Brown AND Caldwell

City of Lake Oswego

Water Master Plan Update

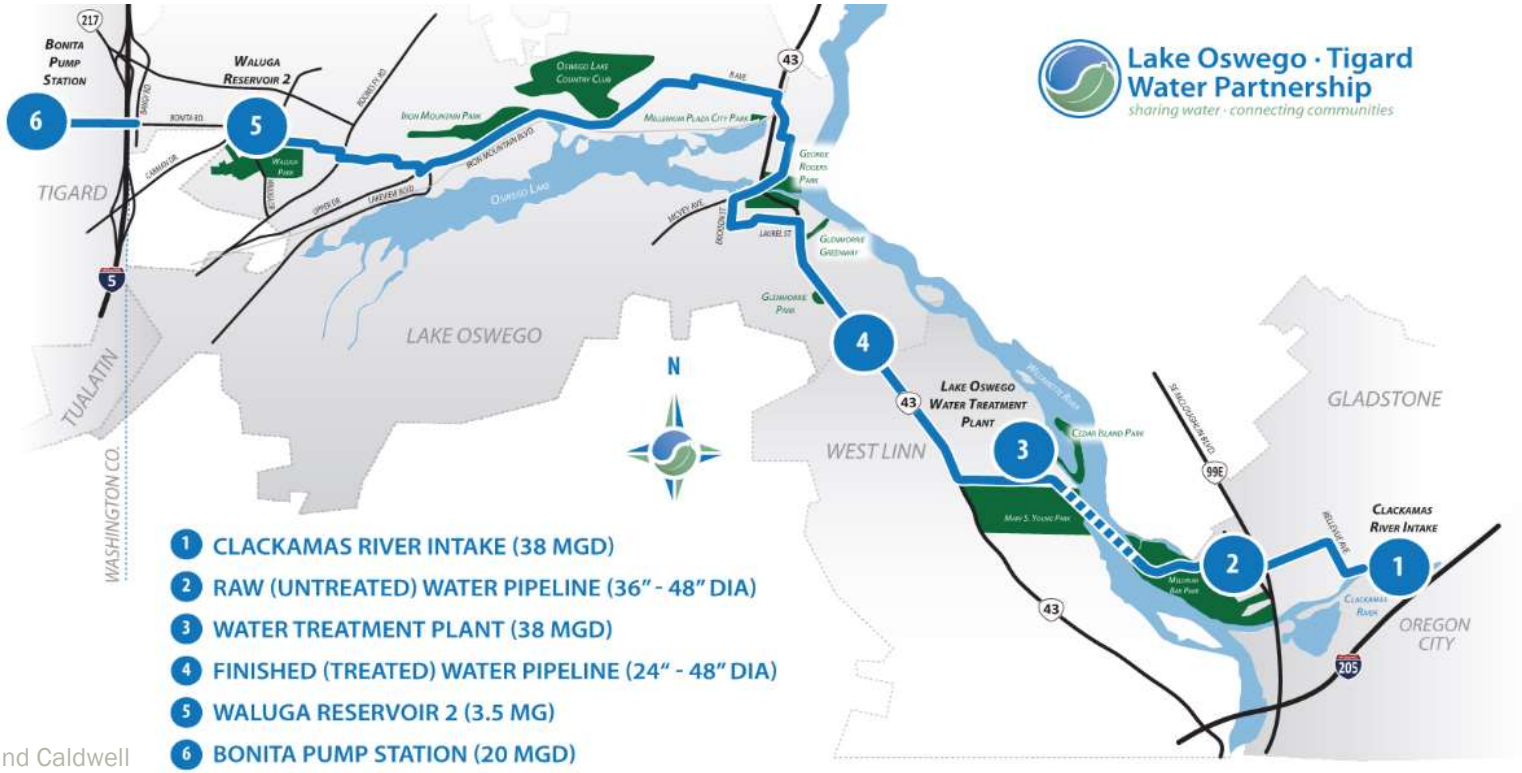
April 25 | 2018

Agenda

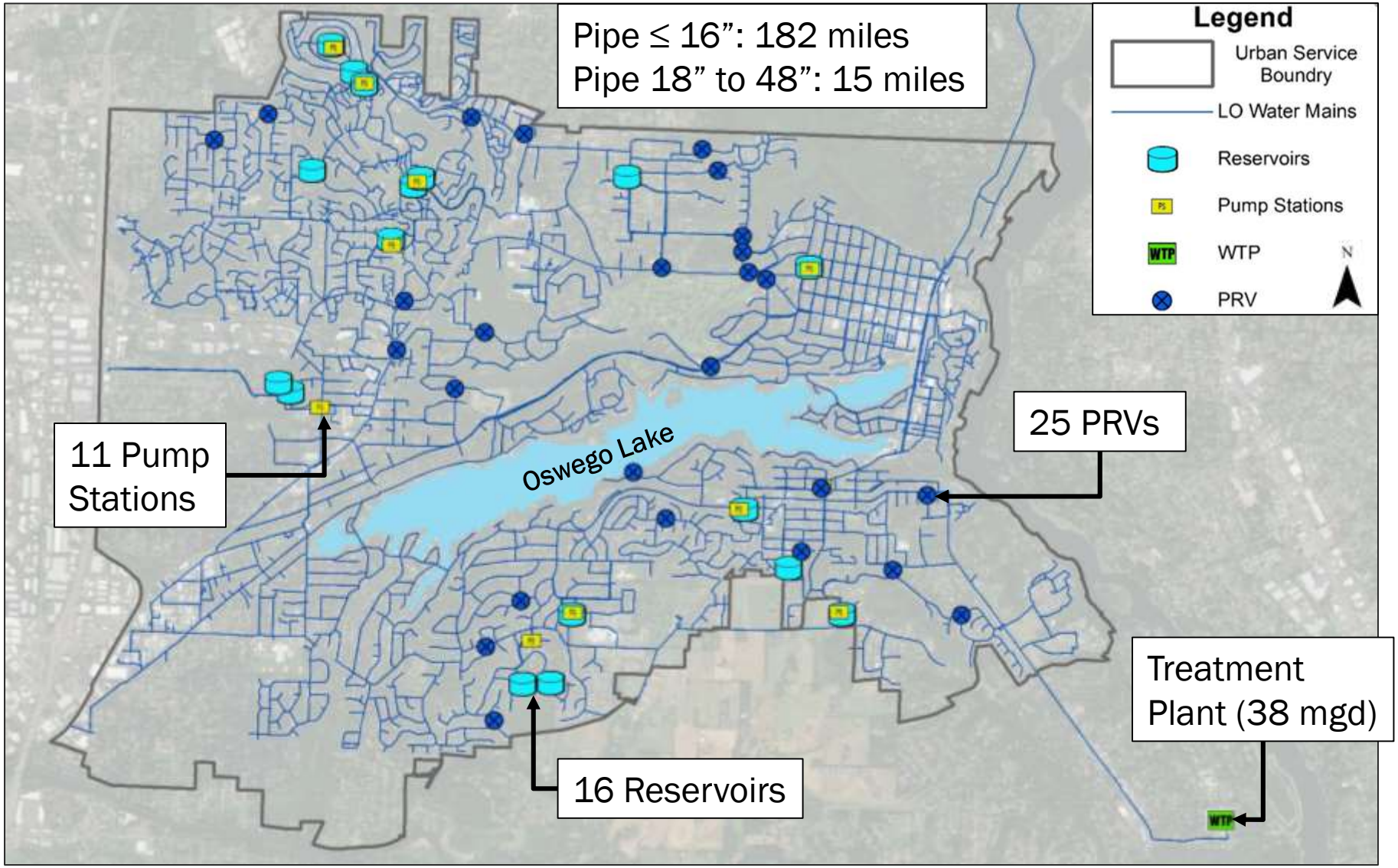
- Project Overview
- Lake Oswego Water System Overview
- Seismic Resiliency Process
- Hydraulic Modeling Process
- Comprehensive CIP Development

Project Overview

- Project Drivers
  - Last master plan in 2001
  - Completion of the Lake Oswego Tigard Water Program
  - Increased population
- Project Goals
  - Address Oregon Resilience Plan (ORP) seismic goals
  - Assess alternative sources of emergency supply
  - Optimize existing system operations



System Overview



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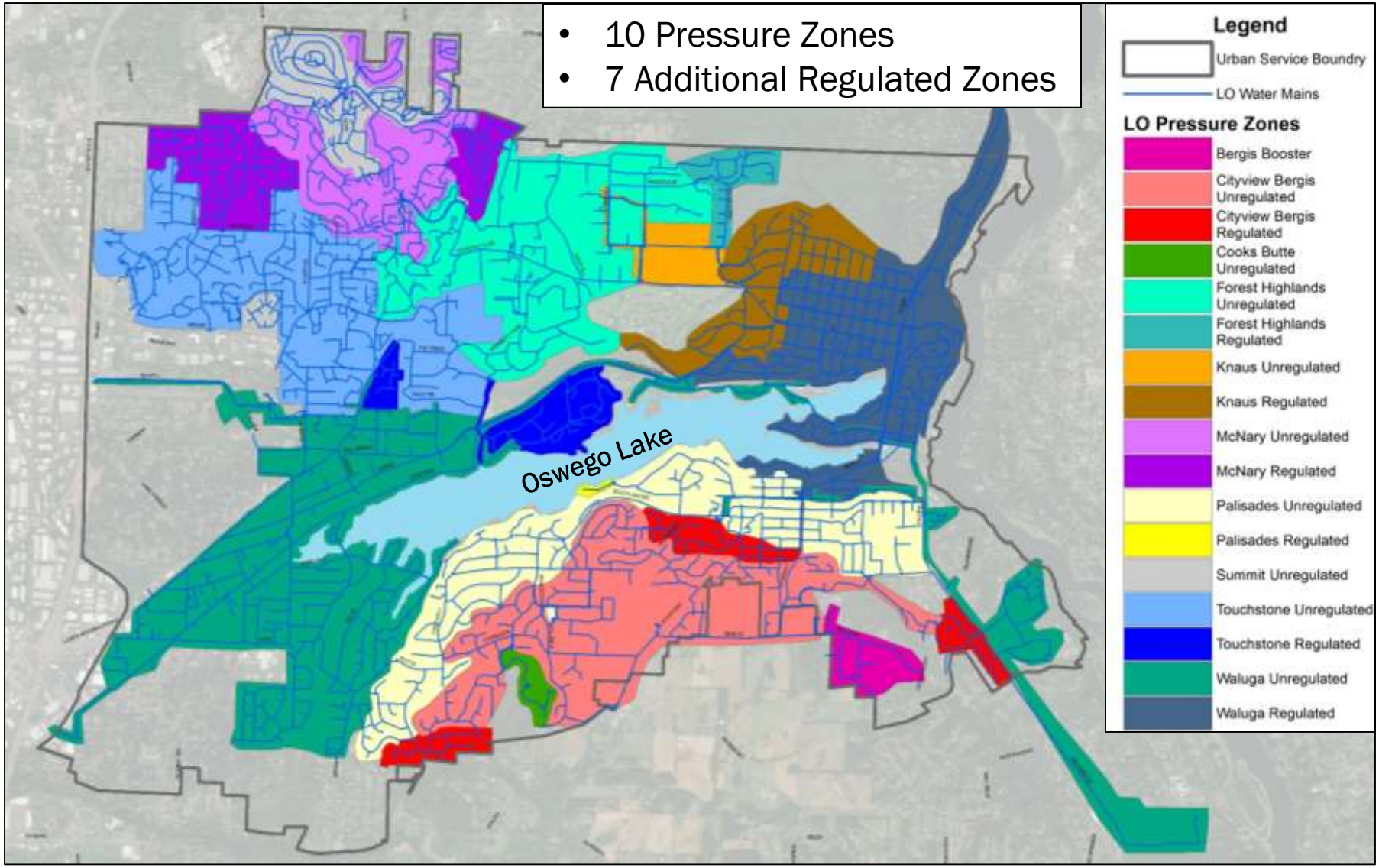
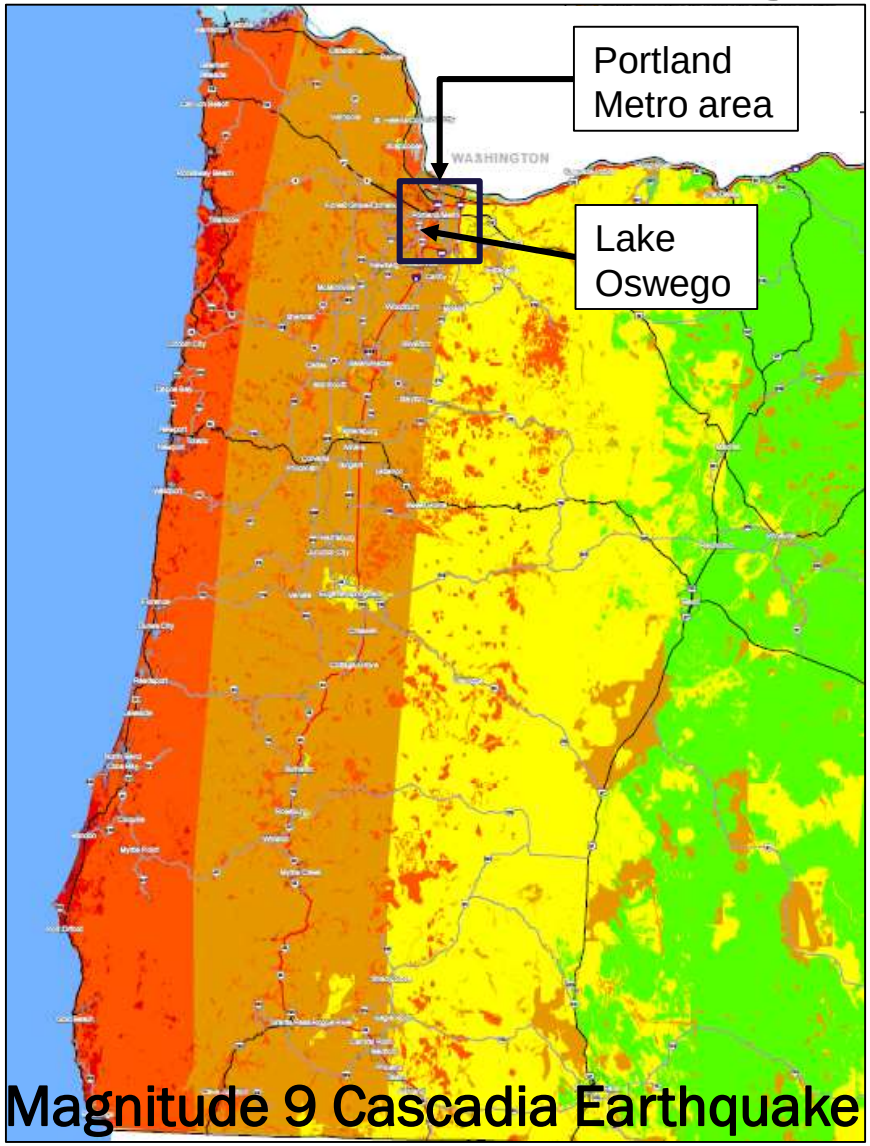


Seismic Resiliency

New Oregon Health Authority (OHA) requirement:

A seismic risk assessment and mitigation plan for water systems located in areas identified moderate to very high damage potential

Seismic Resiliency



OHA: Map of Earthquake and Tsunami Damage Potential

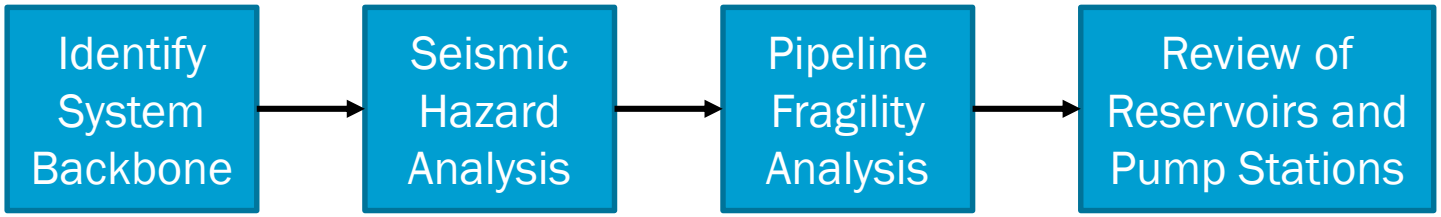
Modified Mercalli Intensity Scale / Damage Potential

None	IV	Felt indoors by many
Very Light	V	Felt outdoors
Light	VI	Felt by all; windows crack
Moderate	VII	Difficult to stand; damage to poorly built masonry buildings
Moderate/ Heavy	VIII	Steering of cars affected; extensive damage to unreinforced masonry
Heavy	IX	General panic; serious damage to collapse of unreinforced masonry
Very Heavy	X	Bridges and well-build wooden structures heavily damaged

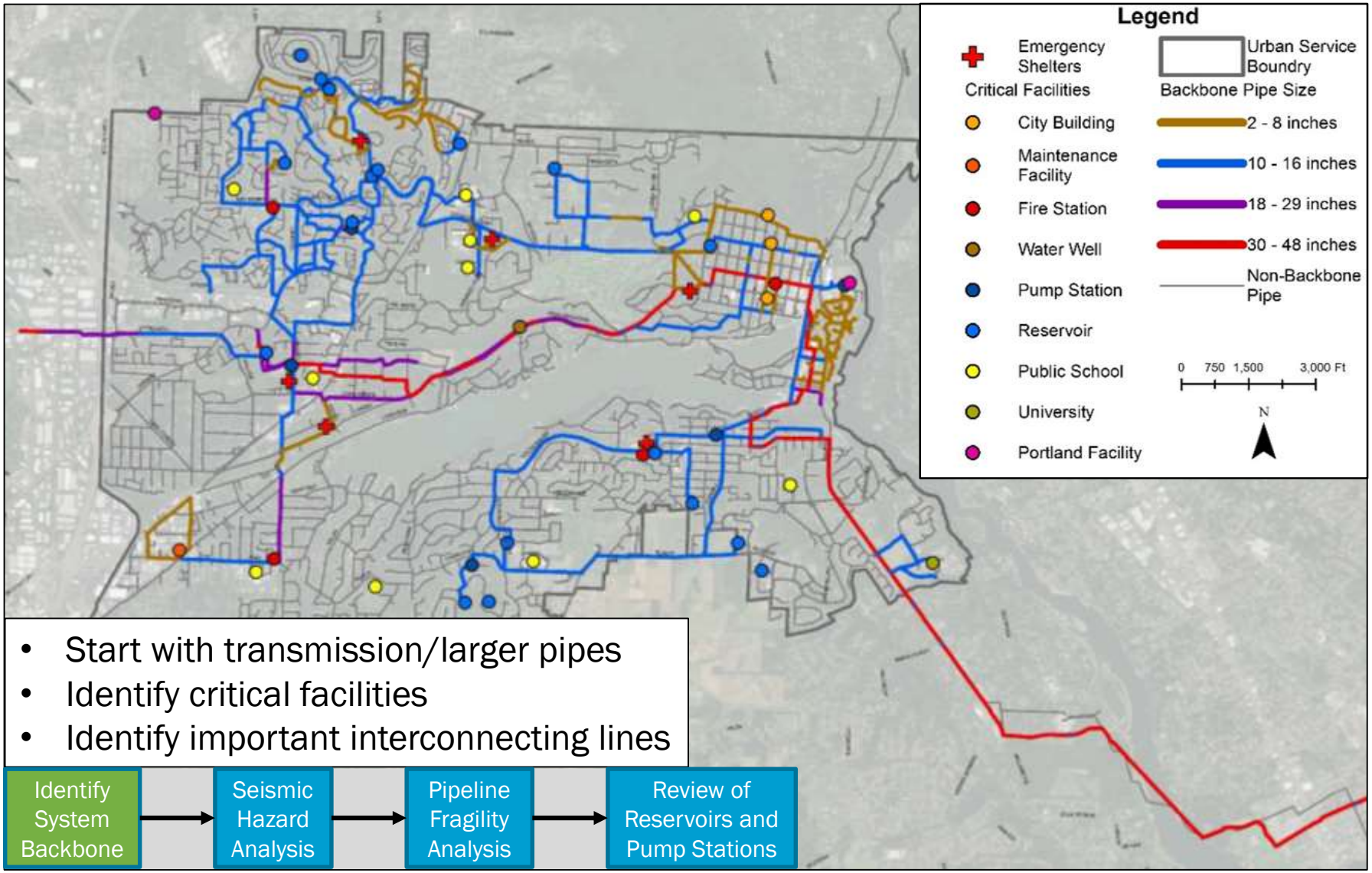
OHA Requirements

- Identify critical facilities
- Identify and evaluate the likelihood and consequence of seismic failures
- Include recommendations to minimize water loss, capital improvements or recommendations for further study or analysis

Seismic Resiliency Process



System Backbone



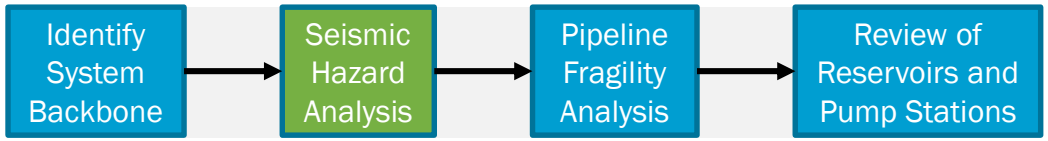
- Start with transmission/larger pipes
- Identify critical facilities
- Identify important interconnecting lines

Identify System Backbone → Seismic Hazard Analysis → Pipeline Fragility Analysis → Review of Reservoirs and Pump Stations

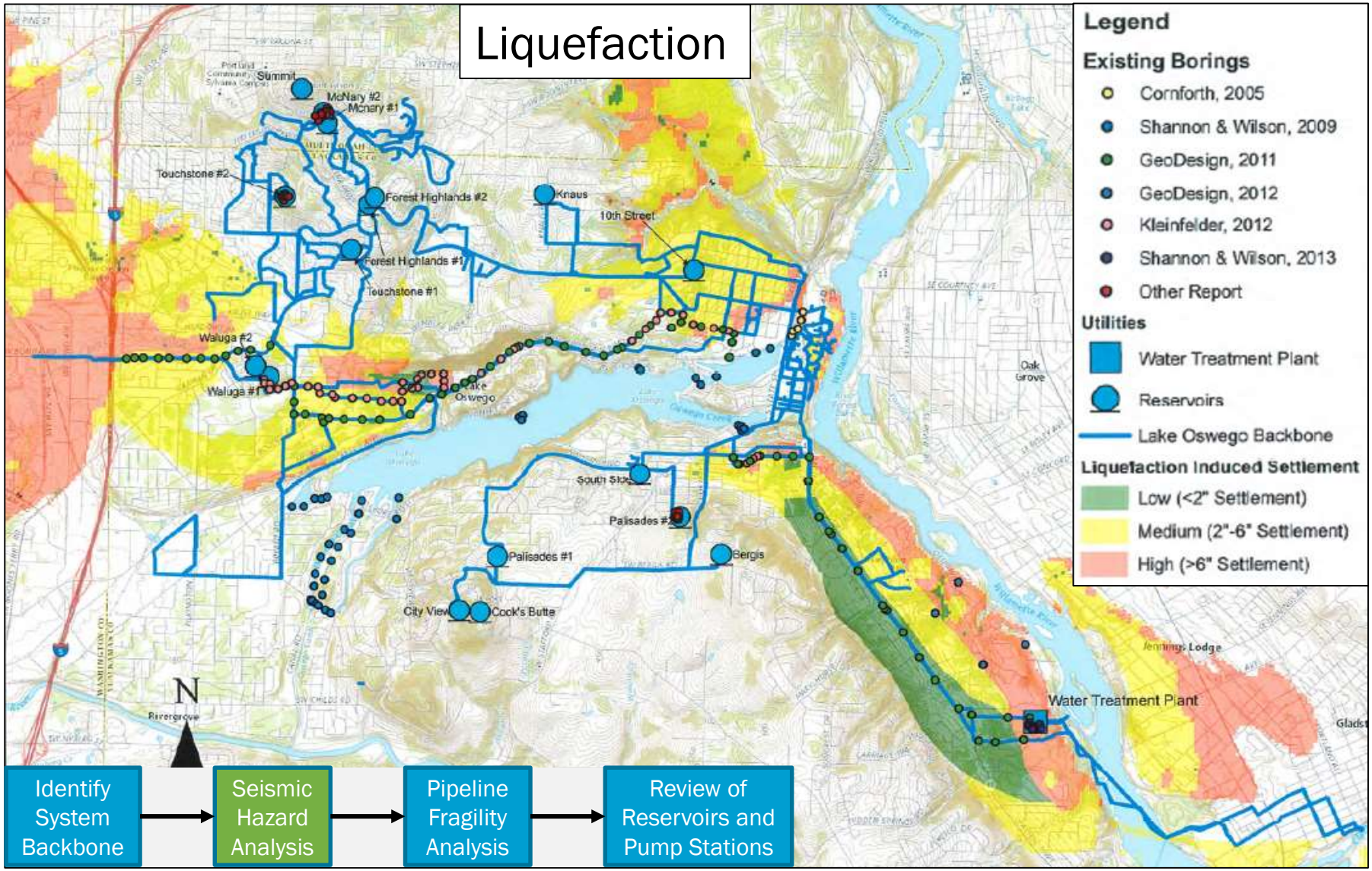
Seismic Hazard Analysis

- Start with DOGAMI seismic hazard maps
- Review geotechnical reports and boring logs
- Site reconnaissance
- Refinement of hazard maps

- Seismic hazards:
  - Permanent ground deformation (PGD)
    - Liquefaction
    - Lateral Spread
    - Landslide
  - Peak ground velocity (PGV)
    - Ground shaking

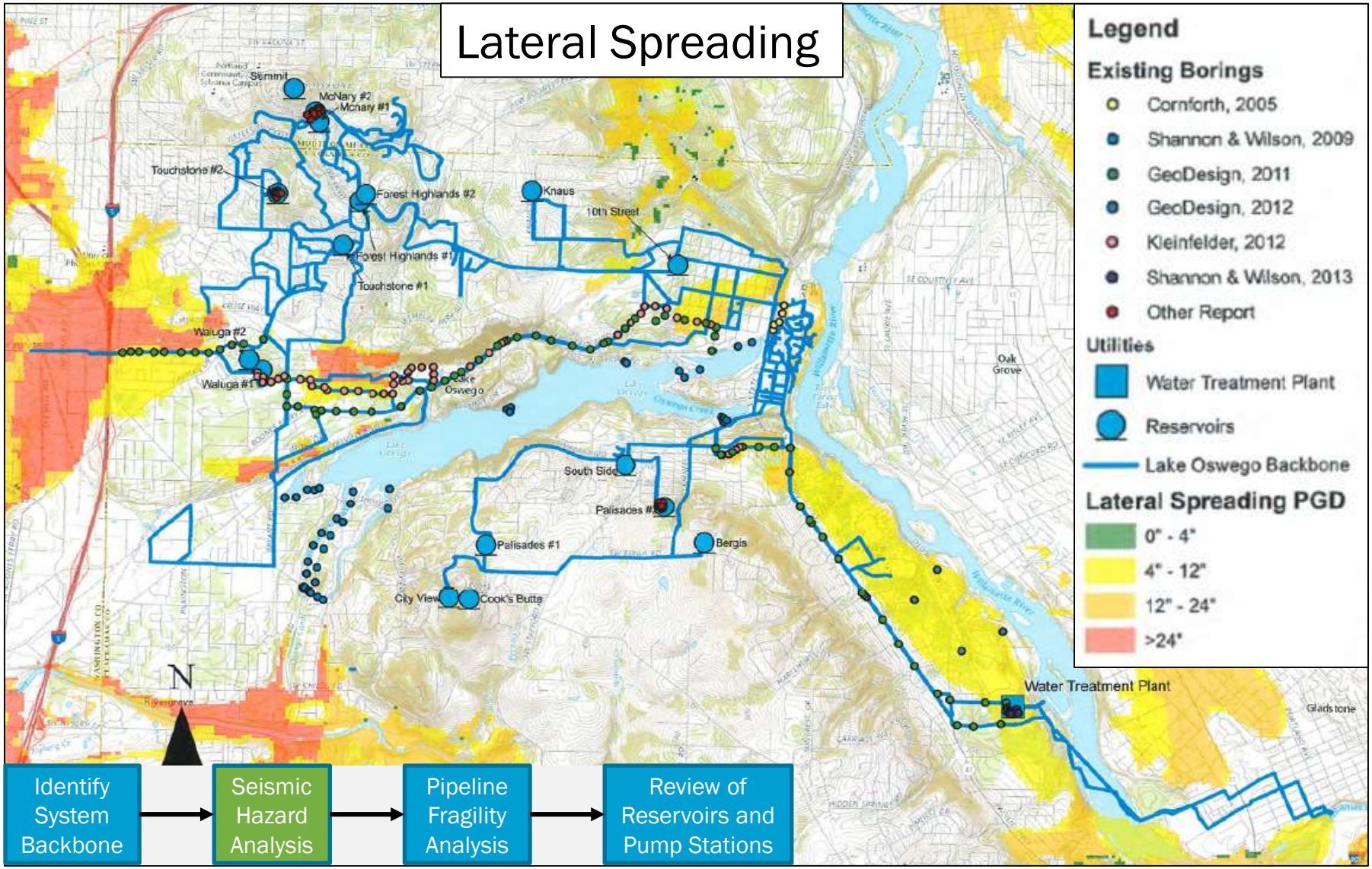


Seismic Hazard Analysis



Identify System Backbone → Seismic Hazard Analysis → Pipeline Fragility Analysis → Review of Reservoirs and Pump Stations

Seismic Hazard Analysis



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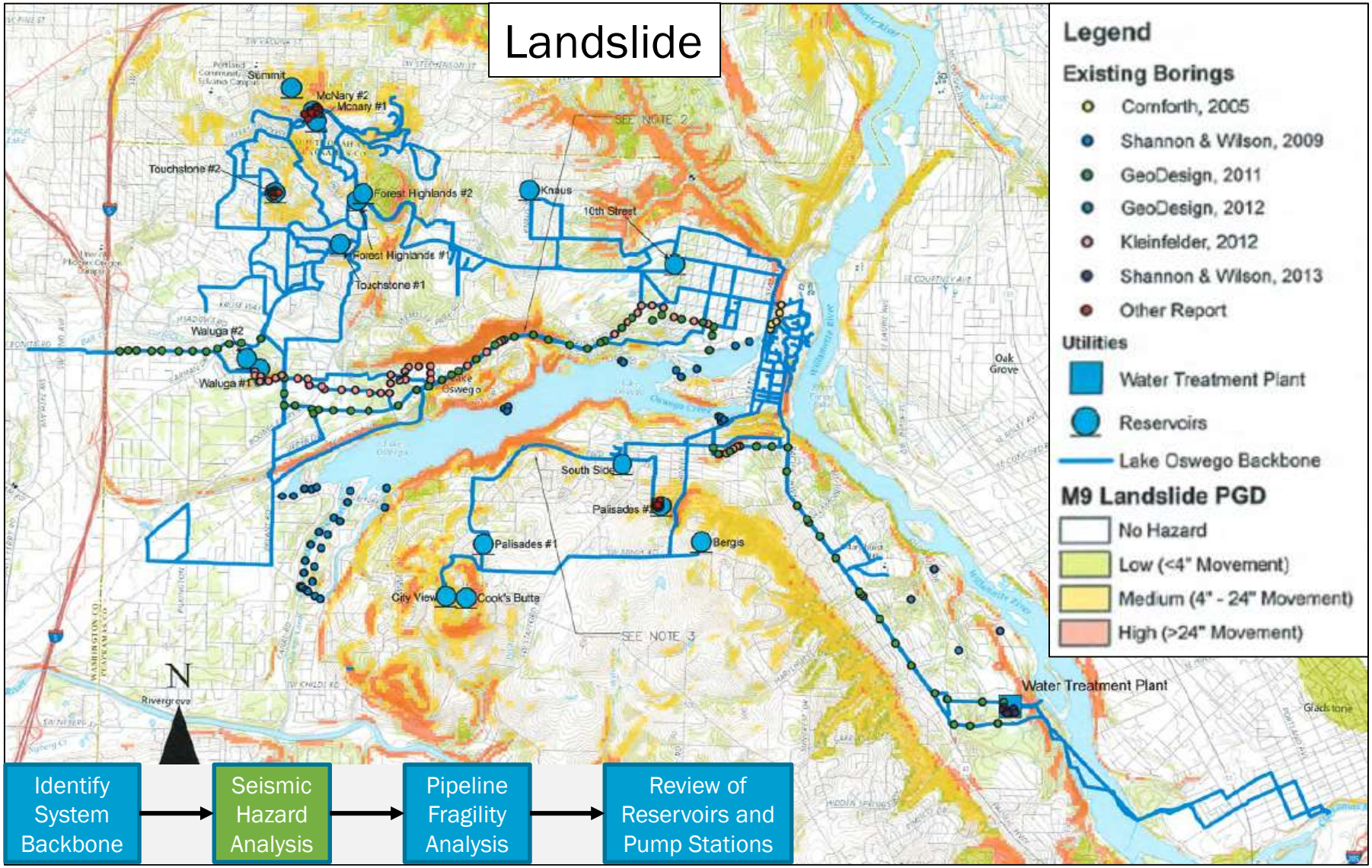
Seismic Hazard Analysis



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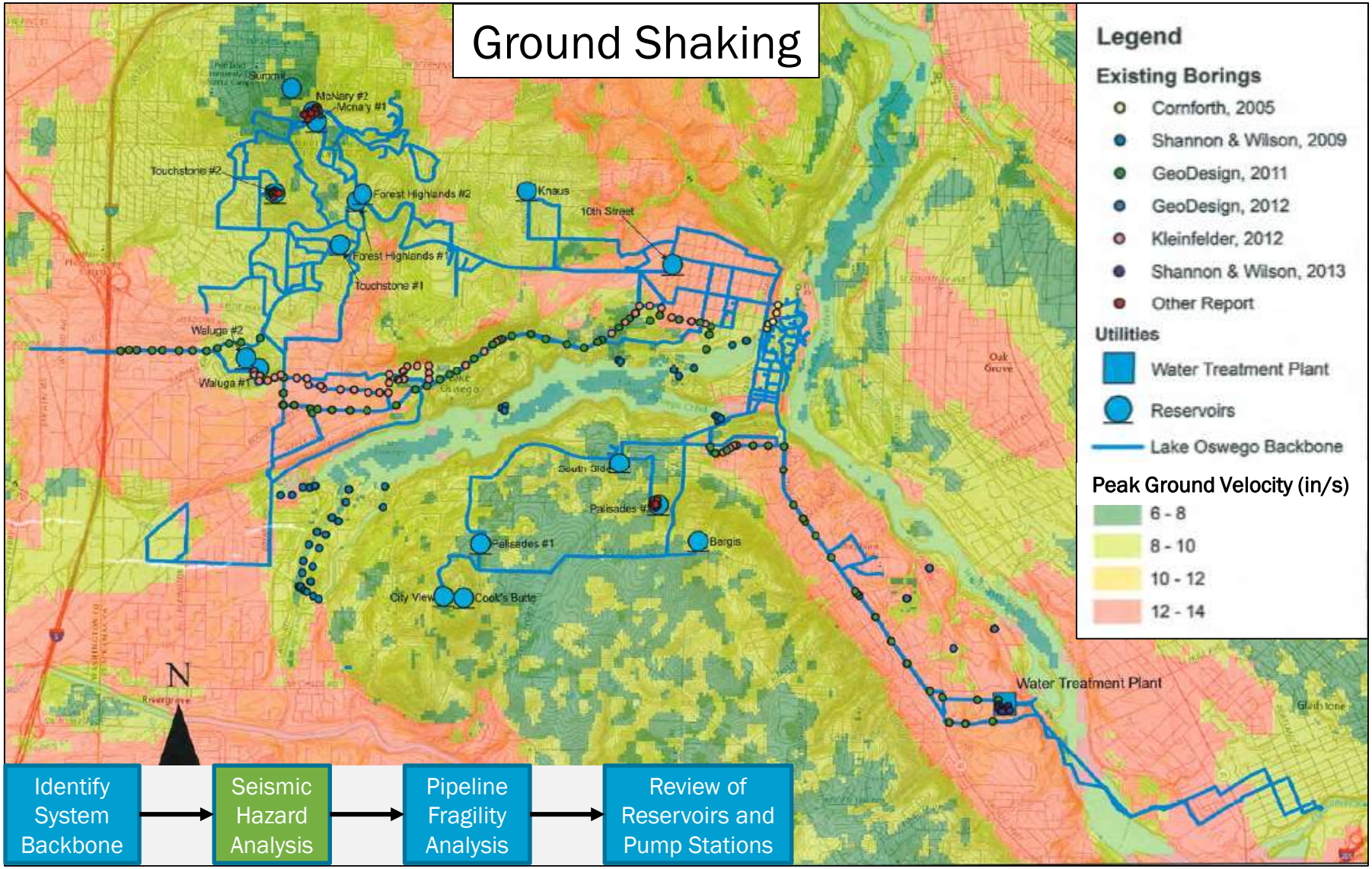
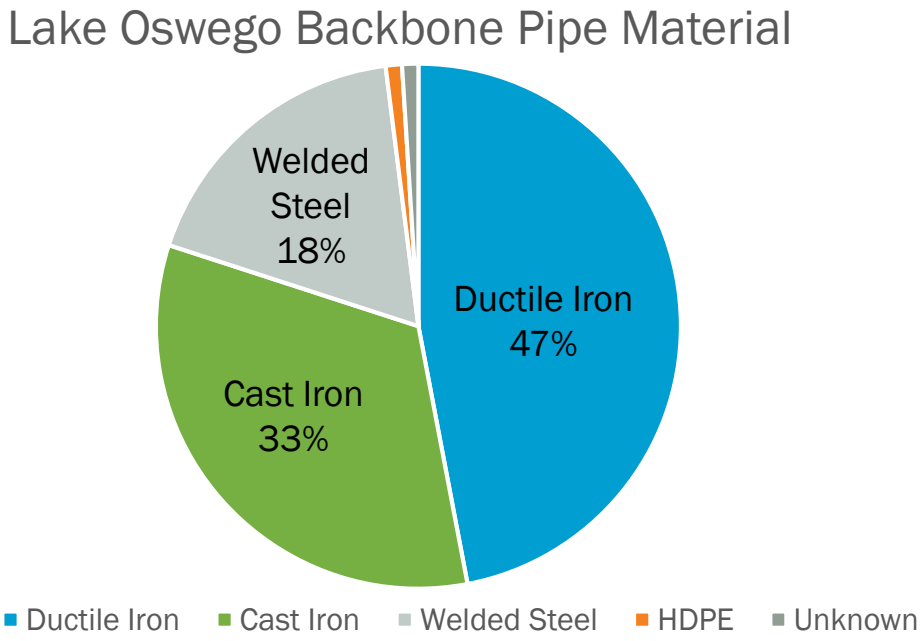
Seismic Hazard Analysis

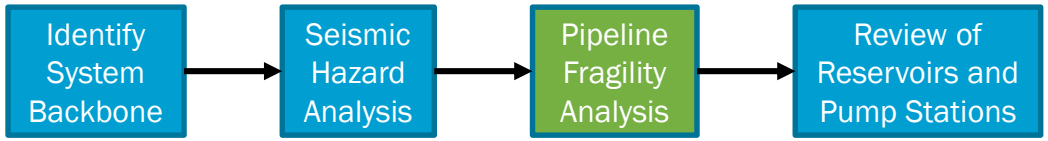


Identify System Backbone → Seismic Hazard Analysis → Pipeline Fragility Analysis → Review of Reservoirs and Pump Stations

Fragility Analysis

- Requires accurate pipe database
  - Material
  - Size
  - Joint type
- Collaborative effort with the City to create comprehensive database





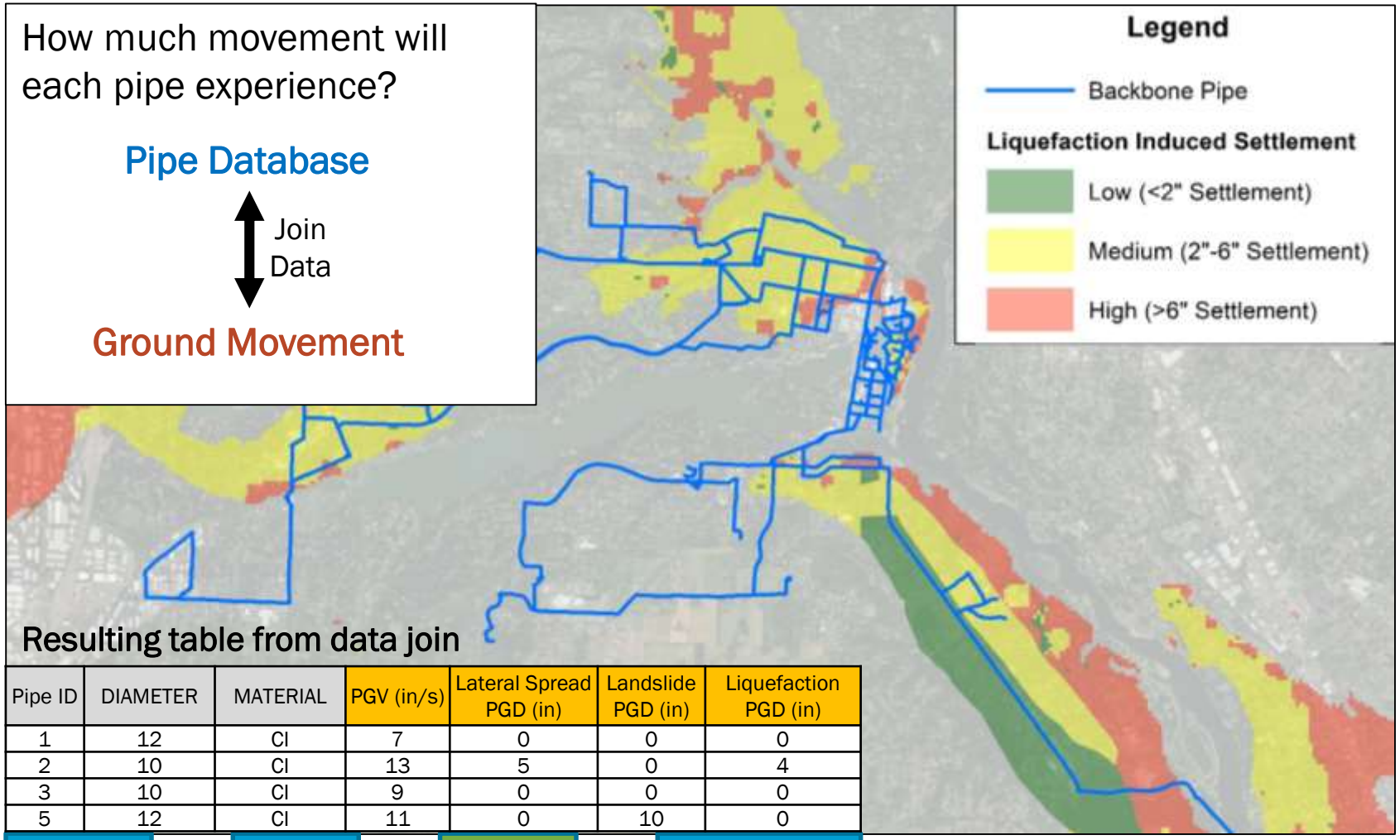
Fragility Analysis

How much movement will each pipe experience?

Pipe Database

↕ Join Data

Ground Movement



Resulting table from data join

Pipe ID	DIAMETER	MATERIAL	PGV (in/s)	Lateral Spread PGD (in)	Landslide PGD (in)	Liquefaction PGD (in)
1	12	CI	7	0	0	0
2	10	CI	13	5	0	4
3	10	CI	9	0	0	0
5	12	CI	11	0	10	0

Identify System Backbone → Seismic Hazard Analysis → Pipeline Fragility Analysis → Review of Reservoirs and Pump Stations

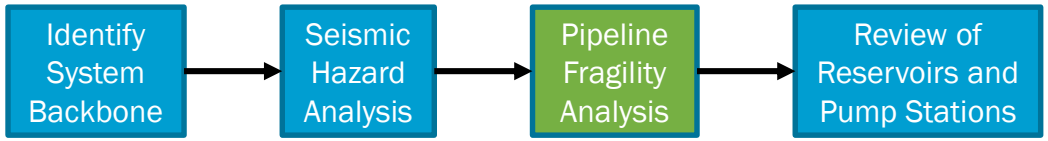
Fragility Analysis – Breakage Calculations

- Calculate:
  - Repair rate
  - Expected pipeline breaks
  - Probability of failure
- Based on expected ground movement (PGD + PGV)
- Guidance provided by American Lifelines Alliance (ALA)
- Correction factors for known pipe characteristics

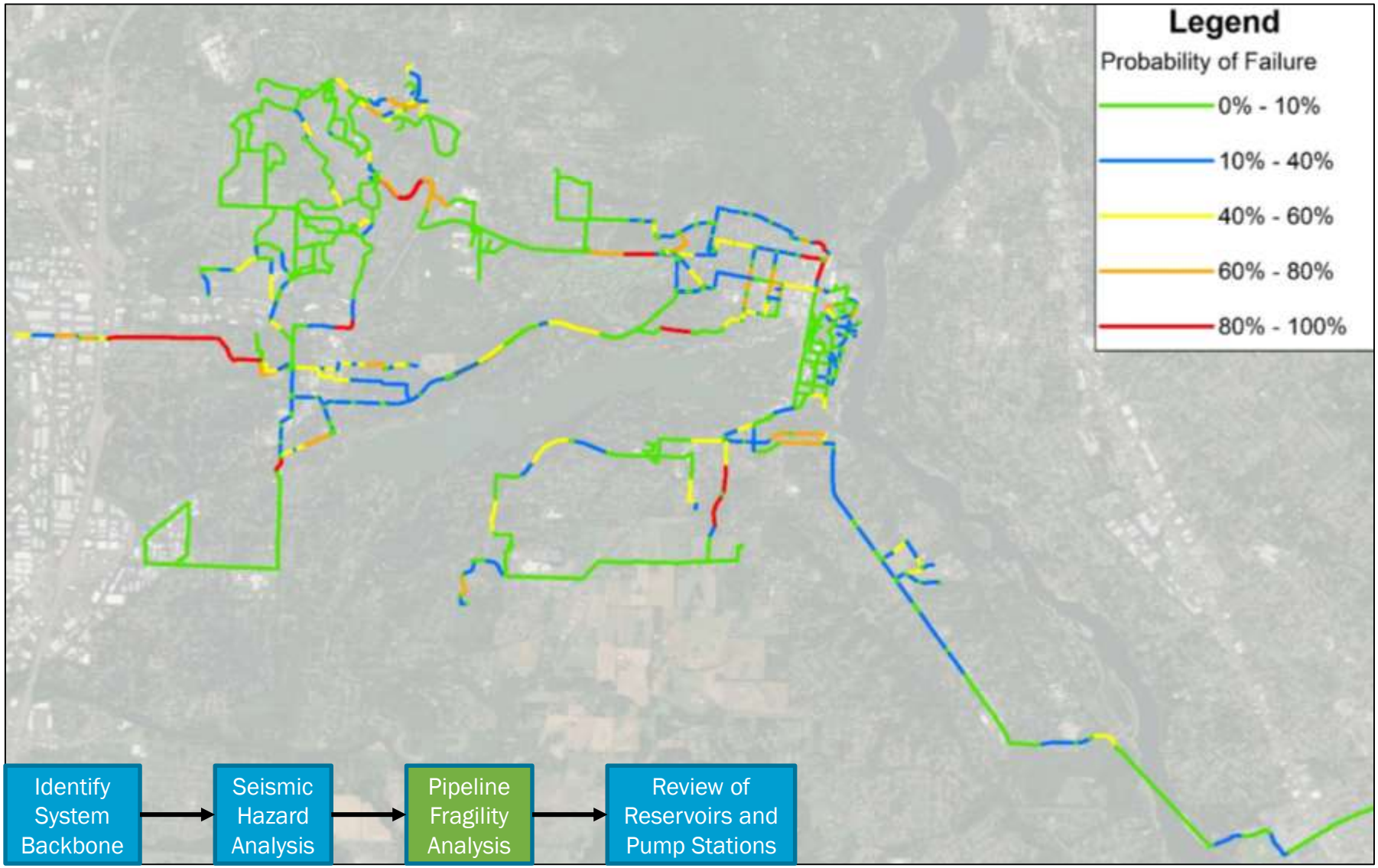
$$Repair\ Rate = 0.00187 \times \boldsymbol{PGV}$$

$$Repair\ Rate = 1.06 \times \boldsymbol{PGD}^{0.319}$$

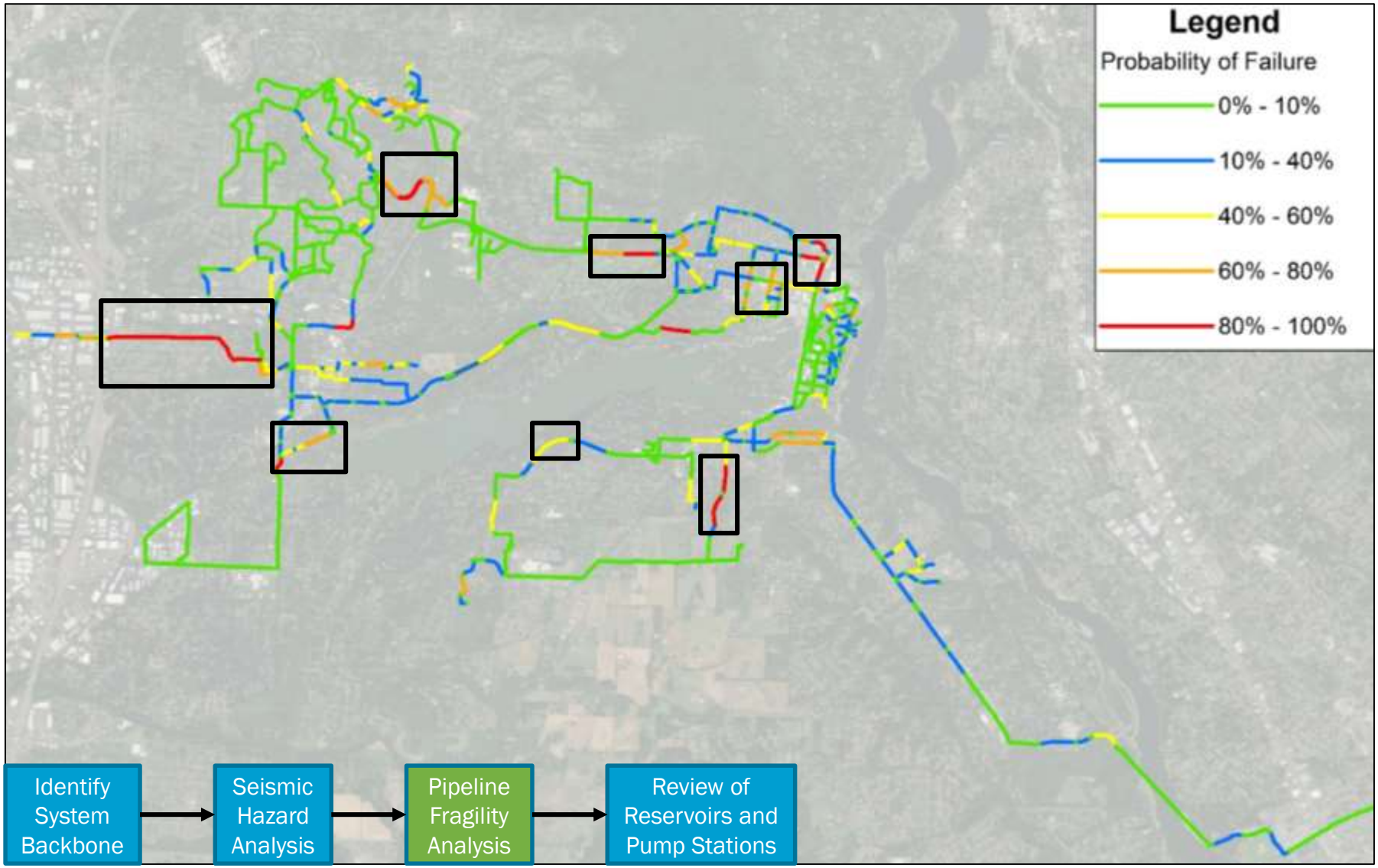
$$Repair\ Rate = Repairs\ per\ 1{,}000\ feet\ of\ pipe$$



Fragility Analysis – Map Expected Pipe Failures



Fragility Analysis – Identify High-Risk Areas



Review of Reservoirs and Pump Stations

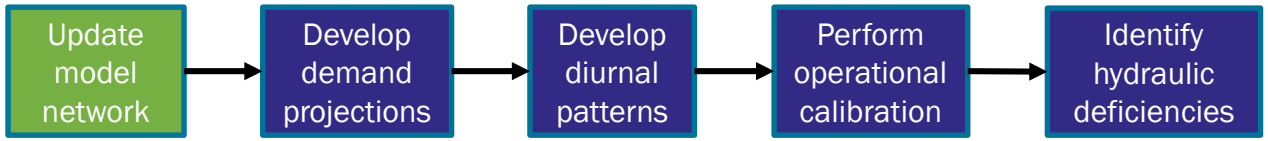
- Review:
  - Construction documents
  - Prior condition assessment and inspection reports
  - Seismic hazards analysis
- Perform 5 inspections of pump stations
- Make recommendations for future inspections

Identify System Backbone → Seismic Hazard Analysis → Pipeline Fragility Analysis → Review of Reservoirs and Pump Stations

Hydraulic Modeling Overview

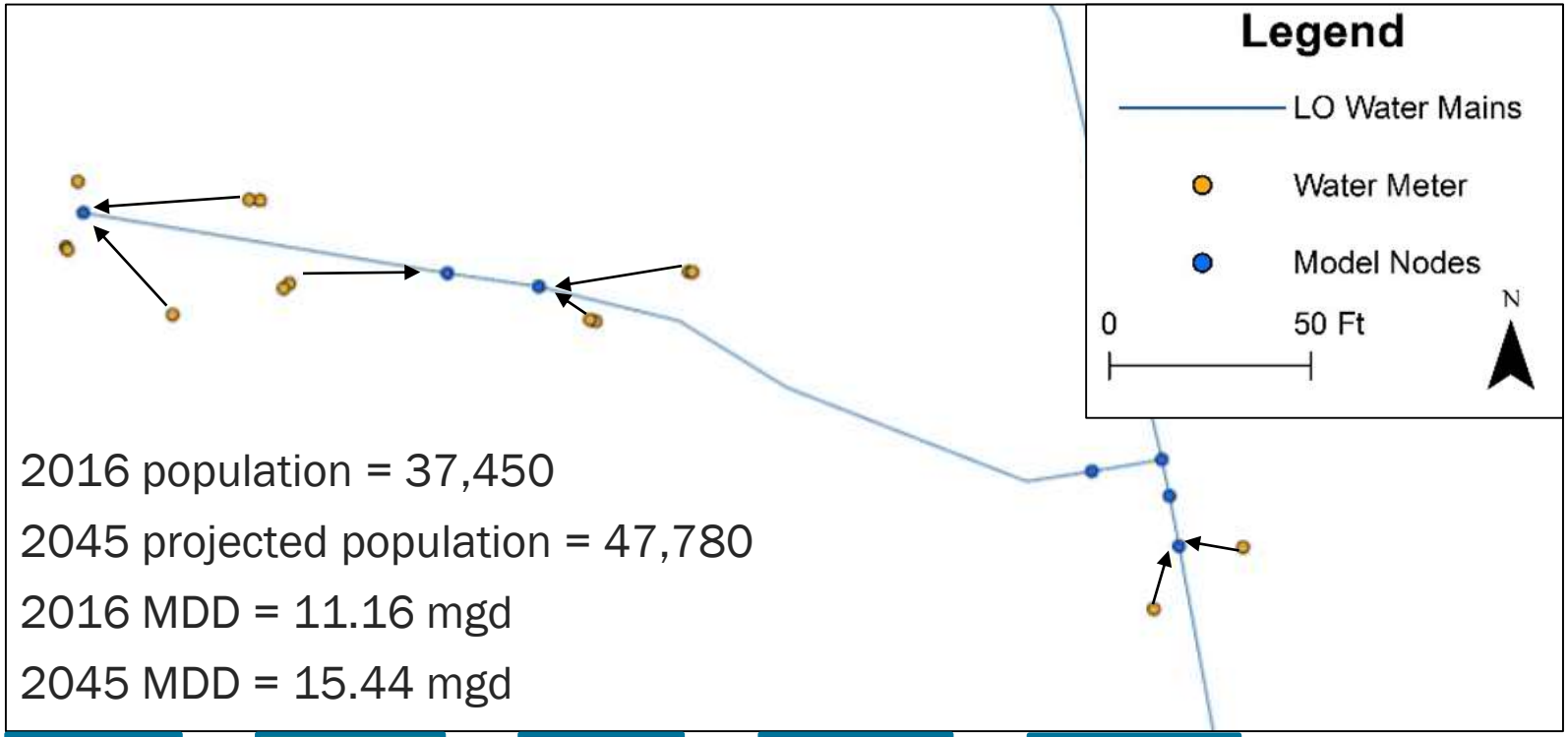
Update Model Network

- Update model with CIP projects completed since last Master Plan
- Capture changes to the system from the Lake Oswego Tigard Water Program



Demand Projection and Allocation

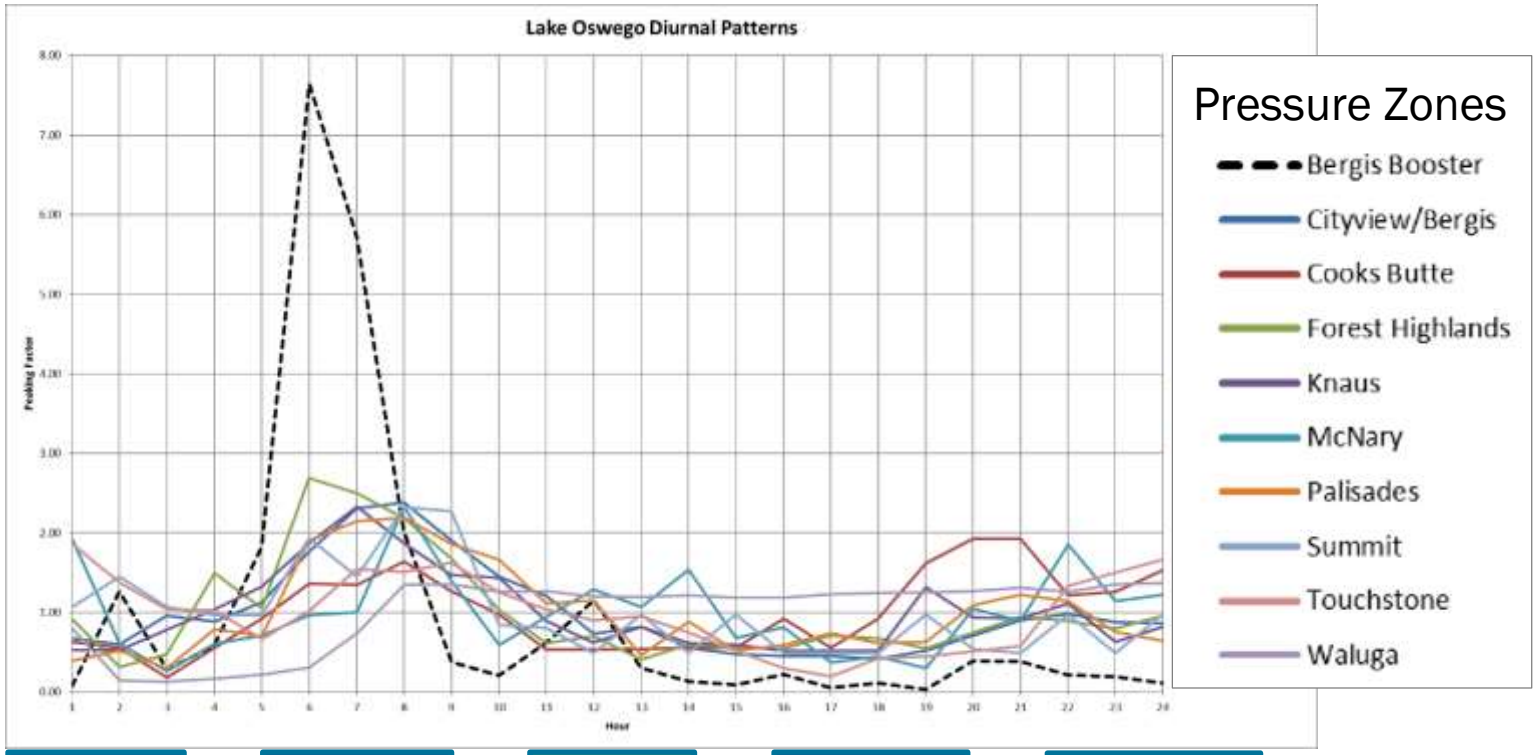
- Use billing data to calculate water use for each customer
- Join water use to water meter GIS layer
- Allocate demands to model nodes
- Project demands using populating data to end of planning period (2045)



Update model network → Develop demand projections → Develop diurnal patterns → Perform operational calibration → Identify hydraulic deficiencies

Develop Diurnal Patterns

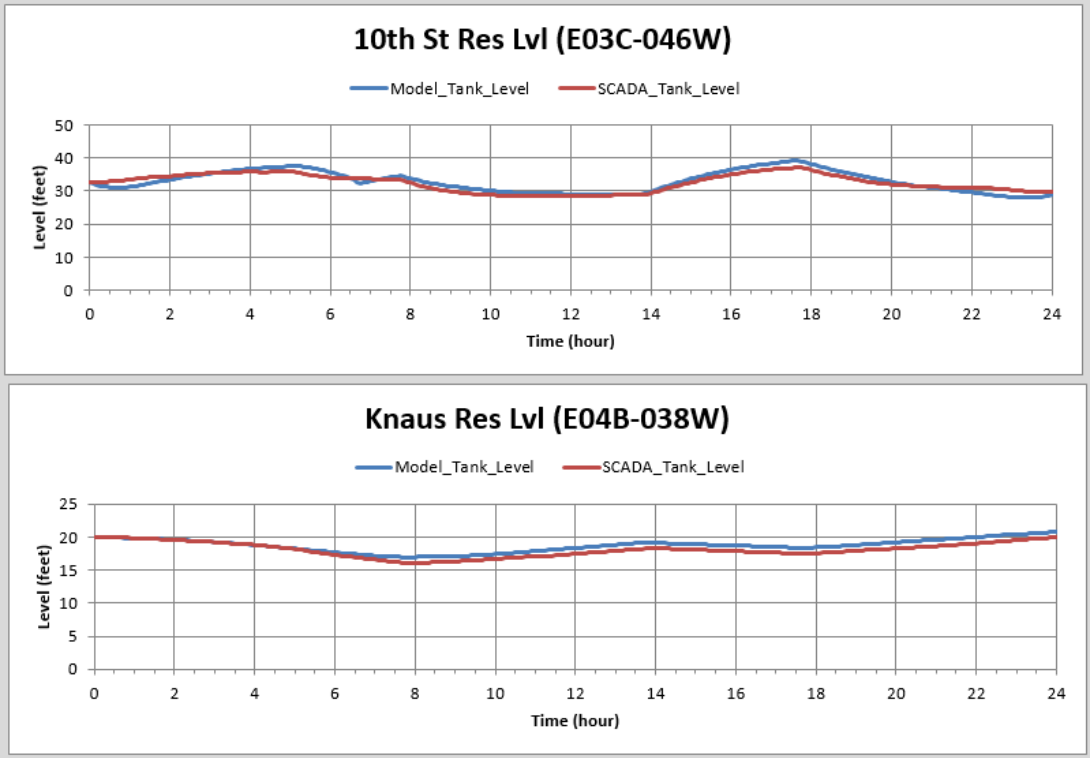
- Use SCADA data
  - Pump station flows
  - Reservoir levels
- Using mass balance approach calculate peaking factors



Update model network → Develop demand projections → **Develop diurnal patterns** → Perform operational calibration → Identify hydraulic deficiencies

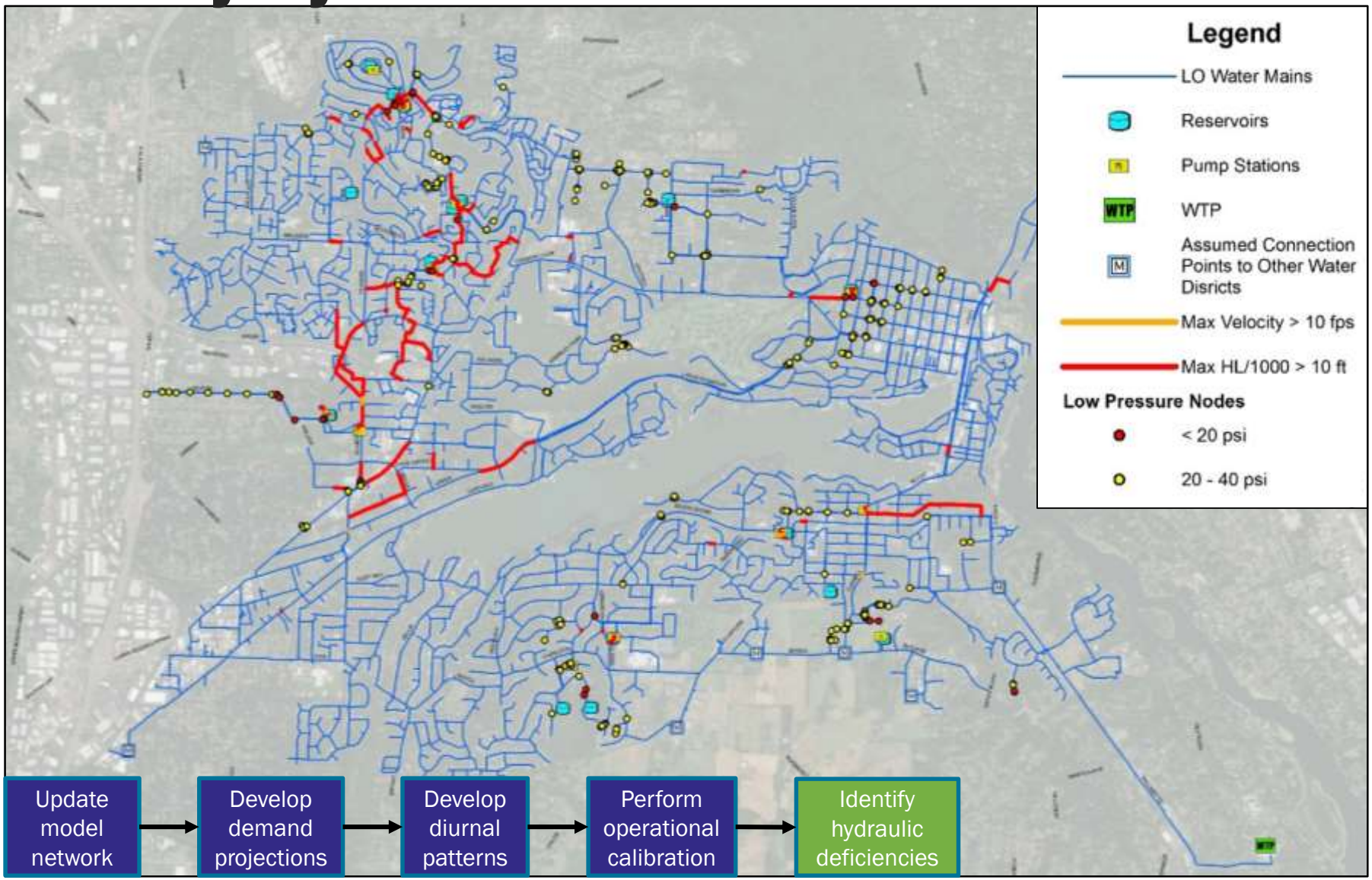
Operational Calibration

- Calibrate to 2016 max day demand
- Perform 24-hour model simulations
- Compare model output to SCADA data at all pump stations and reservoirs
- Adjust model parameters
  - Pump Station setpoints
  - Pressure zone boundaries
  - Valve settings

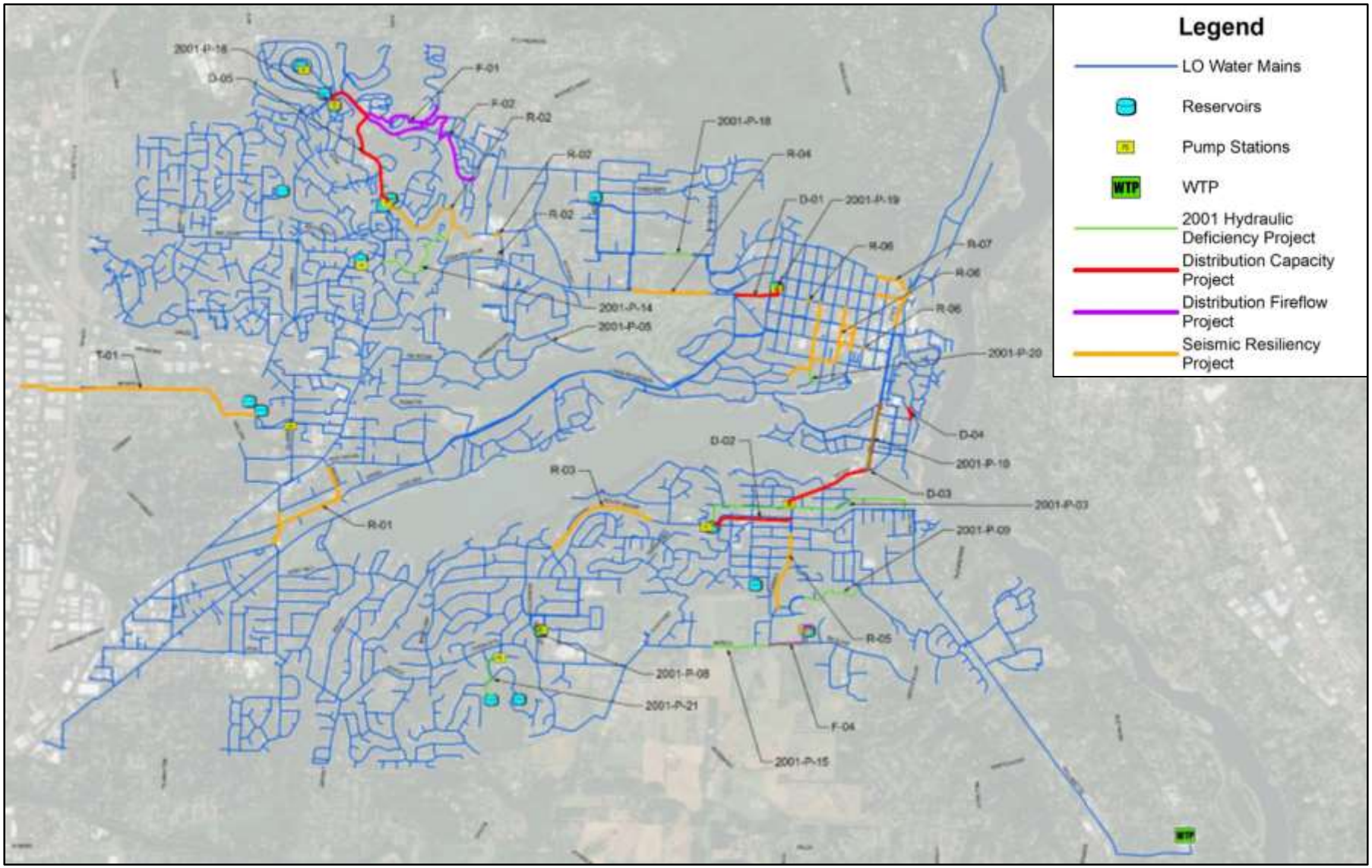


Update model network → Develop demand projections → Develop diurnal patterns → Perform operational calibration → Identify hydraulic deficiencies

Identify Hydraulic Deficiencies



Comprehensive CIP Development



Questions?

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