Often Overlooked - Lessons from WWTP Non-Potable Water Model

Darin Wise, Columbus SWWTP
Dante Fiorino, Brown and Caldwell
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Non-Potable Water

- Treated effluent water
- Pumped from Effluent Pump Station
- Used for process demands
- Used for flushing lines and tanks
- Used for sampling, other misc.
- NOT used for drinking

Don’t drink the water!!!
Existing System

Darin Wise, Southerly WWTP
Existing System

Legend
Pipe
DIAMETER
- <= 8-in
- 12-in
- 16-in
- 20-in
- Other Pipes

Effluent Pumping Station
**Effluent Pump Station**

- 4 vertical turbine pumps with 3,250 gpm capacity, 250 hp motor
- Firm capacity of 9,750 gpm (3 in service + 1 redundant)
- Operated at a pressure of 84 psi
- Controlled by a local control panel and driven by an adjustable frequency drive (AFD)
- Minimum speed of 80%
Existing Demand

Total Flushing Demand vs. Percentile Rank (3/18/15 - 6/1/15)

- Maximum Flow (100%) 4,265 gpm
- Typical Peak (90%) 2,475 gpm
- Average Flow (50%) 1,805 gpm
- Typical Base (10%) 1,375 gpm
Major Process Demands
SCADA Monitored Locations
Existing Demand Distribution

- Gravity Thickener, 500
- Thickening/Digesters, 225
- Grit Tanks, 200
- Other, 250
- Sodium Bisulfite, 850 gpm
- Aerators, 120
- Screens, 30
- Misc., 100

Assumed Flows
Evaluation Goals

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Purpose

- Planned CEPT projects will:
  - Increase demand on existing processes
  - Add new demands
  - Add new mains and hydrants

- A calibrated hydraulic model can:
  - Analyze existing system
  - Assess ability to meet future demands
  - Address existing concerns
Southerly in Transition

- Shutdown Incinerators
- BLAF
- CEPT
- Digester 7
Pump Station Capacity
System Pressure

• Controlled by 84 psi pressure set point
• Based on abandoned incinerator requirements
• Evaluate lowering set point for current demands
• Would save energy and pump maintenance
Pump Cycling

- Pumps frequently cycle on and off
- Operating at low speed on the AFD controlled range
- Undesirable timers built into ‘Pump Director’
- Causes poor operability and increased maintenance
Future Planning Impacts

- CEPT / BLAF connections
- New Gravity Thickener Tank
- Sodium Bisulfite Carrier Water
- Digester Process Water
Model Development

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Model Development

- InfoWater hydraulic modeling platform
- GIS water network from CAD drawings
- Process demands where they connect to system
Goal: obtain field data on current system operations for calibration

- Typical system operation
  - 8 pressure sensors (4 temp)
  - 5 flow meters (4 temp)
  - 1 week period
- Hydraulic stress test
  - High flow scenario
  - Use yard hydrants
- Pump curve testing
Monitoring Locations

[Diagram showing monitoring locations with labels for thickening pressure, gravity thickener dilution flow, flow metering chamber, effluent pumping station pressure, grit hopper flow meters, screen pressure, and legend for pipe diameters.]
Hydraulic Stress Test

Test #3 Thickening
3,625 gpm

Test #4 Gravity Thickener
5,050 gpm

Test #1 Grit Tanks
2,525 GPM

Test #2 E Primary
1,525 gpm

Legend
Pipe
DIAMETER
- <= 8-in
- 12-in
- 18-in
- 20-in
- Other Pipes
Model Calibration

- Steady-state calibration
  - Adjust assumed C-factors
  - Match pressure observed losses
- Extended period simulation
  - Evaluate pressure and flow trends
  - Identify peak conditions
- Within 2 psi at all monitored locations

Non-Potable Water Strainer
## Test Results

<table>
<thead>
<tr>
<th>Test</th>
<th>Location</th>
<th>Pre Flow (gpm)</th>
<th>Test Flow (gpm)</th>
<th>Demand (gpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test #1</td>
<td>Grit Tanks</td>
<td>1,775</td>
<td>4,300</td>
<td>2,525</td>
</tr>
<tr>
<td>Test #2</td>
<td>East Primary</td>
<td>1,525</td>
<td>3,050</td>
<td>1,525</td>
</tr>
<tr>
<td>Test #3</td>
<td>Thickening Facility</td>
<td>1,350</td>
<td>5,025</td>
<td>3,675</td>
</tr>
<tr>
<td>Test #4</td>
<td>Gravity Thickener</td>
<td>2,000</td>
<td>7,050</td>
<td>4,800</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test</th>
<th>Critical PM</th>
<th>P Drop (psi)</th>
<th>Actual P (psi)</th>
<th>Model P (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test #1</td>
<td>PM6 – RSP</td>
<td>28.2</td>
<td>64.3</td>
<td>64.3</td>
</tr>
<tr>
<td>Test #2</td>
<td>PM7 – EPC</td>
<td>9.3</td>
<td>82.1</td>
<td>81.9</td>
</tr>
<tr>
<td>Test #3</td>
<td>PM3 – CPC</td>
<td>10</td>
<td>86.8</td>
<td>88.5</td>
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<tr>
<td>Test #4</td>
<td>PM2 – SCB</td>
<td>13.2</td>
<td>79.3</td>
<td>81.1</td>
</tr>
</tbody>
</table>
Model Analysis

Once the model is calibrated it was used to review capacity and performance:

- System deficiencies in available pressure or flow
- Capacity to support future process demands
- Evaluation of operational or physical changes to mitigate deficiencies

Non-Potable Water Header
Model Determinations

- **Grit Tanks** Q = 200 gpm
- **Fine Screens** Q = 30 gpm
- **12-in main does not exist**
- **Aeration Train West > Center > East**
- **Blowers** Q = 120 gpm
- **Valve closed on 20-in main**
- **Chlorine** Q = 850 gpm
- **Total Demand** Q = 2,025 gpm
- **Gravity Thickener** Q = 500 gpm
- **Thickening & Digesters** Q = 225 gpm

Legend:
- **Pipe Diameter**
  - <= 8-in
  - 12-in
  - 16-in
  - 20-in
  - Other Pipes
Findings

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Existing Pump Station Capacity

![Total Flushing Demand - Existing and Future Scenarios](chart)

**Total Demand (gpm)**

<table>
<thead>
<tr>
<th></th>
<th>Ex. Average</th>
<th>Ex. Peak</th>
<th>Future Average</th>
<th>Future Peak</th>
<th>Future CEPT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEPT Disinfection</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>240</td>
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<tr>
<td>CEPT Clarification</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>380</td>
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<tr>
<td>Miscellaneous</td>
<td>100</td>
<td>850</td>
<td>200</td>
<td>1,350</td>
<td>1,350</td>
</tr>
<tr>
<td>Fine Screen Wash Water</td>
<td>30</td>
<td>60</td>
<td>50</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Aerator Blower Cooling</td>
<td>120</td>
<td>360</td>
<td>150</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>Grit Tanks</td>
<td>200</td>
<td>1,200</td>
<td>225</td>
<td>1,600</td>
<td>1,600</td>
</tr>
<tr>
<td>Thickening and Digester (w/ D12)</td>
<td>225</td>
<td>675</td>
<td>250</td>
<td>900</td>
<td>900</td>
</tr>
<tr>
<td>Gravity Thickener</td>
<td>500</td>
<td>500</td>
<td>2,250</td>
<td>3,375</td>
<td>3,375</td>
</tr>
<tr>
<td>Chlorine Sodium Bisulfite</td>
<td>850</td>
<td>850</td>
<td>850</td>
<td>850</td>
<td>850</td>
</tr>
</tbody>
</table>

PUMP STATION FIRM CAPACITY (9,750 GPM AT 84 PSI)

MAX TANK CLEANOUT AND LINE FLUSHING DEMAND (6,000 GPM)
Existing System Pressure

**EXISTING PUMP CURVE - TDH & EFFICIENCY VS. FLOW AT VARYING MOTOR SPEEDS**

- **ANNUAL COST PER PSI**
  - **EXISTING** = $600
  - **FUTURE** = $1,100

- **P = 84 PSI**
  - **Q = 3,250 GPM**
  - **C = $107,000**

- **P = 75 PSI**
  - **Q = 3,600 GPM**
  - **C = $97,000**

- **P = 60 PSI**
  - **Q = 3,900 GPM**
  - **C = $80,000**
Existing Pump Cycling

Grit Tanks Demand (9/5/2015)

Program grit tanks to cycle on and off together to maintain constant demand.
Future BLAF / CEPT

Legend
Pipe DIAMETER
- <= 8-in
- 12-in
- 16-in
- 20-in
- Other Pipes

12-in main loop for CEPT
8-in main to BLAF
Gravity Thickener Dilution

Operating Pressures
• Existing = 90+ psi
• Required = 30 psi

Problems
• Wasted energy
• Demand increasing
• Difficult Q control

Solution
• P reducing valve
• Increased control
Sodium Bisulfite Carrier Water

Feeder main undersized, unmetered, largest existing demand

- Valve open in warm weather
- Valve closed in cold weather
- CEPT project to modify feed
- Add SCADA controlled valve
- Increase main from 2-inch to 4-inch
Digester Process Water

Legend
Pipe
DIAMETER

- <= 8-in
- 12-in
- 16-in
- 20-in
- Other Pipes

12-in main loop for CEPT
Replace 4-in main with 8-in for Digesters
8-in main to BLAF
Non-Potable Water

- Typically least important process for any given project
- Part of every process at SWWTP
- Individual impact is small
- Overall impact is large
- SWWTP took a holistic look
- Improved existing performance
- Better prepared for future demands
- Don’t drink the water!
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Questions/Discussion