Use of Seismic Hazard Information in Water and Wastewater System Analysis

ATC/USGS Seismic Hazards
User-Needs Workshop
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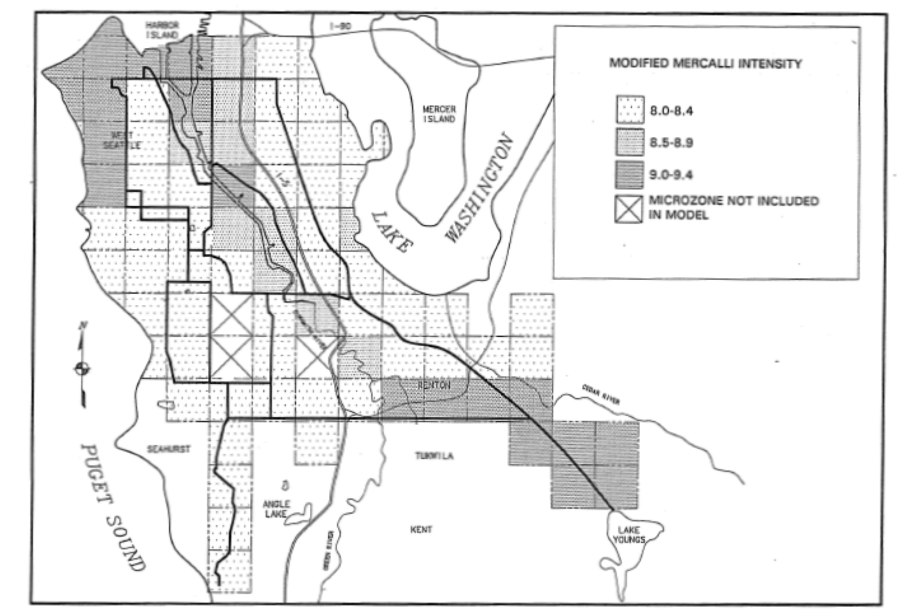
Introduction

- Earthquake engineer focusing on seismic performance of water and wastewater systems
- First system analysis Seattle Water 1987, USGS Funded
- Evaluated over 75 systems since
- Objective – estimate the likely performance of systems when subjected to an earthquake
- Identify needs



Source: Kennedy/Jenks/Chilton (1990b).

Figure 4-1 Modified Mercalli Intensity map for the southern half of Seattle, Wash., for a magnitude 7.5 earthquake

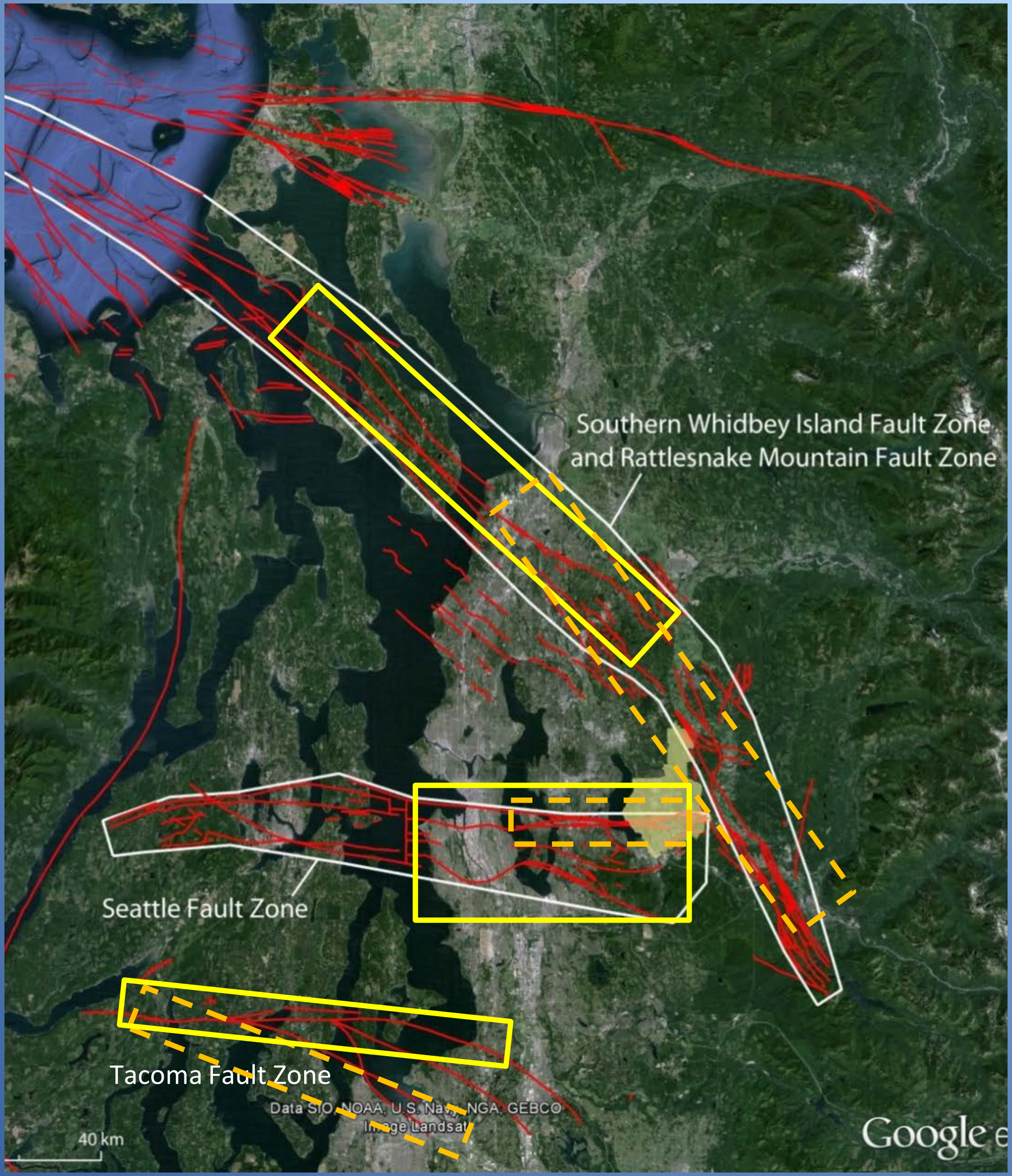
Overview – Modeling Issues

- Seismicity
  - Scenarios
  - ShakeMap, return periods
- Geotechnical Hazards/ Permanent Ground Deformation
  - Surface fault rupture
  - Liquefaction/lateral spread, areal extent
  - Settlement
  - Landslide
  - Lurching

Scenarios

- Used scenarios rather than probabilistic ground motions to avoid over estimating damage
- Select scenarios approximating 500 and 2,500 year return
- PGA – facilities using HAZUS
- PGV – pipelines using ALA
- ShakeMap handy source
- Return Periods?

Designer Faults - Sliding, Different Strand, Return Periods?

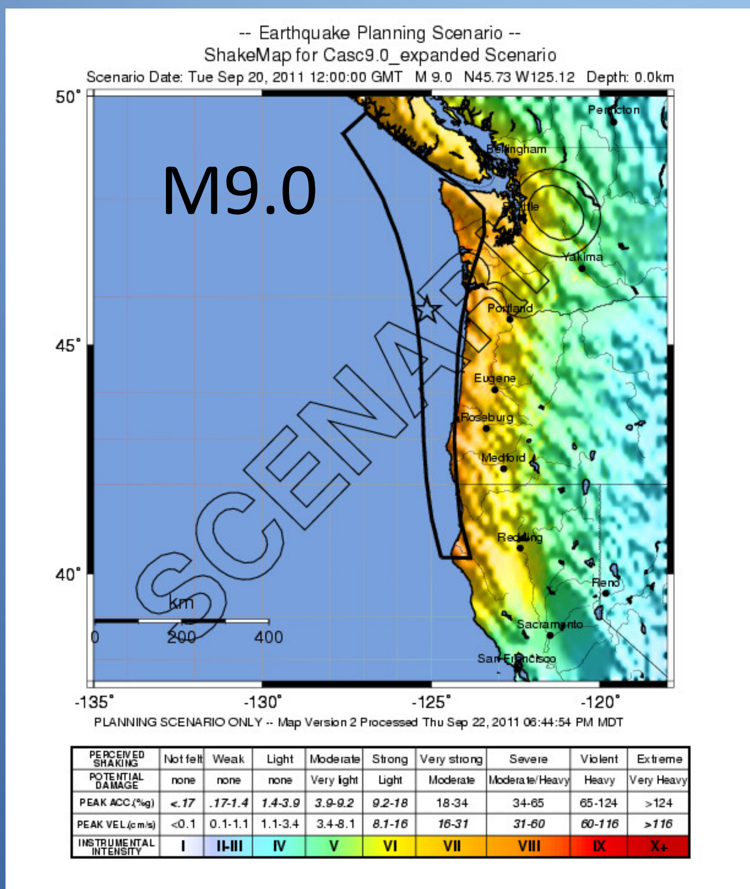


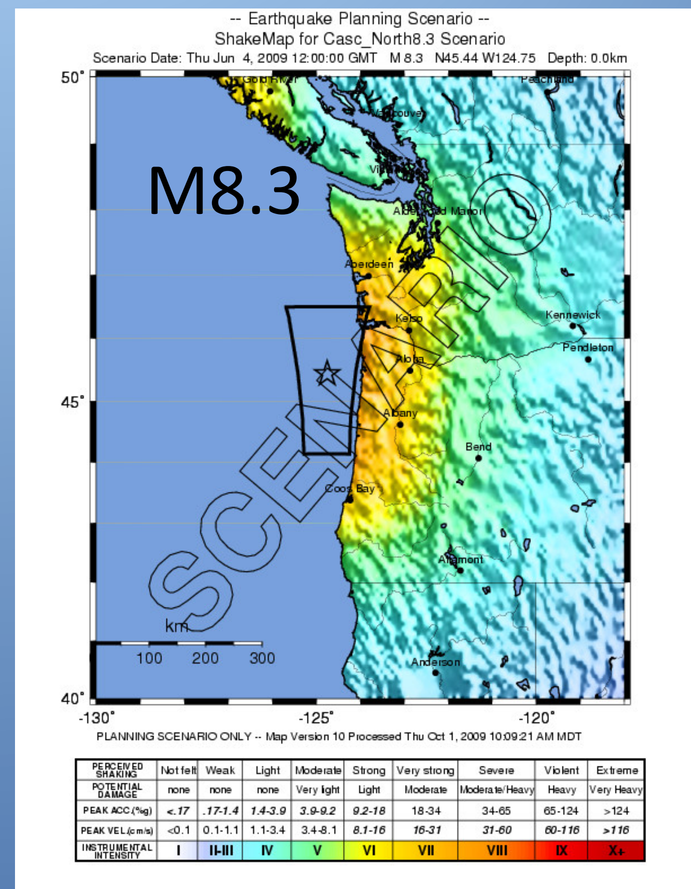
Fault Model - Shannon and Wilson 2013

- Return periods are critical to assess economic risk
- SWIF – 2,700 year return
  - Any where along fault?
- Seattle Fault
  - 1,000 years region
  - 5,000 years northern strand
- Tacoma Fault
  - 4,500 year return
  - Anywhere
  - Specific splay
  - Difference between splays

Cascadia M8.5 versus 9.0

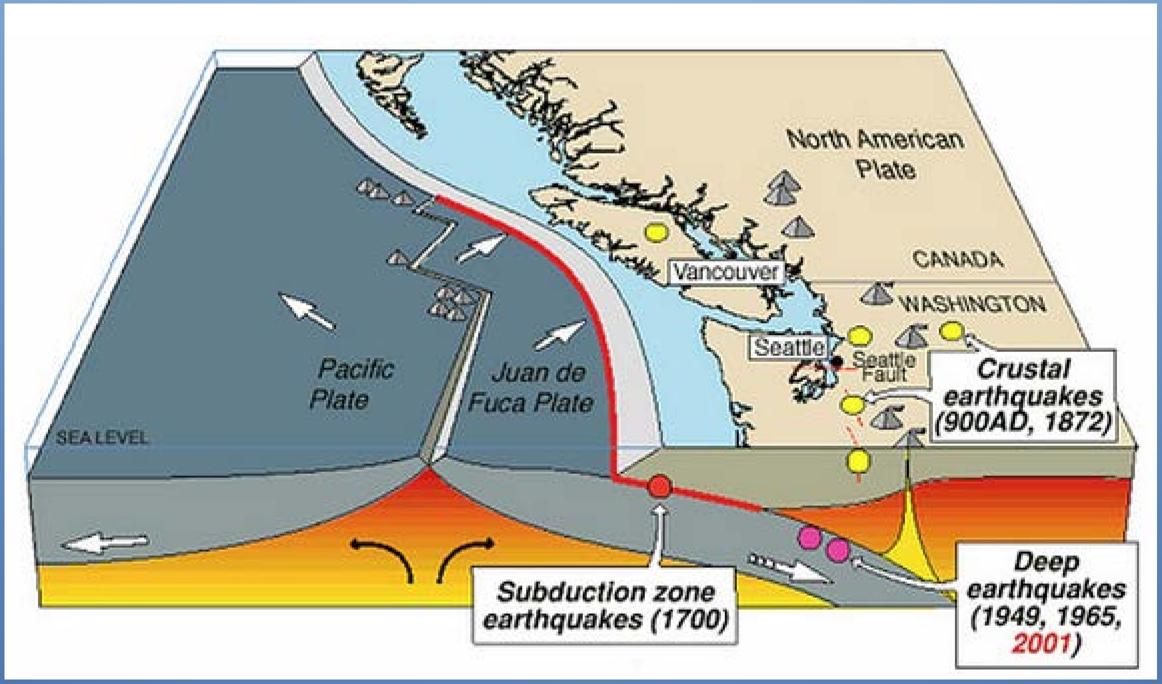
- Return period for region – similar?
- Ground motions – similar?
- Duration – slightly shorter
- Is there a significant difference other than the area impacted??



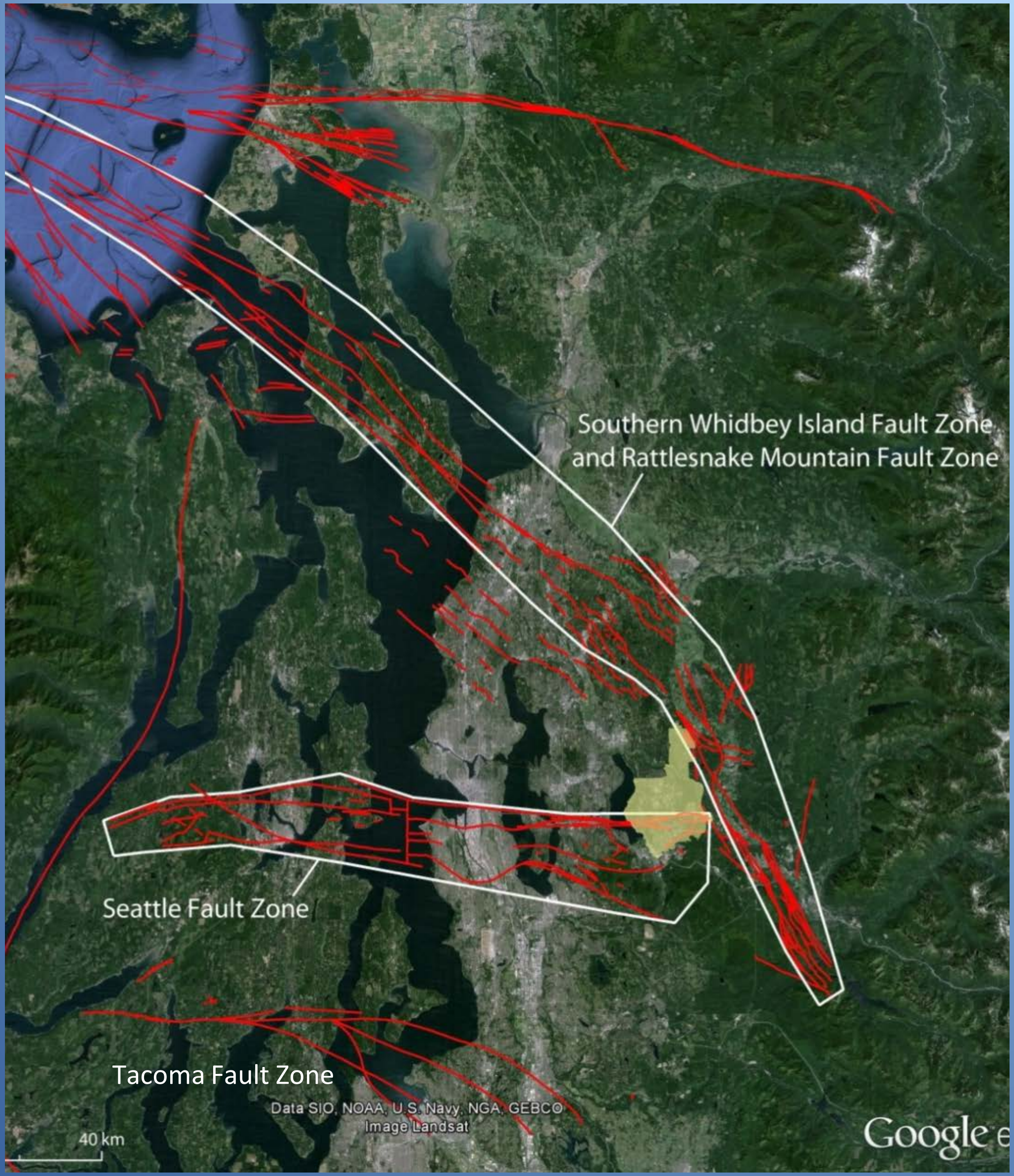


Deep Intraplate/Benioff

- Return period by location?
- Return period by magnitude?



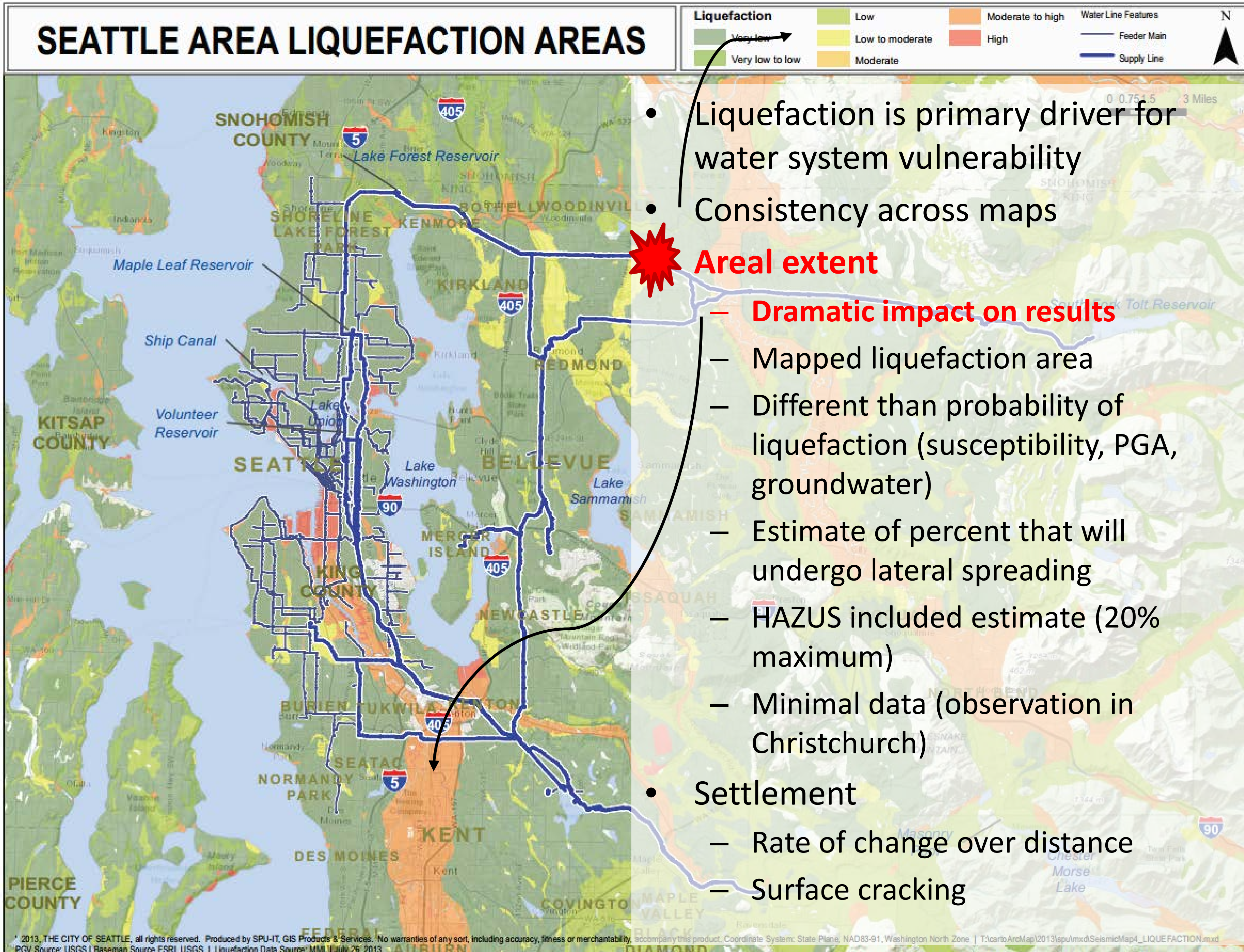
Surface Fault Rupture PGD



Fault Model - Shannon and Wilson 2013

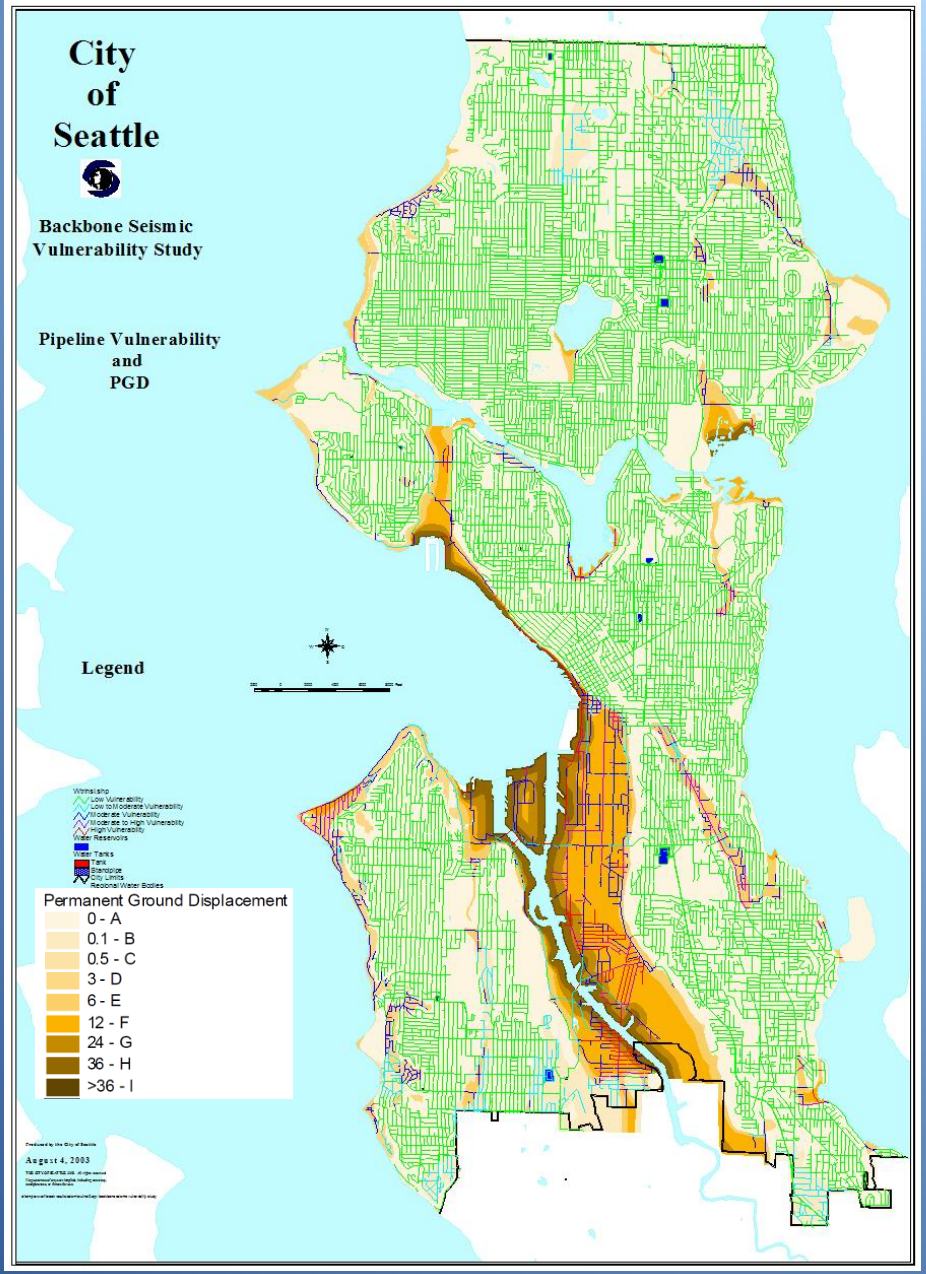
- Future clarity of strand activity
- Better understanding of PGD from reverse (Seattle, Tacoma) or reverse/strike slip (SWIF)?

SEATTLE AREA LIQUEFACTION AREAS



- Liquefaction is primary driver for water system vulnerability
- Consistency across maps
- **Areal extent**
  - **Dramatic impact on results**
  - Mapped liquefaction area
  - Different than probability of liquefaction (susceptibility, PGA, groundwater)
  - Estimate of percent that will undergo lateral spreading
  - HAZUS included estimate (20% maximum)
  - Minimal data (observation in Christchurch)
- Settlement
  - Rate of change over distance
  - Surface cracking

Permanent Ground Deformation



- Required to estimate pipeline damage
- Function of liquefaction susceptibility, PGA, duration, and soil parameters
- Liquefaction PGD developed by DOGAMI for Oregon Resilience Plan
- Otherwise limited availability

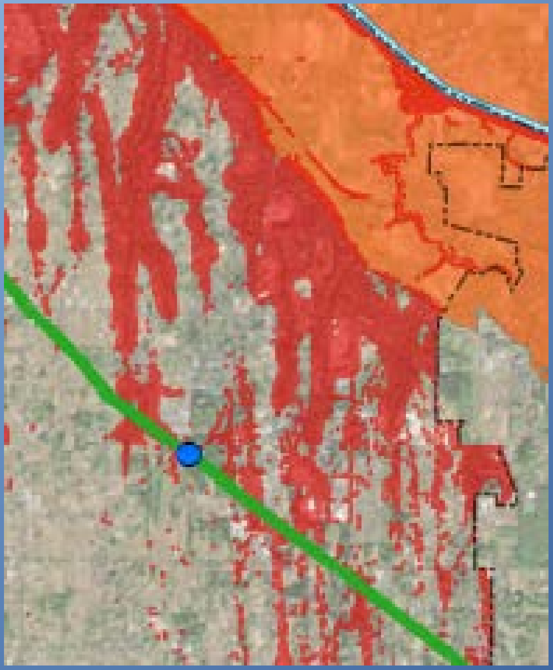
Floating Sewers

- Are there specific characteristics of liquefiable deposits that allow flotation, and that can be mapped?

Tohoku, Japan 2011

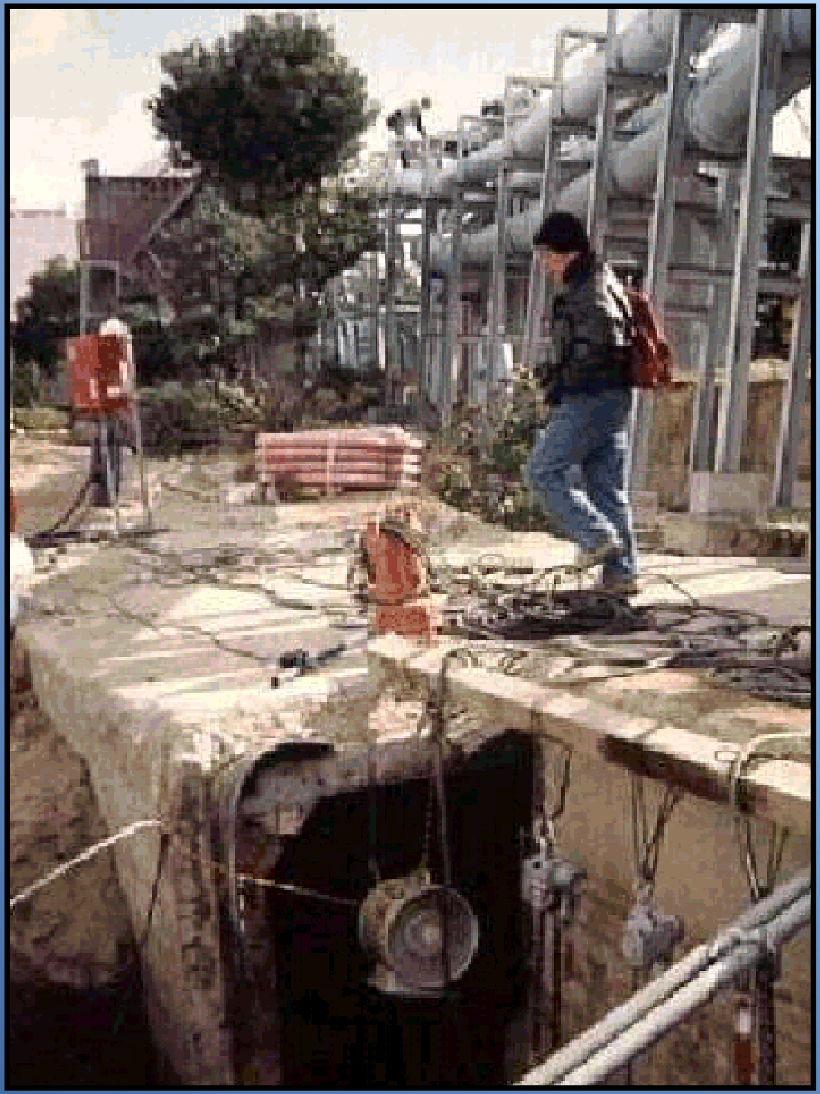
Landslide Mapping

- The availability and quality of landslide mapping lags that of liquefaction.
- The assessment techniques used are often crude (slope, soil type) and end up in over-estimation



Lurching

- Vague term addressing PGD in non-liquefiable formations that can result in movement of large blocks of soil?
  - Northridge – Balboa, sensitive clays
  - Anchorage – sensitive clays
  - Oakland Hills – weak soil layer
- Difficult/expensive to map – not exposed
- Can be as damaging as other forms of PGD



QUESTIONS ?

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