February 7, 2023

NYWEA 95th Annual Meeting

MIAMI-DADE CENTRAL DISTRICT WWTP HIGH PURITY OXYGEN PRODUCTION FACILITY IMPROVEMENTS

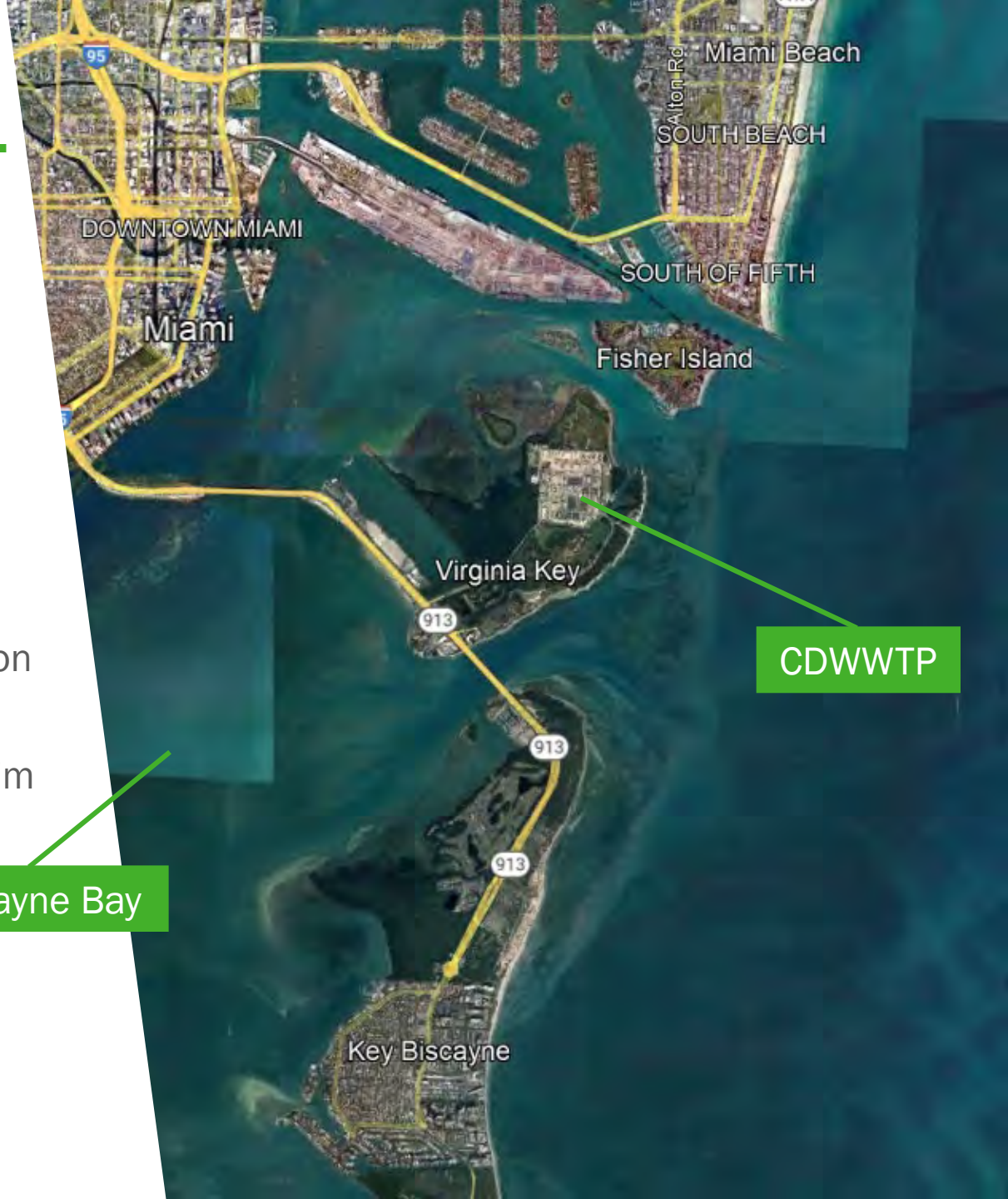
Presenters: Jeff Lowe, PE & Travis Parsons, PE

MIAMI-DADE COUNTY

WADE TRIM

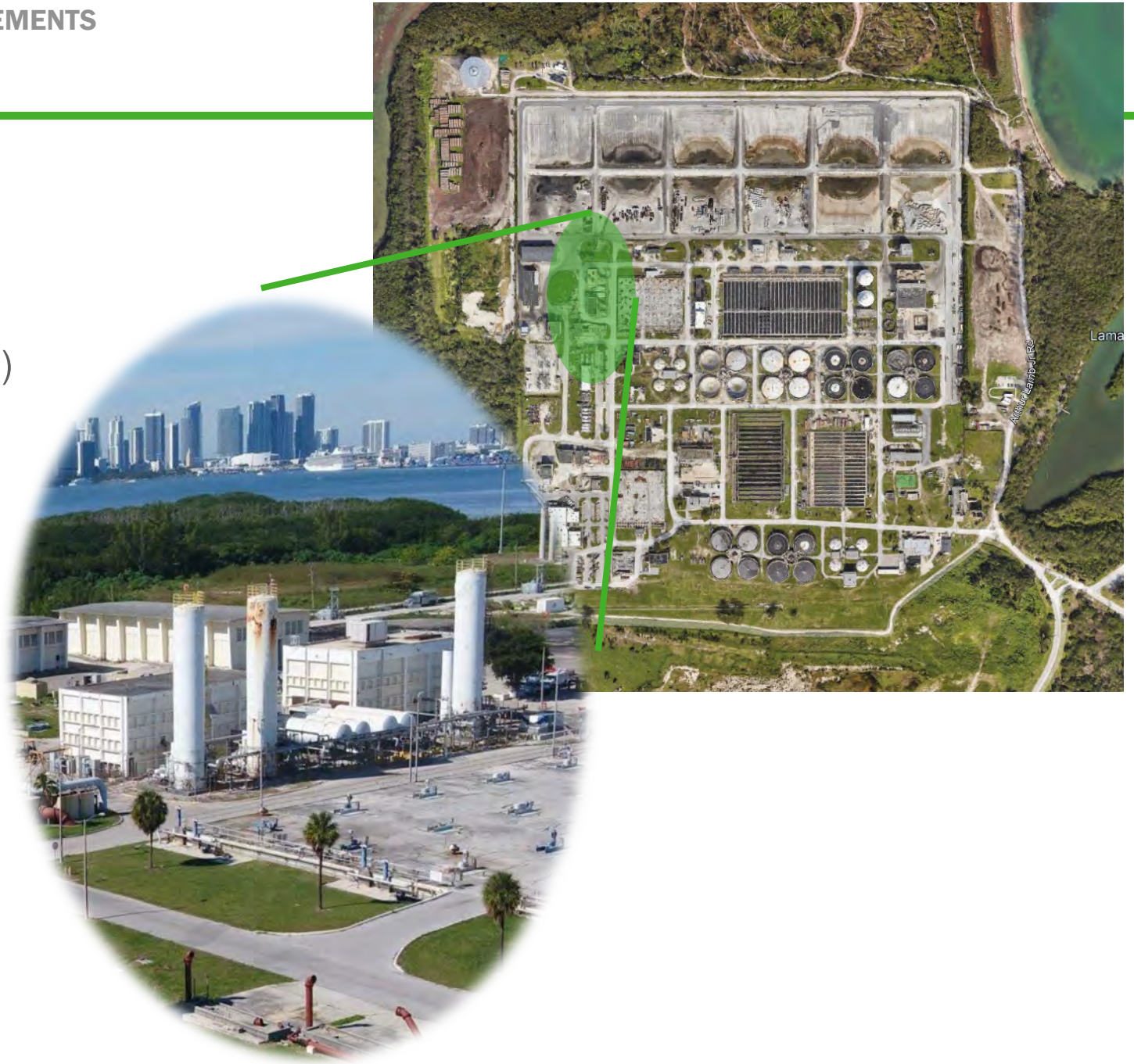
PROJECT OVERVIEW

- ✓ Central District Wastewater Treatment Plant (CDWWTP)
- ✓ Located in Miami-Dade County on Virginia Key
- ✓ 143 MGD High Purity Oxygen Activated Sludge (HPOAS) Facility
- ✓ Current AADF approximately 116 MGD
- ✓ Two new 90 ton per day Vacuum Pressure Swing Adsorption (VPSA) parallels existing Cryogenic system
- ✓ Design-Build project delivery – PCL Construction/Wade Trim



EXISTING SYSTEMS

- ✓ Three 70 TPD Cryogenic Plants (N+1)
- ✓ Cryo Trains 1 & 2 are 43 years old (1980)
- ✓ Cryo Train 3 is 28 years old (1995)
- ✓ Four 15,000 gal liquid oxygen tanks
- ✓ Four hot water bath vaporizer



HIGH PURITY OXYGEN ACTIVATED SLUDGE PROCESS

HPOAS has been in use since 1970s

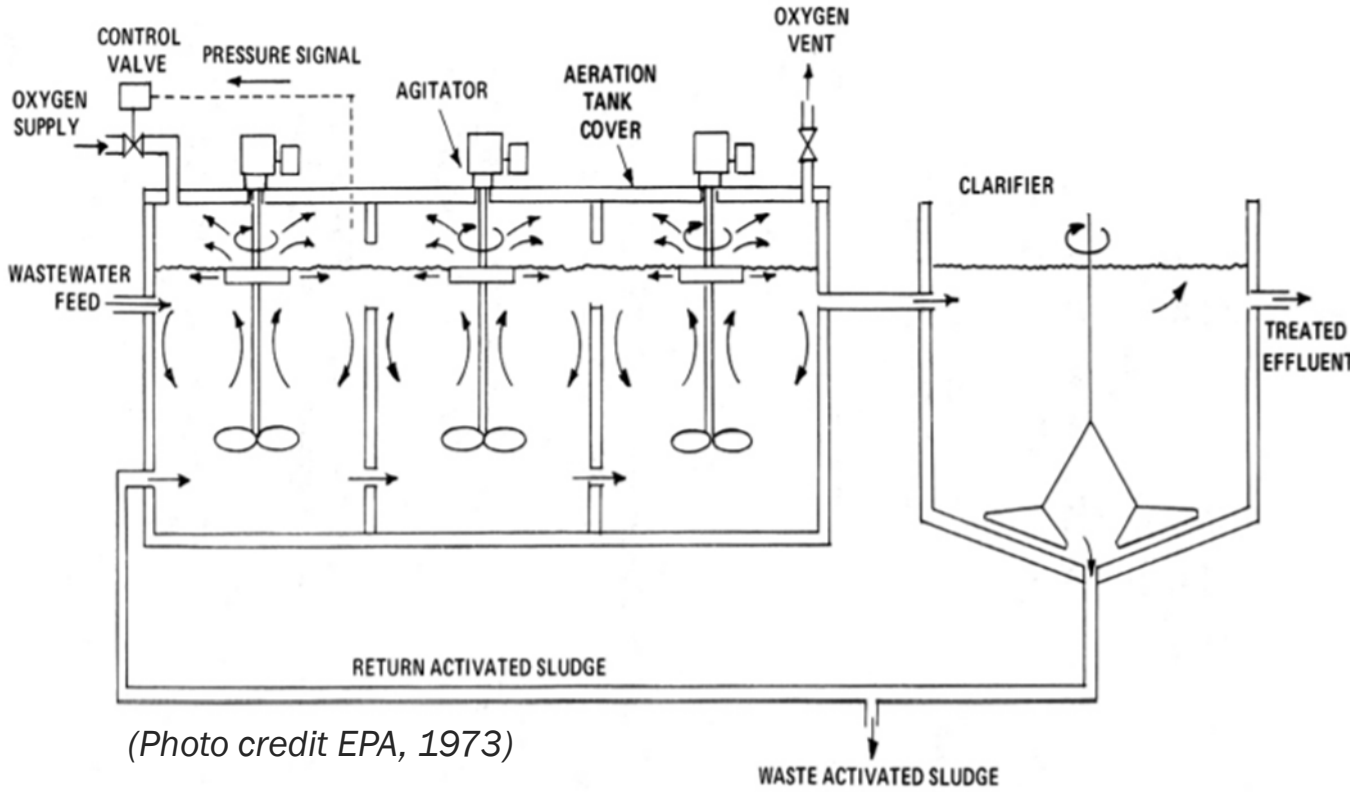
Why use HPOAS?

- ✓ Greater MLSS concentrations = smaller footprint
- ✓ Improved sludge settling
- ✓ More biomass = Increased loading

Why not?

- ✓ Capital cost
- ✓ Complexity
- ✓ Short SRTs limit BNR capability – research ongoing
- ✓ Safety

How do we create high purity oxygen?



(Photo credit EPA, 1973)

HIGH PURITY OXYGEN TECHNOLOGY

Selection Considerations

- ✓ Liquid Oxygen Production
- ✓ Noise
- ✓ Turndown capability
- ✓ Operating pressure
- ✓ Energy consumption
- ✓ Startup Time
- ✓ Simplicity of operation
- ✓ System Safety
- ✓ Maintenance requirements
- ✓ Parts availability
- ✓ Life cycle cost

HIGH PURITY OXYGEN PRODUCTION SYSTEMS – CRYOGENIC

Cryogenic Air Separation Units

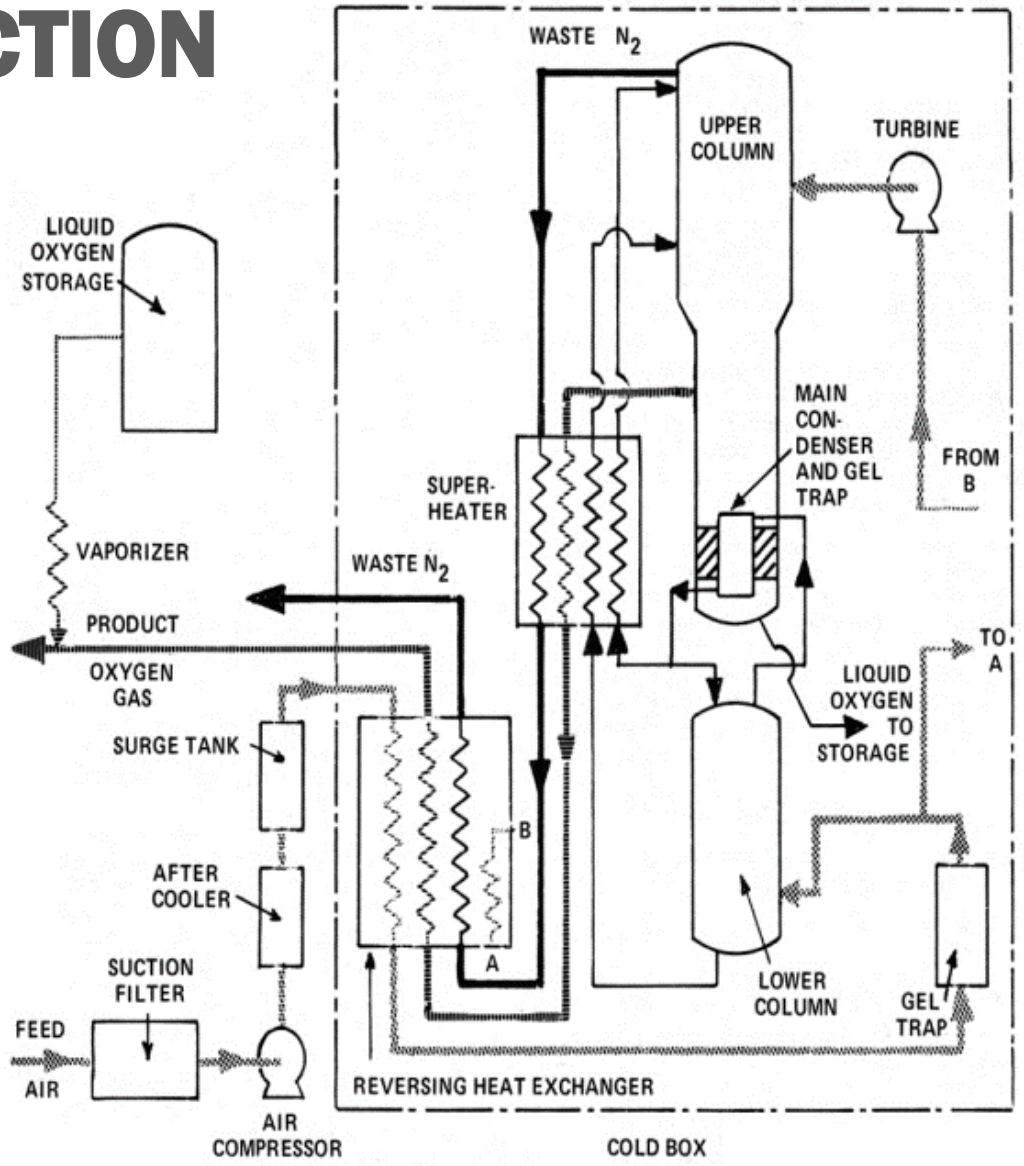
Liquid fractional distillation process

Advantages

- ✓ High purity ~ 95%+
- ✓ Can produce liquid oxygen

Disadvantages

- ✓ Energy Intensive
- ✓ Requires tall cold box structures
- ✓ Complex to operate and maintain
- ✓ Takes days to bring system up to full capacity



HIGH PURITY OXYGEN PRODUCTION SYSTEMS – VACUUM PRESSURE SWING ADSORPTION (VPSA)

VPSA Systems

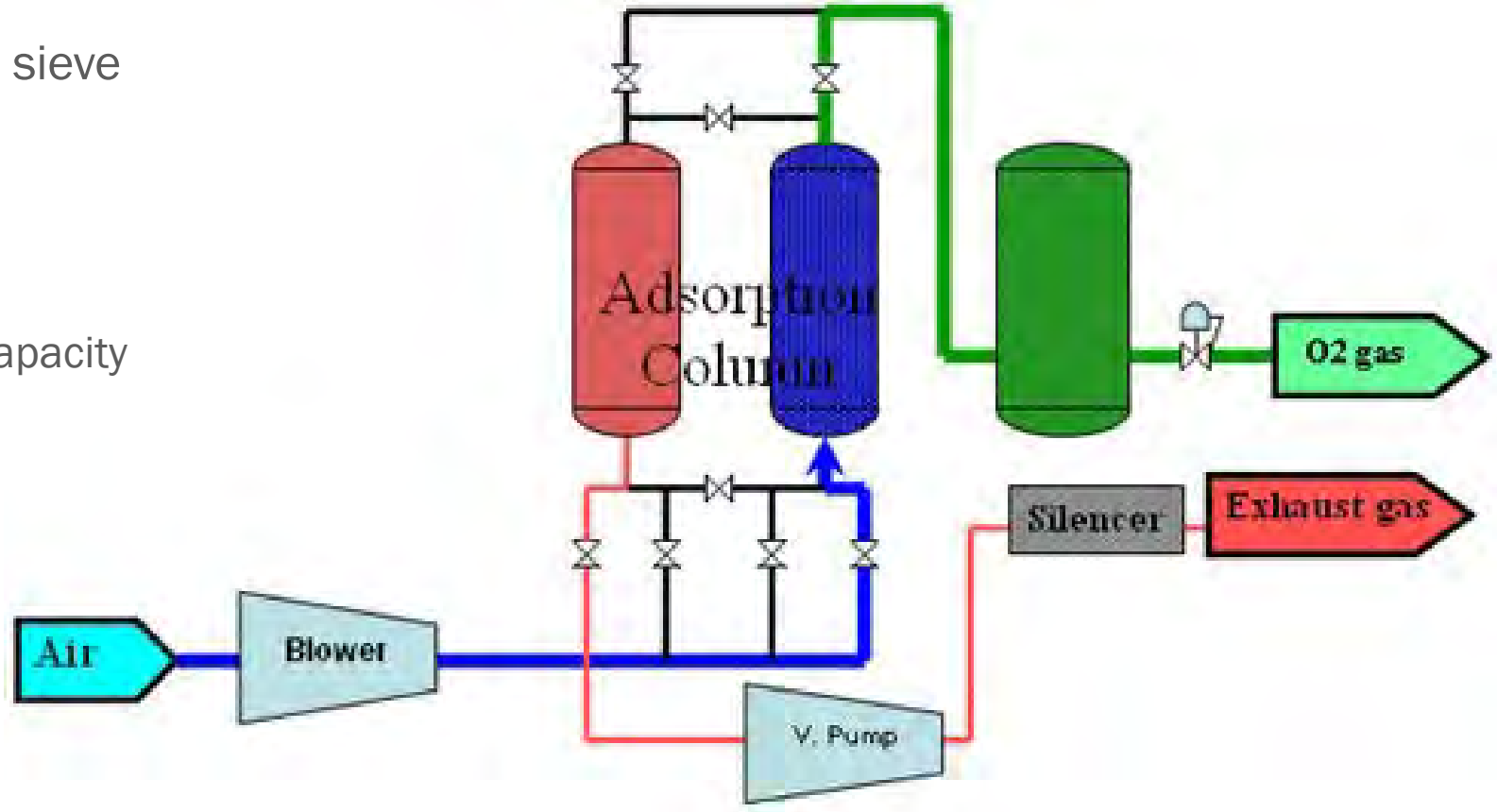
Adsorption process using molecular sieve

Advantages

- ✓ High purity ~ 93%+
- ✓ Simple to operate and maintain
- ✓ Better turndown capability - 40% of capacity
- ✓ Lower operating pressures
- ✓ Quick startup within minutes
- ✓ Reduced Energy Consumption

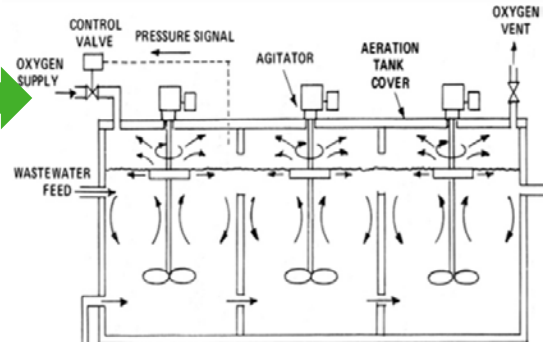
Disadvantages

- ✓ Noise from blowers (over 100dba)
- ✓ No liquid stream production
- ✓ Susceptible to moisture

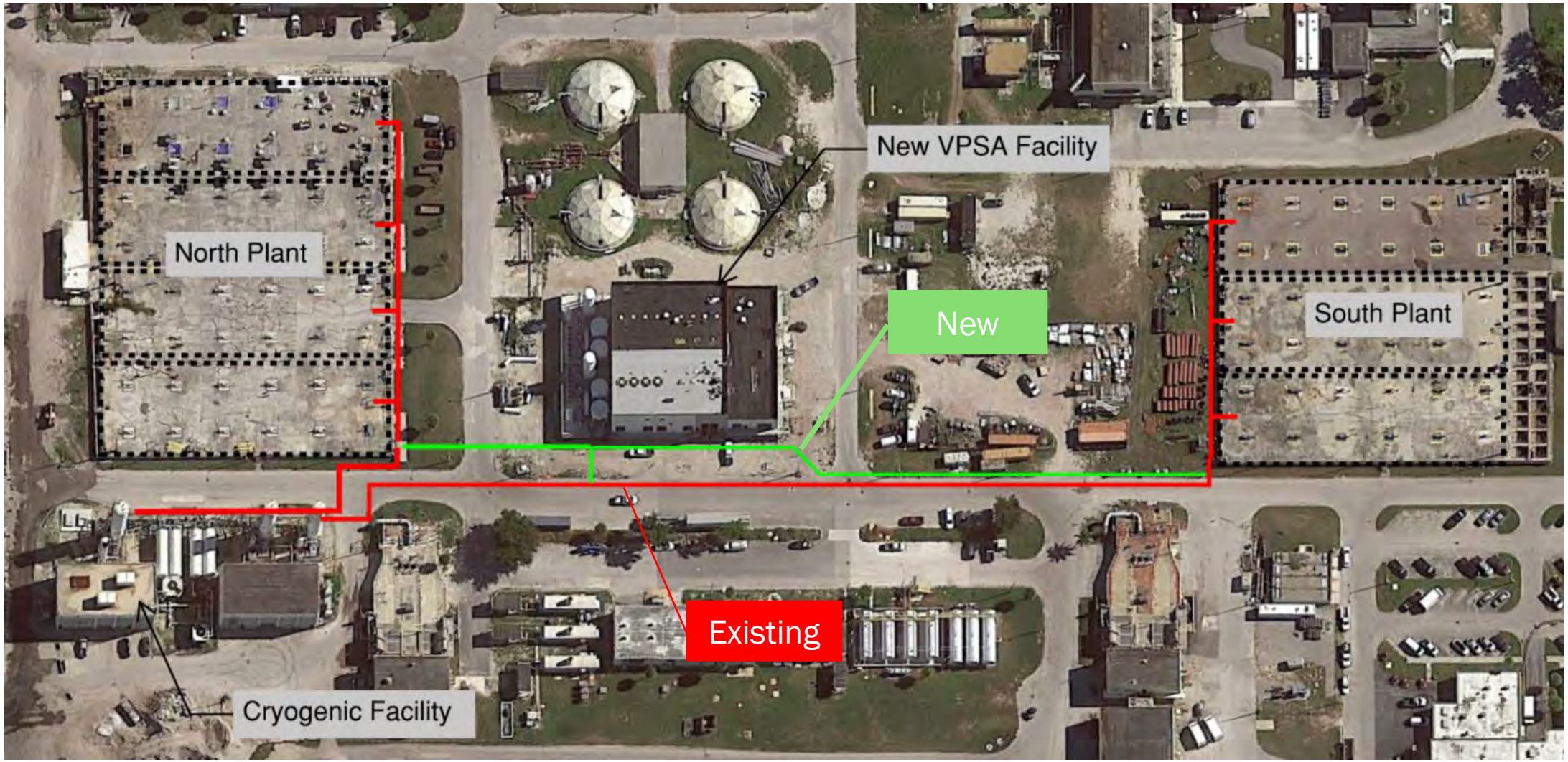


INTEGRATING OLD AND NEW SYSTEMS

- ✓ Cryogenic systems 1 and 2 to be decommissioned
- ✓ Oxygen supply sources maintain manifold pressure
  1. Cryogenic System 3
  2. VPSA
  3. Liquid Oxygen (LOX)
- ✓ Reactor Valves - Flow paced or DO control

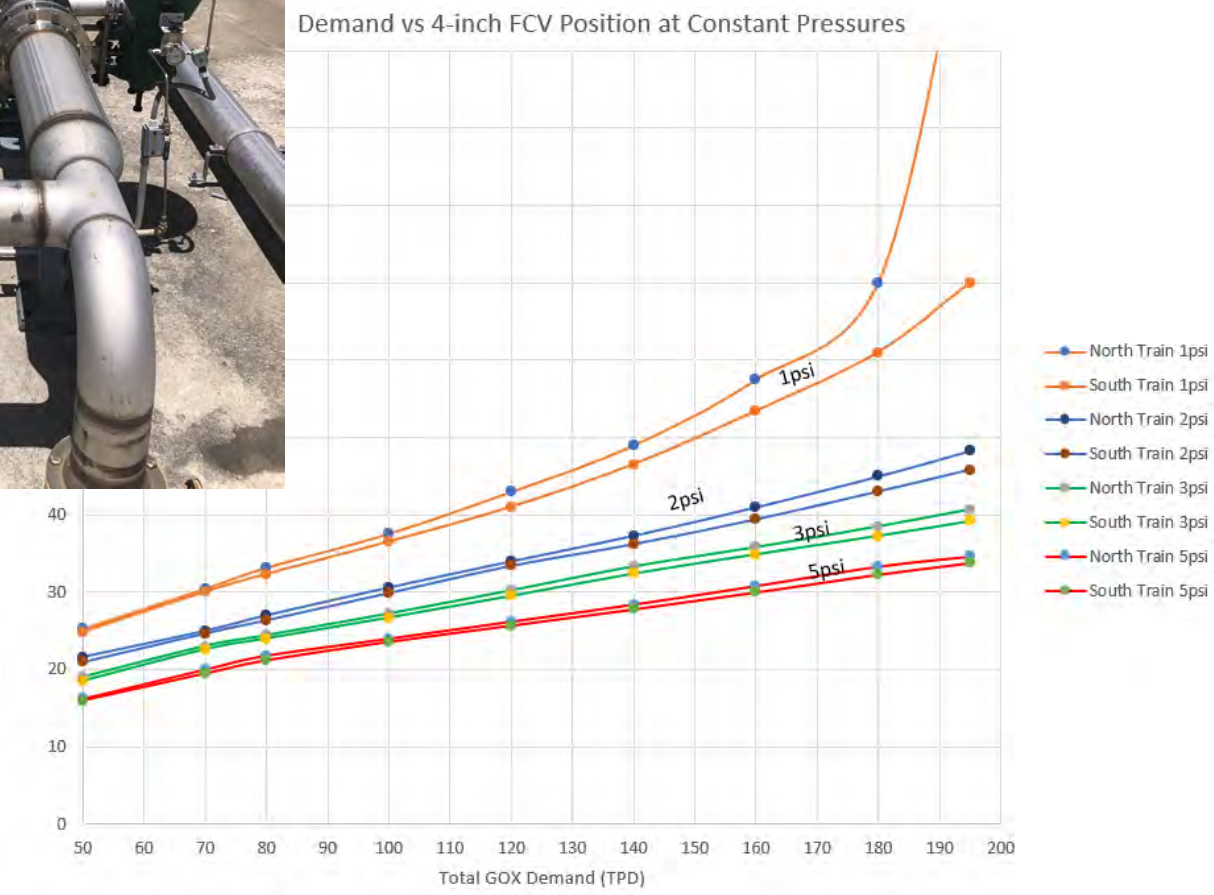


INTEGRATING PIPE NETWORK



SYSTEM MODELING

- ✓ Modeled with AFT Fathom
- ✓ Modeled combinations of system flow/pressures
- ✓ Modeled existing flow control valves to ensure proper GOX flow control capability



INTEGRATED SYSTEM CONTROL STRATEGY

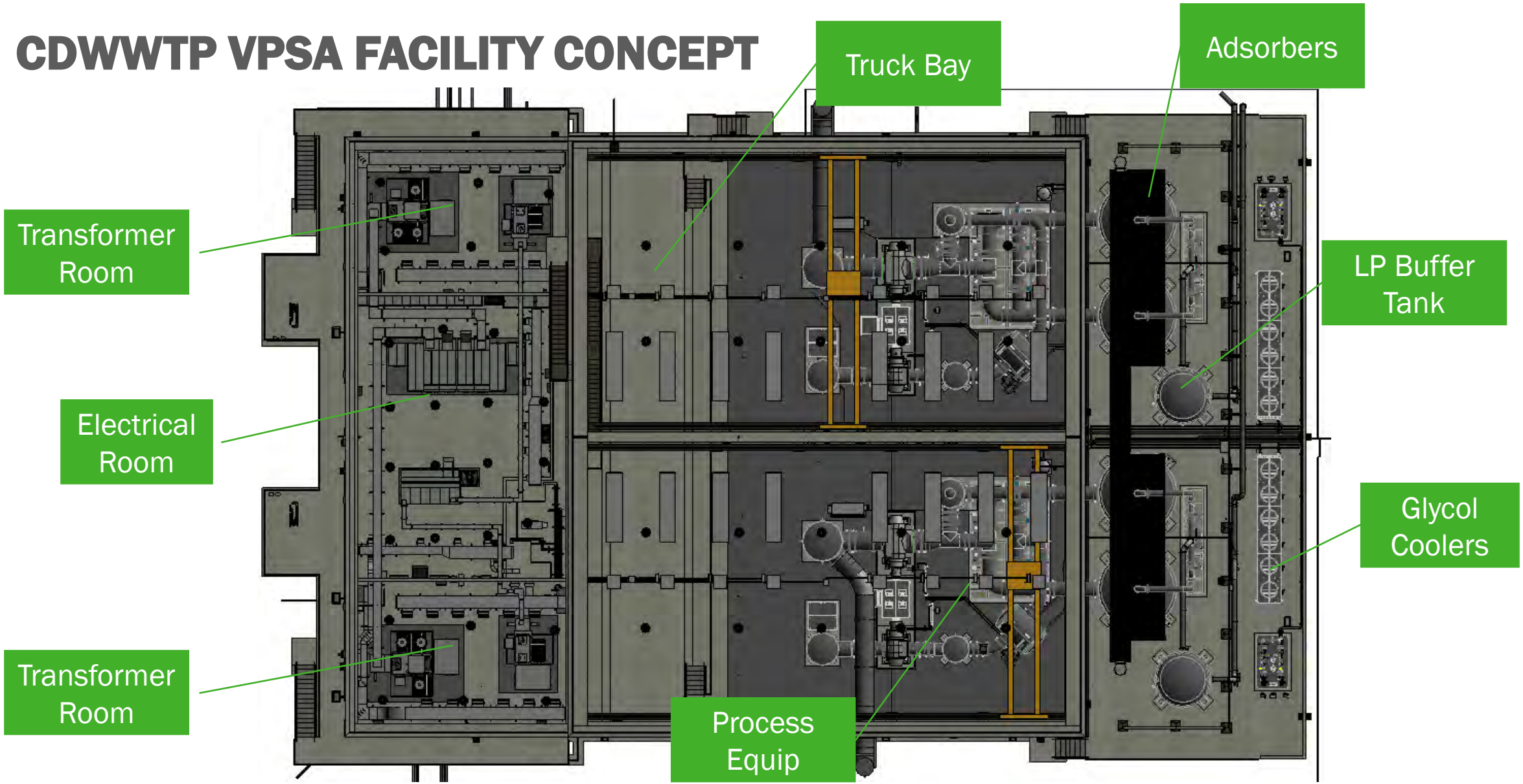
3-PSIG

2-PSIG

0.7-PSIG

- ✓ Cryogenic system is primary at 100%
- ✓ VPSA system provides standby/supplemental oxygen
- ✓ VPSA Cycle timing is adjusted to maintain desired pressure/flowrate
- ✓ LOX system called to service at < 1-psig

CDWWTP VPSA FACILITY CONCEPT



CDWWTP VPSA PROCESS AREA

- AIR
- O2
- WASTE N2

Cooling fans

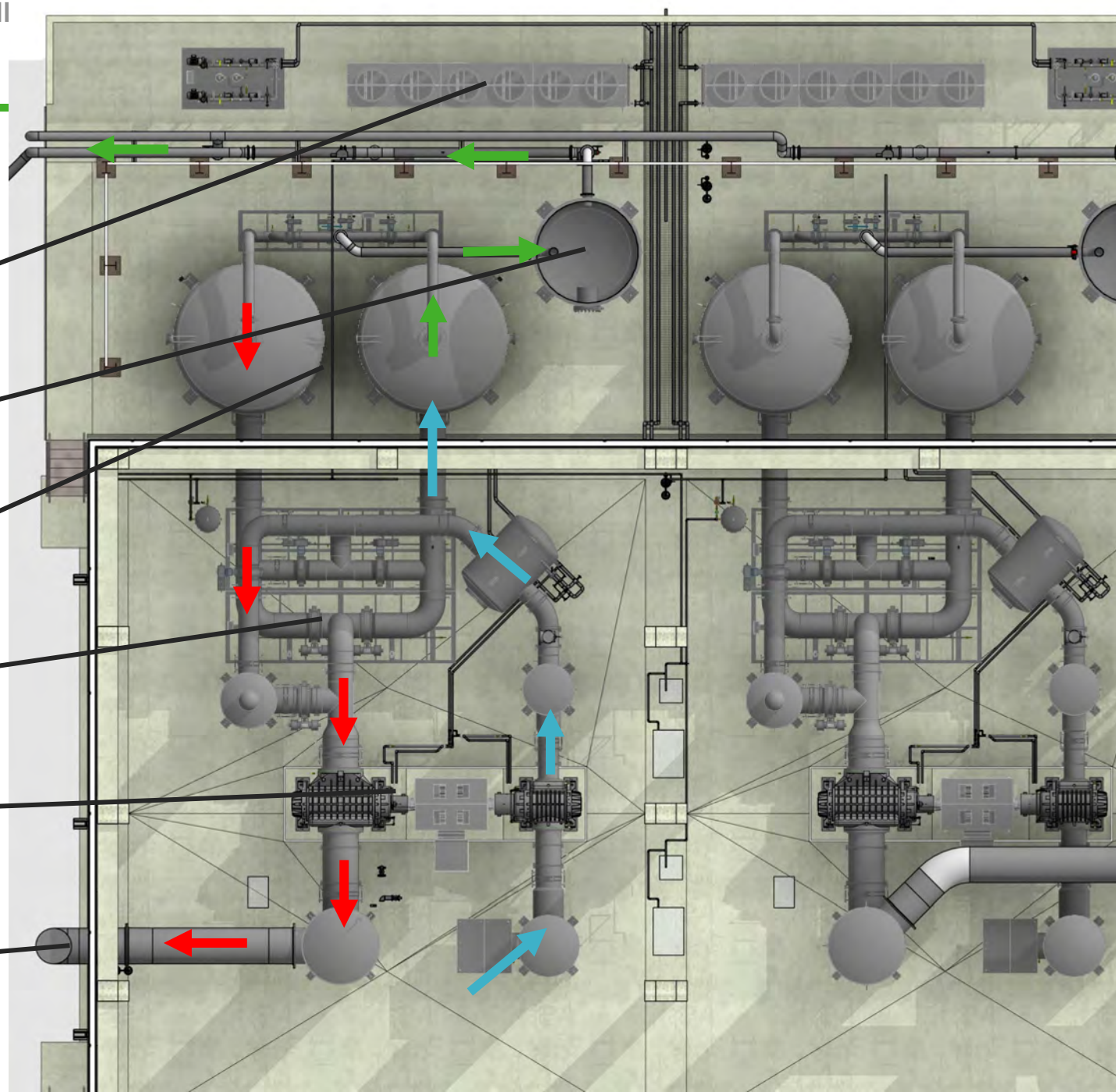
Low Pressure Tank

Adsorber Vessels

Switching Valve Skid

Blowers

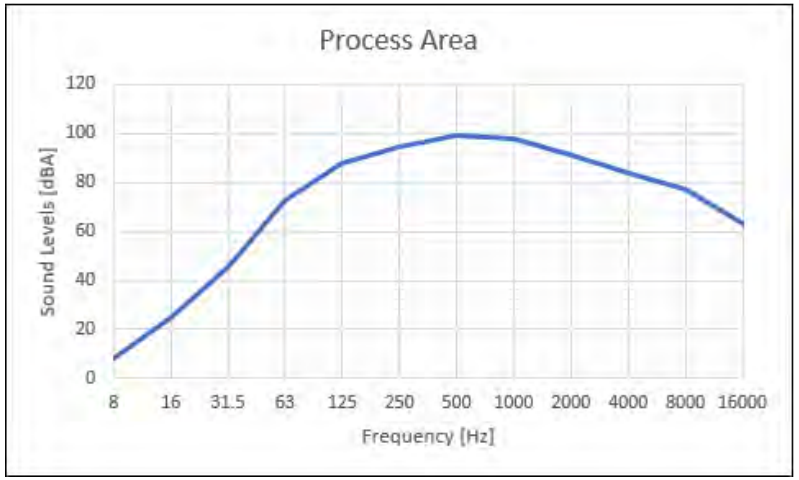
Waste Discharge



CDWWTP VPSA PROCESS AREAS

COMPLETED CDWWTP VPSA FACILITY

PD BLOWER SOUND ATTENUATION



- ✓ 2 at 2,250 Horsepower
- ✓ One Blower - 110 dBA
- ✓ Two Blower - 113 dBA
- ✓ Mid-level frequencies

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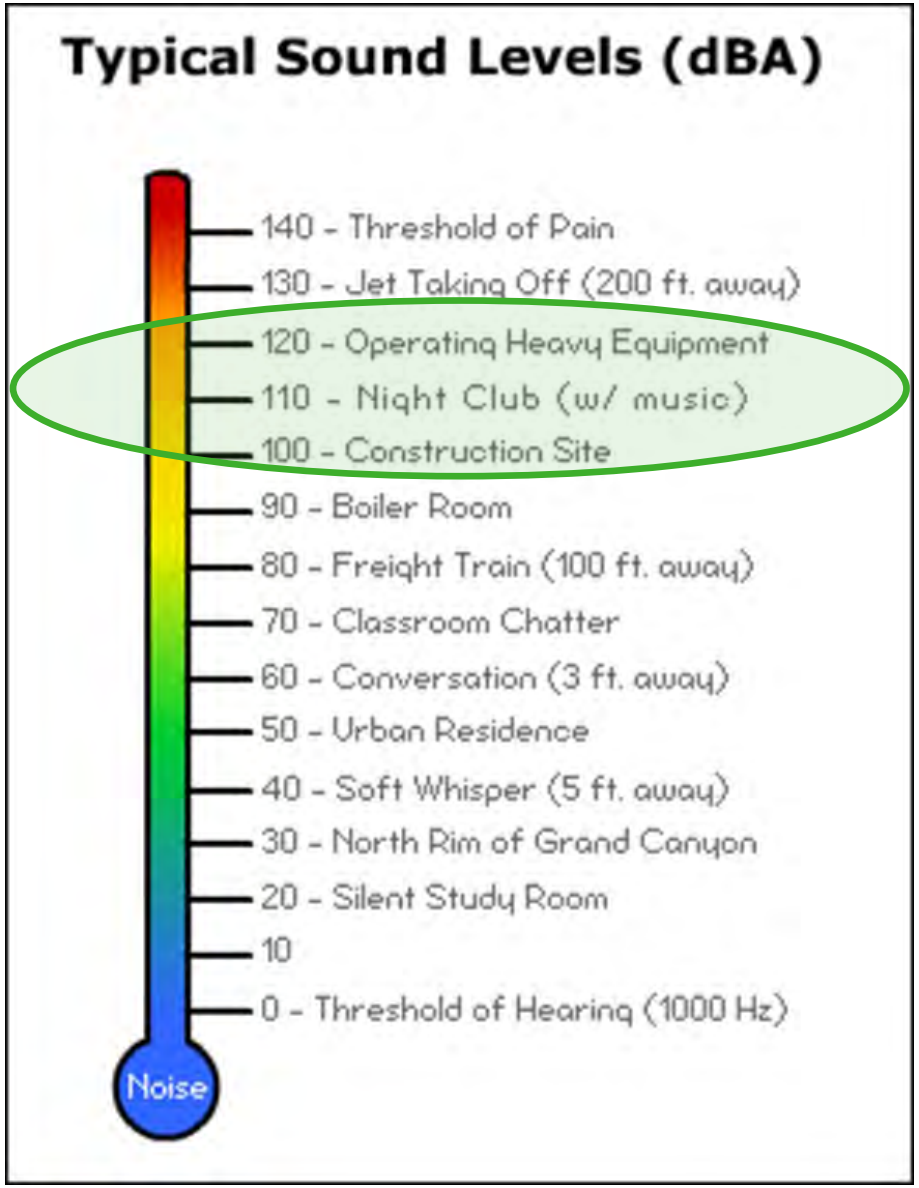
SOUND REQUIREMENTS

- ✓<115 DBA inside process area
- ✓<85 dBA outside the building
- ✓<58 dBA at property line
- ✓Control room unspecified

OSHA Daily Permissible Noise Level Exposure	
Hours per day	Sound level (dBA slow response)
8	90dB
6	92dB
4	95dB
3	97dB
2	100dB
1.5	102dB
1	105dB
0.5	110dB
.25 or less	115dB

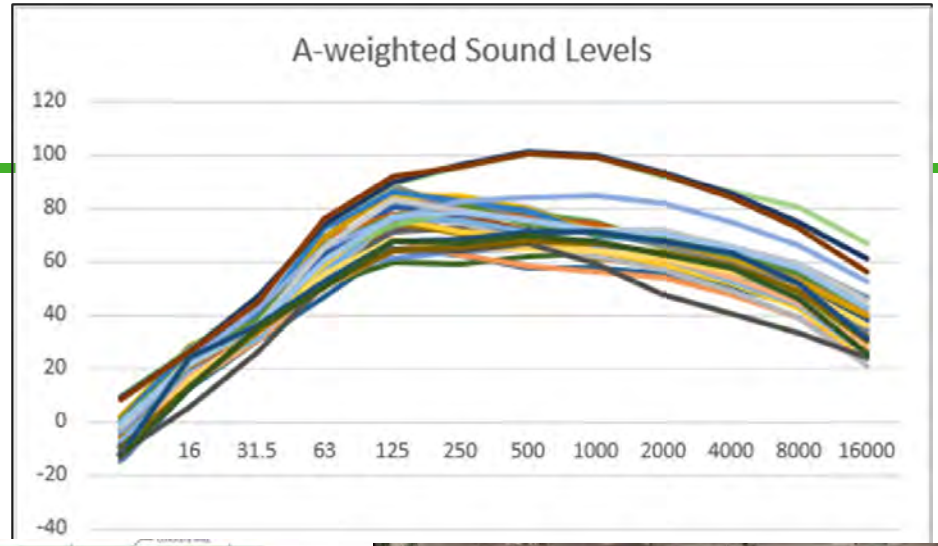


KEY NOISE MITIGATION MEASURES

- ✓ Precast concrete walls
- ✓ Blower pad isolation
- ✓ Pipe isolation & cladding
- ✓ Intake louver sound attenuation
- ✓ Exhaust fan sound attenuation
- ✓ Sound rated doors and windows
- ✓ Blower silencers
- ✓ Control room treatments
- ✓ VPSA adsorbers, low pressure tanks, and glycol cooler placed outside behind sound walls

SOUND MITIGATION RESULTS

- ✓ Process Area – 100dBA
- ✓ East/West side – 84dBA
- ✓ North side – 74 dBA
- ✓ South side – 67 dBA
- ✓ Electrical Area – 70 dBA
- ✓ Control Room – 70 dBA
- ✓ Property Line - 60 dBA



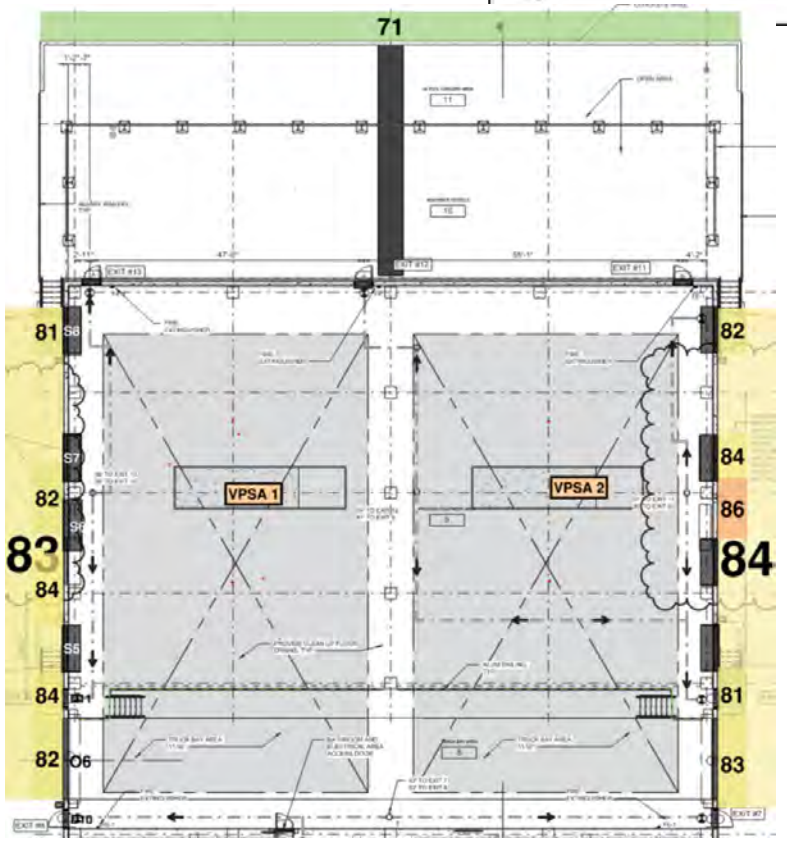


Figure 1. 500 ft measurement locations and measured L_{A90}

PROJECT BENEFITS

- ✓Reduced power consumption by ~20%
- ✓Simplified operation and maintenance
- ✓VPSA can be brought online quickly
- ✓VPSA turndown provides flexibility
- ✓New facility protects against storm surge/wind
- ✓Redundancy provides operational resiliency
- ✓Hardened structure attenuates sound
- ✓Design-build allowed for early project delivery

LESSONS LEARNED

✓ Media dusting

✓ Noise mitigation

AWARD WINNING PROJECT

- Cuban American Association of Civil Engineers – 2021 Project of the Year for Tier 3 projects
- Design-Build Institute of America: Florida Region – 2022 Merit Award for Wastewater Collection, Treatment, Reuse Facilities

ACKNOWLEDMENTS

Wade Trim would like to provide appreciation to the following project team members:

- ✓ Miami-Dade County Water and Sewer Department in association with the PMCM Team
- ✓ PCL Construction
- ✓ Our Many Team Subconsultants and Subcontractors

Questions?