corners
  - Leaking seal in Clarifier 6 further impacting Performance

Clarifier Field Testing – Summary (cont.)

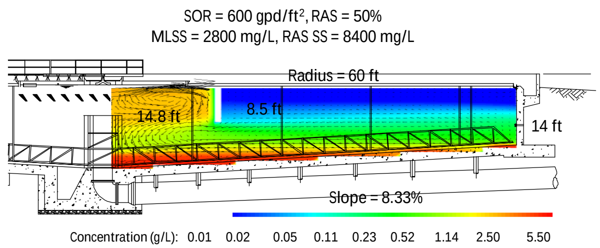
- Secondary clarifier performance and capacity affected by bioflocculation, SVI and clarifier configuration

CFD Modeling

Alonso Griborio



Our Approach to Clarifier Optimization and Design



4

Process, Mechanical and Material Optimization

Modeling
State point analysis, BioWin and CFD

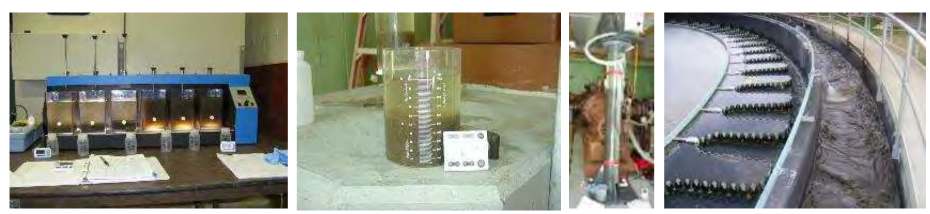
3

Meeting with plant staff and evaluation of historical data

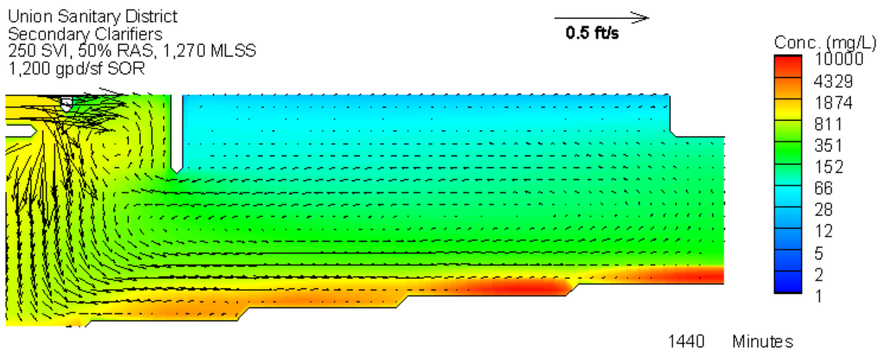
1

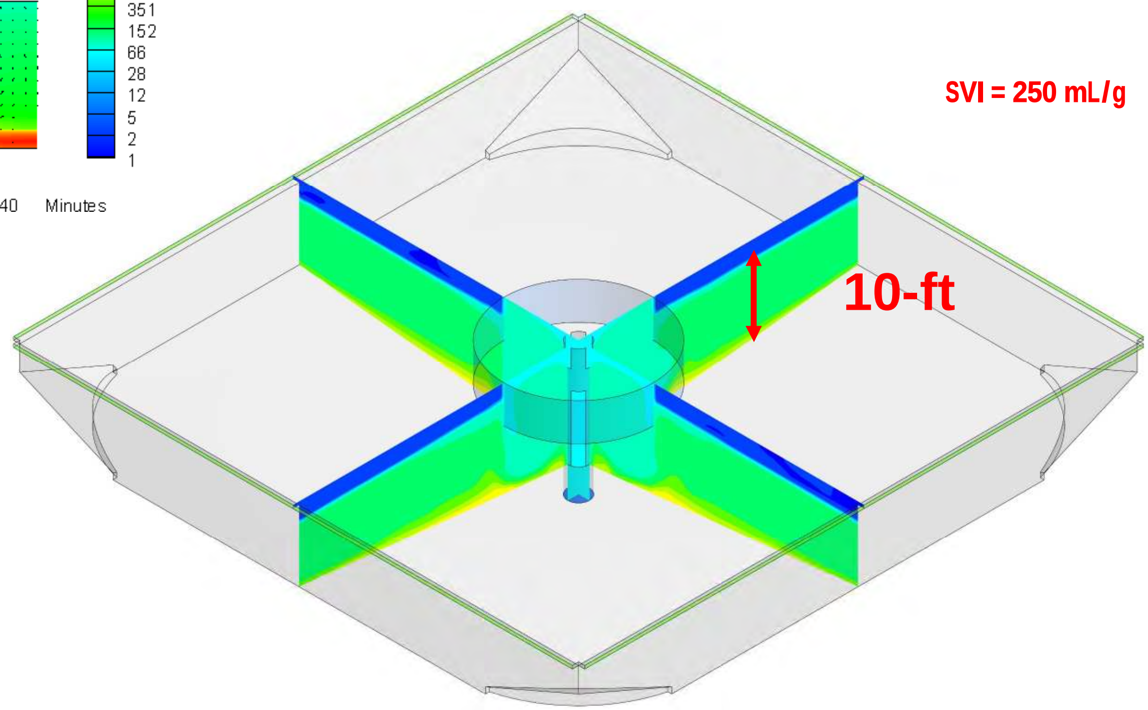
2

Detail field characterization and stress testing



2D Model developed and calibrated
3D model will be used for verification





Results for Peak Flow = 56.5 MGD
SOR = 1,200 gpd/sf

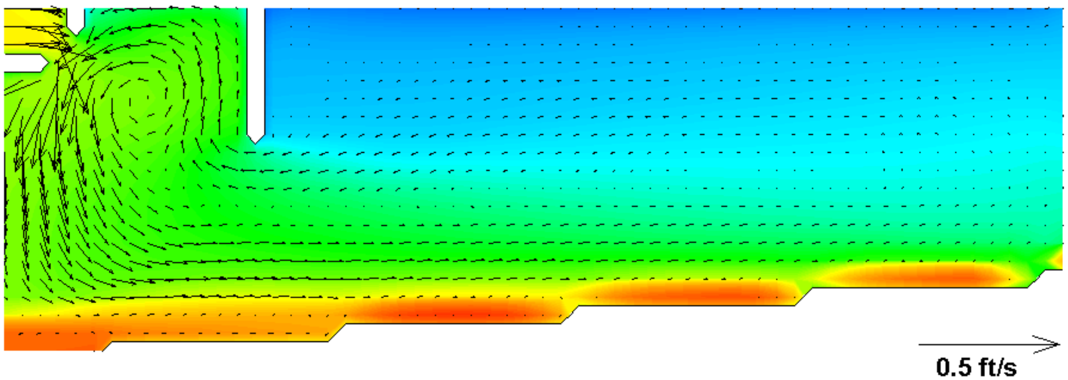
MLSS = 1,270 mg/L

Modeled Suspended Solid Concentration (mg/L)

2D Model – Calibration and Validation

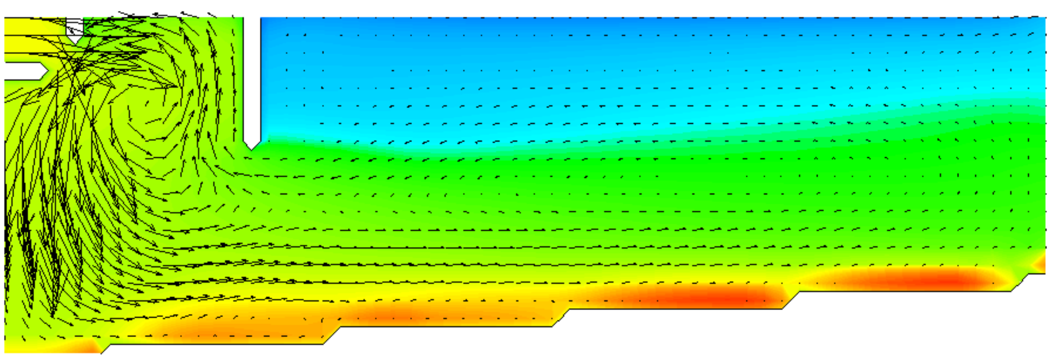
USD West Clarifiers
8/21/2018 Day 2 Average SOR = 590 gpd/sf

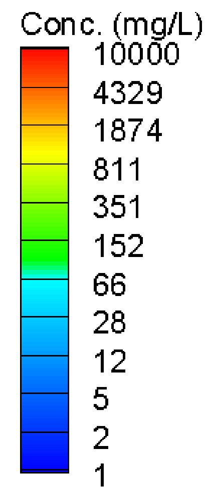
Avg. ESS = 13 mg/L



USD West Clarifiers
8/22/2018 Day 3 Average SOR = 1,000 gpd/sf

Avg. ESS = 17 mg/L





2D Model – Calibration and Validation

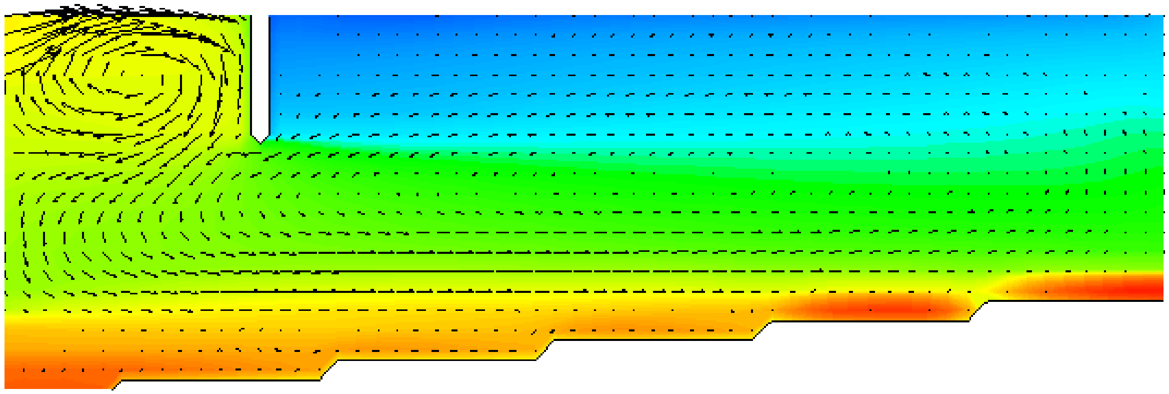
West Clarifiers

West	SOR (gpd/sf)	SLR (ppd/sf)	MLSS (mg/L)	ESS (mg/L)		RAS (mg/L)		Blanket Depth (ft)		Blanket+Dispersed Depth (ft)	
Time Period				Field	Model	Field	Model	Field	Model	Field	Model
Day 2 - Baseline	590	7.6	1,090	11	13	3,200	3,500	1	1	3	5
Day 3 - Stress Testing	1,000	9.5	920	13	17	2,210	3,400	2	2	6	7

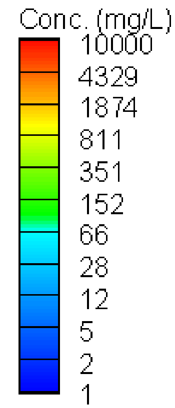
2D Model – Calibration and Validation

USD East Clarifiers
8/21/2018 Day 2 Average SOR = 590 gpd/sf

Avg. ESS = 19 mg/L

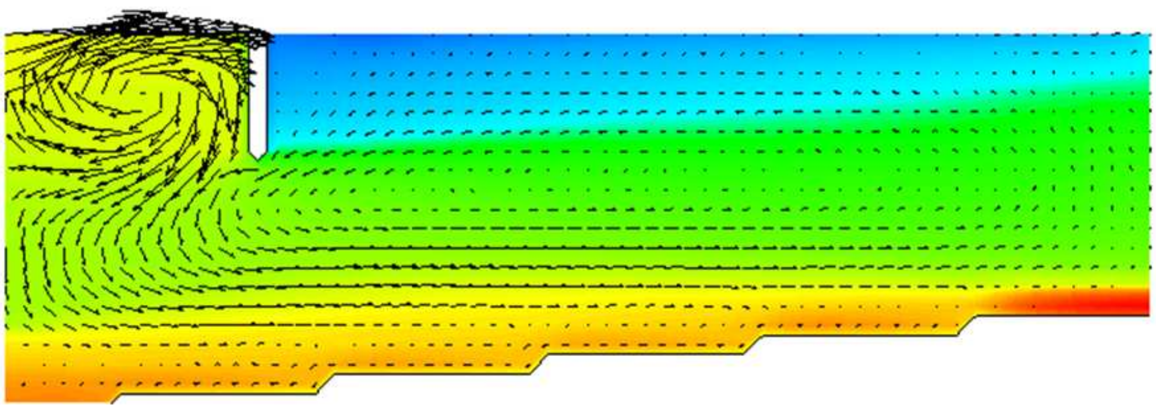


0.5 ft/s

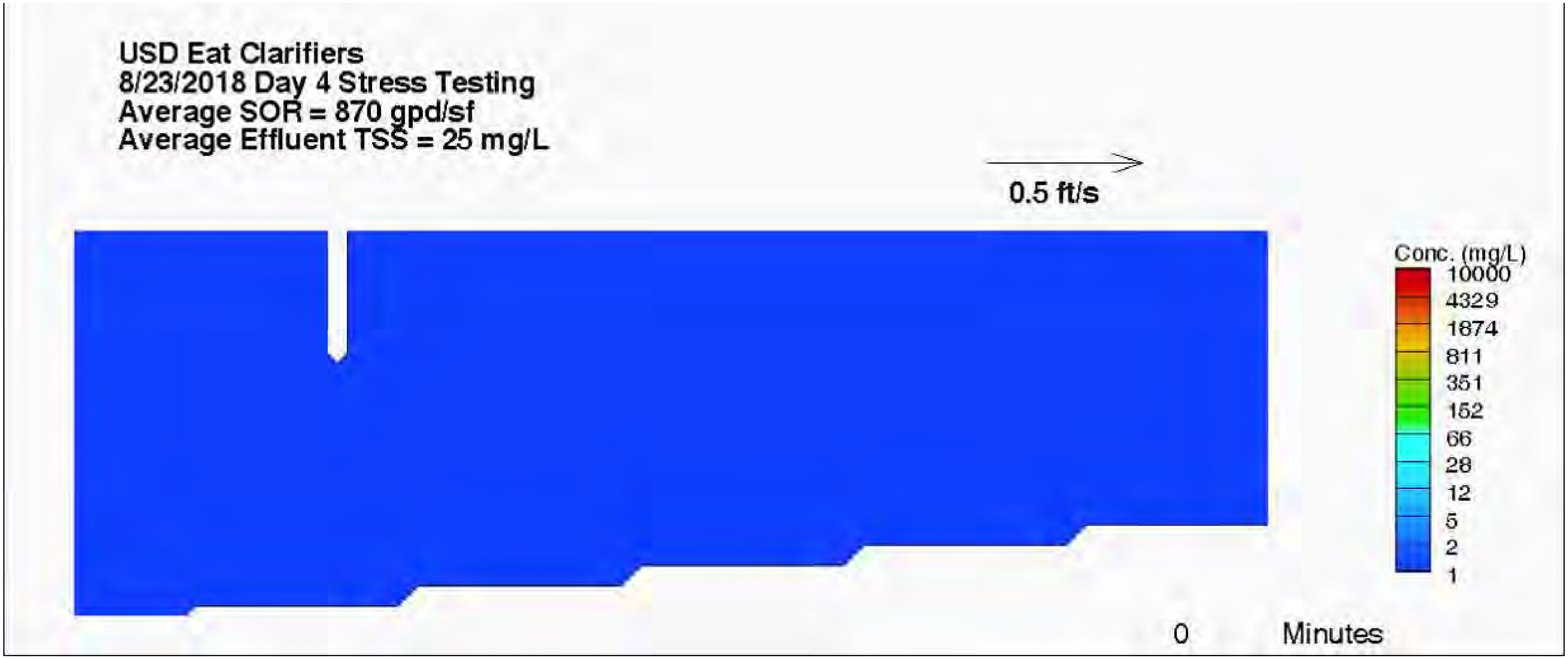


USD East Clarifiers
8/23/2018 Day 4 Average SOR = 870 gpd/sf

Avg. ESS = 25 mg/L



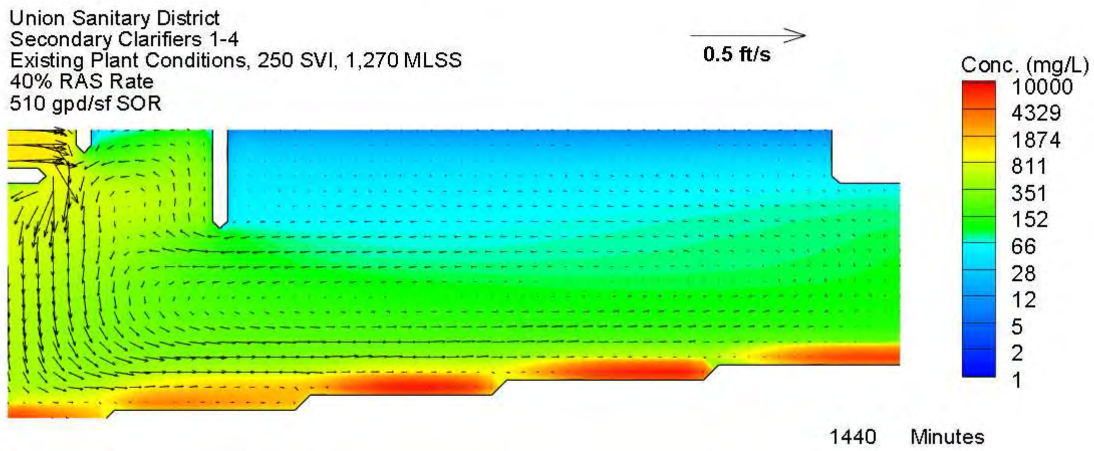
2D Model – Calibration and Validation

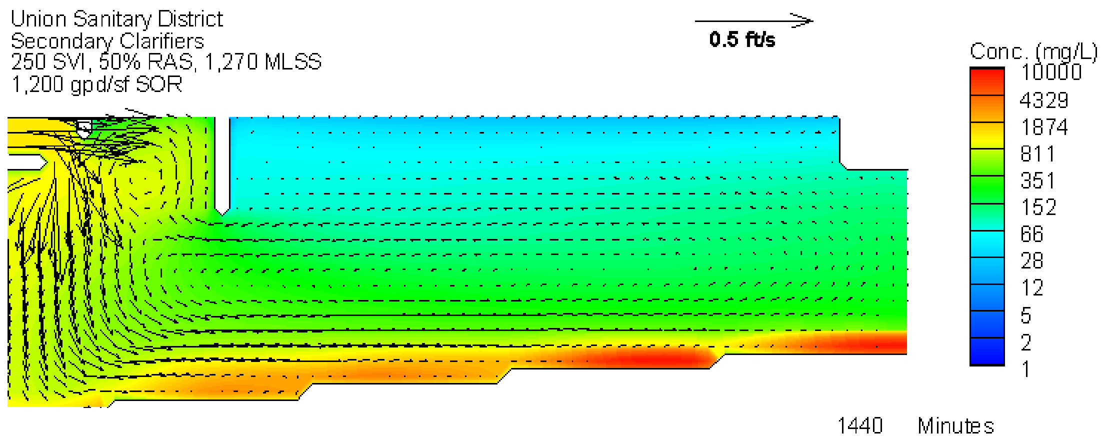


East Clarifiers

East	SOR (gpd/sf)	SLR (ppd/sf)	MLSS (mg/L)	ESS (mg/L)		RAS (mg/L)		Blanket Depth (ft)		Blanket+Dispersed Depth (ft)	
Time Period				Field	Model	Field	Model	Field	Model	Field	Model
Day 2 - Baseline	590	7.6	1,090	16	19	3,200	3,500	2	2	4	5
Day 4 - Stress Testing	870	7.2	900	25	25	No Data	3,050	2	2	8	7

2D Model – Calibration and Validation





CFD Model – Summary

- Two dimensional (2D) models calibrated for East and West clarifiers
  - Good match between observed and predicted effluent TSS, RAS TSS and sludge blankets
  - Three-dimensional (3D) model being calibrated and will be used for verification of selected alternatives

CFD Model – Summary (cont.)

- 2D Models will be used for dynamic analysis and screening of alternatives
- 3D Model will be used for verification of selected alternatives
- 3D Modeling in progress.

What's Coming, Scenario Setup – Initial Level 2 Sizing

Ron Latimer / Paul Pitt

Recap of scenarios

- **Scenario 1**: Capacity of the existing secondary system
- **Scenario 2a**: Capacity of the secondary system with flexible selector operating anaerobically, aeration basin upgrades and step feed
- **Scenario 2b**: Nutrient removal capability with flexible selector operating anoxically
- **Scenario 3**: Secondary system improvements to achieve Level 2 nutrient removal standards
- Refer to assumptions document distributed 8/22

Scenario 3 – Achieve BACWA Level 2

	Normal	Wet Weather	Redundancy
Load	MM	MM	AA
PC TSS removal, %	63	63	63
Temperature, ºC	16	16	20
Basins in service	ALL	ALL	1AB/1SC OOS
Selector operation	Anoxic	Anoxic	Anoxic
Step Feed	No	Yes	Possible
SRT, d	TBD	TBD	TBD
MLSS, mg/L	TBD	TBD	TBD
SVI (ml/gm)	150	150	150

Scenario 3 – 2040 Flow/Load, Level 2 BNR

- Preliminary look at additional infrastructure required
- Will be refined based on detailed sampling and calibration/verification
- 16^{o}C, Max Month Load

Flows and Loads

	2040 – MM Flow and Load		2040 Load and AA flow	
	Load lbs/d	Conc. mg/L	Load lbs/d	Conc. mg/L
MM Flow, mgd	32.2		29	
Peak Flow, mgd	71.4		67.8	
COD	208,900	777	208,900	862
cBOD	75,100	280	75,100	310
TSS	101,000	375	101,000	417
TKN	14,100	55	14,100	61
NH3	10,360	39	10,360	43
TP	2,270	8	2,270	9

Scenario 3 – Achieve BACWA Level 2

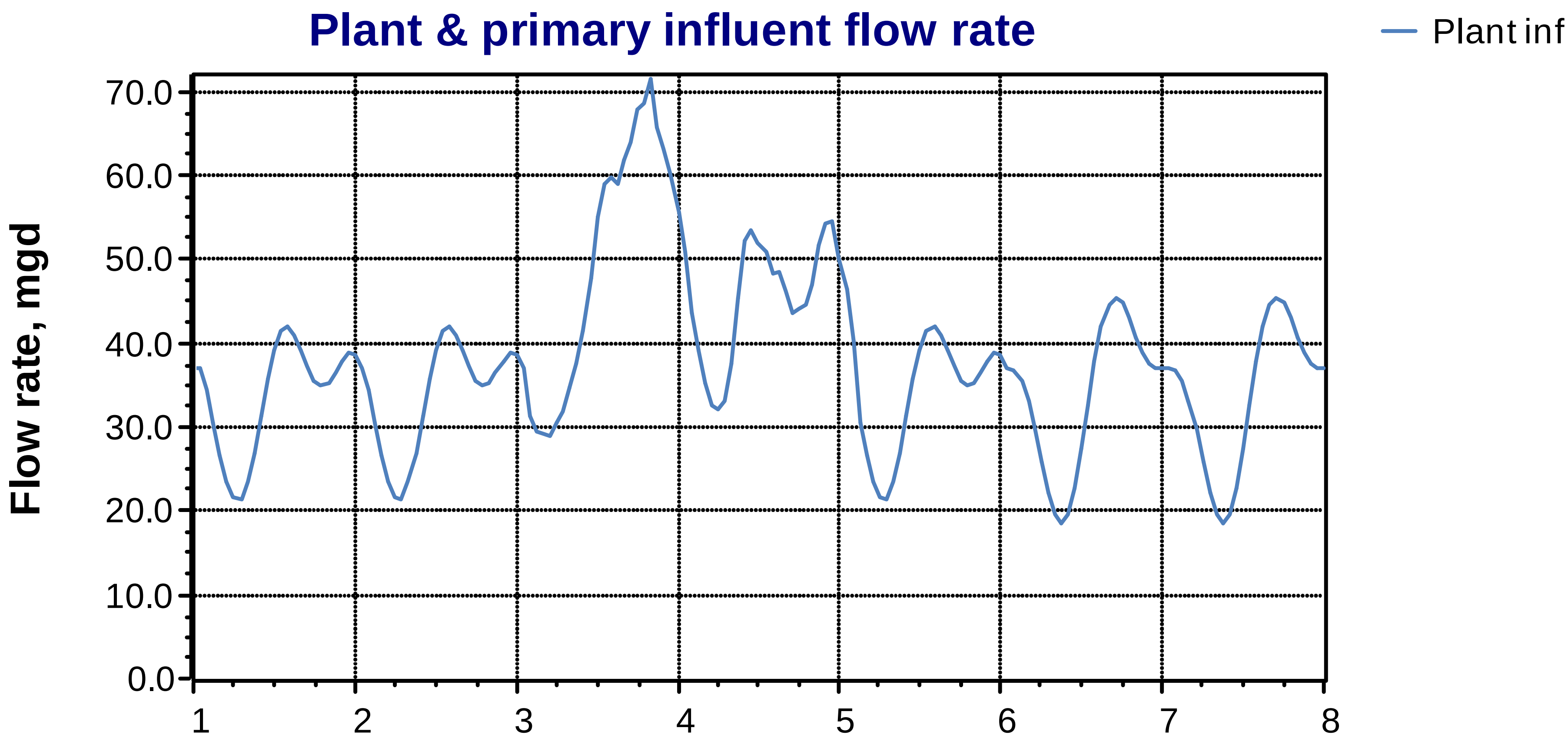
Assume standard is applied monthly

	NH_3-N mg/L	TN, mg/L	TP, mg/L
Level 2	2	15	1

Old Alameda Creek flows during wet weather

	Flows, mgd	cBOD, mg/L	TSS, mg/L
Old Alameda Creek	0-22 mgd (Plant effluent flow greater than 43 mgd up to 65 mgd)	10	15

Scenarios Assumed Hydrograph



BACWA Level 2 Initial Sizing (2040)

	Existing	Hazen Initial Sizing*	Master Plan
New Volume Required, Mgal	--	4 - 7	22.4
Total Volume, Mgal	7.6	11.6 - 14.6	30
Secondary Clarifier		4 new @145’ or Existing + 2 new 160’	6 new @145’

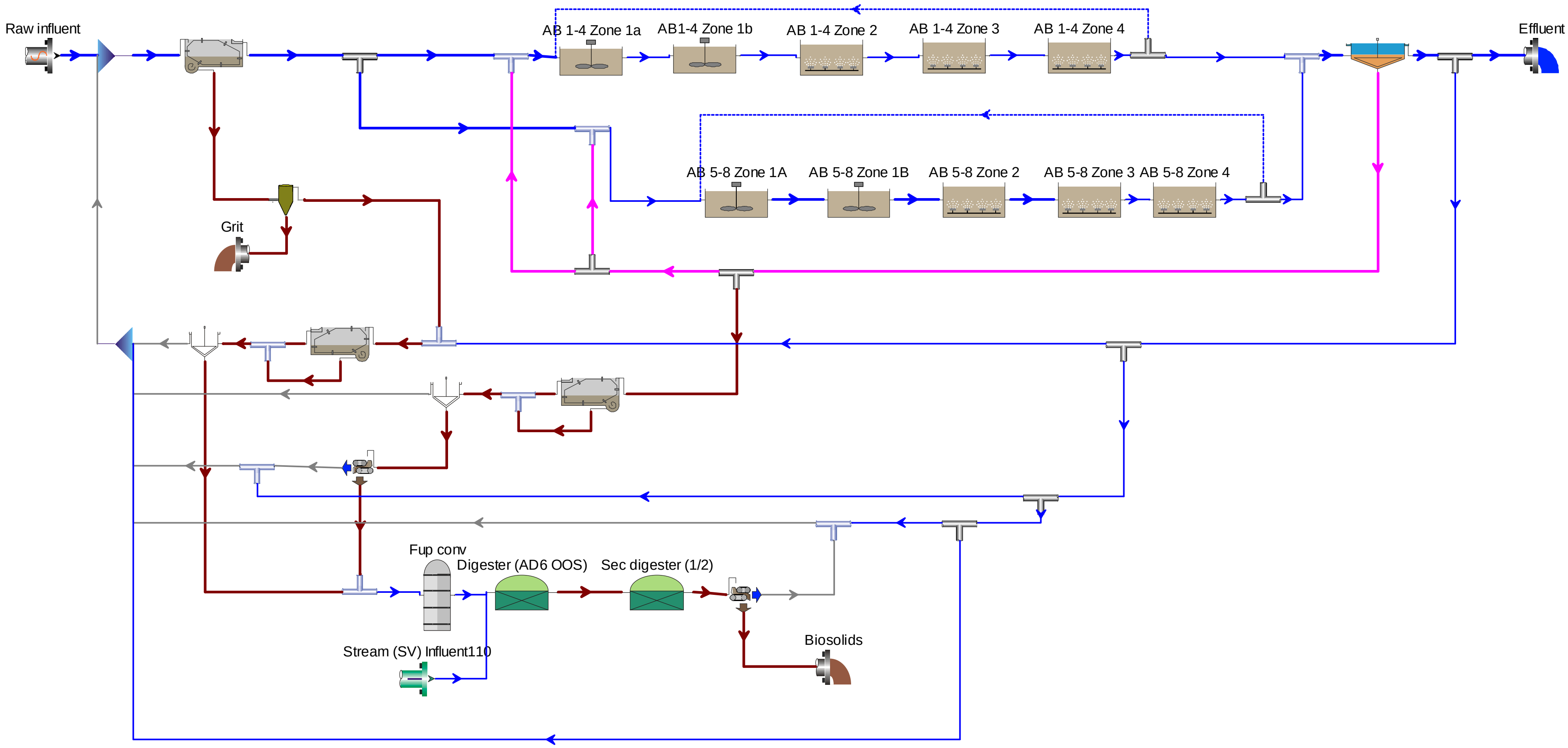
*Based on conservative 7 day aerobic SRT; discussion to follow

BACWA Level 2 Initial Sizing (2040)

	Existing	Hazen Initial Sizing*	Master Plan
New Volume Required with Anaerobic Zone, Mgal	--	6 - 9	22.4
Total Volume with Anaerobic Zone, Mgal	7.6	13.5 - 16.5	30
Secondary Clarifier		4 new @145' or Existing + 2 new 160'	6 new @145'

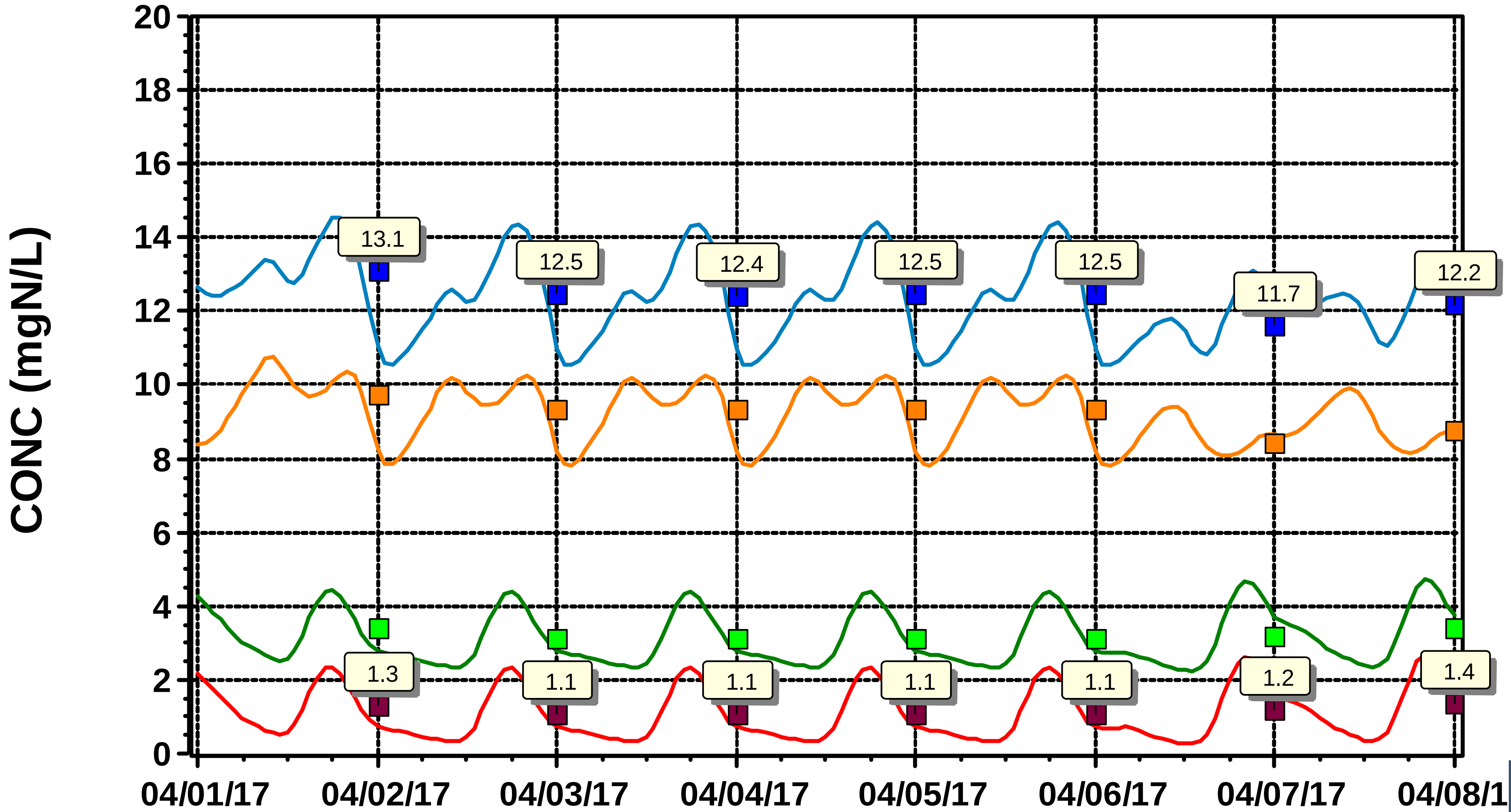
*Based on conservative 7 day aerobic SRT; discussion to follow

Preliminary BioWin Modeling – Level 2 - 2040



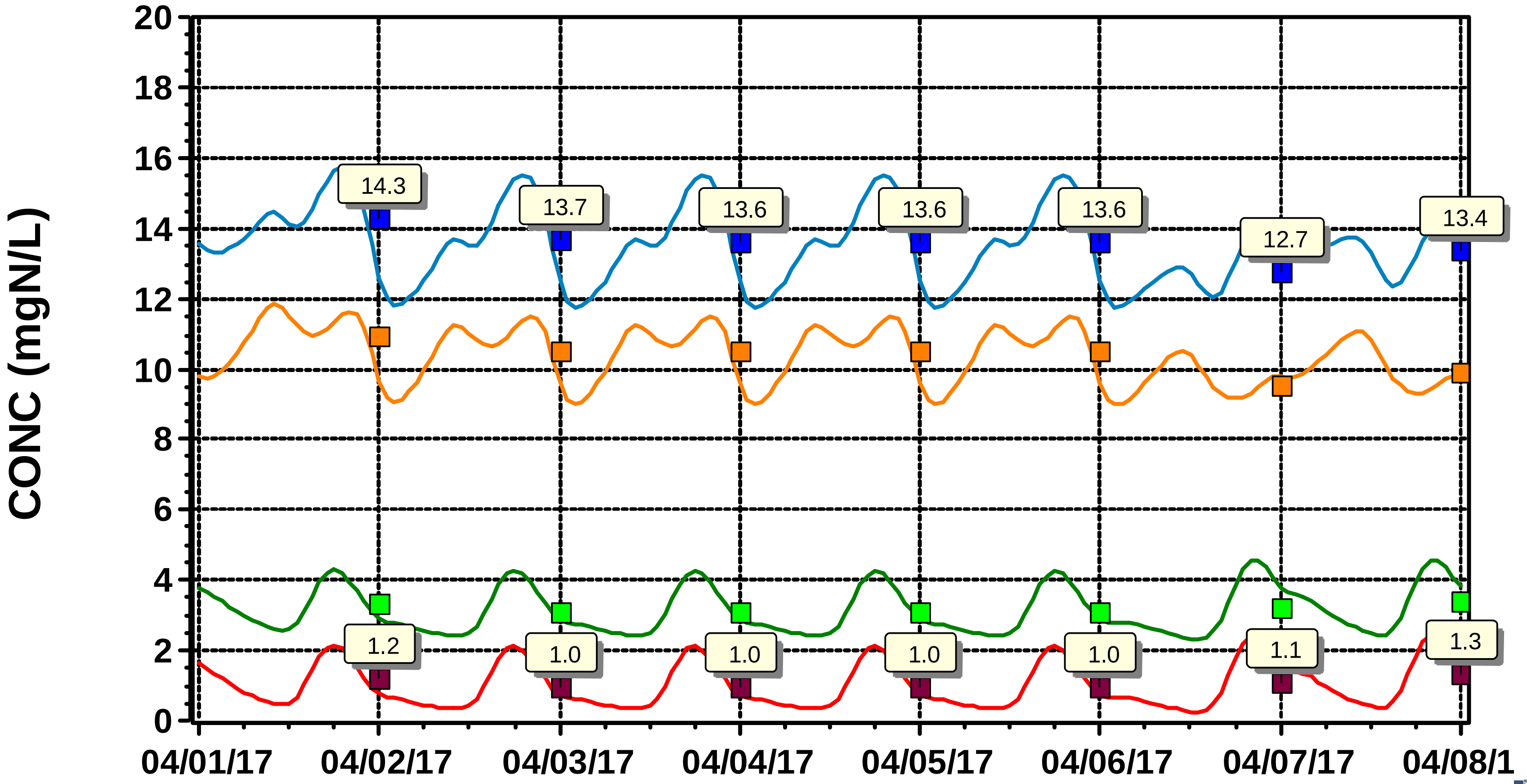
Simulation Results – 2040, MM Q and Load, 16^{o}C

- MLSS = 3,600 mg/L, Aerobic SRT = 6 days
- TN = 12.5 mg/L, NH3-N = 1.1 mg/L



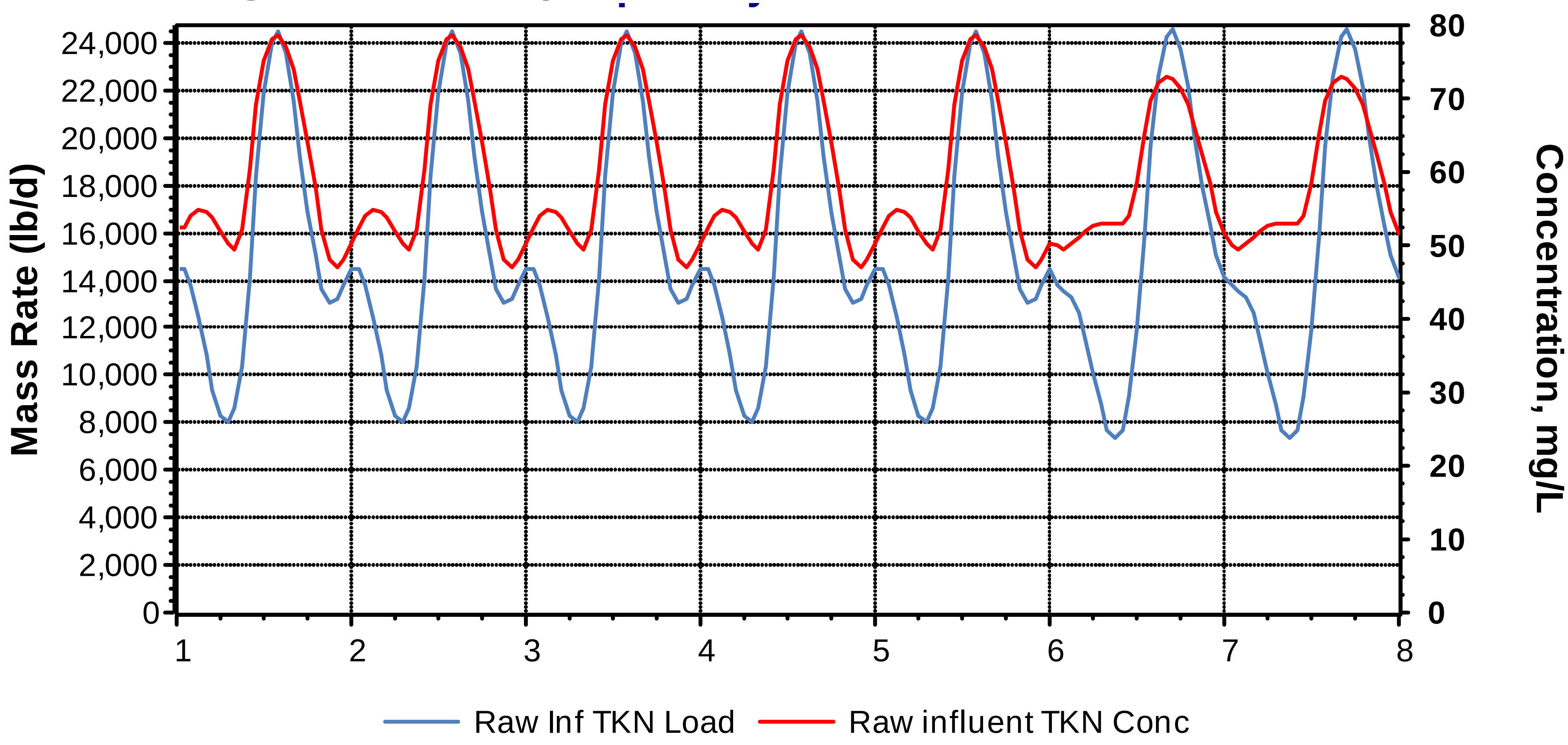
Simulation Results – 2040, AA Q and MM Load, 16^{o}C

- MLSS = 3,600 mg/L, Aerobic SRT = 6 days
- TN = 13.7 mg/L, NH3-N = 1 mg/L

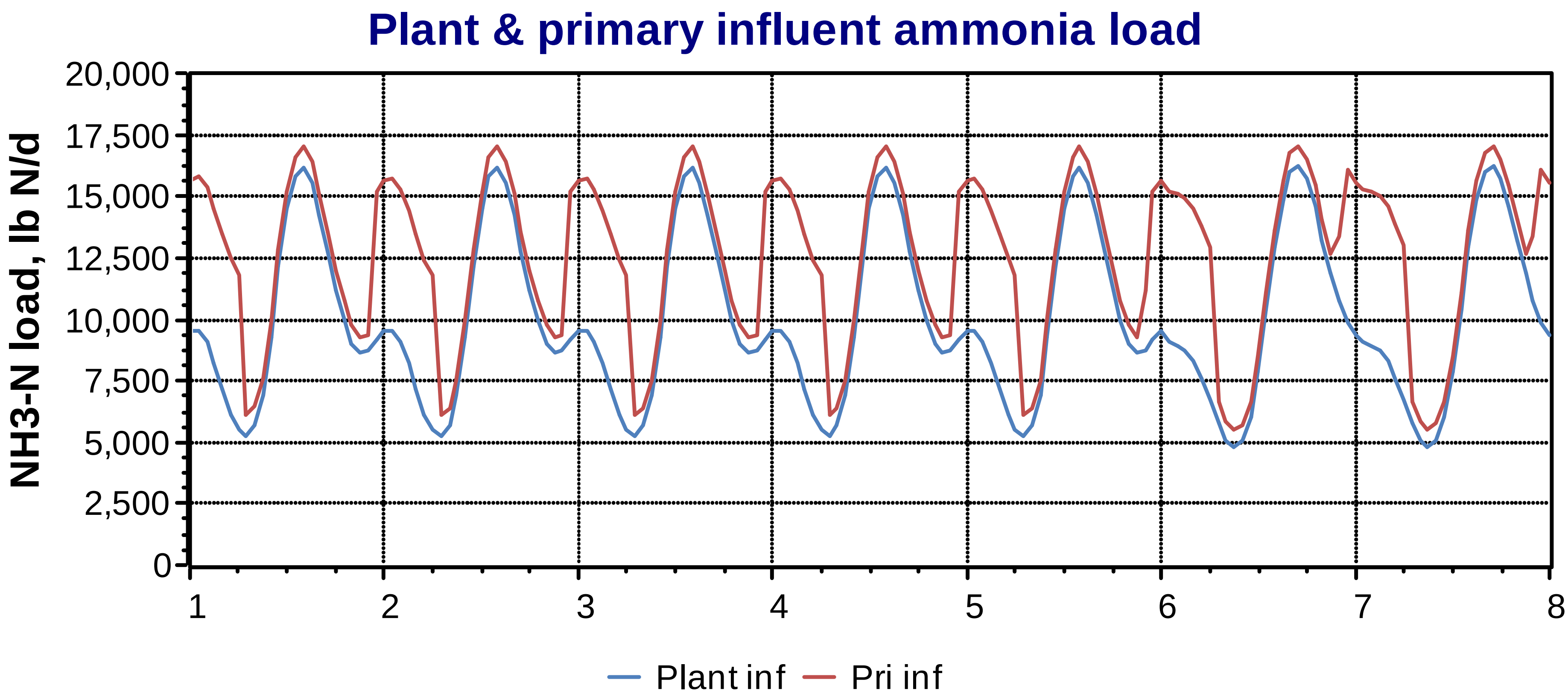


Influent TKN/NH3 - Large Diurnal Swing

- To be confirmed with new data
- Significant impact on diurnal effluent NH3-N

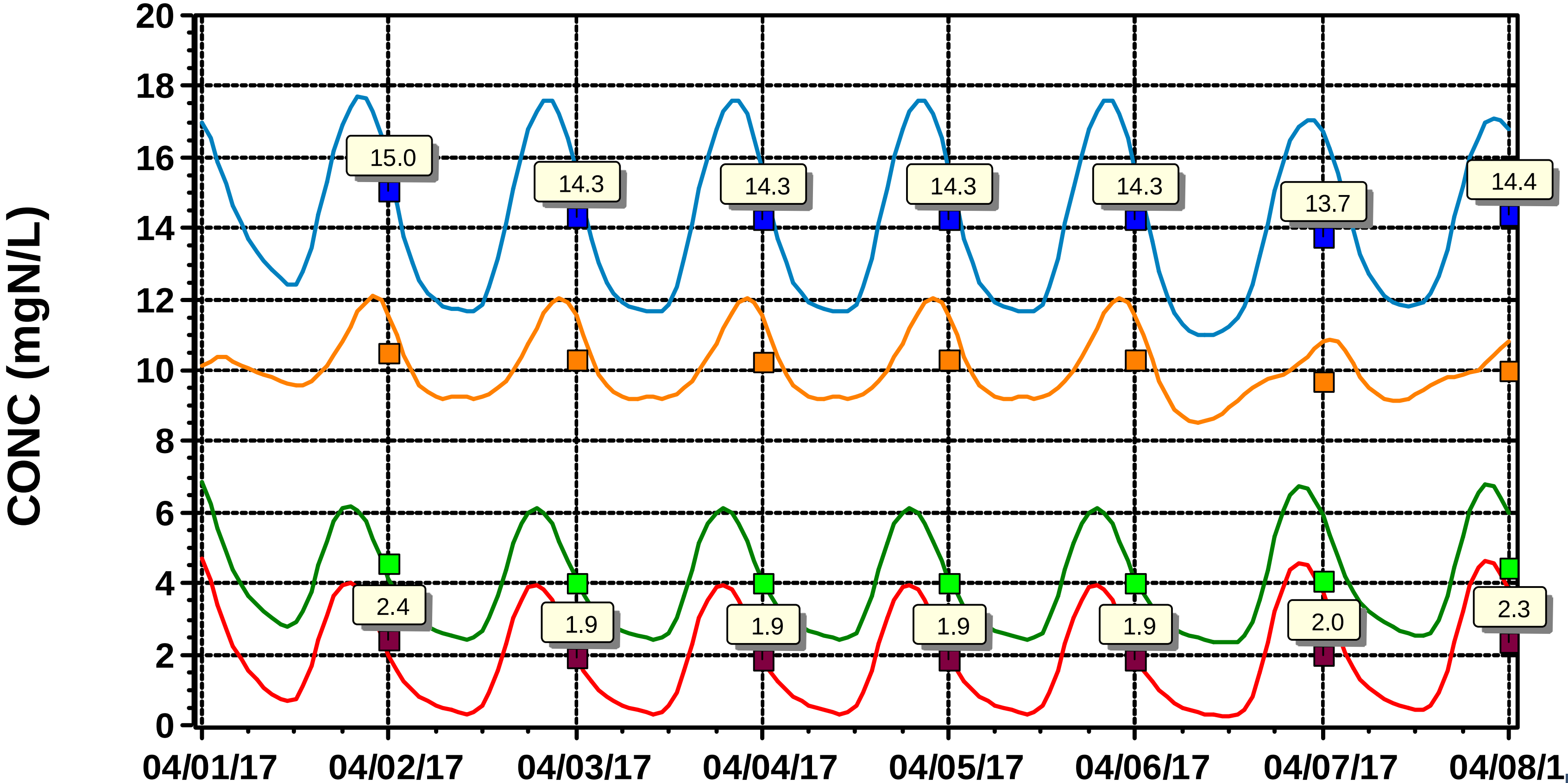


Dewatering at Night Provides Better N Load Distribution



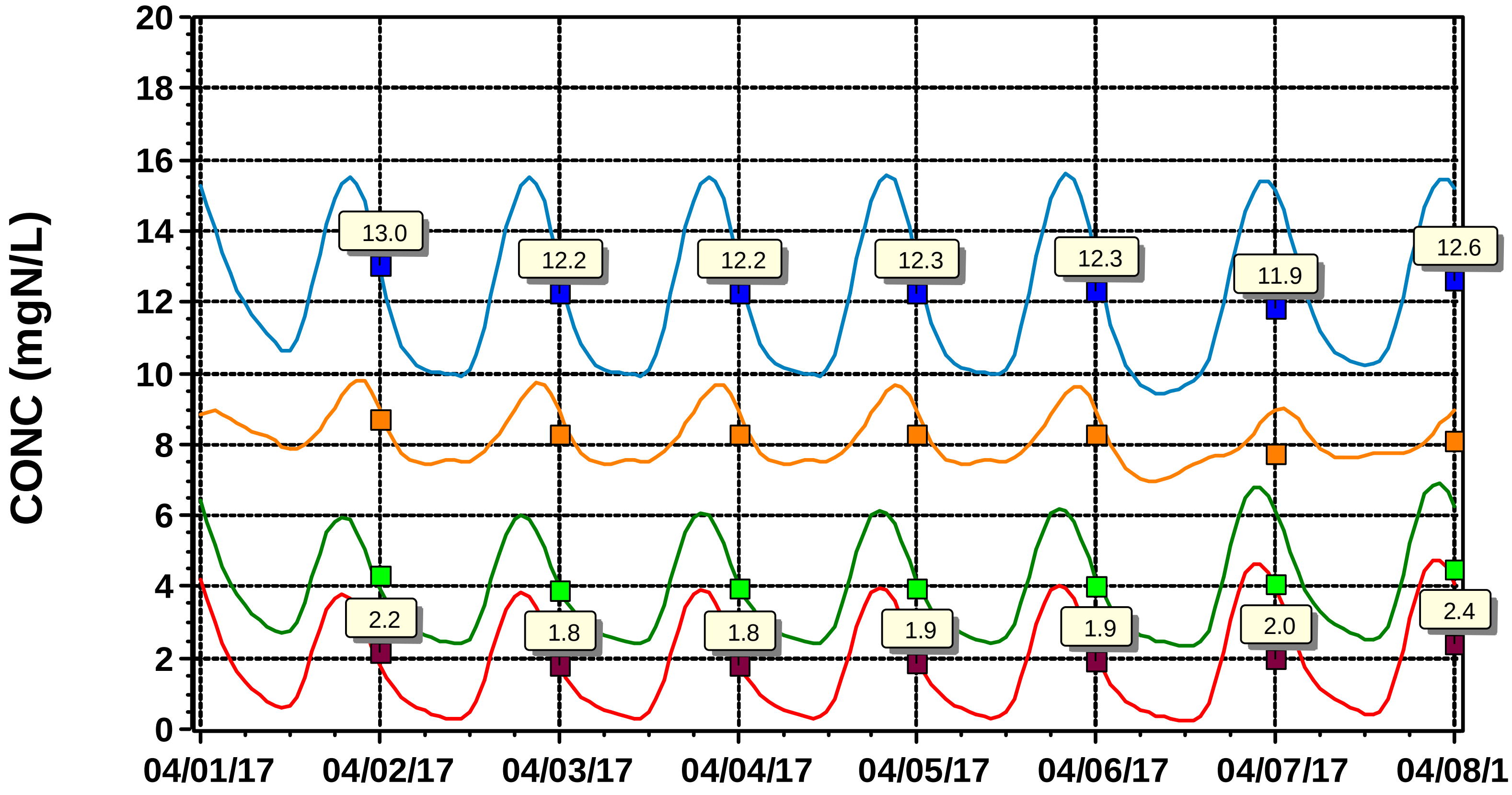
Same Simulation with Centrate Equalized – Poorer Performance

- TN = 14.3 mg/L (was 13.7 mg/L)
- NH3-N = 1.9 mg/L (was 1 mg/L)

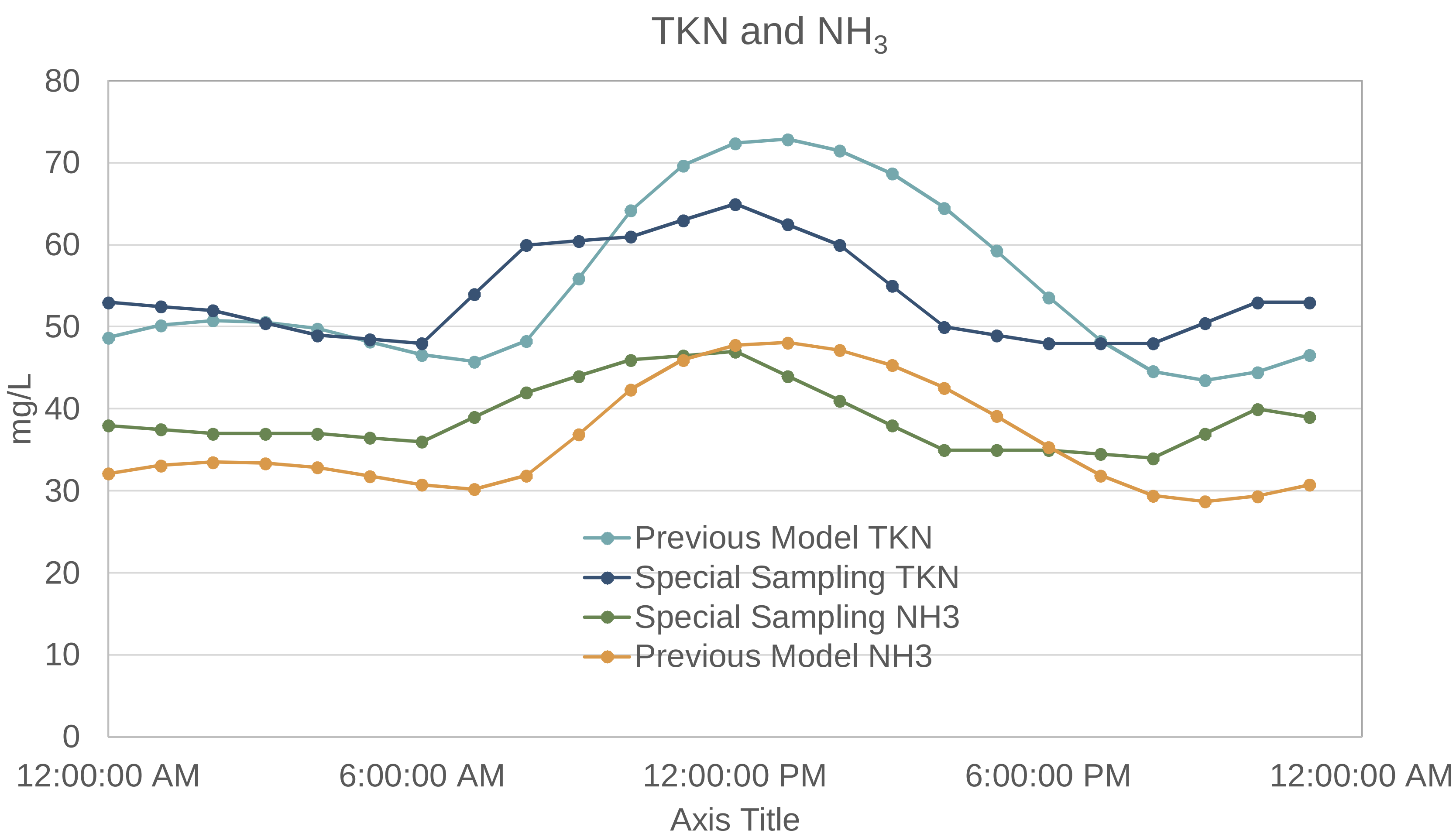


Same Simulation with Sidestream N Treatment

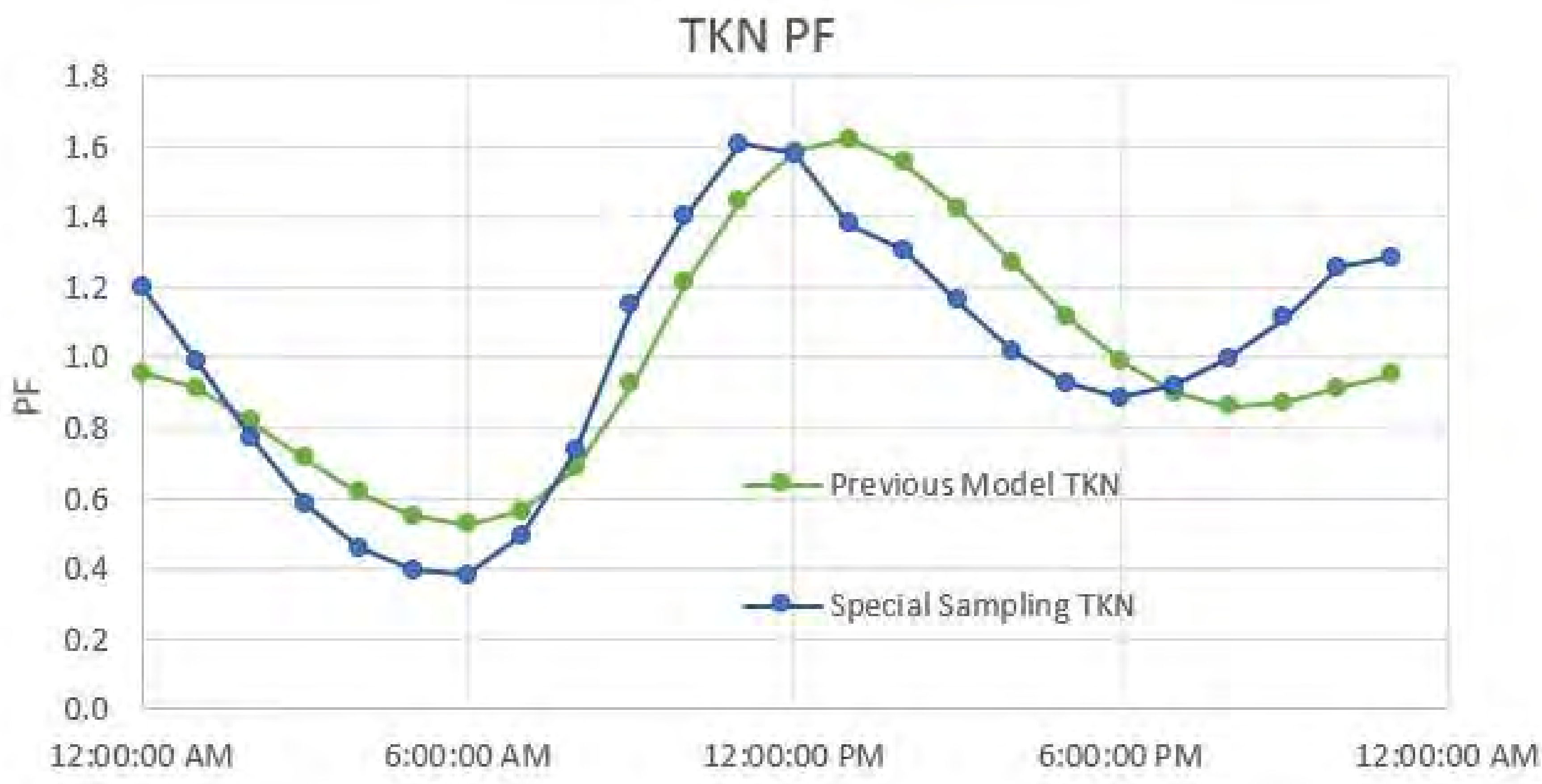
- TN = 12.3 mg/L (was 14.3 mg/L)
- NH3-N = 1.8 mg/L (was 1 mg/L)



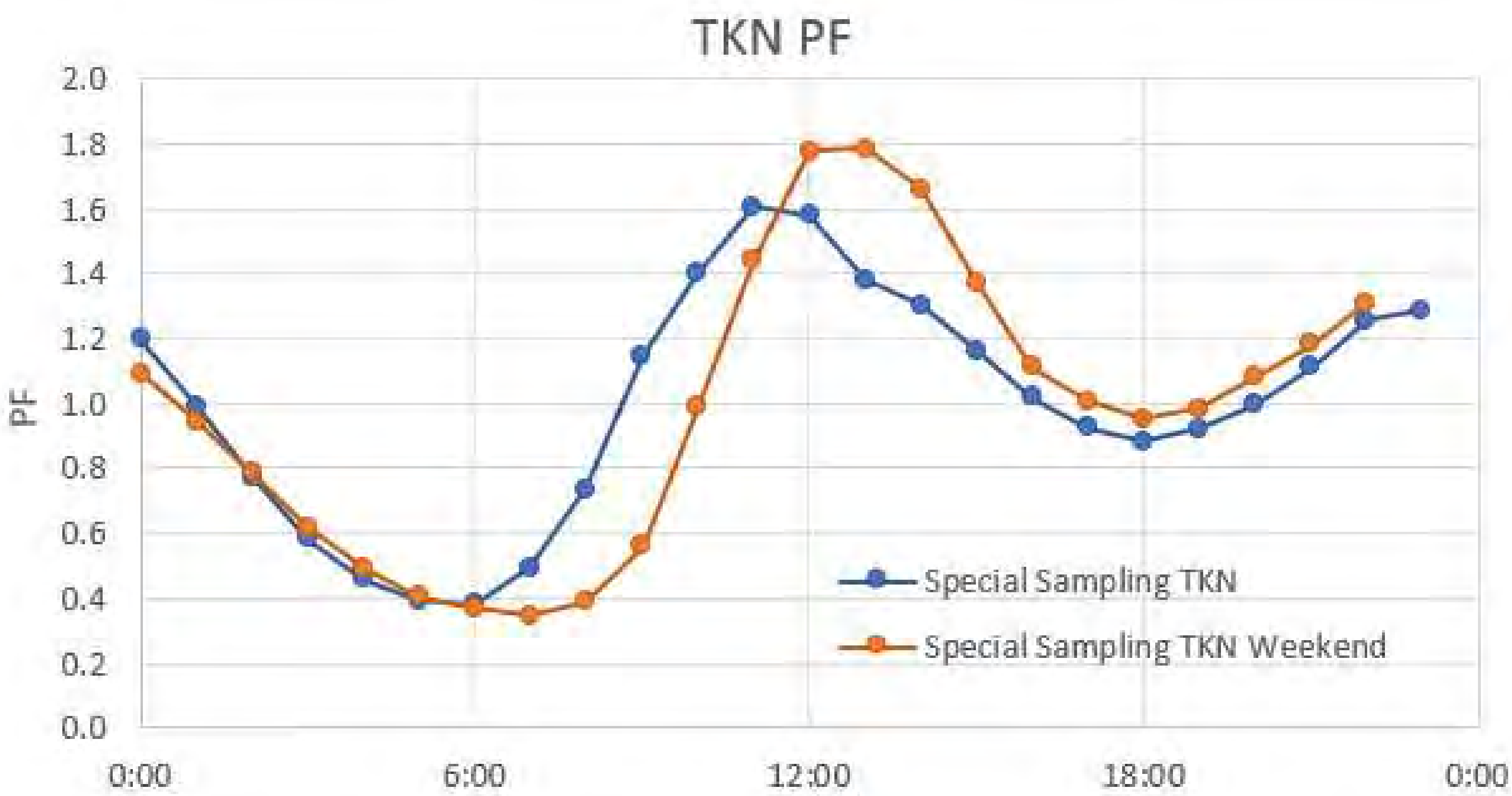
Diurnal Pattern – TKN and NH3-N Concentration Variation



Diurnal Pattern – Peaking Factor Comparison



Diurnal Pattern – PF Weekday and Weekend Comparison



Wastewater Temperature

- Only single daily grab historically?
- Recommend daily monitoring moving forward – significant impacts from BNR perspective
- Since 2007, no values below 19.5°C
- 18°C vs 16°C drops NH3 to < 1 from worse case simulation shown previously

		Plant Effluent Temp, C	
	January	Feburary	Dec
2000	17.4	16.1	18.6
2001	19.7	16.6	19.6
2002	18.1	19.3	19.4
2003		17.8	20.9
2004	18.5	16.7	20.3
2005	16.3	18.8	18.6
2006	17.2	18.1	22
2007	21	20	22
2008	20	19.5	22
2009	20	20.5	21.5
2010	21	19.5	22
2011	21	21	21
2012	20.5	22	21.5
2013	19.5	20	21
2014	21	22	22
2015	22	22	22

Summary

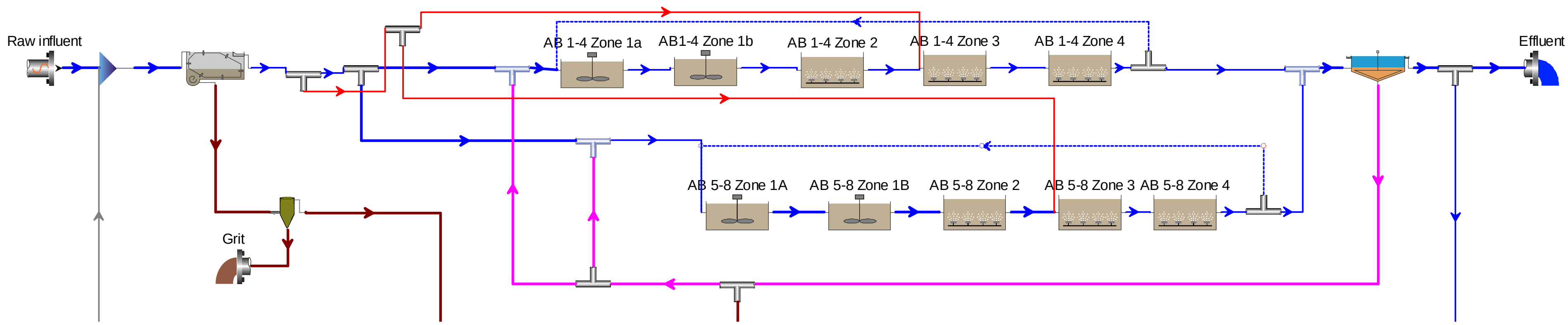
- Initial sizing for 2040, Level 2 BNR
  - 14.6 Mgal total compared with 30 Mgal in Master Plan
- Large diurnal N concentration/loading variation creating NH3 breakthrough issues that should be addressed if real
  - NH3 load equalization (dewatering at night) or larger aerobic volume (stated 14.6 Mgal meets need at 7 day aerobic)

Next Steps

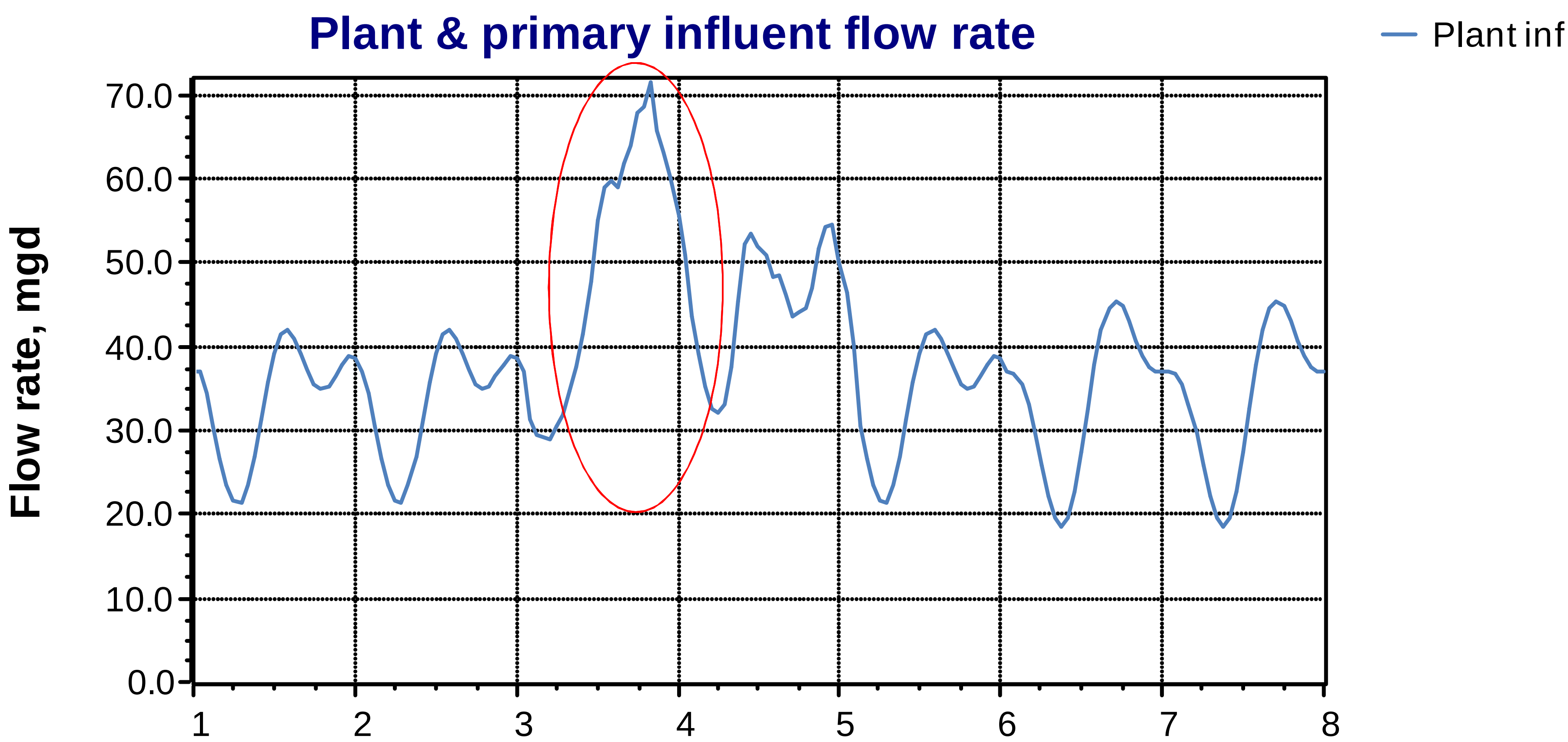
- Repeat design simulations with calibrated/verified model
- Confirm diurnal flow/load pattern and impacts on sizing
- Supplemental sampling and historical data show poorer COD/N ratio in primary effluent than previous model
  - Confirm and evaluate impacts/alternatives to address
  - Larger anoxic, sidestream treatment, fermentation, etc if needed
  - Sensitivity of required volume vs temperature and nutrient requirements.

Wet Weather Step Feed

- Reduce MLSS to clarifiers during peak flow

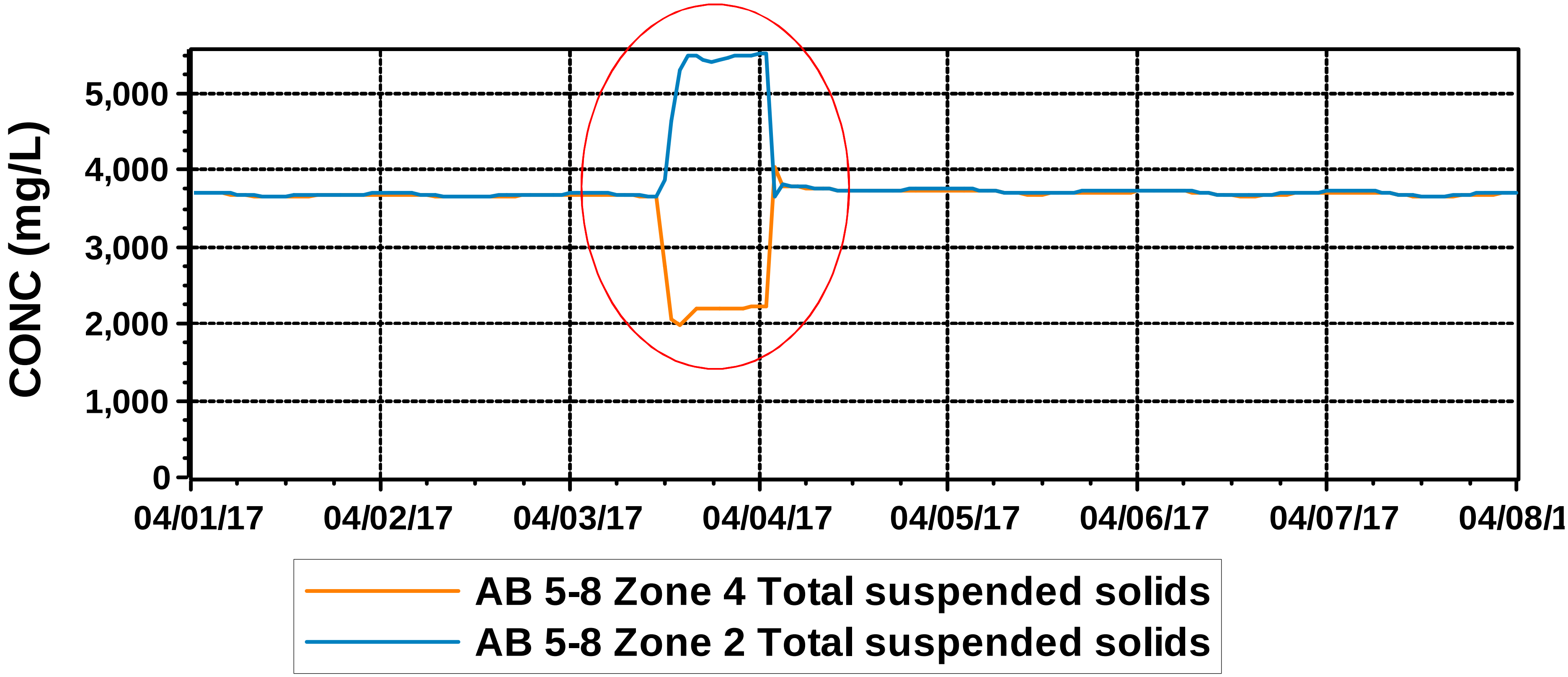


Wet Weather Design Storm



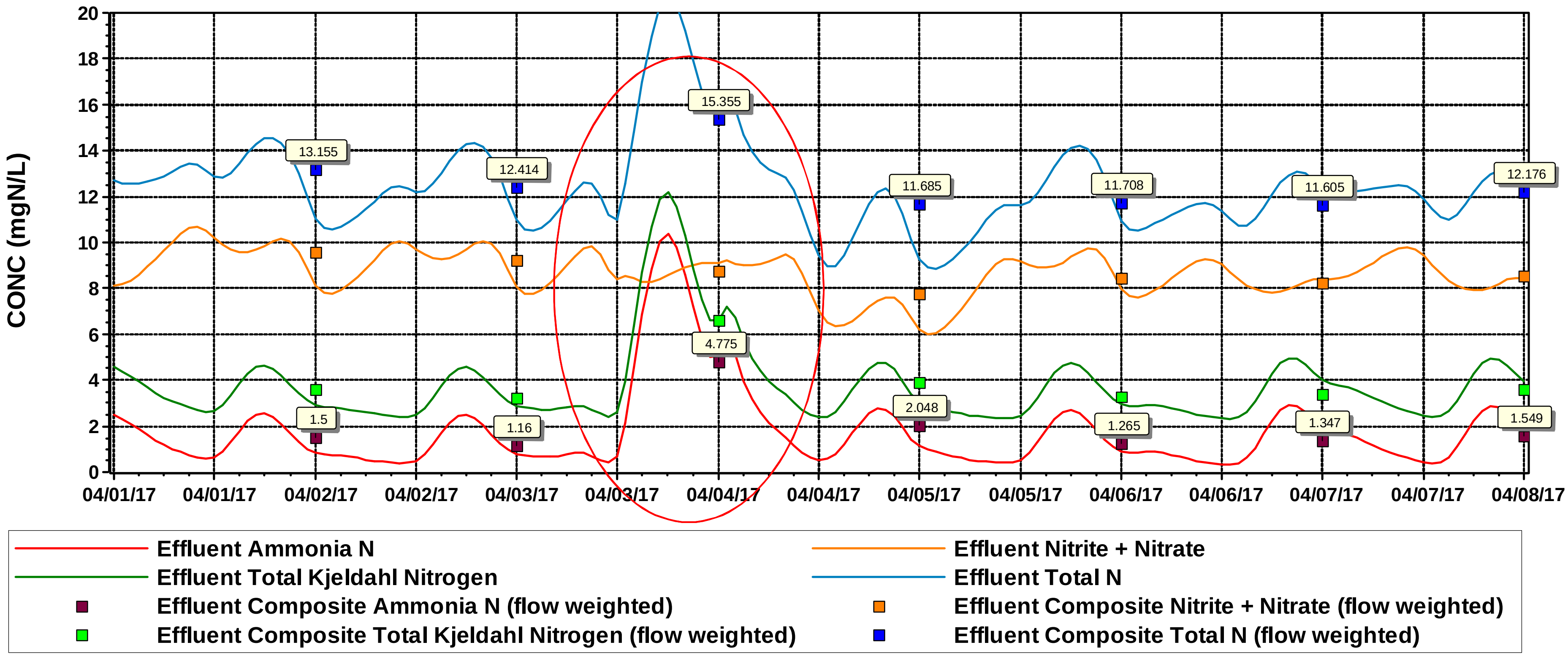
100% Step Feed During Peak

MLSS from 3,600 down to 2,100 mg/L during storm



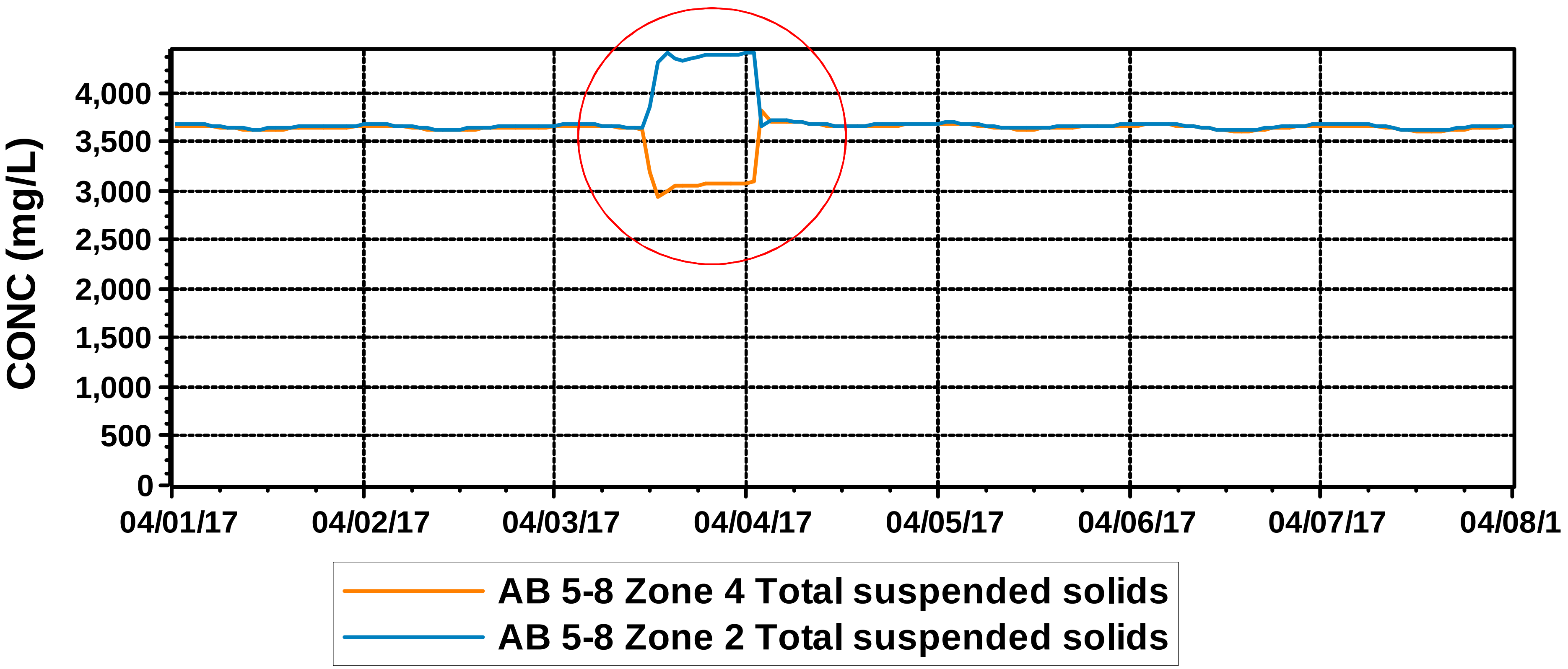
Must consider max day/week NH3 allowable

Peak day NH3 = 5 mg/L, fast recovery after storm



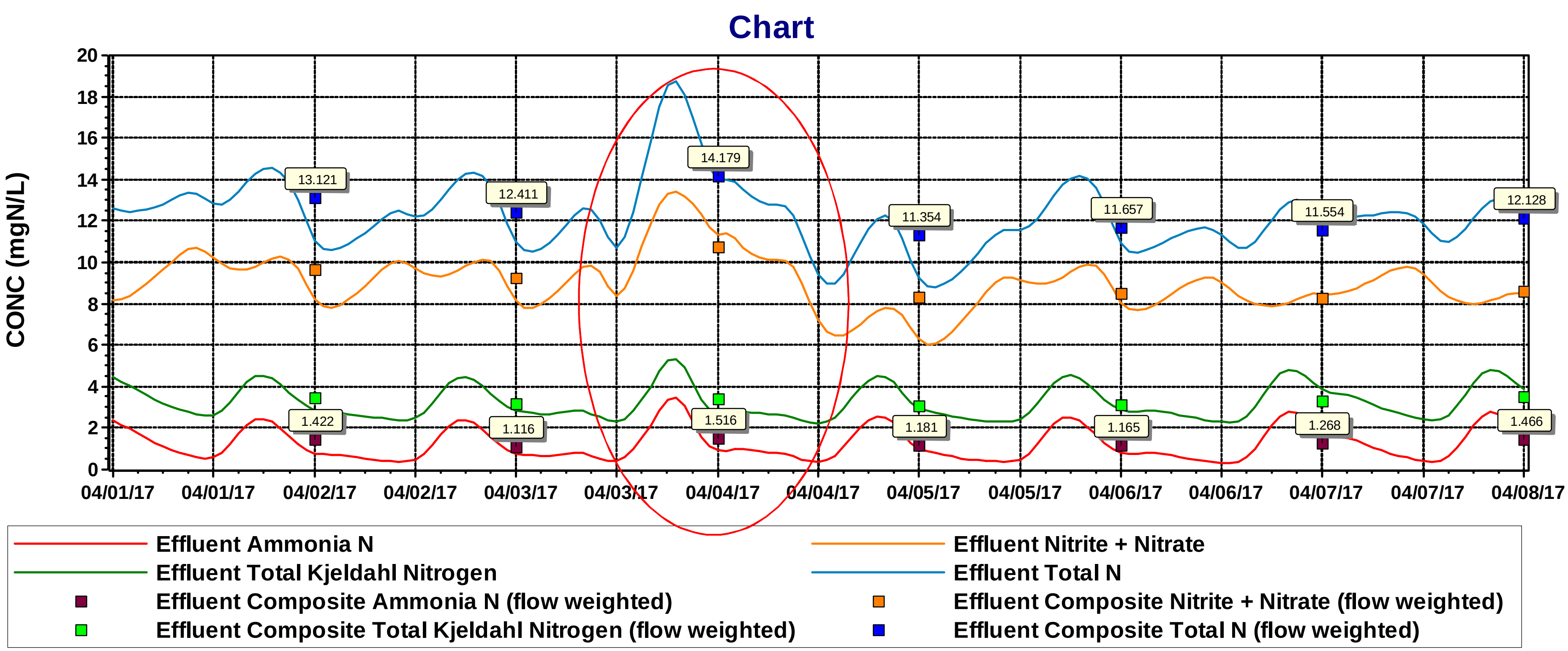
50% Step Feed

MLSS from 3,600 down to 3,000 mg/L during storm



50% Step Feed

Peak Day NH3-N = 1.5 mg/L



Wet Weather Step Feed Next Steps

- Verify assumption related to max day or peak week effluent NH3-N permit limitation
- Link with clarifier CFD model, verify optimum MLSS/clarifier size/aeration volume

Action Items / Next Steps

Marc Solomon

Explore Phase Scope

- Verify existing capacity (Scenario1)
- Near-term improvements
  - Enhance capacity (Scenario 2a)
  - Achieve level 2 nutrients (Scenario 3)
    - Flexible selector
    - MLE, 4 stage, step-feed BNR
    - Chemical P
    - CEPT
    - WW step feed
    - ABAC
    - Sidestream treatment
- Next Workshop: October 24, 2018

Questions?

Hazen *Meeting Minutes*

October 8, 2018

To: Curtis Bosick, USD

From: Irene Chu, Hazen

Reviewed: Marc Solomon, Hazen

cc: Meeting attendees

Re: Comprehend Workshop Meeting Minutes

Hazen presented findings from the Comprehend Phase as well as provided a preview of the future scenarios to be evaluated in the Explore Phase. The meeting agenda and presentation are attached to these minutes. Note only discussion points are summarized here, for presentation key points please see attached slides.

Introduction/Executive Summary

- Explore Phase workshop is set for October 24
- Key findings from each module of the presentation were summarized in the Executive Summary.

Historical Data

- Historical data was reviewed. Data was consistent and provided confidence in flows and loads defined for scenarios and assumptions.
- Mass balance around the primary clarifier showed good agreement. Primary clarifier pollutant removal was reviewed and agreed upon. Prior to the start of the analysis, there were questions about the thickened primary sludge flow data.
- Periodic nitrate in the final effluent was noted to be observed when the sample tubing has some algae growth. The District noted once this was understood, a regular cleaning program was established.
- Data was consistent and provided confidence in defining assumptions for modeling and sizing for the scenarios.
- TWAS load showed 73% capture of WAS load over two unit processes (consistent with 85% capture over each process on average). It was noted by the District that the TWAS flow meter was faulty and was fixed 18 months ago.

Job no

BioWin Sampling

- It was noted that during the period of sampling the District was able to maintain stable operations which helped to provide reliable data.

- Orthophosphate release was observed in the gravity thickener overflow and in the GBT filtrate. While fermentation in the gravity thickeners is possible, composite sampling of the influent, primary influent and primary effluent did not show an increase in soluble COD from the recycle stream.
- Data showed good agreement with applicable historical data. Information was used to determine influent fractionation from modeling.

BioWin Calibration

- Hazen changed two main parameters from the previous model to better match historic data in the yearly dynamic simulation.
- Changes to the unbiodegradable particulate fraction were undertaken to match the observed VSR at the plant.
- Digester gas predicted to be 15% greater than historical plant data. Plant staff noted that the meters are suspect and that they are looking at getting new gas meters. *Additional information on gas flow data was provided subsequent to the meeting. The digester gas measurement is greater than the cogeneration gas measurement.*
- Digested sludge load was predicted to be higher than historical data. While it was noted that struvite formation does occur (on walls and floors) and is removed during routine cleaning, it would not account for the 15% difference in digested sludge load. Cake was noted to contain struvite crystals indicating struvite formation in the sludge matrix as well.
- The number of aeration tanks in service did not change significantly during the selected period of model calibration.
- Poor settling is not accounted for in the process model. A yearly average of the secondary clarifier removal was used in the ideal clarifier representation for calibration. The SVI and settling characteristics of the sludge is captured in the CFD secondary clarifier model. We use the 2dc and 3D clarifier model instead of the clarifier model in BioWin™ because it is a more powerful tool. When modeling the scenarios we will link the process and clarifier models to simulate performance under different mixed liquor concentrations, SVI, and flow conditions. Note that the assumptions previously presented had selected SVIs to model performance based on historical data and assumed (based on experience) values for future scenarios after the flexible selector has been installed.

Filament Analysis

- Filament analysis confirmed plant observations of dominant levels of Type 021N with little to no chlorine damage despite high chlorine dosage. This may indicate that chlorine mixing and or frequency of exposure is not adequate for effective RAS chlorination. USD doses at greater than 10 lbs Cl_2 /1,000 lbs of solids. The District noted that optimization of the RAS chlorination system would be an immediate solution that can increase capacity. The chlorine is dosed to the wet well near the suction side of the RAS pumps.

- Some Bio-P was observed indicating anaerobic conditions are occurring in the channel feeding the aeration basins.

Stress Testing Results

- Stress testing was successful in that data calibration/validation was gathered along with sludge settling, compression and flocculation properties. The collaboration with operations and the quick turn around with lab analysis was tremendous in getting the analysis and model calibrated for this meeting.
  - Day 2 normal operation was observed.
  - Day 3 the west clarifiers were stressed reaching SORs greater than 1,200 gpd/sf. The west clarifiers performed well during the test period.
  - Day 4 the east clarifiers were stressed reaching SORs greater than 1,000 gpd/sf. The stress test lasted 4 hours as blankets continued to rise. Clarifier 6 blanket blow out was observed.
  - While high SORs were reached because the MLSS was maintained around 1,000 mg/L the SLR to the clarifiers remained low during testing.
  - The west clarifiers performed better than the east clarifiers.
  - Profiles indicate that while SVI is a factor, there is compaction in the west clarifiers. The east clarifiers did not show compaction due to the turbulence from the draft tube configuration.
  - DSS testing showed that there was some floc break up in the clarifiers
  - Flocculation testing indicated that even with ideal conditions and maximum flocculation time, the current theoretical limit for clarifier performance is around 12 mg/L. Due to dispersed material that can be expected from low SRT plants, these clarifiers cannot be expected to reach 5 mg/L.
- Stress testing results show that there are improvements that can be made to the clarifier internal structure to improve performance. Modifications made by the District to the effluent weirs at the corners of the clarifiers and to the centerwell were helpful.

CFD Modeling

- The 2dc model has been calibrated and the 3D model will be used to confirm the results.
- During this summer it appears the RAS chlorination was not as effective as in the past. Operation noted that the flow paced RAS system went into place in December of 2017. It is possible with the new system there is less mixing because the wet well level is so variable. The chlorine dosage point is not visible.

What's Coming

- An initial evaluation of Scenario 3 was performed in parallel to the sampling and calibration effort. The scenarios were analyzed using the existing model. The analysis is framed by scenarios as defined in the assumptions document:
    - Scenario 1 – Existing system capacity
    - Scenario 2a – Near-term improvements to gain capacity (anaerobic selector)
    - Scenario 2b – Nutrient performance if the selector is operated anoxically during dry weather (Interview Option)
    - Scenario 3 –Required to meet Level 2 nutrient removal.
- Assumptions on effluent targets:
- BACWA level 2 standards were assumed as targets that will be met during the coldest month. This is the most conservative assumption as a seasonal or annual average standard would be more relaxed.
- It is assumed that discharge to Old Alameda Creek will only be when flows are greater than 43-mgd. The District noted that negotiations with the Regional Board are aiming for year around discharge above 35-mgd. Hazen noted that the limits will be met under worse case conditions.
- Hazen noted that only a $cBOD_5$ and TSS standard was specified for Old Alameda Creek. The District noted that while negotiations are still pending, an assumption of a TN of 15mg/L is reasonable for the Creek discharge. For the Creek, a daily ammonia limit, will likely be the biggest issue given the diurnal swings and potential ammonia break-through. Lab staff noted that ammonia toxicity will be the driving force for limits to the Creek. The direction is to proceed without a daily ammonia standard while determining the required infrastructure to meet the daily limit to support negotiations with the Regional Board.
- The diurnal concentration peaking factor is unusually high in the existing model. Special sampling showed less of a concentration change but still a significant load change. The diurnal pattern results in the system being susceptible to ammonia breakthrough. Dewatering in the evening helps with nitrification performance. The large swings in loads may be indicative of a tight collection system that does not have much I&I and has a short retention time. Equalization of load in the collection system may be helpful in attenuating this. The District's two large pump stations, Irvington and Newark, are possible locations where collection system equalization could possibly be implemented. The District is in the process of selecting a consultant to work on the equalization project. This can be modeled to show a delta in volume needed. A cost analysis can be performed to show if it is an effective option in the Converge Phase.
- Temperature data was discussed. Data provided was from one measurement a month. The temperature will affect the SRT needed to maintain nitrification. This translates to volume and cost. Staff will check if any other temperature data is available. *Subsequent to the meeting, lab temperature data was provided. Readings were not in-situ or daily.*

- A range of sizing for BACWA Level 2 was presented and it showed significant savings over the volumes presented in the master plan.
- Wet weather BACWA level 2 modeling was presented. Two levels of step feed were shown:
    - 100% of PE flow entering at 50% of the aeration basin volume. Initial results show significant drop in solids loading to the clarifiers and ammonia breakthrough during the storm event. The ammonia breakthrough may not work if there is a daily or weekly ammonia standard for the creek.
    - 50% of PE flow entering at the head of the aeration basin and 50% of PE flow entering at 50% of the aeration basin volume. Initial modeling shows no ammonia breakthrough during the storm event but less SLR reduction during the storm. This option will need to balance with the clarifier modeling.
- Engineering and operational staff inquired about what is needed for today since nutrient removal is further in the future. This would be evaluated under scenarios 1 and 2a. Management noted that nutrient removal may be needed by 2024 for Old Alameda Creek. Load caps are expected in the next permit cycle, 2024, at 2019 loading levels.

Appendix 8. Explore Phase Workshop Presentation

Hazen

Secondary Treatment Upgrade Project – Explore Workshop

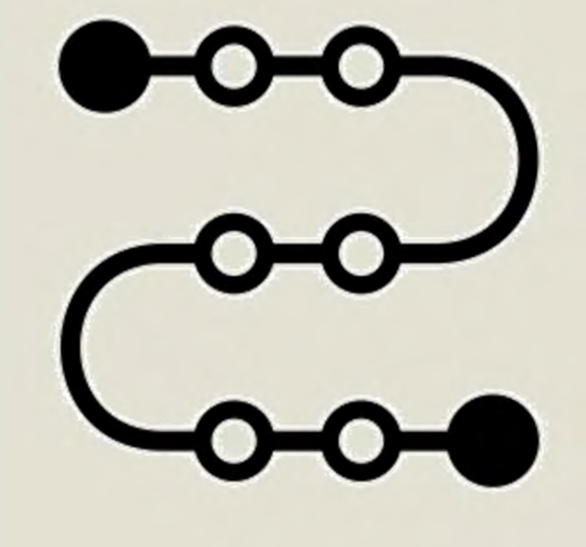
October 24, 2018

Agenda

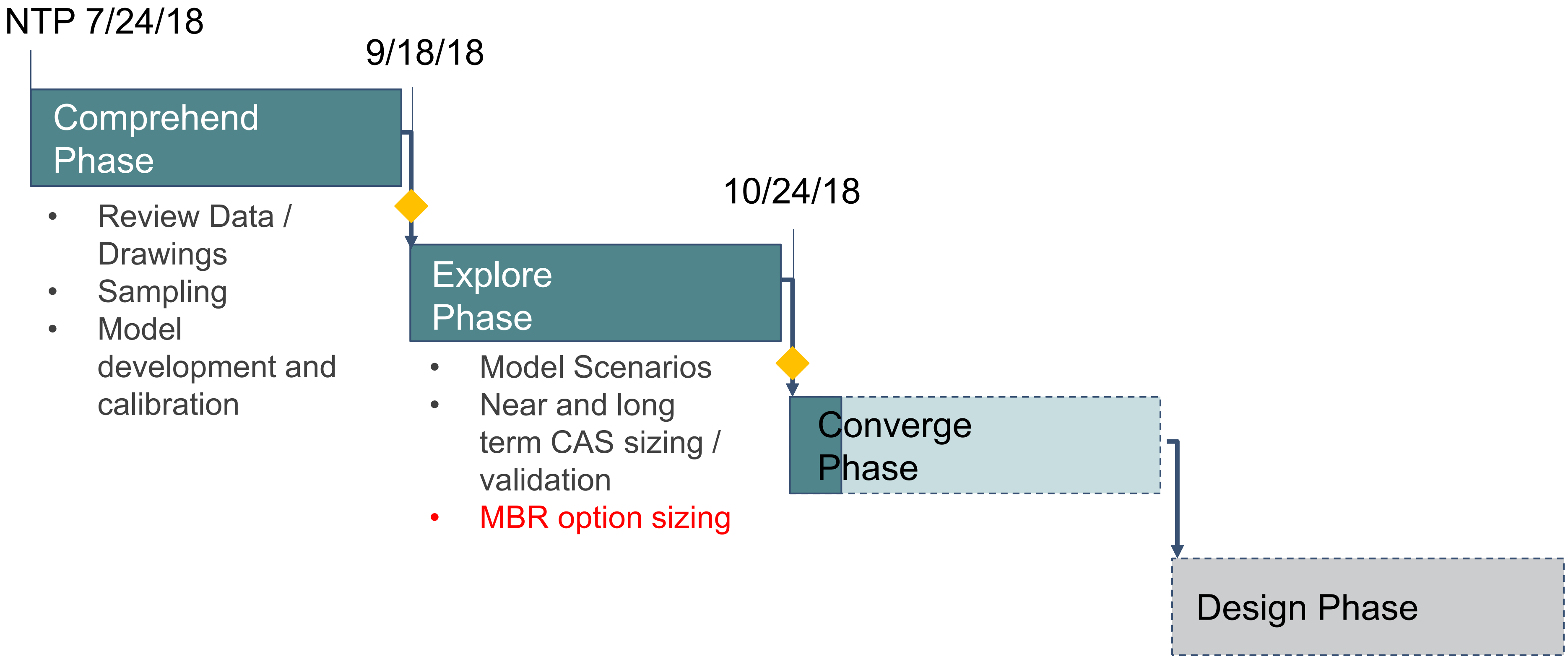
Topic	Duration
1. Status / Timeline	11:00 AM– 11:10 AM
2. Recap of Comprehend Phase	11:10 AM – 11:30 AM
3. Scenario 1 – Existing Capacity	11:30 AM – 11:50 AM
4. Scenario 2 – Modified System Capacity	11:50 AM– 12:25 PM
10 Minute Break	12:25 PM – 12:35 PM
5. Scenario 3 – Level 2 Requirements	12:35 PM – 1:35 PM
15 Minute Break	1:35 PM – 1:50 PM
6. Scenario 4 – MBR Option	1:50 PM – 2:15 PM
7. Layouts	2:15 PM – 2:40PM
8. Next Steps / Summary	2:40 PM – 3:00 PM

1. Status / Timeline

Marc Solomon



Timeline



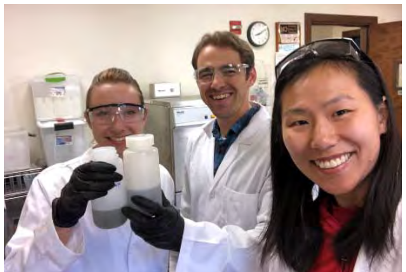
NTP 7/24/18
9/18/18
Comprehend Phase
• Review Data / Drawings
• Sampling
• Model development and calibration
10/24/18
Explore Phase
• Model Scenarios
• Near and long term CAS sizing / validation
• MBR option sizing
Converge Phase
Design Phase

2. Recap of Comprehend Phase

Paul Pitt

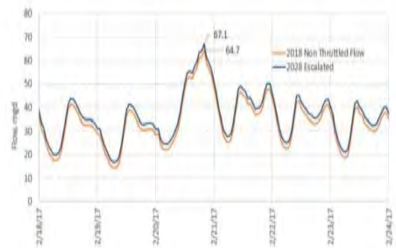
Recap of Comprehend Phase

NTP
7/24

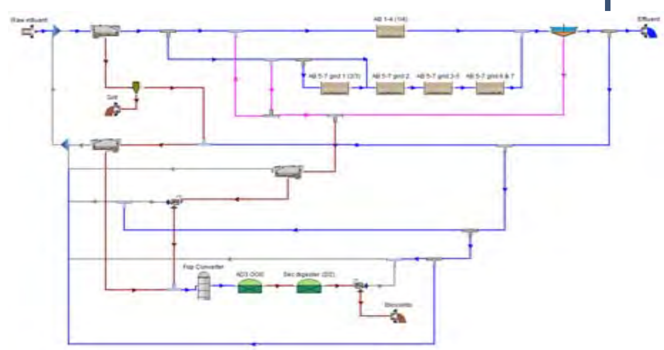


BioWin™ Sampling

Stress Testing

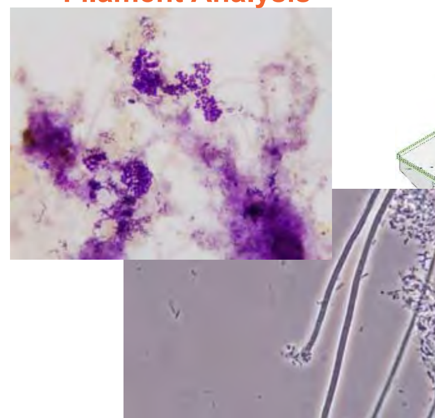


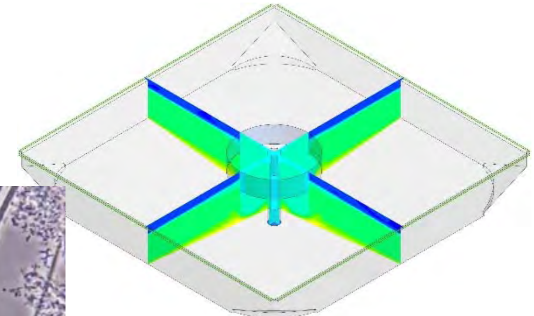
Defined flow and load projections



Biowin Modeling

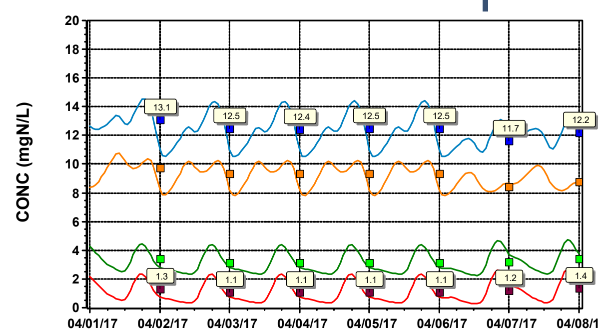
Filament Analysis





CFD Modeling

Scenario Peak



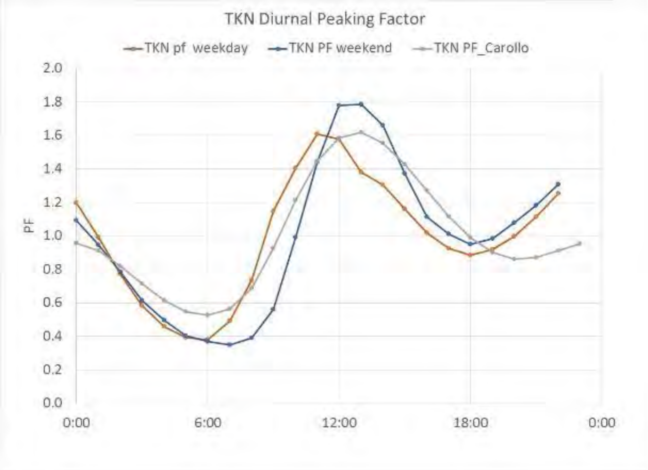
MTG1
9/18

Recap of Comprehend Phase - Historical Data

- Influent ratios make sense and are consistent with expected values for municipal wastewater
- Observed yield and sludge production data makes sense
- Overall historical data quality gave us confidence to calibrate the model and develop flows and loads.

Recap of Comprehend Phase - Biowin Special Sampling

- Special sampling results correspond to historical averages
- PE $cBOD_5$:TKN (3.1) at lower end of typical range (4 – 8)
    - Understand the implications on meeting Level 2 standards
- Gathered critical data on weekday and weekend influent diurnal pattern

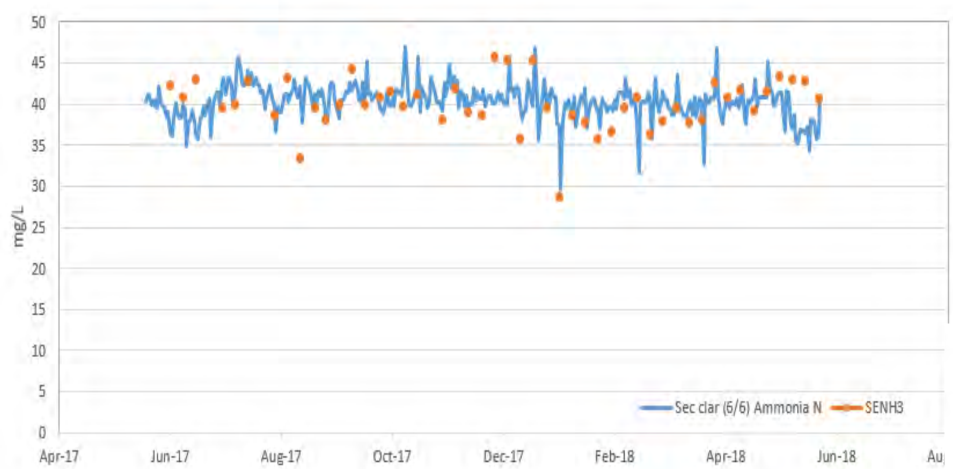


Recap of Comprehend Phase - Biowin Model Development

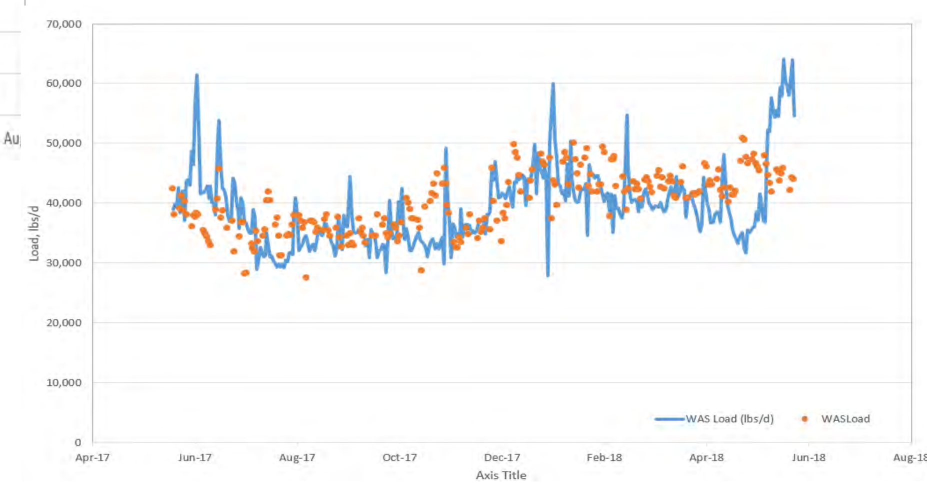
- Increased rbCOD (improves nutrient removal) based on special sampling information
- Increased inert particulate COD (increases solids production)
- Annual daily dynamic and steady state models closely match operating data
- High confidence that the model accurately predicts nitrogen and phosphorus removal and solids production

Recap of Comprehend Phase - Biowin Model Development

Confident that model accurately predicts nutrient removal and solids production



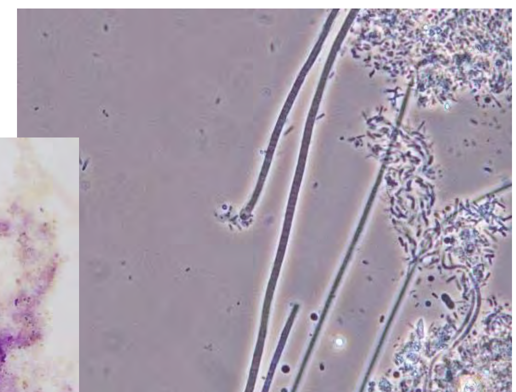
Yearly dynamic Effluent ammonia simulation

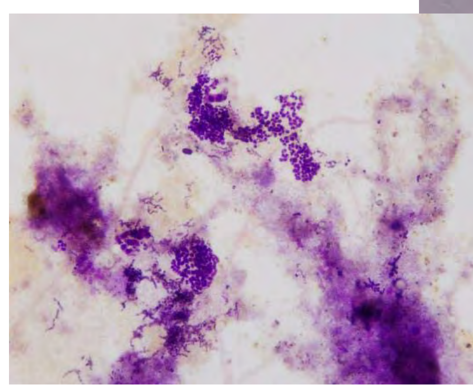


Yearly dynamic WAS load

Recap of Comprehend Phase – Filament Analysis Summary

- Analysis were consistent
- Confirmed Type 021N was dominant filament typically with no sulfur granules
- Not much chlorine damage observed despite dosage
- Some variable bio-P population



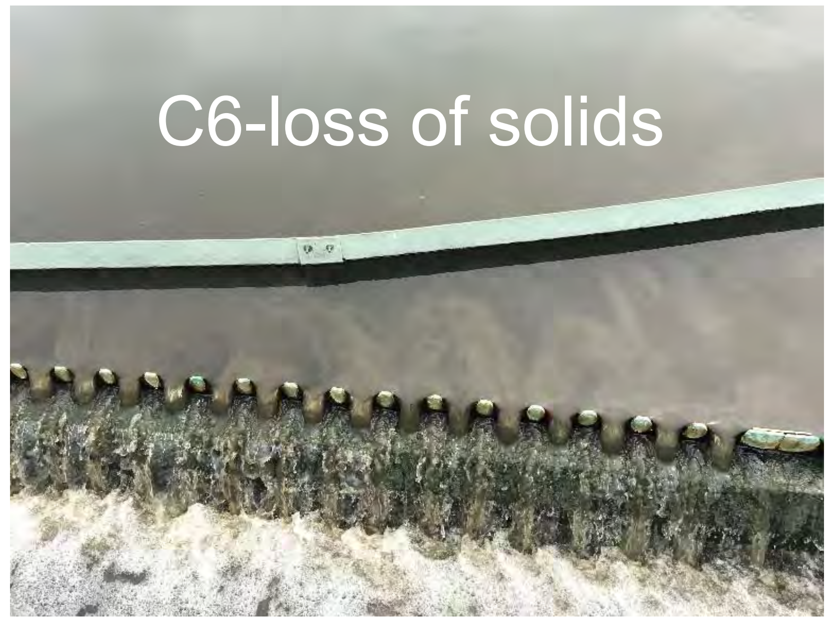


Recap of Comprehend Phase – Stress Testing

- Field testing from 8/20-8/23 included a comprehensive array of tests and evaluations
- West Clarifiers outperformed the East Clarifiers
  - Sustained SORs > 1,000 gpd/sf but with high blankets

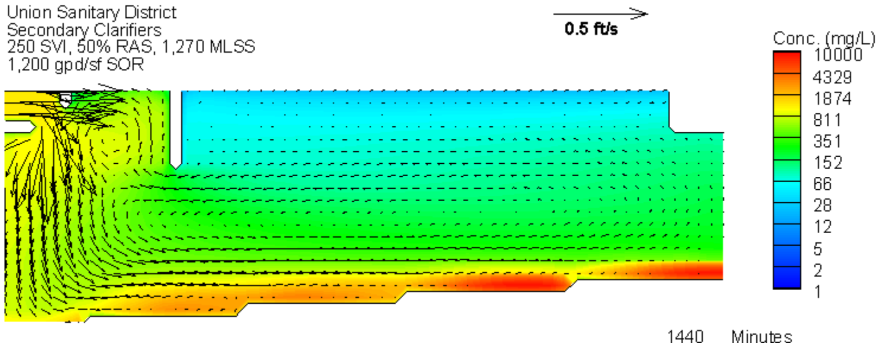
Recap of Comprehend Phase – Stress Testing

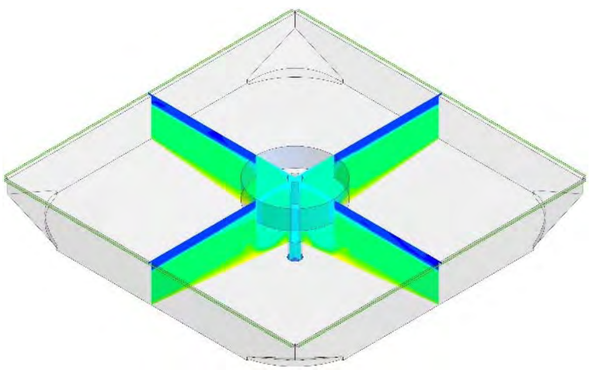
- East Clarifiers failed under lower loading conditions (SOR > 900 gpd/sf)
- Poor hydrodynamics were observed from:
  - Draft tube configuration
  - Lack of EDI
  - Corners
  - Leaking seal



Recap of Comprehend Phase – Clarifier Modeling

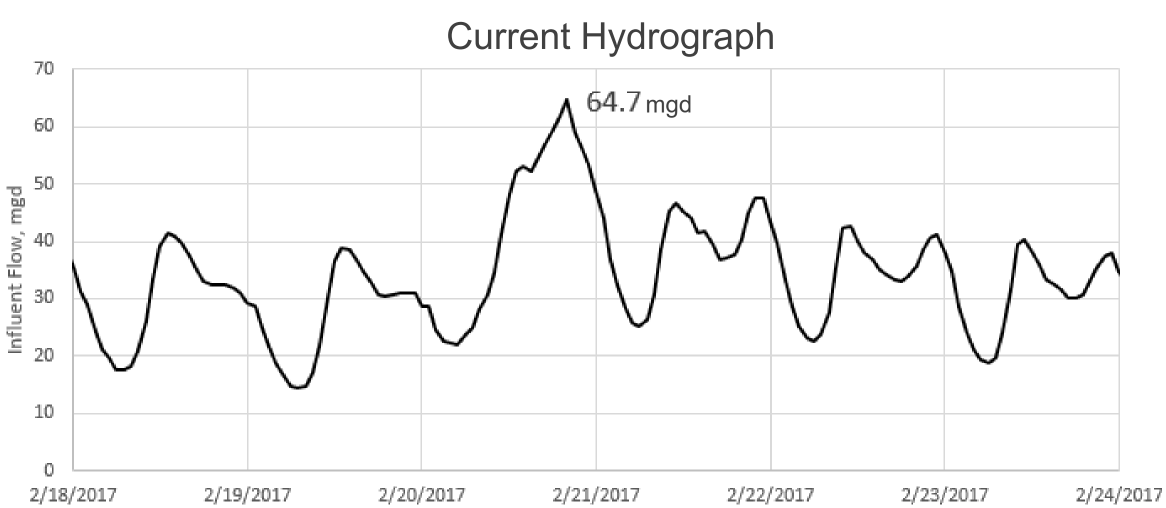
- Two dimensional (2D) models calibrated for East and West clarifiers
  - Good match between observed and predicted effluent TSS, RAS TSS and sludge blankets
  - Three-dimensional (3D) models used for verification of selected alternatives





Recap of Comprehend Phase – Defined Assumptions for Flow Projection

- Average Annual Flows escalated 1% per year
- Maximum 30-d Flow peaking factor taken to be 1.15
- February 2017 hydrograph non-throttled flow used as base
- Baseflow of hydrograph escalated by 1% per year.



USD WWTP		
Flows and Flow Peaking Factors		
Flow Criteria	Historical	
	Flow (MGD)	Peaking Factor
Minimum Day	20.64	0.88
Average Annual	23.38	1.00
Maximum Month	25.80	1.10
Maximum 30-Day	26.89*	1.15*
Maximum 7-Day	28.49	1.22
Maximum Day	33.88	1.45

Recap of Comprehend Phase – Defined Assumptions – Loads Projection

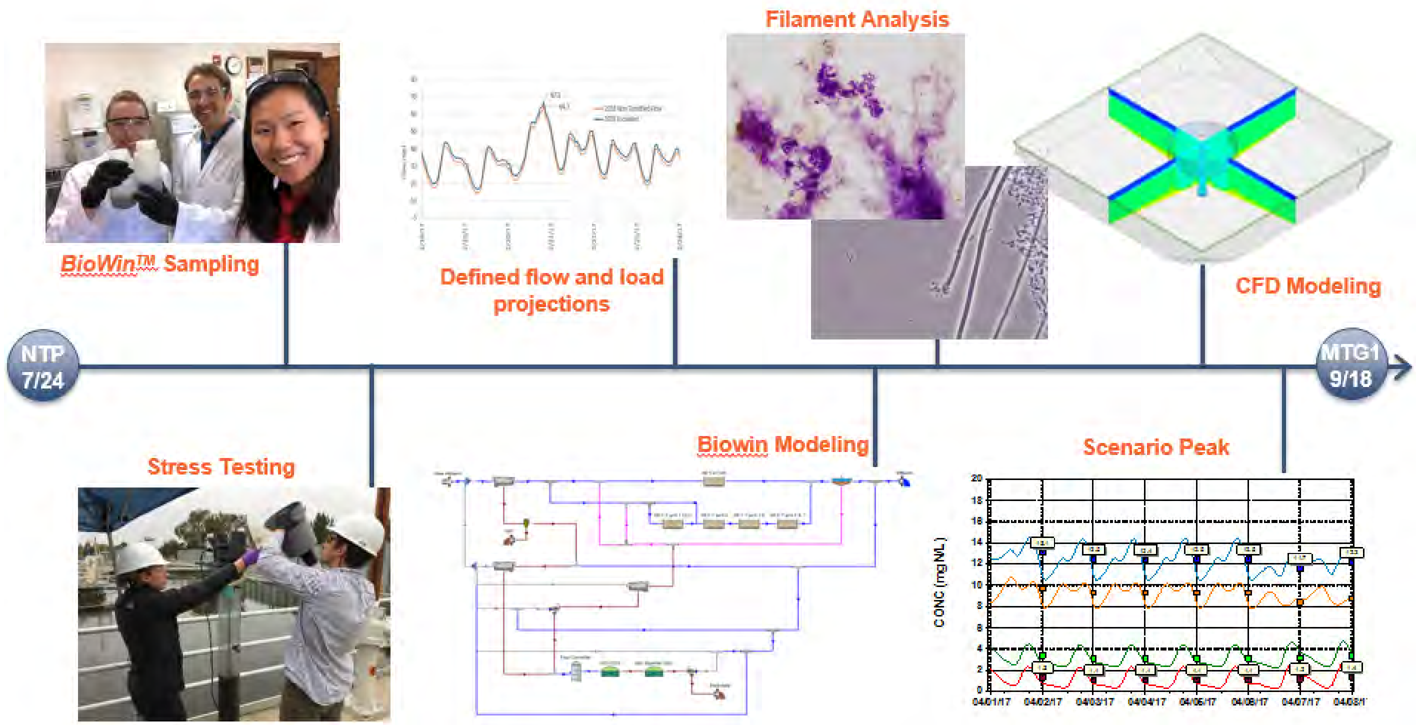
- Average Annual loads escalated 1% per year
- Maximum 30-d load peaking factor = 1.15 for cBOD, TSS, NH3-N
- COD/ cBOD ratio = 2.78 (special sampling)
- NH3/ TKN ratio = 0.68 (special sampling)
- COD/ TP ratio = 108 (special sampling)

Criteria	cBOD		TSS		COD		NH_3-N	
	Load (Lbs/d)	PF	Load (Lbs/d)	PF	Load (Lbs/d)	PF	Load (Lbs/d)	PF
Minimum Day	38,700	0.73	53,200	0.75	111,000	0.76	5,560	0.77
Average Annual	**52,600**	**1.00**	**70,500**	**1.00**	**146,000**	**1.00**	**7,240**	**1.00**
Maximum Month	**59,200**	**1.13**	**76,800**	**1.09**	**159,000**	**1.09**	**7,920**	**1.09**
Maximum 30-Day	60,500	1.15	78,900	1.12	166,000	1.13	8,190	1.13
Maximum 7-Day	66,900	1.27	89,100	1.26	166,000	1.13	7,670	1.06
Maximum Day	75,400	1.43	107,000	1.51	181,000	1.24	9,230	1.27

Recap of Comprehend Phase – Initial Modeling

- Initial sizing for 2040 Level 2 BNR
- Diurnal flow/loading patterns had significant impact on effluent water quality
- Supplemental sampling and historical data show poorer COD/N ratio in primary effluent than previous model
  - Sensitivity of required volume vs temperature and nutrient requirements
  - Improved calibration
- Wet weather step feed provided significant decrease in solids loading rate to secondary clarifiers
  - Refinement on % of flow in Explore phase
- Addition of MBR analysis subsequent to workshop

Purpose of Explore Phase



Questions Answered in Explore Phase

Purpose of Explore Phase – What is….

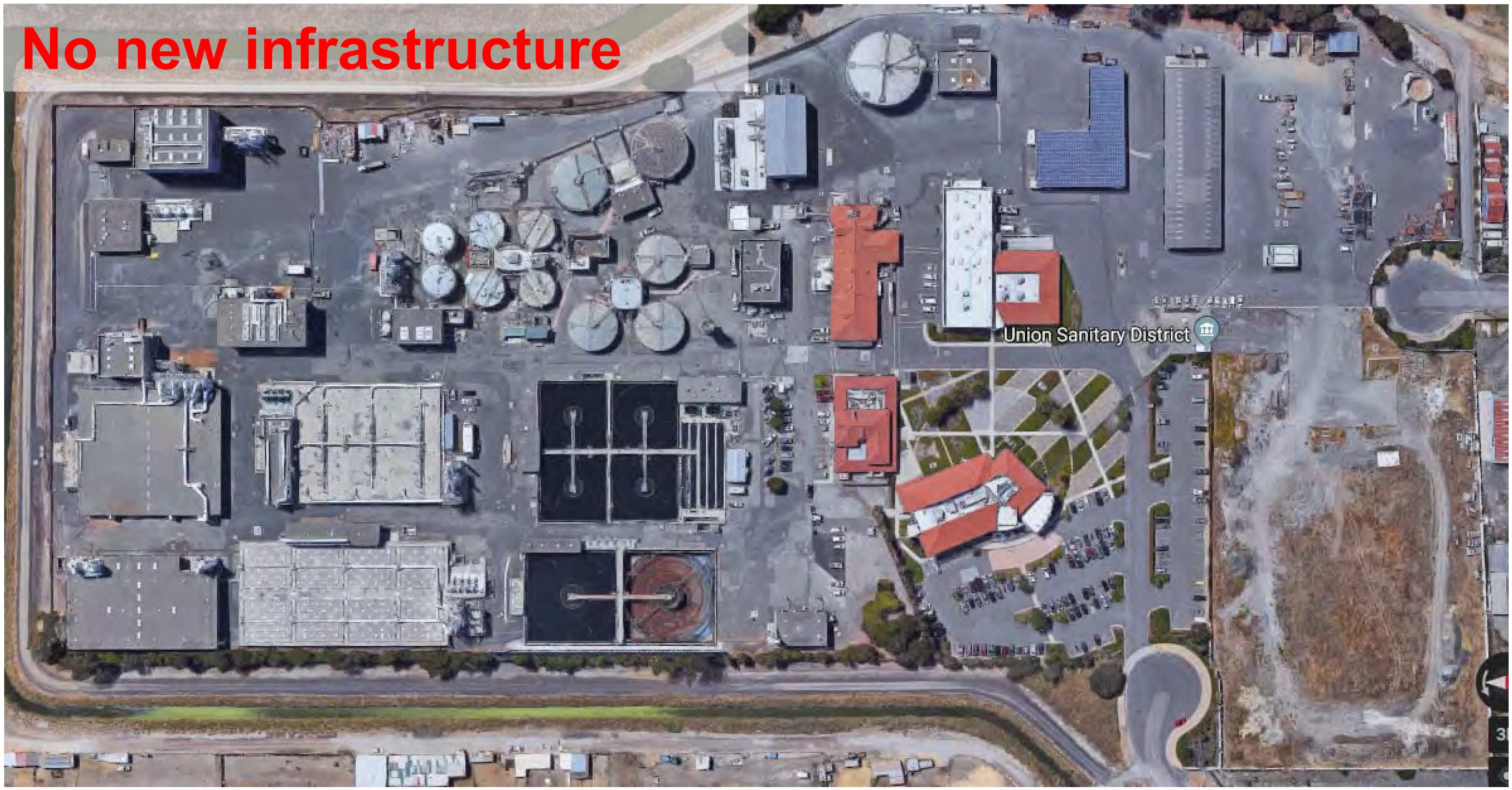
- Scenario 1: Capacity of the existing secondary system
    - Scenario 1a: Capacity w/improved settling from $Ca(NO_3)_2$
- Scenario 2a: Capacity of the secondary system with near-term improvements synergistic with future nutrient removal
    - Scenario 2b: Nutrient removal capability of the modified system with flexible selector operating anoxically
- Scenario 3: Secondary system improvements to achieve Level 2 nutrient removal standards
- Scenario 4: MBR infrastructure is required for Level 2

Scenario 1

What is the capacity of the existing secondary system?

Alonso Griborio, Irene Chu

Scenario 1 - What is the capacity of the existing system? - Infrastructure



Scenario 1 - What is the **capacity** of the existing system? - Specific Assumptions

- Horizon: 2028 (assumed start of nutrient requirements per master plan)

	AA		MM	
Flow, mgd	25.8		29.7	
Peak Flow, mgd	67.1		67.1	
COD, lbs/d	161,300	749	185,500	749
BOD, lbs/d	58,100	270	66,800	270
TSS, lbs/d	77,900	362	89,600	362
TKN, lbs/d	11,800	55	13,500	55
NH_3-H, lbs/d	8,000	37	9,200	37
TP, lbs/d	1,490	6.9	1,720	6.9

- Effluent limitations – Secondary standards

	Monthly	Weekly
cBOD, mg/L	25	40
TSS, mg/L	30	45

Scenario 1 - What is the capacity of the existing system? - Operation modes checked

	Dry Weather	Wet Weather	Redundancy
Load	MM	MM	AA
Flow	DW	WW Hydrograph	DW
PC TSS removal, %	63	63	63
Basins in service	All Basins in Service	All Basins in Service	1AB/1 SC out of service
SRT, d	~1.5	~1.5	~1.5
MLSS, mg/L	~1,200	~1,200	~1,200
Design SVI (mL/g)	310	310	310

Scenario 1 - What is the **capacity** of the existing system? – DW Mode Check

- For 2028 MM loads
- All aeration basins online, all clarifiers online
- ✓ MLSS of ~1,200 mg/L is required to maintain SRT of ~1.3 days
- ✓ Clarifier passes 2028 DW diurnal flow pattern

	Flow (MGD)	SOR (gpd/sf)	SLR (gpd/sf)	Results at SVI = 310 mL/g
Average	29.7	620	8.8	✓
Maximum	44.1	920	13.0	✓

Scenario 1 - What is the capacity of the existing system? – DW Redundancy Check

- For 2028 AA loads
- One aeration basin out of service

	Flow (MGD)	SOR (gpd/sf)	SLR (gpd/sf)	Results at SVI = 310 mL/g
Avg.	25.8	540	10.8	✓
Max.	38.3	800	16.1	✓

✓ MLSS of ~1,700mg/L is required to maintain SRT of 1.3 days

✓ Clarifiers pass 2028 DW diurnal flow pattern

Scenario 1 - What is the capacity of the existing system? – DW Redundancy Check

- For 2028 AA loads
- One clarifier out of service

	Flow (MGD)	SOR (gpd/sf)	SLR (gpd/sf)	Results at SVI = 310 mL/g
Avg.	25.8	700	9.6	✓
Max.	38.3	1,000	14.2	✓

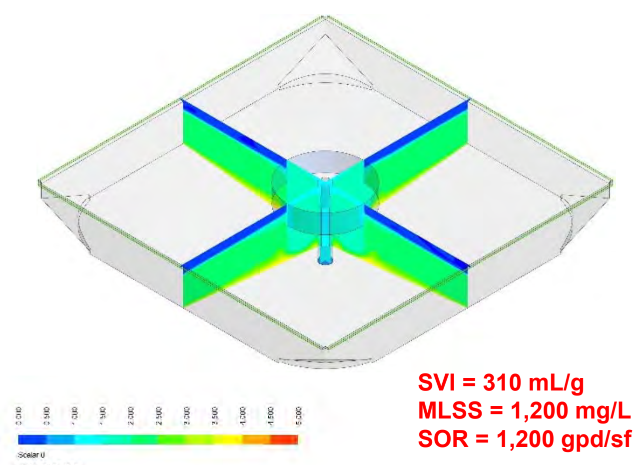
✓ MLSS of ~1,200 mg/L is required to maintain SRT of 1.3 days

✓ Clarifiers pass 2028 DW diurnal flow pattern

Scenario 1 - What is the capacity of the existing system? - WW Mode Check

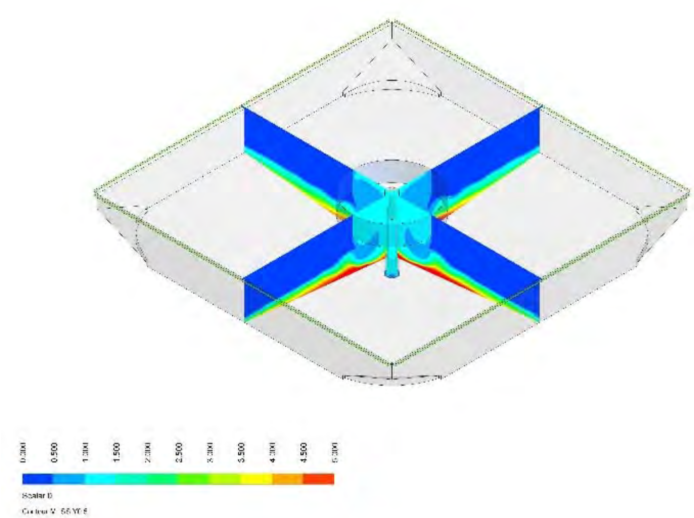
- For 2028 MM loads
- All basins online, all clarifiers online
- ✓ MLSS of ~1,200 mg/L is required to maintain SRT of 1.3 days
- X Clarifiers **cannot** pass WW flows due to high SVI (310 mL/g) and high peak surface overflow rate (SORs)

	Flow (MGD)	SOR (gpd/sf)	SLR (gpd/sf)	Results at SVI = 310 mL/g
Average	42.8	890	10.9	✗
Maximum	67.1	1,400	19.9	



Scenario 1 - What is the capacity of the existing system? Summary

- With SVI = 310 mL/g, significant blanket build up with potential for high effluent TSS (washout)
- Clarifiers can pass 1,200 mg/L at ~ 950 (combined SOR) gpd/sf or ~ 46 mgd
- Clarifier capacity is highly dependent on SVI
  - If settling happens to be poor (likely) during a storm event, plant operations will be severely compromised



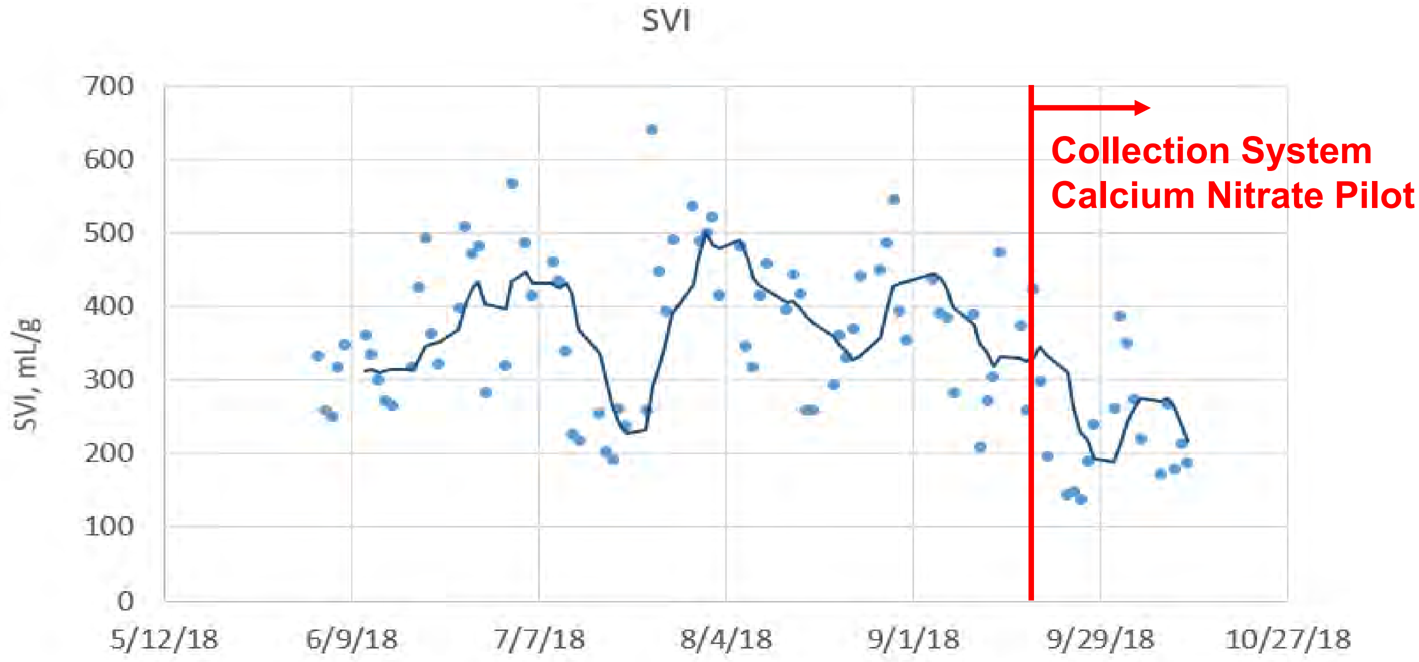
SVI = 310 mL/g
MLSS = 1,200 mg/L
SOR = 950 gpd/sf

Scenario 1a

What is the capacity of the existing secondary system with improved setting due to $Ca(NO_3)_2$?

Alonso Griborio, Irene Chu

Scenario 1a - What is the capacity of the existing system? With improved settling



Percentile	2008-2018 SVI (mL/g)	$CaNO_3$ Pilot SVI (mL/g)
50th	250	225
75th	310	265
90th	404	358
95th	494	ND
99th	672	ND
Flows >28 mgd	270	ND

Marginal improvement in settling

Scenario 1a - What is the capacity of the existing system? With improved settling

- Limited data
- SVI improvements from 310 mL/g to 265 mL/g (if sustained) could:
  - Increase acceptable SORs from 950 gpd/sf to 1,050 gpd/sf
  - Increase peak flow capacity from ~ 46 mgd to~ 50 mgd
  - Improvements are not sufficient to pass proposed wet weather peaks
- Operational issues:
  - Floating sludge

Scenario 1 - What is the capacity of the existing system? Summary

- Existing system does not have sufficient capacity to maintain operations during wet weather with current flows and loads
- Calcium nitrate does not improve settling enough to gain significant capacity
    - Issues are poor SVI and poor clarifier internals

SO

- Need basin modifications to improve SVI
- Need clarifier modifications to improve performance

Scenario 2a

Scenario 2a

What is the capacity of the secondary system with modifications to existing infrastructure?

LEAF
Leverage Existing Assets First

Alonso Griborio, Irene Chu

Scenario 2a - What is modified system capacity? LEAF approach

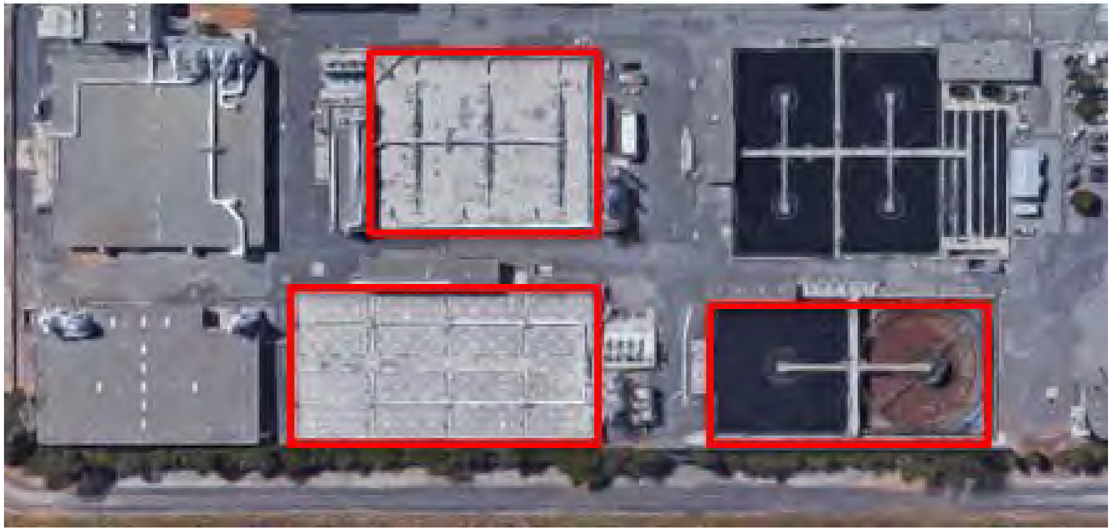
Leverage Existing Assets First:

- Optimization of facilities
- Modifications to existing infrastructure before considering new structures
- Minimize stranded assets

Scenario 2a - What is modified system capacity? Infrastructure

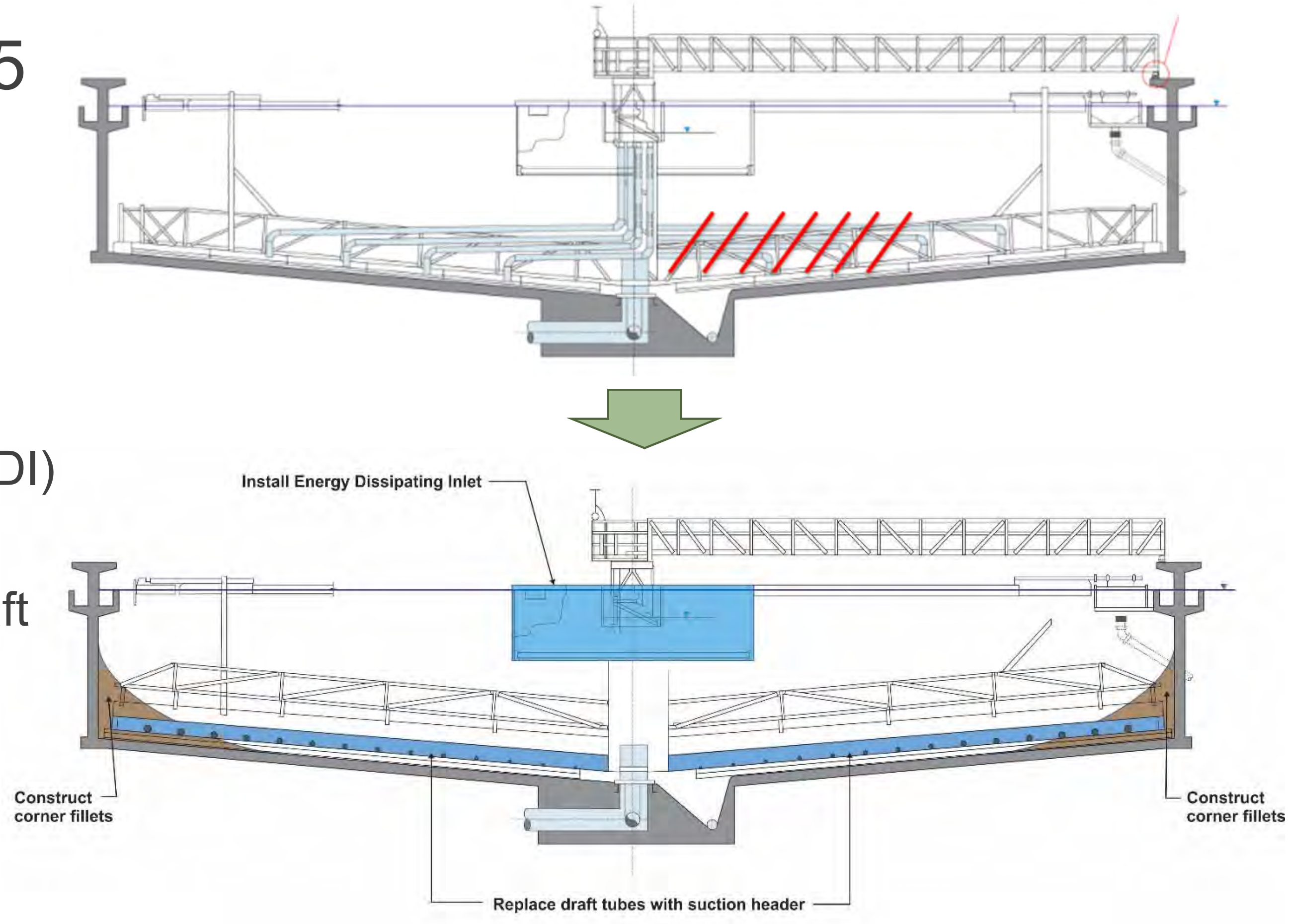
- Modify Aeration Basins with:
  - Flexible selector
  - Step feed capabilities
  - Convert East AB to plug flow

No new volume



Scenario 2a - What is modified system capacity? Infrastructure

- Modify Clarifier 5 and 6 internals
  - Replace seals
  - Corner fillets
  - Install energy dissipating inlet (EDI)
  - Evaluate replacement of draft tubes with suction header



Scenario 2a – What is modified system capacity? Specific Assumptions

- Horizon: **2028** (assumed start of nutrient requirements per master plan)

	AA		MM	
Flow, mgd	25.8		29.7	
Peak Flow, mgd	67.1		67.1	
COD, lbs/d	161,300	749	185,500	749
BOD, lbs/d	58,100	270	66,800	270
TSS, lbs/d	77,900	362	89,600	362
TKN, lbs/d	11,800	55	13,500	55
NH_3-H, lbs/d	8,000	37	9,200	37
TP, lbs/d	1,490	6.9	1,720	6.9

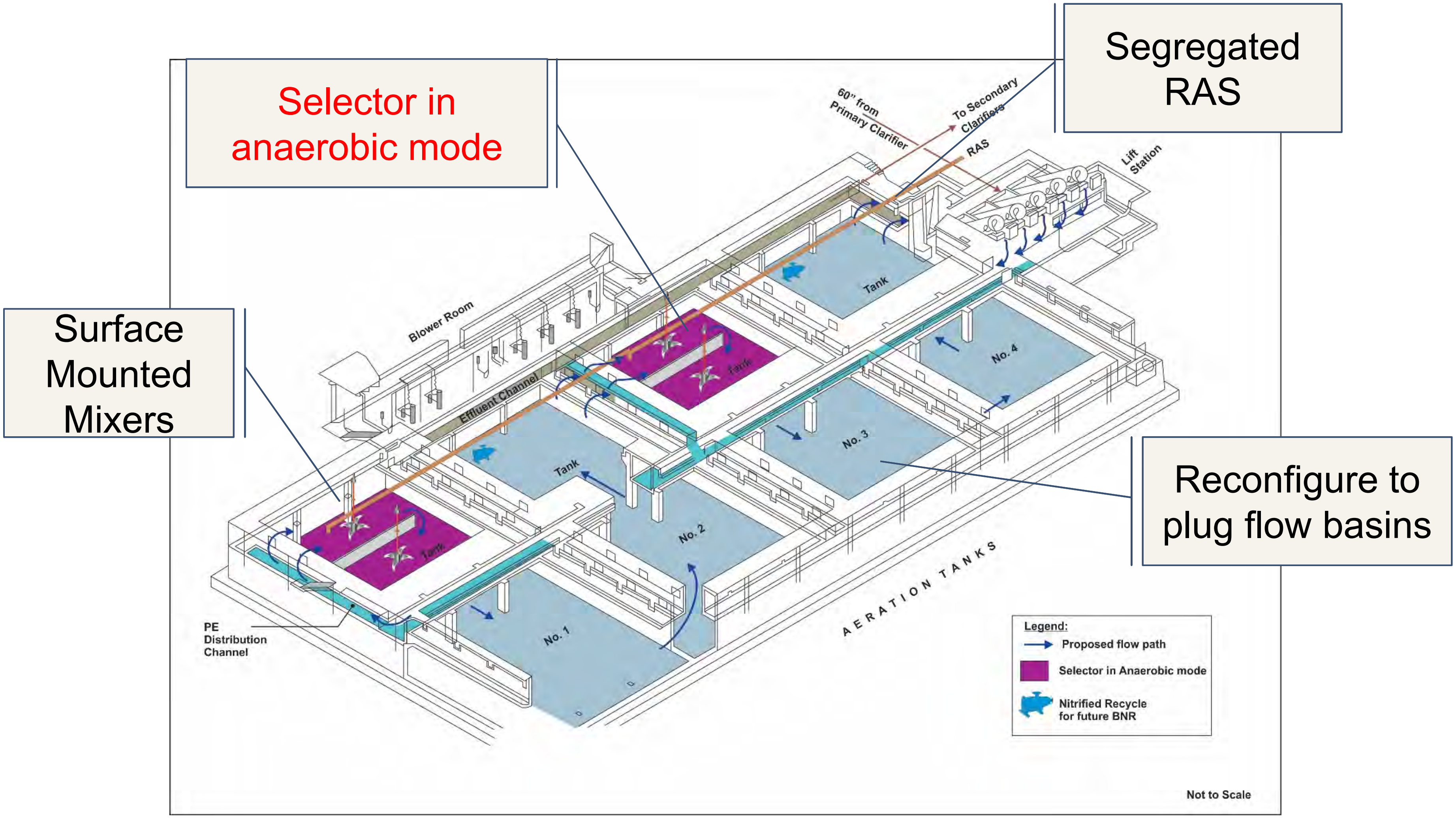
- Effluent limitations –Secondary standards

	Monthly	Weekly
cBOD, mg/L	25	40
TSS, mg/L	30	45

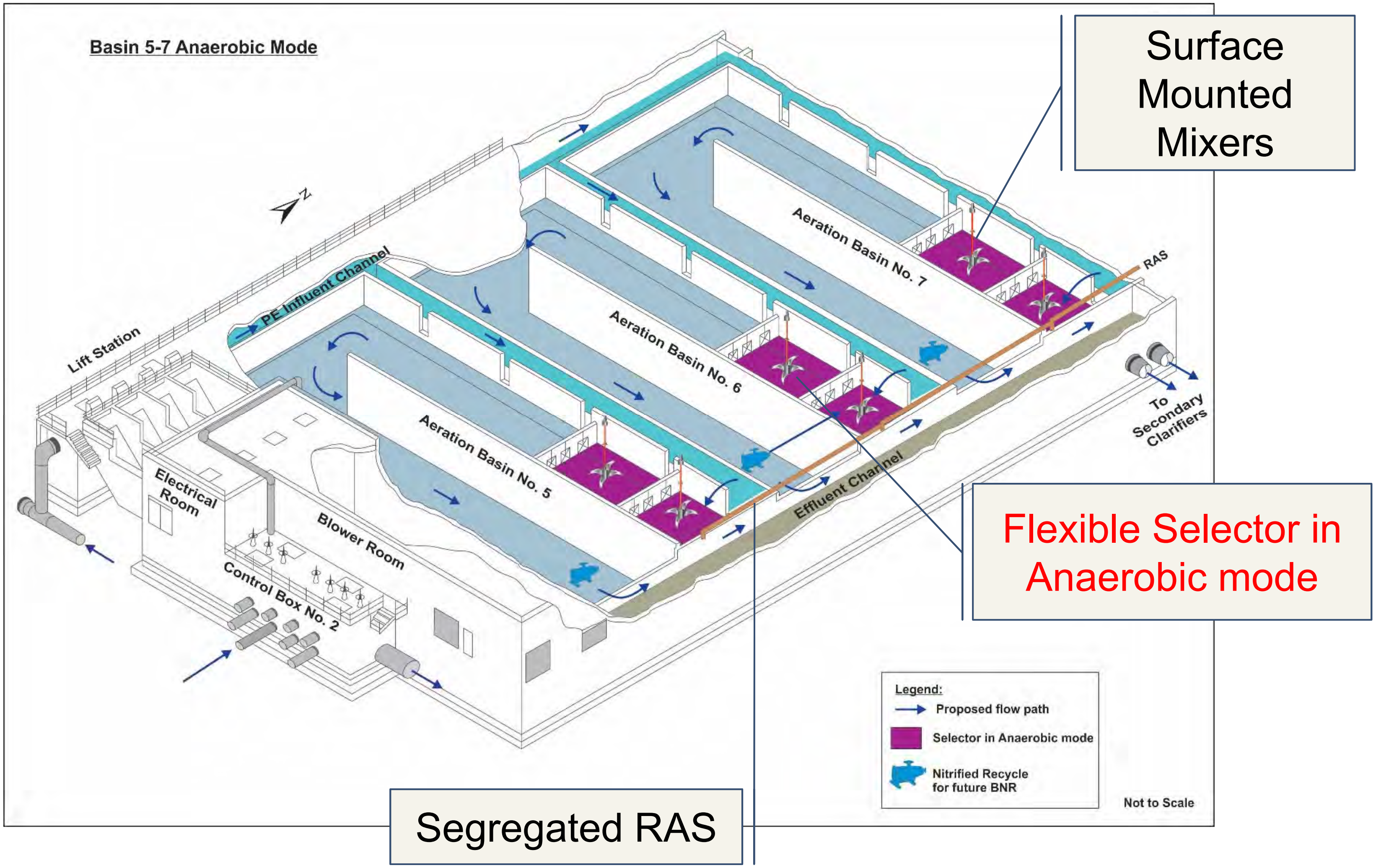
Scenario 2 - What is modified system capacity? Operational modes

	Dry Weather	Wet Weather	Redundancy
Load	MM	MM	AA
PC TSS removal, %	63	63	63
Temperature, °C	16	16	20
Basins in service	ALL	ALL	1AB/1SC OOS
Selector operation	Anaerobic	Anaerobic	Anaerobic
Step feed	No	Yes	Possible
SRT, d	1-2	1-2	1-2
MLSS, mg/L	TBD	TBD	TBD
SVI (ml/gm)	110	110	110

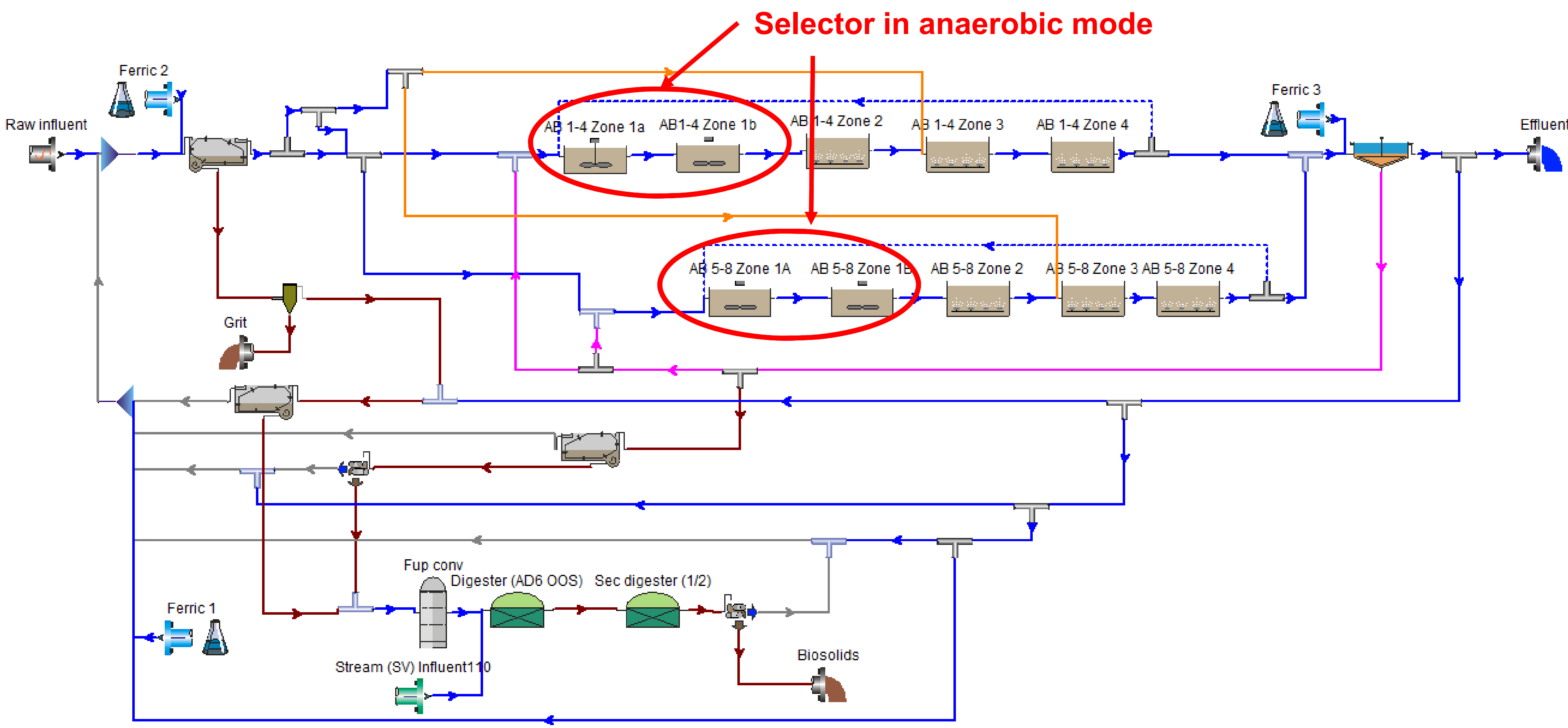
Scenario 2a –What is modified system capacity? DW East AB configuration



Scenario 2a –What is modified system capacity? DW West AB configuration



Scenario 2a –What is modified system capacity? DW Process Model



Scenario 2a –What is modified system capacity? DW Mode Check

- For 2028 MM loads
- All aeration basins online, all clarifiers online

✓ MLSS of ~1,800mg/L is required to maintain SRT of ~1.5 days

✓ Clarifier passes 2028 DW diurnal flow pattern

	Flow (MGD)	SOR (gpd/sf)	SLR (gpd/sf)	Results at SVI = 110 mL/g
Average	29.7	620	12.8	✓
Maximum	44.1	920	19.0	

Scenario 2a –What is modified system capacity? Redundancy Check

- For 2028 AA loads
- One aeration basin out of service

	Flow (MGD)	SOR (gpd/sf)	SLR (gpd/sf)	Results at SVI = 110 mL/g
Avg.	25.8	540	13.0	✓
Max.	38.3	800	19.4	

✓ MLSS of ~2,000 mg/L is required to maintain SRT of ~1.5 days

✓ Clarifiers **pass** 2028 DW diurnal flow pattern

Scenario 2a –What is modified system capacity? Redundancy Check

- For 2028 AA loads
- One clarifier out of service

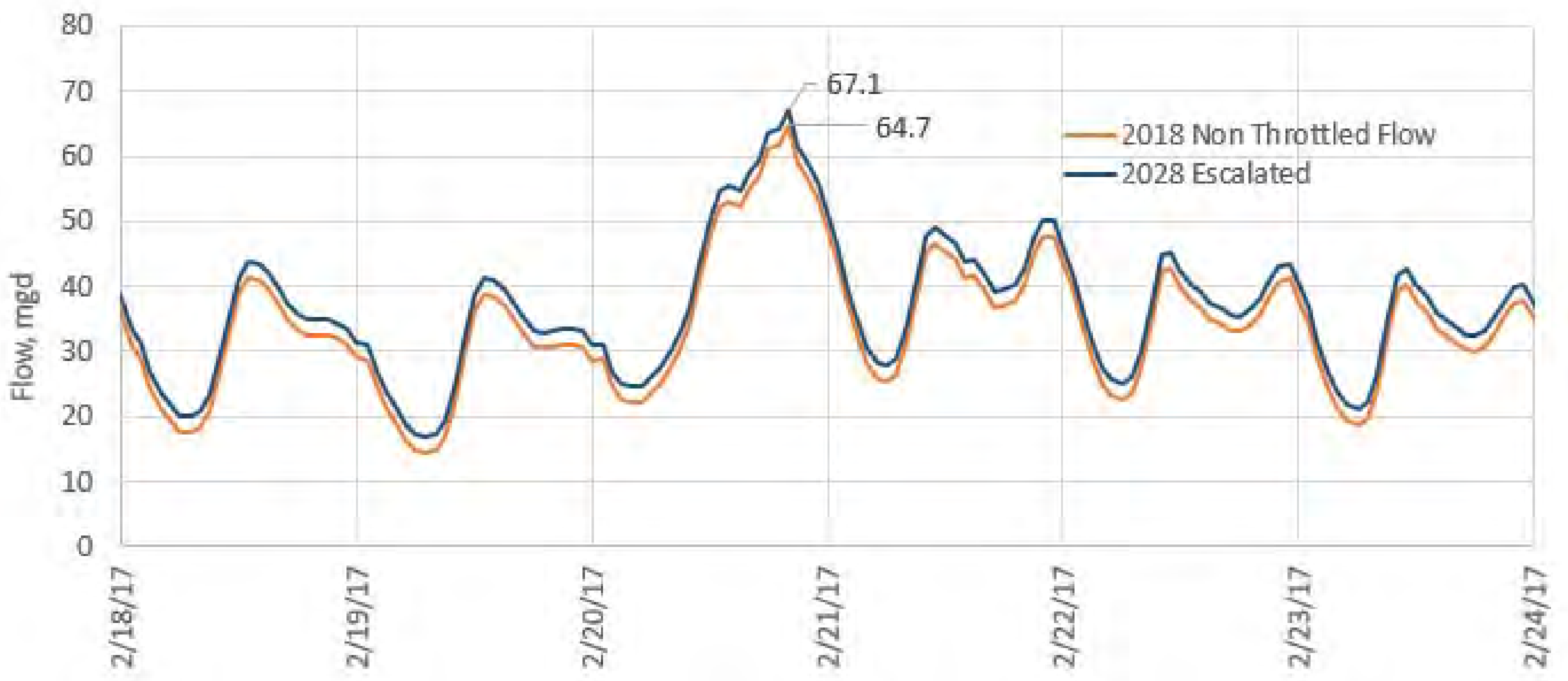
	Flow (MGD)	SOR (gpd/sf)	SLR (gpd/sf)	Results at SVI = 110 mL/g
Avg.	25.8	700	14.6	✓
Max.	38.3	1,000	21.6	

✓ MLSS of 1,750 mg/L is required to maintain SRT of 1.5 days

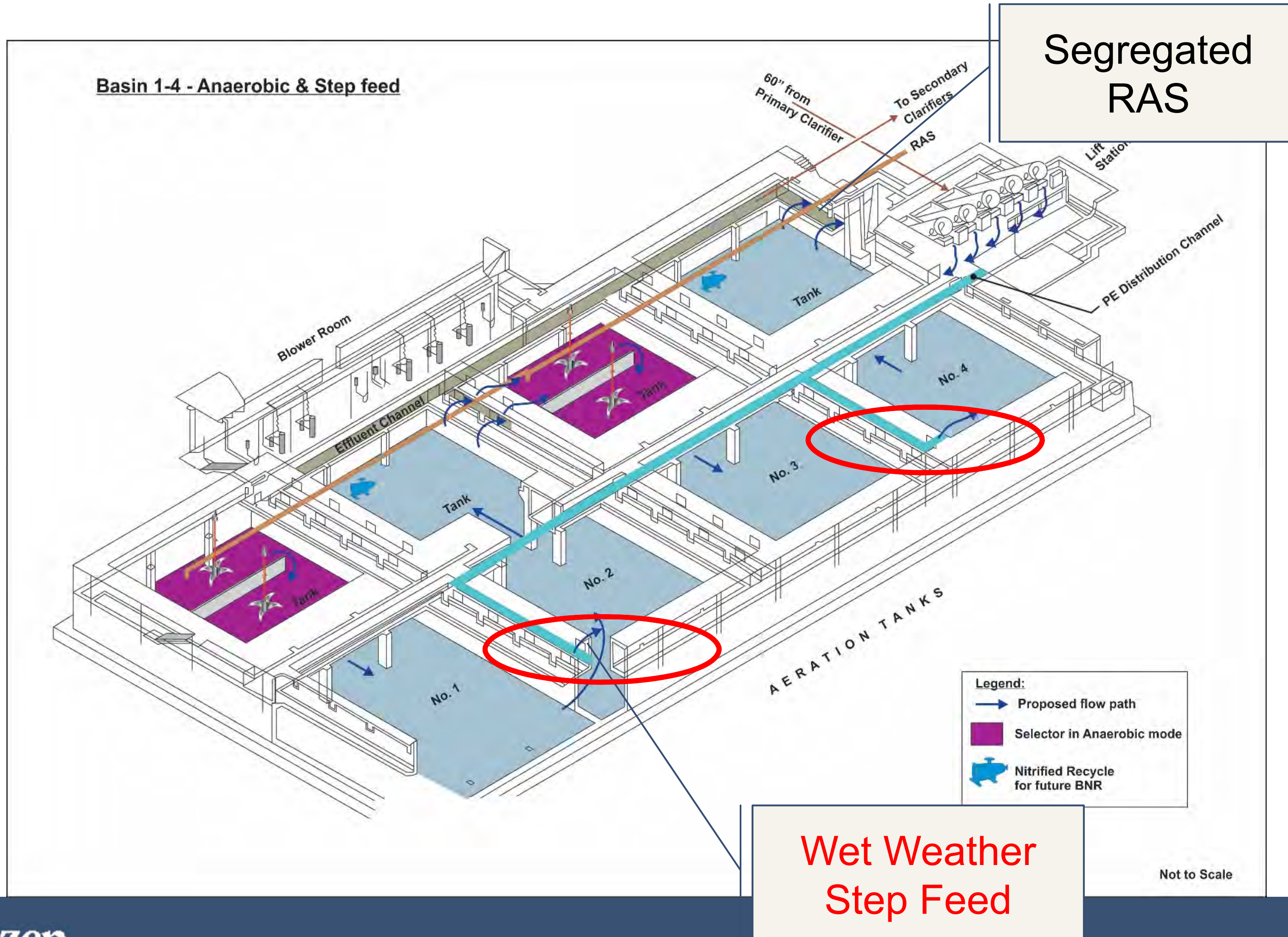
✓ Clarifiers **pass** 2028 DW diurnal flow pattern

Scenario 2a –What is modified system capacity? WW Check

2028 WW hydrograph



Scenario 2a –What is modified system capacity? WW Check East AB configuration

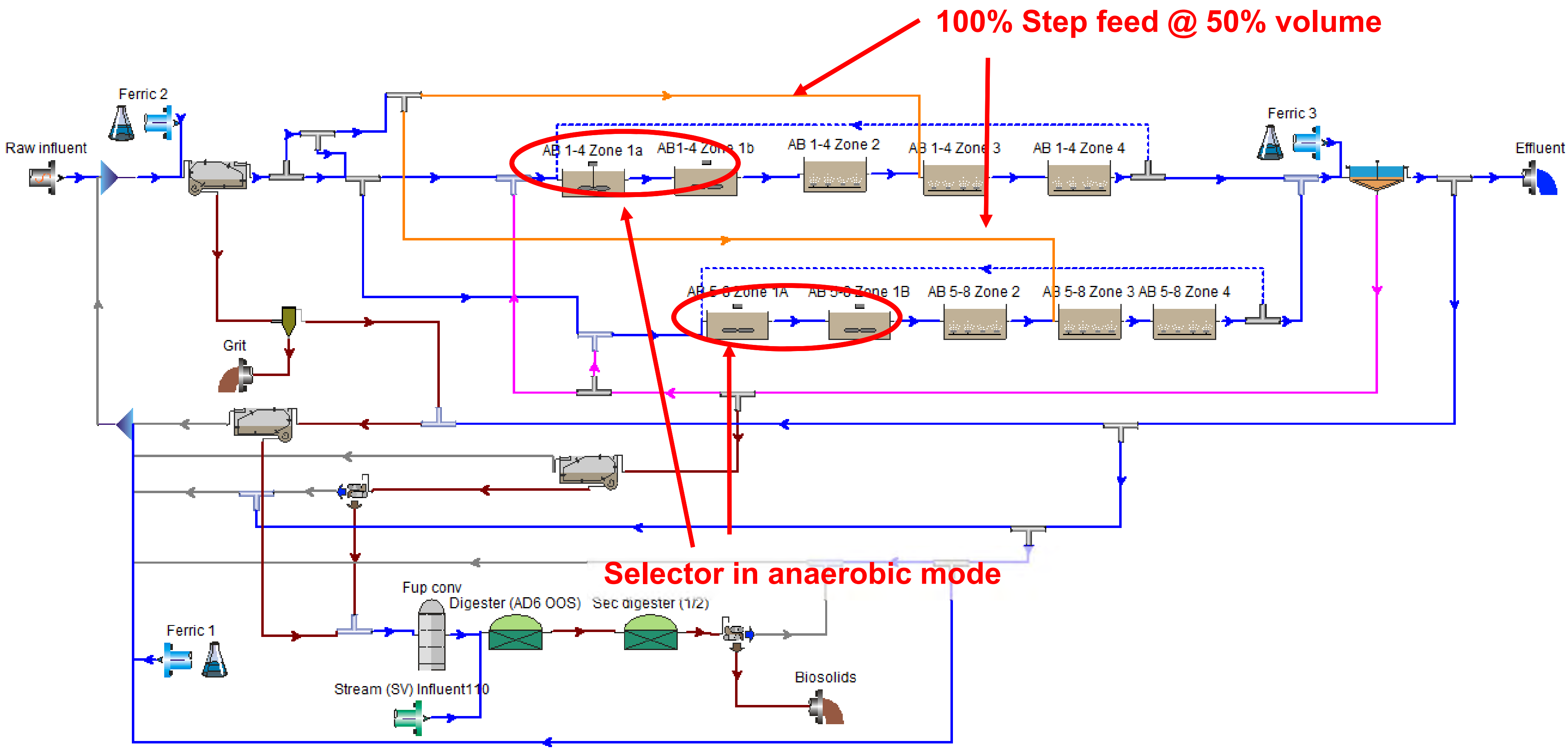


Scenario 2a –What is modified system capacity? WW Check East AB configuration

Wet Weather Step Feed

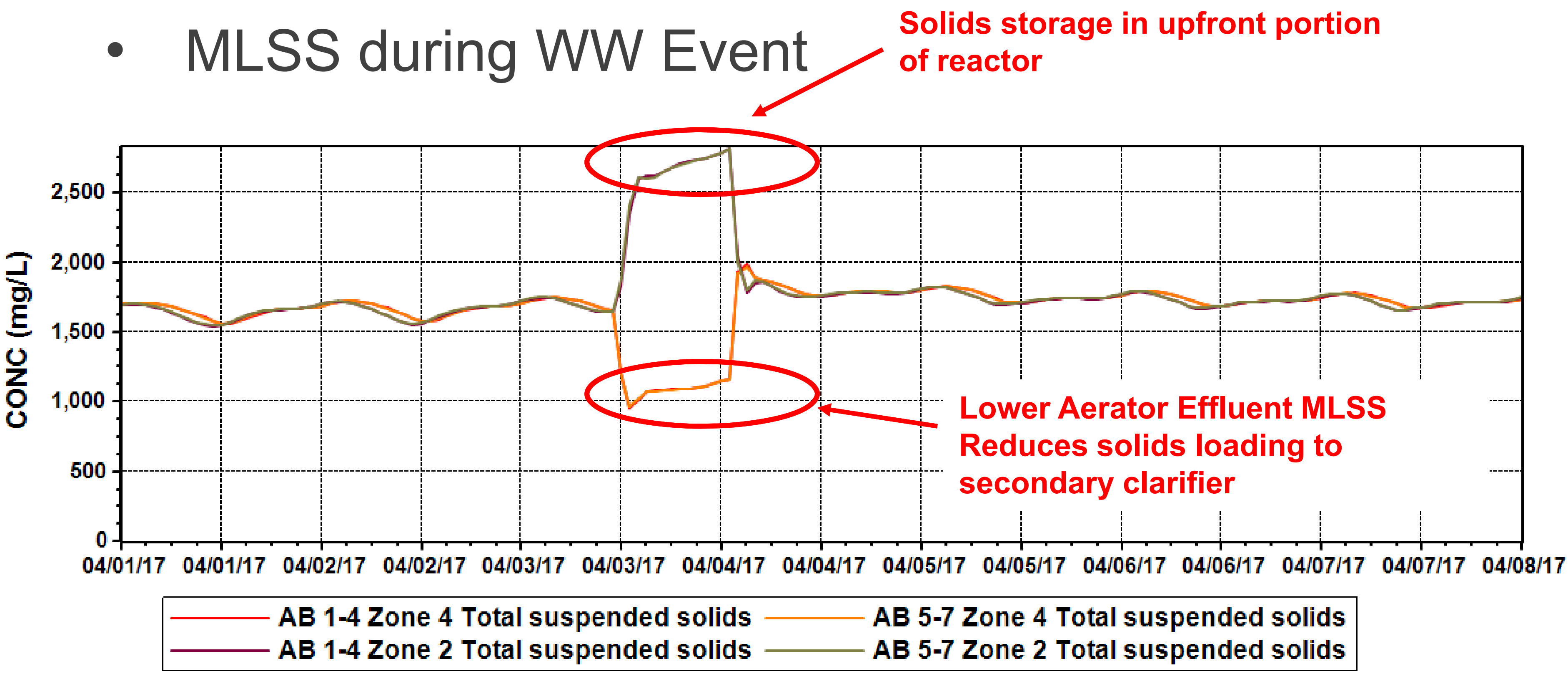
Segregated RAS

Scenario 2a –What is modified system capacity? WW Process Model



Scenario 2a –What is modified system capacity? WW Check

- 2028 MM Load
- MLSS during WW Event



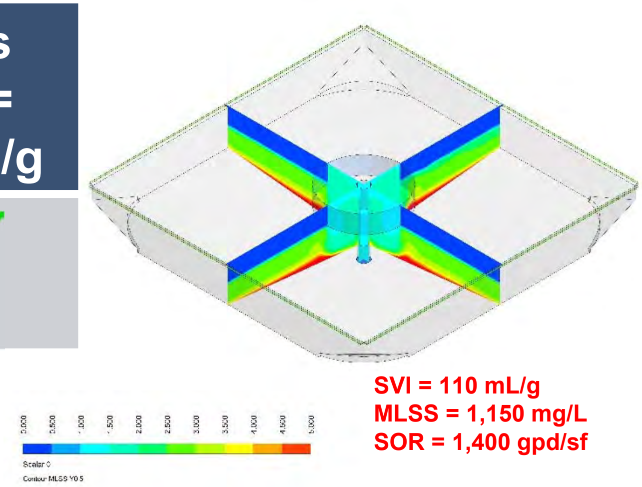
Scenario 2a –What is modified system capacity? WW Check

- For 2028 MM loads
- All Basins online, All clarifiers online

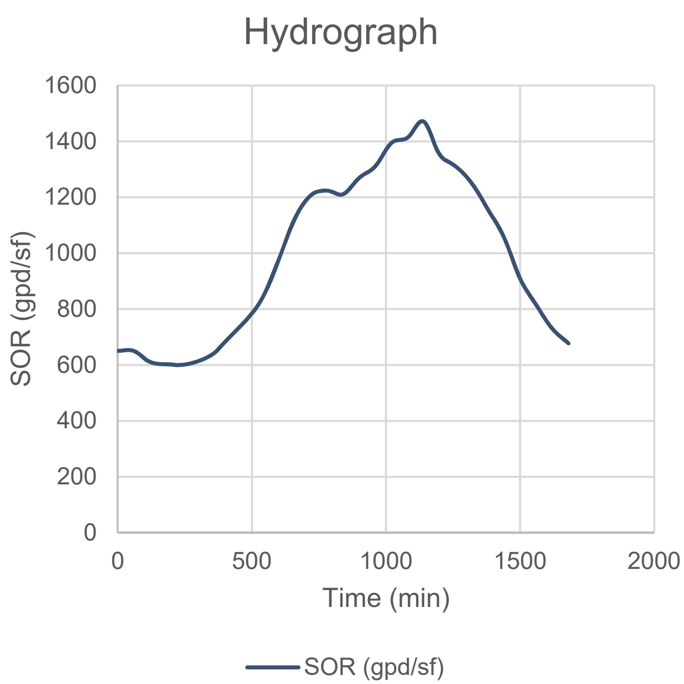
✓ MLSS of ~ 1,150 mg/L with Step Feed

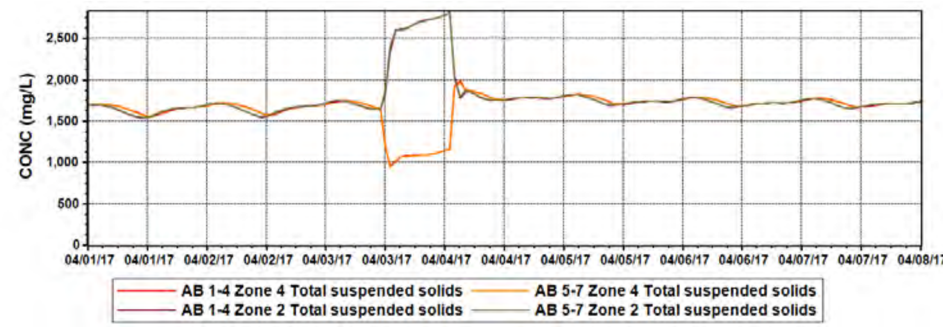
✓ Clarifiers can pass WW flows with improved SVI (110 mL/g)

	Flow (MGD)	SOR (gpd/sf)	SLR (gpd/sf)	Results at SVI = 110 mL/g
Average	42.8	890	10.9	✓
Maximum	67.1	1,400	19.9	



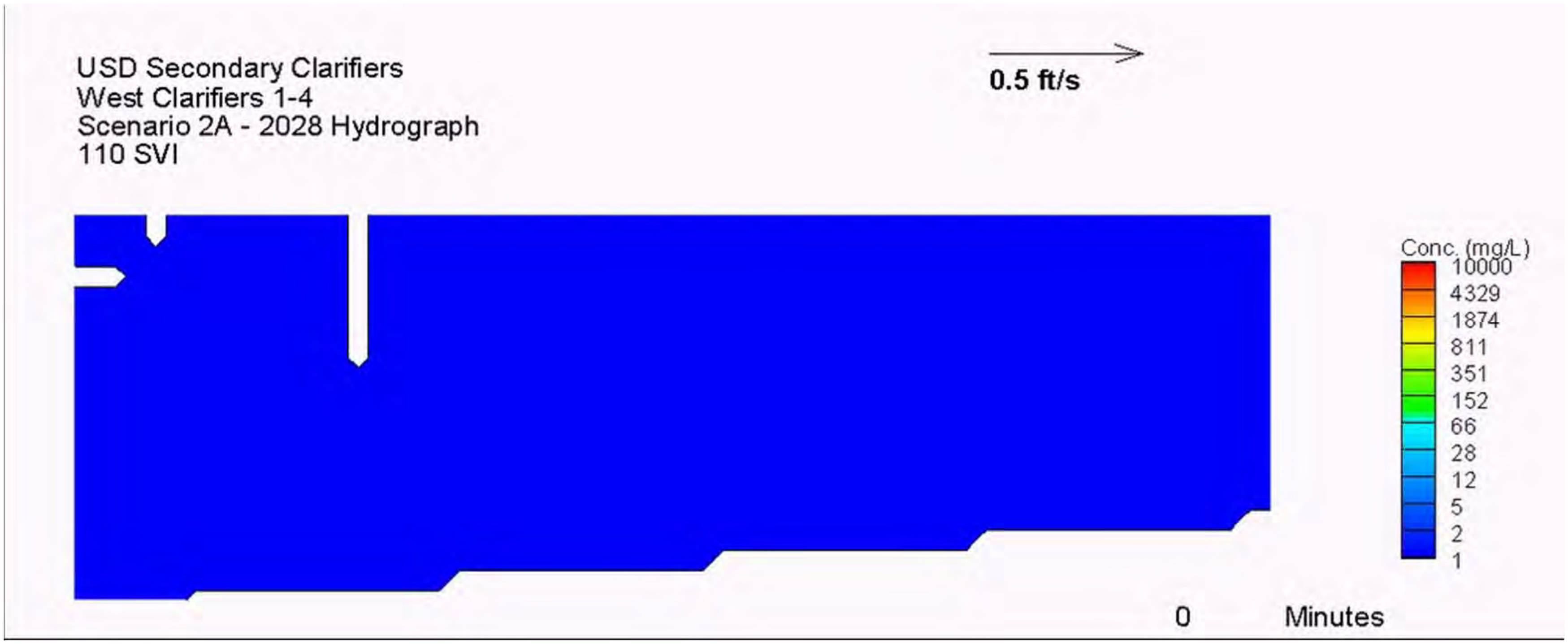
Scenario 2a –What is modified system capacity? WW Check Hydrograph





Input to clarifier models

Scenario 2a –What is modified system capacity? WW Check Hydrograph - West



SVI = 110 mL/g; MLSS ~ 1,150 mg/L (step feed); Peak SOR ~ 1,400 gpd/sf

Scenario 2a –What is modified system capacity? Summary

- ✓ During dry weather **Pass**
- ✓ During dry weather redundancy **Pass**
- ✓ During wet weather **Pass**

Can we test system for nutrient removal experience?

Scenario 2b

Scenario 2b

What is the nutrient removal capability of the modified system?

Paul Pitt, Alonso Griborio, Irene Chu

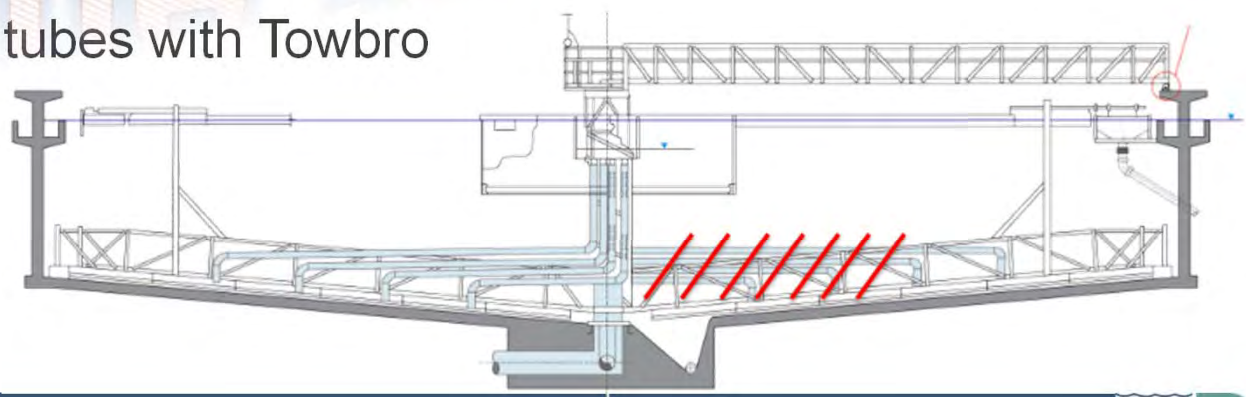
LEAF
Leverage Existing Assets First

Scenario 2b - What is the BNR capability of the modified system? Infrastructure

- Modify Aeration Basins with:
  - Flexible selector
  - Step feed capabilities
  - Convert East AB to plug flow
- Modify Clarifier 5 and 6 internals
  - Replace daft tubes with Towbro
  - Fillets
  - EDI
  - Seals

No new volume

Same as 2A



Scenario 2b - What is the BNR capability of the modified system? Specific Assumptions

- Horizon: 2028 (assumed start of nutrient requirements per master plan)

	AA		MM	
Flow, mgd	25.8		29.7	
Peak Flow, mgd	67.1		67	
COD, lbs/d	161,300	749	185,500	749
BOD, lbs/d	[illegible]	[illegible]	[illegible]	270
TSS, lbs/d	[illegible]	[illegible]	89,600	362
TKN, lbs/d	[illegible]	55	13,500	55
NH_3-N, lbs/d	8,000	37	9,200	37
TP, lbs/d	1,490	6.9	1,720	6.9

Same as 2A

Scenario 2b - What is the BNR capability of the modified system? Specific Assumptions

- Effluent limitations –Secondary standards

	Monthly	Weekly
cBOD, mg/L	25	40
TSS, mg/L	30	45

Operate in BNR mode during the warmer months

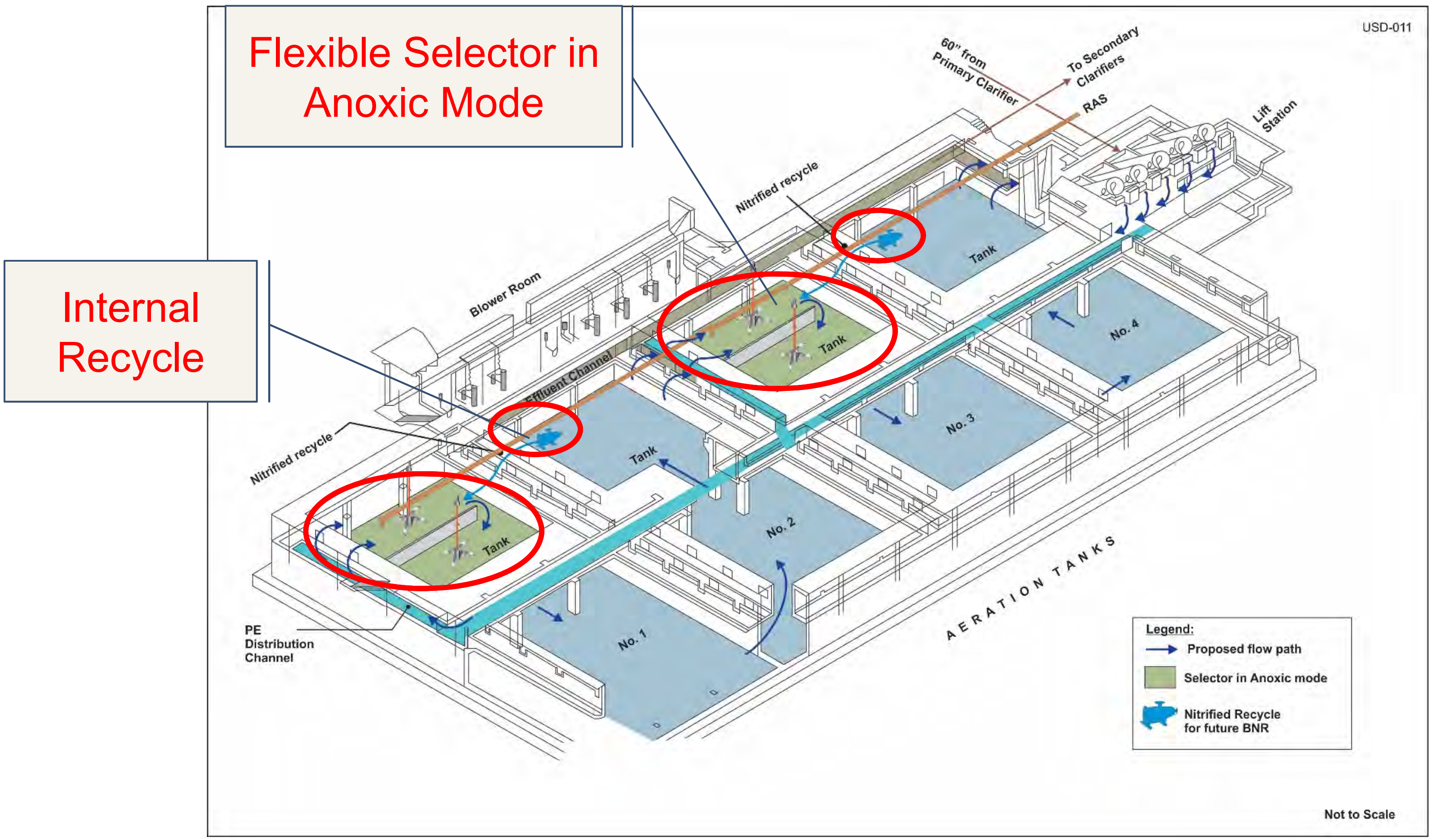
- DO NOT HAVE TO operate in BNR mode for part of the summer…but may WANT to because:
  - Negotiations with regional board (Early adoption)
  - Gain experience with BNR operation

Scenario 2b - What is the BNR capability of the modified system? Operation modes

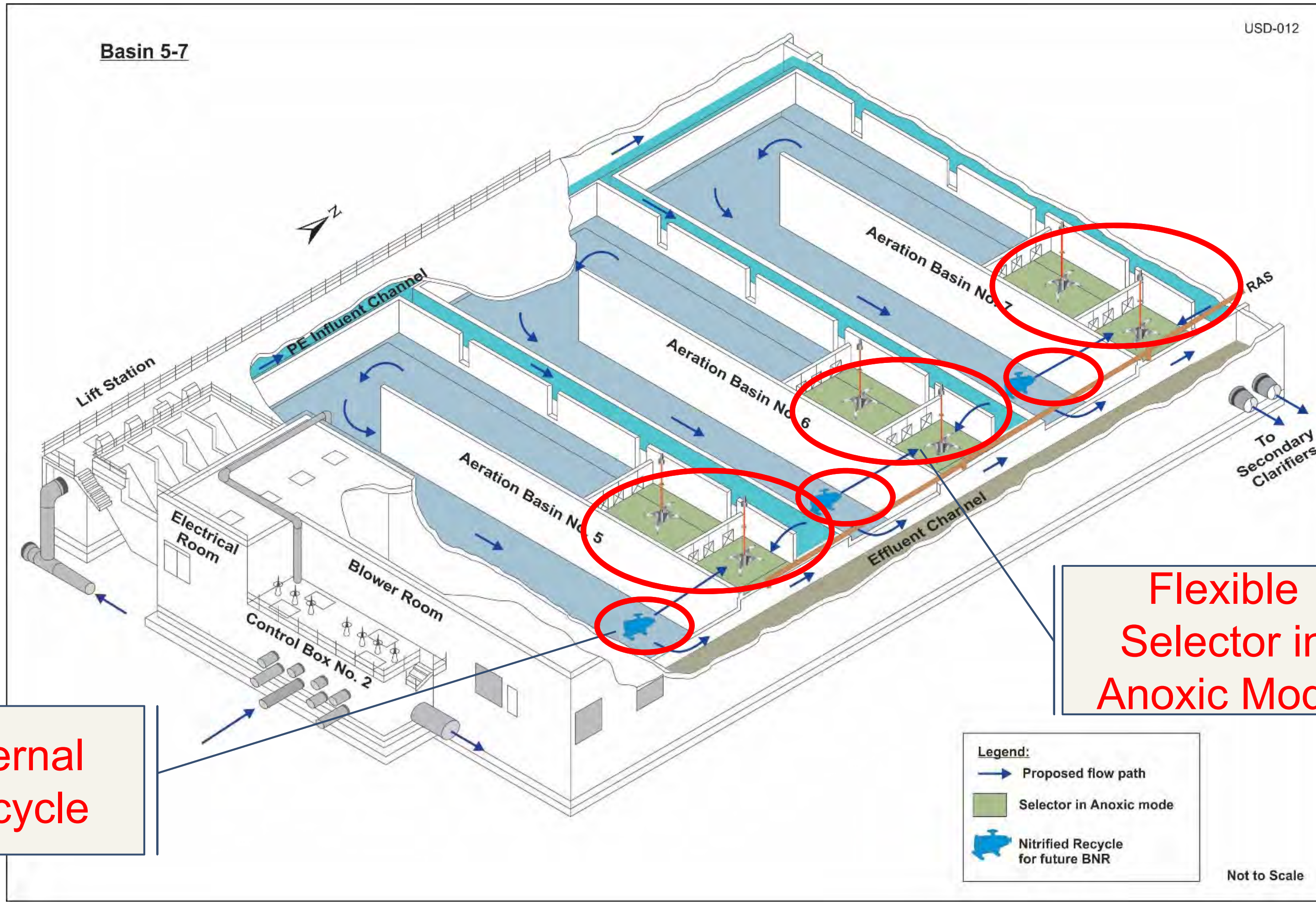
	Winter	Spring	Summer	Fall
Months	Dec – Feb	Mar – May	Jun – Aug	Sept – Nov
Temperature, °C	16	20	27	23

	BNR operation
	Dry season May – September
Temperature	>21°C
Load	MM
PC TSS removal, %	63
Basins in service	ALL
Selector operation	Anoxic
Step feed	No
SRT, d	TBD
MLSS, mg/L	TBD
SVI (ml/gm)	130

Scenario 2b - What is the BNR capability of the modified system? East AB configuration



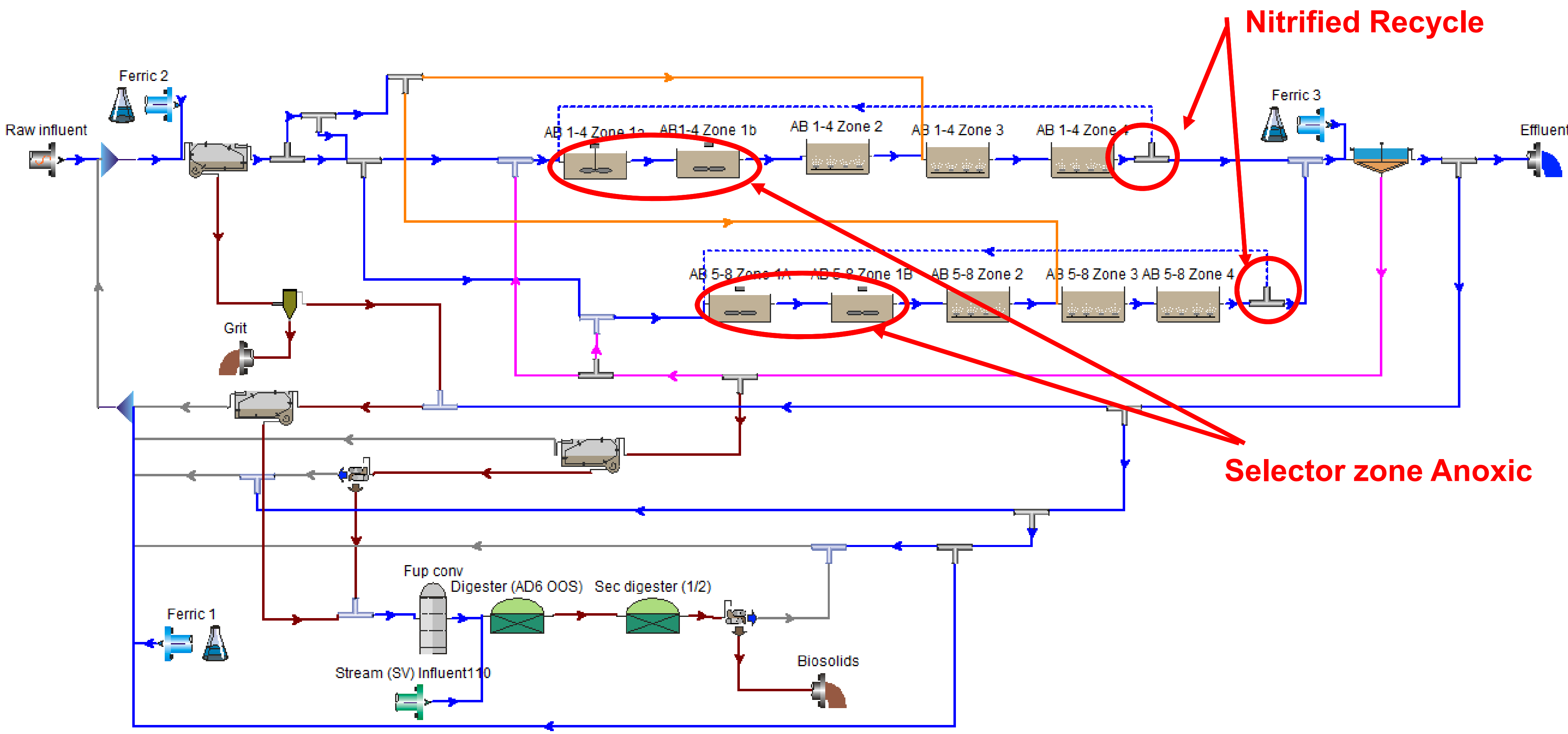
Scenario 2b - What is the BNR capability of the modified system? West AB configuration



Flexible Selector in Anoxic Mode

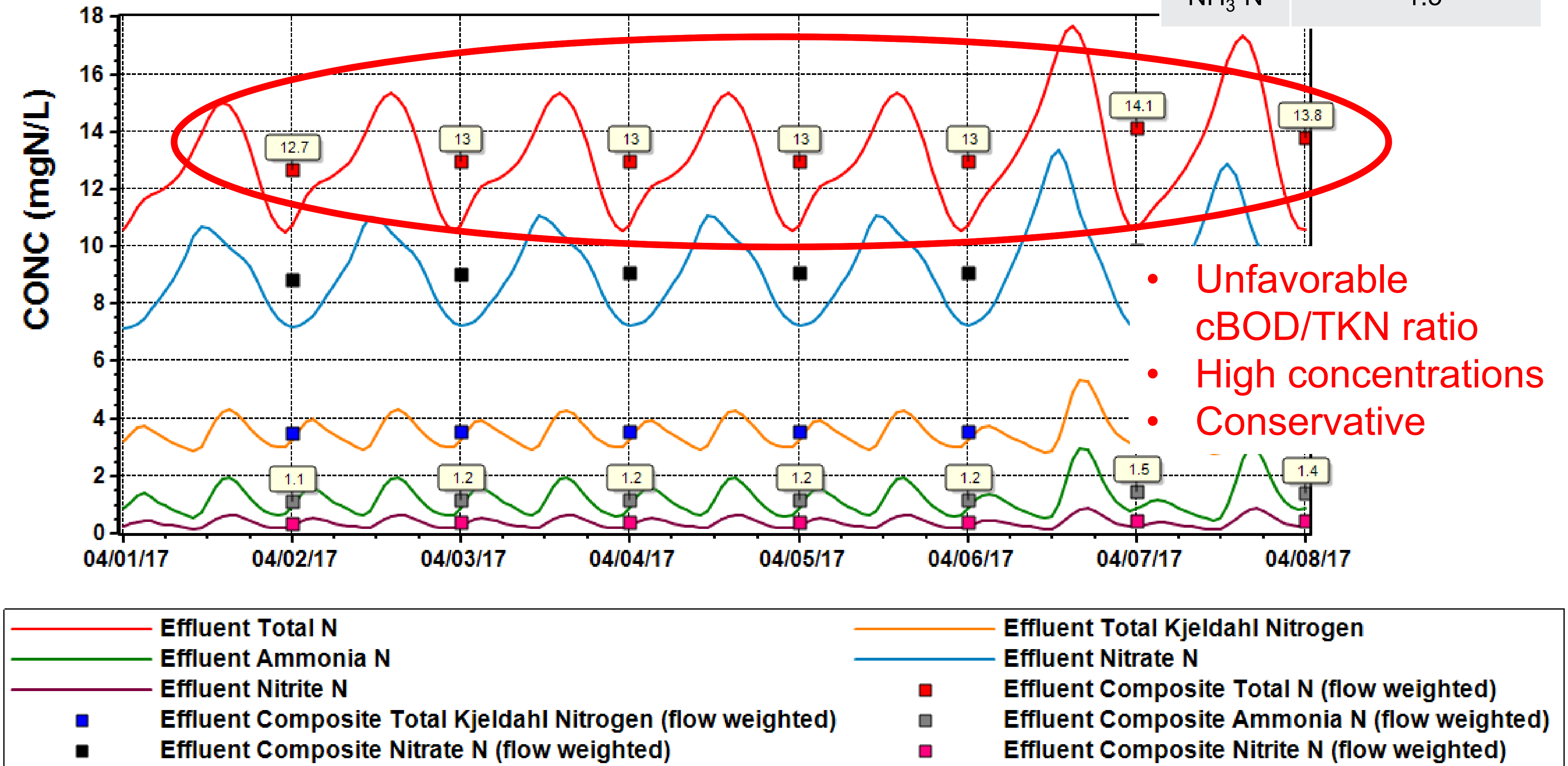
Internal Recycle

Scenario 2b - What is the **BNR** capability of the modified system? BNR process model



Scenario 2b - What is the BNR capability of the modified system? Effluent N

	Weekly average (mgN/L)
TN	~13.5
NH_3-N	~1.5

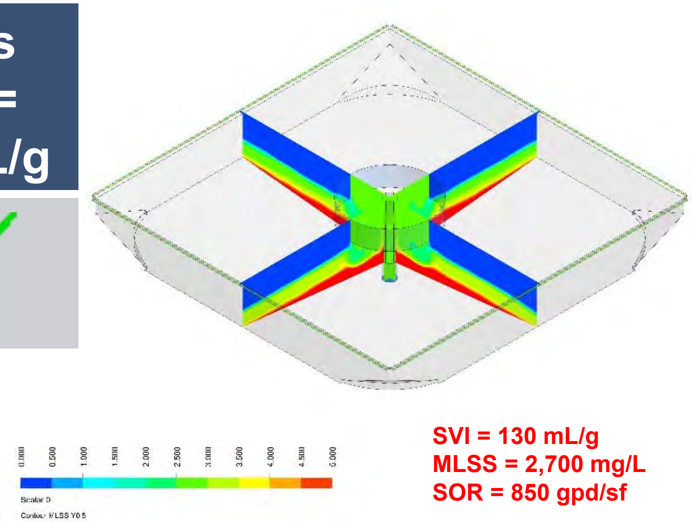


- Unfavorable cBOD/TKN ratio
- High concentrations
- Conservative

Scenario 2b - What is the BNR capability of the modified system? Clarifier Check

- For 2028 AA loads
- All aeration basins online, all clarifiers online
- ✓ MLSS of 2,700mg/L is required to maintain aSRT of ~3.5 days
- ✓ Clarifier passes 2028 DW AA diurnal flow pattern

	Flow (MGD)	SOR (gpd/sf)	SLR (gpd/sf)	Results at SVI = 130 mL/g
Average	25.8	540	18.0	✓
Maximum	38.3	800	27.0	



SVI = 130 mL/g
MLSS = 2,700 mg/L
SOR = 850 gpd/sf

Scenario 2b - What is the BNR capability of the modified system? Summary

- ✓ Can operate in BNR mode during dry weather
- Clarifier results **OK** for MLSS of 2,700 mg/L and all units in service but stressed for units out of service and wet weather
- Increased solids loading to modified clarifiers
  - High diurnal peaks stress clarifier during dry weather
  - Clarifier capacity limits MLSS, aSRT, and therefore BNR

Scenario 2b - What is the BNR capability of the modified system? Summary

To treat BNR year-round and make the system more robust we will need:

- Need more AB Volume to increase aSRT
- Need more clarifiers to pass more solids in WW

↓

Scenario 3

How much more process volume do we need to achieve Level 2 standards for (2040 flows and loads)?

10 Minute Break

Scenario 3

What are the improvements needed to achieve Level 2 nutrient standards?

(2040 Design Horizon)

Paul Pitt, Ron Latimer

Scenario 3 - What is needed for Level 2?

Yes, new infrastructure!

What infrastructure requirements? How many?, Where?

Scenario 3 - What is needed for Level 2? - Specific Assumptions

- Horizon: **2040**
- **Note further design horizon than Scenario 2**
- **Also different than Master Plan (2058)**

	AA		MM		MML-AAF
Flow, mgd	29.1		33.5		29.1
Peak Flow, mgd	70.4		70.4		
COD, lbs/d	181,700	749	209,000	749	861
BOD, lbs/d	65,500	270	75,300	270	310
TSS, lbs/d	87,800	362	100,900	362	416
TKN, lbs/d	13,250	55	15,240	55	63
NH_3-H, lbs/d	9,010	37	10,360	37	43
TP, lbs/d	1,680	6.9	1,940	6.9	8.0

High concentration scenario

- Minimum week temperature **16ºC**

Scenario 3 - What is needed for Level 2? - Specific Assumptions

- Effluent limitations – BACWA Level 2
  - Assumed this a monthly standard to be met during the coldest month ← Most conservative Assumption

	NH_3-N mg/L	TN, mg/L	TP, mg/L
Level 2	2	15	1

Note more stringent cBOD and TSS for this partial flow

-

Discharge point	Old Alameda Creek	Comment
Flows, mgd	0-22 mgd	> 43 mgd
cBOD, mg/L	10	
TSS, mg/L	15	
TN, mg/L	15	Assumed per 9/18 meeting
Ammonia, mg/L	2	Assuming no daily / weekly limit per 9/18 meeting. BACWA monthly limit was assumed.

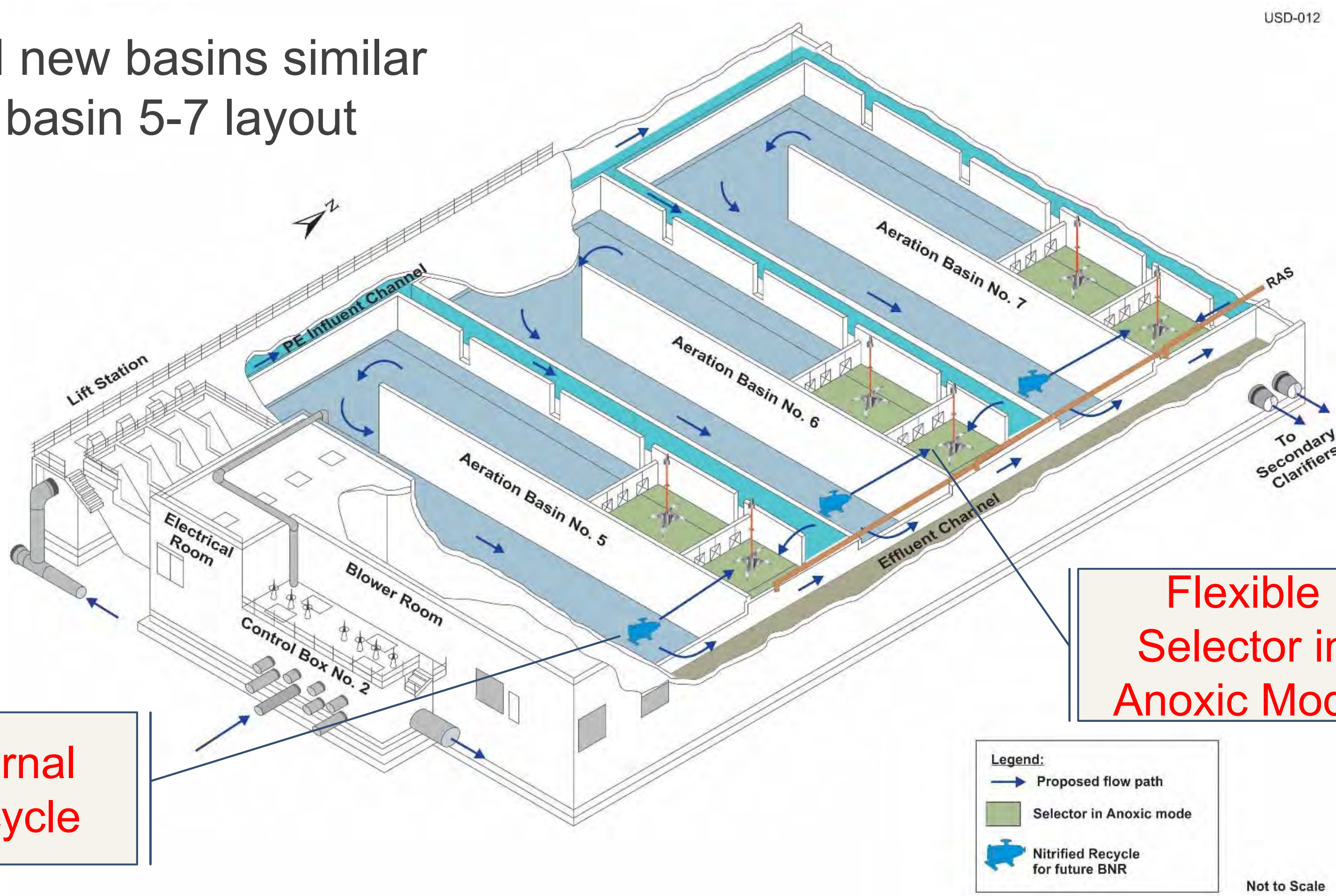
Scenario 3 - What is needed for Level 2? - Operation modes

	Winter	Spring	Summer	Fall
Months	Dec – Feb	Mar – May	Jun – Aug	Sept – Nov
Temperature, °C	16	20	27	23

	Normal	Wet Weather	Redundancy
Load	MM	MM	AA
PC TSS removal, %	63	63	63
Temperature, °C	16	16	20
Basins in service	ALL	ALL	1AB/1SC OOS
Selector operation	Anoxic	Anoxic	Anoxic
Step Feed	No	Yes	Possible
SRT, d	~6.5	~6.5	~6.5
MLSS, mg/L	TBD	TBD	TBD
SVI (ml/gm)	130	130	130

Scenario 3 - What is needed for Level 2? – West and new AB DW BNR mode

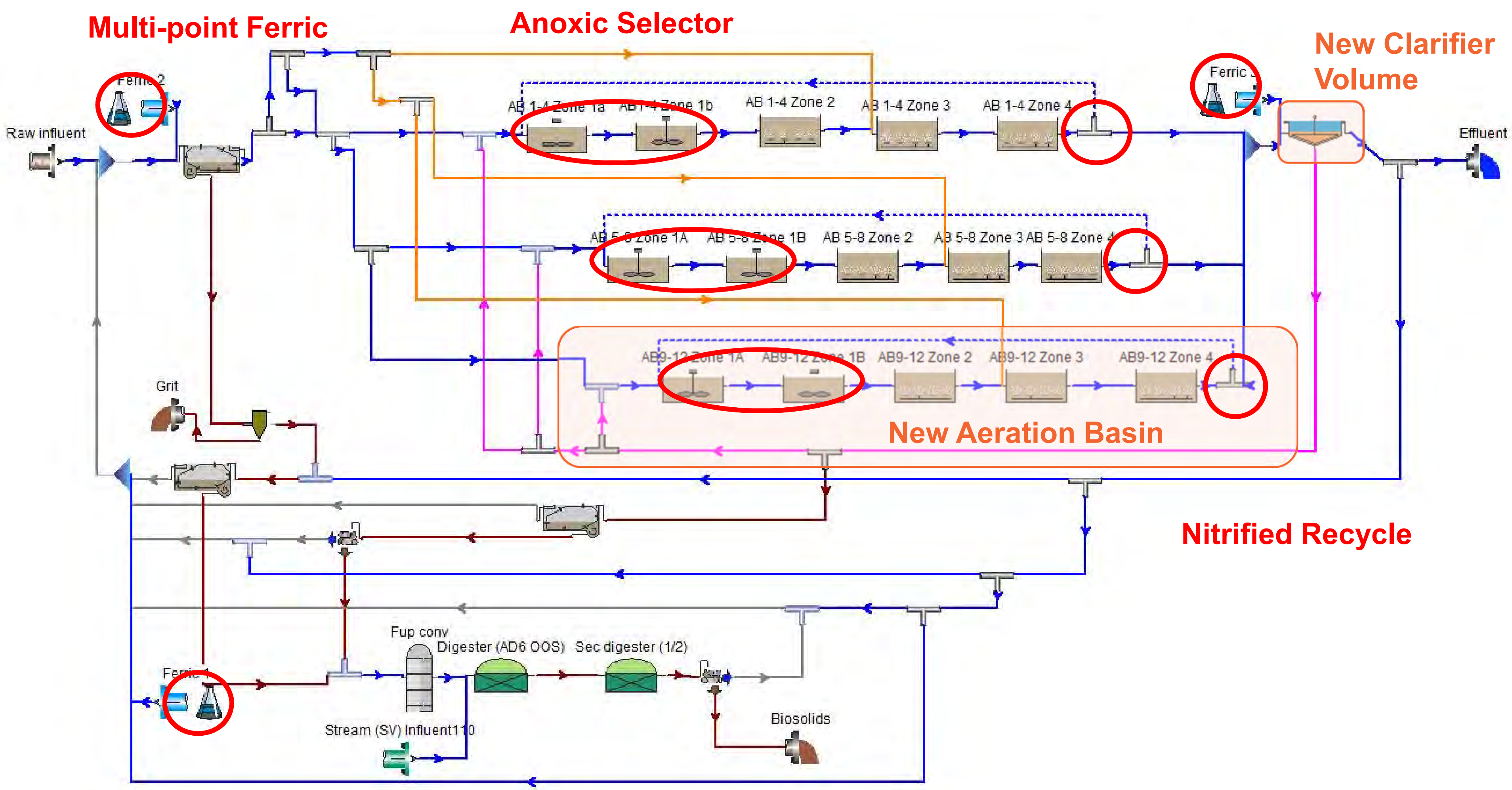
All new basins similar to basin 5-7 layout



Internal Recycle

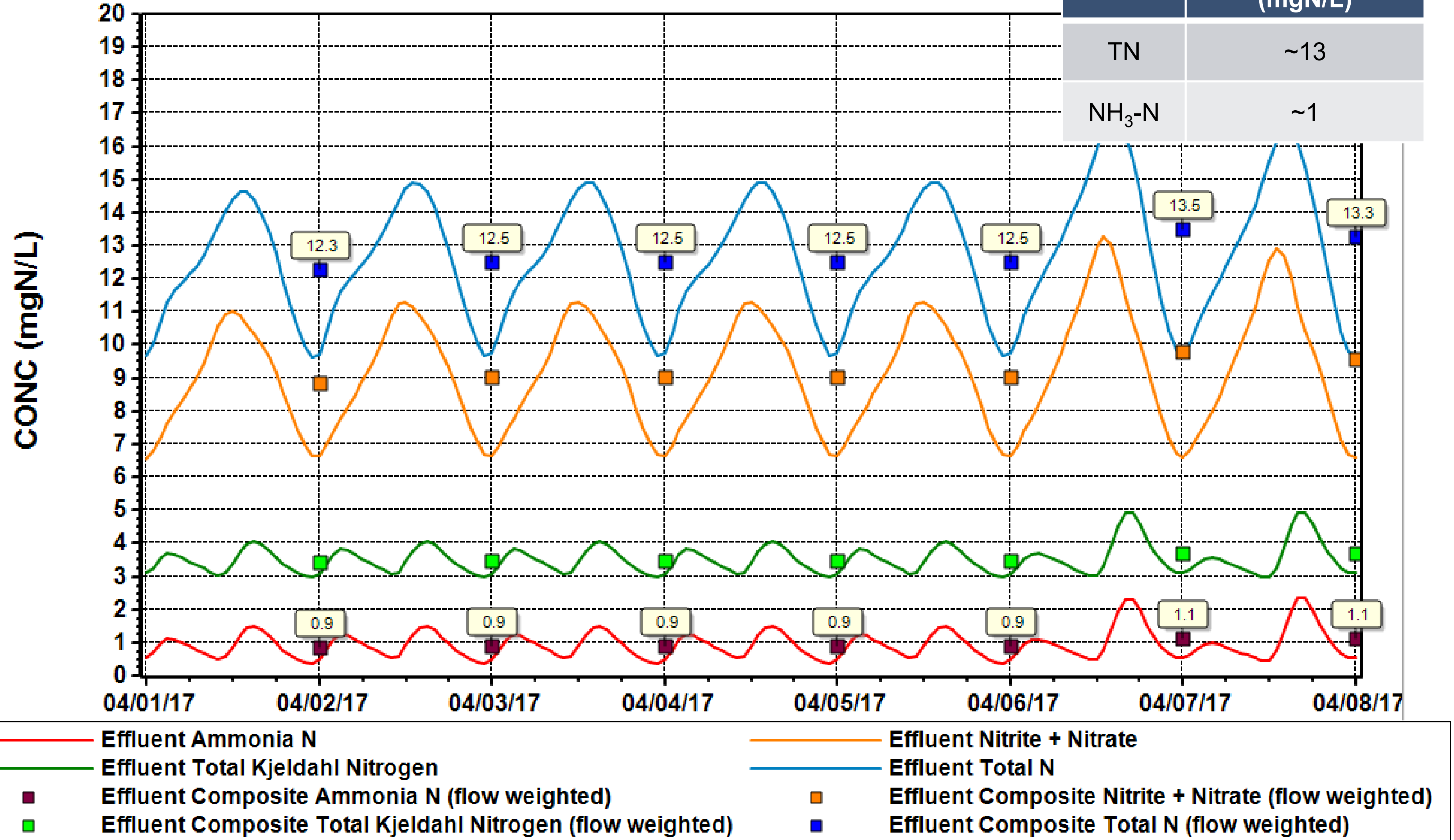
Flexible Selector in Anoxic Mode

Scenario 3 - What is needed for Level 2? – Process Model



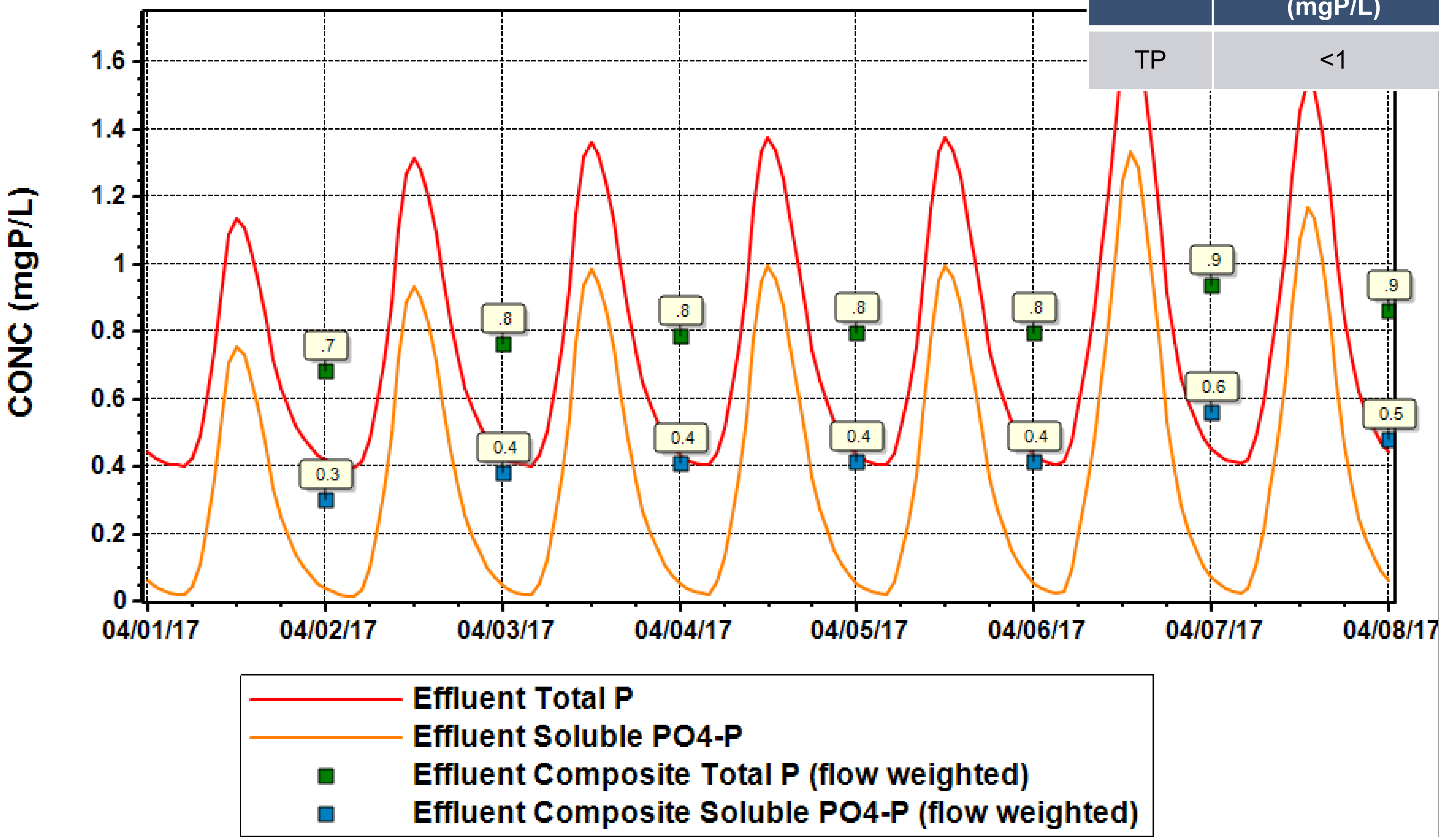
Scenario 3 - What is needed for Level 2? –
MM DW Effluent N

	Weekly average (mgN/L)
TN	~13
NH_3-N	~1



Scenario 3 - What is needed for Level 2? – MM DW Effluent P

	Weekly average (mgP/L)
TP	<1



Scenario 3 - What is needed for Level 2? – DW operation and water quality

Flow/Load		AA	MM	MML-AAF
aSRT	d	6.5	6.5	6.5
MLSS	mg/L	3,100	3,600	3,600
Effluent TN	mgN/L	~12	~13	~14
Effluent NH_3-N	mgN/L	~1	~1	~1
Effluent TP	mgP/L	< 0.8	< 0.8	< 0.8

Function of:

- High PI TKN concentrations
- Poor PE $cBOD_5$: TKN ratio

Scenario 3 - What is needed for Level 2? – DW operation and water quality

Flow/Load		AA	MM	MML-AAF	MML-AAF 22ºC
aSRT	d	6.5	6.5	6.5	6.5
MLSS	mg/L	3,100	3,600	3,600	3,600
Effluent TN	mgN/L	~12	~13	~14	~13
Effluent NH_3-N	mgN/L	~1	~1	~1	<0.2
Effluent TP	mgP/L	< 0.8	< 0.8	< 0.8	< 0.8

Warmer temperature improves nitrification but not overall nitrogen removal

Function of:

- High PI TKN concentrations
- Poor PE $cBOD_5$: TKN ratio

Scenario 3 - What is needed for Level 2? – DW operation and water quality

We looked at sidestream treatment to address this issue:

- Sidestream treatment reduces TKN load to secondary treatment significantly

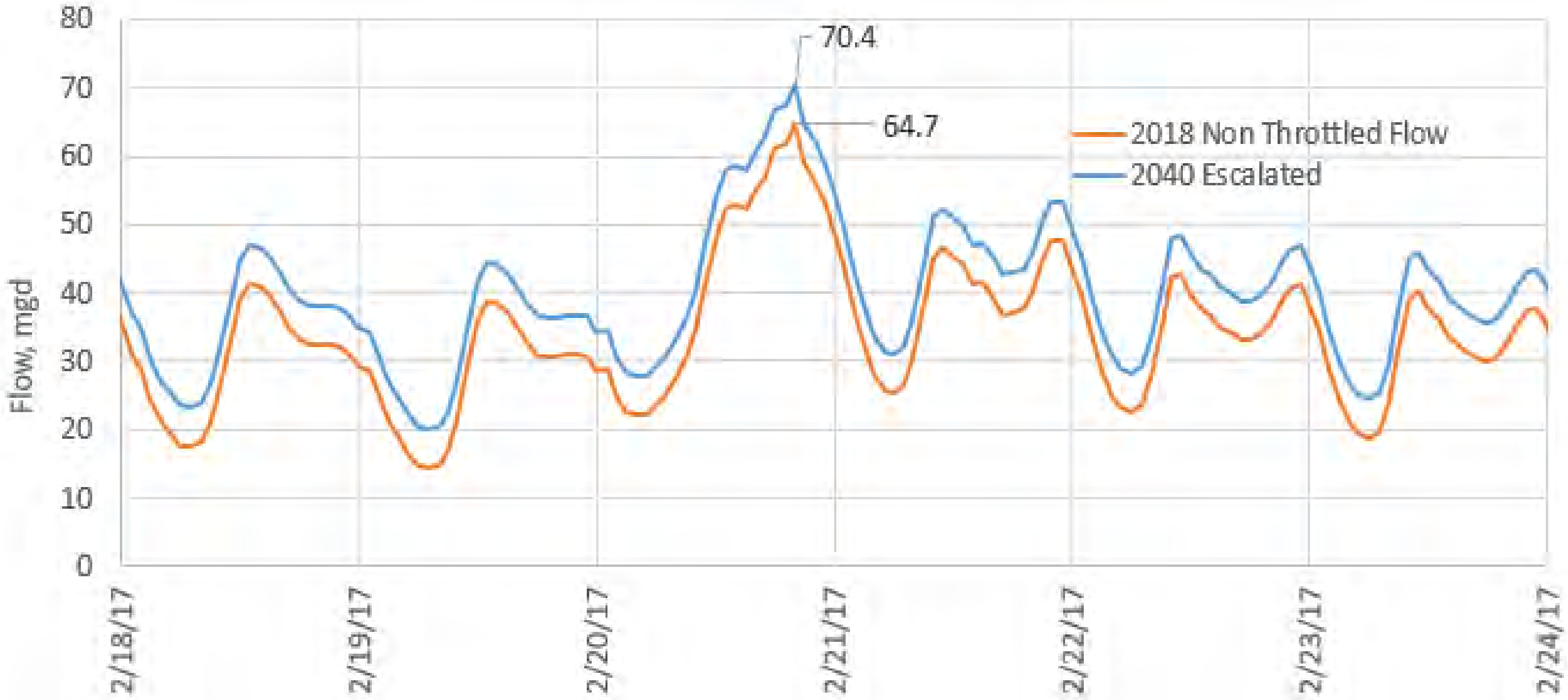
	AA	MM	MML-AAF
Effluent TN W/o SST (mgN/L)	~12	~13	~14
Effluent TN W/SST (mgN/L)	~10	~11	~11

Scenario 3 - What is needed for Level 2? – DW Summary

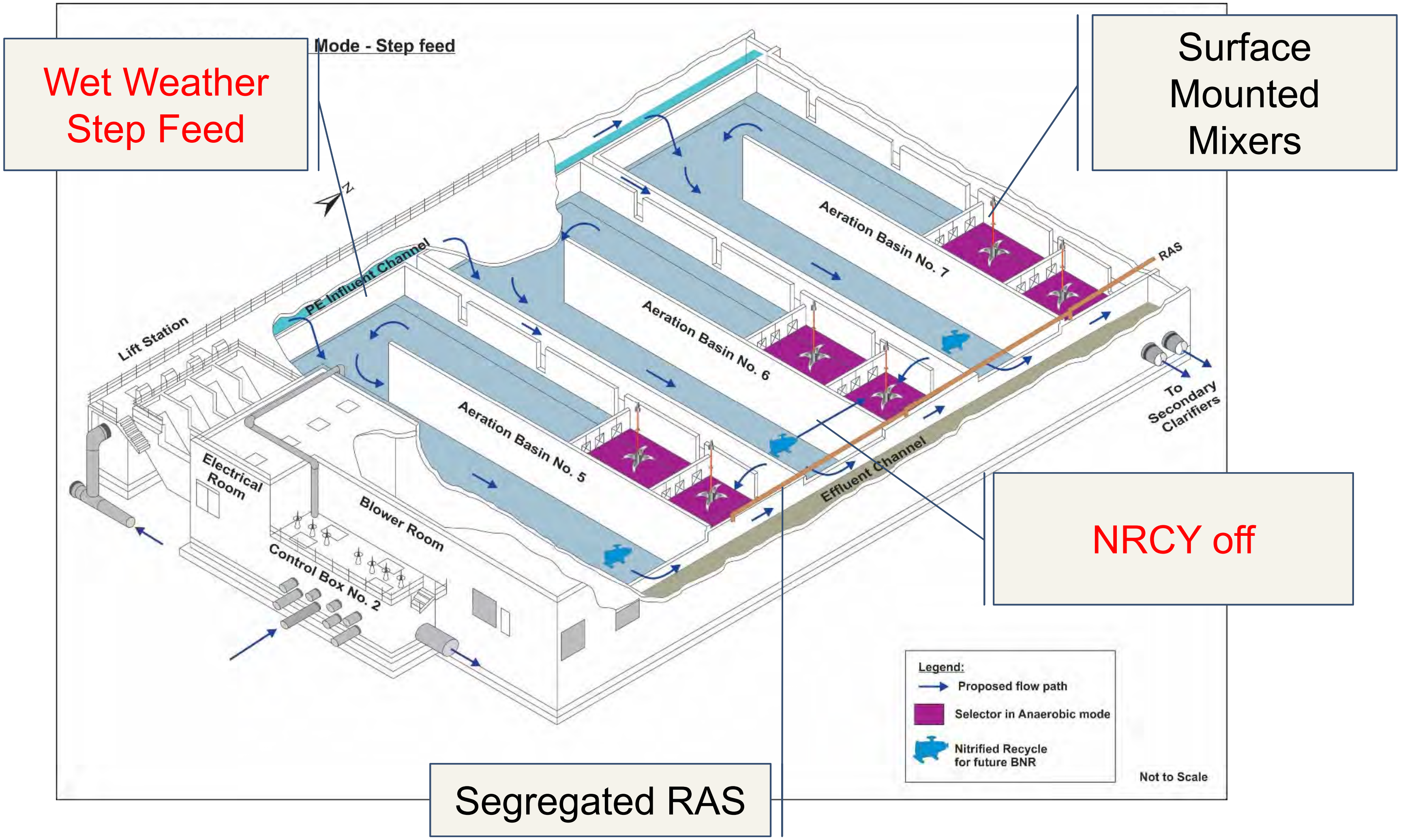
- To achieve NH_3<2 mgN/L for coldest month, aSRT ~6.5 d
  - Minimum **5.3 mg new** aeration basin volume for 16ºC (conservative temperature)
- **Sidestream treatment** is recommended to be included in the upgrade for nutrient removal

✓ **New clarifiers** needed to pass these solids
  - Clarifier volume further defined in WW scenarios

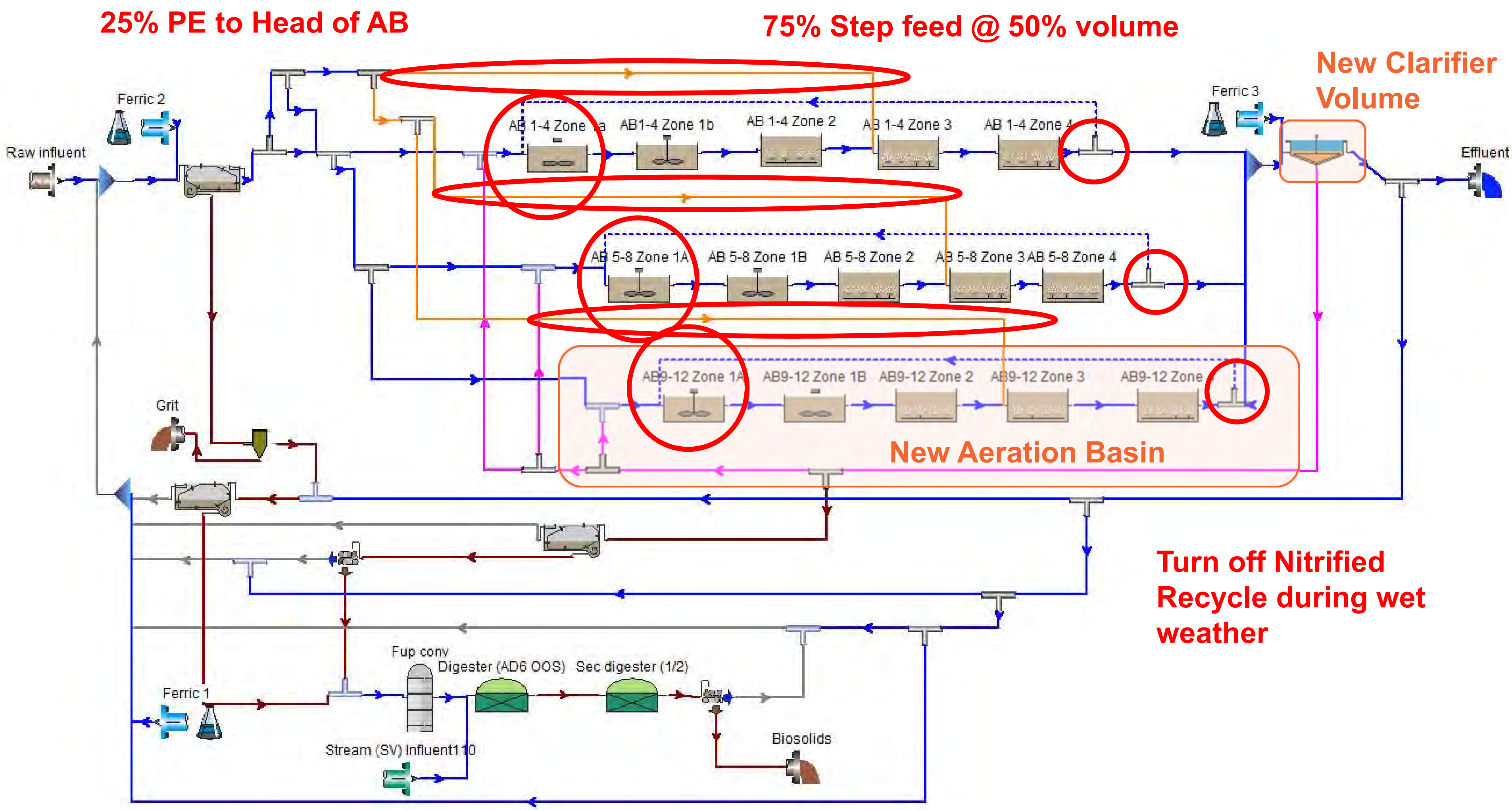
Scenario 3 - What is needed for Level 2? – Wet Weather Hydrograph



Scenario 3 - What is needed for Level 2? –
West and NEW AB WW Configuration

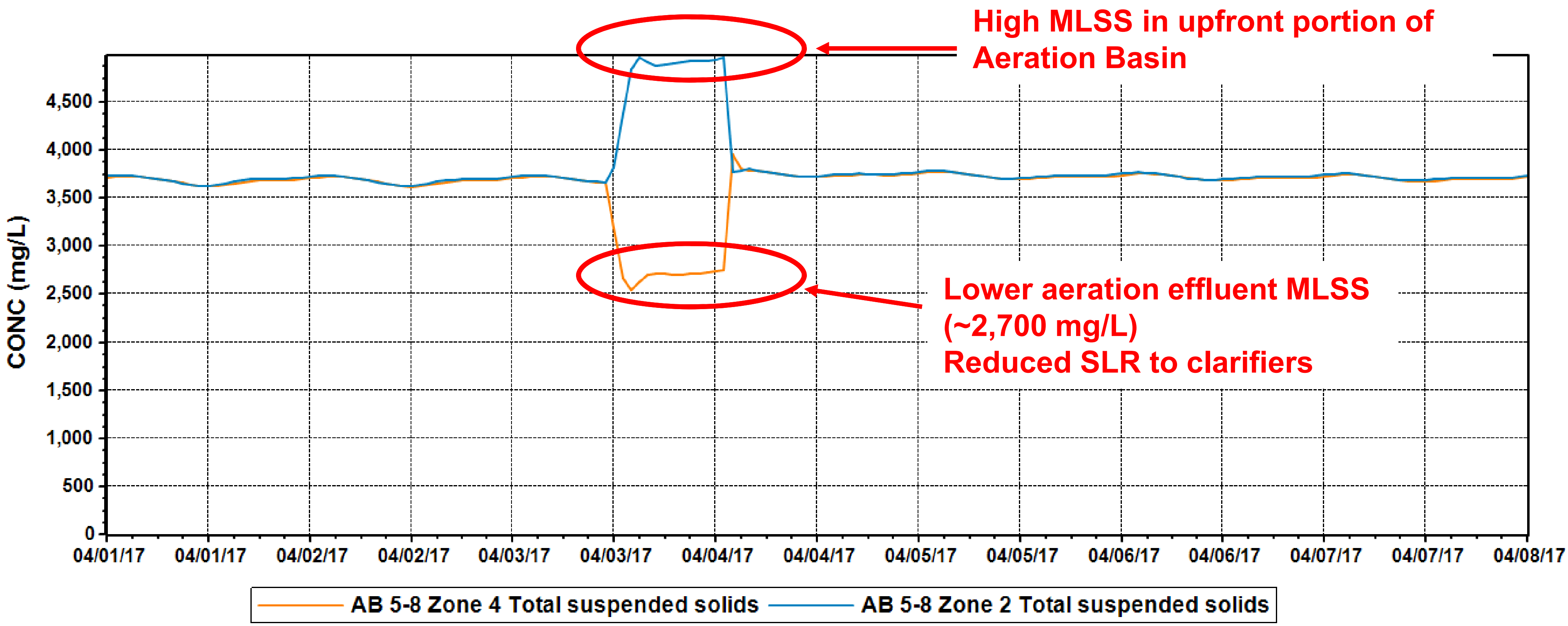


Scenario 3 - What is needed for Level 2? –
WW process model



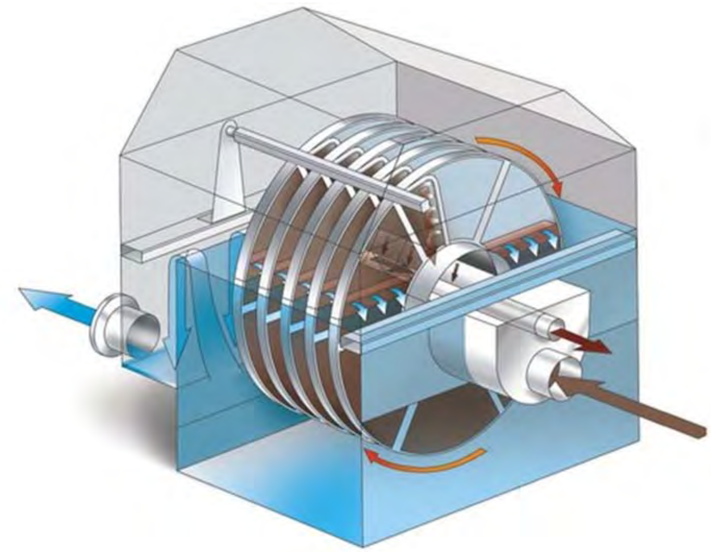
Scenario 3 - What is needed for Level 2? – Wet Weather MLSS

- Step-Feed is limited to 75% at ½ way point in basin



Meeting Old Alameda Creek TSS standards

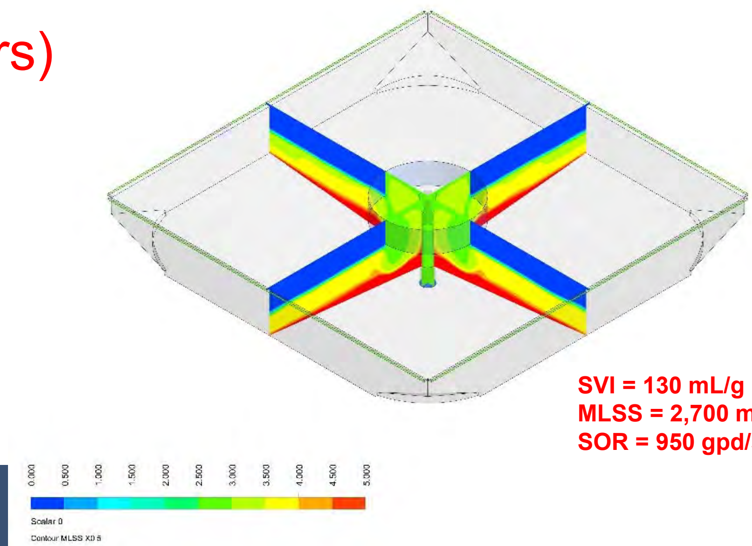
- Disc filters will be required after clarification to meet Old Alameda Creek TSS standards during wet weather.
- Converge Phase:
  - How to tie in with chlorination / dechlorination
  - How will flow get to Old Alameda Creek



Scenario 3 - What is needed for Level 2? – Wet Weather Summary

- Wet weather step feed was limited to 75% of PE flow ½ way down the basin
- Aerator Effluent MLSS reduced to 2,700 mg/L during storm
- Clarifier maximum SOR at 2,700 mg/L =
  - 900 gpd/sf (existing clarifiers)
  - 1,100 gpd/sf (new circular clarifiers)
- Additional clarifier area =

  35,000 sf



SVI = 130 mL/g
MLSS = 2,700 mg/L
SOR = 950 gpd/sf

Scenario 3 - What is needed for Level 2? – Infrastructure Summary

	Existing	Hazen Initial Sizing*	Master Plan
New Volume Required with Anaerobic Zone, mgal	--	5.3	22.4
Total Volume with Anaerobic Zone, Mgal	7.6	13.5 - 16.5	30
Secondary Clarifier		4 new @145' or Existing + 2 new 160'	6 new @145'

Scenario 3 - Questions that became apparent as we worked through the details:

***Converge** phase will answer these questions in more depth*

1. What is the impact of the minimum week **temperature**?
2. What is the impact of **diurnal EQ**?
3. How does **Chemical P** compare to **Bio-P** removal (A2O)?
4. What is more **synergistic** with Level 3, 4 stage with disc filter or MLE with denitrification filters?

Scenario 3: Question 1 - What is the impact of the minimum week temperature?

- Monitor Influent Temperature ← **start now** if it has not started
- At higher temperature, lower SRT is required for full nitrification
- Reduced SRT ~ 10% less total Aeration Basin Volume
- If built for 16ºC, but is actually 18ºC, more capacity past 2040

Temperature, ºC	16ºC	18ºC	18ºC
Total Aeration Basin Volume, mg	12.9	12.9	11.7
New AB Volume, mg	5.3	5.3	4.1
SRT, d	~6.5	~6.5	~5.5
MLSS, mg/L	~3,650	~3,600	~3,600
Effluent TN, mg/L	13	<13	<13
Effluent Ammonia, mg/L	1.2	0.6	1.1

23% less new volume

Scenario 3: Question 2 - What is the impact of diurnal EQ?

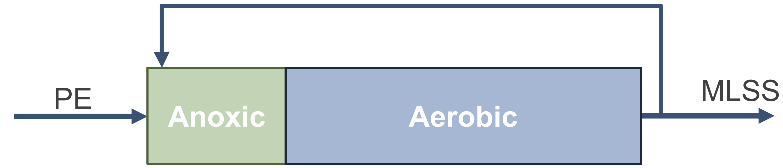
- With influent EQ, diurnal load variations are attenuated
- Lower SRT is required
- Reduced SRT ~ 10% less total Aeration Basin Volume
- Or better effluent quality with same Aeration Basin Volume

Influent EQ	No	Yes	Yes
Total Aeration Basin Volume, mg	12.9	12.9	11.7
New AB Volume, mg	5.3	5.3	4.1
SRT, d	~6.5	~6.5	~5.6
MLSS, mg/L	~3,650	~3,600	~3,600
Effluent TN, mg/L	13	12	13
Effluent Ammonia, mg/L	1.2	0.5	0.9

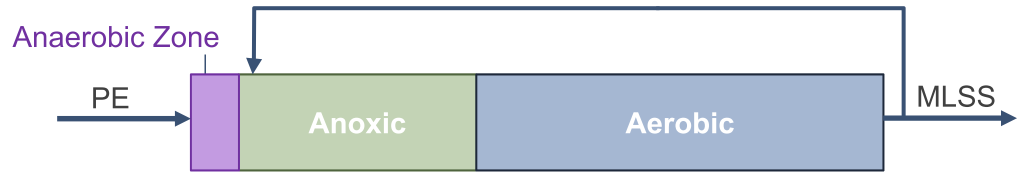
23% less new volume

Scenario 3: Question 3 – How does Chemical P compare to Bio-P removal?

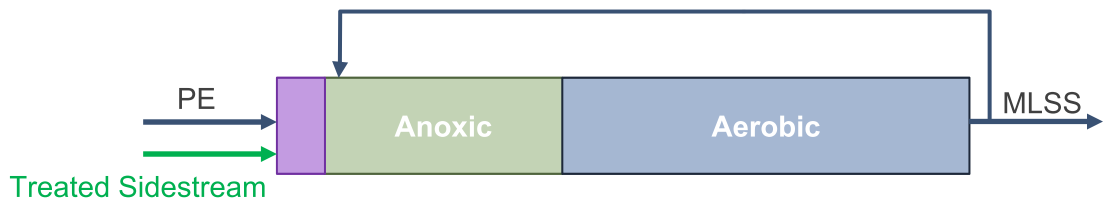
- MLE + Ferric addition



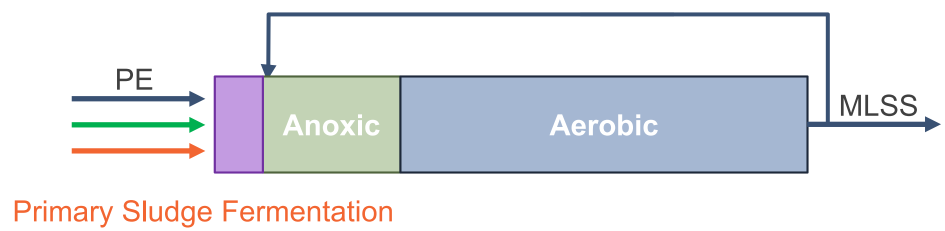
- Anaerobic zone for EBPR



- Anaerobic zone for EBPR + Sidestream treatment



- Anaerobic zone for EBPR + SST + PS Fermentation



Scenario 3: Question 3 – How does Chemical P compare to Bio-P removal?

Mode	MLE + Ferric	A2O	A2O + SST	A2O + SST+ PS Fermentation
Anaerobic Volume, mg	0	1.3	1.3	1.3
Anoxic Volume, mg	3.6	6.2	6.2	3.6
Aerobic Volume, mg	9.3	10.6	10.6	10.6
Total Volume, mg	12.9	18.0	18.0	15.5
Ferric, gpd	1,450			
Effluent TN, mg/L	13.7	15.7	12.3	12.9
Effluent Ammonia, mg/L	0.9	0.9	1.2	1.3
Effluent TP	0.8	1.8	1.0	1.1

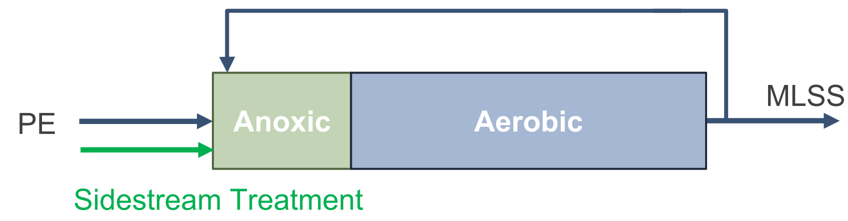
Scenario 3: Question 3 – How does Chemical P compare to Bio-P removal?

To **converge** on the best phosphorus removal option for USD, we will need to weigh different factors:

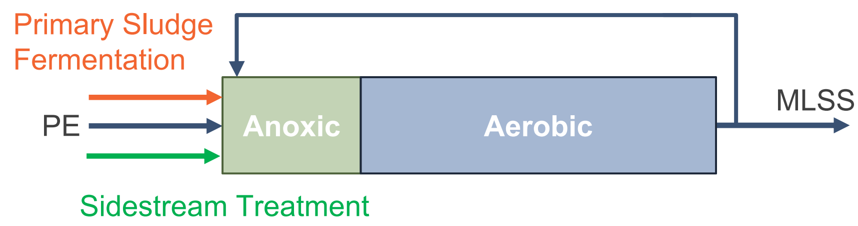
- Capital Costs
- Operational Costs of chemical addition
- Struvite formation
- Operational ease
- Phasing of projects (SST, etc)
- Collection system chemical use
- Synergy with level 3 options

Scenario 3: Question 5 – Synergy with Level 3: 4 stage + disc vs MLE + Denite?

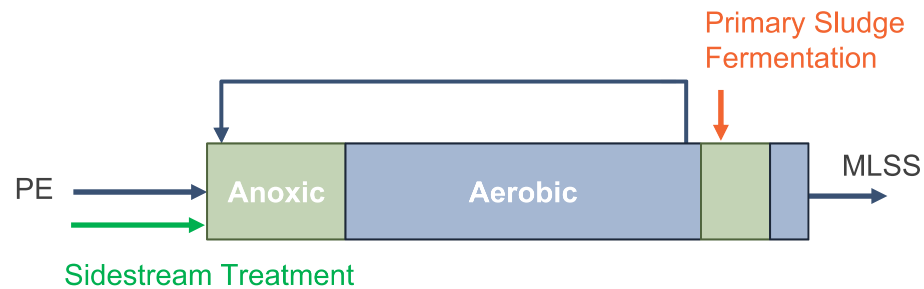
- MLE + SST



- MLE + SST + PS Fermentation



- 4-Stage + PS Fermentation + SST



Scenario 3: Question 4 – Synergy with Level 3: 4 stage + disc vs MLE + Denite?

Mode	MLE +SST	MLE + SST + PS Fermentation	4 Stage + PS Fermentation + SST
Anoxic Volume, mg	3.6	3.6	5.4
Aerobic Volume, mg	9.3	10.2	10.3
Total Volume, mg	12.9	13.8	15.7
Effluent TN, mg/L	11.1	10.8	7.6
Effluent Ammonia, mg/L	1.4	1.1	1.0

Fermentation will provide more carbon for TN removal

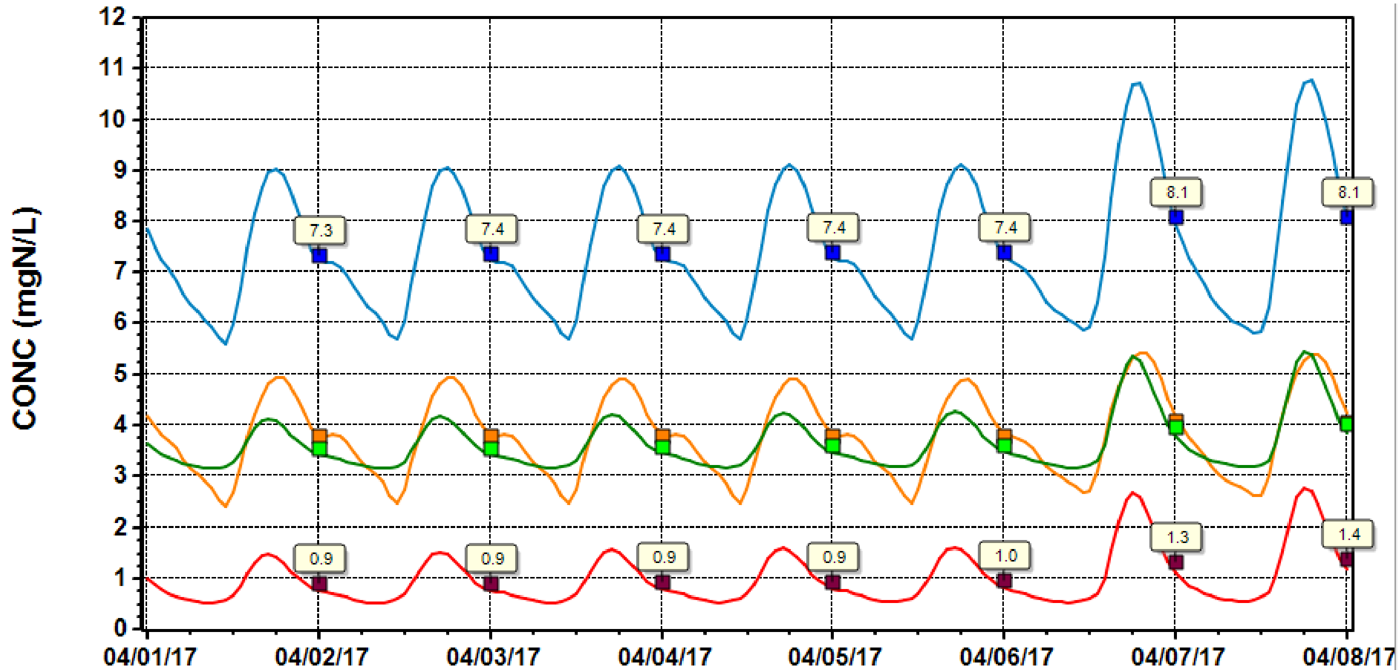
A second anoxic zone will provide more denitrification

Scenario 3: Question 4 – Synergy with Level 3: 4 stage + disc vs MLE + Denite?

4-Stage + SST + PS Fermentation

- 2.8 mg extra volume total
- Fermentate to 2nd Anoxic zone
- Can reach **Level 3** with clean carbon

	Weekly average (mgN/L)
TN	<8
NH_3-N	~1



15 Minute Break

Scenario 4

What MBR volume is required to reach Level 2 standards?

Paul Pitt, Ron Latimer

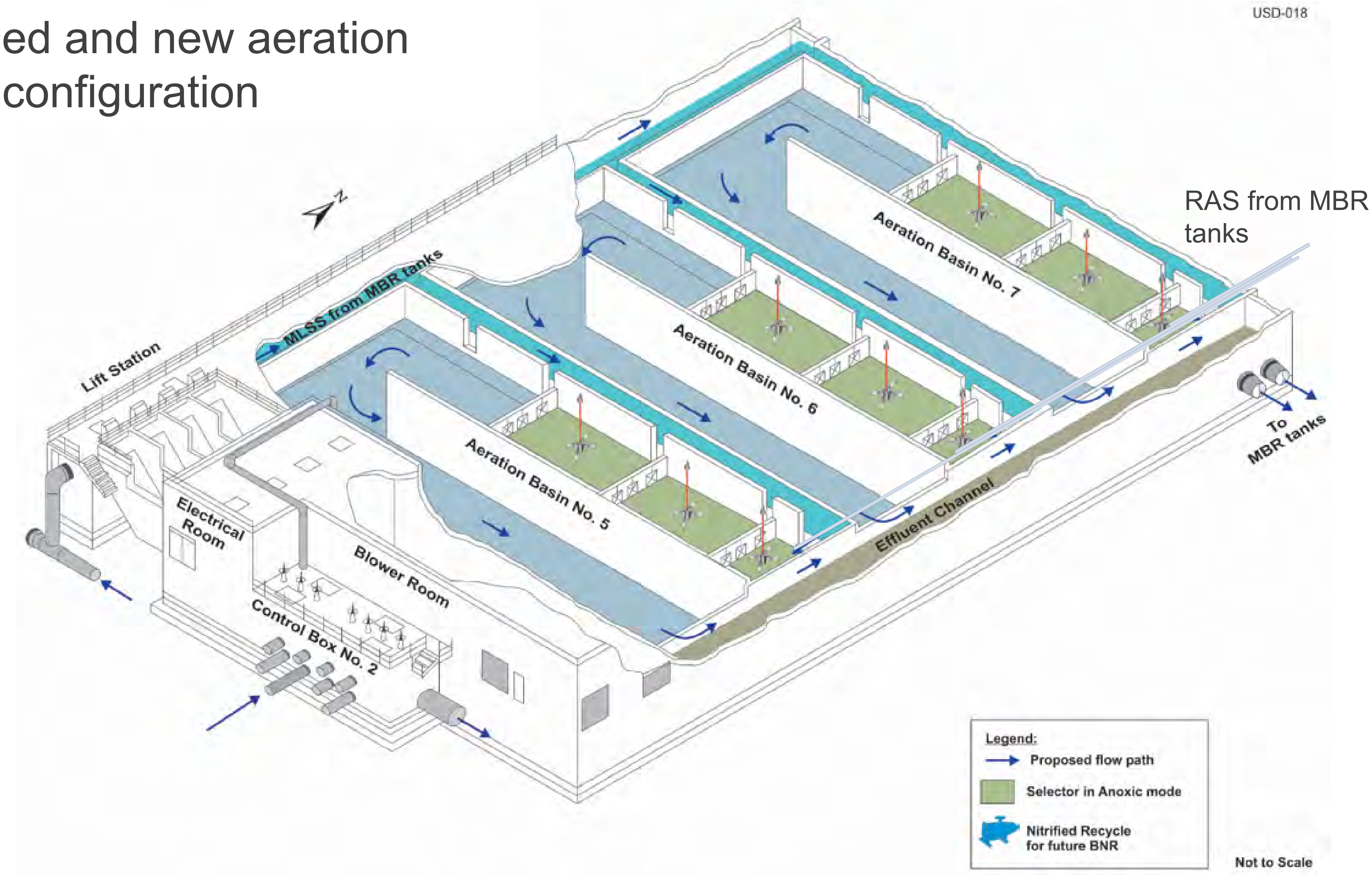
Scenario 4 – What MBR volume is required to reach Level 2? Infrastructure

Yes, new MBR!

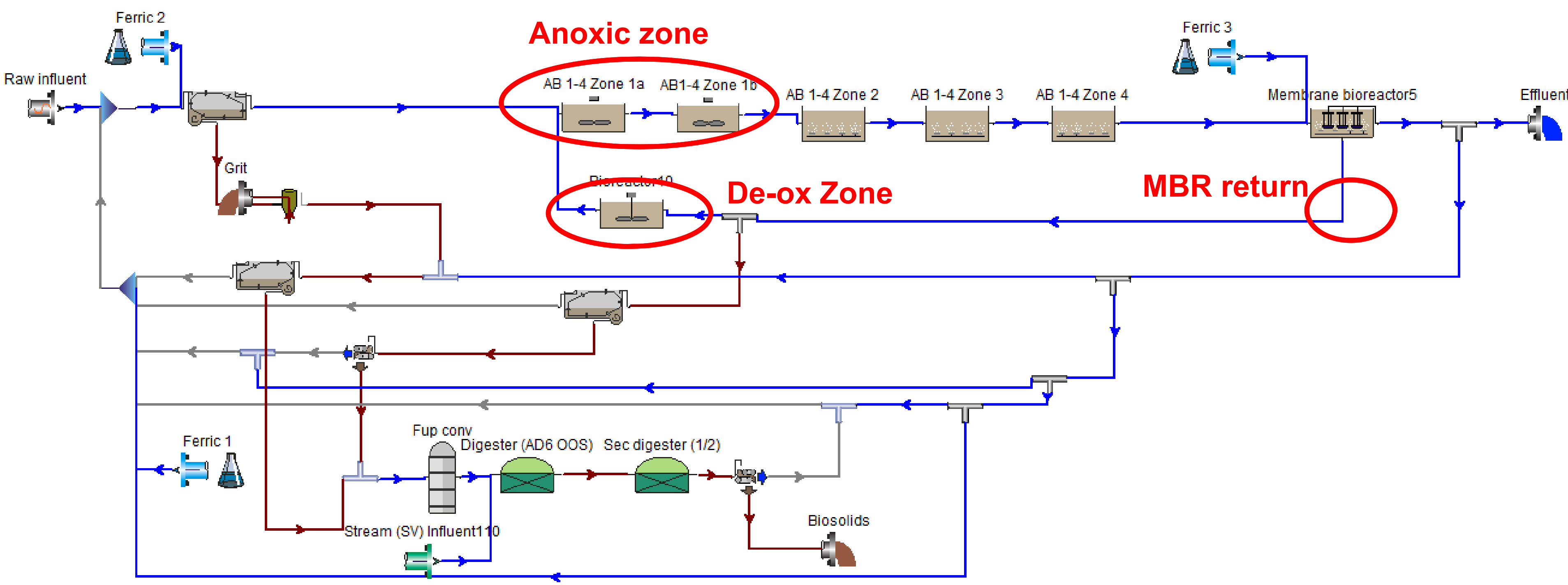
What infrastructure requirements? How many?, Where?

Scenario 4 – What MBR volume is required to reach Level 2? Aeration basin configuration

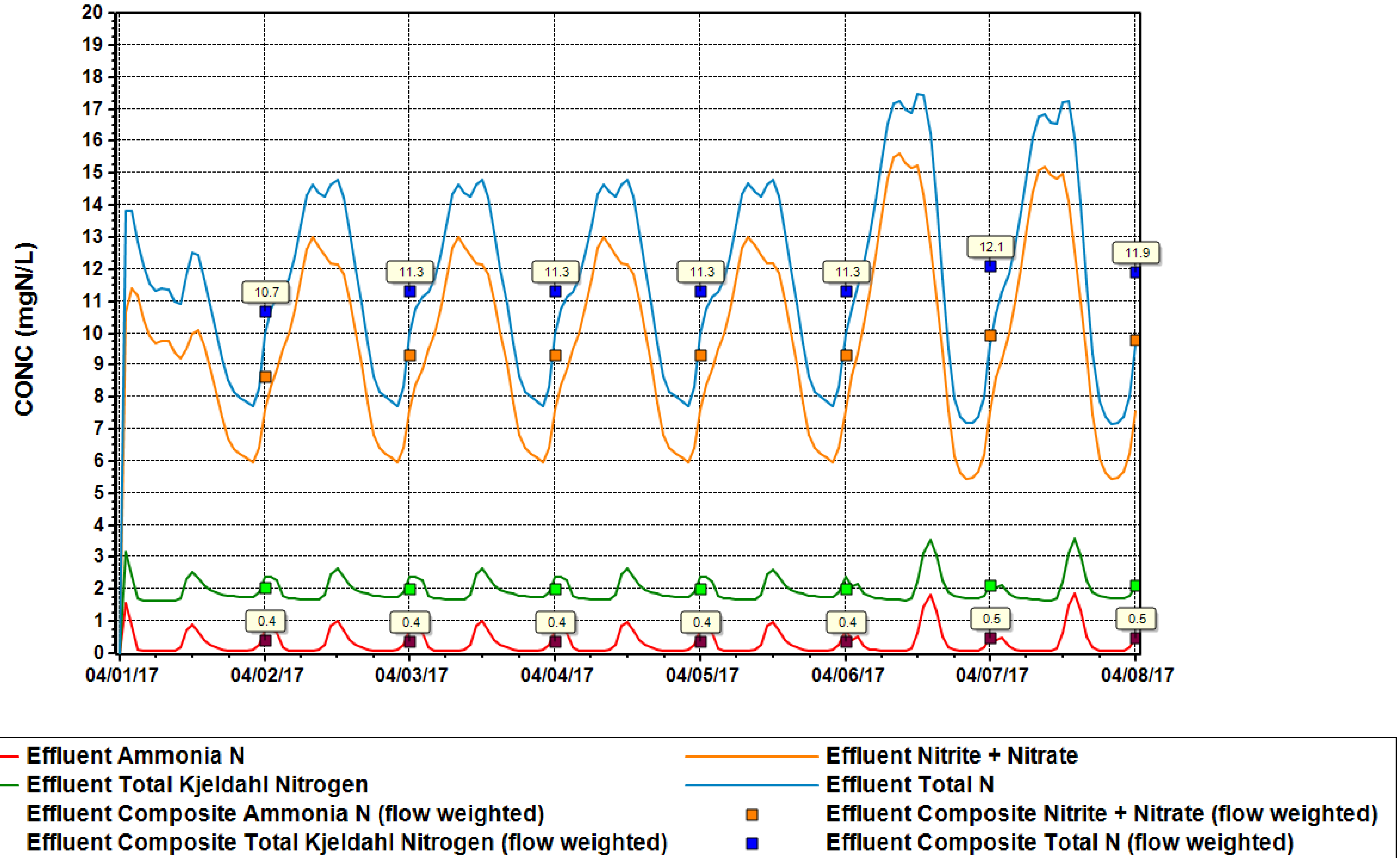
Modified and new aeration basin configuration



Scenario 4 – What MBR volume is required to reach Level 2? Process model



Scenario 4 – What MBR volume is required to reach Level 2? DW MM Effluent N



Scenario 4 – What MBR volume is required to reach Level 2? DW Summary

Flow/Load		AA	MM	MML-AAF
aSRT	d	8.4	7.9	7.9
MLSS	mg/L	7,100	7,800	7,800
Effluent TN	mgN/L	11	11.4	12.9
Effluent NH_3-N	mgN/L	0.3	0.4	0.3
Effluent TP	mgP/L	<0.6	0.63	0.73

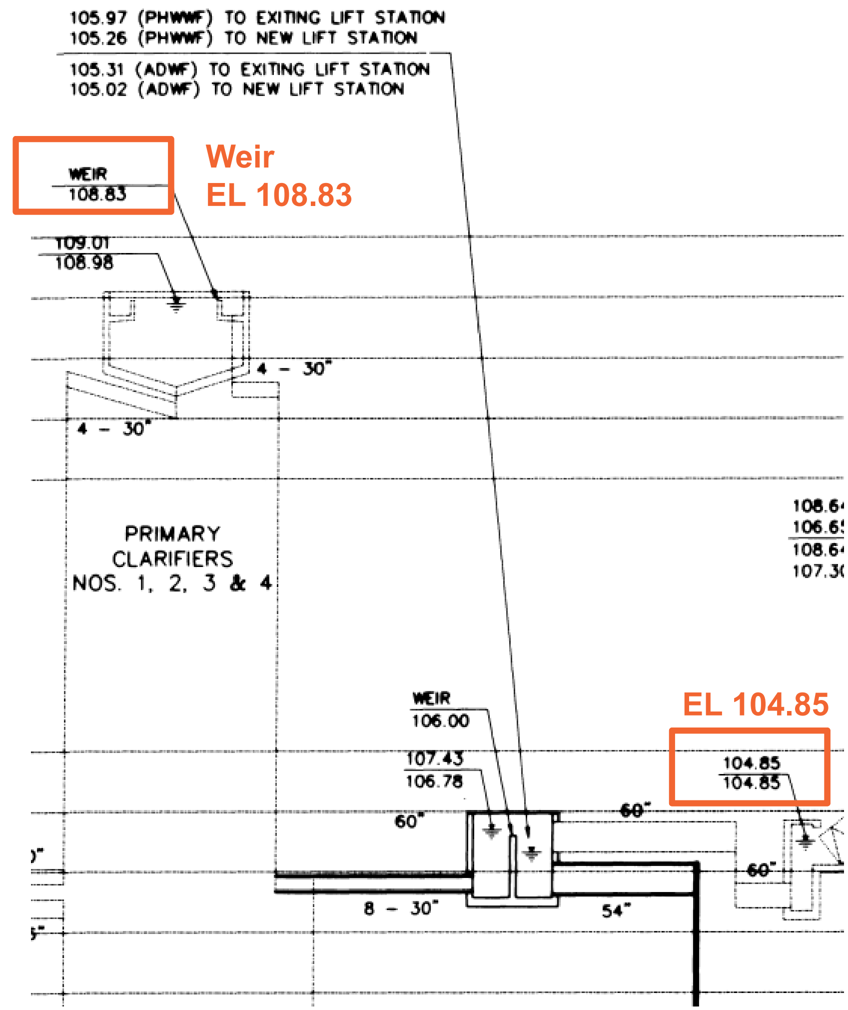
Scenario 4 – What MBR volume is required to reach Level 2? Summary

- Total aeration volume required 8.3 mgd
  - De-oxygen zone = 0.5 mg
  - New Aeration Basin 8 = 1.1 mg
- Can operate at higher MLSS ~ 7,000mg/L
  - Requires less volume to achieve SRT >6.5 days for full nitrification

	Current projection	Master Plan
Total aeration basin volume	8.5 mg	
New aeration volume (AB 8)	1.1mg	
MBR tank volume	21,000 sf	50,000sf

Scenario 4 – What MBR volume is required to reach Level 2? Initial look at fine screens

- No secondary pumping required
- MBR and fine-screening facilities can fit on-site
    - No ideal location
    - Must consider conflicts, construction sequencing, and hydraulics to arrive at “best” solution



7. Layouts

Initial High Level Layouts – volume summary

	Existing	Hazen Initial Sizing*	Master Plan
New Volume Required with Anaerobic Zone, mgal	--	5.3	22.4
Total Volume with Anaerobic Zone, Mgal	7.6	12.9	30
Secondary Clarifier		4 new @145' or Existing + 2 new 160'	6 new @145'

	Current projection	Master Plan
Total aeration basin volume	8.5 mg	
New aeration volume (AB 8)	1.1mg	
MBR tank volume	21,000 sf	50,000sf

Initial High Level Layouts

Initial layouts to:

- Understand what the new plant might look like
- Facilitate high level costing
- Initial comparison of options

To be considered during **converge** phase

- Detailed review of yard piping
- Infrastructure phasing with other planned work
- Costs (capital and operational)
- Hydraulics
- Triggers
- Foot print
- MOPO

Initial High Level Layouts – CAS Layout (all new clarifiers)

- **Retrofit** existing aeration basins
- **New** aeration basin 8 1.1 MG
- **New** 4.2 MG aeration basin module over C5 and C6
- **Demo** all old clarifiers
- **Four new** 150ft diameter circular clarifiers

Initial High Level Layouts – 50/50 split plant

- **Retrofit** existing aeration basins
- **New** 6.7 MG AB module
- **Retrofit** C5 and C6
- **Three new** 140 diameter circular clarifiers

Initial High Level Layouts – MBR Layout Options

8. Next Steps / Summary

Timeline

NTP 7/24/18

Comprehend Phase

- Review Data / Drawings
- Sampling
- Model development and calibration

9/18/18

Explore Phase

- Model Scenarios
- Near and long term CAS sizing / validation
- MBR option sizing

10/24/18

Converge Phase

1 week converge phase workshop with USD

- Costing
- Site Plans / Layouts
- Trigger base solution
- Sequencing / MOPO
- Synergy with Level 3
- Diurnal Equalization
- Primary Sludge Fermentation

Converge on best value solution

Design Phase

Appendix 9. District Notes

Timeline	Existing Capacity	Design Capacity	Alternative No. 1 – Conventional Treatment	Alternative No. 2 – MBR Membrane Tanks
Phase 1 - Secondary Treatment Capacity Upgrades and Effluent Management	23.4 MGD AAF (2018)	25.8 MGD AAF (2028)	Retrofit Aeration Basins 1 through 7 to operate with anaerobic selectors to improve settling. Project will include modifying Basins 1 through 4 for plug flow operation, installing dedicated RAS lines to each basin to facilitate step feed, installing internal recycle pumps/piping, and the construction of flexible anaerobic/anoxic selector zones. *Note that anoxic selectors can only be operated from May through September with this project and would allow staff to become familiar with BNR operation and for Hazen to further calibrate their secondary treatment models.*	Construct new Aeration Basin 8 and retrofit Aeration Basins 1 through 7 to operate as a MLE process. Project includes establishing new anoxic and aerobic zones, internal nitrate recycle pumps and discharge piping, modifications in influent/effluent channels, and new blowers for additional process aeration. *Hazen to confirm if Aeration Basin 8 can be postponed until Phase 2 or 3.*
			Obtain the ability to discharge to Old Alameda Creek during WW using one of the following options: (1) Construct new Aeration Basin 8 to facilitate year-round nutrient removal. *Hazen to determine the additional aeration basin volume (1.1 MG - 3.0 MG) and/or other improvements are needed for year-round removal and the level of TN removal that is obtainable with this added volume.* (2) Modify the retrofit design of Aeration Basins 1 through 7 to convert Ammonia to Nitrate during WW. *Hazen to work with staff to determine which of these options and/or combination of improvements makes the most since based on the District's objectives, timing, costs, and long term approach.*	Construct new fine screening facility with associated building and equipment. Project includes new yard piping and possibly a new pump station to convey primary effluent flow through the fine screens to the aeration basins. *Location of fine-screening facility needs to be determined.*
			Construct a new disc filter facility to meet Alameda Creek TSS standards during wet weather. *Hazen to determine how to tie in with existing disinfection and conveyance systems.*	
			Retrofit Secondary Clarifiers 5 & 6. Project will include installing corner fillets, installing energy dissipating inlets, replacing draft tubes/mechanism, and improvements to the existing RAS conveyance system. *Hazen to determine if Secondary Clarifiers 5 & 6 and the existing RAS system can remain unchanged for approx. 5-6 years or until the relocation of the administration and control building can be completed and new clarifiers can be constructed. In addition, the District would like to know how much nutrient removal is obtainable with existing Secondary Clarifiers 1 through 4, two new secondary clarifiers, Aeration Basin 8, and retrofitted Aeration Basins 1 through 7.*	Construct five new MBR membrane tanks with an anticipated membrane surface area of approximately 2.7 MSF. Project includes a building and all additional supporting equipment such as: MBR permeate pumps, back pulse system and tank, membrane air scour system/blowers, deox channel, chemical cleaning tanks/pumps, membrane lifting system, and odor control.

Timeline	Existing Capacity	Design Capacity	Alternative No. 1 – Conventional Treatment	Alternative No. 2 – MBR Membrane Tanks
			General Comment: Hazen to determine what potential cost savings their would be if discharging to Old Alameda Creek is no longer necessary. The assumption would be that the District would be able to address effluent management via another approach: e.g. EQ, Hayward Marsh, Hayward Ponds, ACFC Pond.	*Hazen to confirm if the relocation of the control building is required prior this project.*
Phase 2 - Secondary Treatment Capacity Upgrades and New NPDES Permit Requirements (Level 2 Nutrient Removal)	25.8 MGD AAF (2028)	29.1 MGD AAF (2040)	Construct four new secondary clarifiers, each with a 150' diameter. Project will include the construction of a new control box and RAS pump station. *Note that the construction of the new control and administration buildings will need to be completed prior to this project. This project or the construction of two new secondary clarifiers may take place at the tail end of Phase 1 (immediately following building relocation) if the retrofit of Secondary Clarifiers 5 & 6 can be avoided.*	Included with Alternative No. 2 - Phase 1? *Hazen to confirm if any additional improvements are necessary to increase capacity and/or achieve Level 2 Nutrient Removal.*
			Construct new Aeration Basins 8 (or 9) through 11, or equivalent with a total volume of approx. 5.3 MG between Phases 1 and 2. Project may include converting existing secondary clarifiers to PE equalization, construction of a new PE lift station, construction of a new RAS splitter box, and construction of a new EQ/site waste pump station. *Note that the construction of new secondary clarifiers will need to be completed prior to this project. In addition, this project could potentially be delayed if external resources become available to meet nutrient targets in the watershed permits. For example, investing in projects within EBDA or other agencies in our subembayments to achieve credits in addition to seasonal nutrient removal onsite and side stream treatment.*	
			Construct new side stream MBBR treatment facility to reduce effluent TN concentrations and comfortably achieve Level 2 removal. *Note that the construction of the new Standby Generator Building may need to be completed prior to this project. Completion of the Standby Generator Building is anticipated in end of Calendar Year 2021.*	

Timeline	Existing Capacity	Design Capacity	Alternative No. 1 – Conventional Treatment	Alternative No. 2 – MBR Membrane Tanks
Phase 3 - Secondary Treatment Capacity Upgrades and New NPDES Permit Requirements (Level 3 Nutrient Removal)	29.1 MGD AAF (2040)	33.0 MGD ADWF (2058)	Construct Aeration Basin 12 and expand MLE process to a 4-stage process with chemical addition facilities or PS fermentation or install denitrification filters. *Note that expanding to a 4-stage process would be an add on to previous phases and requires approx. 2.8 MG of additional total volume.*	Included with Alternative No. 2 - Phase 1? *Hazen to confirm if any additional improvements are necessary to increase capacity and/or achieve Level 3 Nutrient Removal.*

Appendix 10. Converge Phase Workshop Presentation and Minutes

Hazen

Converge Phase Workshop

February 28, 2019

1

Today's Agenda

Topic

1. Project Timeline and Workshop Objectives
2. Summary of Previous Work
3. Options
4. Cost Model
5. Membrane Bioreactor Now Option
6. Conventional Activated Sludge Option 1
7. Conventional Activated Sludge Option 2 (New clarification early)
8. Conventional Activated Sludge Option 3 (EQ not OAC Discharge)
9. Cost Summary
10. Other Considerations
11. Summary and Next Steps

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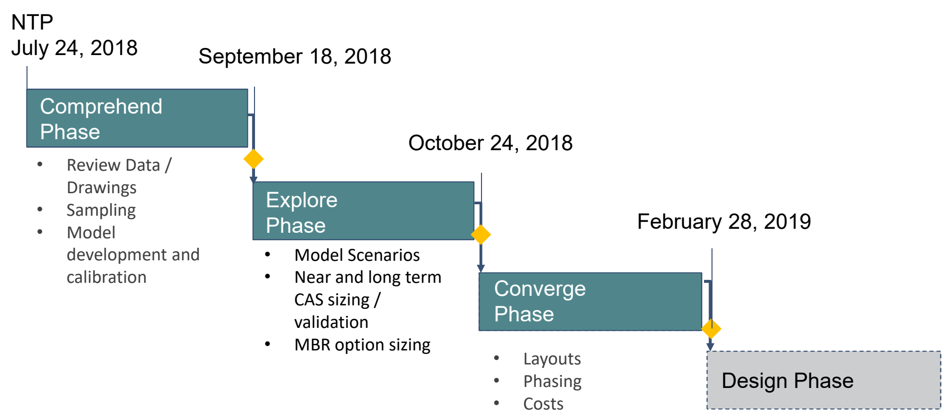
2

Where Have We Been and Where Are We Now?



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3

Workshop Objectives

- Present MBR and CAS options
- Review phased approach for implementation of both options
  - Address plant capacity
  - Meet needs for effluent discharge
  - Plan for future nutrient removal
- Define costs for implementation packages
- District to select best-value option

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4

Recap of Previous Work

5

Recap of Previous Work

- ✓ Data and Sampling
- ✓ Calibrated Models
- ✓ Scenario Modeling
- ✓ Sizing
- ✓ Process Decisions
  - ✓ 16ºC Conservative
  - ✓ MLE + Ferric place holder for P removal
  - ✓ Size for No EQ but look for EQ
  - ✓ Leave space for Level 3 four stage configuration

Converge Phase

- Detailed planning level layouts
- Phasing to meet immediate and long term-needs
- Costs – Capital and O&M

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6

Recap of Approach to Sizing and Layouts

Condition	2040	Buildout (2053)	Buildout (2053)
AA Flow, mgd	29	33	33
Peak Flow, mgd	70	74	74
Nutrient Standard	Level 2	Level 2	Level 3

2040:
- Sized processes for phased approach
- Costs based on this

Buildout (2053), Level 2:
- Sized piping and clarifier for peak flow
- Additional volume can be phased in

Buildout (2053), Level 3:
- Left space to meet these future standards (place holder solution)

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7

Recap of Previous Work: Decisions

Conventional Activated Sludge

All New Clarifiers	Modify Existing Clarifiers + 2 New Clarifiers	Split Plant Option
Most reliable technology	Increased redundancy	Easiest construction
✓	Squircle reliability for BNR No EQ opportunity Operationally Complex Construction tie- ins ✗	Operationally complex without significant benefits than Modify Existing Option ✗

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8

Recap of Previous Work: Decisions

Membrane Bioreactor

MBR Tanks by Existing Admin. Bldg. + Aeration Basin 8	MBR Tanks by Existing SC 5/6
Easier construction	Compact footprint
Can use existing clarifiers as EQ ✓	Difficult MOPO ✗

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9

Recap of Previous Work: Decisions

PE Lift Station

Modify CB2 + new 3rd PE Lift Station	Common PE Lift Station and flow split at existing CB2	Common PE Lift Station and flow split Centralized
Leaves east and west lift station and piping alone	New flow split, Reuse piping east and west	New flow split, Centralized location
Air entrainment of screw pumps not good for BNR Construction difficulty Difficulty for EQ More space More bypass ✗	No major benefit over centralized location Piping is more complicated ✗	✓

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10

Options

11

Summary of Options

Capacity and Creek Discharge	MBR Now Option	CAS Option 1 Two Effluent Qualities Package 1	CAS Option 2 New Clarifiers Now Package 1	CAS Option 3 No Alameda Creek Discharge Package 1
Level 2 Nutrients Year-round		CAS Option 1 Two Effluent Qualities Package 2	CAS Option 2 New Clarifiers Now Package 2	CAS Option 3 No Alameda Creek Discharge Package 2

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12

Cost Model

13

Hazen's Cost Estimating Group

- Corporate Group
- Regional-focus
- Focused on the Local Economy
- Certified Estimating Professionals (CEPs)
- Track construction labor market and raw materials
- 138 estimates in 2018 representing $5.4B averaging within 3% of low bid price
- Spreadsheet-based using vendor quotes, local labor prices and semi-detailed unit costs

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14

Cost Estimate Methodology

AACE class definition

Estimate Level	Project Level	Basis	Accuracy
Class 5 – Factored Estimate	Conceptual / Screening	Similar	-50% to +100%
Class 4 – Equipment Factored Estimate	Study / Feasibility	Parametric model / Major Equipment	-30% to + 50%
Class 3 – Budgetary Cost Estimate	Budget Authorization	Semi-detailed Unit Costs	-20 to + 30%
Class 2 – Control Budget Estimate	Budget / Bid Estimate	Detailed Take-offs	-15 to + 20%
Class 1 – Detailed Estimate	Definitive Estimate	Material Take-offs	-10 to + 15%

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15

Cost Estimate Assumptions

	Typical Values, %	Assumption, %	Note
Division 1	8-25	15	
Overhead	10-22	10	
Profit	10-22	15	
Subcontractor Markup	2.5-10	5	
Escalation	2-5	4	Annual
Bonding / Insurance	2-6	3	
Contingency	25-50	30	For study or predesign
Market Conditions	Varies		Robust market
TOTAL		72	

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16

Summary of Options

Capacity and Creek Discharge	MBR Now Option	CAS Option 1 Two Effluent Qualities Package 1	CAS Option 2 New Clarifiers Now Package 1	CAS Option 3 No Alameda Creek Discharge Package 1
Level 2 Nutrients Year-round		CAS Option 1 Two Effluent Qualities Package 2	CAS Option 2 New Clarifiers Now Package 2	CAS Option 3 No Alameda Creek Discharge Package 2

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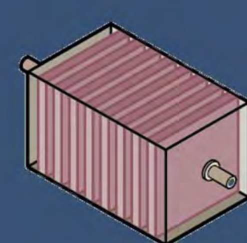
17

MBR Option



18

MBR– Sizing and Infrastructure

Condition	2040 Level 2	Buildout (2053) Level 2	Buildout (2053) Level 3
Total Aeration Volume, mg	8.5	9.6	10.5
New Aeration Volume, mg	1.1	2.2	3.1
Membrane Tank Volume, mg	1.1	1.2	1.2
Cassettes	130 (120 installed)	140 (130 installed)	140 (130 installed)

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19

MBR – Infrastructure Summary

- 1.1 MG new aeration basin volume
  - MLE configuration
- MBR Tanks
  - Permeate pumps
  - CIP
  - Scour air blowers
  - RAS pump station
  - RAS force main
- Blowers and blower building
- PE pump station and splitter box
- Fine screens
- Chemical P removal
- Odor control

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20

MBR – Blower Building

	AA	MM	MD
2040 Level 2 Blower requirements, SCFM	31,500	36,800	46,300

- 5+1 Neuros NX 700 blowers

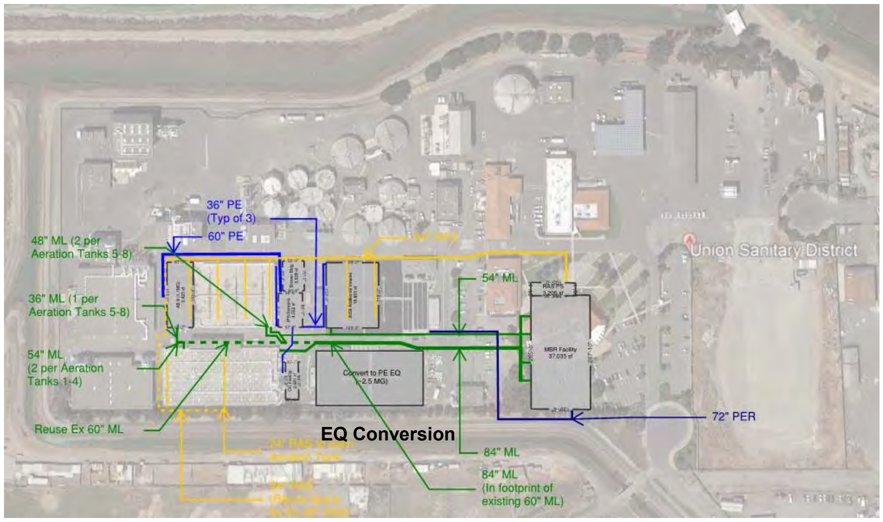
New Blower Building	East Blower Building
Central location	Reuse building
Simplifies aeration piping and can provide better access ✓	Access and removal will require substantial modifications ✗

21

MBR Now – Phase 1

22

MBR Now – Phase 1



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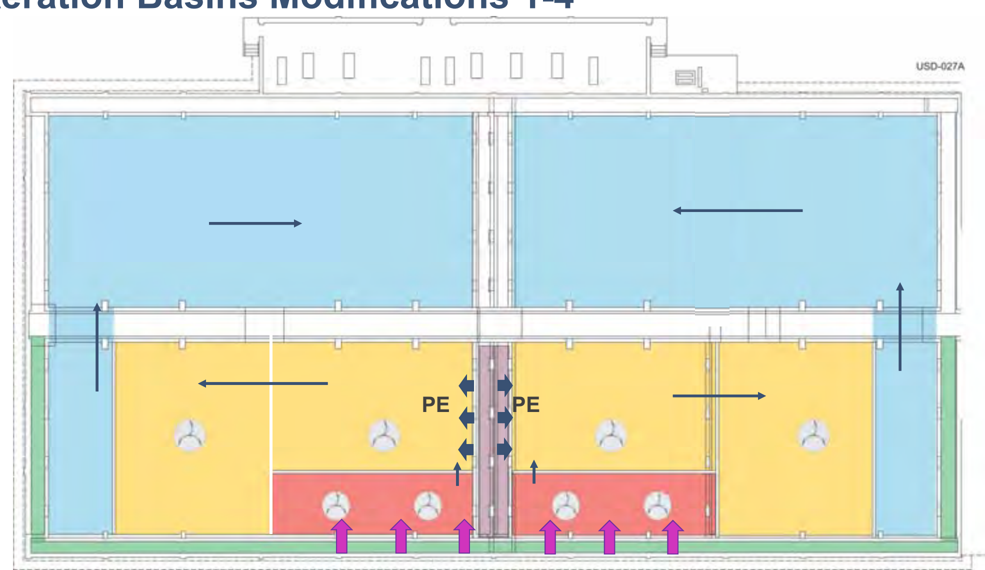
23

MBR Aeration Basins Modifications 1-4



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24

MBR AB Modifications 5-7 and new Aeration Basin 8

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25

MBR– Capital Costs

Item	Cost, $M
Aeration Basin 8 + 1-7 Modifications	41
MBR Tanks and Accessories	246
PE Pump Station / Flow split	4
Fine Screens	16
Blowers + Building	24
Effluent (CCT, EBDA and Pumping)	25
Sidestream Treatment	15
Equalization	15
Chemical P	4
Total Capital Cost	**390**
Total Project Cost	**505**
Annual O&M Cost	**6.7**
Campus/Buildings Project Cost	**80**

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26

MBR Cost Comparison

Item	MBR Option	BACWA
Aeration Basin 8 + 1-7 Modifications		
MBR Tanks and Accessories		
PE Pump Station		NA
Fine Screens		
Blowers + Building		
Effluent (CCT, EBDA and Pumping)		NA
Sidestream Treatment		NA
Equalization		NA
Chemical P		
Total Capital Cost	**390**	**400**
Total Project Cost	**505**	**500**
Annual O&M Cost	**6.7**	**7.5**
Campus/Buildings Project Cost	**80**	**NA**

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27

MBR Cost Comparison

Item	MBR Option	OAC
Aeration Basin 8 + 1-7 Modifications		✓
MBR Tanks and Accessories		✓
PE Pump Station		✓
Fine Screens		✓
Blowers + Building		✓
Effluent (CCT, EBDA and Pumping)		✓
Sidestream Treatment		✓
Equalization		
Chemical P		
Total Capital Cost	**390**	
Total Project Cost	**505**	
Annual O&M Cost	**6.7**	
Campus/Buildings Project Cost	**80**	

Less opportunity for phasing:

- A lot of upfront capital
- Old Alameda Creek discharge is delayed until all projects are completed

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28

Conventional Activated Sludge – Package Approach

29

A Phased Approach Will Spread Out Capital Costs

Benefits of CAS option is to package projects:

- Address near-term needs immediately
- Setting up for nutrients that can be executed based on trigger

	Package 1	Package 2	Package 3
Timeline	Immediate	Anticipated 2040	Anticipated 2060
Objectives	Increase capacity Old Alameda Creek Discharge Set up for Level 2	Achieves Year-round Level 2 Nutrient Removal	Achieves Year-round Level 3

Sizes and cost

Developed place holder to leave space

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30

Summary of Options

Capacity and Creek Discharge	MBR Now Option	CAS Option 1 Two Effluent Qualities Package 1	CAS Option 2 New Clarifiers Now Package 1	CAS Option 3 No Alameda Creek Discharge Package 1
Level 2 Nutrients Year-round		CAS Option 1 Two Effluent Qualities Package 2	CAS Option 2 New Clarifiers Now Package 2	CAS Option 3 No Alameda Creek Discharge Package 2

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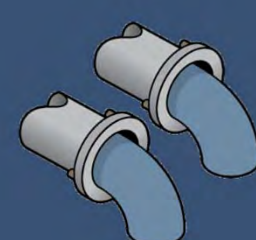
31

Conventional Activated Sludge Option 1 – Two Effluent Qualities



32

CAS Option 1 – Two Effluent Qualities – Package 1

33

Package 1 – Immediate needs

			Synergistic with Level 2
	Capacity Improvements	• Aeration basin modifications	✓
		• Secondary clarifier modifications	✓
	Old Alameda Creek Discharge	• Disk filters for creek discharge	
		• New chlorine contact channels	
		• New dechlorination facility	
		• New effluent pump station	
		• Move EBDA FM	
		• Sidestream Treatment	✓
1b	Set up for Level 2	• Move buildings: FMC, Admin, Lab	✓

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34

Aeration Basin Modifications

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35

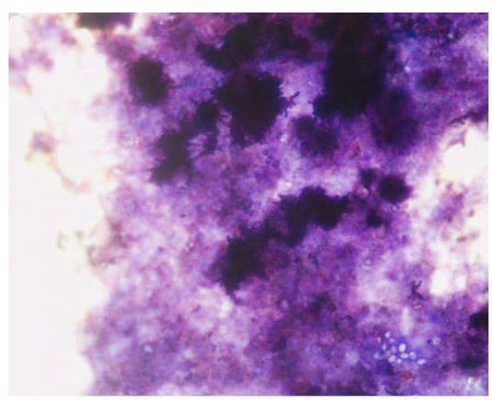
CAS Option 1 – Package 1: Aeration Basin Modifications

Upfront zones:

- Flexibility of PE feed
- Flexibility of anaerobic / anoxic operation

Enhanced Settling

Enhanced TN removal



Bio P bacteria

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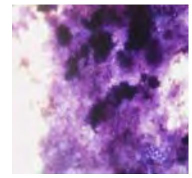
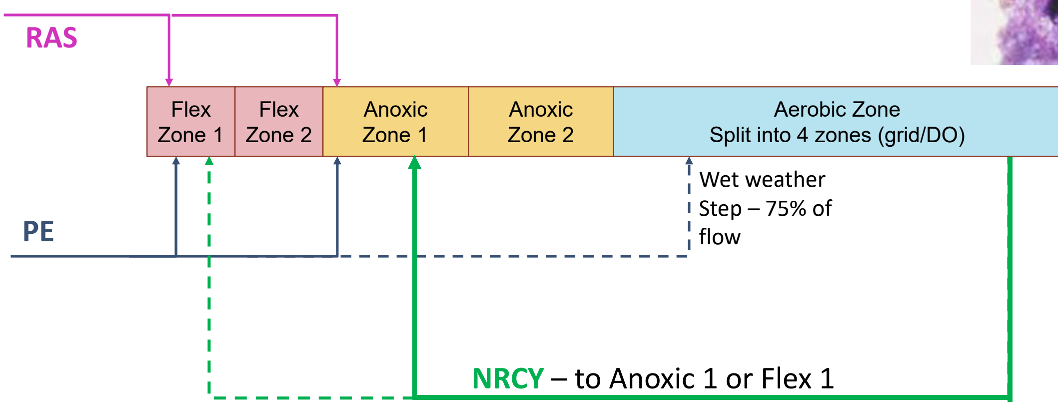
36

CAS Option 1 – Package 1: Aeration Basin Modifications

Bio P bacteria



Ability to Split RAS and PE btw Flex 1 and Anoxic 1



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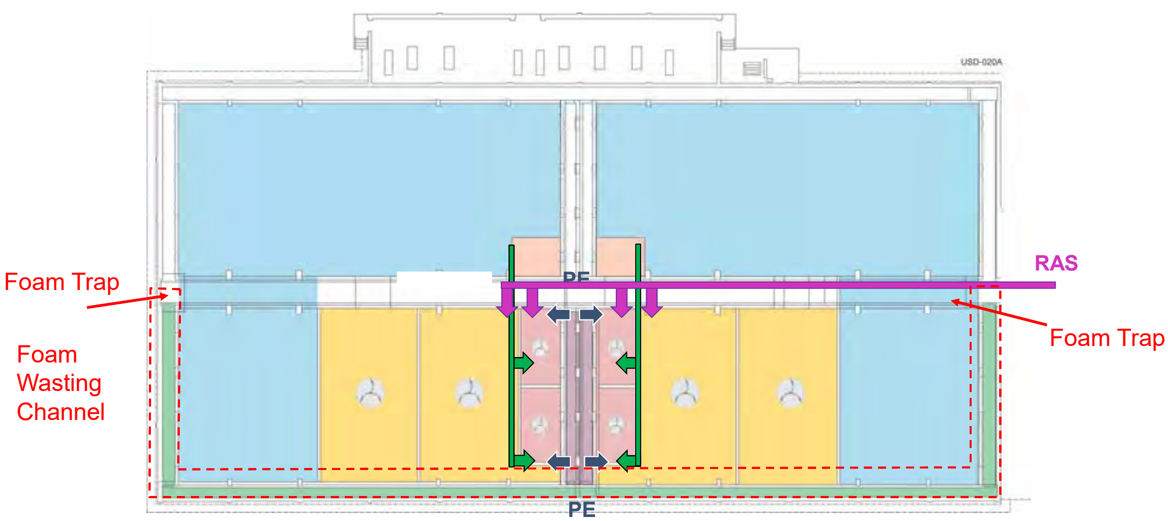
37

CAS Option 1 – Package 1: AB 1- 4 Modifications



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38

CAS Option 1 – Package 1: Aeration Basin Modifications Foam control

Foam wasting problem

Foam wasting solutions:

Surface Wasting

Transport baffles to reduce airlift trapping

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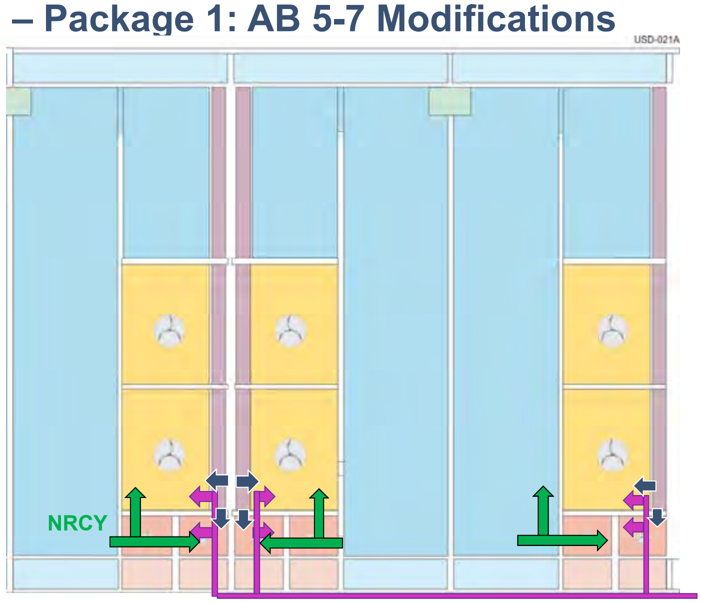
39

CAS Option 1 – Package 1: AB 5-7 Modifications



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40

Clarifier Modifications

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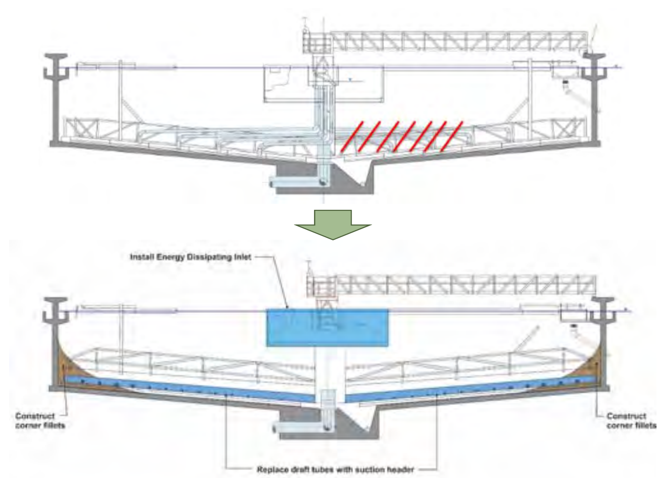
41

CAS Option 1 – Package 1: Clarifier modifications

- Replace seals
- Corner fillets
- Install energy dissipating inlet (EDI)
- Evaluate replacement of draft tubes with suction header



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42

CAS Option 1 – Package 1: RAS enhancements

- RAS control is an operational enhancement
- Note that this interim phase may be 10-15 years

Option 1

RAS control for Clarifier 5&6 only

Option 2

All new RAS control for clarifiers 1-6 with an expanded pump station

Option 3

All new RAS control for clarifiers 1-6 two pump stations

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43

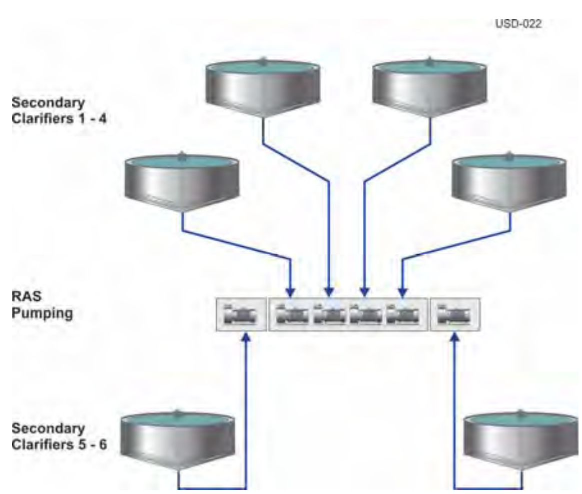
CAS Option 1 – Package 1: RAS enhancements (Clarifiers 5&6 only)

New dedicated RAS Control from Secondary Clarifiers 5 and 6

Modifications to existing RAS wet well for improvements to Secondary Clarifier 1 – 4 redundancy

Strength
Provides needed control improvements without impacts to site access

Weakness
Difficult construction in eastern corridor



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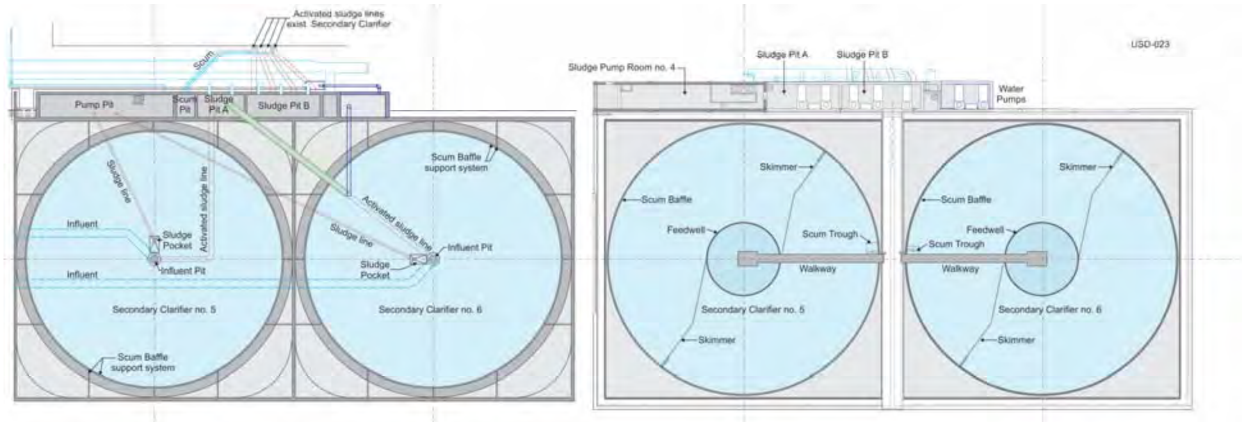
44

CAS Option 1 – Package 1: RAS enhancements (Clarifiers 5&6 only)



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45

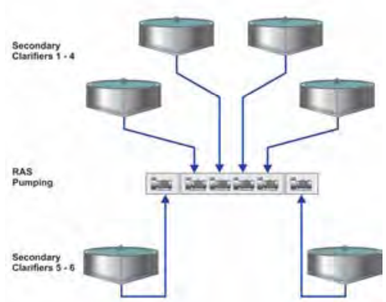
CAS Option 1 – Package 1: RAS enhancements (All Clarifiers – expanded pump station)

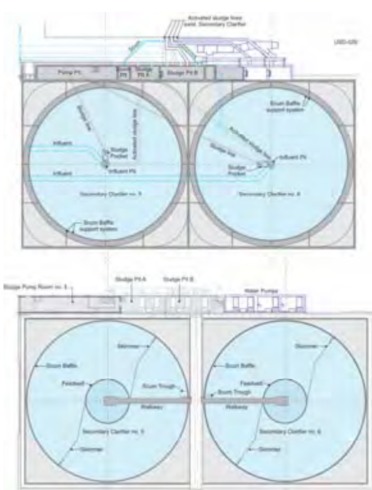
New dedicated RAS Control from Secondary Clarifiers 5 and 6

Modifications to existing RAS wetwell for improvements to Secondary Clarifier 1 – 4 redundancy

Strength
Provides needed control improvements without impacts to site access

Weakness
Difficult construction in eastern corridor





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46

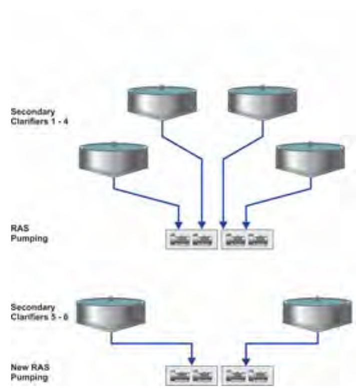
CAS Option 1 – Package 1: RAS enhancements (All Clarifiers - 2 pump stations)

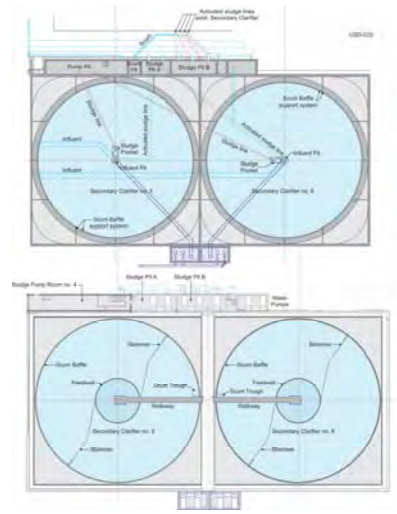
New dedicated RAS Control from Secondary Clarifiers 5 and 6

Modifications to existing RAS wetwell for improvements to Secondary Clarifier 1 – 4 redundancy

Strength
Provides needed control improvements without impacts to site access

Weakness
Difficult construction in eastern corridor





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47

Effluent End Modifications

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48

CAS Option 1 – Package 1: Effluent end modifications

- Chlorine contact tank is in poor condition
- Additional volume to provide adequate CT time for peak flows
- Provide disk filters to achieve TSS< 15mg/L during discharge to Old Alameda Creek
- Better dechlorination set up for Old Alameda Creek
- discharge
- EBDA pump station in poor condition

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49

CAS Option 1 – Package 1: Effluent end modifications

Modify Existing CCT and EBDA PS	New CCT and EBDA Pump Station
Less construction	More reliable facilities, more space for future expansion
Supplemental volume is too large and would require buildings be moved first, delaying ability to discharge to Old Alameda Creek ✗	✓

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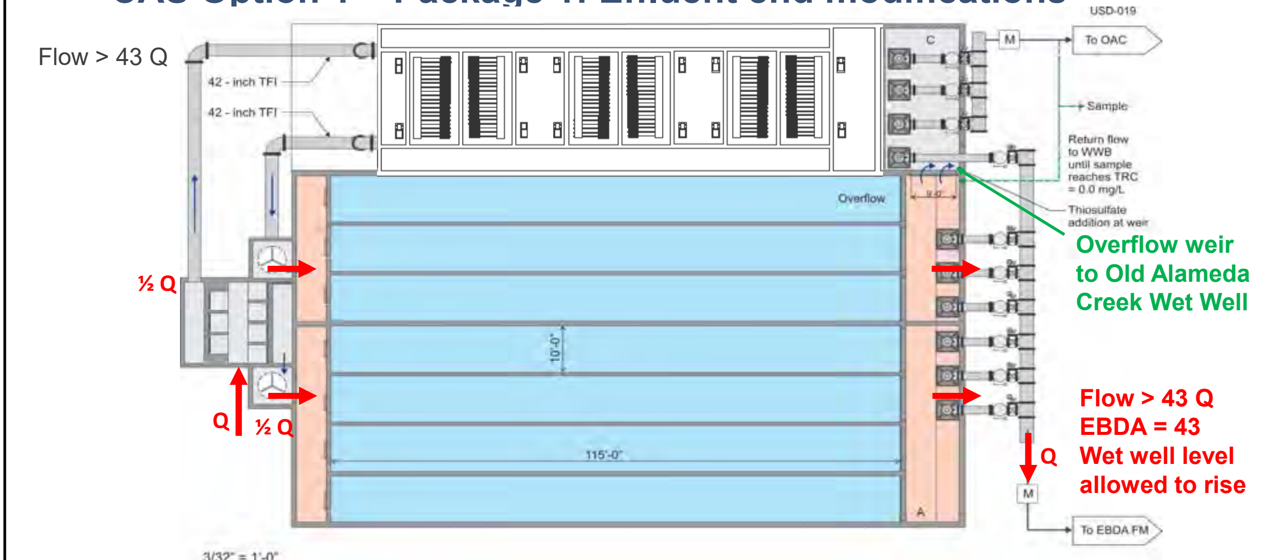
50

CAS Option 1 – Package 1: Effluent end modifications

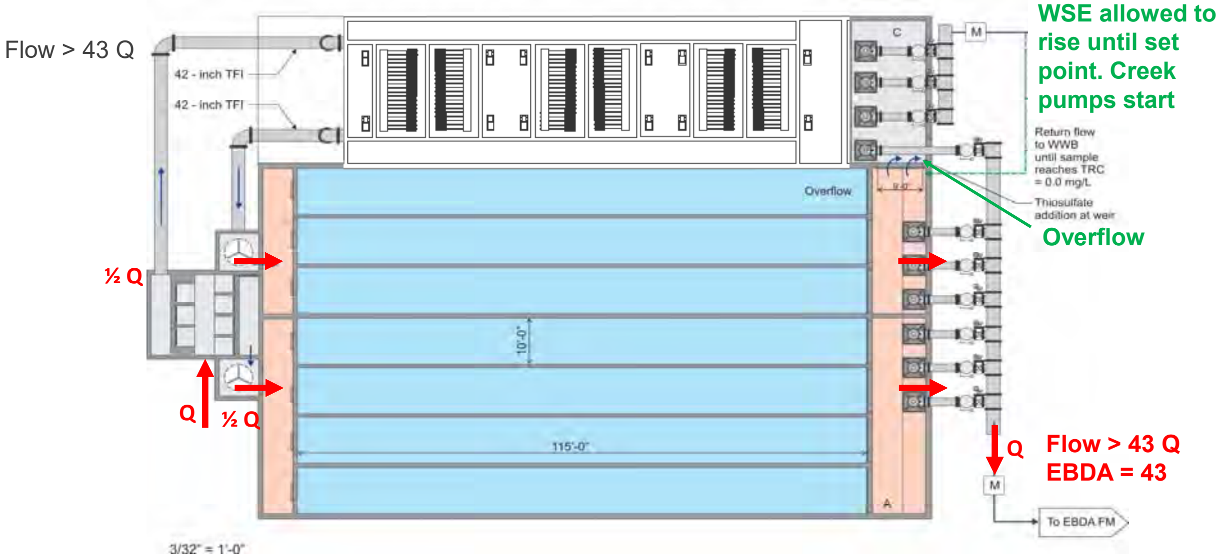
51

CAS Option 1 – Package 1: Effluent end modifications



52

CAS Option 1 – Package 1: Effluent end modifications



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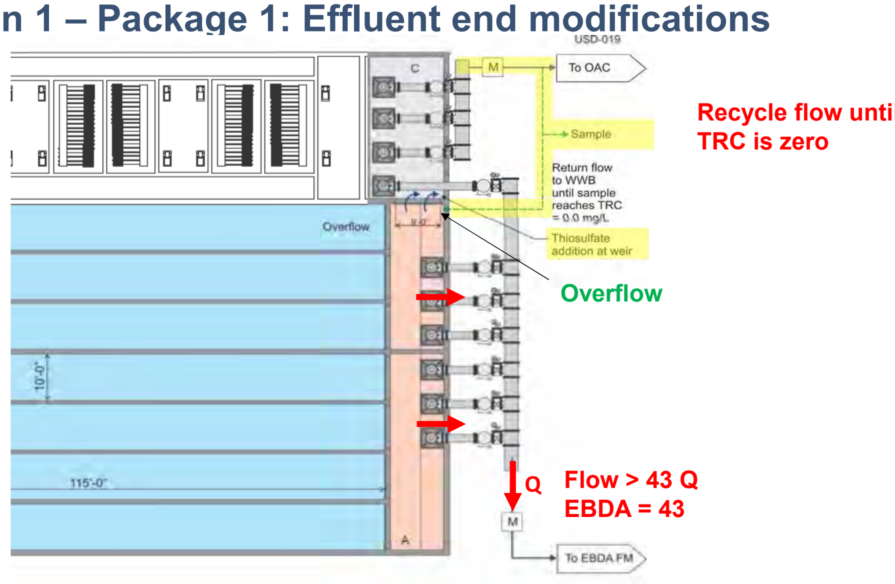
53

CAS Option 1 – Package 1: Effluent end modifications



Recycle flow until TRC is zero

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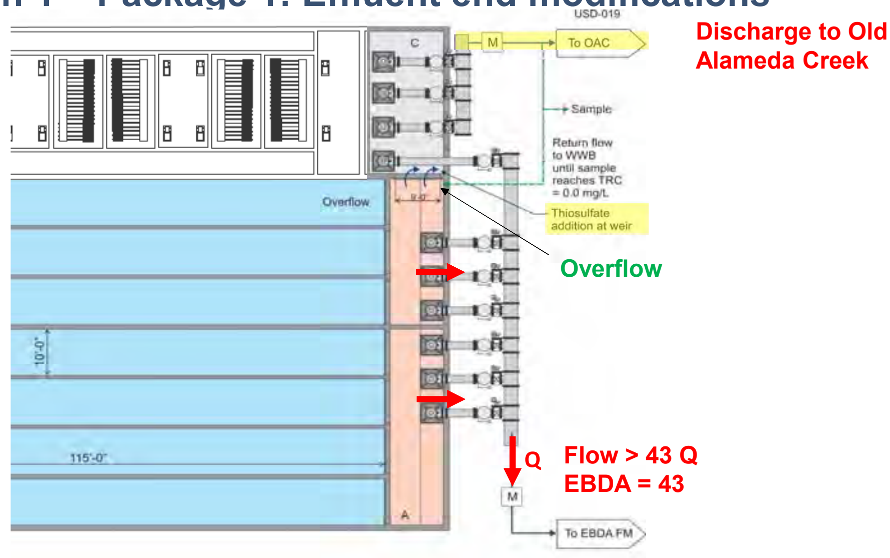
54

CAS Option 1 – Package 1: Effluent end modifications



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55

New Sidestream Treatment

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56

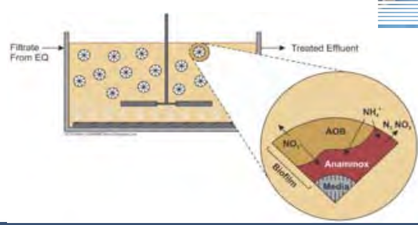
CAS Option 1 – Package 1: Sidestream Treatment

Kruger ANITA Mox MBBR

Continuous flow through process

AOBs and anammox bacteria colonized within plastic media carriers

	ANITA™ Mox MBBR
Reactor configuration	MBBR
Biomass characteristic	Biofilm
Proprietary retention strategy	Plastic carrier and screen



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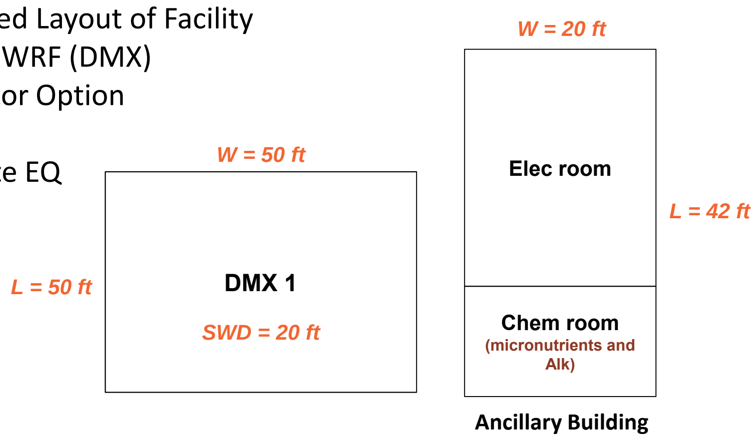
57

CAS Option 1 – Package 1: Sidestream Treatment

Proposed Layout of Facility
for PVRWRF (DMX)
1 Reactor Option

Centrate EQ



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58

CAS Option 1 - Sequencing

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59

CAS Option 1 – Phase 1

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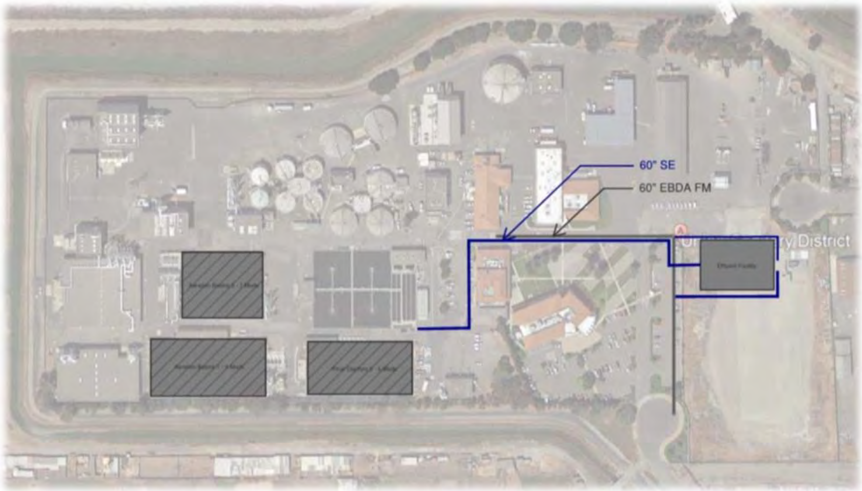
60

CAS Option 1 – Phase 1



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CAS Option 1 – Package 1: Summary

	Item	Need
	Capacity	
1	Aeration Basin Modifications (East and West)	27
2	Secondary Clarifier Modifications (Option 1)	13
	Old Alameda Creek Discharge	
3	Disk filters for creek discharge	14
4	New contact channels	8
5	New dechlorination facility	1
6	New effluent pump station (EBDA and Old Alameda Creek)	11
7	Sidestream treatment	13
8	EBDA FM	3
	Total Capital Cost	**90**
	Total Project Cost	**120**
	Campus/Buildings Project Cost	**80**

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CAS Option 1 – Two Effluent Qualities – Package 2

63

CAS – Sizing and Infrastructure

Condition	2040 Level 2	Buildout (2053) Level 2	Buildout (2053) Level 3
New Aeration Volume, mg	5.5	1.7 over 2040 L2	3.2 over Buildout L2
Total Aeration Volume, mg	12.9	14.6	17.8
Secondary Clarifiers	4 - 155 ft diameter	Same as 2040 L2	Same as 2040 L2

Sized and Cost

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64

CAS – Blower Building

	AA	MM	MD
2040 Level 2 Blower requirements	22,900 scfm	26,700 scfm	33,700 scfm

- 4+1 Neuros NX 700 blowers

New Blower Building	East Blower Building
Central location	Reuse building
Simplifies aeration piping and can provide better access ✓	Access and removal will require substantial modifications ✗

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65

CAS Option 1 – Package 2 - Infrastructure Summary

- PE pump station
- PE Splitter box
- 2.5 MG EQ
- 5.5 MG new aeration basin volume
  - Same as 5-7 modified configuration
- Blowers and blower building
- Chemical P removal
- Secondary Clarifiers
  - MLSS distribution box
  - RAS pump station
  - RAS force main

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66

CAS Option 1 – Package 2

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67

CAS Option 1 – Phase 2

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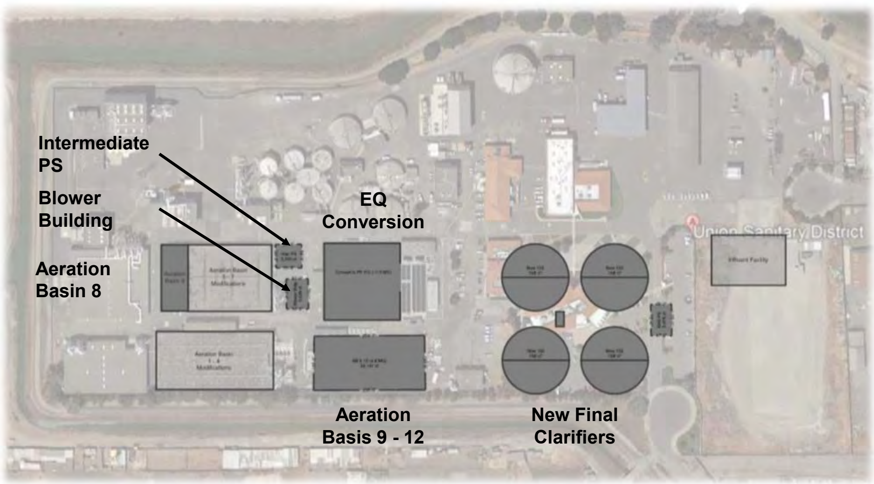
68

CAS Option 1 – Phase 2



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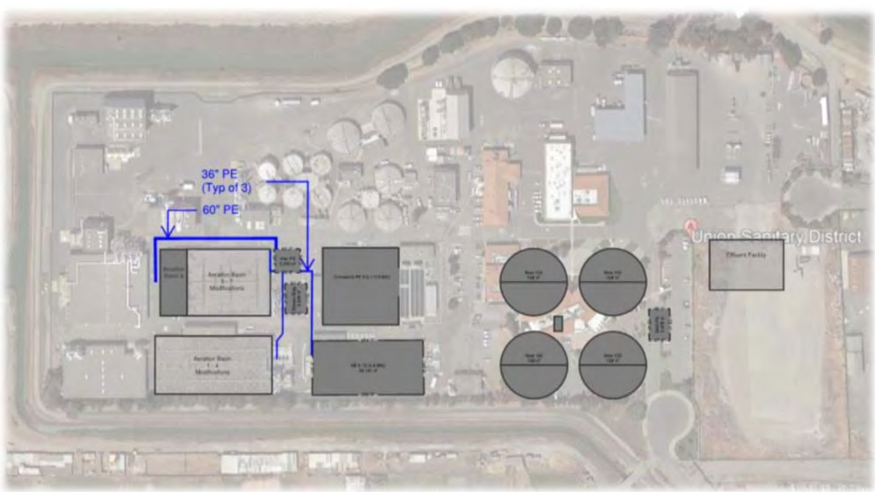
69

CAS Option 1 – Phase 2



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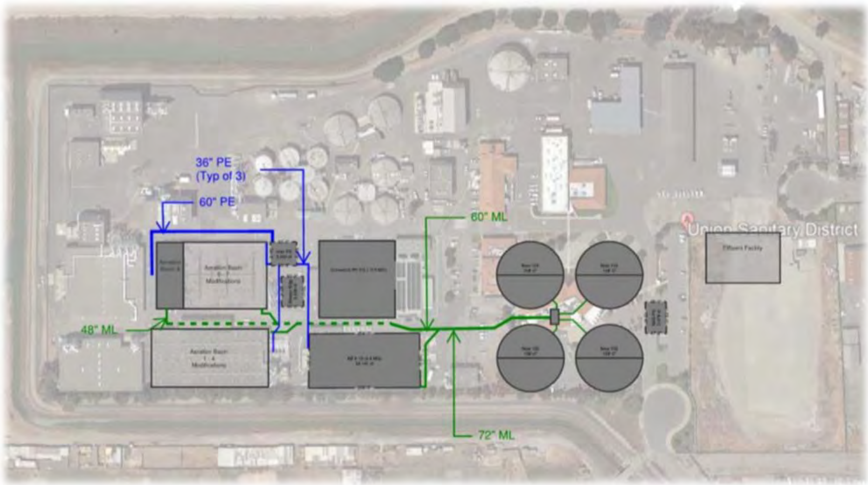
70

CAS Option 1 – Phase 2



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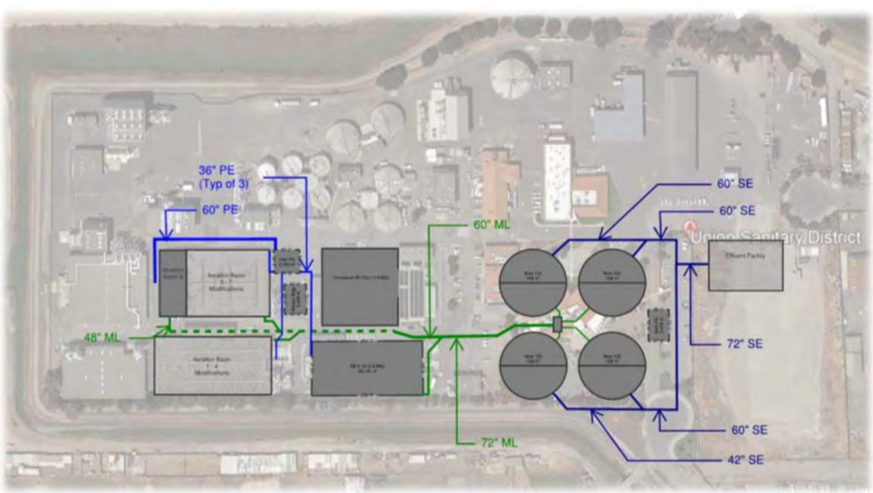
71

CAS Option 1 – Phase 2



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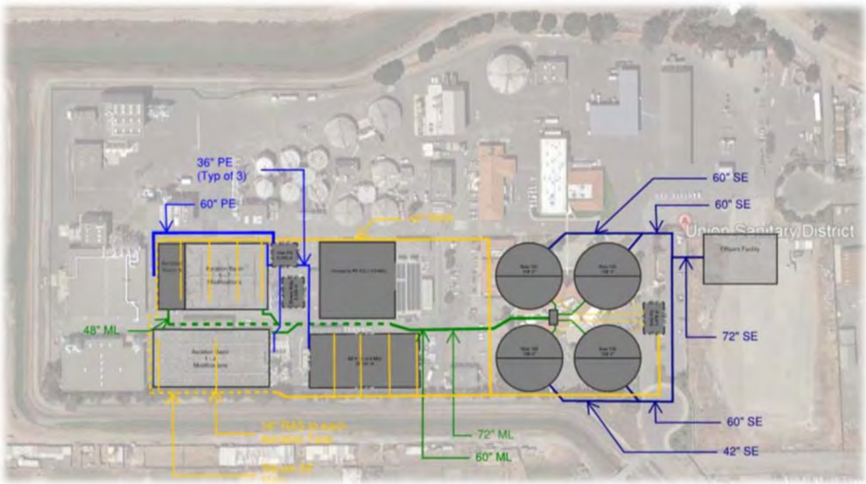
72

CAS Option 1 – Phase 2



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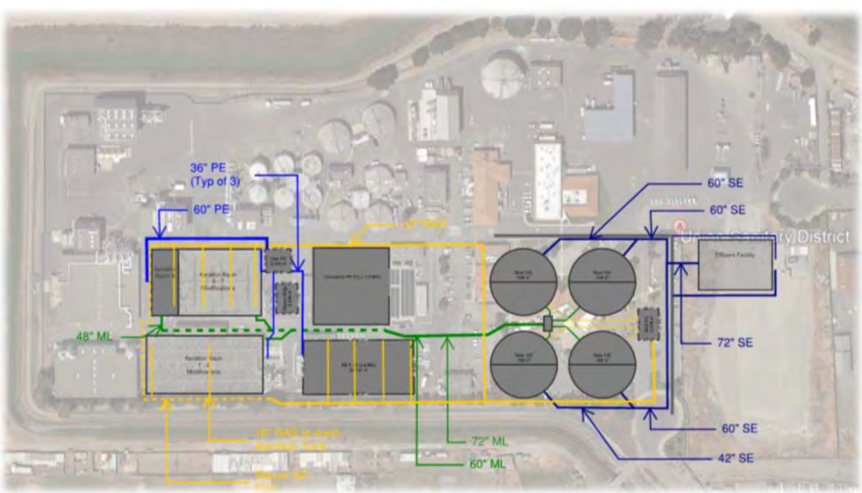
73

CAS Option 1 – Phase 2



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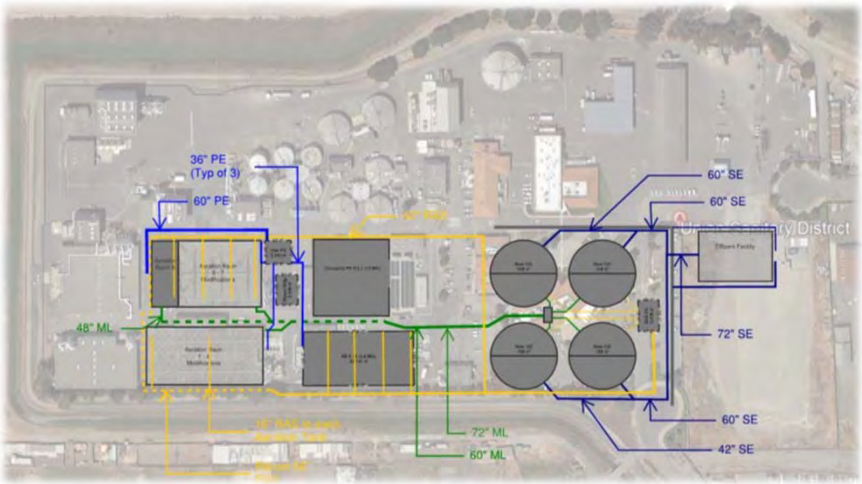
74

CAS Option 1 – Phase 2



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75

CAS Option 1 Package 2 –Costs

Item	Cost, $M
PE pump station	9
2.5 MG PE equalization	9
New Aeration Basin Volume (5.5 MG)	56
New Secondary Clarifiers	69
Chemical P removal	4
Blower + Blower building	22
Total Capital Cost	170
Total Project Cost	220
Annual O&M Cost	3.7
Campus/Buildings Project Cost	**80**

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76

Phased MBR Option

77

Can we phase the MBR similarly to CAS Option 1?

Package 1

- **Aeration basin modifications**
- **Secondary clarifier modifications**

- **Disk filters for creek discharge**
- New chlorine contact channels
- New dechlorination facility
- New effluent pump station
- Move EBDA FM
- Sidestream Treatment

1B
- Move buildings: FMC, Admin, Lab

Package 2

- PE pump station
- PE splitter box
- New Aeration Basin (1.1 MG)
- Blowers & blower building
- MBR tanks
  - Permeate pumps
  - CIP
  - Scour air
- RAS pump station
- RAS force main

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78

Summary of Options

Capacity and Creek Discharge	MBR Now Option	CAS Option 1 Two Effluent Qualities Package 1	CAS Option 2 New Clarifiers Now Package 1	CAS Option 3 No Alameda Creek Discharge Package 1
Level 2 Nutrients Year-round		CAS Option 1 Two Effluent Qualities Package 2	CAS Option 2 New Clarifiers Now Package 2	CAS Option 3 No Alameda Creek Discharge Package 2

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79

CAS Option 2 - New Clarifiers Early

80

CAS Option 2 - New Clarifiers Early – Package 1

81

CAS Option 2 New Clarifiers – Package 1: Scope

	Item	CAS Option 1 Package 1	CAS Option 2 Package 1
	Capacity		
1	Aeration Basin Modifications (East and West)	Y	
2	Secondary Clarifier Modifications (Option 1)	Y	✖
	Old Alameda Creek Discharge		
3	Disk filters for creek discharge	Y	✖
4	New contact channels	Y	Some mods
5	New dechlorination facility	Y	Some mods
6	New effluent pump station (EBDA and Old Alameda Creek)	Y	Some mods
7	Sidestream treatment	Y	
	Buildings		
8	Move Buildings	1B	1A

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82

CAS Option 2 New Clarifiers – Package 1: Process Comparison

	CAS 1 Package 1	CAS 2 Package 2
Aeration Basins	Same modifications = Achieve same SVI	
Clarifiers	No change in surface area	More surface area because sized for buildout peak
	Poorer technology	Modern clarifier technology
RAS control	Sub optimal	Optimized
BNR	Seasonal, Wet weather must be in carbon removal mode to prevent washout	Better clarifier technology allows for higher MLSS (aSRT). Can achieve BNR at lower temperatures (18°C) and potentially year round

Better technology + EQ will = Comfortably meet effluent TSS < 15 mg/L during wet weather → no disc filters

- Implications for negotiations with regional board
- Old Alameda Creek or Level 2 early adoption
- Potential to delay
- Package 2 even further (TMDL, loads are flat, minimum temperature > 18°C)

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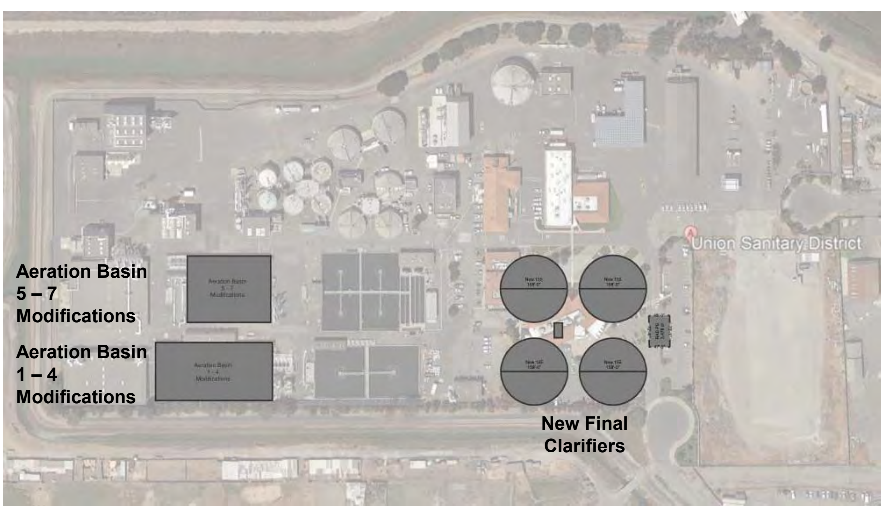
83

CAS Option 2 – Phase 1



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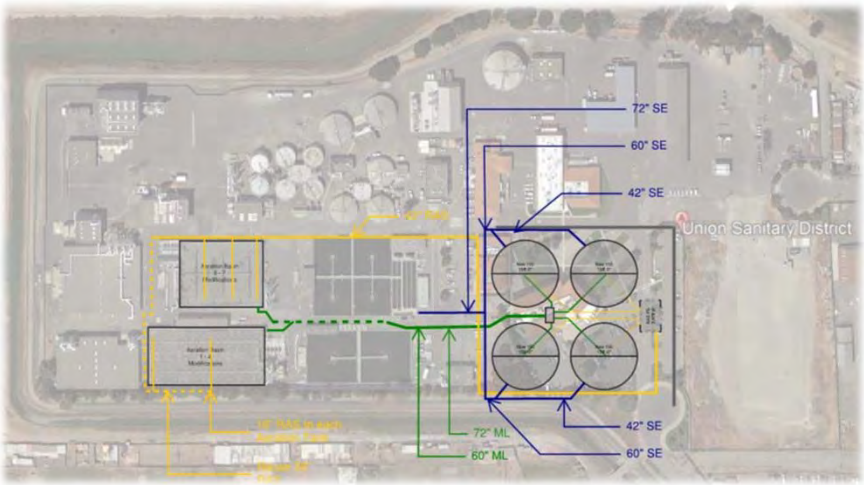
84

CAS Option 2 – Phase 1



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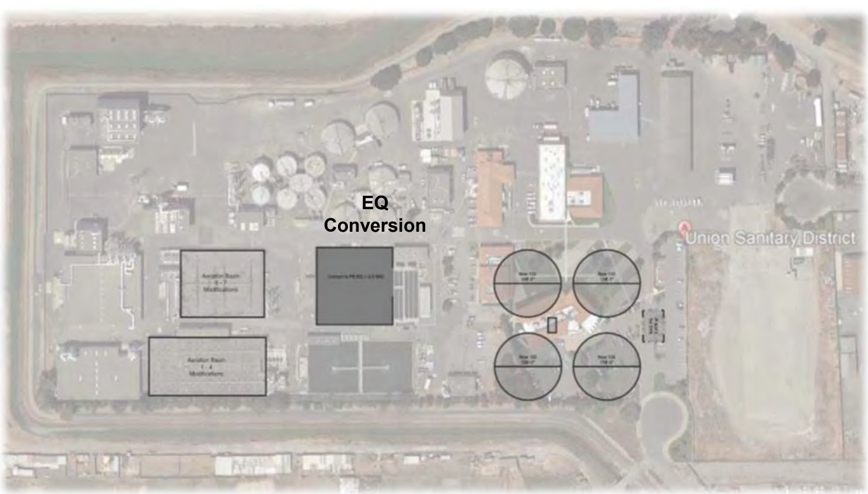
85

CAS Option 2 – Phase 1



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86

CAS Option 2 New Clarifiers – Package 1

Benefits

- Better clarifier technology
- 2.5 MG EQ
- Potential year-round BNR
- No stranded assets (disk filters, clarifier modifications)
- Single effluent quality

Considerations

- More upfront costs
- Need to move buildings
- Longer lead time to get to Old Alameda Creek Discharge

Hazen

87

CAS Option 2 Package 1 – Capital Costs

Item	Cost, $M
5MG PE Equalization	8
Aeration Basin Modifications	28
New Secondary Clarifiers	57
EBDA PS Rehab	5
EBDA FM	3
Sidestream Treatment	14
Total Capital Cost	**115**
Total Project Cost	**150**
Campus/Buildings Project Cost	**80**

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88

CAS Option 2 – New Clarifiers Early – Package 2

89

CAS Option 2 Package 2 – Infrastructure Summary

- PE Pump station
- PE splitter box
- Blowers
- Blower building
- 5.5 MG new aeration basin volume
  - Same as 5-7 modified configuration
- Chemical P removal

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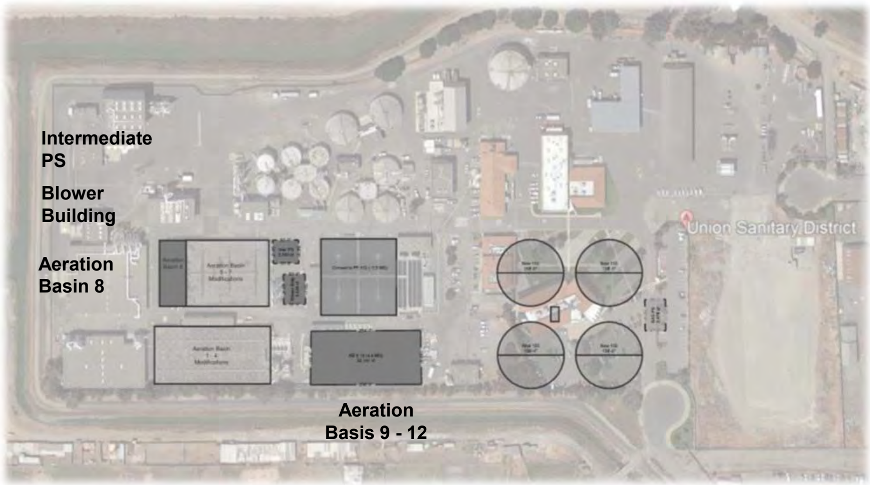
90

CAS Option 2 – Phase 1



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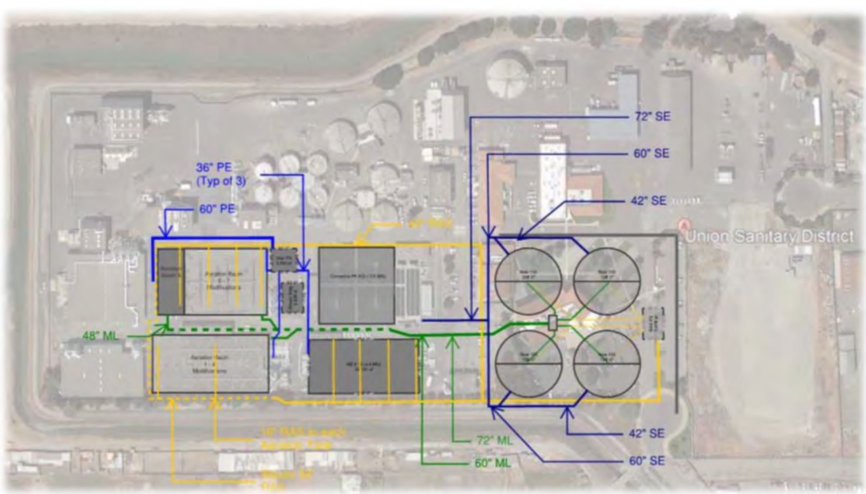
91

CAS Option 2 – Phase 1



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92

CAS Option 2 Package 2 – Capital Costs

Item	Cost, $M
PE Pump Station	11
New Aeration Basin Volume	71
Blower and Blower building	28
Chemical P removal	5
Total Capital Cost	**115**
Total Project Cost	**150**
Annual O&M Cost	**3.7**
Campus/Buildings Project Cost	**80**

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93

Summary of Options

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94

CAS Option 3 – No Old Alameda Creek Discharge

95

CAS Option 3 – No Old Alameda Creek Discharge – Package 1

96

CAS Option 3 No OAC Discharge – Package 1: Scope

Capacity upgrades

- Aeration basin modifications
- Clarifier modifications
- 15 MG Secondary effluent equalization
  - Attenuate wet weather to 43 mgd (max EBDA flow)
  - Land acquisition and mitigation
  - Potential pumping to and from EQ

Based on design hydrograph that has high peak but short duration. Recommend revisiting other storm events with longer duration for sizing

CAS Option 3 – Phase 1

CAS Option 3 No OAC Discharge – Package 1

Benefits

- No Old Alameda Creek discharge
- Off spec water storage

Considerations

- Less potential for early adoption of Level 2 nutrients
- Significant land acquisition costs
- Significant restoration costs

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99

CAS Option 3 Package 1 – Costs

Item	Cost, $M
Aeration basin modifications	23
Secondary clarifier modifications	7
Secondary effluent equalization	62
Land Acquisition	**?**
Total Capital Cost	**90**
Total Project Cost	**120**
Annual O&M Cost	
Campus/Buildings Project Cost	**80**

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100

CAS Option 3 – No Old Alameda Creek Discharge – Package 2

101

CAS Option 3 – Package 2 - Infrastructure Summary

	CAS Option 1 Package 2	CAS Option 3 Package 2
PE pump station and splitter box	Y	Y
2.5 MG PE EQ	Y	Y
5.5 MG new aeration basin volume	Y	Y
New blowers and blower building	Y	Y
Secondary clarifiers	Y	Y
Chemical P removal	Y	Y
Sidestream Treatment		Y
EBDA FM		Y

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102

CAS 3 Package 2 – Costs

Item	Cost, $M
PE pump station & flow split	8
2.5 MG PE equalization	9
New Aeration Basin Volume (5.5 MG)	53
New Secondary Clarifiers (4@ 155ft)	65
Chemical P removal	4
Sidestream treatment	16
Blower + Blower building	21
EBDA FM	3
Total Capital Cost	**180**
Total Project Cost	**230**
Annual O&M Cost	**4**
Campus/Buildings Project Cost	**80**

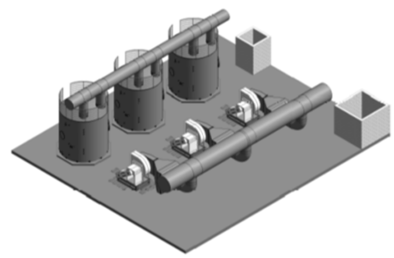
103

Other Considerations

104

Other Considerations – Odor Control

- Mist wet scrubbers – newer technologies available
- For new facilities consider:
  - Centralized location – reduces redundant units and O&M costs
  - Reduce volume treated
- New technologies
  - Dual bed Dual Bed Activated Carbon Option
  - Radial Flow Activated Carbon Vessel



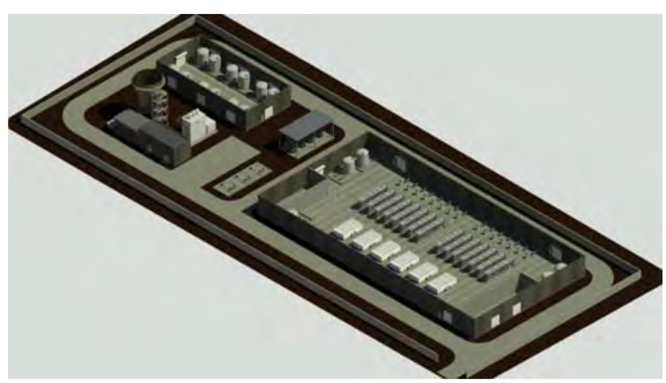
Dual bed Dual Bed Activated Carbon Option

Hazen

105

Other Considerations - Indirect Potable Reuse Potential at USD

- Microfiltration / Reverse Osmosis downstream of L2 CAS or MBR Options
  - Approximately 200 x 400 facility
  - Pumps
  - CIP
  - Backwash



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106

Costs Summary

107

Project, O&M and NPV Cost Comparison

	MBR	CAS Option 1 Two Effluents	CAS Option 2 New Clarifiers Early	CAS Option 3 No OAC Discharge
Package 1 Project Cost	505	120	150	120
Package 2 Project Cost	-	220	150	230
Total Project Cost	**505**	**340**	**300**	**350**

1) Project costs based on 30% of capital cost

Hazen

108

Cost – O&M Considerations

Approach to O&M cost – focus on major O&M differences at this stage

CAS

- Aeration Basin Blowers
- Intermediate Pump Station
- RAS
- Disk filters
- Secondary clarifiers

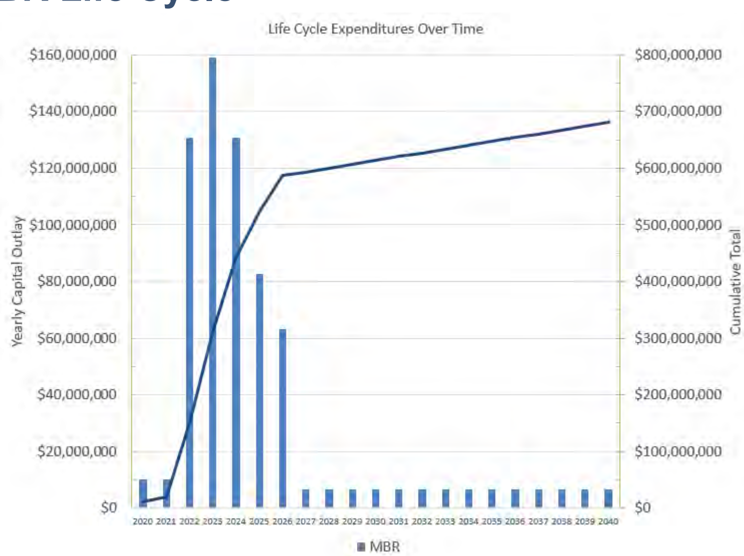
MBR

- Aeration Basin Blowers
- Intermediate Pump Station (fine screens)
- More RAS
- Permeate pumps
- Clean-in-place
- Scour air
- Membrane replacement

Hazen

109

Cost – MBR Life Cycle



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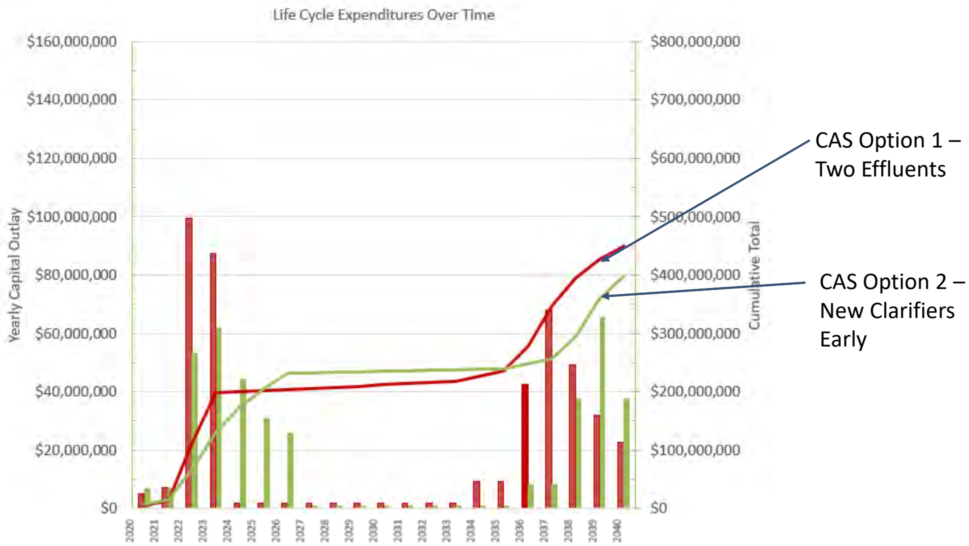
110

Cost – CAS Options Life Cycle Costs



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111

Project, O&M and NPV Cost Comparison

	MBR	CAS Option 1 Two Effluents	CAS Option 2 New Clarifiers Early	CAS Option 3 No OAC Discharge
Package 1 Project Cost	505	120	150	120
Package 2 Project Cost	-	220	150	230
Total Project Cost	505	340	300	350
20-Year NPV O&M	115	40	40	20
NPV	**620**	**380**	**340**	**370**
Building/Campus Project	80	80	80	80

1) Campus and Buildings Capital Cost $63M, Project Cost $80M
2) Project costs based on 30% of capital cost
3) All CAS Options (1,2 and 3) have comparable O&M Costs

Hazen

112

Next Steps

113

Next Steps

- Answer the question: MBR vs CAS?
- Integrate with Master Plan
- Pre-Design

Hazen

114

Hazen Meeting Minutes

March 12, 2018

To: Curtis Bosick, USD

From: Irene Chu, Hazen

Reviewed: Marc Solomon, Hazen

District Attendees: Tim Grillo, Connie Li, Mitchell Costello, Sami Ghossain, Wade Coggins, Curtis, Raymond Chau, James Schofield, Jose Rodrigues, Paul Eldridge, Rick Pipkin, Armando Lopez

Hazen: Marc Solomon, Irene Chu, Allan Briggs, Paul Pitt, Paul Saurer, Ron Latimer, Jared Hartwig

Woodard and Curran: Dave Richardson, Mark Takemoto.

Re: Converge Phase Workshop Meeting Minutes

Hazen presented MBR and CAS phased options including costs, sequencing and layouts:

1. MBR option
2. CAS Option 1: Two Effluent Qualities
3. CAS Option 2: New Clarifiers Early
4. CAS Option 3: No Old Alameda Creek Discharge

The meeting agenda and presentation are attached to these minutes. Note only key points and discussion are summarized here, for presentation key points please see attached slides.

Cost Assumptions

- Costs include market conditions embedded in some of the markups.

MBR Options

- Aeration basin modifications:
  - The aeration basins will be modified for MLE configuration. Will have a RAS de-oxygenation zone.
  - The east aeration basins were reconfigured from four (4) tanks to two tanks in plug flow fashion. A four-tank configuration can be considered in pre-design.
  - Activated sludge foaming will be more likely when operating in BNR mode because of the higher MLSS. Surface wasting features will be incorporated into both the east and west aeration basins. Channels in east the aeration basins can be repurposed for surface wasting. PE can be used to flush the surface wasting channel in the east aeration basins.

Job no

- The Districted noted that the BACWA MBR option may not have been constructible because of where the MBR tanks were located. The costs may not have included all the costs associated with construction of the MBR option.
- The O&M costs represents just a few key elements where there are major differences between MBR and CAS.
- The fact that the MBR option cannot be phased will have a major impact on the District's cashflow as most of the elements of the project are required to discharge to Old Alameda Creek.

CAS Package Approach

- The CAS option can be phased option. Phasing will allow the District to execute projects based on triggers and manage cashflow.

	Package 1	Package 2
CAS Option 1 Two Effluent Water Qualities	Aeration Basin Modifications Secondary Clarifier Modifications Disk Filters New Chlorine Contact Channels New Dechlorination Facility New Effluent Pump Station Move EBDA Force Main Sidestream Treatment	PE Pump Station 2.5 MG of PE Equalization New Aeration Basin Volume (5.5 MG) New Secondary Clarifiers Chemical P Removal Blower and Blower Building
CAS Option 2 New Clarifiers Early	Aeration Basin Modifications Rehab Chlorine Contact Channels Rehab Dechlorination Facility Rehab Effluent Pump Station Move EBDA Force Main 2.5 or 5 MG of PE equalization	PE Pump Station New Aeration Basin Volume (5.5 MG) Chemical P Removal Blower and Blower Building Sidestream treatment
CAS Option 3 Old Alameda Creek	Aeration Basin Modifications Secondary Clarifier Modifications Secondary Effluent Equalization	PE Pump Station 2.5 MG of PE Equalization New Aeration Basin Volume (5.5 MG) New Secondary Clarifiers Chemical P Removal Blower and Blower Building Move EBDA Force Main Sidestream treatment

- Package elements:
  - Aeration basin modifications (Common to all CAS options)

    - Peak wet weather flows have not reached 50 mgd during current the rainfall events. Although this storm did not affect the District's watershed compared to other parts of northern California.
    - Foaming occasionally occurs in the aeration basins when chemicals are present in the wastewater. Activated sludge foaming will be more likely when operating in BNR mode because of the higher MLSS. Surface wasting features will be incorporated into both the east and west aeration basins. PE can be used to flush the surface wasting channel in the east aeration basins.
  - Clarifier Modifications (CAS Option 1 and Option 3)
    - Internal modifications are needed to improve clarifier performance
    - Several options for modifications for RAS control:
      - Option 1 – Clarifier 5 and 6 RAS improvements via additional wet well.
      - Option 2 – Dedicated wet wells would have RAS control based on wet well level. One shared pump that can pull from either wet well for redundancy.
      - Option 3 – New East side RAS pump station for Clarifier 5 and 6. Direct connection to pump with VFD.
  - Effluent (CAS Option 1)
    - Disk filters installed upstream of chlorination to prevent damage of filter cloth.
    - Dechlorination configuration gives a shorter run for recycle of flow? and checking the residual before discharge to OAC.
  - Sidestream Treatment design assumes 1 day of equalization. Provisions to heat centrate and cover have been included in costs. The pilot experienced issues with struvite buildup. To limit this problem we would include design features including parallel pipes, metal salt addition and minimization of travel time.
- **CAS Option 1 – Two Effluents**
  - Package 1: Modify east aeration basins, modify west aeration basins, modify clarifiers, construct new CCT and move EBDA FM, sidestream treatment.
  - Operation during wet weather carbon removal: Wet weather would need all existing clarifiers in service. This is consistent with the assumption documents.
  - Summer seasonal BNR: All existing clarifiers in service. Maintenance on the clarifiers would typically occur outside the wet weather and seasonal BNR periods.
  - Package 2: Relocate buildings, construct 4 clarifiers, intermediate pump station, aeration basin 8, aeration basins 9-12 and 2.5 MG EQ.

- **CAS Option 2 – New Clarifiers Early**
    - Package 1: Modify east aeration basins, modify west aeration basins, move buildings, construct clarifiers, 2.5 MG equalization basin volume (2.5 MG temporary equalization volume available?), sidestream treatment.
    - Potentially achieves year-round BNR at a lower level TN removal than BACWA requirements.
    - The new CCT was not included due to the availability of equalization in this option. Rehabilitation of the existing CCT is included in cost.
    - Need to undertake a more detailed analysis of various hydrographs to determine EQ requirements.
    - Additional aeration basin volume would be triggered by increased load or BACWA level 2 standards.
    - Is there benefit to build the intermediate pump station earlier? It is not hydraulically needed until aeration basin 8 is placed on line. The intermediate pump station and aeration basin 8 could be undertaken as an intermediate phase based on triggers and/or the early benefits of these facilities.
    - Current redundancy is one clarifier out of service in dry weather. All clarifiers are needed for peak flow conditions.
    - Package 2: Intermediate pump station, aeration basin 8, aeration basins 9-12.
- **CAS Option 3 – No Old Alameda Creek Discharge**
    - Package 1: Modify east aeration basins, modify west aeration basins, modify secondary clarifiers, 15MG equalization volume. Would like to revisit the equalization volume based on a longer storm duration.
    - Equalization cost did not include land acquisition. Land is estimated to be 5-10 $/sf but would probably require purchase and mitigation of all 17 acres. Mitigation costs are estimated to be $1M per acre. Would need the City and residents to agree to effluent storage basins.
    - Package 2: Relocate buildings, relocate EBDA force main, construct 4 clarifiers, intermediate pump station, aeration basin 8, aeration basins 9-12 and 2.5 MG EQ, sidestream treatment.

Next Steps

- Provide a copy of slides to the District (provided at the end of the meeting)
- Provide increased breakdown of costs

- Develop new chlorine contact tank details without disk filters. Consider flow paced dechlorination for this option. Can use footprint of existing FMC building for new CCT or dechlorination facility.
- Provide Curtis with projected solids numbers for various scenarios.
- Refine O&M costs.
- Update CAS 3 option costs based on 17 acres and 5-10$/sf
- CAS Option 2: What does aeration basin 8 get you for BNR? Can District eliminate or delay sidestream treatment as part of Option 2?

Appendix 11. Cost Estimate

Union Sanitary District
Alvarado Water Treatment Plant
Secondary Improvements Projects
Conceptual Estimate

Date: March 29, 2019

Item	Description	Probable Construction Cost	Probable Project Cost	Annual O&M	20-Year Annualized O&M	20-Year Lift Cycle Cost
0	***MBR Day 0***	***$ 451,500,000***	***$ 587,000,000***	***$ 8,519,340***	***$ 144,925,000***	***$ 731,925,000***
1	*CAS 1 Package 1*	*$ 154,300,000*	*$ 200,600,000*	*$ 2,317,605*		*$ 200,600,000*
1a	*CAS 1 Package 2*	*$ 172,500,000*	*$ 224,300,000*	*$ 4,635,210*	*$ 50,112,000*	*$ 274,412,000*
	CAS 1 TOTAL	***$ 326,800,000***	***$ 424,900,000***	***$ 6,952,815***	***$ 50,112,000***	***$ 475,012,000***
2	*CAS 2 Package 1*	*$ 206,000,000*	*$ 267,800,000*	*$ 2,317,605*		*$ 267,800,000*
2a	*CAS 2 Package 2*	*$ 103,100,000*	*$ 134,100,000*	*$ 4,635,210*	*$ 50,112,000*	*$ 184,212,000*
	CAS 2 TOTAL	***$ 309,100,000***	***$ 401,900,000***	***$ 6,952,815***	***$ 50,112,000***	***$ 452,012,000***
	CAS 3 Package 1	*$ 90,700,000*	*$ 118,000,000*	*$ 250,000*		*$ 118,000,000*
	CAS 3 Package 2	*$ 248,806,000*	*$ 323,506,000*	*$ 4,885,210*	*$ 24,585,000*	*$ 348,091,000*
	EQ TOTAL	***$ 339,506,000***	***$ 441,506,000***	***$ 5,135,210***	***$ 24,585,000***	***$ 466,091,000***
	BACWA	*$ 400,000,000*	*$ 500,000,000*	*$ 7,500,000*	*$ 127,585,000*	*$ 627,585,000*

Union Sanitary District
Alvarado Water Treatment Plant
Secondary Improvements Projects
MBR Conceptual Estimate

Date: March 29, 2019

Item	Description		Demolis	
0	*General Conditions*	15%	$	24,860,441
1	*Demolish Existing Process Structures*		$	259,629
2	*Intermediate Pump Station*		$	1,002,740
3	*Fine Screening*		$	4,408,125
4	*West Aeration Basin Modifications*		$	3,638,477
5	*East Aeration Basin Modifications*		$	5,284,820
6	*New Aeration Basin 8*		$	3,134,668
7	*Blower Building*		$	1,770,294
8	*Blowers*		$	4,774,525
9	*MBR Building*		$	14,651,562
10	*MBR*		$	50,199,268
11	*RAS/WAS*		$	4,774,144
12	*Flow Equalization Secondary Clarifier Nos 1-4*		$	2,335,484
13	*Flow Equalization Secondary Clarifier Nos 5-6*		$	1,839,601
14	*Sidestream Treatment*		$	4,132,159
15	*Sidestream Treatment Building*		$	348,955
16	*Disinfection*		$	2,719,499
17	*Effluent Pumping*		$	2,442,263
18	*Effluent Pump Station Building (for effluent, electrical)*		$	1,401,938
19	*Dechlorination*		$	196,031
20	*EBDA Pipeline*		$	840,752
21	*Multi-Point Ferric Addition*		$	1,019,607
22	*Yard Piping*		$	15,270,789
23	*Electrical Infrastructure*		$	33,171,873
24	*Odor Control*		$	-
25	*Bypass and Dewatering*		$	6,119,072
	Subtotal:		**$**	**190,596,717**
	Portion of work performed by Subcontractor		$	38,120,000
	Subcontractor Overhead and Profit	25%	$	9,530,000
	Subtotal:		**$**	**47,650,000**
	Contractor Mark-up on Subcontractor work	5%	$	2,382,500
	Subcontractor Subtotal:		**$**	**50,032,500**
	Contractor Overhead	10%	$	15,247,672
	Subtotal:		**$**	**167,724,388**
	Contractor Profit	15%	$	25,158,658.26
	Subtotal:		**$**	**192,883,047**
	Escalation at 3% annually	19%	$	46,889,095
	Subtotal:		**$**	**289,804,642**
	Bond and Insurance	3%	$	8,694,139.26
	Subtotal:		**$**	**298,498,781**
	Contingency	30%	$	89,549,634
	Probable Bid Cost:		**$**	**388,048,000**

MBR Conceptual Estimate

Operational and Maintenance Costs						
Spare Parts						
Spare Parts				Estimated Life Span (yr)	Estimated Spare Part Cost ($)	Annualized Spare Part Cost ($)
Allow at 1% of equipment cost						$512,503
					Subtotal Spare Parts Costs:	**$512,503**
Chemicals						
Chemical			Gallons per day	Days in Service each Year	Cost per gallon ($/gal)	Annual Chemical Cost
Ferric Chloride			1000	365	$4.25	$1,551,250
					Subtotal Chemicals Costs:	**$1,551,250**
Electricity						
Equipment	hp	Number in Operation	Total kW	Days in Service each Year	Power Cost ($/kW-hr)	Annual Electricity Cost
Blowers			1252	365	$0.16	$1,729,787
Intermediate Pump Station	100	3	223.71	365	$0.16	$309,143
Intermediate Pump Station	75	(3)	(167.78)	365	$0.16	-$231,857
PE EQ	80	1	59.66	14.6	$0.16	$3,345
Anoxic zone mixers	66	1	49.22	365	$0.16	$68,981
RAS	150	7	782.98	365	$0.16	$1,081,999
MBR						$313,170
SWAS	7.5	4	22.37	62.05	$0.16	$5,255
Chlorination Flash Mix	30	1	22.37	365	$0.16	$30,914
De Chlorination Flash Mix	30	1	22.37	29.2	$0.16	$2,473
OAC pumping	50	4	149.14	29.2	$0.16	$16,488
SST			20.00	365	$0.16	$30,914
Blowers (existing)			626.00	365	$0.16	-$865,063
Chlorination Flash Mix (existing)	15	1	11.19	365	$0.16	-$15,457
RAS (existing)	100	5	372.85	365	$0.16	-$515,238
					Subtotal Electricity Costs:	**$1,964,854**
Maintenance						
		Annual Supervisor Man-Hours	Supervisor Wage ($/mh)	Annual Operator Man-Hours	Operator Wage ($/mh)	Annual Labor Cost
Fine screenings						$53,108
Membrane cleaning						$237,250
Membrane replacement						$1,354,150
Clarifier (existing)		372	$180	1488	$150	-$290,160
Operator Labor		4021	$180	16084	$150	$3,136,380
					Subtotal Maintenance Costs:	**$4,490,728**

Total Annual O&M Costs: **$8,519,340**

Hazen

Union Sanitary District
Alvarado Water Treatment Plant
Secondary Improvements Projects
CAS1 P1 Conceptual Estimate

Date: March 29, 2019

Item	Description		West
0	*General Conditions*	*15%*	*$ 6,203,525*
1	*West Aeration Basin Modifications*		*$ 3,638,477*
2	*East Aeration Basin Modifications*		*$ 5,284,820*
3	*Secondary Clarifier Modifications*		*$ 2,675,530*
4	*RAS/WAS*		*$ 1,574,555*
5	*Sidestream Treatment*		*$ 4,132,159*
6	*Sidestream Treatment Building*		*$ 348,955*
7	*Disinfection*		*$ 2,719,499*
8	*Disk Filtration*		*$ 4,822,704*
9	*Effluent Pumping*		*$ 2,341,864*
10	*Dechlorination*		*$ 196,031*
11	*Effluent Pump Station Building (for effluent, electrical)*		*$ 1,401,938*
12	*EBDA Pipeline*		*$ 840,752*
13	*Yard Piping*		*$ 2,295,002*
14	*Electrical Infrastructure*		*$ 7,389,219*
15	*Bypass and Dewatering*		*$ 1,695,328*
		Subtotal:	**$ 47,560,360**
	Portion of work performed by Subcontractor		$ 9,520,000
	Subcontractor Overhead and Profit	*25%*	*$ 2,380,000*
		Subtotal:	**$ 11,900,000**
	Contractor Mark-up on Subcontractor work	*5%*	*$ 595,000*
		Subcontractor Subtotal:	**$ 12,495,000**
	Contractor Overhead	*10%*	*$ 3,804,036*
		Subtotal:	**$ 41,844,396**
	Contractor Profit	*15%*	*$ 6,276,659*
		Subtotal:	**$ 48,121,055**
	Escalation at 4% annually	*12%*	*$ 7,568,763*
		Subtotal:	**$ 68,184,818**
	Bond and Insurance	*3%*	*$ 2,045,545*
		Subtotal:	**$ 70,230,363**
	Contingency	*30%*	*$ 21,069,109*
		Probable Bid Cost:	**$ 91,299,000**

Hazen

Union Sanitary District
Alvarado Water Treatment Plant
Secondary Improvements Projects
CAS1 P2 Conceptual Estimate

Date: March 29, 2019

Item	Description			Demolis
0	*General Conditions*	*15%*	*$*	*11,501,101*
1	*Demolish Existing Process Structures*		*$*	*606,164*
2	*Intermediate Pump Station*		*$*	*2,312,485*
3	*New Aeration Basin 8*		*$*	*3,093,534*
4	*New Aeration Basin 9-12*		*$*	*11,947,789*
5	*Blowers*		*$*	*3,989,052*
6	*Blower Building*		*$*	*1,689,276*
7	*New Secondary Clarifiers*		*$*	*14,301,982*
8	*RAS/WAS*		*$*	*3,283,856*
9	*RAS/WAS Building*		*$*	*948,572*
10	*Flow Equalization Secondary Clarifier Nos 1-4*		*$*	*2,335,484*
11	*Multi-Point Ferric Addition*		*$*	*1,019,607*
12	*Yard Piping*		*$*	*9,151,247*
13	*Electrical Infrastructure*		*$*	*16,265,886*
14	*Odor Control*		*$*	*-*
15	*Bypass and Dewatering*		*$*	*5,729,072*
		Subtotal:	**$**	**88,175,107**
	Portion of work performed by Subcontractor		$	17,640,000
	Subcontractor Overhead and Profit	*25%*	*$*	*4,410,000*
		Subtotal:	**$**	**22,050,000**
	Contractor Mark-up on Subcontractor work	*5%*	*$*	*1,102,500*
		Subcontractor Subtotal:	**$**	**23,152,500**
	Contractor Overhead	*10%*	*$*	*7,053,510.69*
		Subtotal:	**$**	**77,588,618**
	Contractor Profit	*15%*	*$*	*11,638,292.63*
		Subtotal:	**$**	**89,226,910**
	Escalation at 3% annually	*14%*	*$*	*15,987,846.36*
		Subtotal:	**$**	**128,367,257**
	Bond and Insurance	*3%*	*$*	*3,851,017.70*
		Subtotal:	**$**	**132,218,274**
	Contingency	*30%*	*$*	*39,665,482.28*
		Probable Bid Cost:	**$**	**171,884,000**

Hazen

CAS1 Conceptual Estimate

Operational and Maintenance Costs						
Spare Parts						
Spare Parts				Estimated Life Span (yr)	Estimated Spare Part Cost ($)	Annualized Spare Part Cost ($)
Allow at 1% of equipment cost						$150,999
					Subtotal Spare Parts Costs:	**$150,999**
Chemicals						
Chemical			Gallons per day	Days in Service each Year	Cost per gallon ($/gal)	Annual Chemical Cost
Ferric Chloride			1000	365	$4.25	$1,551,250
					Subtotal Chemicals Costs:	**$1,551,250**
Electricity						
Equipment	hp	Number in Operation	Total kW	Days in Service each Year	Power Cost ($/kW-hr)	Annual Electricity Cost
Blowers			900	365	$0.16	$1,243,284
Intermediate Pump Station	75	3	167.78	365	$0.16	$231,857
PE EQ	80	1	59.66	14.6	$0.16	$3,298
Aeration Mixing	72	1	53.69	365	$0.16	$74,194
NRCY Pumping	30	10	223.71	365	$0.16	$309,143
Filters	5	5	18.64	365	$0.16	$25,762
Clarifiers	3	4	8.95	365	$0.16	$12,366
RAS	100	5	372.85	365	$0.16	$515,238
SWAS	7.5	6	33.56	62.05	$0.16	$7,883
Chlorination Flash Mix	30	1	22.37	365	$0.16	$30,914
De Chlorination Flash Mix	30	1	22.37	29.2	$0.16	$2,473
OAC pumping	50	4	149.14	29.2	$0.16	$16,488
SST			20.00	365	$0.16	$27,638
Blowers (existing)			626.00	365	$0.16	-$865,063
Intermediate Pumping (existing)	75	3	167.78	365	$0.16	-$231,857
Clarifiers (existing)			5.22	365	$0.16	-$7,213
Chlorination Flash Mix	15	1	11.19	365	$0.16	-$15,457
RAS (existing)	100	5	372.85	365	$0.16	-$515,238
					Subtotal Electricity Costs:	**$865,708**
Labor						
		Annual Supervisor Man-Hours	Supervisor Wage ($/mh)	Annual Operator Man-Hours	Operator Wage ($/mh)	Annual Labor Cost
Blowers (existing)		90	$180	360	$150	-$70,200
Clarifiers (existing)		365	$180	1460	$150	-$284,700
Intermediate Pumping (existing)		240	$180	960	$150	-$187,200
Activated Sludge (existing)		794	$180	3176	$150	-$619,223
Operator Labor		4139	$180	16557	$150	$3,228,566
					Subtotal Labor Costs:	**$2,067,244**

Total Annual O&M Costs: **$4,635,210**

Hazen

Union Sanitary District
Alvarado Water Treatment Plant
Secondary Improvements Projects
CAS2 P1 Conceptual Estimate

Date: March 29, 2019

Item	Description			West
0	*General Conditions*	*15%*	*$*	*9,588,871*
1	*West Aeration Basin Modifications*		*$*	*3,638,477*
2	*East Aeration Basin Modifications*		*$*	*5,284,820*
3	*New Secondary Clarifiers*		*$*	*14,301,982*
4	*RAS/WAS*		*$*	*3,283,856*
5	*RAS/WAS Building*		*$*	*948,572*
6	*Clarifier pipe rehabilitation*		*$*	*440,000*
7	*Flow Equalization Secondary Clarifier Nos 1-4*		*$*	*2,962,835*
8	*Disinfection*		*$*	*2,905,217*
9	*Effluent Pumping*		*$*	*2,486,243*
10	*OAC Effluent Pump Station Building (for effluent, electrical)*		*$*	*730,151*
11	*Effluent Pump Station Building (for effluent, electrical)*		*$*	*1,064,994*
12	*Dechlorination*		*$*	*590,119*
13	*EBDA Pipeline*		*$*	*840,752*
14	*Yard Piping*		*$*	*10,164,197*
15	*Electrical Infrastructure*		*$*	*10,864,518*
16	*Odor Control*		*$*	*-*
17	*Bypass and Dewatering*		*$*	*3,419,072*
		Subtotal:	**$**	**73,514,674**
	Portion of work performed by Subcontractor		$	14,710,000
	Subcontractor Overhead and Profit	*25%*	*$*	*3,677,500*
		Subtotal:	**$**	**18,387,500**
	Contractor Mark-up on Subcontractor work	*5%*	*$*	*919,375*
		Subcontractor Subtotal:	**$**	**19,306,875**
	Contractor Overhead	*10%*	*$*	*5,880,467*
		Subtotal:	**$**	**64,685,142**
	Contractor Profit	*15%*	*$*	*9,702,771*
		Subtotal:	**$**	**74,387,913**
	Escalation at 3% annually	*14%*	*$*	*13,329,647*
		Subtotal:	**$**	**107,024,435**
	Bond and Insurance	*3%*	*$*	*3,210,733*
		Subtotal:	**$**	**110,235,168**
	Contingency	*30%*	*$*	*33,070,550*
		Probable Bid Cost:	**$**	**143,306,000**

Hazen

Union Sanitary District
Alvarado Water Treatment Plant
Secondary Improvements Projects
CAS2 P2 Conceptual Estimate

Date: March 29, 2019

Item	Description			Demolis
0	*General Conditions*	*15%*	*$*	*6,863,123*
1	*Demolish Existing Process Structures*		*$*	*606,164*
2	*Intermediate Pump Station*		*$*	*2,312,485*
3	*New Aeration Basin 8*		*$*	*3,093,534*
4	*New Aeration Basin 9-12*		*$*	*11,947,789*
5	*Blowers*		*$*	*3,989,052*
6	*Blower Building*		*$*	*1,689,276*
7	*Sidestream Treatment*		*$*	*4,132,159*
8	*Sidestream Treatment Building*		*$*	*348,955*
9	*Multi-Point Ferric Addition*		*$*	*1,019,607*
10	*Yard Piping*		*$*	*2,323,665*
11	*Electrical Infrastructure*		*$*	*9,912,392*
12	*Odor Control*		*$*	*-*
13	*Bypass and Dewatering*		*$*	*4,379,072*
	Subtotal:		**$**	**52,617,273**
	Portion of work performed by Subcontractor		$	10,530,000
	Subcontractor Overhead and Profit	*25%*	*$*	*2,632,500*
	Subtotal:		**$**	**13,162,500**
	Contractor Mark-up on Subcontractor work	*5%*	*$*	*658,125*
	Subcontractor Subtotal:		**$**	**13,820,625**
	Contractor Overhead	*10%*	*$*	*4,208,727*
	Subtotal:		**$**	**46,296,000**
	Contractor Profit	*15%*	*$*	*6,944,400*
	Subtotal:		**$**	**53,240,400**
	Escalation at 3% annually	*14%*	*$*	*9,540,550*
	Subtotal:		**$**	**76,601,575**
	Bond and Insurance	*3%*	*$*	*2,298,047*
	Subtotal:		**$**	**78,899,622**
	Contingency	*30%*	*$*	*23,669,887*
	Probable Bid Cost:		**$**	**102,570,000**

CAS2 Conceptual Estimate

Operational and Maintenance Costs						
Spare Parts						
Spare Parts				Estimated Life Span (yr)	Estimated Spare Part Cost ($)	Annualized Spare Part Cost ($)
Allow at 1% of equipment cost						$150,999
					Subtotal Spare Parts Costs:	**$150,999**
Chemicals						
Chemical			Gallons per day	Days in Service each Year	Cost per gallon ($/gal)	Annual Chemical Cost
Ferric Chloride			1000	365	$4.25	$1,551,250
					Subtotal Chemicals Costs:	**$1,551,250**
Electricity						
Equipment	hp	Number in Operation	Total kW	Days in Service each Year	Power Cost ($/kW-hr)	Annual Electricity Cost
Blowers			900	365	$0.16	$1,243,284
Intermediate Pump Station	75	3	167.78	365	$0.16	$231,857
Clarifiers	3	4	8.95	365	$0.16	$12,366
RAS	100	5	372.85	365	$0.16	$515,238
Blowers (existing)				365	$0.16	$0
Intermediate Pumping (existing)			0.00	365	$0.16	$0
Clarifiers (existing)			0.00	365	$0.16	$0
RAS (existing)			0.00	365	$0.16	$0
					Subtotal Electricity Costs:	**$2,002,744**
Labor						
		Annual Supervisor Man-Hours	Supervisor Wage ($/mh)	Annual Operator Man-Hours	Operator Wage ($/mh)	Annual Labor Cost
Blowers (existing)		90	$180	360	$150	-$70,200
Clarifiers (existing)		365	$180	1460	$150	-$284,700
Intermediate Pumping (existing)		240	$180	960	$150	-$187,200
Activated Sludge (existing)		794	$180	3176	$150	-$619,223
Operator Labor		3957	$180	15827	$150	$3,086,216
					Subtotal Labor Costs:	**$1,924,894**

Total Annual O&M Costs: **$5,629,890**

Appendix 12. Follow up Converge Phase Workshop Presentation

Hazen

Converge Phase Follow- up

March 26, 2019

Today's Agenda

Topic

1. Information request
2. Recap of Previous Work
3. Increased specificity on CAS Option 2 - Early Clarification
   - Process Questions
   - Old Alameda Creek Discharge Control
   - Sequence

Information Request and Final Report

- Information request – Mid April
- Report outline – Today
- Draft report – End of April

Recap of Previous Work

Summary of Options

Capacity and Creek Discharge	MBR Now Option	CAS Option 1 Two Effluent Qualities Package 1	CAS Option 2 Early Clarification Package 1	CAS Option 3 No Alameda Creek Discharge Package 1
Level 2 Nutrients Year-round		CAS Option 1 Two Effluent Qualities Package 2	CAS Option 2 Early Clarification Package 2	CAS Option 3 No Alameda Creek Discharge Package 2

CAS Option 1 and 2 Comparison

Package	CAS Option 1 Two Effluent Water Qualities	CAS Option 2 Early Clarification
1	Aeration Basin Modifications **Secondary Clarifier Modifications** **Disk Filters** New Chlorine Contact Channels New Dechlorination Facility New Effluent Pump Station Move EBDA Force Main **Sidestream Treatment**	Aeration Basin Modifications **New Clarifiers** New/Rehab Chlorine Contact Channels New/Rehab Dechlorination Facility New/Rehab Effluent Pump Station Move EBDA Force Main **2.5 or 5 MG of PE equalization** **Move Buildings**
2	Move Buildings PE Pump Station 2.5 MG of PE Equalization New Aeration Basin Volume (5.5 MG) New Secondary Clarifiers Chemical P Removal Blower and Blower Building	PE Pump Station New Aeration Basin Volume (5.5 MG) Chemical P Removal Blower and Blower Building Sidestream treatment

CAS Option 1 and 2 Comparison

	CAS 1 Package 1 Two Effluent Qualities	CAS 2 Package 1 Early Clarification
Aeration Basins	Same modifications = Achieve same SVI	
Clarifiers	No change in surface area	More surface area because sized for buildout peak
	Poorer technology	Modern clarifier technology
RAS control	Sub optimal	Optimized
BNR	Seasonal, Wet weather must be in carbon removal mode to prevent washout	Modern clarifier design allows for higher MLSS (aSRT). Achieve BNR at lower temperatures

Better technology + EQ will = meet effluent TSS < 15 mg/L during wet weather → no disc filters required

- Implications for negotiations with regional board
- Early adoption nutrient removal

CAS Option 2 - Early Clarification

CAS Option 2 – Interim Phase Flows and Loads Assumptions

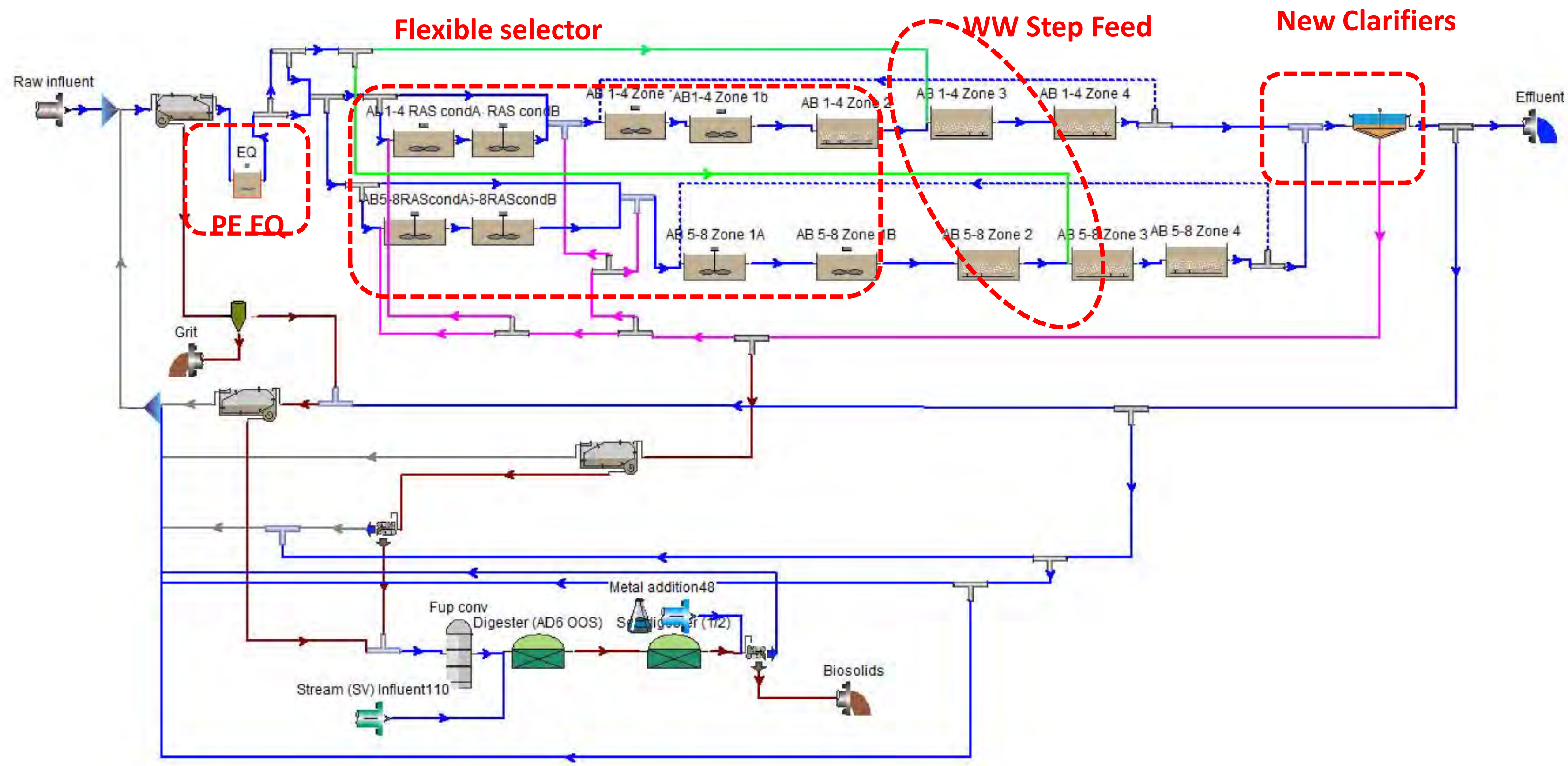
Horizon: **2028**

	AA		MM	
Flow, mgd	25.8		29.7	
Peak Flow, mgd	67.1		67.1	
COD, lbs/d	161,300	749	185,500	749
BOD, lbs/d	58,100	270	66,800	270
TSS, lbs/d	77,900	362	89,600	362
TKN, lbs/d	11,800	55	13,500	55
NH_3-H, lbs/d	8,000	37	9,200	37
TP, lbs/d	1,490	6.9	1,720	6.9

Revised Assumption now that we have EQ:

- **EQ is used for daily diurnal flow**
- **EQ is used for Peak flow**

CAS Option 2 – Interim Phase Flows and Loads Assumptions



CAS 2 Early Clarification Package 1 – Interim Effluent Quality – Nutrients

Significant Yearly Mass TN Reduction

Temperature, °C	16	18	20	22	24
Load	MM	MM	MM	MM	MM
Flow, mgd	26	26	26	26	26
AB Volume, MG	7.4	7.4	7.4	7.4	7.4
SC total SA, sf	75,500	75,500	75,500	75,500	75,500
SVI, mL/g	110	110	110	110	110
SRT, d	4	4	4	4	4
MLSS	3,670	3,600	3,600	3,600	3,500
SE NH3, mg/L	~6	~3	<2	<1	<1
SE TN, mg/L	<25	<18	<16	<16	~15

MM loads and AA flows = highest concentrations

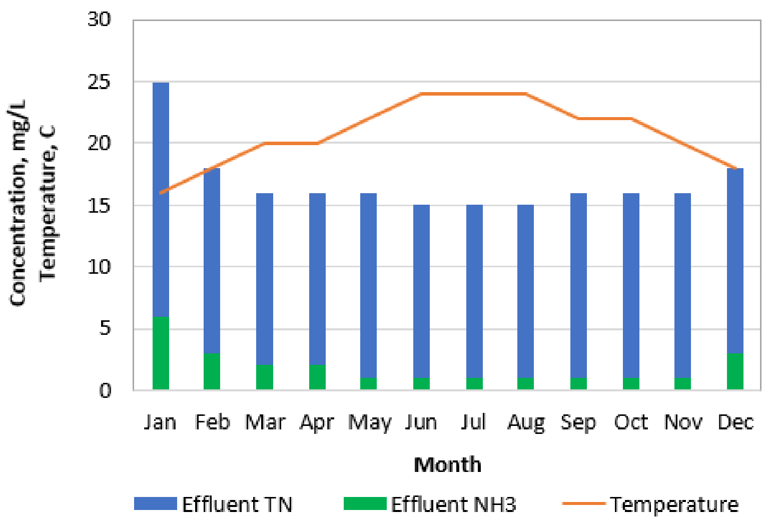
More clarifier surface area

SRT, higher MLSS, can be accommodated by new clarifiers (better technology and more surface area)

TN 15 – 18 mg/L most of the year. Lose nitrification in coldest months

Significant Yearly TN Reduction and Ammonia Removal

- Without sidestream treatment, ~ 15-18 mg/L TN most of the year
  - Ammonia breakthrough in coldest months
- Significant ~50% TN load reduction
  - All units in service
- Current discussions with regional board ~15% reduction for Old Alameda Creek

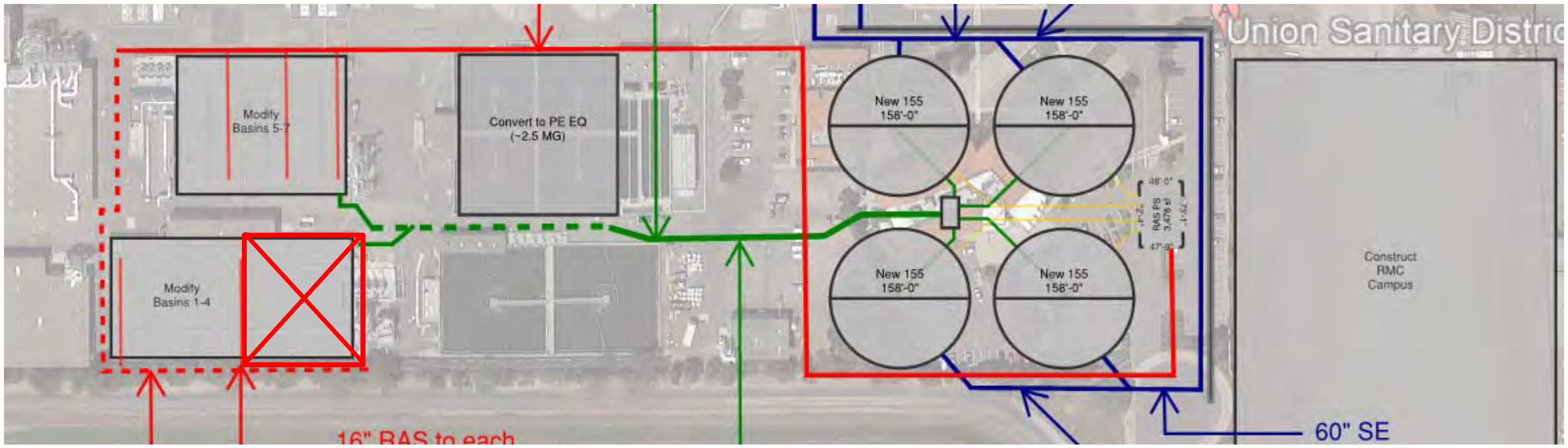


Significant Yearly TN Reduction and Ammonia Removal – Redundancy check

AA load; one aeration basin out of service

	Summer	Fall/Spring
Temperature, C	24	20
TN, mgN/L	~15	~19
NH_3 – N, mgN/L	<3	~8

Original design focused on reducing # of basins for 2040 condition. If interim operation is prolonged, may consider 4 basin arrangement in detailed design



Significant Yearly TN Reduction and Ammonia Removal – Nutrient Summary

Excellent Effluent TN

- ~50% annual TN load reduction without sidestream treatment
- TN ~15 mg/L for most of the year
- Complete nitrification most of the year
- TN ~25 mg/L in cold weather
- NH3-N breakthrough during cold weather but still < 6 mgN/L

Redundancy

- Lose nitrification if a basin is taken offline during the winter
- Detailed design of east aeration basins may keep 4 basins if interim operation is the goal

CAS 2 Early Clarification Package 1 – Interim Effluent Quality – WW TSS

What is the Predicted Interim Effluent Quality? – WW TSS

Old Alameda Creek Effluent Requirements (wet weather only)

Discharge point	Old Alameda Creek	Comment
Flows, mgd	0-22 mgd	> 43 mgd
cBOD, mg/L	10	
TSS, mg/L	15	

Check effluent quality for:

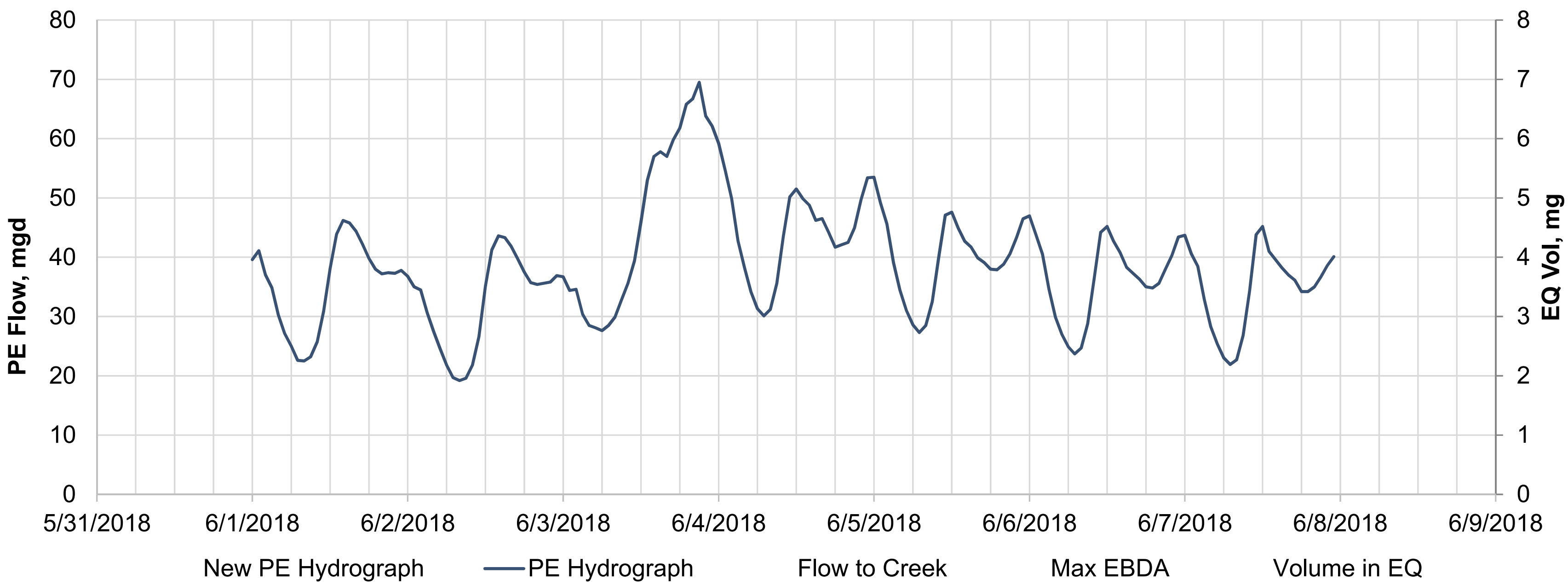
- Equalized wet weather

- **Modeling kept Peak Hour TSS below 15 mg/L.**
- **Recommend negotiating a more relaxed standard**

CAS Option 2 Early Clarification – Interim Phase Equalized Peak Flows

Escalated 2028 Hydrograph with and without EQ

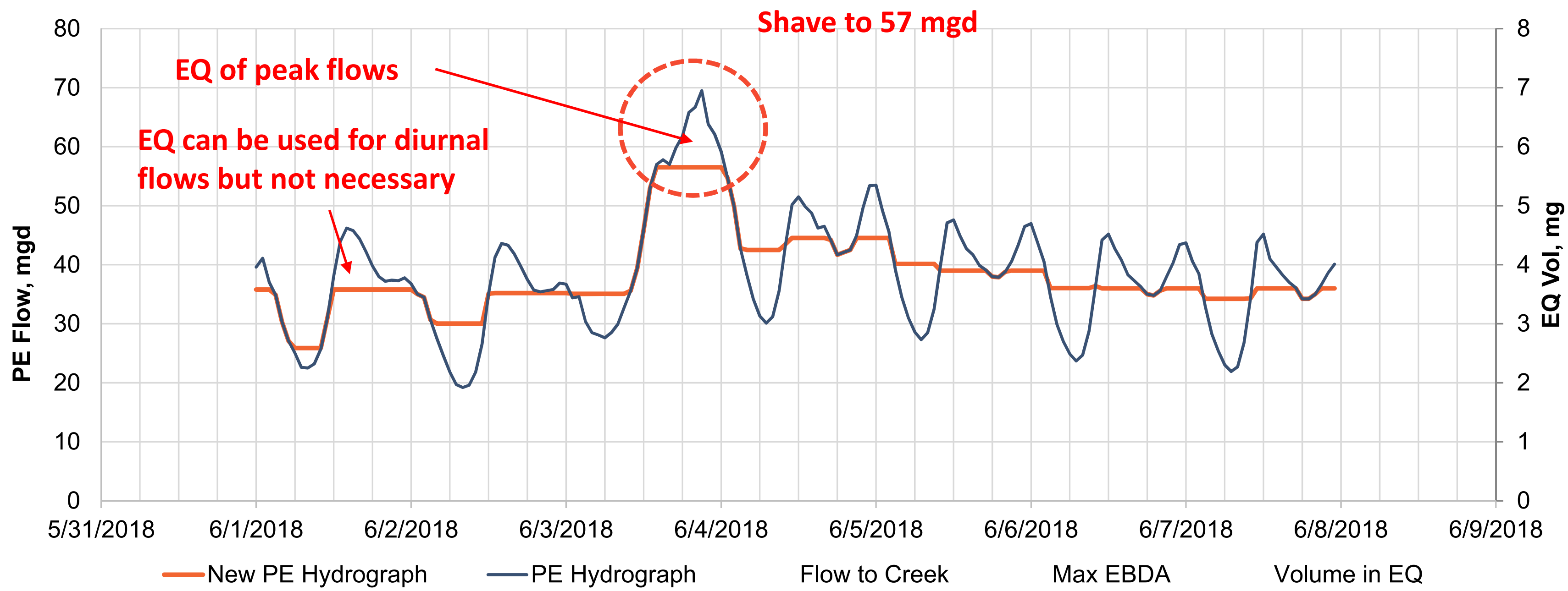
Note EQ needs to be available during storm events



CAS Option 2 Early Clarification – Interim Phase Equalized Peak Flows

Escalated 2028 Hydrograph with and without EQ

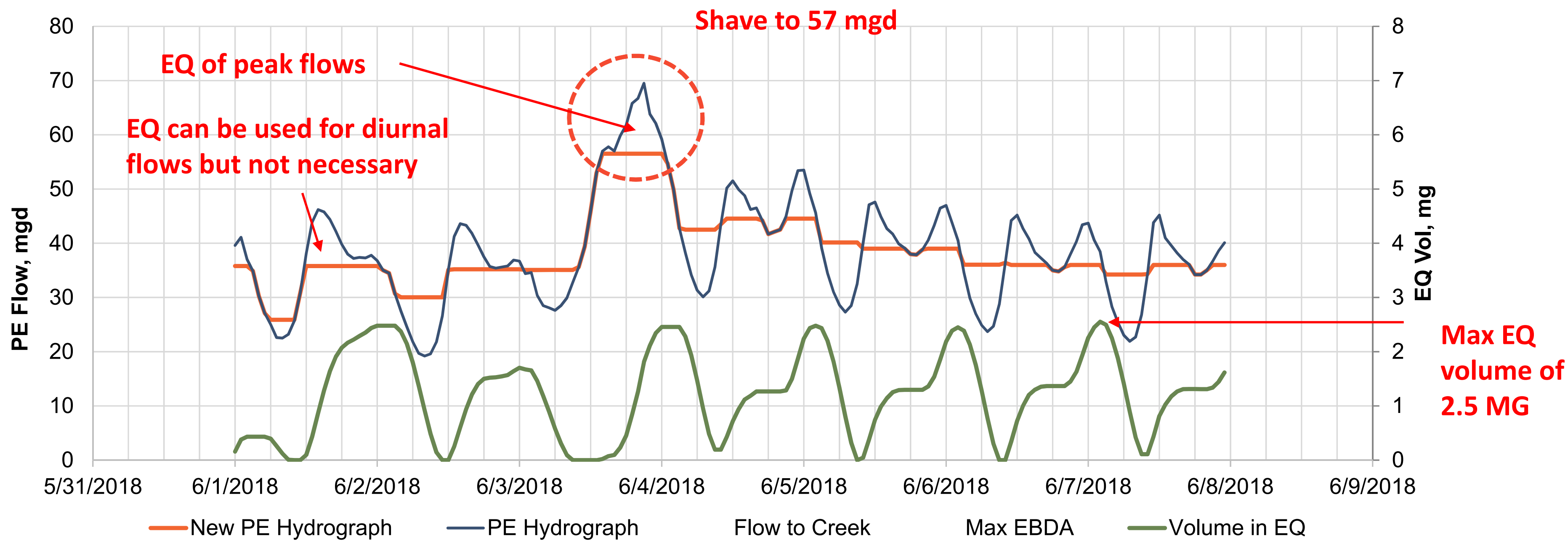
Note EQ available during storm events



CAS Option 2 – Interim Phase Equalized Peak Flows

Escalated 2028 Hydrograph with and without EQ

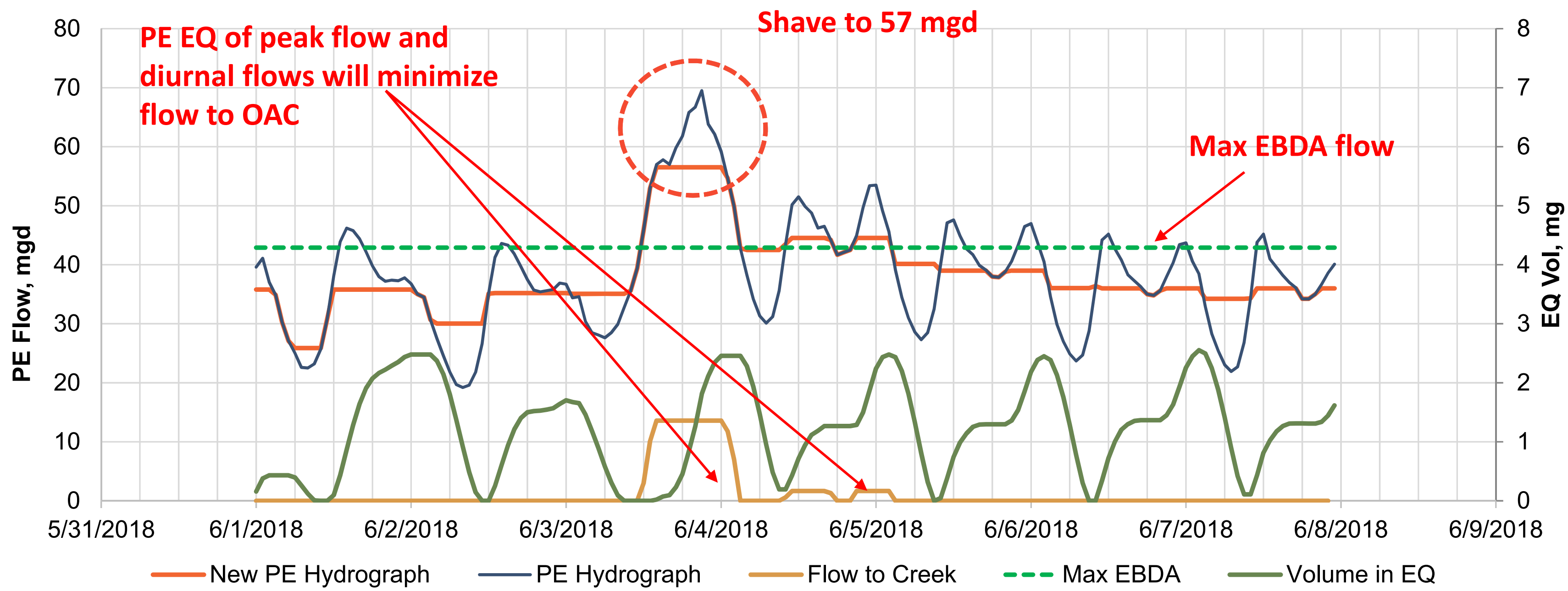
Note EQ needs to be available during storm events



CAS Option 2 Early Clarification – Interim Phase Equalized Peak Flows

Escalated 2028 Hydrograph with and without EQ

Note EQ needs to be available during storm events



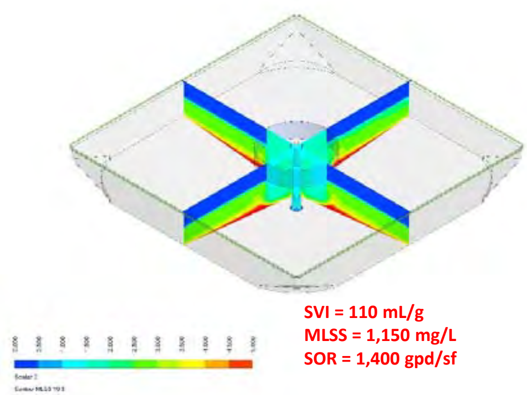
Question 1: What is the Predicted Interim Effluent Quality? – WW TSS

- For 2028 MM loads
- All Basins online, All clarifiers online

✓ MLSS of ~ 2,700 mg/L with Step Feed

✓ Clarifiers can pass **equalized** WW flows with improved SVI (110 mL/g)

✓ Effluent TSS Peak Hour < 15 mg/L



CAS 2 Early Clarification Package 1 – Interim Effluent Quality – Effluent Quality Improvement with Aeration Basin 8

Significant Yearly Mass TN Reduction – Effluent Quality Improvement with Aeration Basin 8

Aeration Basin 8 provides more stable nitrification in cold weather months and better TN

	Existing Volume	Existing Volume + AB8
Total AB Volume, MG	7.4	8.5
Load, lb/d	MM	MM
TN, mg/L	<25	<18
NH_3-N, mg/L	~6	~3

Significant Yearly Mass TN Reduction – Effluent Quality Improvement with Aeration Basin 8

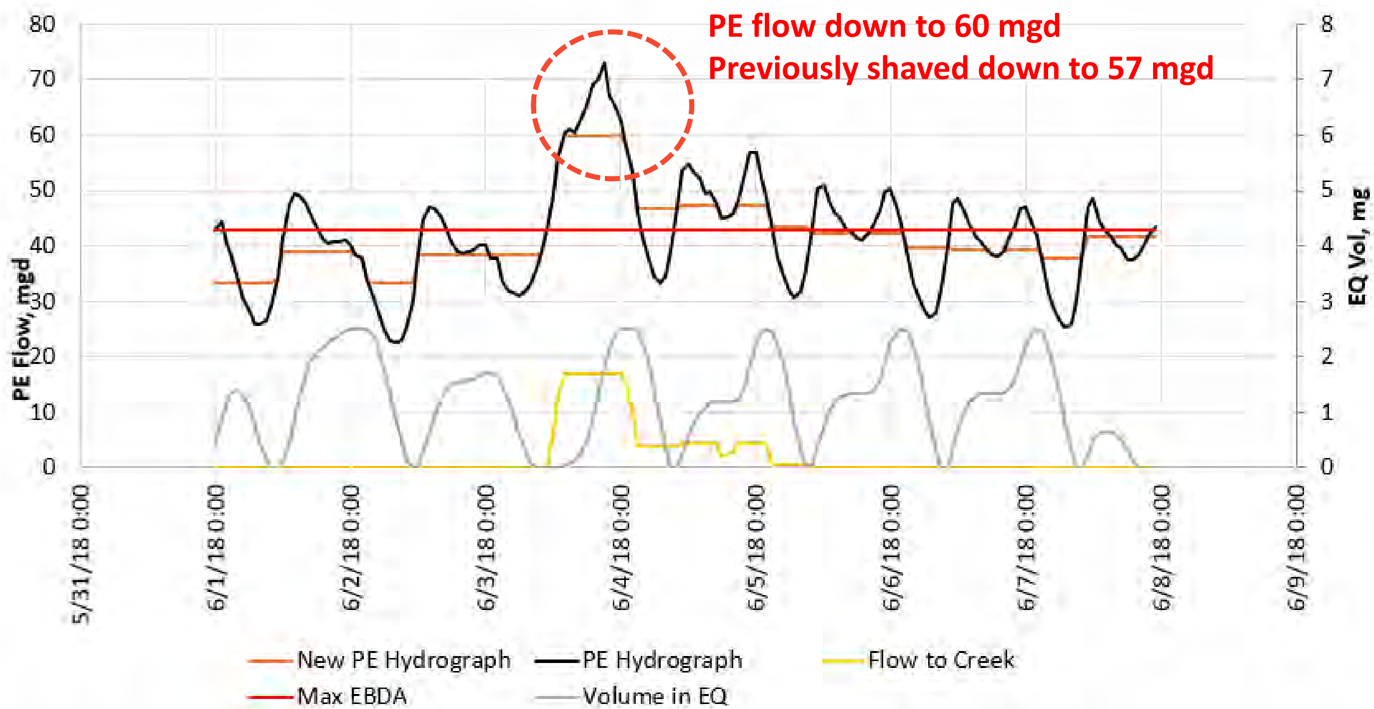
Aeration Basin 8 provides more flexibility of when to take off clarifiers

	Existing Volume	Existing Volume + AB8
Total AB Volume, MG	5.35	6.45
AB Vol. Out of Service, MG	2.05	2.05
Load, lb/d	AA	AA
TN, mg/L	~19	~18
NH_3-N, mg/L	~8	<7

Original design focused on reducing # of basins for 2040 condition. If interim operation is prolonged, may consider 4 basin arrangement in detailed design

CAS 2 Early Clarification Package 2 – Meets BACWA Level 2 – WW TSS

2040 Check: Equalized Wet Weather Flow



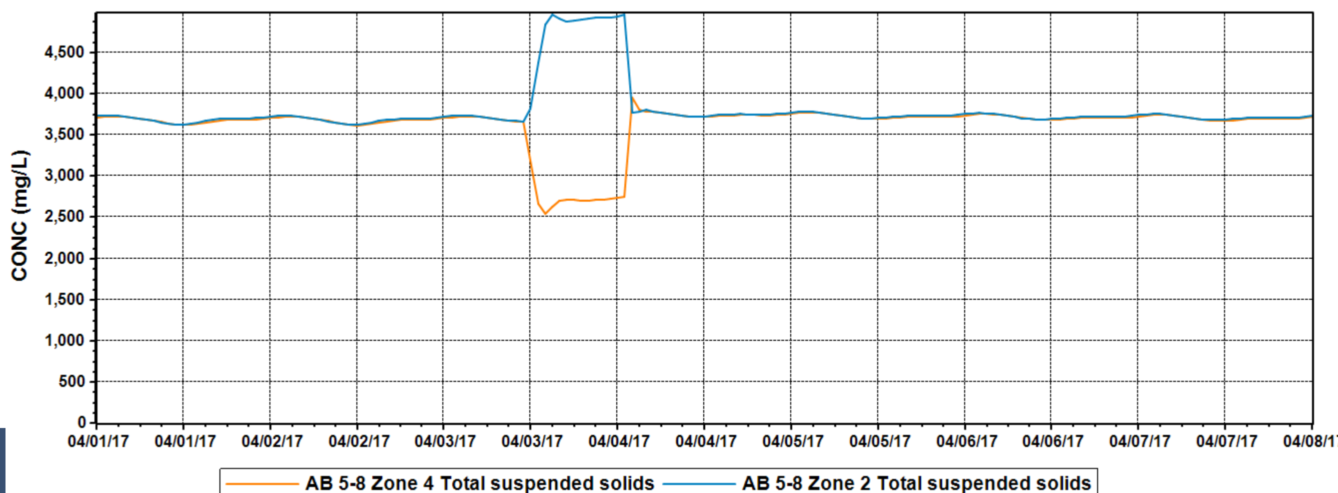
2040 Check: Wet Weather

- For 2028 MM loads
- All Basins online, All clarifiers online

✓ MLSS of ~ 2,700 mg/L with Step Feed

✓ Clarifiers can pass **equalized** WW flows with improved SVI (110 mL/g)

✓ Effluent TSS Peak Hour < 15 mg/L



CAS Option 2 – Early Clarification– Package 1 Elements

CAS Option 2 Early Clarification Package 1 – Elements

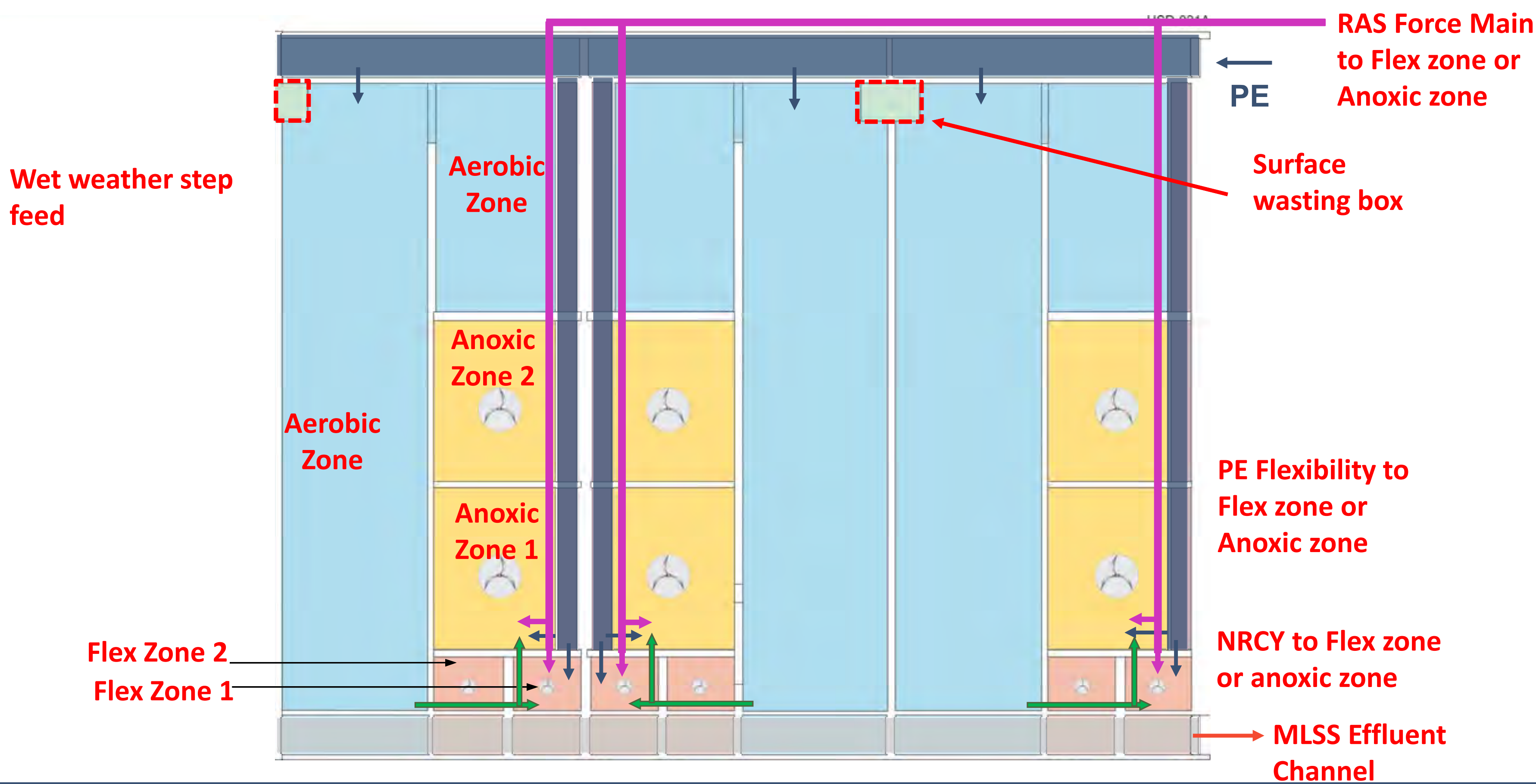
- Aeration basin modifications
- New chlorine contact channels
- New dechlorination facility
- New effluent pump station
- 2.5 MG PE EQ
- Relocate EBDA force main
- New secondary clarifiers
- Move Buildings

Effluent Facilities to Accommodate Old Alameda Creek Discharge

PE EQ without New PE lift station

Aeration Basin Modifications

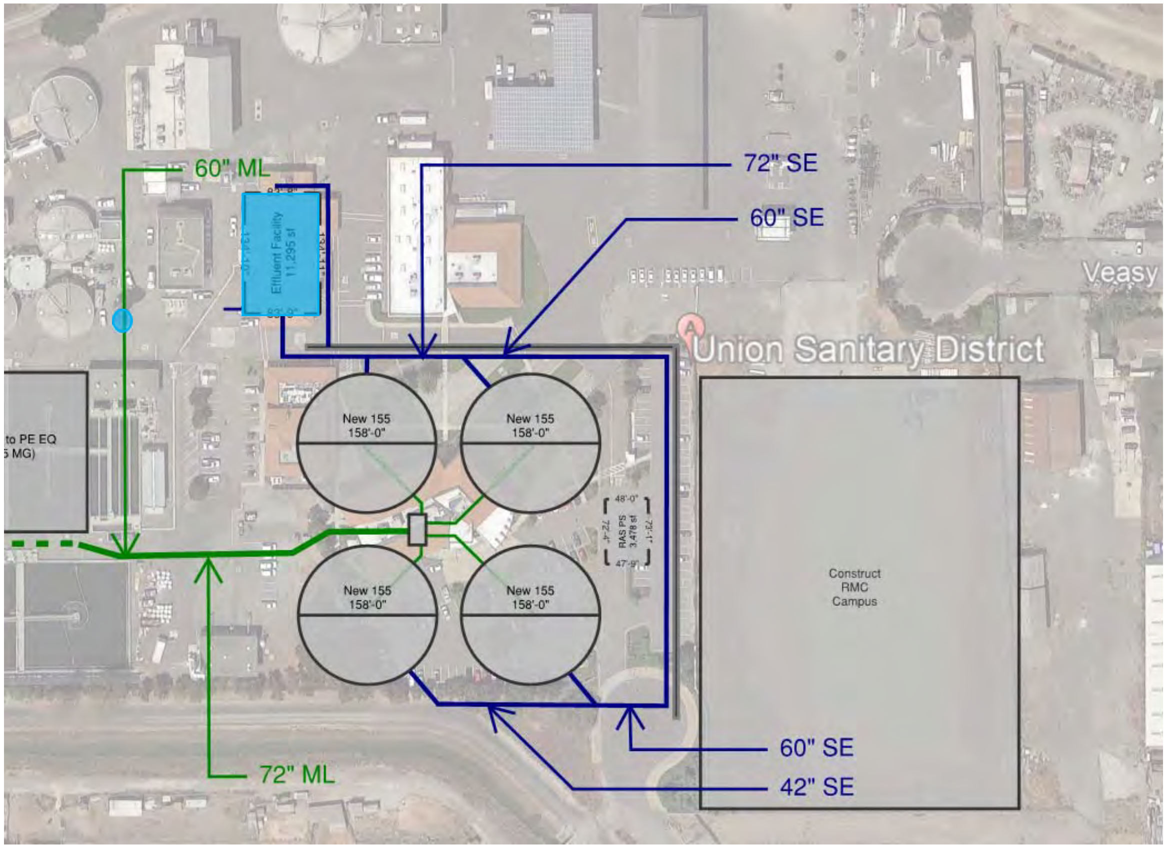
CAS Option 2 – Aeration Basin Modification Features



Effluent Facilities to Accommodate Old Alameda Creek Discharge

Effluent Facilities to Accommodate Old Alameda Creek Discharge – Location

- Closer location = less yard piping
- New CCT
- New Dechlorination facility
- New EBDA Pump Station
- Reuse Surge tower
- Reuse portion of EBDA FM
- Reuse line to OAC by connecting downstream of the valve box



New Effluent Facility

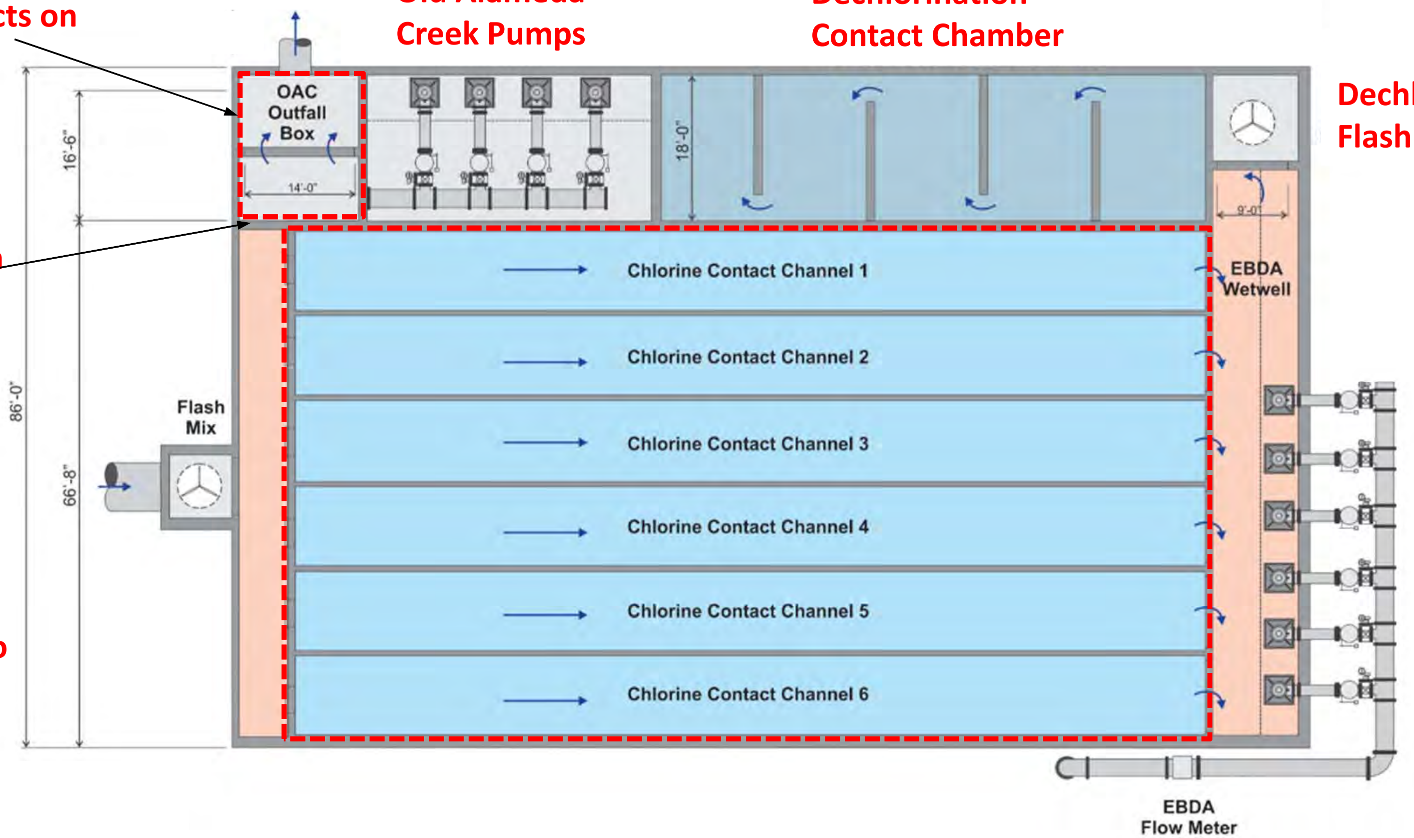
Outfall box prevents tidal impacts on pumps

Old Alameda Creek Pumps

Dechlorination Contact Chamber

Dechlorination Flash Mix

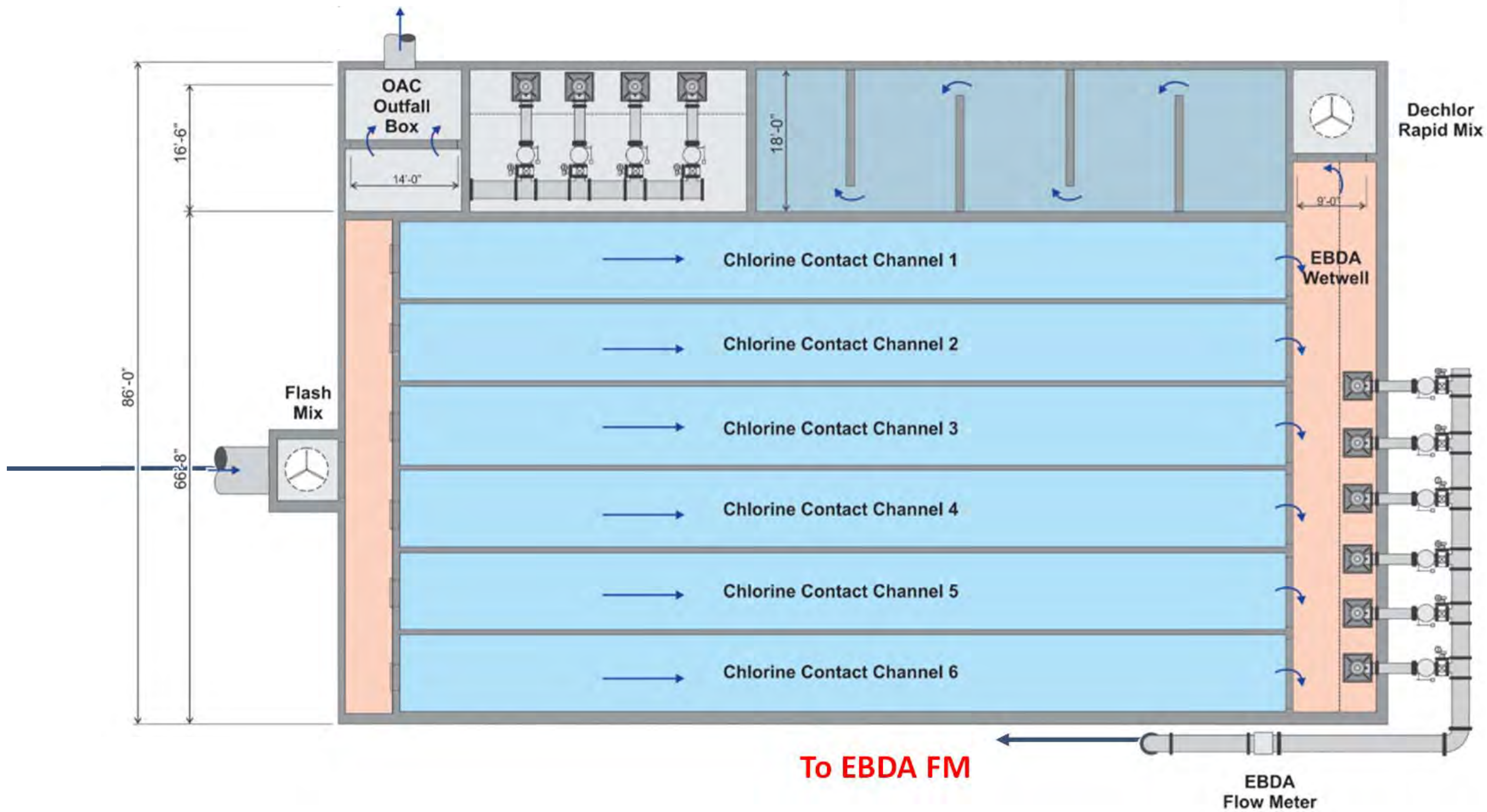
Ability to drain back to CCT



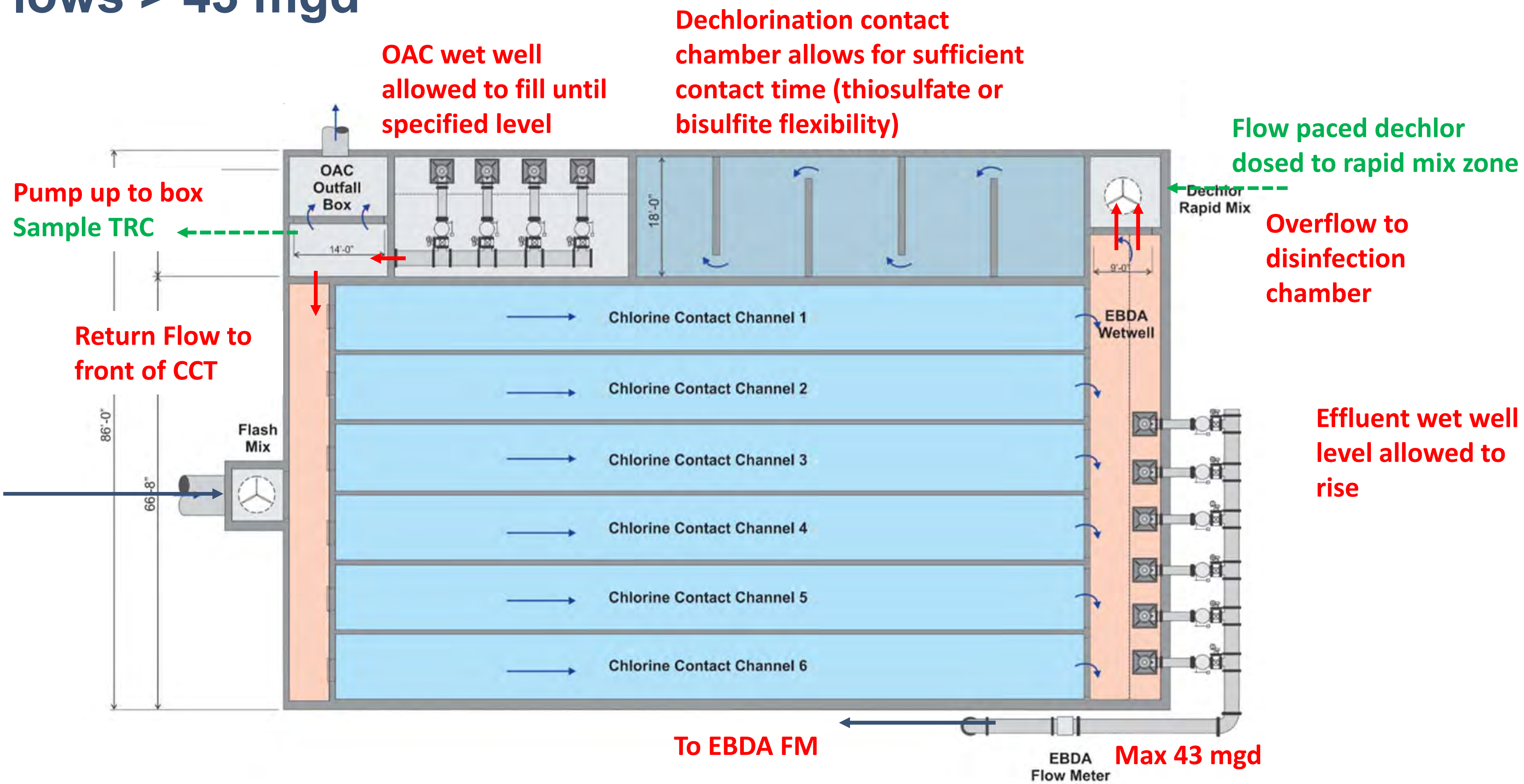
6 CCT can be configured in parallel or as two three pass plug flow reactors

New EBDA pumps

Flows < 43 mgd


OAC
Outfall
Box
14'-0"
18'-0"
Dechlor
Rapid Mix
9'-0"
16'-6"
86'-0"
66'-8"
Flash
Mix
EBDA
Wetwell
Chlorine Contact Channel 1
Chlorine Contact Channel 2
Chlorine Contact Channel 3
Chlorine Contact Channel 4
Chlorine Contact Channel 5
Chlorine Contact Channel 6
To EBDA FM
EBDA
Flow Meter

Flows > 43 mgd



OAC wet well allowed to fill until specified level
Dechlorination contact chamber allows for sufficient contact time (thiosulfate or bisulfite flexibility)
Flow paced dechlor dosed to rapid mix zone
Pump up to box
Sample TRC
OAC Outfall Box
14'-0"
18'-0"
Dechlor Rapid Mix
Overflow to disinfection chamber
9'-0"
Return Flow to front of CCT
EBDA Wetwell
Chlorine Contact Channel 1
Chlorine Contact Channel 2
Chlorine Contact Channel 3
Chlorine Contact Channel 4
Chlorine Contact Channel 5
Chlorine Contact Channel 6
Flash Mix
86'-0"
66'-8"
Effluent wet well level allowed to rise
To EBDA FM
EBDA Flow Meter
Max 43 mgd

Flows > 43 mgd

Overflow to OAC outfall box which goes by gravity to OAC

OAC wet well allowed to fill until specified level

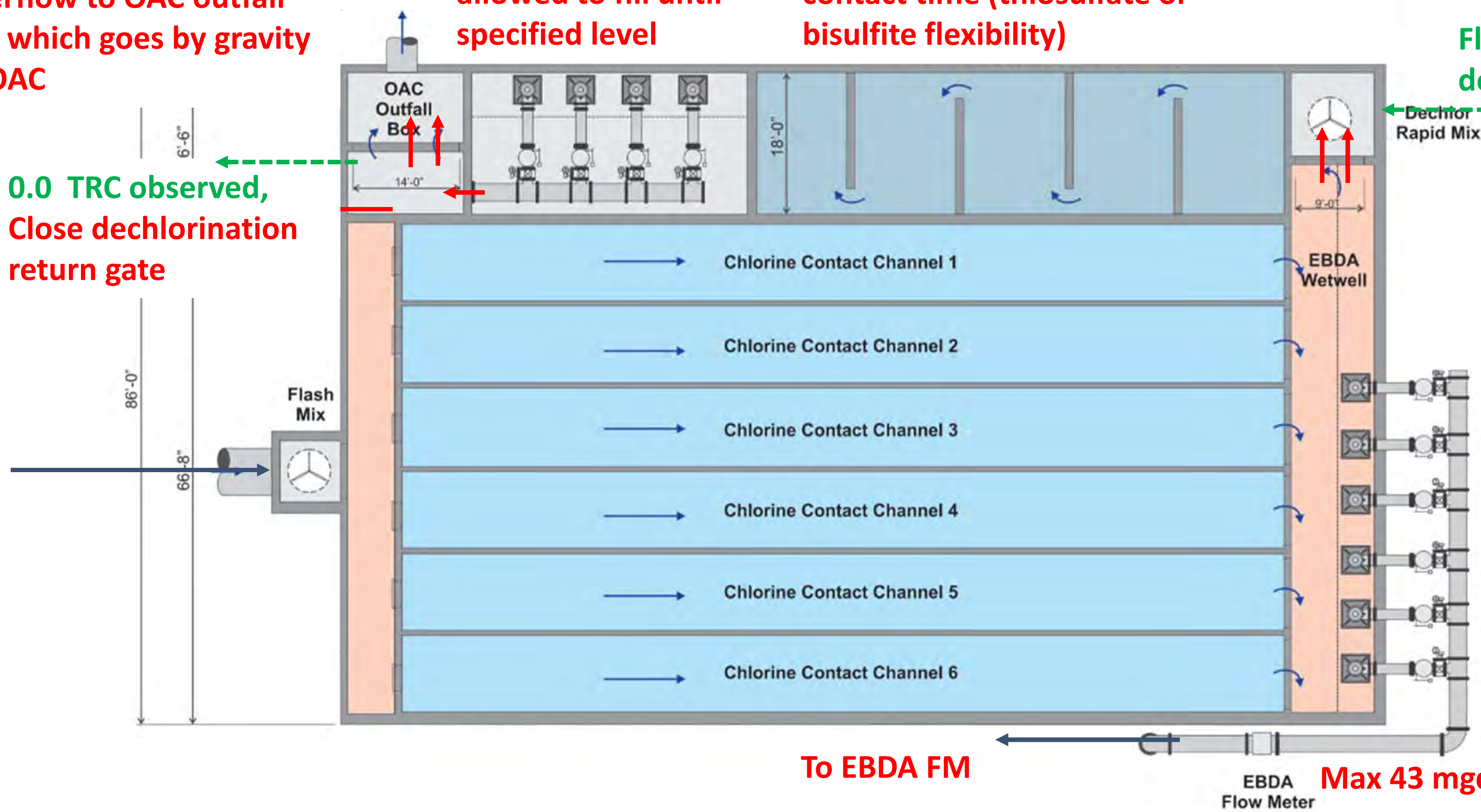
Dechlorination contact chamber allows for sufficient contact time (thiosulfate or bisulfite flexibility)

Flow paced dechlor dosed to rapid mix zone

0.0 TRC observed, Close dechlorination return gate

Overflow to disinfection chamber

Effluent wet well level allowed to rise



To EBDA FM

Max 43 mgd

Primary Effluent EQ

Primary Effluent Equalization

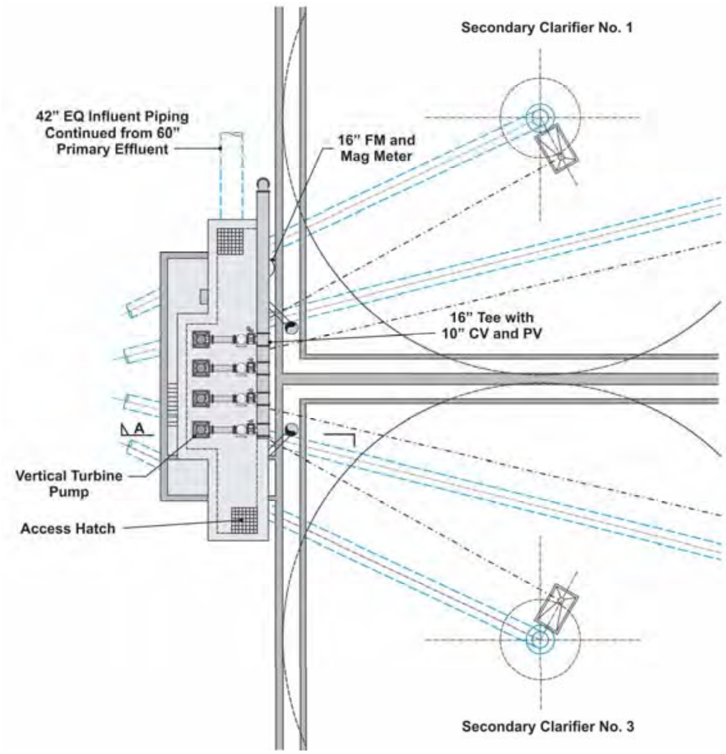
Utilize Clarifiers 1-4 to get 2.5 MG PE EQ

Challenges

1. EQ return utilizing existing Infrastructure
2. EQ influent flow control and fill

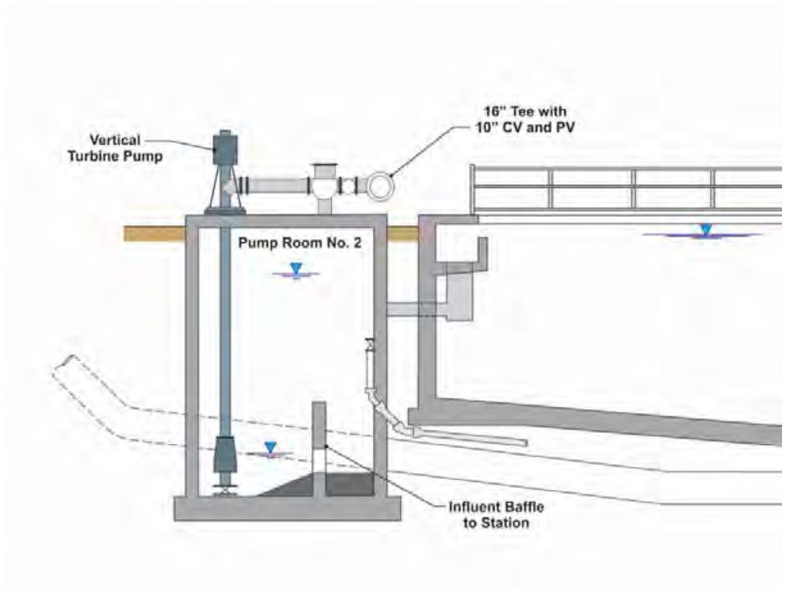
PE EQ: EQ Return Utilizing Existing Infrastructure (SC1-4)

- EQ return using Clarifiers 1-4 drain lines is not feasible
- EQ return using 30-inch influent line
- New wet well at CB3 location
- EQ pumping to drain clarifiers
- Discharge:
  - Interim: Control Box 2
  - Future: New PE splitter box downstream of New PE lift station



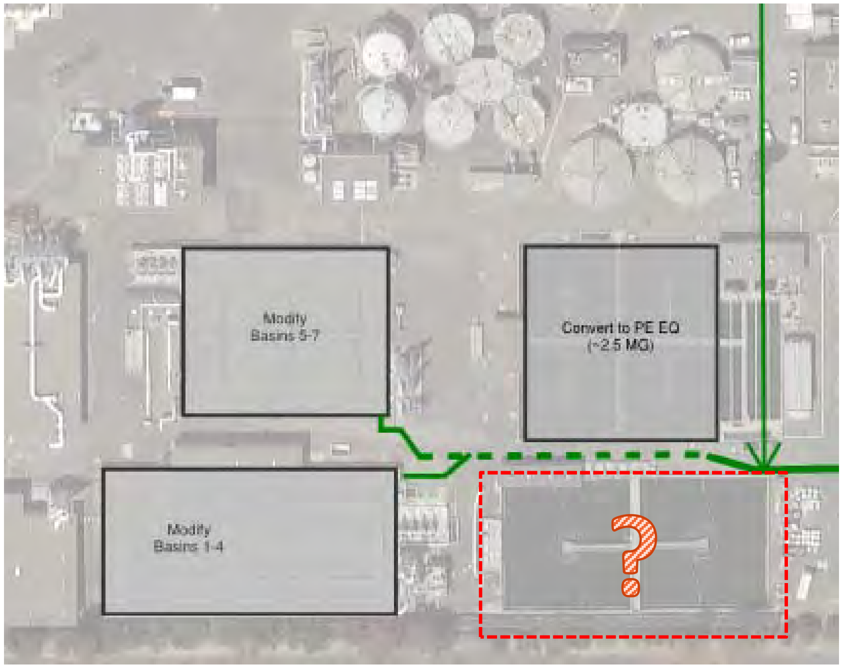
PE EQ: EQ influent flow control and fill (SC1-4)

- PE from CB 2 to proposed wet well
  - 42-inch PE line from PC 1-4 lines connect to
  - 60-inch PE line from PC 5 and 6 end
- Utilize the same 30-inch piping as used for EQ return to fill Clarifiers 1-4
  - Allow for isolation of a given tank volume for cleaning during diurnal operation



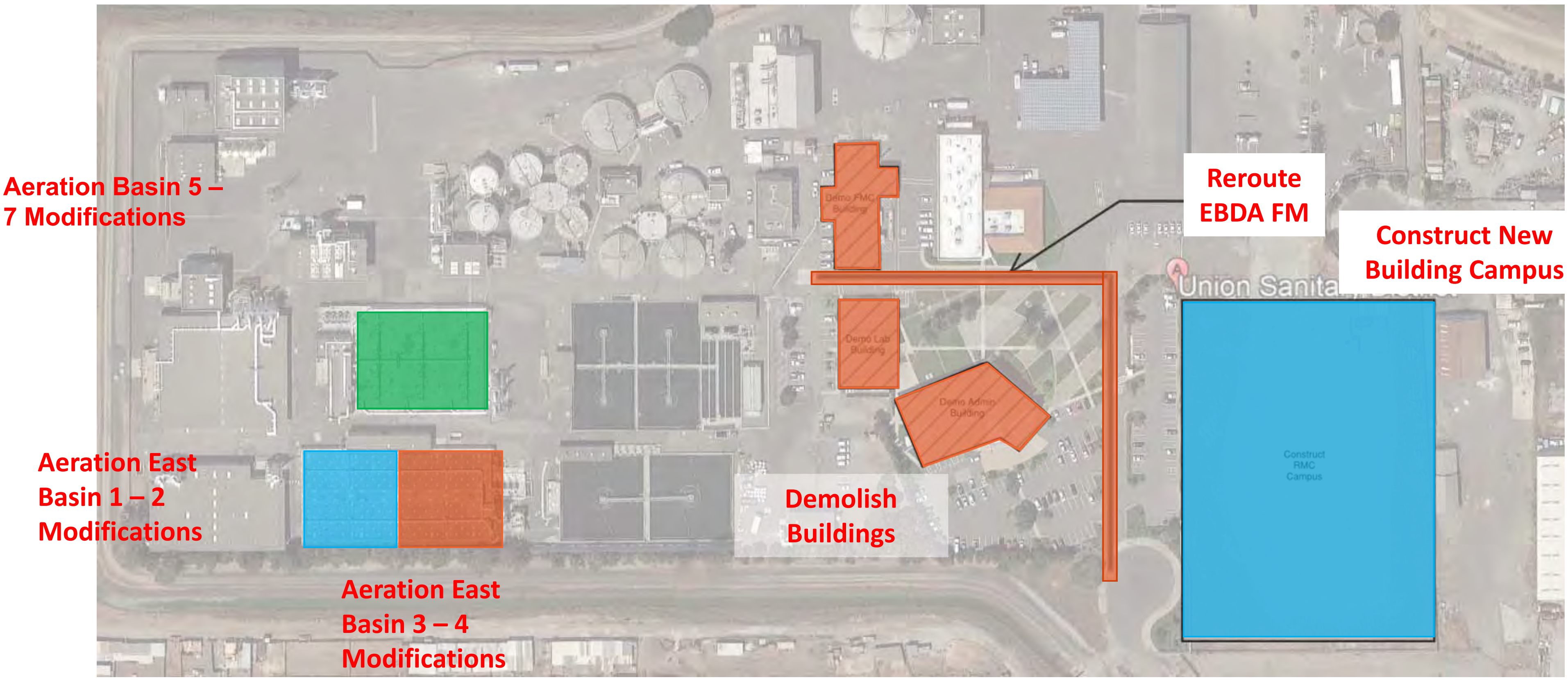
PE EQ: Clarifiers 5 and 6

- Clarifier 5 and 6 volume (2.5 mg) available for PE EQ
- Provides additional process flexibility
- Further evaluation in pre-design / detailed design

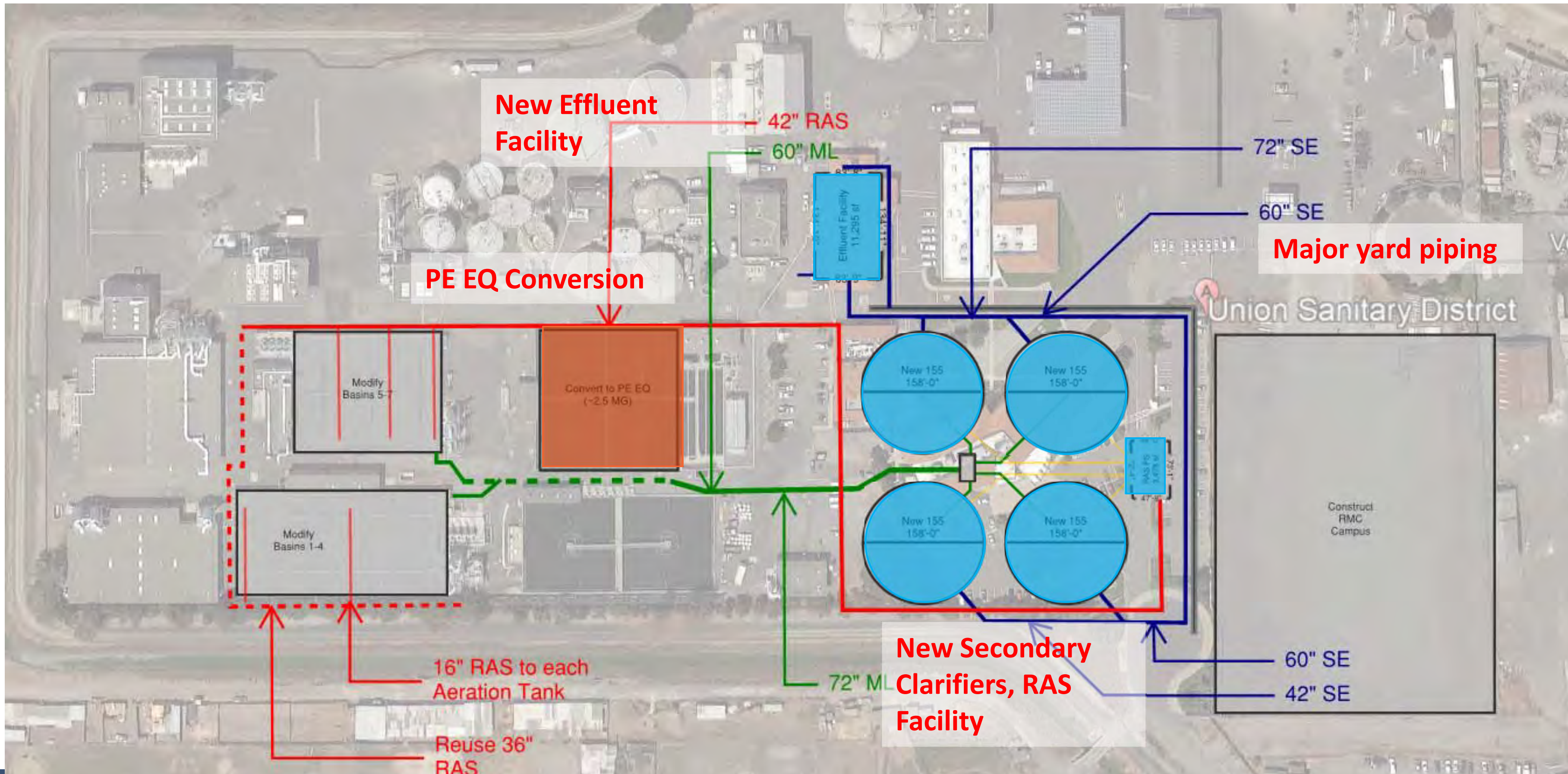


CAS Option 2 Early Clarification - Sequencing

CAS Option 2 Early Clarification – Package 1



CAS Option 2 Early Clarification – Package 1



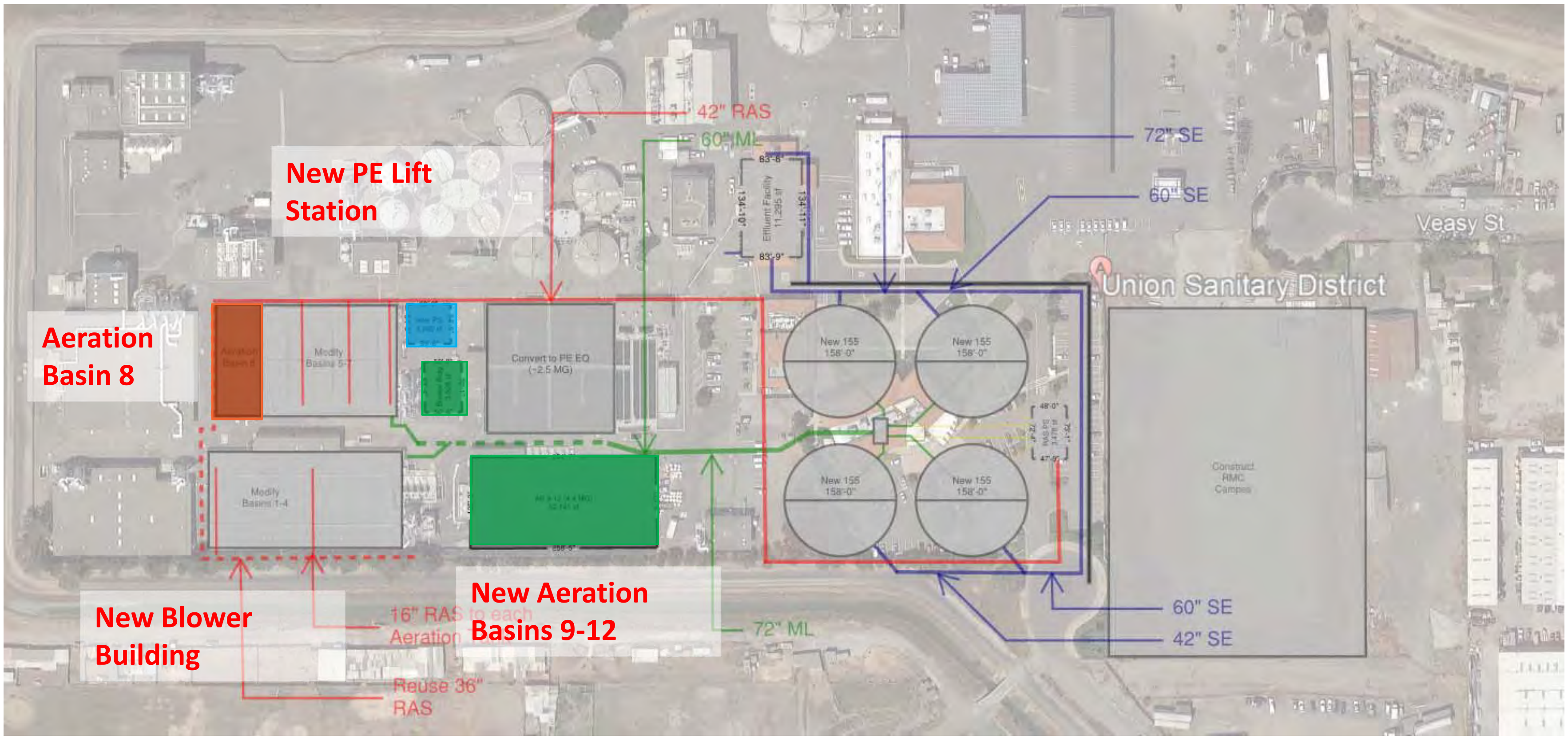
CAS Option 2 – Early Clarification – Package 2

CAS Option 2 Early Clarification Package 2 – Infrastructure Summary

Achieves **BACWA Level 2**

- PE pump station
- PE splitter box
- Blowers
- Blower building
- 5.5 MG new aeration basin volume
  - Same as 5-7 modified configuration
- Chemical P removal
- Sidestream Treatment

CAS Option 2 – Package 2

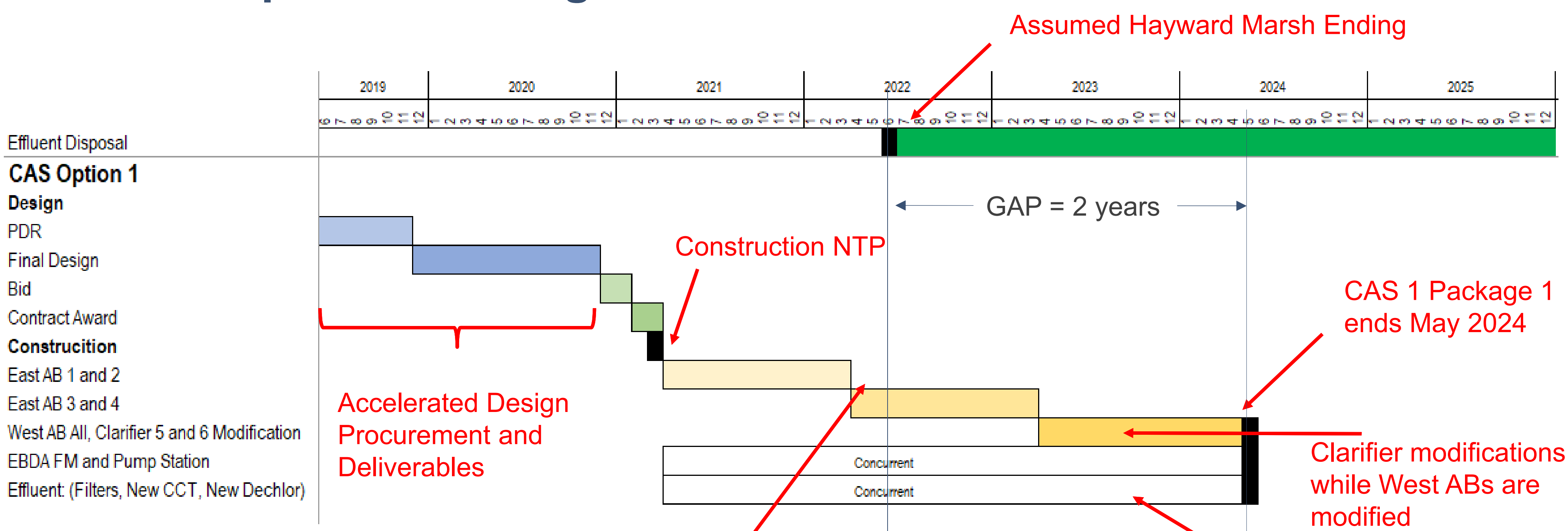


Construction Schedule Comparison

CAS Options – Timing for OAC Discharge

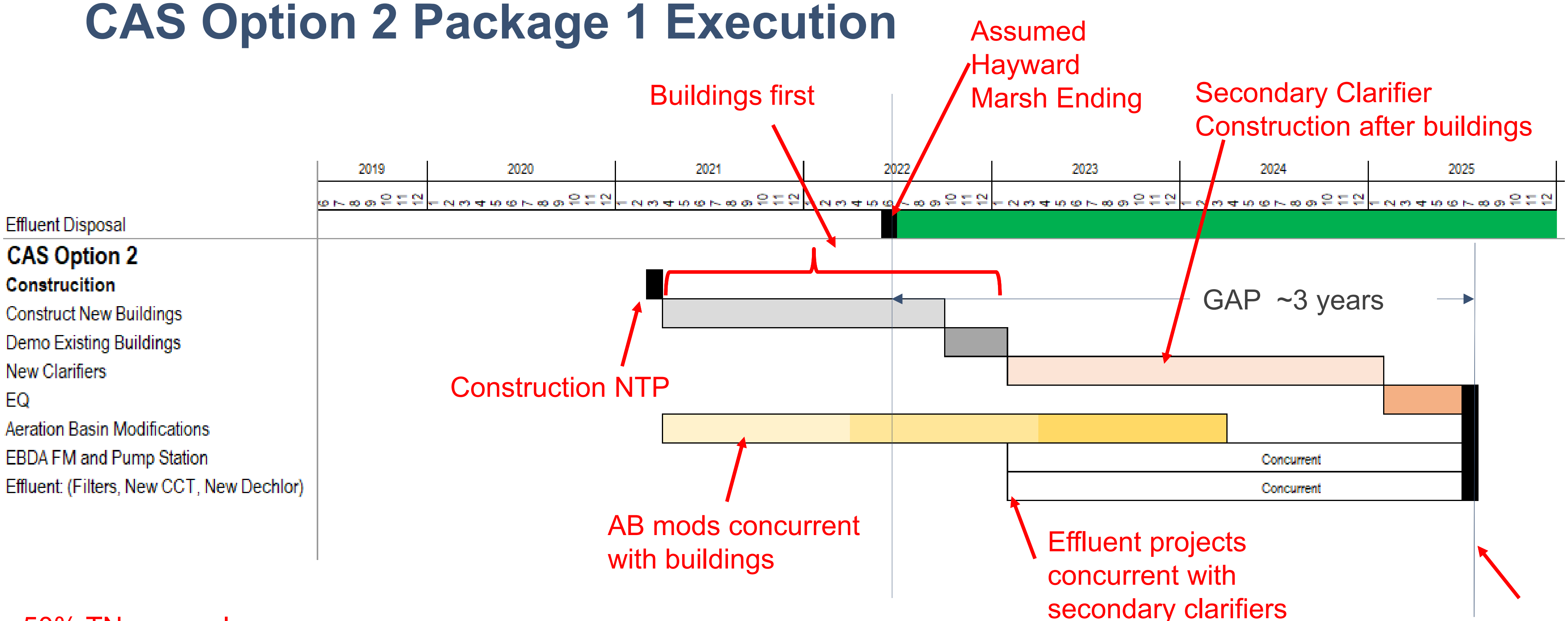
- End of Hayward Marsh Discharge
  - Discussions on when the Hayward Marsh Discharge point will no longer be available are underway
  - Early estimates put this at 2-3 years
  - This accelerated schedule makes timing of package 1 completion **critical**

CAS Option 1 Package 1 – Execution



- 20% TN removal after May 2024
- WW TSS< 15 after Disk Filters online

CAS Option 2 Package 1 Execution



- 50% TN removal after Jul 2025
- WW TSS< 15 EQ

Same Design and Bid Timeline

CAS Option 1 and Option 2 10-year TN Load Reduction

Cumulative nutrient removal 10 years after Hayward Marsh Discharge point is eliminated:

	CAS Option 1 – Two Effluent Qualities	CAS Option 2 – Early Clarification
Design	June 2019	June 2019
Construction Start	Mar 2021	Mar 2021
Construction End	May 2024	July 2025
“GAP”	~2 years	~3 years
Yearly Mass TN Reduction achieved	20%	50%
Years BNR	8 years	7 Years
Annual loads worth of TN removed 10 years after Hayward Marsh ends	1.6	3.5
Ammonia discharge to OAC	Not mitigated (seasonal BNR)	BNR during wet weather

Schedule

The Journey

- March 2018
- July 2018
- March 2019