

# Leveraging AMI Data for Distribution System Model Calibration

AWWA PNWS

4/3/2019

**WATER**  
OUR FOCUS  
OUR BUSINESS  
OUR PASSION

RENTON

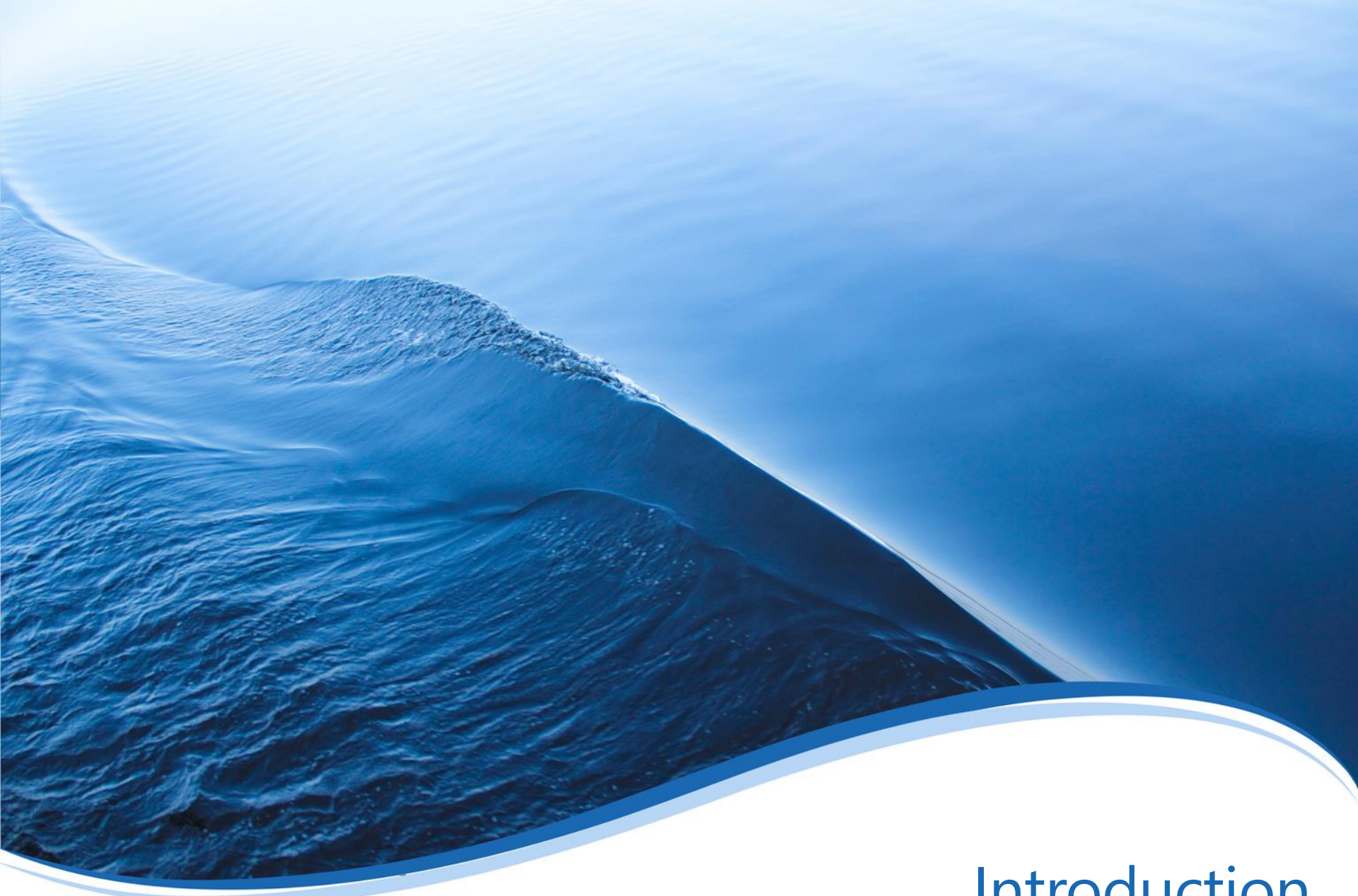
AHEAD OF THE CURVE

**carollo**

Engineers...Working Wonders With Water®

# Today's Presentation

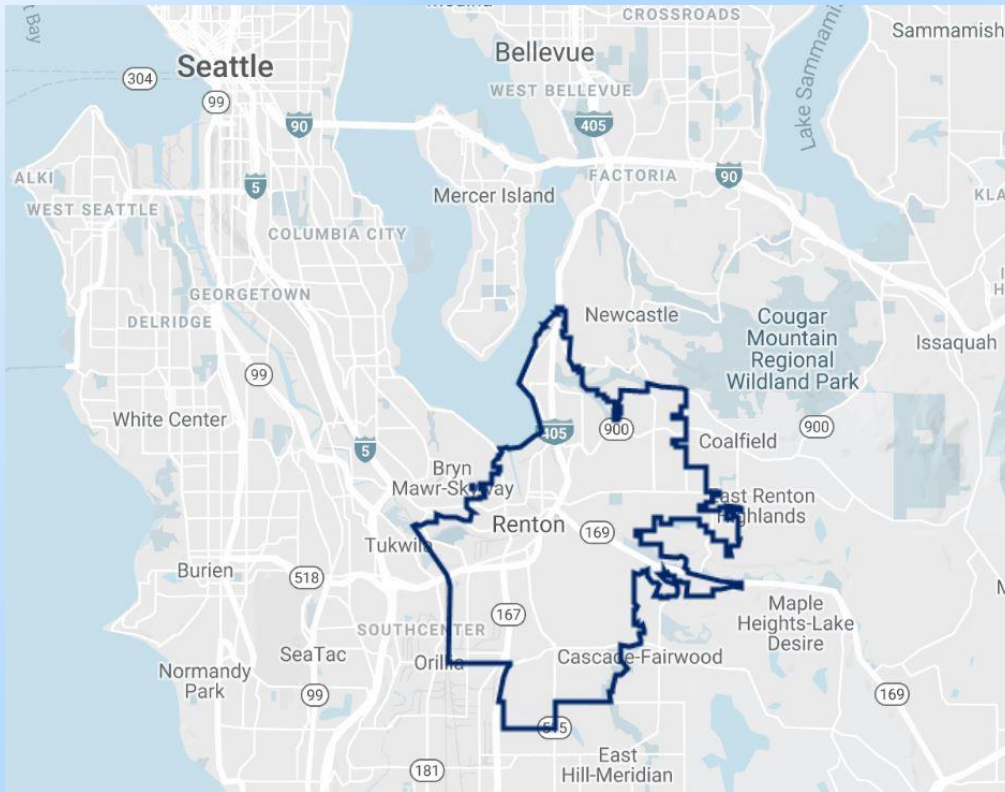
- Introduction
- Renton's AMI System
- Demands and Diurnal Patterns
- Hydraulic Model Overview
- Field Testing and Calibration



# Introduction



# Where is Renton?

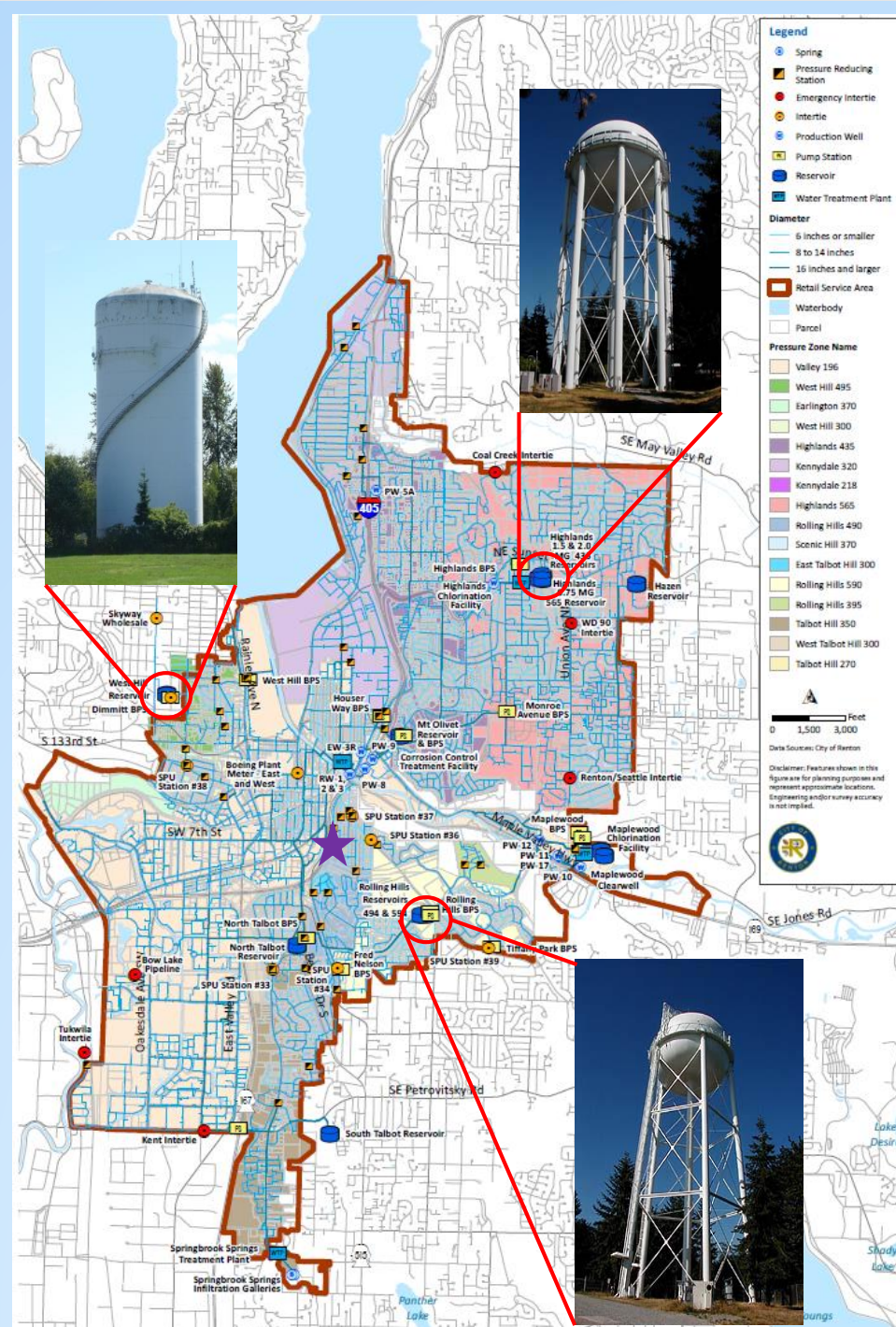


- 11 miles south of downtown Seattle
- Juncture of Cedar River and Lake Washington
- Serve ~72,000 customers
- Over 17,800 service connections
- One wholesale customer

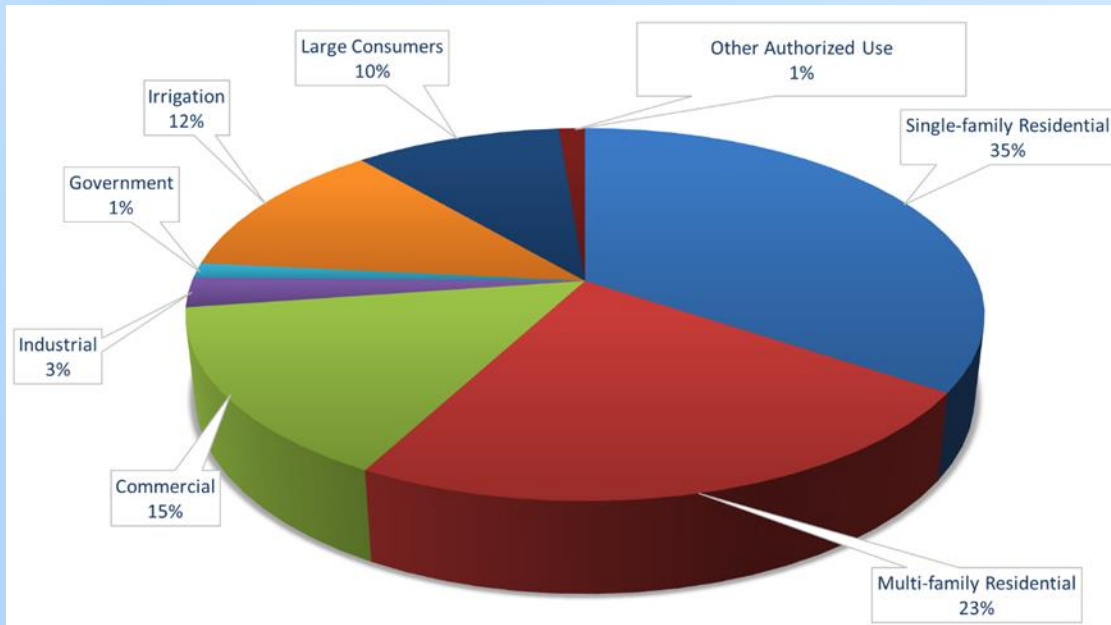
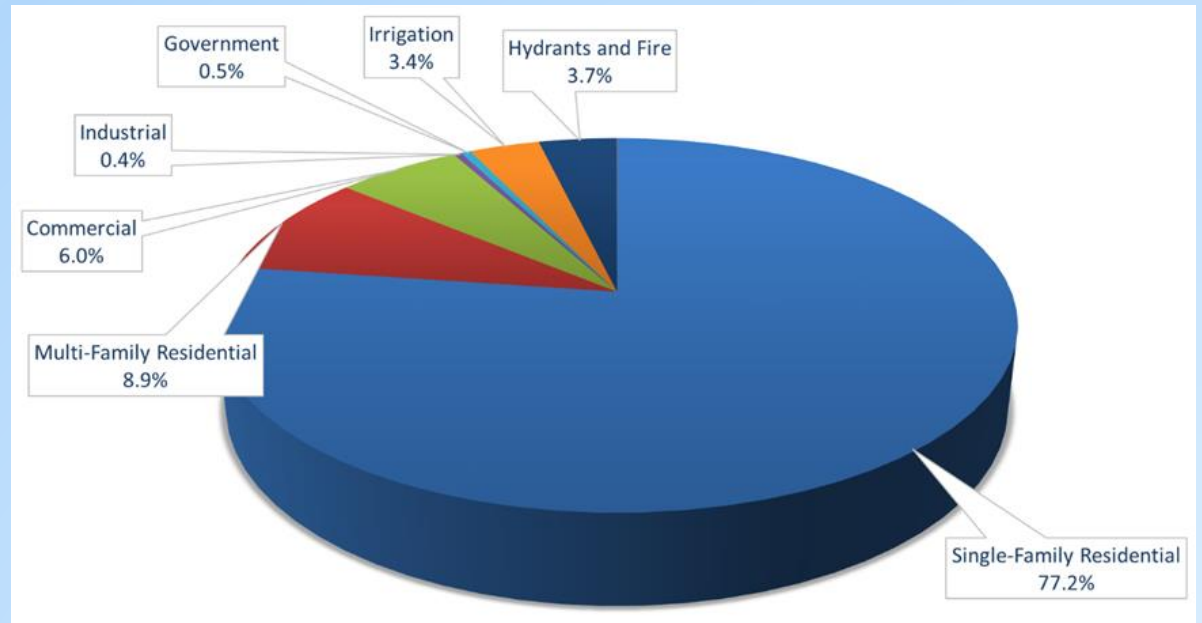


# Renton's Water Distribution System

- 314 miles of pipes
- 11 reservoirs
- 11 pump stations
- 43 PRV stations
- 16 pressure zones
- 8 wells, 1 spring
- Average daily demand
  - ~7.3 million gallons



## Percent of Connections by Customer Type



## Percent of Consumption by Customer Type





# Renton's AMI System

# Renton System Deployment History

2008 Council Approval	Development of Request for Proposals, Procurement Strategies, and Business Case Evaluation
2009 Council Approval	Advertise for RFPs, select “Sensus Flexnet Metering” system, Start to negotiate contract
2010	Continued contract negotiations
2011 Council Approval	Executed contract (5-year deployment), Begin installation of radios and replacement of meters
2012- 2014	Installation of 12,830 end-point radios through July 2014, Customer outreach through annual CCR
2014-2015	Complete installation of remaining 4,620 end-point radios by August 2015



# Renton's AMI System

West Hill Reservoir Collector



Water meter with AMI radio

Highlands Reservoir Collector



Rolling Hills Reservoir Collector



Regional Network Interface



CITY HALL



# Some Features of the System

- Fixed base – as opposed to drive-by or walk-by reads
- Meter registers are read hourly; readings transmitted to server every four hours
- Alarm flags generated by end-point radios and transmitted to server



**Upgraded system: Remotely Operated (close, reduce, open) and Intelligence Sensors (pressure and temperature)**

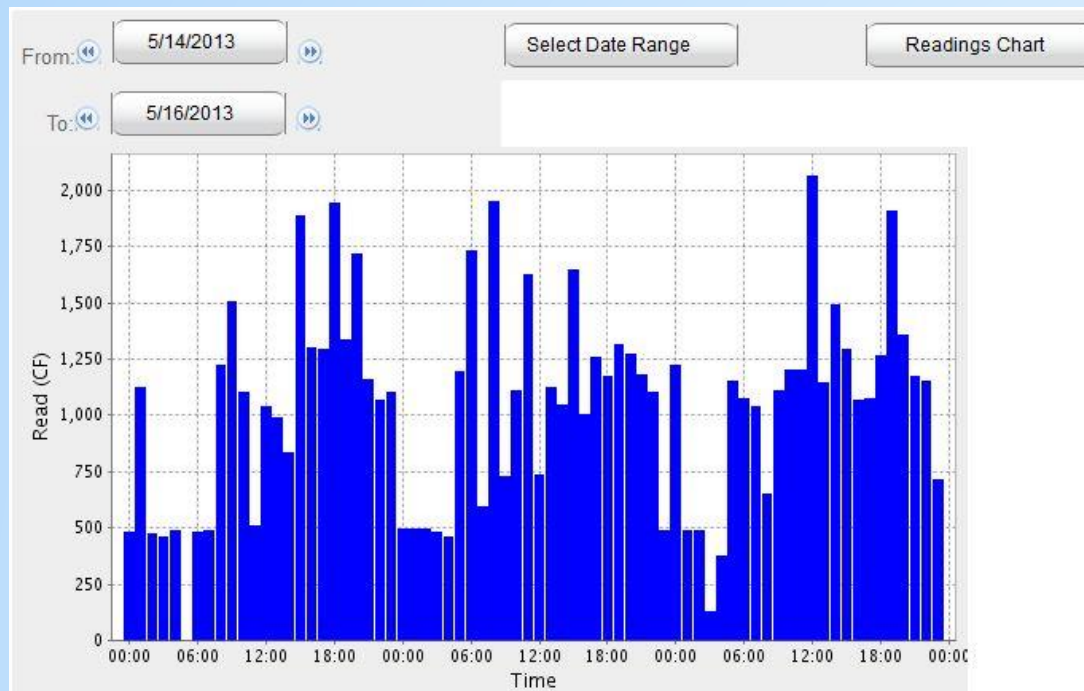
# Benefits of AMI System

- Reduced meter reading costs
- Reduced staff exposure to hazards
- Rapid leak detection and early notification to customer
- Earlier detection of 'stuck' meters and tampering
- Facilitate accurate and timely billing
- Improved demand information to support
  - Water use efficiency
  - **Modeling and analysis**



# Demand Information for Modeling and Analysis

- All Meters Read Every Hour – Exactly on the Hour
- Much Better Information for System 'Leakage' Calculations
- Improved Diurnal Patterns for Hydraulic Modeling, etc





# Demands and Diurnal Patterns

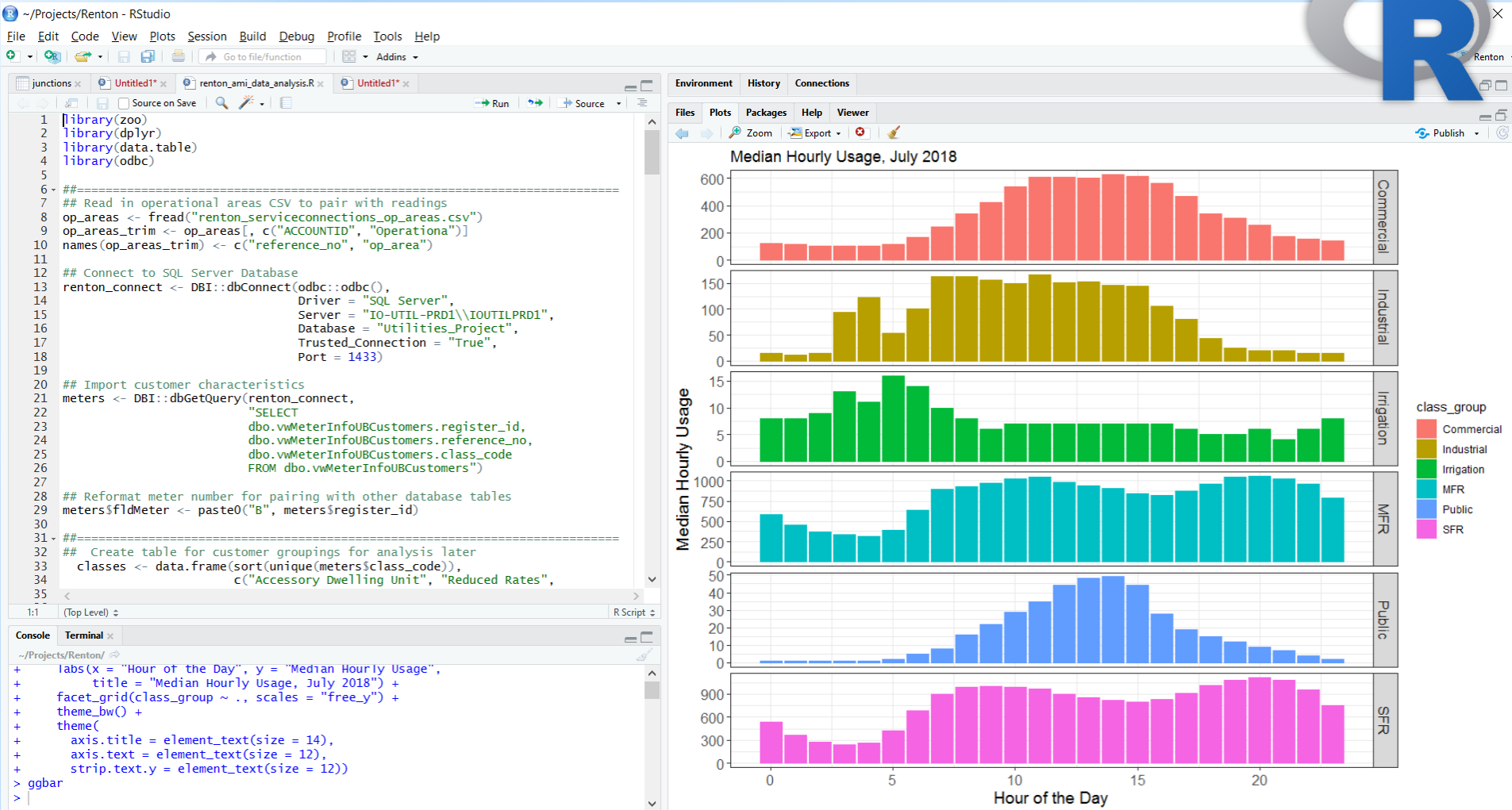
# AMI usage data was analyzed using a combination of SQL Server, R, and Tableau



- Initial data was stored in SQL Server
- Database connection was made using R, with some SQL scripting
  - Incremental readings were calculated using SQL
- Hourly and daily summaries were calculated using R
- Outputs were loaded into Tableau for data exploration



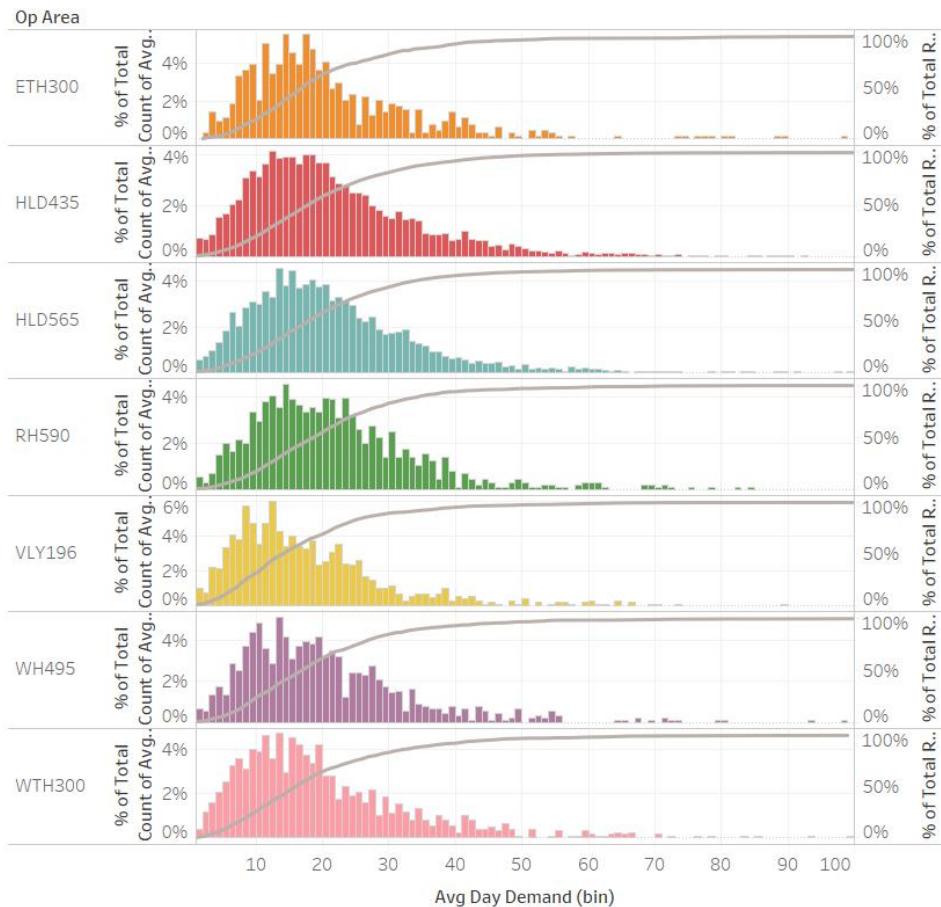
# AMI data was used to develop custom patterns



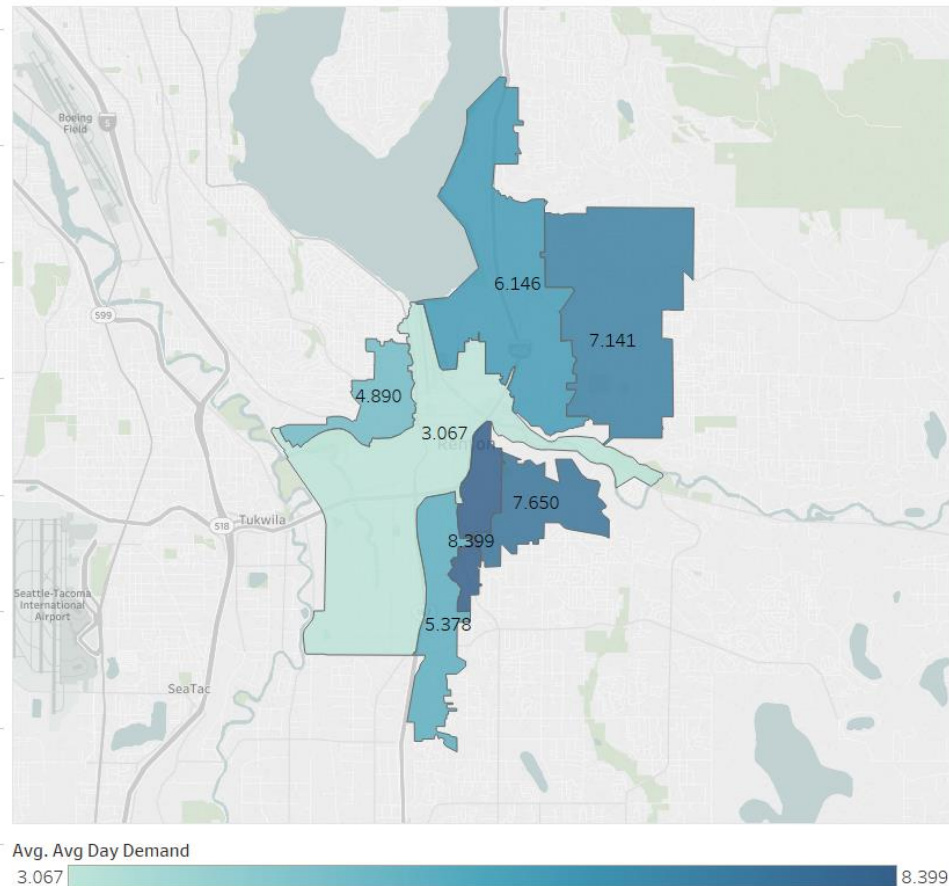
# AMI data and GIS were used to allocate demands in hydraulic model



Distribution of Daily Demand by Operational Area

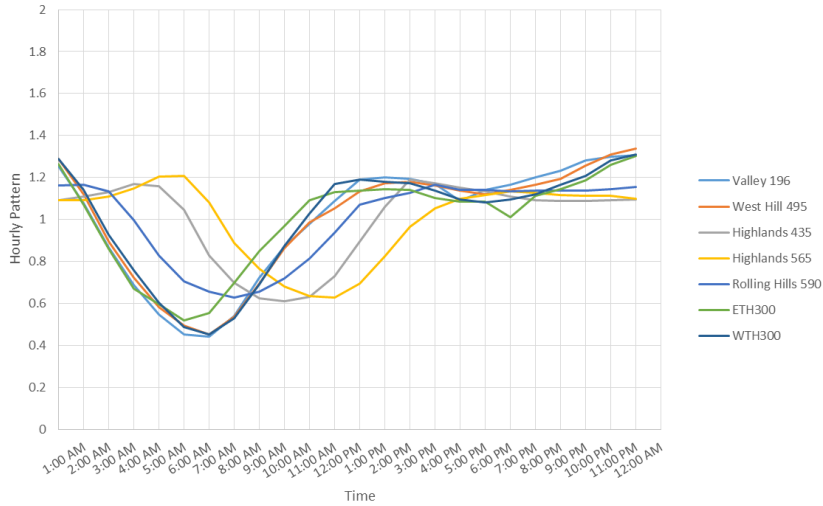


Operational Areas

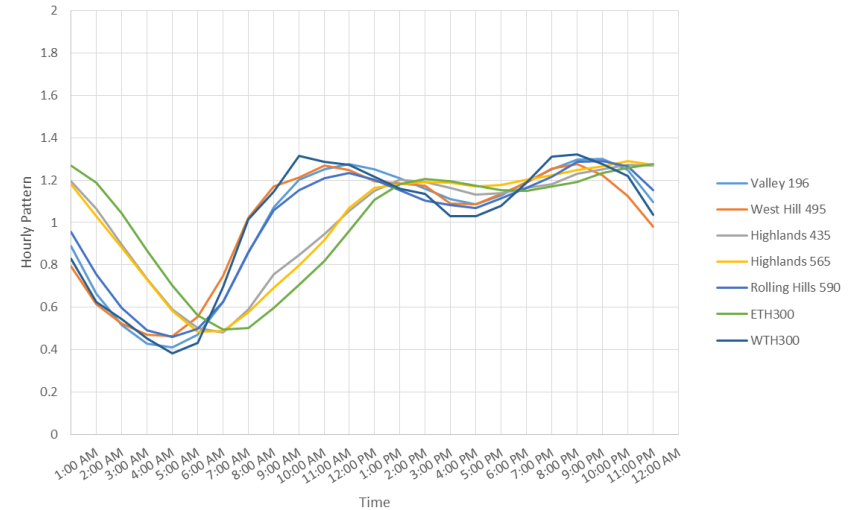


# Diurnal Patterns developed for each customer class and operational area

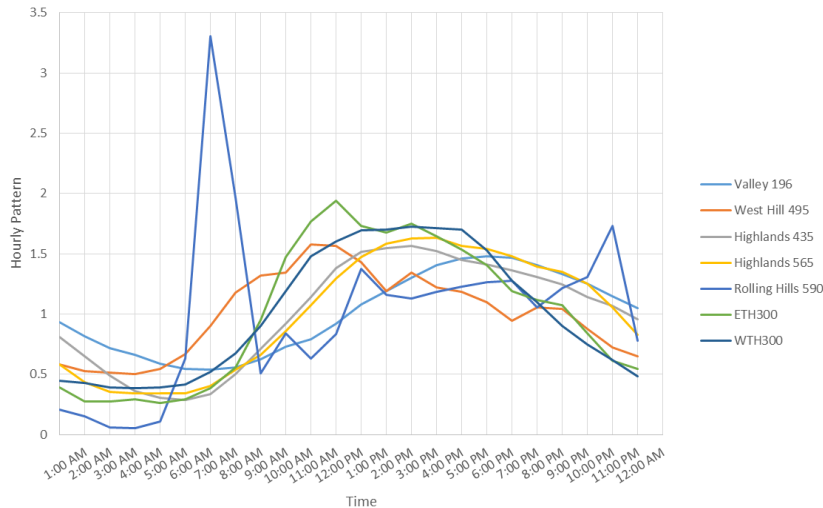
Single Family Residential Patterns



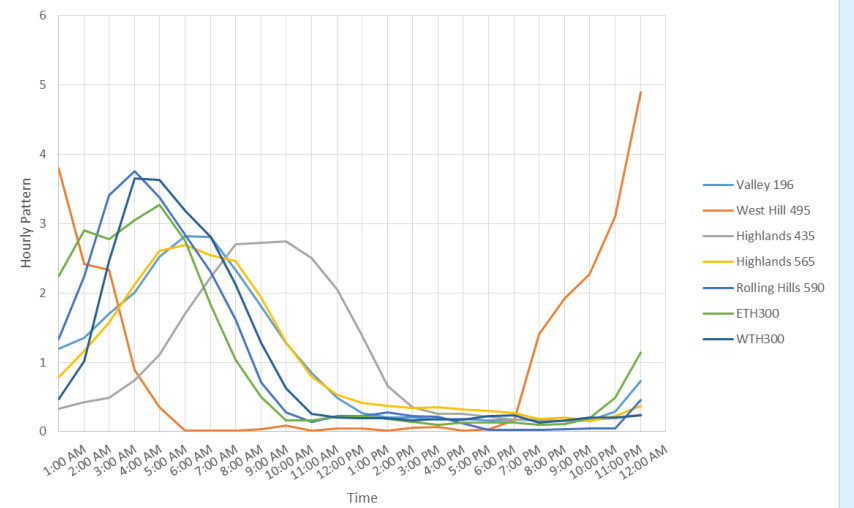
Multi Family Residential Patterns



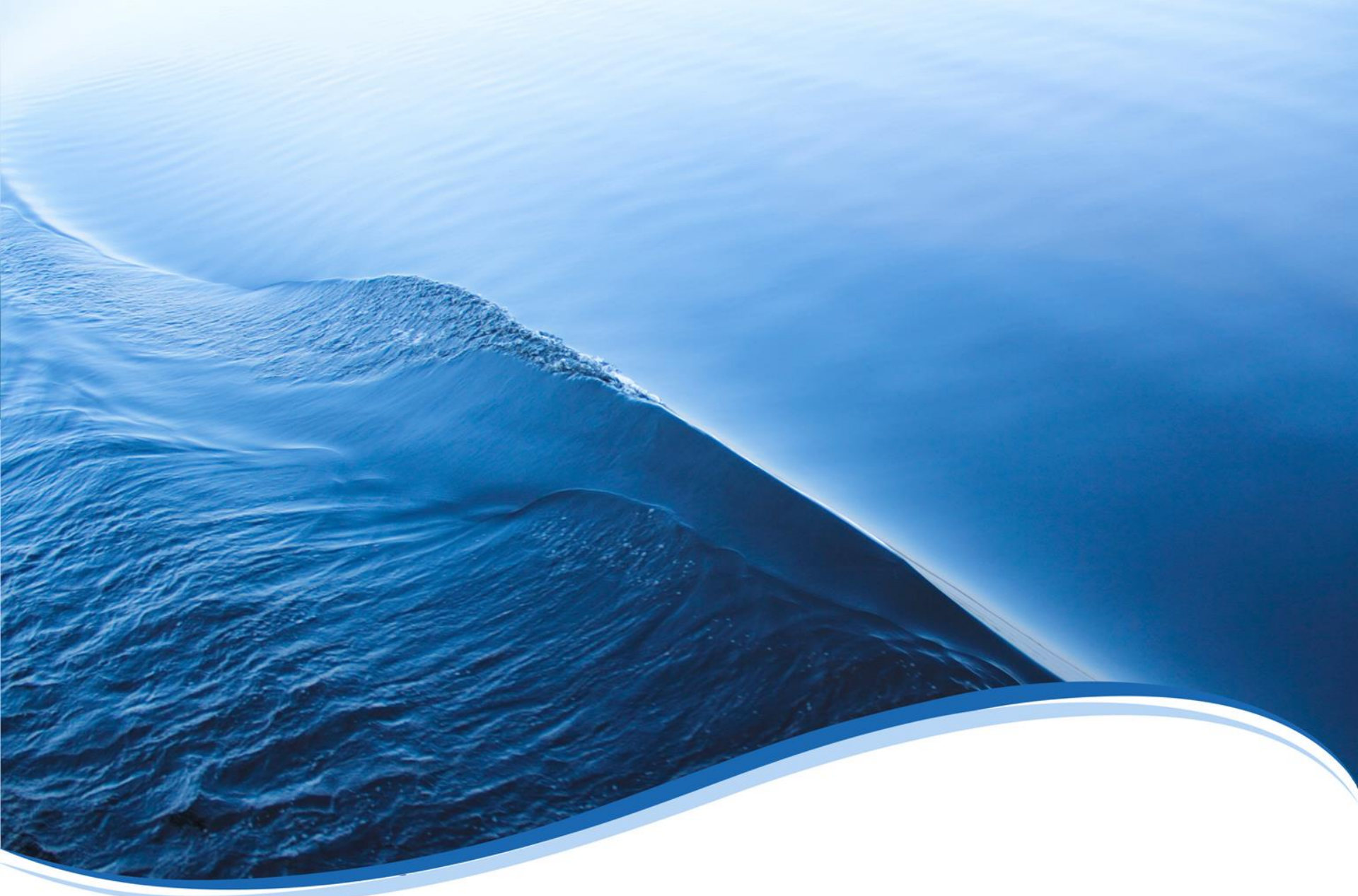
Commercial Patterns



Irrigation Patterns







# Hydraulic Model Overview

# Renton's Model is state of the art

- 1:1 model/GIS relationship
- All-pipe model
- 9,553 pipe segments
- 107 valves
- 50 pumps

The screenshot shows the ArcMap interface with the following components:

- Table of Contents:** Lists layers for Junction, Tank, Reservoir, Pump, and Valve, each with sub-categories for TYPE, Active, Domain, and Inactive.
- Model Explorer:** Shows the 2031\_MDD model with a selected junction (J2842). The details for this junction are as follows:

JUNCTION: J2842	
(ID)	J2842
Description	
<input checked="" type="checkbox"/> Geometry	
X	1306188.824874130
Y	187681.497465894
<input checked="" type="checkbox"/> Modeling	
Demand 1 (gpm)	3.72
Pattern 1	DRNL_WINTER_HLD4
Demand 2 (gpm)	0.00
Pattern 2	
Demand 3 (gpm)	0.00
Pattern 3	
Demand 4 (gpm)	0.00
Pattern 4	
Demand 5 (gpm)	0.00
Pattern 5	
Demand 6 (gpm)	0.00
Pattern 6	
Demand 7 (gpm)	0.00
Pattern 7	
Demand 8 (gpm)	0.00
Pattern 8	
Demand 9 (gpm)	0.00
Pattern 9	
Demand 10 (gpm)	0.00
Pattern 10	
<input checked="" type="checkbox"/> Information	
Year of Installation	
Year of Retirement	
Zone	HLD435
Elevation (ft)	344.52
- Message Board:** Shows a "Validation Result" message.

1310960.651 186108.726 Feet





# Field Testing and Calibration



# EPS Testing - Pressure Loggers

- SCADA data @
  - 7 pump stations
  - 7 wells and sources
  - 10 reservoirs
- 20 pressure loggers

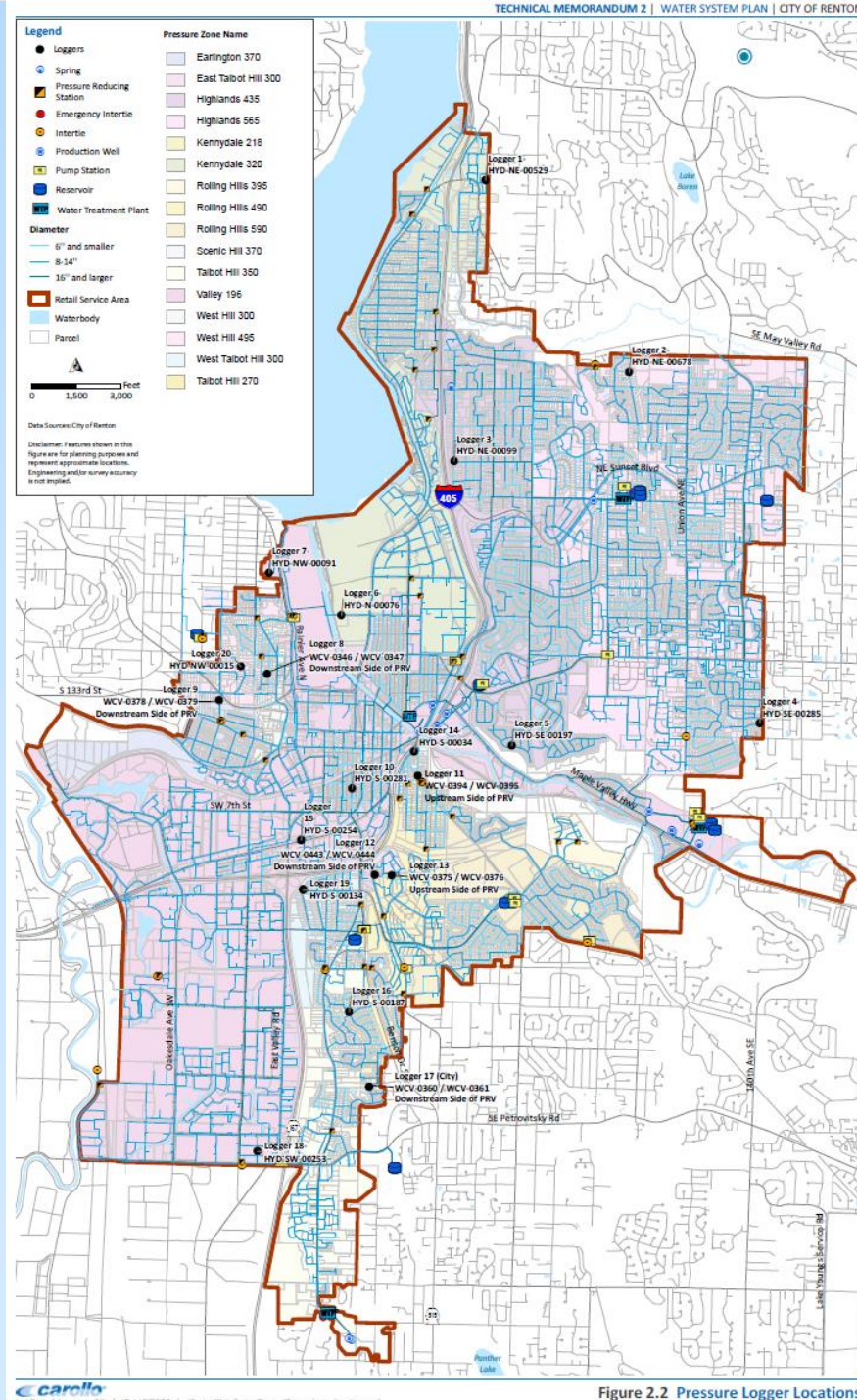


Figure 2.2 Pressure Logger Locations

# 20 Fire Hydrant Tests

- 20 hydrant tests
  - 2 pressure loggers
  - 1 flowing hydrant
- 44 pressure loggers installed by sections

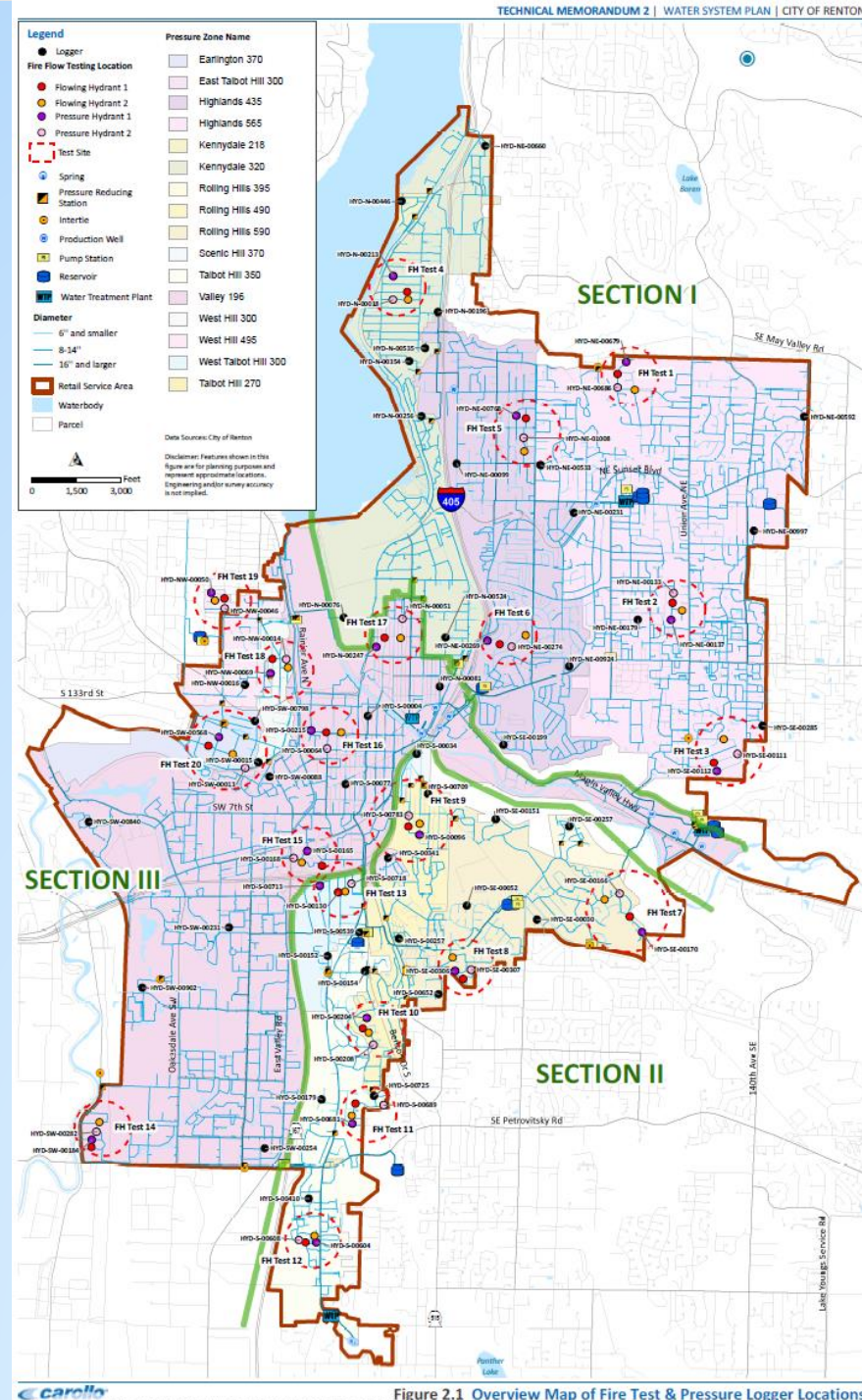
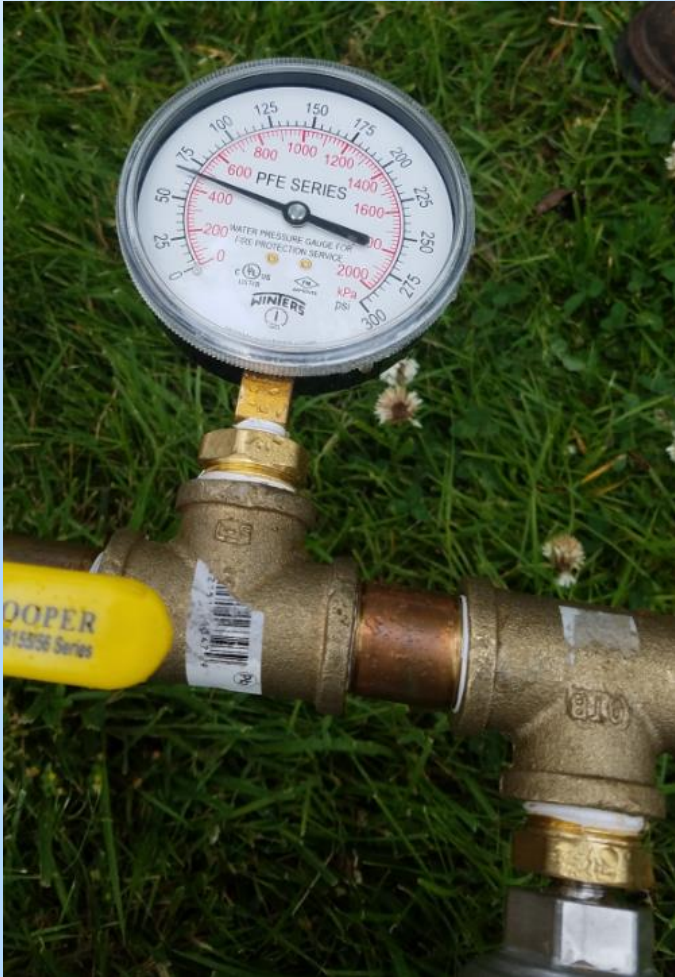


Figure 2.1 Overview Map of Fire Test & Pressure Logger Locations



# Extensive Field Testing





# Extensive Field Testing



Thank you to everyone  
on Renton's team!





# Extensive Field Testing

## Notes/Photographs:

Location of pressure hydrant P1



Logger setup for pressure hydrant P1



## Notes/Photographs:

Location/setup of pressure hydrant 1

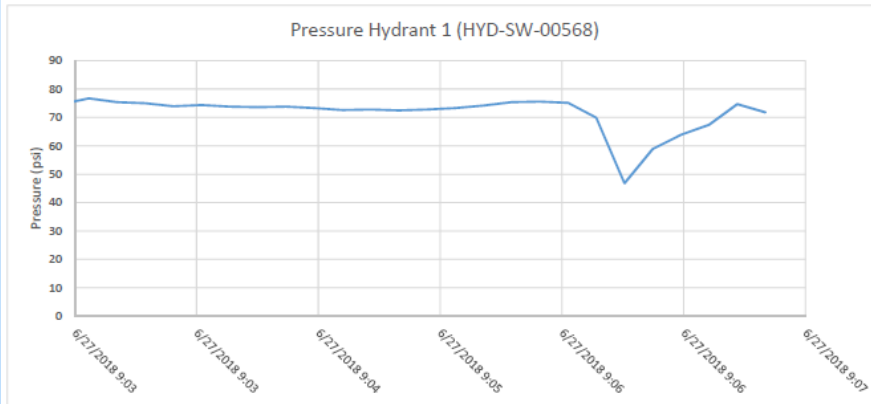


Logger setup for pressure hydrant 1



Logger setup for pressure hydrant P2

## Pressure at Data Loggers:



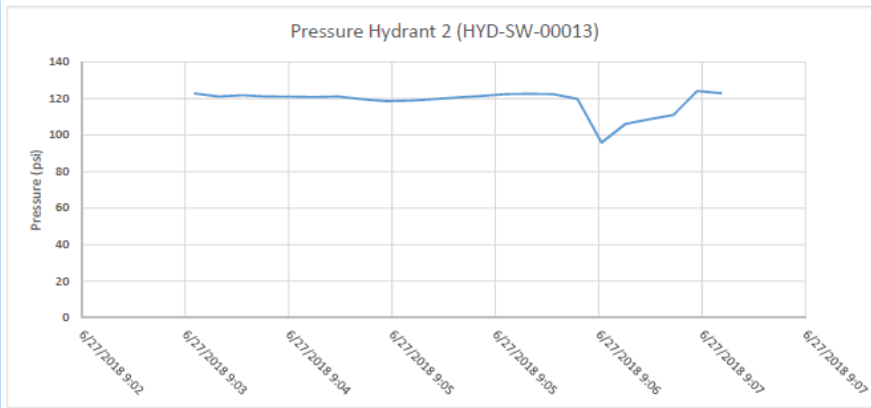
Pressure Hydrant 2



Logger setup for pressure hydrant 2



Pressure gauge for hydrant F1 discharge control



Flowing the hydrant F1



Flooding caused by flowing the hydrant F1

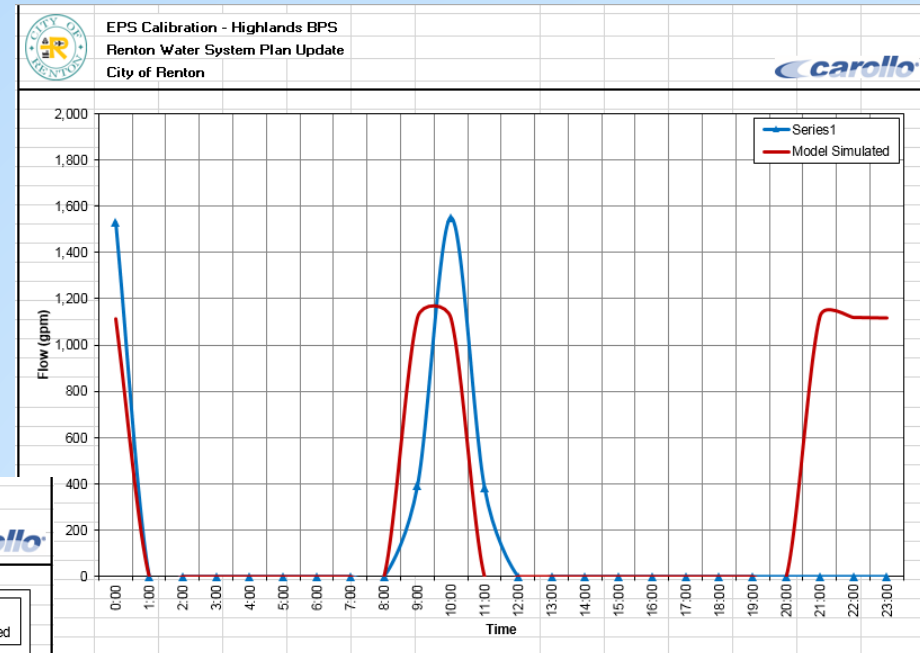
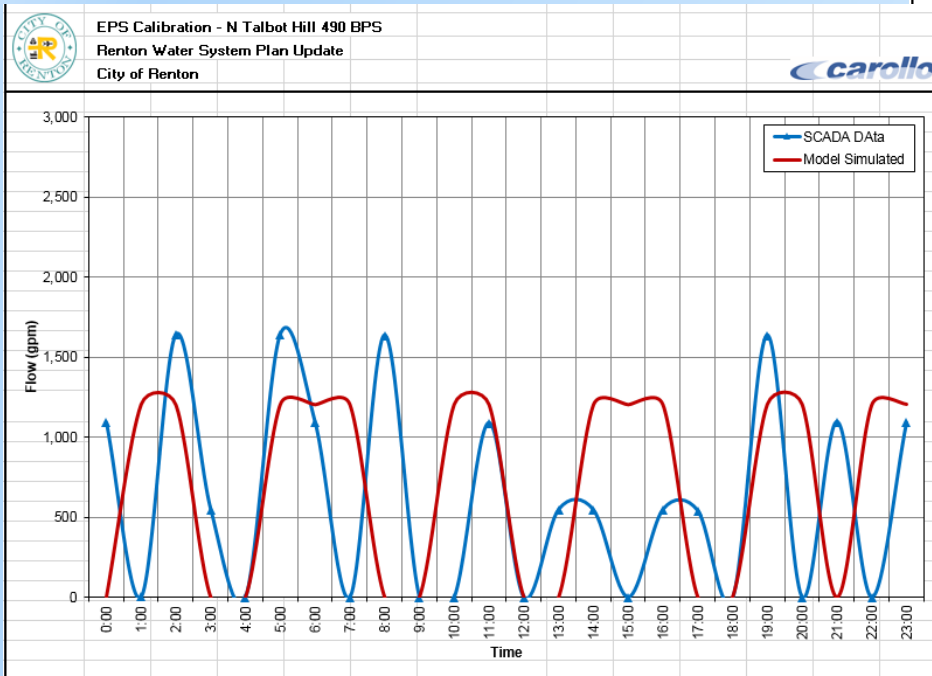


# Two steps in Model Calibration

- EPS Calibration
  - Pressures check
  - Tank operation
  - Pumps/wells operation
- Fire Hydrant Test Calibration
  - Static and Residual Pressures



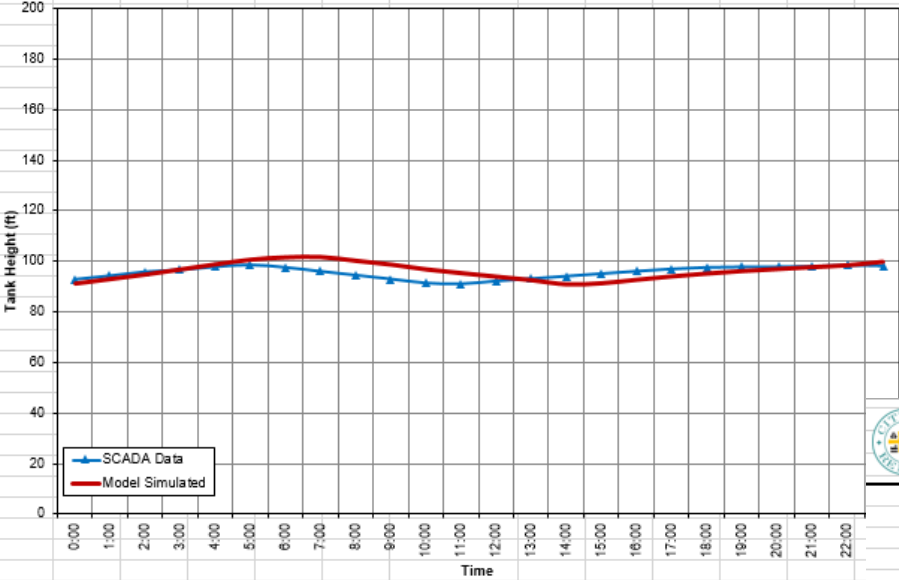
# Booster Pump Stations



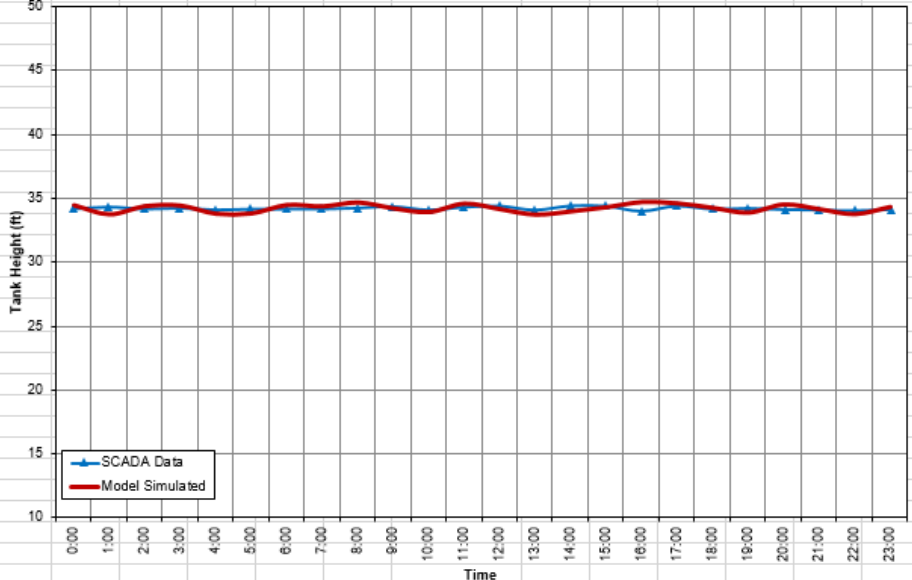
# Reservoirs



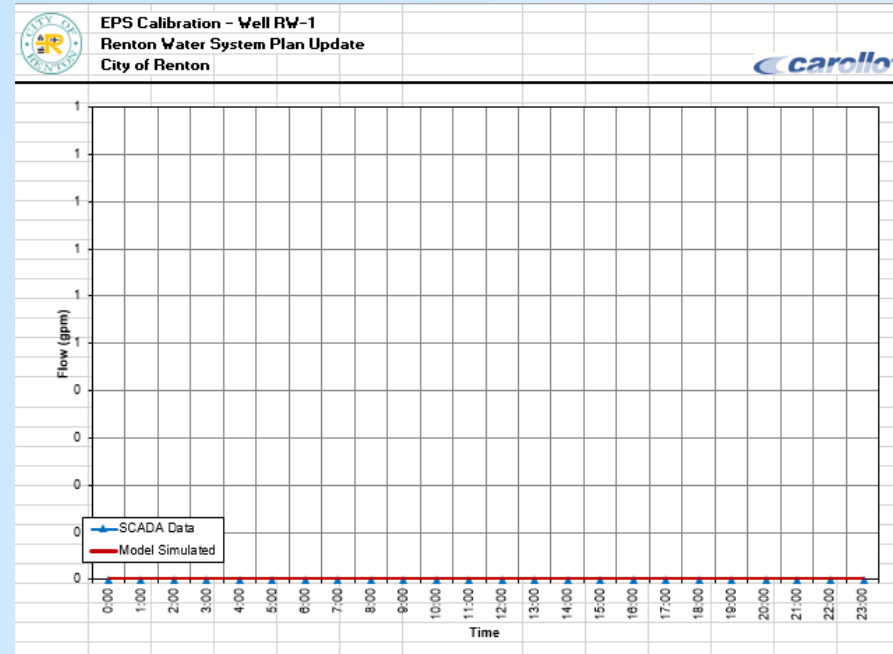
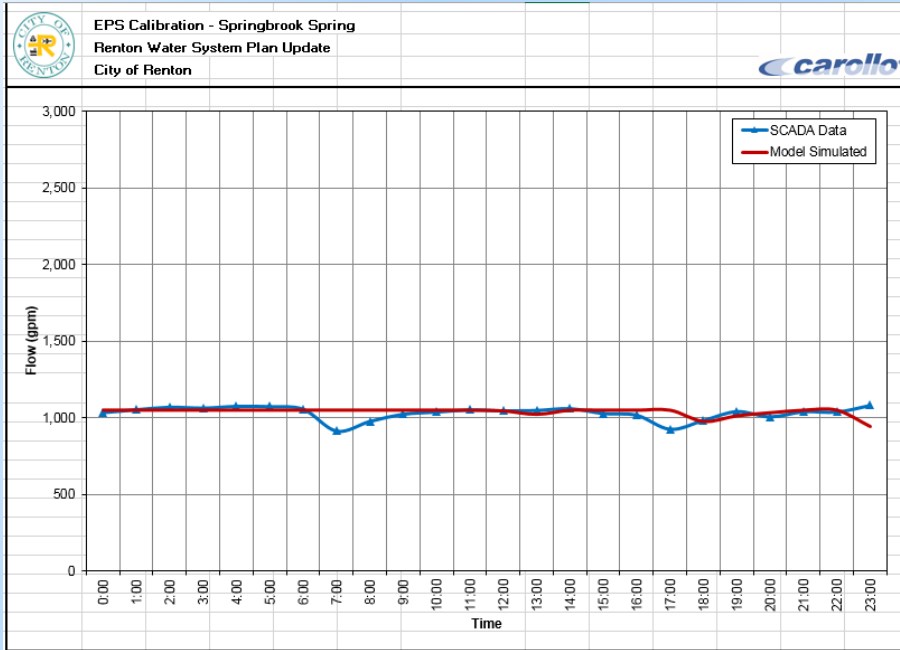
EPS Calibration - West Hill Res  
 Renton Water System Plan Update  
 City of Renton



EPS Calibration - Rolling Hills 490 Res  
 Renton Water System Plan Update  
 City of Renton

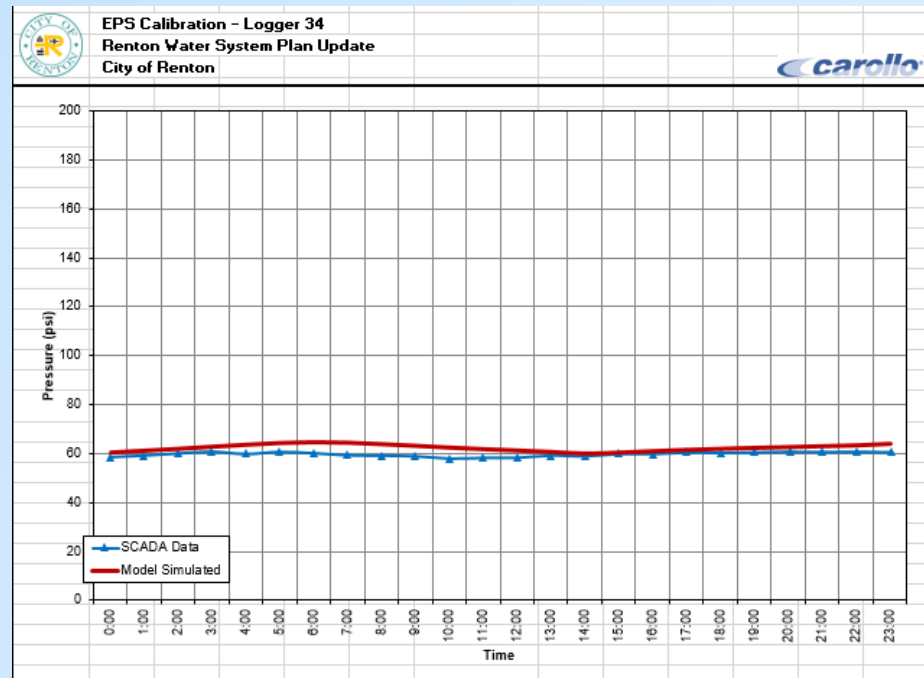
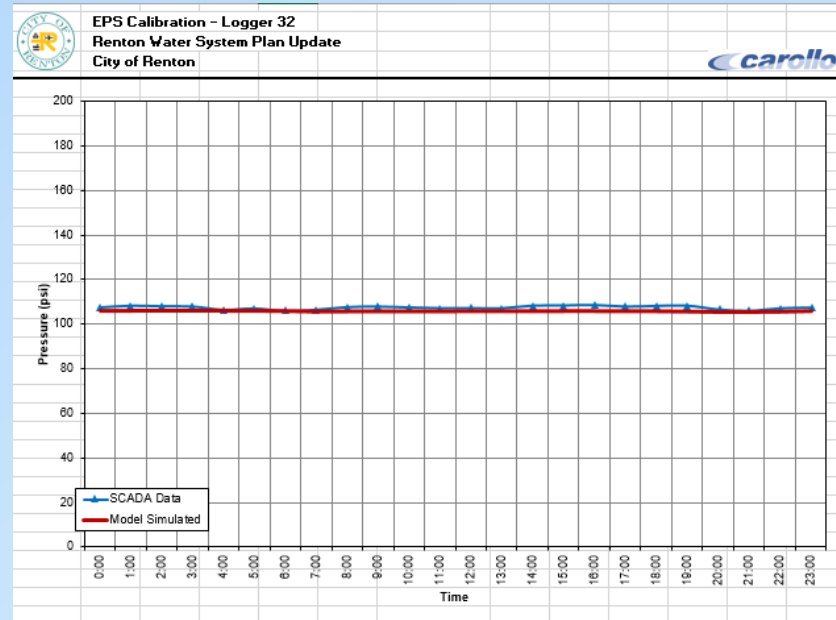
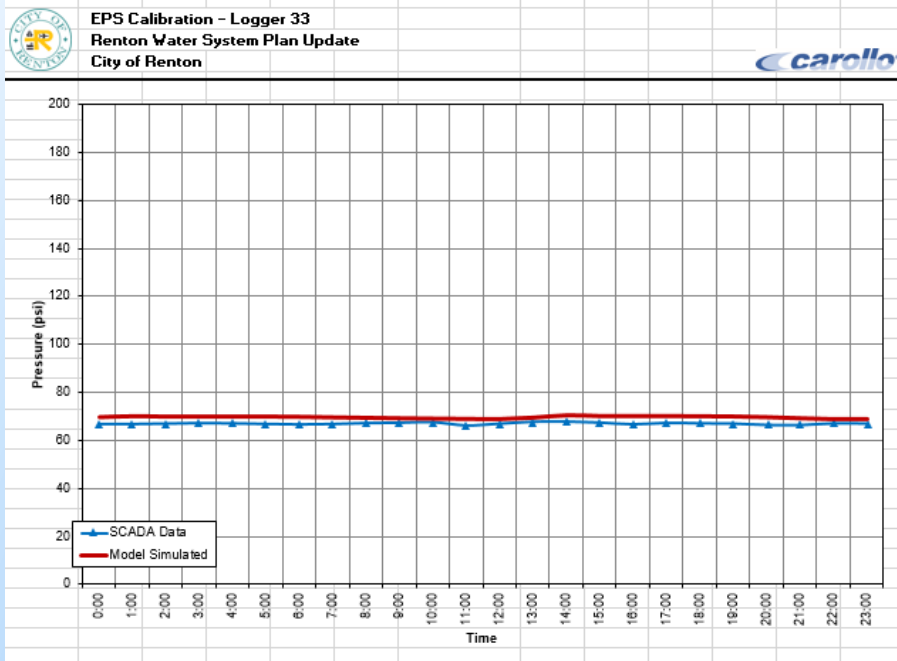


# Wells



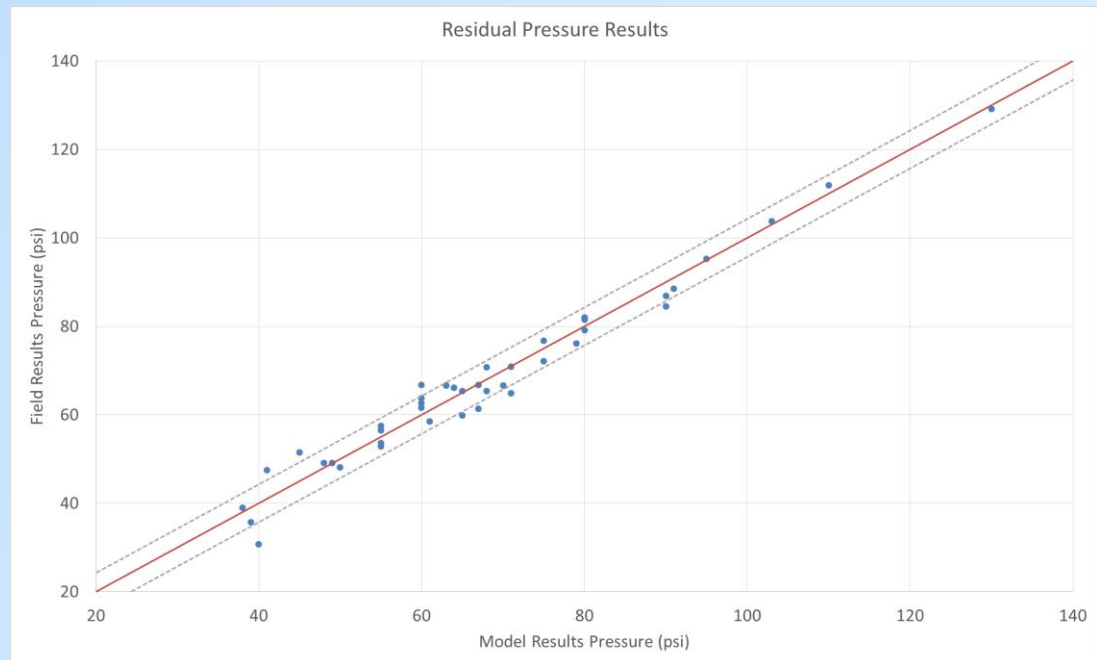
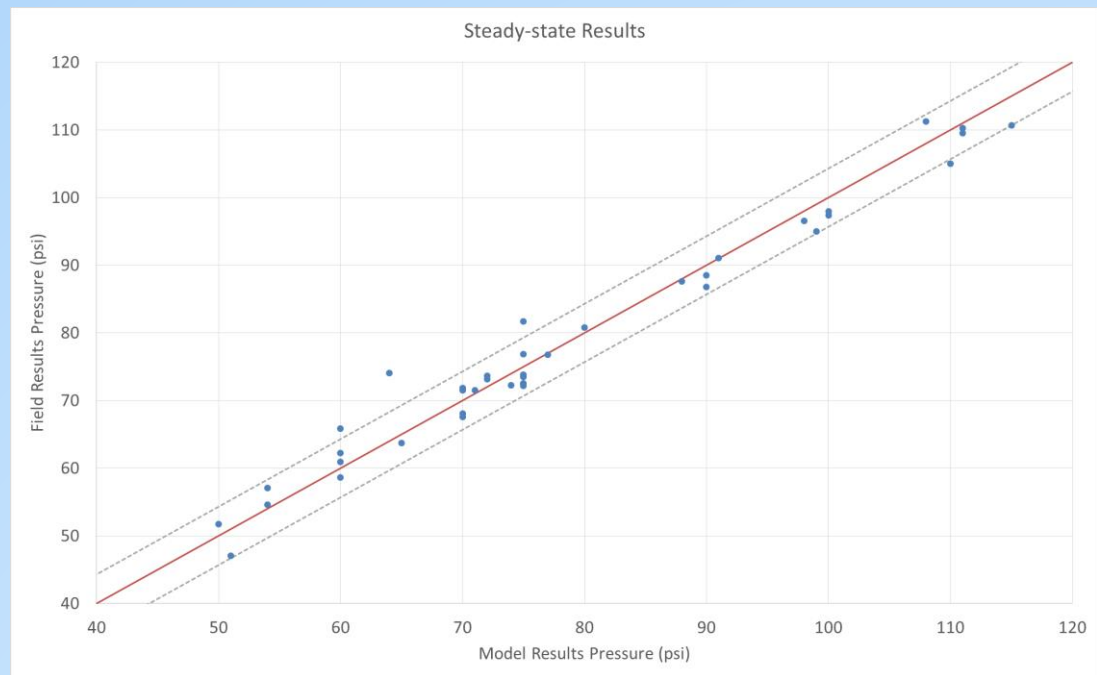


# Pressure Loggers



# Calibration Results Overview

- A total of 88 calibration points
- ~85% of points calibrated
- Pressure within +/- 4.3 psi



# Summary

- AMI information allowed to remove a typical unknown parameter during calibration
- Better understanding of demands and variation by zone and season
  - ADD/MDD Peaking Factor
  - MDD/PHD Peaking Factor
- Model can be used for:
  - Planning
  - Design
  - Operational Analysis
  - Water Quality



# Questions??

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- Aurelie Nabonnand – [Anabonnand@carollo.com](mailto:Anabonnand@carollo.com)

