How Modeling Can Help Your System

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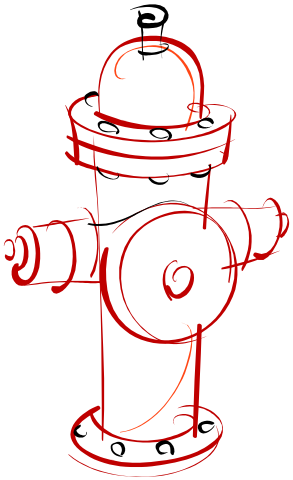
OVERVIEW

- Why Have a Model?
- Building a Model
- Adding Customer Demands
- QA/QC
- Calibration
- Maintenance
- Analysis
- Optimization

WHY HAVE A MODEL?

- ❑ **Master Planning**
- ❑ **Capital Improvement Analysis**
- ❑ **Development Reviews**
- ❑ **Fire Flow Analysis**
- ❑ **System Operations**
- ❑ **Water Quality**
- ❑ **Optimization**
  - Capital
  - Operations
  - Energy
  - Water Quality



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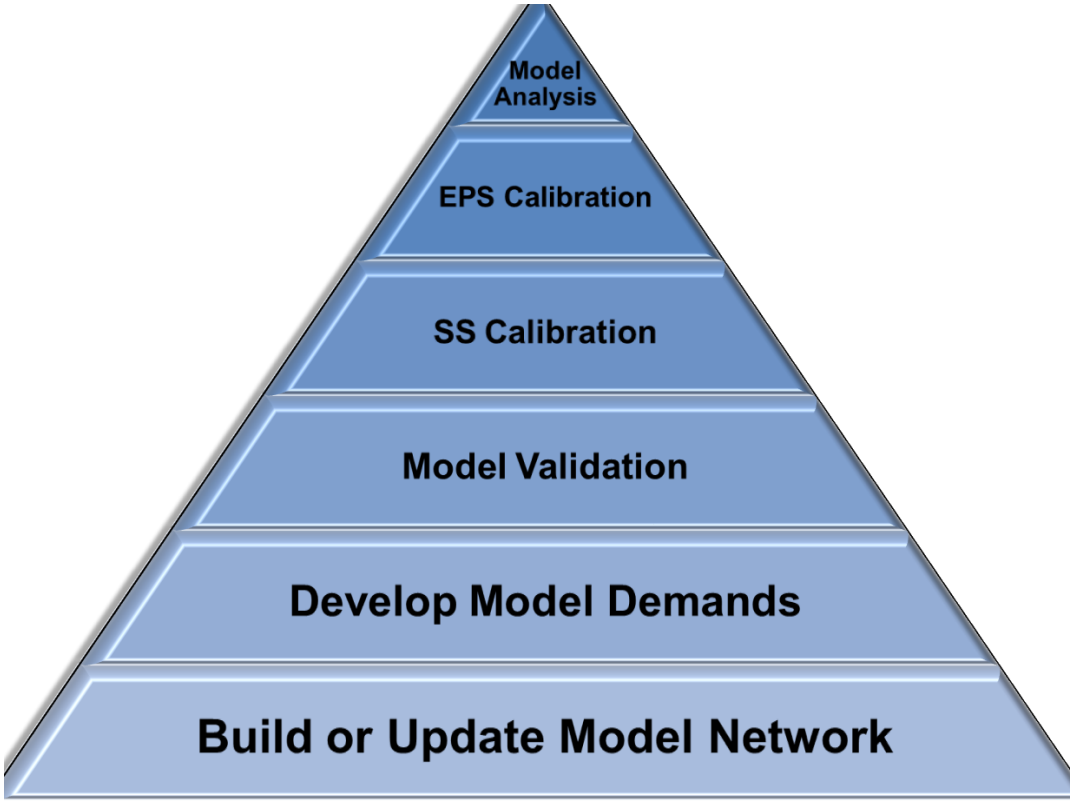
MODEL BUILDING PROCESS

- **If You are Now Convinced a Model is Important…What Next?**

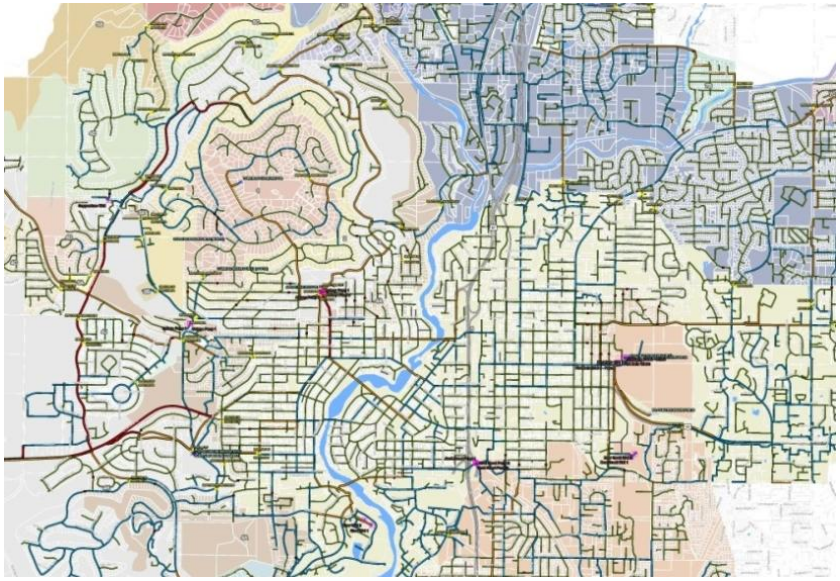


BUILDING A MODEL

- **Decide what to Include**
  - All-pipe vs. All-valve model
- **All-pipe**
  - All pipes except hydrant and service laterals
- **All-valve**
  - Includes pipe segmentation at tees and crosses and may also include hydrant and service laterals

BUILDING A MODEL

- **Consider what is Hydraulically Significant**
- **Consider the Integration with other Data Systems**
- **Balance Detail and Size**
  - The devil is in the details.



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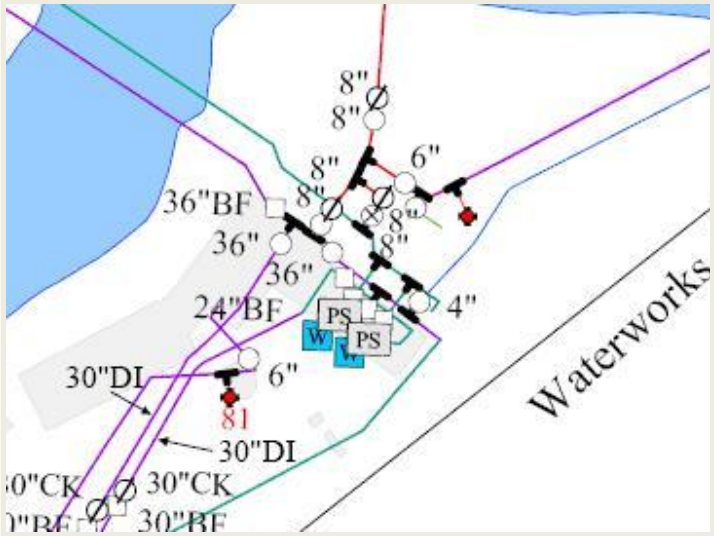
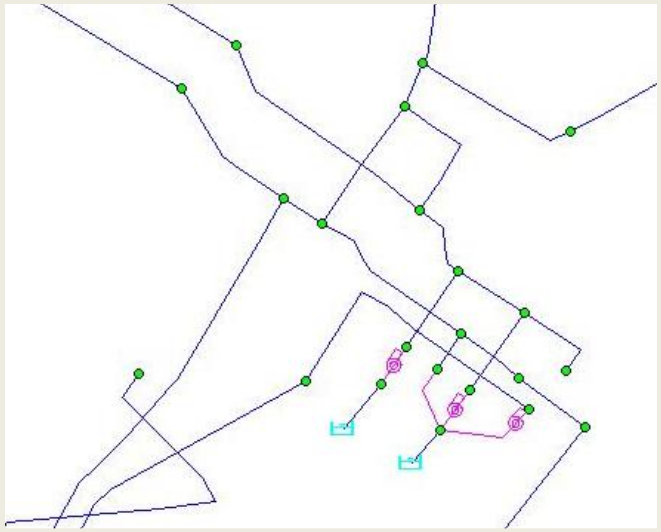
BUILDING A MODEL

- ❑ **CAD Sources**
- ❑ **Scanned Hard Copy Digitization**
- ❑ **Import from GIS**
- ❑ **Conversion Between Different Software**



GIS



MODEL

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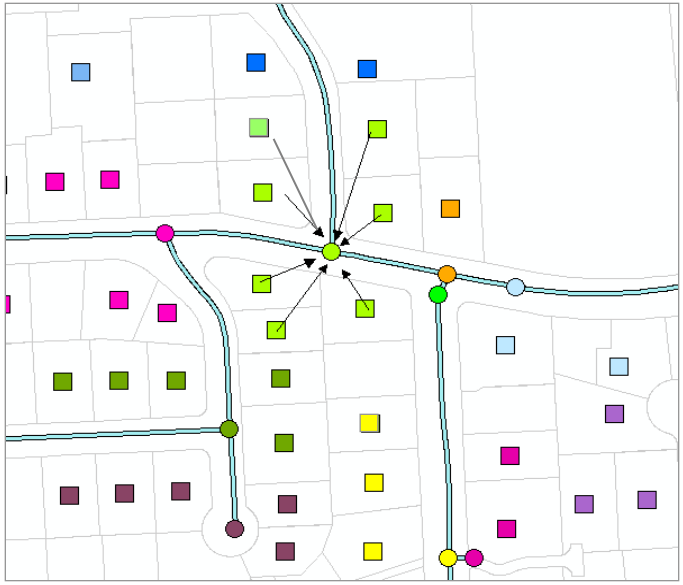
DEMAND DEVELOPMENT

- **Identify Customer Water Usage**
  - Ideally Use Billing Records
  - Land Use Data
- **“Locate” Customer in System**
  - Link Billing Records to Parcels
  - Link Billing Records to Meter Location
  - Geocode Customer Locations

Demands

- **Determine Where Demand Should Not be Assigned**
  - Near Pumps, Tanks, Valves and on Transmission Lines
- **Spatially Link Model Junctions to Customer or Parcel Locations**
- **Process is Updatable**
  - Once Relationship Between Customers and Nodes is Established



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DEMANDS

- **Peak Demands to Match Water Production**
  - Average Day
  - Maximum Day
  - Peak Hour

- **Future Demand Development**
  - Traffic Analysis Zones (TAZ)
  - Future Land Use Zoning
  - Population Forecasts

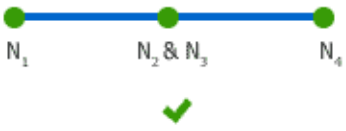
QA/QC – Prior to Using the Model

- Garbage In = Garbage Out

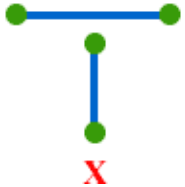
- This is a Crucial Step that is Often Overlooked or Minimized!

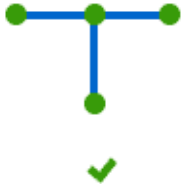
QA/QC

- **Models Include Tools to Validate Data**
  - Connectivity

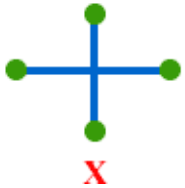


  - Splitting



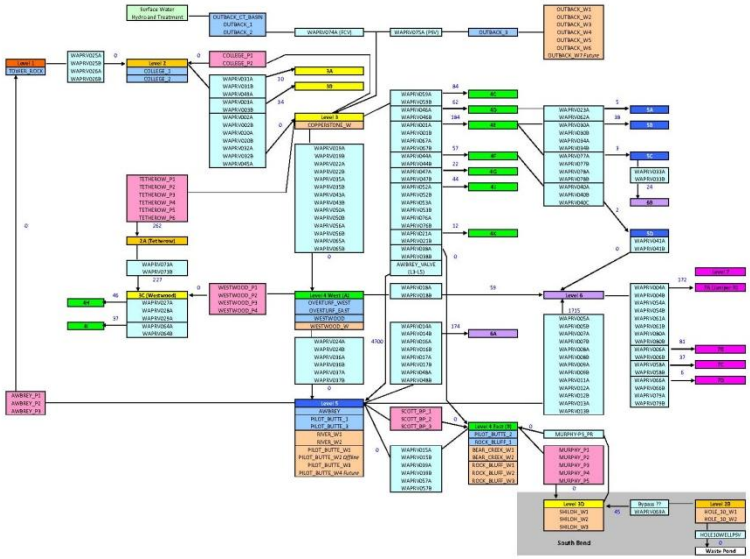


  - Intersecting



QA/QC

- **Basic Validation**
  - Check Facility Parameters
  - Elevation Verification
  - Friction Factor and Minor Loss Review
  - Hydraulic Profile
  - Pressure Zone Accuracy
  - Mass Balance



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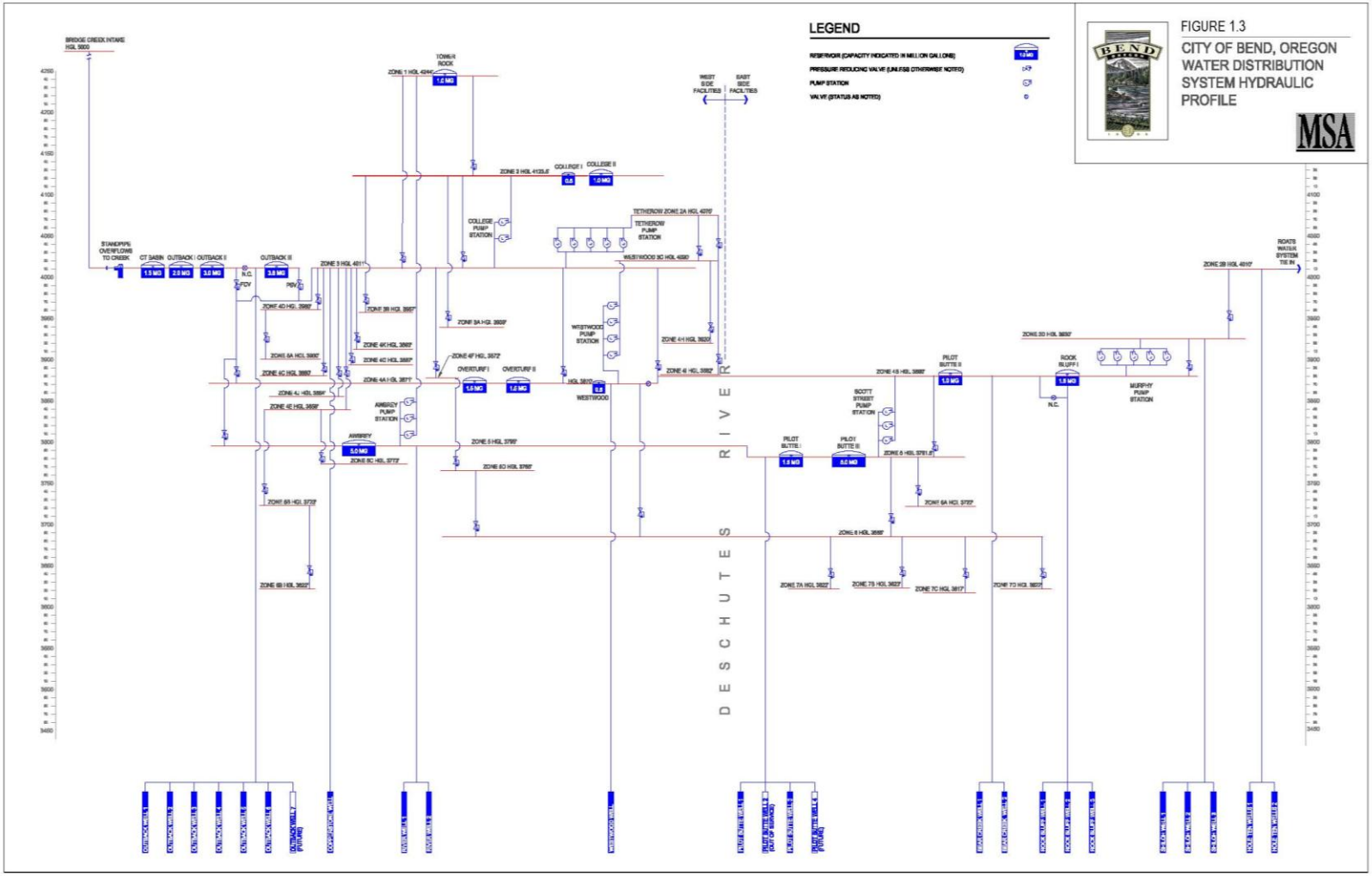
HYDRAULIC PROFILE



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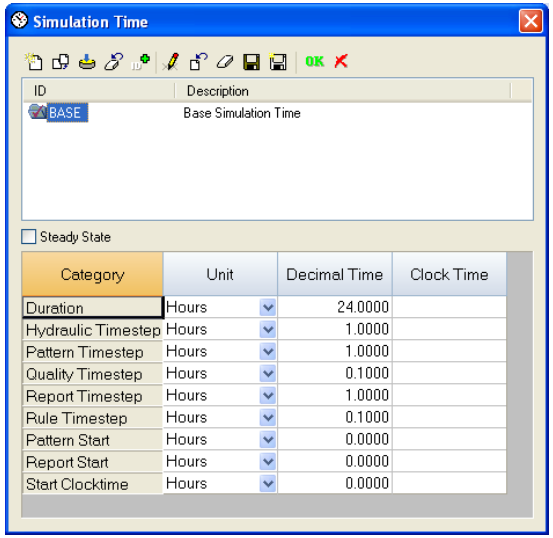
CALIBRATION

Steady State

- Quantitative Comparison – "number to number"
- System Response to Isolated Stress



Extended Period Simulation

- Qualitative Comparison – "trends"
- Overall System Controls
- How System Behaves Over Time

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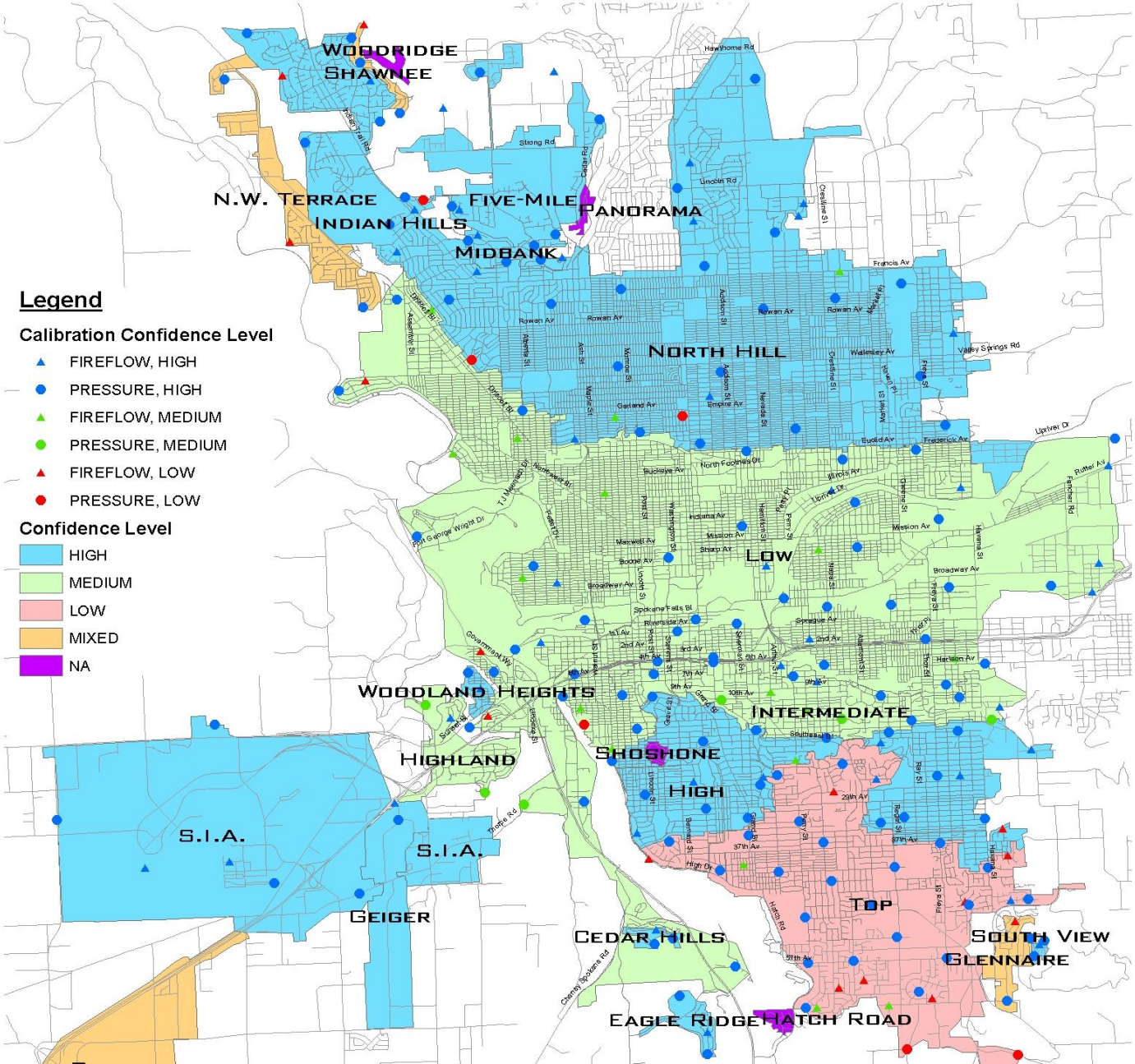
STEADY STATE CALIBRATION

- **Develop Calibration Plan**
  - If possible, do multiple tests within each pressure zone
- **Collect Field Data**
  - Use Calibrated Equipment & Consistent Techniques
- **Utilize SCADA to Acquire Boundary Conditions**
  - Provides Model Settings for Tanks, Pumps and Valves
- **Compare Field Pressure to Model Pressure**
  - Under Both Static and Residual Conditions

Steady State Calibration Results

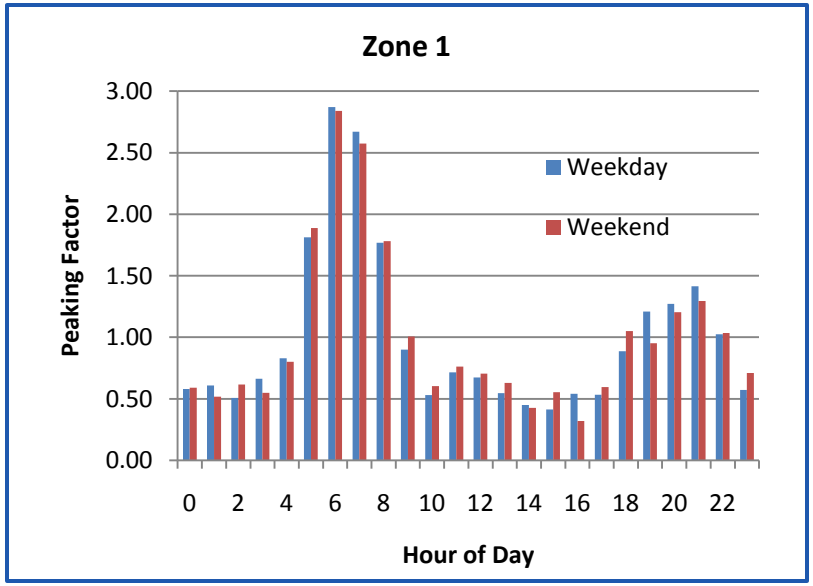


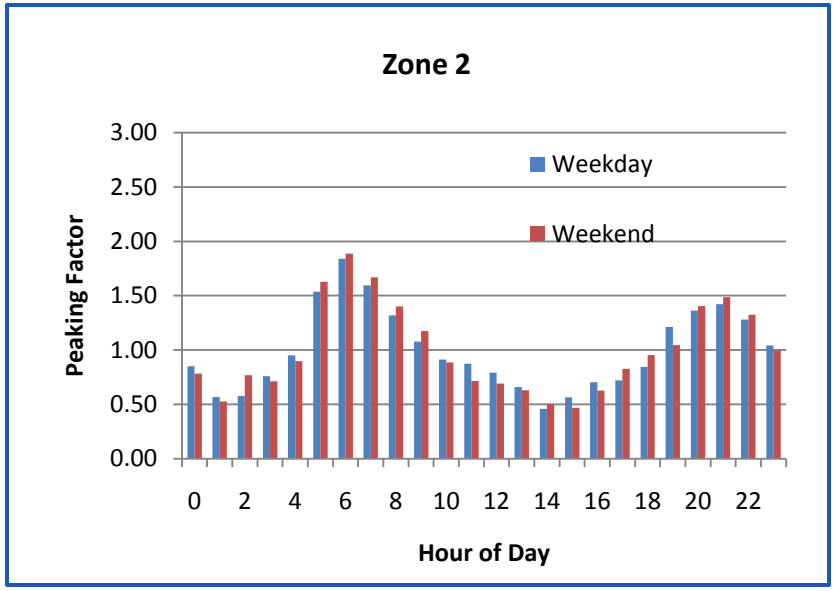
EPS CALIBRATION

- ❑ **Develop Diurnal Curves**
- ❑ **Identify Control Set Points for Pumps**
- ❑ **Collect SCADA over an Extended Period (2 weeks)**
- ❑ **Perform Model Calibration**
  - Compare SCADA Trends and Model Data
    - Reservoir Fill Rates and Cycles
    - Pump Station On/Off and Flow Rates
- ❑ **Adjust Model and Potentially Collect More Data**

EPS DIURNAL CURVES

- **Develop Diurnal Curves to Track Demand Over Time**
  - Ideally a Unique Curve for Each Pressure Zone
  - Typically Separate “Weekday” and “Weekend” Curves





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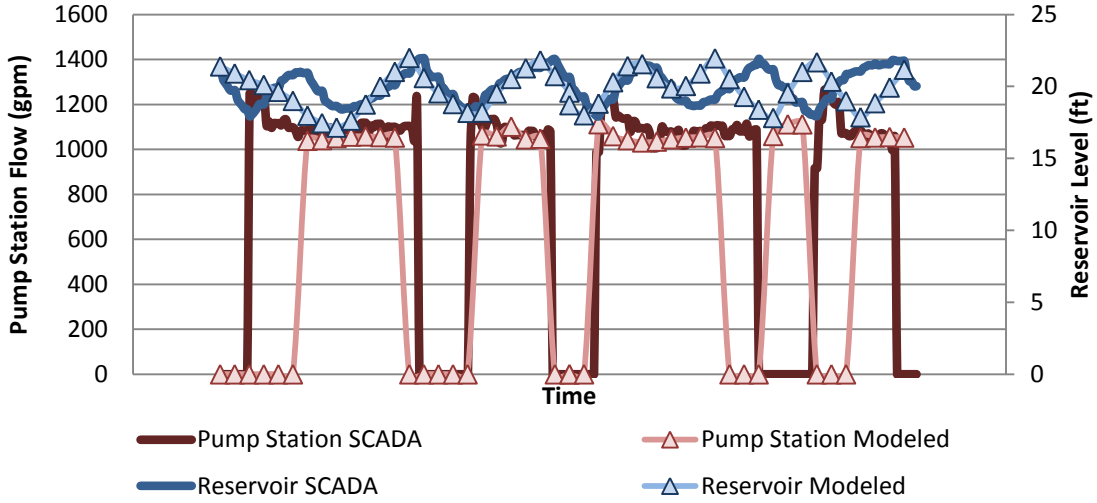
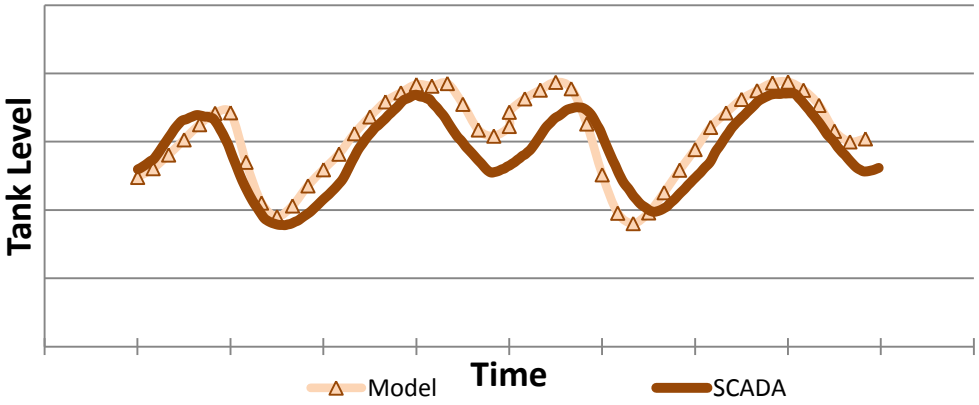
EPS CALIBRATION RESULTS





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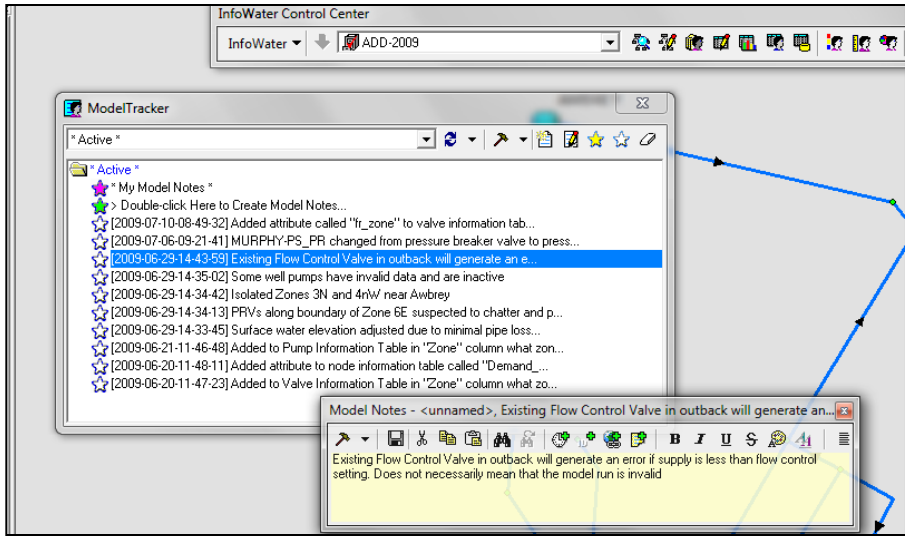
MODEL MAINTENANCE

- Establish Protocol for How Data Moves within the Utility
- Maintain Consistency and Track Changes
- Without These, You Can’t Have Confidence in Your Model Results!



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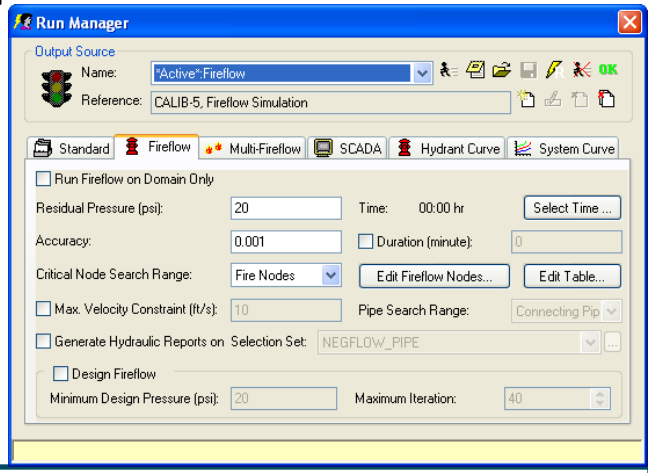
IDENTIFY DESIGN CRITERIA

- **Design Criteria**
  - System Pressure (Minimum)
    - ADD, MDD, PHD, Fire Flow
  - System Pressure (Maximum)
    - Domestic
  - Velocity Criteria
    - Domestic and Fire Flow Conditions
  - Fire Flow Requirements
    - Residential, Commercial, Industrial, Schools, etc

STEADY STATE HYDRAULIC ANALYSIS

- **Simulate System Demand and Fire Flows**
  - Max Day, Peak Hour, Min Hour/Reservoir Refill
- **Batch Fire Flow Analysis**
- **Evaluate Against Design Criteria**



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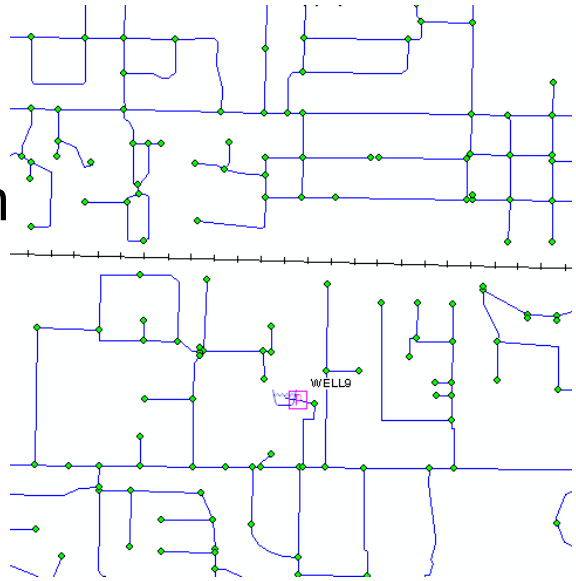
EPS HYDRAULIC ANALYSIS

- **Simulate System Over Selected Time Period**
- **Focuses on "Operation" of System**
- **Siting Analysis**
  - Reservoir Filling/Draining Over Time
- **Water Quality Analysis**
  - Age, Tracer or Chemical Degradation
- **Water System Operations**
  - What-ifs for Differing Set Points, etc
- **Energy Usage Evaluations**
  - Using Pumps to Fill Tanks at Night



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TYPICAL TRADITIONAL HYDRAULIC ANALYSIS

- Simulate Existing Peak Domestic and Fire Flows
- Utilize Design Criteria to Identify Deficiencies
- Identify a Solution or Solutions for Each Deficiency
- Iteratively Add Potential New Pipes & Facilities Until Deficiencies are Eliminated
- Repeat Process for Future Conditions

ANALYSIS CONT.

- **Traditional Trial and Error Process has Been Employed on Most Projects**

- **Works Well for Relatively Simple Systems or for Those With Few Improvement Options**

- **However the Approach is Constrained in the Number of Alternatives that Can be Evaluated**
  - Budget
  - Schedule
  - Both

TRANSITION TO OPTIMATICS

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