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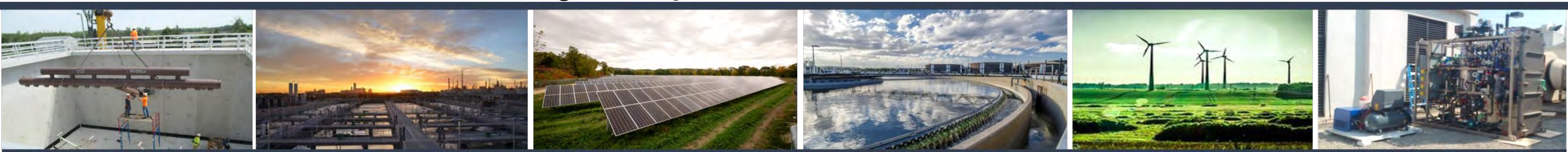
We will begin our presentation in a few minutes...



Leadership and Excellence in Environmental Engineering and Science

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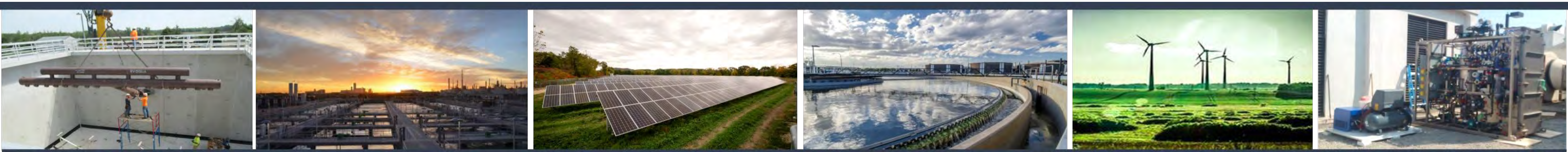

AMERICAN ACADEMY OF ENVIRONMENTAL ENGINEERS & SCIENTISTS®

City Underwater: The Ongoing Challenge of New Orleans Drinking Water Management

Chris Bergeron, P.E.,P.M.P. SWBNO

Kate Despinoy, P.E., P.M.P., Stanley Consultants

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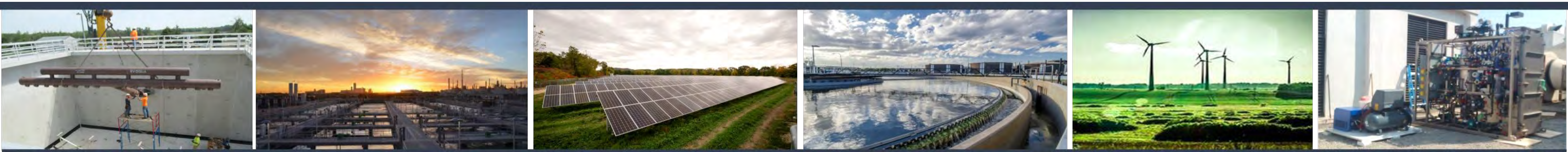
July 19, 2023



Leadership and Excellence in Environmental Engineering and Science

Presentation Contents

1. SWBNO background and Carrollton Water Treatment Plant
2. Factors affecting operation
3. Iterative upgrade plan
4. Three-phased improvements plan
5. Instrumentation and controls design
6. Current state and future improvements

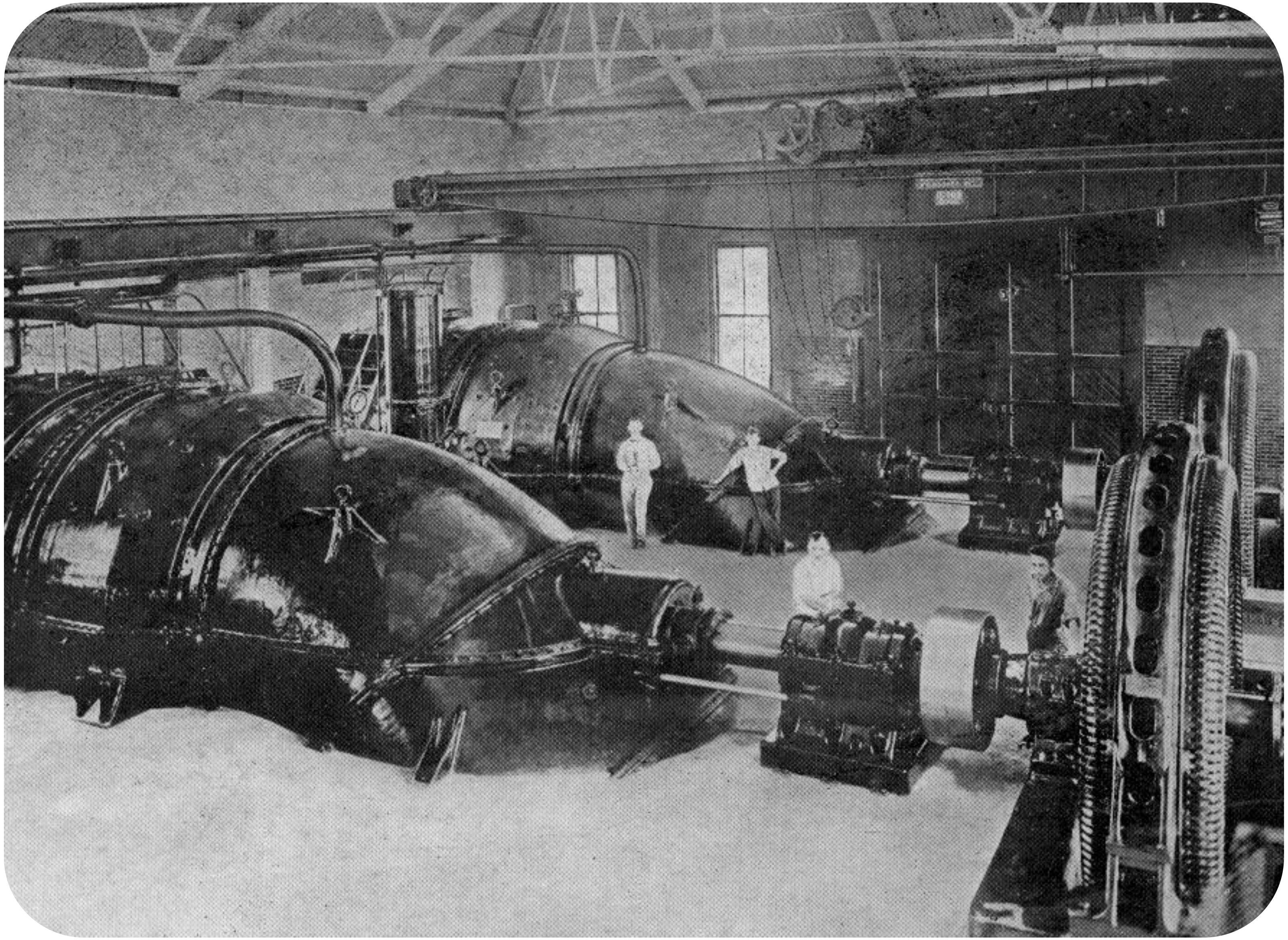
Sewerage & Water Board of New Orleans History

- Founded in 1899
- Three systems
  - Water
  - Sewage
  - Drainage

Drainage System

City of New Orleans Ground Elevations

From Canal St. at the Mississippi River to the Lakefront at U.N.O.



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The Water System

- Carrollton Water Treatment Plant
  - Constructed in 1908
  - Water and power plant
- Two intake river pumping stations
- 7-step purification process
- 130 MGD average production

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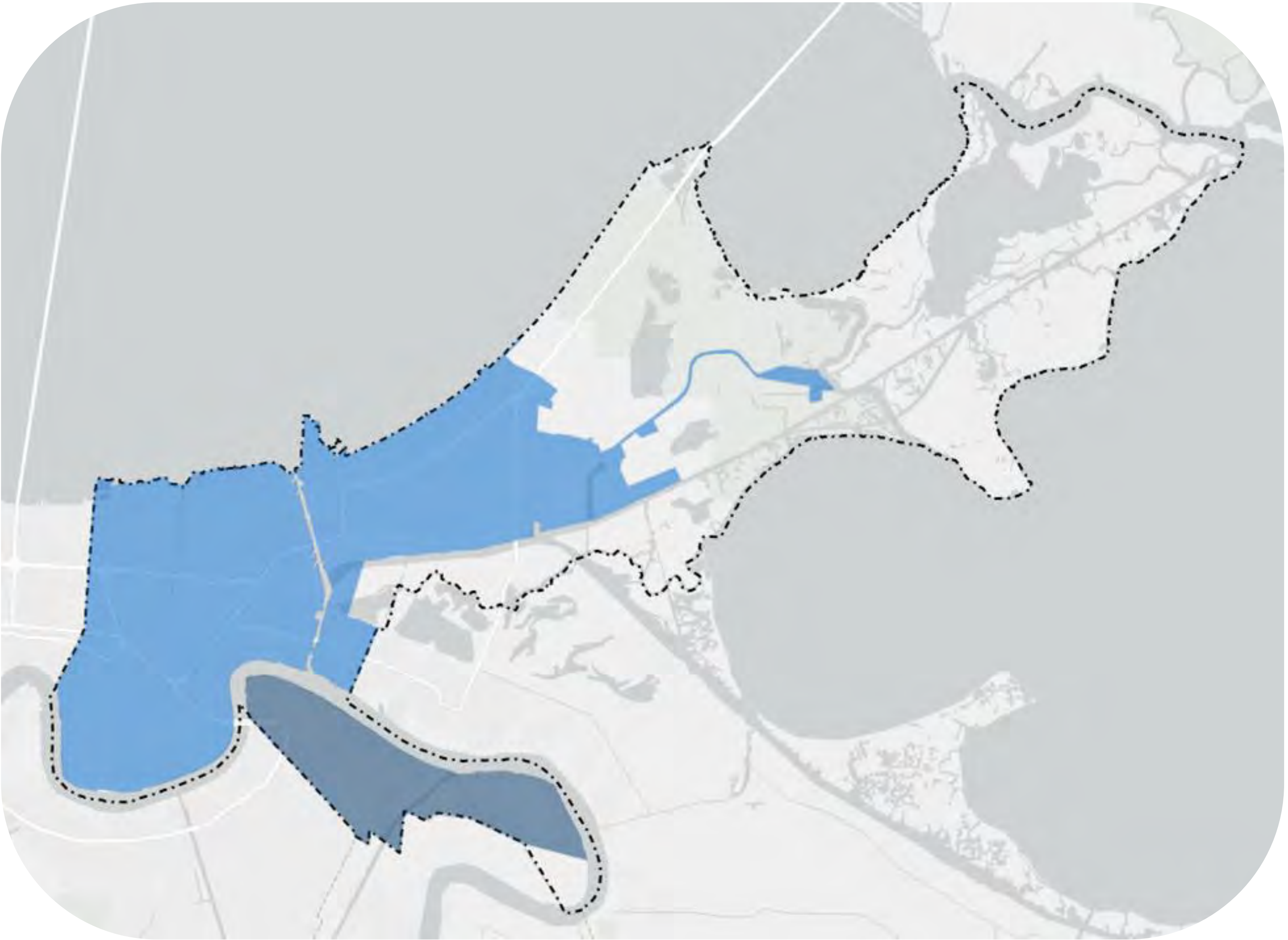
The Water System

- Two Separate Systems
  - East Bank
  - West Bank



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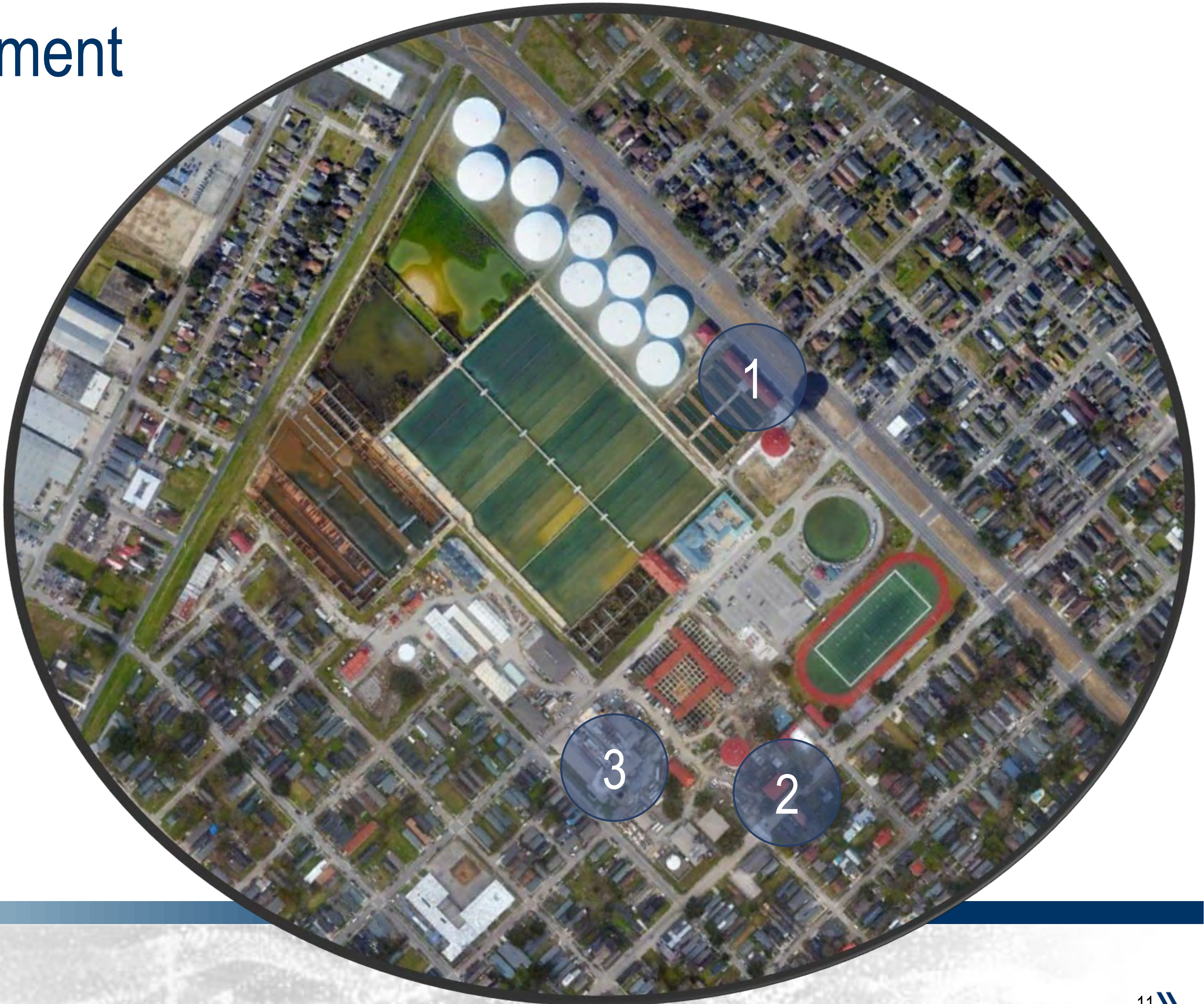
Carrollton Water Treatment Plant

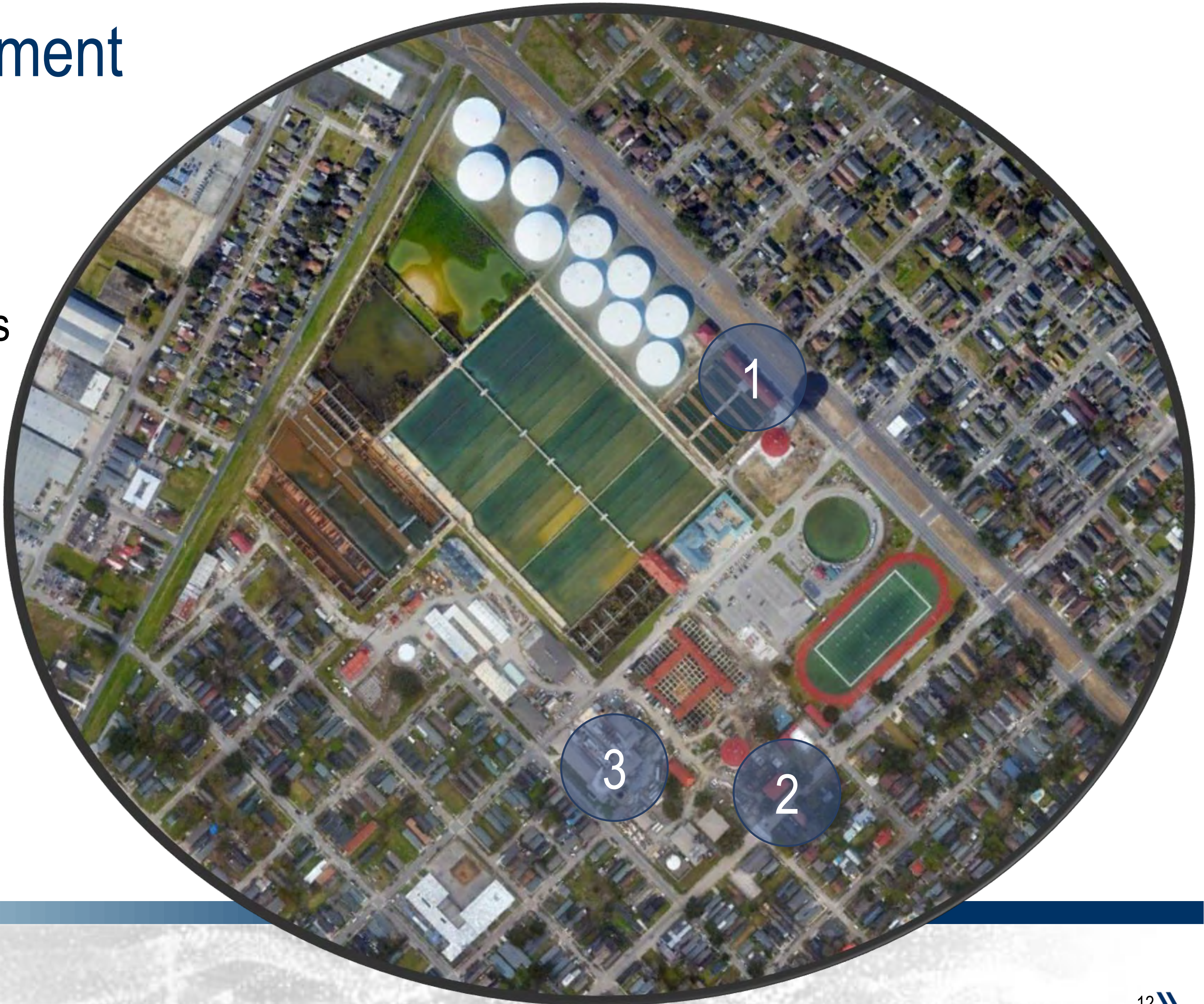
1. Claiborne Pump Station
2. Panola Pump Station
3. High Lift Pump Station



Carrollton Water Treatment Plant

1. Two 25 Hz, Two 60 Hz pumps
2. Two 25/60 Hz pumps
3. Two steam-driven pumps

Eight total distribution pumps



Hurricane Katrina

August 29, 2005

Water Treatment Plant Pre- and Post Katrina

Factors Affecting Operation

- Hurricane Katrina
- Power outages
- Water main leaks
- Water hammer

FEMA’s Upgrade Plan

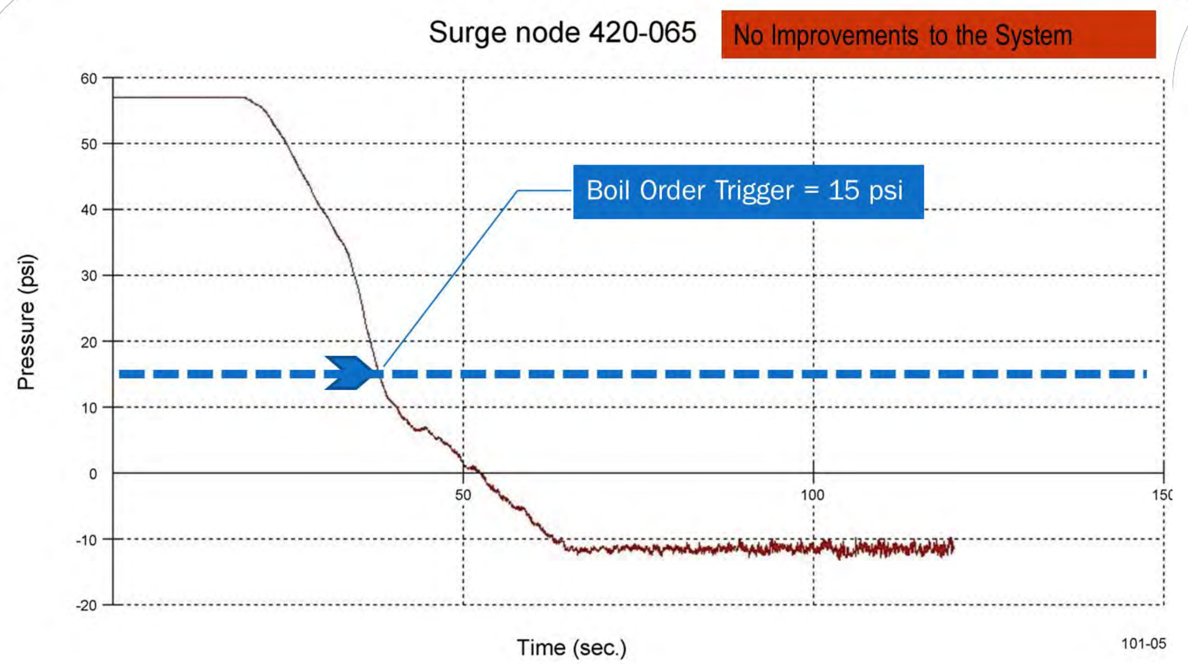
- Reiterative process
- Initial plan comprised of:
    - Eight new pumps and motors
    - New slowly opening and closing valves
    - Variable frequency drives (VFD)
    - Vacuum priming system

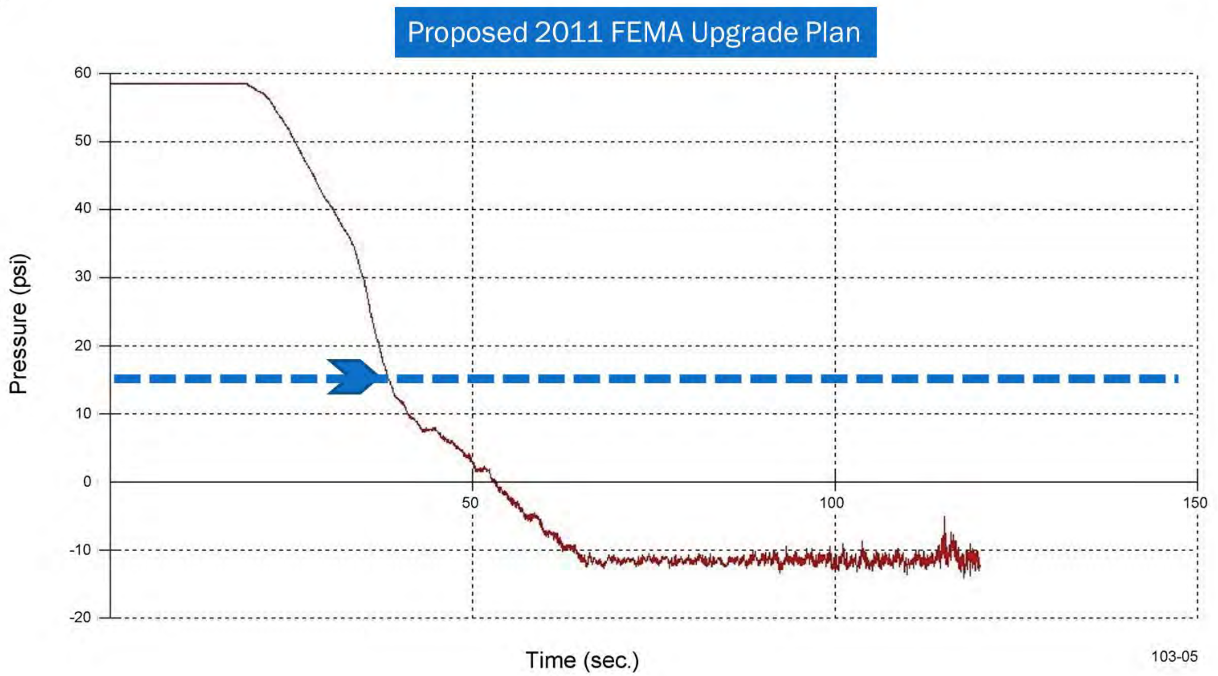
Surge Analysis Scenario

- 5 pumps running, 4 lose power
- Peak demand 170 MGD
- High vs low pressure transients

Surge Analysis Scenario

Surge Analysis Scenario

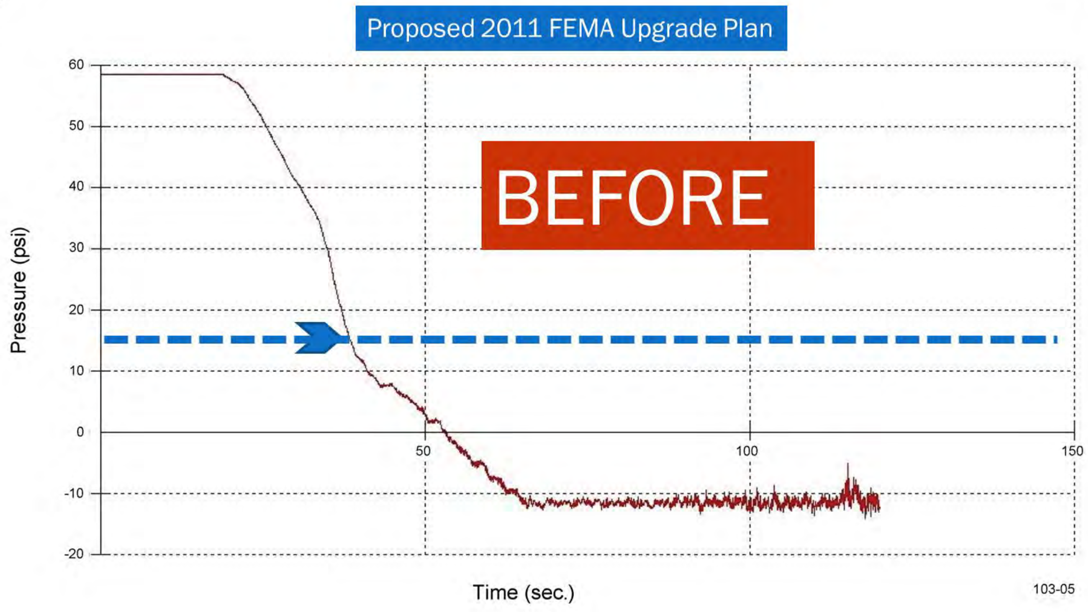


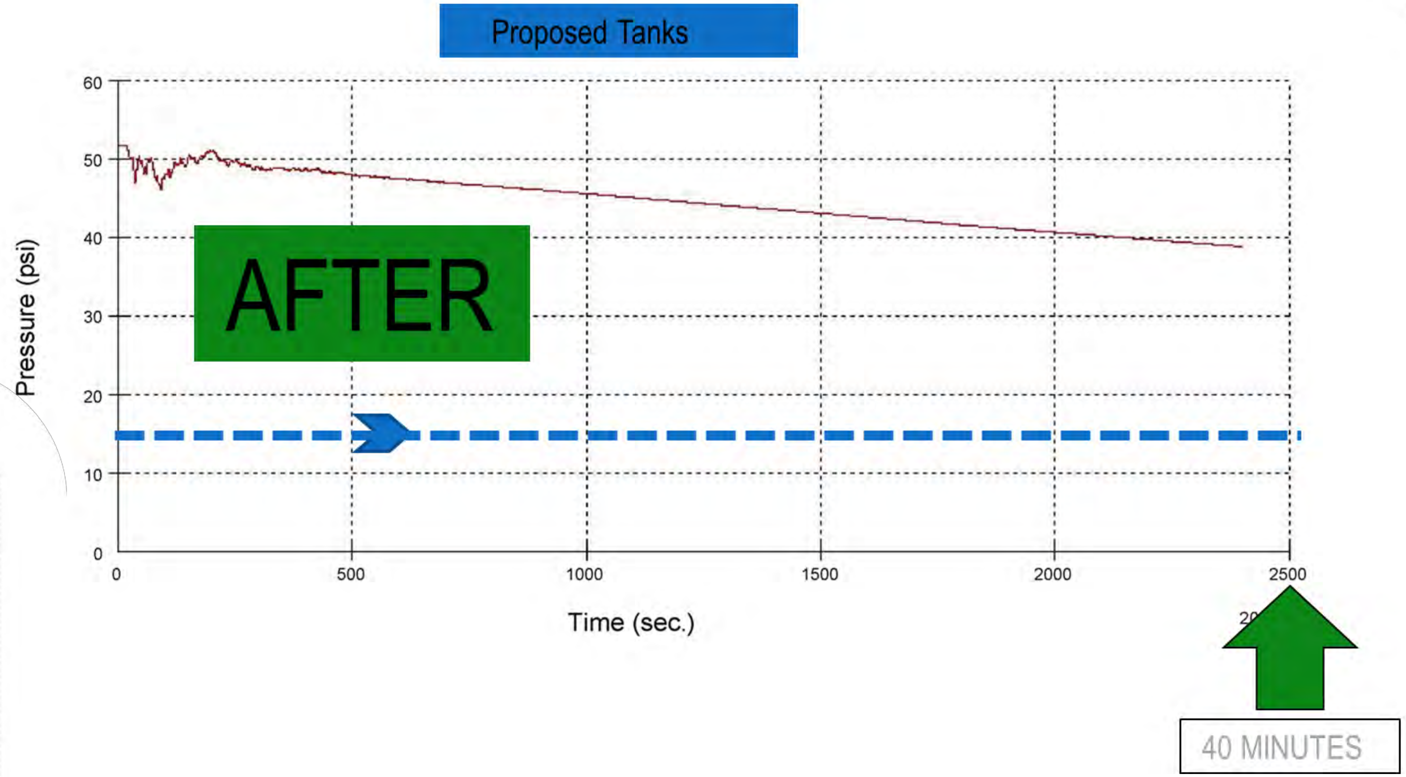


Potential Solutions

- Stand pipes
- Bladder tanks
- ***Elevated storage***

Surge Analysis Scenario



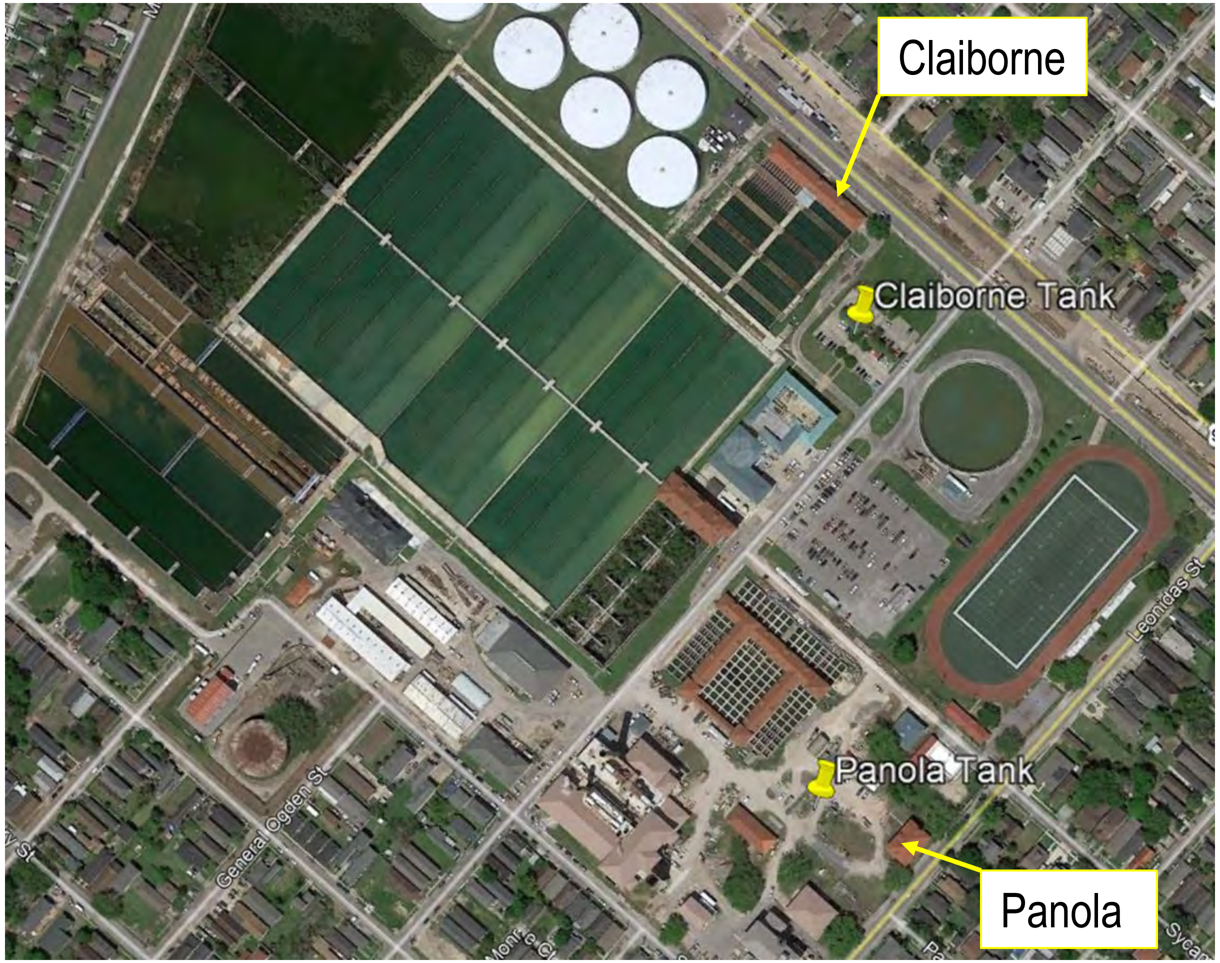


FEMA's Revised Upgrade Plan

- Five refurbished pumps
- Four new motors
- Four VFDs
- Two water towers
- New valves and meters

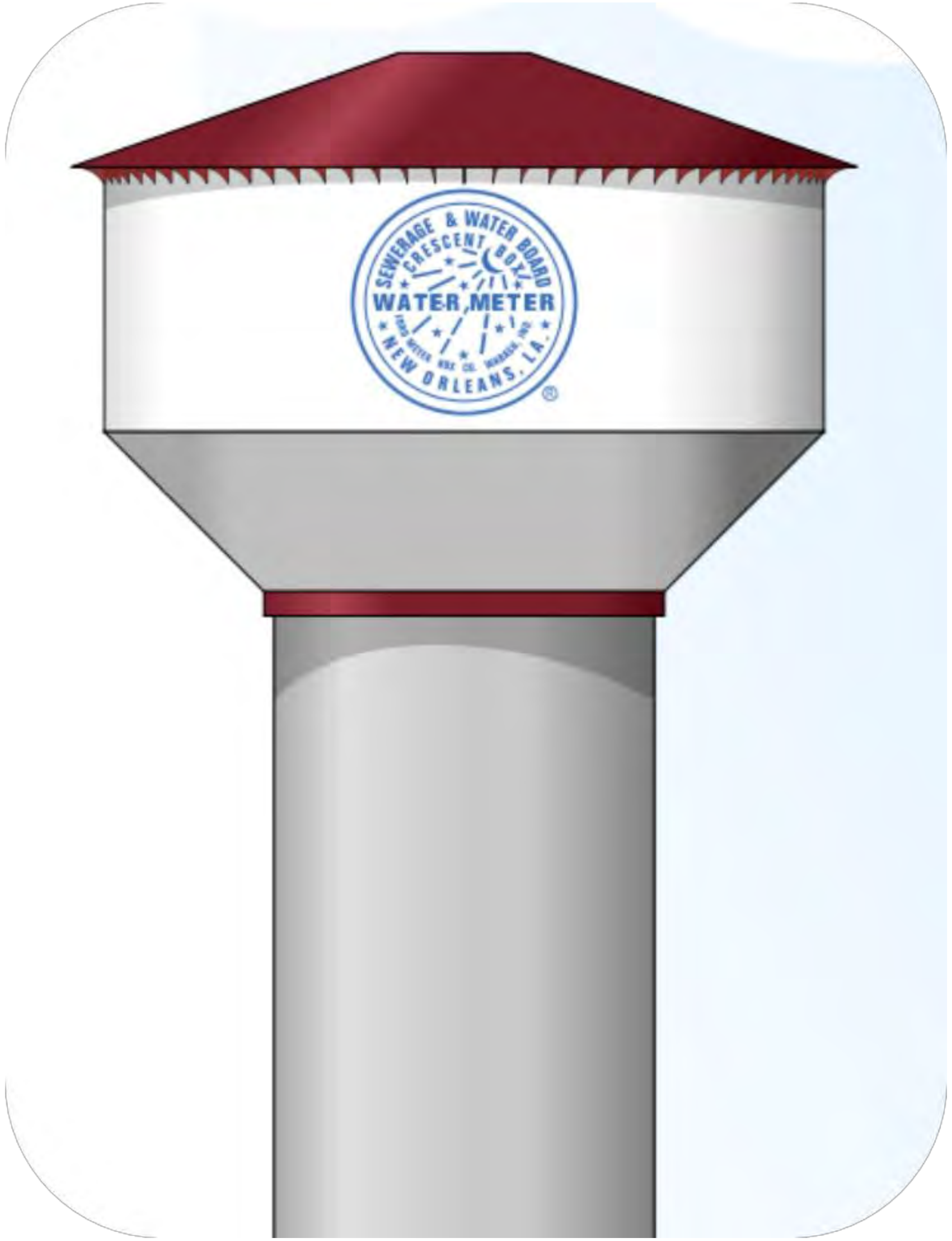
Overall Water Hammer Program

- Phase 1 – Two elevated 2 MG storage tanks
- Phase 2 – Claiborne improvements
- Phase 3 – Panola and High Lift improvements



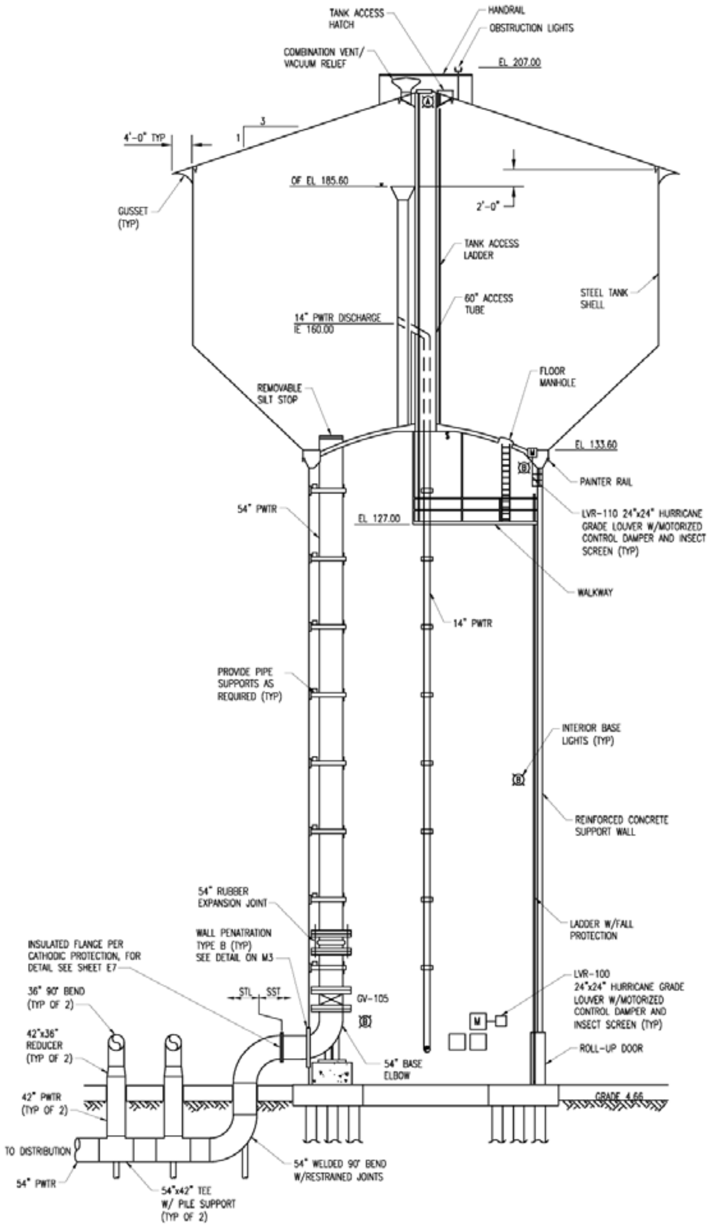
Water Towers

- 2 million gallons each
- 200 feet tall
- Composite style – concrete and steel



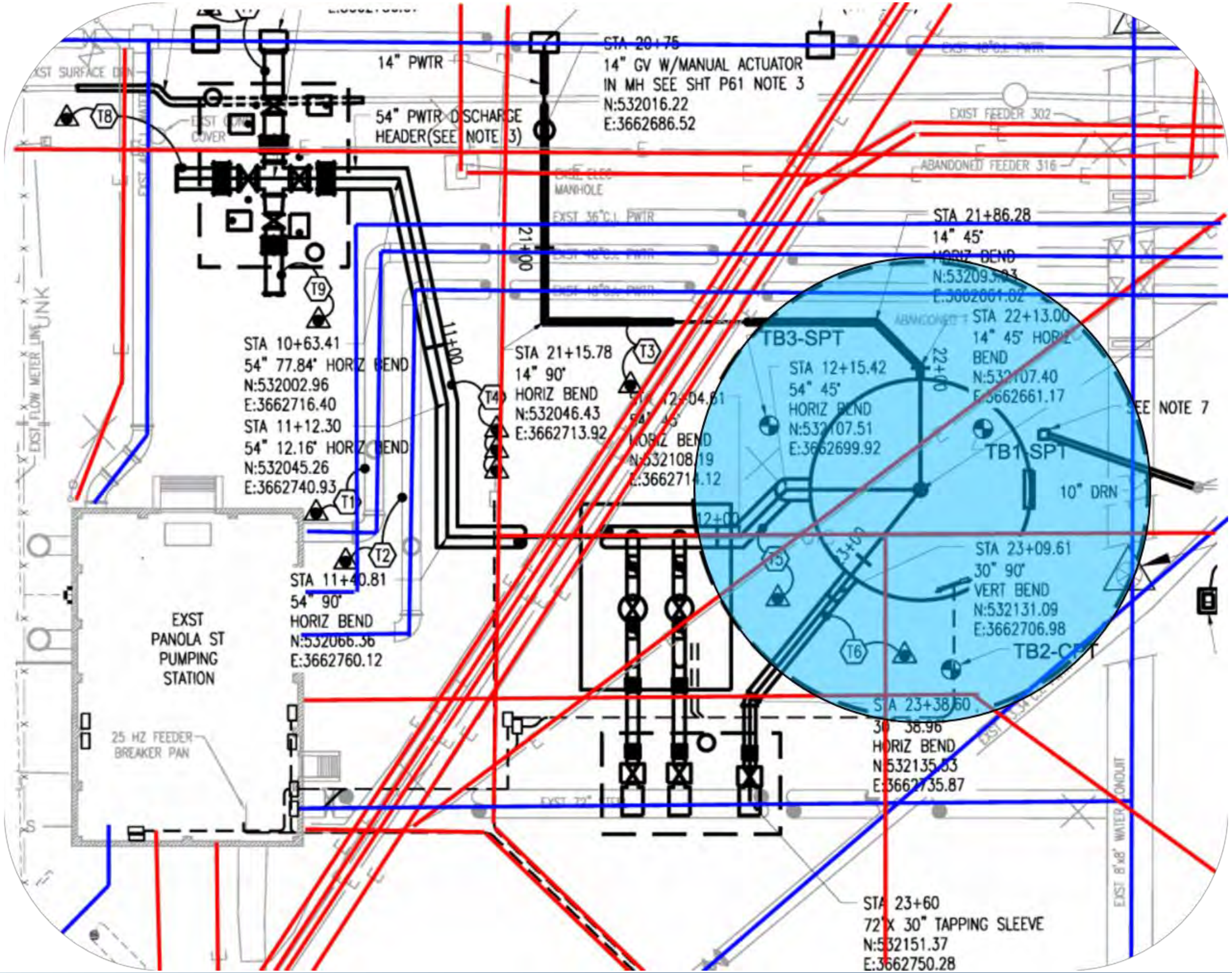
Hydraulics

- Connected to distribution system
- 40 minutes of water pressure
- Pressurized at 75 psi

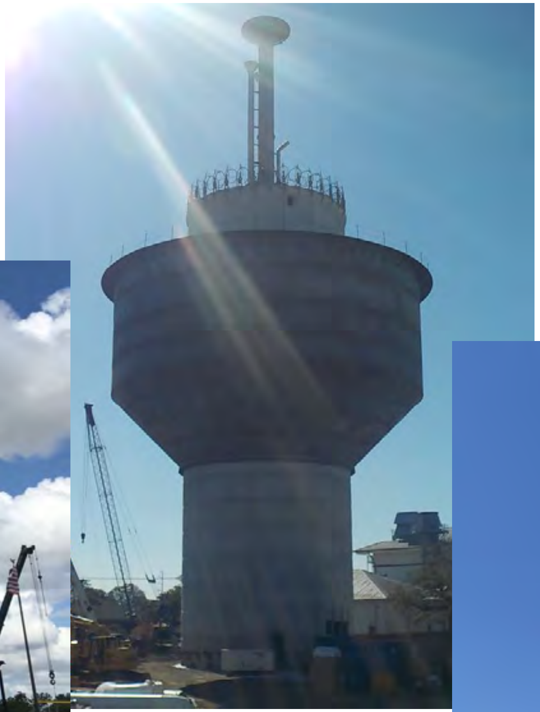


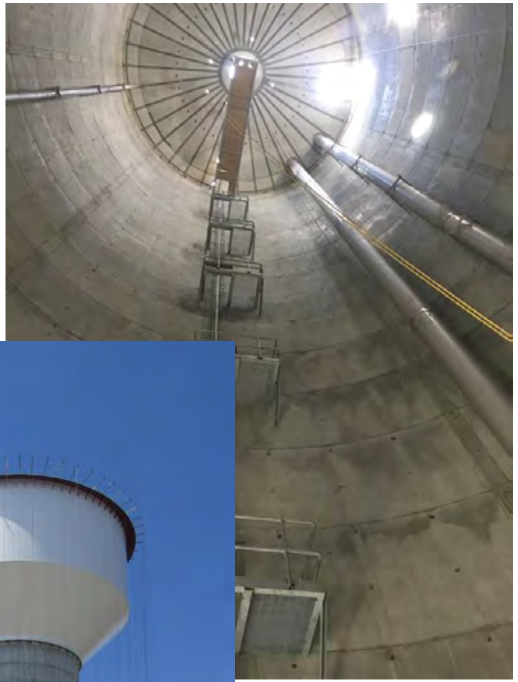
Challenges

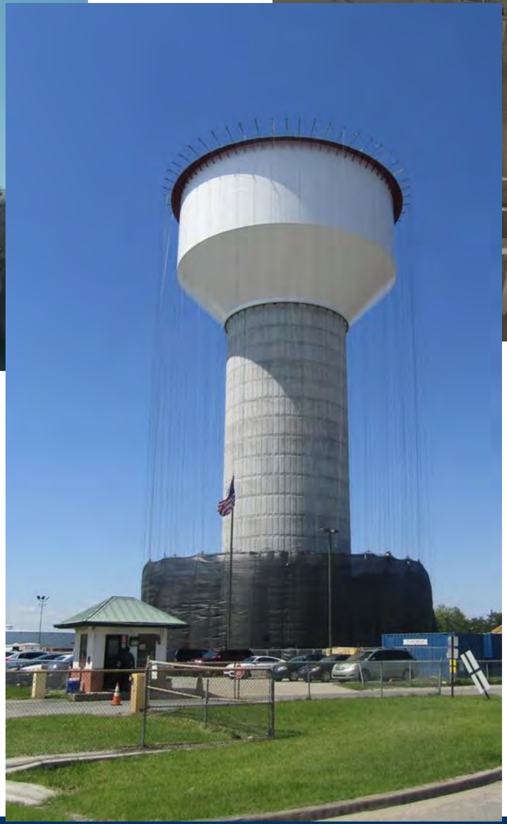
- Plant utilities



Water Tower Installation







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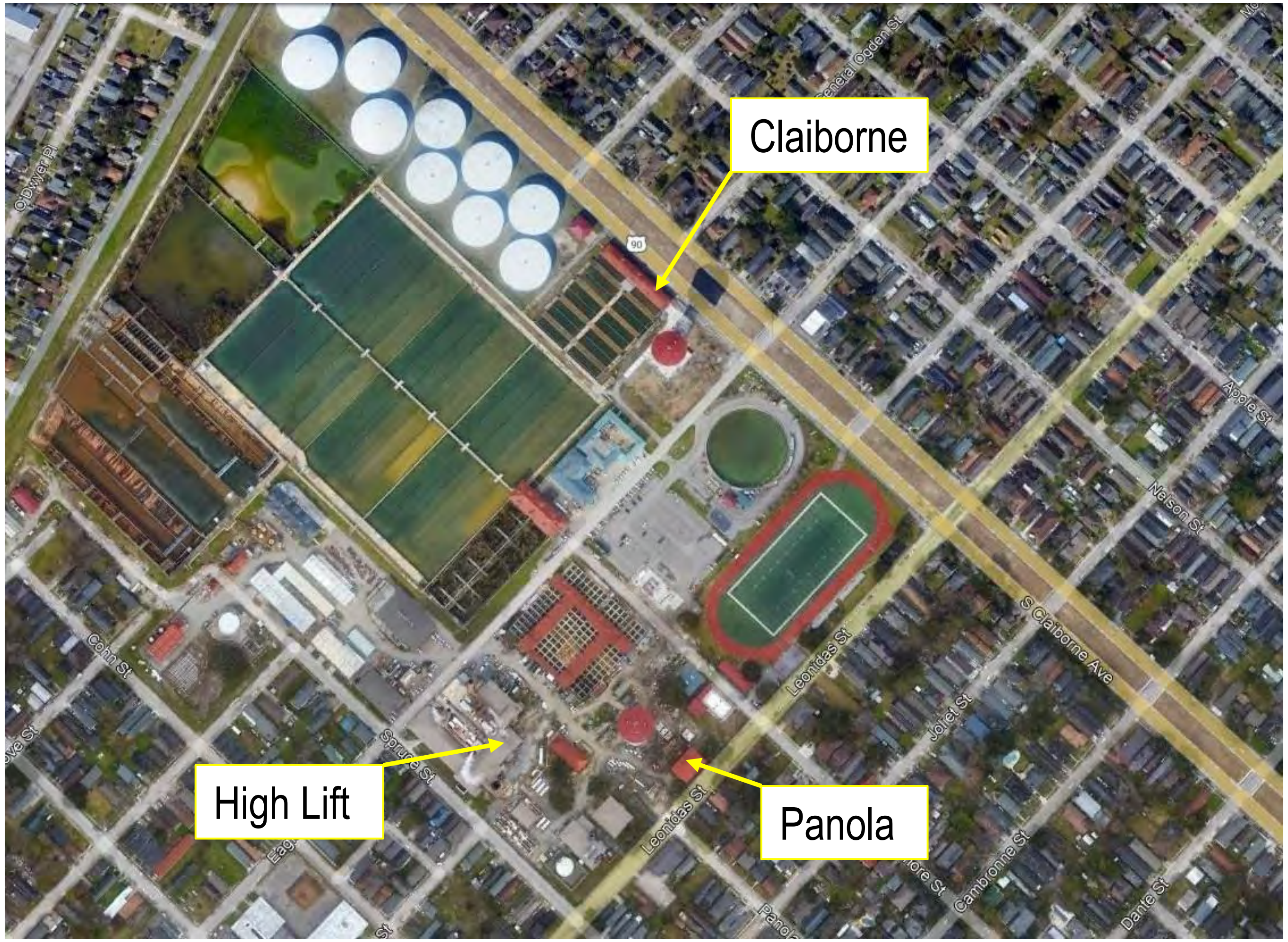
Overall Water Hammer Program

- Phase 1 – Two elevated 2 MG storage tanks
- Phase 2 – Claiborne improvements
- Phase 3 – Panola and High Lift improvements

Water Pump Stations

- Three existing pump stations that distribute potable water into one pressure zone
- The water level in the clear wells is at the same elevation throughout the plant, balanced through a series of pipes
- The clear wells are supplied from the Sycamore and Claiborne filters



Pump Station Flow

- The peak hour pumping capacity is 170 MGD combined
- System pressure is maintained between 68 and 72 PSI

Pumping Capacity

The capacity for each of the pump stations is indicated in the following table:

Table 5-1 Pumping Capacity of Each Pump Station

Pump Station	Pump No.	Maximum Speed (RPM)	Capacity (MGD)	Drive Type
Pump Room	A	742	45.0	Steam
Pump Room	B	742	45.0	Steam
Panola	1 (C)	750*	45.0*	Electric
Panola	2 (D)	750*	45.0*	Electric
Claiborne	1	740	44.0	Electric
Claiborne	2	720	41.0	Electric
Claiborne	3	720	41.0	Electric
Claiborne	4	740	44.0	Electric

* The Panola pumps will run faster and produce the flow rate indicated in the table at 25 Hz; at 60 Hz the motors will run slightly slower and produce less capacity.

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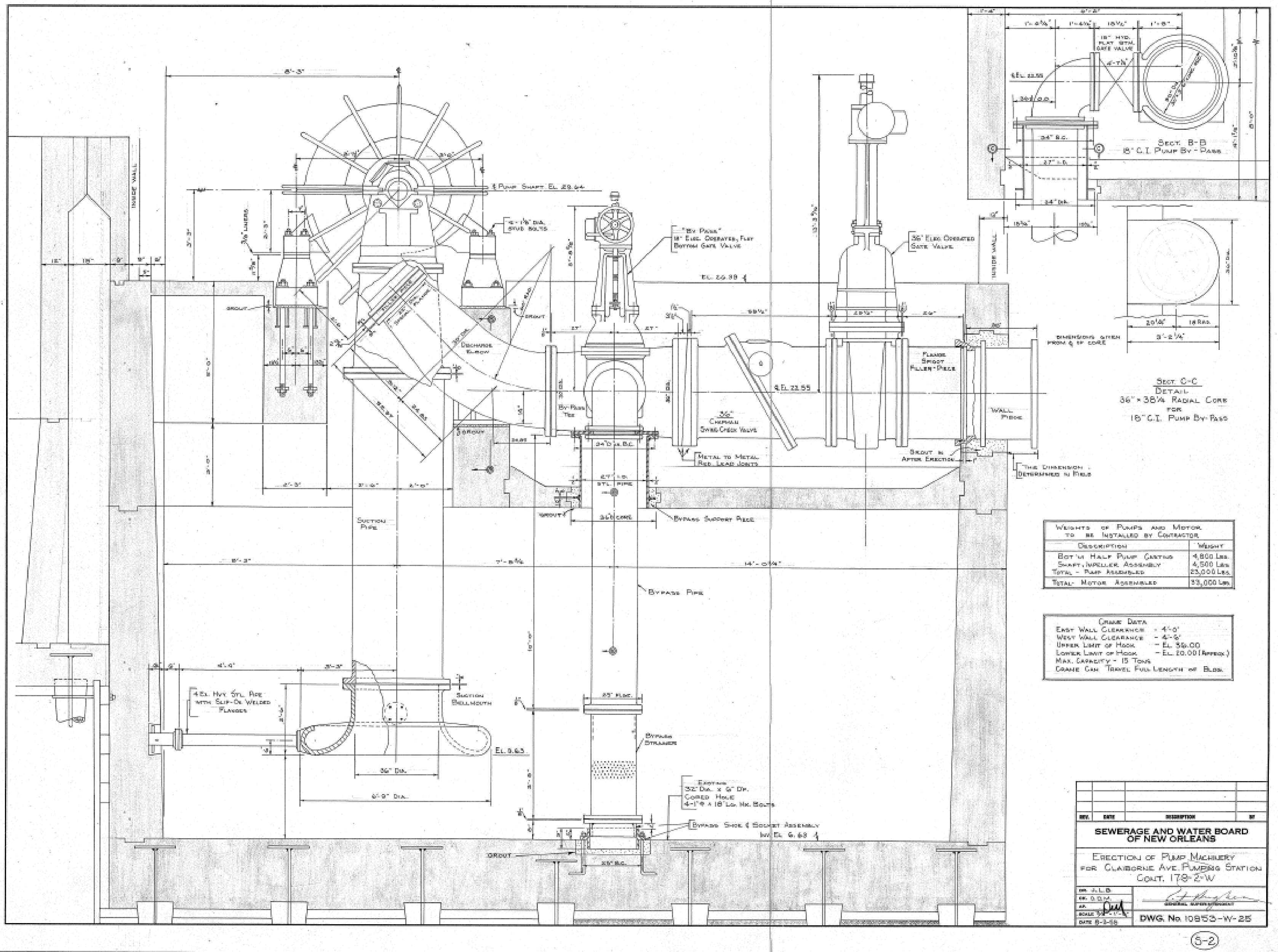
Original Drawings



Existing Conditions

Claiborne Pump Station Improvements

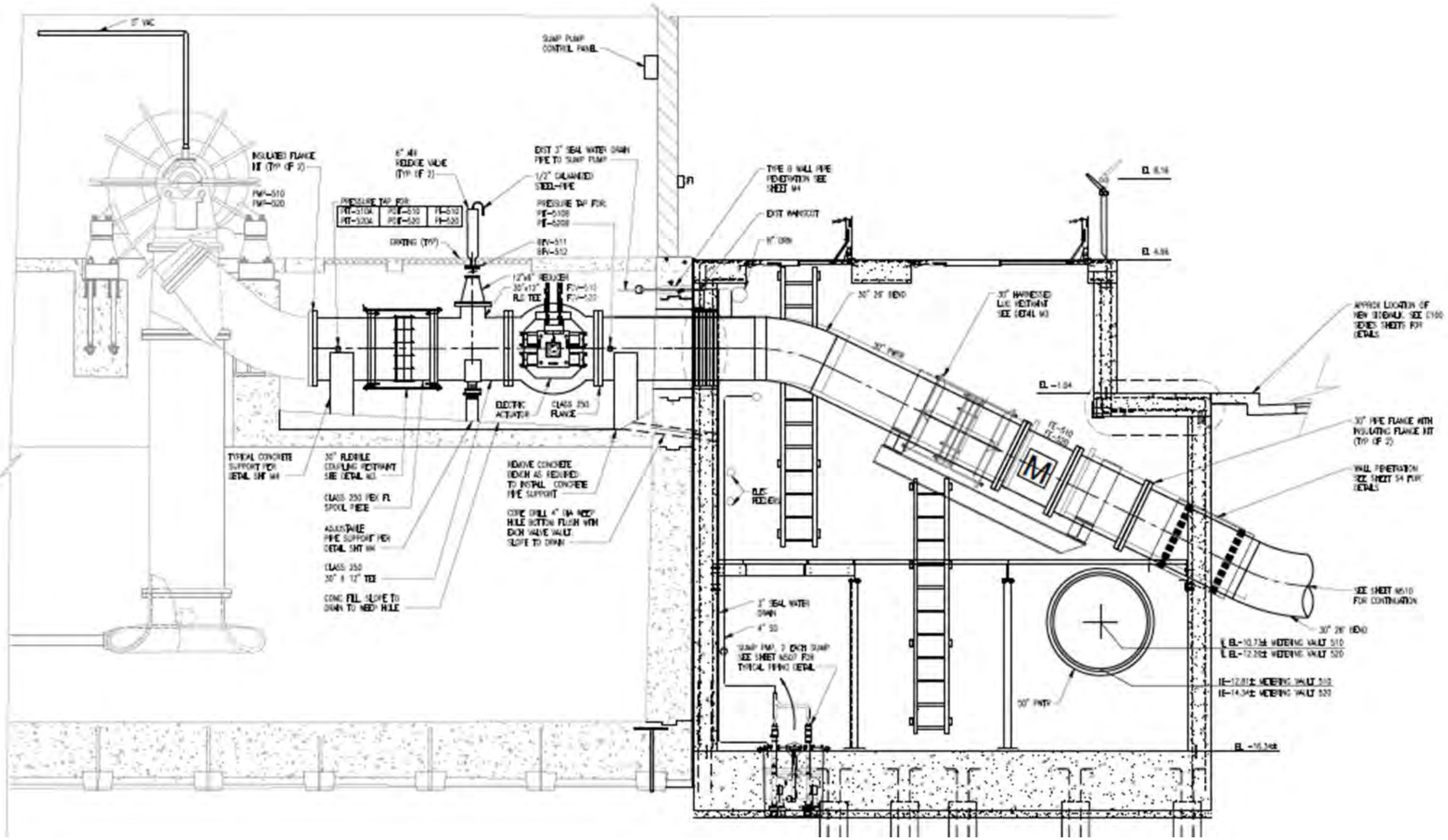
- Significant rehabilitation of the existing pumps including:
  - Pump impellers and shaft removed scanned and rebuilt
  - Anti-reverse ratchets for all pumps
- New electric motors and VFDs to regulate discharge pressure

Construction

Construction

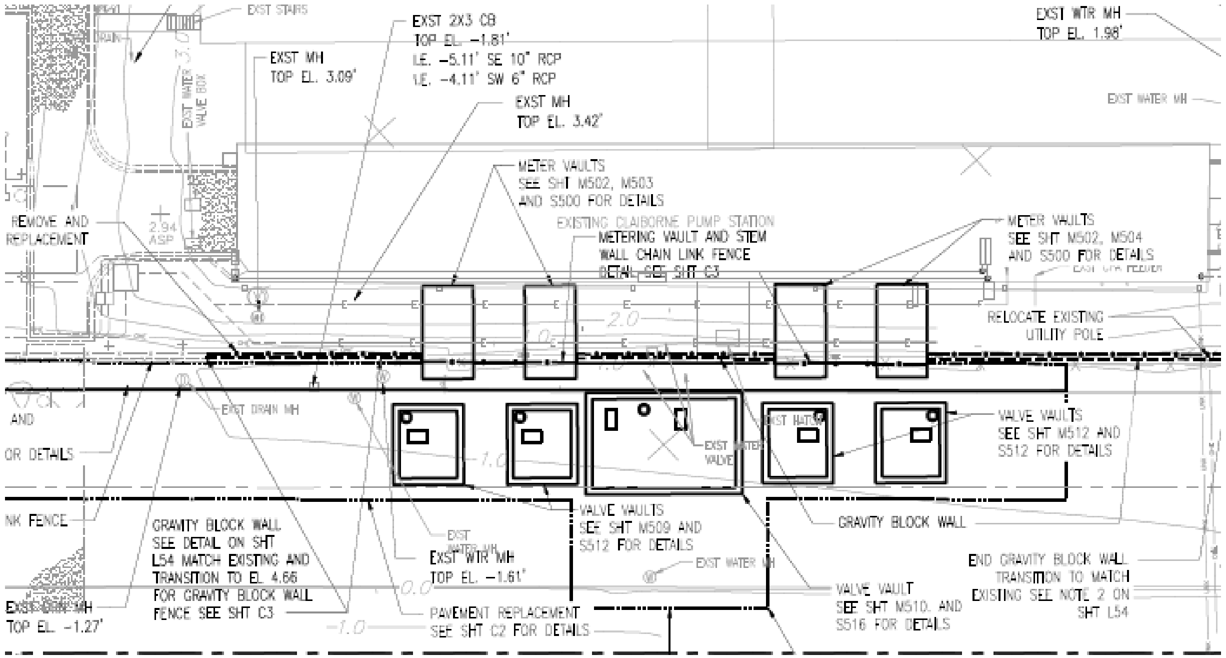
Improvements

- Air release valves
- Hydraulic actuated ball valves
- Yard piping, metering vaults, discharge valves and replacement piping

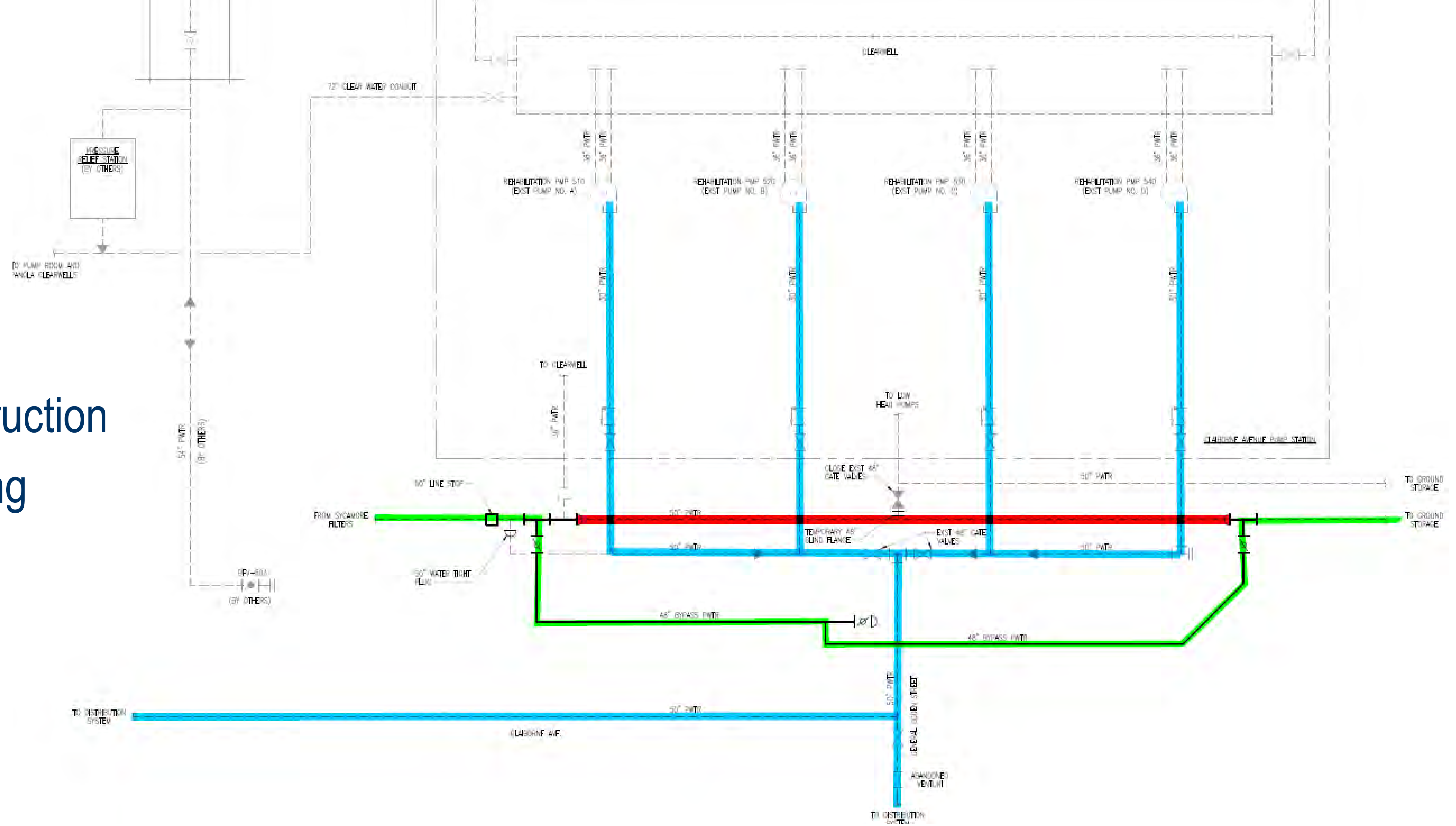


Construction Phasing

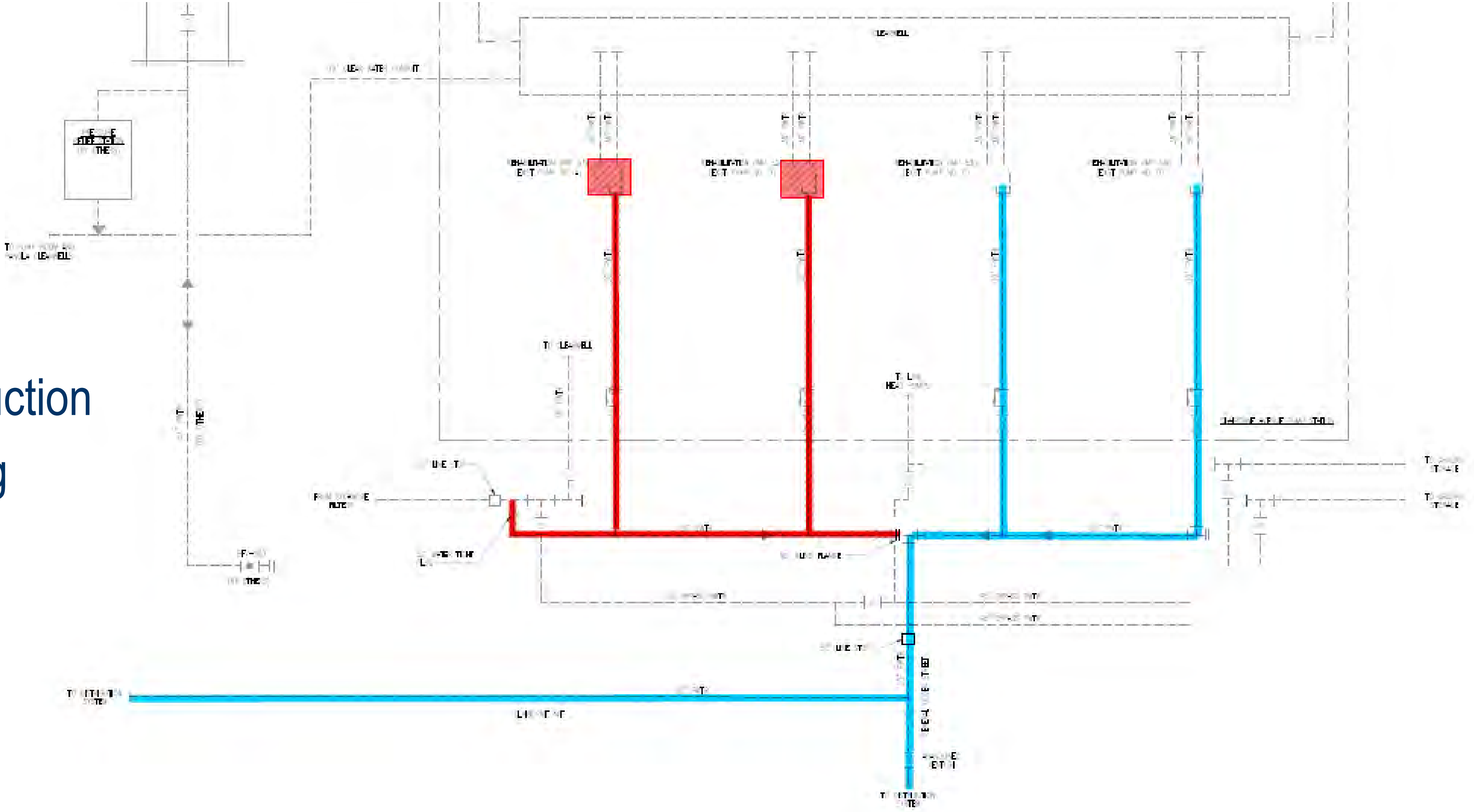
- Claiborne is a critical station
- A bypass sequence plan was developed
- While Claiborne was under construction, other two stations and the Claiborne elevated tank needed to be in operation
  - Two pumps were done at a time, never fully shut down



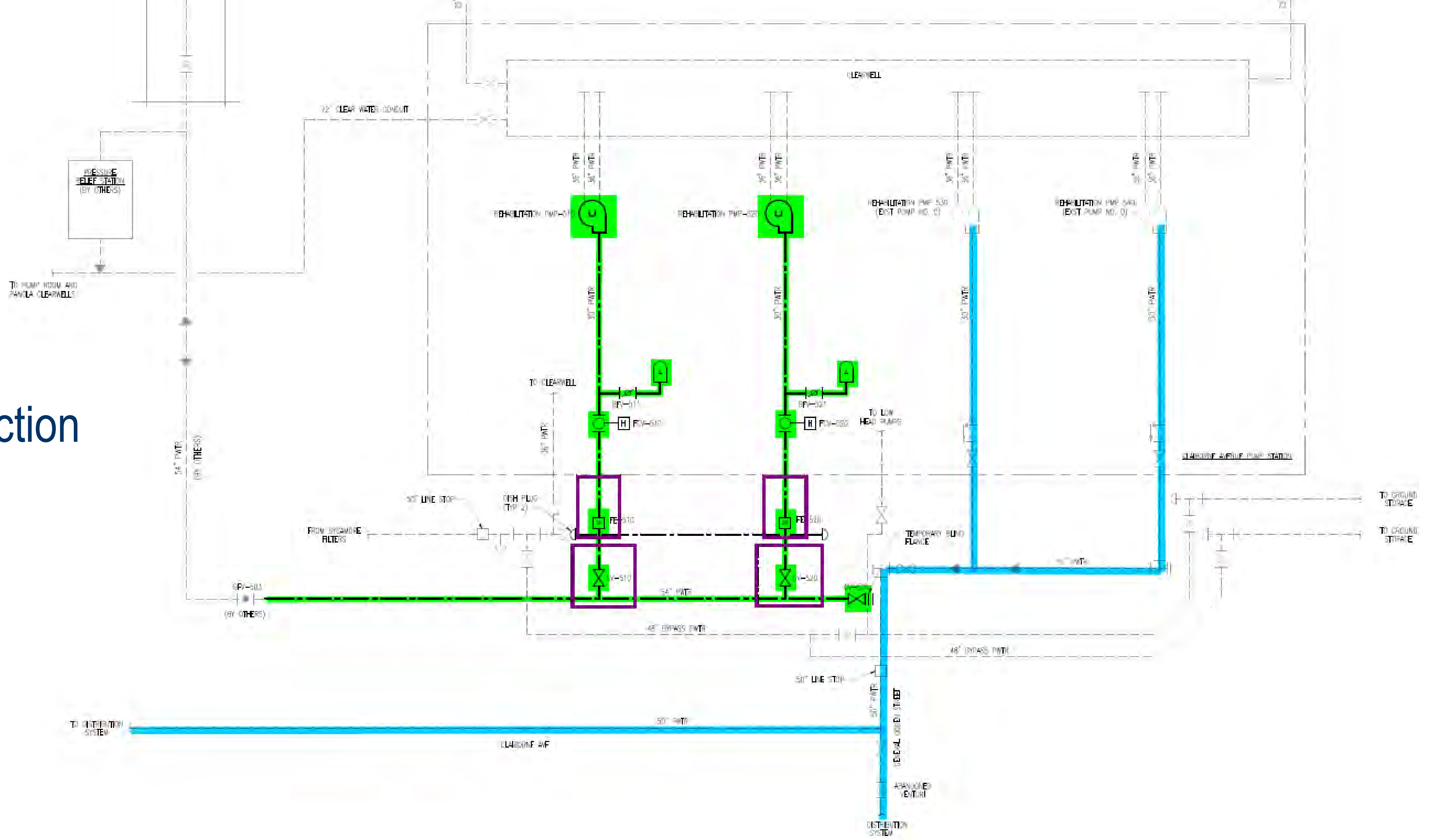
Construction Phasing



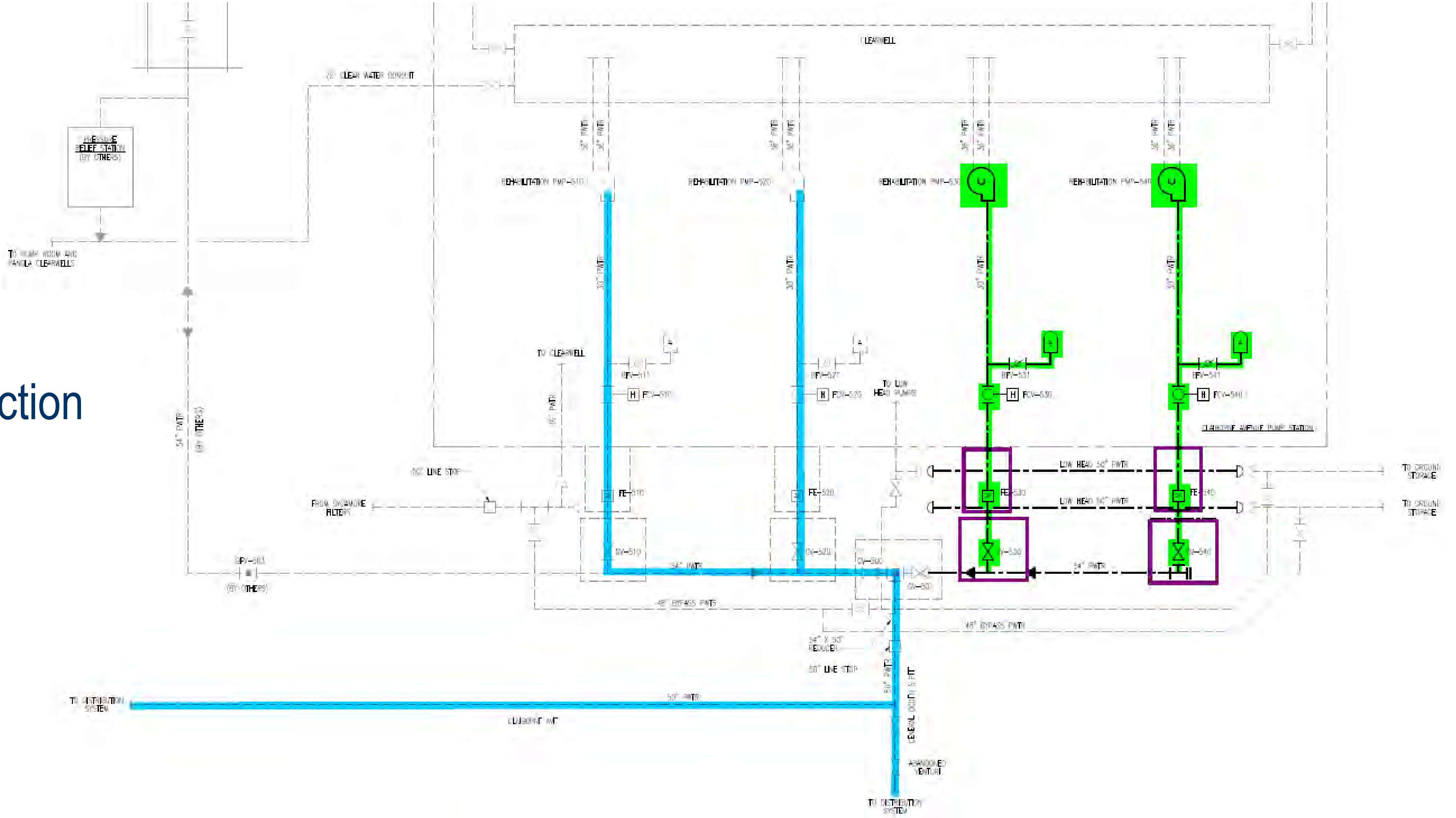
Construction Phasing



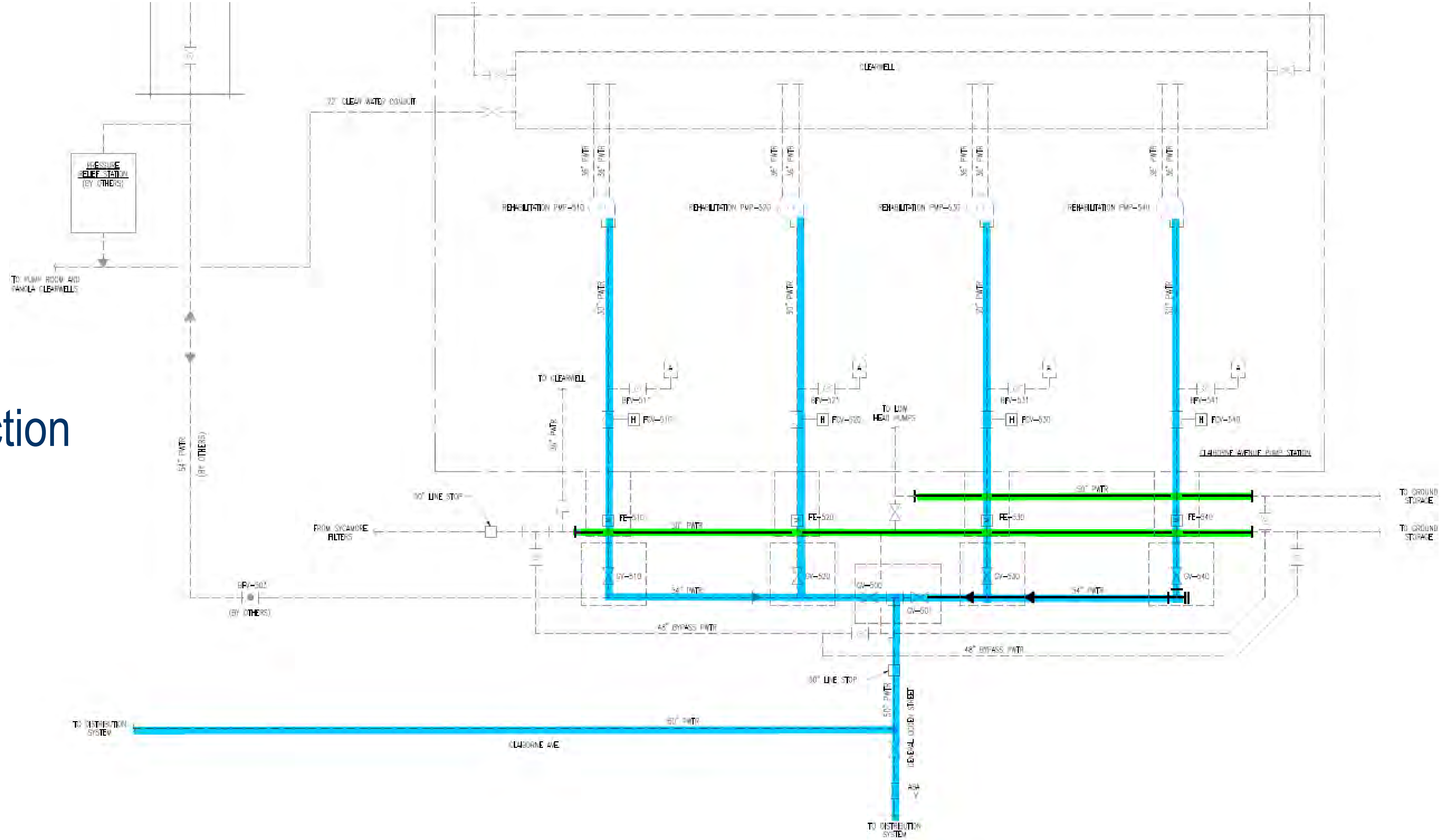
Construction Phasing



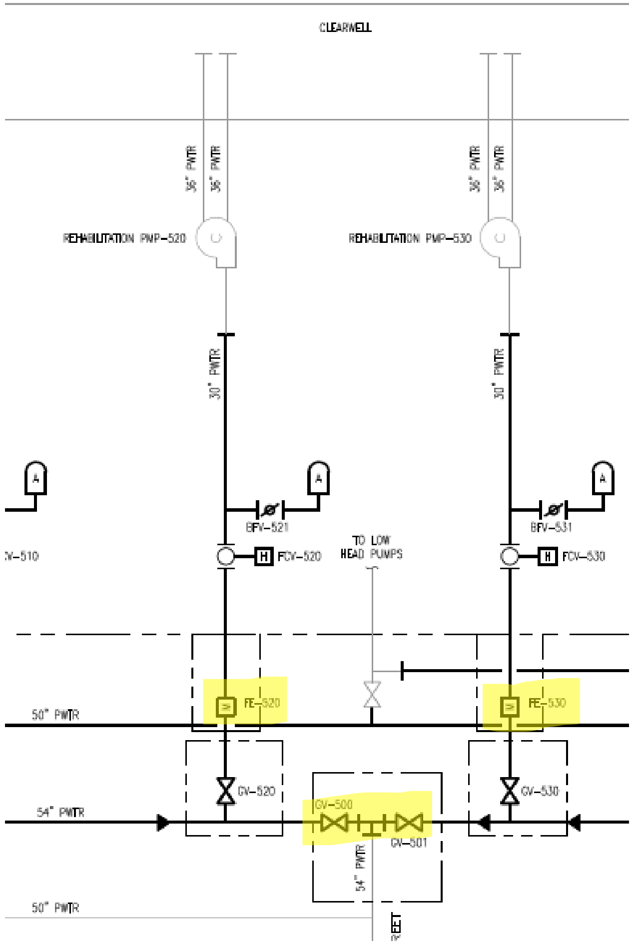
Construction Phasing



Construction Phasing



Construction

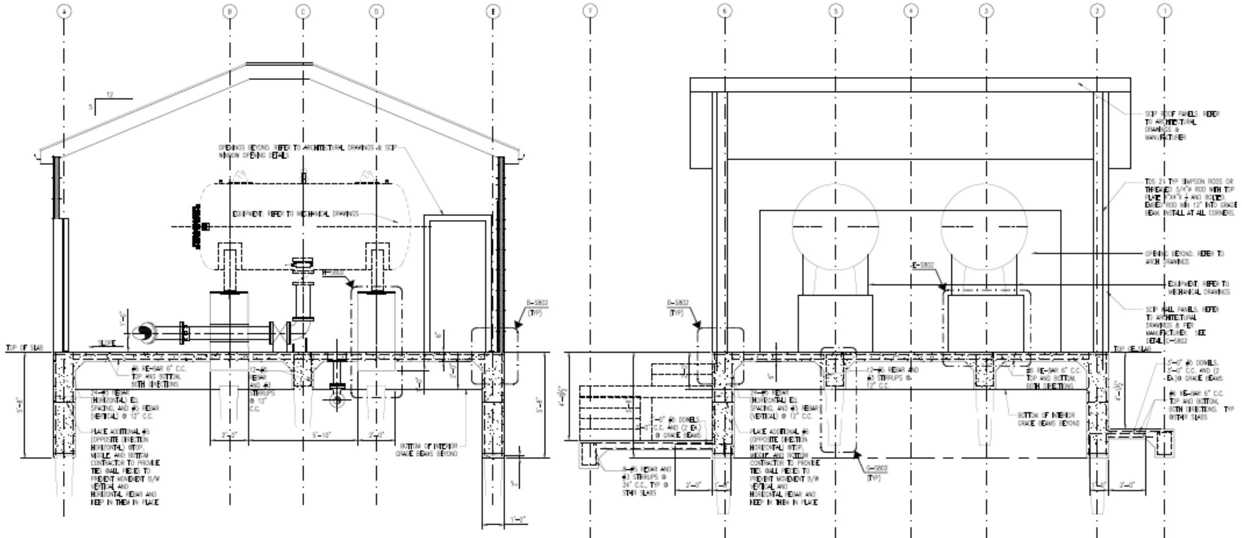


Vacuum Priming System

- Sized to maintain a constant prime
- Instantaneous pump starts
- Automatic and manual operation configured for remote monitoring
- Two vacuum pumps

Improvements

- Surge control facility (remote facility)
- VFD building and switch gear electrical improvements.

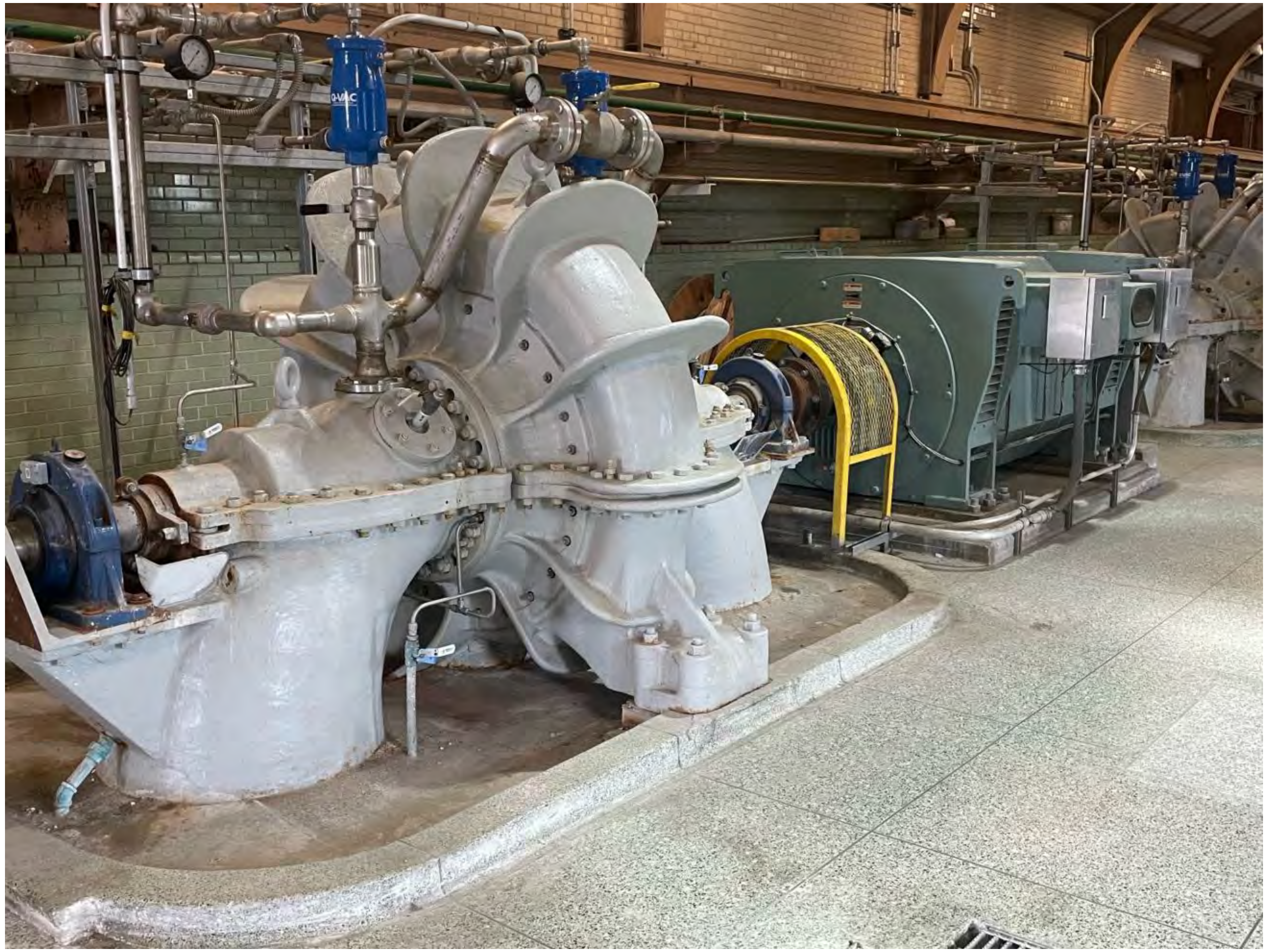


The President Visits

- Highlighted the dire need to modernize infrastructure

Roadway Rehabilitation

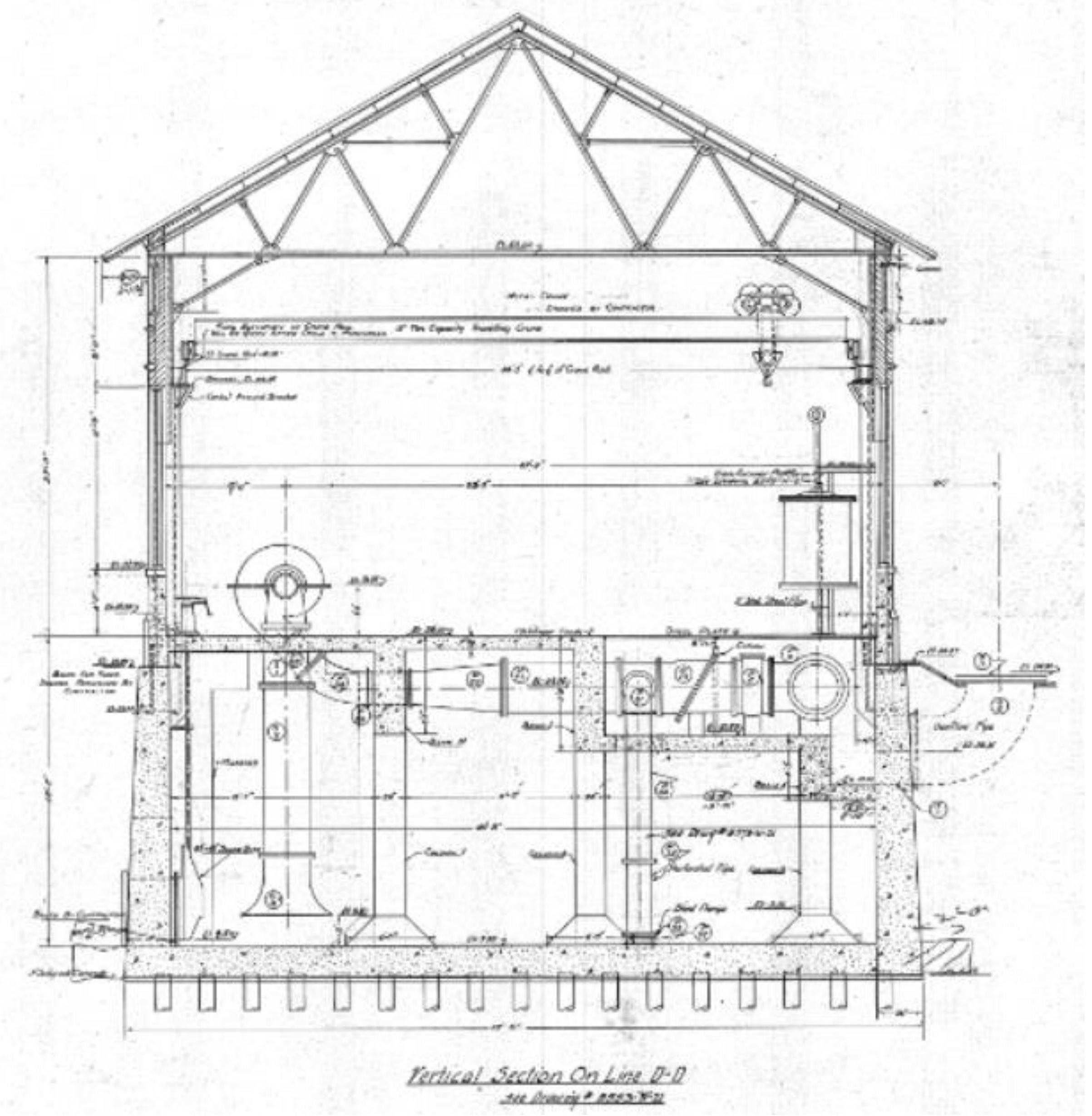
Project Completion



Project Completion

Overall Water Hammer Program

- Phase 1 – Two elevated 2 MG storage tanks
- Phase 2 – Claiborne improvements
- Phase 3 – Panola and High Lift improvements



Panola Improvements

- Complete rehabilitation of pump no. 1
- Replacement of rotating assemblies
  - Impellers
  - Increase shaft size to add anti-rotation back-spin prevention devices
- New vacuum priming system
- New discharge valves and piping, yard piping
- Structural, electrical and I&C
- Change order – structural lining of clear well

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Panola Pump Station Construction

High-Lift Improvements

- Replacement of rotating assemblies
  - Impellers
  - Increase shaft size to add anti-rotation backspin prevention devices
- Vacuum priming system modifications
- New discharge valves and piping, yard piping
- Structural, electrical and I&C
- Change order – convert second pump over to electric motor

Claiborne Pump Station Controls

What is Instrumentation & Controls Engineering?

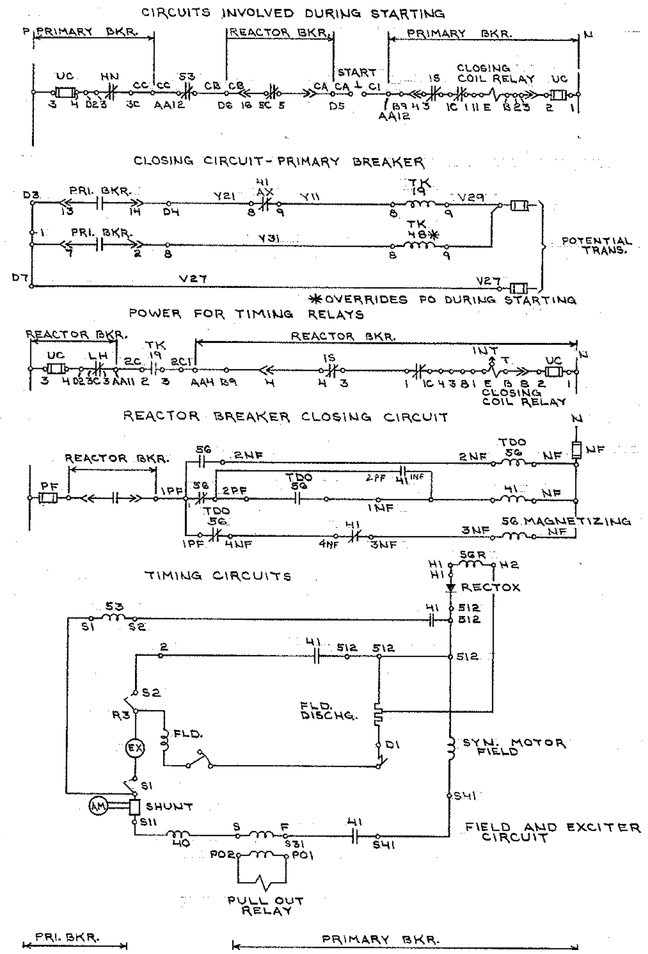
- Unique discipline
- Interface with process, mechanical, electrical and client operations
- Always the last out the door
- Controls design is personal

History of the Controls at Claiborne Station

- Pump station built in 1958, 11 years before the first programmable logic controller (PLC) was developed
- Pumps were manually started and stopped
- No technology forward leaps

CIRCUITS AND OPERATIONS INVOLVED IN AUTOMATIC STARTING OF SYNCHRONOUS MOTORS--CLAIBORNE PUMPING STATION

1. Pressing start button closes circuit thru Closing Coil EB of closing relay. Circuit extends thru HN relay that closes when breaker is in raised position, 53 a checking relay that assures field is not applied at start, and auxiliary switches that assume starting reactor breaker and primary breaker being open.
2. When primary breaker is closed, circuits are closed to apply power to the operating coils of timing relays 19 & 48 from the potential transformers. Timing relay 19 closes the closing circuit for the reactor breaker after a set time. Timing relay 48 keeps a contact in the grip circuit in series with the Pull Out relay contact open, until the motor has come up to speed, thus avoiding a false trip out.
3. A normally open auxiliary switch on the reactor breaker closes when the breaker closes to energize magnetizing coil of relay 56. A NO contact on 56 closes to energize 56 TDO. Simultaneously, the synchronous motor is coming up to speed. A fluctuating current is induced in the field circuit which includes the field discharge resistor. A portion of the voltage developed across the discharge resistor is tapped off thru the operating coil of 56 RUN and made unidirectional by a "one way" rectox. When 56 TDO has closed thru 2 PF-INF and when the flux thru 56 RUN has grown sufficiently 56M is neutralized, 56 closed 1PF2PF and this completes the circuit thru 41 closing the synchronous motor field circuit. A NO auxiliary switch on 41 "seals in" around 56 TDO.
4. If the revolving field goes out of step with the stator field, the windings S,F, and PO1,PO2 which have been acting as a current transformer, energizing PO coil tend to fluctuate and allow PO to be de-energized thus tripping primary breaker thru T1-T11, relay 48 to T.
5. A relatively low overload will eventually energize BL-1 relay and trip the primary breaker before the motor windings are damaged.
6. CO overload relays will trip in the event of a short circuit or severe ground current.
7. Manual operation of the TRIP button will trip the primary breaker. This in turn will trip the reactor breaker. Opening the reactor breaker will de-energize 56M resetting the field circuit for the next start.



History of the Controls at Claiborne Station

Manual control stations.

History of the Controls at Claiborne Station

- Wound rotor motor control panel, pre-cursor to variable frequency drives (VFDs)

- Had speed control

- Several panels abandoned in the station as motors were upgraded

Discovery Process by Controls Engineers

- Uphill battle on implementing controls
- Started discovery process early 2012
- Not yet digitally cataloged
- Most were the originals from the plant or plant upgrades

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Discovery Process

- Temperatures, pump speeds, system pressure manually recorded
- Chart recorders using paper disk

Discovery Process

System pressure gauge

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Discovery Process

- Met with SWB engineering staff and operators, observed operations
- Questions we needed to understand:
  - How were pumps brought online?
  - How did controls function?
  - Function of auxiliary systems?
  - Which were essential?

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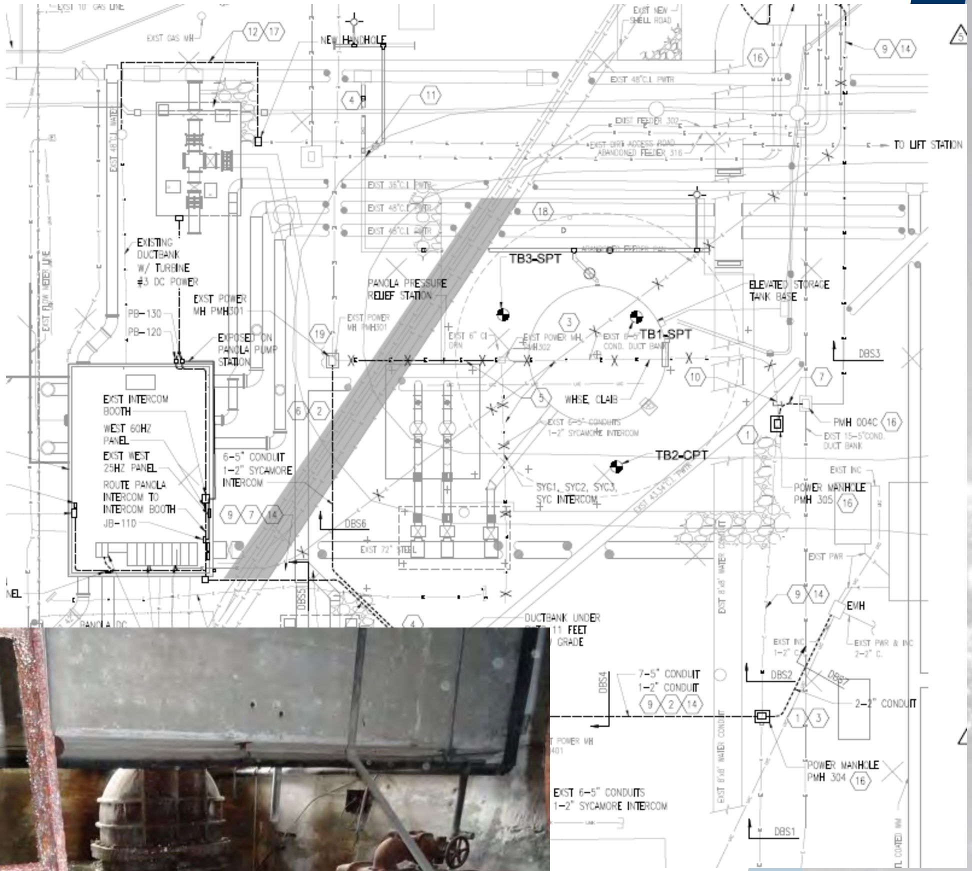
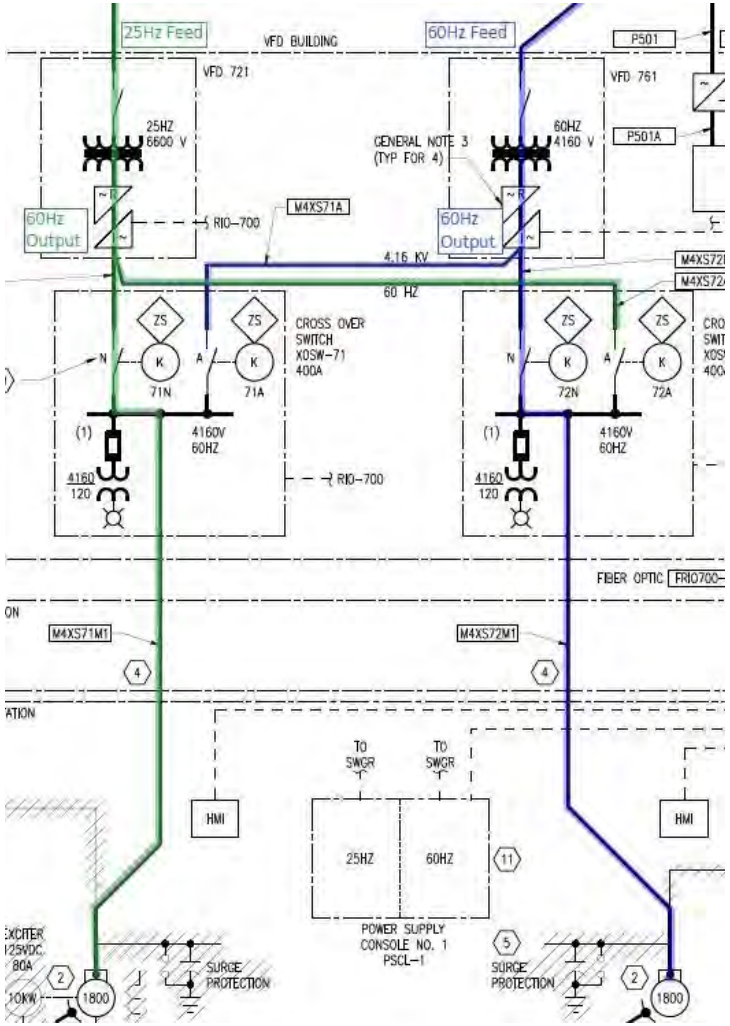
Physical Inspections

- Spent time on-site, tracing large diameter pipes
- Used info to understand vast and complex piping system on the Carrollton site



Physical Inspections – Venturi Flow Metering

Design Challenges, Solutions



Controls-Electrical:

- System redundancy – Must continually run under all scenarios, especially <u>hurricanes</u>
- Consider loss of
  - Incoming power
  - Specific power on sub-systems
  - Control system power
- Uninterruptable power supply (UPS)

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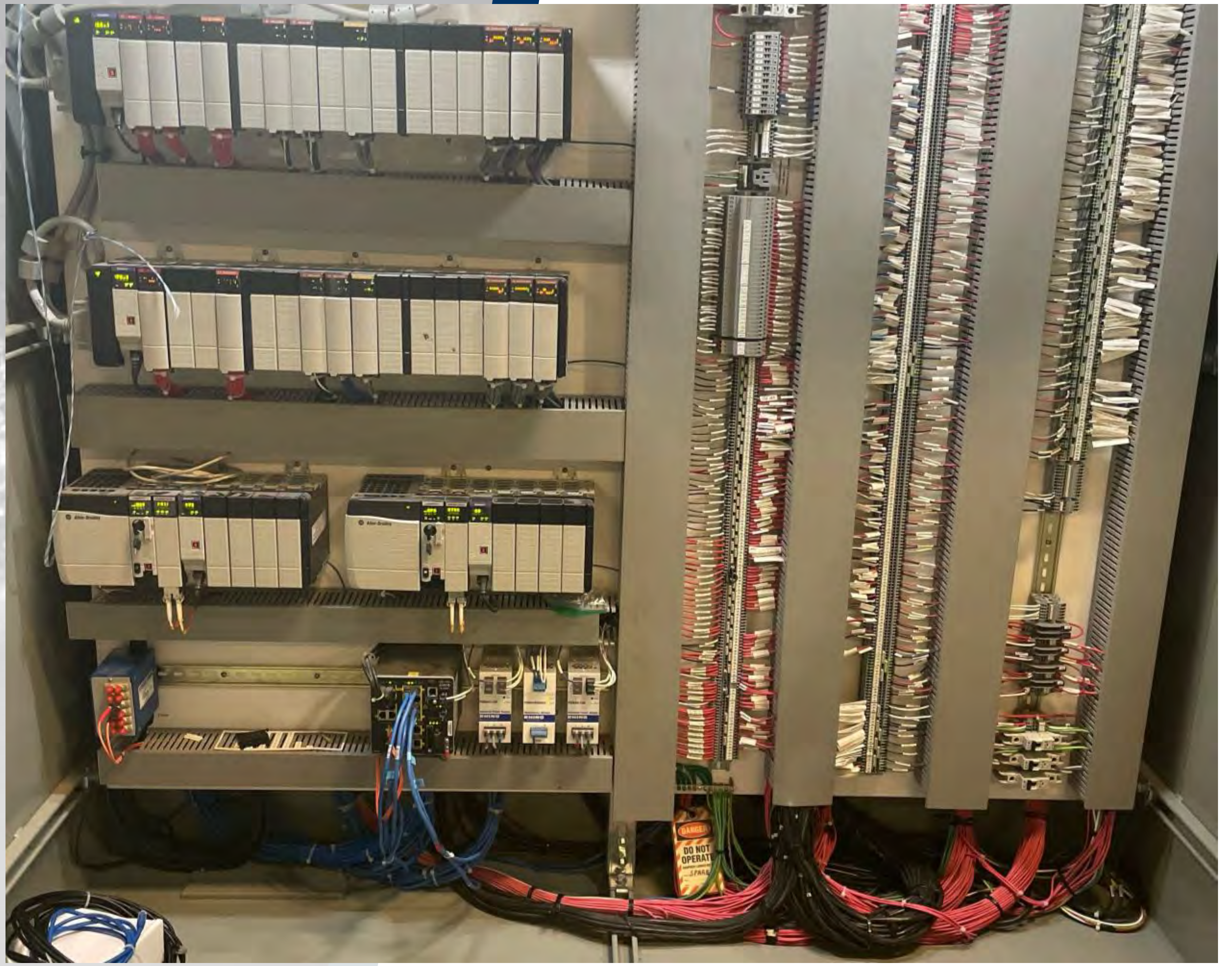
Design Challenges, Solutions

Controls-Mechanical:

- Water hammer effect
- New design added ball valves with electro-hydraulic actuators
  - Must close valves if power loss
- Automation decision

Programmable Logic Controllers (PLCs) Installed



- All new instrumentation signals pulled into new “brain”
- Controls VFD speed simultaneously, can change pressure output by adjusting speed
- Controls discharge valves
- Monitors sub-systems

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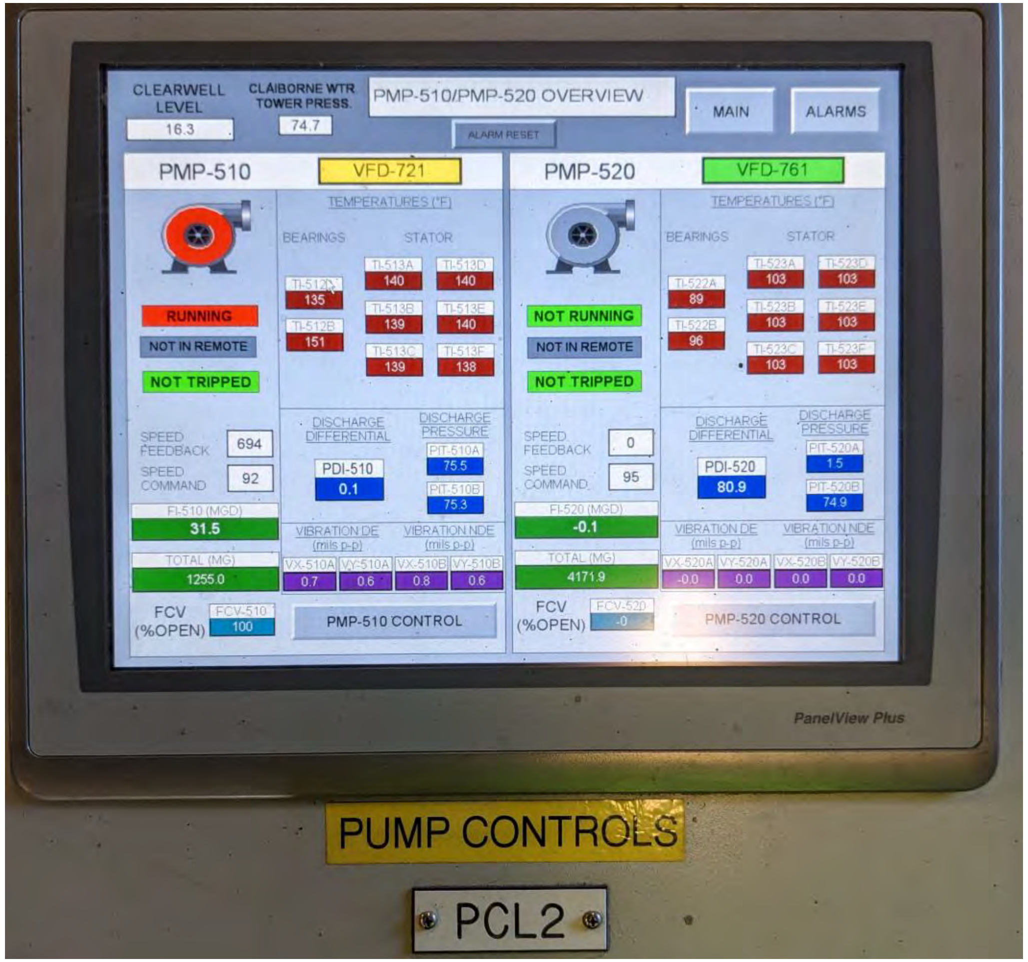
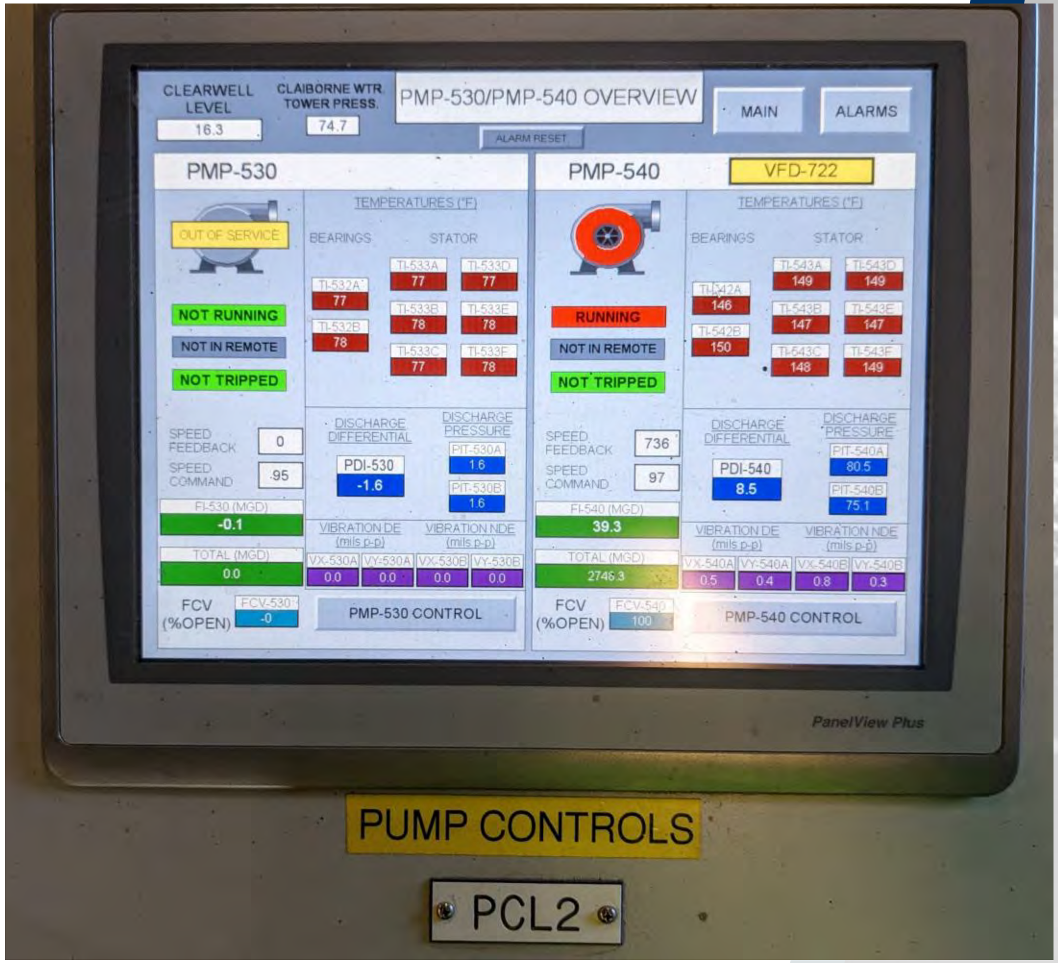
Control Panel – New Screens





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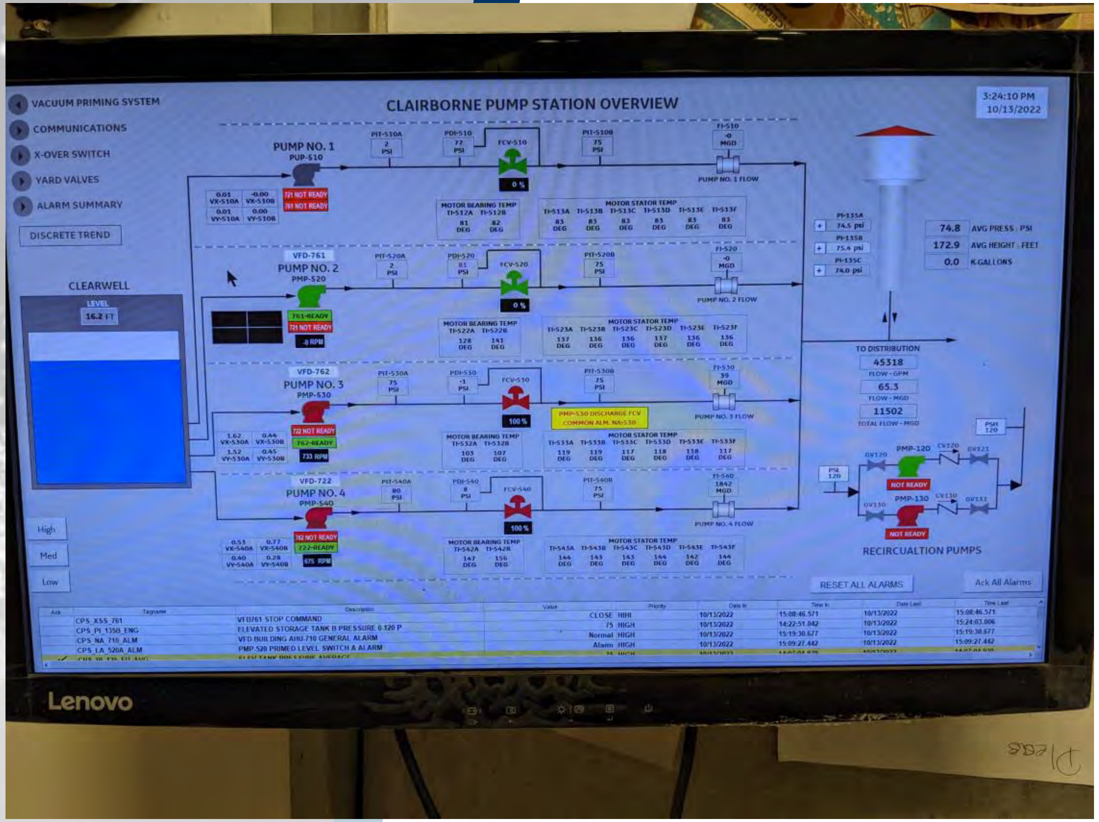
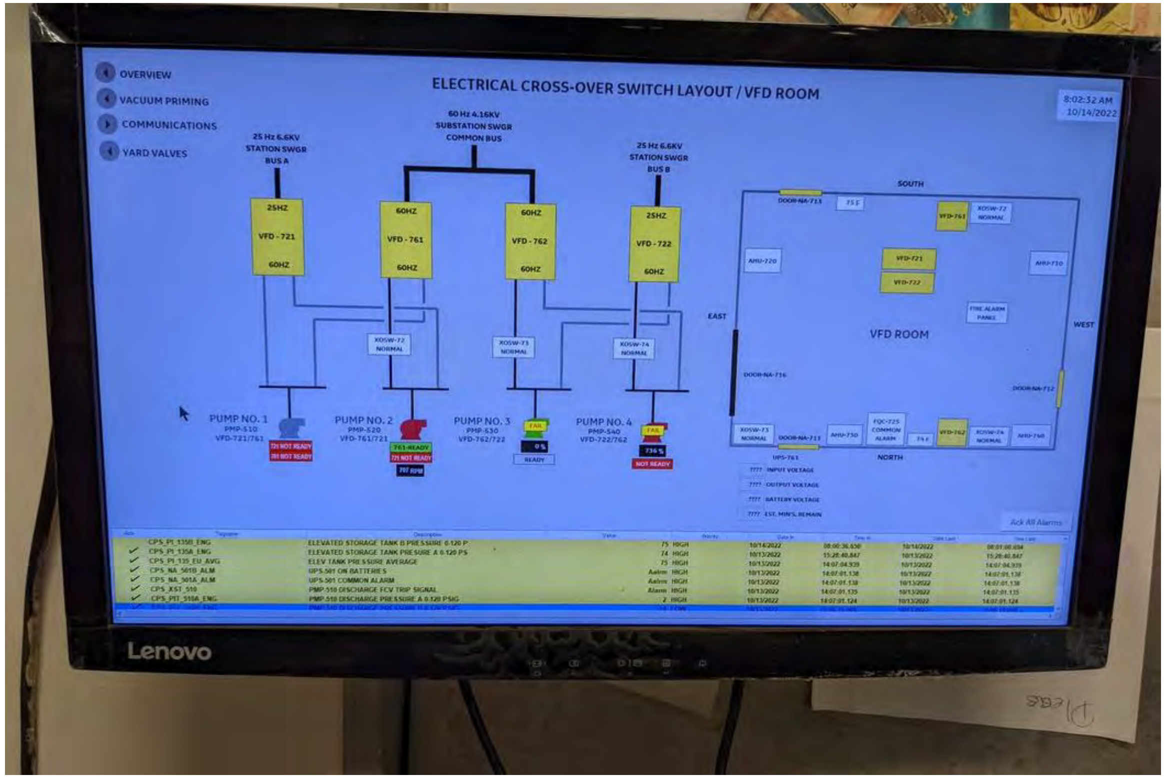
SCADA Computer





Instrumentation Installation and Construction

- Flow meters added at discharge of each pump
- Monitoring of the automated vacuum priming system

Variable Frequency Drives (VFD)

Controls Lessons Learned

- Determine how much to automate
- Flexibility needed during equipment startup
- New Equipment Training for staff
- Too much technology, too fast to meet client needs

MAKING OUR WATER SYSTEM MORE RESILIENT

Phase 1
Completed 2019

Water Towers

Build water towers that hold two million gallons of water to provide up to 40 minutes of uninterrupted water pressure in the event of a power outage.

Phase 2
Completed 2022

Claiborne Pumping Station

Upgrade all four pumps and motors at the Claiborne Pumping Station with new controls that can adjust to fluctuations in water pressure.

Phase 3
Underway

Panola and High Lift Pumping Stations

Install new meters and valves at the Panola and High Lift Pumping Stations so we can monitor water flow rates in addition to improvements to the pumps.

Estimated Completion **2024**

Construction projects were phased to prevent water service interruptions.

Future Plans

- Electrical system upgrade
- Evaluate equipment that could be fully automated
- Determine how much automation to implement in the complex pumping system

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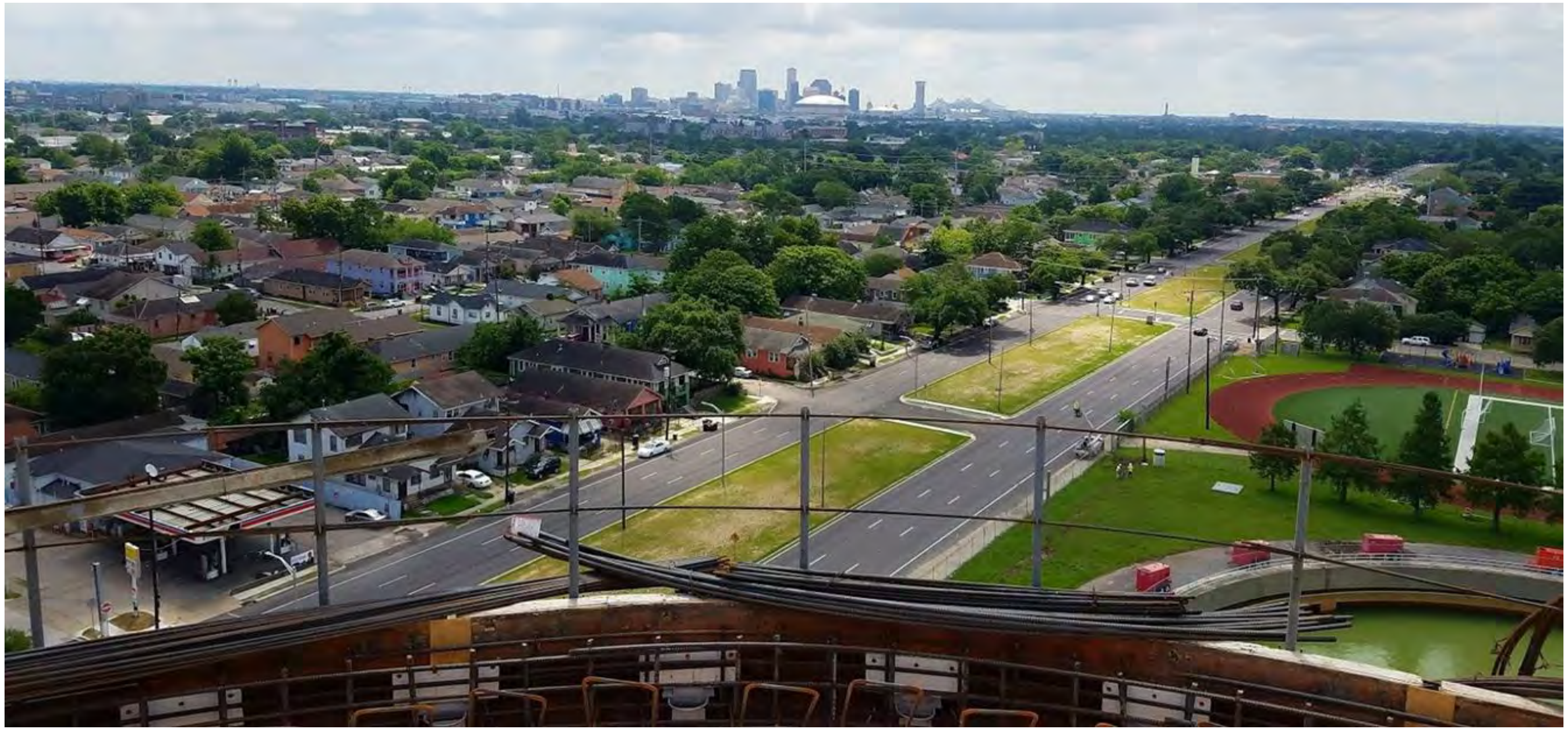
Questions



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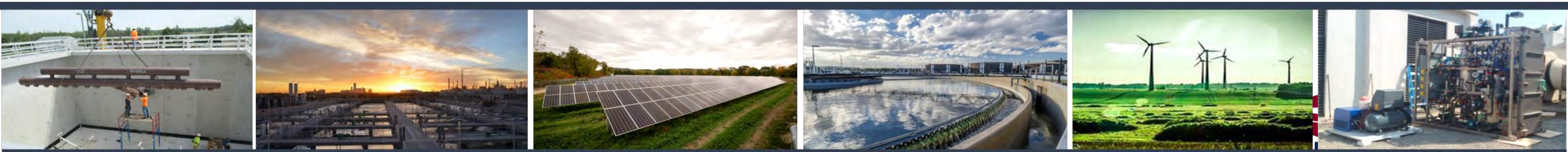

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