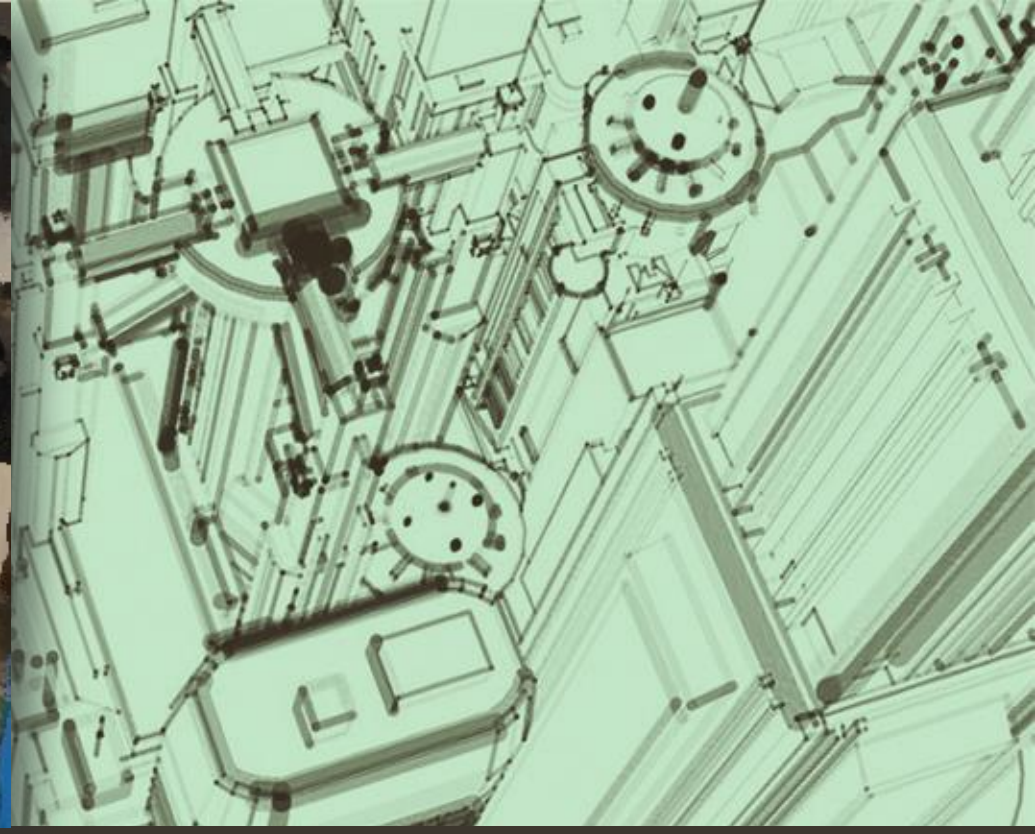
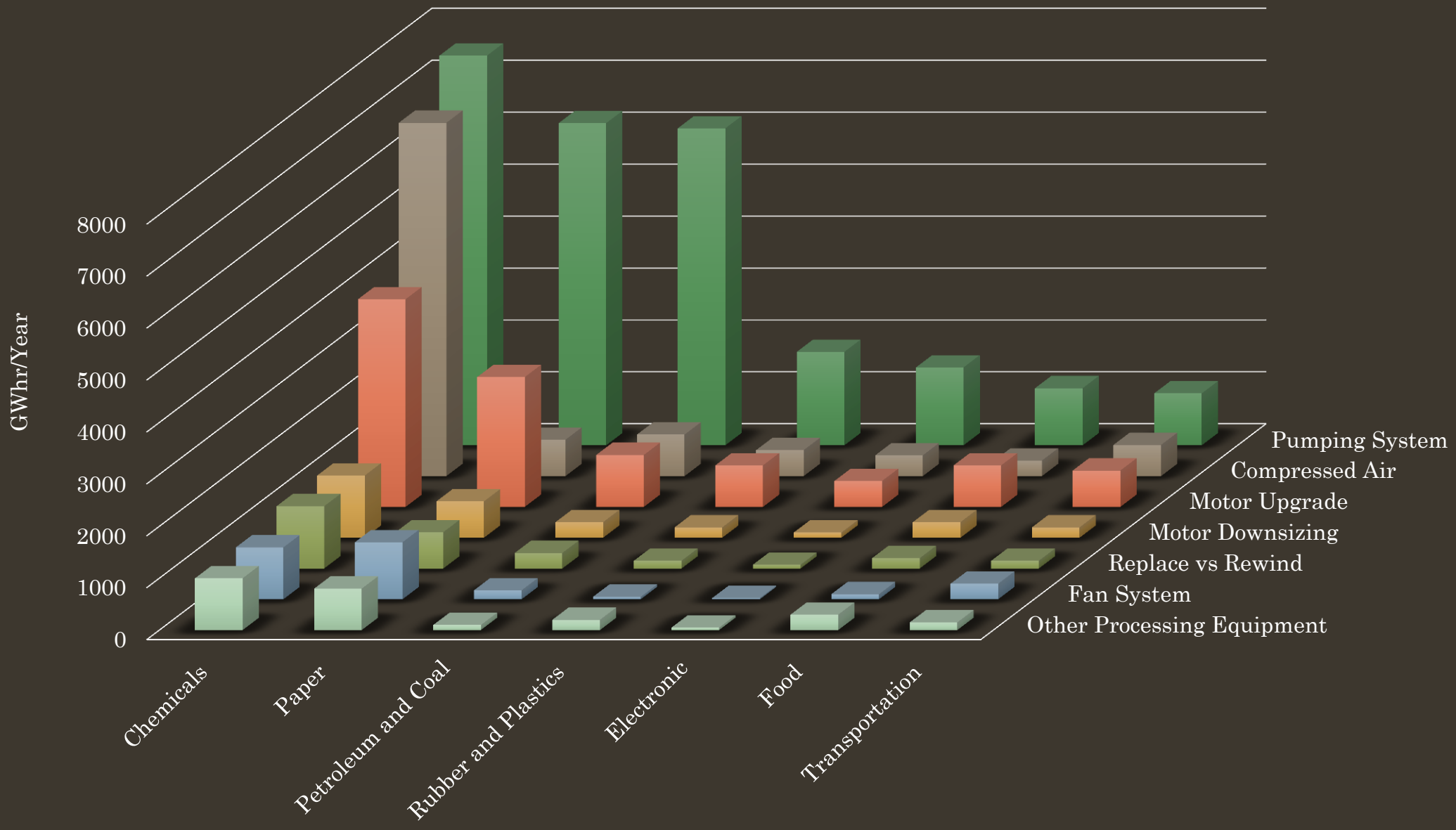


Perfecting Your Pumps – Pump System Optimization

Jessica Dzwonkoski
JKMuir

Pumping Energy



Benefits of Assessments

- Electrical motors in North American industrial electricity usage = 66% with pumping systems **accounting for 25%**
- Electrical usage with wastewater pumping systems **= 20-30% of total consumption**
- Electrical usage with water pumping systems **=46%**

DOE Standards for Pump Efficiency – Final Rule

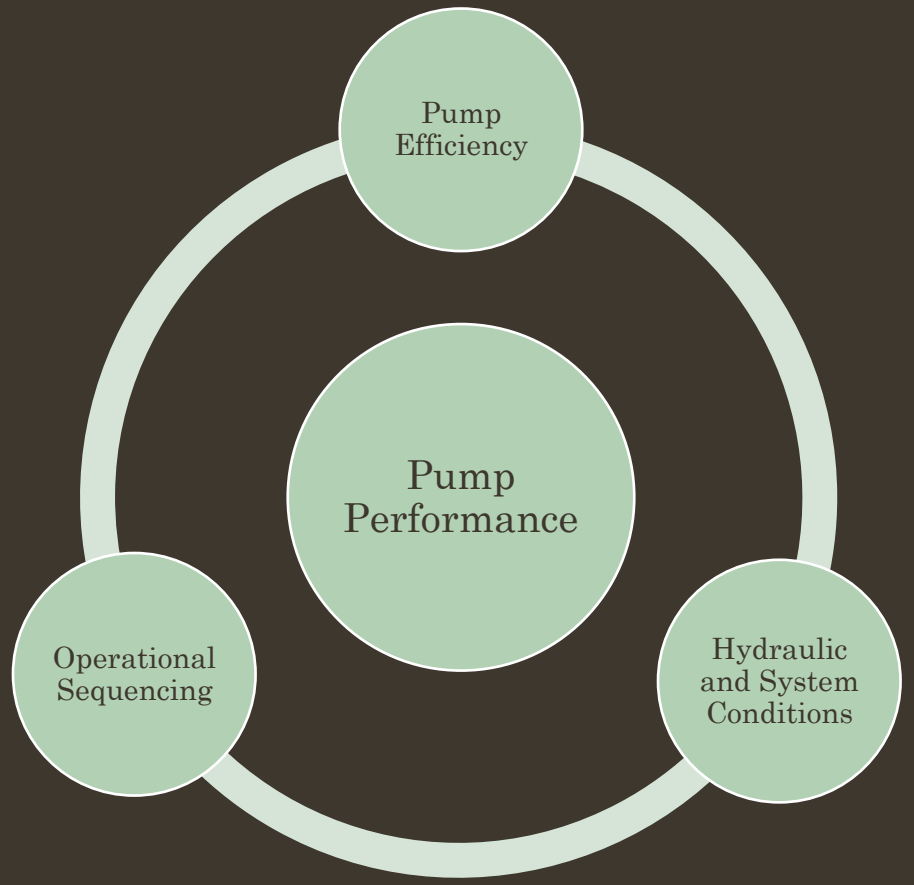
- Clean Water Pumps
- Finalized in Jan 2016
- Defines Pump System Efficiency Testing Procedure
  - What efficiencies need to be met
  - How to define the efficiencies
- 1st Rule related to Pump System Efficiency
- Measures efficiency at varying loads
- Compliance begins in 2020

What The DOE Rule Does NOT Do:

- Prevent oversizing
- Control where on the curve pump operates (BEP)
- Address pump throttling
- Correct for misapplication of pumps
- Reduce friction loss
- Impact motor efficiency
- Improve system controls
- Control wear

What Affects Pump Performance

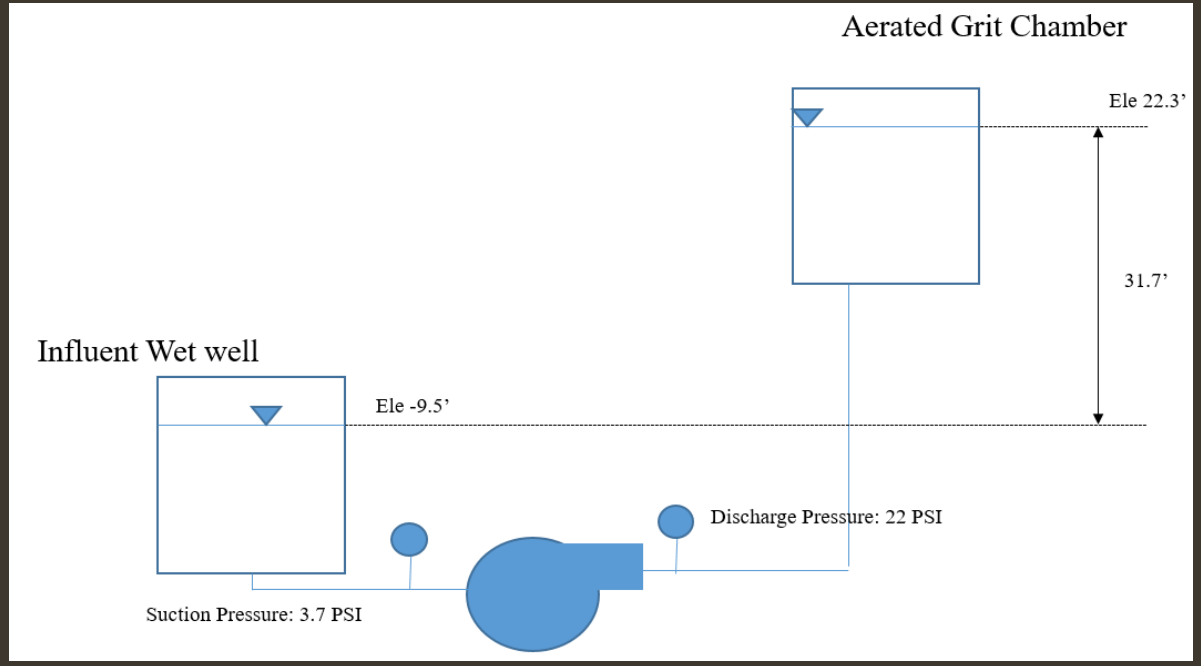
- Hydraulic and System Conditions
  - Valves
  - Piping
  - Elevations
- Operational Sequencing
  - VFD Operation
    - Best Efficiency Point (BEP)
- Pump Efficiency
  - Impeller modifications
  - Wear



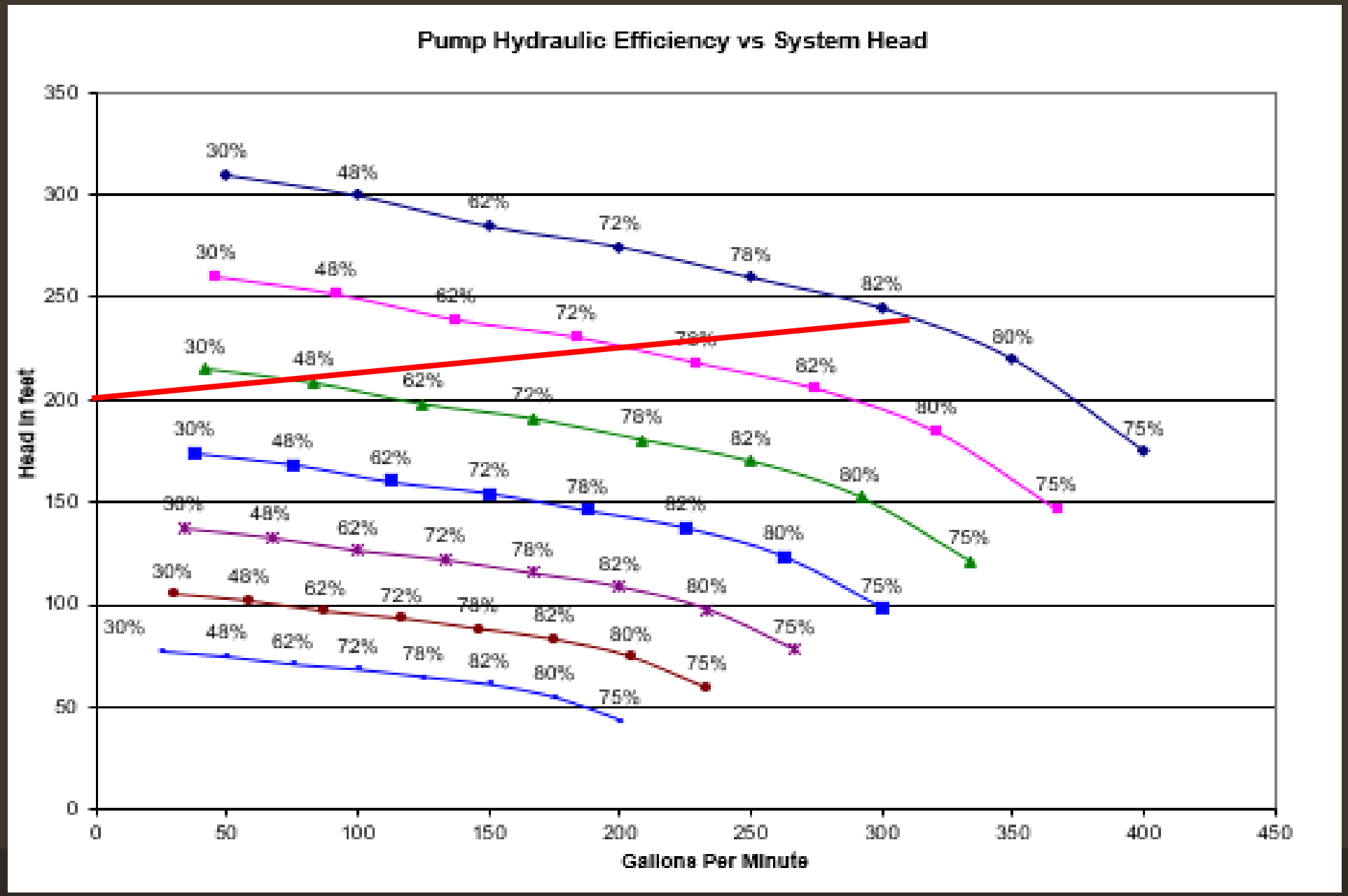
Hydraulic and System Conditions

Change is Hydraulics

- Wetwell level
  - Changes in level impact the suction pressure
- System Pressure
  - Changes in tank or distribution systems impact the static head
- System Changes
  - Less flow or head than design



Operational Sequencing – VFD Operation



Pump Efficiency

What Impacts Pump Efficiency

- Hydraulic and System Conditions
- Operational Sequencing
- Wear and Tear from operation
  - Impeller
  - Wear rings
  - Clearances Increase
  - Tolerances Change

How Can Pump Efficiency Be Restored

- Pump Rebuilds/ Replacements
  - Application of Interior Coatings
- VFD Installation
  - Head and Flow reduction
  - Move the operating point closer to BEP
- System Configuration
  - Piping Modifications
  - Setpoint Modifications

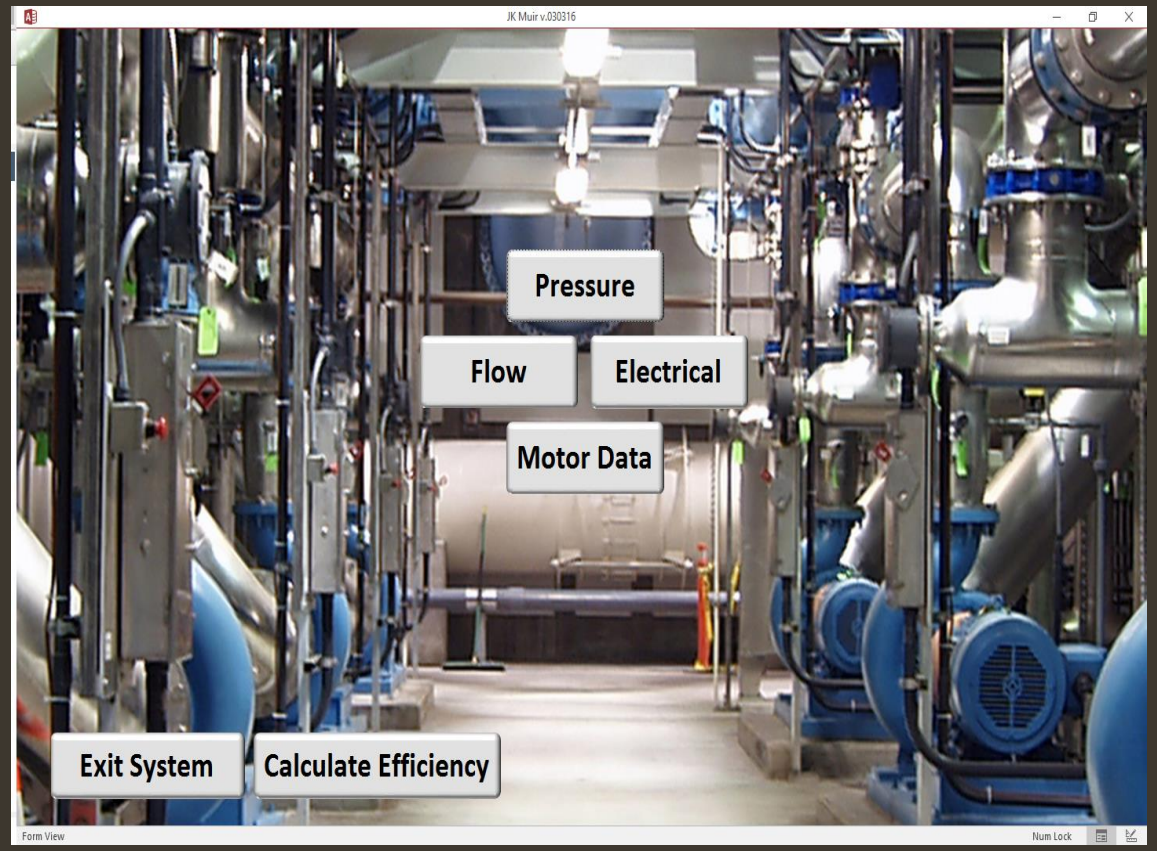
What is Pump Efficiency

What are the Important Factors

- Using Portable Instrumentation
  - Flow
  - Pressure
  - Power

- $$Pump\ Efficiency = \frac{Flow * Total\ Dynamic\ Head\ (ft) * 0.746}{3{,}960 * Motor\ Efficiency * VFD\ Efficiency\ (if\ applicable) * Power\ (kW)}$$

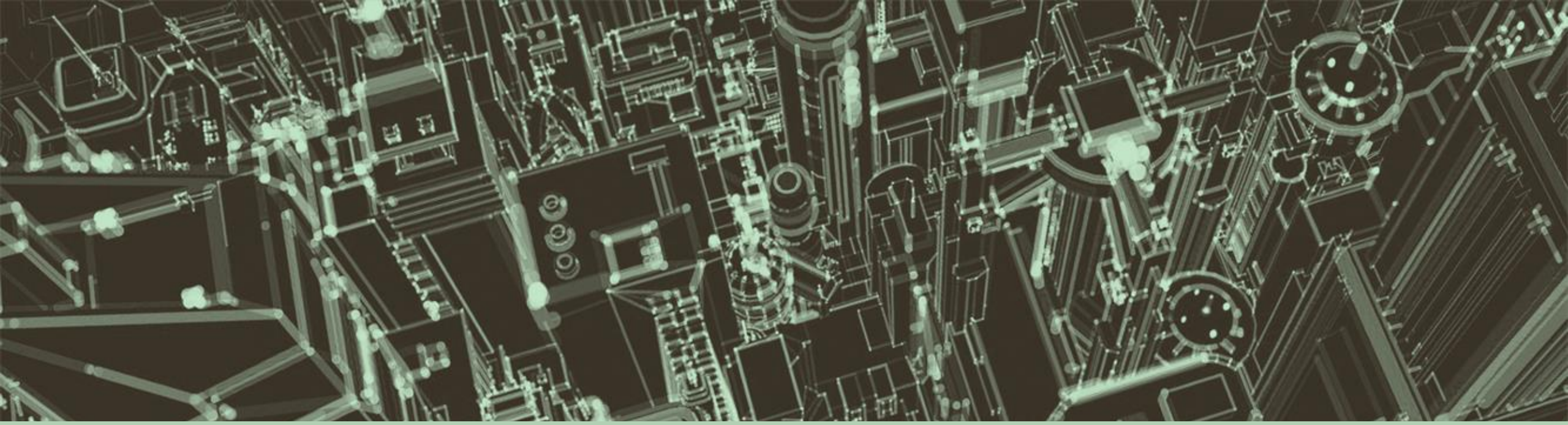
Pump Efficiency Testing App



- Offers Real Time Efficiency
- Aids in Cross Validation
- Can this be integrated into existing SCADA?
- Compare Field Readings with Original Design Information to Determine Best Opportunities

National Grid Pumping System Optimization

- Assess Pumping Systems to Determine Room for Improvement
  - Detailed analysis and field measurements to establish baseline operating conditions
  - Any maintenance concern – what are they telling us
- Existing water and wastewater pumping systems
  - Hydraulic Changes
  - System Conditions
  - Pumping Efficiency
- Potential Benefits from applying Ceramic Based Interior Coating
  - Increased Pump Efficiency?
  - Increase in Longevity of Restored Efficiency?
- Funding
  - Providing incentives not straight forward
  - Utilities want to fund these projects



Case Studies

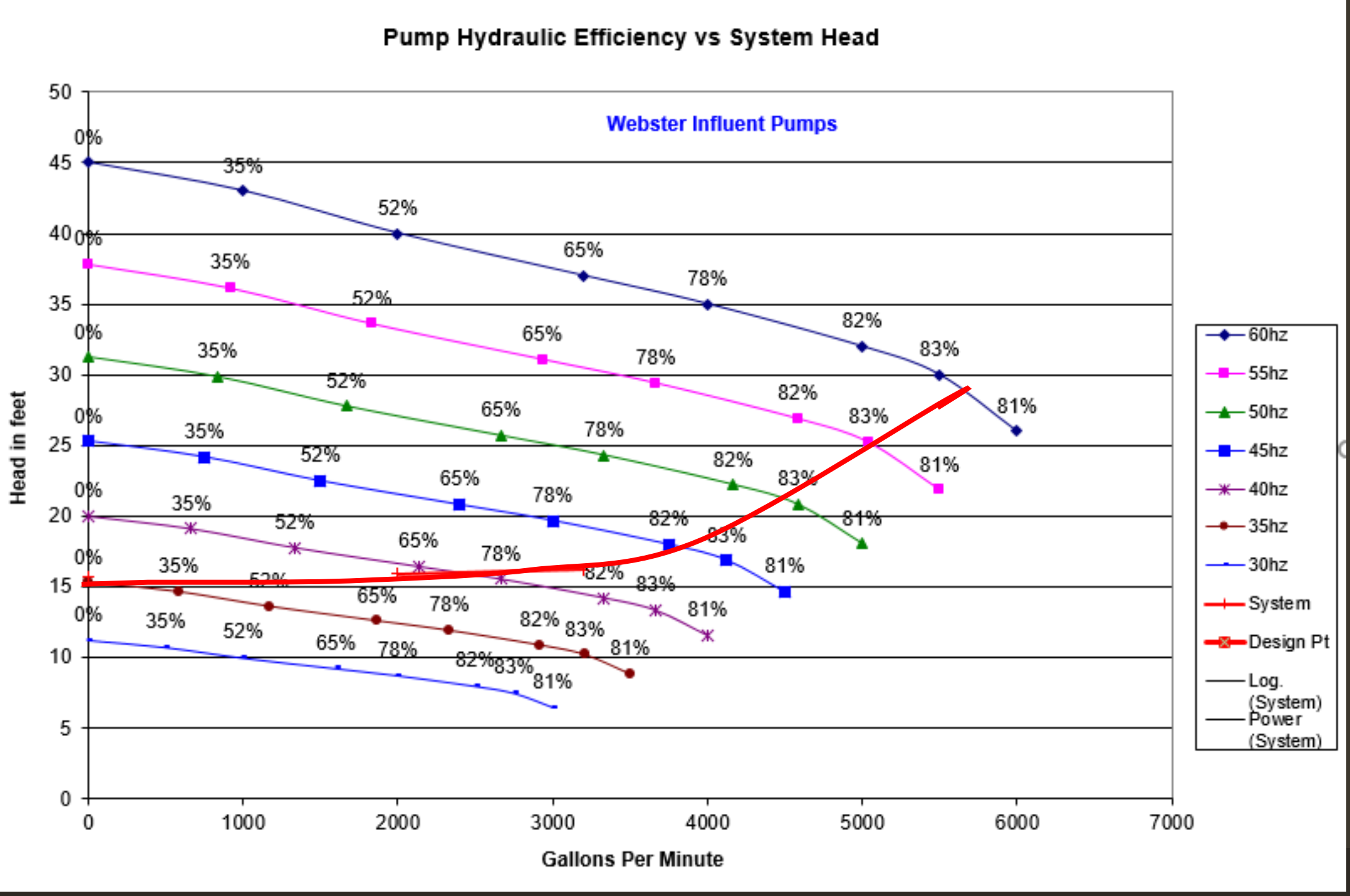
Webster Wastewater Treatment Plant

Site Conditions

- 3 Influent Pumps
  - 60 HP, 32', 5,000 GPM
- Maintaining Wetwell Level
- Operation
  - Lead/Lag Operation of One Pump
  - Typically one pump in operation
- Existing Efficiency = 46%
- Manufacturers Efficiency = 83%

Maintenance

- Regular/ Normal Maintenance Requirements
- No Concerns
  - Not always an indication of reduced efficiency


Pump Hydraulic Efficiency vs System Head
Webster Influent Pumps
Head in feet
Gallons Per Minute
0
5
10
15
20
25
30
35
40
45
50
0
1000
2000
3000
4000
5000
6000
7000
60hz
55hz
50hz
45hz
40hz
35hz
30hz
System
Design Pt
Log. (System)
Power (System)

Webster Wastewater Treatment Plant

ECM – Rebuild all Three Pumps

- Efficiency = 70-85%
- Savings = $6,945 per year in electrical costs
- Project Cost = $43,200
- Payback = 6.2 Years

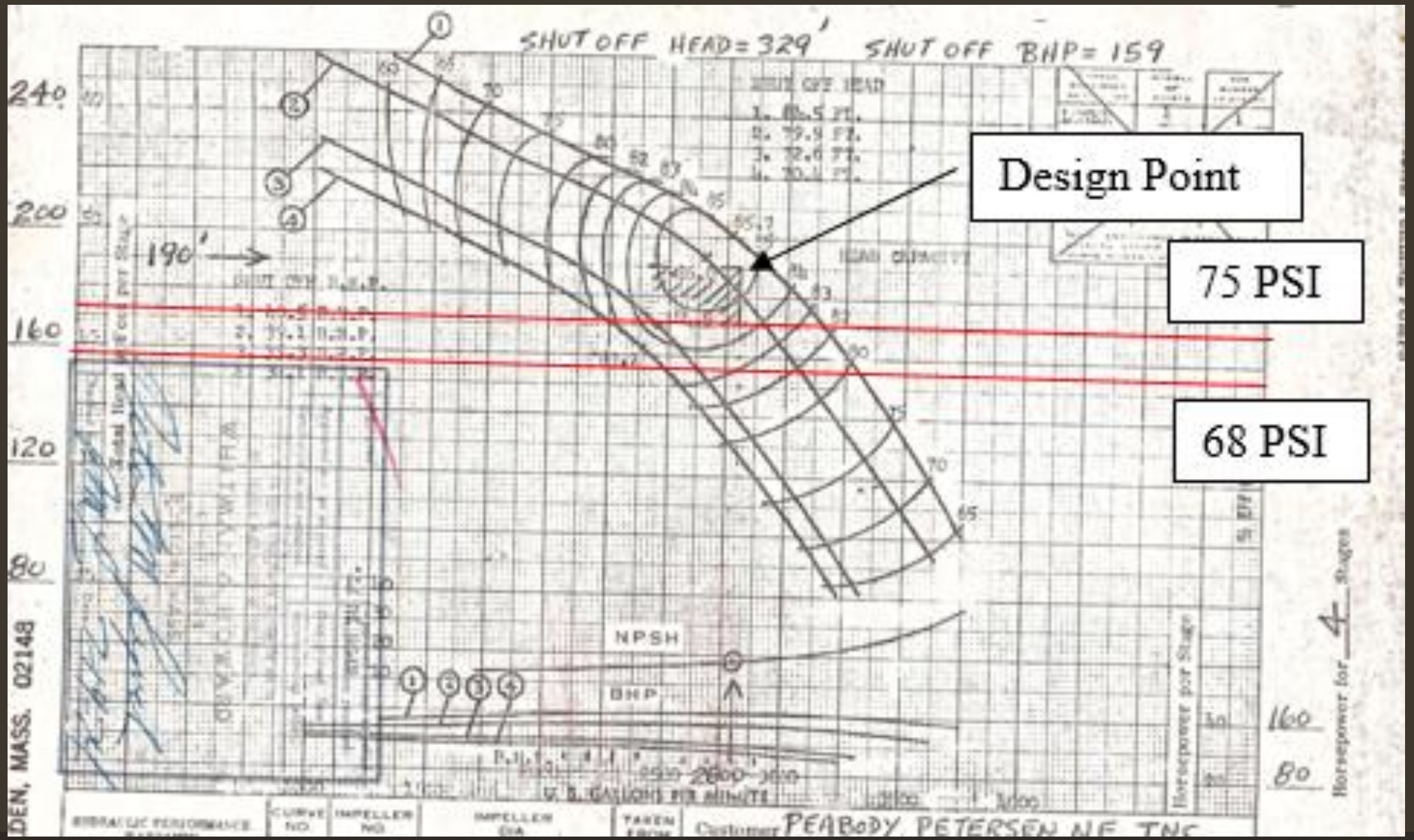
Fall River Drinking Water Treatment Facility

Site Conditions

- 4 Finished Water Pumps – Three Different Sizes
  - Pumps 1,2 – 250 HP, 2,800 GPM, 190’
  - Pump 3 – 250 HP, 4,200 GPM, 190’
  - Pump 4 – 500 HP, 8,400 GPM, 189’
- Maintaining System Pressure
  - Between 68 and 75 PSI
- Operation
  - Constant speed operation of 2, 250 HP pumps
- Existing Efficiency = 60%
  - Manufacturer Efficiency = 82%

Maintenance

- Motor on one of the pumps overheating
  - Found to be operating within the service factor
- Reduced flowrate due to wear of pumps causing chemical dosing issue


SHUT OFF HEAD = 329'
SHUT OFF BHP = 159
Design Point
75 PSI
68 PSI
190'
NPSH
BHP
240
200
160
120
80
160
80
PEABODY, PETERSEN NE TNS

Fa

EC
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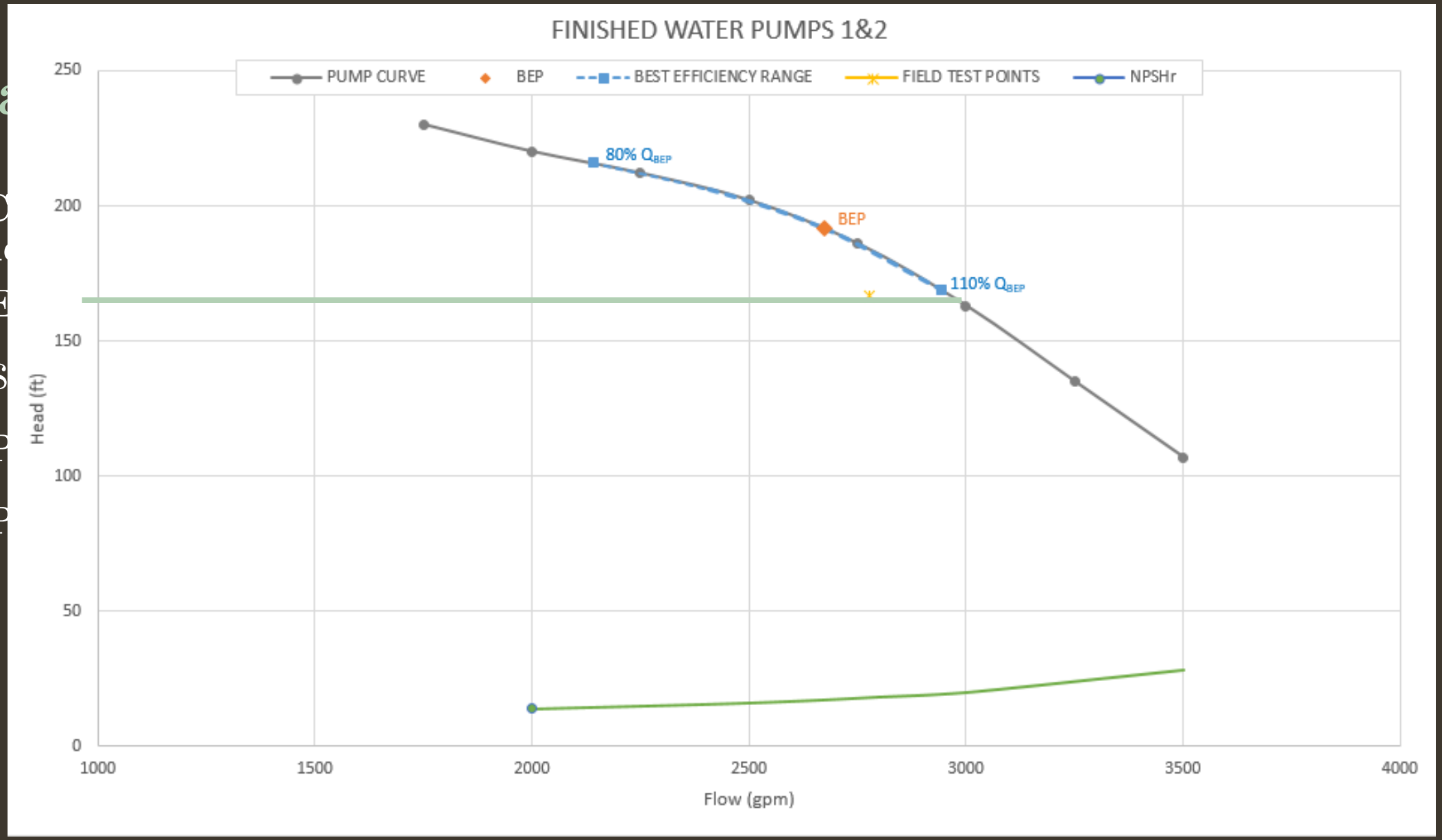
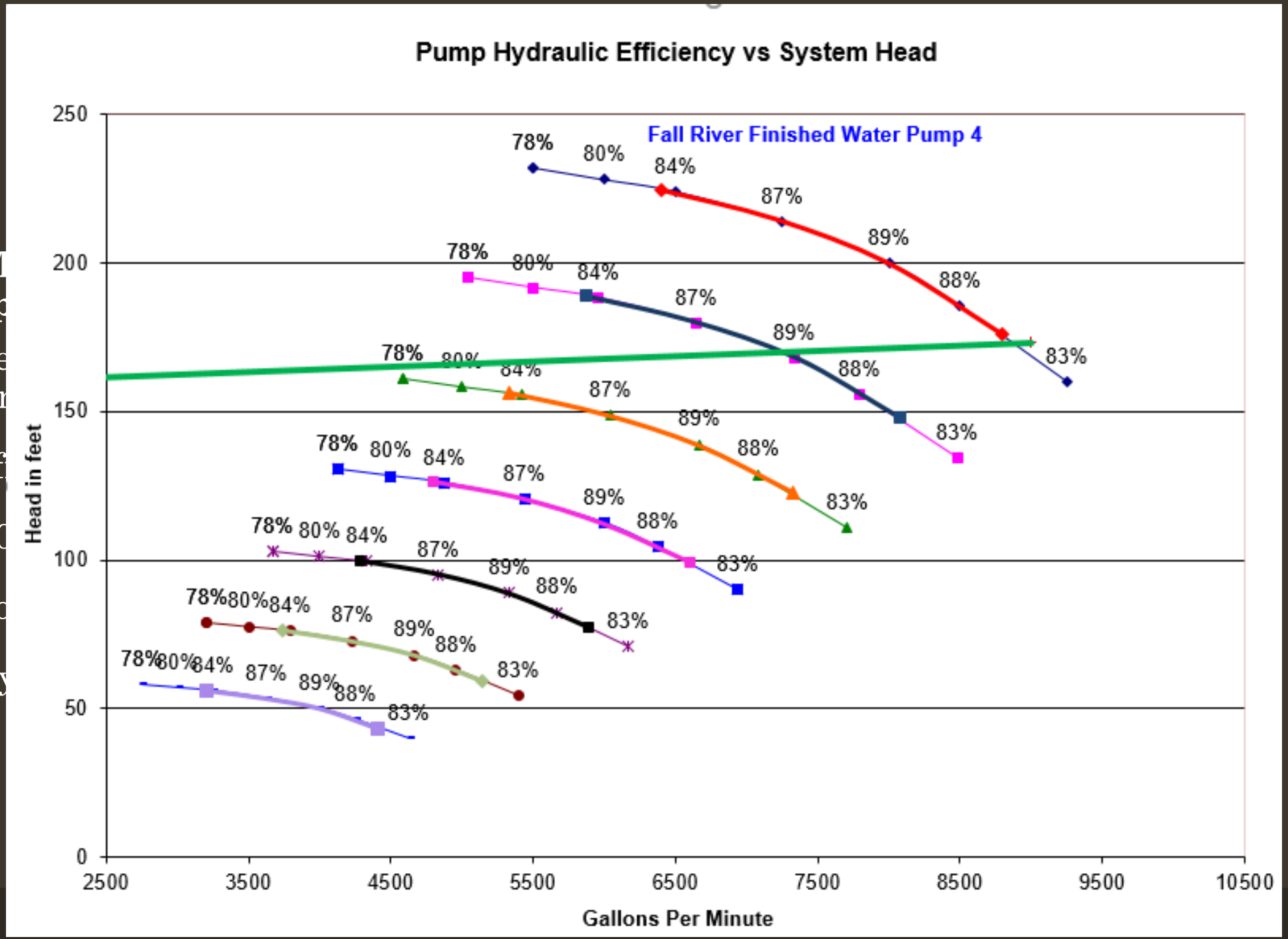

FINISHED WATER PUMPS 1&2
PUMP CURVE
BEP
BEST EFFICIENCY RANGE
FIELD TEST POINTS
NPSHr
80% Q_{BEP}
BEP
110% Q_{BEP}
Head (ft)
250
200
150
100
50
0
1000
1500
2000
2500
3000
3500
4000
Flow (gpm)

ECM
HP p

- Pre
  pur
- Eff
- $10
- Pro
- Pay



Gardner Drinking Water Treatment Facility

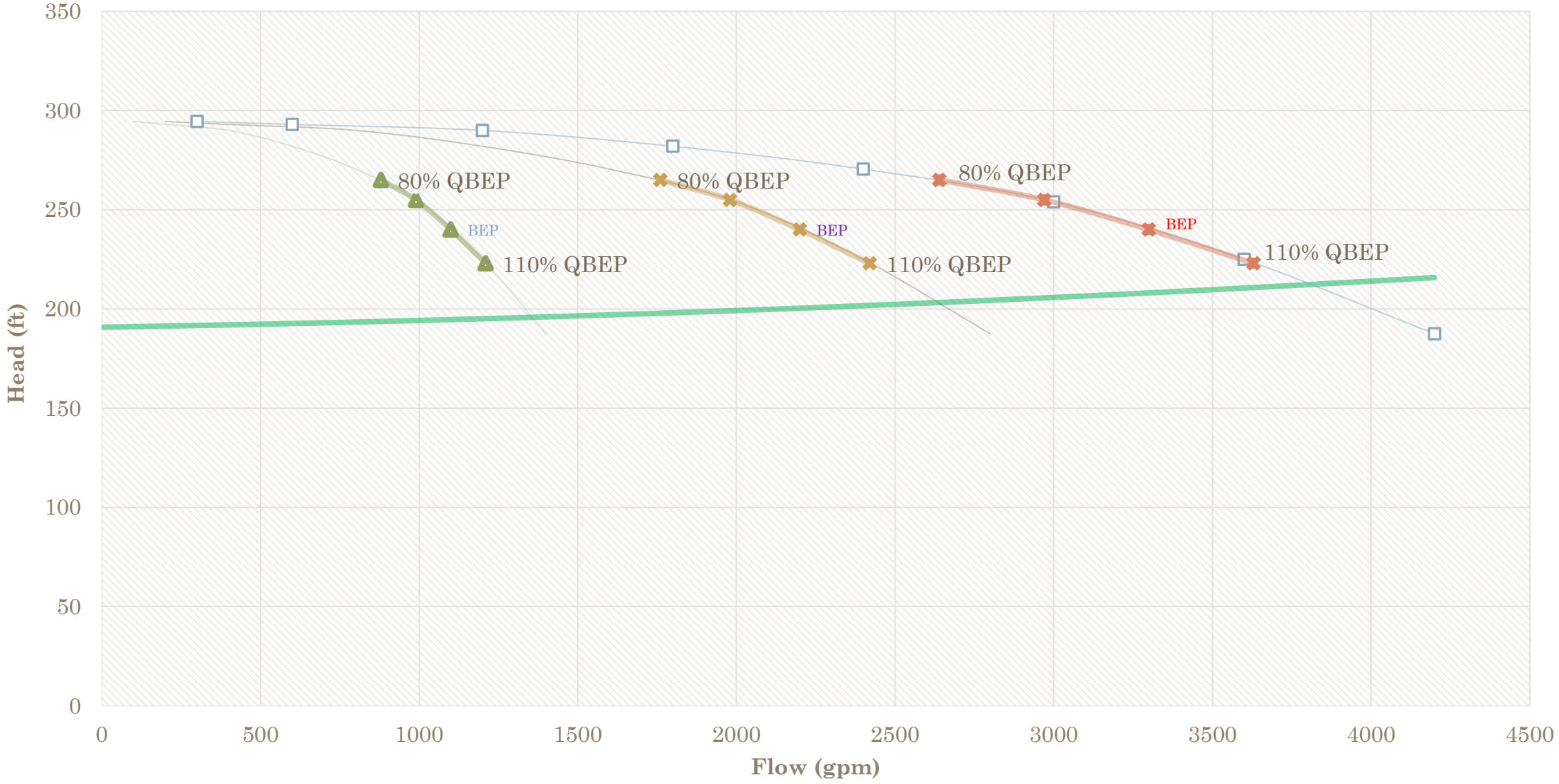
Site Conditions

- High Service Pumps
  - 100 HP, 240’ TDH, 1,043 gpm
- Two pumps operate at a constant speed to fill two service tanks
- Existing Efficiency =45%
  - Manufacturers Efficiency = 80%

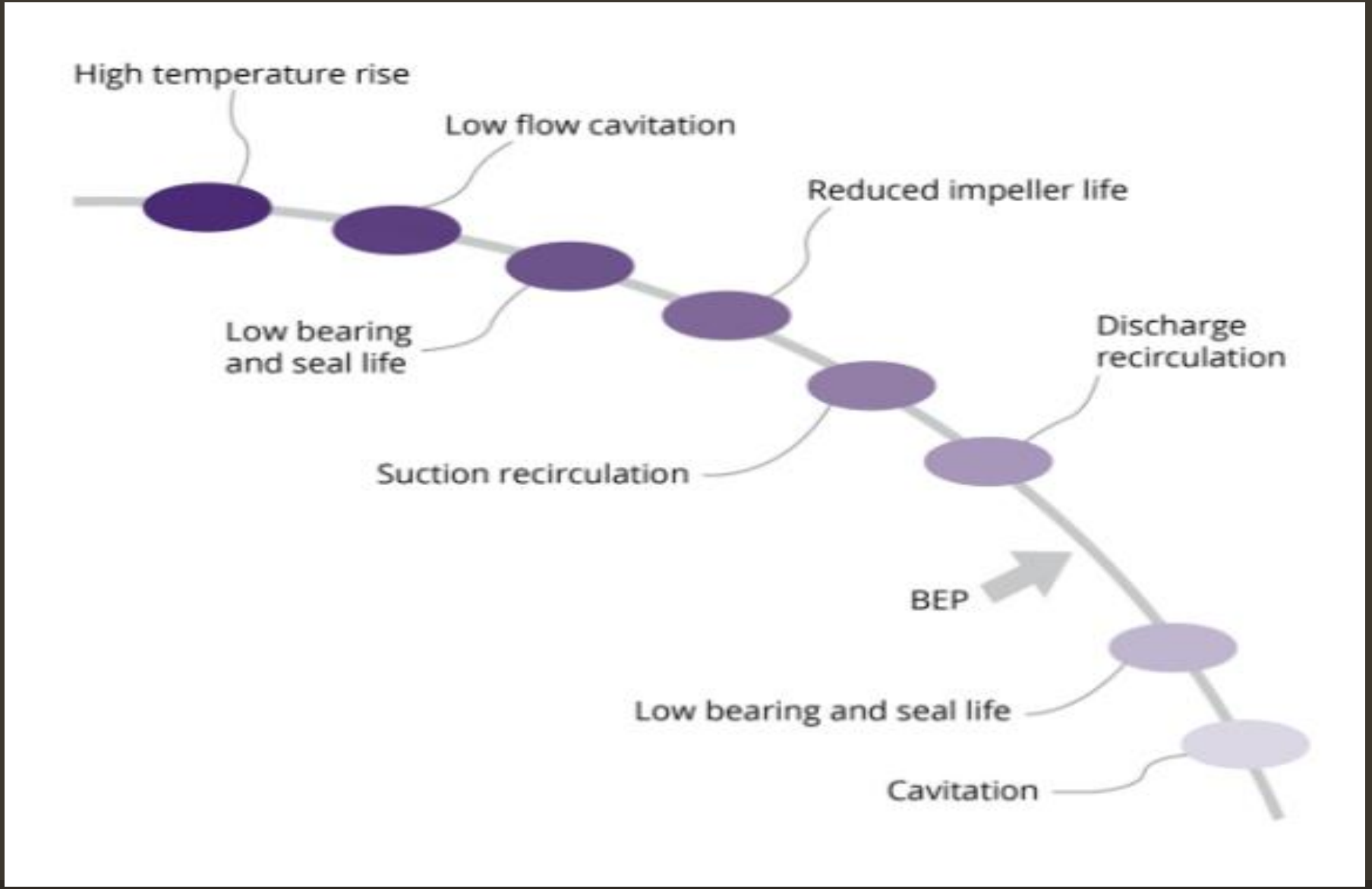
Maintenance

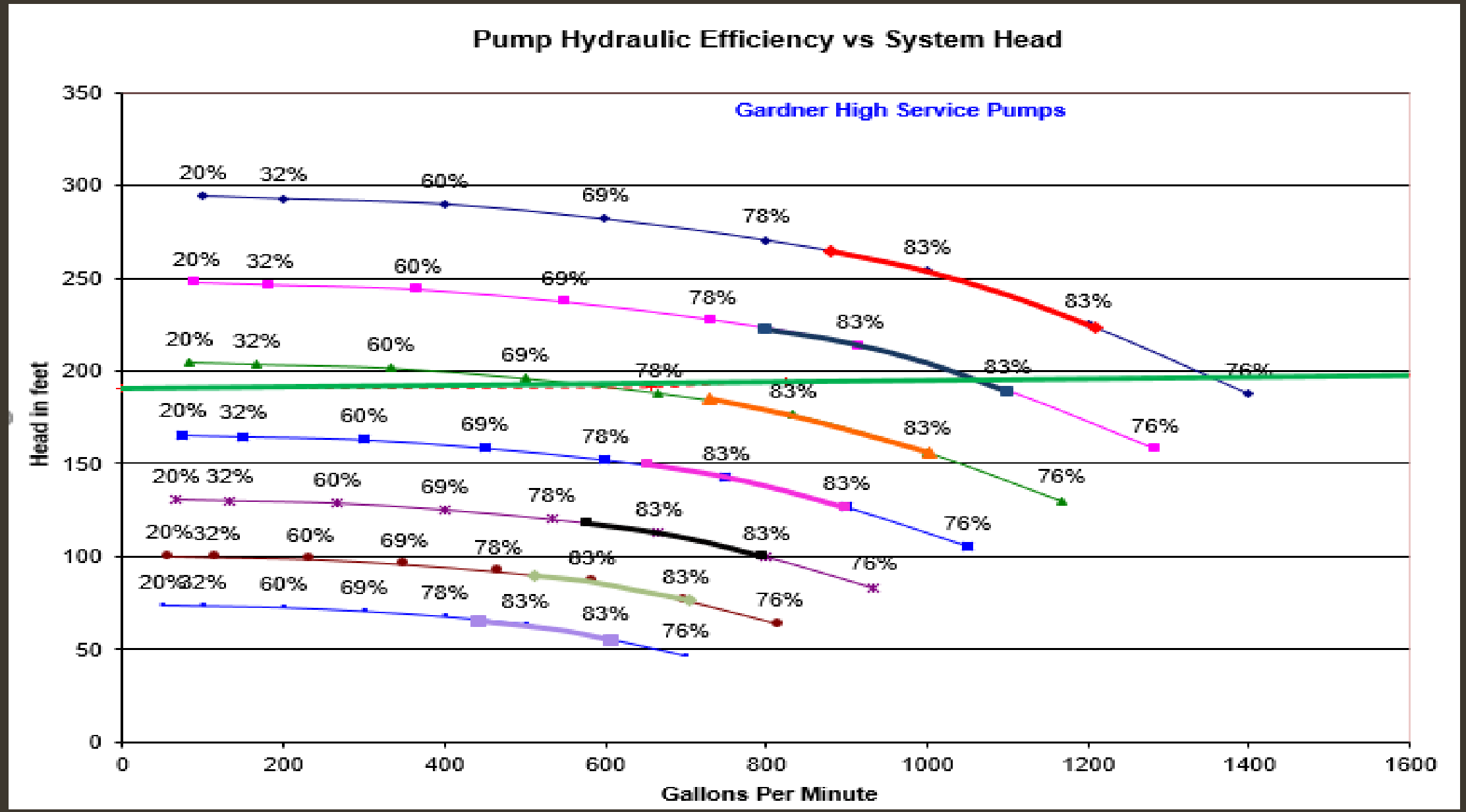
- No issues at this site
  - Maintenance Not Always an indication of Efficiency Loss

Gardner High Service Pumps



What happens when we operate outside BEP




Pump Hydraulic Efficiency vs System Head
Gardner High Service Pumps
Head in feet
Gallons Per Minute
350
300
250
200
150
100
50
0
0
200
400
600
800
1000
1200
1400
1600
20%
32%
60%
69%
78%
83%
76%

Gardner Drinking Water Treatment Facility

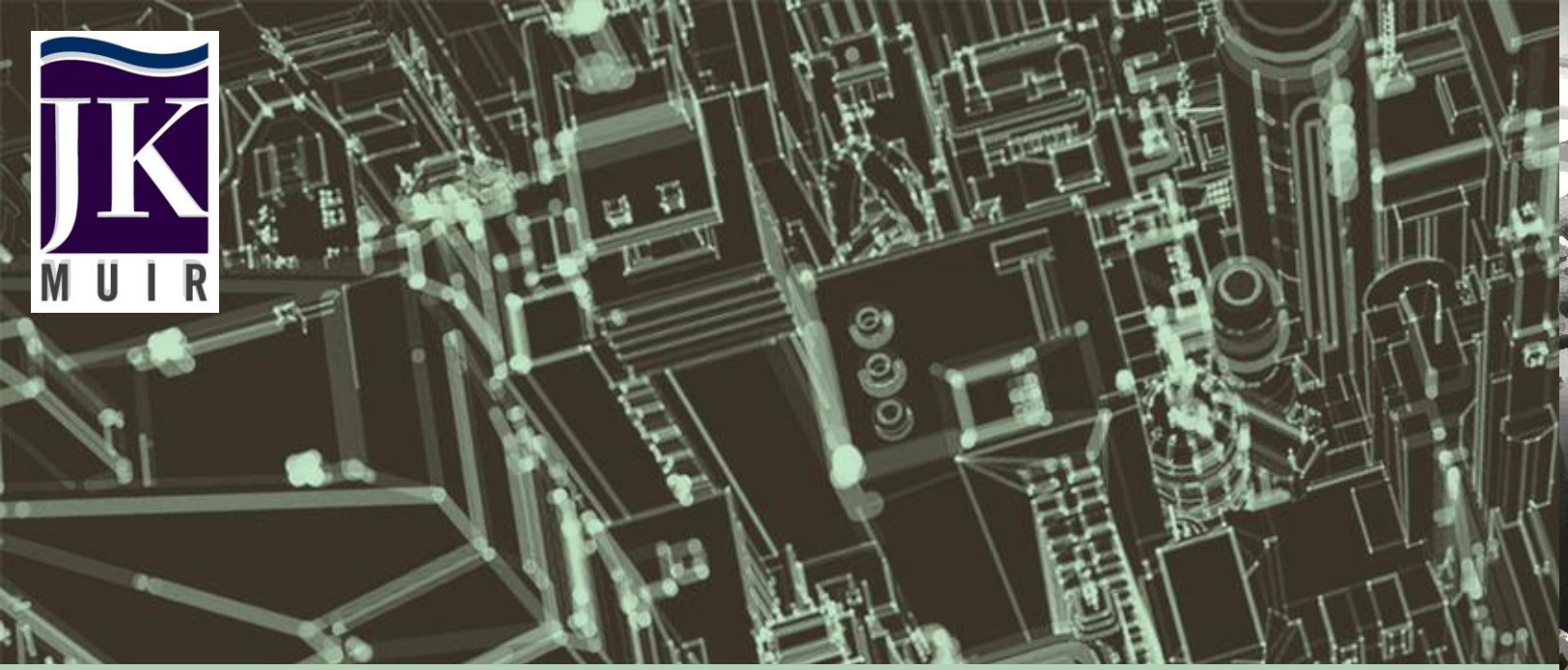
ECM – Pump Rebuild and VFD Installation

- Pumps to be rebuilt
  - Under the rebuilt conditions the pumps would be operating outside of their BEP
- Install VFD to reduce speed/Q to get the pump back into BEP
- $33,824 annual electric savings
- Project Cost = $145,418
- Payback = 4.3 years

What's Next

- Hydraulic Institute (HI)
  - Pump Efficiency Testing Standards
  - Certification for Pump Testing Professionals (PSA)
  - Masters Certification in Pump System Assessment
- Coatings/materials to improve performance
- Monitoring: real time feedback
  - Smart grid
  - Internet of things
  - Program v. one time replacement
- Asset Management, Capital Improvements, Commissioning
- Utility support & customer/end user out reach

Hydraulic INSTITUTE
Creating Pump Standards Since 1917



Thank You

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