

# Tacoma Water's Comprehensive All Hazards Vulnerability Assessment

PNWS-AWWA Conference  
April 25, 2018

**TACOMA WATER**  
TACOMA PUBLIC UTILITIES

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# Agenda

1. Tacoma Water system
2. “All Hazards Vulnerability Analysis”
3. Implementation plan

# Acknowledgments

## Tacoma Water Team

- Mark Linden
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- Glen George
- Michael Washington
- Seth Doull
- John Luu
- Chris Johnson
- Robert Walker
- Chris McMeen

## CH2M (now Jacobs) Team

- Forrest Gist
- Wally Bennett
- Christina Kapoi
- Aaron George

## Ballantyne Consulting

- Don Ballantyne

## PRR

- Jamie Strausz-Clark

# Safety Minute

## Protect Yourself During Earthquakes

FEMA 9-1078

**1** In a high-rise office, stay away from windows. Drop, cover and hold on. If you are near a desk, crouch under it. If you are in a hallway, crouch in a doorway. If you are in a room with a table, crouch under it. If you are in a room with a desk, crouch under it.

**2** In a chair, drop, cover and hold on. If you are in a room with a table, crouch under it. If you are in a room with a desk, crouch under it.

**3** In a bedroom, drop, cover and hold on. If you are in a room with a table, crouch under it. If you are in a room with a desk, crouch under it.

**4** In a wheelchair, drop, cover and hold on. If you are in a room with a table, crouch under it. If you are in a room with a desk, crouch under it.

**5** In a classroom, drop, cover and hold on. If you are in a room with a table, crouch under it. If you are in a room with a desk, crouch under it.

**6** In a park, drop, cover and hold on. If you are in a room with a table, crouch under it. If you are in a room with a desk, crouch under it.

**7** In a stadium, drop, cover and hold on. If you are in a room with a table, crouch under it. If you are in a room with a desk, crouch under it.

**8** In a car, drop, cover and hold on. If you are in a room with a table, crouch under it. If you are in a room with a desk, crouch under it.

**9** In a theater, drop, cover and hold on. If you are in a room with a table, crouch under it. If you are in a room with a desk, crouch under it.

**?** Do you know what to do, wherever you are, when the earth begins to shake?



Why are these protective actions recommended?  
[www.EarthquakeCountry.org/step5](http://www.EarthquakeCountry.org/step5)



Practice with millions worldwide:  
[www.ShakeOut.org](http://www.ShakeOut.org)



Learn how to reduce injury and damage:  
[www.FEMA.gov/earthquake](http://www.FEMA.gov/earthquake)



# Tacoma Water System

# TACOMA WATER FACTS

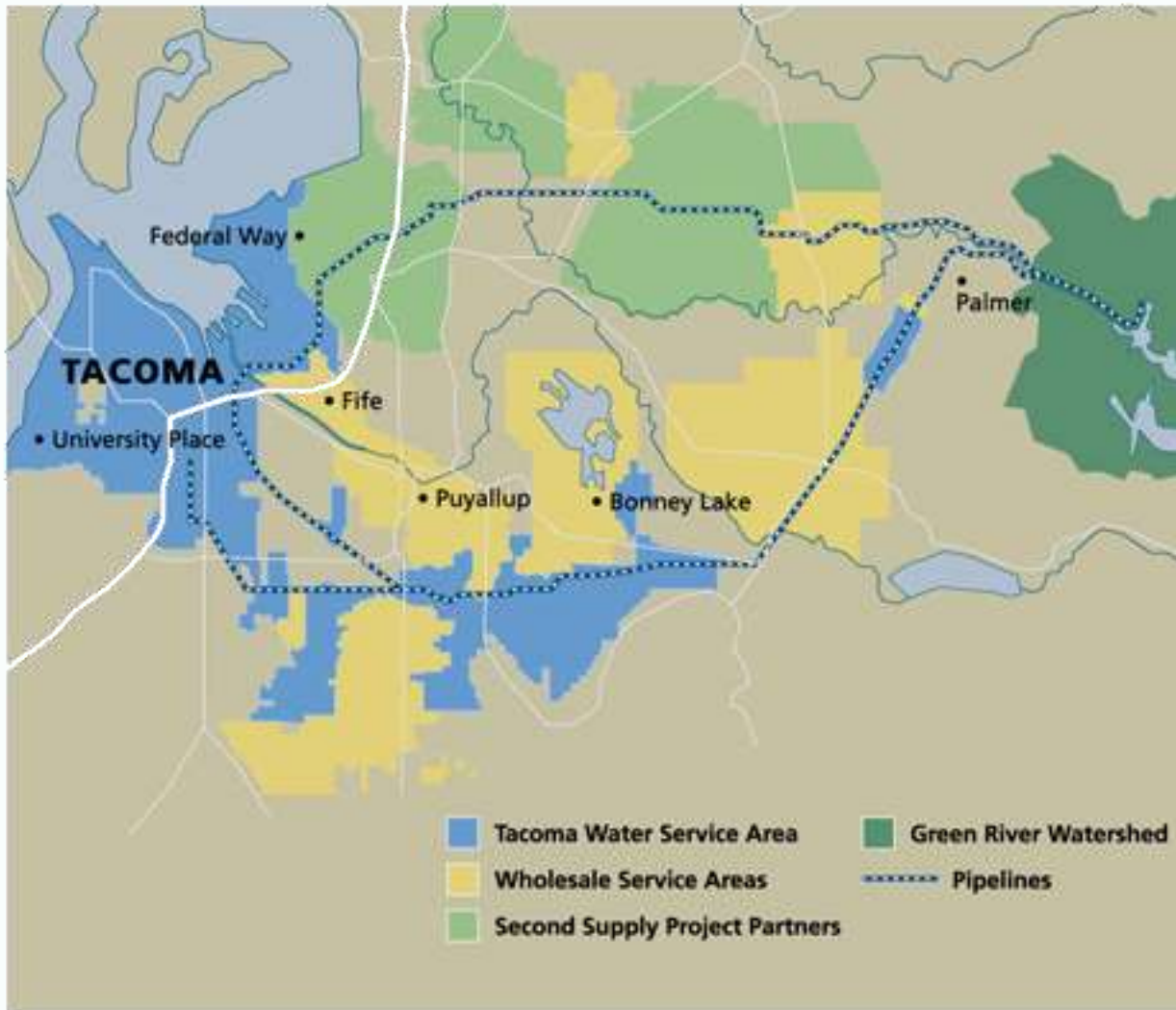
## CUSTOMERS:

- More than 300,000 people served
- 3 Major Hospitals
- Port of Tacoma industrial area
- Downtown commercial area, including the Greater Tacoma Convention Center

## WATER SUPPLY:

- Up to 136 million gallons per day from the Green River
- 0 to 72 million gallons per day from North Fork wells (seasonally)
- 55 million gallons per day from local “In-town” wells

# TACOMA WATER SERVICE AREA



# All Hazards Vulnerability Assessment



# Key Project Tasks



# Key Project Tasks



# Stakeholder interviews



Health Care



Commercial  
Businesses



Large  
Industrial



Retail  
Providers



Education



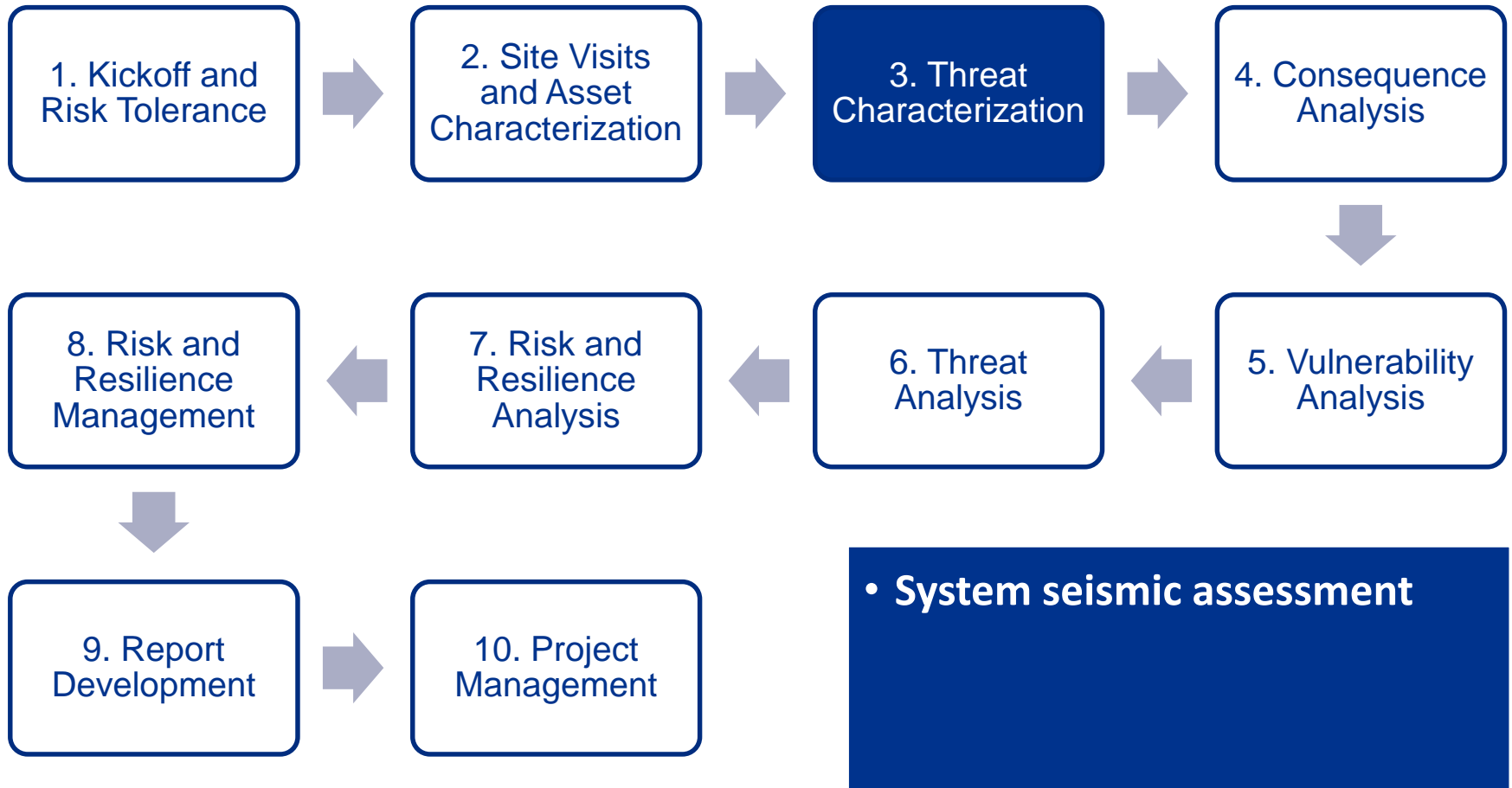
Assisted  
Living



# Key Project Tasks



# Key Project Tasks



# Threat Categories Considered



## Malevolent Threats

- Diversion/Theft
- Product contamination
- Process Sabotage
- Human Error
- Aircraft / Marine / Automobile Attack
- Assailant



## Natural Hazards

- Earthquake
- Flood
- Ice Storm/ Snow
- Wildfire / Plant Fire
- Lahar
- Volcano
- Drought
- Tsunami



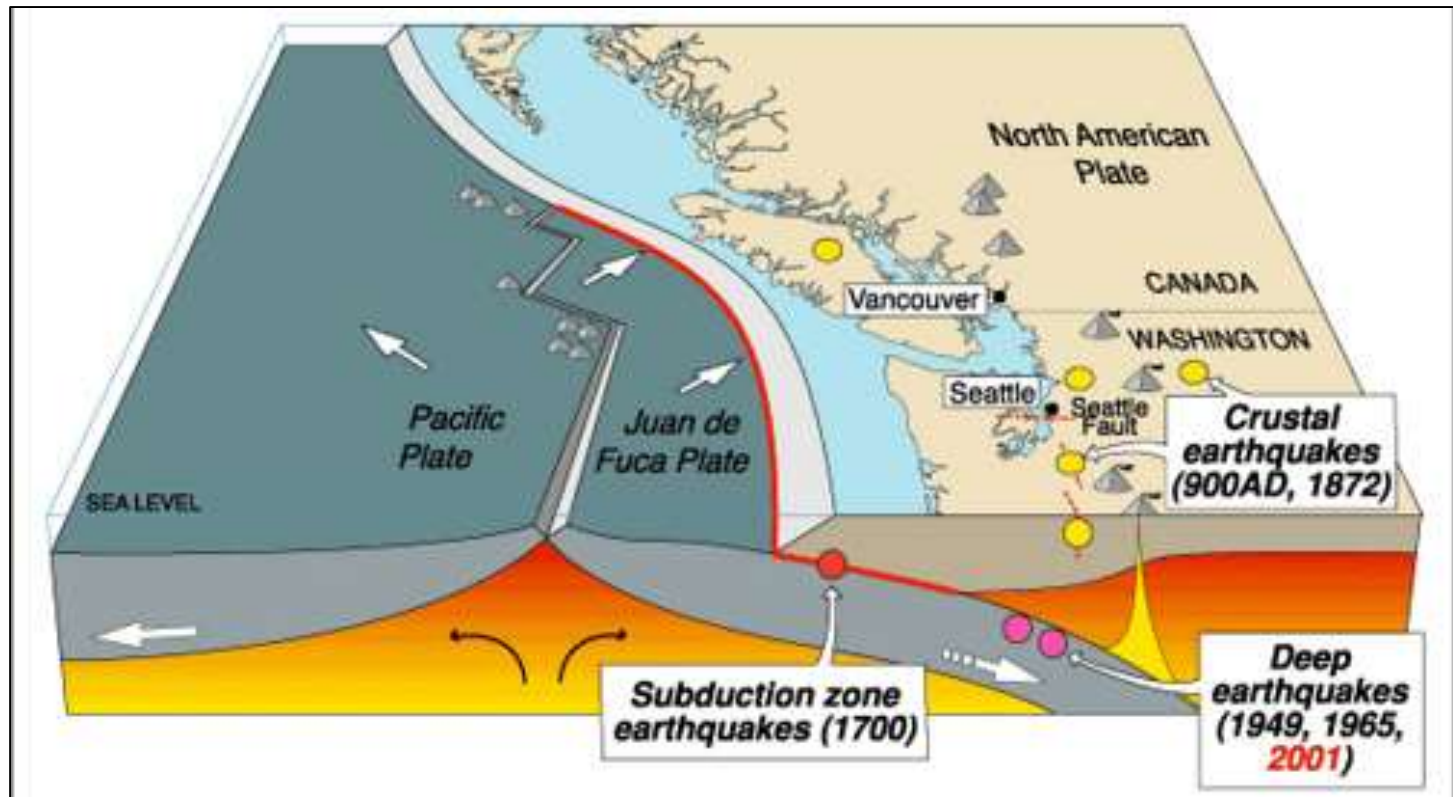
## Proximity Threat

- Rail
- Other Targets

## Dependency Threat

- Loss of Utilities
- Loss of Suppliers
- Loss of Employees

# Seismic scenarios – 4 scenarios explored

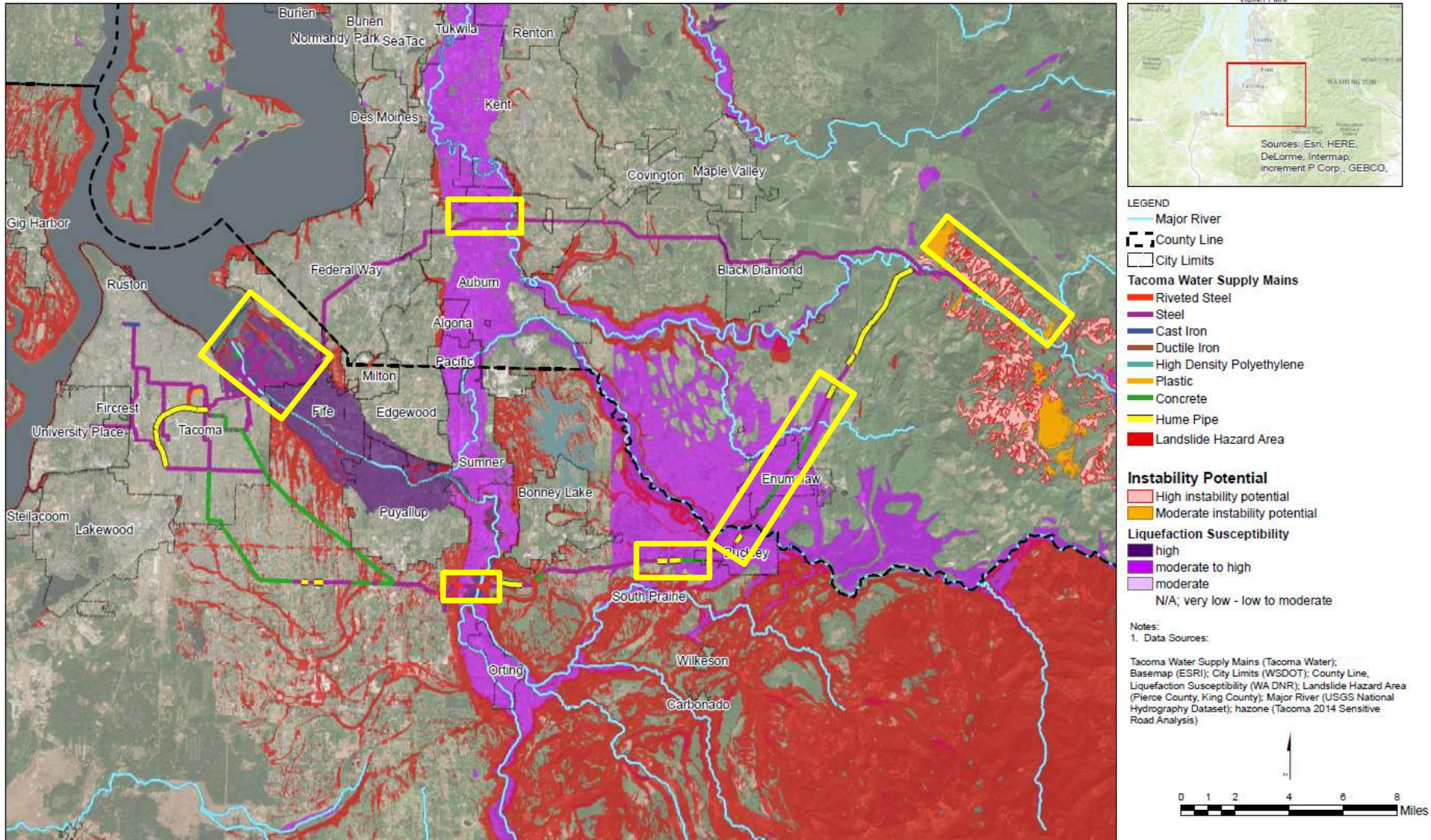


*Image reprinted from Pacific NW Seismic Network*

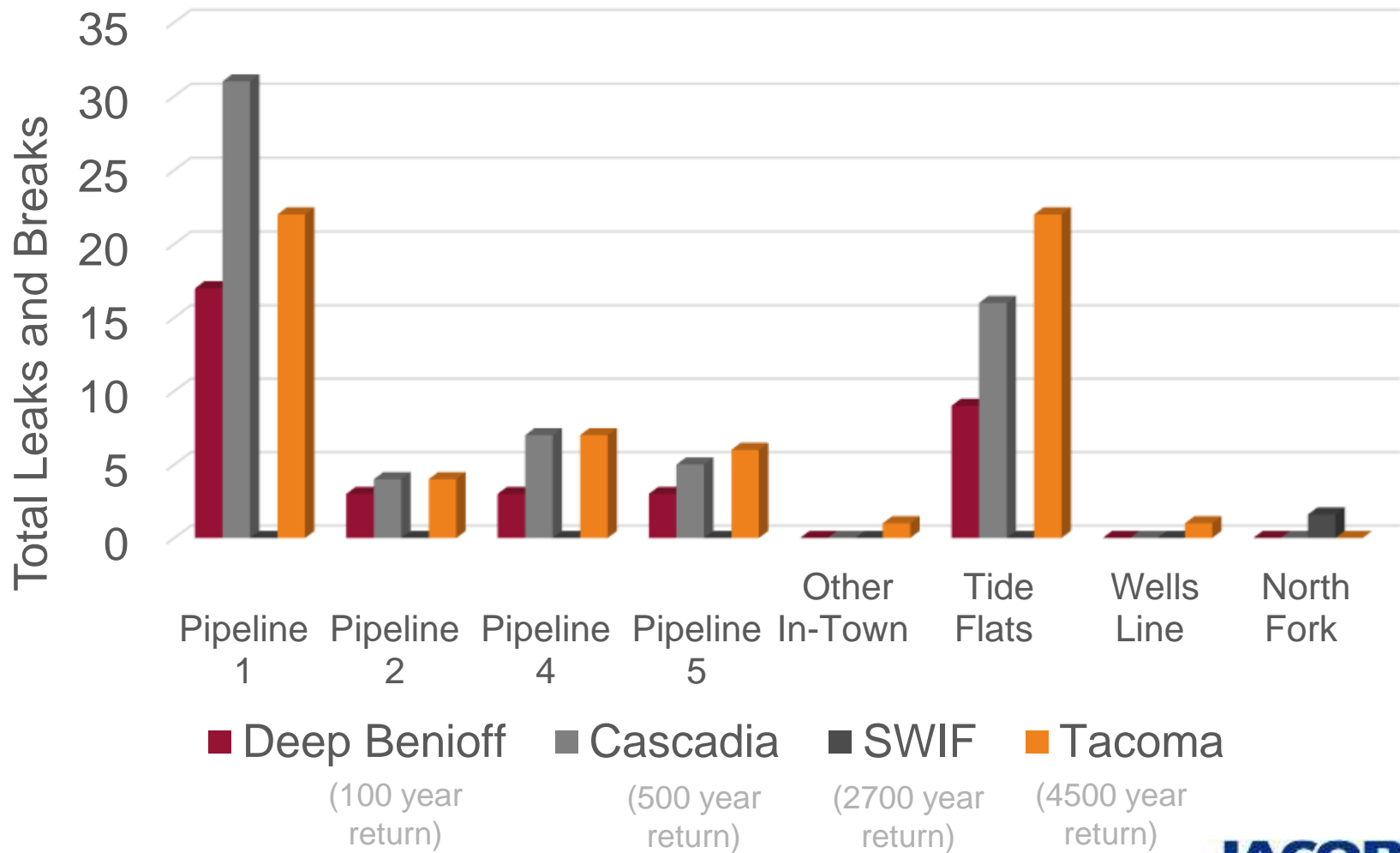
- **Scenario 1 – Deep Benioff (100 year return)**
- **Scenario 2 – Cascadia Subduction Zone (500 year return)**
- **Scenario 3 – South Whidbey Island Fault (SWIF) (2700 year return)**
- **Scenario 4 – Tacoma Fault (4500 year return)**



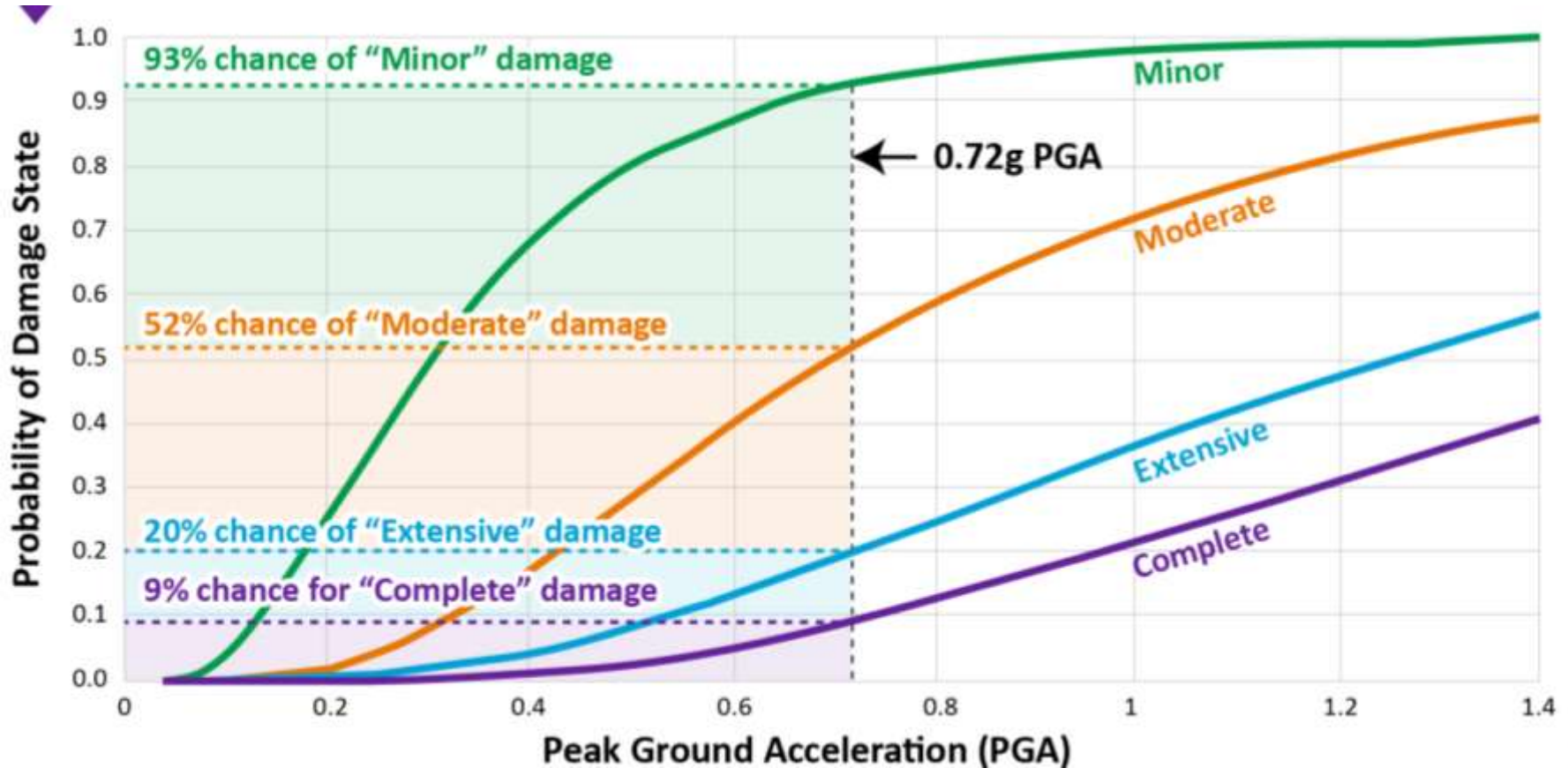
# Seismicity and hazard mapping



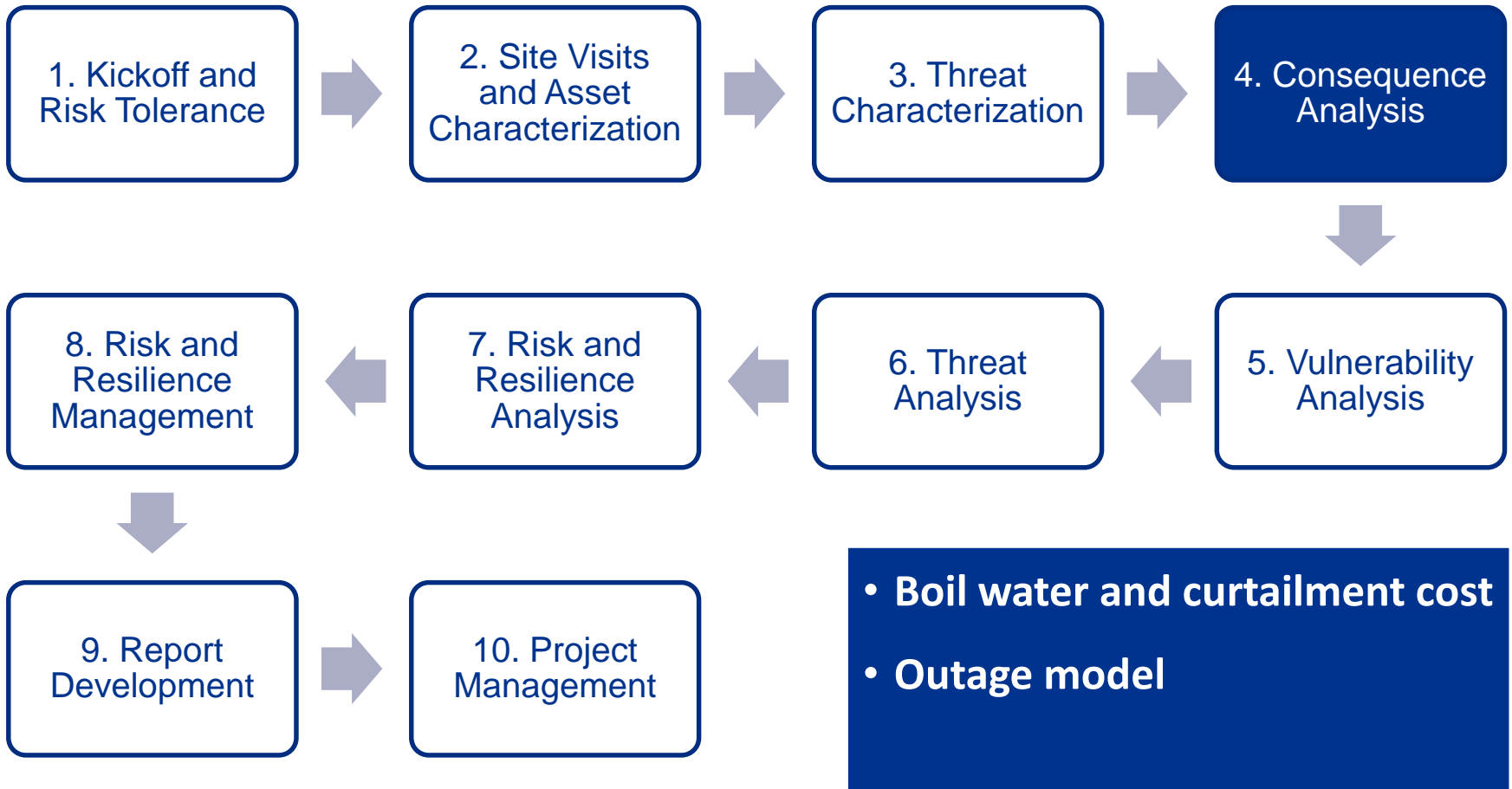
# Performance in seismic scenarios - pipelines



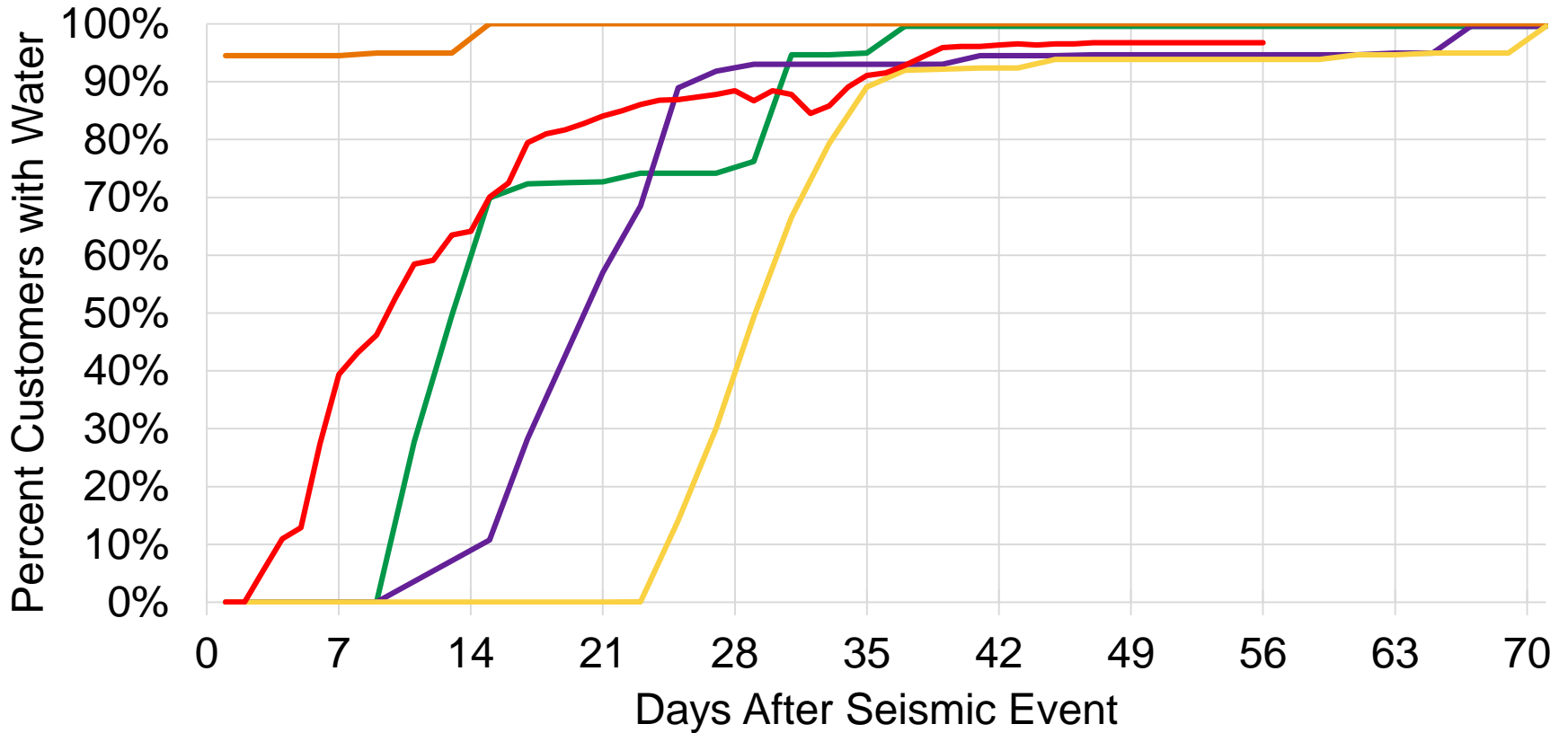
# Facility Performance (HAZUS example for above ground steel tank)



# Key Project Tasks



# Water service restoration time (4 calculated seismic scenarios – Tacoma Water)



— Deep Benioff

— Cascadia

— SWIF

— Shifted Tacoma

— Great East Japan Earthquake

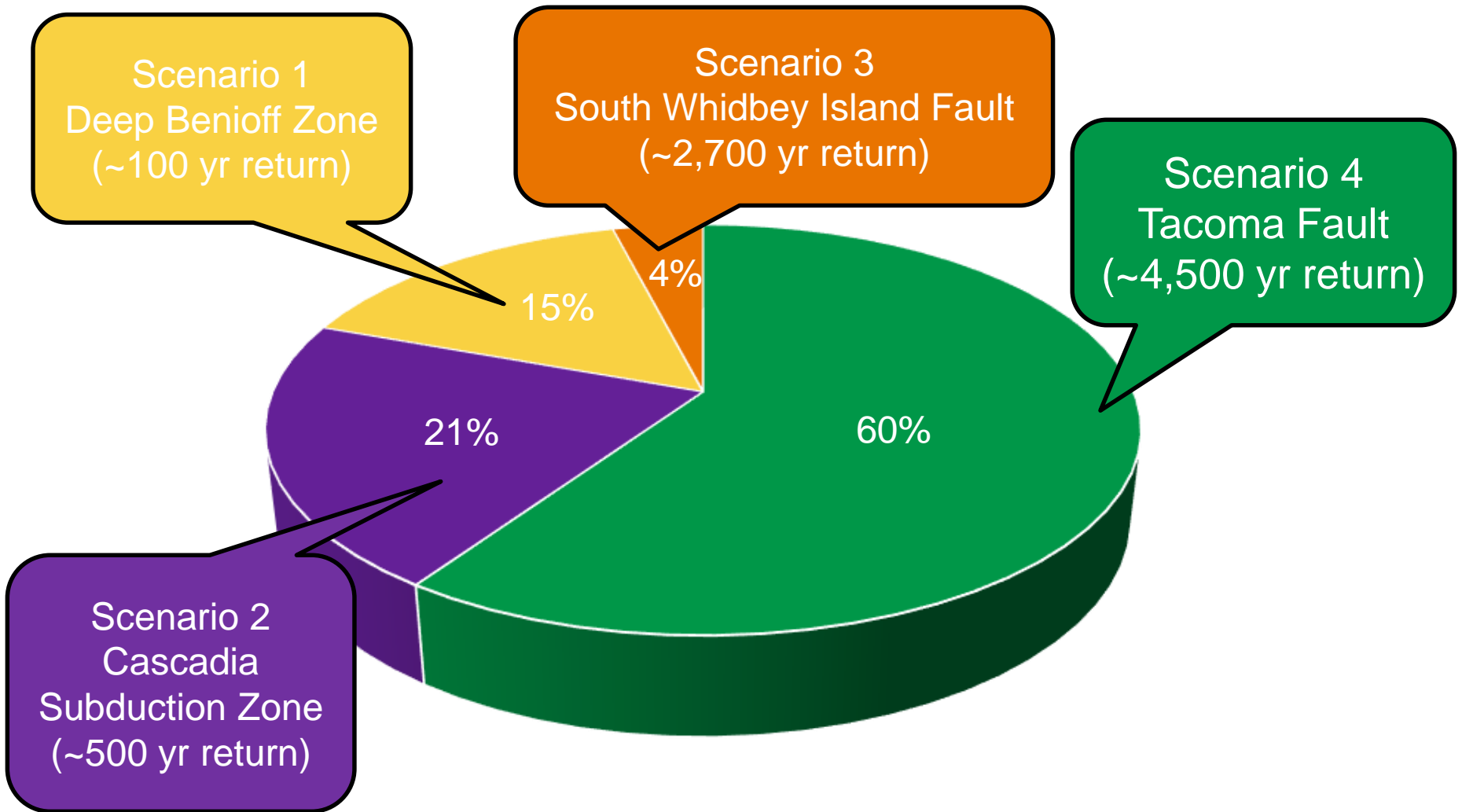
(100 year  
return)

(500 year  
return)

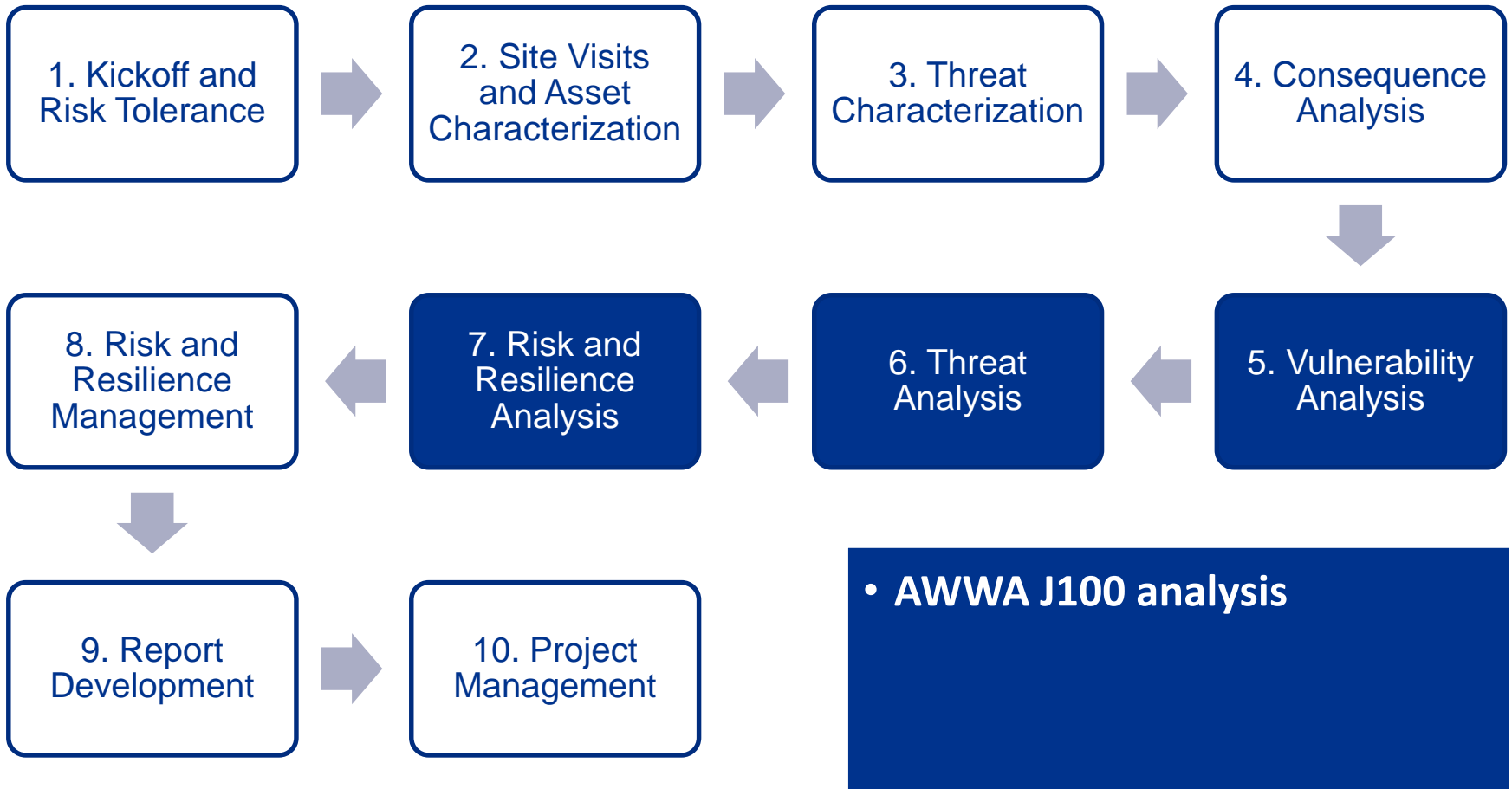
(2700 year  
return)

(4500 year  
return)

# Consequence (\$) by earthquake scenario



# Key Project Tasks



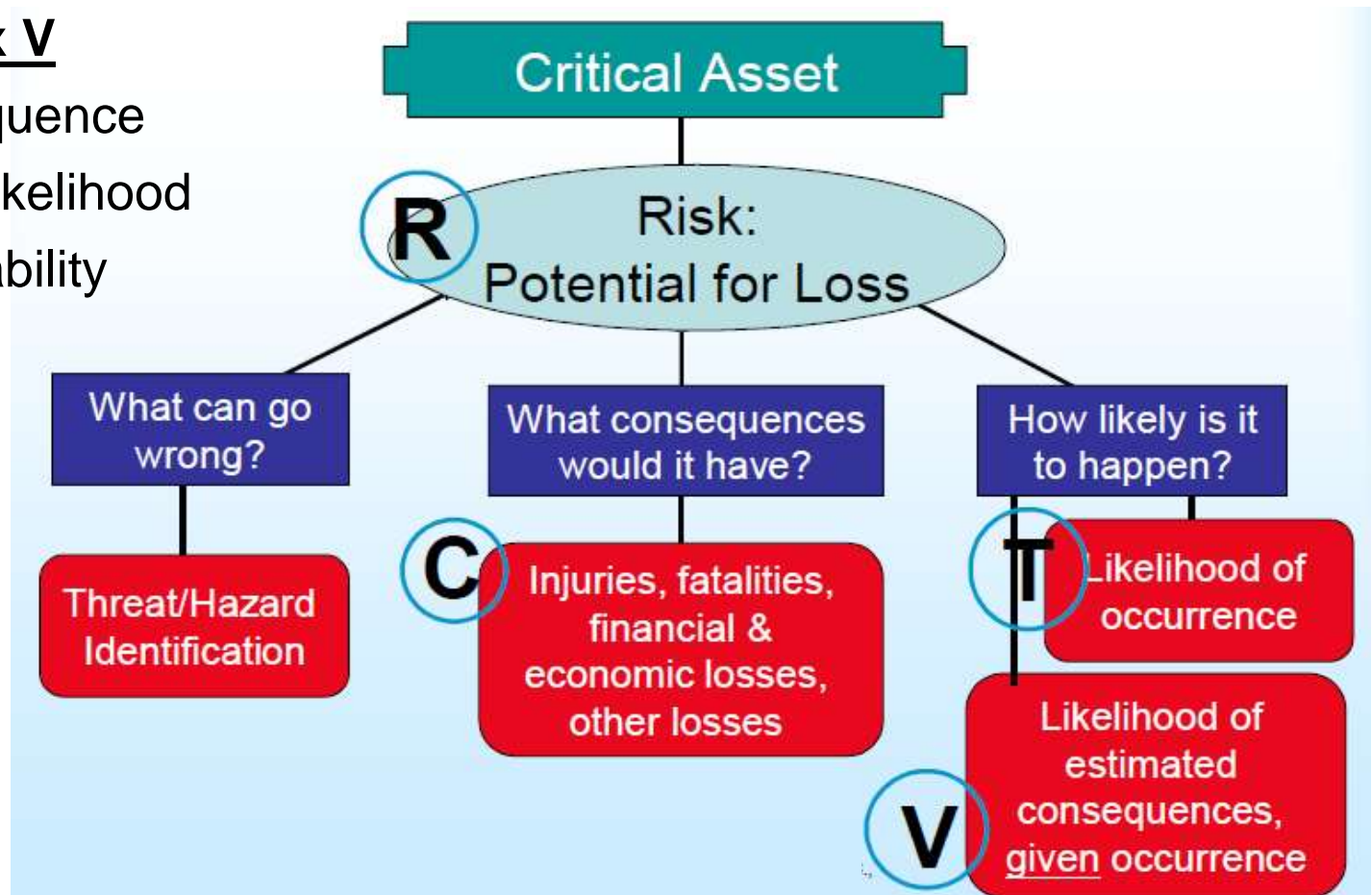
# Risk Calculation Process

$$R = C \times T \times V$$

C = consequence

T = threat likelihood

V = vulnerability

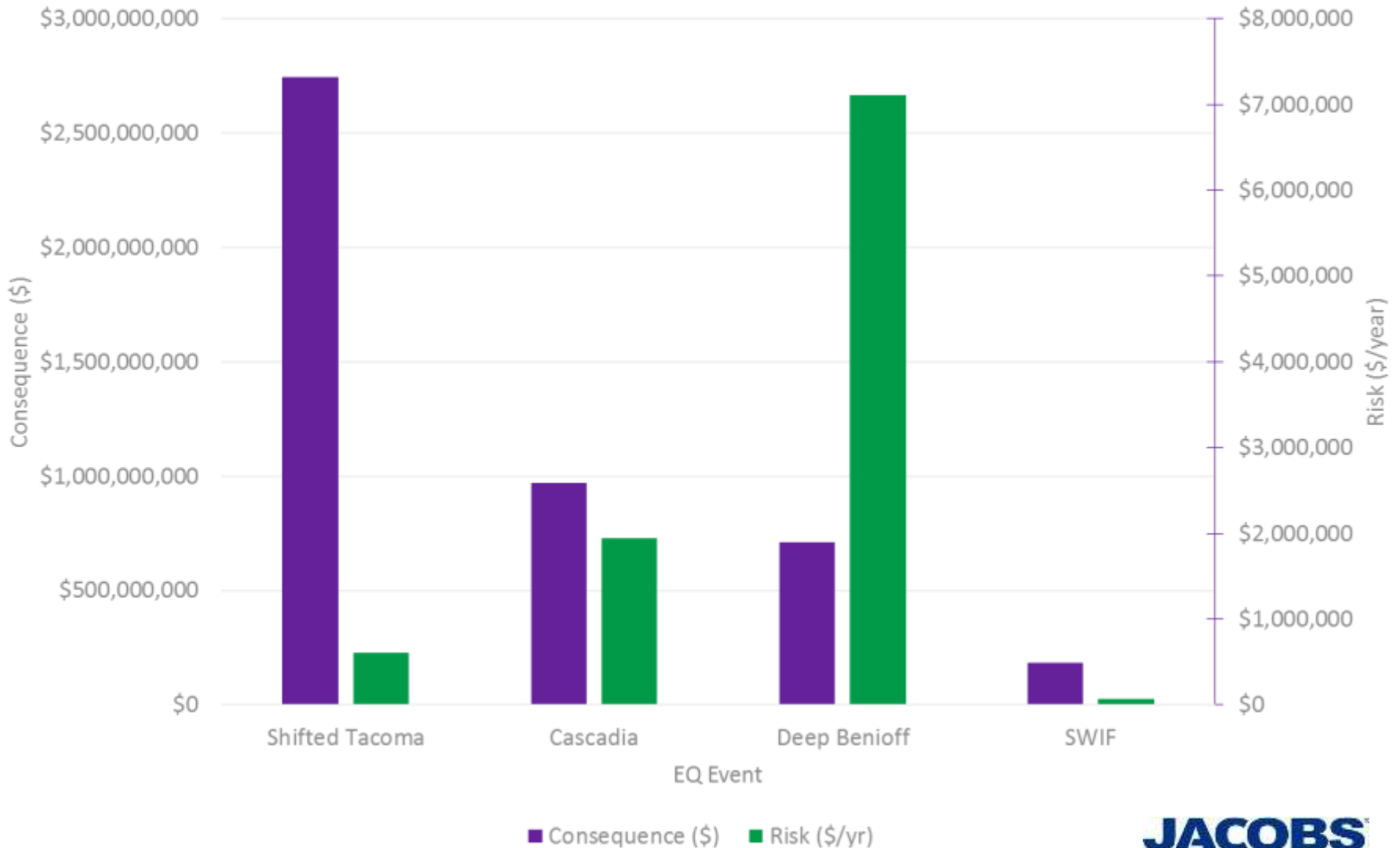


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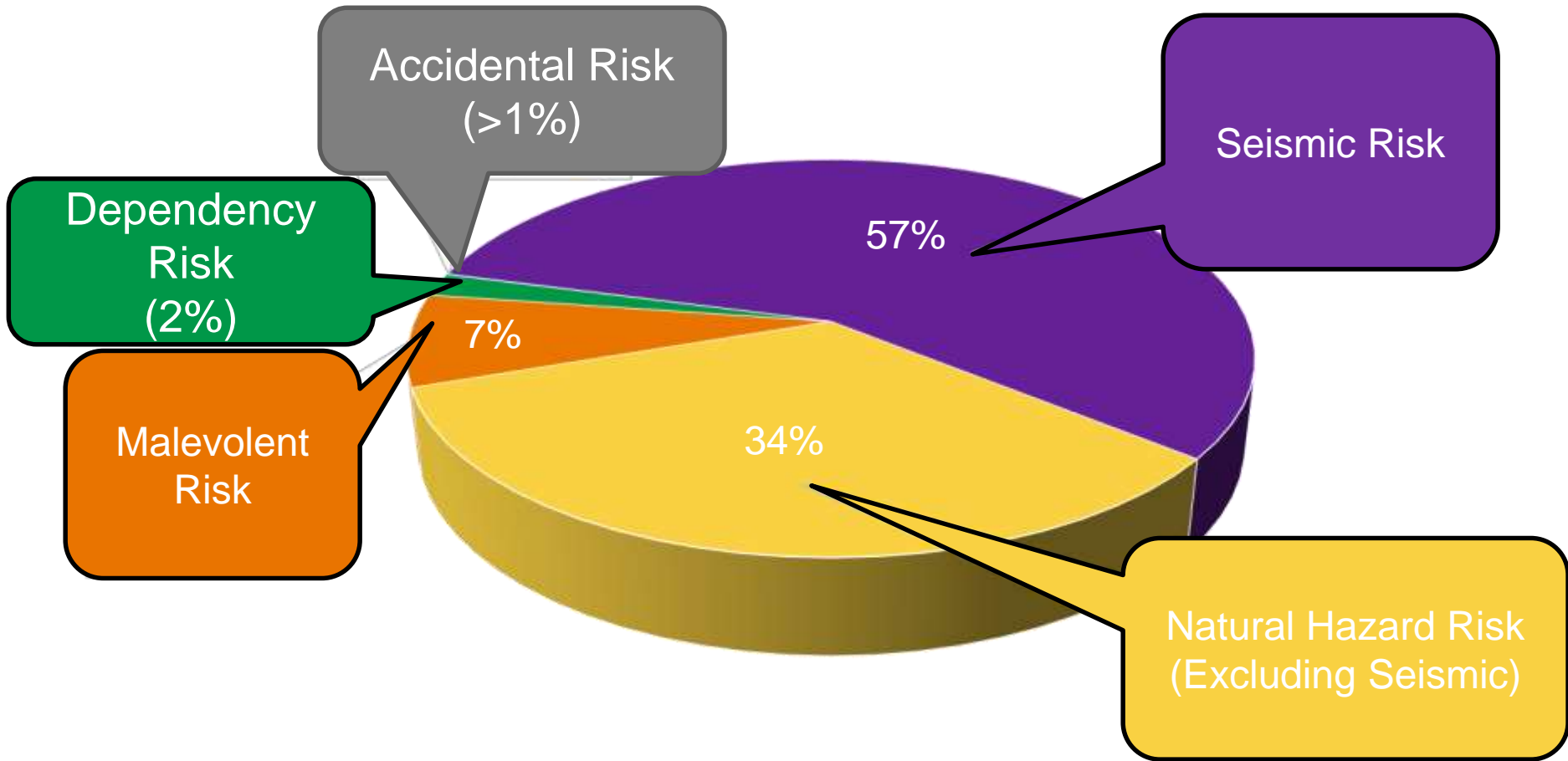


# Consequence vs. Risk

Consequence vs. Risk for EQ Events



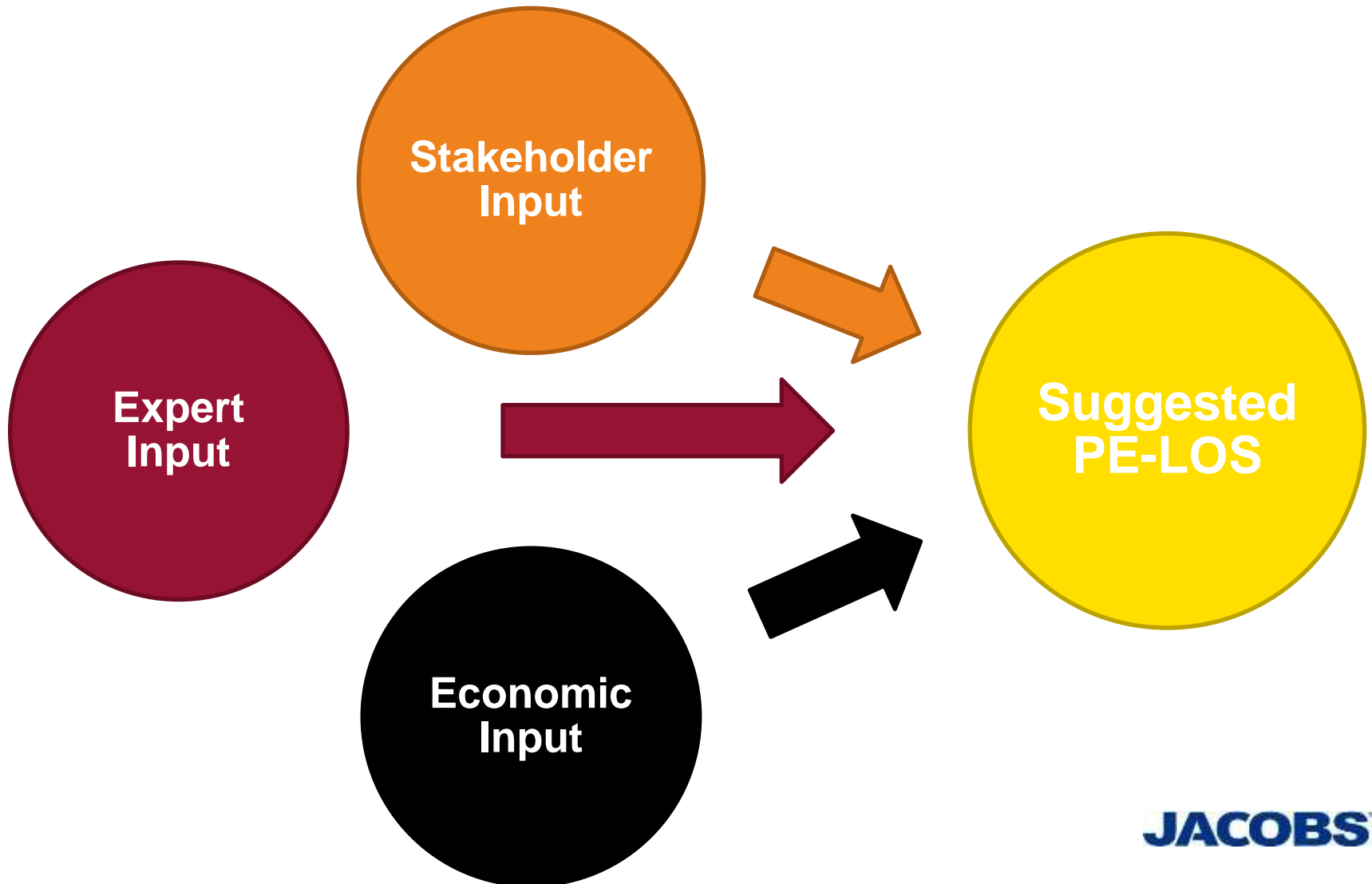
# Total risk by category



# Key Project Tasks



# Preliminary Suggested Post-Earthquake - Level of service (PE-LOS) goals



# Example Post-Earthquake - Level of service goal



Goal of partial system functionality within 1 day following **500 Year** Return Earthquake (Cascadia Scenario for Tacoma Water)



- In-town Groundwater or
- Green River and transmission system
- Move water into town
- In-town transmission
- Hospitals
- Fire suppression along backbone
- Water distribution centers along backbone

NOTE: Goal does not include entire distribution system functionality

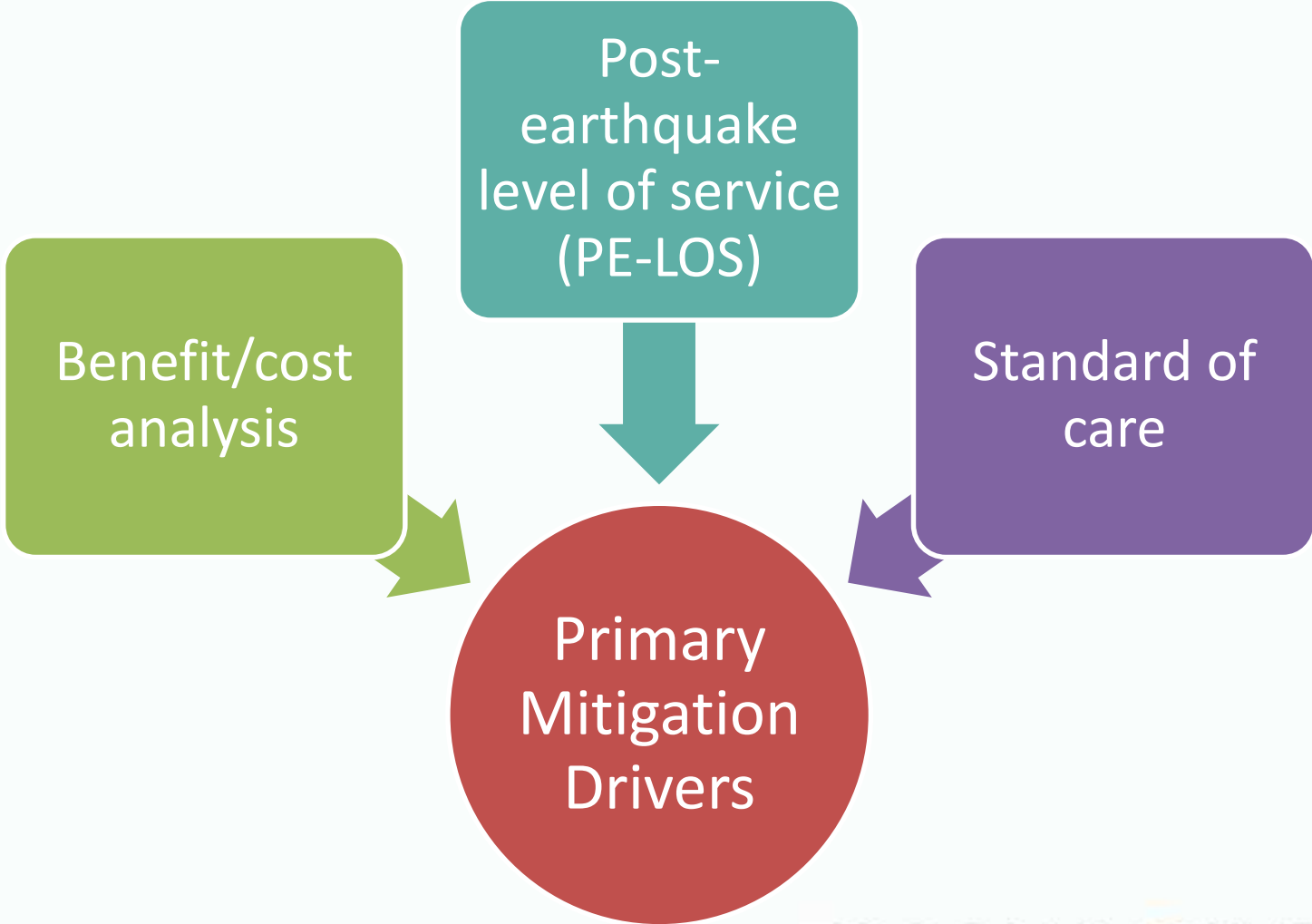
# What Will the Recommendations Cost?

- To move towards achieving post-earthquake level of service goals suggested by the assessment, the following are estimated:

Timeline	Totals	Primary Components
Years 1-2	\$1.5M	Low Hanging Fruit
Years 2-5	\$4M - \$25M	Facility seismic upgrades
Years 5-10	\$4M - \$75M	Facility upgrades and replacement
Year 10 and following	\$250M - \$450M	Major asset replacement

# Implementation Plan

# MITIGATION DRIVERS





# RECOMMENDATION SUB-GROUPS



# FUNDAMENTAL PRINCIPLES

- 1. Recommendations were based on the information available at the time and knowledge will continue to grow**
- 2. Post Earthquake-Level of Service (PE-LOS) is the single most important driver**
- 3. Establishment of PE-LOS goals will take some time**
- 4. Start improving the PE-LOS of the system while we work to establish PE-LOS goals**
- 5. Tacoma water decision making framework needs to incorporate PE-LOS once it has been fully developed**

# NEXT STEPS

- **Develop a strategic initiative for VA implementation plan**
- **Prioritize and allocate resources to implement projects**
- **Carry out PE-LOS development**
- **Near term focus on critical, inhabited operations building and strengthening the in-town groundwater supply**
- **Budget for the next 10 years**

# NEXT STEPS (CONTINUED)

- **Connect VA implementation with our Strategic Asset Management Plans**
- **Complete development of recommended PE-LOS, including public and policy maker involvement**
- **Educate staff about the capabilities and use of existing risk models such as the pipeline economic model and VA risk analysis model**
- **Incorporate the concept of PE-LOS in the budget decision making framework, as ultimately approved by utility leadership and policy makers**



## Questions?

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