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# WATER DISTRIBUTION SYSTEM PRESSURE MANAGEMENT

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# PRESSURE OPTIMIZATION

- Water loss through cracked water main
- ½ - inch diameter hole in pressurized water main
- Bernoulli's Equation

$$\frac{P_1}{\gamma} + z_1 + \frac{V_1^2}{2g} = \frac{P_2}{\gamma} + z_2 + \frac{V_2^2}{2g}$$

$$Q = c_d A\sqrt{(2g)(H)}$$

# PRESSURE OPTIMIZATION

- Q = 54 gpm at 105 psi
- Q = 52 gpm at 100 psi
- 2 gpm difference
  - 2,800 gallons per day
  - 1.05 MG per year

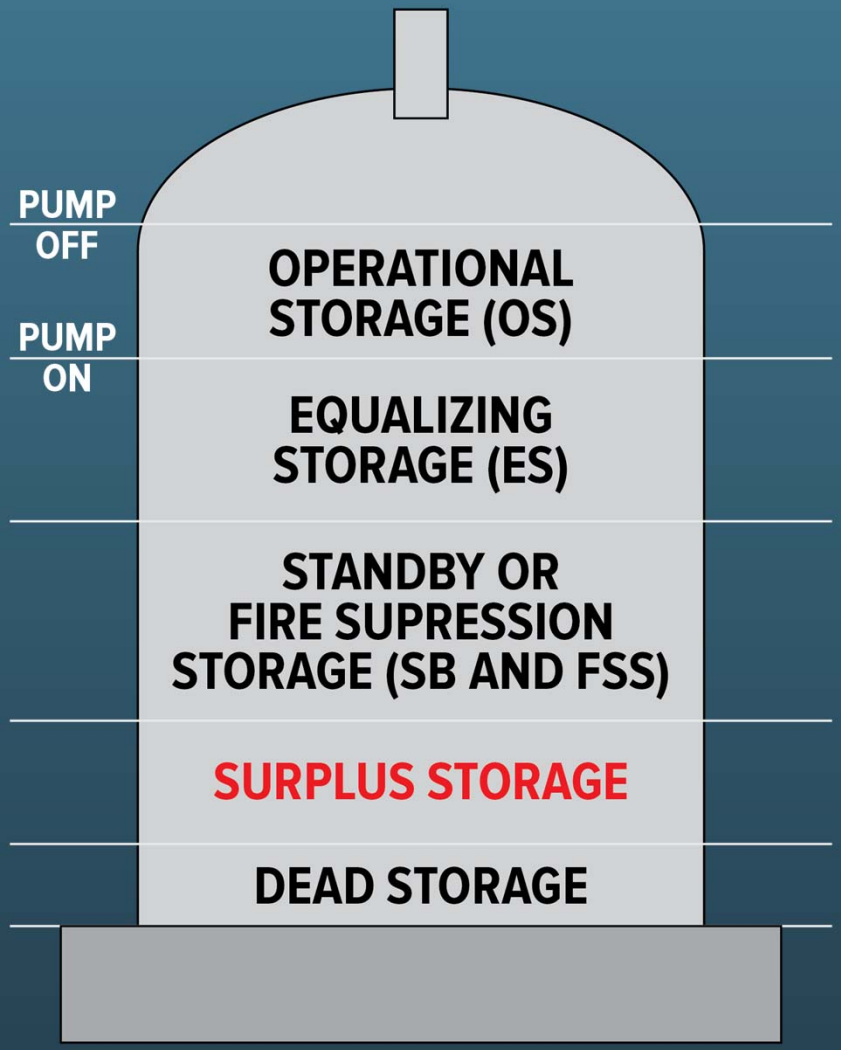
# FACILITY SET POINTS

- How are pump set points determined?
- How are reservoir fill and draw levels determined?

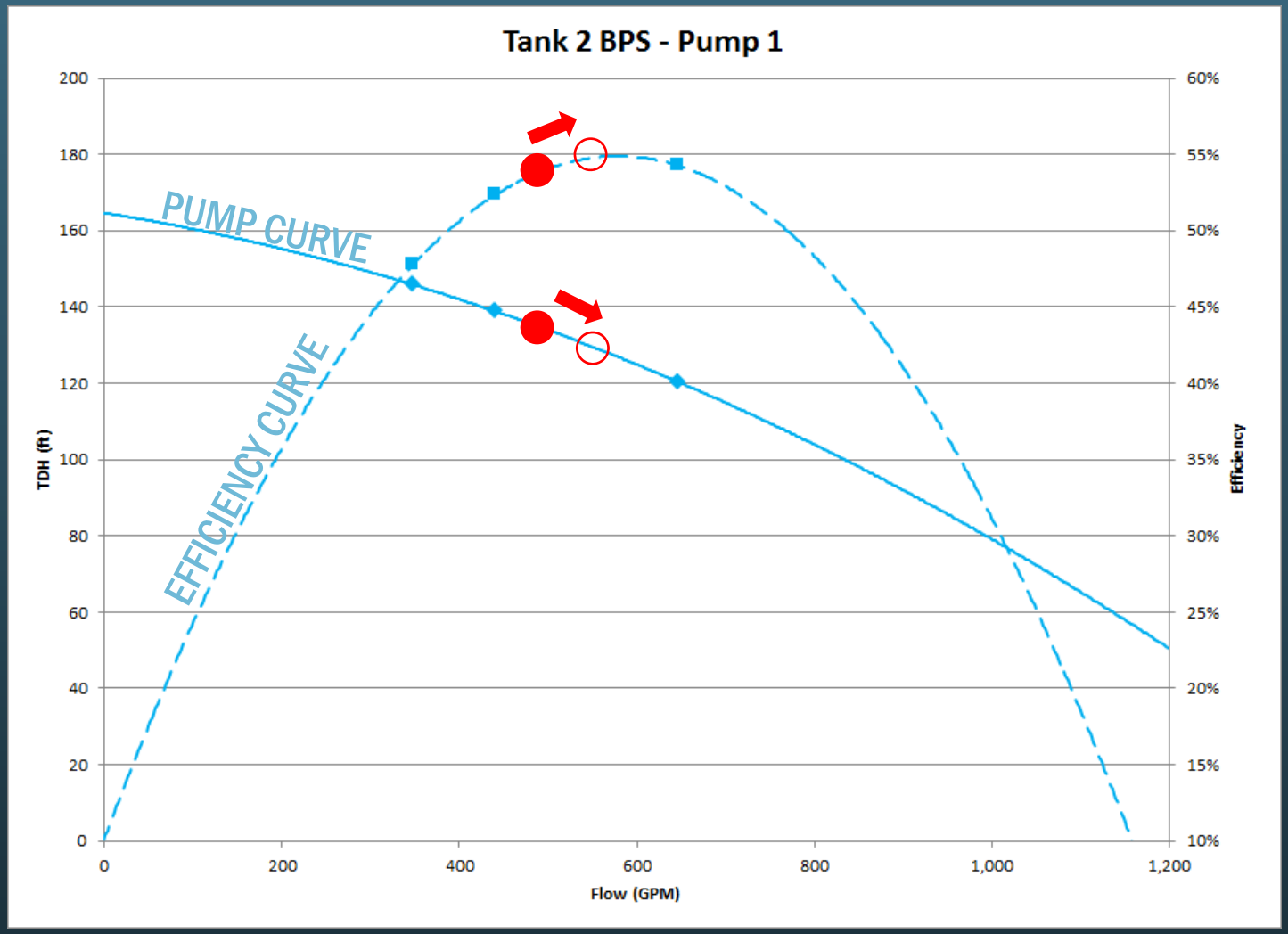
# BONNEVILLE POWER ADMINISTRATION STUDY

- Grant funding provided by Bonneville Power Administration
- Studied 4 water systems of various sizes
- Visited 87 sites
- Collected data and evaluated 170 different pumps

# PRESSURE OPTIMIZATION



# PUMP CURVE ANALYSIS



# POWER BILL ANALYSIS

# SUMMER 2006 AND 2007 BILLING COMPARISON

| | Summer 2006 | | Summer 2007 | |
|---|---|---|---|---|
| Customer Charge | | $ 24.90 | | $ 27.20 |
| Energy Charge | 20,000 KWHS @ $.068036 Per KWH | $ 1,360.72 | 20,000 KWHS @ $.074782 Per KWH | $ 1,495.64 |
| Energy Charge | 116,600 KWHS @ $.054888 Per KWH | $ 6,399.94 | 93,760 KWHS @ $.060754 Per KWH | $ 5,696.30 |
| Demand Charge | 50 KW @ $.00 Per KW | $ 0.00 | 50 KW @ $.00 Per KW | $ 0.00 |
| Demand Charge | 159.28 KW @ $5.24 Per KW | $ 834.63 | 155.44 KW @ $5.54 Per KW | $ 861.14 |
| Reactive Power Charge | 66,360 KVRH @ $.00253 Per KVRH | $ 167.89 | 46,400 KVRH @ $.00265 Per KVRH | $ 122.96 |
| Electric Conservation Program Charge | 136,600 KWHS @ $.001406 Per KWH | $ 192.06 | 136,600 KWHS @ $.001406 Per KWH | $ 190.89 |
| Power Cost Adjustment | 136,600 KWHS @ $.008066 Per KWH | $ 1,101.82 | 113,760 KWHS @ $.00 Per KWH | $ 0.00 |
| Wind Power Production Credit | 136,600 KWHS @ $.000650CR Per KWH | $ 88.79CR | 113,760 KWHS @ $.001415CR Per KWH | $ 160.97CR |
| **Current Electricity Charges** | | $ 9,993.17 | | $ 8,233.16 |

# RH2'S EVALUATION

RH2 analyzed the existing Asbestos Cement pipe to determine true condition and load carrying capacity.

# CONSTRUCTION EQUIPMENT LOADS

**Caterpillar 14M Motor Grader**
http://www.cat.com/cmms/images/C201836.pdf

Has 6 tires (1 tandem rear axle, 1 front axle)

| | Max Gross Vehicle Weight | | |
|---|---|---|---|
| Total | 65,998 lbs. | | |
| Front Axle | 21,912 lbs. | **Front Axle Single Wheel Load =** | **10,956 lbs.** |
| Tandem Rear Axle | 44,086 lbs. | **Tandem Single Wheel Load =** | **11,022 lbs.** |
| Tandem Axle Wheelbase | 65 in. | | |
| Front Tires to Rear Axle Wheelbase | 258 in. | | |
| Width between Tire Center Lines | 93 in. | | |

**Caterpillar 385C L Hydraulic Excavator**
http://www.cat.com/cmms/images/C400866.pdf

Has 2 tracks

| | | | |
|---|---|---|---|
| Approx. Operating Weight | 192,000 lbs. | | |
| Ground Track Length | 16.83 ft. | **Track Load =** | **5,704 lbs./ft. track length** |
| Track Width | 30 in. | | |
| Width between Track Center Lines | 9 ft. | | |

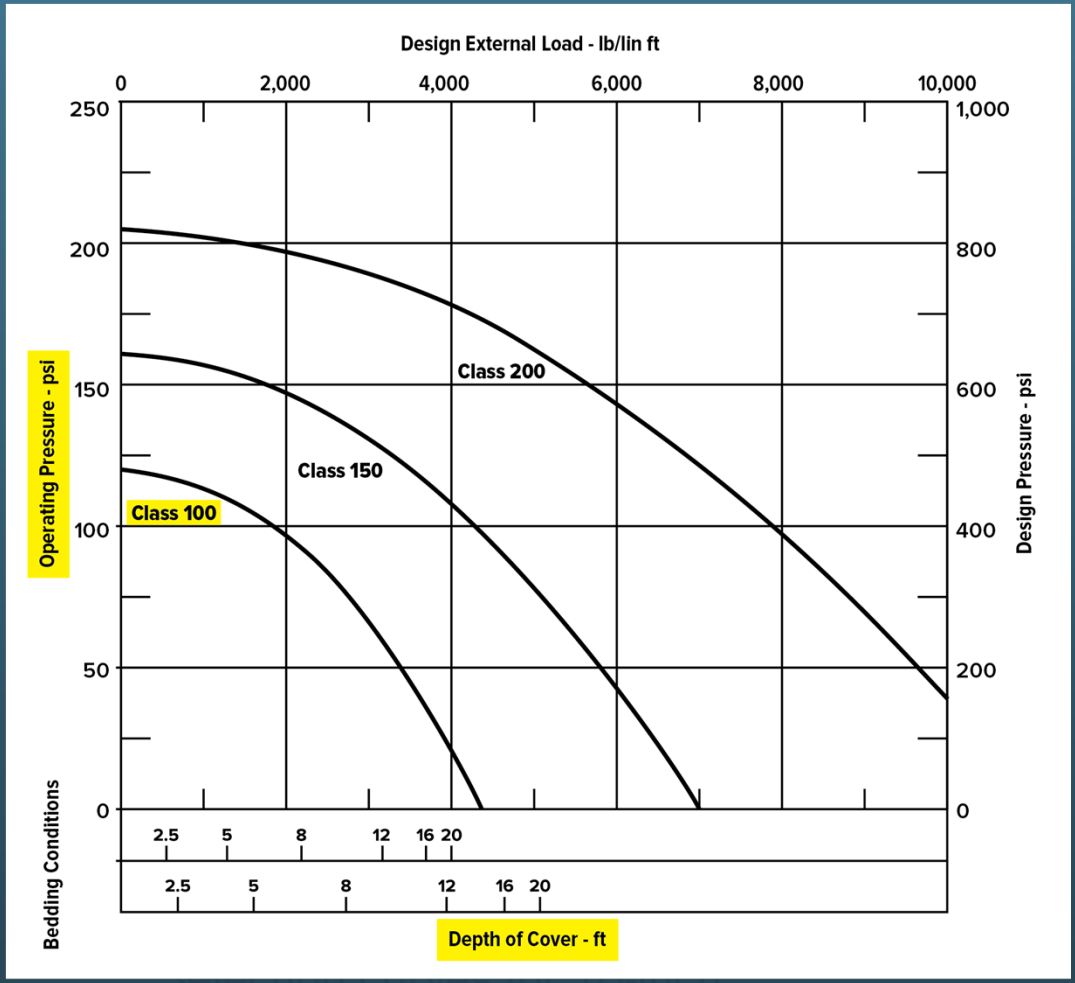
# DESIGN EXTERNAL LOAD LIMITS

| Pg. 23 AWWA C401-93 - Figure 14B<br>6" Class 100 AC Pipe | | | |
|---|---|---|---|
| Operating Water Pressure: | | | 100 psi |
| Reduced Water Pressure (1): | | | 60 psi |
| Reduced Water Pressure (2): | | | 40 psi |
| Design External Load Limits (lbs. per lineal ft. of pipe): | | | |
| At operating pressure | At 60 psi pressure | At 40 psi pressure | No water in pipe |
| 1,150 | 2,600 | 3,150 | 4,000 |

| Pg. 24 AWWA C401-93 - Figure 14C<br>8" Class 100 AC Pipe | | | |
|---|---|---|---|
| Operating Water Pressure: | | | 100 psi |
| Reduced Water Pressure (1): | | | 60 psi |
| Reduced Water Pressure (2): | | | 40 psi |
| Design External Load Limits (lbs. per lineal ft. of pipe): | | | |
| At operating pressure | At 60 psi pressure | At 40 psi pressure | No water in pipe |
| 1,500 | 2,800 | 3,200 | 4,000 |

| Pg. 25 AWWA C401-93 - Figure 14D<br>10" Class 100 AC Pipe | | | |
|---|---|---|---|
| Operating Water Pressure: | | | 100 psi |
| Reduced Water Pressure (1): | | | 60 psi |
| Reduced Water Pressure (2): | | | 40 psi |
| Design External Load Limits (lbs. per lineal ft. of pipe): | | | |
| At operating pressure | At 60 psi pressure | At 40 psi pressure | No water in pipe |
| 1,900 | 3,100 | 3,600 | 4,400 |

# LOAD BEARING CAPACITY




Conclusion: Some pipes were overloaded and had to be replaced.

# TECHNIQUES

Initiating pressure management techniques in your system

- Start small – focus on one pressure zone
- Review pressure and fire flow requirements in zone
- Closed zones
  - Perform hydraulic analyses
- Zones with storage
  - Perform storage analysis calculations and hydraulic analyses
- Adjust pump set points in small increments, preferably starting during low demand periods (typically night) to reduce system pressures

# SUMMARY

- Small pressure reductions are a cost effective method to reduce water loss
- Pressure management can reduce the potential for AC main breaks
- Pressure management can reduce pumping and treatment costs

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# QUESTIONS?