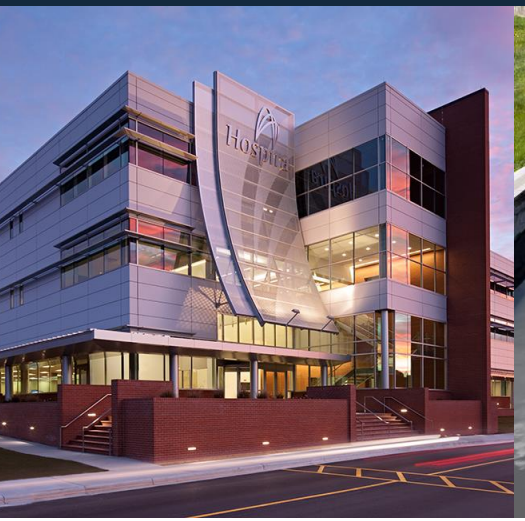

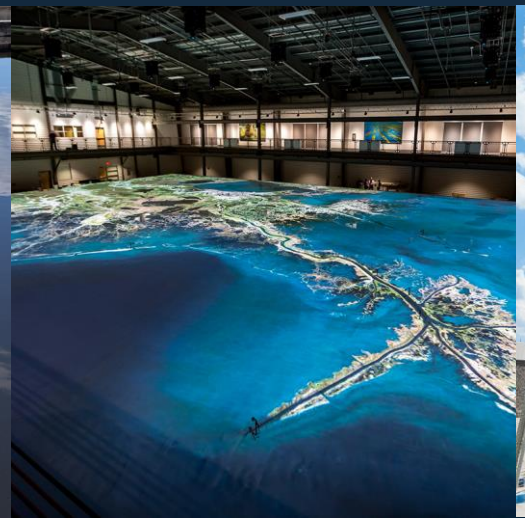


Corpus Christi Water

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# Oso WRP Process Conversion and Upgrades (An O&M Perspective)

January 27, 2023

# Today's Objective

- Review Background
- Project Goals
- Overview of Improvements by Treatment Unit
- How O&M Perspective guided the design

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# Oso WRP Background

- Constructed in 1941
- 5 major plant upgrades since
- Largest WWTP in Corpus Christi
- Growing service area
- Current Capacities:
  - 16.2 MGD ADF
  - 98 MGD Peak 2hr

- Discharge Permit since 2013
  - 20 mg/L BOD
  - 20 mg/L TSS
  - 4 mg/L NH3


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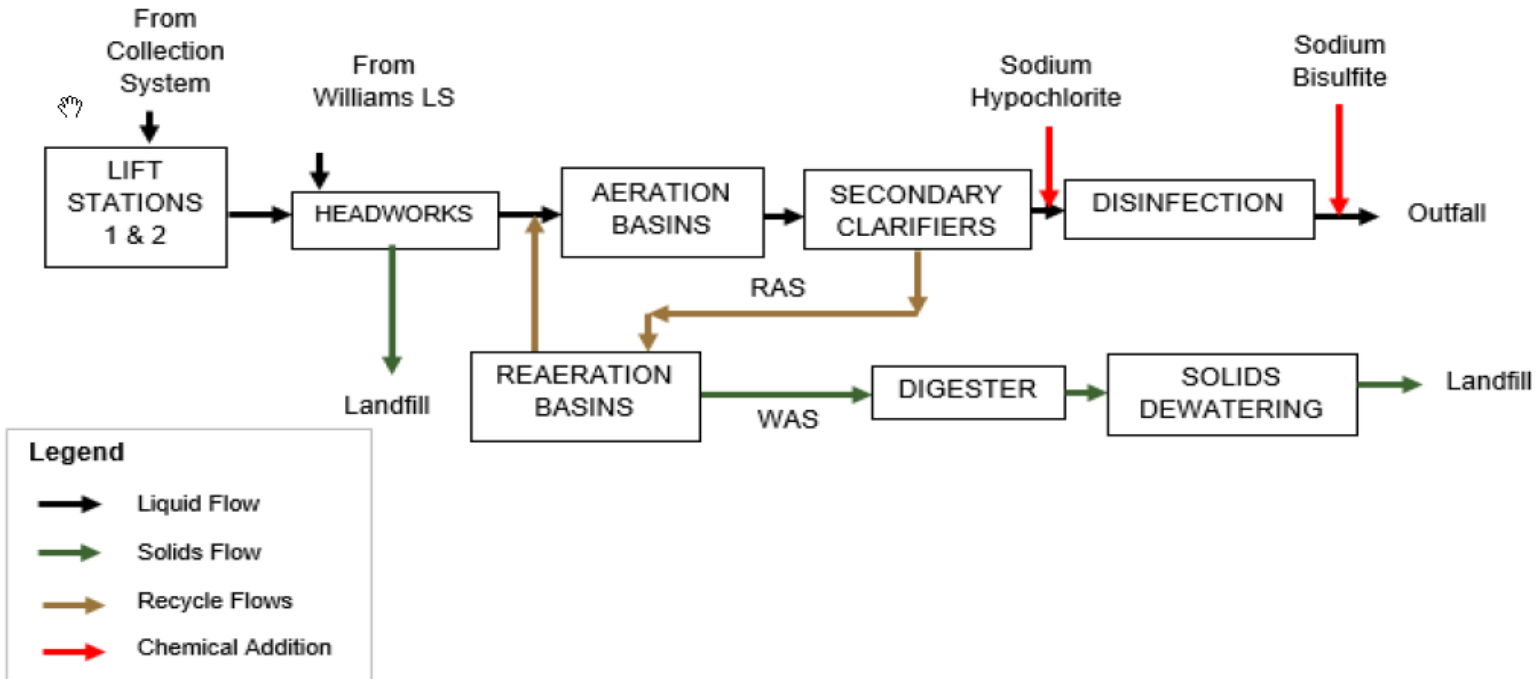
# Existing Process

- Contact stabilization
- Removes BOD efficiently but…..
  - Short SRT → limited nitrification
  - Prohibited by TCEQ as stand-alone process for NH3 removal
- Breakpoint Chlorination added in 2013

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# Issues with Existing Process

- Very limited nitrification capabilities
- Inefficient and aged air system
- O&M challenges:
  - Unable to perform AB O&M:  ADF 12 MGD > 8.1 MGD/ea train
  - BPC requires significant staff attention & monitoring
  - High risk associated with de-chlorination
- O&M Costs - BPC chemicals and aeration electrical power

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# Project Goals

| Goal | Why? |
| --- | --- |
| 18 MGD capacity – 3rd Train | Currently at 75% capacity and growing service area |
| Replace BPC system with BNR | Cost savings and reduced risk |
| Replace disinfection equipment | Exceeded design life and reduced capacity required |
| Replace aged and inefficient aeration equipment | Cost savings and reduced maintenance |
| Upgrade clarifier equipment | Reduce O&M efforts required to maintain service |

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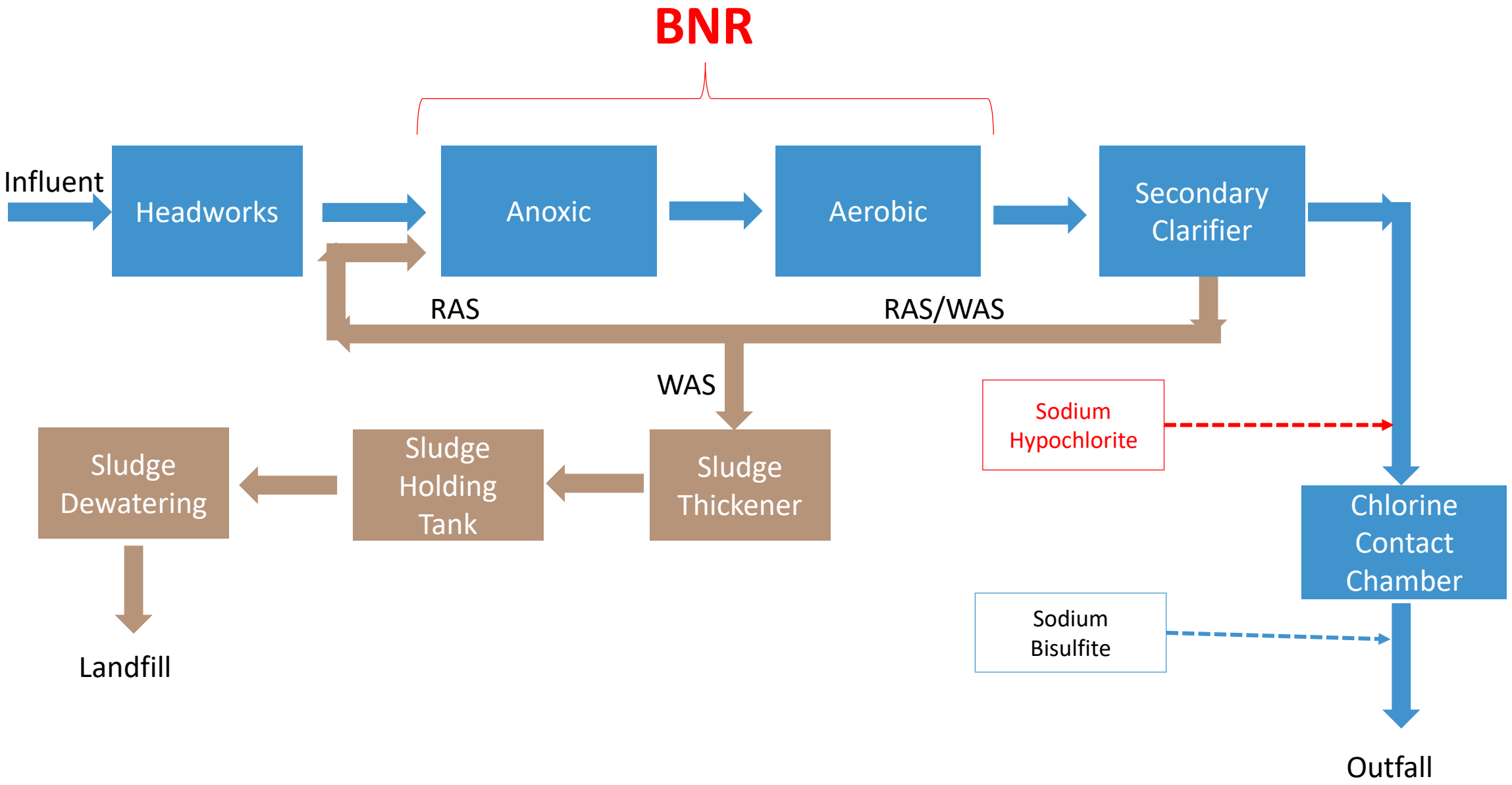
# Proposed Process

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# Key Improvements & O&M Considerations

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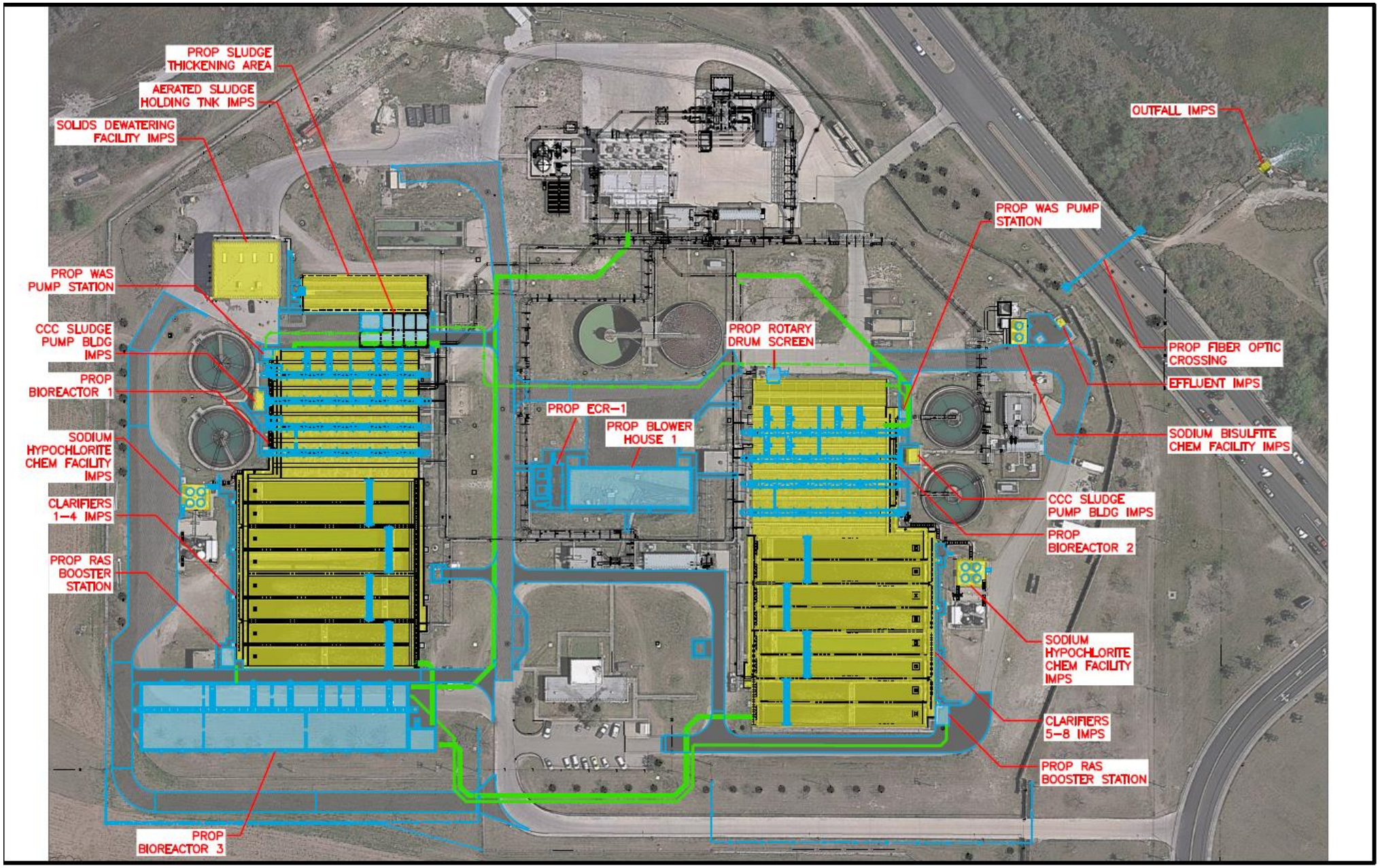
# Overall Site Layout

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# Bioreactors 1, 2 & 3

- Provide BNR and 18 MGD capacity
  - Retrofit E/W Aeration Basins → Bioreactors 1 & 2
  - New Bioreactor 3
  - Fine bubble diffusers
  - Hyperbolic mixers
  - IMLR pumps
- Access walkways with appurtenances
  - Hose bibs
  - Power outlets
  - Lighting


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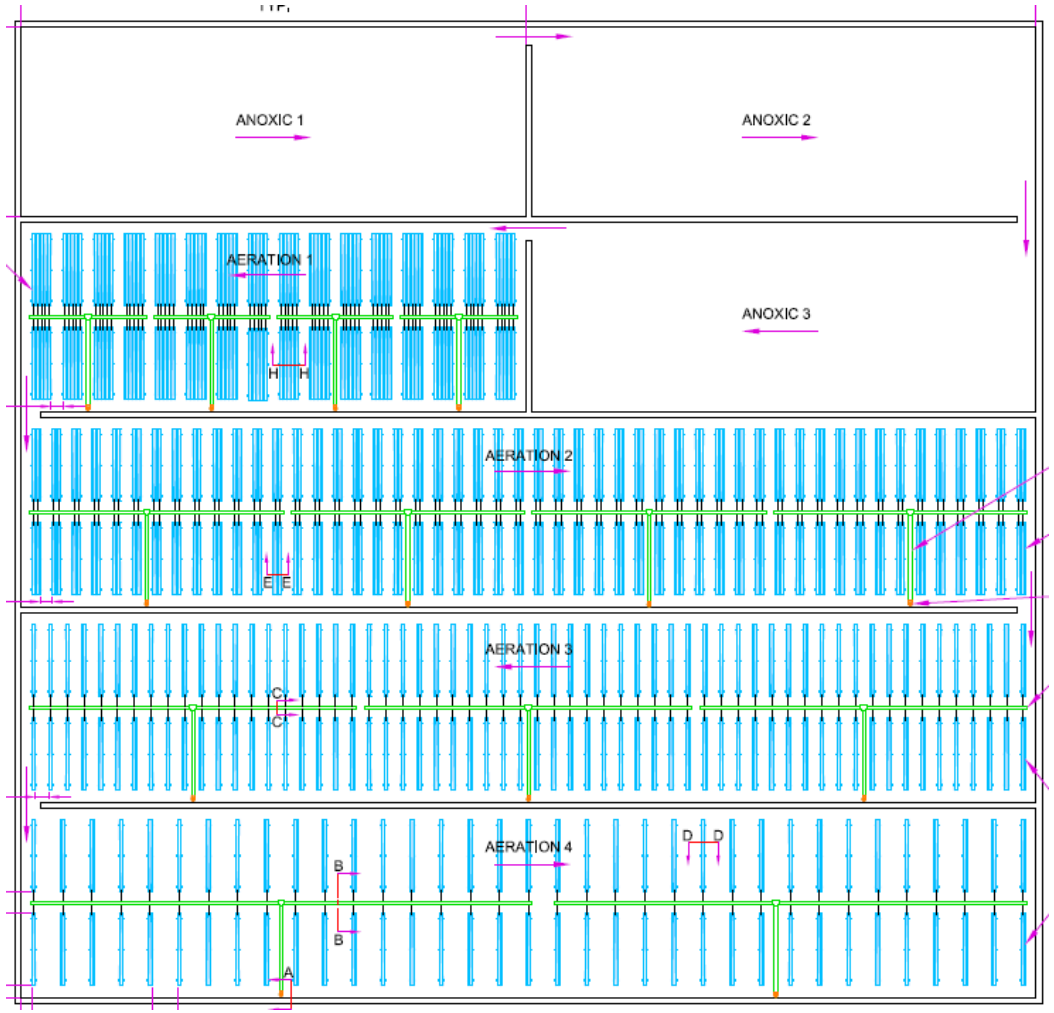
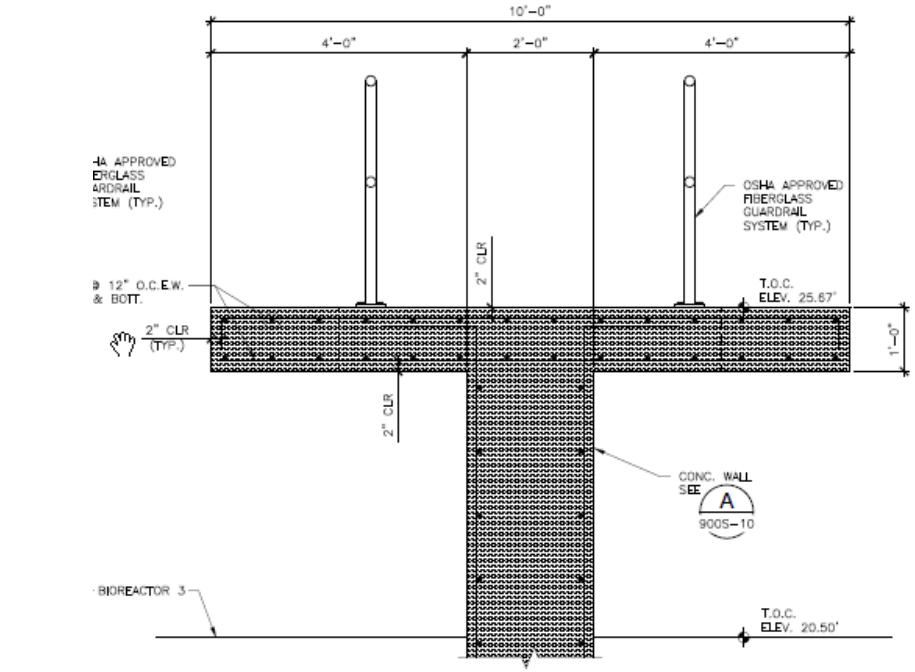
# Bioreactors - O&M Considerations

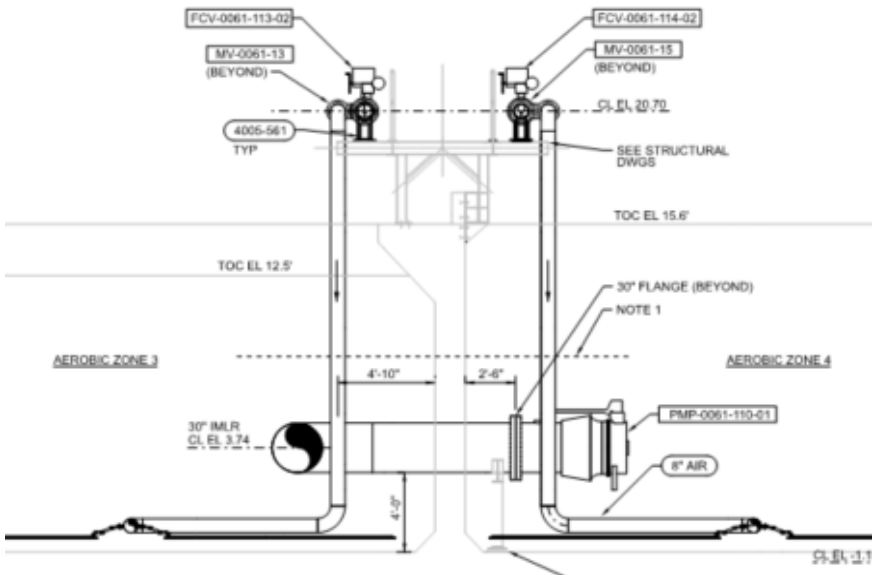
- Strip diffusers
  - 1,600 strips <<<<< 11,000 discs
  - Apprx 40% more energy efficient
  - Varied diffuser density
- 3 Bioreactors
  - Allows for taking a train offline
- Air Piping Design
  - Meters air flow measurement & monitoring
  - Modulating FCV for operational flexibility
  - Isolation capability for maintenance & inspection
- DO sensors for process optimization
- SCADA
  - Operator feedback on system control and performance



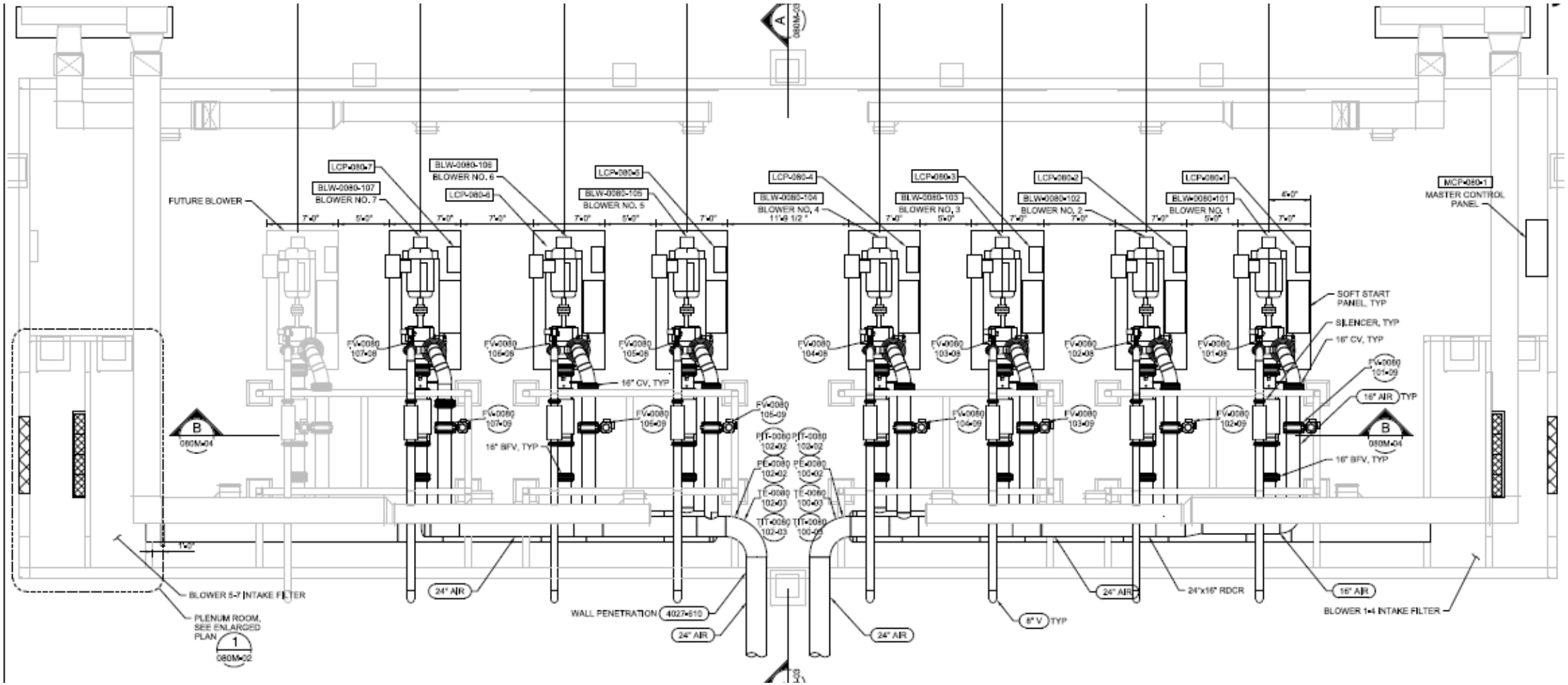
# Bioreactors – Other O&M Considerations

- Provide draining capability for maintenance
- Walkway and equipment access
  - Provided 10ft wide walkways with removable handrails
  - Access to each mixer
- Lighting along walkway railings and equipment
- FRP grating to reduce corrosion
- Reduce tripping hazard with diffuser piping layout
- Adequate hose bib connections and racks for washdown and hose storage



# Blower House 1 - Overview



# Blower House 1 – O&M Considerations

- Blower redundancy:  5 duty + 2 standby units

- Geared centrifugal type blowers
  - Operator familiarity (Allison WWTP)
  - Improved reliability
  - Proximity of service provider
  - Improved efficiency

- Filter rooms for simple filter replacement

- Separate air system for BRs (fine bubble) and sludge holding tanks (coarse bubble)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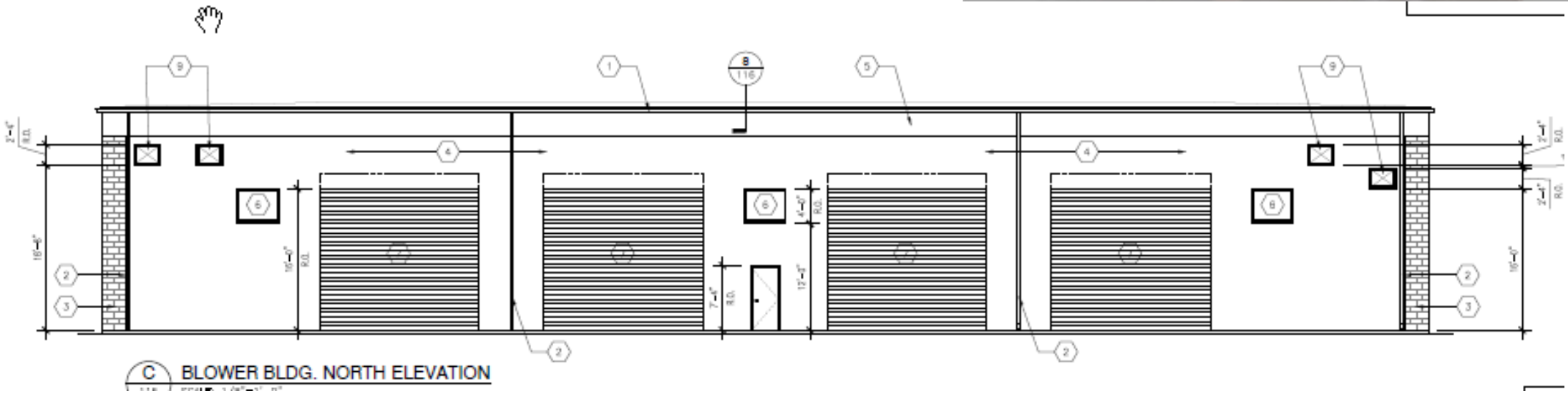
# Blower House 1 - O&M Considerations

- Access-access-access
  - 7’ blower spacing
  - 14’ access corridor inside building
  - Large 18’ W x 16’ H rollup doors for crane truck access
  - Raised building ceiling to accommodate boom reach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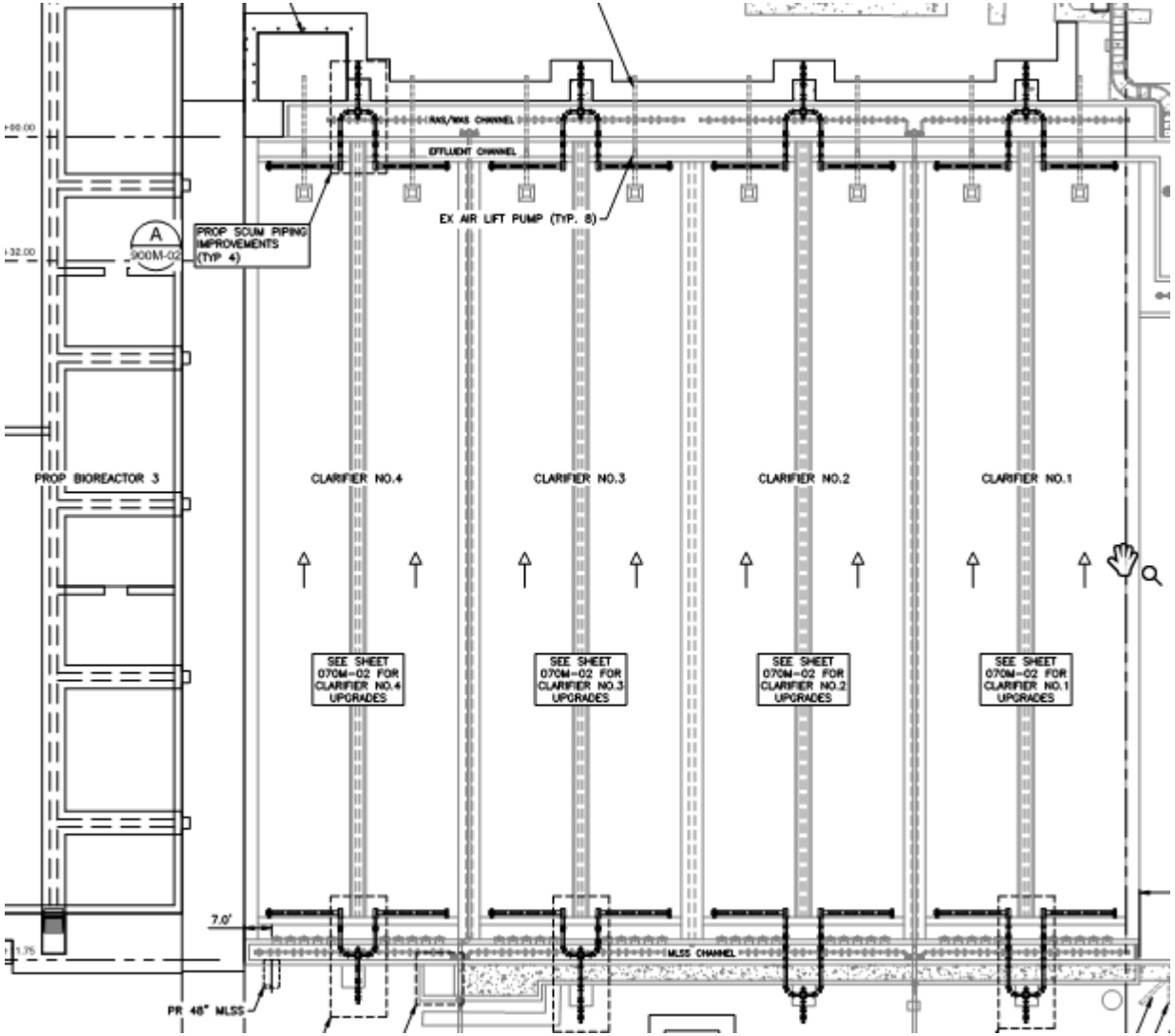
# Secondary Clarifiers - Overview

- Traveling bridge replacement
- Scum system replacement



# Secondary Clarifiers – O&M Considerations

- New traveling bridges with improved functionality
  - Line shaft drive with a cog wheel and track system to decrease alignment failures
  - Replace festoon cables with conductor bar power supply for decreased emergency failures (high winds)
  - Replace hydraulic drive system with electric driven system
- Replace automatic and spray skimming with manual scum skimming system
- RAS and WAS flow measuring capabilities for process control

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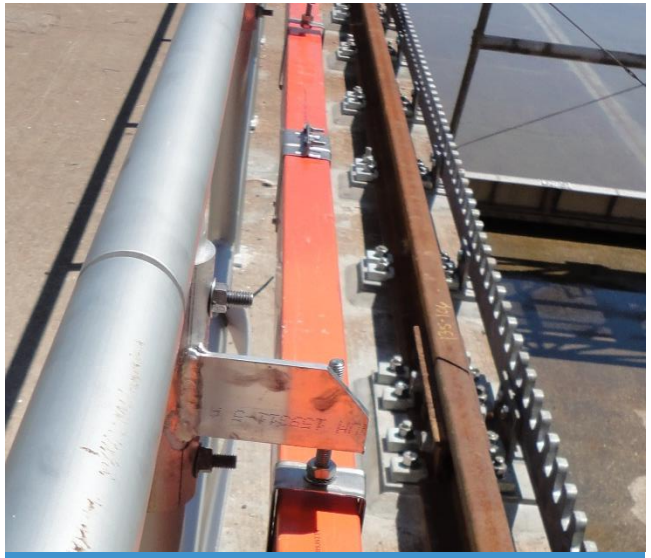
# Traveling Bridge Components

Traveling Bridge



Rail and Cog Track

Line Shaft Drive

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# Secondary Clarifiers – Other O&M Considerations

- Submerged Effluent Launder (SEL) System
  - Equipped with electrically actuated gates
  - Eliminates need for launder covers
  - Minimizes algae growth
  - Reduced flow short circuiting
- Repair clarifier drain system for maintenance
- Simplified slotted pipe skimmers equipped with a handwheel operator
- Provide redundant scum transfer pumps (1 duty + 1 standby)
- Redundant drum screen system

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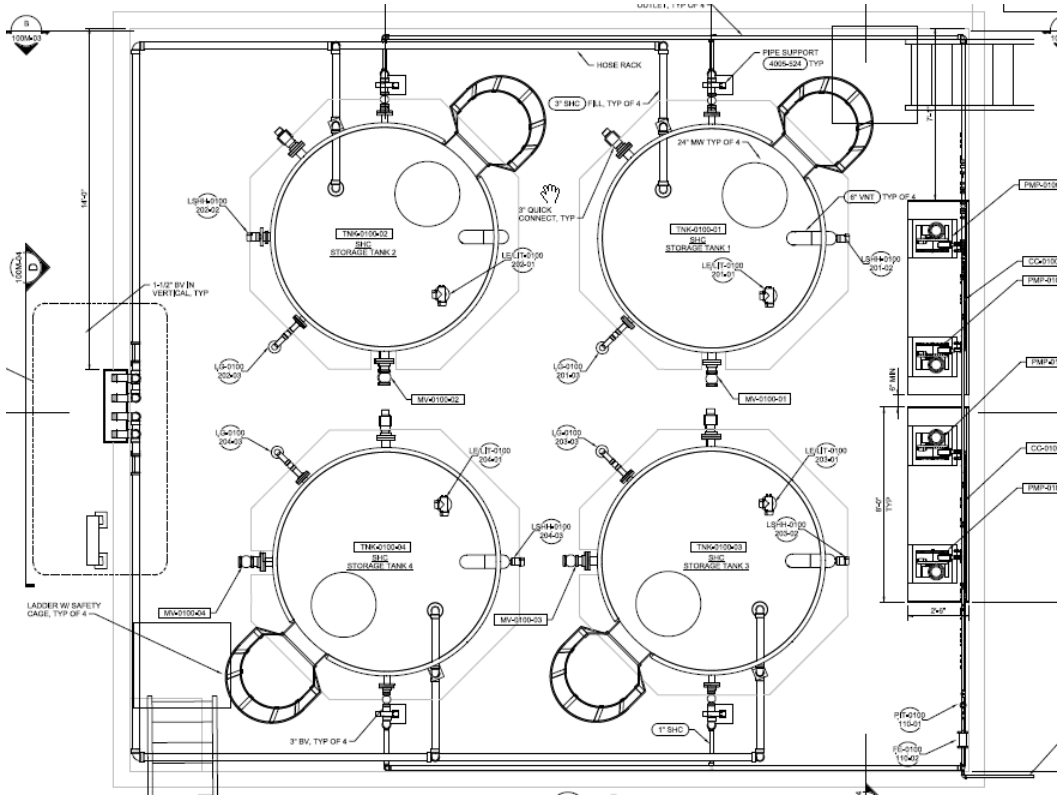
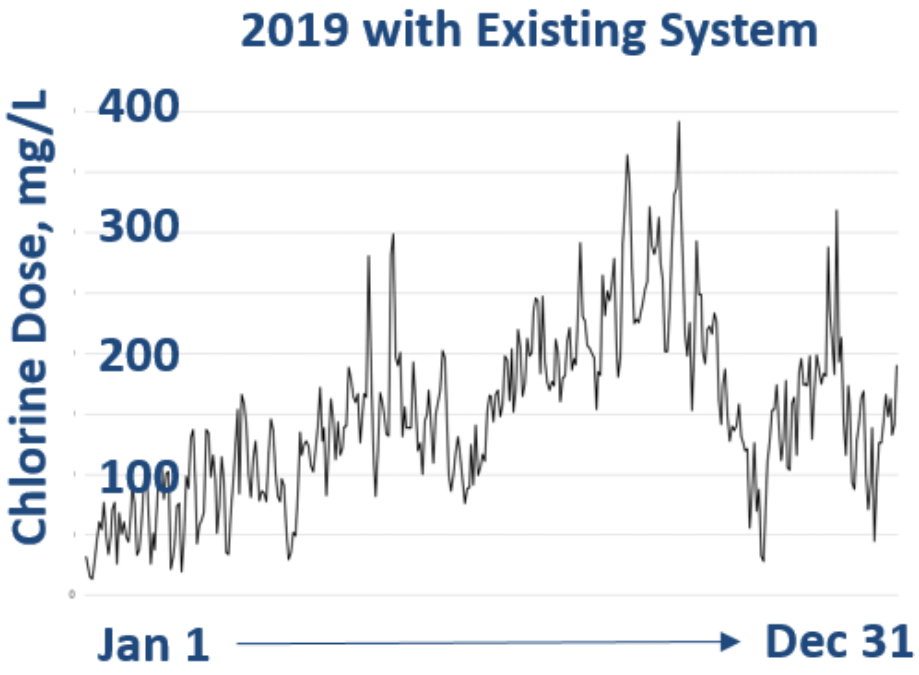
# Disinfection Systems

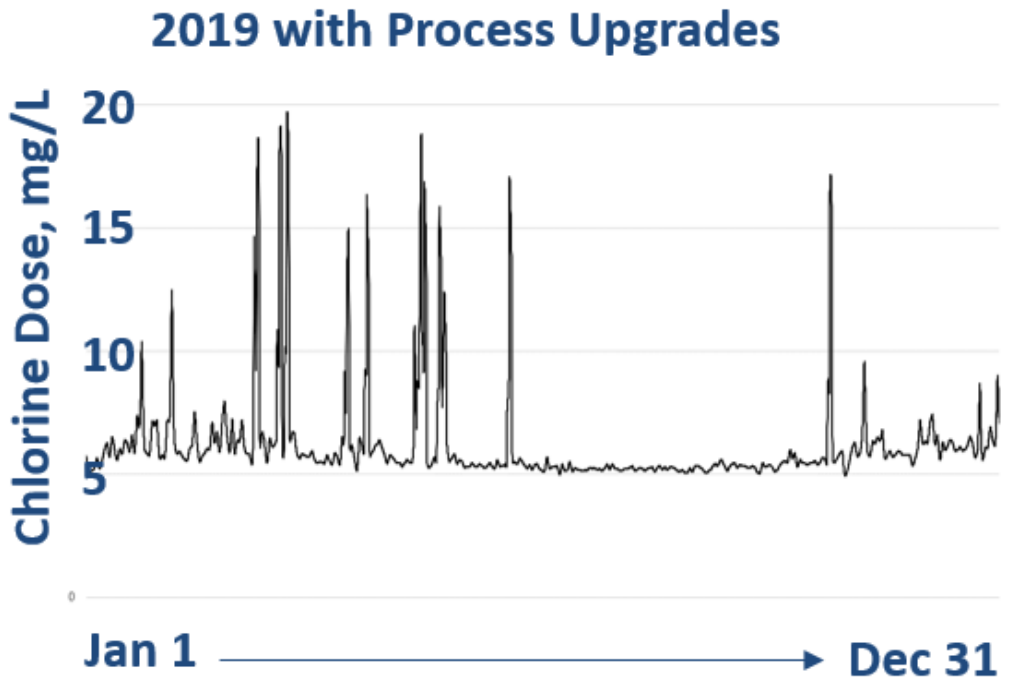
- Significant Cl demand reductions with BNR
- Decommission existing BPC system
- FRP storage tanks for sodium hypochlorite and sodium bisulfite
  - Poor history of poly tank reliability
- New NaClO feed pumps: 2 duty, 2 standby per train
- New NaHSO3 feed pumps: 1 duty, 1 standby



# Current vs Proposed Disinfection Systems

| Parameter | Cl2 Dose (mg/L) | Free Cl2 Residual (mg/L) | Cost ($/year) |
|---|---|---|---|
| Current Disinfection System - BPC | 13 - 110 | 1.5 | $1.9M |
| Proposed Disinfection System with BNR | 6.0 | 1.5 | $0.2M |
| | | **Approximate Savings per Year** | **$1.7M** |

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# Solids Thickening System – O&M Considerations

- 3 Units: 2 Duty + 1 Standby
  - Slot for future unit
- Operates automatically with WAS Pumps
- Piping configuration allows for emergency WAS storage
- Pressure sustaining valve at ASHT1 for operational flexibility
- Unmanned operation: 24/7
- Forklift access to polymer totes
- Maintenance truck access to thickeners

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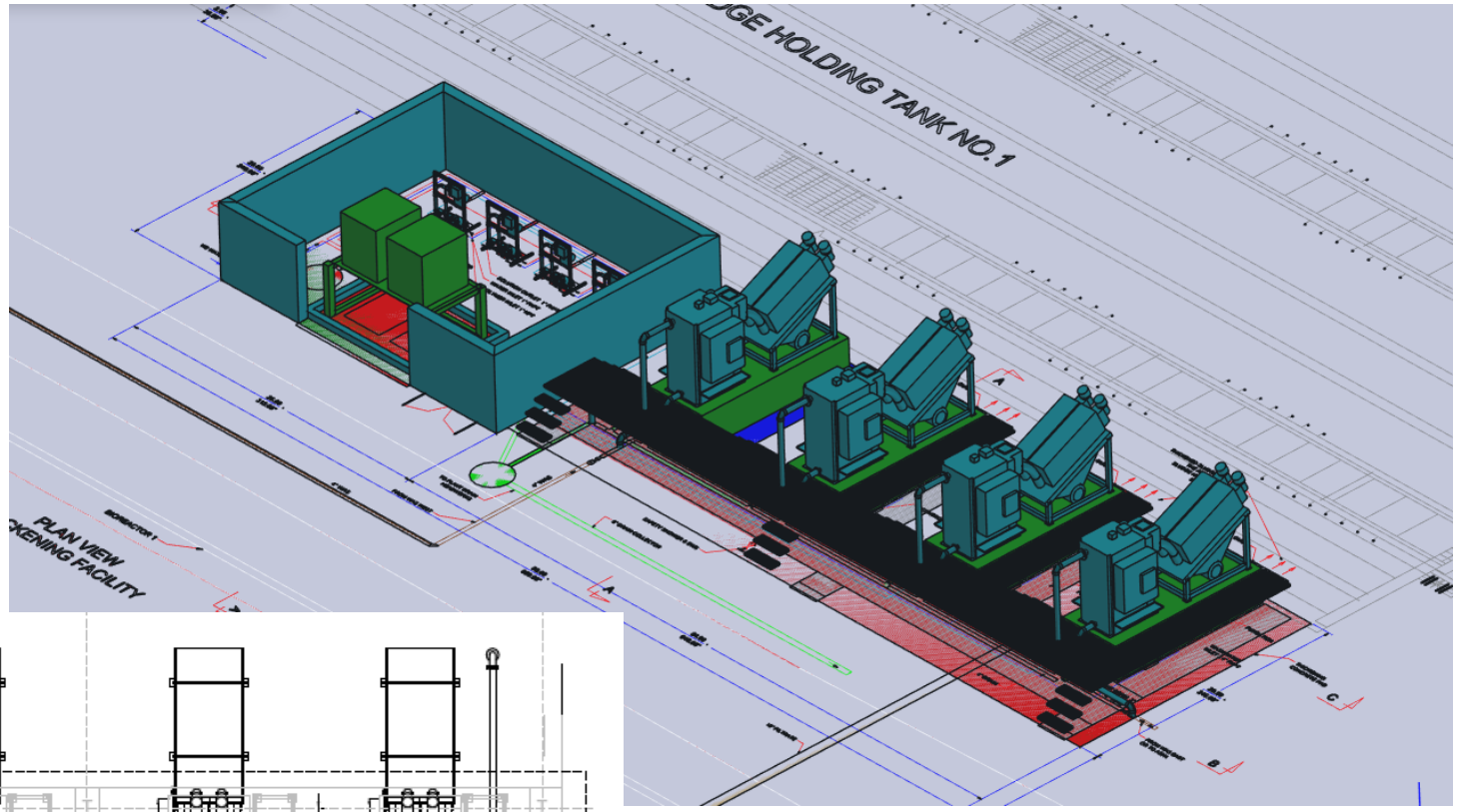
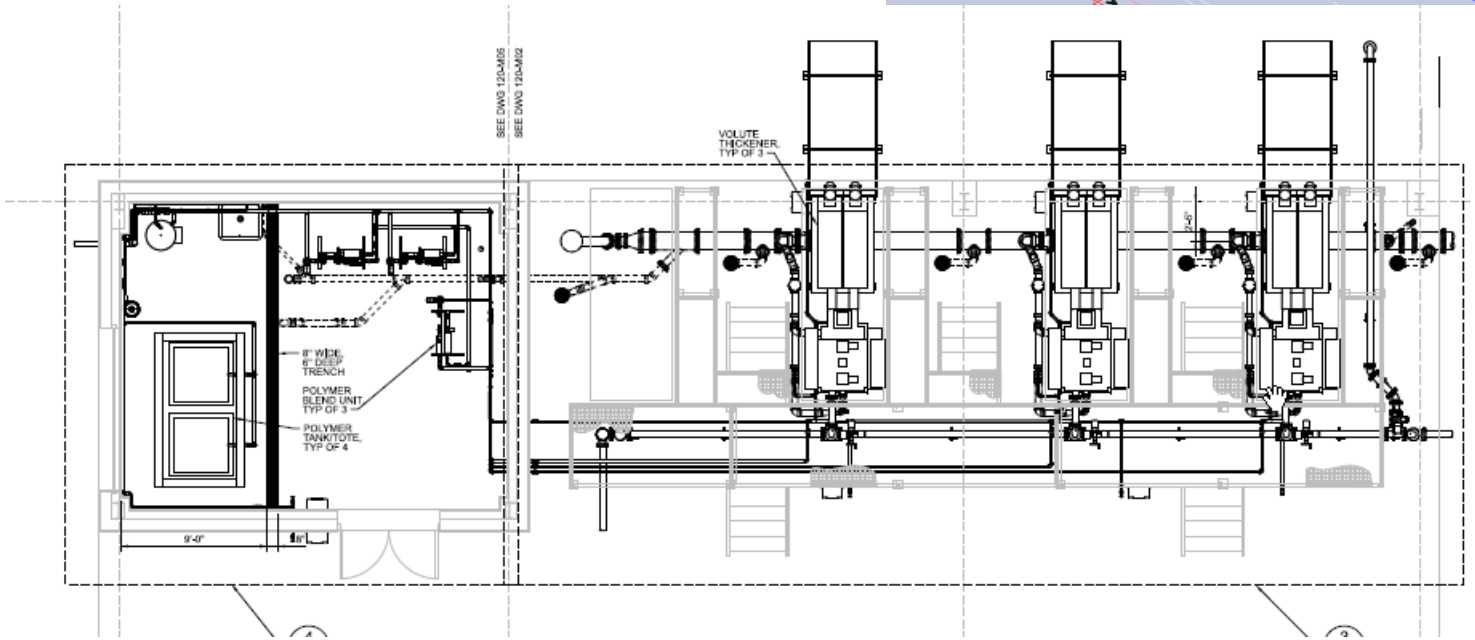
# Sludge Thickening Layout



# Solids Dewatering System – O&M Considerations

- 3 Units: 2 Duty + 1 Standby
  - Slot for future unit
- Piping arrangement eliminates single pt failure (TWAS to any unit)
- Decreased operating time required
  - 2 Unit Operation (Design): 11.2 hrs/day, 5 days/week operation
  - 3 Unit Operation (Emergency): 7.5 hrs/day, 5 days/week operation

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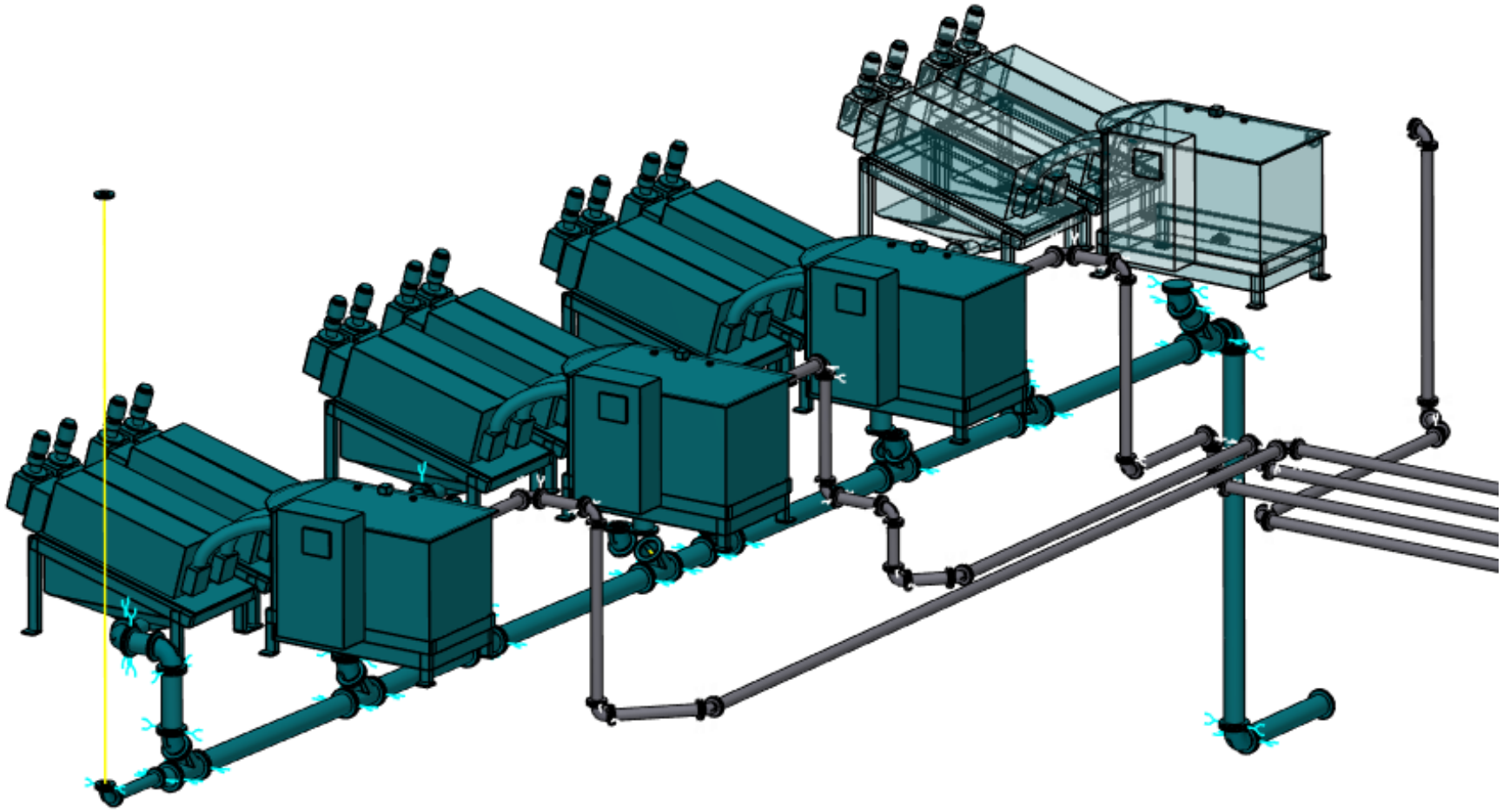
# Solids Dewatering Layout



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# Thanks To Our Partners


**City of Corpus Christi Utilities**

Daniel Deng

Earl Richardson

Freddy DeLeon

Sandra Gomez

JACOBS

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# Questions?

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# Additional Slides



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# TPDES Permit

# Current Permit

- Issued on April 29, 2011
- Permit renewal application pending (submitted in December 2013)
- Revised Blind Oso Bay DO standards - Adopted  by TCEQ – Feb 7, 2018
- No more hurdles for renewing/amending Oso WRP TPDES permit.

| Parameter | Unit | 30-day Avg. | 7-day Avg. | Daily Max. |
|---|---|---|---|---|
| CBOD | mg/L | 20 | 30 | 45 |
| TSS | mg/L | 20 | 30 | 45 |
| Ammonia-Nitrogen | mg/L | 4.0 | 6.0 | 10.0 |
| Chlorine Residual | mg/L | N/A | N/A | 0.1 |
| Minimum DO | mg/L | 5.0 | 5.0 | 5.0 |
| pH | standard units | 6.0 to 9.0 | 6.0 to 9.0 | 6.0 to 9.0 |
| Enterococci | (CFU/100 ml) | 35 | N/A | 89 |

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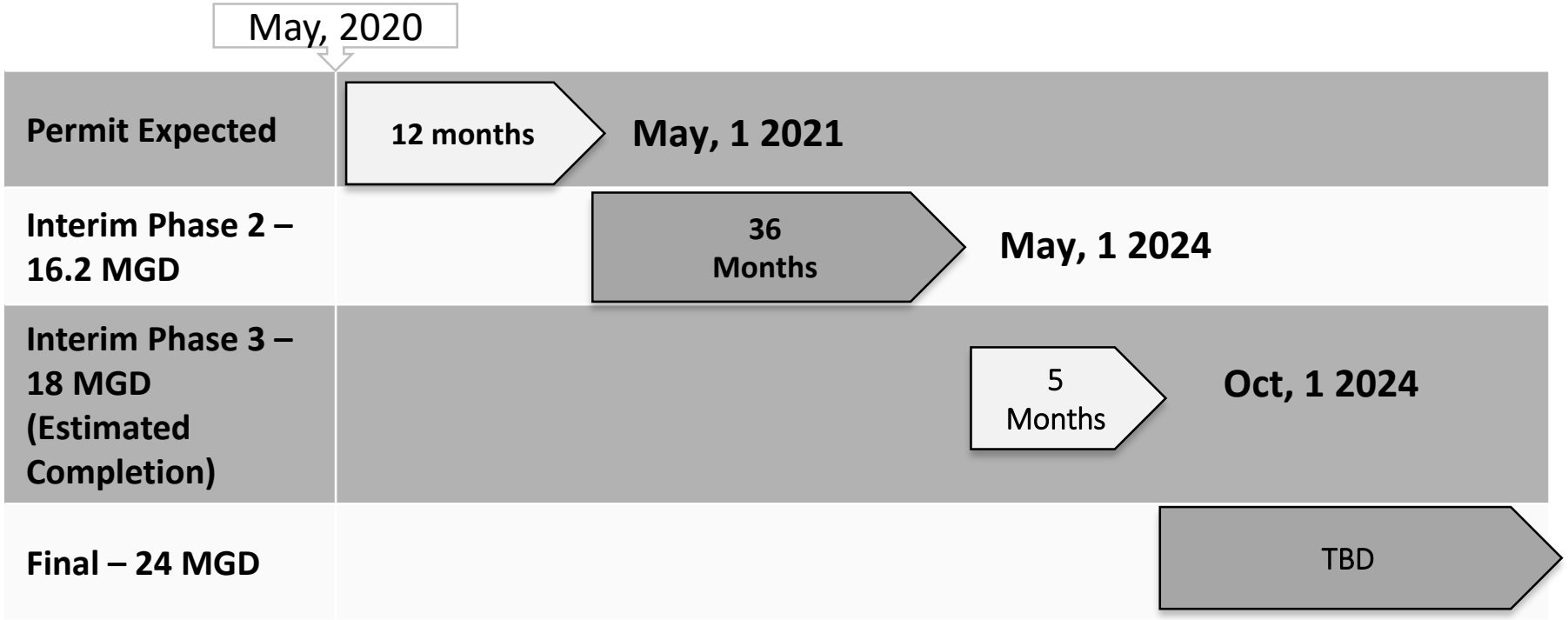
# Project Driver

- **Anticipated Permit Limits and Schedule**

| Proposed Phase | Flow (MGD) | CBOD (mg/L) | TSS (mg/L) | NH3 (mg/L) | DO (mg/L) |
|---|---|---|---|---|---|
| Interim Phase 1 | 16.2 | 20 | 20 | 4 | 5 |
| Interim Phase 2 | 16.2 | 7 | 15 | 2 | 6 |
| Interim Phase 3 | 18 | 7 | 15 | 2 | 6 |
| Final | 24 | 7 | 15 | 2 | 6 |

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# Design Criteria

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# Design Flows and Loadings

| Flow Parameter | Value |
|---|---|
| Historical Average Flow (MGD) | 12 |
| Standard Deviation of Daily Flows (MGD) | 2.5 |
| Average Flow + 1 Standard Deviation (MGD) | 14.5 |
| Design Average Flow for Phase 2 Upgrade (MGD) | 18 |
| Design Peak Flow for Phase 2 Upgrade (MGD) | 98 |

| Parameter | Design | | Data, lbs/d (date) |
|---|---|---|---|
| Minimum Daily Flow (MGD) | 9.7 | | - |
| Average Daily Flow (MGD) | 18 | | - |
| Peak 2-Hr Flow (MGD) | 98 | | - |
| BOD (MM lbs/d, mg/L@ ADF) | 39,800 | 265 | 31,200 (Mar 2015) |
| TSS (MM lbs/d, mg/L@ ADF) | 39,000 | 260 | 30,000 (May 2019) |
| TN (MM lbs/d, mg/L@ ADF) | 8,400 | 56 | 5,500 (est.) |
| $NH_3$ (MM lbs/d, mg/L@ ADF) | 5,600 | 37 | 3,660 (Dec 2019) |
| Alkalinity (as CaCO3) (mg/L) | 300 | | - |
| Min Mixed Liquor Temperature (°C) | 18 | | - |
| Max Mixed Liquor Temperature (°C) | 27 | | - |

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# Bioreactors 1 & 2 - Basis of Design

| Zone Description | Sidewater Depth | Zone Width | Zone Length | Zone Volume | Organic Loading | Organic Loading | Aerobic SRT | MLSS |
|---|---|---|---|---|---|---|---|---|
| - | ft | ft | ft | MG | lbs BOD/d | lbs BOD/d/1000cf | days | mg/L |
| Anoxic Zone 1 | 15.7 | 30.0 | 80.0 | 0.28 | – | – | – | 3,900 |
| Anoxic Zone 2 | | 30.0 | 80.0 | 0.28 | | | | |
| Anoxic Zone 3 | | 30.0 | 80.0 | 0.28 | | | | |
| Aerobic Zone 1 | | 30.0 | 80.0 | 0.28 | | | | |
| Aerobic Zone 2 | | 30.0 | 160.0 | 0.56 | | | | |
| Aerobic Zone 3 | | 30.0 | 160.0 | 0.56 | | | | |
| Aerobic Zone 4 | | 30.0 | 160.0 | 0.56 | | | | |
| Single Bioreactor | 15.7 | 150.0 | 160.0 | 2.82 | 13,259 | 35.2 | 5.0 | 3,900 |

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# Bioreactor 3 - Basis of Design

| Zone Description | Sidewater Depth | Zone Width | Zone Length | Zone Volume | Organic Loading | Organic Loading | Aerobic SRT | MLSS |
|---|---|---|---|---|---|---|---|---|
| - | ft | ft | ft | MG | lbs BOD/d | lbs BOD/d/1000cf | days | mg/L |
| Anoxic Zone 1 | 15.7 | 30.0 | 80.0 | 0.28 | – | – | – | 3,900 |
| Anoxic Zone 2 | | 30.0 | 80.0 | 0.28 | | | | |
| Anoxic Zone 3 | | 30.0 | 80.0 | 0.28 | | | | |
| Aerobic Zone 1 | | 77.0 | 73.0 | 0.66 | | | | |
| Aerobic Zone 2 | | 46.5 | 121.0 | 0.66 | | | | |
| Aerobic Zone 3 | | 46.5 | 121.0 | 0.66 | | | | |
| Total | 15.7 | 43.4 | 555.0 | 2.82 | 13,259 | 35.1 | 5.0 | 3,900 |

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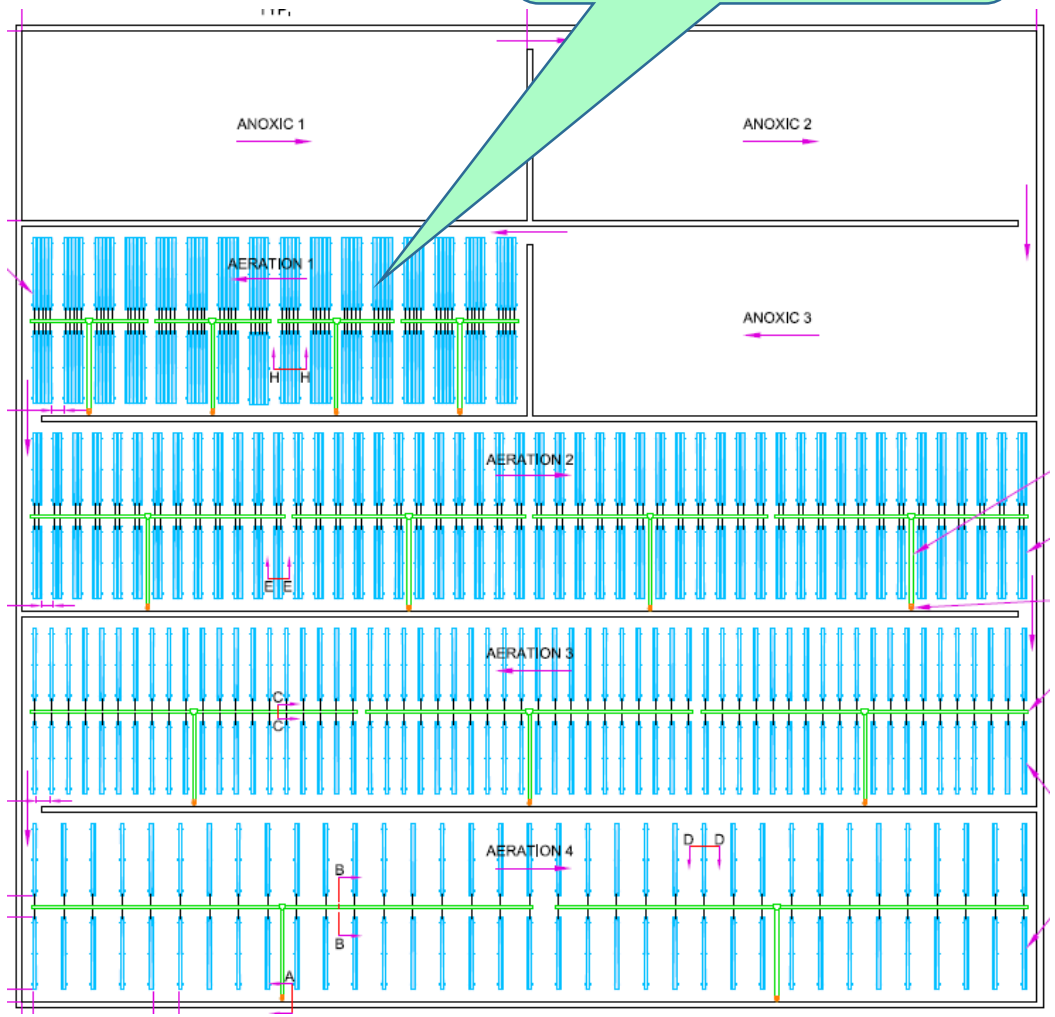
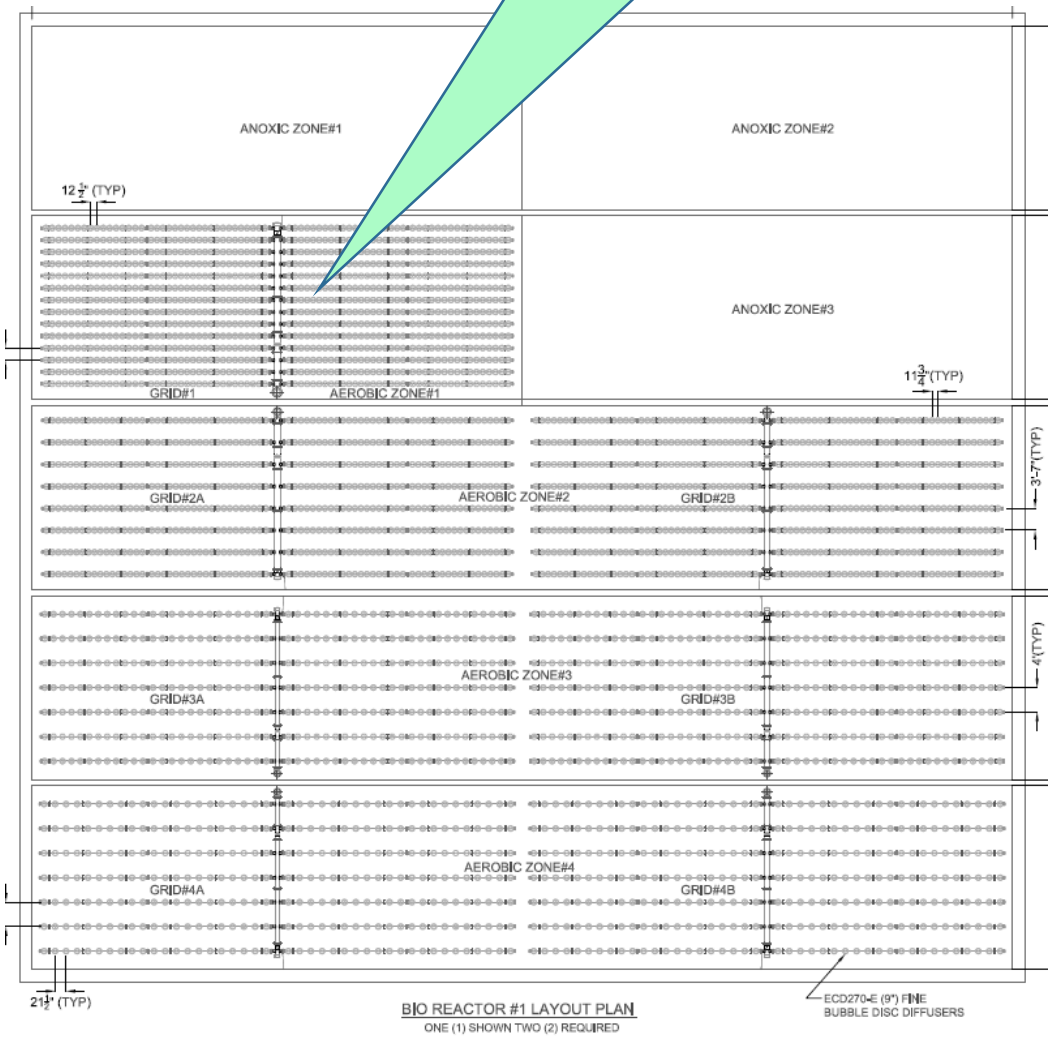
# Bioreactors - O&M Considerations

**Ovivo USA LLC:**
**1600# Strip Diffusers**




**Sanitaire, Aquarius:**
**11000# Disc Diffusers**

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# Process Modeling

# Process Modeling & Calibration

- **Biowin Modeling Steps**
  - Calibration
  - Model Scenarios
    - *Steady-state maximum month load*

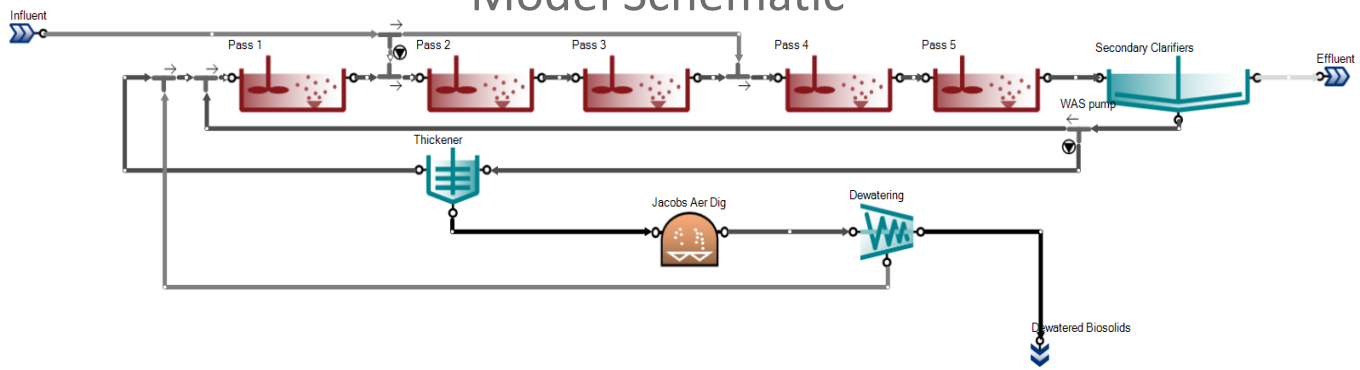
***--- Effluent quality, Existing and New AB Reconfigurations/Sizing***

    - *Dynamic 1-year influent itinerary*

***---- Year 2015 wet and high loading event on effluent Nitrate and TN***

    - *Dynamic 4-day 98 MGD peak flow event*

Model Schematic




Calibration Results

| Parameter | Model | 2019 Data |
|---|---|---|
| MLSS, mg/L | 3400 | 3400 |
| MLVSS, mg/L | 2500 | 2630 |
| Dewatered Biosolids, lbs/d | 16,500 | 15,900 |
| Effluent TSS, mg/L | 5 | 9 |
| Effluent $BOD_5$, mg/L | 2 | 7 |
| Effluent $NH_3$, mg/L | 10 | 10 |

- **GOOD CALIBRATION OF SOLIDS BALANCE**
- **EFFLUENT AMMONIA CALIBRATION WITH NO STEP FEED AND AERATION BASIN DO <1 MG/L**

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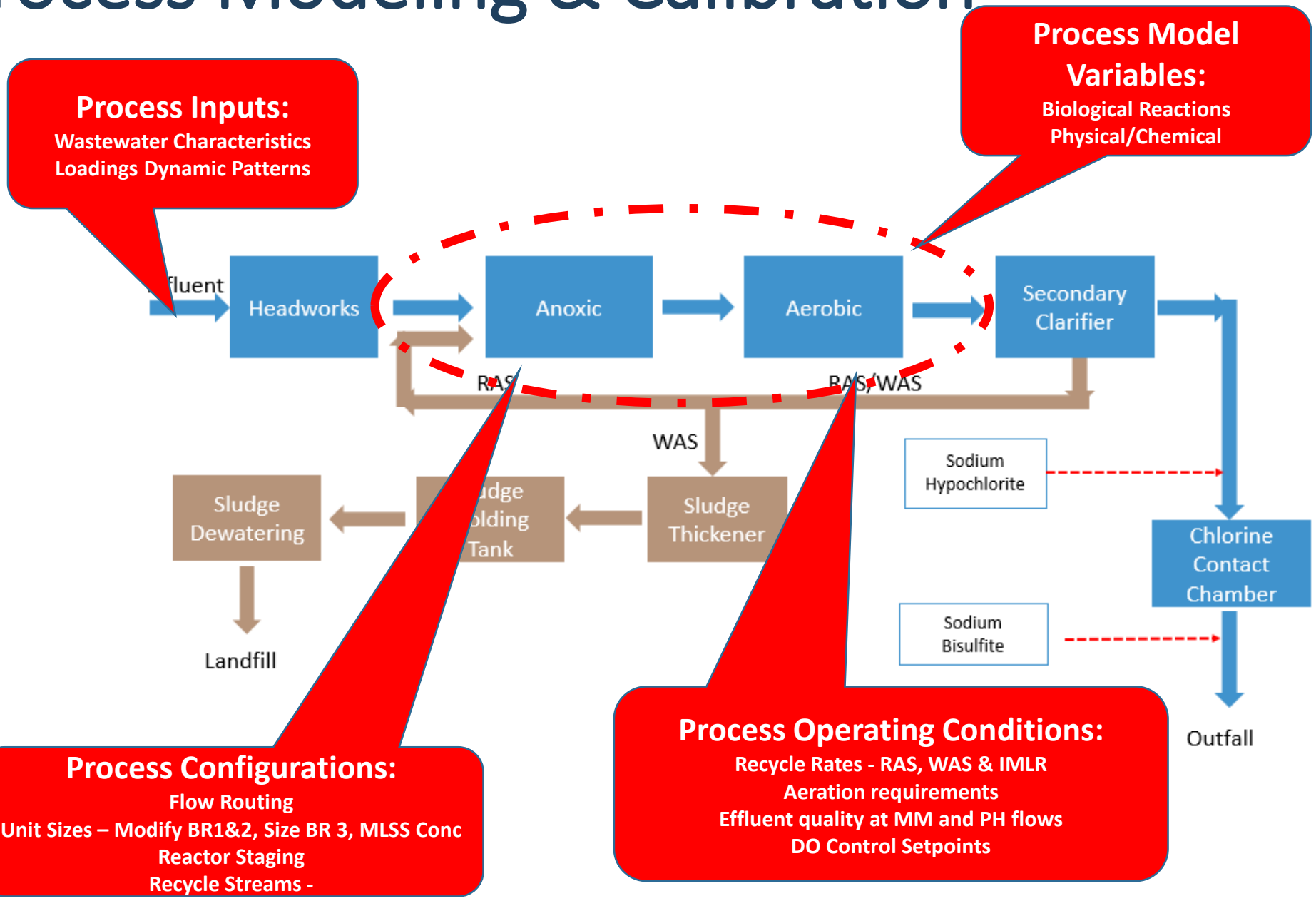
# Process Modeling & Calibration

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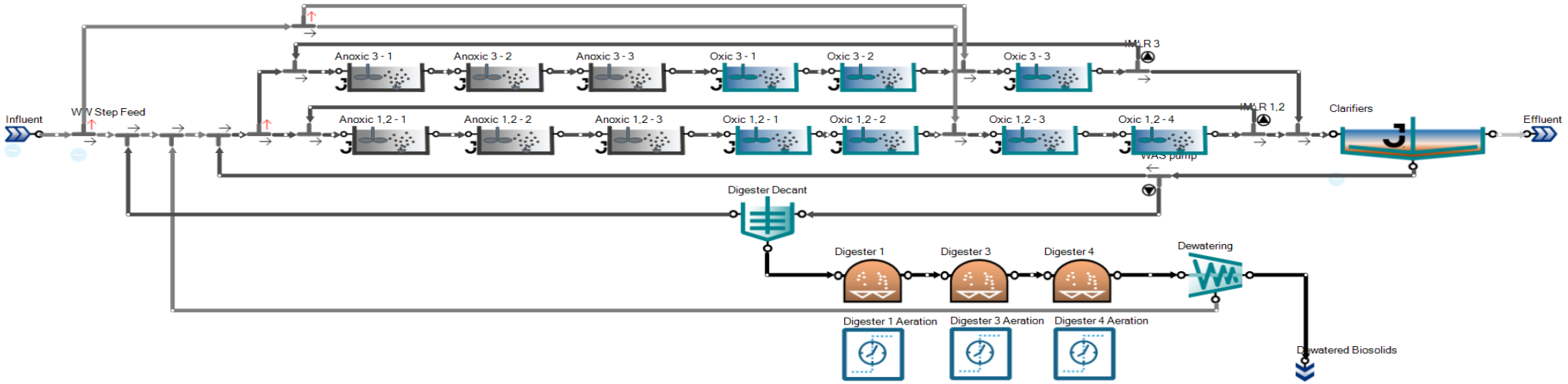
# Maximum Month (18 MGD) Model Results




| Parameter | Input/Result |
|---|---|
| Aerobic SRT, d | 5 |
| TCEQ Required SRT | 4.76 |
| MLSS, mg/L | 3700 |
| Airflow, SCFM | 24,500 |
| Clarifier Solids Loading Rate, lbs/d/ft$^2$ | 13 |
| Clarifier Surface Overflow Rate (SOR) gpd/ft$^2$ | 240 |
| Maximum SOR Allowed by TCEQ, Table F.9. | 400 |

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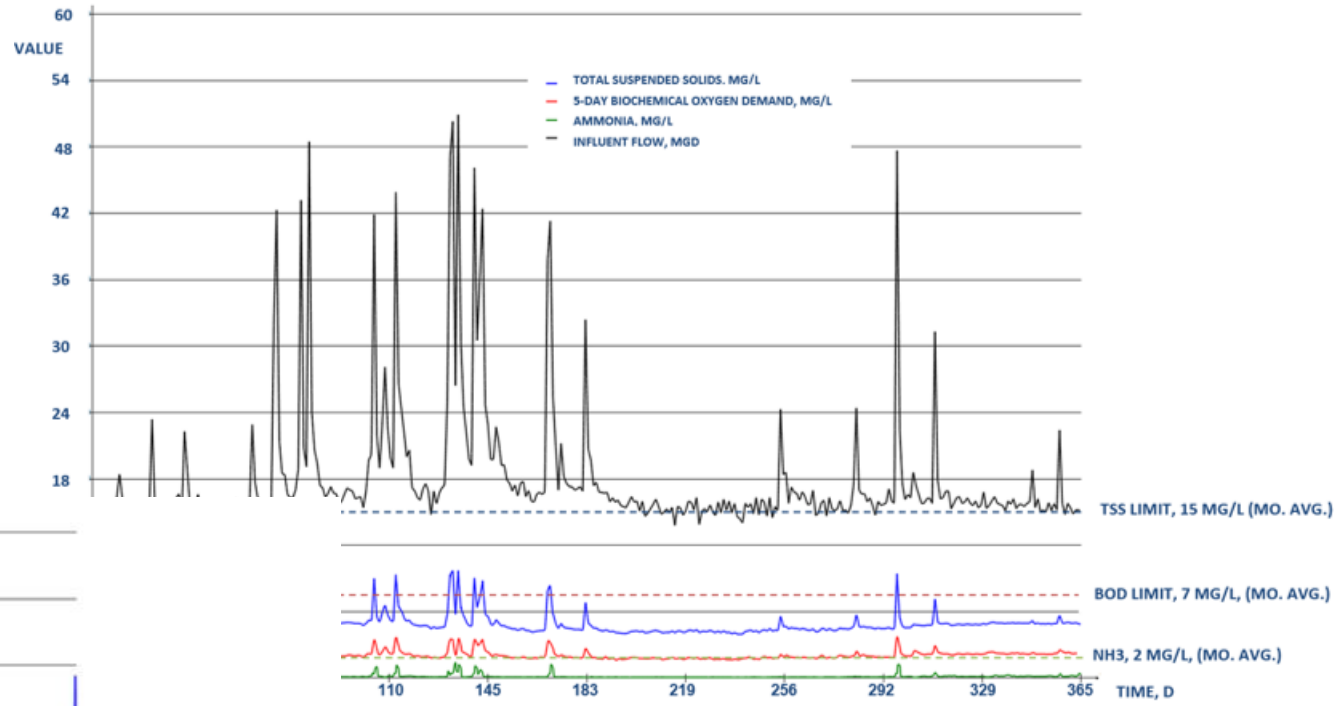
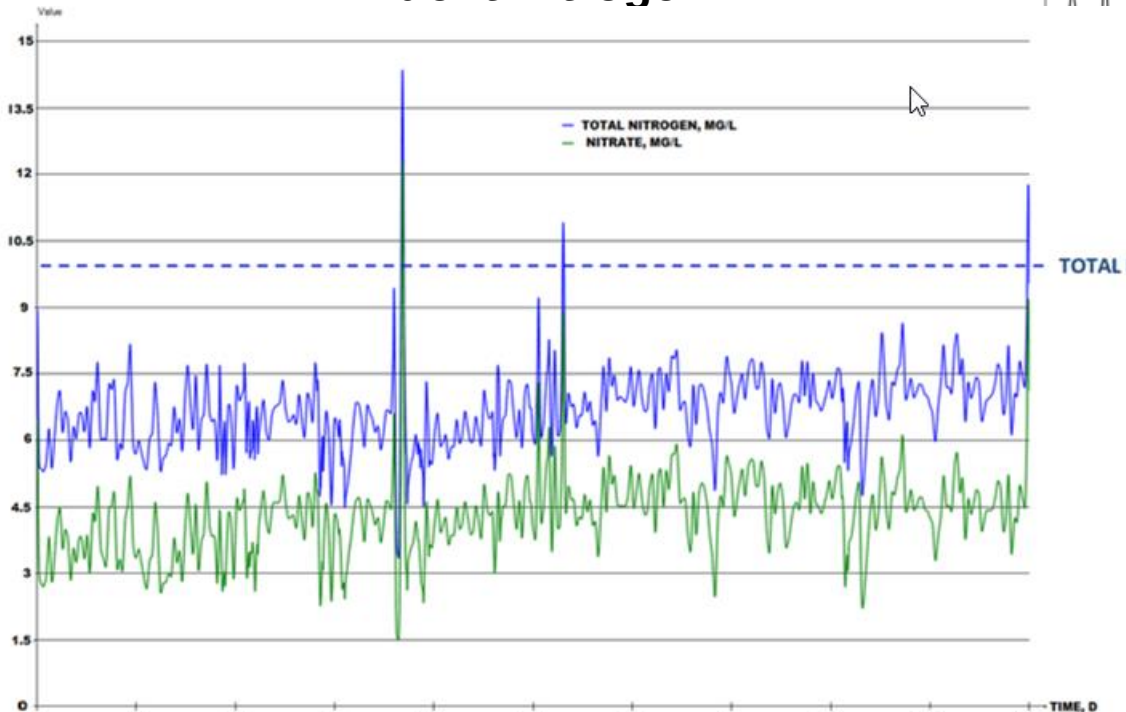
# One-Year Dynamic Model Results

## 2015 Data set used due to having several wet-weather and high loading peaks

**One-Year Dynamic Model Effluent Quality vs. Flow**




**One-Year Dynamic Model Results – Effluent Nitrogen**

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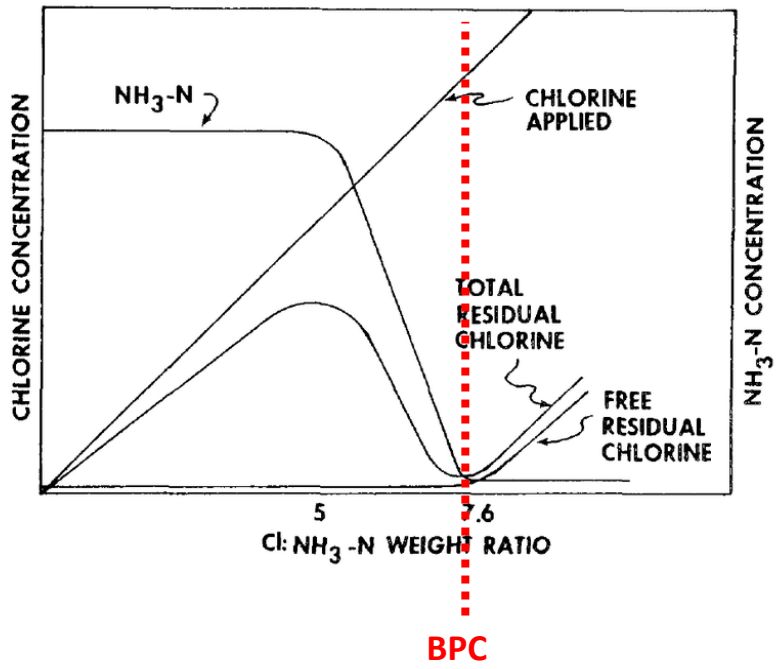
# Significantly less NaClO required after BNR upgrades

- Free Chlorine Residual Control
  - **BPC** = chemical treatment to remove all NH3
  - **Free Chlorine Residual System** = biologically remove NH3 **before** chemical treatment




| SODIUM HYPOCHLORITE (NaClO)- PROPOSED SYSTEM | | | |
|---|---|---|---|
| Parameter | Value | Unit | Notes |
| **NaOCl Doses** | | | |
| Cl2:NH3 Ratio | 10:1 | | |
| Chlorine Demand | 3 | mg/L | **Max** demand in addition to ammonia demand |
| Target Free Chlorine **Residual** | 1.5 | mg/L | Will meet the enterococci limits at all flows |
| **Avg Dose** | | | |
| Avg Effluent NH3 | 0.2 | mg/L | From Process Modeling |
| Avg Design NaClO Dose | 6.5 | mg/L | |
| **Min Dose** | | | |
| Avg Effluent NH3 | 0.2 | mg/L | From Process Modeling |
| Min Design NaClO Dose per TCEQ | 6 | mg/L | TCEQ Table K.1 |
| **Chem Feed Pumps Max Dose** | | | |
| Cl:NH3 Ratio | 7:1 | | Dilute influent |
| Max Effluent NH3 | 1.5 | mg/L | From Processing Modeling |
| Chlorine Demand | 1 | mg/L | Demand of dilute influent |

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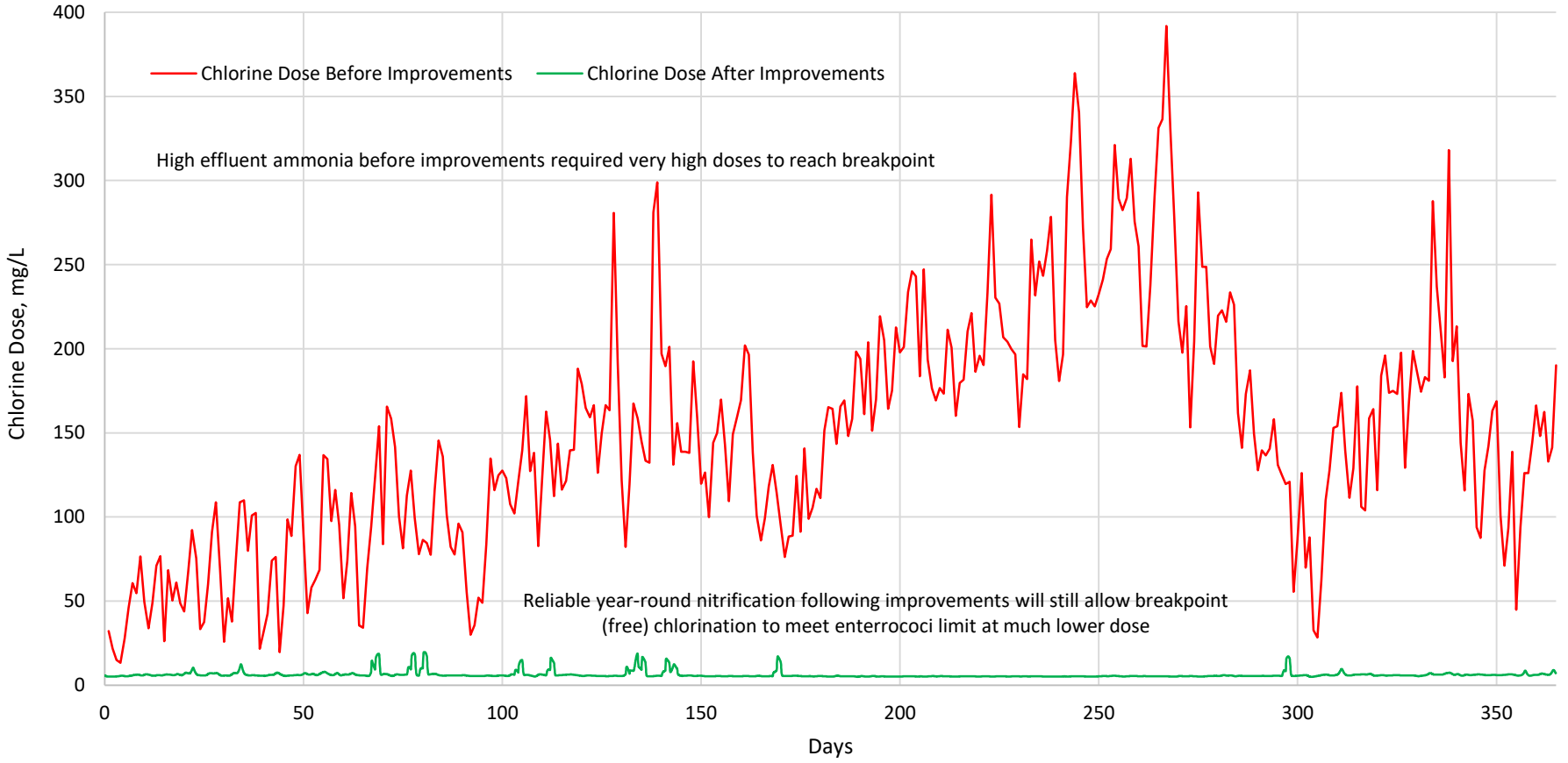
# Significantly less NaClO required after BNR upgrades

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# Key Improvements per Treatment Unit

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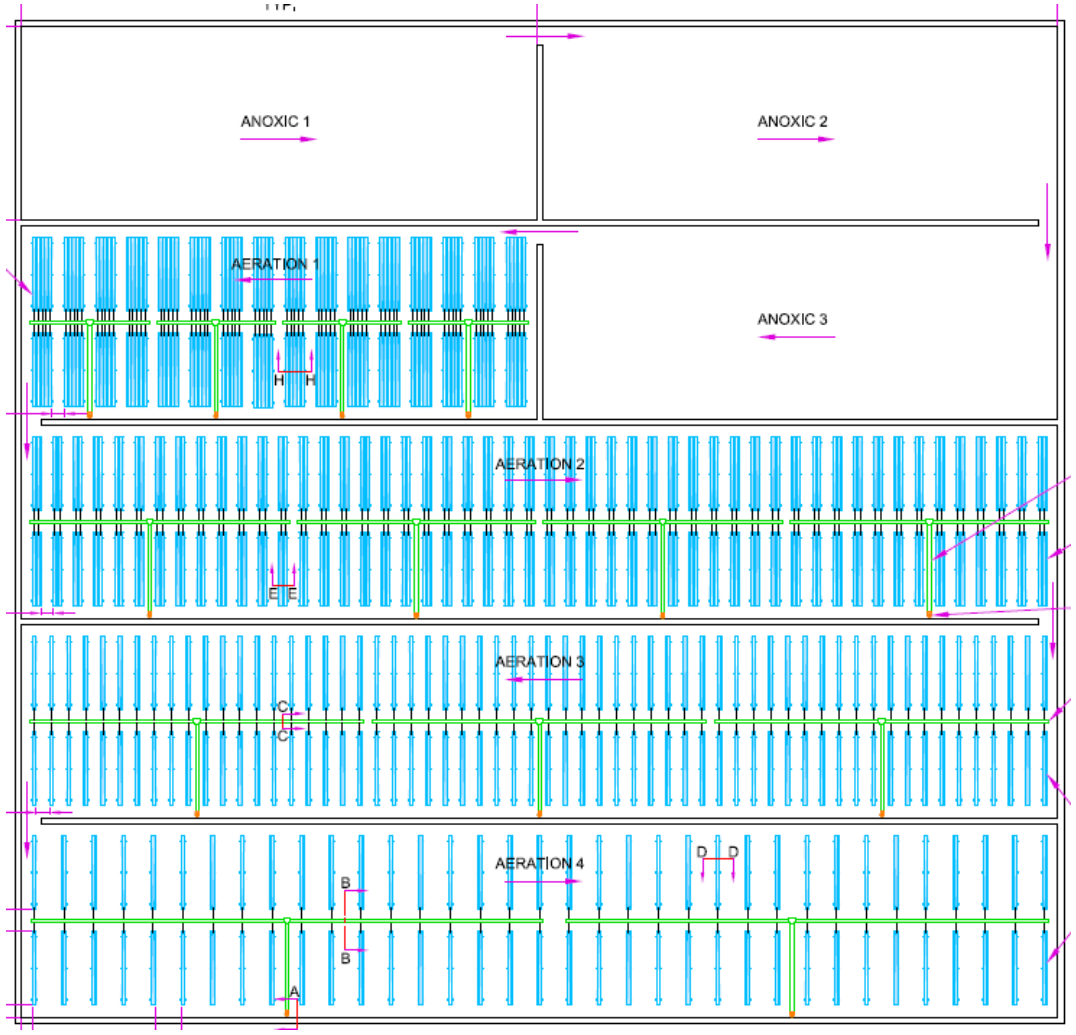
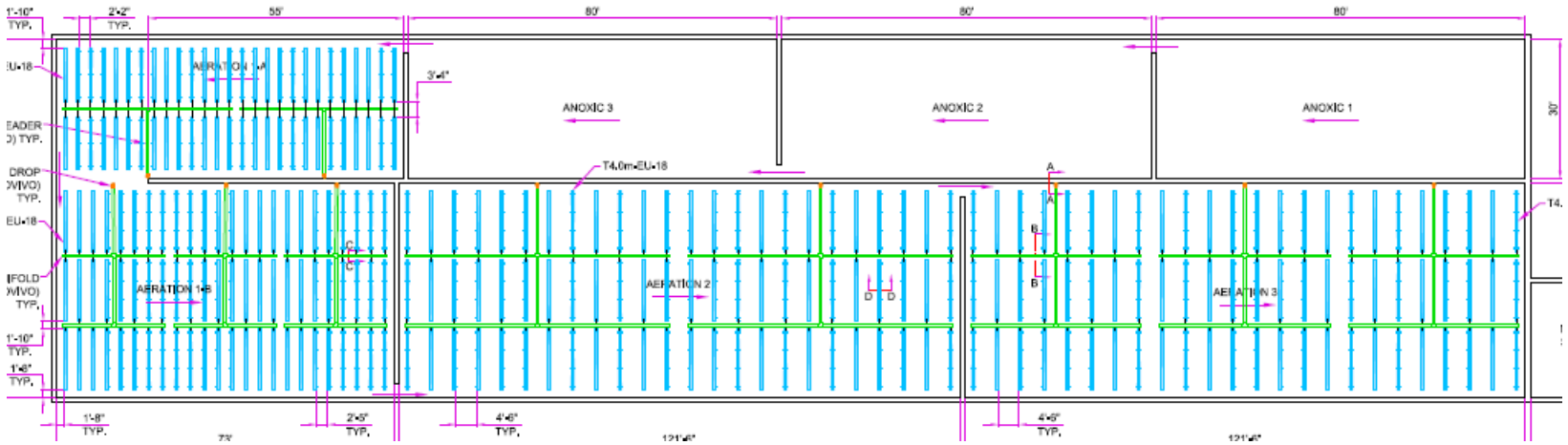
# Bioreactors 1 & 2 – Diffusers Layout

| Parameter | Value | Units |
|---|---|---|
| Type | Fine Bubble, EPDM Disc | – |
| Manufacturer | Sanitaire, SSI, Aquarius | – |
| Discs per Train | ≈ 3,400 | # |
| Disc Diameter | 9 | inches |



# Bioreactor 3 – Fine Bubble Diffusers Layout

| Parameter | Value | Units |
|---|---|---|
| Type | Fine Bubble, EPDM Disc | – |
| Manufacturer | Sanitaire, SSI, Aquarius | – |
| Discs per Train | ≈ 3,400 | # |
| Disc Diameter | 9 | inches |



# Bioreactors - Mixers

## Design Criteria

| Parameter | Value | Units |
|---|---|---|
| Type | Hyperbolic | – |
| Manufacturer | Invent | – |
| Mixers per Anoxic Zone | 2 | # |
| Diameter | 98.4 | inches |
| Power Consumption (per mixer) | 1.7 | hp |

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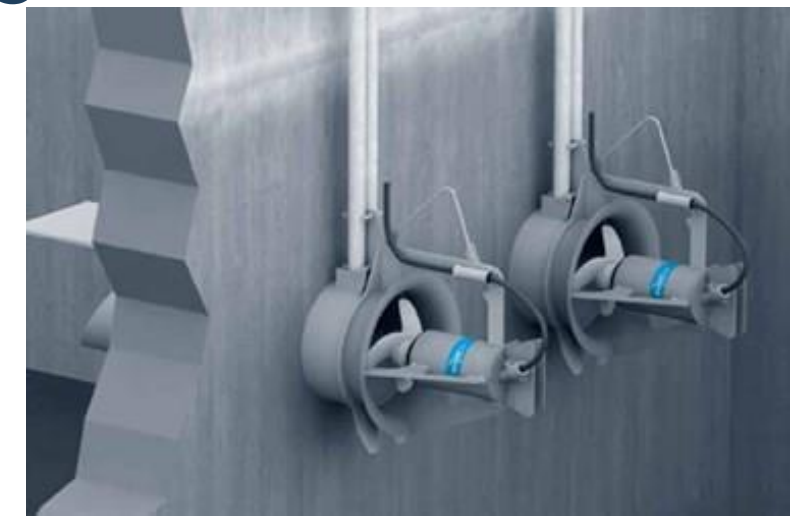
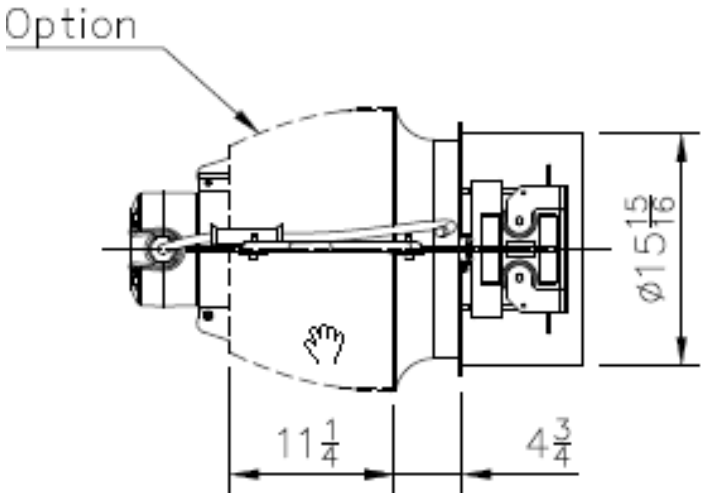
# Bioreactors - IMLR Pumps

## Design Criteria

| Parameter | Value | Units |
|---|---|---|
| Type | Propeller | – |
| Manufacturer | Flygt | – |
| Quantity (per Bioreactor) | 1 duty<br>w/ shelf spare | # |
| Flow (min/avg/max) | 12 / 17 / 24 | MGD |
| Drive | VFD | – |
| Motor Size | 5 | hp |



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# Bioreactors - O&M Considerations

- Goals for diffuser system - reliability, low maintenance and long-term performance

- Diffusers Comparison – Strip vs Retrievable vs Standard 9” Disc
  - Strip: Apprx 40% more energy efficient

| Manufacturer | Standard System Material Cost | Retrievable System Material Cost | Aerostrip Aeration System Cost |
|---|---|---|---|
| SSI Aeration | $360,000 | $1.8M | |
| Aquarius | $355,000 | $1.5M - $2M | |
| Sanitaire | $490,000 | $1.55M | |
| Ovivo USA | | | $1.57 |

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# Secondary Clarifiers - Key Operational Benefits/O&M Considerations

- Improved TB functionality with electric motor drive (move away from hydraulic drive system and festoon cables)
- SELs - Eliminates need for launder covers, minimizes algae growth, Reduced flow short circuiting
- Improved scum collection and transfer system
  - Simplified scum skimming mechanism – Mechanical blade skimmer with handwheel
  - Slotted pipe skimmer w/hand wheel operation
  - Replace scum drain lines
- Improved tank drain system
- Redundant rotary screen for operational flexibility

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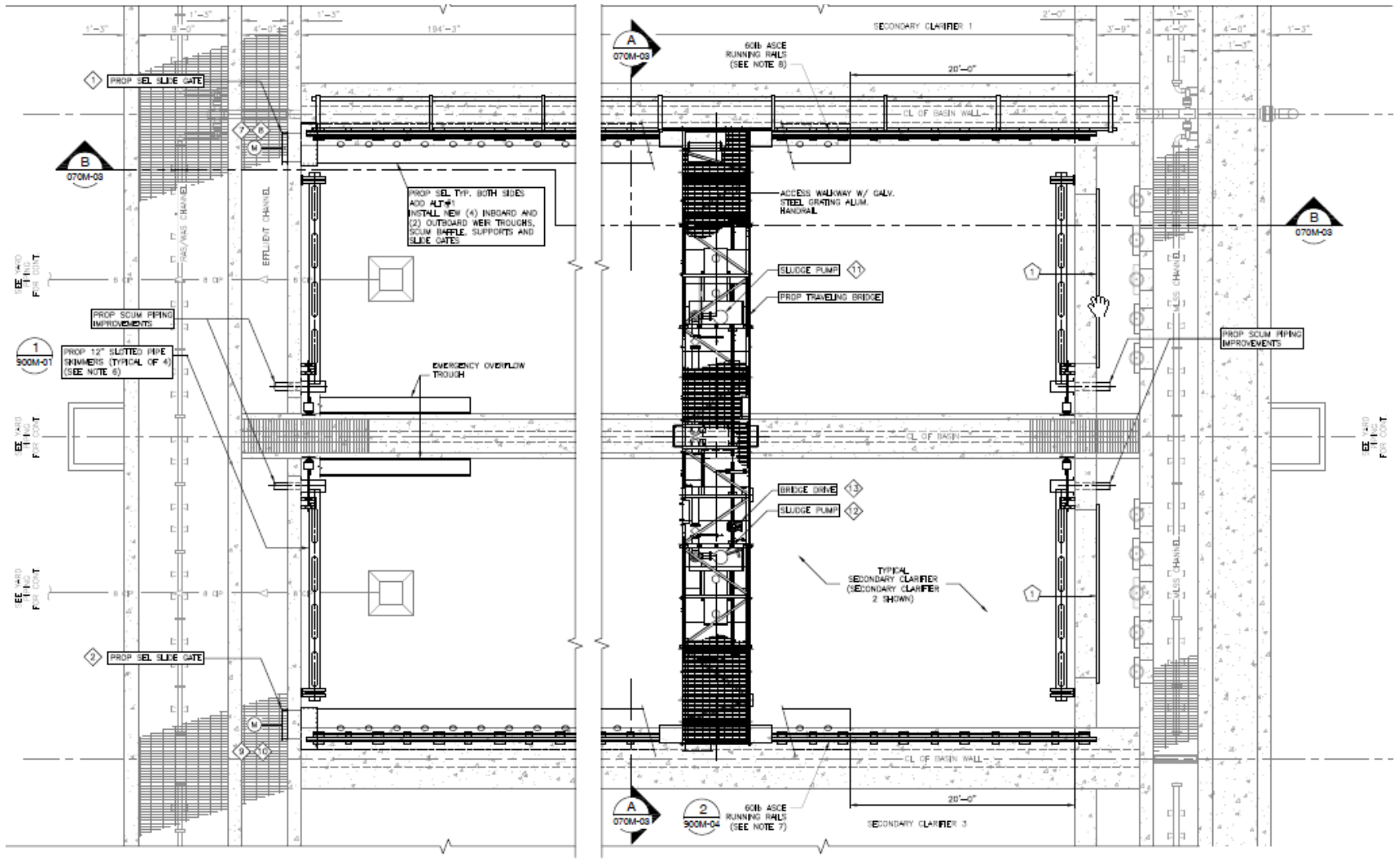
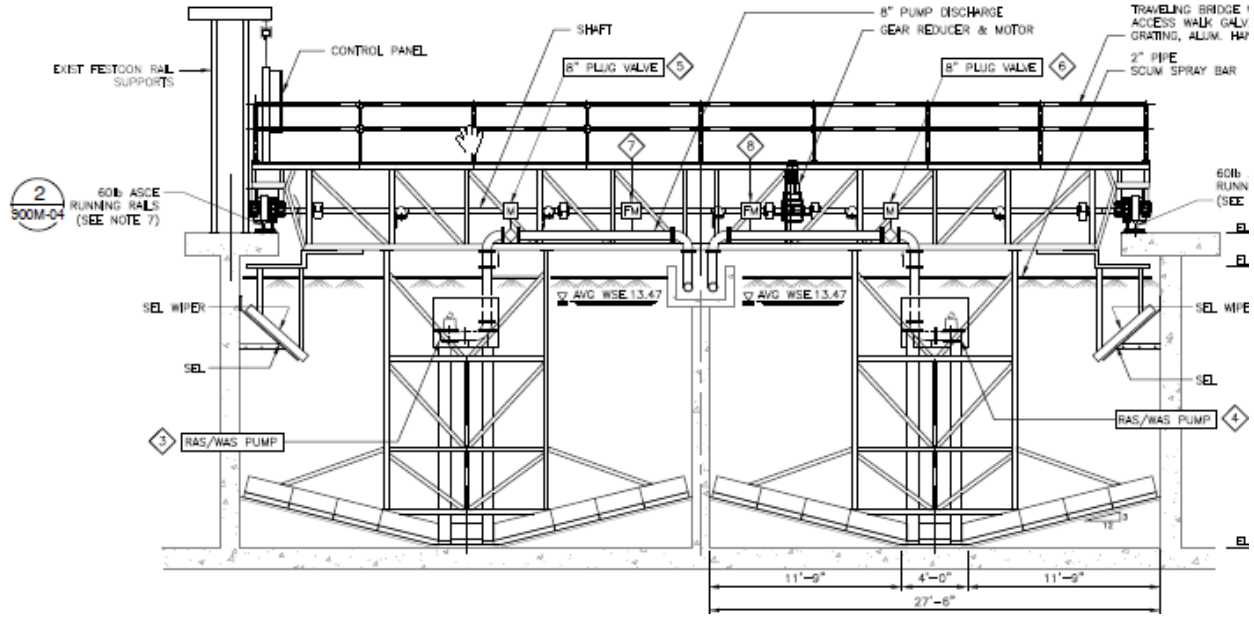
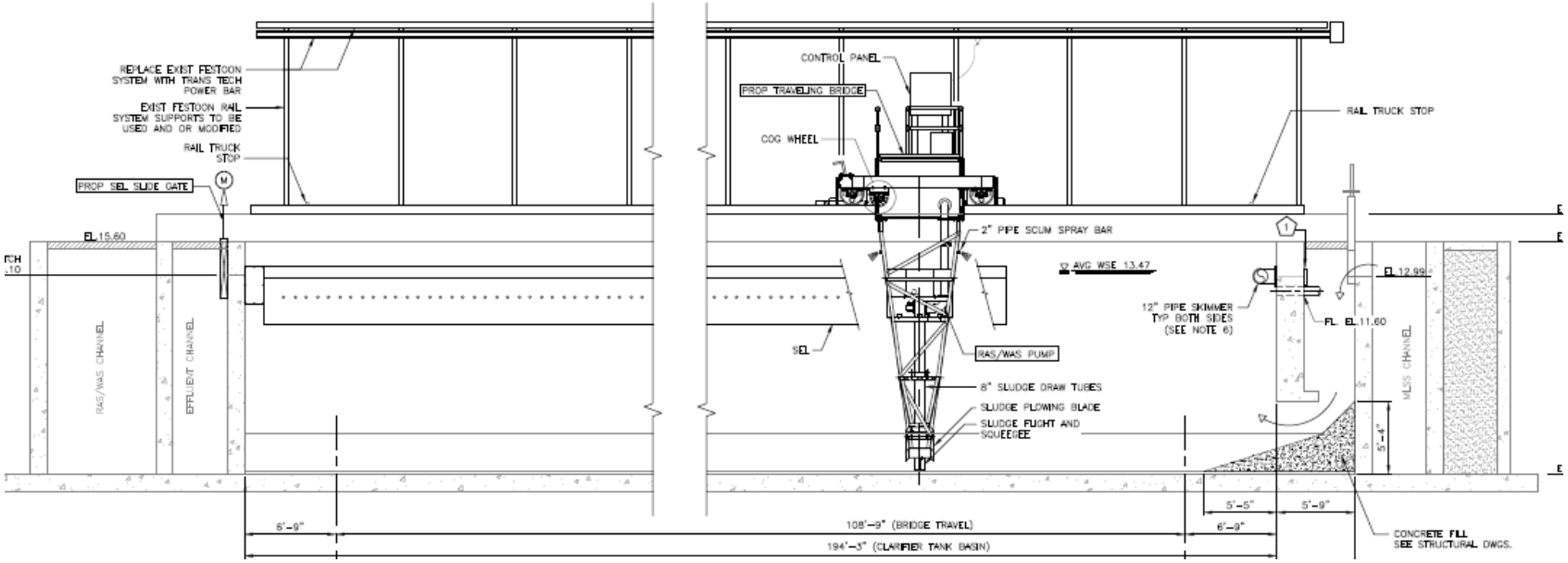
# Secondary Clarifiers



# Secondary Clarifiers

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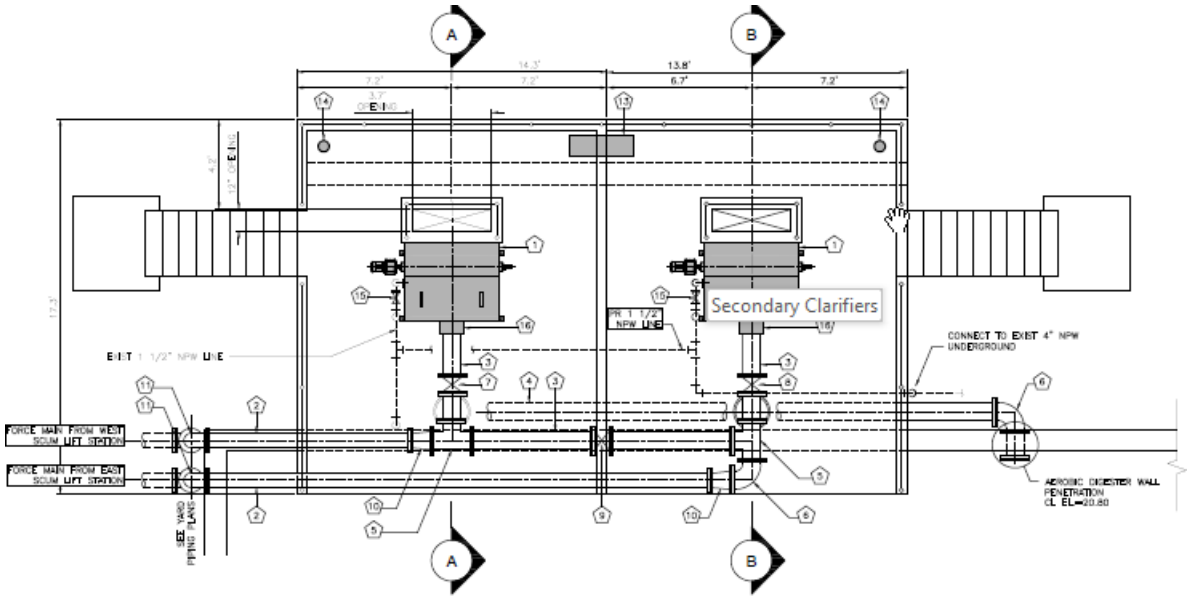
# Scum Improvements

**Key Operational Benefits/O&M Considerations**

- Convert existing Aeration Basins to Bioreactors
- New 6 MGD Bioreactor
- Increase plant AAF treatment capacity to 18 MGD
- Step feed for wet weather events
- Fine bubble diffusers
- Hyperbolic mixers
- IMLR pumping

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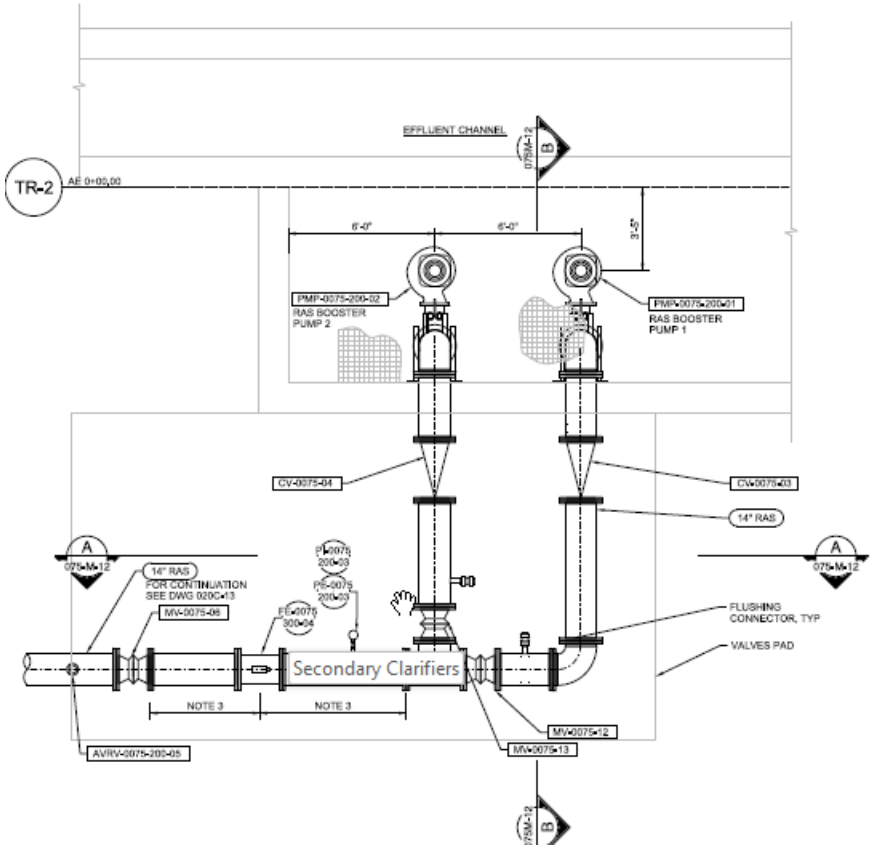
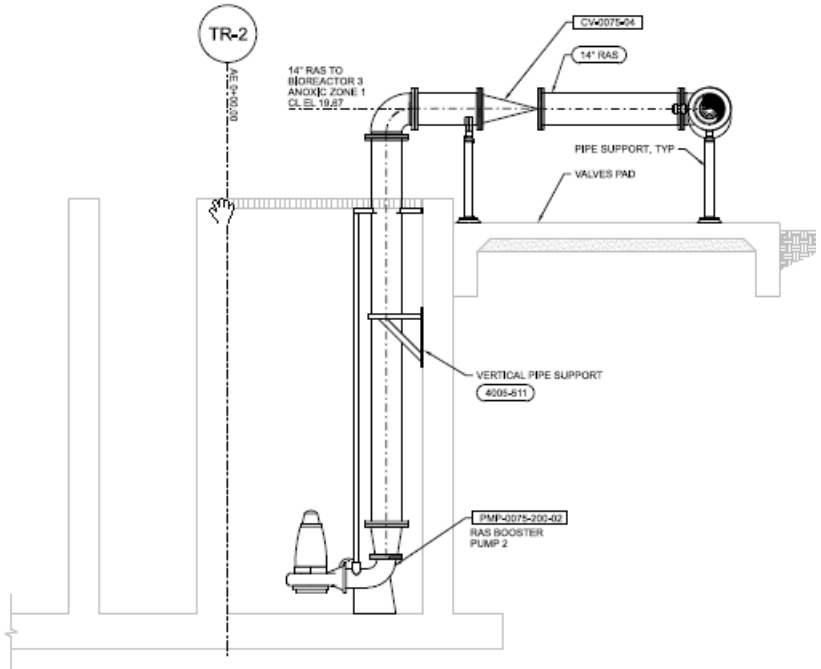
# RAS Booster Station

**O&M Considerations**

- Convert existing Aeration Basins to Bioreactors
- New 6 MGD Bioreactor
- Increase plant AAF treatment capacity to 18 MGD
- Step feed for wet weather events
- Fine bubble diffusers
- Hyperbolic mixers
- IMLR pumping

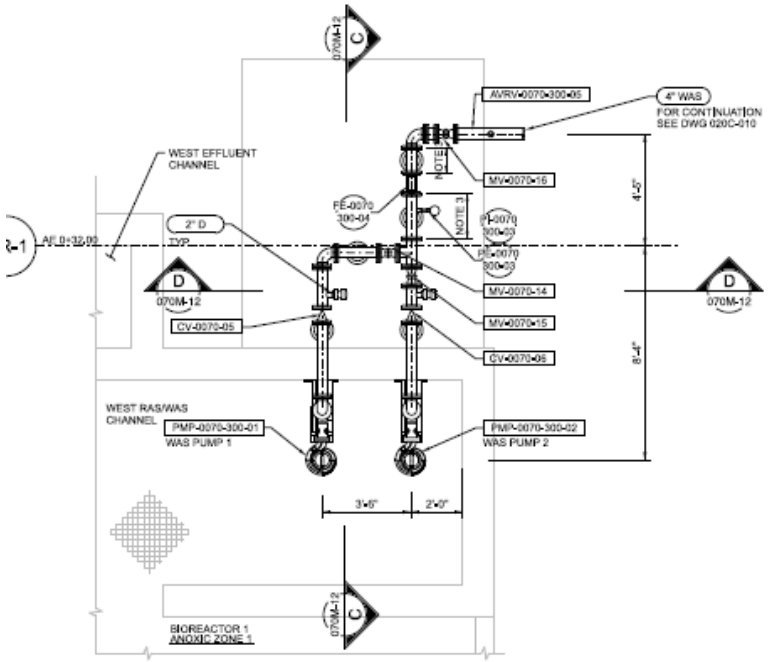


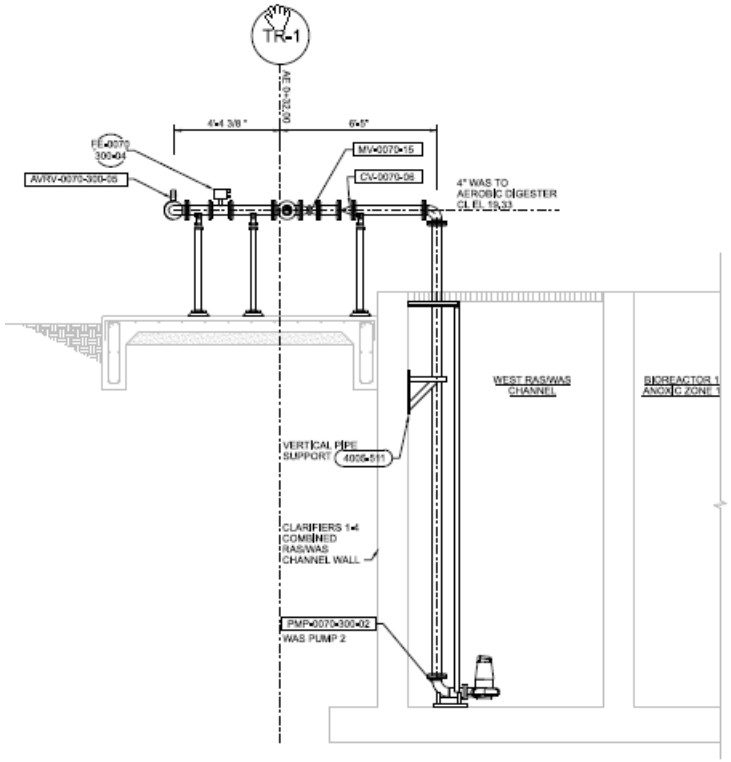



# WAS Pump Station

**Key Operational Benefits/O&M Considerations**

- Convert existing Aeration Basins to Bioreactors
- New 6 MGD Bioreactor
- Increase plant AAF treatment capacity to 18 MGD
- Step feed for wet weather events
- Fine bubble diffusers
- Hyperbolic mixers
- IMLR pumping

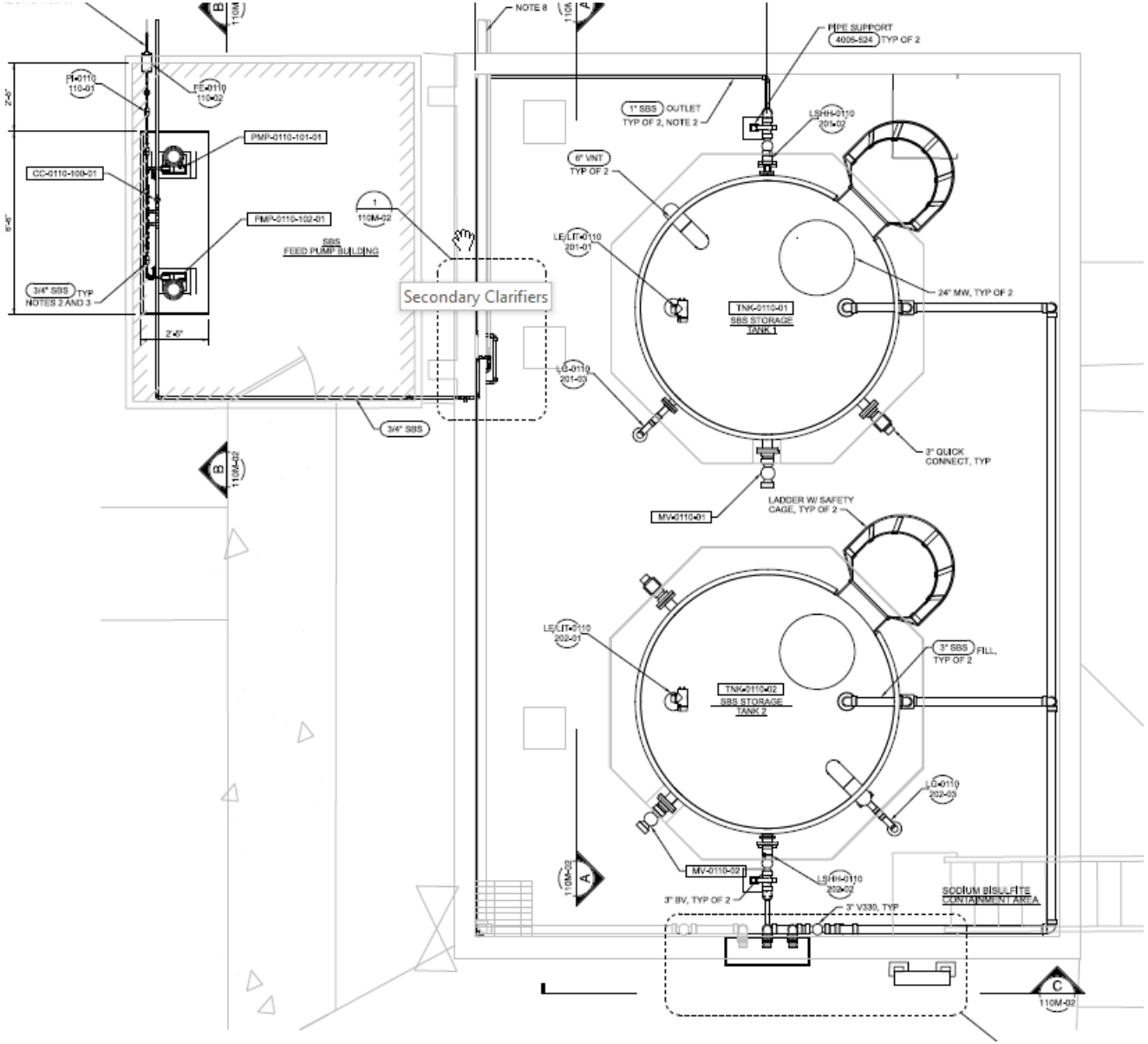


# Chem Feed Systems

**Facility Description**

- Existing BPC system will be decommissioned
- FRP sodium hypochlorite (NaClO) storage tanks
- New NaClO feed pumps: 3 duty, 1 standby (per train)
- FRP sodium bisulfite (NaHSO3) storage tanks
- New NaHSO3 feed pumps: 3 duty, 1 standby (per train)
- Significant chemical demand reductions



# Solids Handling Improvments - Basis of Design

- 18 MGD -- Maximum Month:
  - WAS Flow: 520,000 gpd
  - Solids Loading: **33,700 lbs/d**

- 14 MGD -- Annual Average:
  - WAS Flow: **590,000 gpd**
  - Solids Loading: 26,400 lbs/d

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# Basis of Design – Thickening Equipment

| Thickening Equipment | | |
|---|---|---|
| Type | Volute Thickener | |
| Manufacturer | PWTech VT-302 | |
| Design Thickened Solids Concentration | 3 | percent |
| Quantity of units (duty / standby) | 2/1 | |
| Hydraulic capacity per unit | 300 | gpm |
| Installed Capacity | 900 | gpm |
| Firm Capacity | 600 | gpm |

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# Basis of Design – Dewatering Equipment

| Dewatering Equipment | | |
|---|---|---|
| Type | Volute Press | |
| Manufacturer | PWTech<br>ES-354 | |
| Quantity of units (duty / standby) | 2/1 | |
| Solids loading capacity per unit | 2,100 | dry lb / hr |
| Installed Capacity | 6,300 | dry lb / hr |
| Firm Capacity | 4,200 | dry lb / hr |
| Percent Solids Discharge (Minimum) | 15 | |

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# Basis of Design – Dewatering Feed Design

| Parameter | Value | Units |
|---|---|---|
| Configuration | ASH1 with dedicated pump for each dewatering volute press. AHS4 for emergency WAS storage. | |
| Aerated Sludge Holding Tank 1 | 670,000 | gallons |
| Dewatering Feed Pumps | Submersible, Non-clog, Centrifugal | – |
| Manufacturer | Flygt, KSB | – |
| Number of Pumps (Duty + Standby) | 2 + 1 | # |
| Drive Type | VFD | – |
| Pump Capacity Range, each | 150 | gpm |
| Total Dynamic Head | 20 - 50 | psi |
| Estimated Motor Size, each | 10 | hp |

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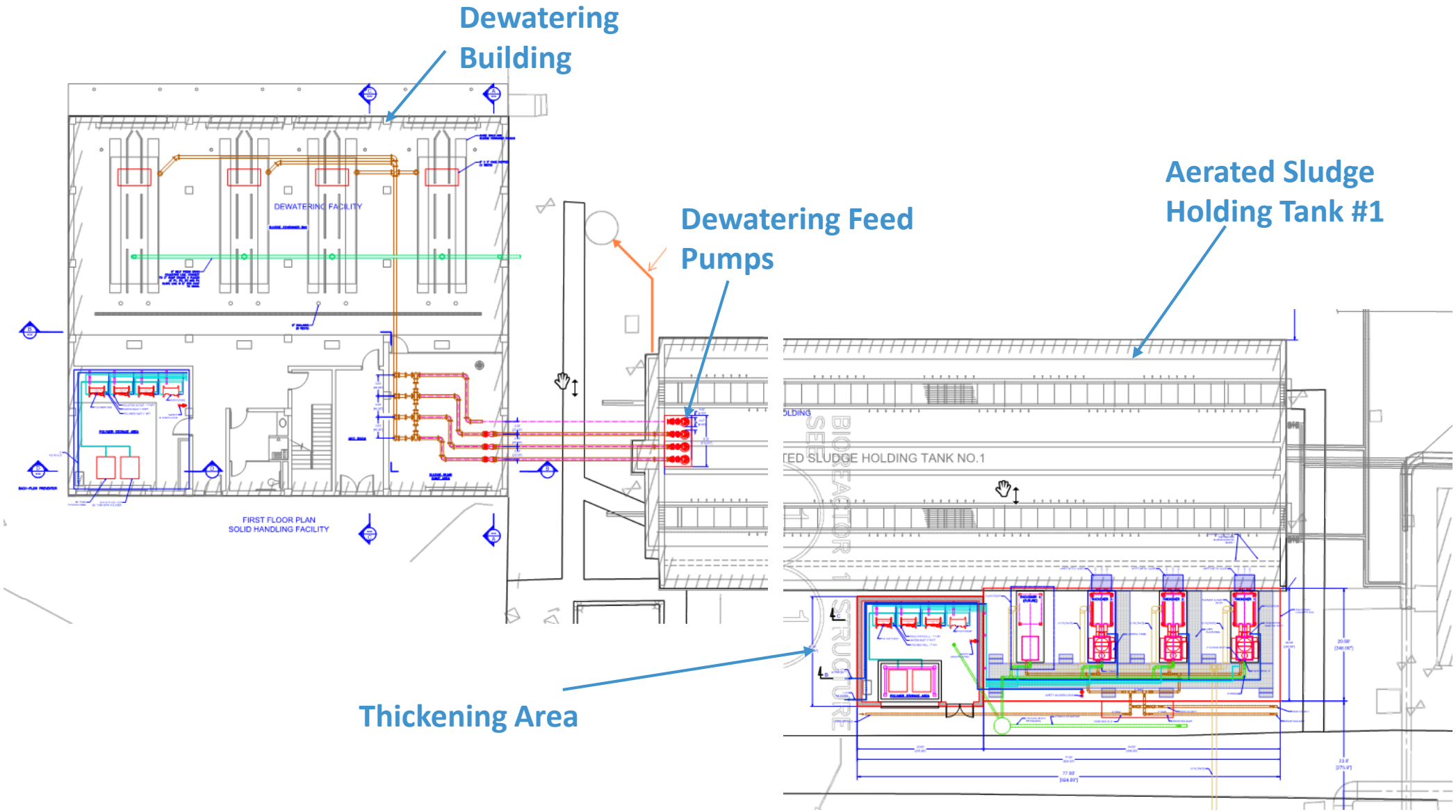
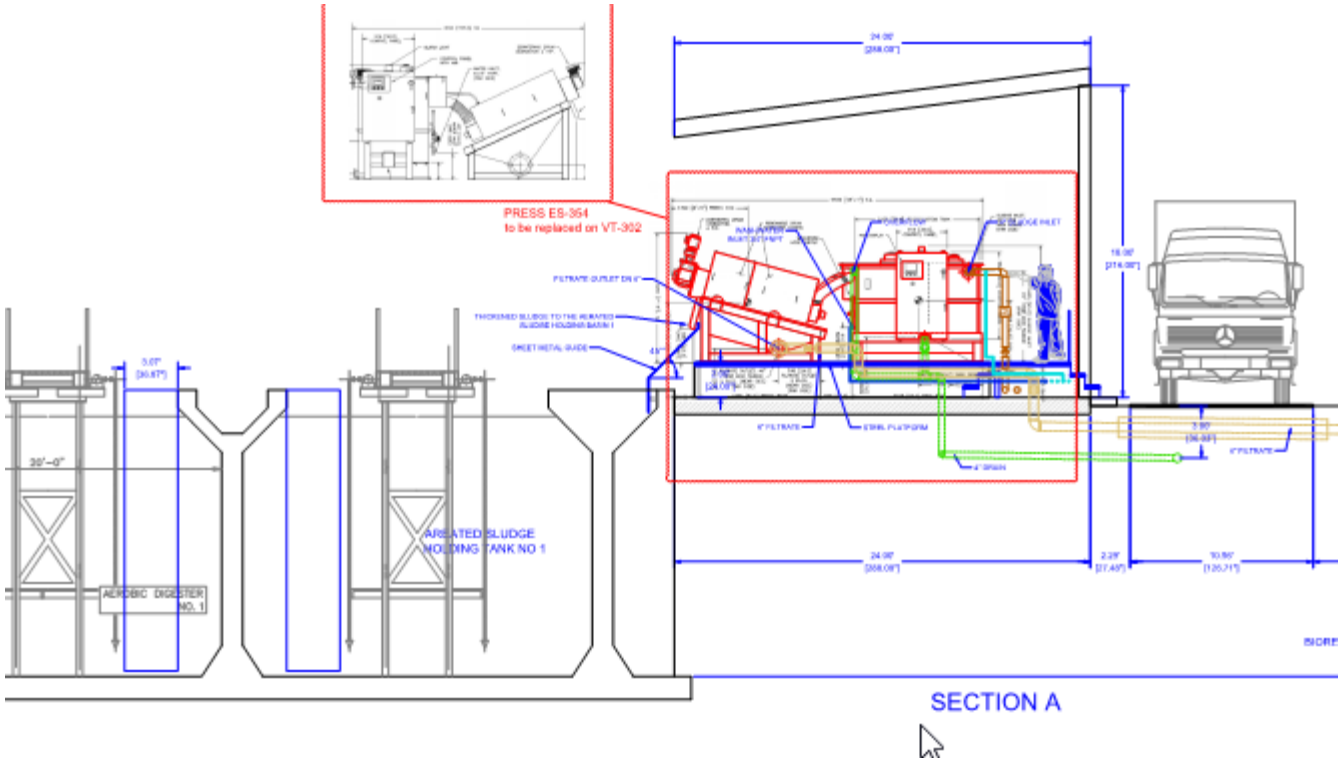
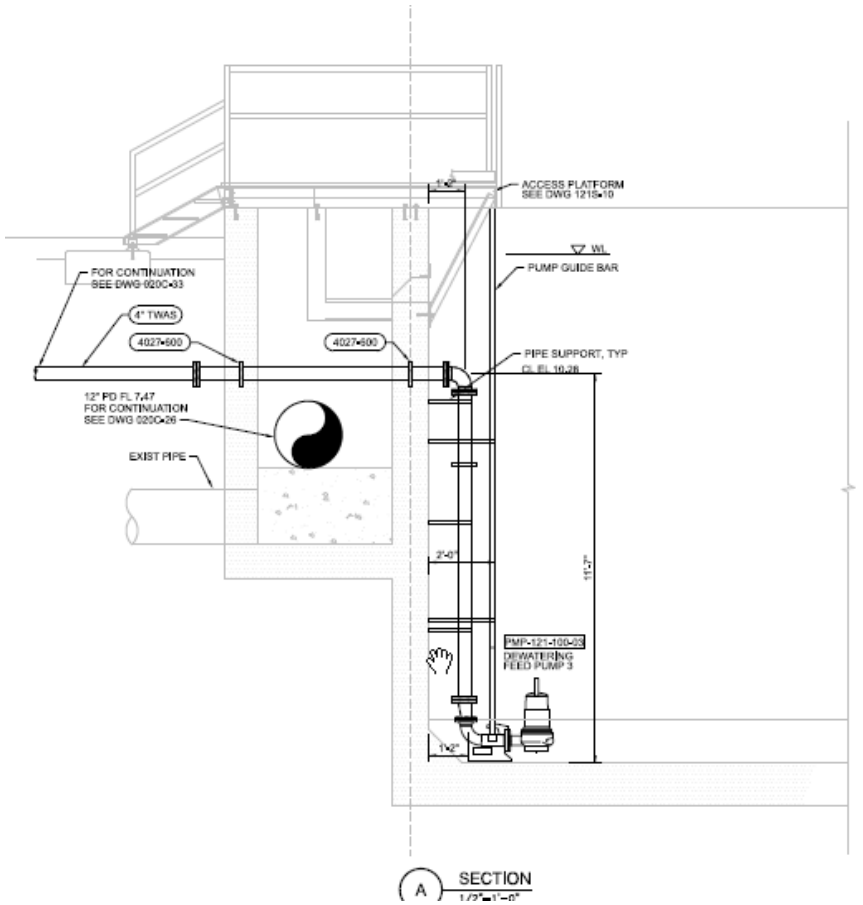
# Solids Handling - Area Overview

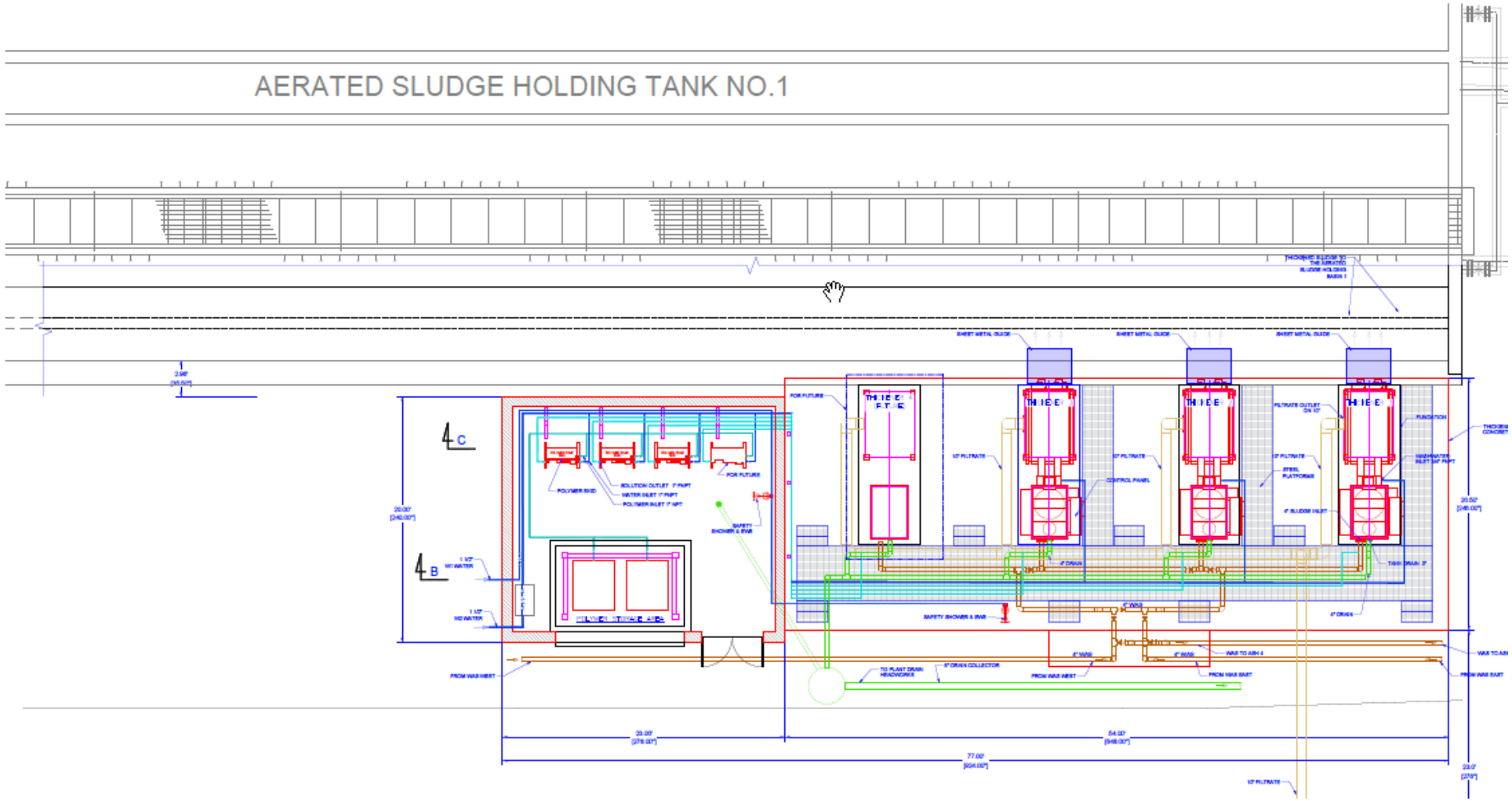


# Aerated Sludge Holding Tank



# Aerated Sludge Holding Tank

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# Solids Handling - O&M Considerations

- Operation flexibility in dewatering unit layout, TWAS pumps and discharge configuration eliminates “single point of failure” issue in system. If desired the use of any dewatering unit at any time can receive flows from any pump
- System design allows for emergency WAS storage at ASHT 4. A 4” overflow pipe/valve around WAS Pumps to ASHT 4 is included in design
- A bypass line around thickeners to allow dilution of biosolids (< 4% solids) in ASHT 1
- Potential to add more units to the system in the future
- Improved tank drain system
- FRP Grating to reduce corrosion
- Low operational complexity
  - Separate air system for BRs and sludge holding tanks allows for isolation of system when necessary
  - Add pressure sustaining valve on aeration header feeding ASHT 1 to avoid operating blowers at too low of a discharge pressure

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# Engineer's OPCC

| Opinion of Probable Construction Cost | |
|---|---|
| **Facility** | Total Cost |
| Headworks Facility Stilling Weir Gate | $145,000 |
| Bioreactors 1 & 2 | $8,423,000 |
| Bioreactors 3 | $11,251,000 |
| New Blower Building and Aeration Piping | $9,015,000 |
| Clarifier 1-8 Traveling Bridge Equipment Replacement, Boosters & Pump Station | $15,895,000 |
| Scum System Improvements | $3,831,000 |
| Clarifier 1-8 - New Submerged Effluent Trough/Launders | $3,244,000 |
| Chlorine Contact Chamber 1-4 Equipment Replacement and Chem. Feed Improvements | $4,550,000 |
| Chlorine Contact Chamber 1-4 - New Effluent Weir Troughs | $1,748,000 |
| ECR Building and Electrical Improvements | $4,875,000 |
| Solids Dewatering and Sludge Thickening | $9,940,000 |
| Effluent JB Mech Improvements | $15,000 |
| Outfall Structure Improvements | $35,000 |
| Miscellaneous Improvements – Sitework, Paving, Utilities | $6,035,000 |
| CONSTRUCTION SUB TOTAL (2022 $) | $79,002,000 |
| CONSTRUCTION SUB TOTAL (2024 $) | $87,100,000 |

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