When the big one hits…
will your pipes and valves stand the test?

Evaluating pipe and valve redundancy in Sammamish Plateau Water's System

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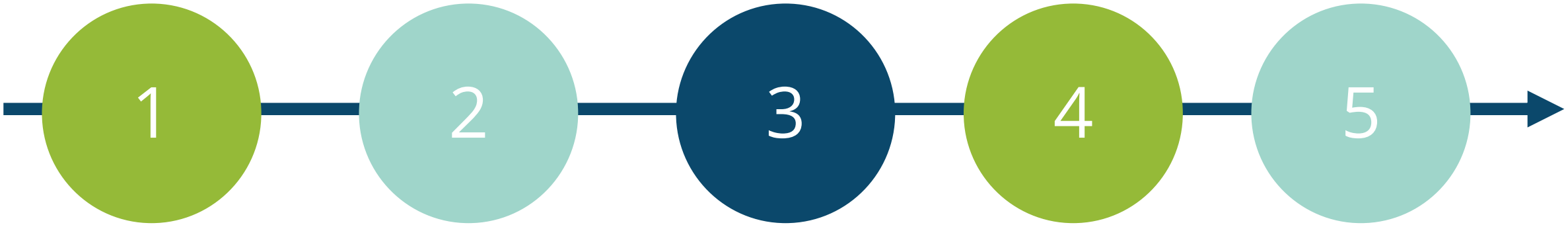
Agenda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SPW Who?
Supply Evaluation
Conclusions
Pipe & Valve Evaluation
Conclusions

29 square miles

Population: **63,000**

Water connections: **18,700**

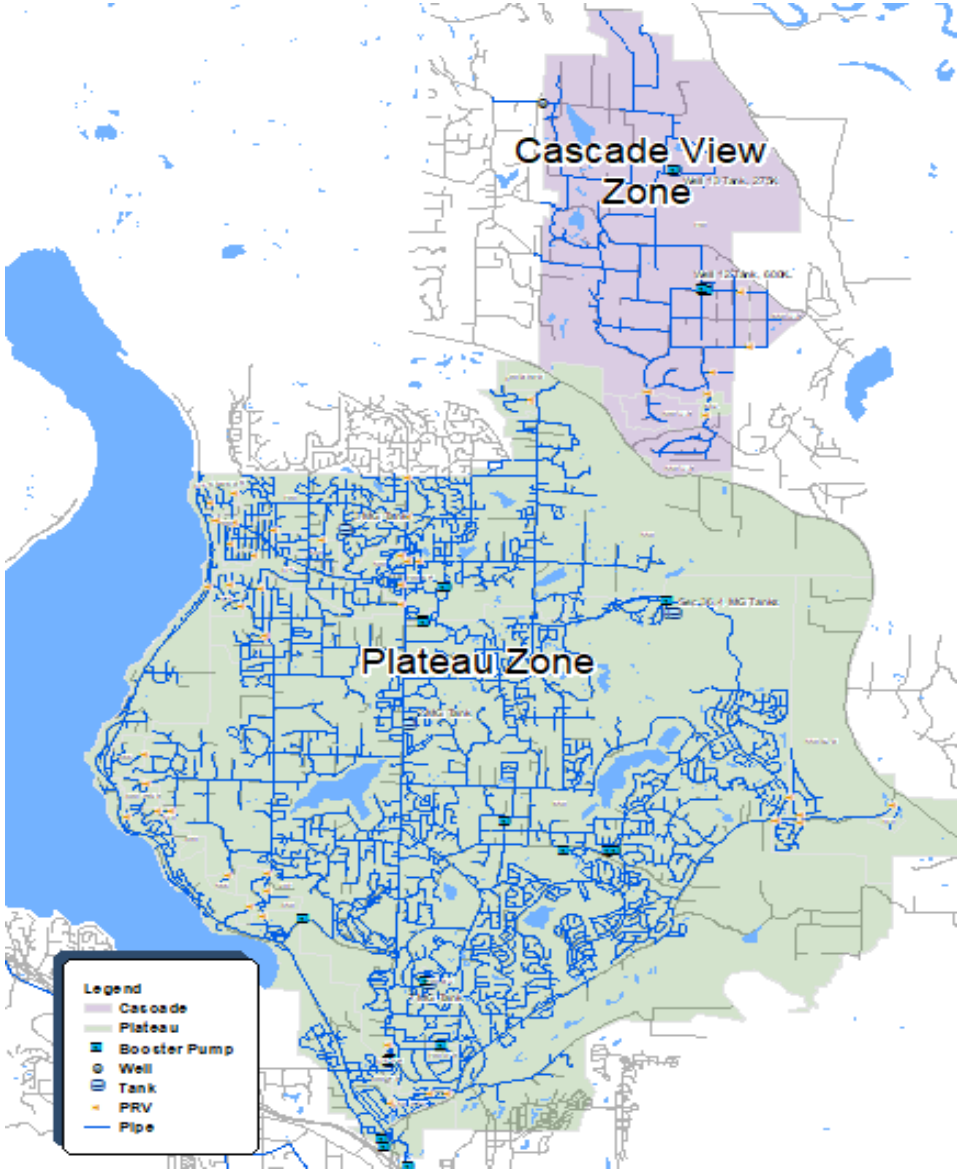
Sewer connections: **12,300**

Replacement value: **$1 Billion**

Sammamish Plateau Water

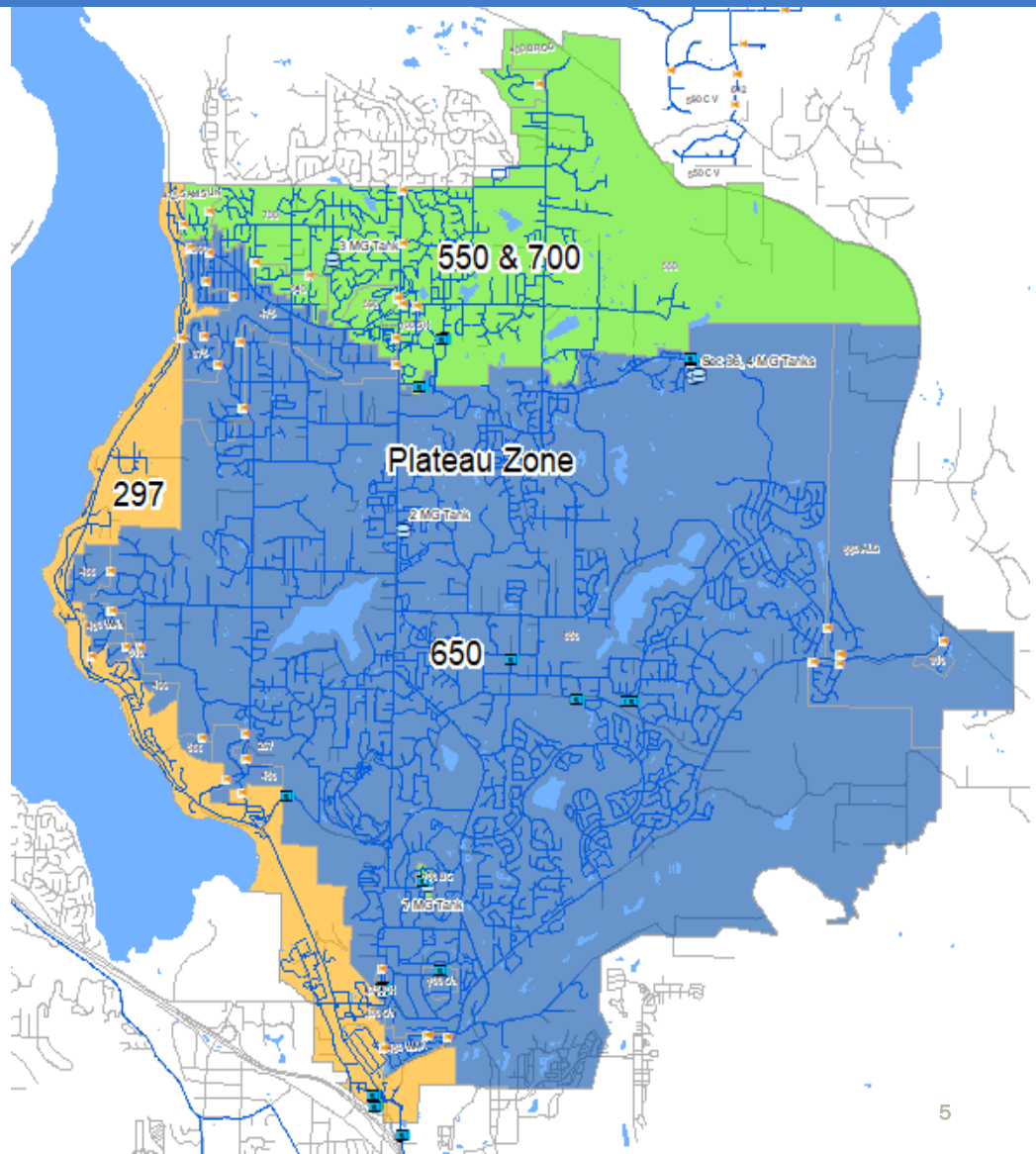
- Mid-size water and sewer utility
  - Located 20 miles east of Seattle, WA
  - 2018 budget: $74,000,000
- About the community we serve
  - Population: **63,000**
  - **29** square miles, covering **2** cities (Sammamish and Issaquah) and unincorporated King County
  - Median household income: **$144,775**
  - % of population with Bachelor degree or higher: **72.5**
- Our Mission

  Sammamish Plateau Water will provide safe, efficient, and reliable water and sewer services by being a leader in the planning and the practice of fiscal and environmental stewardship.



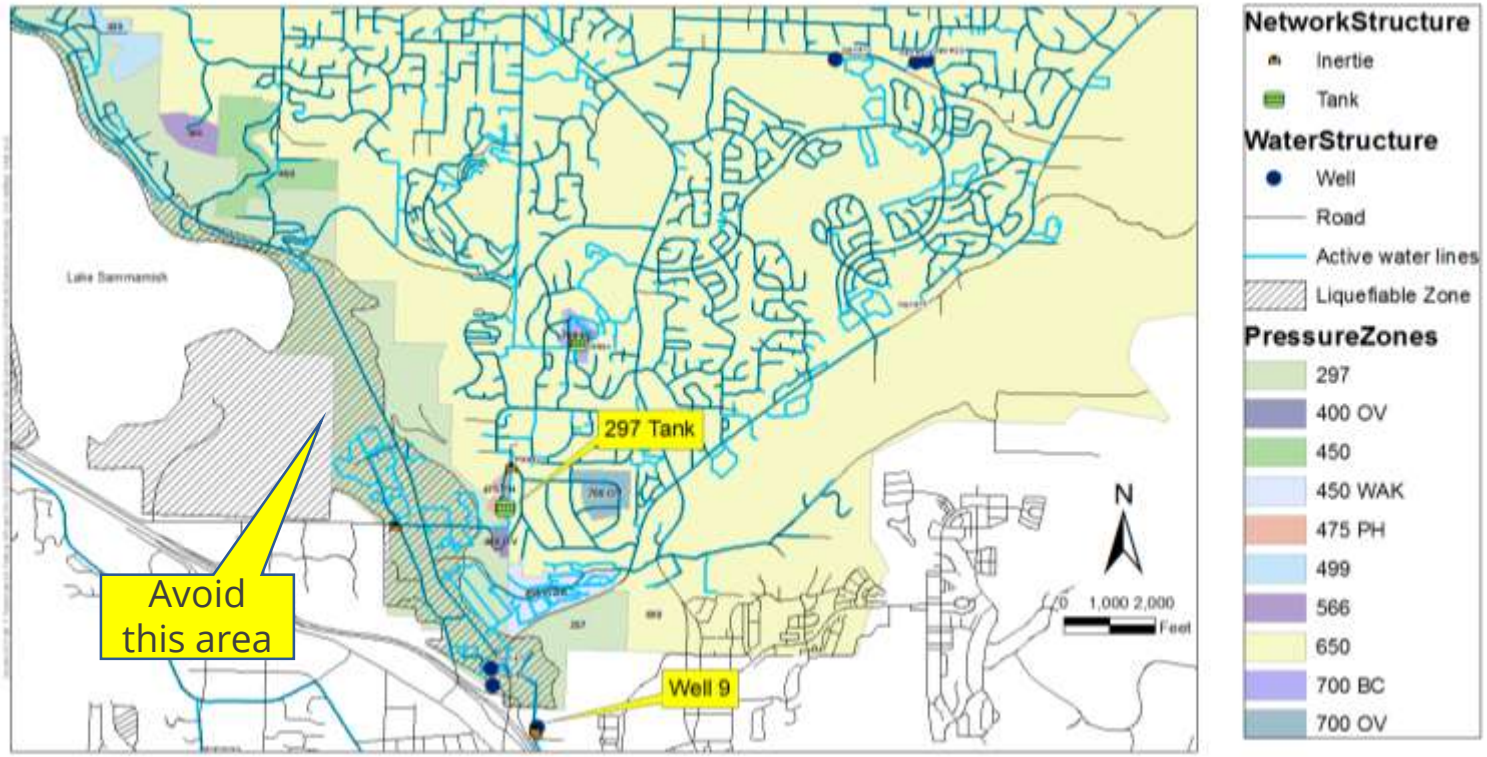
Purpose of the 2017 Seismic Pipeline Study

- Follow up to the Seismic Vulnerability Report, 2014
- Reassess the need for a New Supply Pipe to the 650 Zone
  - Determine Potential Level of Service after an earthquake
  - Develop alternatives for a new seismically resilient supply pipe to the 650 zone
- Evaluate the resiliency of SPW's distribution system to a pipe breaking seismic event



Effects of an Earthquake - Assumptions

- Seismic Liquefaction Zone
  - Well 9 would function
  - Many facilities would be inoperable
  - Many broken pipes
- Plateau Area 650 Zone
  - Some pipes break however most would be in service
  - Wells would be in service



- Plateau area supply could feed the 297 zone through pressure reducing valves

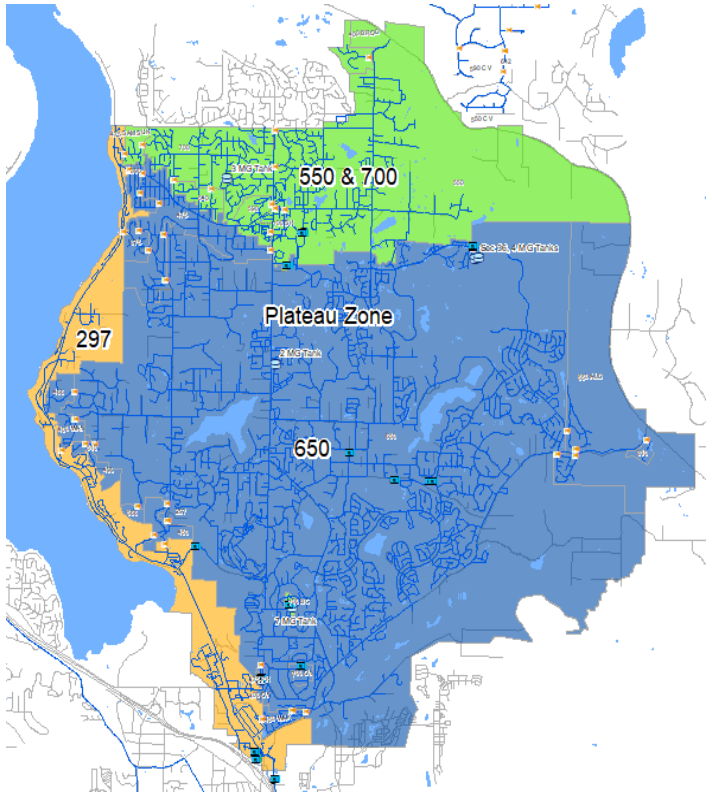
Level of Service - Demand

- What demand should be supplied during an emergency?
- All agreed it is reasonable to reduce the Level of Service following an earthquake.

	MGD	gpm
Average Winter Demand (Nov-Feb)	3.3	2,300
2016 Average Day Demand	4.7	3,262

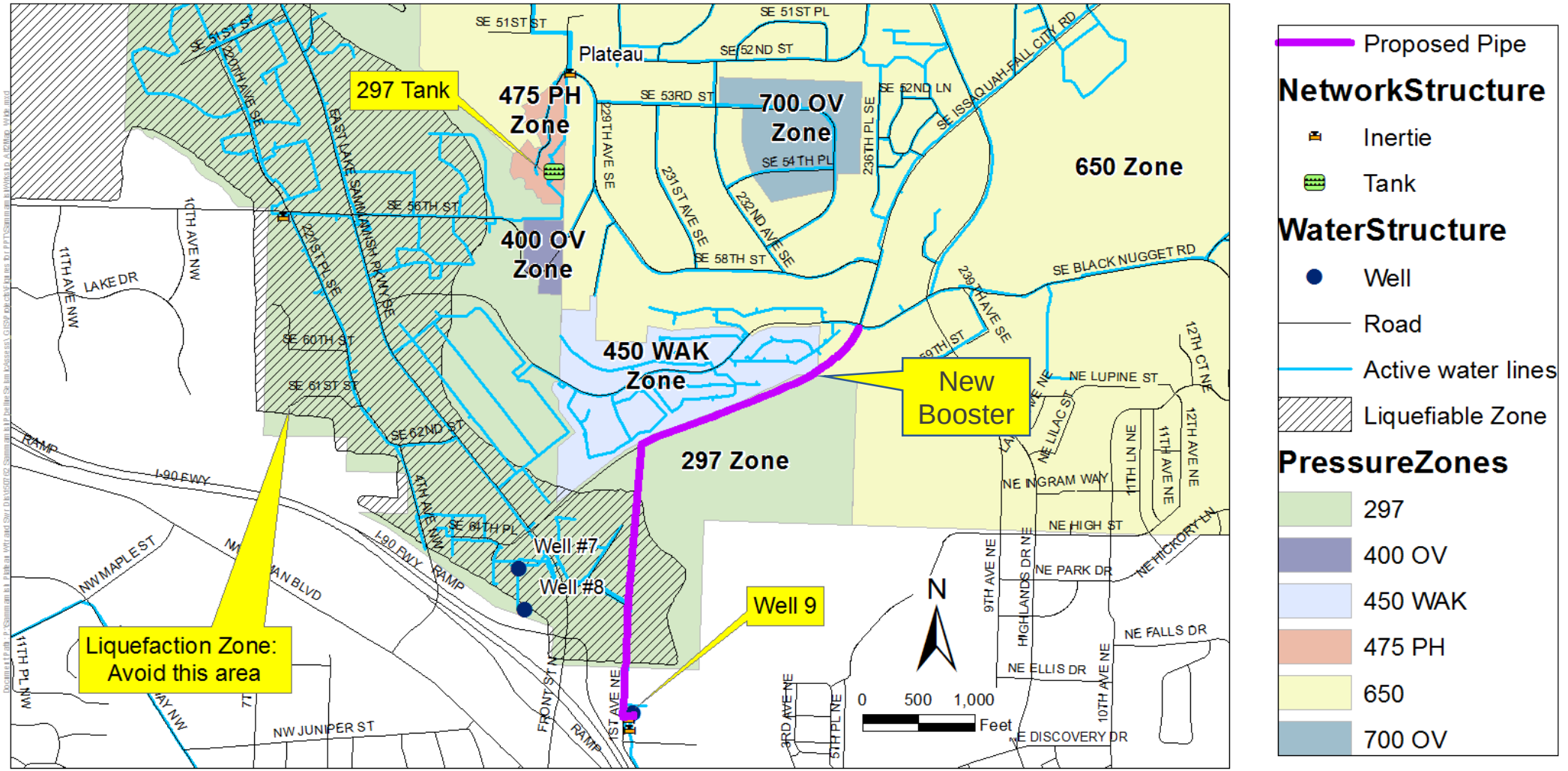
← More conservative, use this

Level of Service



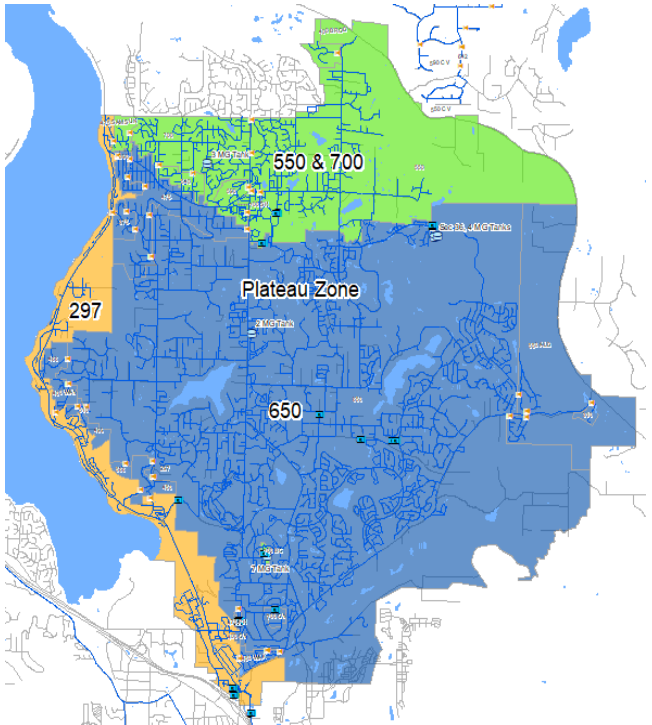
- Demand
  - 2016 Average Day Demand = 4.7 MGD (3,262 gpm)
  - This is more conservative than the average winter day demand
  - Demand will increase in the future and eventually this won't be enough
- Supply
  - Plateau, without 297 Zone supply = 6.7 MGD (4,675 gpm)
- 6.7 MGD supply > 4.7 MGD demand
  - Plateau sources exceed "emergency" demand and can supply the overall system

Issaquah Fall City Road Pipe and Booster Station



Supply Evaluation Summary

- Using relatively conservative demand assumptions, supply is adequate to serve system under emergency conditions
- A new 297 supply pipeline can provide additional redundancy to the 650 Zone; however, it can be delayed



Pipe and Valve Evaluation

Distribution System Resiliency Analysis

- What is required to conduct the analysis
- Performance Criteria
- How does the system perform with the loss of components?
  - Pipe Breaks to assess:
    - Violation of system pressure thresholds - Innovyze
    - Demand isolated by pipe breaks - Optimatics
  - Number of valves to isolate a pipe - Optimatics
  - Number of valves to isolate a valve - Innovyze
  - Supply redundancy (Single Pipeline to/From Facilities) – Optimatics & Innovyze

Data and resource requirements

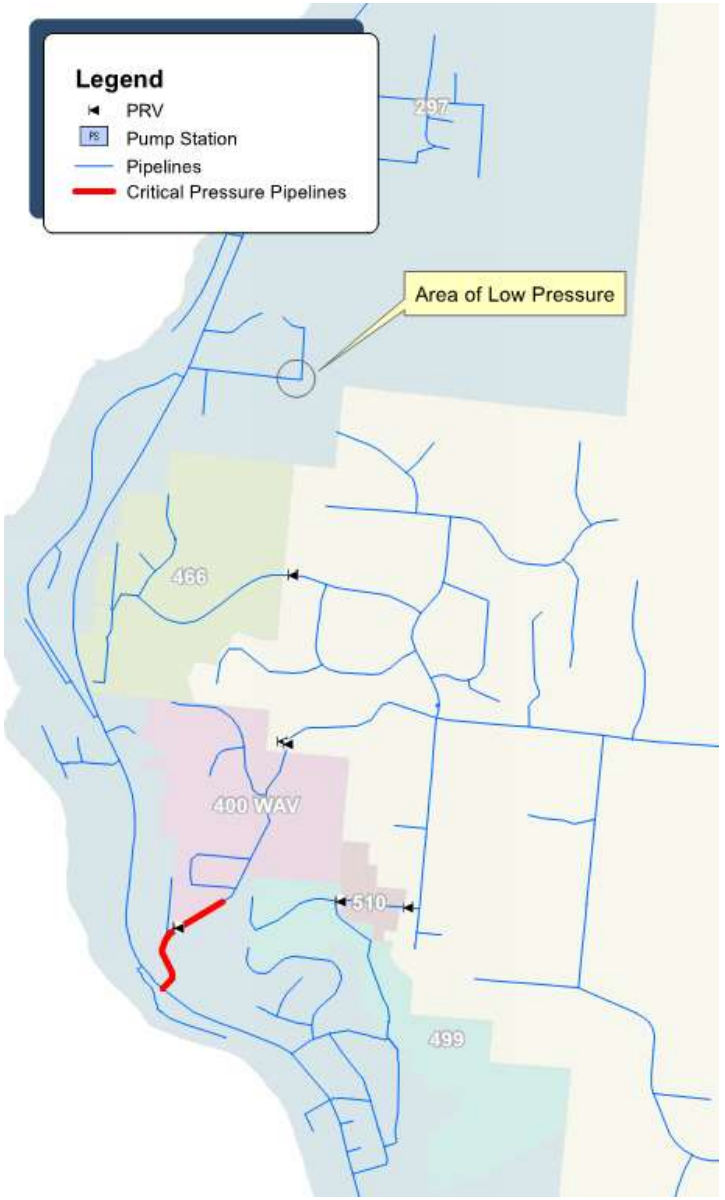
- Calibrated hydraulic model
- Mainline valve locations (from GIS)
- Performance criteria

Performance Criteria

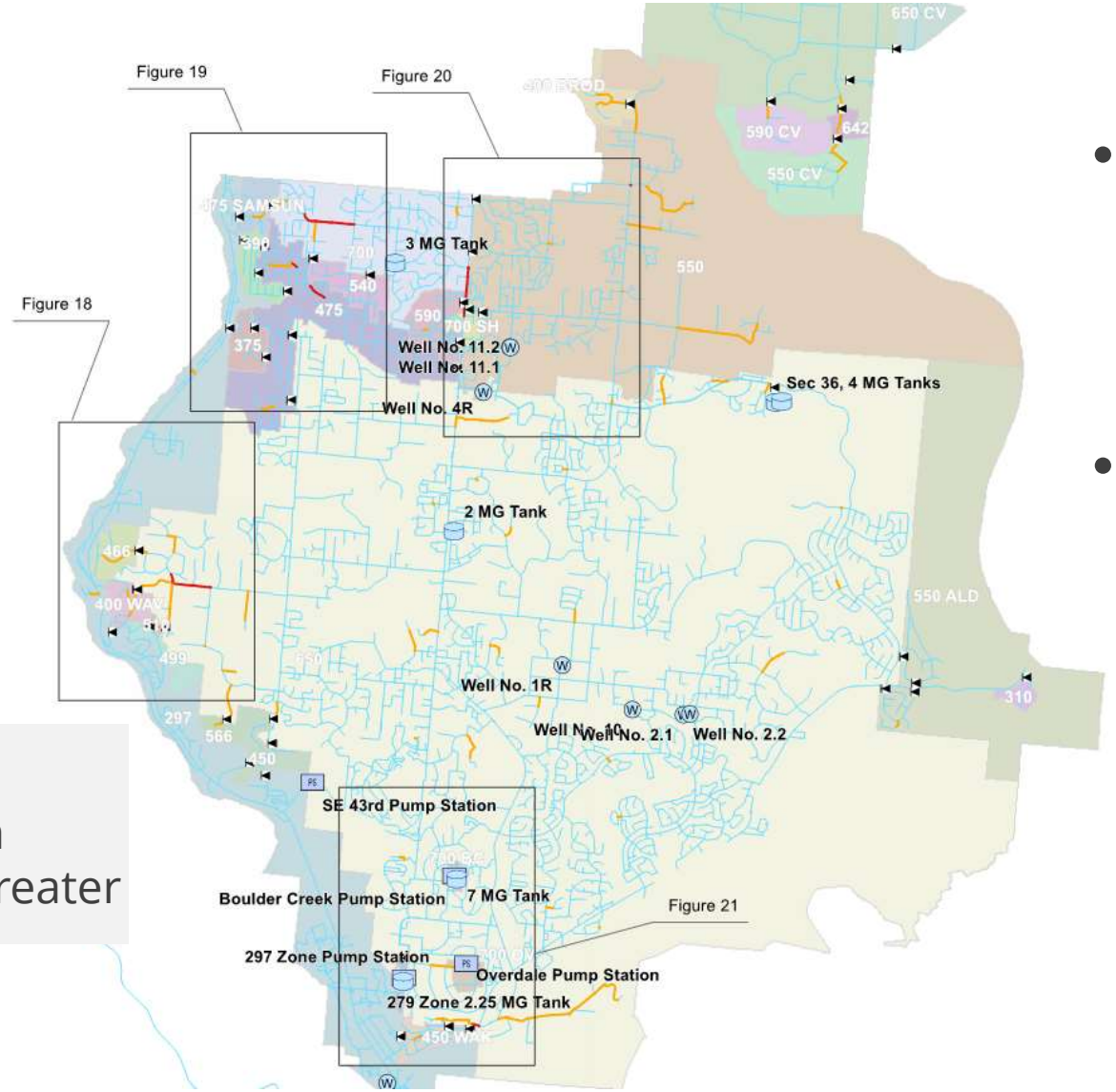
- Scenario utilized (Max Day Demand)
- Pressure criteria
  - Customer Meter Locations (>20 psi)
  - Transmission lines and facilities (>0 psi)
- Critical Pipe connections (Removal from service isolates customers):
  - Approx. 0.5 gpm (MDD)/EDU (EDU = 1 Residential customer)
  - 0-10 gpm (MDD) (0-20 ERU)
  - 10-50 gpm (MDD) (20-100 ERU)
  - 50 gpm or more (MDD) (100 or more ERU)
- Number of Valves required to isolate pipe = 4 or fewer
- Number of Valves required to isolate a valve = 5 or fewer

Pipe Break Pressure and Demand Isolation Analysis

- Process:
  - Batch modeling simulations are run where each pipe is broken in the distribution system one by one
  - Software identifies which pipe breaks result in pressures below set criteria (<20 psi) and the location of the low pressure
  - Software identifies which pipe breaks cause the isolation of demand



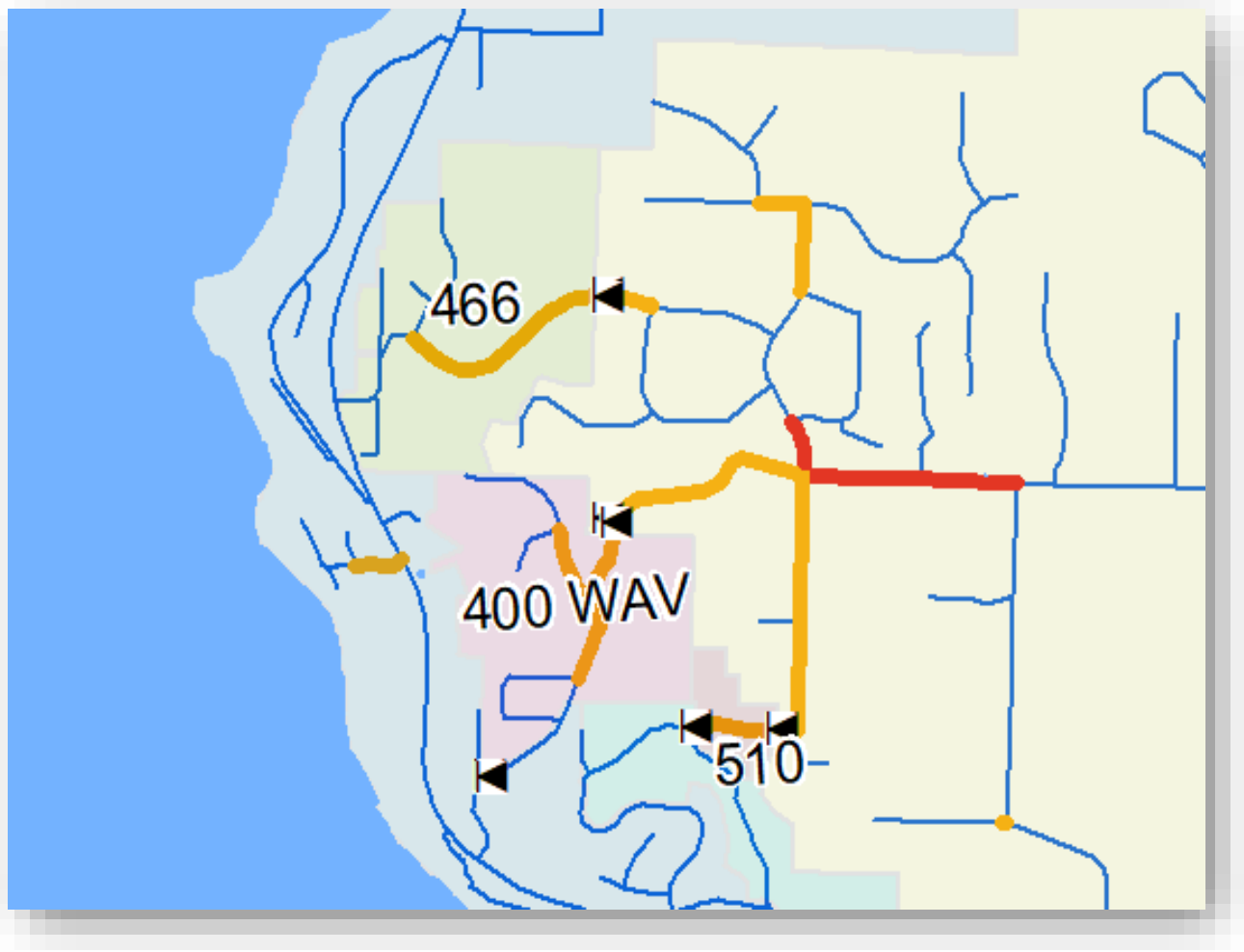
Pipe Breaks – Demand Isolation/Number of Customers Out of Service



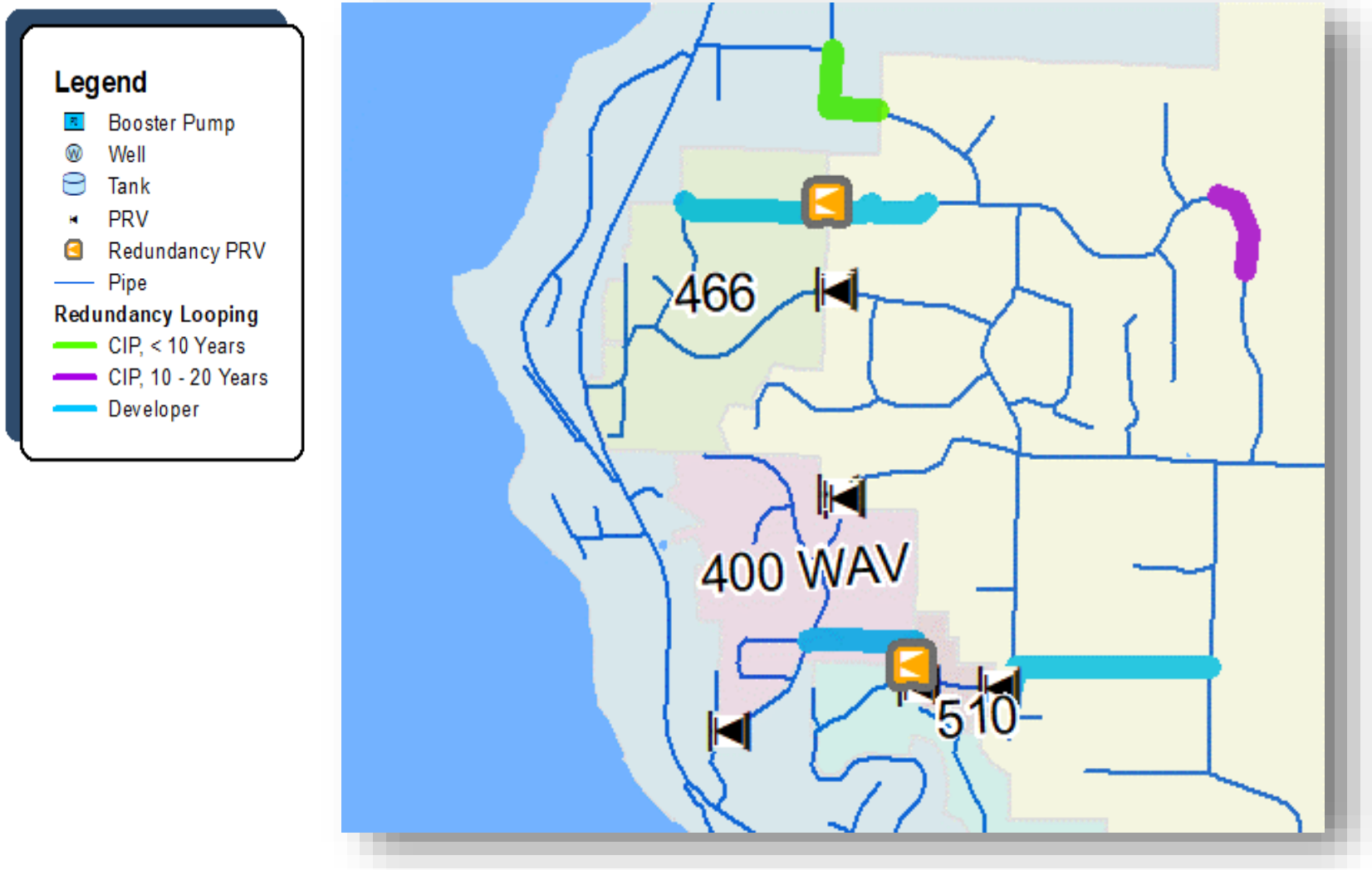
Demand Isolated:
Orange = 10-50 gpm
Red = 50 gpm and greater

- Some areas may be addressed by changing operations
- Single PRV stations can create a dead-end

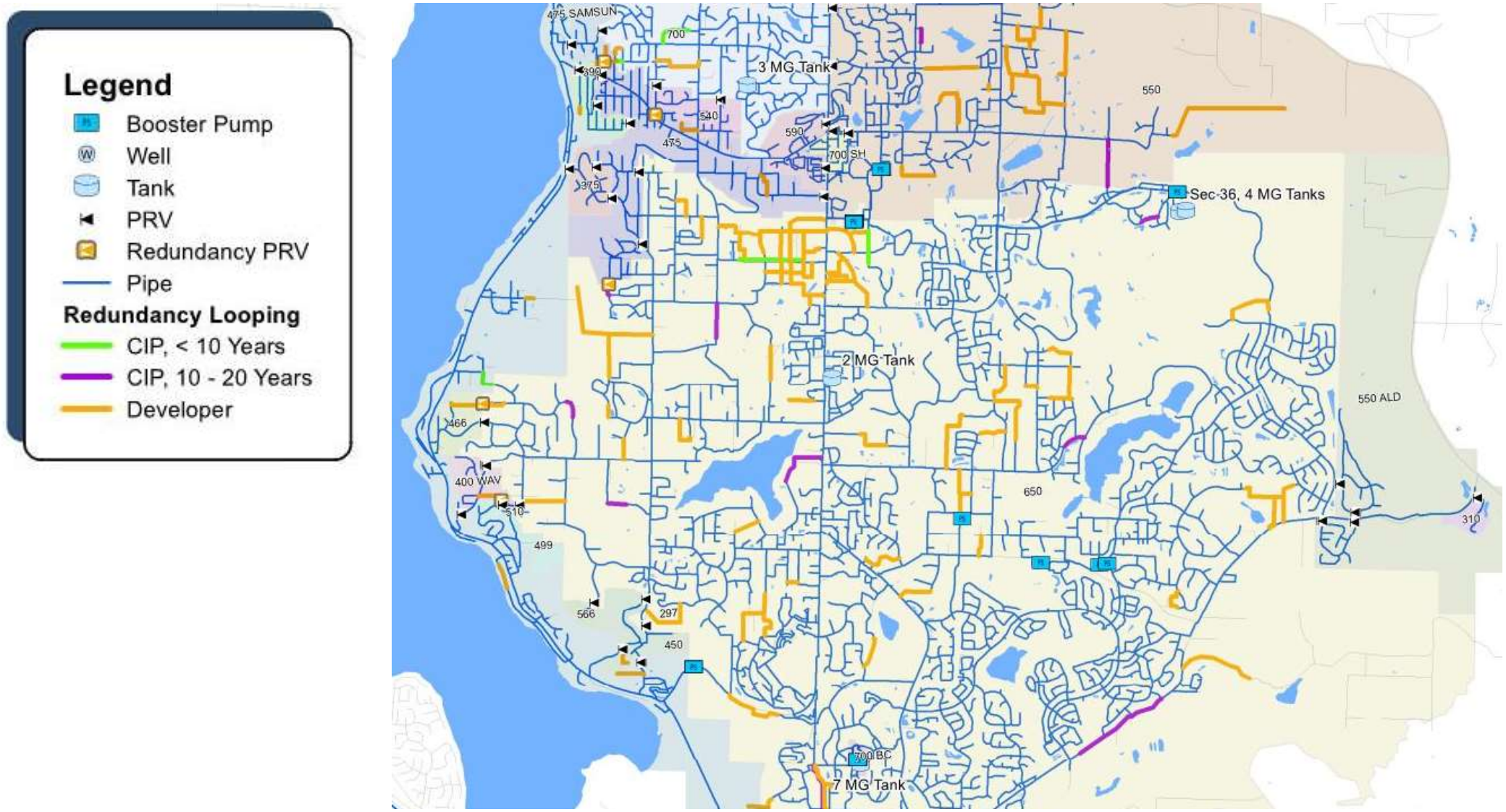
Example Demand Isolation Results



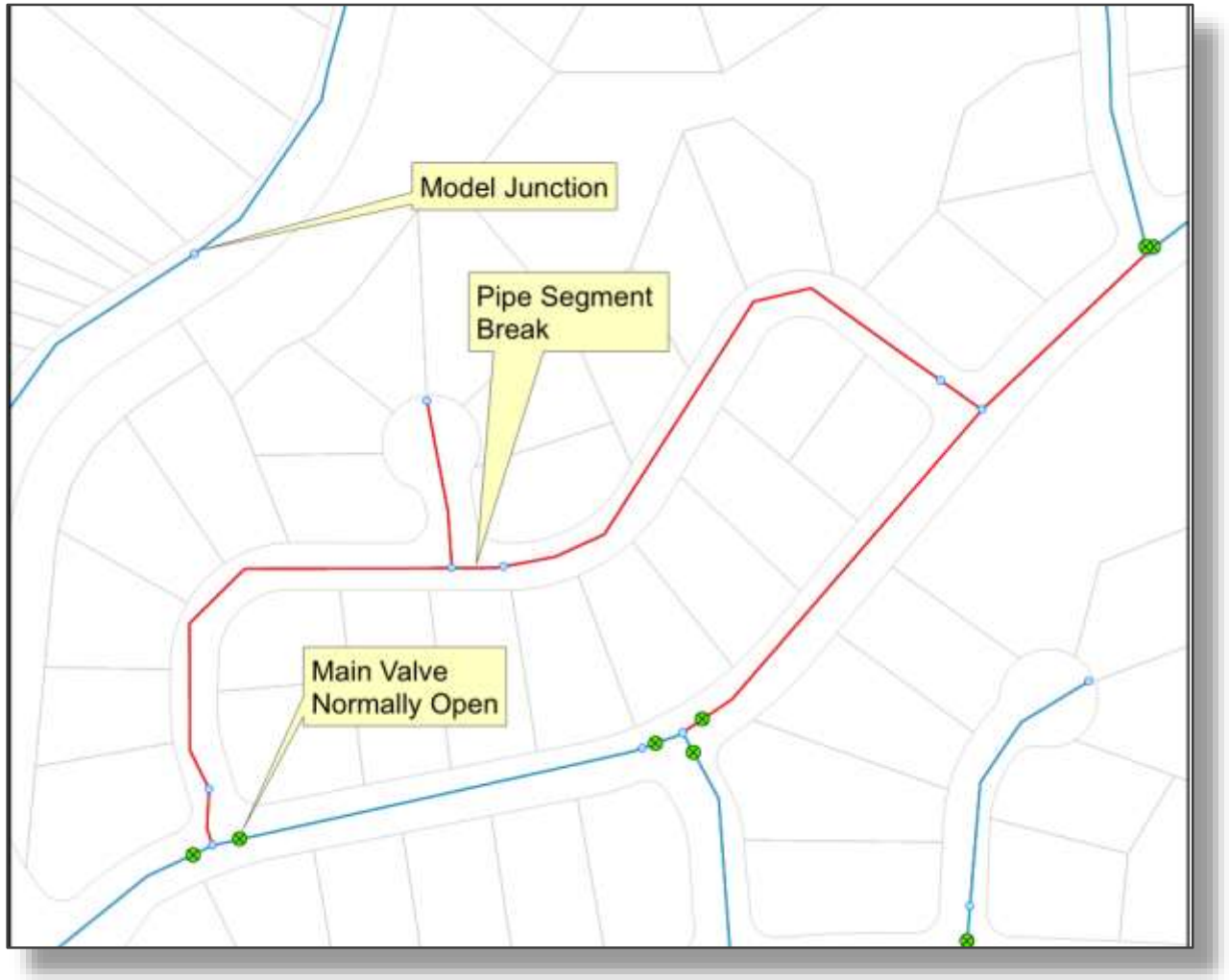
Redundancy Improvements



Redundancy Improvements

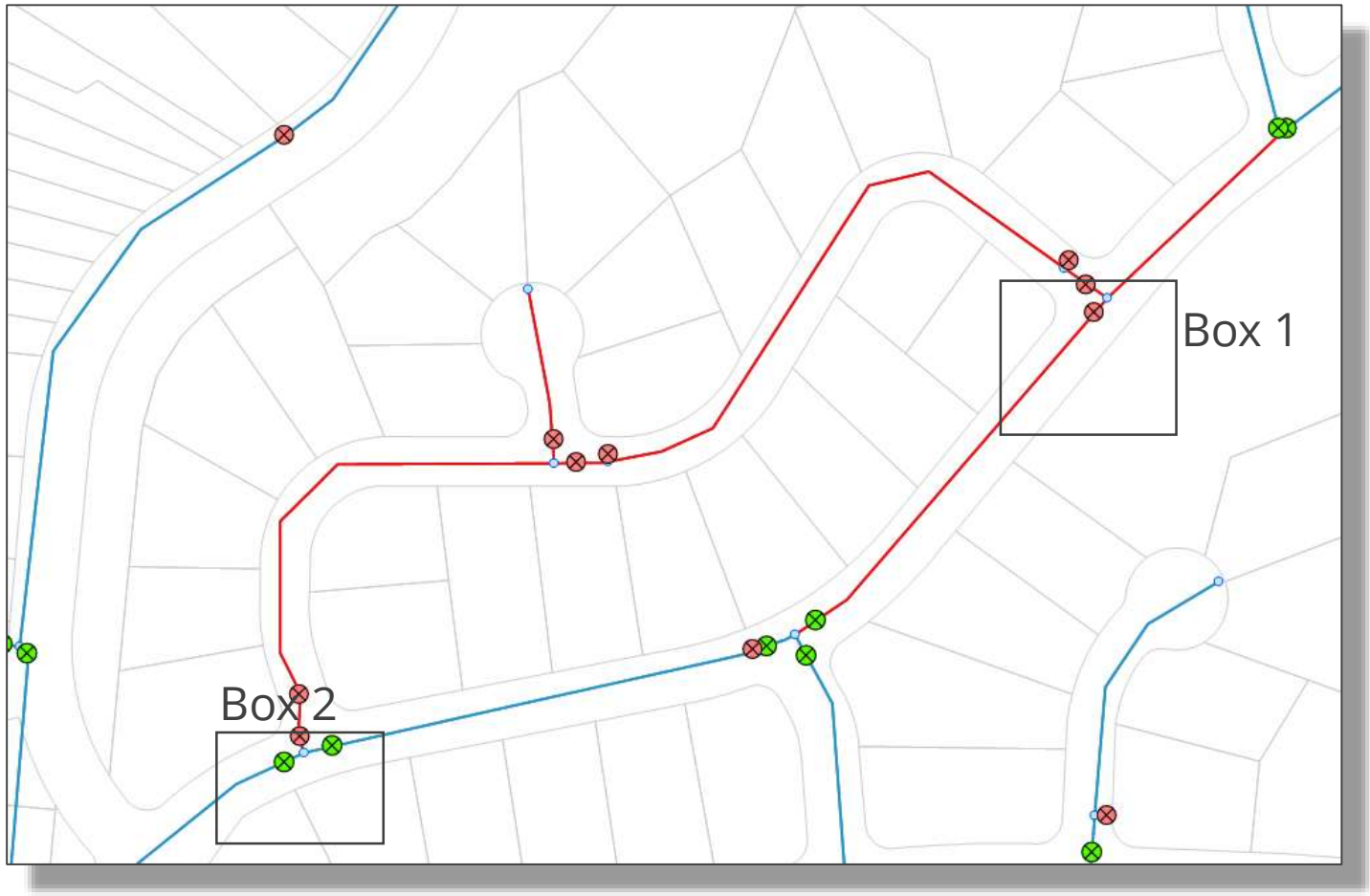


Model Components: Pipes, Nodes, and Valves



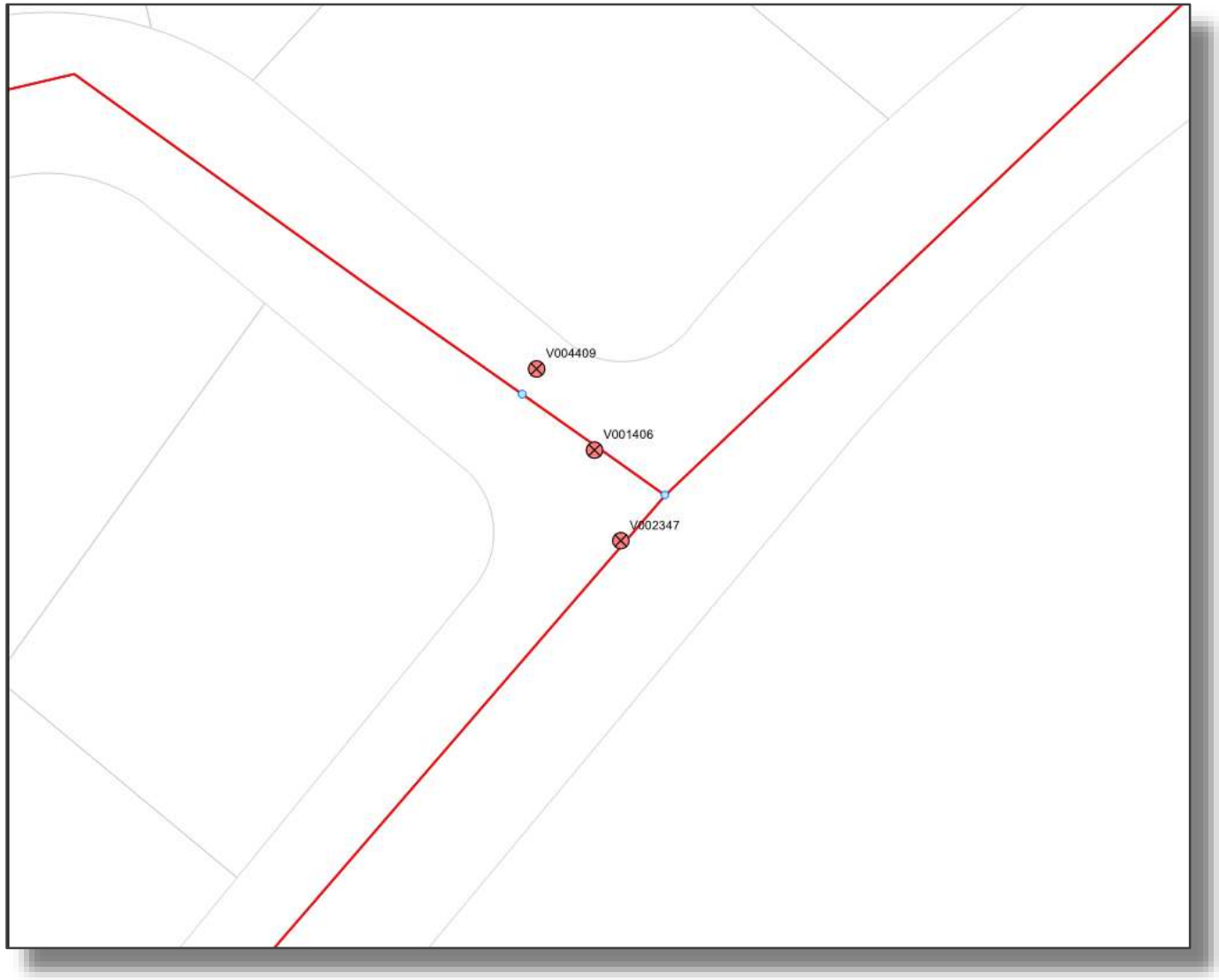
Valve Spatial and Attribute Quality Control

- Valve attributes:
  - Active “status = active”
  - Typically open “normally open <> N”
  - On main line “main line valve = on”
- Spatial location of valves
  - On mainline
  - Near mainline (associated with nearest main)



Red = “Excluded” Green = “Included”

Valve Spatial and Attribute Quality – Box 1



SPW's Valve Attribute Summary

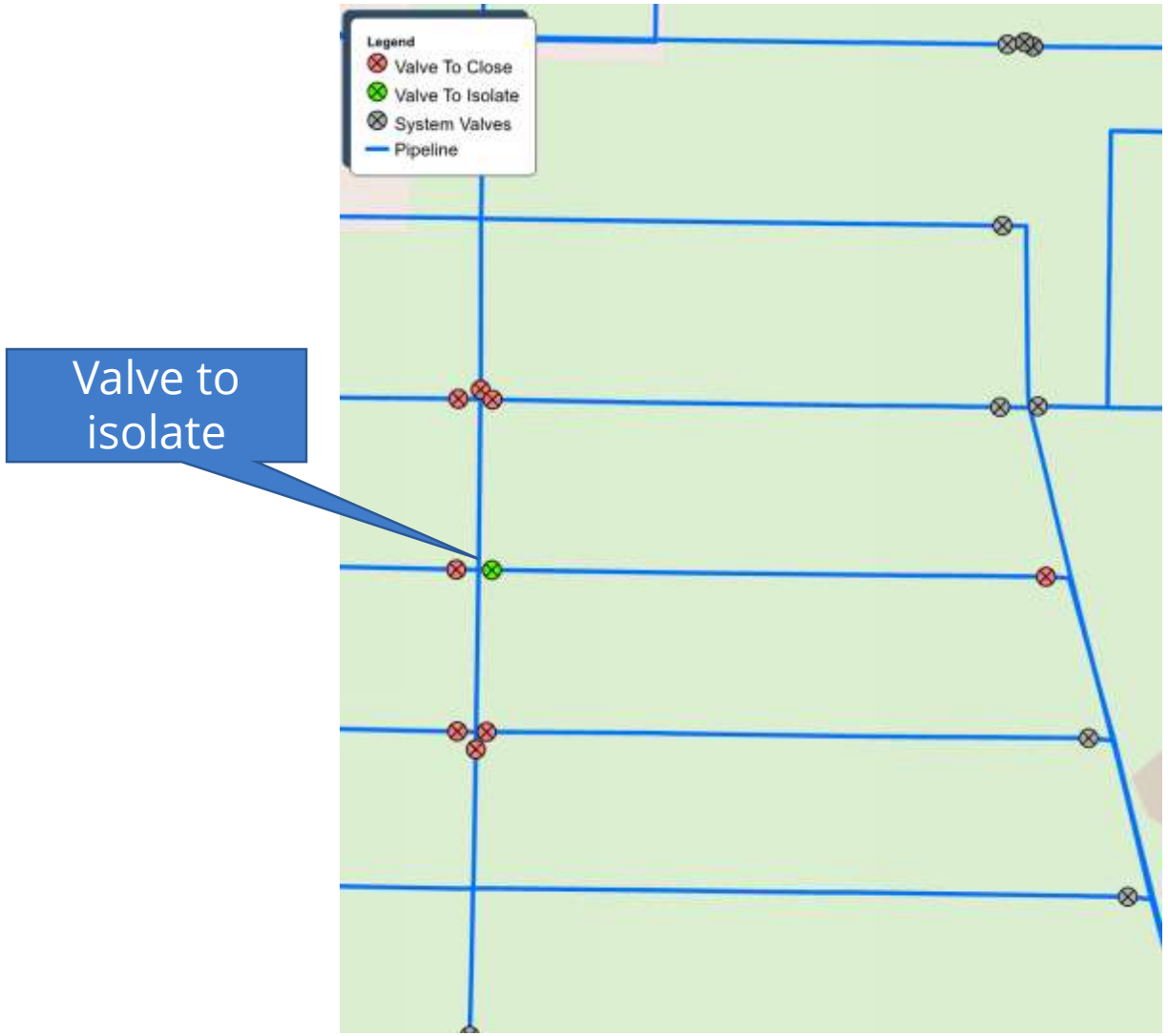
- Out of 8,726 valves:
  - 4,874 valves met attribute criteria (Active, Mainline, not closed) and were used
  - 3,935 of those were spatially located on pipelines (Approx. 81%)
    - 939 required review by SPW staff
  - 380 valves in total, had a null "Mainline valve" status and were not used
    - Required review by SPW staff

Valves required to isolate pipe breaks

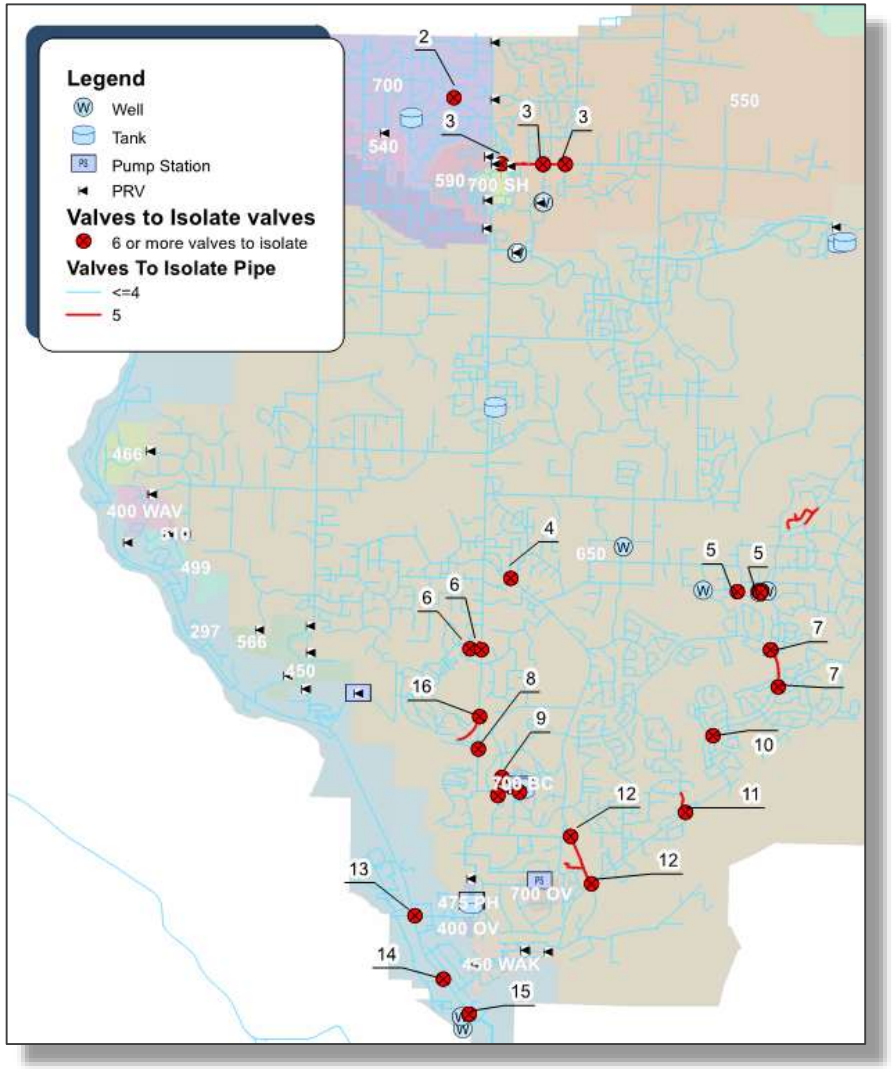
- SPW generally has good valve coverage
- A number of locations were identified to have additional valves installed

Valves Required	Occurrences
8	1
7	2
6	20
5	173
4	557
3	1463
2	1033

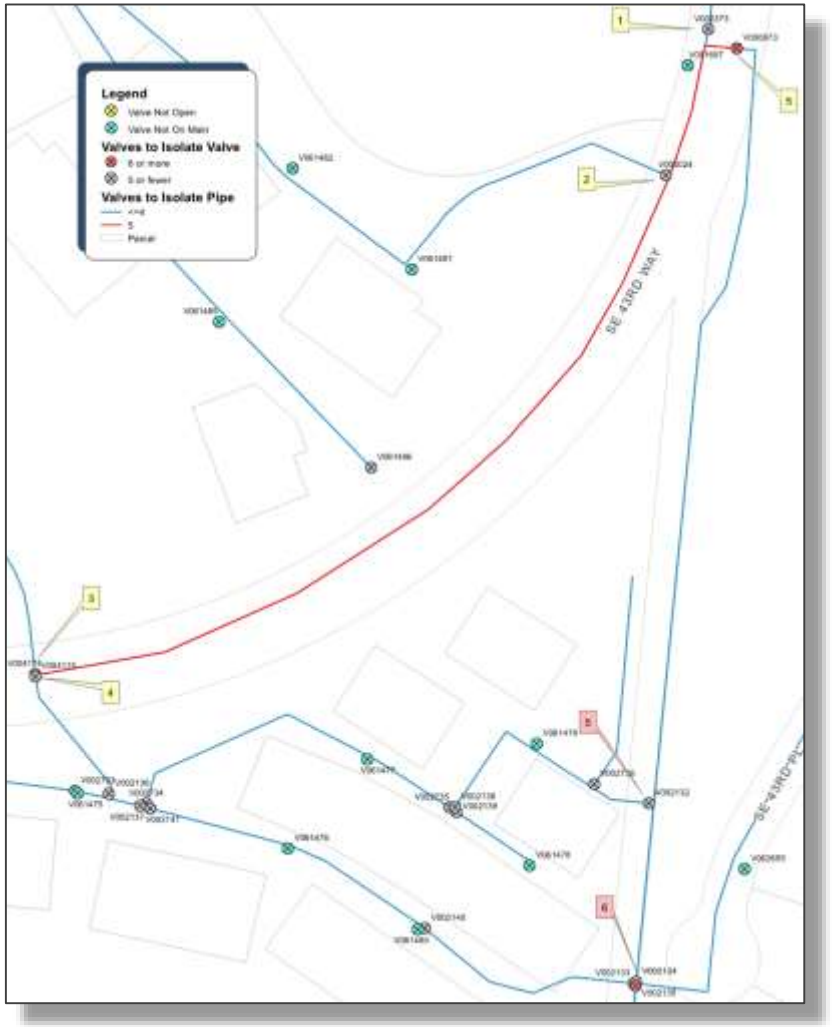
Number of valves to isolate broken valves



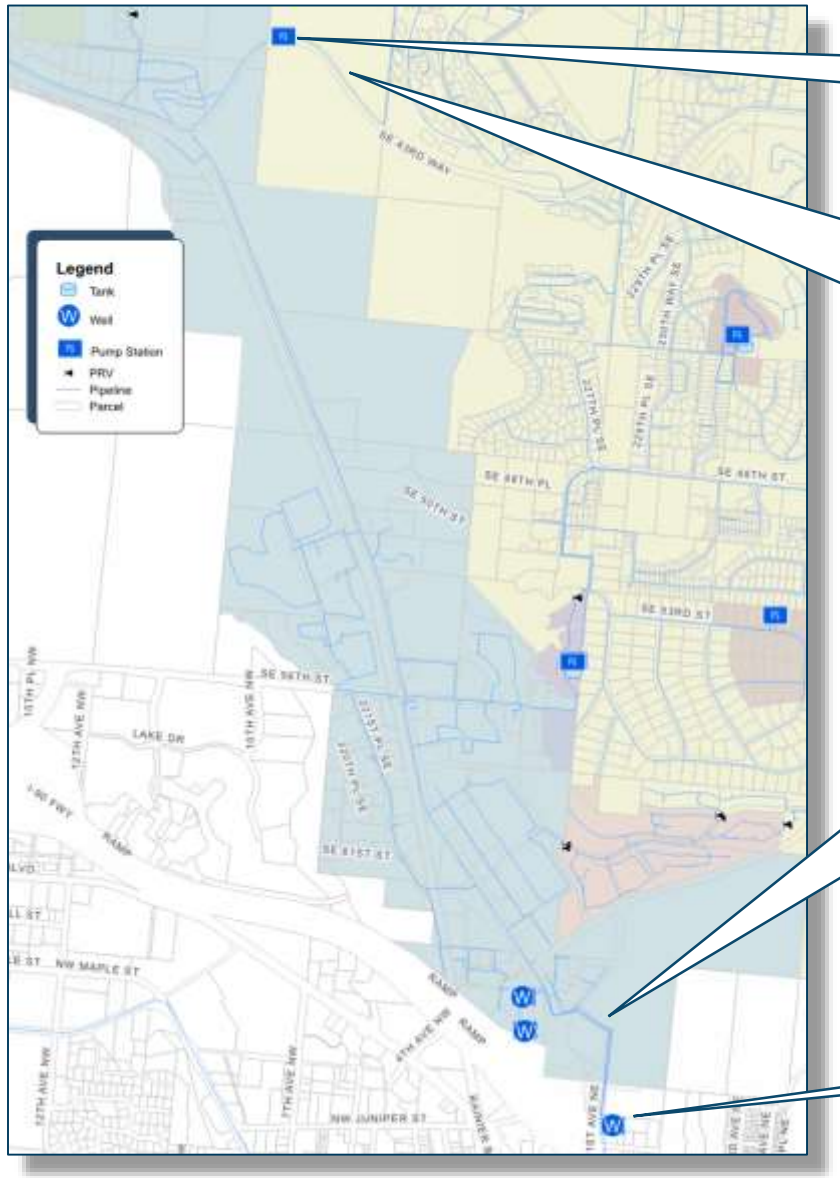
Valve Criticality



ValveID	To Close
V004139	V000875
V004139	V004141
V004139	V004140
V004139	V004136
V004139	V004138
V004139	V000953
V004136	V004141
V004136	V004140
V004136	V004137
V004136	V001063
V004136	V004138
V004136	V004139
V003214	V003212
V003214	V003234
V003214	V003210
V003214	V003213
V003214	V003211
V003214	V003229
V003469	V001250
V003469	V003467
V003469	V184051
V003469	V003466
V003469	V002445
V003469	V001249
V002445	V001250
V002445	V002446
V002445	V002444
V002445	V184051
V002445	V003469



Critical Facilities – Supply Redundancy



Pump Station

If a facility is critical to provide pressure or supply demand due to network connectivity, the (single) connecting pipeline will be critical.

Well

- Model controls set up to automatically turn on any alternate facilities that are available.

Conclusions

- Assess “Level of Service” goals before focusing on specific projects
  - SPW has flexibility to serve non irrigation demands with the loss of 297 zone supplies indefinitely
- Historically most resiliency studies have focused on facilities and transmission piping
  - Now modeling tools allow for assessment of distribution system
- For systems with varied topography and/or multiple pressure zones, pipe and valve criticality is often tough to visually discern
  - SPW generally has a high level of piping and valve redundancy
  - SPW identified approximately 20 pipe and PRV projects that would improve the redundancy of the system

Conclusions (cont.)

- A secondary benefit to the analysis is improving the quality of water GIS
  - SPW identified mis-coded and mis-located valves
  - Identified several locations where additional valves will be installed
- Software tools are generally available to complete this analysis
  - Requires calibrated steady state model and accurate system valve information
  - Tools from Optimatics and Innovyze were utilized in this project
  - Unfortunately no single piece of software provides all required functionality

Acknowledgements

- Ron Bard - *Brown and Caldwell*
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- Optimatics
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Q&A

Sammamish Plateau Water

murraysmith

Thank you!