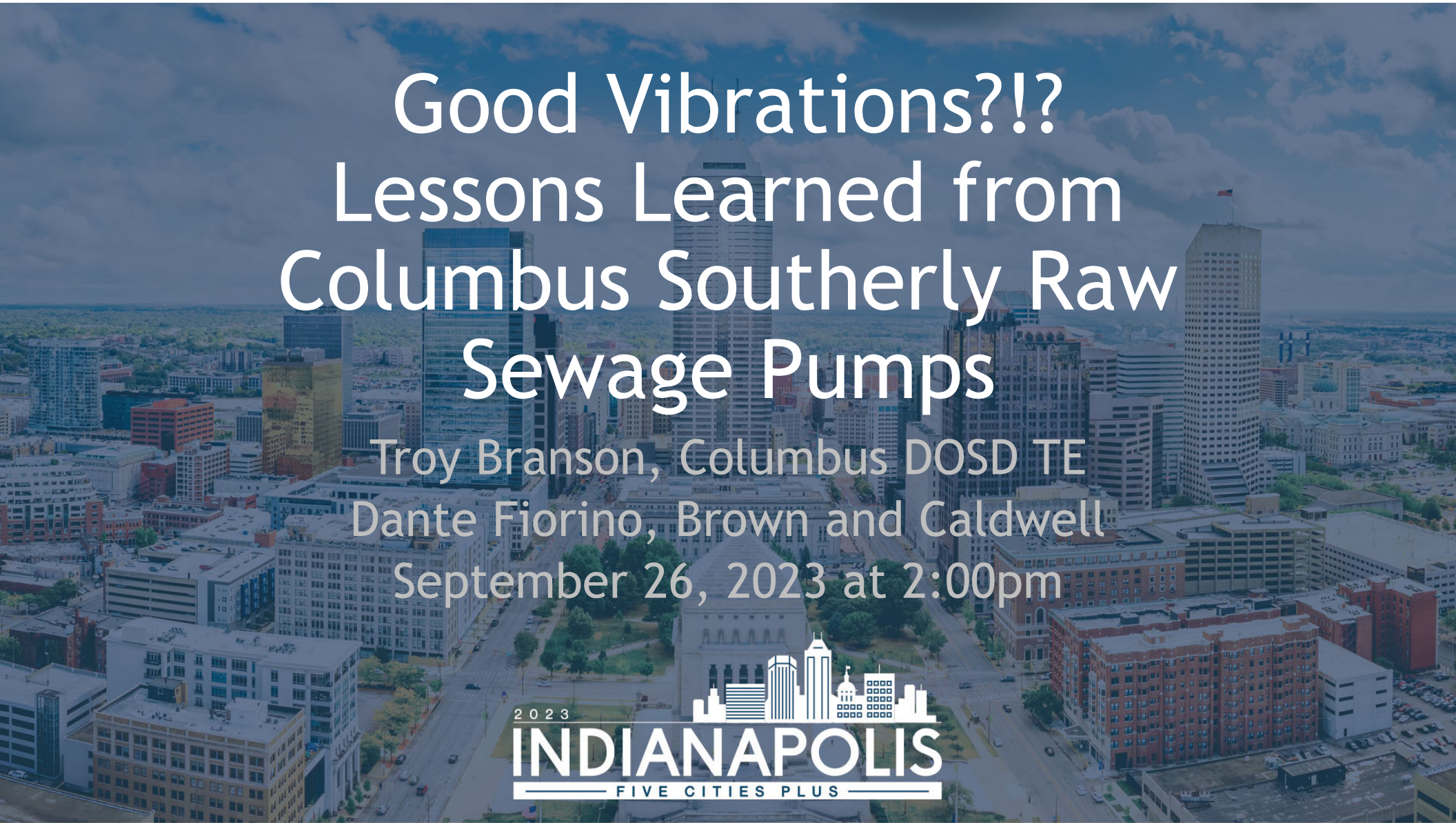
Good Vibrations?!?
Lessons Learned from
Columbus Southerly Raw
Sewage Pumps
Troy Branson, Columbus DOSD TE
Dante Fiorino, Brown and Caldwell
September 26, 2023 at 2:00pm
2023
INDIANAPOLIS
FIVE CITIES PLUS

Agenda

BACKGROUND

CONDITION ASSESSMENT

DESIGN AND CONSTRUCTION

PERFORMANCE TESTING

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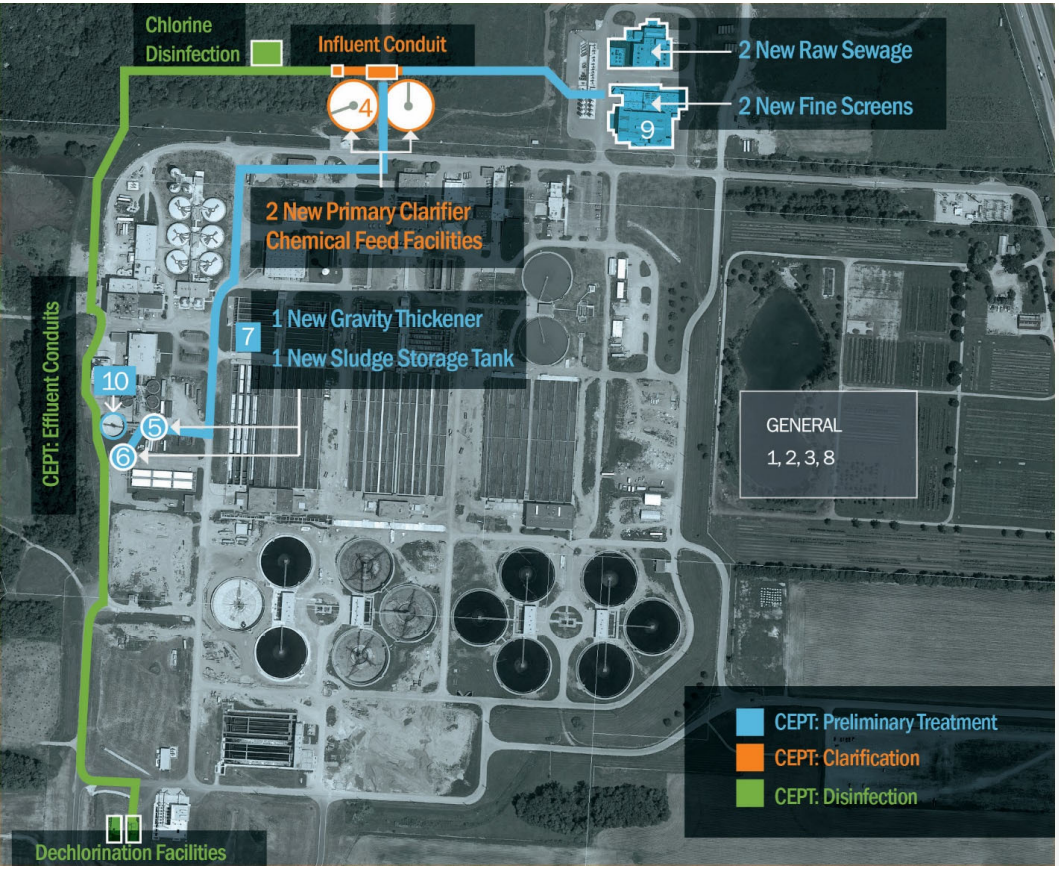
Background

Troy Branson, Columbus DOSD TE

Chemically Enhance Primary Treatment



- S87 was part of overall Southerly CEPT project
- Increased wet weather capacity from 330 MGD to 440 MGD
- S87 (blue) included improvements to Raw Sewage Pumps, Fine Screens, and Gravity Thickeners

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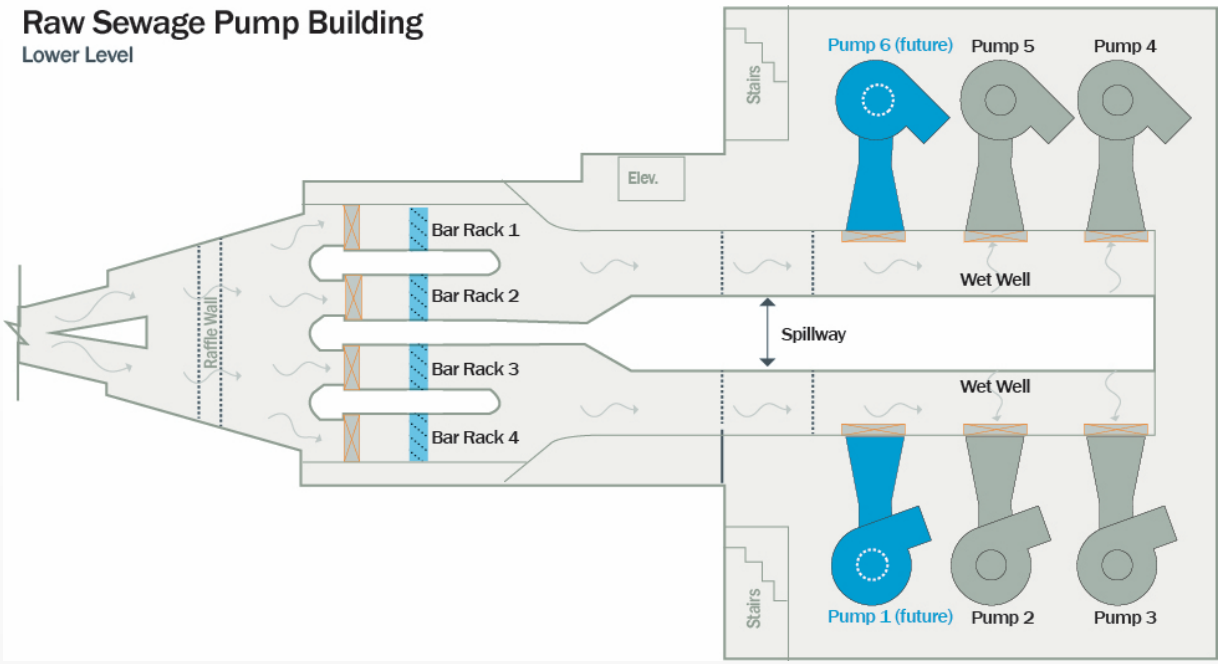
Existing Raw Sewage Pumps

- Four single stage vertical, non-clog, dry-pit, centrifugal pumps with VFDs
- 1,250 hp motors, 395 rpm, 42-inch suction pipe
- Intended peak design capacity of 110 MGD at 41 feet of total head
- Two slots for future pumps available



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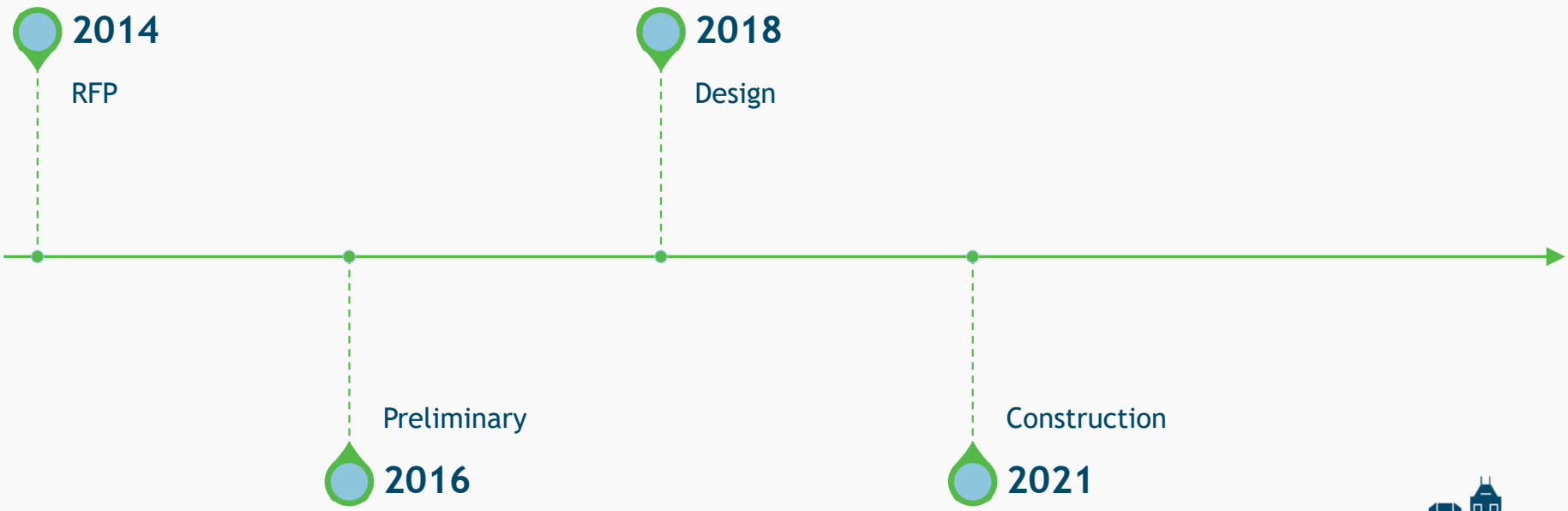
S87 CEPT Preliminary Treatment Project



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Condition Assessment

Troy Branson, Columbus DOSD TE

Issues with Existing Pumps

- Excessive and increasing pump vibration
- Capacity drift up to 15% after four hours
- Progressive deterioration of pump foundation
- Verified flow meter calibration, not the issue

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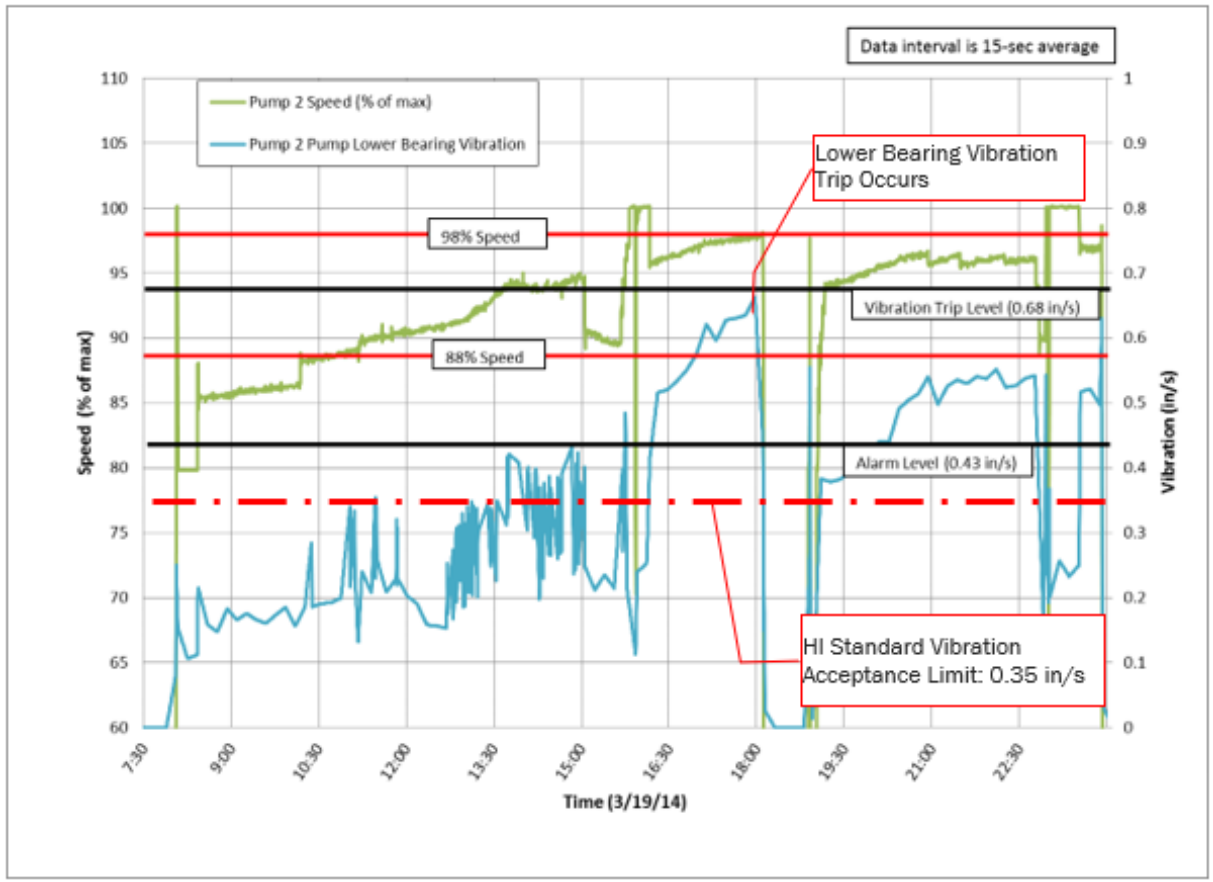
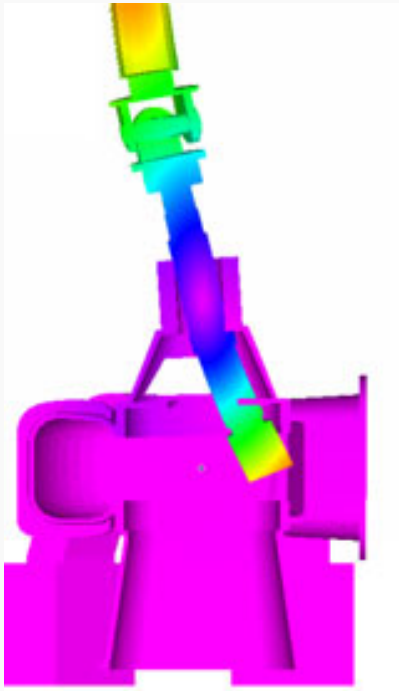
Vibration





Rotordynamic Analysis

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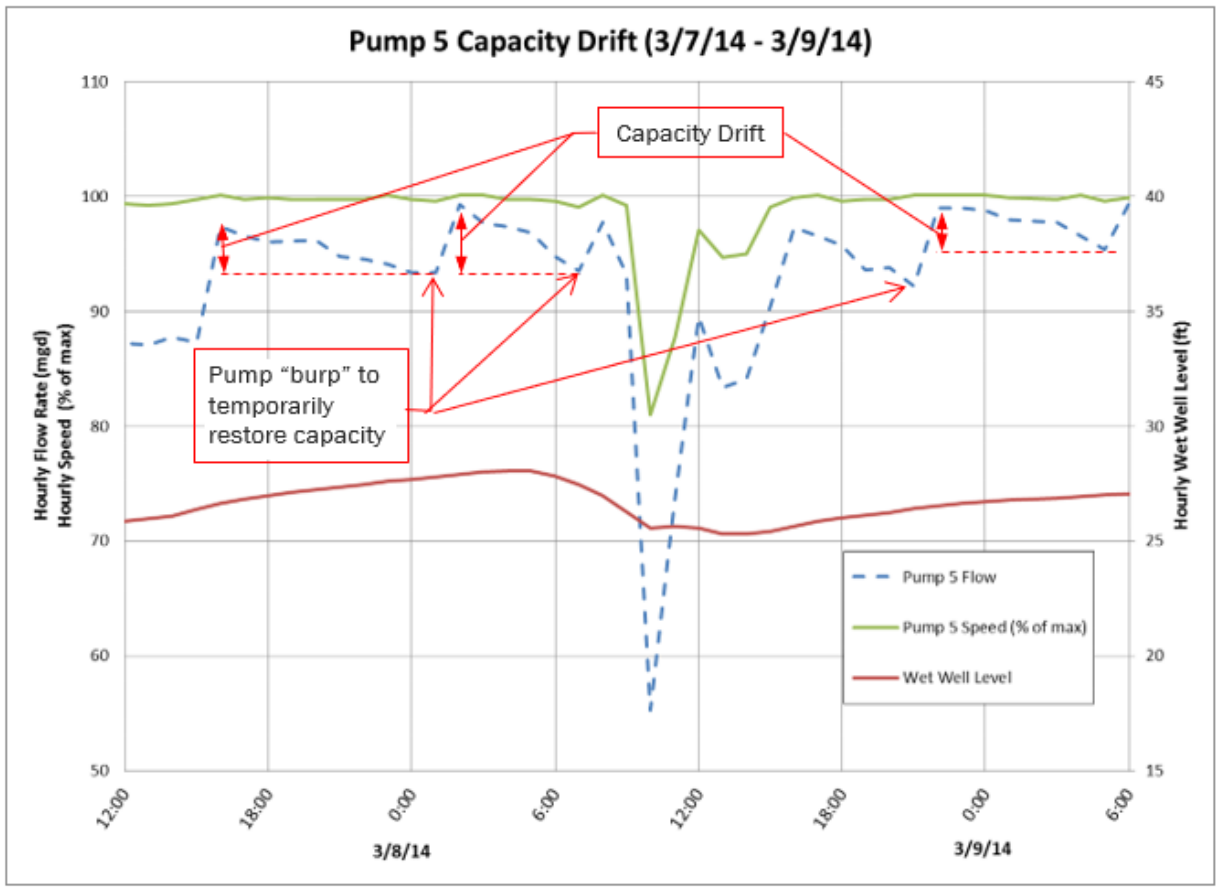
Capacity Drift



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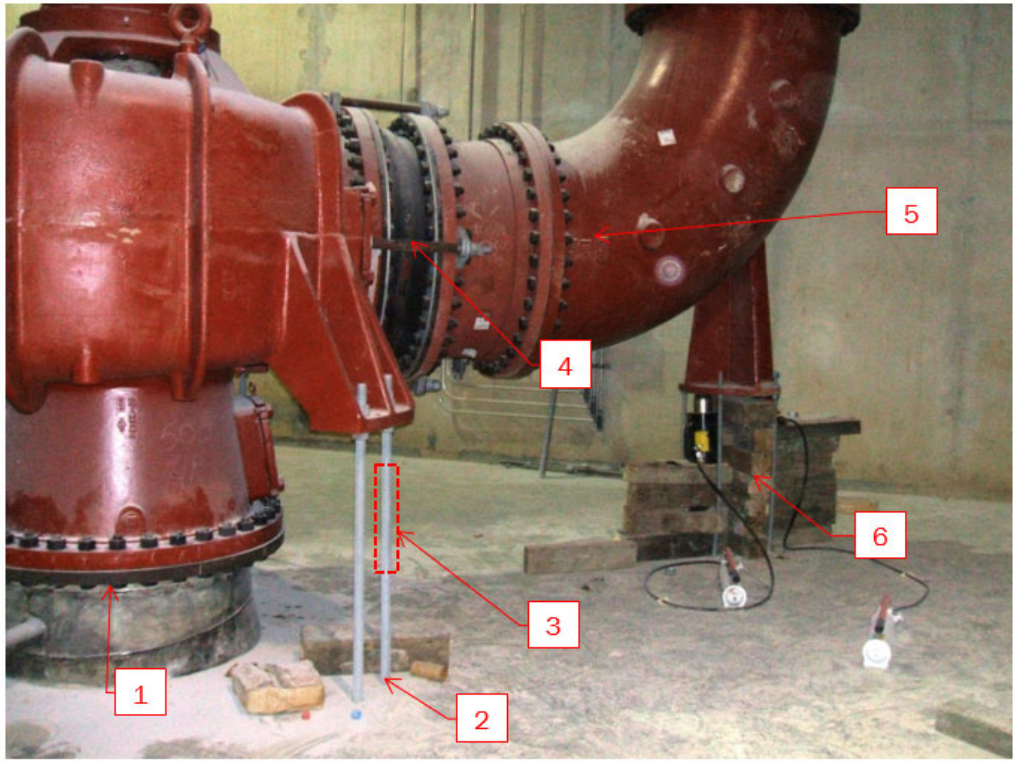
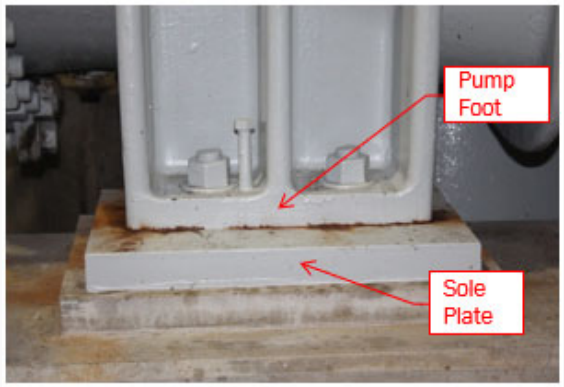
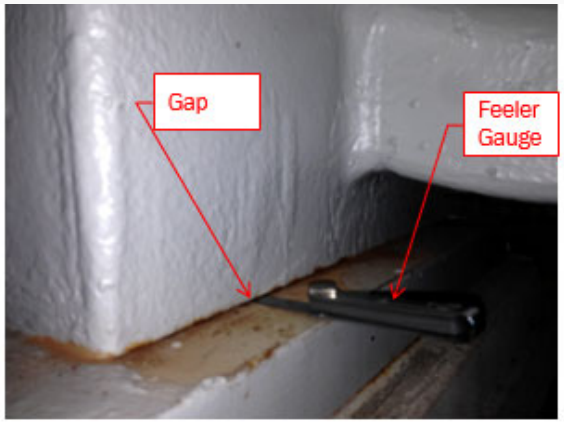
Pump Anchorage





Pump Sole Plate Rust



Pump Sole Plate Gap

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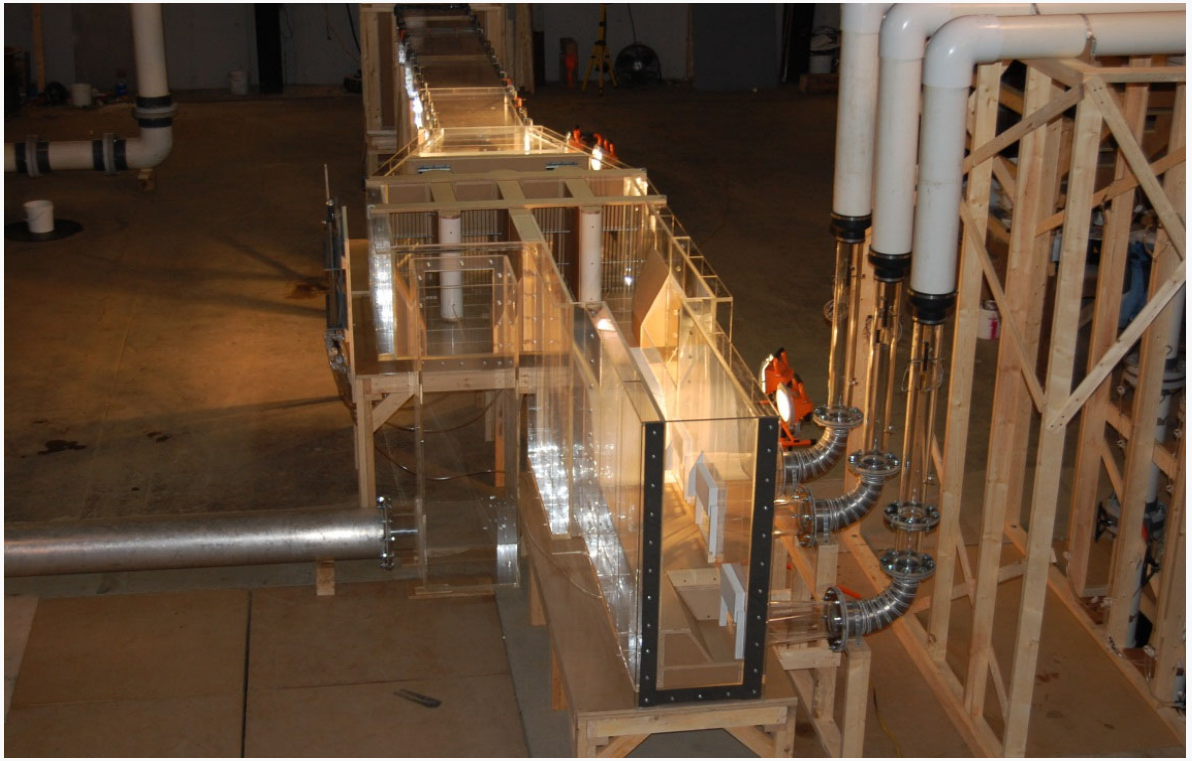
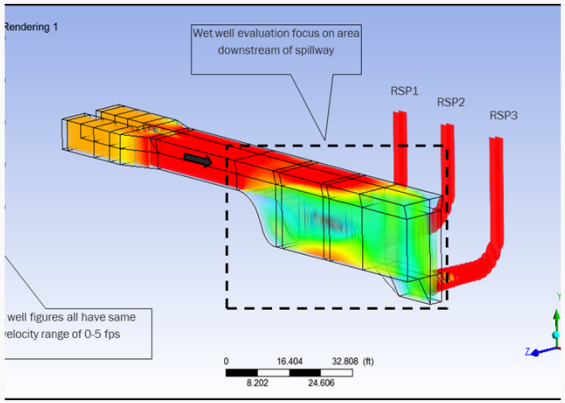
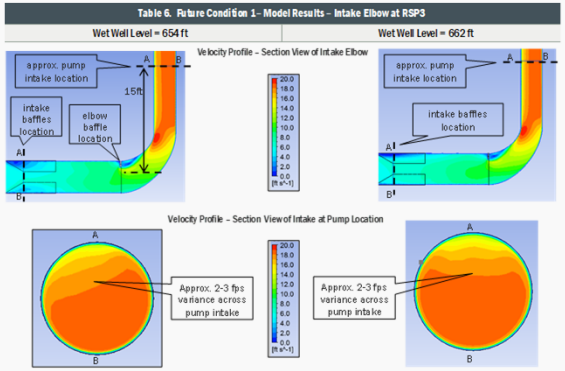
Suction Intake





Wet Well CFD Model



Suction Intake CFD Model

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Design and Construction

Dante Fiorino, Brown and Caldwell

Six New Pumps

- City decided to replace the four existing raw sewage pumps with six new pumps and foundations instead of just expanding with two new pumps.

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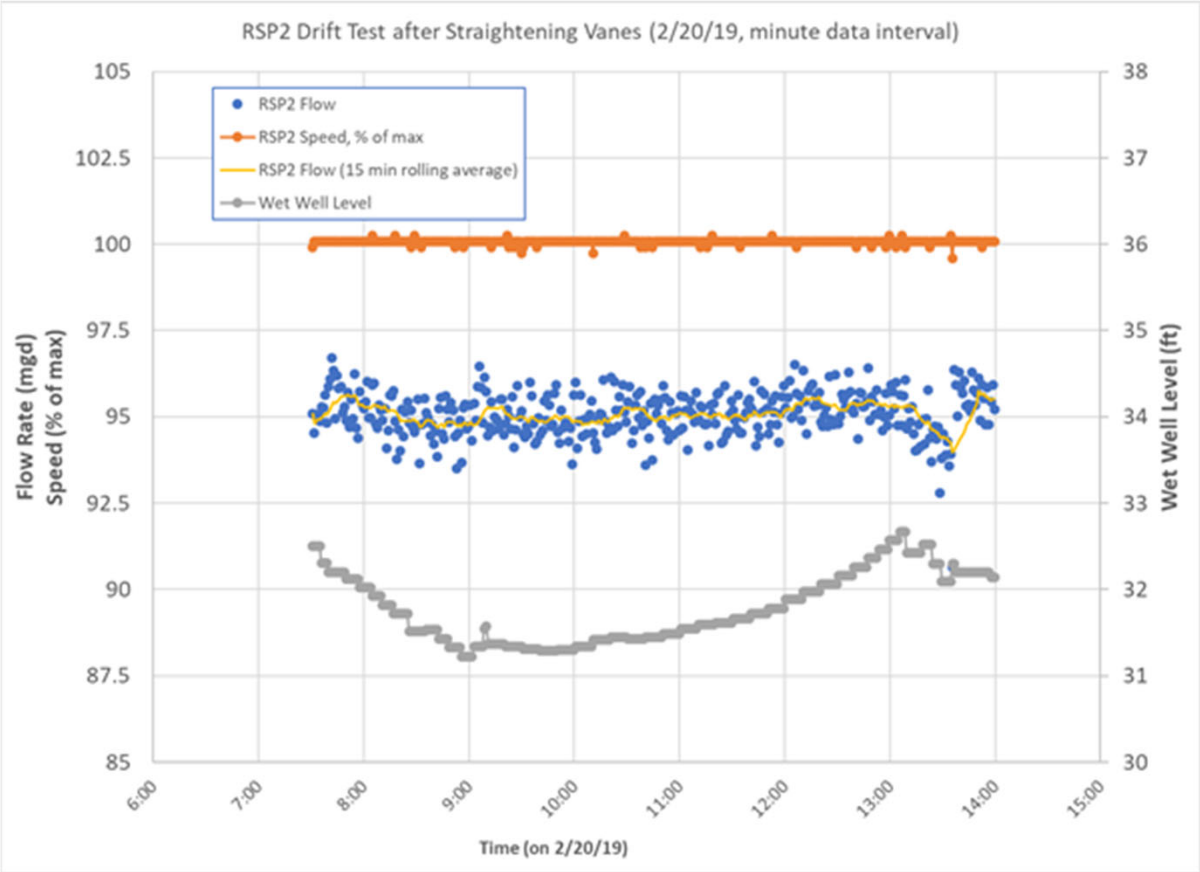
Flow Straightening Vanes



RSP2

RSP1

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Keys to Successful Pump Installation

1. Flow straightening vanes on pump intake
2. Robust pump support foundation design
3. Single integral sole plate for pump support
4. Thrust support in all directions and planes
5. Accurate control and measure of shaft alignment
6. Proper integration of anchor bolts in foundations
7. Exact sole plate leveling and grout installation
8. Stringent pump performance and vibration criteria

Pump Mounting Steps

FORM 11002-A. RIGID EQUIPMENT MOUNT INSTALLATION CHECKLIST

[CITY OF COLUMBUS, SOUTHERLY WWTP CEPT: PRELIMINARY TREATMENT PROJECT]

Equipment Tag No.: _____ Date: _____

Grout Product Name and Type: _____

Grouting System Manufacturer: _____

Grouting Application Contractor: _____

General Contractor: _____

Step 1: Verify Equipment Anchor Installation Conformance to Equipment Pad Details		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Millwright		Date
Step 2: Completion of Cleaning and Concrete Substrate Preparation Prior to Grouting		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 3: Equipment Leveling		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Millwright		Date
Step 4: Installation of Protection of Adjacent Surfaces or Structures NOT TO BE GROUTED		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 5: Preparation and Construction of Forms and Epoxy Grout Filling Standpipes		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 6: Completion of Ambient Condition Control in Structure or Building Area and Acceptance of Ambient Conditions as They Apply to Application and Curing Requirements for the Grouting System		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date

Step 7: Epoxy Grout Installation		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 8: Completion of Full and Proper Cure of Epoxy Grout		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 9: Completion of Localized Repair of Grout Voids		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 10: Final Acceptance of Grouting System Installation Including Final Clean-Up of the Work Site Complying with All Specification Requirements and the GSM's Quality Requirements		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date

+ + END OF SECTION + +

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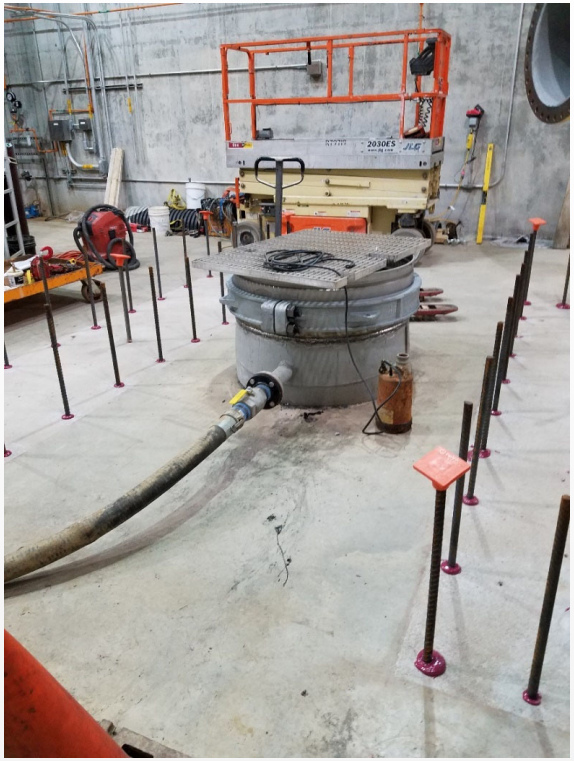
Anchor Bolts and Surface Preparation



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Pump Foundation Forms and Rebar

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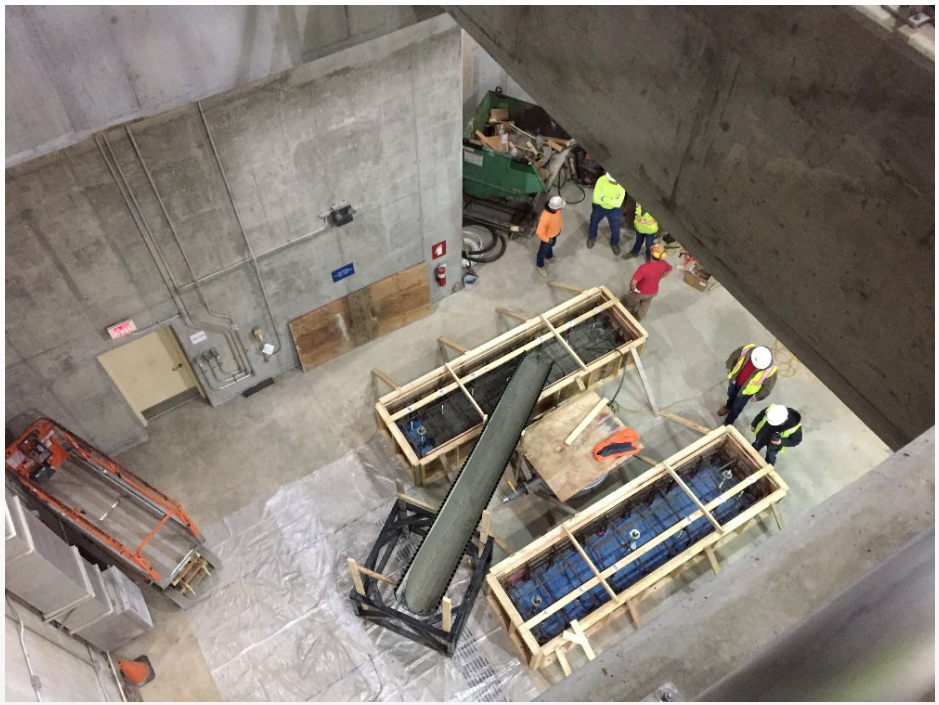
Pump Foundation Pour



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Sole Plate Setting

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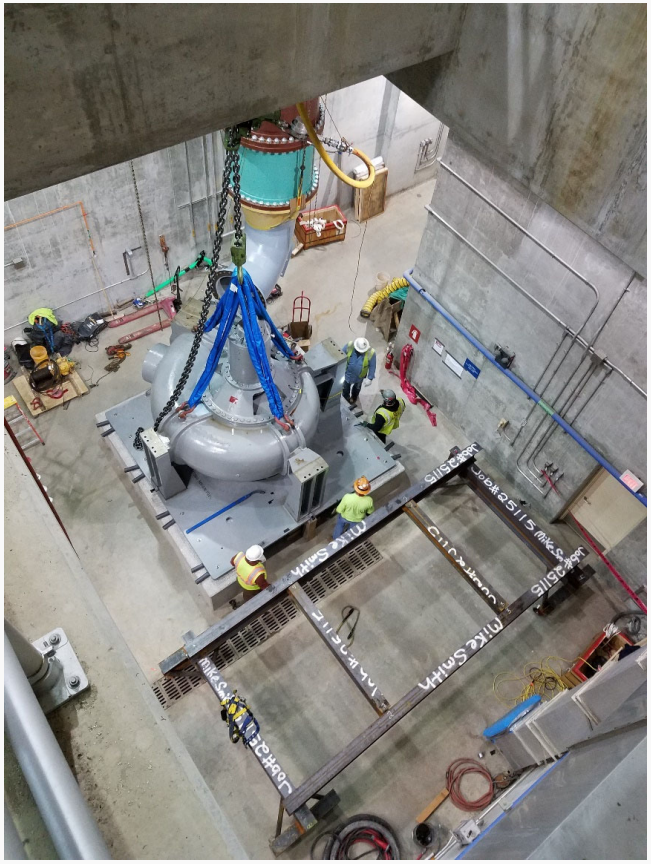
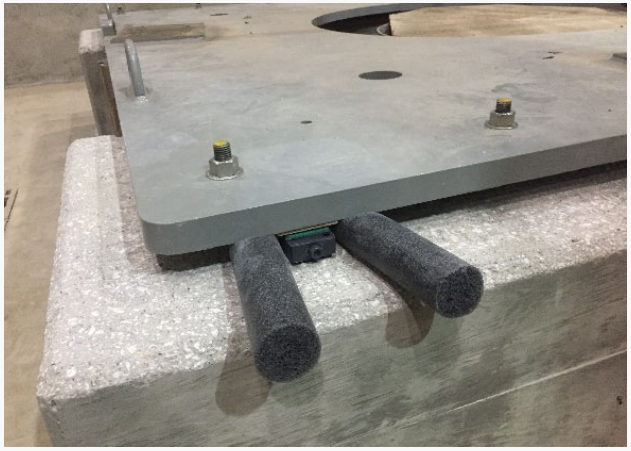
Pump Setting





Leveling Wedges

Equipment Connection
Fitting Slot

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Discharge Piping Support

Epoxy Grout Training

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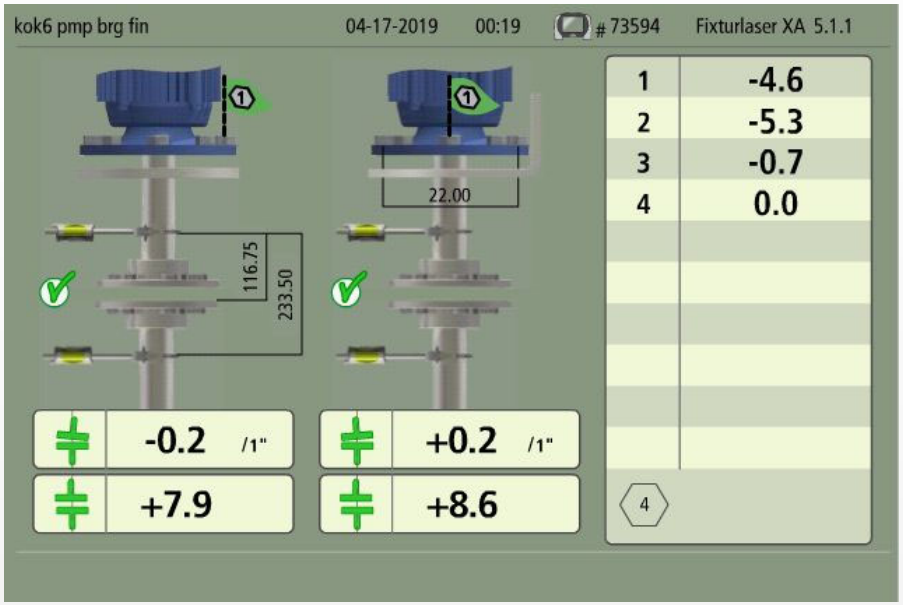
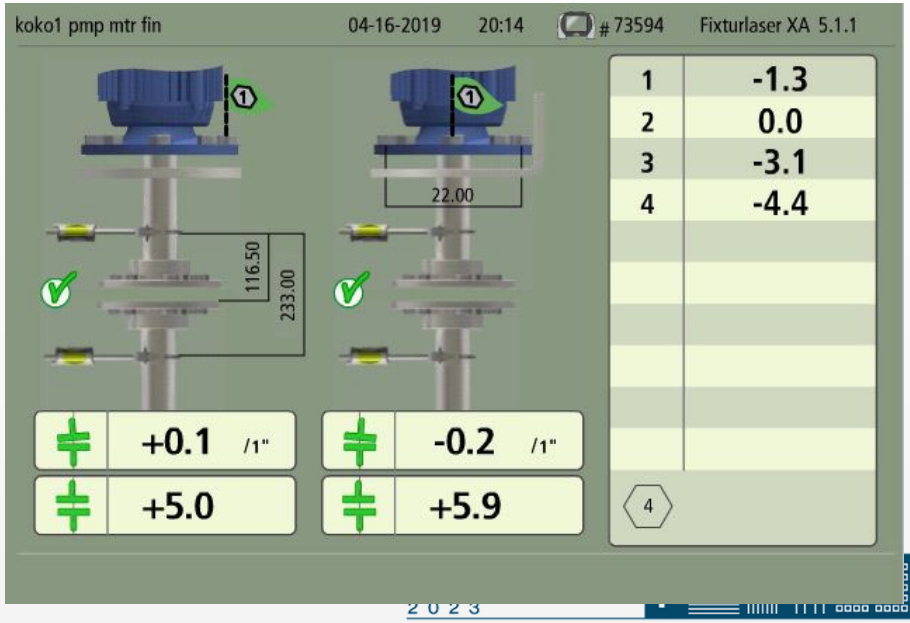
Epoxy Grout Pour

Shaft Alignment

Pump 1



Pump 2



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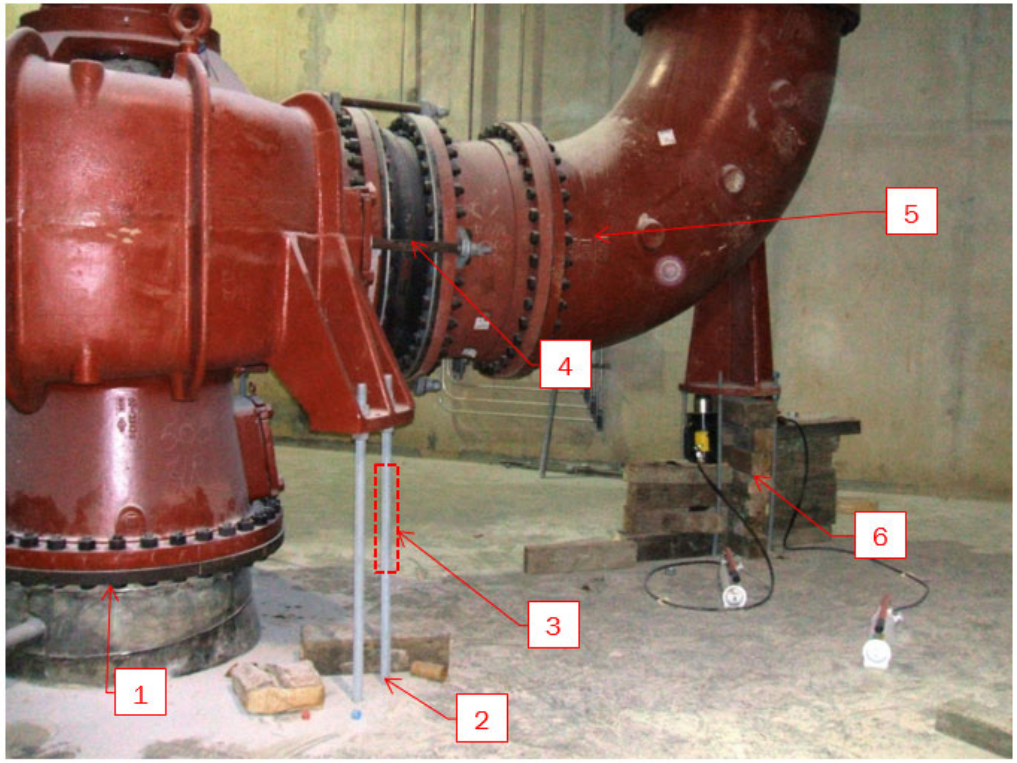
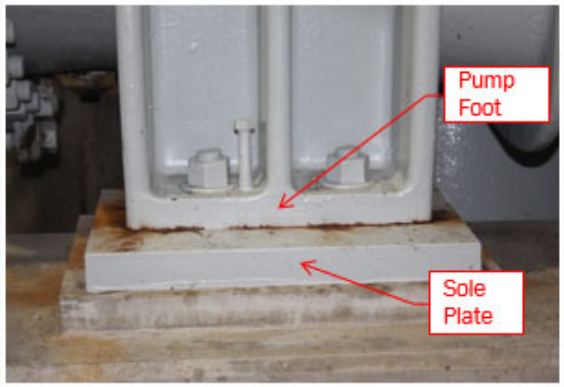
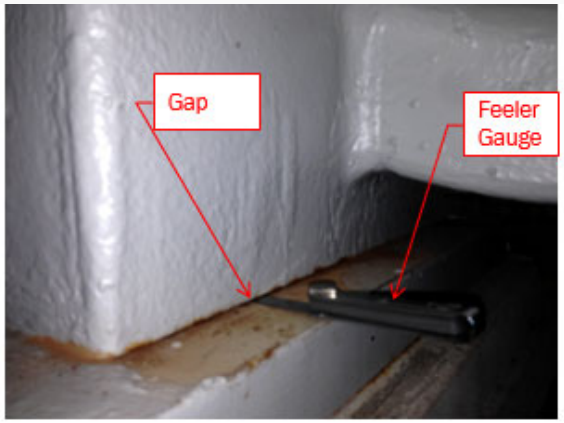
Remember This?





Pump Sole Plate Rust



Pump Sole Plate Gap

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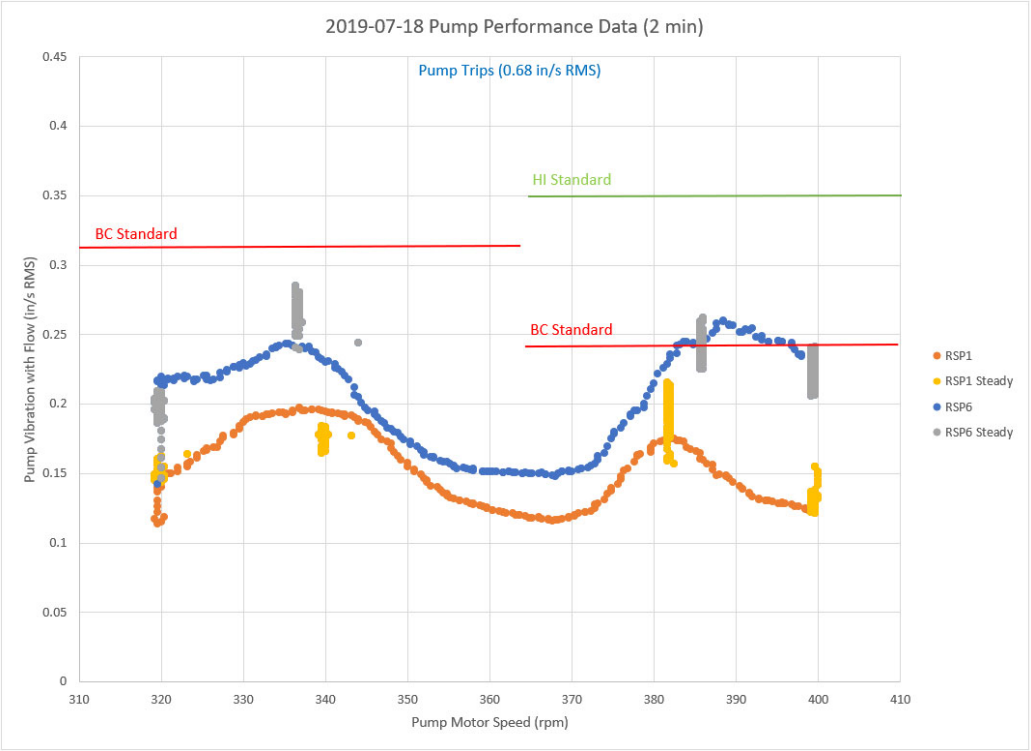
Performance Testing

Dante Fiorino, Brown and Caldwell

Pump Performance Example



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Brown and Caldwell – The Pump Company

When we started having sudden mechanical failures on our large raw sewage pumps, we called on Brown and Caldwell to investigate. Dave Nitz, Garr Jones, and Al Sehloff evaluated our pumping station and provided us with both near- and long-term solutions to improve the reliability of our pumps. Since implementing their recommendations, we have had no pump failures.

—Ryan Welsh, Project Manager, Mill Creek WWTP, Metropolitan Sewer District of Greater Cincinnati

PASSIONATE ABOUT PUMPS: BC's Garr Jones, Technical Expert for this project, listens to one Southerly WWTP pump for vibrations to help diagnose the problem. Garr literally wrote the book on pumping station design—the only complete resource on the topic. His involvement will ensure a successful design despite the project's complex hydraulic issues.

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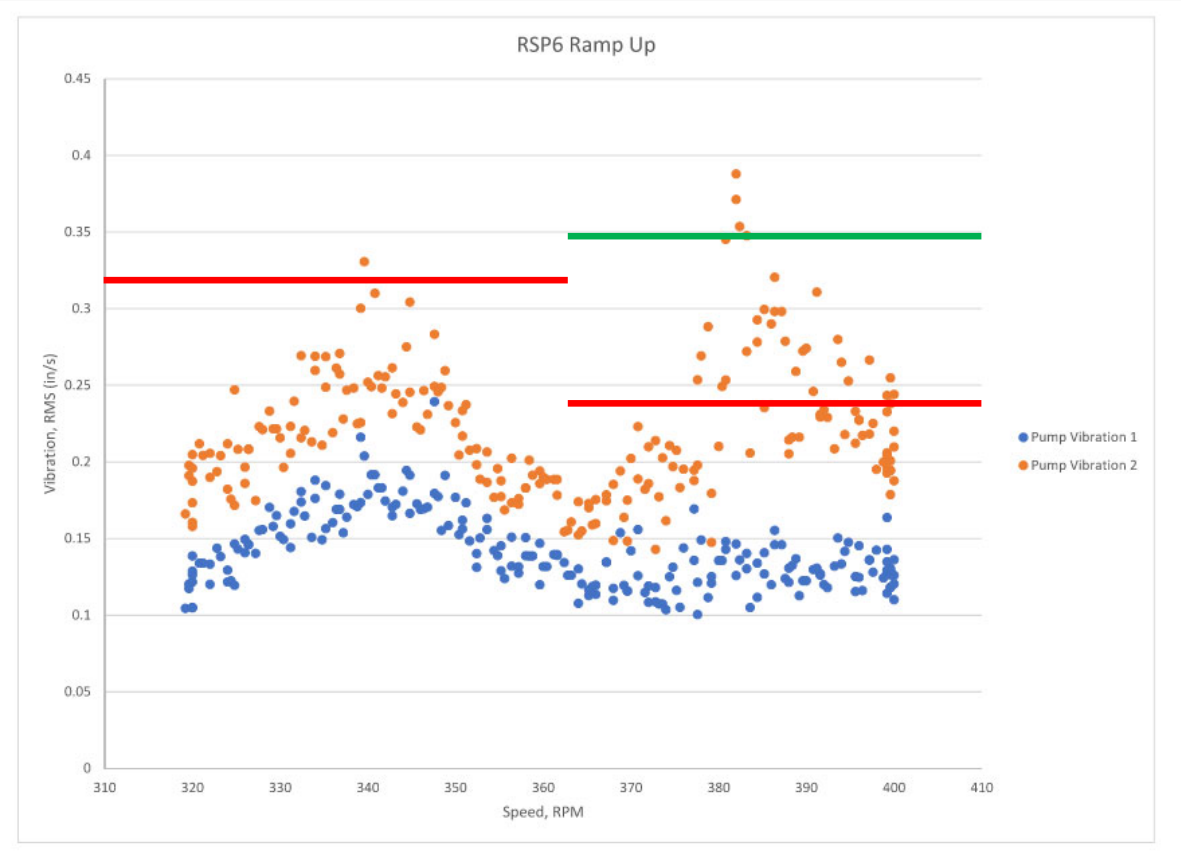
RSP6 2019-06-13 – Early Testing



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Nose Cone Failure

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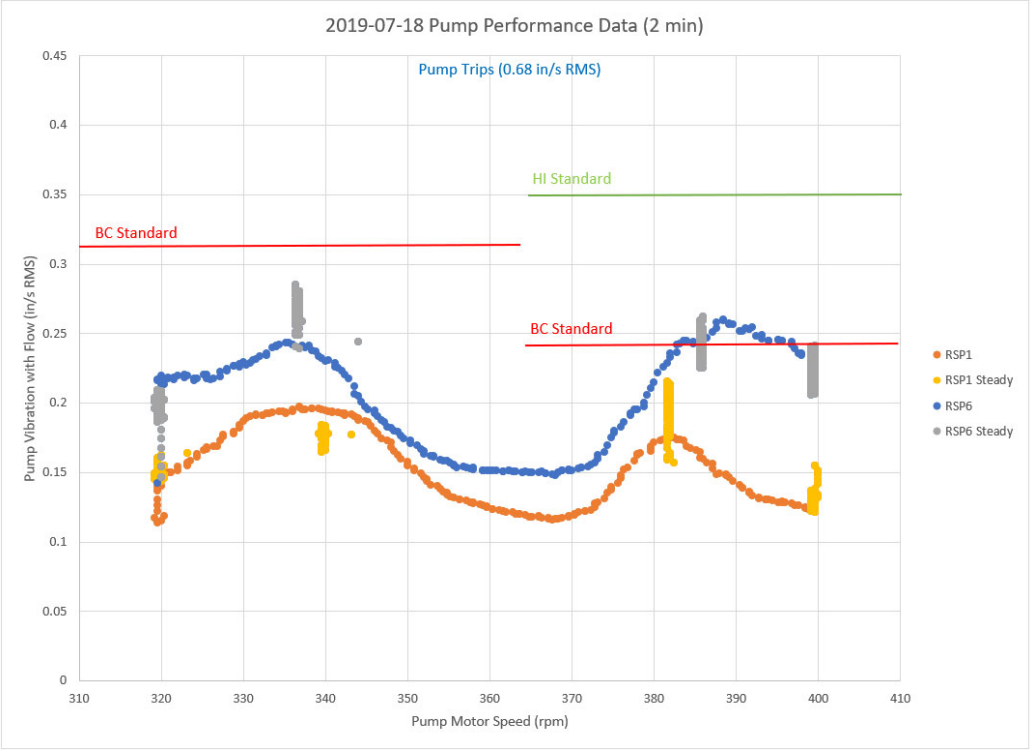
RSP6 2019-07-18 – Additional Testing



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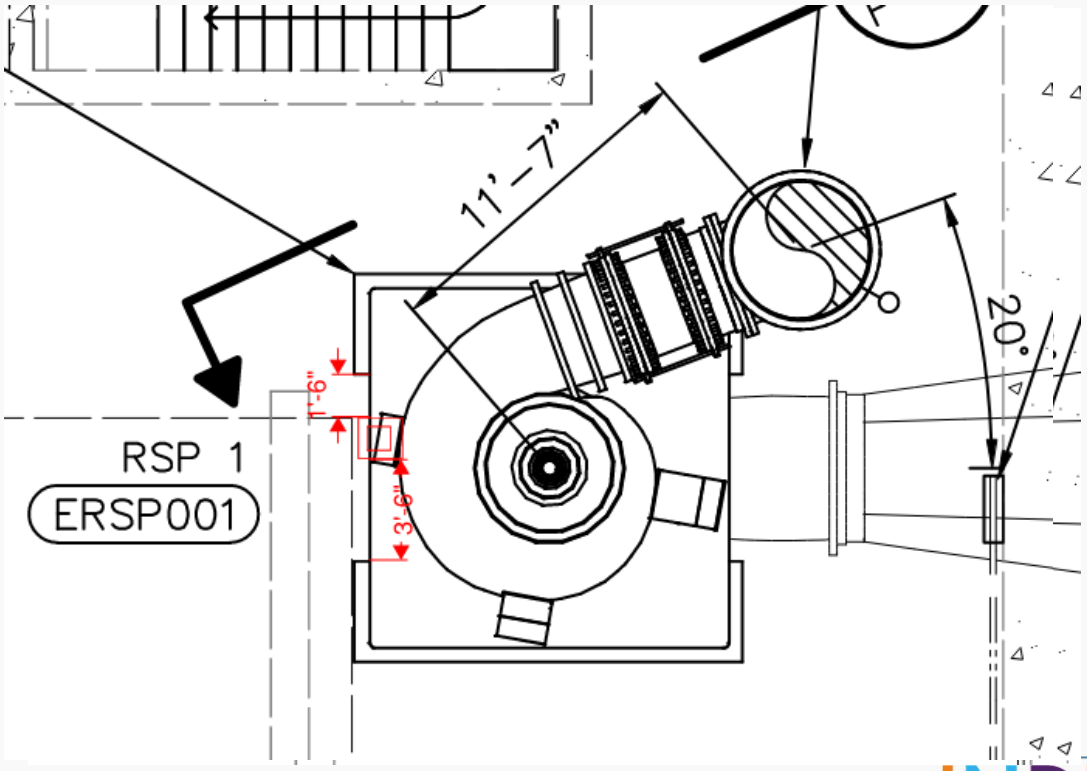
Pump Feet Support - Plan



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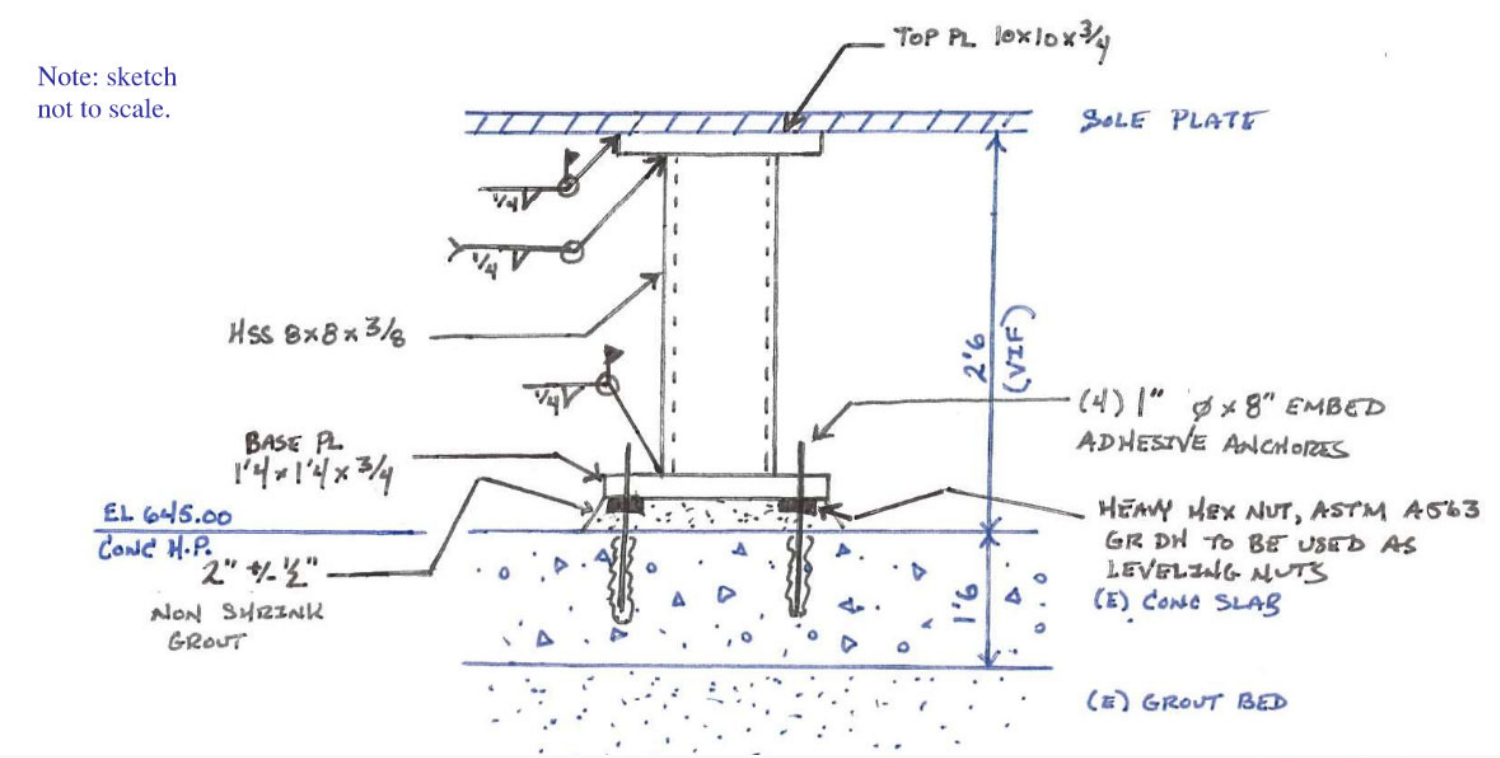
Pump Feet Support - Detail



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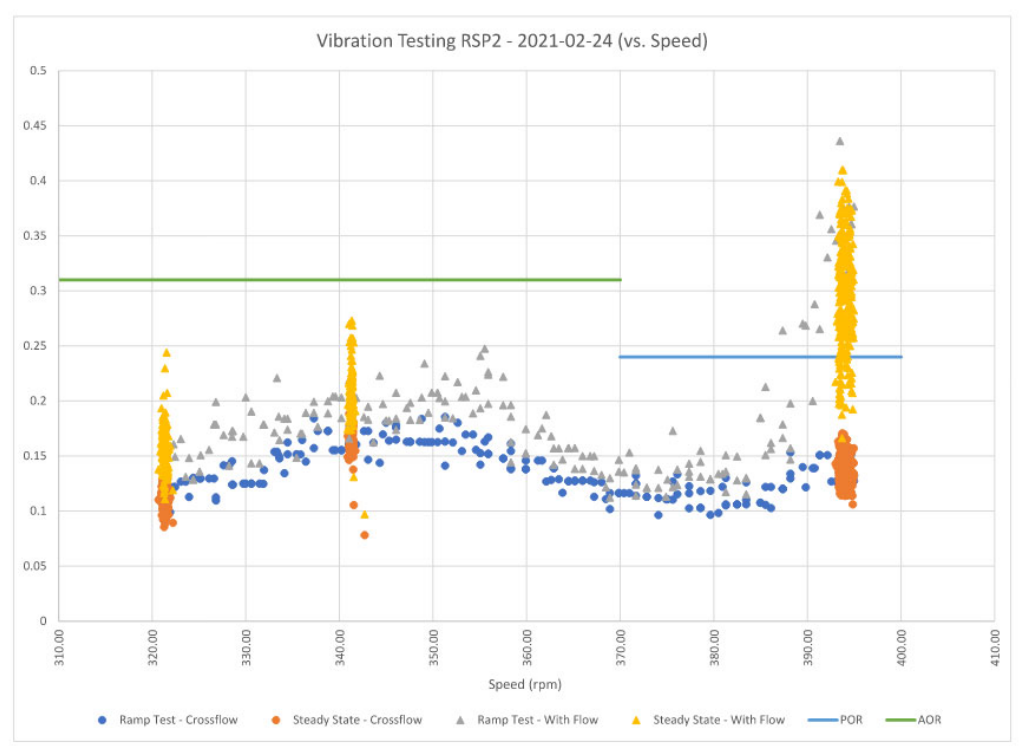
RSP2 2021-02-24 – Without Supports



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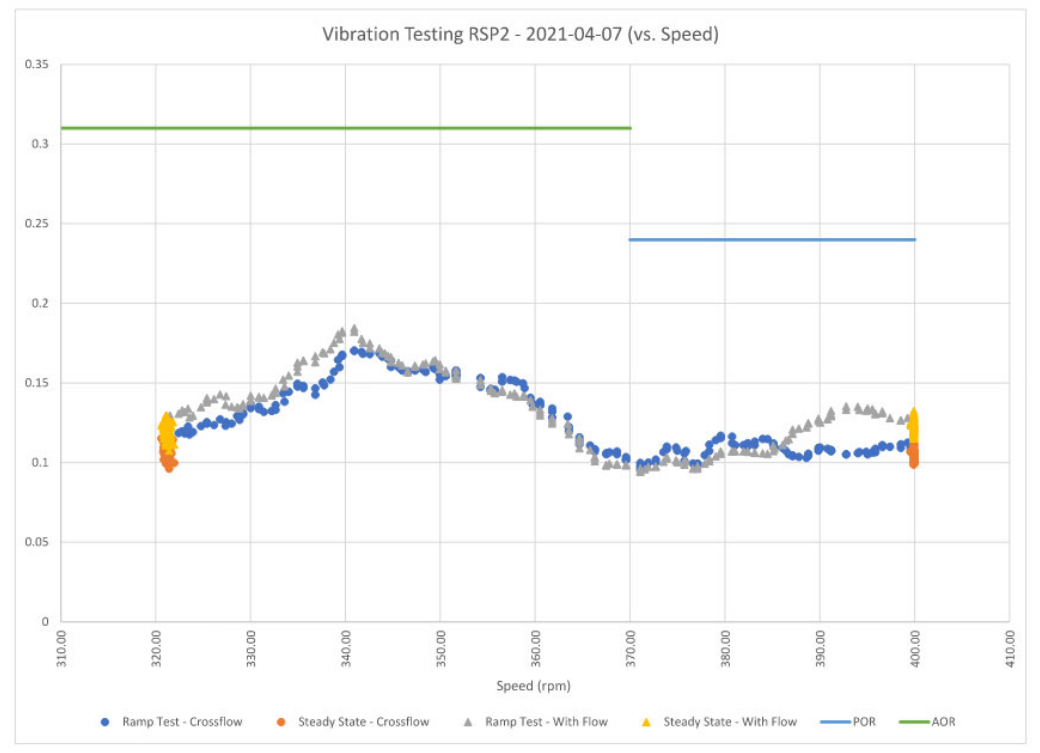
RSP2 2021-02-24 – With Supports



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Retrofit Supports

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Lessons Learned

- The engineer’s job isn’t done once the project is bid
- Performance specifications are a requirement for large pieces of moving equipment and need to be enforced
- Vibration is not random, it has a cause and solution

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Acknowledgements

- Southerly WWTP
  - Darin Wise (retired)
  - Doug Dixon
  - Jeff Bartoe (retired)
  - William Oakden
- City of Columbus
  - Stacia Eckenwiler
  - John Newsome
- Brown and Caldwell
  - Donnie Stallman
  - Danny Yodzis (former)
  - John Fabian
  - Dave Nitz
  - Al Sehloff

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Questions?

Troy Branson, Columbus DOSD TE

Dante Fiorino, Brown and Caldwell