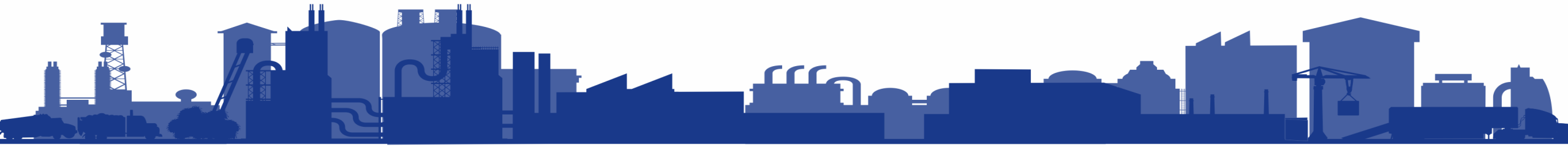
Better Plants
U.S. DEPARTMENT OF ENERGY

WATER VIRTUAL IN-PLANT (VINPLT) TRAINING

Session 6

U.S. DEPARTMENT OF ENERGY

Session 6: Hydraulic Modeling and Energy Efficient Design



Thank You!

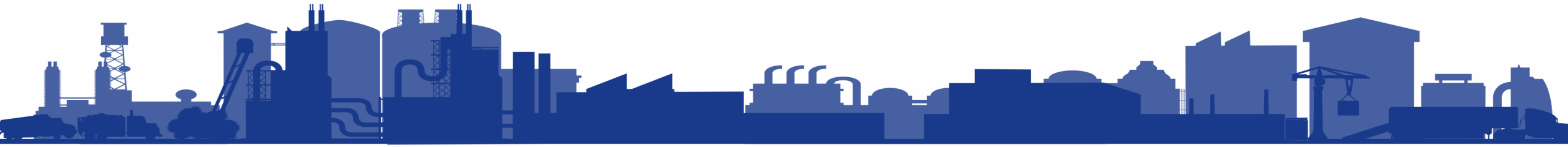
Sponsor:

Today's Agenda

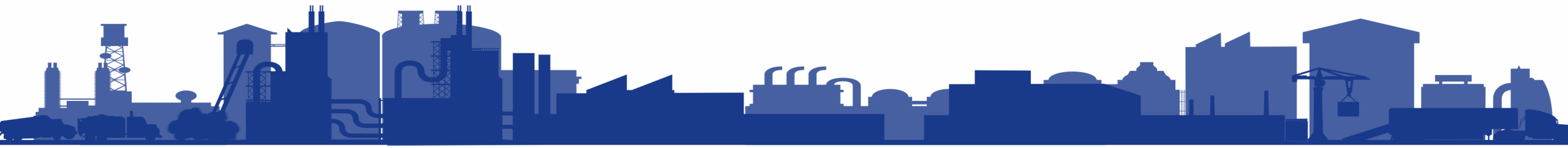
- Homework Recap
- Hydraulic Modeling
- Break
- Energy-Efficient Design
- Capital Project Incentives
- Kahoot!
- Q&A

HOMEWORK RECAP

POLL



WEEK 8 PRESENTATIONS



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Drinking Water Systems VINPLT: Close-out Presentation

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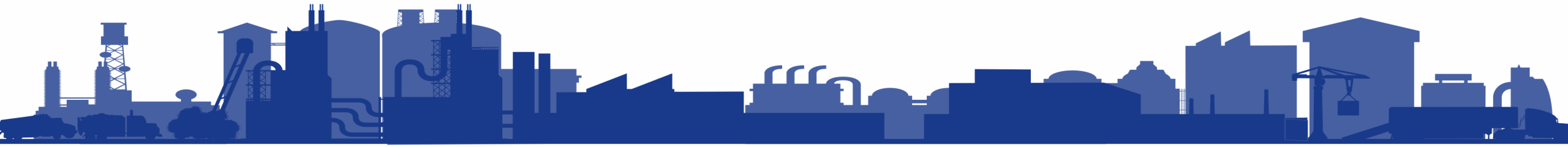
Company Name:
Facility Name:
Participant Name(s):



Savings Opportunities in Water Treatment

Savings Opportunities in Source Selection

Savings Opportunities in “Leaping”

Savings Opportunities in “Looping”

Savings Opportunities in “Leaking”

Savings Opportunities in “Losing”

Savings Opportunities in “Loading”

Savings Opportunities in Pumps

Savings Opportunities from Hydraulic Model

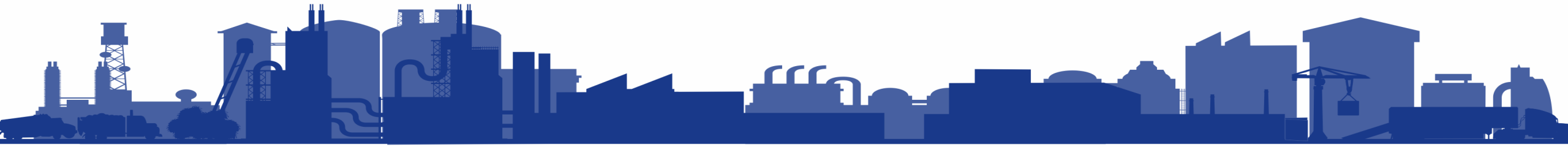
Tips Learned from this Training

Next Steps or Action Items after the VINPLT

- What are your next steps to implement opportunities?
- What are you planning to do after the VINPLT?
- Lessons learned?

Questions and Answers

HYDRAULIC MODELING



Hydraulic Model Demos...

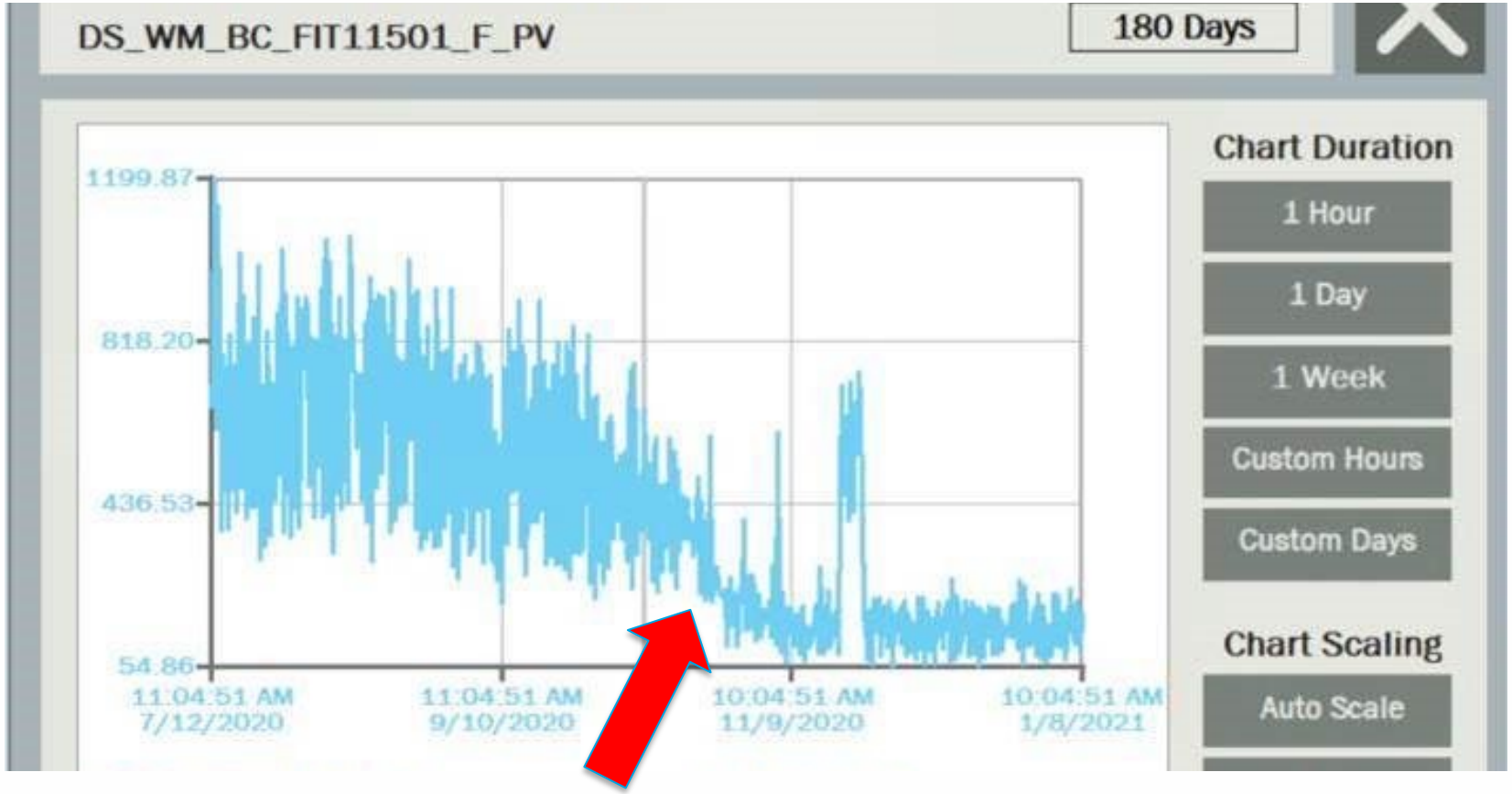
- High Pressure Areas
- Low Pressure Areas
- Broken PRV
- Pump Power
- WTP Trace
- Tank Levels

Broken PRV: How much does it cost?

- 642 gpm
- 4858 ft upstream – 4706 ft downstream = 152 ft
- Assume 75% efficiency for upstream pump

Power = (642)(152)/(3960*0.75) = 32.9 HP

(32.9 HP)(0.746 kW/HP)(24 h/d)(30 d/mo)($0.085/kWh) = **$1,502/mo**


DS_WM_BC_FIT11501_F_PV
180 Days
1199.87
818.20
436.53
54.86
11:04:51 AM
7/12/2020
11:04:51 AM
9/10/2020
10:04:51 AM
11/9/2020
10:04:51 AM
1/8/2021
Chart Duration
1 Hour
1 Day
1 Week
Custom Hours
Custom Days
Chart Scaling
Auto Scale

BREAK

ENERGY-EFFICIENT DESIGN

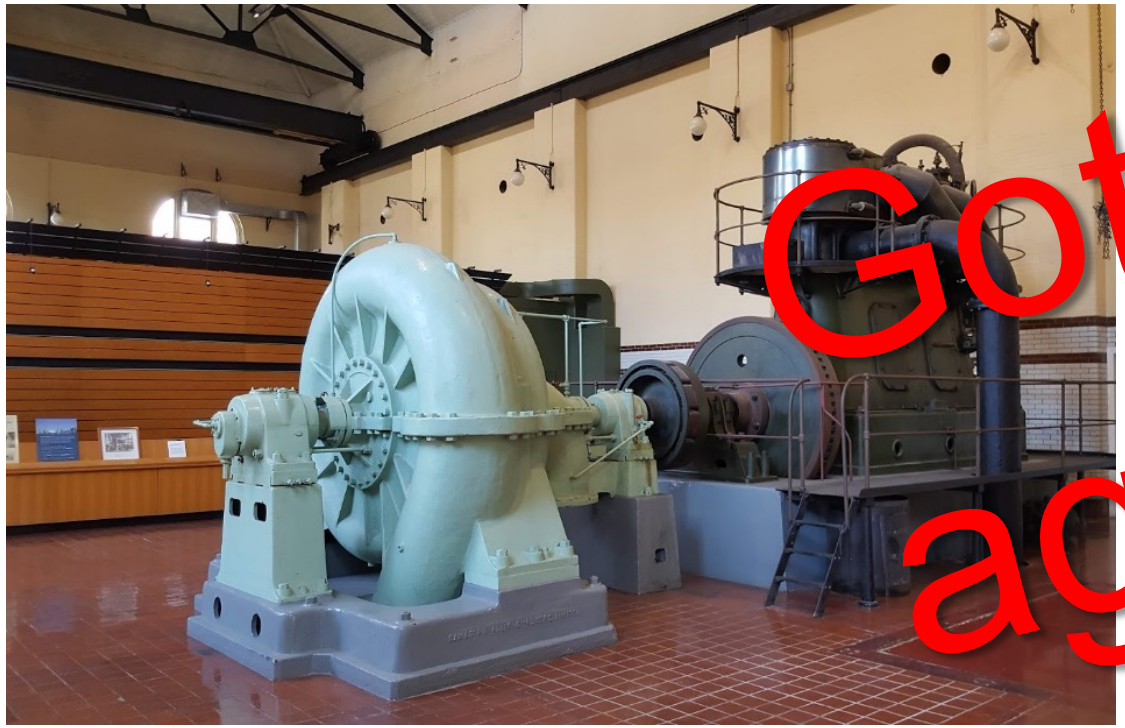
Which pump station is more efficient?

Gotcha!

A

B

Which pump station is more efficient?



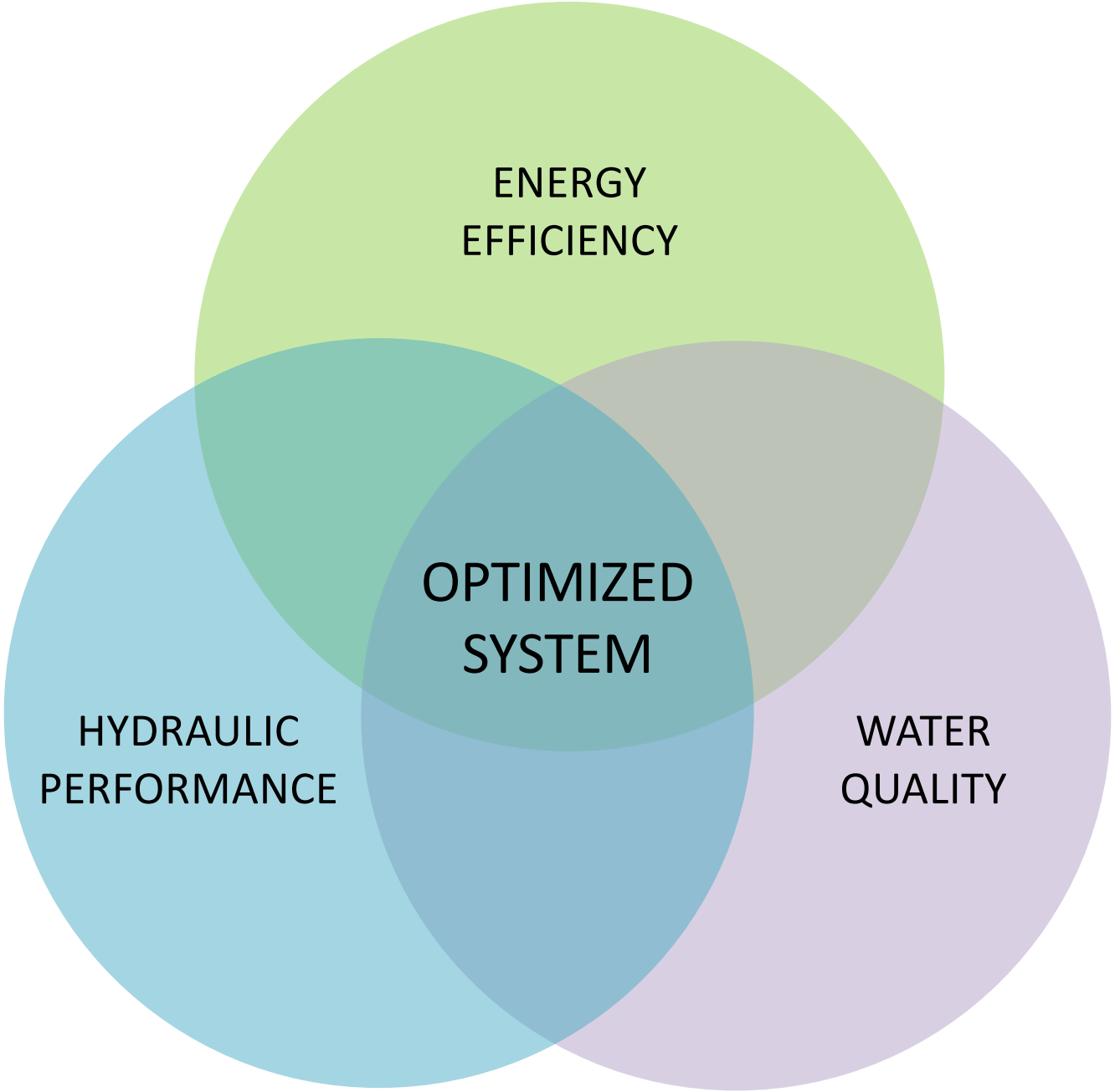
Gotcha again!

A

B

You can’t always SEE energy efficiency

- Much occurs before construction
- Much depends on how the facility is used, not what’s in it
- Facility is just a piece of the system puzzle
- Conditions (e.g., hydraulics, climate) vary



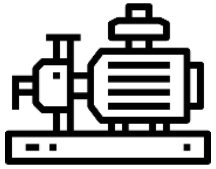
Jones and Sowby, “Water System Optimization” (*Journal AWWA*, June 2014)

Overview

Planning

Energy analysis

Layout



Equipment

Monitoring

Planning

- Evaluate master planned projects
  - Typically developed with historic system function
  - Not developed with energy efficiency in mind
  - May modify or eliminate master planned projects
- Is this the right project?

Planning

- What's the range of operating conditions?
  - Existing, future
  - Peak day, winter
- Consider energy efficiency
  - Does an alternative minimize energy cost?
  - Or reduce/eliminate other capital projects?
- Extended-period simulation (EPS) hydraulic model

Case Study: Logan City, Utah

Logan City Water System

- Population 50,000
- Utah State University
- >10,000 metered connections
- 190 miles of mainline
- 1 spring and 4 deep wells

Problems

- Deteriorating infrastructure
- Many mainline breaks: over 300 per year
- High pressures: over 220 psi
- Water shortage in summer
- High pumping costs
- Reactionary, rather than proactive, operations

Specific System Performance Goals

- Minimize pressure fluctuations
- Maximize storage use
- Eliminate unnecessary pumping
- Eliminate unnecessary PRV flow
- Improve water quality
- Minimize pumping costs

Initial Scope (RFQ)

Actual Scope

~~Well~~

~~Transmission line~~

Hydraulic modeling

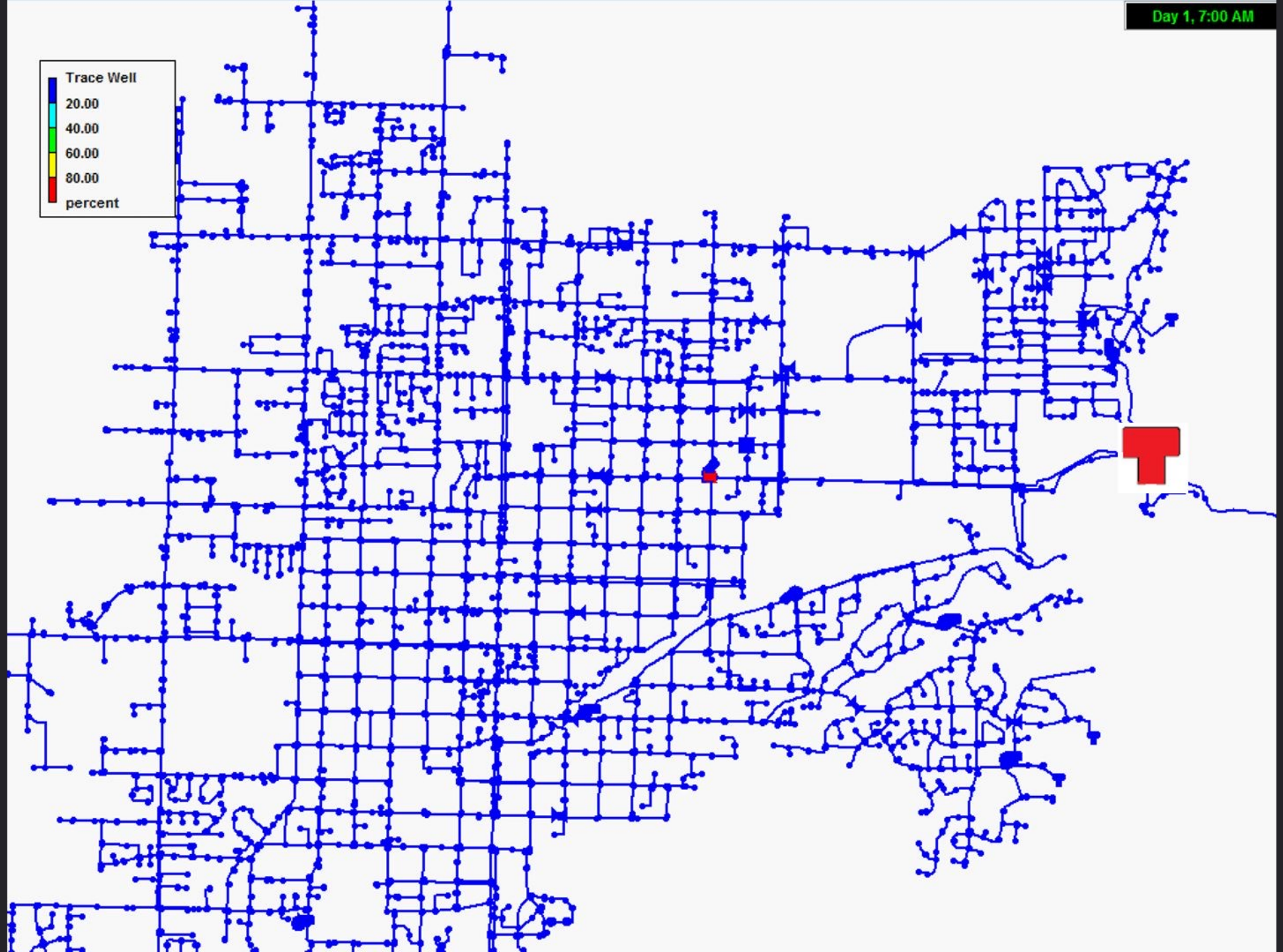
Audit of water & energy use

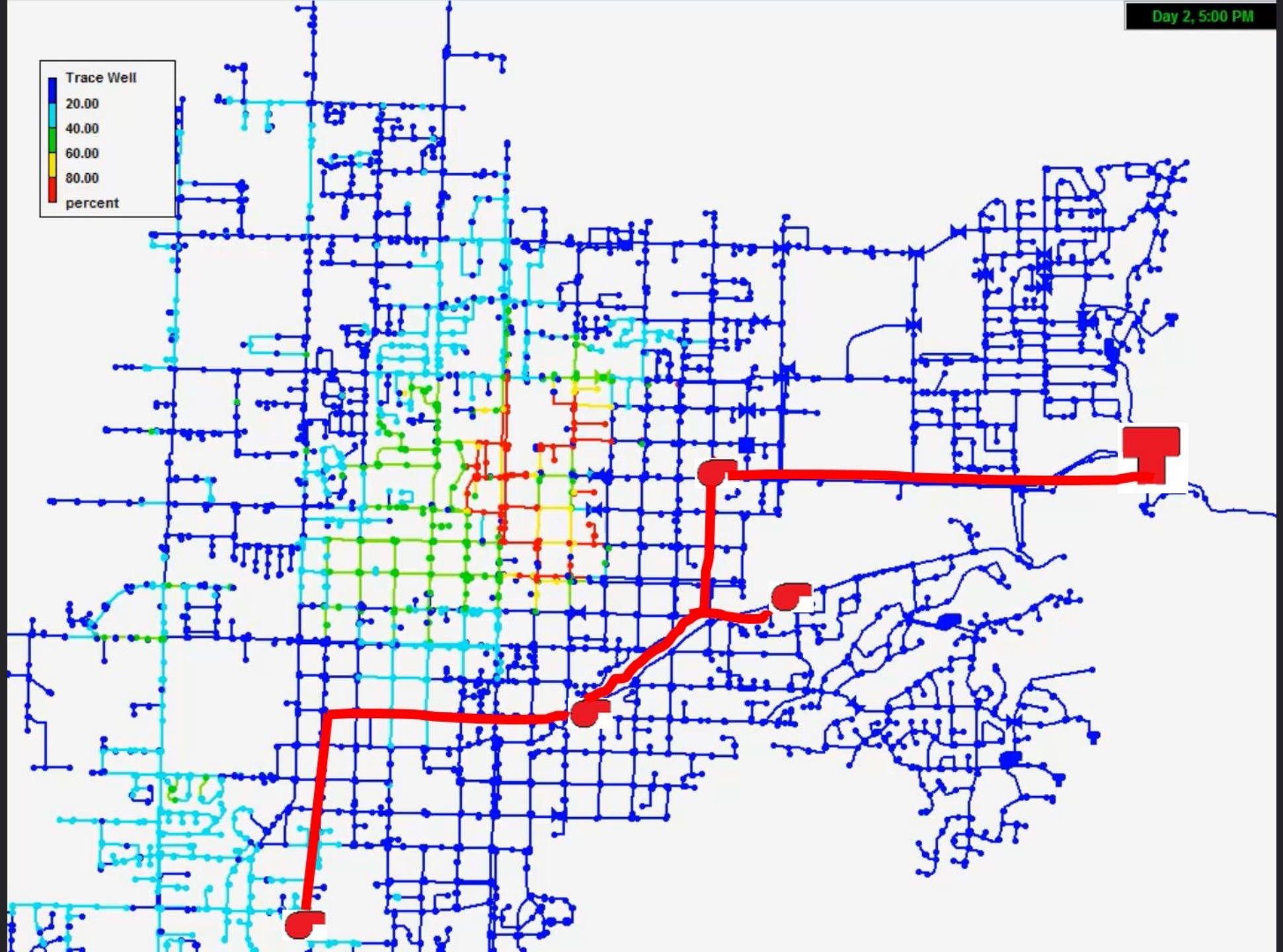
New pressure zone

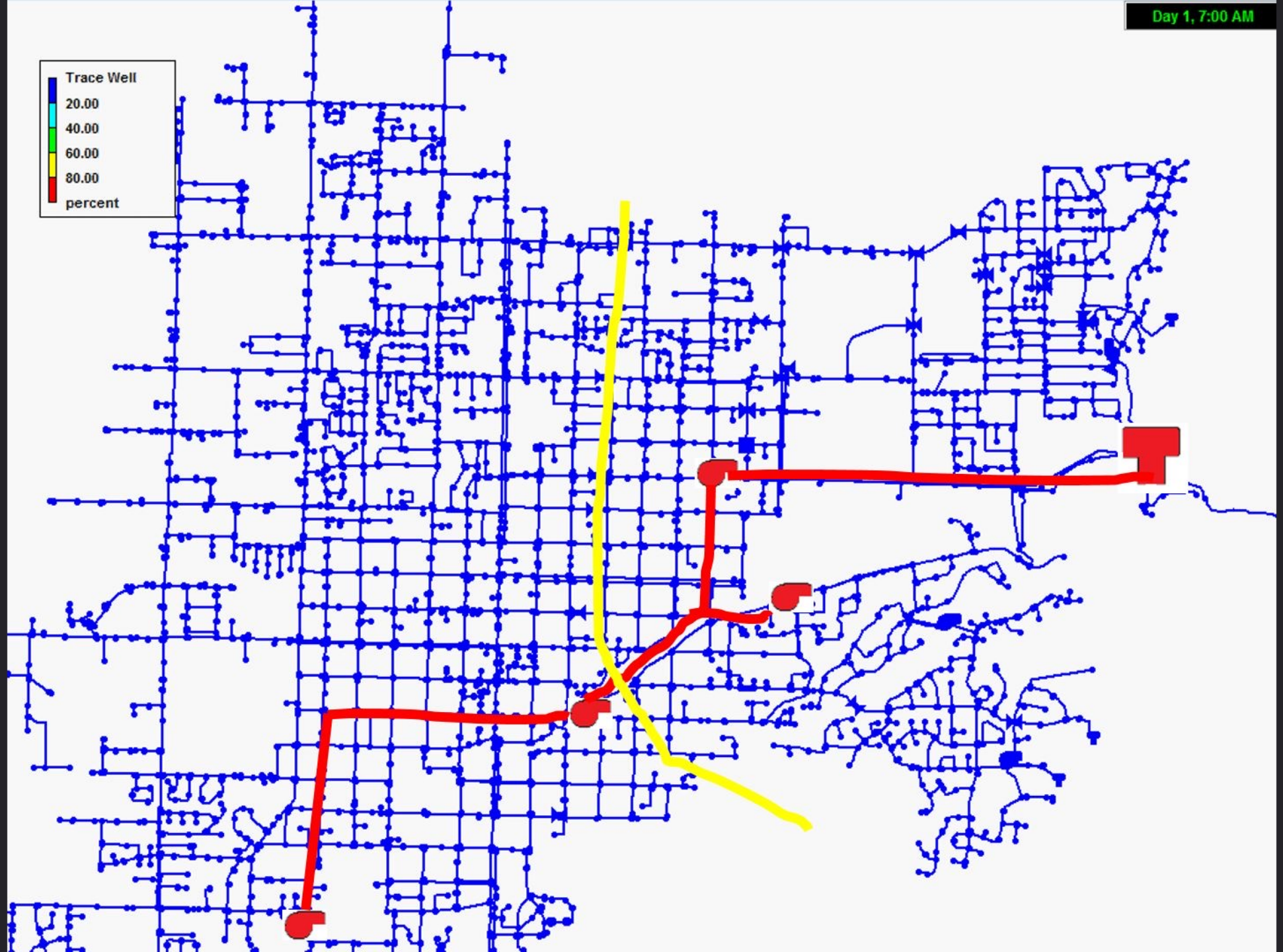
Well pump station retrofits

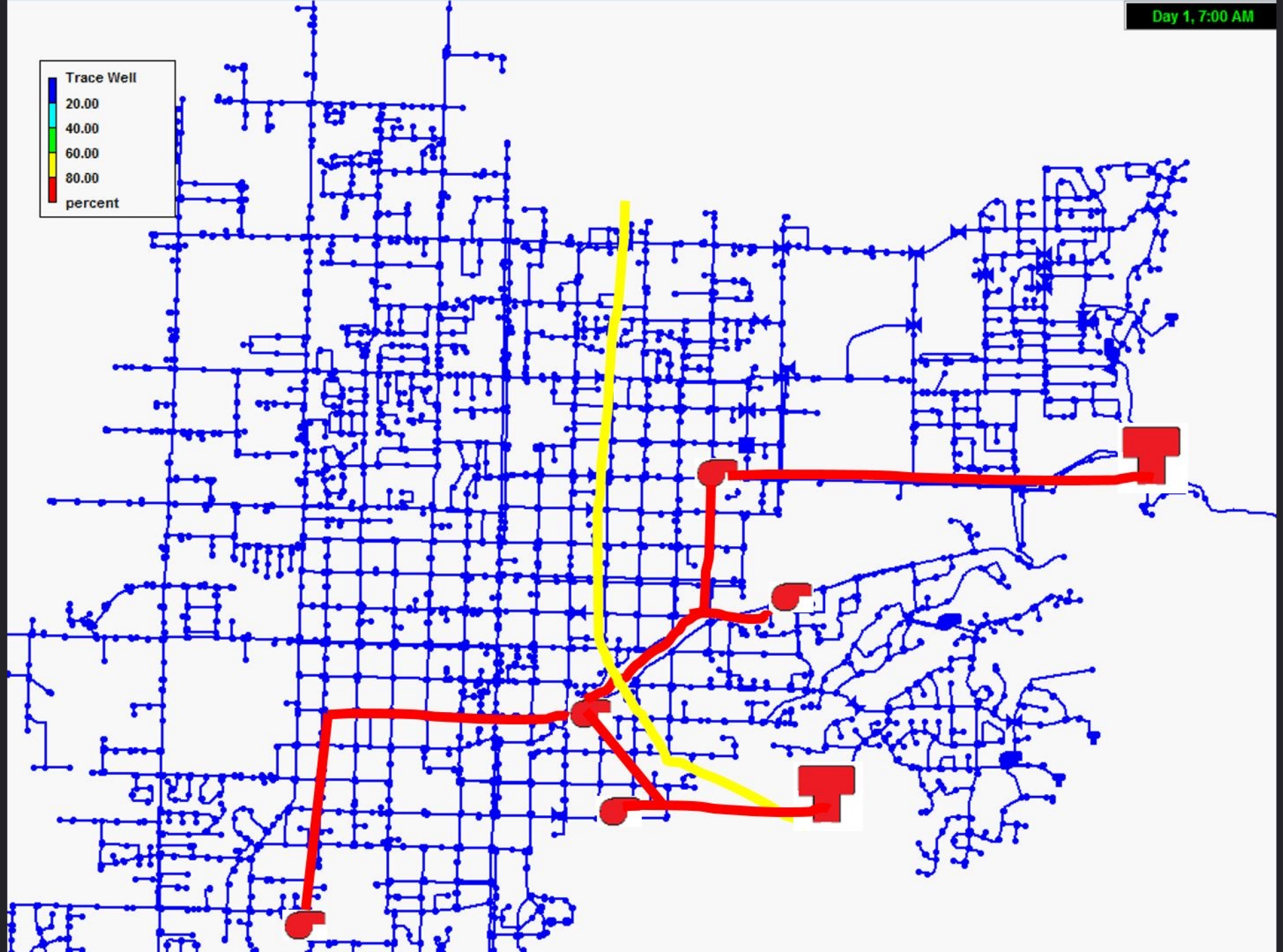
Minor transmission upsizing

Efficient operation

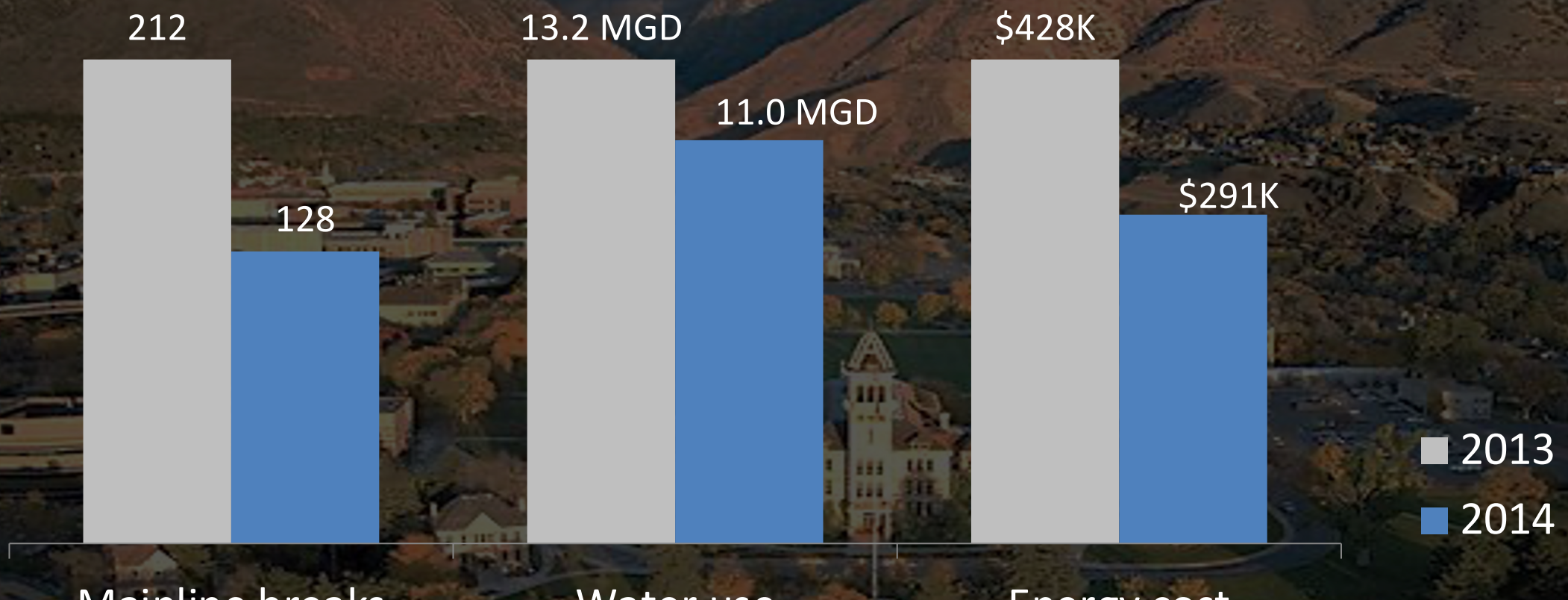

Trace Well
20.00
40.00
60.00
80.00
percent
Day 1, 7:00 AM


Trace Well
20.00
40.00
60.00
80.00
percent
Day 2, 5:00 PM


Trace Well
20.00
40.00
60.00
80.00
percent
Day 1, 7:00 AM


Trace Well
20.00
40.00
60.00
80.00
percent
Day 1, 7:00 AM

Project Results



↓ 40%

↓ 17%

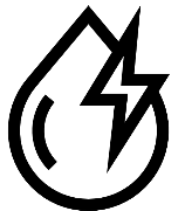
↓ 32%

City-Identified Benefits

- Less water wasted = Less energy and money wasted
- Fewer pressure complaints
- Preventive maintenance occurring
- Crew attitudes improved
- Safer working environment – lower pressures
- Eliminated the need for a $3 million transmission project
- Postponed construction of new water source

Paul Lindhardt, W/WW Manager

The savings and operational efficiency have continued each year since 2013. … The payback period for this project will be shorter than projected.

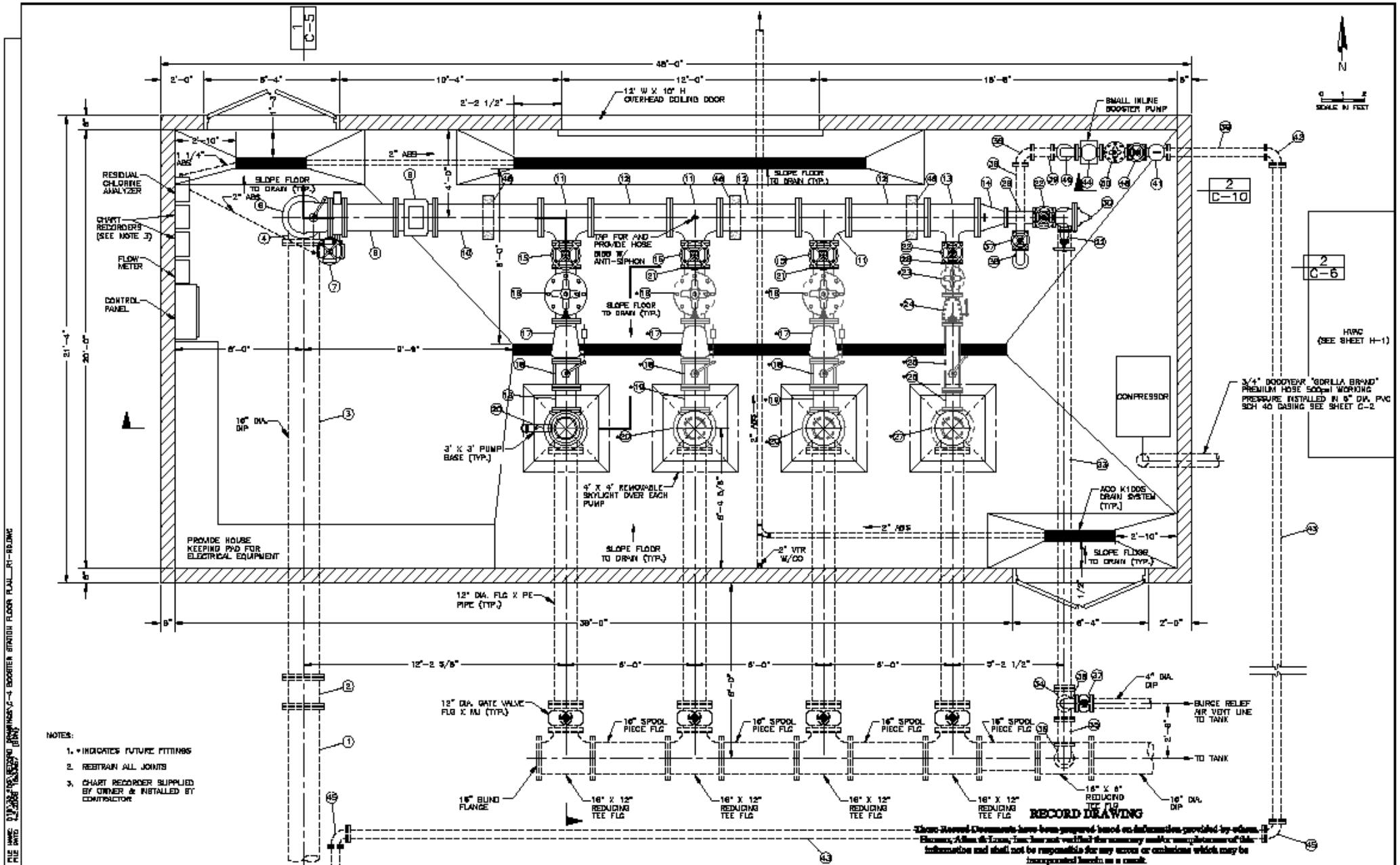


Energy Analysis

- Include energy analysis in engineer's scope!
  - Otherwise it won't happen
  - How much will it cost to operate?
  - Look beyond capital costs
- Pumping components
- Building components

Layout

- Pump array of different sizes
  - Efficiently handle range of water demands
  - Jockey pump—small, efficient, constant
- Bays for future pumps
- Space for VFD and other controls



NOTES:

1. * INDICATES FUTURE FITTINGS
2. RESTRAIN ALL JOINTS
3. CHART RECORDER SUPPLIED BY OWNER & INSTALLED BY CONTRACTOR

RECORD DRAWING

These Record Documents have been prepared based on information provided by others. It is Hoover, Allen & Lacy, Inc. has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions which may be incorporated herein as a result.

DESIGNED VGC	0					
DRAFTED SDH	2					
CHECKED MEA	1	04/2008	RECORD DRAWING	SDH	VGC	
DATE SEPTEMBER 2008	NO.	DATE	REVISIONS	BY	APP.	

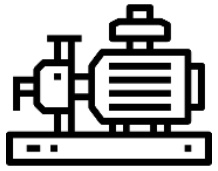
PROJECT ENGINEER

AS SHOWN

ANDRA BOOSTER PUMP STATION
CIVIL
FLOOR PLAN

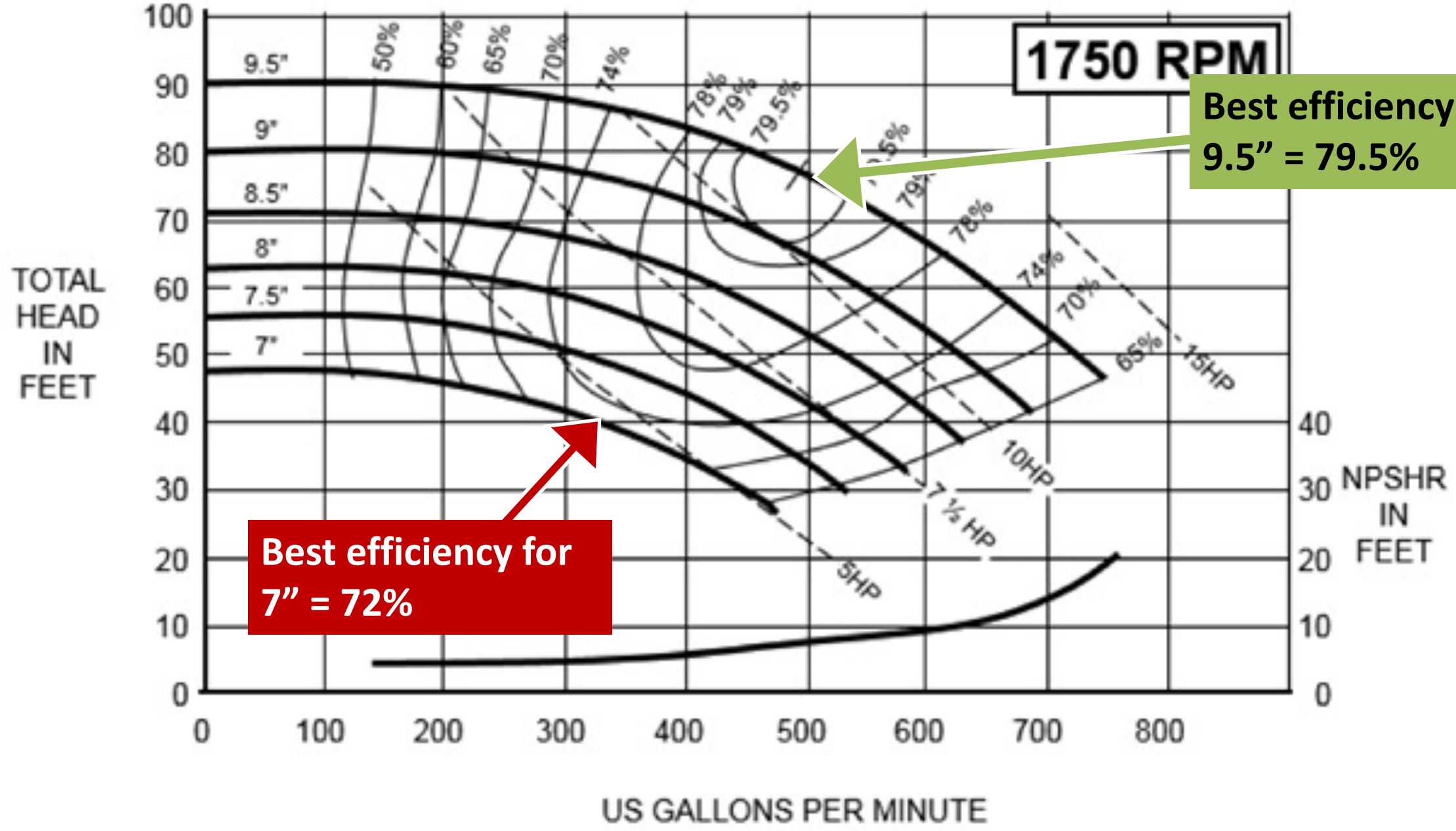
C-4

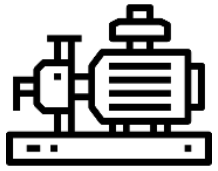
019.32.200



Equipment

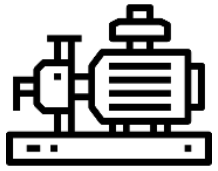
- Premium high-efficiency motors
- Avoid oversizing pumps and motors
  - Worst-case condition?
  - Safety factor applied at every step?
- Largest impeller for given pump casing
  - Smaller gap between casing and impeller
  - More power applied to fluid
  - Higher efficiency


1750 RPM
Best efficiency for 9.5” = 79.5%
Best efficiency for 7” = 72%
TOTAL HEAD IN FEET
NPSHR IN FEET
US GALLONS PER MINUTE
9.5"
9"
8.5"
8"
7.5"
7"
50%
60%
65%
70%
74%
78%
79%
79.5%
5HP
7 ½ HP
10HP
15HP
0
100
200
300
400
500
600
700
800
10
20
30
40
50
60
70
80
90



Equipment

- Variable Frequency Drive (VFD)
  - Control flow rate
  - Respond to varying water demands
  - Maintain high efficiency
  - Bypass at full speed
  - Also for mixers and other treatment equipment

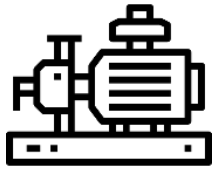


Equipment

- Flow meter
  - Please!
- Suction and discharge pressure gages
  - Total dynamic head when pump is running
- Power submeter for major components
  - E.g., well + booster


SIEMENS
SITRANS F
FLOW GAL/MIN
3153
TOTAL MGAL
4122.71
FLOW GAL/MIN
2718
TOTAL MGAL
3492.32
VALVE-2
OPEN
STOP
CLOSE
VALVE-1
SIEMENS

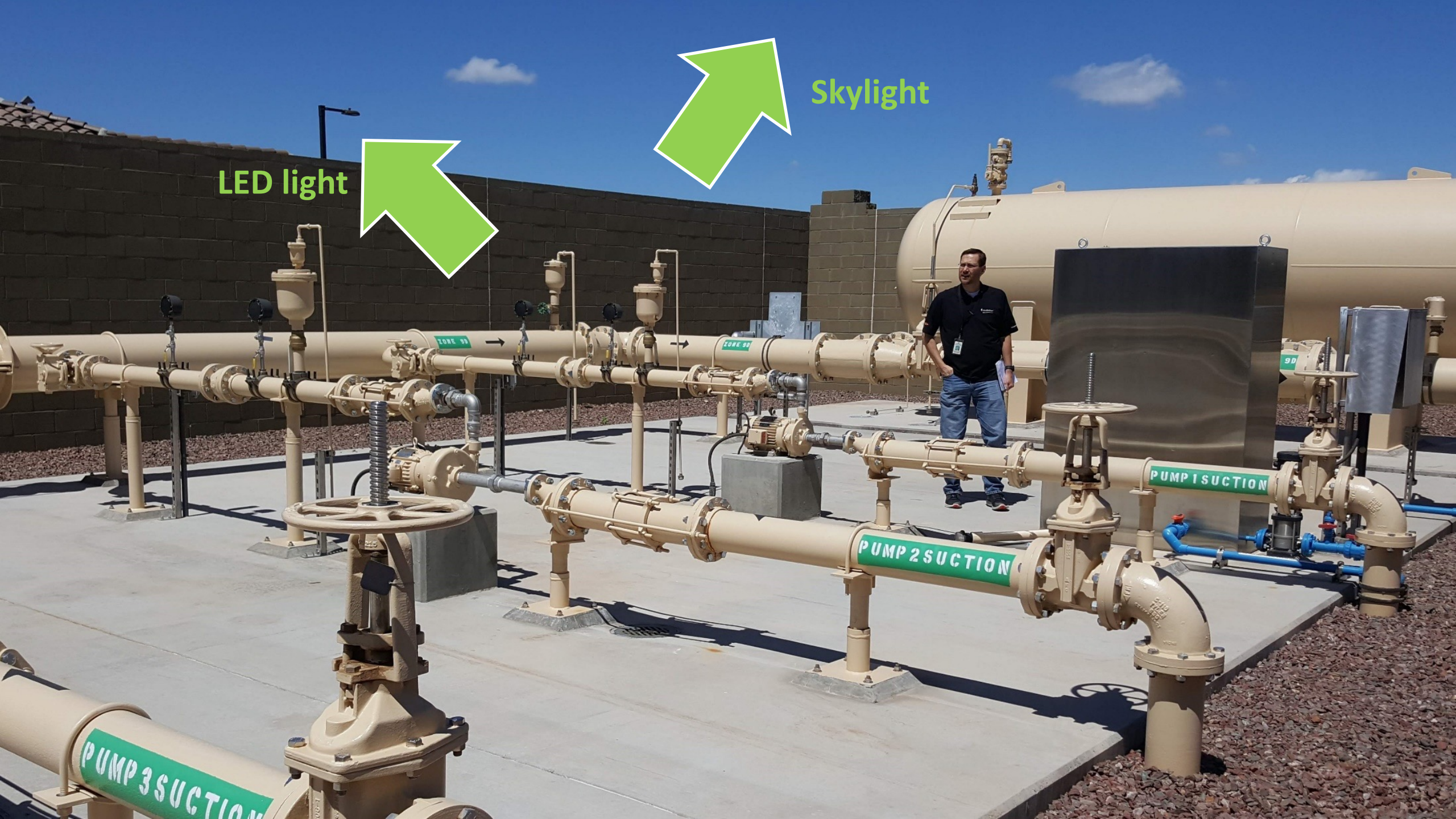

kV2c
Multifunction Meter
FITZALL
PACIFICORP
55 317 094
DANGER
CAUTION
480



Equipment

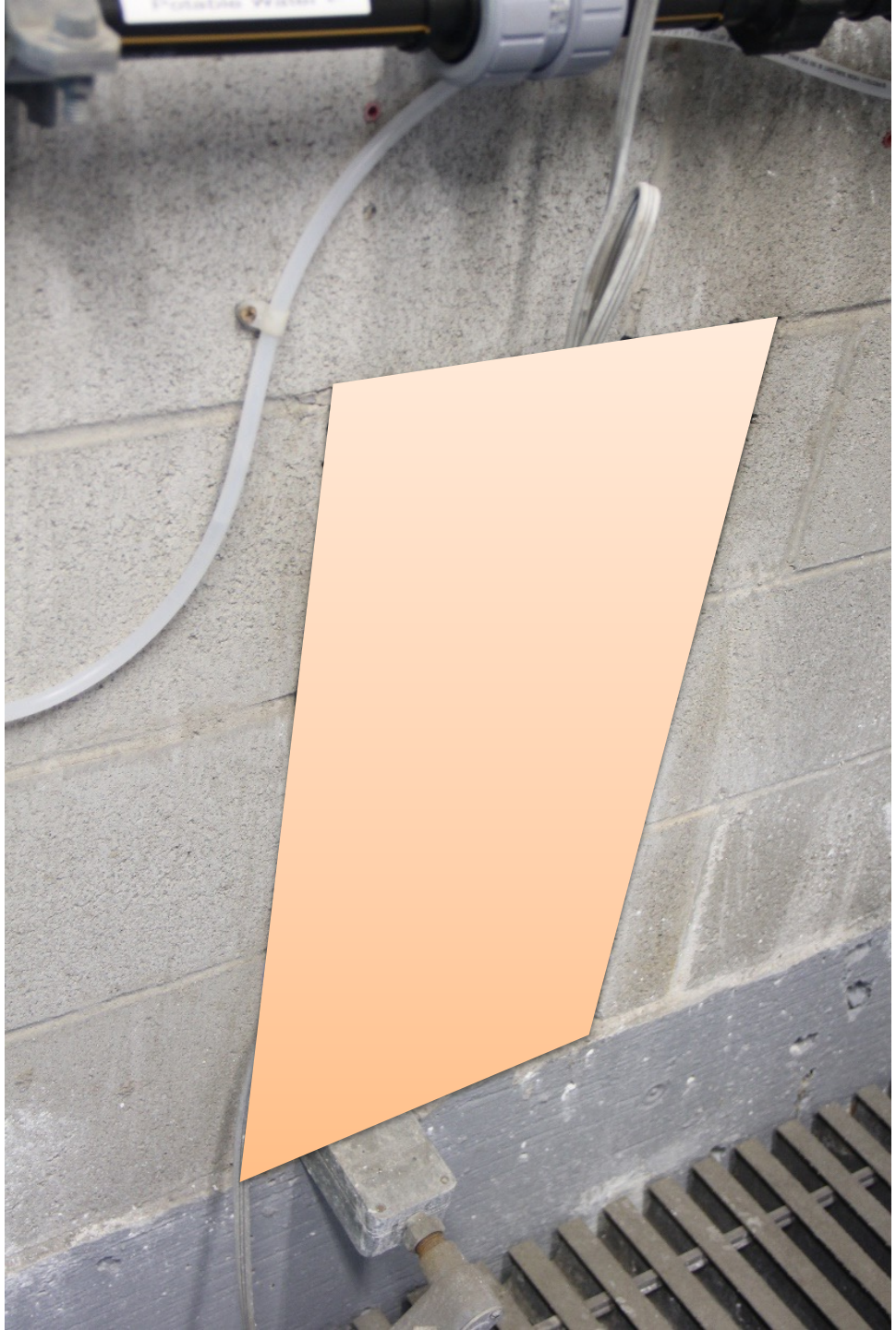
- Other
  - Skylights
  - LED lights
  - Occupancy sensors or timers
  - Programmable HVAC
  - Fans (high volume, low speed)
  - Insulation over vents and hatches when winterized


Creepy old light
← with spider webs


Skylight
LED light
PUMP 1 SUCTION
PUMP 2 SUCTION
PUMP 3 SUCTION

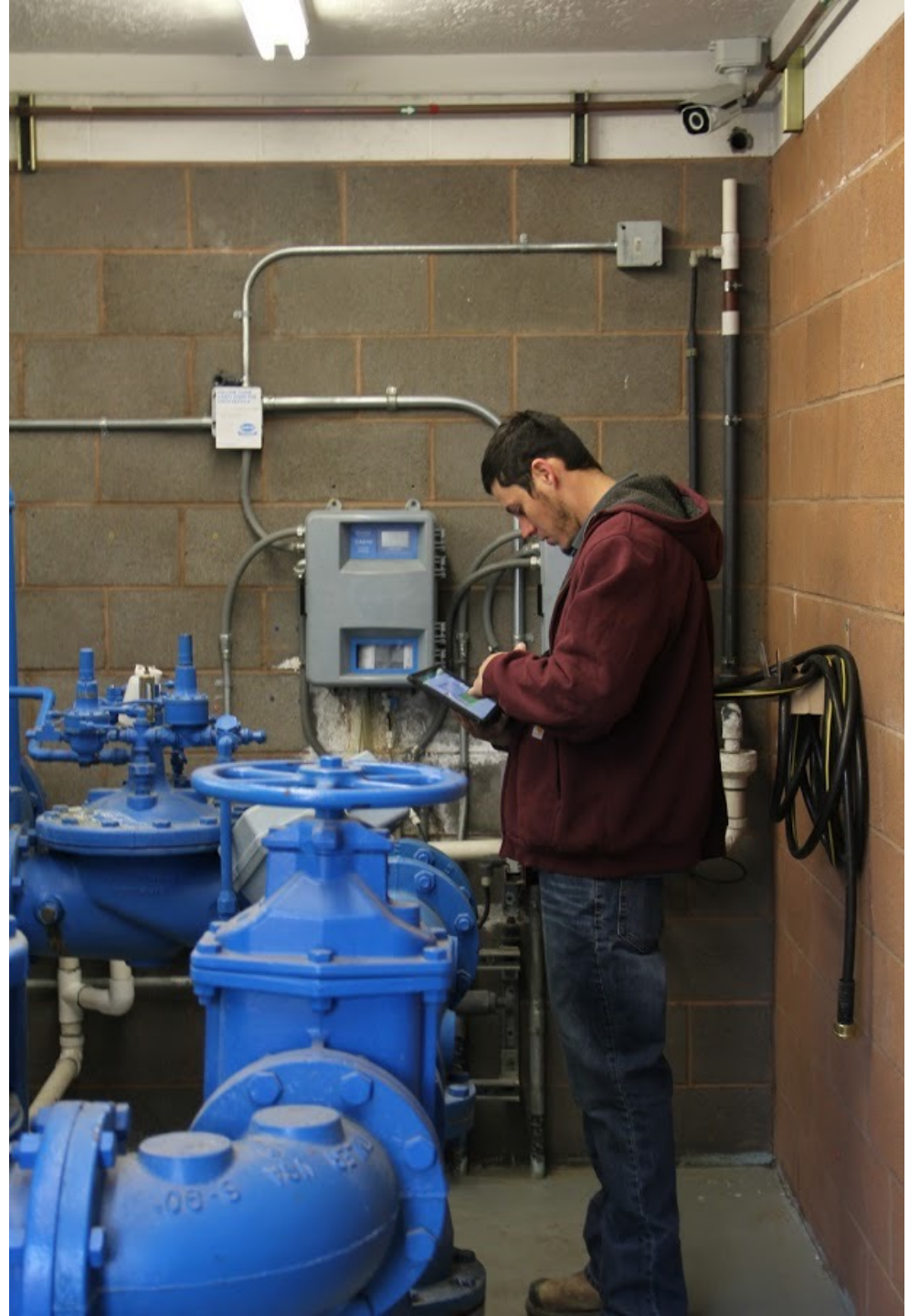

LO
?


TRANE
FAN
AUTO
74
630
76
DONE
CANCEL



Monitoring

- Pump curves (or at least make and model)
  - Pump and motor inventory
- Power meter number/account
  - Match to facility
  - Facilitate customer service and engineering



Monitoring

- Annual performance review
  - "How do you know if your pumps are stealing from you?"
  - Use flow, pressure, and energy data to evaluate performance
  - Does it match design?
  - Informs action

Monitoring: Efficiency vs. Intensity

- Energy Efficiency
  - Equipment
  - 0%–100%
  - High value good
- Energy Intensity
  - Facility or system
  - kWh/MG
  - Low value good

Example: Performing as Expected?

Favorite Greek letter

- Design: 79% wire-to-water efficiency
  - 84% pump efficiency
  - 94% motor efficiency
- Actual:
  - 1,000 gpm
  - 210 ft TDH
  - 75 kW = 100 HP

$$\eta = \frac{Qh}{3960P}$$

$$\eta = \frac{(1000)(210)}{3960(100)}$$

$$\boldsymbol{\eta = 53\%}$$

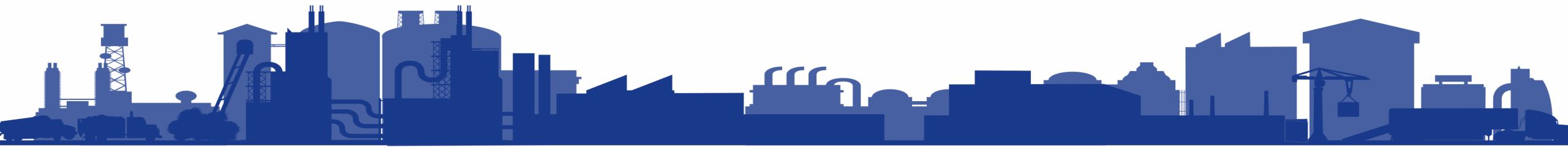
Which water well will want what watts when working?

Well 1
750,000 kWh
300 MG

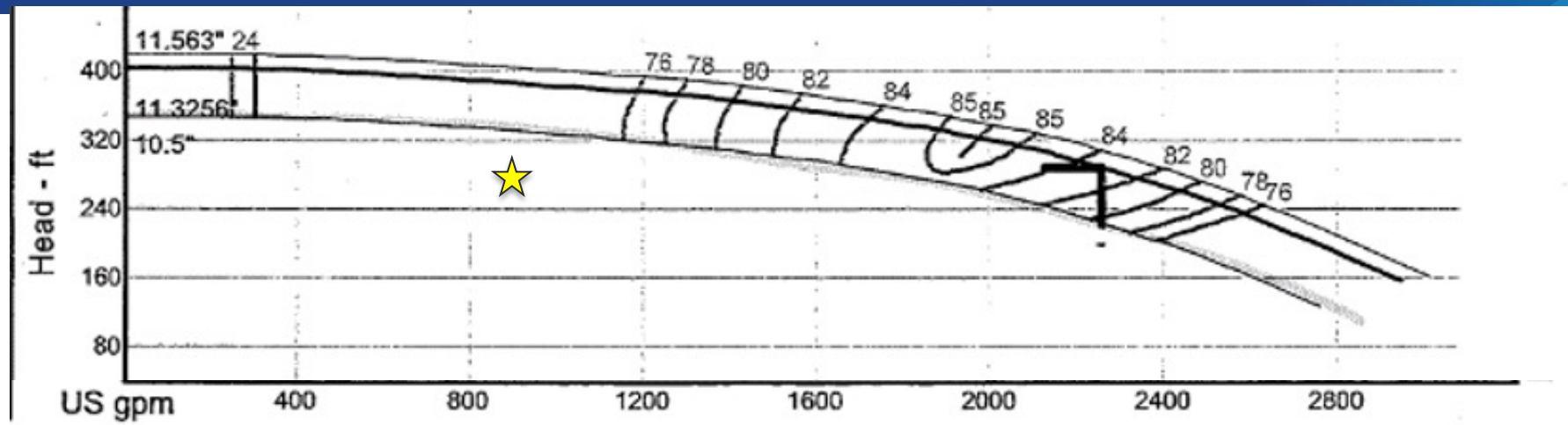
Well 2
345,000 kWh
230 MG

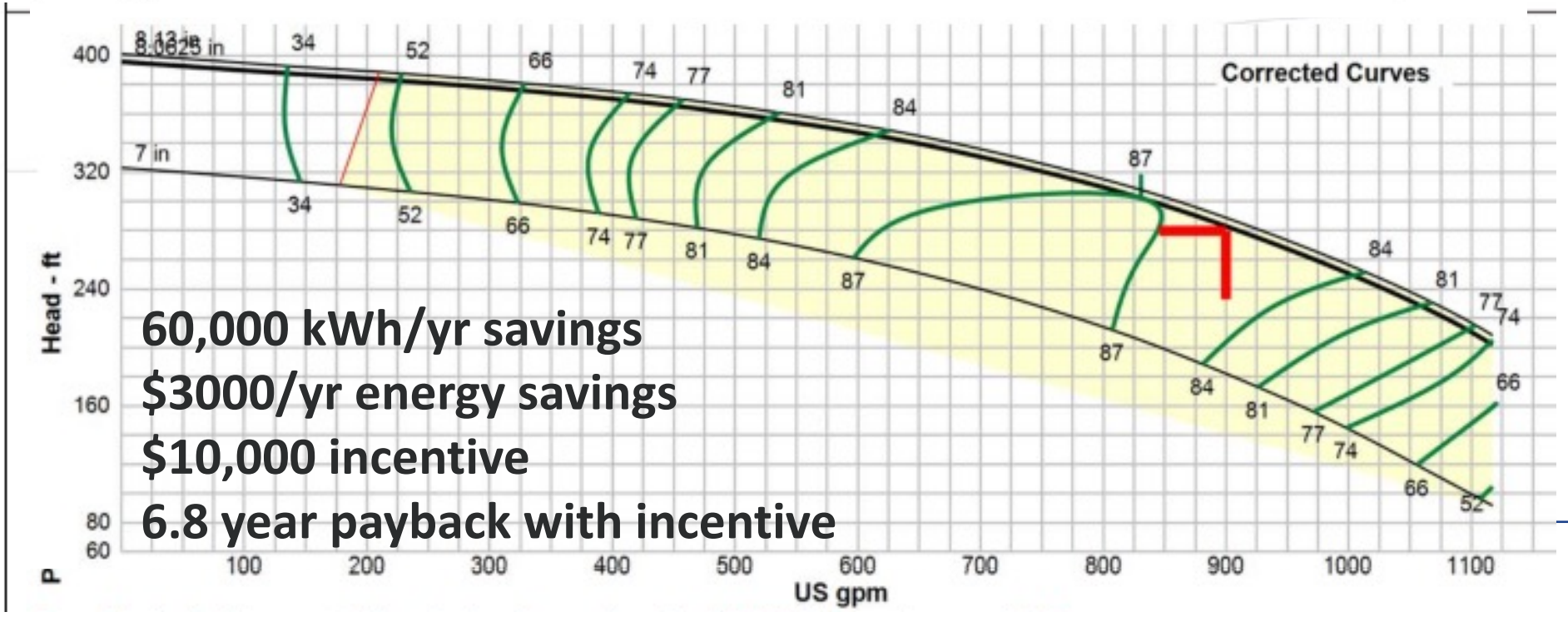
Well 3
252,000 kWh
120 MG

CAPITAL PROJECT INCENTIVES



Well Pump Retrofit





60,000 kWh/yr savings
$3000/yr energy savings
$10,000 incentive
6.8 year payback with incentive

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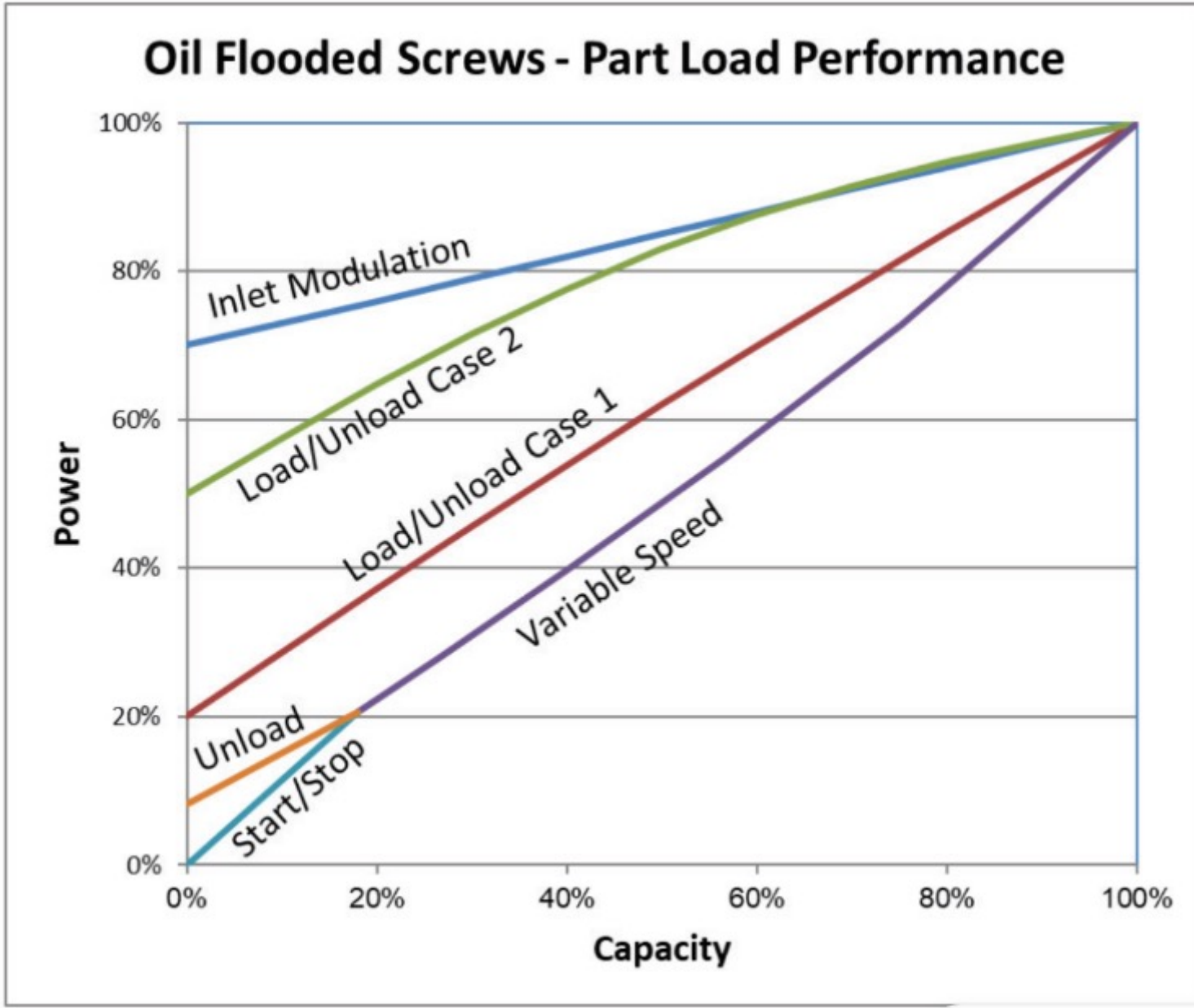
Water Treatment Plant Compressor Upgrade

- Baseline – Existing
  - 40 hp screw compressor with inlet modulation and non-cycling dryer
- Energy Efficient Upgrade
  - 30 hp screw air compressor with VFD with cycling dryer
    - 98,000 kWh savings
    - $17,000 incentive
    - Payback without incentive 5.6 years
    - Payback with incentive 2 years



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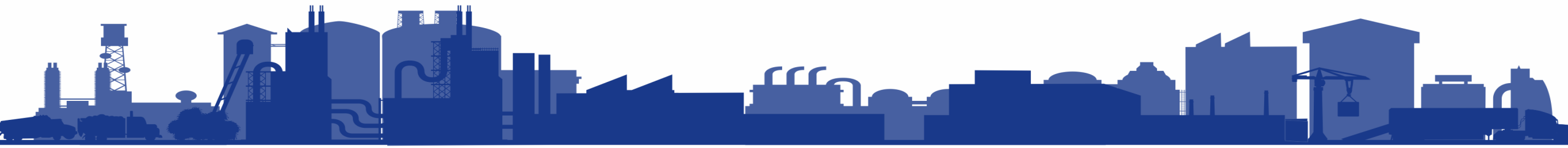
Pumphouse Retrofit Incentive

- 10 hp pump w/VFD operates instead of a 20 hp & 50 hp
- $27,000 estimated incentive
- $7,700 estimated electrical cost savings per year

Plan for efficient operation

On your smart phone
Go to: https://kahoot.it/
Game PIN:

KAHOOT!



Takeaways

- If you have a hydraulic model – use it
- Design and plan for upgrades/replacements with energy efficiency in mind
- Reach out to your power provider about incentives when you are considering new equipment

Closing

Questions
Comments
Discussion

SEE YOU TUESDAY!

aquafficiency®

Saving energy, one gallon at a time