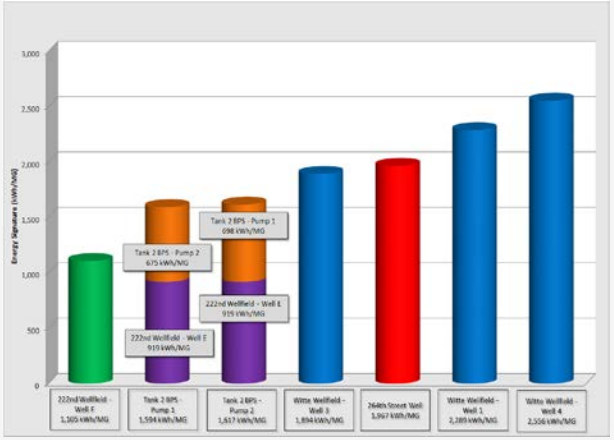
WATER SYSTEM CONTROL OPTIMIZATION



Ryan Withers, P.E.
RH2 Engineering, Inc.

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Outline

- Funded by BPA
- Analyzed 4 water systems
- Based on pump and motor field data, determined optimum control sequences for each facility

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Data Collection

- Mechanical and electrical data collected for 17 pumps and motors

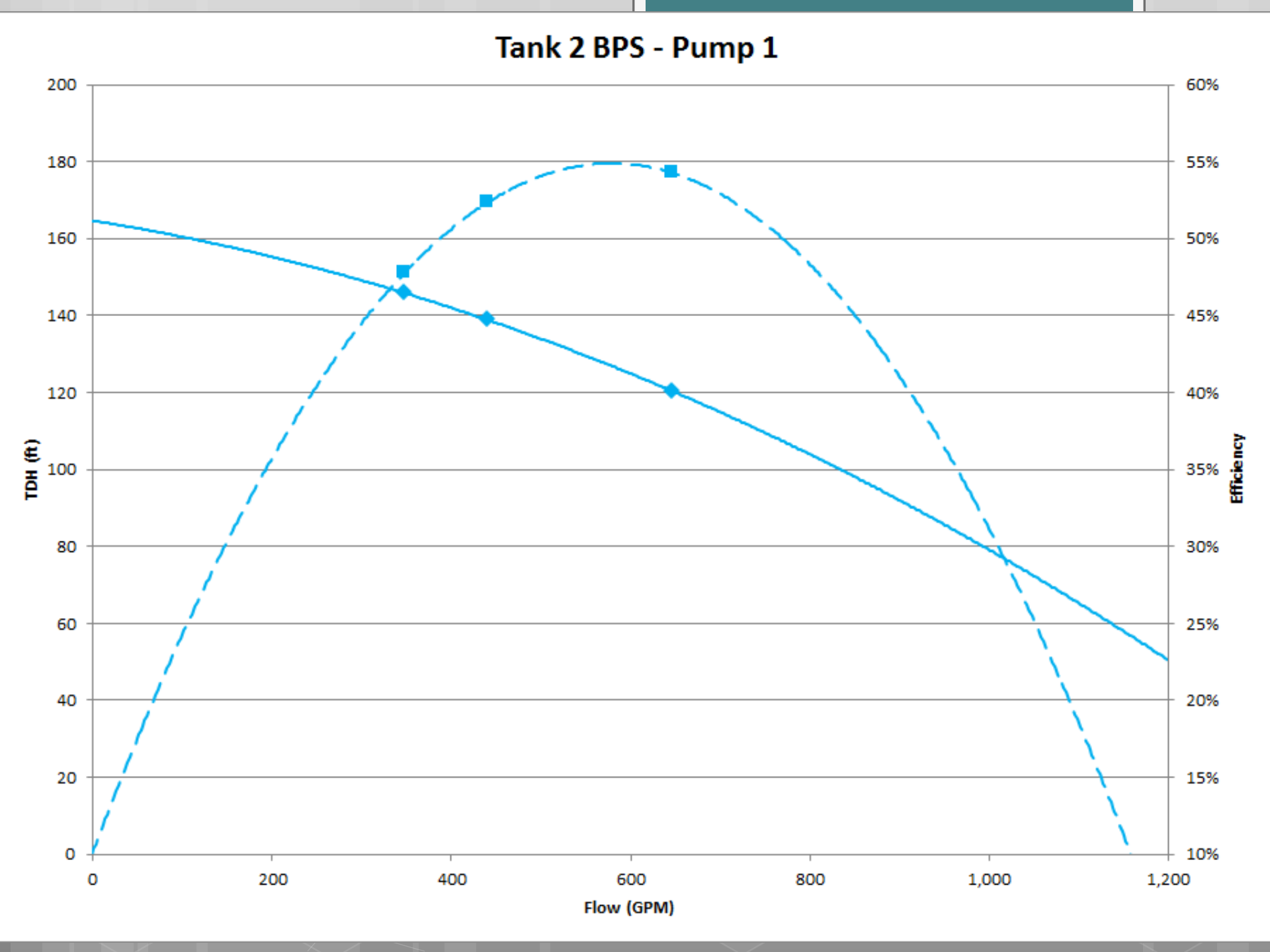

PUMP 3
HEAVY DUTY SAFETY SWITCH
INTERRUPTOR DE SEGURIDAD DE SERVICIO PESADO
DANGER / PELIGRO
DANGER / PELIGRO


ARC FLASH DANGER!
ON
OFF
ARC FLASH DANGER!
DANGER
FOREIGN / CONTROL VOLTAGE MAY BE PRESENT EVEN IF YOU TURN OFF THE MAIN BREAKER. CHECK THE VOLTAGES BEFORE YOU BEGIN WORK ON THIS UNIT.
OFF
SIEMENS


PowerSight
Power Analyzer
PS 3500

Data Analysis

- Developed pump curves
- Calculated energy signatures

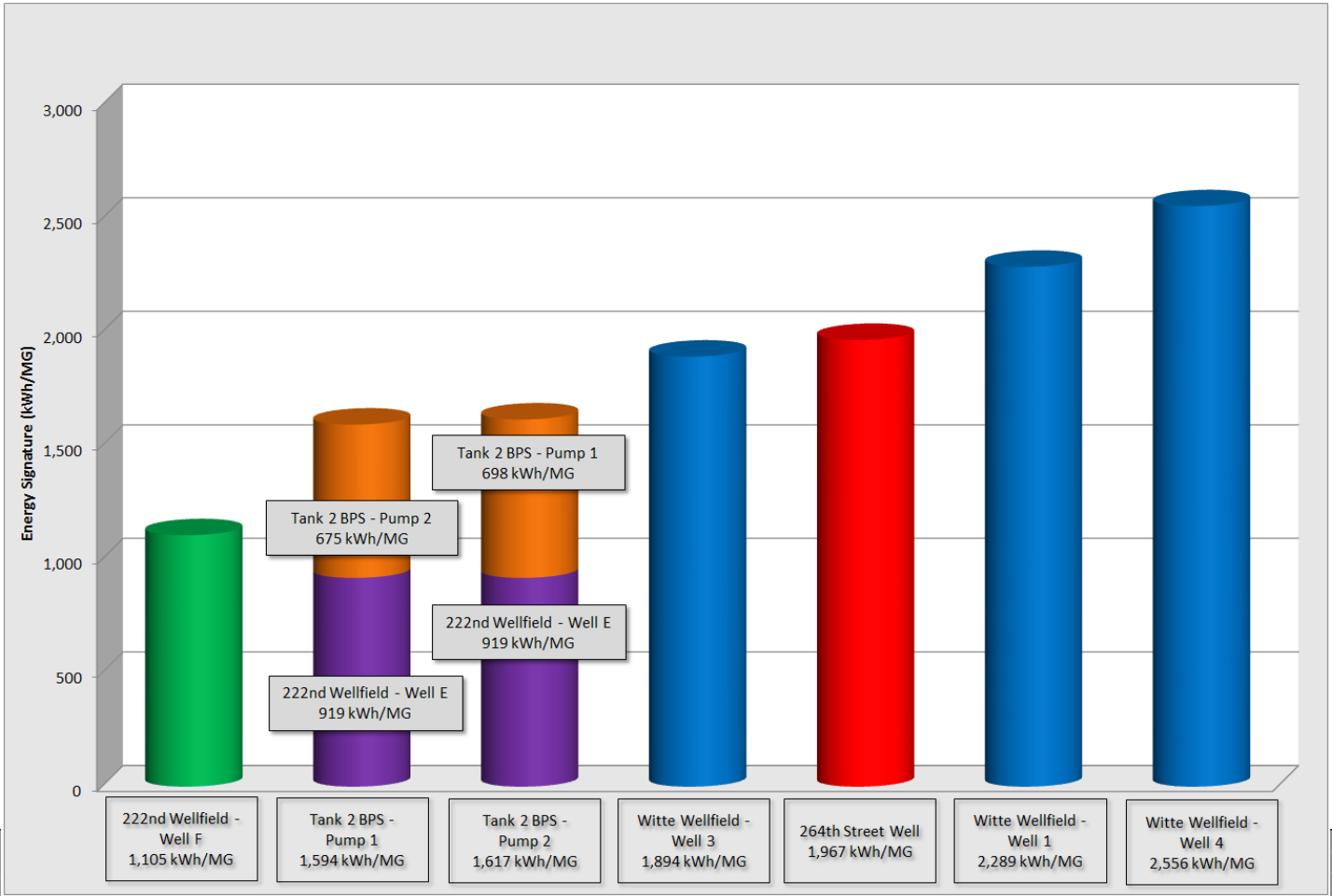

Tank 2 BPS - Pump 1
TDH (ft)
Efficiency
Flow (GPM)
200
180
160
140
120
100
80
60
40
20
0
60%
55%
50%
45%
40%
35%
30%
25%
20%
15%
10%
0
200
400
600
800
1,000
1,200

Energy Signature

- Function of:
  - System demands
  - Mechanical and electrical equipment efficiency
  - Suction and discharge pressures
  - Groundwater level (for well pumps)

Pump Sequencing

- Based on energy signature



Multiple Pump Operation

- Pumps may operate at different points on curve
- InfoWater hydraulic model used to estimate the energy signature of each pump

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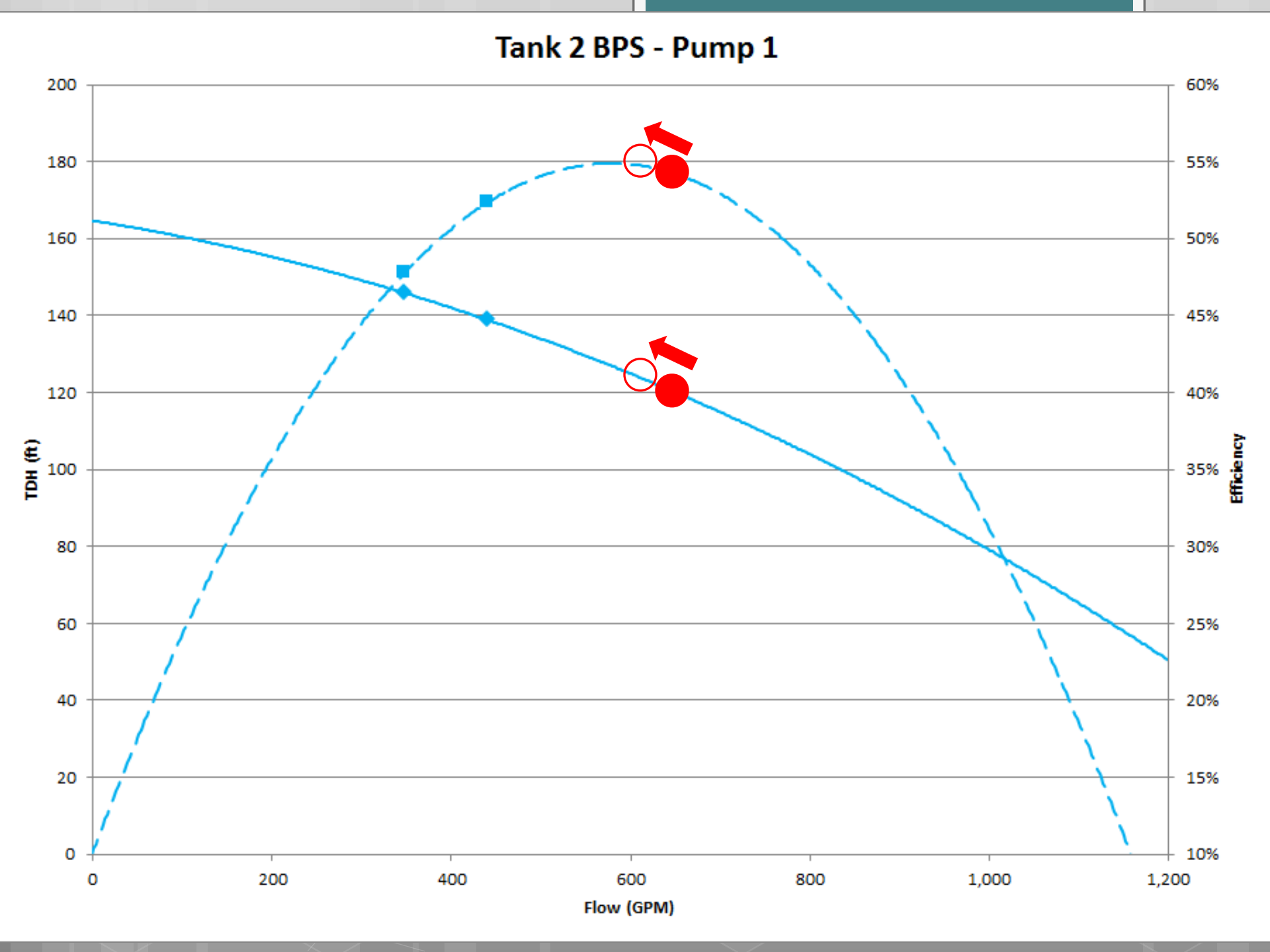
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40%
35%
30%
25%
20%
15%
10%
0
200
400
600
800
1,000
1,200

Single Pump	Energy Signature (kWh/MG)[1]	Two-Pump Combo	Energy Signature (kWh/MG)[1]
T2 - 1[1]	1,617	T2 - 1, T2 - 2	2,561
T2 - 2[1]	1,594	T2 - 1, WR 1	3,885
WR 1[2]	2,289	T2 - 1, WR 3	3,543
WR 3[2]	1,894	T2 - 1, WR 4	4,182
WR 4[2]	2,556	T2 - 1, 264	3,514
264	1,967	T2 - 1, 222 F	3,082
222 F[2]	1,105	T2 - 2, WR 1	3,857
		T2 - 2, WR 3	3,513
		T2 - 2, WR 4	4,164
		T2 - 2, 264	3,523
		T2 - 2, 222 F	3,064
		WR 1, WR 3	4,188
		WR 1, WR 4	4,816
		WR 1, 264	4,198
		WR 1, 222 F	3,715
		WR 3, WR 4	4,471
		WR 3, 264	3,834
		WR 3, 222 F	3,372
		WR 4, 264	4,465
		WR 4, 222 F	4,013
		264, 222 F	3,366

(1) The energy signatures of the Tank 2 BPS pumps include the energy signature of the 222nd Wellfield - Well E, which is required to indirectly supply the 770 Zone when the Tank 2 BPS is operating. The energy signature of the Tank 2 BPS Pump 1 is 698 kWh/MG and the energy signature of the Tank 2 BPS Pump 2 is 675 kWh/MG.

(2) The Witte Road Wellfield wells alternate as the lead supply pumps during the summer months, and the 222nd Wellfield - Well F is the lead supply pump in the winter months.

T2 Prefix = Tank 2 BPS
WR Prefix = Witte Road Wellfield
264 Prefix = 264th Street Well
222 Prefix = 222nd Place Wellfield

####	Existing pump sequence for each pump combination (see footnote 2)
####	Most efficient energy signature for each pump combination
####	Existing pump sequence and most efficient energy signature for each pump combination

System-wide Energy Savings

- Energy Efficiency Measure #1
  - Optimum pump sequencing

Description	Baseline System	Proposed System[1]	Total Savings	Percent Savings
Energy and Demand Costs ($)	$61,225	$46,708	$14,518	23.7%
Energy Consumption (kWh)	526,494	456,667	69,827	13.3%
Power Demand (kW)	3,100	1,942	1,158	37.3%
(1) Proposed system with Energy Efficiency Measure #1.				

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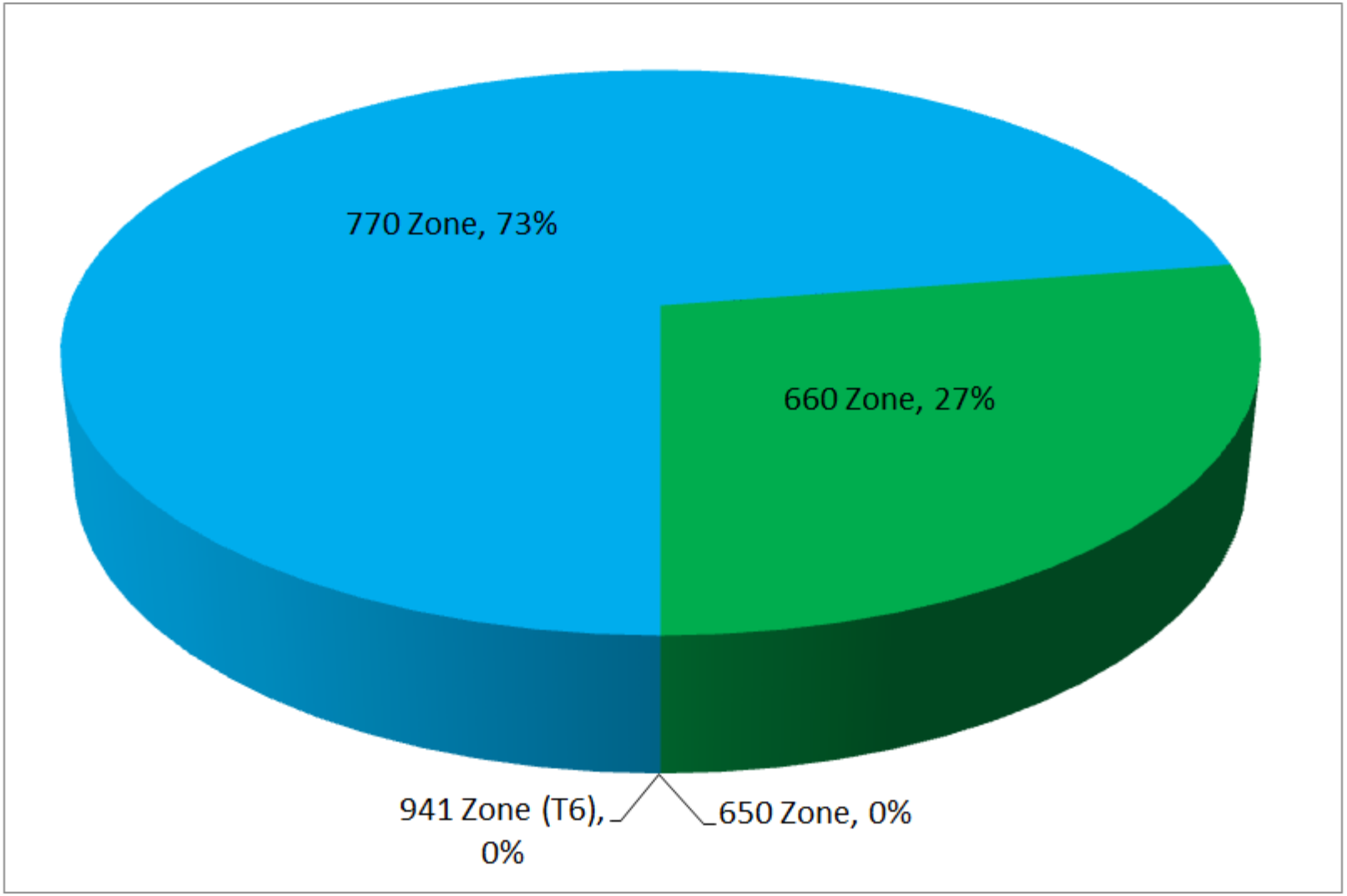
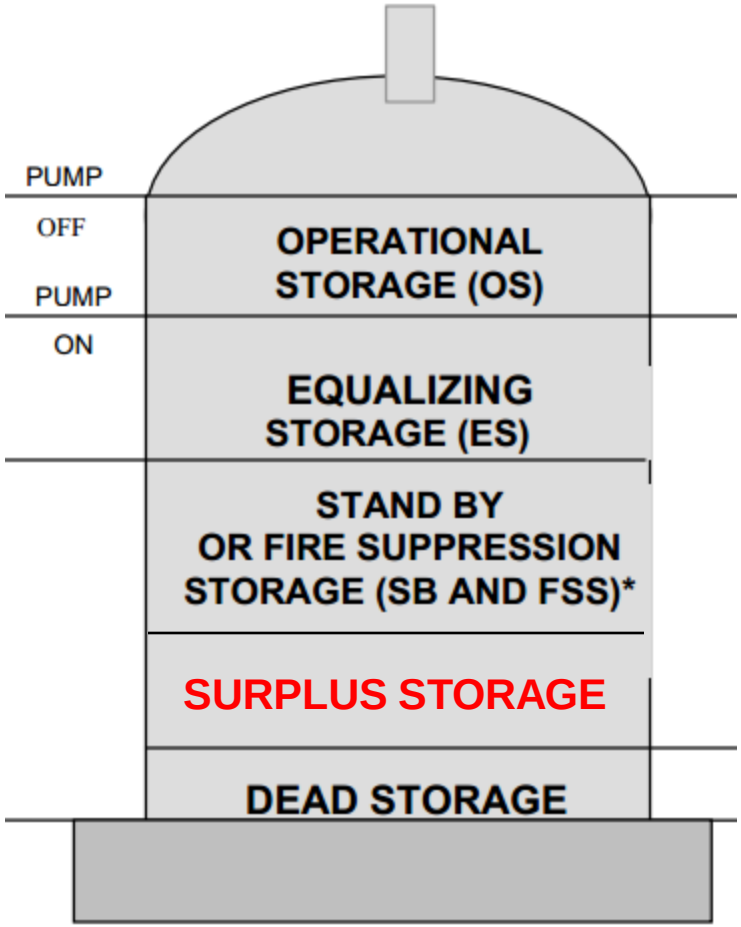
Cost Saving Measures



System-wide Energy Savings (cont.)

- Energy Efficiency Measure #2
  - Optimum pump sequencing
  - Pressure/hydraulic grade optimization

System-wide Energy Savings (cont.)



System-wide Energy Savings (cont.)

- Energy Efficiency Measure #2
  - Optimum pump sequencing
  - Pressure/hydraulic grade optimization

Description	Baseline System	Proposed System[1]	Total Savings	Percent Savings
Energy and Demand Costs ($)	$61,225	$41,975	$19,250	31.4%
Energy Consumption (kWh)	526,494	416,076	110,418	21.0%
Power Demand (kW)	3,100	1,615	1,485	47.9%
(1) Proposed system with Energy Efficiency Measures #1 and #2.				

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Implementation

3 options

1. Manual sequencing
2. SCADA and PLCs estimate energy signatures and optimum sequences
3. SCADA and PLCs monitor actual real-time energy signatures

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Implementation

1. Manual Sequencing

- No cost
- Operators can change lead/lag pumps in existing SCADA system
- Energy signatures not monitored
- Possibility for sequences to be changed to less efficient scenarios over time

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Implementation

2. Estimating Energy Signatures

- $4,000 per pump and motor combination
- Energy signatures estimated by the PLC
  - If flow, suction, and discharge pressures are monitored by the SCADA system
  - Estimate based on field data used in this study
  - Update the HMI at each PLC

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Implementation

3. Actual Real-Time Energy Signatures

- $6,000 per pump and motor combination
- Connect sensors to the 3 power phases to monitor power data digitally
- Communication to the PLC via a serial connection

Implementation

3. Actual Real-Time Energy Signatures (cont.)

- Energy signatures vary based on system conditions
- Monitor pump or motor over time to see if it is in need of maintenance or overhaul prior to failure

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Implementation

3. Actual Real-Time Energy Signatures (cont.)

- Simple payback
  - 6 years

    OR
  - 4 years with PSE incentive
    - Only receive incentive with real-time monitoring

Projected Annual Energy Savings

- Organization A: 9.1%
- Organization B: 8.7%
- Organization C: 13.3%
- Organization D: 7.5%

Questions?

Ryan Withers, P.E.
RH2 Engineering, Inc.
rwithers@rh2.com
425.951.5334