Modeling from Within: SAWS Recycled Water Model Update and Calibration

Presented By: Scott Cole, P.E.

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Acknowledgments

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• SAWS Master Planning Department
• SAWS Recycle System Operations Department
Agenda

• **Overview of Recycle Water System**
• Model Development Quality Assurance and Control
• Field Pressure Testing
• Model Calibration
• Lessons Learned
Recycle Water System Facts

• Completed in 2001 as the nation’s largest reclaimed water system
• Current demand = 15 to 20 MGD
• Current capacity = 30 MGD
• Integral part of San Antonio’s water conservation efforts by significantly reducing Edwards Aquifer withdrawals
• 8” to 42” lines
• Six services areas (pressure zones)
Recycle Water System Map

- 2005:
  - 45 customers
  - 400,000 LF of pipeline
- 2010:
  - 100 customers
  - 500,000 LF of pipeline
- Two independent sub-systems (East and West) until recent interconnect
Recycle Water System Schematic Profile
Recycle Water System vs. Typical Water Distribution System

• Similarities
  – Same general hydraulics as pressurized systems
  – Service areas function as pressure zones

• Differences
  – Number of customers
  – Distinct diurnal curves for each customer
  – Time of day usage predictability
  – Seasonal variations
  – Branched system configuration vs. looped system configuration
Project Drivers

• Recycle water system continues to grow
• Need assurances that model reflects real-world conditions
• Improved management and updating of GIS
• Investment in internal modeling/master planning staff
• Update model software from H₂OMAP to InfoWater
• Public/Private partnership approach to model calibration
  – Consultant provides guidance and QA/QC
  – Utility staff performs day-to-day tasks
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Model QA/QC Process

1. Update Model with GIS Data
2. Establish Connectivity
3. Verify Pipe Data
4. Verify Node Data (Fittings & Valves)
5. Verify Facility Data (Pumps, Tanks & Valves)
6. Verify Customer Location
#1 Update Model with GIS Data

- **Create “UID” Field for all Lines & Nodes in Recycle System GIS**
- **Create “Modeled” Field in GIS & Select Lines & Nodes to be Imported into Model**
  - Assign (Yes/No) to “Modeled” Field
  - Pump Station Facilities should NOT be selected
- **Import Pipes & Nodes Into Model**
  - Utilize the UID for the Model ID
- **Create Verification Fields in Model for all:**
  - Pipes
  - Nodes
  - Tanks
  - Pumps
- **Additional Node Information to Import from GIS:**
  - Comp key
  - Install Date
  - Unity Type
  - As-built Reference Number
- **Pipe & Node Verification Fields:**
  - Source (GIS/Asblt/Model/ Survey)
  - As-builts_Verified (Yes/No)
  - Last_Updated (Date)
  - Last_Updated by (User Initials)
  - Notes
- **Additional Pipe Information to Import from GIS:**
  - Compkey
  - Install Date
  - Pipe Material
  - Pipe Diameter
  - As-built Reference Number
- **Tank Verification Fields:**
  - Source (GIS/Asblt/Model/ Survey)
  - Volume_Verified (Yes/No)
  - Diameter_Verified (Yes/No)
  - Last_Updated (Date)
  - Last_Updated by (User Initials)
- **Pump Verification Fields:**
  - Source (GIS/Asblt/Model/ Survey)
  - Pump_Curve_Verified (Yes/No)
  - Last_Updated (Date)
  - Last_Updated by (User Initials)
Sample Detailed QA/QC Step

#2 Establish Connectivity

- Import Pump Station Facilities from Previous Model
- When Gaps are Identified Research As-built Drawings to Connect System and Fill in Verification Information Upon Completion
- Verify Imported Pump Station Pipes and Nodes are Connected to Distribution System
- Starting at Each Water Treatment Plant, Utilize the Trace Upstream Network Utility to Verify the System is Connected
- Utilize Infowater’s “Connectivity” Utility to Identify and Resolve any Orphaned Nodes and Pipes
- Utilize Infowater’s “Network Review/Fix” Utility to Identify and Resolve any:
  - Nodes in Close Proximity
  - Pipe-Split Candidates
  - Crossing/Intersecting Pipes
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Field Pressure Testing

- Hourly demand patterns essential for model calibration
- Wide range of customer take rates and times, but most customer valves are either open or closed
- Limited hourly usage data at customer delivery points
- **The Question**: How do I estimate each customer’s hourly demands?
- **The Answer**: Utilize pressure recorders at large customer locations to define “on/off” times.
Pressure Recorders

- 32 locations
  - 16 West
  - 16 East
- 30% of customers
- 87% of usage
Sample Pressure Recorder Data

Fort Sam Cemetery Pressure Recorder Data

- Pressure [psi]
- Dates: 8/12/2009 to 8/20/2009
- ON/OFF states
- Graph showing pressure changes over time
- Minimum (Min) and Maximum (Max) pressure lines
<table>
<thead>
<tr>
<th>Customer</th>
<th>Customer Type</th>
<th>Field Use (Cu Ft)</th>
<th>Field Use (gal)</th>
<th>Total (hrs)</th>
<th>Average Flow Rate (gpm)</th>
<th>“ON” Time (hrs)</th>
<th>“ON” Flow Rate (gpm)</th>
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</thead>
<tbody>
<tr>
<td>Dodd Field</td>
<td>Direct Irrigation</td>
<td>1,014</td>
<td>758,573</td>
<td>238.2</td>
<td>53.1</td>
<td>40.8</td>
<td>310.3</td>
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<td>New BAMC Cool Twr</td>
<td>Cooling Tower</td>
<td>2,818</td>
<td>2,108,146</td>
<td>235.8</td>
<td>149.0</td>
<td>128.5</td>
<td>273.4</td>
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<td>Blue Wing Club</td>
<td>Direct Irrigation</td>
<td>9,616</td>
<td>7,193,730</td>
<td>142.7</td>
<td>840.4</td>
<td>90.0</td>
<td>1332.2</td>
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<td>Cole High School</td>
<td>Direct Irrigation</td>
<td>552</td>
<td>412,951</td>
<td>235.5</td>
<td>29.2</td>
<td>50.8</td>
<td>135.5</td>
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<td>DPT Labs</td>
<td>Direct Irrigation</td>
<td>30</td>
<td>22,443</td>
<td>89.8</td>
<td>4.2</td>
<td>28.0</td>
<td>13.4</td>
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<td>Fort Sam Cemetery</td>
<td>irrigation - pond</td>
<td>11,094</td>
<td>8,299,421</td>
<td>238.3</td>
<td>580.6</td>
<td>195.2</td>
<td>708.7</td>
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<td>Golf Course (BAMC)</td>
<td>Direct Irrigation</td>
<td>12,362</td>
<td>9,248,012</td>
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<td>654.3</td>
<td>158.0</td>
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<td>Riverside G.C.</td>
<td>Pond</td>
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<td>5,524,719</td>
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<td>497.7</td>
<td>93.5</td>
<td>984.8</td>
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<td>Direct Irrigation</td>
<td>716</td>
<td>535,640</td>
<td>214.7</td>
<td>41.6</td>
<td>54.5</td>
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<td>Salado WRC</td>
<td>Direct Irrigation</td>
<td>4,835</td>
<td>3,617,064</td>
<td>202.8</td>
<td>297.3</td>
<td>94.5</td>
<td>637.9</td>
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<td>San Antonio C.C.</td>
<td>irrigation - on-site storage</td>
<td>7,133</td>
<td>5,336,197</td>
<td>242.1</td>
<td>367.4</td>
<td>170.0</td>
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<td>SAWS H&amp;C Plant</td>
<td>Cooling Tower</td>
<td>1,640</td>
<td>1,226,884</td>
<td>209.2</td>
<td>97.8</td>
<td>209.3</td>
<td>97.7</td>
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<td>SBC Arena</td>
<td>Cooling Tower / Irrigation</td>
<td>1,419</td>
<td>1,061,554</td>
<td>142.0</td>
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<td>40.0</td>
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<td>The Alamo</td>
<td>Direct Irrigation</td>
<td>336</td>
<td>251,362</td>
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<td>The Republic G.C.</td>
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<td>Trinity University</td>
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<td>2,640,793</td>
<td>237.9</td>
<td>185.0</td>
<td>230.0</td>
<td>191.4</td>
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</tbody>
</table>
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• Lessons Learned
Typical Diurnal Curves for Smaller Customers

- **Direct Irrigation**
- **Pond**
- **Cooling Tower**
<table>
<thead>
<tr>
<th>Facility</th>
<th>Controlled Facility</th>
<th>On Setting</th>
<th>Off Setting</th>
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</thead>
<tbody>
<tr>
<td>Pearsall GST</td>
<td>Leon Creek Pump 1</td>
<td>24’</td>
<td>27.75’</td>
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<tr>
<td></td>
<td>Leon Creek Pump 2</td>
<td>22’</td>
<td>27.5’</td>
</tr>
<tr>
<td></td>
<td>Leon Creek Pump 3</td>
<td>20’</td>
<td>27’</td>
</tr>
<tr>
<td>Pinn Road GST</td>
<td>Pearsall Pump 1</td>
<td>42’</td>
<td>72’</td>
</tr>
<tr>
<td></td>
<td>Pearsall Pump 2</td>
<td>40’</td>
<td>71’</td>
</tr>
<tr>
<td></td>
<td>Pearsall Pump 3</td>
<td>0’</td>
<td>70’</td>
</tr>
<tr>
<td>Fredericksburg EST</td>
<td>Pinn Road Pump 1</td>
<td>28.5’</td>
<td>41’</td>
</tr>
<tr>
<td></td>
<td>Pinn Road Pump 2</td>
<td>25’</td>
<td>40’</td>
</tr>
<tr>
<td>Stotzer GST</td>
<td>Pinn Road Pump 6</td>
<td>33’</td>
<td>41’</td>
</tr>
<tr>
<td></td>
<td>Pinn Road Pump 7</td>
<td>32’</td>
<td>40’</td>
</tr>
</tbody>
</table>
Major Calibration Issue: Mass Balance Doesn’t Add Up

**Houston Ground Storage Tank**

**Houston Pump Station**

**Devine Elevated Storage Tank**
Calibration Issues Resolved

- Inaccurate pump station flow meters
  - Flow meters had not been calibrated recently
  - Assumed model flows were correct
  - Flow meter has since been recalibrated and now SCADA matches model

![Graph showing flow comparison]

**1800 gpm**
• Overview of Recycle Water System
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Lessons Learned

- Integration with GIS through common unique ID allows for easier data management and model updates
- Accurate diurnal patterns are essential when calibrating transmission system models
- Historical SCADA data should be stored and not just trended in real-time
- Deliberate model development QA/QC process reduces calibration effort
- Custom fields in model and GIS help define data source and confidence
Lessons Learned

• In the absence of good flow data, pressure data can be used to estimate flows
• Models can be used to identify inaccuracies in flow measurement devices
• Permanent remote pressure recorders help with system operations and model calibration
• Recycle water system planning can help with conservation efforts
• Public-Private partnership is a “win-win”
  – Reduces consultant fees
  – Trains utility staff
  – Helps with buy-in
Questions?

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