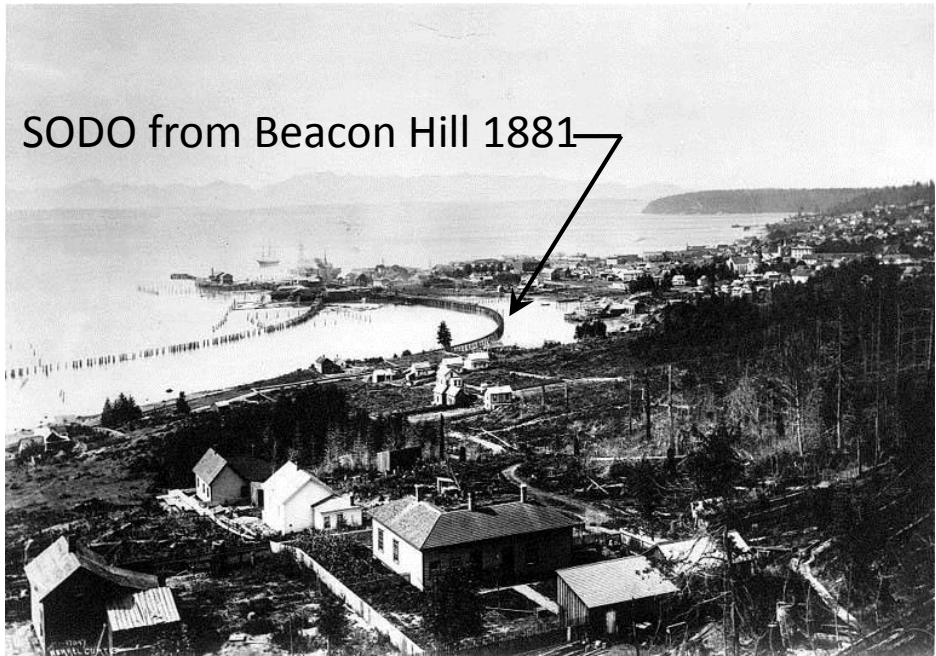
Seattle Public Utilities
Post-Earthquake Water System Performance Goals

Water System Advisory Committee

November 18, 2015

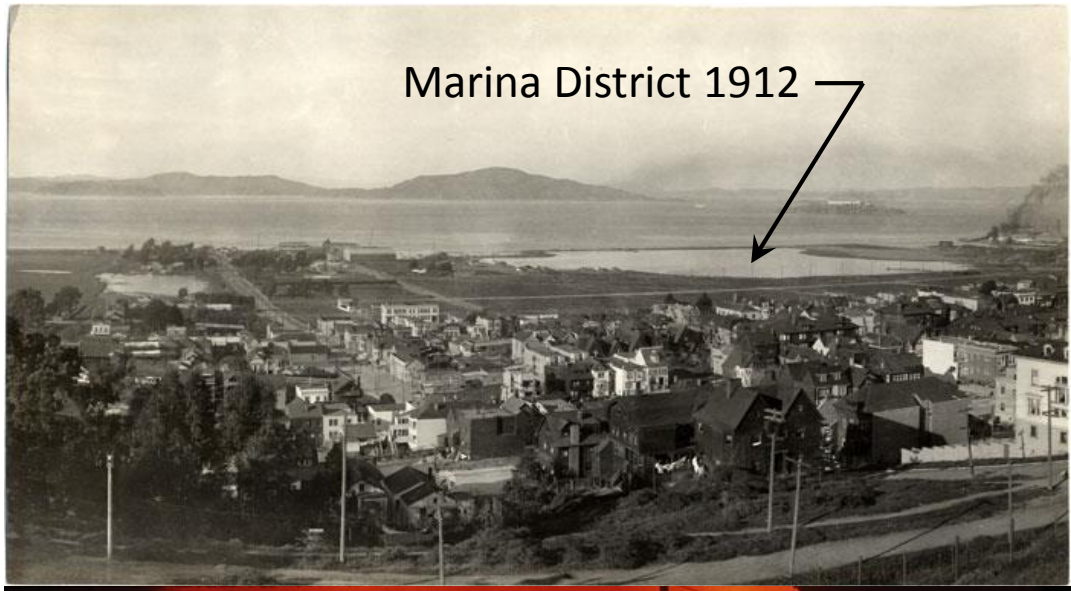
Presentation Outline

- Background
  - Performance of Water Systems in Past Earthquakes
  - Previous SPU Seismic Mitigation Activities
  - SPU Water System Seismic Study
- Post-Earthquake Water System Performance Goals
  - Purpose
  - Examples From Other Utilities
- SPU Post Earthquake Water System Goals
  - Development Process
  - Draft Goals



Loma Prieta (San Francisco) - 1989

- M6.9 (epicenter 60 miles south/southeast of San Francisco)
- Approximately 1000 watermain breaks
- Water system damage mostly in areas of poor soils
  - Water outage durations usually less than a few days
  - Fire suppression water was an issue in Marina District

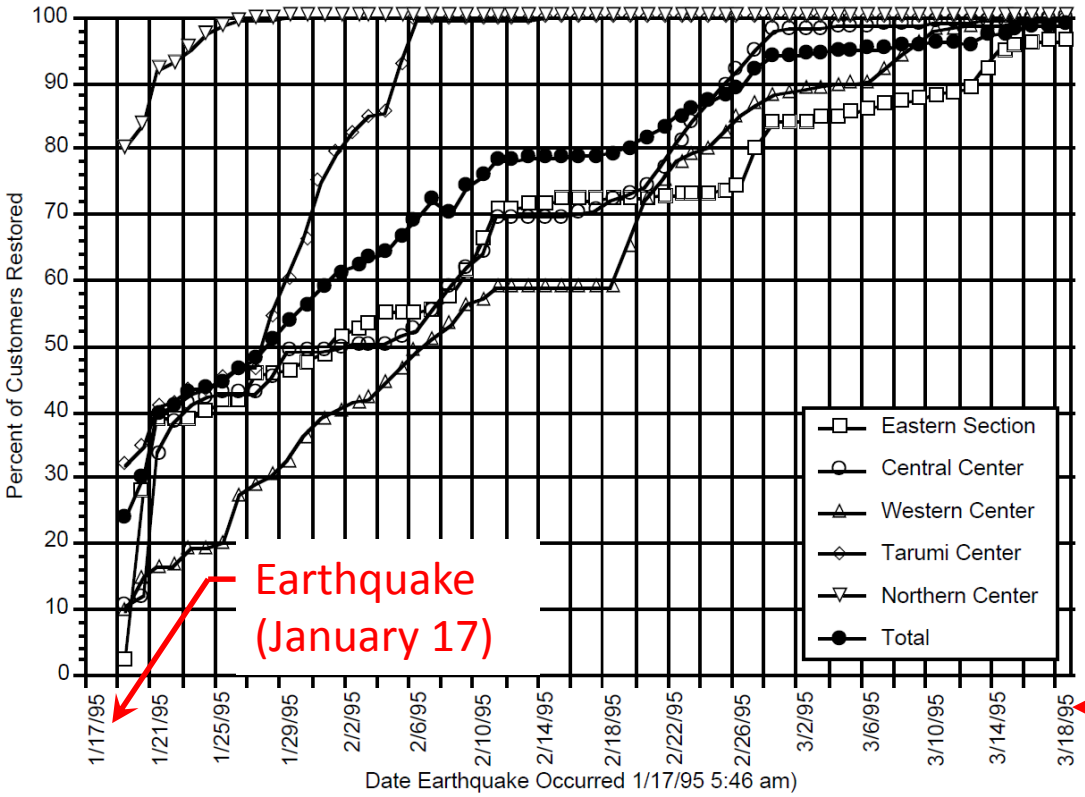


Northridge - 1994

- M6.7 (previously unknown fault)
- Over 1000 watermain breaks
- Over 100 fires
- Water system damage mostly in areas of poor soils
- Outage durations over 8 to 13 plus days

Kobe (Hyogo-Ken Nanbu) – 1995 (M6.9)

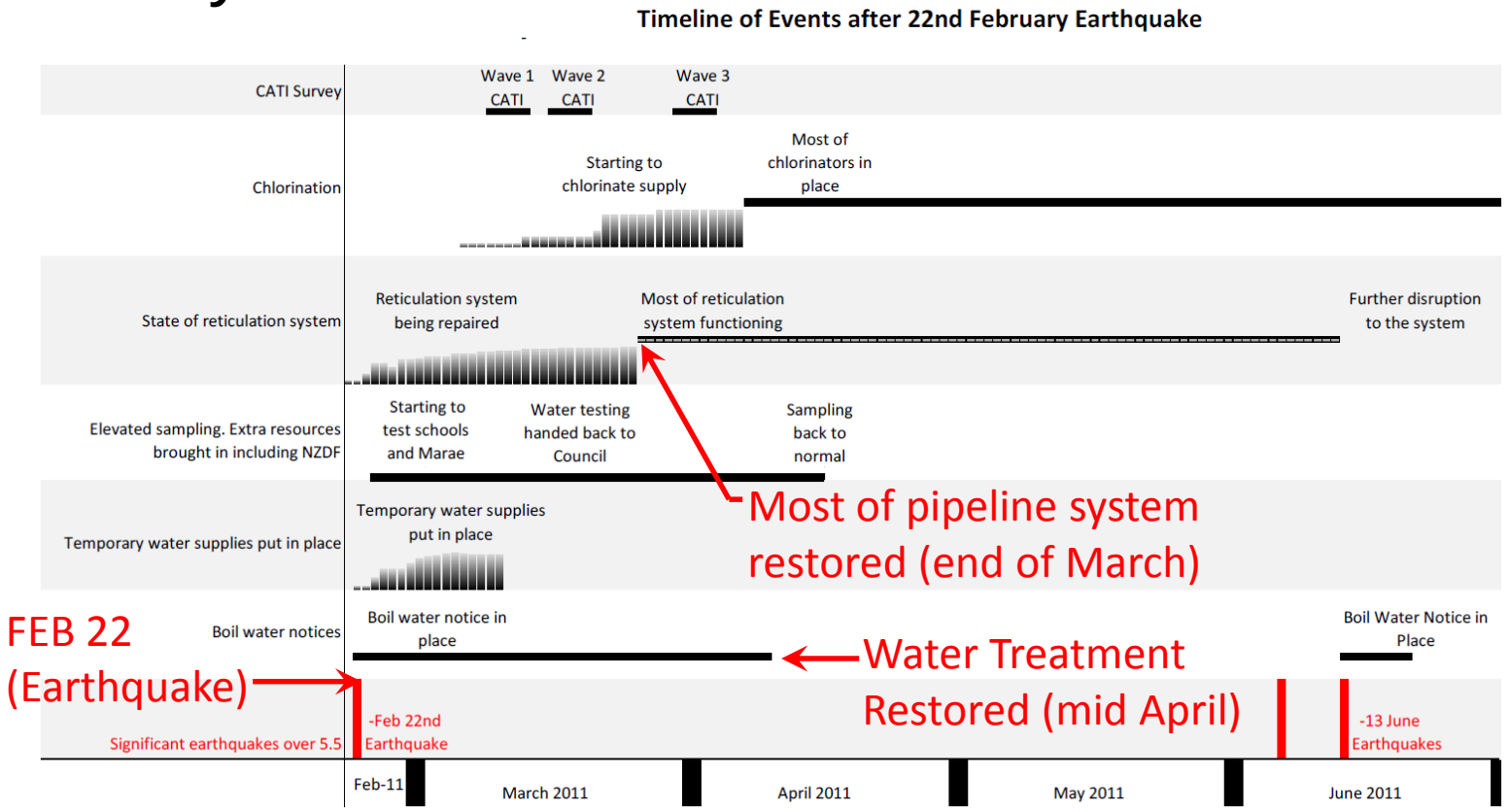
- Over 1700 Pipe Breaks Just in Kobe
- 109 Kobe Fire Ignitions Immediately After Earthquake (Another 88 in Surrounding Cities)
- 60 Days Plus for Restoration of Service



"Substantial" Restoration
(March 18)

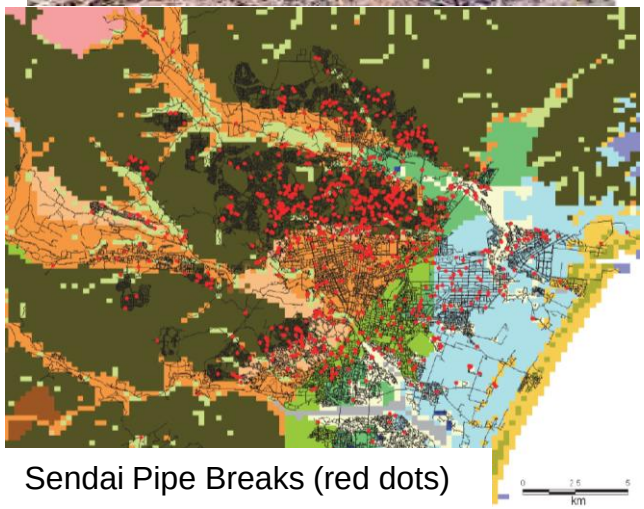
2011 Christchurch Earthquake (M6.2)

- 1645 Watermain Breaks (February 2011 Earthquake) in Christchurch
- Limited Number of Fire Ignitions
- 45 Days Plus for Restoration of Service

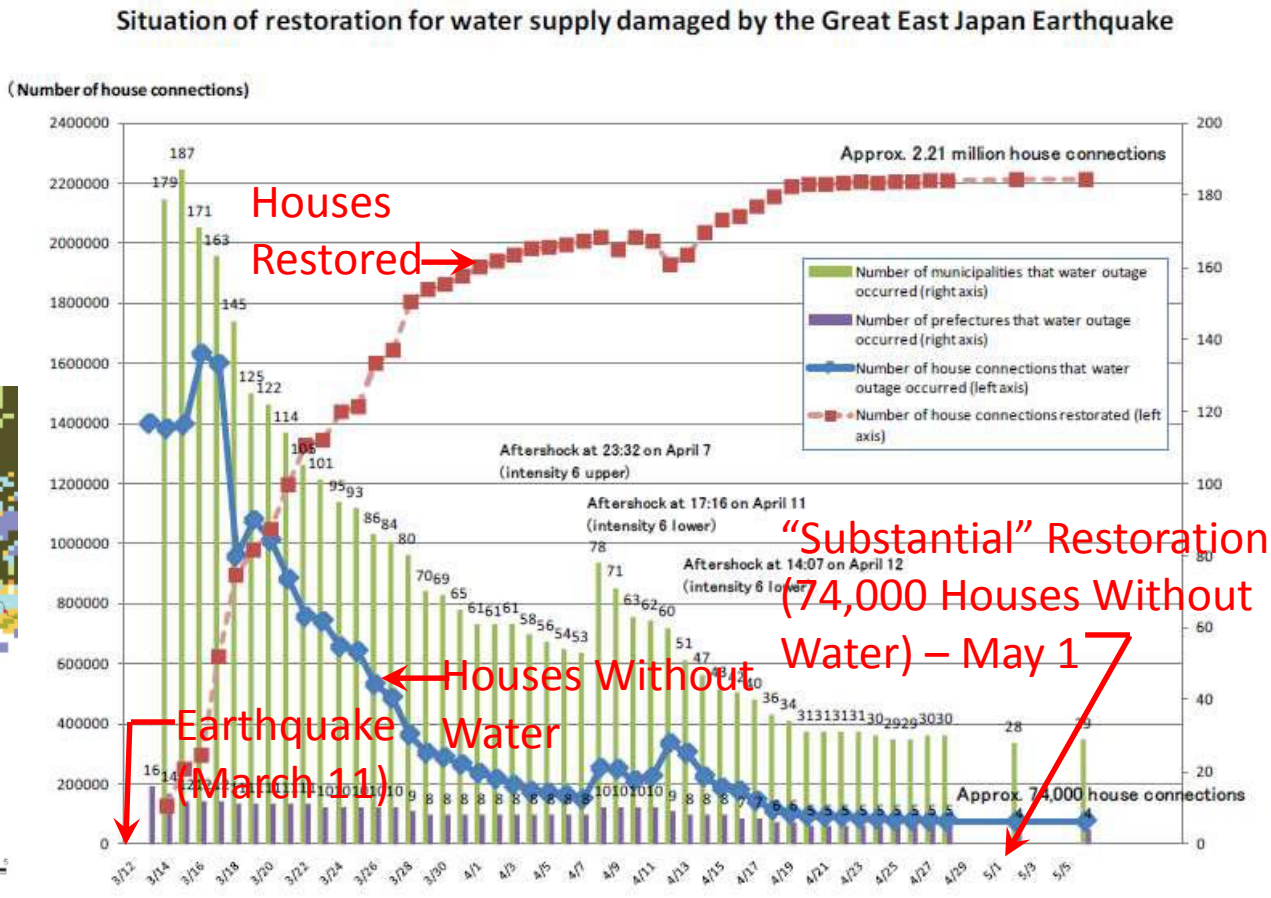


Tohoku (East Japan) – 2011 (M9.0)

- Water Systems of Over 180 Municipalities Affected
- 345 Fire Ignitions
- 45 Days Plus for Substantial Restoration of Service

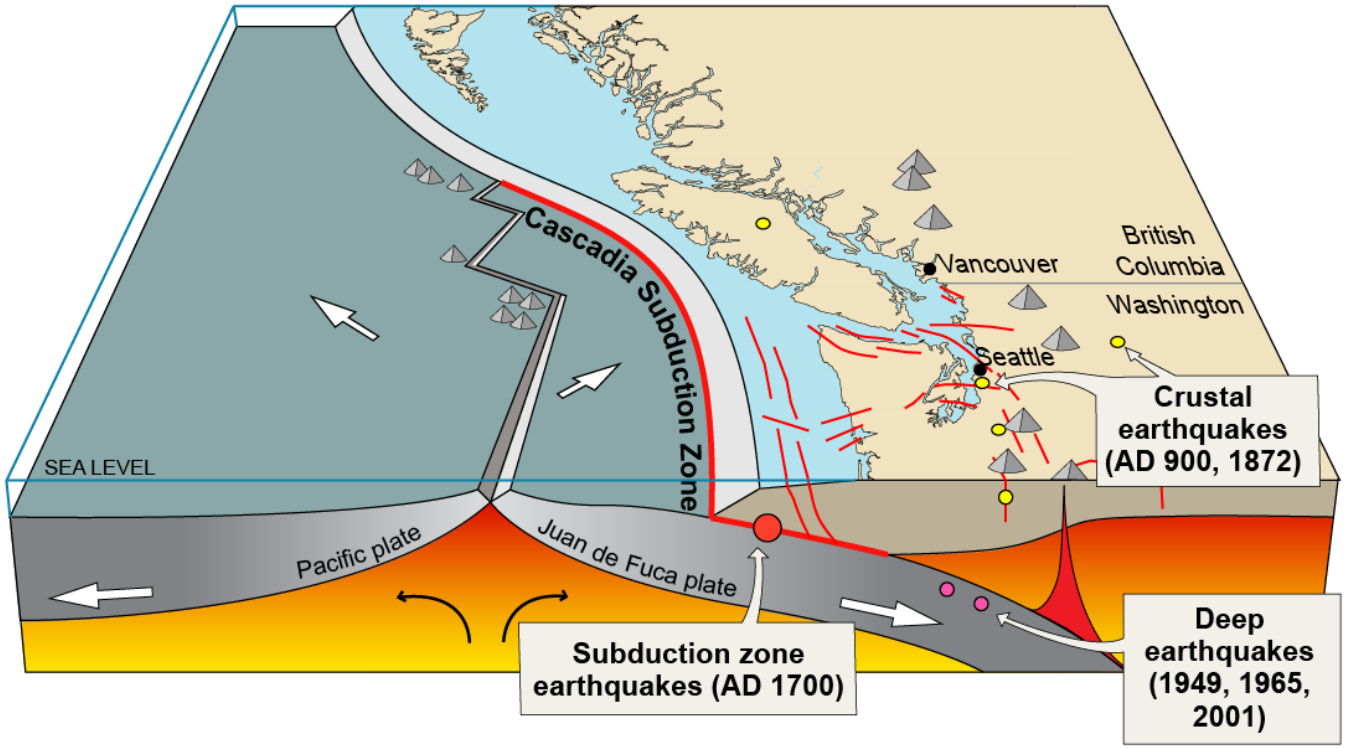


Sendai Pipe Breaks (red dots)



Pacific Northwest Earthquake Sources

(Washington State Department of Natural Resources and USGS)



Source	Max. Size	Recurrence
Subduction zone	M 9+	200–600 years
Deep Juan de Fuca plate	M 7+	30–50 years
Crustal faults	M 7+	Hundreds of years?

Volcano

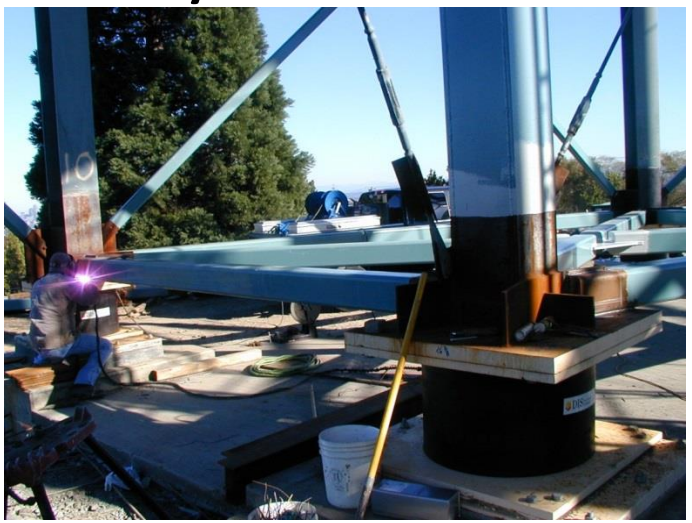
Active crustal fault

Active plate boundary fault

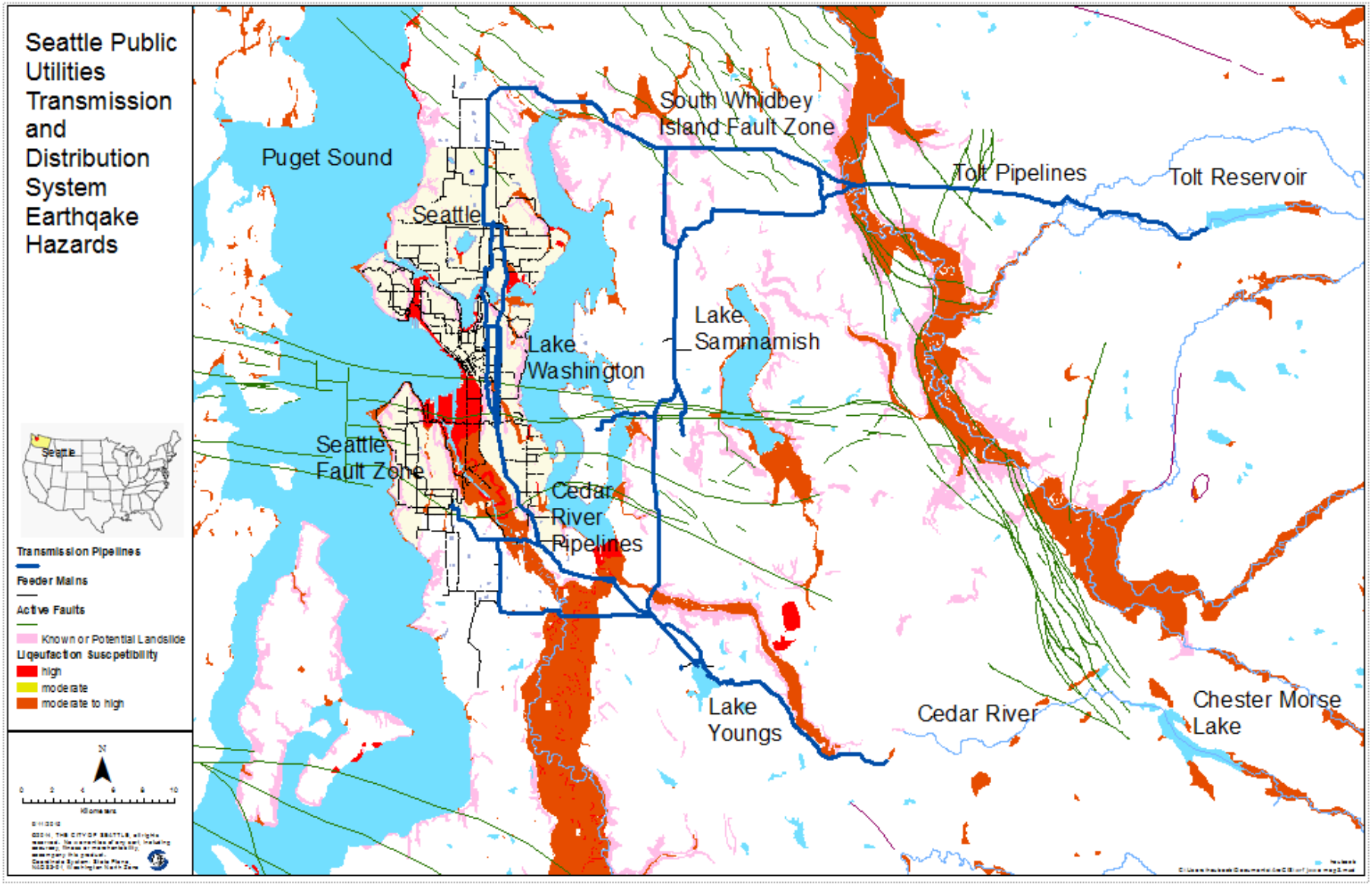
*figure modified from USGS Cascadia earthquake graphics at http://geomaps.wr.usgs.gov/pacnw/pacnweq/index.html

Previous Earthquake Vulnerability Assessments

- Cygna Study of Water System Facility Vulnerability (1990)
- System Response to Pipeline Breaks
  - Kennedy/Jenks/Chilton 1990
  - Water Research Foundation 2009
- Miscellaneous Individual Facility Assessments



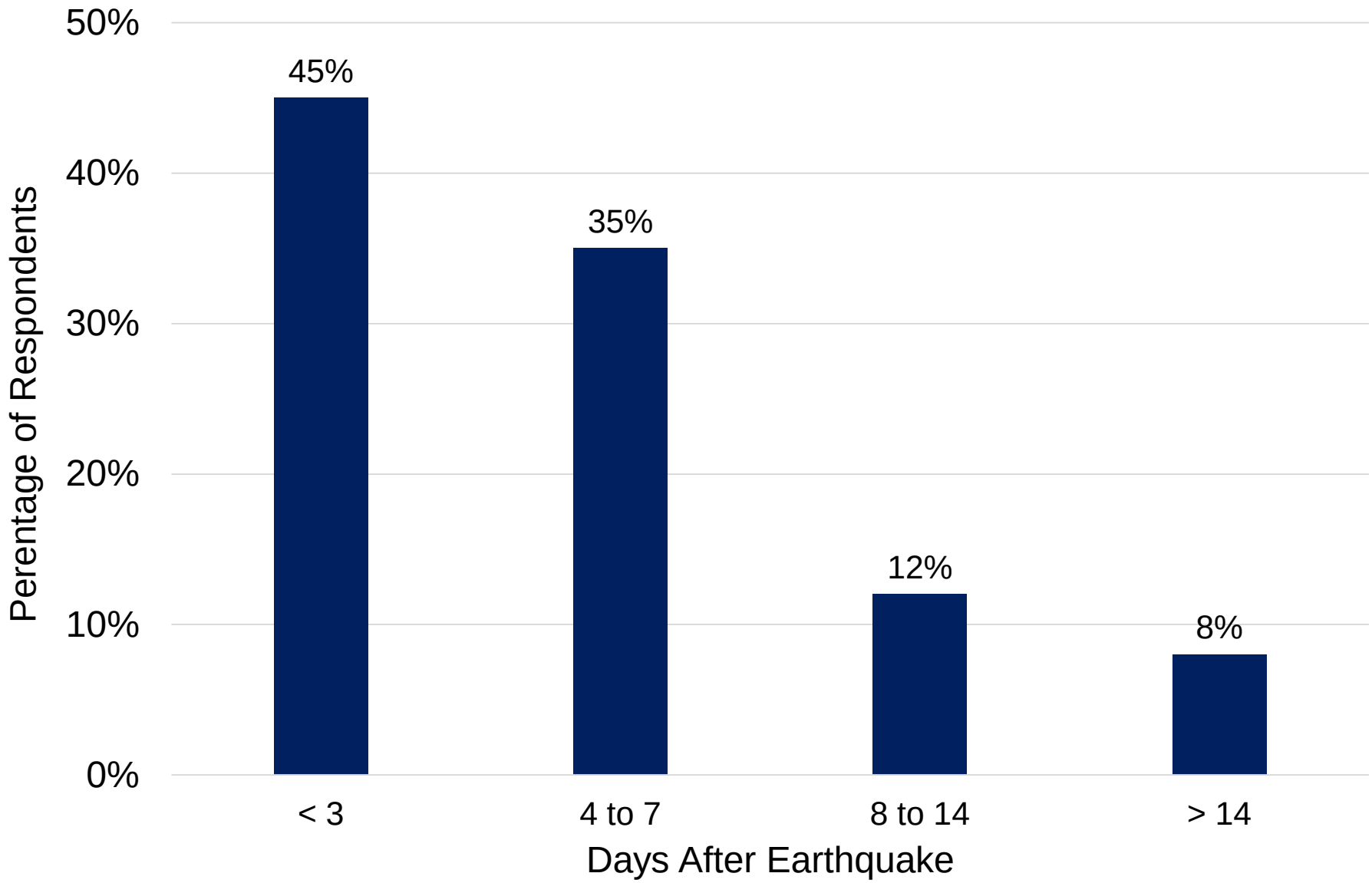
SPU Earthquake Hazards – 1990 and 2015



Estimated/Preliminary SPU Water System Performance to M6.5 to M7.5 Seattle Fault Event

- Performance Likely Similar to Kobe and Christchurch
- Cedar and Tolt Transmission Systems
  - Loss of at Least Cedar System
  - 3 to 7 Days for Partial (50%?) Restoration
  - One to Two Months For Substantial Restoration
- Distribution (Direct Service) System
  - Loss of Pressure Throughout System Possible Within 8 to 12 Hours After Earthquake
  - Water Service Restoration
    - 50% ± After 14 Days
    - 45 to 60 Days to Reach Nearly 100% Restoration

Customer Service Restoration Expectations Following a Major Earthquake



SPU Water System Seismic Study - Project Goals

- **Establish post-earthquake water system performance goals**
- Preliminary critical facility seismic vulnerability assessments
  - Defined earthquake scenarios
  - ASCE/SEI 7-10 (Code Assessment)
- Overall post-earthquake water system performance
- Develop planning level mitigation measures, cost estimates and timeframe to meet service level goals
- Define seismic design standards for water transmission and distribution pipelines

Post-Earthquake Water System Performance Goals

- Define water availability and water service restoration time after an earthquake
- Purposes
  - Establish acceptable water system post-earthquake performance
  - Define seismic program objectives
  - Provide others with expected system performance so they know what to expect and prepare for

SFPUC Performance Goals

- “The basic “Level of Service” criterion shall be to deliver winter day demand (WDD) of 215 million gallons per day (MGD) (February 2030 demand) within 24 hours after a major earthquake.

- Deliver WDD to at least 70% of SFPUC wholesale customers’ turnouts within each of the three customer groups (Santa Clara/Alameda/South San Mateo County, Northern San Mateo County, and City of San Francisco).

- Achieve a 90% confidence level of meeting the above goal, given the occurrence of a major earthquake.

EBMUD Performance Goals

Table A-2. Water System Service Goals - Probable Earthquake (EBMUD)

Service Category		Probable Earthquake
General	1	Minimal secondary damage and risk to the public
	2	Limit extensive damage to system facilities
	3	All water introduced into the distribution system minimally disinfected
	4	All water introduced into the distribution system fully treated
Fire Service	5	Sufficient portable pumps and hose to provide limited fire service in all areas
	6	All areas have minimal fire service (one reliable pumping plant and reservoir)
	7	High risk areas have improved fire service (all facilities reliable, minimum fire reserves)
	8	Normal service to all hydrants within 20 days
Hospitals and Disaster Centers	9	Minimum service to affected area within 1 day (water available via distribution system near each facility)
	10	Impaired service to affected area within 3 days (water available via distribution system to each facility, possibly at reduced pressures)
Domestic Users	11	Potable water via distribution system or truck within 1 day
	12	Impaired service to affected area within 3 days (water available via distribution system to each domestic user, possibly at reduced pressures)
Commercial, Industrial and Other Users	13	Impaired service to affected area within 3 days (water available via distribution system to each commercial or industrial user, possibly at reduced pressures)

Table A-3. Water System Service Goals - Maximum Earthquake (EBMUD)

Service Category		Maximum Earthquake
General	1	Minimal secondary damage and risk to the public
	2	Limit extensive damage to system facilities
	3	All water introduced into the distribution system minimally disinfected
	4	All water introduced into the distribution system fully treated
Fire Service	5	Sufficient portable pumps and hose to provide limited fire service in all areas
	6	All areas have minimal fire service (one reliable pumping plant and reservoir)
	7	High risk areas have improved fire service (all facilities reliable, minimum fire reserves)
	8	Normal service to all hydrants within 100 days
Hospitals and Disaster	9	Minimum service via distribution system or truck within 3 days
Centers	10	Minimum service within 10 days (water available via distribution system near each facility)
	11	Impaired service within 30 days (water available via distribution system to each facility, possibly at reduced pressures)
Domestic Users	12	Potable water at central locations for pickup within 3 days
	13	Minimum service to 70% of customers within 10 days
Commercial, Industrial and	14	Potable water at central locations for pickup within 1 week
Other Users	15	Minimum service to 70% of customers within 10 days
	16	Impaired service to 90% of customers within 30 days (water available via distribution system to 90% of commercial or industrial users, possibly at reduced pressures)

Oregon Resiliency Plan Performance Goals

TARGET STATES OF RECOVERY: WATER & WASTEWATER SECTOR (VALLEY)

	Event occurs	0–24 hours	1–3 days	3–7 days	1–2 weeks	2 weeks–1 month	1–3 months	3–6 months	6 months –1 year	1–3 years	3 + years
Domestic Water Supply											
Potable water available at supply source (WTP, wells, impoundment)		R	Y		G			X			
Main transmission facilities, pipes, pump stations, and reservoirs (backbone) operational		G					X				
Water supply to critical facilities available		Y	G				X				
Water for fire suppression—at key supply points		G		X							
Water for fire suppression—at fire hydrants				R	Y	G			X		
Water available at community distribution centers/points			Y	G	X						
Distribution system operational			R	Y	G				X		

TARGET TIMEFRAME FOR RECOVERY:

Desired time to restore component to 80–90% operational — G

Desired time to restore component to 50–60% operational — Y

Desired time to restore component to 20–30% operational — R

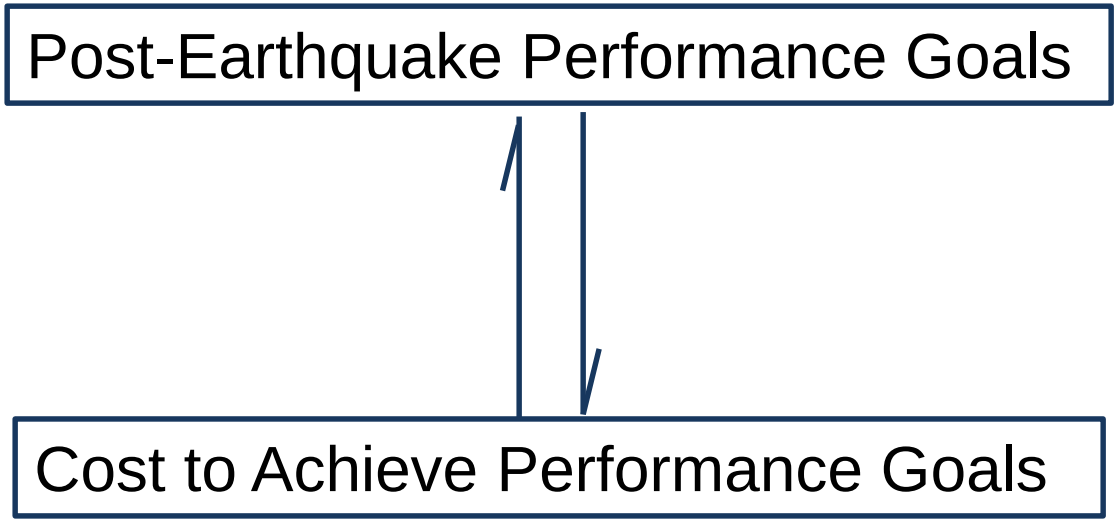
Current state (90% operational) — X

Performance Goal Development – Stakeholder Input

- Public/Direct Service Customers
  - Survey/Choice Experiment (Willingness to Pay)
  - Water System Advisory Committee
- Wholesale Customers (Operating Board)
- City Leadership
  - Fire Department
  - SPU
  - Emergency Executive Board
- SPU Water LOB Staff

Performance Goal Development – Seismic Study Findings

- Consultant Recommendations
- Cost Considerations



Milestones/Target Dates

- Consultant and Stakeholder Review
  - May 1, 2015 through October 31, 2016
- Development of Mitigation Options/Costs to Meet Performance Goals
  - June 1, 2016 through July 31, 2016
- Modification of Performance Goals to be Consistent with Seismic Study Findings
  - July 1, 2016 through September 30, 2016
- Final Performance Goals
  - November 1, 2016

Emergency Executive Board Input

- Review Performance Goals
- Provide Input and Reaction to Bill Heubach (Bill.Heubach@Seattle.Gov, 684-0623) with Questions, Comments and Suggestions by December 31, 2015
- SPU Report Back to Emergency Executive Board
  - Spring/Summer 2016: Performance Goals for Earthquake Mitigation Development
  - Summer/Fall 2016: Cost to Achieve Performance Goals

DRAFT (November 2015) Post-Earthquake Water System Level of Service Goals - 2035
Surface Fault or Cascadia Subduction Event

		Immediately After	24 Hours	3 Days	7 Days	14 Days	1 Month
Water Supply at Wholesale Meters	Minimum Water Volume	Winter Demand	Winter demand	Winter demand	Winter Demand	Winter Demand	Normal
	Water Quality	Non Potable	Non Potable	Non Potable	Non Potable	Potable	Potable
	Water Availability	50% of Meters	50% of Meters	50% of Meters	75% of Meters	100% of Meters	100% of Meters
Fire Suppression Water – Designated Supply Points (e.g., reservoirs and tanks)	Minimum Water Volume	300,000 gallons per location	150,000 gallons per location	Full storage capacity	Full storage capacity		
	Water Availability	90% of Supply Points	75% of Supply Points	75% of Supply Points	100% of Supply Points		
Water Supply at Hydrants and Retail Meters	Water Quality	Non Potable	Non Potable	Non Potable	Non Potable	Non Potable	Potable
	Water Availability	50%	50%	60%	75%	90%	100%
Water Supply for Critical Retail Customers (e.g., hospitals)	Water Quality	Non Potable	Non Potable	Non Potable	Non Potable	Non Potable	Potable
	Water Availability	50% of critical customers	50% of critical customers	100% of critical customers	100% of critical customers	100% of critical customers	100% of critical customers
Water Supply at Retail Customer Emergency Supply Points	Water Quality	Potable	Potable	Potable			
	Water Availability	0%	50%	100%			

DRAFT (November 2015) Post-Earthquake Water System Level of Service Goals - 2065
Surface Fault or Cascadia Subduction Event

		Immediately After	24 Hours	3 Days	7 Days	14 Days	1 Month
Water Supply at Wholesale Meters	Minimum Water Volume	Winter demand	Winter demand	Winter demand	Winter demand	Normal	
	Water Quality	Non Potable	Non Potable	Non Potable	Potable	Potable	
	Water Availability	50% of Meters	75% of Meters	100% of Meters	100% of Meters	100% of Meters	
Fire Suppression Water – Designated Supply Points (e.g., reservoirs and tanks)	Minimum Water Volume	300,000 gallons	150,000	Full storage capacity			
	Water Availability	90% of Supply Points	90% of Supply Points	100% of Supply Points			
Water Supply at Hydrants and Retail Meters	Water Quality	Non Potable	Non Potable	Non Potable	Potable	Potable	
	Water Availability	67%	67%	75%	90%	100%	
Water Supply for Critical Retail Customers (e.g., hospitals)	Water Quality	Non Potable	Non Potable	Non Potable	Potable		
	Water Availability	90% of critical customers	90% of critical customers	100% of critical customers	100% of critical customers		
Water Supply at Retail Customer Emergency Supply Points	Water Quality	Potable	Potable				
	Water Availability	90%	100%				

Performance Goal Comparison
- Water Supply at Wholesale Meters

		Immediately After	24 Hours	3 Days	7 Days	14 Days	1 Month	2 months	3 months	6 months
Water Supply at Wholesale Meters	SPU - 2035	Winter demand, untreated water to 50% of meters			Winter demand, untreated water to 75% of meters	Winter demand, treated water to 100% of meters	Full service to all wholesale meters (reduced to 14 days by 2065)			
	Contra Costa		Emergency and fire suppression water available to all wholesale meters (within 2 days)		Partial service to all wholesale meters with periodic three day interruptions for repair (within 10 days)		Full service to all wholesale meters			
	Everett				Minimally disinfected with variable flow and pressure at all wholesale meters (5 to 10 days)	Full treatment at winter demand with variable pressure and flow to all wholesale meters (10 to 20 days)		Full treatment at average winter demand to all wholesale meters (60 to 120 days)		
	Humboldt				Impaired (not treated, occasional outages, reduced volume) service within 7 days			Full service		
	SFPUC		Winter day demand to 70% of wholesale meters				Average day demand to 100% of wholesale meters			

Performance Goal Comparison – Supply Points

		Immediately After	24 Hours	3 Days	7 Days	14 Days	1 Month	2 months	3 months	6 months
Fire Suppression Water – Designated Supply Points (e.g., reservoirs and tanks)	SPU - 2035	300,000 gallons per location at 90% of the supply points	150,000 gallons per location at 75% of supply points	Full storage capacity at 75% of supply points	Full storage capacity at 100 percent of supply points (reduced to 3 days by 2065)					
	Contra Costa	Temporary repairs to achieve full fire service as soon as possible								
	EBMUD	Limited fire service to all areas with potable pumps and hoses								
	Oregon	Water available at key supply points (0 to 24 hours)								

		Immediately After	24 Hours	3 Days	7 Days	14 Days	1 Month	2 months	3 months	6 months
Water Supply at Retail Customer Emergency Supply Points	SPU	No Locations Supplied	Water available at 50% of locations	Water available at 100% of locations (reduced to 24 hours by 2065)						
	Humboldt		Potable water supplied via truck to all accessible locations							
	Oregon			Water available at 50% to 60% of locations (1 to 3 days)	Water available at 80% to 90% of locations (3 to 7 days)	Water available at 90% of locations (1 to 2 weeks)				

Performance Goal Comparison – Retail Meters

Water Supply at Hydrants and Retail Meters

		Immediately After	24 Hours	3 Days	7 Days	14 Days	1 Month	2 months	3 months	6 months
Water Supply at Hydrants and Retail Meters	SPU - 2035	Untreated supply to 50% of meters/hydrants		Untreated supply to 60% of meters/hydrants	Untreated supply to 75% of meters/hydrants	Untreated supply to 90% of meters/hydrants	Potable supply to 100% of meters/hydrants (reduced to 14 days by 2065)			
	Contra Costa						Full service within 30 days			
	EBMUD				Minimum service to 70% of customers within 10 days				Normal service to all hydrants	
	Humboldt Bay				Impaired service to all customers			Normal service to all customers		
	Oregon			20% to 30% of distribution system operational (1 to 3 days)	20% to 30% of hydrants, 50% to 60% of distribution system operational (3 to 7 days)	50% to 60% of hydrants, 80% to 90% of distribution system operational (1 to 2 weeks)	80% to 90% of hydrants operational (2 weeks to one month)			Normal service to all hydrants and meters (6 months to one year)

Water Supply for Critical Retail Customers (e.g., hospitals)

		Immediately After	24 Hours	3 Days	7 Days	14 Days	1 Month	2 months	3 months	6 months
Water Supply for Critical Retail Customers (e.g., hospitals)	SPU - 2035	50% of critical customers	50% of critical customers	100% of critical customers	100% of critical customers	100% of critical customers	100% of critical customers (reduced to 7 days by 2065)			
	EBMUD			Minimum service via truck or distribution system		Minimum service via distribution system (10 days)	Impaired service			
	Oregon		50% to 60% of critical facilities	80% to 90% of critical facilities					Normal service to critical facilities	

QUESTIONS?

COMMENTS?

SUGGESTIONS?