Use of Seismic Hazard Information in Water and Wastewater System Analysis

ATC/USGS Seismic Hazards
User-Needs Workshop
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Don Ballantyne PE
Ballantyne Consulting LLC
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
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?

- Return periods are critical to assess economic risk
- SWIF – 2,700 year return
  - Anywhere 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

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

Don Ballantyne PE
Ballantyne Consulting LLC
dbballan@comcast.net