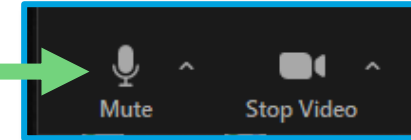


Using Zoom!

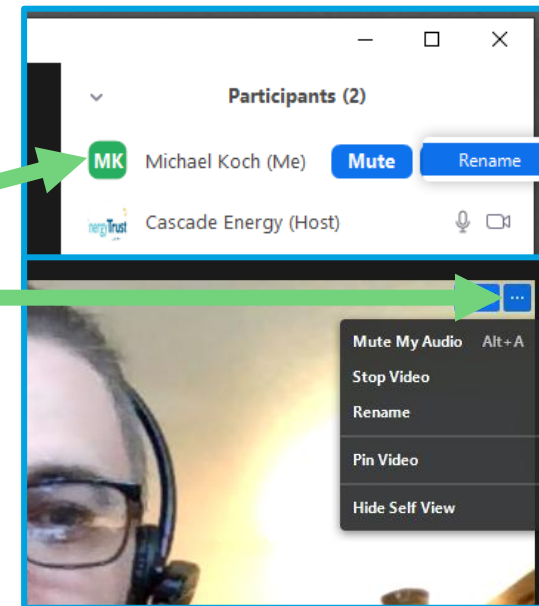
Mute yourself!

Have a question?
Use the chat feature or unmute.
Controls accessed at the bottom

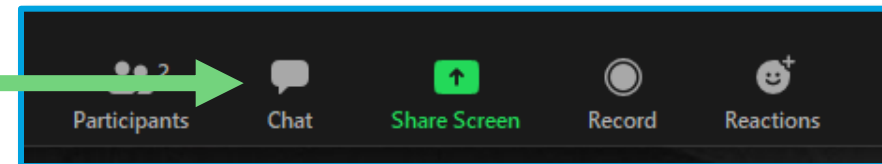


Rename yourself

“Name (Company)”
Right click on your picture or 3 dots
OR
Controls accessed at the right after clicking ‘Participants’ at bottom.



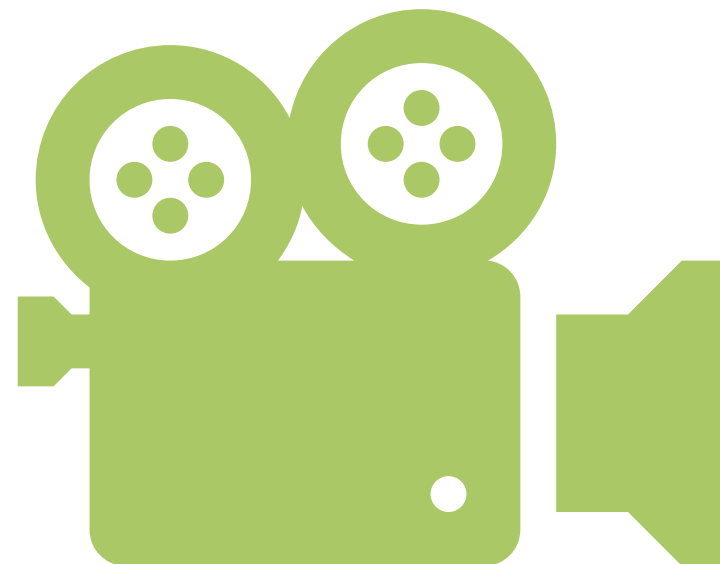
Access Chat at the bottom



Recording

This meeting is being recorded (both audio and video)

*If you do not consent to being recorded,
please let the meeting moderator know
ASAP and we will facilitate your
participation in another way or adjust
our procedure.*



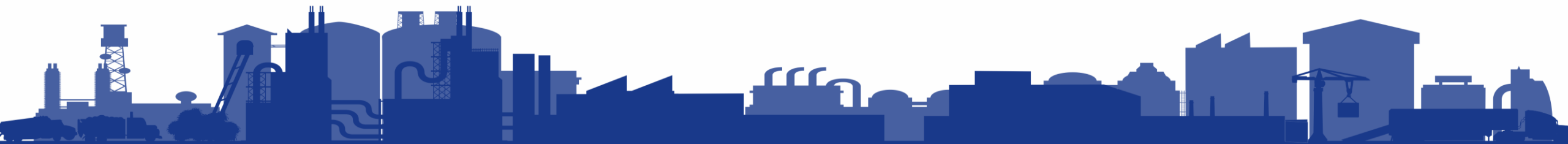


WATER VIRTUAL IN-PLANT (VINPLT) TRAINING

Session 7



Session 7: Persistence Strategies

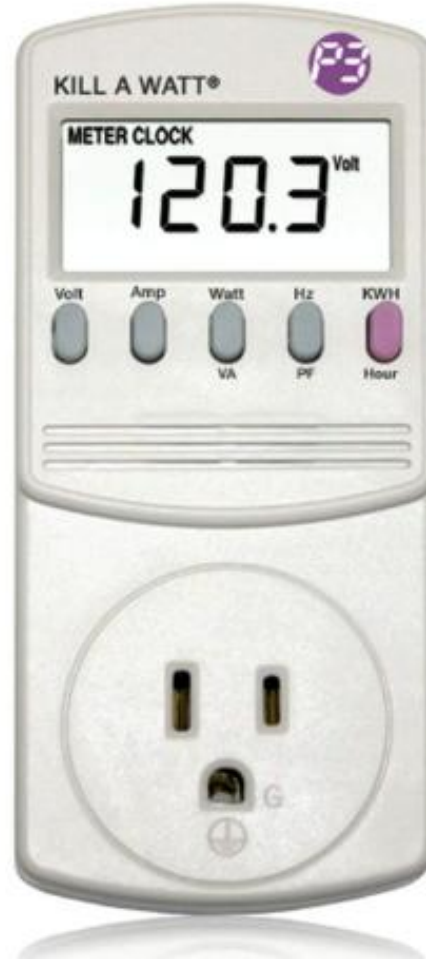


Thank You!

Sponsor:



Final Kahoot Prizes!

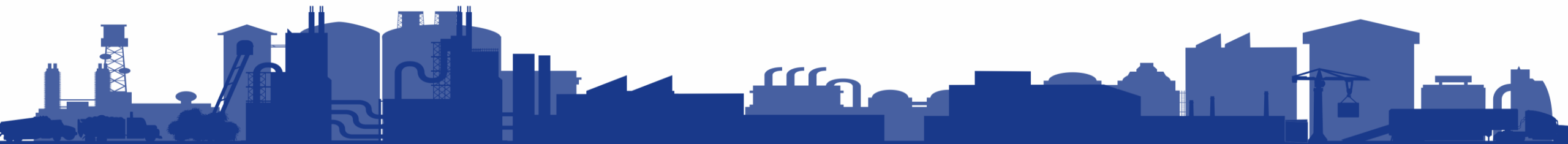


Training Schedule Overview

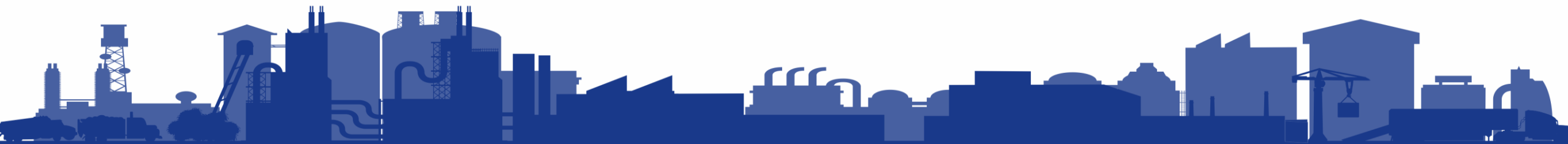
Week	Date and Time	Content
Week 1	Oct 2, 2025 10:00 AM ET	Introduction, Energy Basics, & Power Company Relationships
Week 2	Oct 9, 2025 10:00 AM ET	Water Source Selection, KPIs, and Energy Teams
Week 3	Oct 16, 2025 10:00 AM ET	Water Treatment Energy Opportunities, the 5 L's
Week 4	Oct 23, 2025 10:00 AM ET	The 5L's (cont'd), Treasure Hunts
Week 5	Oct 30, 2025 10:00 AM ET	Pumps
Week 6	Nov 6, 2025 10:00 AM ET	Hydraulic Modeling, Energy-Efficient Design and Capital Projects
Week 7	Nov 13, 2025 10:00 AM ET	Persistence Strategies
Week 8	Nov 20, 2025 10:00 AM ET	Closeout

HOMework RECAP

POLL



SESSION 8: CLOSEOUT





Drinking Water Systems VINPLT: Close-out Presentation



Savings Opportunities in

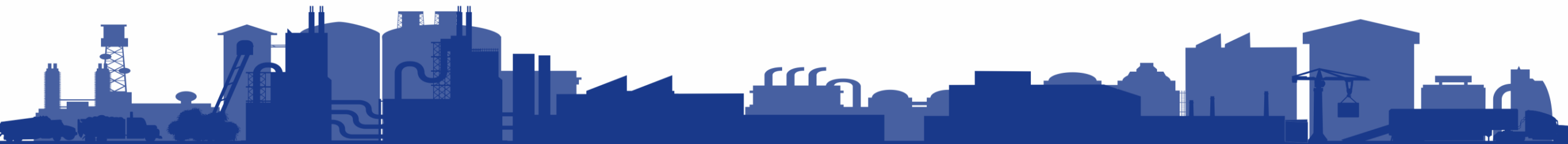
- Water Treatment
- Source Selection
- Leaping
- Looping
- Leaking
- Losing
- Loading
- Pumping
- Hydraulic Model

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?

ENGAGING EMPLOYEES





— DENNIS D. TRUAX, PH.D., P.E.,
DEE, D.WRE, F.NSPE, F.ASCE

The solution to creating an effective, successful workplace is engaged people. Engaged people are more involved with their work and compelled to do their best; they will work smarter, serve better, and innovate more.

[6] *Civil Engineering* NOVEMBER | DECEMBER 2021

*When people are financially invested,
they want a return.*

*When people are emotionally invested,
they want to contribute.*

**Simon Sinek,
leadership guru and
promoter of “The Golden Circle”**

An Engaged Workforce...

UNDERSTANDS the goals and objectives for energy management.

KNOWS their jobs impact energy performance.

Feels **EMPOWERED** to take steps.

Is **AWARE** of the process for collecting and vetting their energy ideas.

Is **RECOGNIZED** for their contributions.

SEM Alumni Employee Engagement Strategies



LESSONS LEARNED

- Staff bought in completely and quickly
- Questioning assumptions was crucial
- Surprised by how many energy saving ideas were generated
- Even with a small team, many projects were completed
- It didn't take a lot of time or money to get most projects implemented
- Energy saving projects were interesting and fun to work on



SEM Alumni Employee Engagement Strategies



Keep your team informed about successes (and failures)

Communication is critical to maintaining momentum. Failures are okay and expected. Take small steps with a new measure so you can back out before an issue grows.

Team effort with operations, engineering, and management

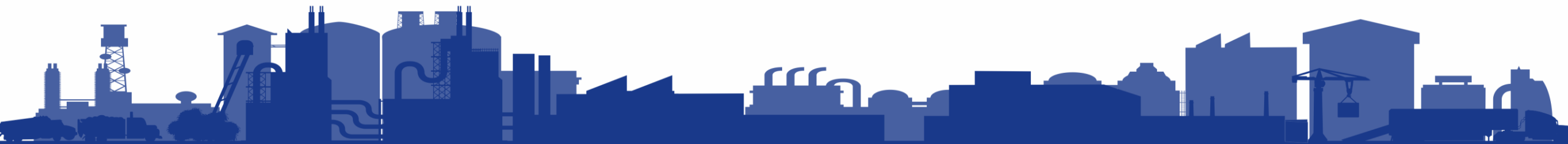
All team members, including upper management, need to be involved and supportive. Ask for ideas from the entire staff.

Past Experience with Employee Engagement

BREAK



ENERGY CALCULATIONS REVIEW



3 ways to estimate/calculate power

From nameplate information

Estimating from Motor HP and Load Factor

HP

= Motor HP from the nameplate
(horsepower)

Load Factor

= Estimated capacity/loading (0-100%)

Motor Efficiency = Motor efficiency rating from the nameplate

MOTOR POWER

$$\text{BHP} = \text{Motor Nameplate hp} \times \text{Motor Load (\%)}$$

$$\text{kW} = \frac{\text{bhp} \times 0.746}{\text{Motor Efficiency (\%)}}$$

$$\text{kW} = \frac{\text{Motor nameplate hp} \times \text{Motor load (\%)} \times 0.746}{\text{Motor Efficiency (\%)}}$$

VFD efficiency


$$*\text{Input motor kW} \times \frac{1}{\text{VFD eff}} = \text{VFD input kW}$$

VFD efficiency = 97%

Running at 100% speed consumes 3% more energy than running without a VFD.

From your actual plant information

Power from Current Measurement

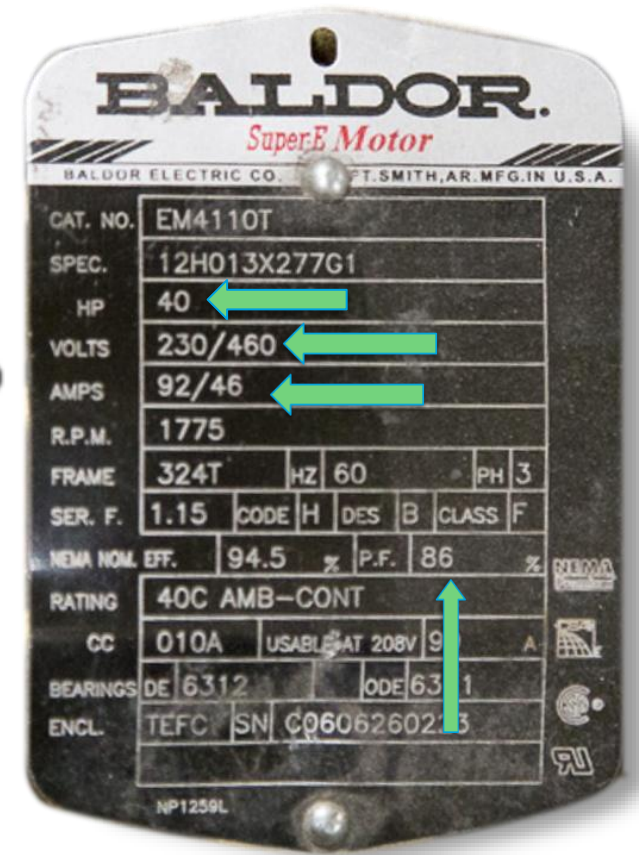
- V = system voltage, measured or assumed
- A = measured current of load
- Pf = power factor
- This is a more accurate way of estimating power using real data

Amps can be measured

- From SCADA
- Via amp reader
- Current Transducer

$$kW = \frac{\sqrt{3} \times V \times A \times pf}{1000} \text{ (3 Phase)}$$

$$kW = \frac{V \times A \times pf}{1000} \text{ (Single Phase)}$$



For Centrifugal Pump Power

$$BHP = \frac{Q * H}{39.6}$$

MotorPower

ΔHP)

η_{motor}

MotorPower

$$MotorPower(hp) \cdot \frac{0.746kW}{hp}$$

VFD efficiency



$$*Input\ motor\ kW \times \frac{1}{VFD\ eff} = VFD\ input\ kW$$

VFD efficiency = 97%

Running at 100% speed consumes 3% more energy than running without a VFD.

Estimating Energy Cost



$$\text{kWh} = \text{kW} * \text{Hours of Operation}$$

$$\text{Cost (\$)} = \text{kWh} * \$ \text{ per kWh}$$

Pressure Reduction

Booster station pumped 30 MG in June to maintain 85 PSIG line pressure.

Energy Calc:

3.14 kWh x MG x Feet = energy consumption in a perfect world

MG*Feet

$$\frac{3.14 \text{ kWh}}{\text{MG*Feet}} * 30 \text{ MG} * 85 \text{ psi} * \frac{2.31 \text{ Feet}}{\text{psi}} = 18,500 \text{ kWh in a perfect June}$$

Pressure Reduction

Booster station pumped 30 MG in June to maintain 85 PSIG line pressure.

18,500 kWh in a perfect June

Wire-to-Water efficiency is the total efficiency stack, from the grid through the pump system to the material moved.

$97\% \text{ VFD} \times 94\% \text{ motor} \times 85\% \text{ pump} = 77.5\%$

$\frac{18,500 \text{ kWh}}{0.775} = 24,000 \text{ kWh in June}$

What is the energy intensity?

$24,000 \text{ kWh} / 30 \text{ MG} = 800 \text{ kWh/MG}$

Pressure Reduction

Booster station pumped 30 MG in June to maintain **80** PSIG line pressure.

5 psi reduction * 24,000 kWh in June = 1400 kWh savings
85 psi

Leak repair

Energy intensity is 2,700 kWh/MG

Leak repair saves 60 MG/year

$$\frac{2,700 \text{ kWh}}{\text{MG}} * \frac{60 \text{ MG}}{\text{year}} = \frac{162,000 \text{ kWh}}{\text{year}}$$

Source Selection

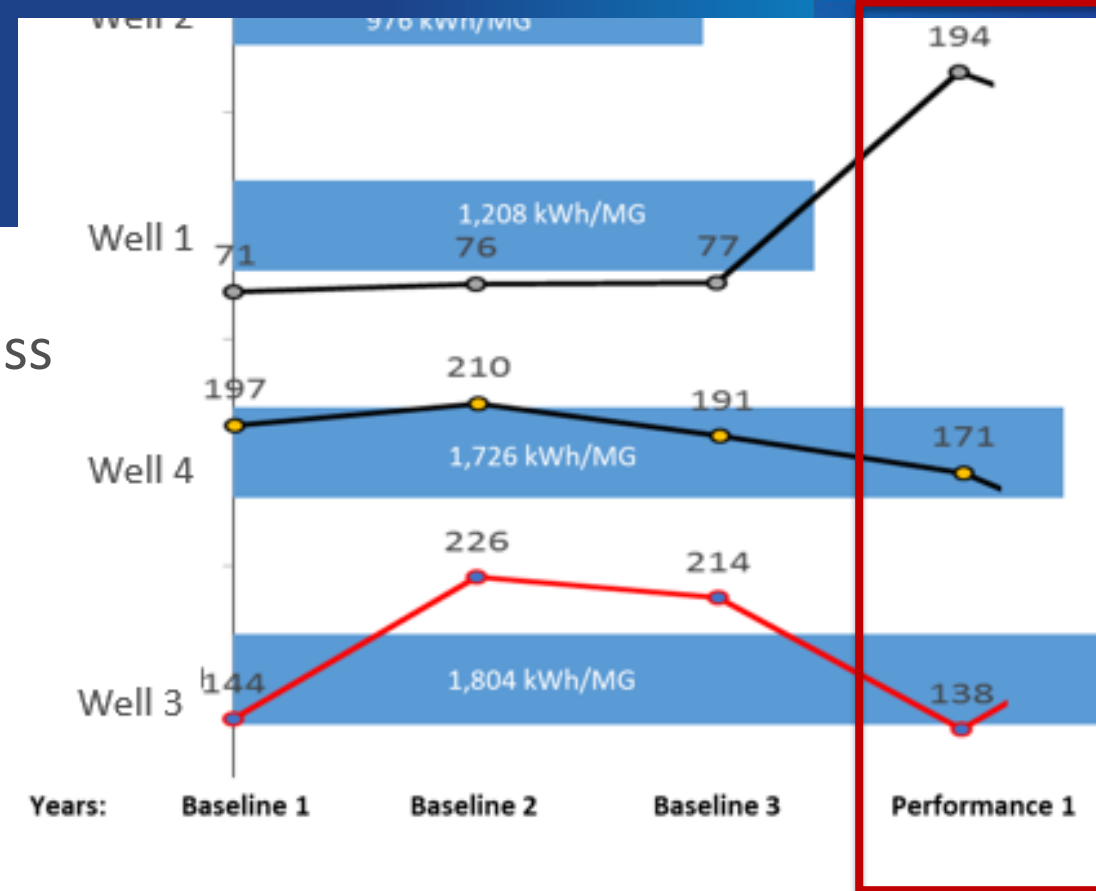
Energy savings from using Well 1 more and Well 3 less

- Reduced Well 3 by 76 MG
- Assume Well 1 produced extra 76 MG

$$\frac{1800 \text{ kWh}}{\text{MG}} - \frac{1200 \text{ kWh}}{\text{MG}} = \frac{600 \text{ kWh savings}}{\text{MG}}$$

$$\frac{600 \text{ kWh savings}}{\text{MG}} * \frac{76 \text{ MG}}{\text{MG}} = 45,600 \text{ kWh savings}$$

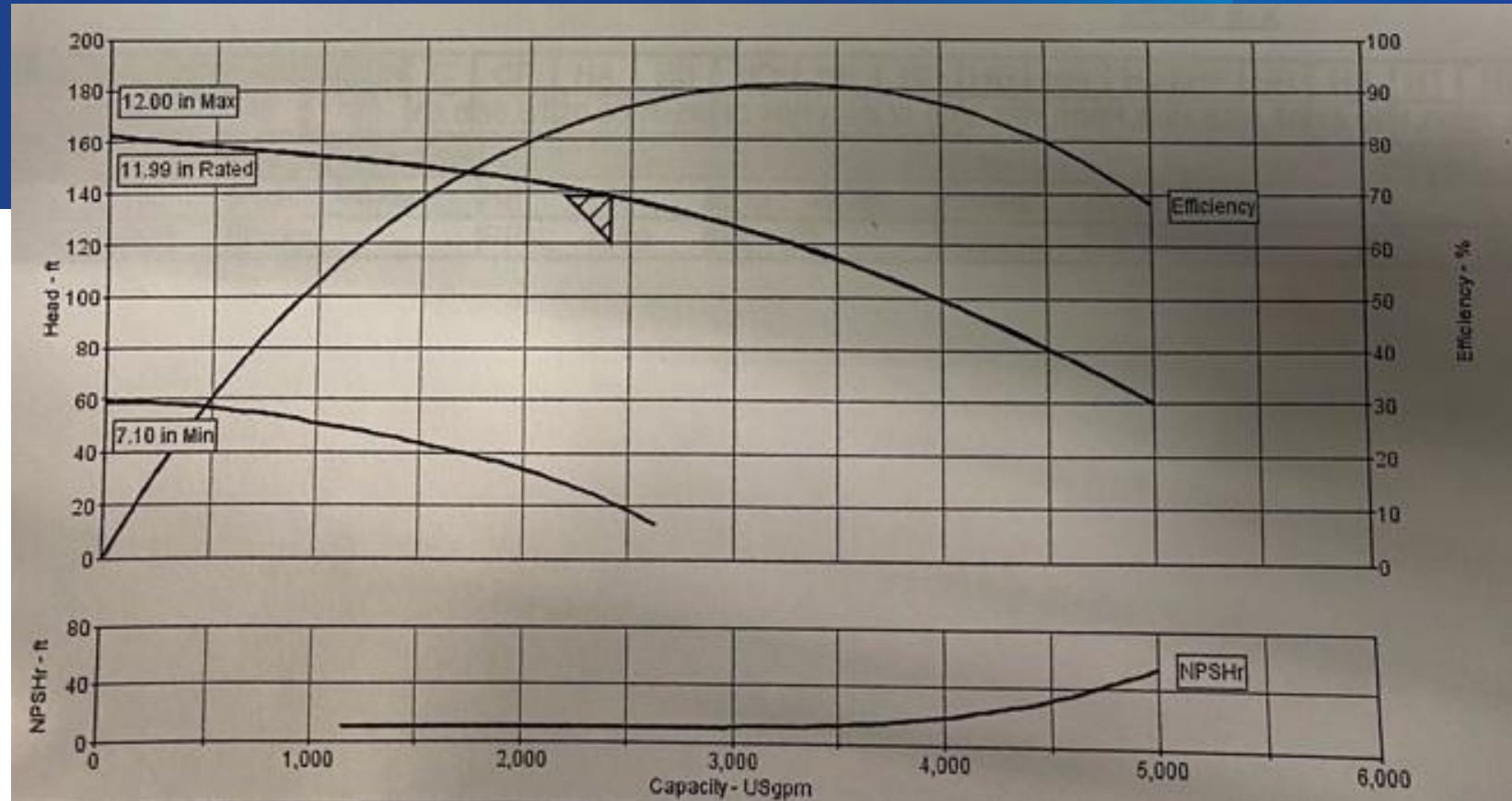
$$\frac{45,600 \text{ kWh}}{\text{year}} * \frac{\$0.10}{\text{kWh}} = \$4,560 \text{ in energy (kWh) savings}$$



Increase efficiency

$$BHP = \frac{Q * H}{3960 * \eta}$$

$$BHP = \frac{2300 * 140}{3960 * 0.85} = 96 \text{ hp}$$

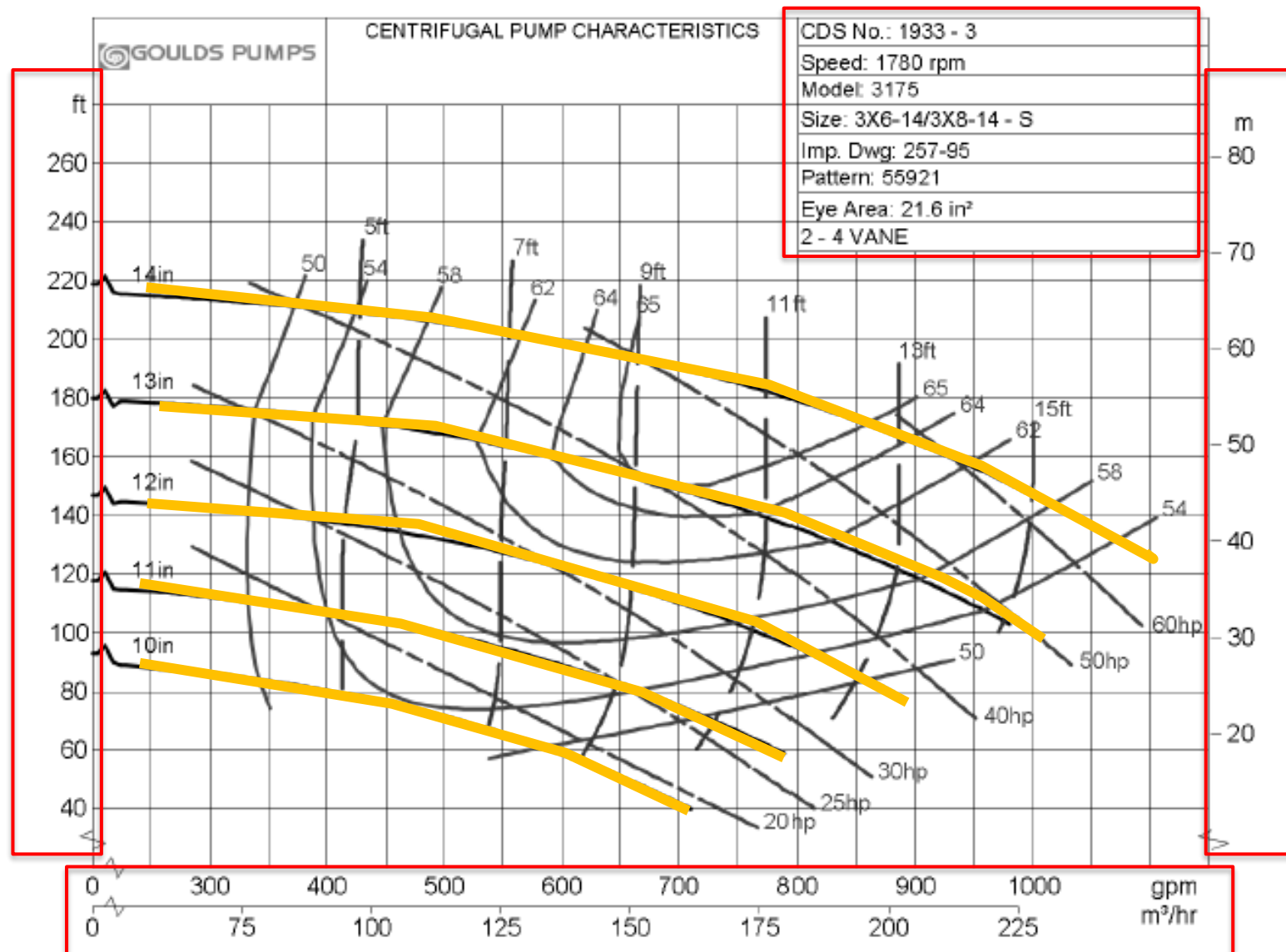


96 hp * 0.75 kW/hp / 0.93 / 0.97 * 5,000 hrs/year = 400,000 kWh/yr

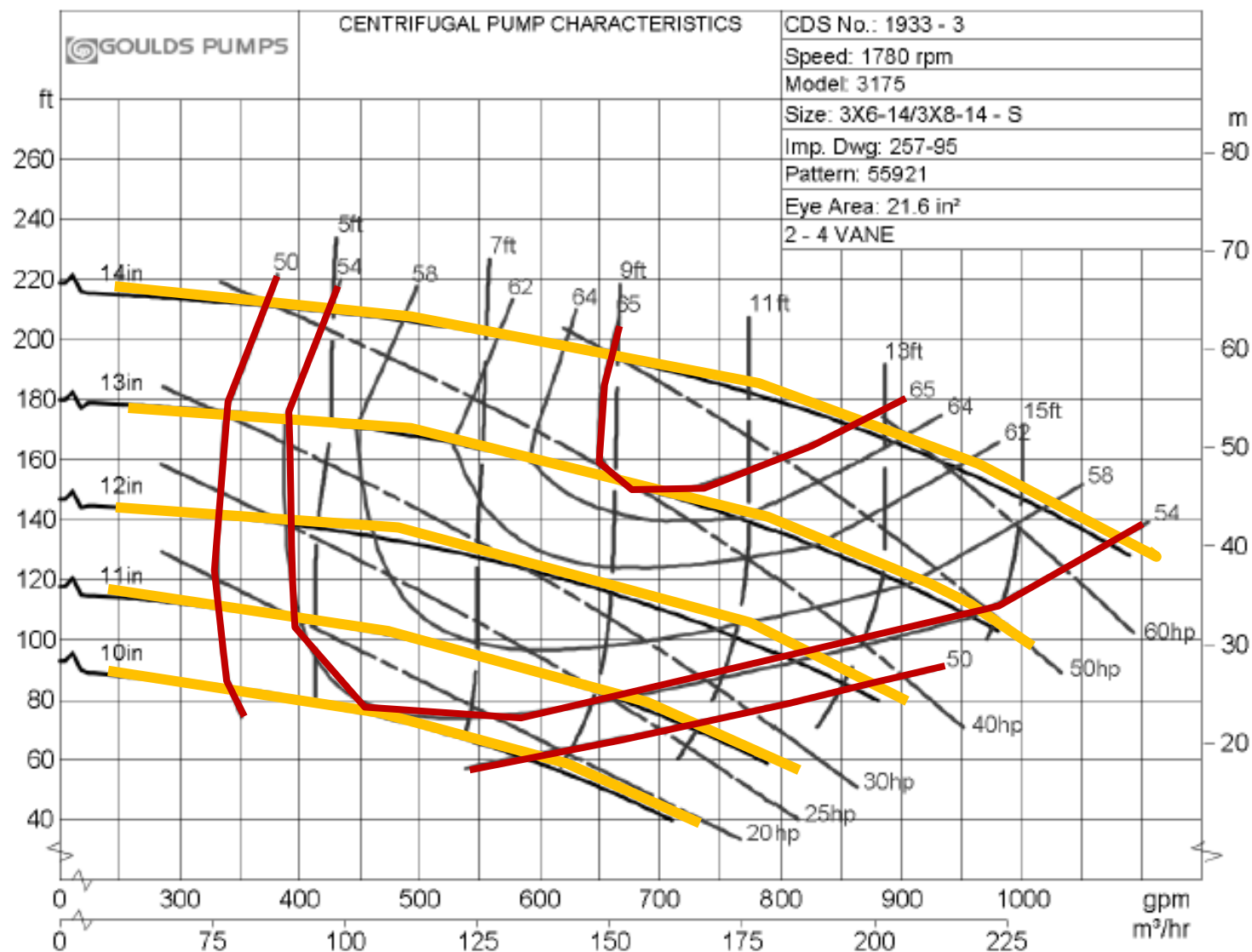
400,000 kWh/yr * 5% = 20,000 kWh/year

20,000 kWh/year * \$0.10/kWh = \$2,000/year

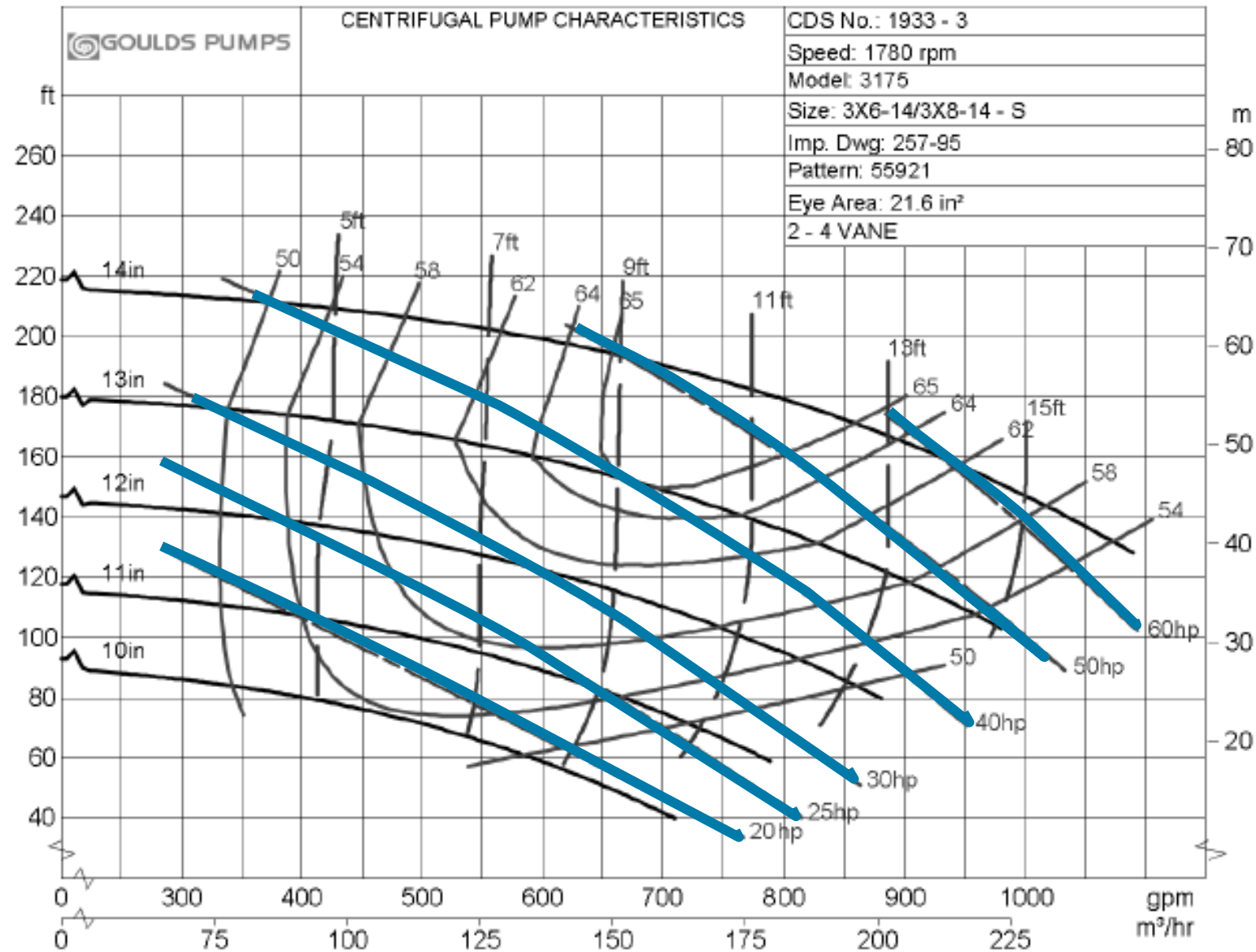
Reading Pump Curves



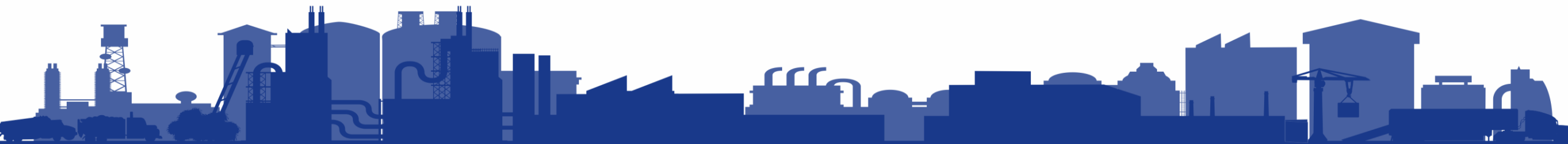
Reading Pump Curves



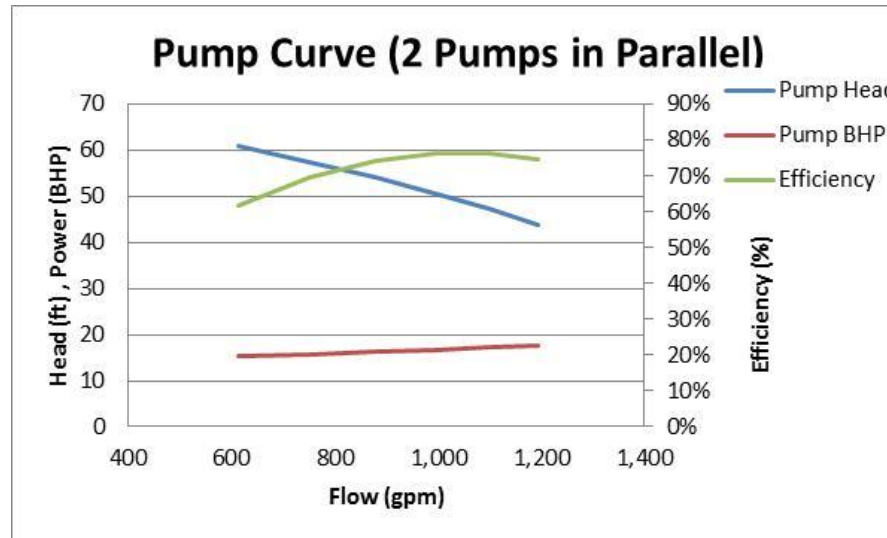
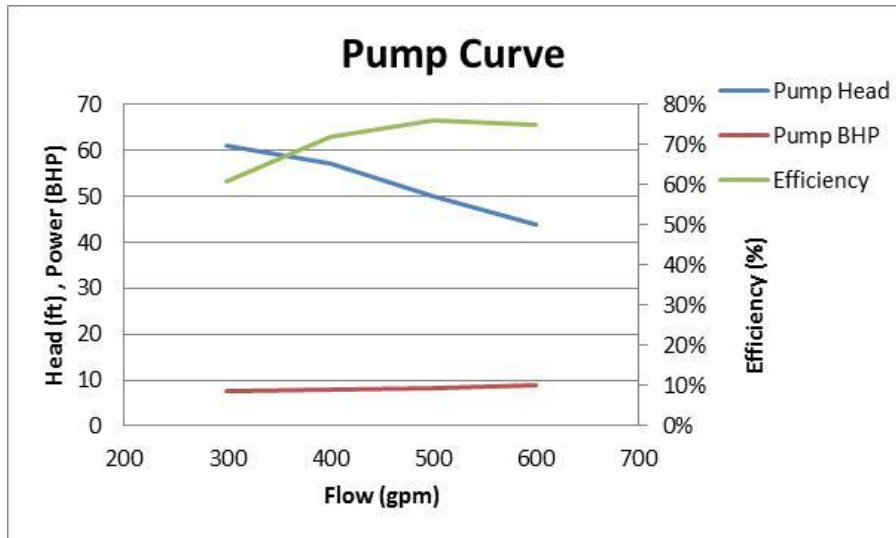
Reading Pump Curves



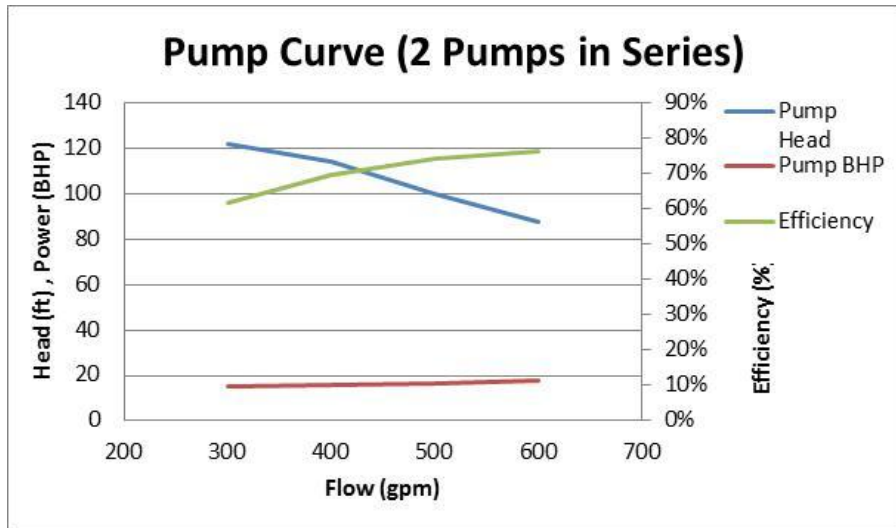
MULTIPLE PUMPS



Combining Pump Curves

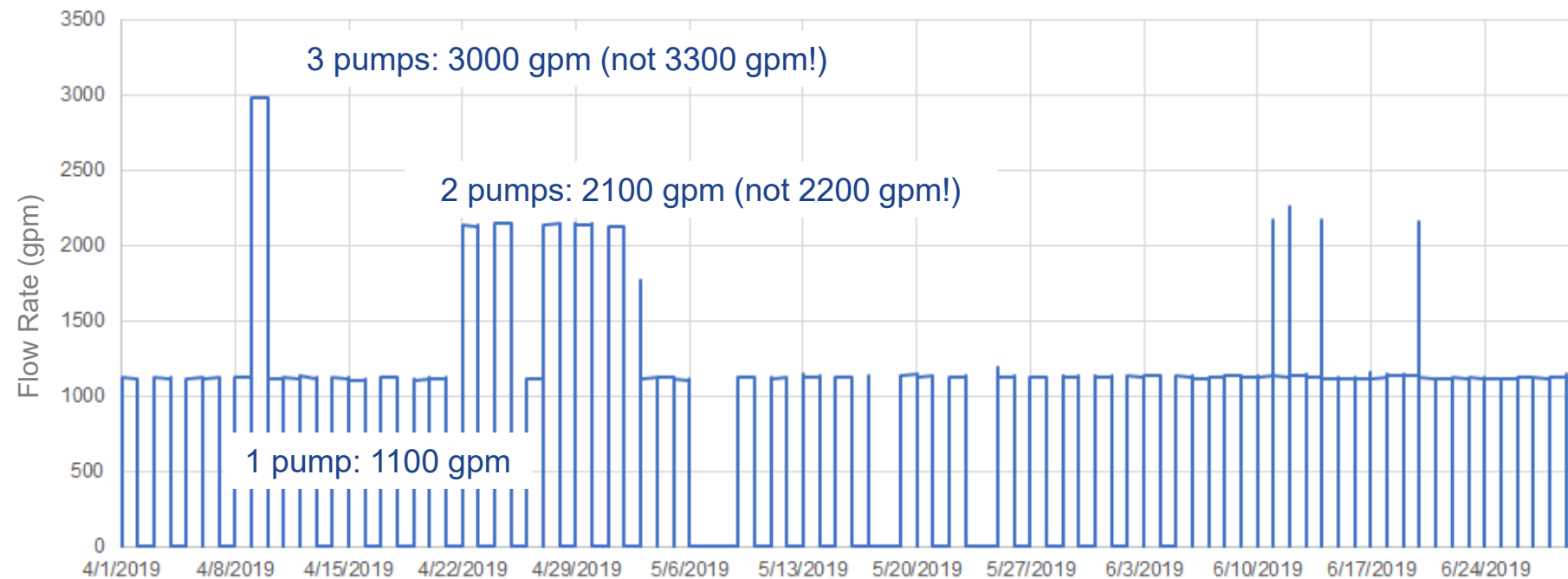


Pumps in Parallel
Add flows at same pump head...in theory.



Pumps in Series
Add pump head at same flow...in theory.

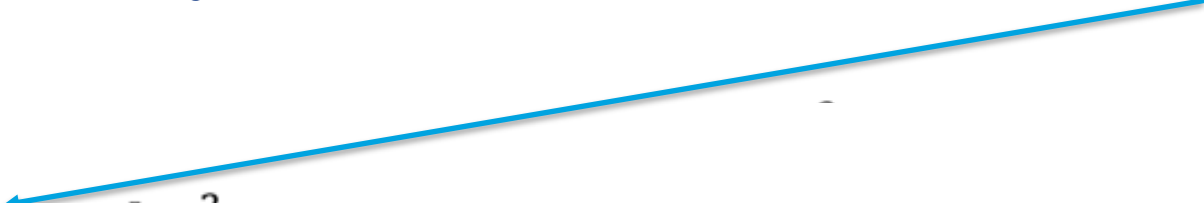
Pump Station with 3 Pumps



Why? The faster you pump, the more friction you create!

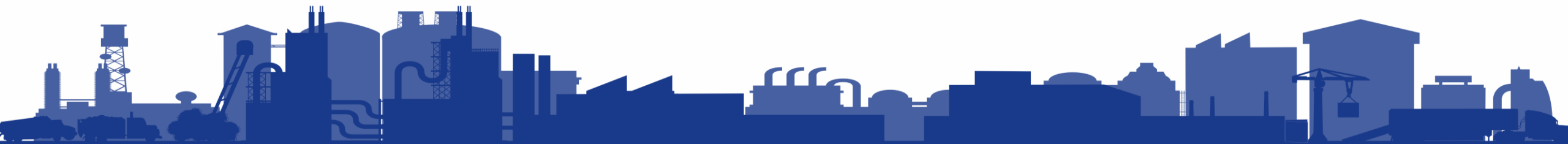
What affects head loss the most?

Total Dynamic Head = Static Head + Head Loss


$$h_L = f \frac{L}{D} \frac{v^2}{2g} =$$

Head loss is most sensitive to changes in **diameter**

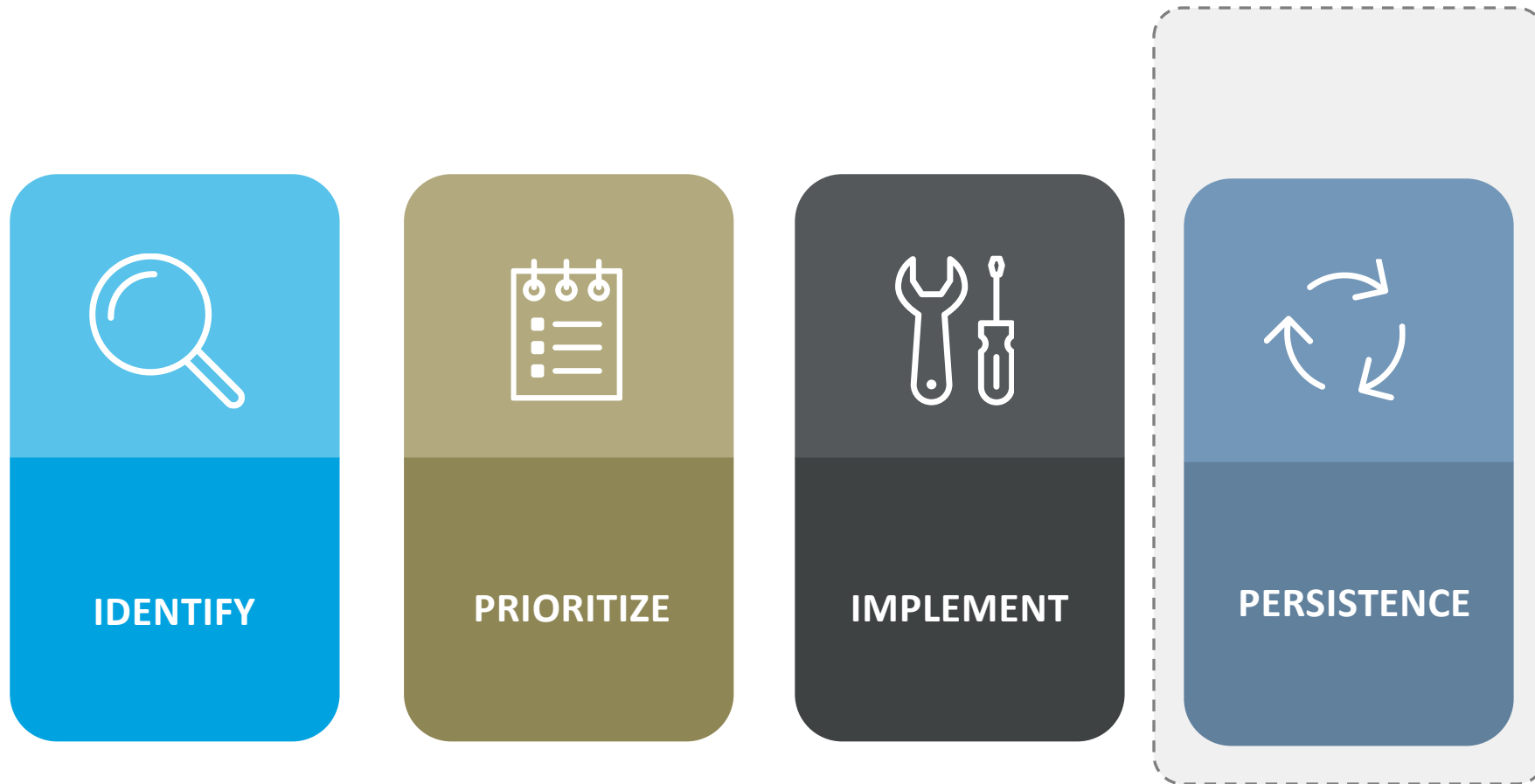
PERSISTENCE STRATEGIES



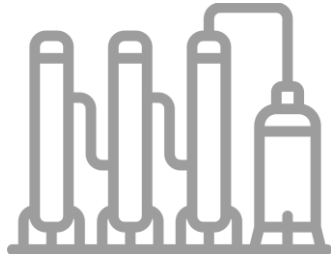
It's not just what you know, but how you practice what you know that determines how well the learning serves you later.

Peter C. Brown
Make It Stick

Energy Project Lifecycle



What could happen? Or has already happened?



New
Equipment



New
Operator



Change in
Requirements

Persistence Strategies

- Backsliding Risk level – low, medium, high
- Frequency of monitoring implemented project – weekly, monthly, quarterly, semi-annually, annually
- Implemented projects:
 - Use lowest energy intensity source most
 - Backwash based on turbidity or pressure instead of hours
 - Reduce compressed air pressure
 - Eliminate looping (redundant pumping of same water) - modify PRV settings to keep water in desired zone
 - Optimize HVAC setpoints – unoccupied spaces

3 POWER/ENERGY ESTIMATES BASED ON MOTOR HP

MOTOR HP	POWER (kW)	ANNUAL ENERGY (kWh)
0.5	0.3	2,800
1	0.6	5,500
5	3.1	27,500
10	6.3	55,000
20	12.6	110,100
50	31.4	275,200
75	47.1	412,700
100	62.8	550,300
150	94.2	825,500
200	125.6	1,100,600
250	157.1	1,375,800
300	188.5	1,650,900
500	314.1	2,751,600

Assumes

80% motor load,
95% motor efficiency,
24/7 operation.

Water System Energy **FACTS AND FIGURES**

PROBLEM	DESCRIPTION	SOLUTION
Looping	Redundant pumping of the same water. Can occur when water descends through a PRV into a lower zone and then is boosted back into the original zone.	Use hydraulic model to identify. Modify PRV settings to keep water in desired zone. Determine if pumps are appropriately sized.
Leaping	Boosting water to a higher zone than necessary and using PRVs to supply a lower zone.	Install pipeline or other facility to bypass higher zone; supply target zone directly.
Losing Head	Breaking pressure prematurely, e.g., at a spring or wholesale delivery point, when pressure could be used beneficially.	Configure system to maintain and/or reroute pressure.
Loading	Intermittent pump operation—spikes for short durations. Can occur when a facility is oversized for the current demand or when equalization storage is not used efficiently.	Implement controls to pump more consistently, install jockey pump, and/or use storage rather than pumps to meet peak demand.
Leaking	Water loss through aged pipes, loose equipment, and unmetered use. Water loss is also energy loss and revenue loss.	Invest in leak-detection equipment. Start leak-detection program and fix leaks. Use model to identify hotspots. Reduce pressure in system to minimize leaks.

1 PUMPING ENERGY CALCULATIONS

BASIC EQUATION

$$\frac{\text{GPM} \times \text{Feet}}{3960} \times \frac{1}{\text{Pump Eff}} \times \frac{1}{\text{Motor Eff}} \times 0.746 = \text{kW from utility}$$

Water HP Brake HP (or Shaft HP) Motor HP



Input HP x 0.746 = motor input kW

Include transmission loss between motor and machine if not direct coupled:

Gear box - 92-98% depending on type

V-belt - 89-95% depending on proper tension

"cogged" or "synchronous" belt - 98%

Estimating energy from nameplate data

BHP = Motor Nameplate HP x 90% (for mixers) x "% of Full Load Power"

BHP = Motor Nameplate HP x 80% (for pumps) x "% of Full Load Power"

BHP = Motor Nameplate HP x Operating Amps / Full Load Amps (FLA)

$$\frac{\text{Brake Horsepower (BHP)} \times 0.746}{\text{Motor Efficiency}} \times \text{hours} = \text{kWh}$$

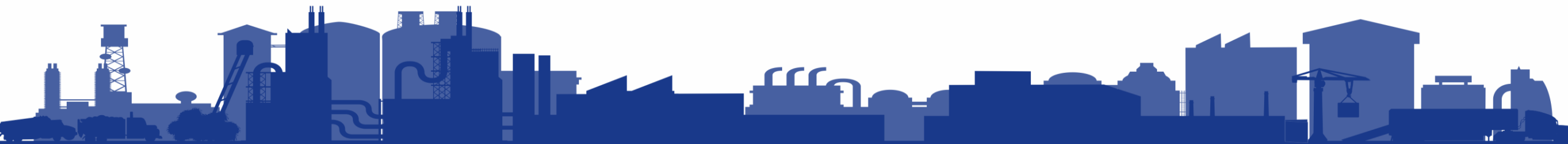
It takes 3.14 kWh to lift 1 million gallons 1 foot at 100% efficiency

Saving energy in pumping

- Reduce the head static and/or friction
- Reduce the flow pump only what is needed
- Improve equipment efficiency new equipment or better operating point

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

KAHOOT!



Takeaways

- Engage employees around energy savings
- Implement persistence strategies whenever you implement energy saving projects
- Use rough energy calculations to estimate savings
- Prepare to share next week

Closing

Questions
Comments
Discussion

Email Giulia, Katie or Mike

giulia.pollastri@cascadeenergy.com

katie@halengineers.com

mike.lewis@cascadeenergy.com

SEE YOU THURSDAY!

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