Presentation Overview

• Overview of seismic planning work

• Current-state findings: Damage and restoration estimates

• Level of Service discussion: policy & implications

• Key work ahead
Modern Resilience Planning

<table>
<thead>
<tr>
<th>DOCUMENT</th>
<th>DRIVER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1996</strong> Seismic Assessment</td>
<td><em>Post Northridge Earthquake</em>**</td>
</tr>
<tr>
<td><strong>2003</strong> Vulnerability Assessment</td>
<td><em>Bioterrorism Preparedness and Response Act of 2002 (Post 9/11 – Malevolent Threats only)</em></td>
</tr>
<tr>
<td><strong>2015</strong> All Hazards Vulnerability Assessment</td>
<td><em>Proactive, with all-hazards perspective</em></td>
</tr>
<tr>
<td><strong>2016-2018</strong> Phase 1 &amp; 2 Forum Resilience Plans</td>
<td><em>Proactive Regional Resilience Planning</em></td>
</tr>
<tr>
<td><strong>2019-2020</strong> New All Hazards Vulnerability Assessment requirement</td>
<td><em>America’s Water Infrastructure Act (AWIA) of 2018 (New all hazards vulnerability assessment requirement)</em></td>
</tr>
</tbody>
</table>
2015 All-Hazards Vulnerability Assessment

- **Proximity Threat**
  - Rail
  - Other Targets
- **Dependency Threat**
  - Loss of Utilities
  - Loss of Suppliers
  - Loss of Employees
- **Natural Hazards**
  - Earthquake
  - Flood
  - Ice Storm/Snow
  - Wildfire/Plant Fire
  - Lahar
  - Volcano
  - Drought
  - Tsunami
- **Malevolent Threats**
  - Diversion/Theft
  - Product contamination
  - Process Sabotage
  - Human Error
  - Aircraft/Marine/Automobile Attack
  - Assailant
2015 All-Hazards Vulnerability Assessment
Major risk categories

- Total Seismic Risk: 57%
- Total Natural Hazard (Excluding Seismic): 34%
- Total Malevolent Risk: 7%
- Total Dependency: 2%
- Total Accidental: <1%
Water Supply Forum Resiliency Project

Preparing for Water Supply Disruption

- Earthquake
- Water Quality
- Climate Change
- Drought
Earthquake Resiliency

Cascadia Subduction Zone

The Really Big One
An earthquake will destroy a sizable portion of the coastal Northwest. The question is when.

By Kathryn Schultz

When the 2011 earthquake and tsunami struck Tohoku, Japan, Chris Goldfinger was two hundred miles away, in the city of Kashiwa, at an international meeting on seismology. As the shaking started, everyone in the room began to laugh. Earthquakes are common in Japan—that one was the third of the week—and the participants were, after all, at a seismology conference. Then everyone in the room checked the time.

Seismologists know that how long an earthquake lasts is a decent proxy for its magnitude. The 1989 earthquake in Loma Prieta, California, lasted just a few seconds.

Illustration by Christoph Niemann; Map
Earthquake Resiliency

Surface (Crustal) Faults:

- South Whidbey Island Fault
- Seattle Fault
- Tacoma Fault
Earthquake Resiliency

<table>
<thead>
<tr>
<th>Physical Damage</th>
<th>Restoration Time</th>
<th>Economic Impact</th>
<th>Likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extensive damage to water system facilities,</td>
<td>Up to 60 days to restore water</td>
<td>Cost of water system damage could exceed $2 billion.</td>
<td>14 percent chance of Mw9.0 Cascadia Subduction event in next 50 years</td>
</tr>
<tr>
<td>Over 100 transmission pipeline breaks/leaks</td>
<td></td>
<td></td>
<td>15 percent chance of Mw6.5 or larger surface fault event in next 50 years</td>
</tr>
<tr>
<td>Up to 6,000 distribution system breaks/leaks</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cost of water system damage could exceed $2 billion.
Alaska 1964

Mw 9.2
Duration 4 minutes
$2.3 Billion in Damage
Subduction – type EQ
Figure 4-9 depicts the estimated water system restoration time in the Cascadia scenario for each distribution zone, as well as critical facilities. The longest outages are again anticipated for distribution zones to the south and east along Pipeline 1. Areas including Bonney Lake, Fennel Creek, Prairie Ridge, and Cumberland show prolonged customer outage lasting more than 61 days. Additionally, the 251 – Low Zone is expected to have customer outage estimated at 40 days, which falls in the 31 to 60 day range.
Service restoration time (4 seismic scenarios – Tacoma Water)

The outage times were based on the expected damage, and the estimated restoration times of critical components required to restore service.

Source: Tacoma Water Seismic Vulnerability Assessment

<table>
<thead>
<tr>
<th>Percent Service Restored</th>
<th>Days after EQ Event</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cascadia</td>
</tr>
<tr>
<td>50%</td>
<td>21</td>
</tr>
<tr>
<td>75%</td>
<td>25</td>
</tr>
<tr>
<td>90%</td>
<td>27</td>
</tr>
<tr>
<td>99%</td>
<td>67</td>
</tr>
</tbody>
</table>

Table 4-3. Post-Earthquake Scenario System Restoration Times Summary
Level of Service

(Customer Experience)

Routine operational

Level of Service
Pressure, reliability, quality

Post-Event (Earthquake)
Level of Service
- Expected (Acceptable) restoration time?
- Expected (Acceptable) quality (initially, ultimately)
## Conceptual Level of Service Goals

### Table 6-1. Cascadia Scenario compared to Preliminary Target Long-Term PE-LOS Goals for Example 500-Year Return Earthquake

<table>
<thead>
<tr>
<th>System Function</th>
<th>Event Occurs</th>
<th>0-24 Hours</th>
<th>1-3 Days</th>
<th>3-7 Days</th>
<th>1-2 Weeks</th>
<th>2-4 Weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potable water available at supply source</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main transmission facilities, pipes, pump stations, and reservoirs operational</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water supply to critical facilities available (^1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water for fire suppression at key supply points</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water for fire suppression at fire hydrants</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water available at community distribution centers/points</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distribution system operational</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Green diamond**: Desired time to restore component to 80-90% operational
- **Yellow diamond**: Desired time to restore component to 50-60% operational
- **Red triangle**: Desired time to restore component to 20-30% operational
- **X**: Tacoma Water Anticipated Results (80-90% Operational)
- **Red X**: Tacoma Water Anticipated Results (20-30% operational)

\(^1\)Further evaluation required to evaluate scorecard for Water supply to critical facilities
## Conceptual Level of Service Goals

Table 6-2. Shifted Tacoma Scenario compared to Preliminary Target Long-Term PE-LOS Goals for Example 2,500-Year Return Earthquake

<table>
<thead>
<tr>
<th>System Function</th>
<th>Event Occurs</th>
<th>0-24 Hours</th>
<th>1-3 Days</th>
<th>3-7 Days</th>
<th>1-2 Weeks</th>
<th>2-4 Weeks</th>
<th>1-3 Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potable water available at supply source</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main transmission facilities, pipes, pump stations, and reservoirs operational</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water supply to critical facilities available</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water for fire suppression at key supply points</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water for fire suppression at fire hydrants</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water available at community distribution centers/points</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distribution system operational</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- ♦️ Desired time to restore component to 80-90% operational
- ✔️ Desired time to restore component to 50-60% operational
- □️ Desired time to restore component to 20-30% operational
- 🏗️ Tacoma Water Anticipated Results (80-90% operational)
- 🏗️ Tacoma Water Anticipated Results (20-30% operational)

¹Further evaluation required to evaluate scorecard for Water supply to critical facilities
# Conceptual Level of Service Goals

Table 8. PE-LOS Goals for a CSZ Earthquake Scenario. (Attain within 50 years and establish interim milestones leading to these goals.)

<table>
<thead>
<tr>
<th>System Component</th>
<th>Service Provided</th>
<th>Immediately After</th>
<th>24 Hours</th>
<th>3 Days</th>
<th>7 Days</th>
<th>14 Days</th>
<th>1 Month</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water Supply</strong></td>
<td>Supply transmission system, provide local distribution source (wells), fill tank trucks.</td>
<td>Quantity</td>
<td>Storage</td>
<td>Storage</td>
<td>50% AWD</td>
<td>50% AWD</td>
<td>50% AWD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quality</td>
<td>Non-Potable</td>
<td>Non-Potable</td>
<td>Non-Potable</td>
<td>Potable</td>
<td>Potable</td>
</tr>
<tr>
<td><strong>Transmission to End Points</strong></td>
<td>Supply terminal reservoir, wholesale meters along transmission line, provide fire suppression along transmission lines. Includes critical facilities (pump stations, treatment etc.)</td>
<td>50% AWD</td>
<td>50% AWD</td>
<td>50% AWD</td>
<td>50% AWD</td>
<td>AWD</td>
<td>AAD</td>
</tr>
<tr>
<td><strong>Transmission/Supply to Major Regional Essential Services</strong></td>
<td>Serve essential customers (e.g. hospitals).</td>
<td>50% AWD</td>
<td>50% AWD</td>
<td>50% AWD</td>
<td>50% AWD</td>
<td>50% AWD</td>
<td>AWD</td>
</tr>
<tr>
<td><strong>Backbone</strong></td>
<td>Supply special seismic resistant lines to essential customers, service to community distribution points, provide fire suppression along backbone.</td>
<td>Individual utility decision</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>System Storage</strong></td>
<td>Support backbone and local distribution</td>
<td>limited water from storage for fire, drinking</td>
<td>Individual utility decision</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Distribution</strong></td>
<td>Service to individual customers - residential, business, industrial. Water to fire hydrants for fire suppression.</td>
<td>Individual utility decision</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

AWD = Average Winter Demand; AAD = Average Annual Demand

Notes:
1. Percentages represent the estimated percent of total delivery. Not all areas will be feasible to serve within the first month.
2. Transmission to End Points includes one or more transmission pipelines providing the noted level of service connecting the supplies to and including the first terminal reservoirs downstream from each supply. At the utility’s discretion, additional transmission pipeline segments and reservoirs can be included in this criterion.
3. Transmission/Supply to Major Regional Essential Services includes a supply, and transmission line supplying water to hospitals designated as essential by the utility. The supply and transmission may be dedicated to supply to essential services and be different than the supply and transmission system serving the overall utility service area. Additional facilities in addition to hospitals such as nursing homes, may be designated by the utility.
4. Water supply and water held in terminal reservoir are expected to be potable immediately after the event. However, there could be short-term disruptions/damage to water
The Policy Discussion:
Establishing a Post-Event Level of Service Goal

• Considerations
  – Time span to achieve the identified service level
    • 50-70 years may be a realistic goal
  – Preferred evaluation and goal development process
    • Board, Council, Public
  – Needed information
    • Relationship between service level goal and cost to achieve
    • Priority order of work
Key work ahead

**Infrastructure**
- Focused hardening of groundwater supply and operations center components.
- Continued development and policymaker adoption of target Post-Earthquake Levels of Service, and a seismic resiliency investment plan to achieve those targets over a period of time.
- Priority decisions with respect to hardening supply to hospitals.
- Build seismic resilience more directly into infrastructure renewal.

**Programmatic**
- Continued and sustained relationships with Emergency Managers & Responders at all levels of government.
- Conversations with customers and employees about realistic expectations and personal preparedness.