Hazen

CARY | NORTH CAROLINA

“Airing” on the side of caution – a story of future planning at North Cary WRF

David Wankmuller, Hazen and Sawyer

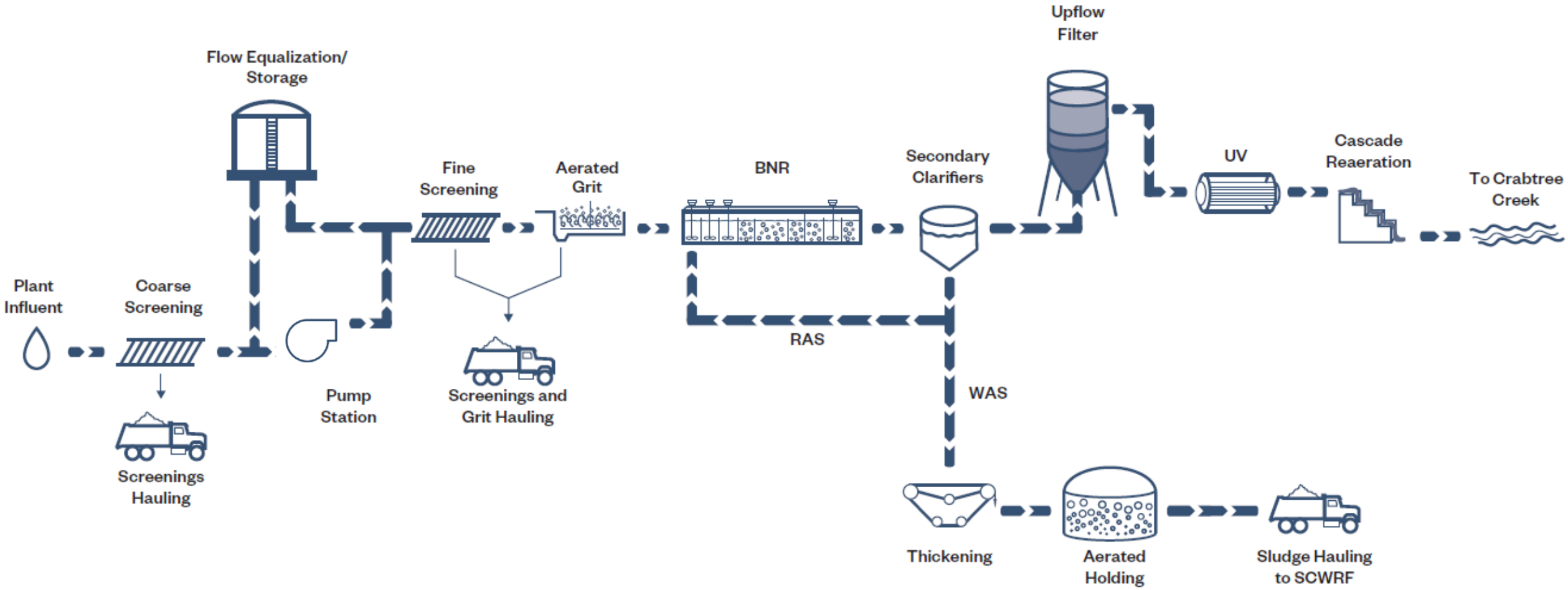
Agenda

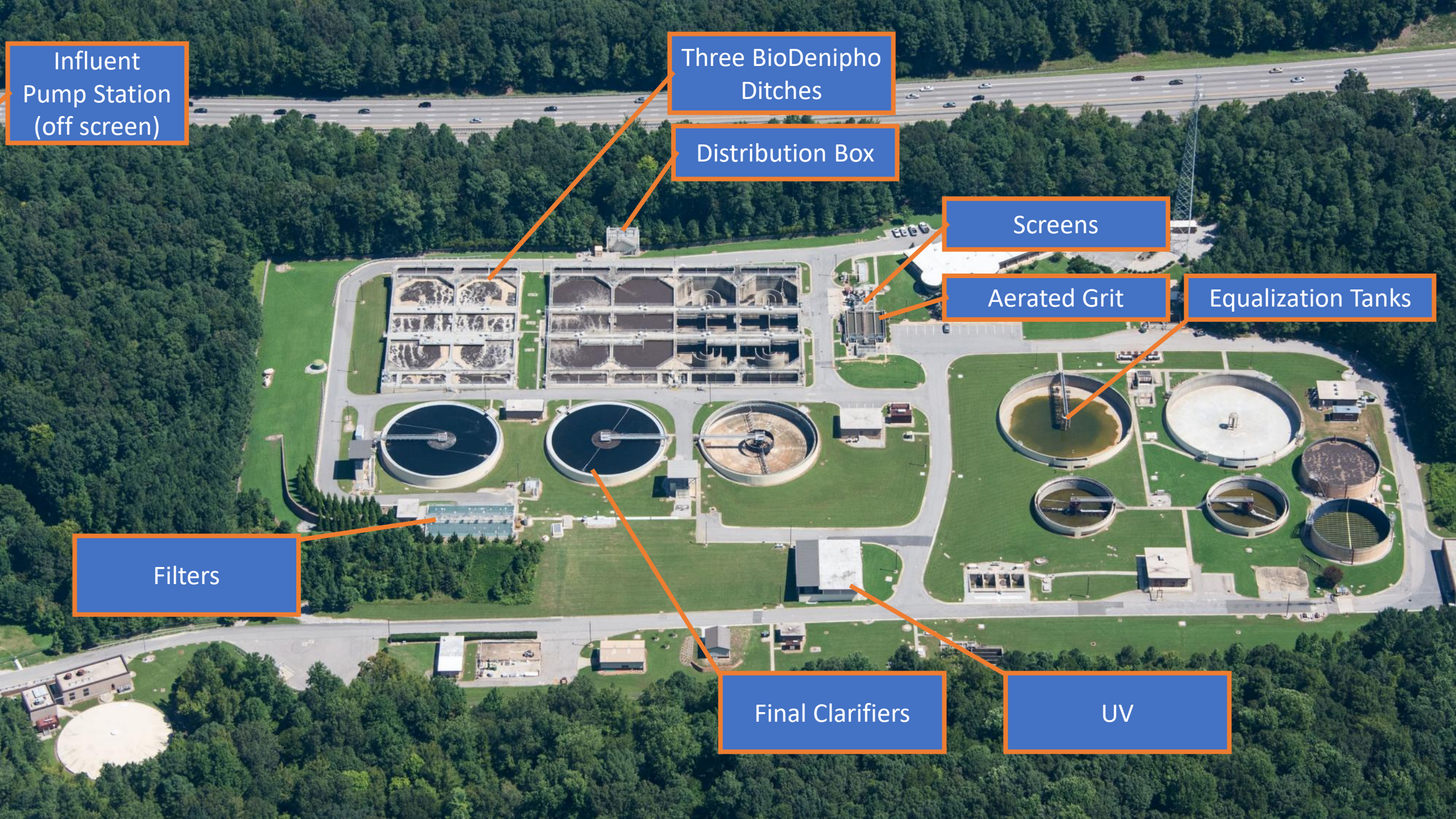
- NCWRF Background
- Project Drivers
- PER Evaluation
- Construction

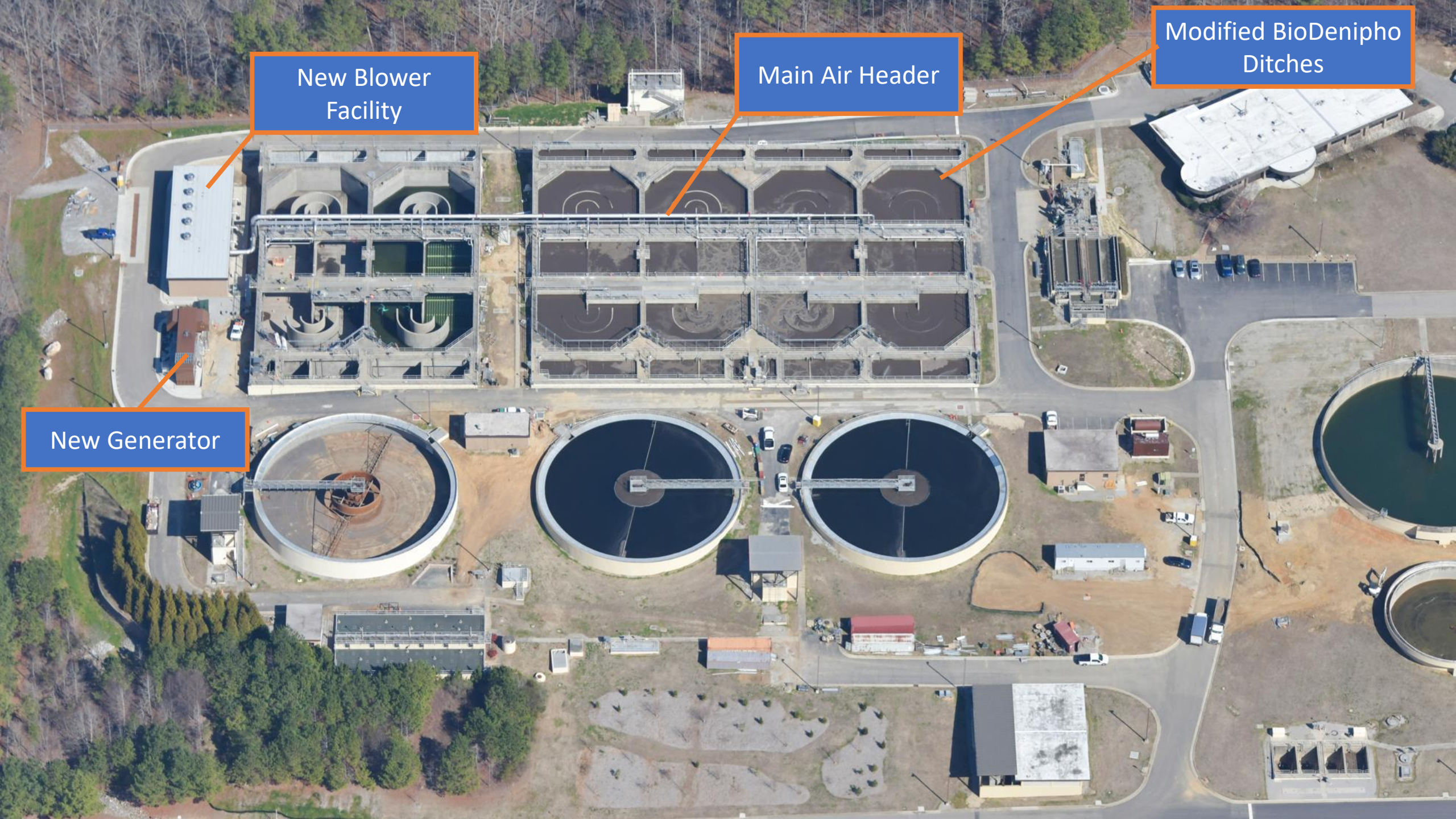
North Cary WRF Background

- 12 MGD Facility
- Effluent TN limit (at design flow) = 3.92 mg/L
- Effluent TP limit = 2.0 mg/L
- Effluent monthly ammonia limit of 0.5 / 1.0 in summer/winter
- Target Removals
  - **TN removal = 95% (~2.7 mg/L)**
  - **TP removal = 95% (~ 0.3 mg/L)**
- Current flow 7.0 mgd

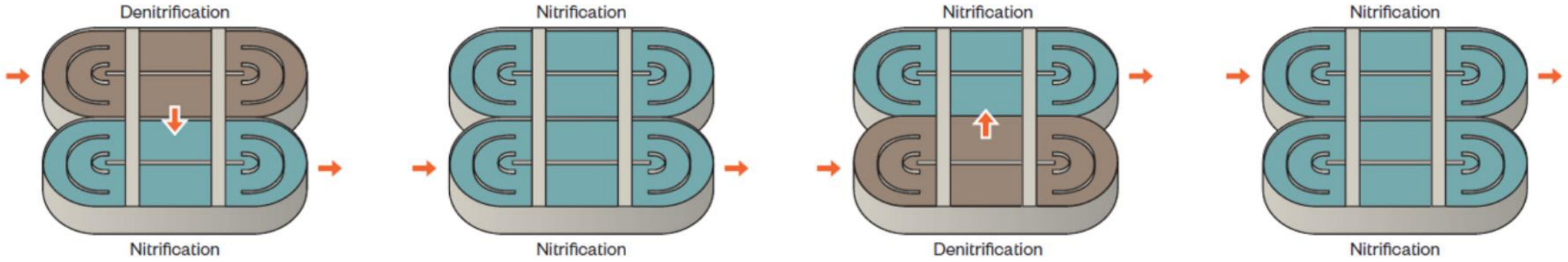
Process Flow Diagram




Influent Pump Station (off screen)
Three BioDenipho Ditches
Distribution Box
Screens
Aerated Grit
Equalization Tanks
Filters
Final Clarifiers
UV


New Blower Facility
Main Air Header
Modified BioDenipho Ditches
New Generator

Pre-modification BioDenipho™ Phasing

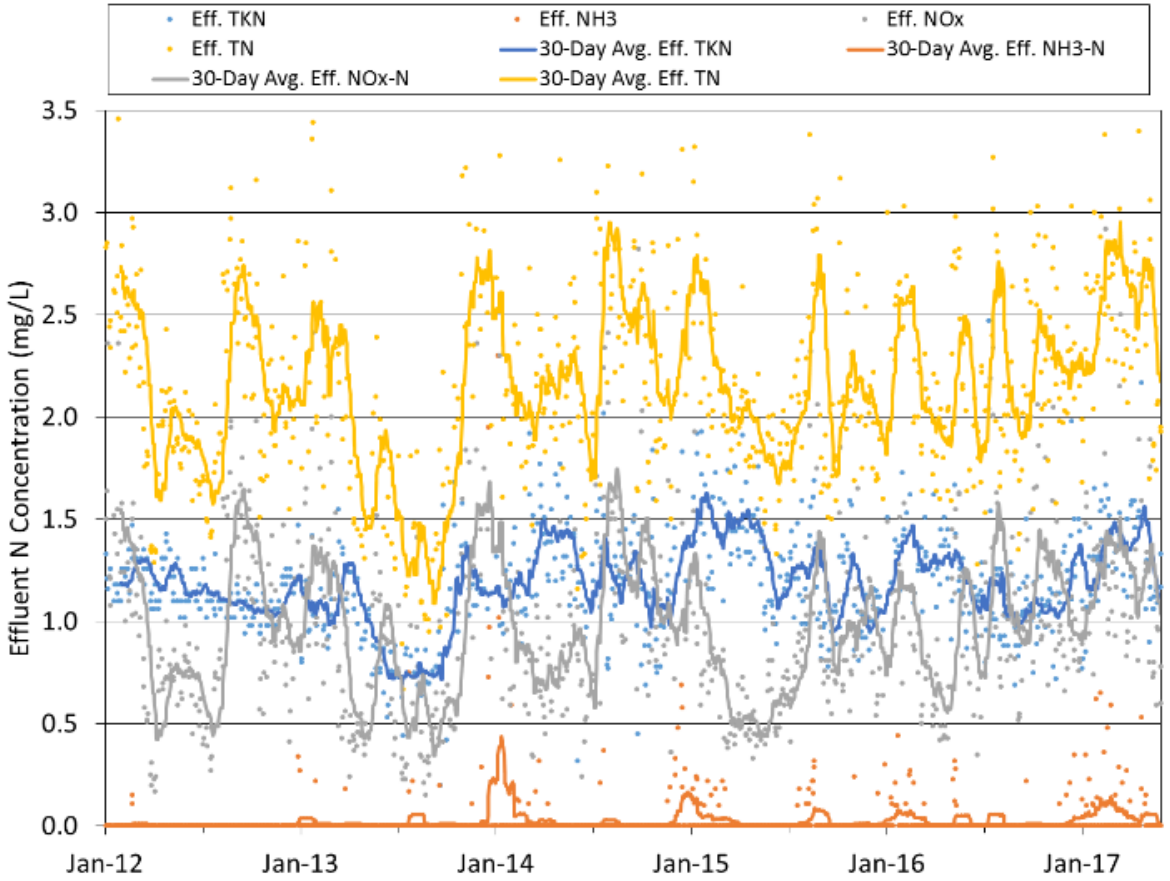


Phase B (minutes)	Phase E (minutes)	Phase G (minutes)	Phase J (minutes)
70	20	70	20

Preliminary Engineering Report (PER)

Project Drivers

- Increase capacity to maintain excellent treatment for future conditions
- Aeration capacity limitations (brush aerators)
- Hydraulic limitations in the existing ditches (submergence on brush aerators)
- Replace old/outdated equipment (brush aerators / PLCs / etc.)
- Timing - Expansion / modification of existing basins while facility can still have a basin offline
- Wet weather operational flexibility



Effluent Permit Limits

Parameter	12.0 MGD	13.5 MGD	15.0 MGD	Historical
Effluent TN (mg/L)[1]	3.9	3.5	3.1	2.1
Ammonia Summer (mg/L) [3]	0.5	0.5	0.5	0.02
Ammonia Winter (mg/L) [3]	1.0	1.0	1.0	
Total Phosphorus (mg/L)[2]	2.0	2.0	2.0	0.56
TSS (mg/L) [3]	30.0	30.0	30.0	0.06
cBOD5 Summer (mg/L) [3]	4.1	4.1	4.1	0.06
cBOD5 Winter (mg/L) [3]	8.2	8.2	8.2	

[1]WLA – 143,246 lb N/d

[2]Quarterly average

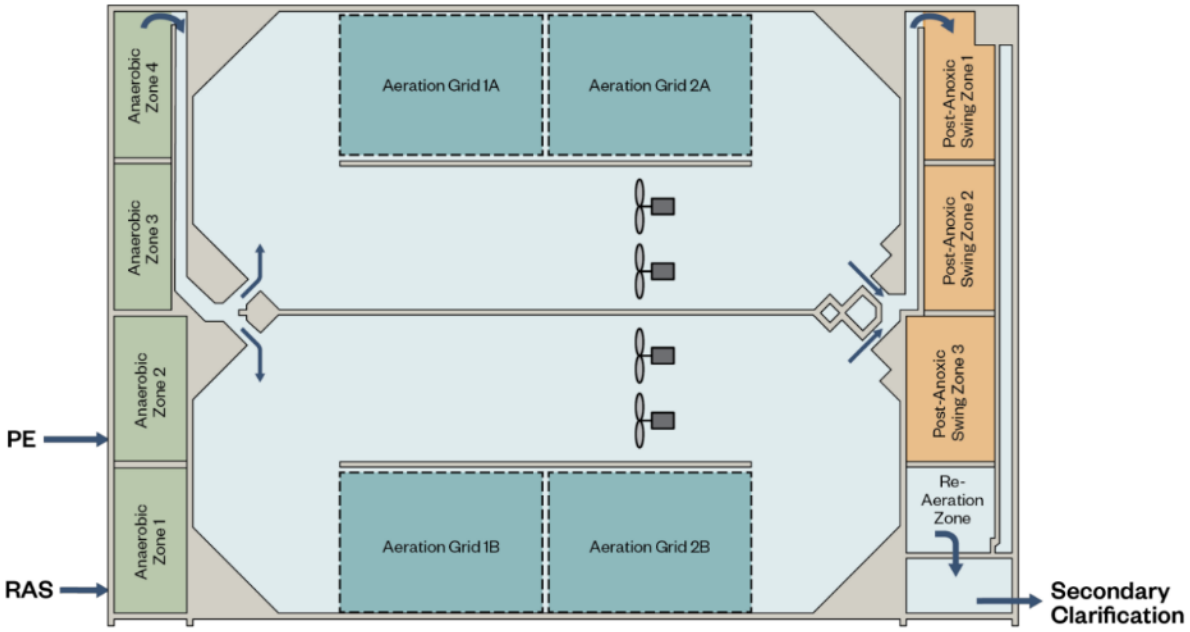
[3]Monthly Average

PER Capacity and Expansion Analysis

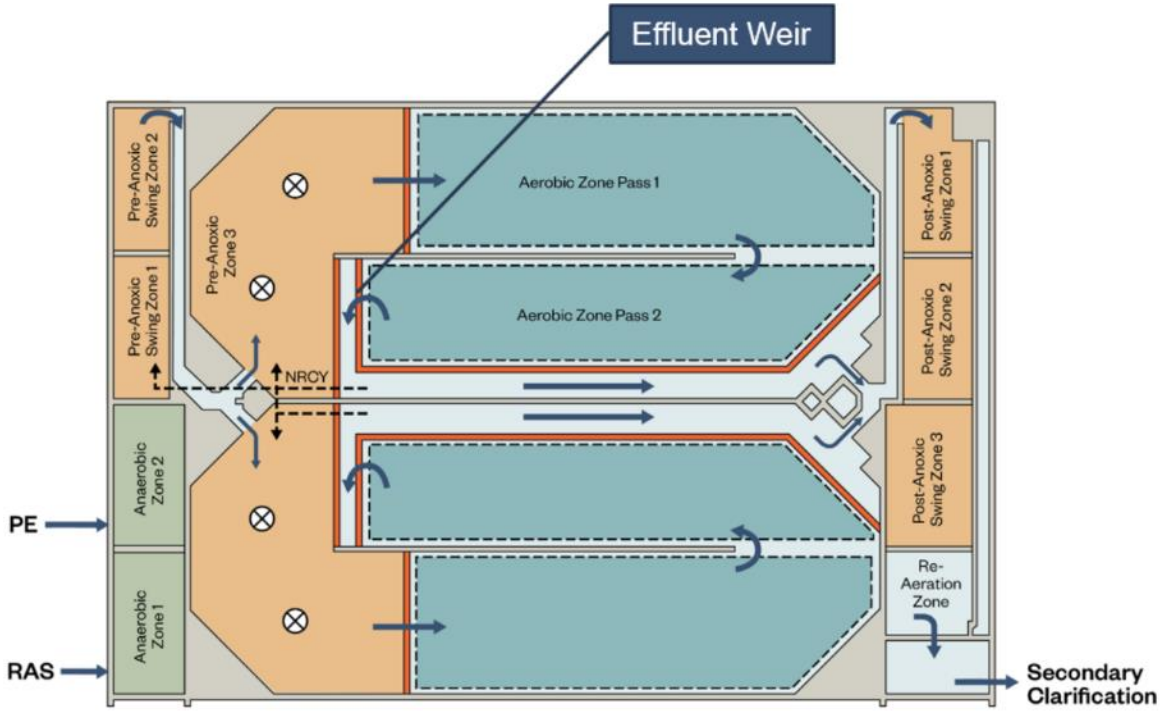
1. Determined capacity of existing system
   - Additional air necessary to reliably achieve effluent limits at design flow / temperature
   - Modifications to the BioDenipho™ cycle necessary for future flows / loads
2. Developed plan for expansion to 13.5 and 15.0 mgd
   - Three BioDenipho™ ditches could treat 15.0 mgd if converted to fine bubble diffusers / blowers
   - One additional final clarifier necessary
   - Misc. other facilities need upgrading (screens, filters, etc.)

Process Configurations Evaluated

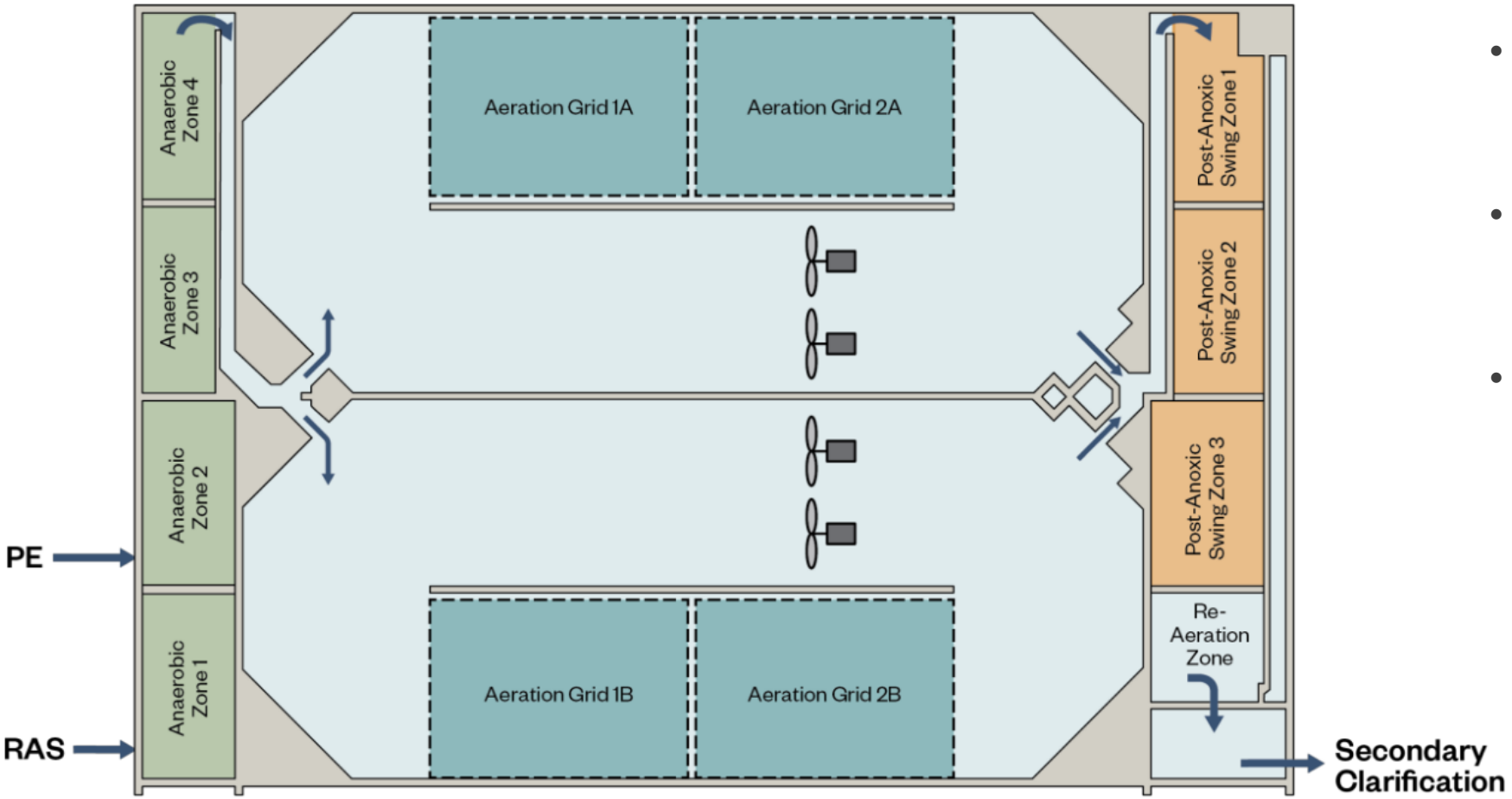
BioDenipho™ with Diffused Aeration



Plug Flow Configuration with Diffused Aeration

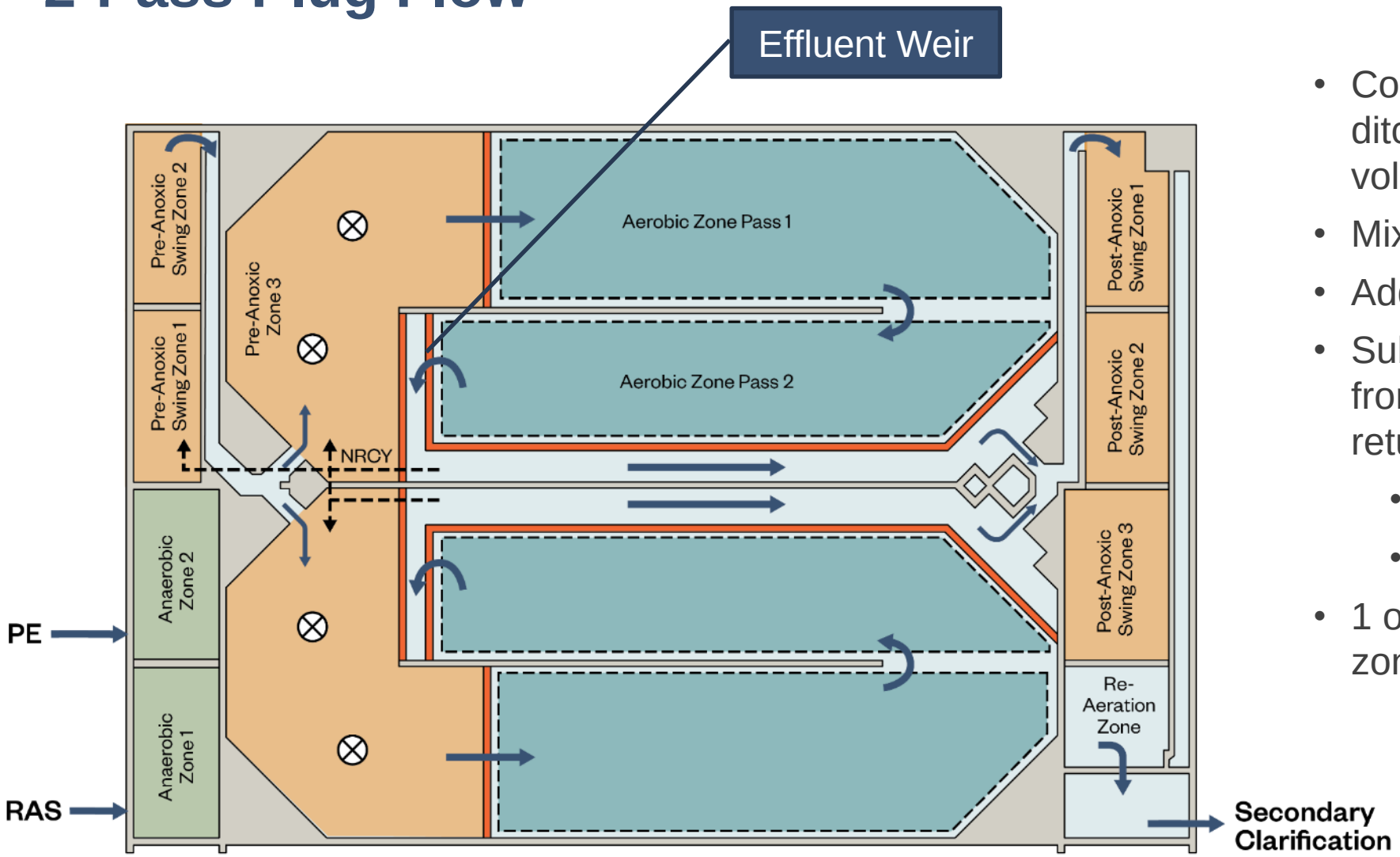


BioDenipho



- Install fine bubble diffusers on floor in the area of the existing brush aerators
- Keep the BioDenipho cycling (adjust cycle times, see next slide)
- Keep existing effluent weirs (fixed at their lowest elevation)

2-Pass Plug Flow



- Convert ~ 25% of the oxidation ditch volume to pre-anoxic volume
- Mixers
- Add effluent channel & weir
- Submersible NRCY pumps pull from end of Aerobic pass 2 and return flow to
  - Pre-Anoxic Swing 1 or
  - Pre-Anoxic Zone 3
- 1 or 2 mixers in pre-anoxic zone

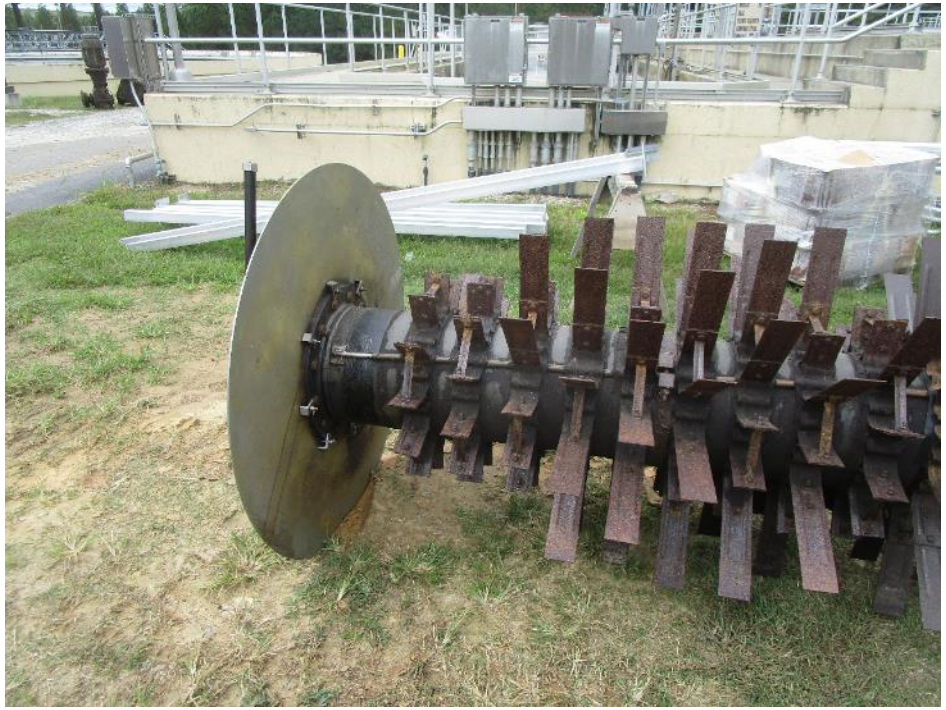
BioWin Modeling Results

Plant Flow	BioDenipho	Plug Flow
Peak Factor	MM	MM
Temperature, C	13	13
MLSS, mg/L	4,000	3,900
Carbon to post anoxic, gpd	85	220
Eff TN, mg/L	3.1	3.0
Eff NH3, mg/L	0.2	0.1
Eff. TP, mg/L	0.2	0.45

- Both plug flow and BioDenipho was able to meet effluent limits
- Supplemental carbon is necessary
  - **Model estimated less carbon necessary for BioDenipho**
- Capacity of BioDenipho ditches could be increase from 12.0 to 15.0 with the addition of one secondary clarifier

Decision Criteria

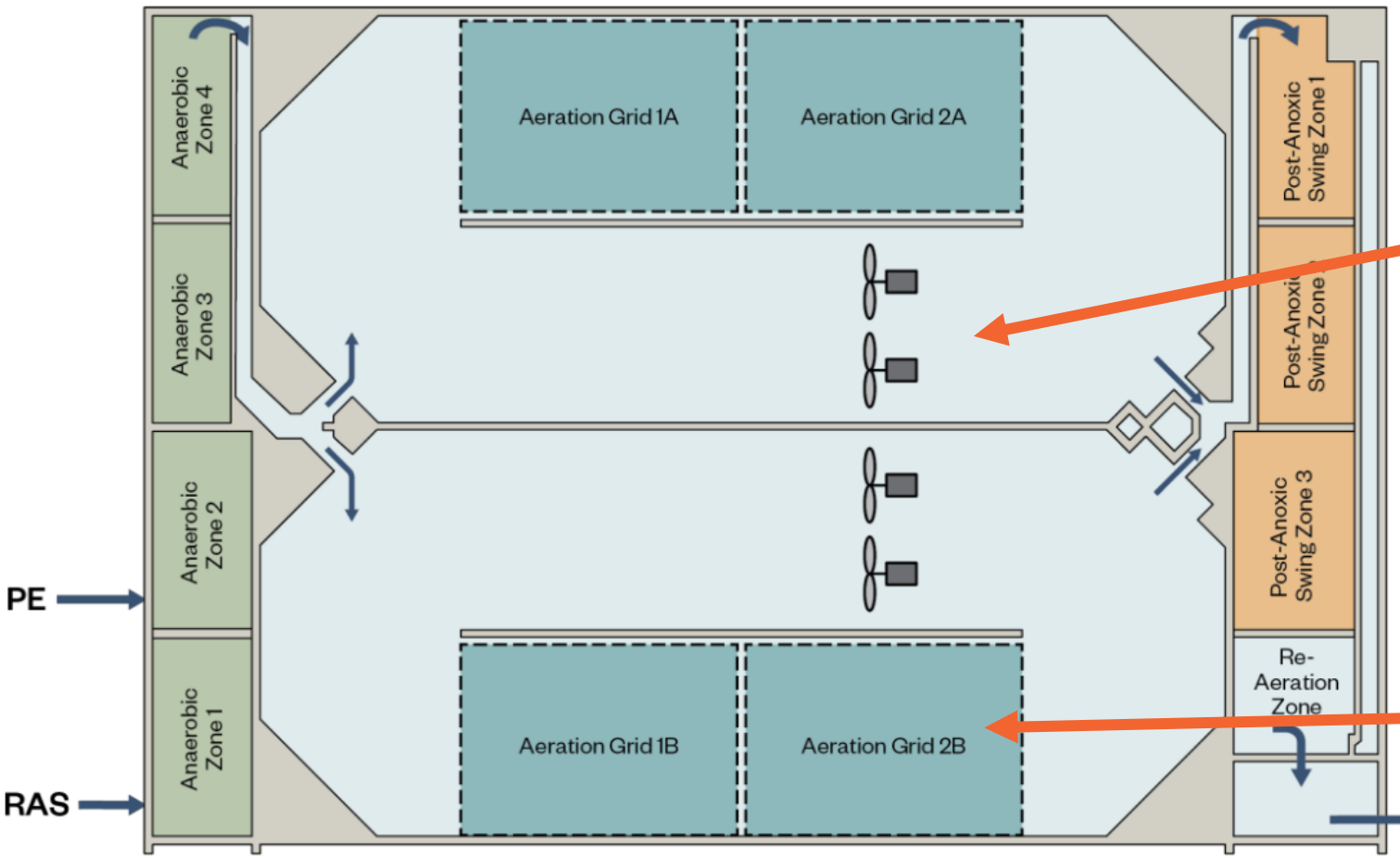
- Prepare for the NCWRF for future expansion
- Select a secondary process technology that:
  - **Continues to provide excellent nutrient removal**
  - **Improves energy efficiency**
  - **Improves reliability**
- Perform secondary process upgrades while plant can still operate with 1 basin offline

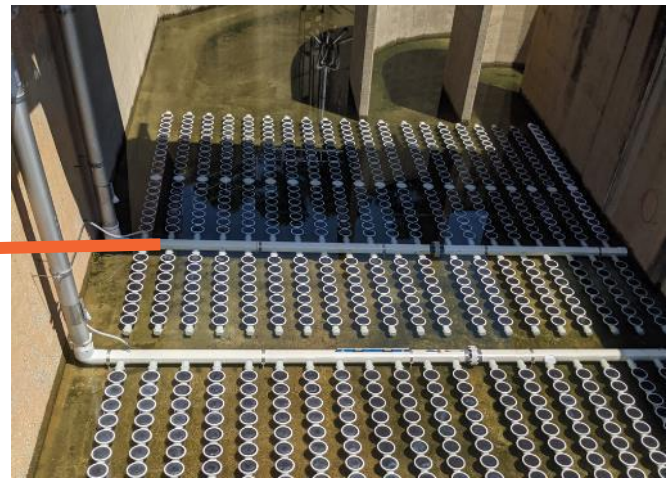


PER Decisions

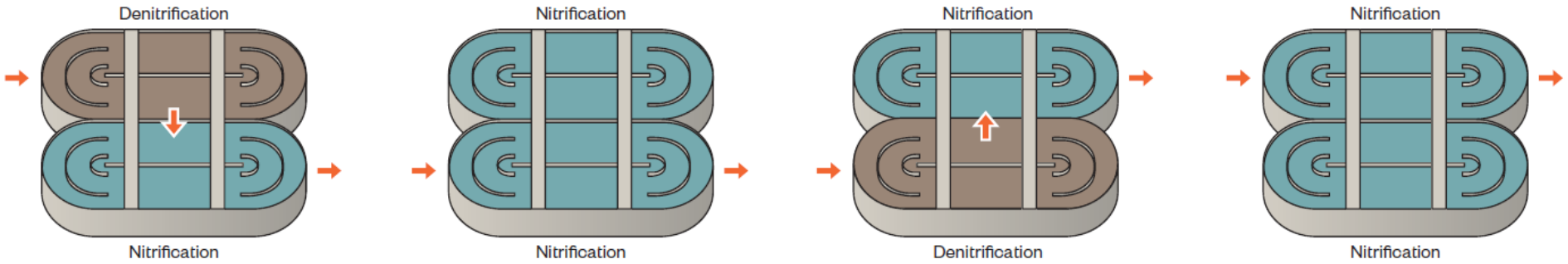
- Modification of BioDenipho™ ditches
  - **Keep BioDenipho™ configuration**
  - **Add fine bubble diffusers**
  - **Add new mixers**
- Blower facility - Multi-Stage blowers
- 5 mgd influent equalization pump station for wet weather
- Install chemical lines for future supplemental carbon addition

BioDenipho Modifications



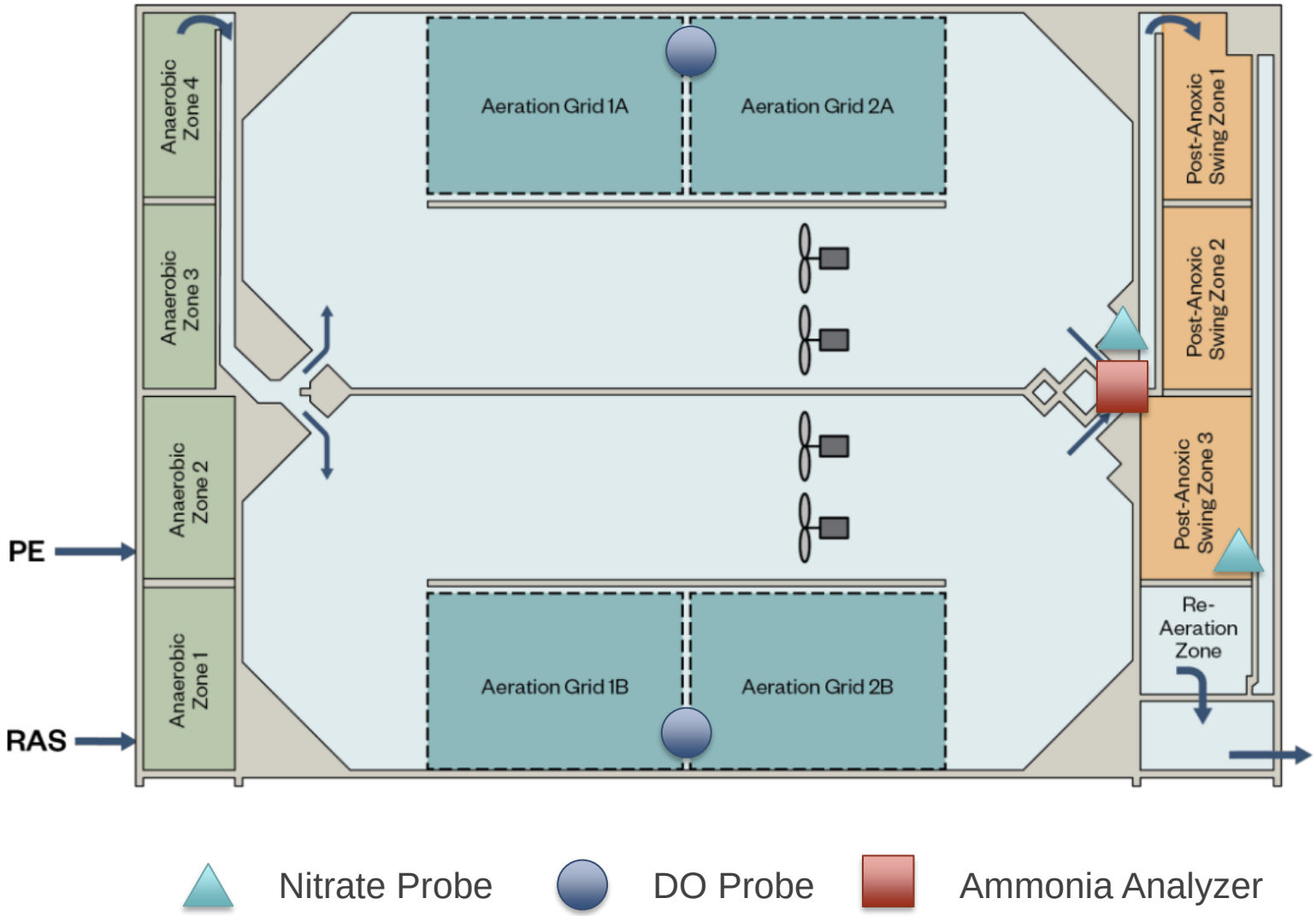


Evaluated Different Cycle times to maintain aerobic SRT



Condition	% Aerobic	Phase B (min)	Phase E (min)	Phase G (min)	Phase J (min)
Current	61	70	20	70	20
12 MGD	72	50	40	50	40
13.5 MGD	78	40	50	40	50
15.0 MGD	83	30	60	30	60

Biodenipho Instrumentation



Probe	Total #
Nitrate	2
DO	6
Ammonia	3

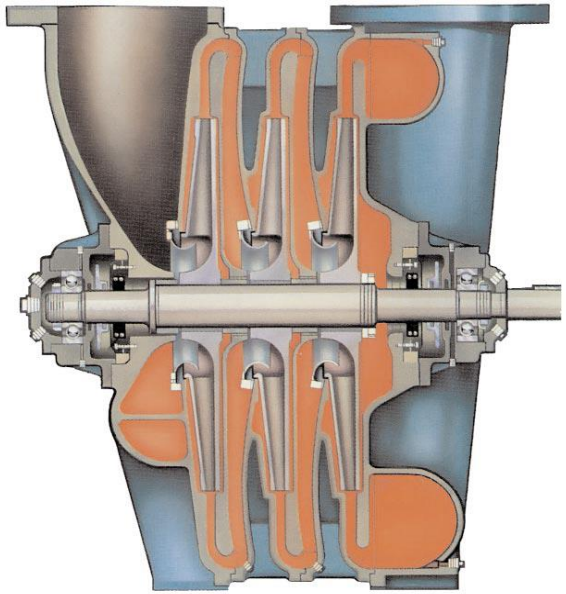
Nitrate Probe DO Probe Ammonia Analyzer

Multiple Blower Technologies Considered

- Multi-stage with inlet throttling (Gardner-Denver, Continental)
- Multi-stage with variable frequency drive (Gardner-Denver, Continental)
- Integrally geared with dual-point control (Turblex)
- High speed turbo blowers (air-foil bearing) (APG-Neuros)
- High speed turbo blowers (magnetic bearing) (ABS-Sulzer)

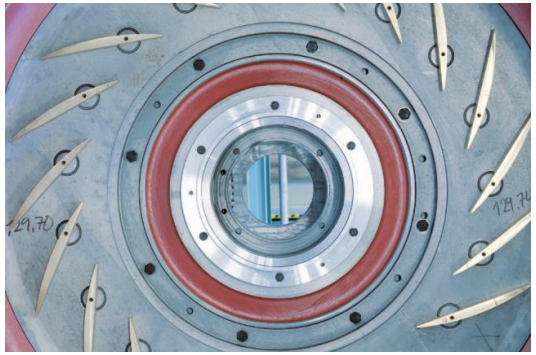
Multistage Centrifugal Blowers

- Multiple impellers in series increase air pressure
- Historically used at medium to large WWTPs
- Have good track record / reliable operation
- Efficient operation at design point
- Less efficient at turndown
  - **Inlet throttling**
  - **VFDs**



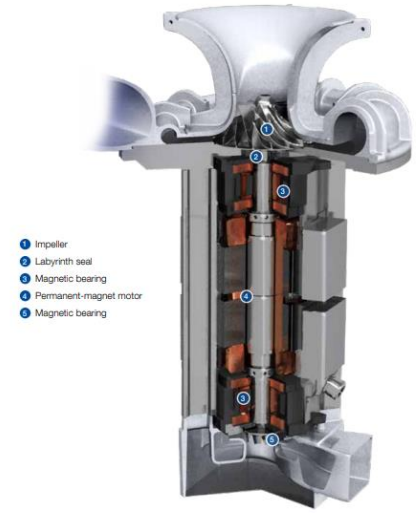
Single Stage Centrifugal Blowers

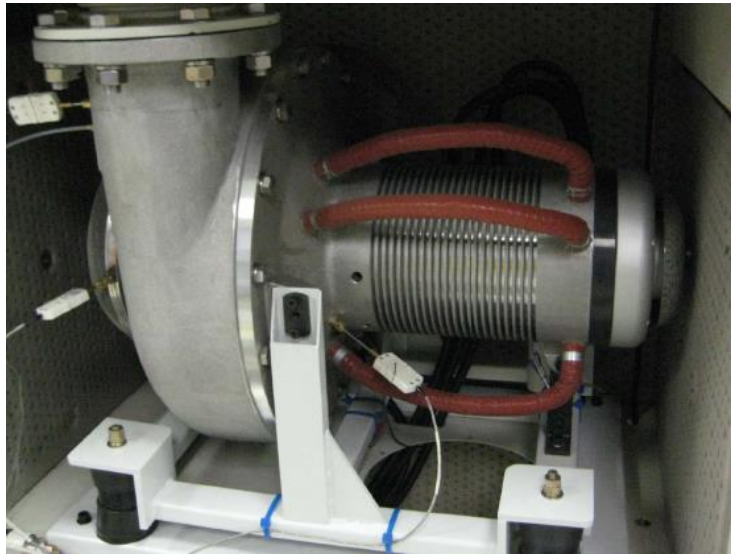
- Inlet guide vanes
  - Adjust to achieve the most efficient operating point at current conditions
- Discharge Diffuser vanes
  - Adjust to deliver the appropriate airflow
- Gearing system increases motor speed to impeller
- Used at medium to large WWTPs
- Efficient over wide range of air flows
- Complex lubrication system



High Speed Direct Drive/Gearless Blowers (aka Turbo Blowers)

- Blower and motor directly coupled
- Blower speed varied with VFD
  - **More efficient turndown than multistage**
  - **VFD and controls integrated into blower package**
- Two bearing designs
  - **Air-foil**
  - **Magnetic bearing**





Typical Blower Efficiencies & Turndown

Multistage Centrifugal
Inlet Valve or VFD
50% - 68% Efficiency
30% - 50% Turndown

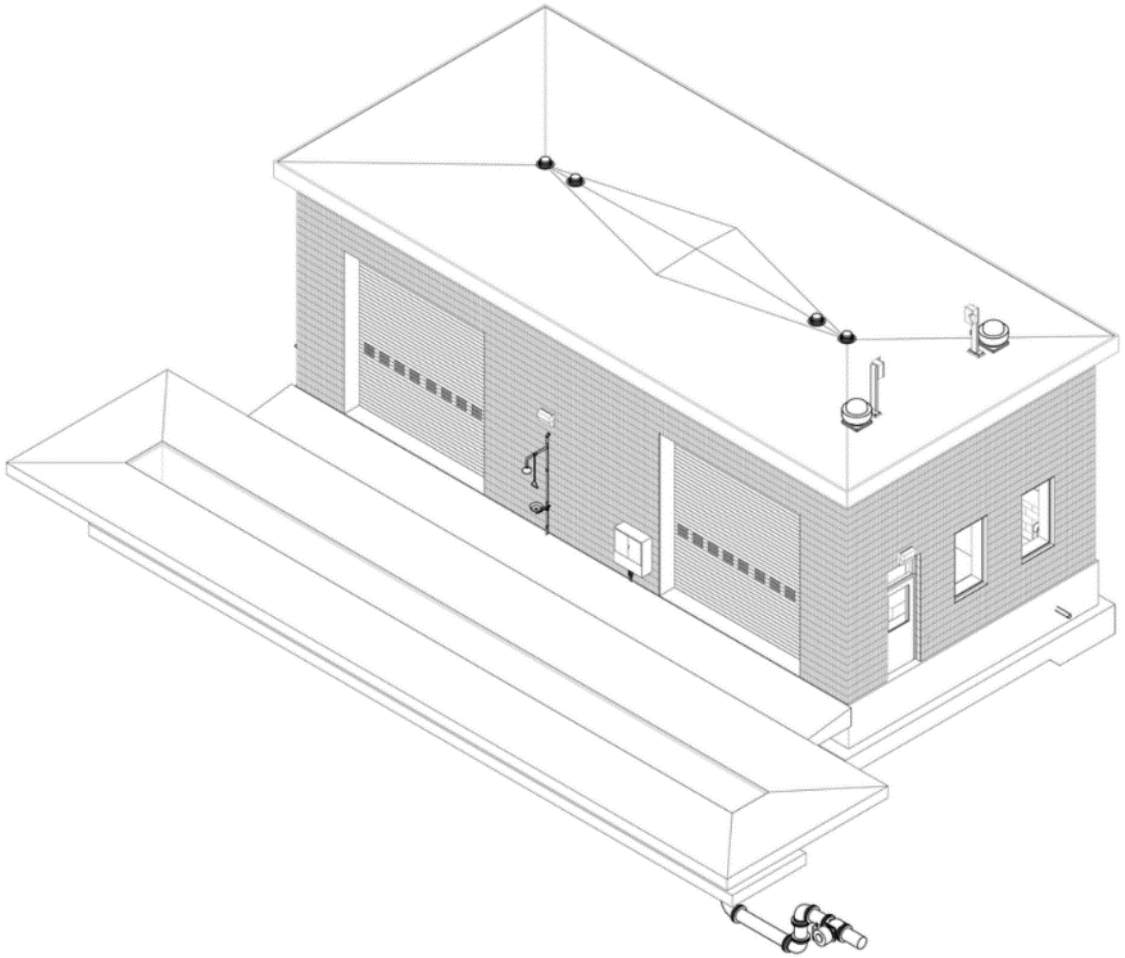
Single Stage Integrally Geared
Inlet Guide Vanes & Diffuser Vanes
65% - 78% Efficiency
50% - 60% Turndown

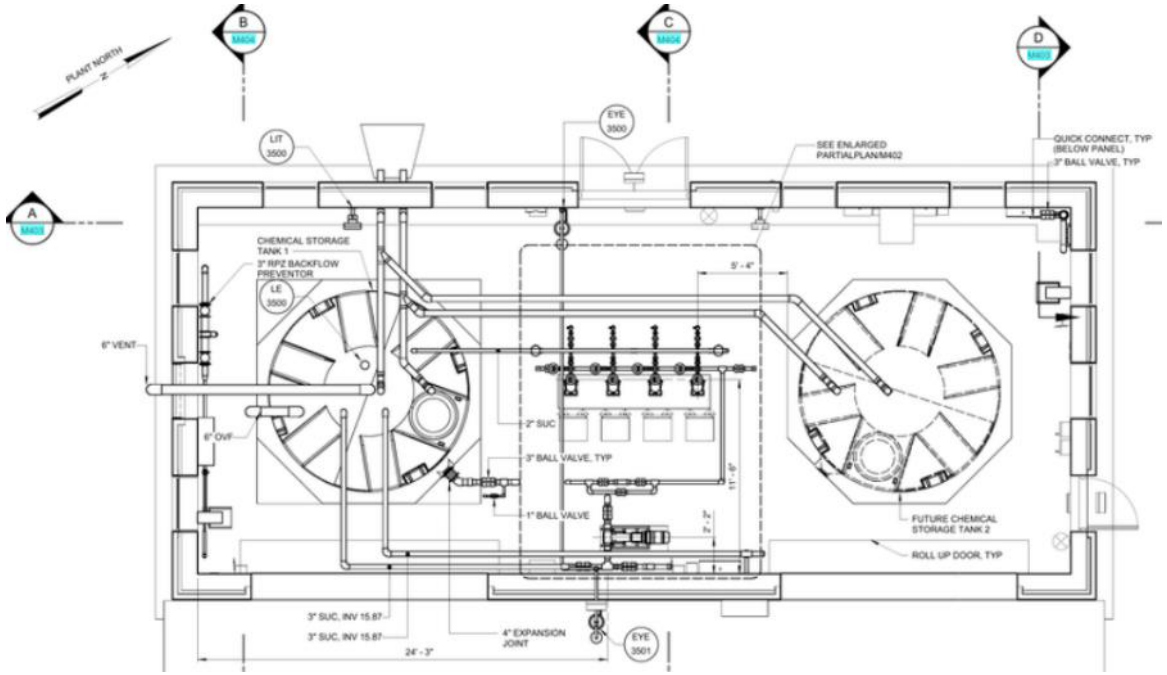
High Speed Turbo
VFD
65% - 78% Efficiency
35% - 50% Turndown

- Multi-stage with VFD the best combination of energy savings / capital cost / maintenance

Supplemental Carbon Facilities Designed, but not Installed

Carbon feed lines were installed





Construction

- Timeline
  - **2018 PER (6 Months)**
  - **2019 Detailed Design & Permitting (1 year)**
  - **2020-2022 Construction (2 years)**
- $15 Million Dollars; 2 Years Contract Time
- Started May 2020 – End June 2022
- COVID IMPACTS!

VEOLIA

HACH®

CROWDER

Hazen

CARY | NORTH CAROLINA

Lord & Company
INDUSTRIAL AUTOMATION

Construction Photos 2020 – May & June

Construction Photos 2020 – August & October

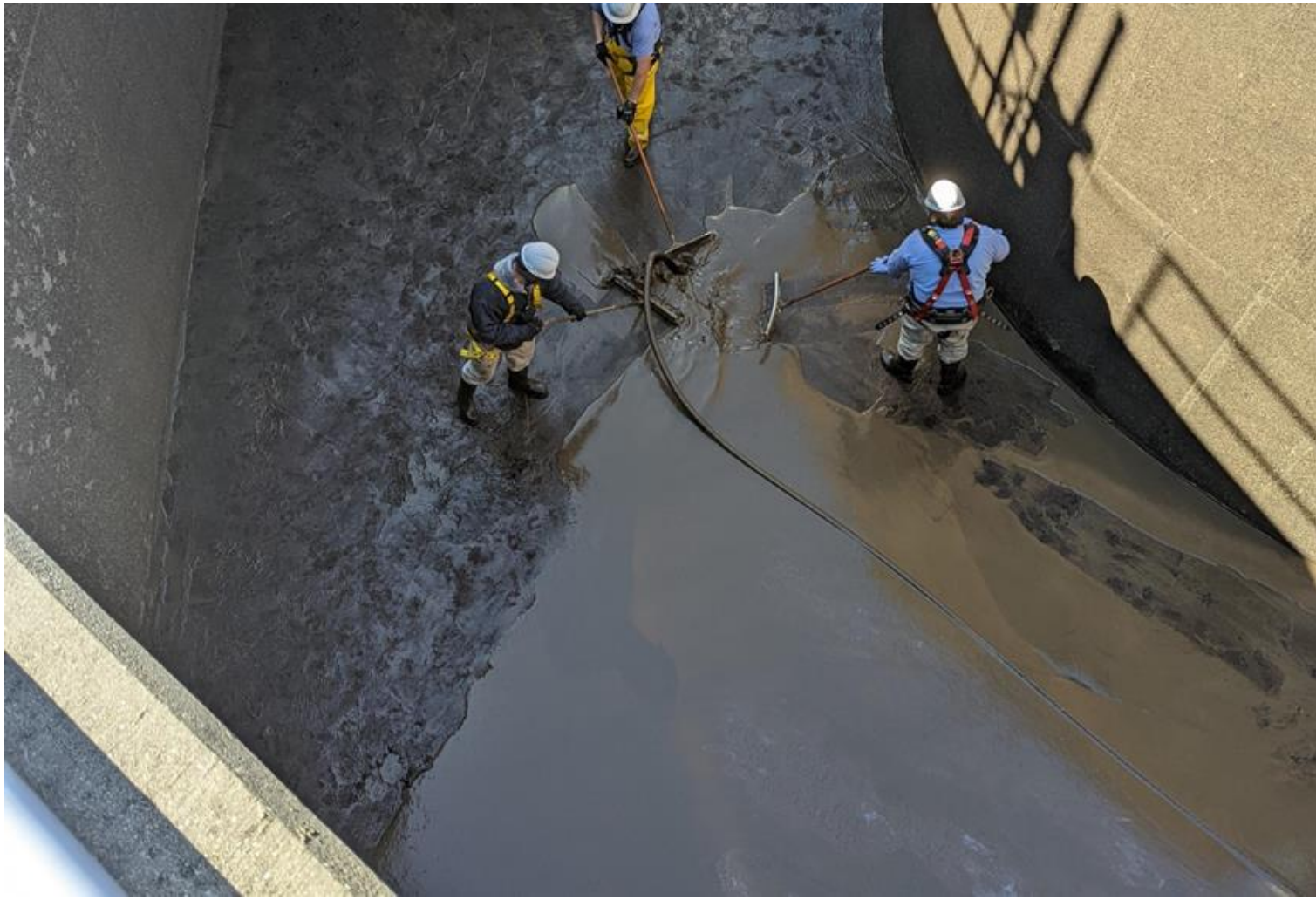
Construction Photos 2020 – November & December

Basin Air Piping Upgrades

Biosolids Transfer - 4MG

- Started at 3am; Finished at 12 noon (9 hours!)
- 14+ Pumps running at idle speed; not damage bacteria
- Two Transfers successfully completed in Project

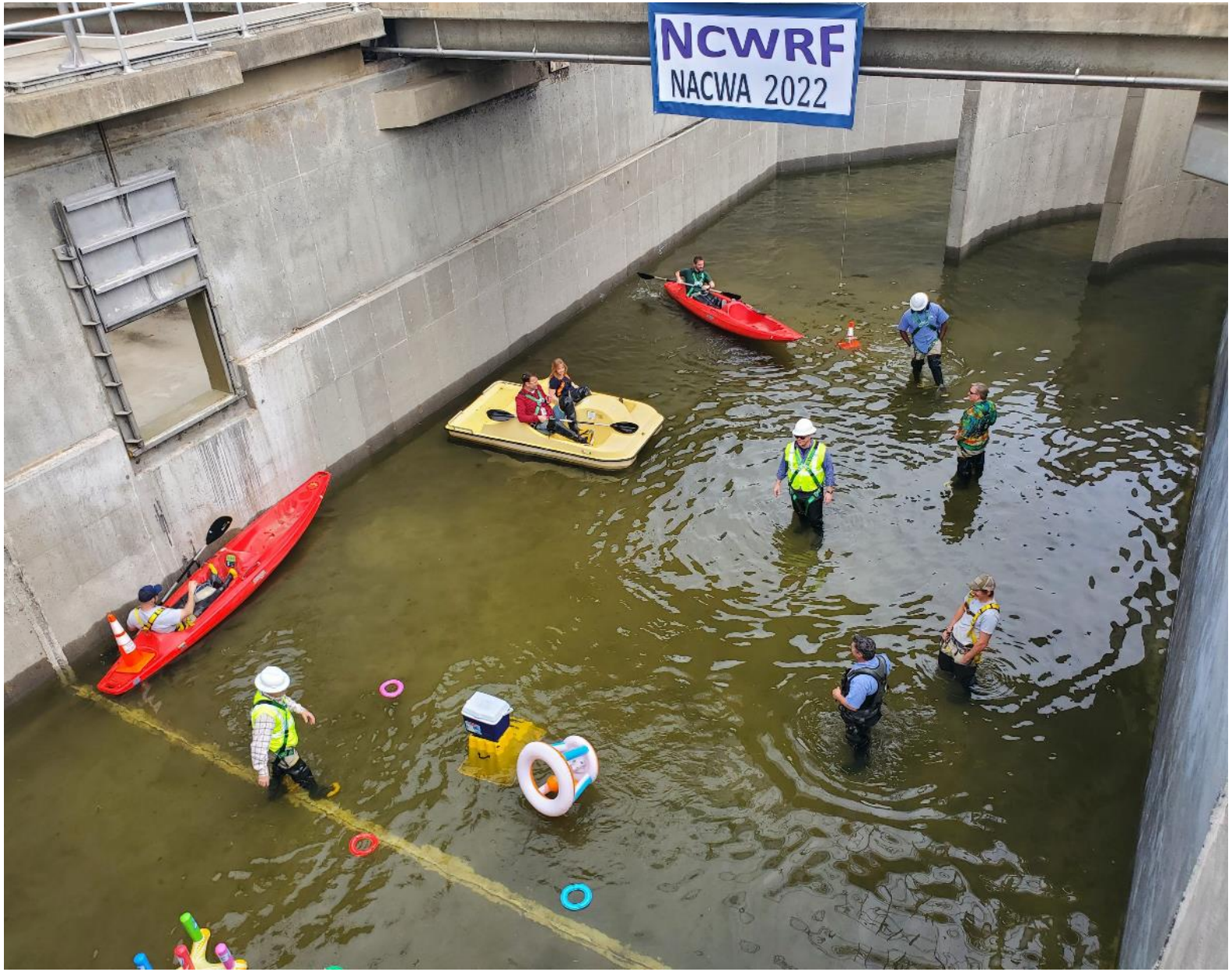
Cleaning Basins



Cleaning Basins

What's the best thing to do in a clean basin?

GO BOATING!!



Control / Instrumentation

HACH Equipment

- Filtrax – Pumps sample from basin, filters
- Amtax – Reads sample for Ammonia concentration (mg/l)
- Nitritax - Reads sample for Nitrate concentration (mg/l)
- SC1000 – Displays for each basin, removeable
- Every 10 minutes real time data!

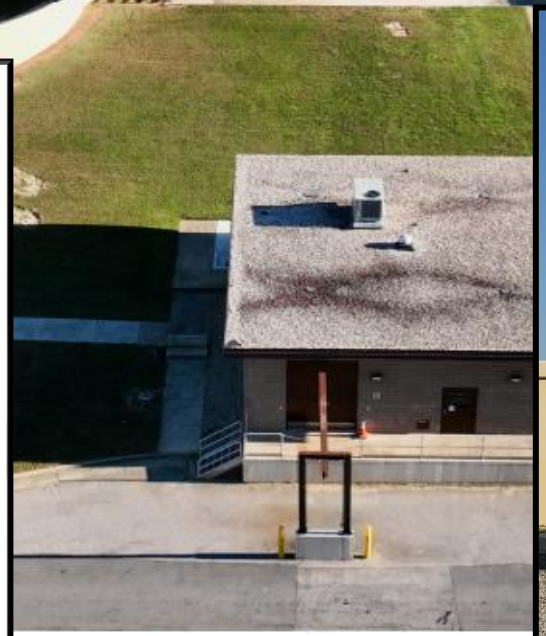
Multistage Blower Facility

Advantages:

- Old proven technology; Highly efficient; Have some on facility 20+ years old
- Added VFDs for energy efficiency
- Easy to Repair! Parts overnighted, technician arrives, back in business

Equalization Pump Station

- 5 MGD Capacity
- 16" DIP Force main; Pump back to the headworks
- Provides operational flexibility to empty EQ basins in 1 day
- Currently 1 – 10" Drain line (takes days to empty)

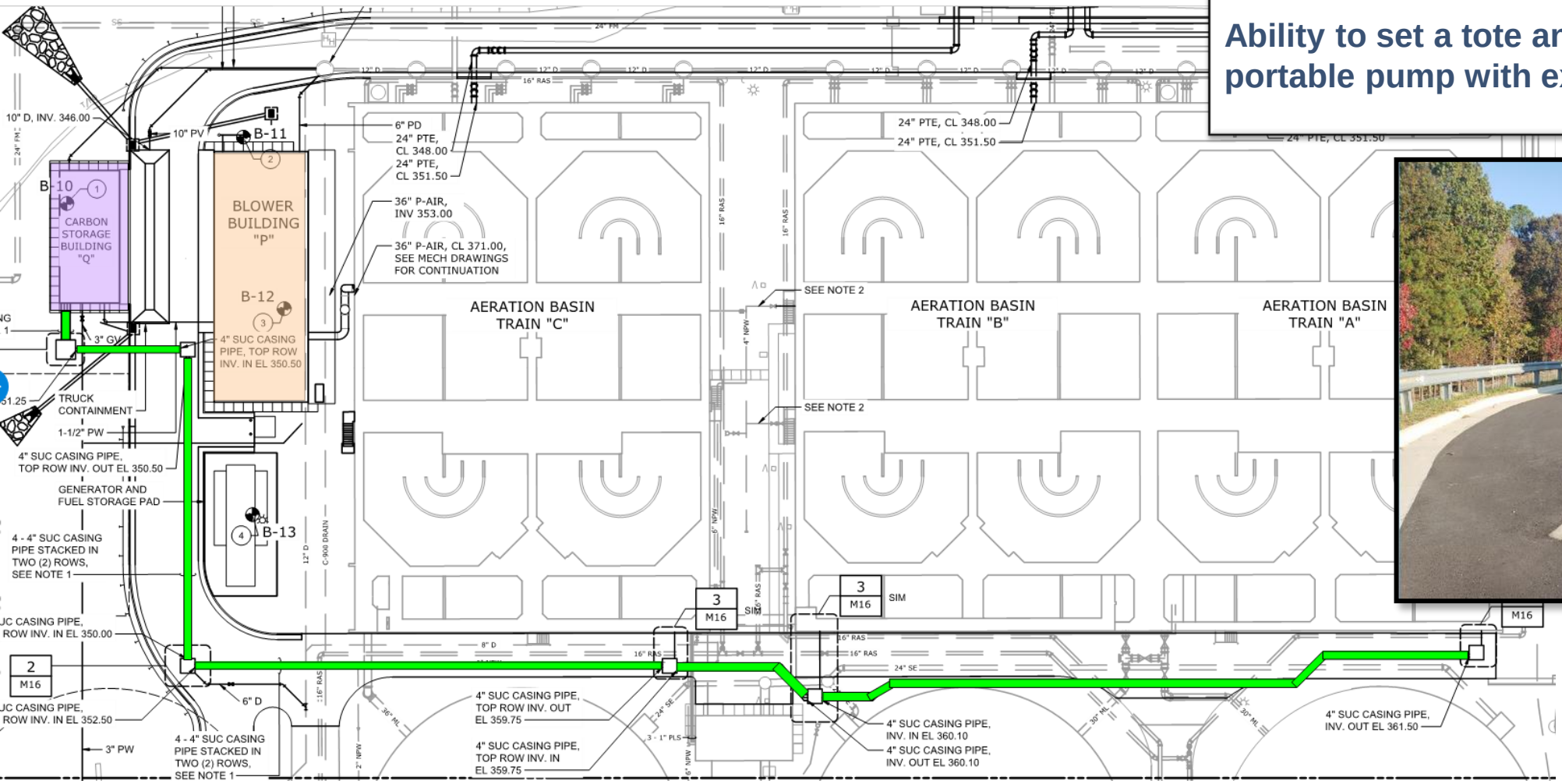


Chemical Lines

Carbon Storage Building (Purple Square) not needed until 15 mgd expansion

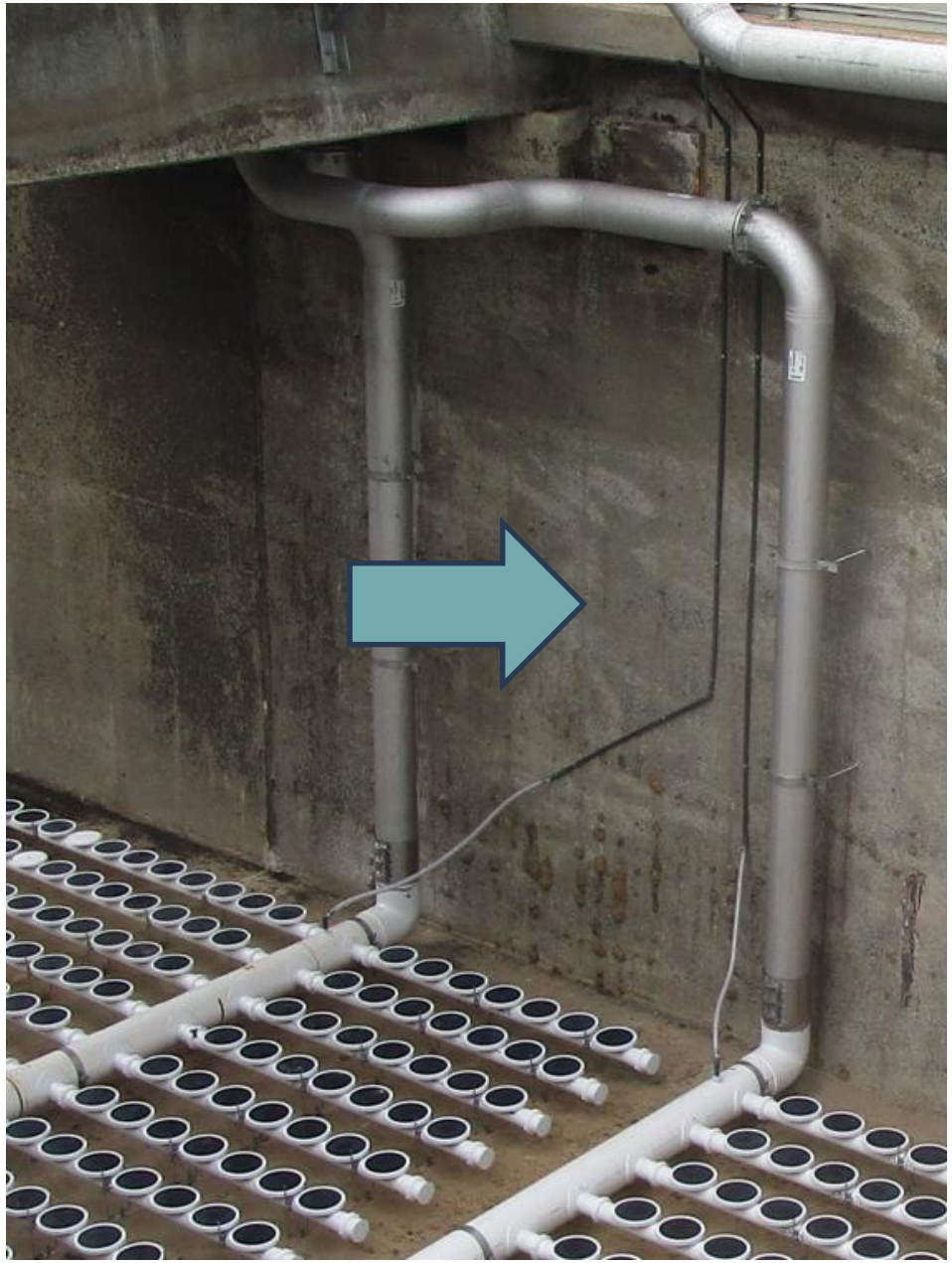
Instal chemical lines/vaults, Truck containment area

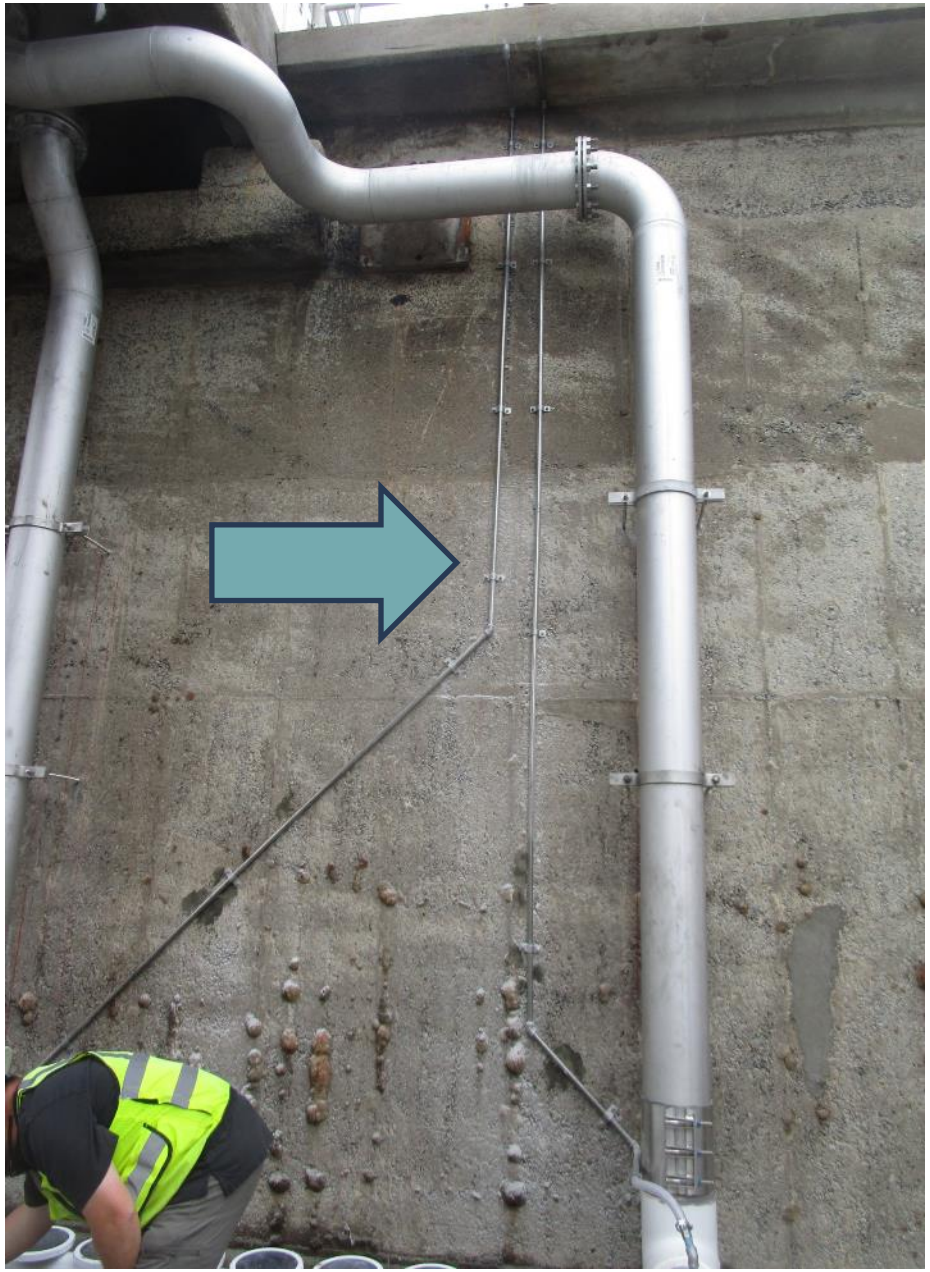
Ability to set a tote and feed chemical with a portable pump with external outlet if needed.



Project Problems:

<u>Issue #1</u>
Purge Line Breaks!



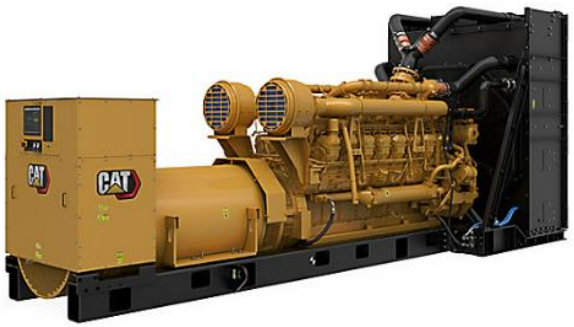


Issue #2: Melted Wire in VFD

Issue #3: Scuba Steve and the Steel Plate

New 2 Megawatt Generator

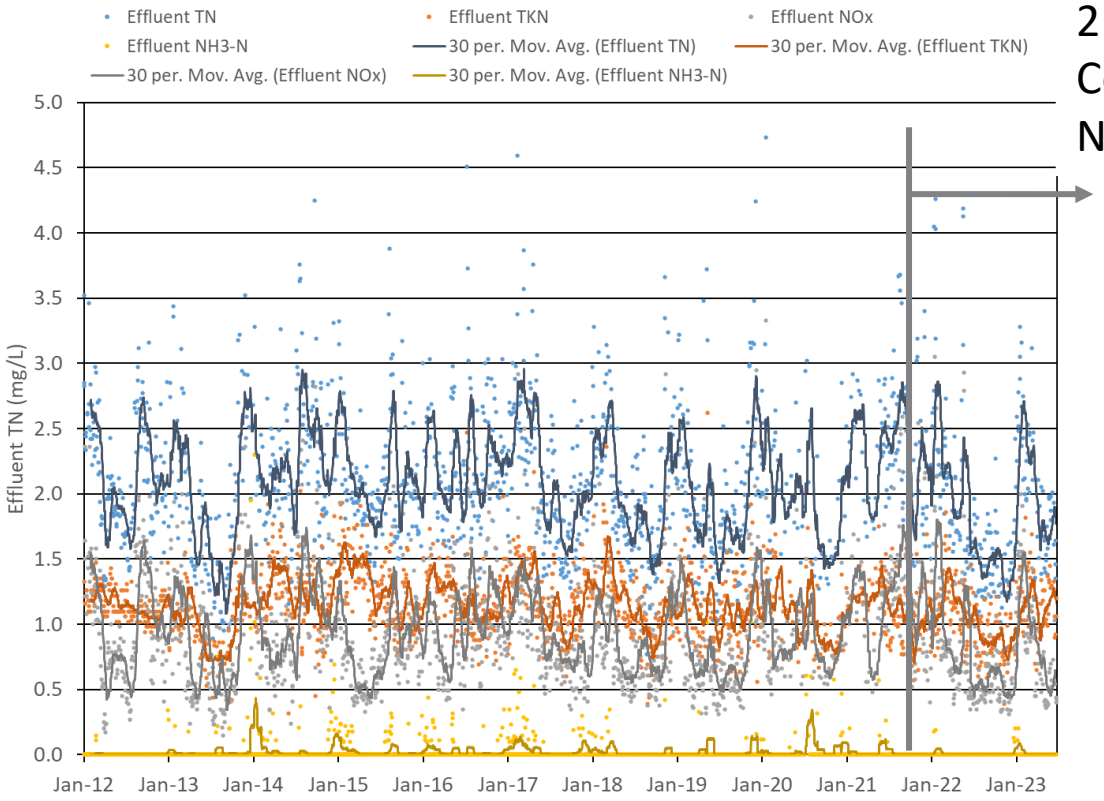
- CAT 3615C Model
- 16,000-gallon belly fuel tank
- Sound attenuated (62 dBA measured at 7 meters away)
- Load bank
- Sized for future (15 mgd) needs
- Includes Fuel Polishing system (300 gallons per hour) 5 GPM



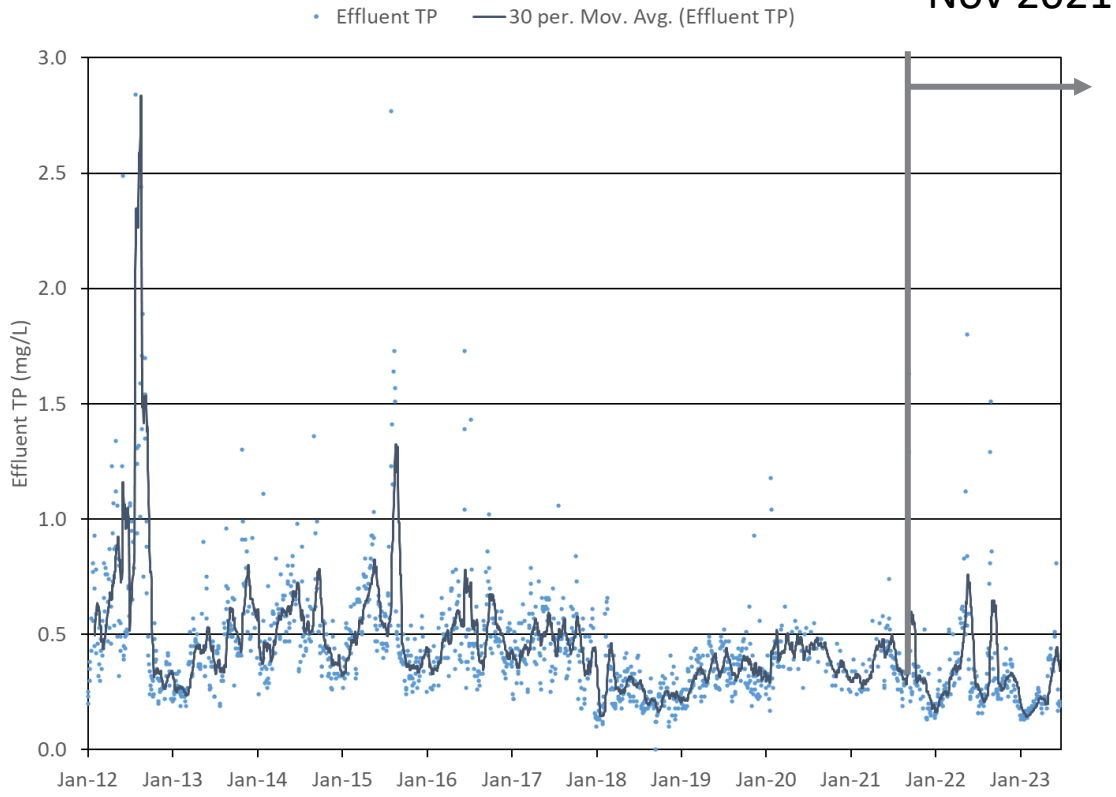
- Goldhofer modular hydraulic platform trailers.
- 16 Independent turning axels to make very tight turns!!

Setting Generator March 2021

Effluent TN and TP 2012 – 2023



2 Basins Complete Nov 2021



2 Basins Complete Nov 2021

Effluent TN = 2.1 mg/L

Effluent TP = 0.44 mg/L

Lessons Learned

- **Involve** plant staff throughout design and construction, use the knowledge and experience!

- **Move IN**! Beneficial for Town Engineer/PM to be on site for the duration of the construction project

- **Talk it out**! MOPO of biomass transfer beneficial to maintaining compliance during construction

- **Follow your GUT instinct**! We noticed the purge line design was inadequate

Thank you!

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