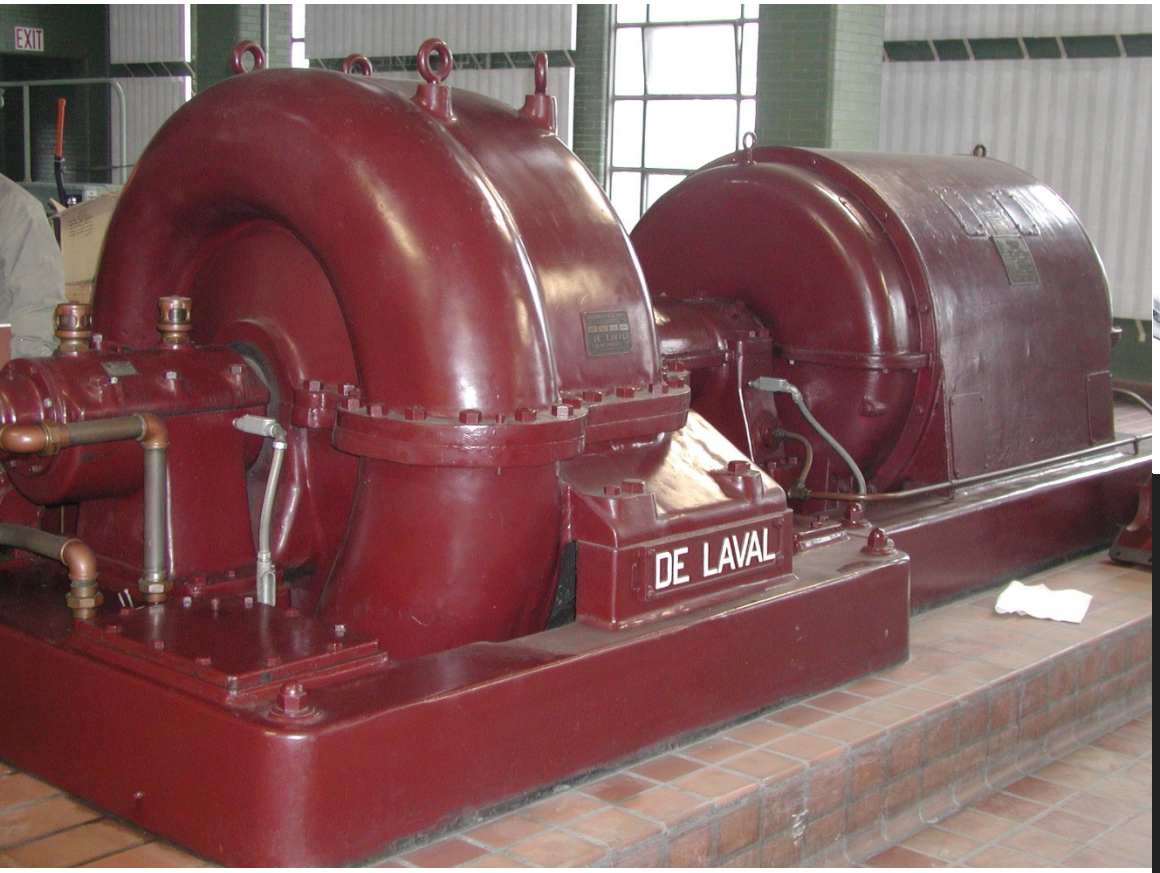

One Water
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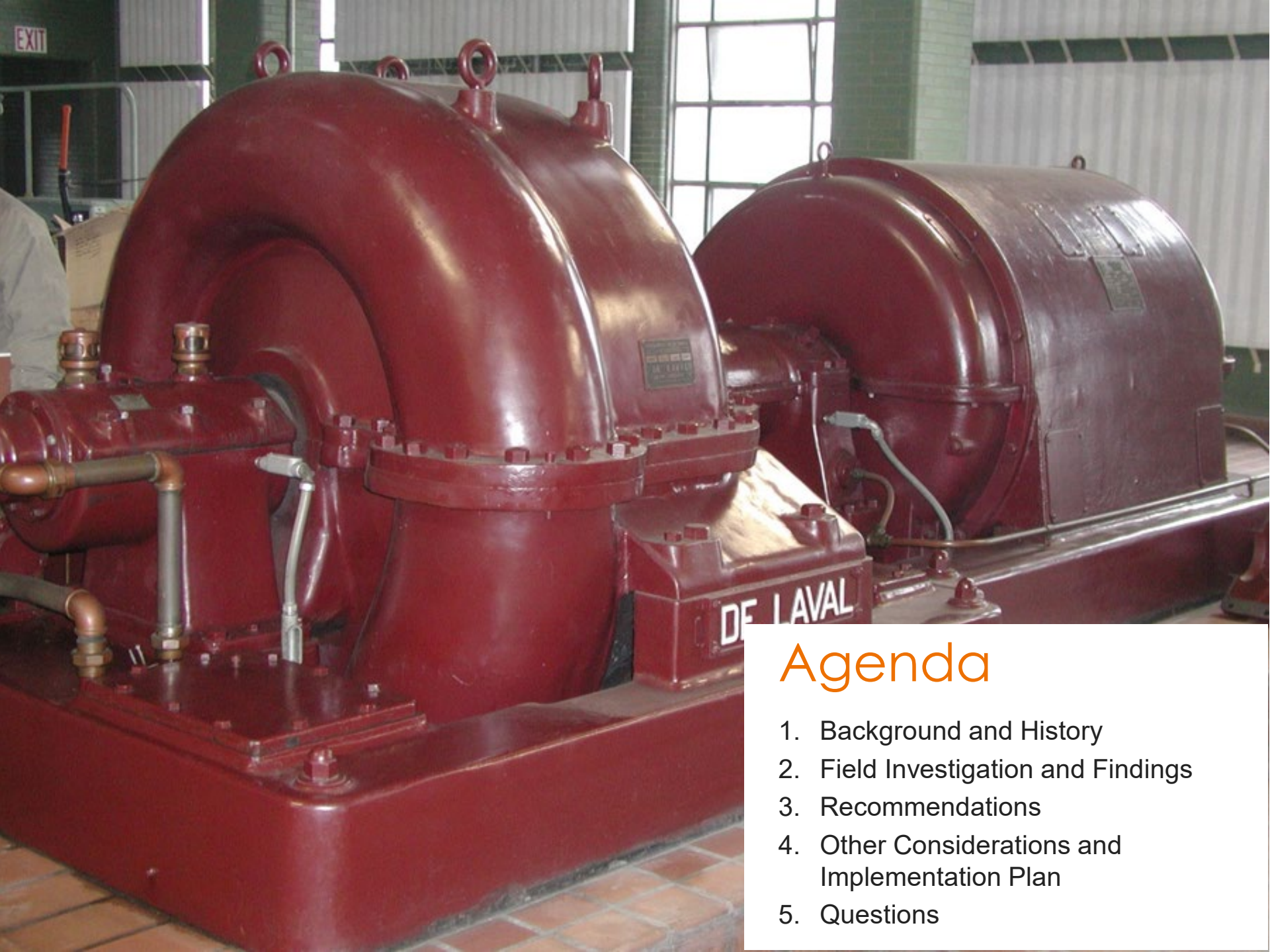
Power Quality Study Offers Solutions with Added Benefits - Improved Operability and Energy Savings

Bruce Buchanan, PE – NEORSD
Doug Reed, PE - Stantec

Northeast Ohio Regional Sewer District

Stantec



Agenda

1. Background and History
2. Field Investigation and Findings
3. Recommendations
4. Other Considerations and Implementation Plan
5. Questions

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Background and History

Project Background and History

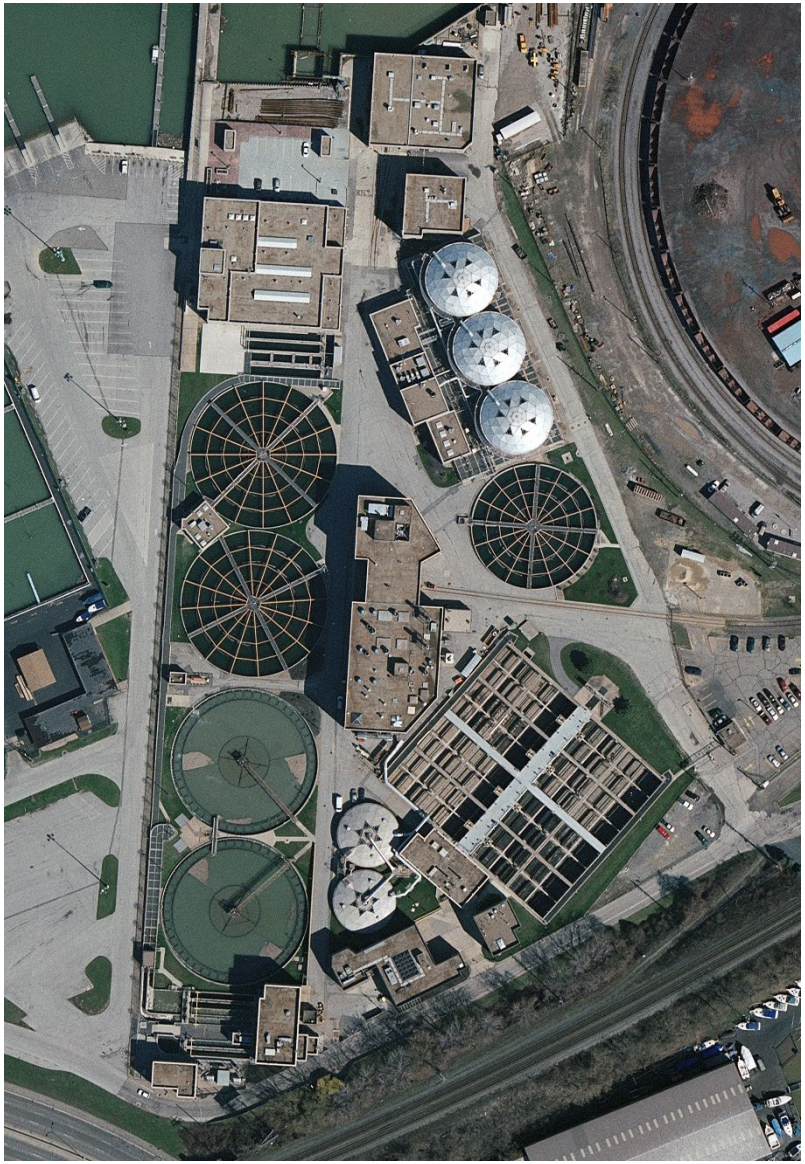
Issues at the Easterly and Westerly Treatment Facilities Included:

- Disruption of Utility Power
- Problems Starting Blowers
- Random Undervoltage Trips
- Brief Power Fluctuations
- Generators Unable to Sync Back with the Utility After an Outage

Project Background and History

Project Scope Consisted of Three General Tasks for Easterly and Westerly:

- Assessment of Electrical Utility Services
- Energy Efficiency Audit
- Internal Power Quality Investigations and Analysis



Request for Proposal/Selection

NEORSD Issued a Qualifications-Based RFP

- Three (3) Proposals Submitted
- NEORSD Internal Review Committee Evaluated Proposals
- Stantec Proposal Evaluated as Most-Responsive
  - Proposal Identified Easterly Blowers for Energy Efficiency Improvement AND a Possible Solution for Some Electrical Issues

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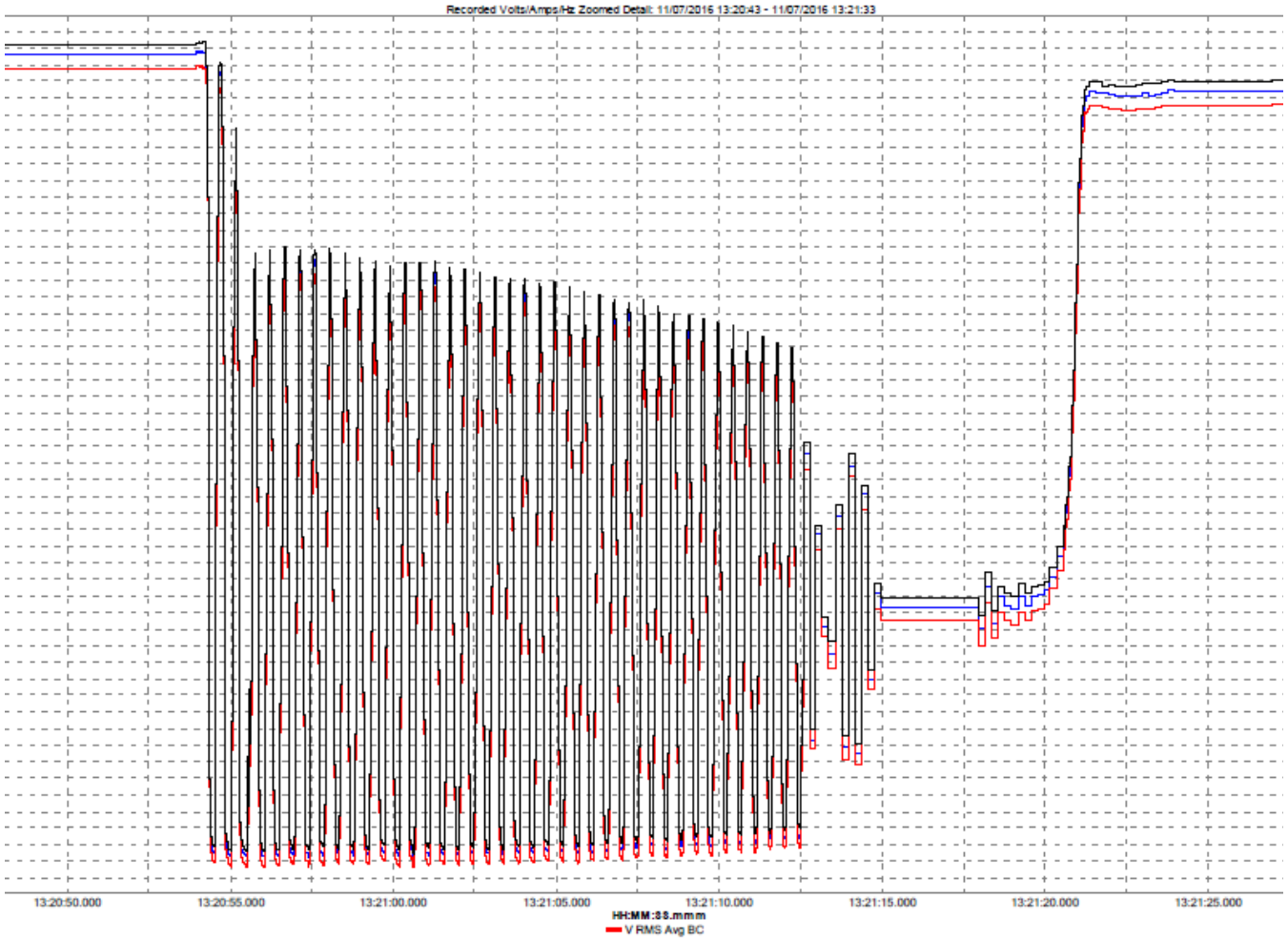
Field Investigation and Findings

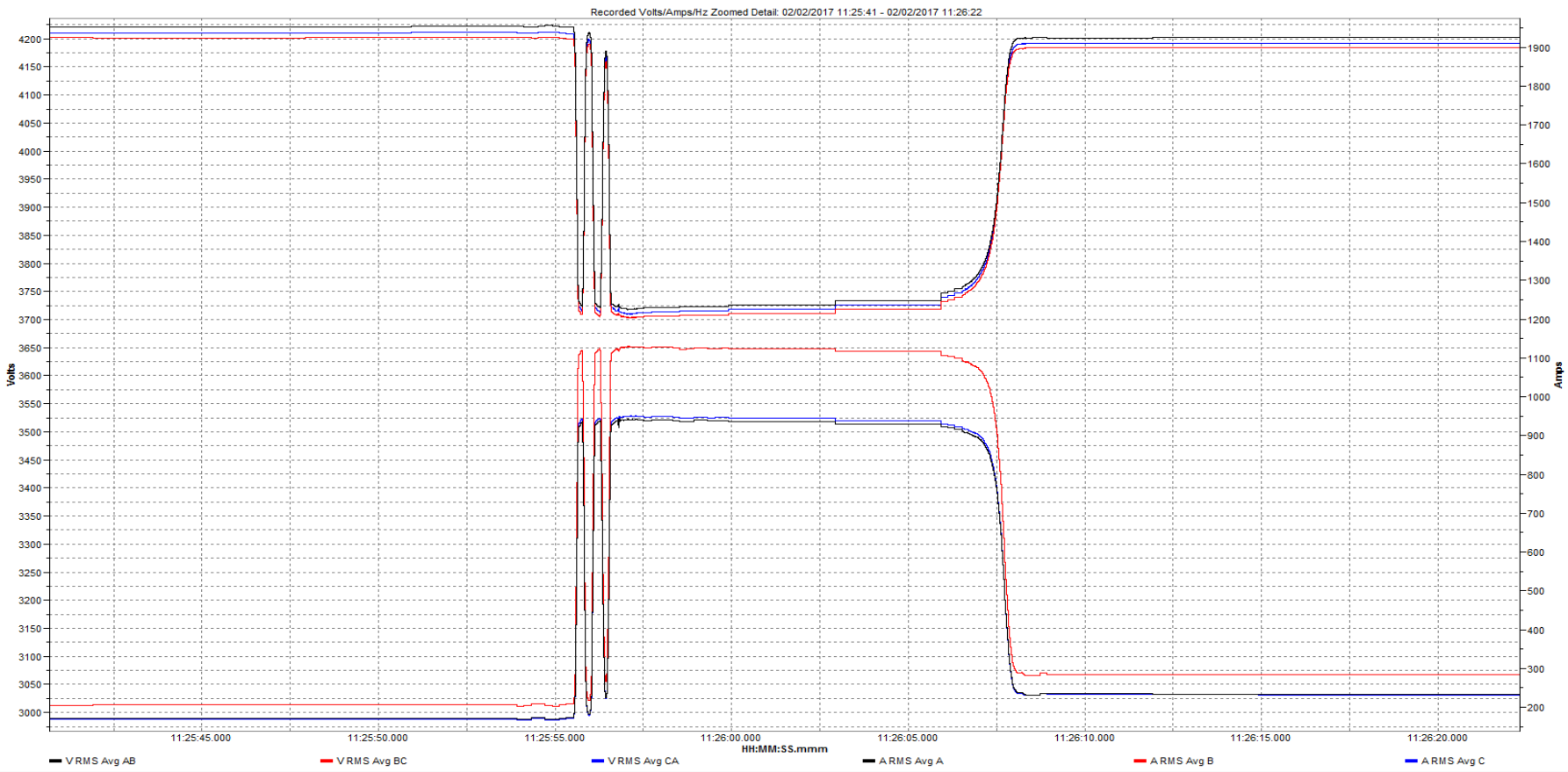
Field Investigation

- Installed sensitive recording metering on the main breakers at each plant for a 5-6 month period
- Installed meters on each unit substation and switchgear lineup for one month, and rotated each month to capture all substations/switchgear over a 6-month period.



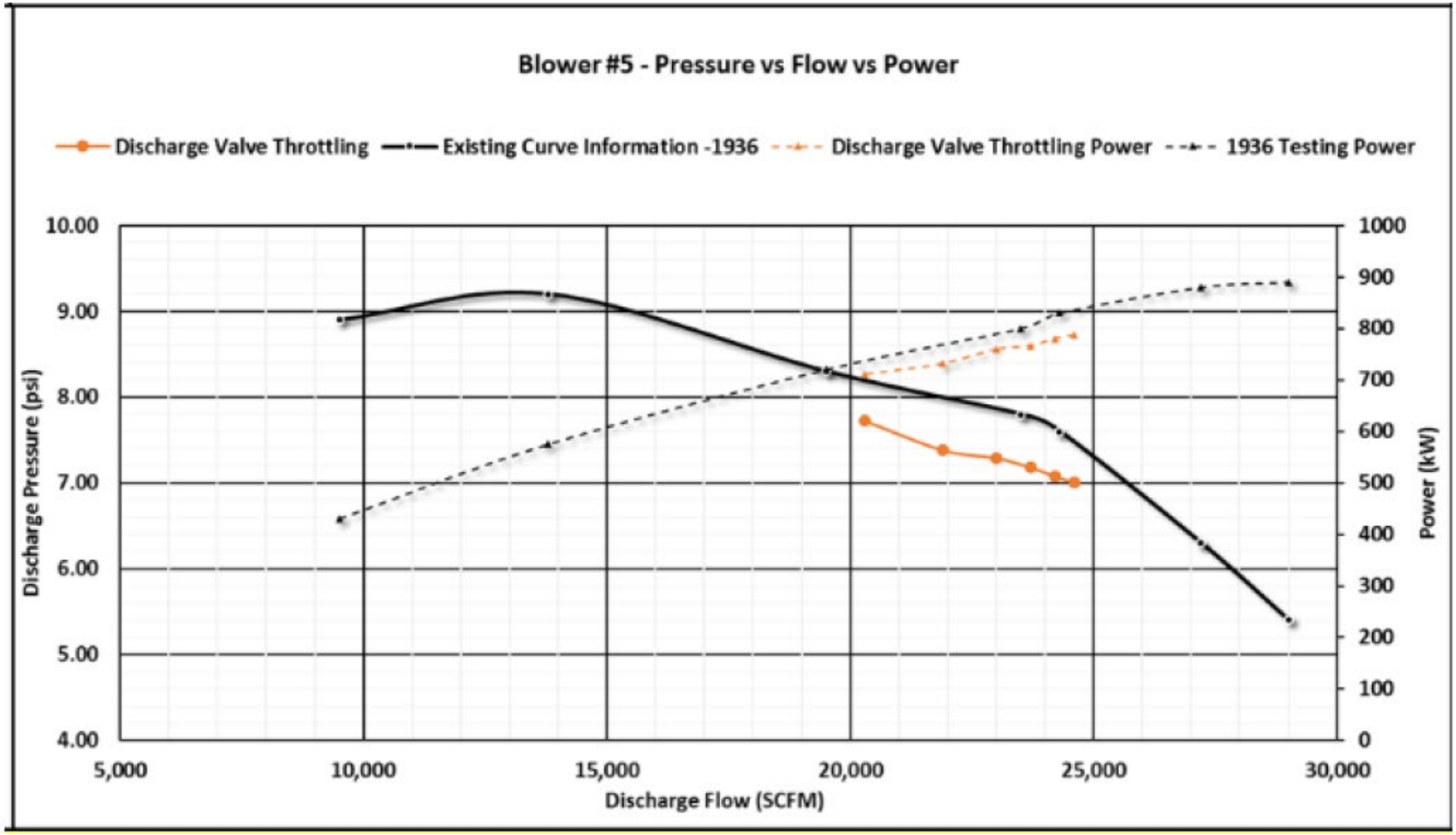
Field Investigation

- Meters measured amps, volts, power factor, harmonic distortion, KW/KVA demand, outage events
- Utilized existing plant instrumentation for blower performance testing
- Used District's ETAP Electrical Model to simulate voltage dips during blower starts, and validated the model using actual field metering data



Field Investigation

Blower Testing identified some loss of performance over the 80 equipment year lifespan (1938 vintage blowers)



Analysis and Findings

Based on field data, air demands and historical flow data, the aeration system annual power costs were estimated.

Table 5.3.3.1 - Existing Configuration Annual Energy Costs

Aeration SCFM	Channel Air SCFM	Total SCFM	Blowers Required	SCFM per Blower	BHP per Blower	Total KW	Time (%)**	Annual Usage (kWh)	Annual Costs*
14,000	4,000	18,000	Small	18,000	872	650	5%	284,810	$ 22,785
16,000	4,000	20,000	Small	22,000	984	734	19%	1,221,285	$ 97,703
22,000	4,000	26,000	Large	31,500	1386	1,034	30%	2,716,144	$ 217,291
26,000	4,000	30,000	Large	31,500	1386	1,034	45%	4,074,215	$ 325,937
40,000	6,000	46,000	Small	16,700	835	1,636	1%	143,314	$ 11,465
			Large	30,400	1358				
								Annual Costs	**$675,200**

**Assuming $0.08 / kWh*

*** Estimated from 2011-2012 Easterly Flow Data*

Analysis and Findings

- Voltage dips were measured under “two-utility line” operation, and modeled in the plant electrical model to validate results.
- Model was used to estimate “single-utility line” voltage dips.

Voltage Dip Results (Existing Blowers)			
Blower Motor Size (HP)	Voltage Dip (Measured) – Two Line Operation	Voltage Dip (Estimated – ETAP) – Two Line Operation	Voltage Dip (Estimated – ETAP) – Single Line Operation
1500	6%	6%	12%
2000	12%	9%	17%

Field Investigation and Findings

Alternatives were considered:

- Use variable frequency drive to vary flow and eliminate voltage dip.
  - Very limited turn-down capabilities due to affinity laws – no energy benefit
  - VFD starters were considered, but eliminated due to complexity and cost.
- Increase electric utility service capacity
  - No energy efficiency improvement
  - Short circuit limitations on plant switchgear
- Replace one or more blowers with smaller motors
  - Higher efficiency
  - Reduced HP
  - Lower starting current (reduced voltage dip)
  - Wide turn-down capabilities/Ability to implement DO control

&

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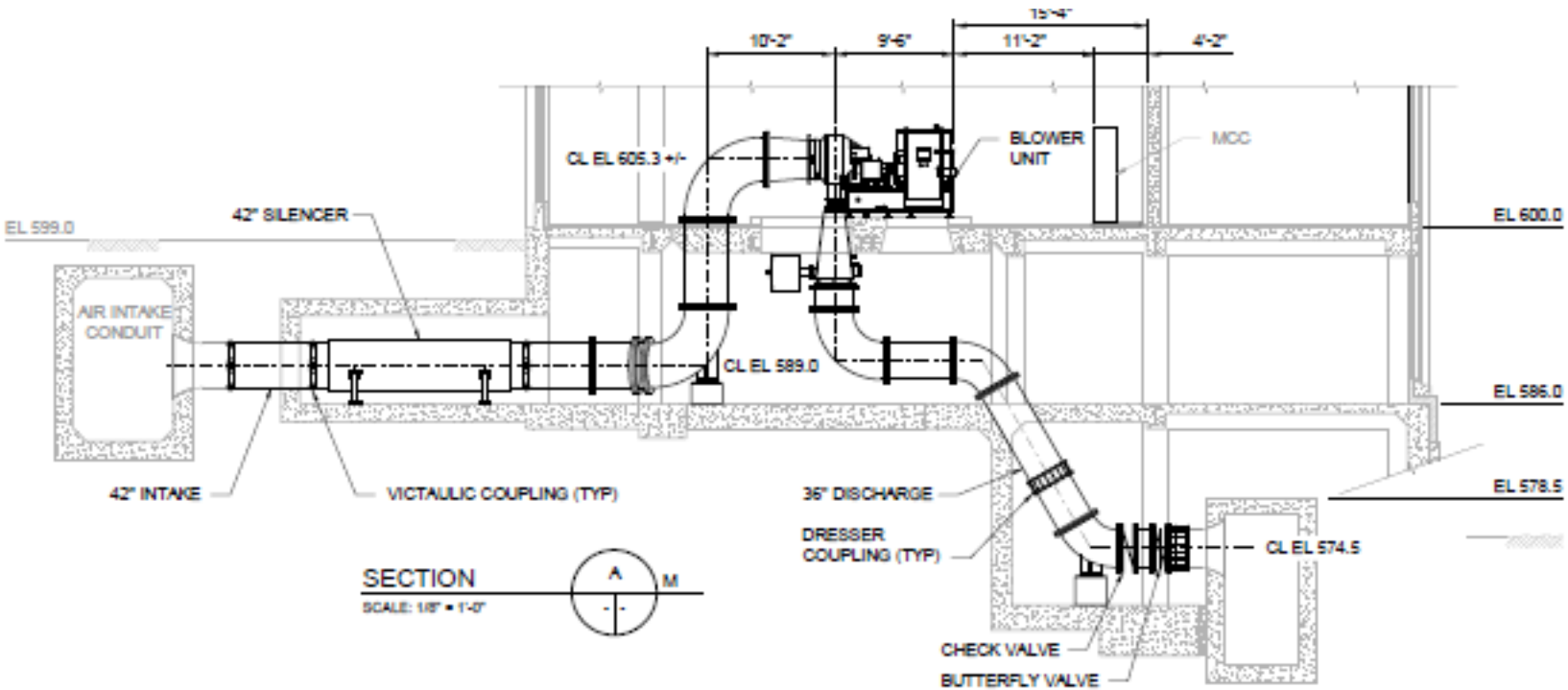
Recommendations

Recommendations

Existing Plant has 3 large (40,000 cfm) and 2 small (25,000 cfm) blowers with space for one additional blower

- Add Blower #6 and Replace Blower #2 with new 35,000 cfm single-stage, integrally-geared, centrifugal blowers
- New configuration would have 2@25,000 cfm (existing), 2@35,000 cfm (new) and 2@40,000 cfm (existing) blowers for redundancy



Recommendations

New Blower is estimated at 1350 hp with **55%** turn-down capability

ESTIMATED ANNUAL ENERGY COST SAVINGS – **OVER $170,000**

New Blower Annual Energy Costs									
Aeration SCFM	Channel Air SCFM	Total SCFM	Blowers Req'd	SCFM per Blower	HP per Blower	Total KW	Time (%)**	Annual Usage (kWh)	Annual Costs*
14,000	4,000	18,000	1	18,000	663	494	5%	216,550	$ 17,324
16,000	4,000	20,000	1	20,000	728	543	19%	903,565	$ 72,285
22,000	4,000	26,000	1	26,000	937	699	30%	1,837,042	$ 146,963
26,000	4,000	30,000	1	30,000	1,089	812	45%	3,201,199	$ 256,096
36,000	4,000	40,000	2	23,000	830	1,636	1%	143,314	$ 11,465
				23,000	830				
								Annual Costs	**$501,400**

**Assuming $0.08 / kWh*

*** Estimated from 2011-2012 Easterly Flow Data*

Recommendations

Smaller motor with reduced starting current solves voltage dip issues under single line conditions

Estimated Voltage Dip Results (ETAP – Proposed Blowers)				
Blower Motor Size (HP)	Voltage Dip (Linear Ramp) Two Line Operation	Voltage Dip (Linear Ramp) Single Line Operation	Voltage Dip (Current Limited) Two Line Operation	Voltage Dip (Current Limited) Single Line Operation
1350	6%	12%	4%	8%

8% Voltage Dip vs. 17% Voltage Dip on a single utility line!

Recommendations

- Approximately $5M total cost for blower modifications (study-level estimate)
- Retain four (4) existing 1938 vintage blowers and motors for redundancy– existing units are still serviceable
- Salvage Blower #2 as spare parts for Blowers #3 and #4
- Re-use existing starter for new Blower #2, and add new starter for Blower #6 (existing space provision)

Utilize blower turndown capabilities to implement DO control for improved operability and efficiency!

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Other Considerations and Implementation Plan

Other Considerations

- Found that two primary electrical service lines share a common duct bank to the plant
- Investigation is ongoing with utility for a cost-effective solution to separate the lines using existing infrastructure
- Multiple standard energy conservation methods being implemented over multiple projects

Blower Upgrade Implementation Plan

- Installation of the new blowers to be part of a larger project.
- $11M CIP project focusing on aeration system improvements.
- Design contract currently in negotiations. Design NTP scheduled for November 2018
- Construction NTP tentatively scheduled for late 2019.
- Construction substantial completion scheduled for early 2022

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Questions