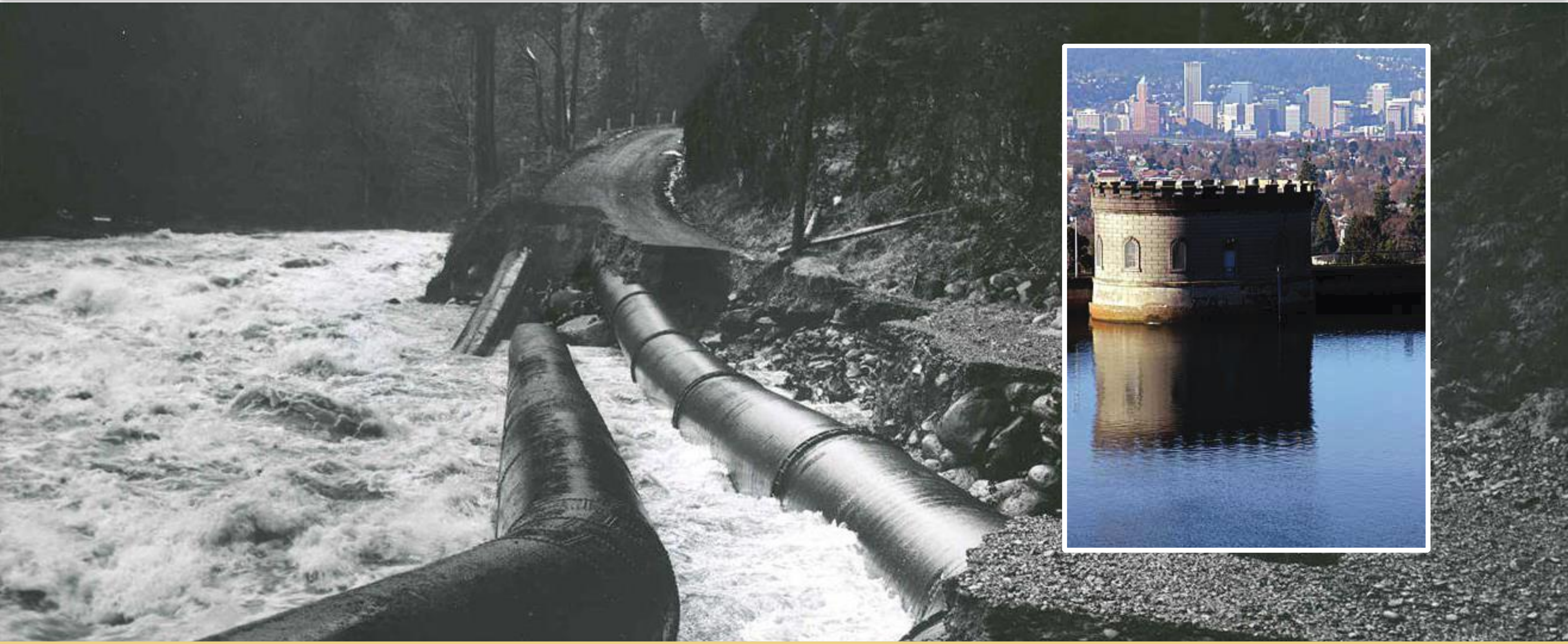
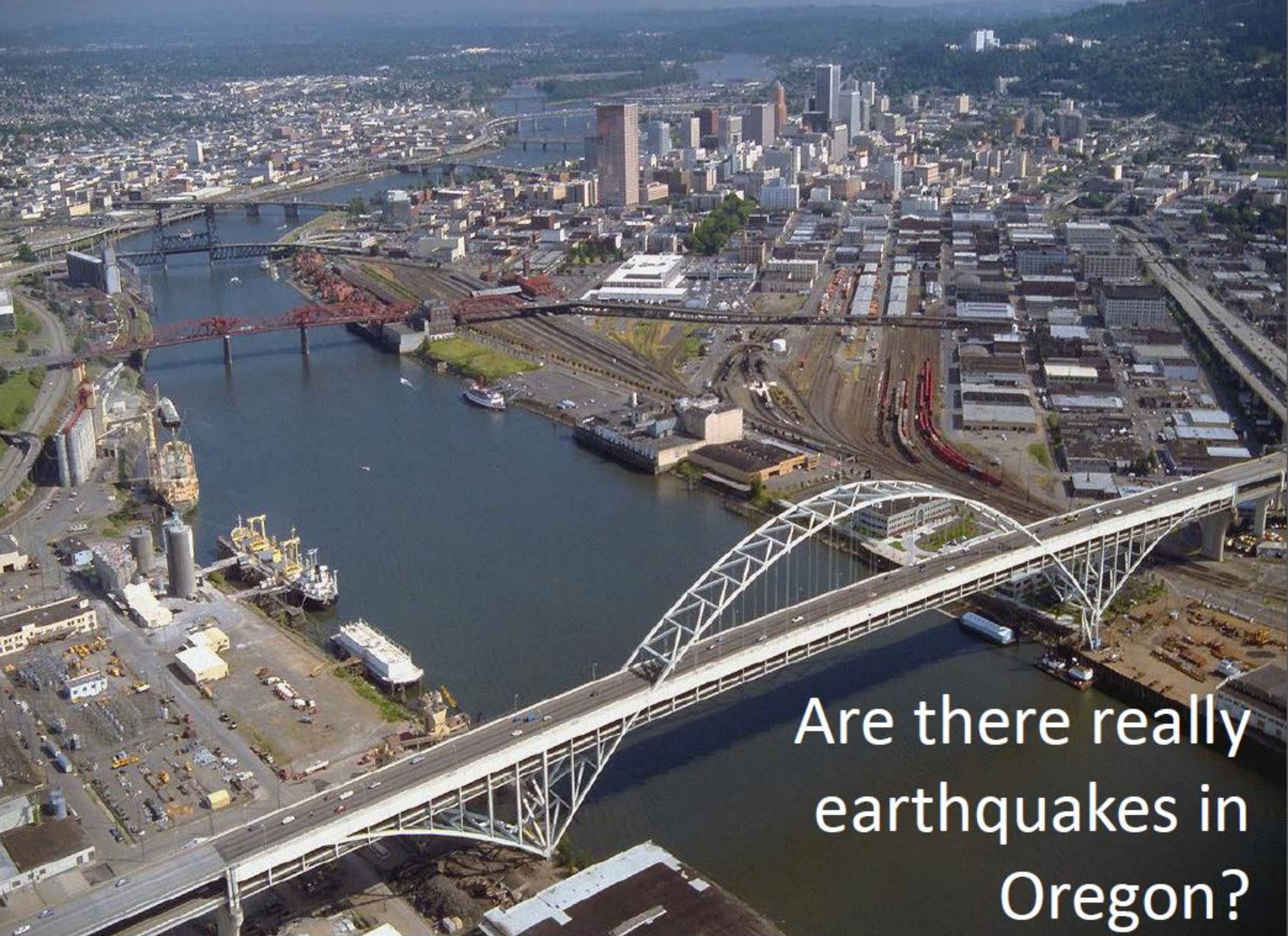
City of Portland Water Bureau

Portland's Seismic Vulnerabilities



Columbia Corridor Association
23 March 2016

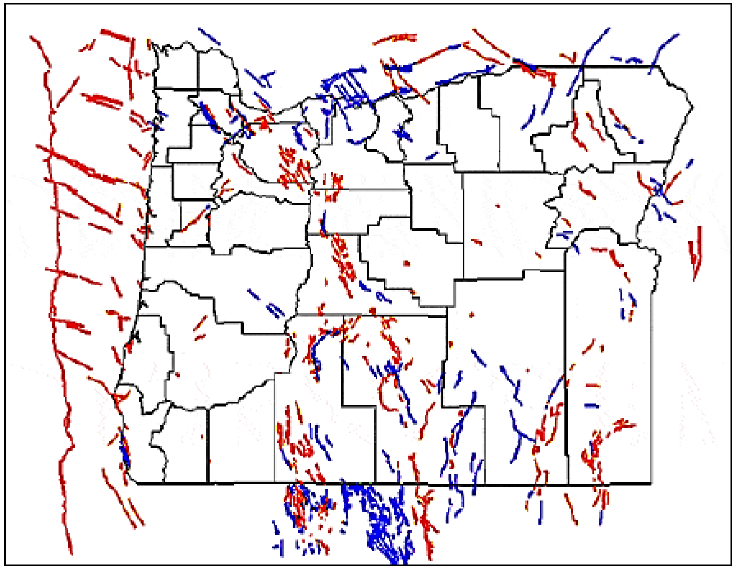
PORTLAND WATER BUREAU
FROM FOREST TO FAUCET


Are there really earthquakes in Oregon?

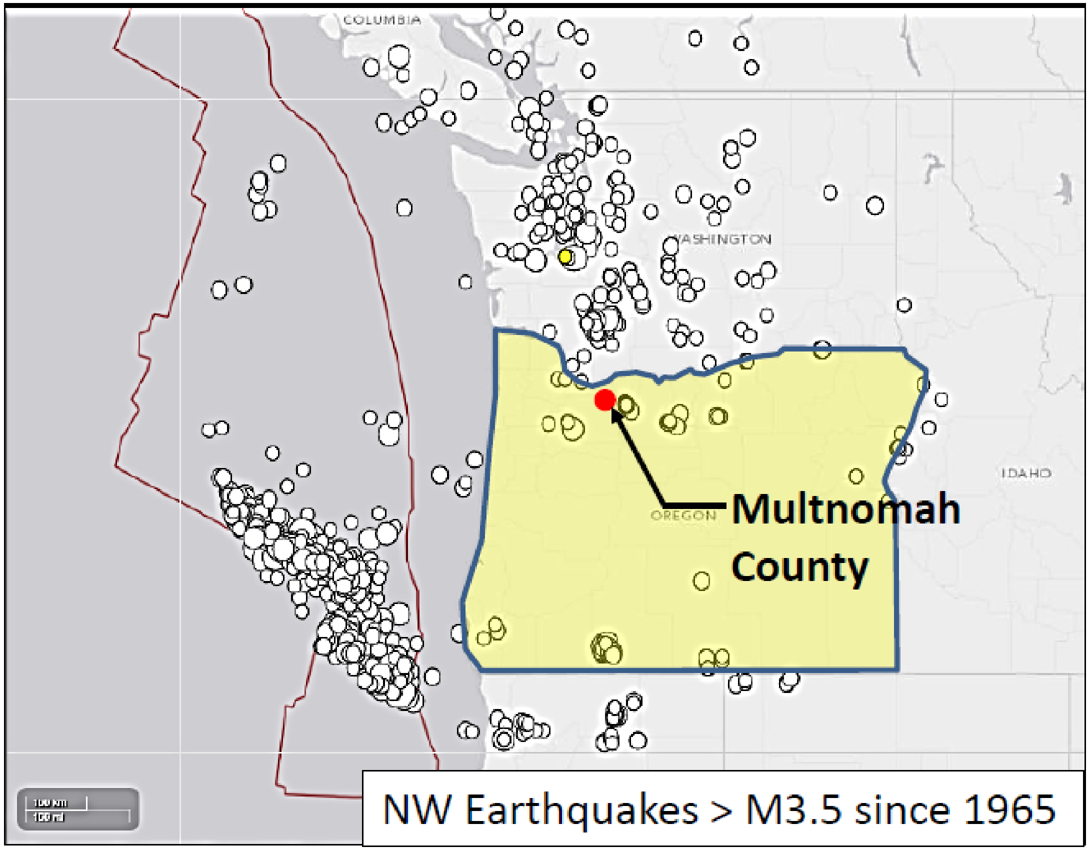
NW Earthquake Activity

Source	Magnitude	Frequency	Latest Occurrence
Crustal	M < 5.5	Every 15–20 years	Annually
	M ≥ 5.5	???	1993: Scotts Mills & Klamath-Falls
CSZ*	M ≥ 8.0	Every 350–500 years	January, 1700
Intraplate	M = 4–7	Every 30–50 years	Feb., 2009 M4.1, Grants Pass, OR

Note: M9.0 = 1000 x 2014 Napa EQ

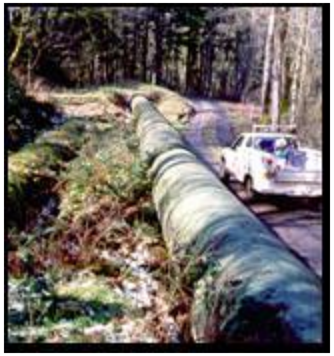


Known Oregon EQ Faults



NW Earthquakes > M3.5 since 1965

2 Dams



100+ miles of large pipe

2,300+ miles of Smaller dia. pipe

66 Tanks and Reservoirs

14,000+ hydrants

50,000+ valves

180,000 meters

41 pump stations

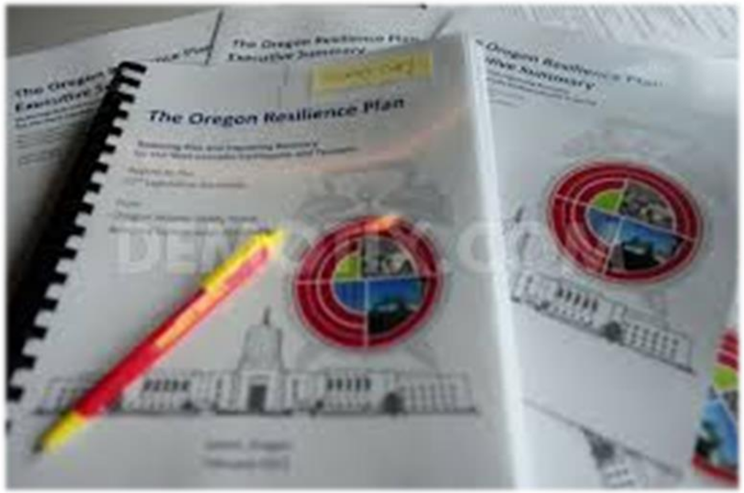
Portland Water Bureau Statistical Information

Water System Seismic Study
Project Objective

- ❖ Comply with the Oregon Resilience Plan (ORP)
  - i. Complete a seismic risk assessment of PWB's water system.
  - ii. Produce an infrastructure mitigation plan to meet or exceed the water recovery goals (target states of recovery) listed in the ORP.

Oregon Resilience Plan (ORP)

- Specifies likely impacts of a magnitude 9.0 Cascadia earthquake.
- Defines target states of recovery goals to be met within 50 years.
- Recommends changes in practice and policy.



ORP – Target States of Recovery

KEY TO THE TABLE

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

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		

(To be continued on next page)

KEY TO THE TABLE

TARGET TIMEFRAME FOR RECOVERY:

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Current state (90% operational)	X

	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
Wastewater Systems											
Threats to public health & safety controlled			R	Y		G			X		
Raw sewage contained & routed away from population		R		Y			G		X		
Treatment plants operational to meet regulatory					R			Y	G		X

KEY TO THE TABLE

TARGET TIMEFRAME FOR RECOVERY:

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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

Water System Seismic Study Tasks

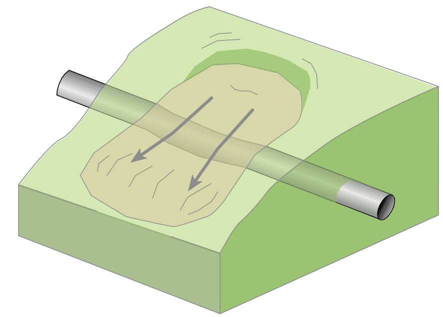
- Task 1 – Assess liquefaction and lateral spreading
  - Produce hazard maps to assist in PWB’s emergency response
  - Produce high-resolution data of Permanent Ground Deformation (PGD) that can be utilized in determining risk (damage)
- Task 2 – Assess & Model backbone system performance
- Task 3 – Assess distribution system performance
- Task 4 – Evaluate emergency preparedness for response and recovery
- Task 5 – Develop & prioritize mitigation measures

Causes of Damage due to Seismicity

Two Categories:

1) Permanent Ground Deformation
   - Liquefaction
   - Lateral Spreading
   - Dynamic Slope Instability (Landslides)
   - Surface Rupture (study assumes it will not occur)
2) Seismic Wave Propagation

General Explanation of Liquefaction & Lateral Spreading

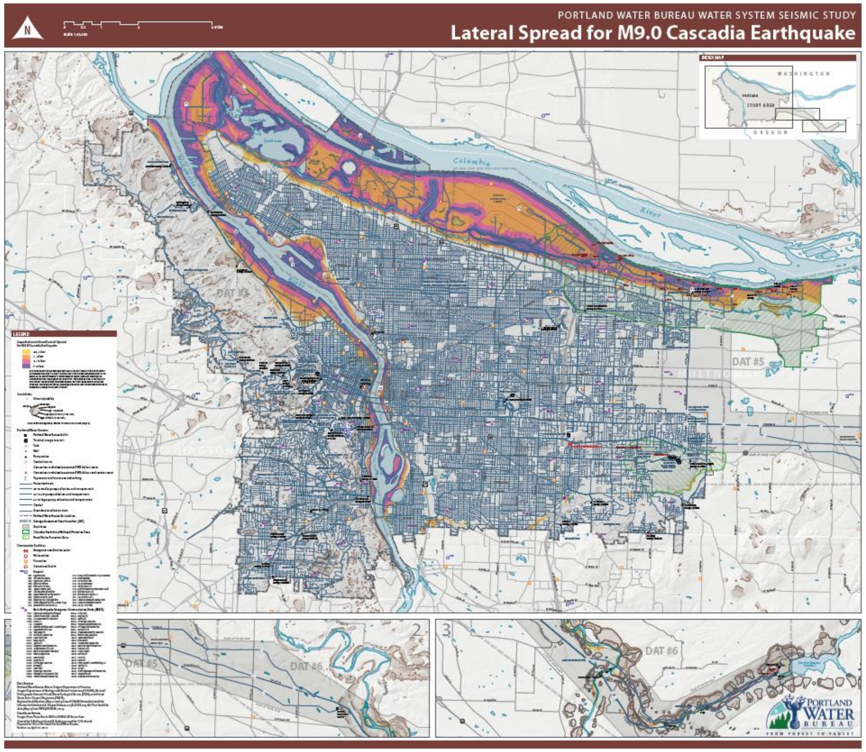


- Occurs due to strong ground shaking
- In saturated soil profiles with significant sand content
- Results in a semi-fluid state
- Causes loss of soil strength and bearing capacity

Video of Liquefaction During East Japan Earthquake

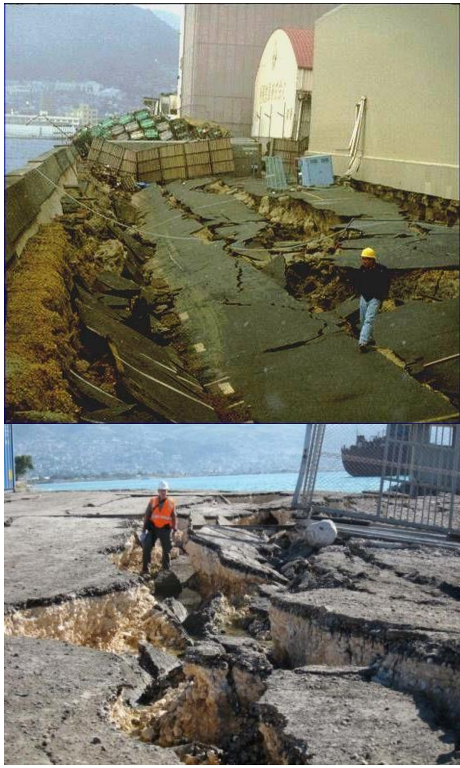
PWB's New Hazard Maps from Seismic Study

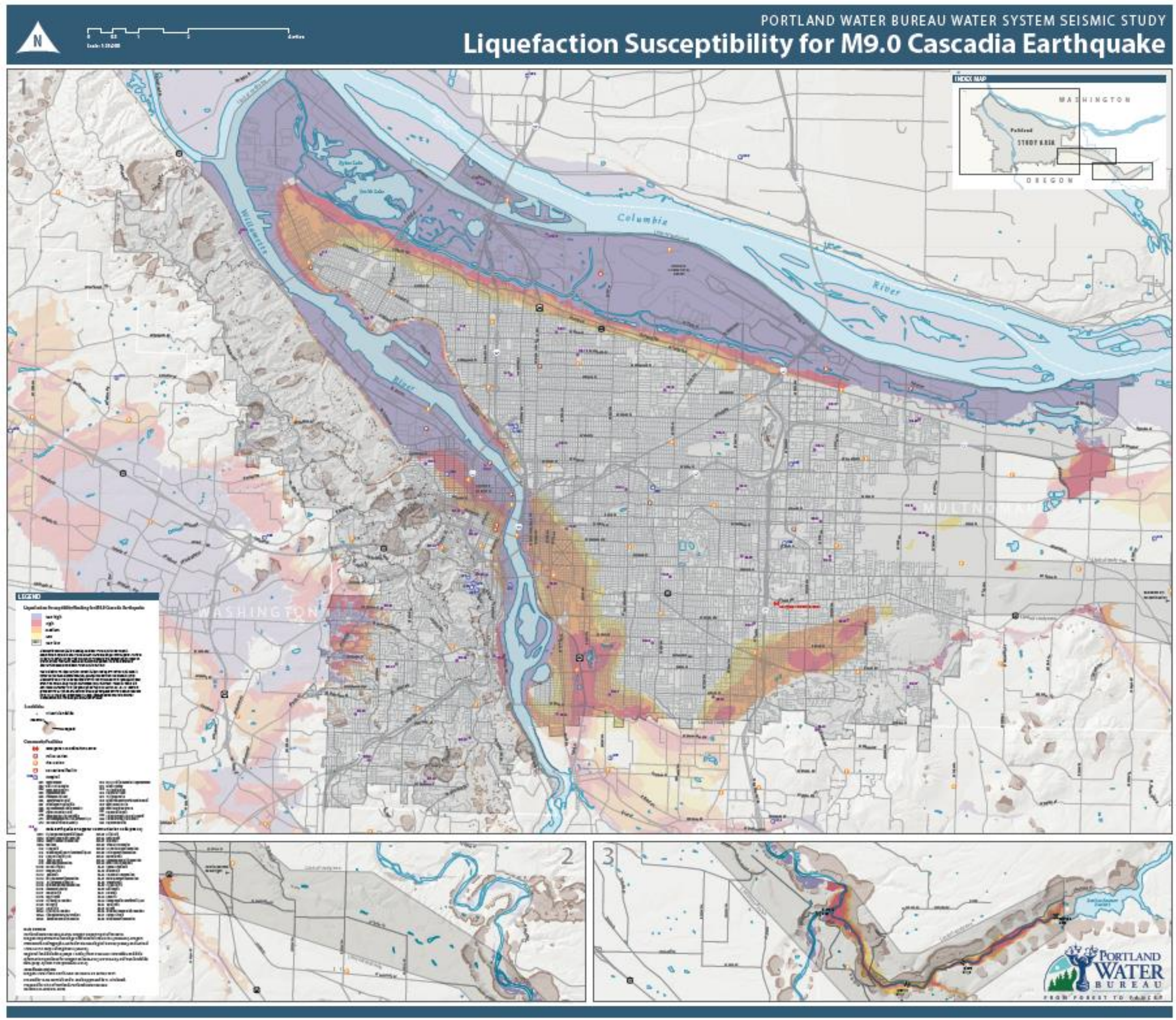
- Four (4) PDF Maps along with four new ArcGIS layers in the City's CorporateGIS system
  - Liquefaction Susceptibility
  - Lateral Spread
  - Liquefaction Ground Settlement
  - Landslide Deformation



PWB’s PGD Maps Incorporate

- DOGAMI produced regional hazard maps (Madin and Burns, 2013) for the ORP
- recently developed three-dimensional geologic model by DOGAMI
- ground water depth using the regional USGS depth to groundwater model
- substantially more geotechnical borings then the ORP mapping
- settlement using estimated volumetric strain calculated for the total saturated thickness of liquefiable deposits based on the three-dimensional geologic model and depth to groundwater
- lateral spreading calculated on estimated strain from ground shaking applied to the cumulative liquefiable thickness of subsurface deposits and modified by LiDAR-base ground slope/distance from the free faces

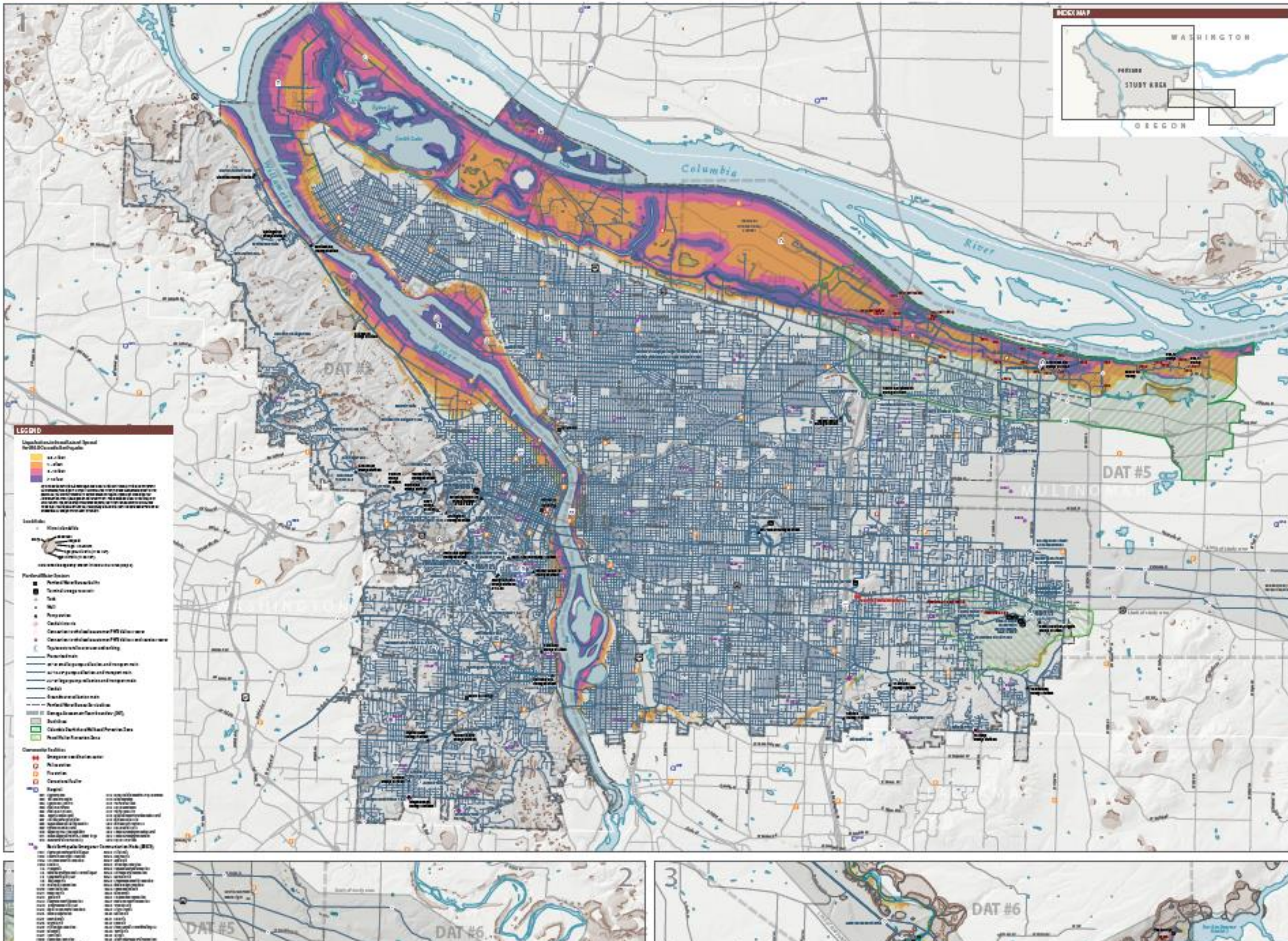


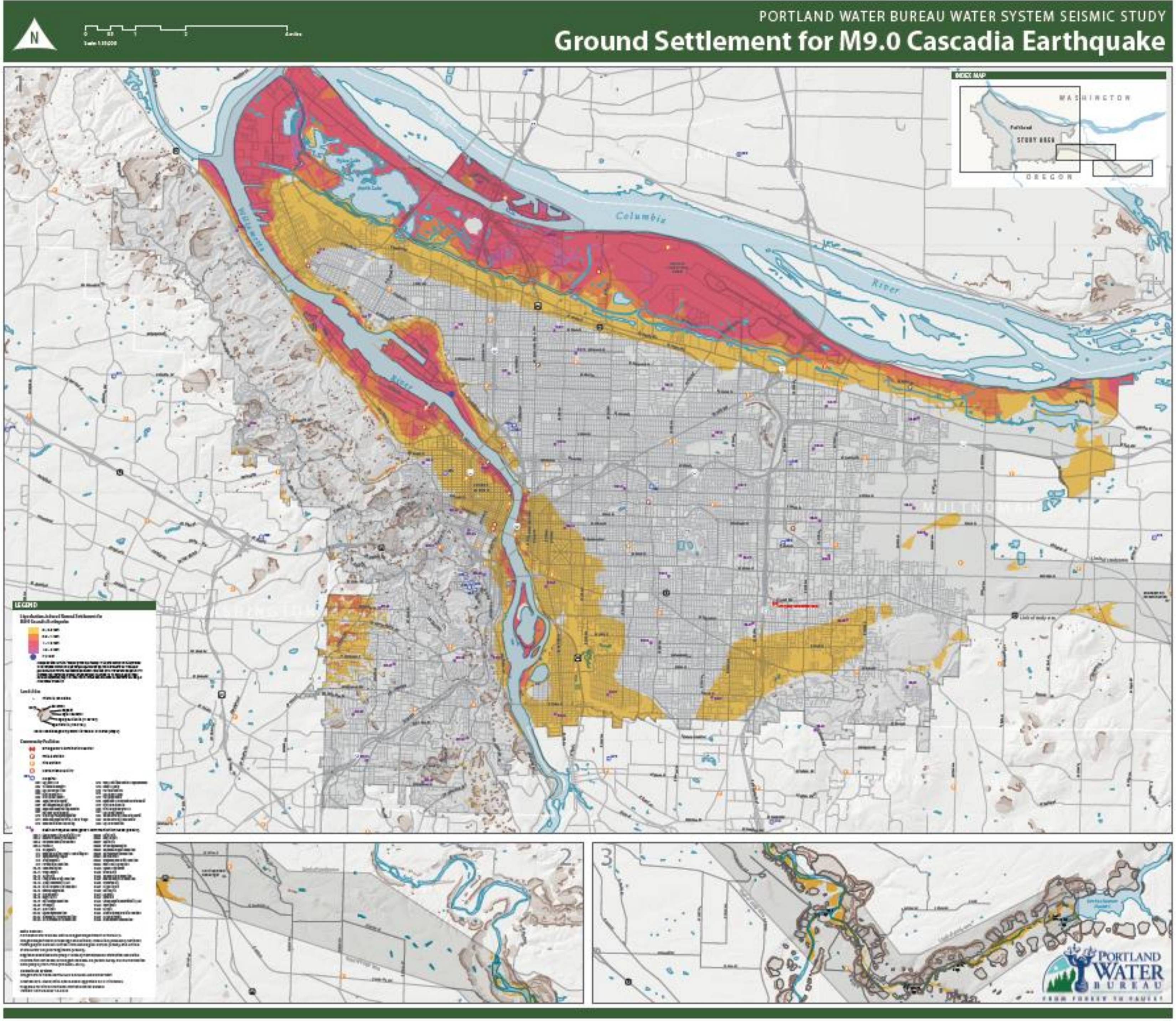


PORTLAND WATER BUREAU WATER SYSTEM SEISMIC STUDY
Liquefaction Susceptibility for M9.0 Cascadia Earthquake
N
INDEX MAP
WASHINGTON
OREGON
Columbia
River
Willamette
River
WASHINGTON
MULTNOMAH
LEGEND
PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

PORTLAND WATER BUREAU WATER SYSTEM SEISMIC STUDY

Lateral Spread for M9.0 Cascadia Earthquake




PORTLAND WATER BUREAU WATER SYSTEM SEISMIC STUDY
Ground Settlement for M9.0 Cascadia Earthquake
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INDEX MAP
WASHINGTON
OREGON
STUDY AREA
Columbia
River
Willamette
River
MULTNOMAH
LEGEND
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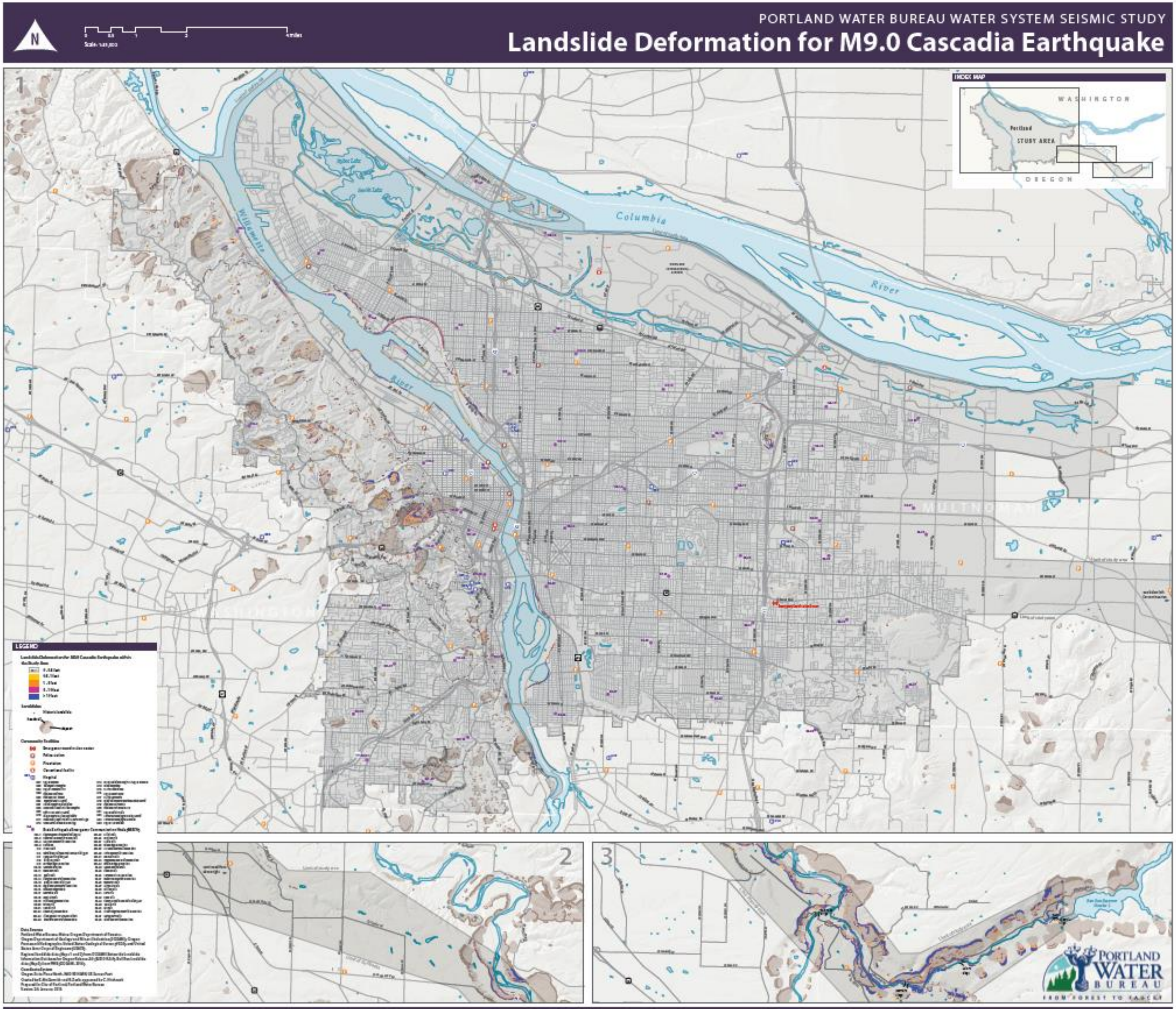
PORTLAND WATER BUREAU
FROM FOREST TO FAUCET


PORTLAND WATER BUREAU WATER SYSTEM SEISMIC STUDY
Landslide Deformation for M9.0 Cascadia Earthquake
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INDEX MAP
WASHINGTON
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STUDY AREA
OREGON
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River
Willamette
River
MULTNOMAH
LEGEND
1
2
3
PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

Possible Uses

- Planning level analyses, not site specific.

Next Steps

- Finalize Maps and GIS Layers, CGIS Feb 2016
- Continue work on System
  - Assess Facility Performance
  - Model Backbone System
  - Repair Plan, Fire Plan, Potable Water Plan
  - Water System Mitigation Plan
- Final Seismic Report, Summer 2016


Questions ?