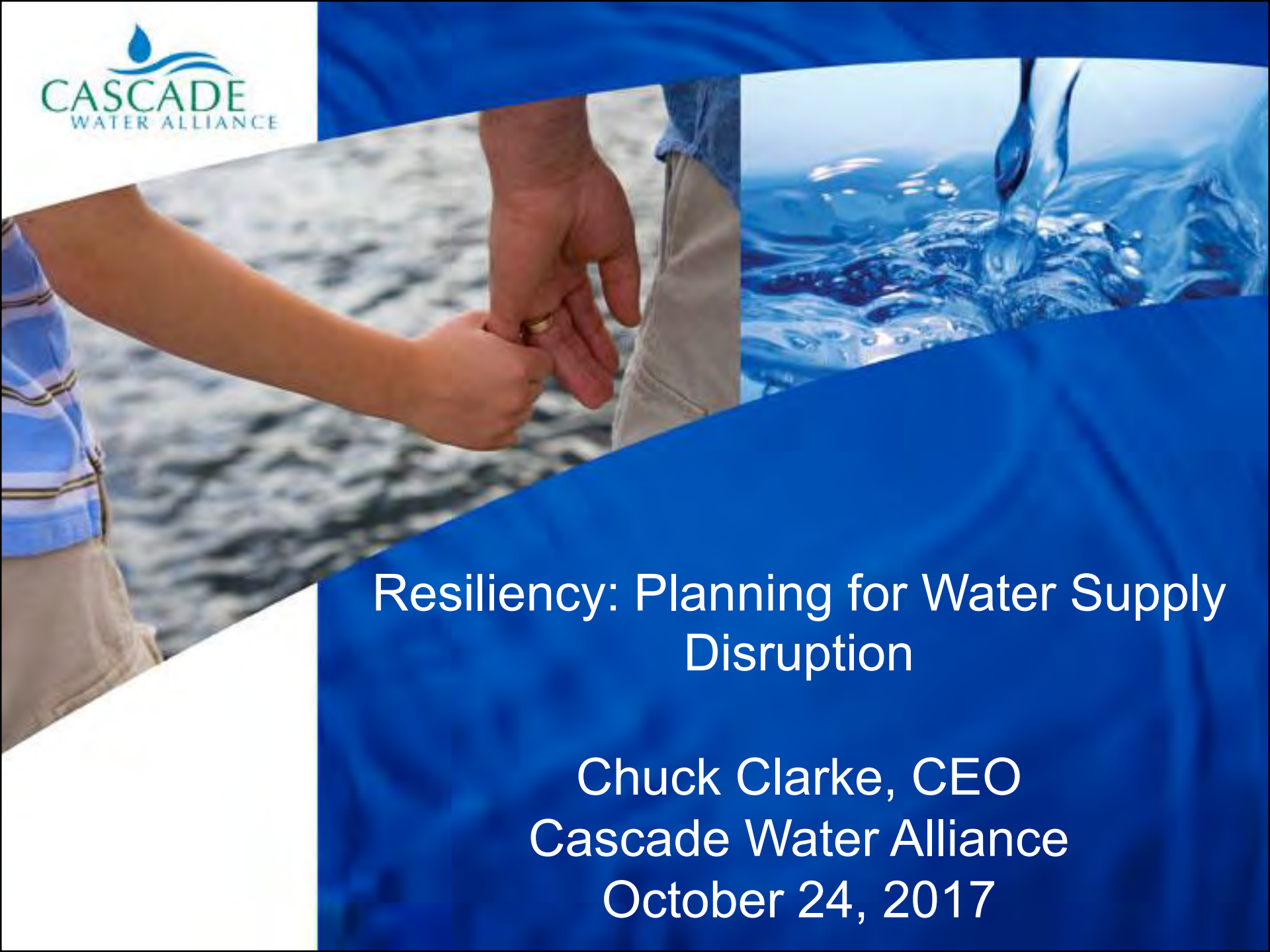

Resiliency: Planning for Water Supply Disruption

Chuck Clarke, CEO
Cascade Water Alliance
October 24, 2017

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Resiliency is defined as the ability to reduce the impact of (prevention/mitigation) and recover rapidly from (response) disruptive events, so that an acceptable level of service (LOS) is maintained and the impacts on public health and safety and the economy are minimized.

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Critical Steps in a Resiliency Analysis

1. Fully commit to the analysis both the necessary resources and addressing the outcomes.
2. Determine a desired level of service (LOS) expected by elected officials and citizens (and timeframe for recovery).
3. Determine your most significant disruptive events. This should include some level of prioritization that includes consequence, likelihood and time dimension.

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cont'd

4. Develop disruptive scenarios for your selected high priority events that break your system.
5. Examine your ability to meet or restore your desired service levels in an acceptable timeline and determine the cost to meet these timelines.

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cont'd

6. Either adjust your LOS and recovery objectives or recommit to the LOS.
7. Start an investment program that allows you to mitigate the LOS risks at a future date to achieve your LOS.
8. Develop a response program to react post disruptive event.

Water Supply Forums Work

www.watersupplyforum.org

Water Supply Forum includes:

- Cascade Water Alliance
- City of Everett
- Everett Water Utility Committee
- King County
- Pierce County Regional Water Association
- Seattle Public Utilities
- Tacoma Water

Water Supply Forum Resiliency Goal

" A water utility's resiliency-the ability to provide an uninterrupted supply of safe, clean water can-be affected by natural occurrences such as earthquakes, drought, climate change and mater quality conditions. The Water Supply Forum has embarked on a project to help water utilities in King, Pierce and Snohomish Counties proactively evaluate the regions existing water supply systems resiliency and plan for potential water supply disruptions. Resources developed by the Forum include a summary report and technical memoranda for climate change, earthquakes, drought and water quality."

Water Supply Forum Approach

The Water Supply Forum has chosen a phased approach.

Phase 1

The would be step 1-5 of the critical steps discussed earlier. This work was done primarily by member utility staff with project management guidance from HDR. It also included bringing in technical experts from outside the utilities as needed.

Cont'd

Phase 1

The Phase 1 process selected four areas where the consequences of disruptive events they believed were most significant: Earthquake, Climate Change, Drought, and Water Quality. Desired levels of service were discussed (differed by member), disruptive scenarios were developed and applied, consequences determined including the ability to meet levels of service.

Cont'd

Phase 2

Phase 2 is just beginning and has more involvement from HDR. It is beginning to reexamine appropriate service levels particularly in Earthquakes. It is also beginning to look at appropriate mitigation and recovery investments.

Phase 3

???

Examples of why Earthquakes are the highest risk scenario

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Resilience - Examples

- Kobe Earthquake M7.2, 1995
  - Port of Kobe of 6th largest worldwide
  - Earthquake devastated the infrastructure
  - Today – 22 years later, they're about No. 20
- New Orleans – Hurricane Katrina, 2005
  - Devastated housing, power and water systems
  - Residents started leaving after weeks without services
  - Population was reduced by 25%

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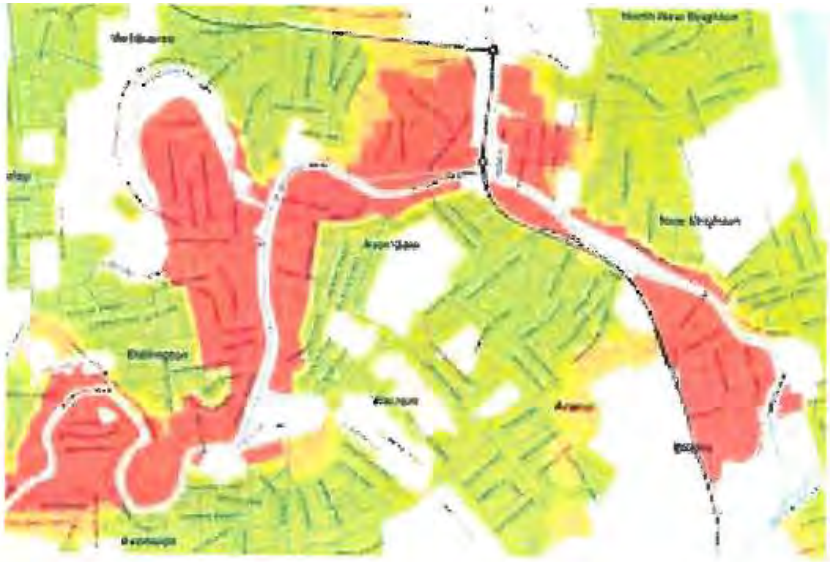
Christchurch NZ Feb 22, 2011



- City of 360,000 people
- M6.3 Direct Hit
- 190 fatalities
- CBD destroyed, 1,800 buildings demolished
- 55,000 residences damaged
- $25-$30B damage; 20% of GDP
- Extensive liquefaction along the Avon River

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Christchurch NZ

- 1645 water pipeline repairs out of 1000 miles pipe
- Most was AC pipe
- Have moved to HDPE
- 300 km of sewer damaged
- 8 PS require replacement
- Chemical toilets distributed to 30,000 residents

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Historic Earthquake Performance

- Tohoku, Japan 2011, M9.0 - 40+ days
- Christchurch, New Zealand 2011, M6.3 – 40+ days
- Kobe Japan, 1995, M6.9 – 60 days
  - 1,200 pipeline failures
- Northridge, California 1994, M6.7 – 13+ days
  - 1,000 distribution failures
  - 35 transmission main failures

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Economic Impacts and Consequences

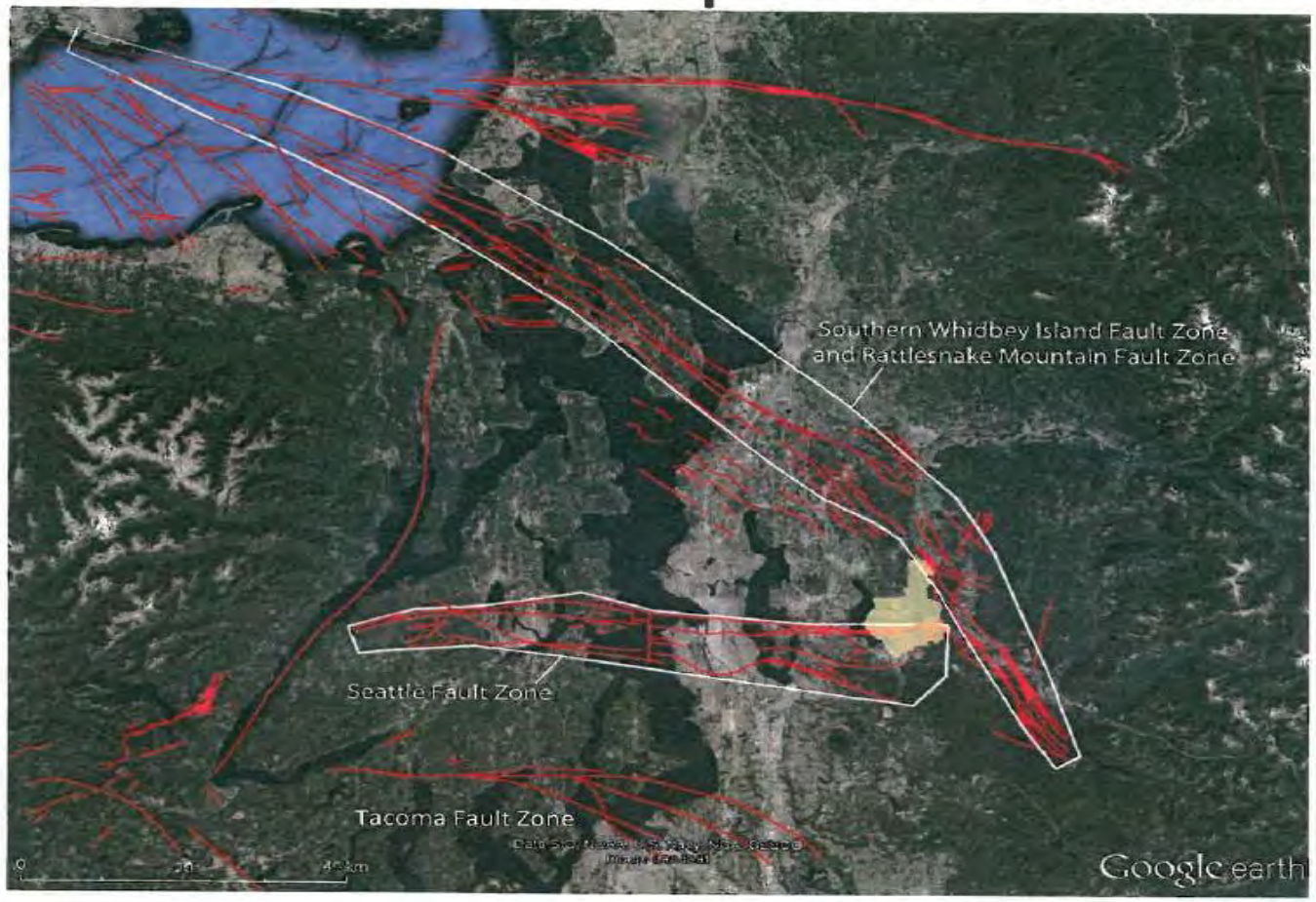
- People leave town after 2 to 4 weeks without services
  - Key to resilience-people not available to rebuild (Katrina)
  - Primarily those without ownership of local assets-renters
  - Small businesses very fragile-cash flow
- FEMA $103/day/person
- Fire suppression-
  - San Francisco, losses due to fire estimated to be same order of magnitude as direct damage
  - High-rise buildings close-fire sprinklers inoperable (Des Moines, IA)
- Critical facilities
  - Potential loss of life if required to move patients.
  - Laundries required to operate hospitals et al
- Potable
  - Distribution via tank trucks/local tanks and bottle water

Cont'd

- Public health
  - Restaurants and hotels close-loss of service, economic impact
  - People carry water for bathing, cooking
  - Rely on portable toilets, latrines-sewers inoperable without water
  - Inconvenience results in people leaving
- High tech office buildings-sprinkler? public health?
- Manufacturing, industries dependent on water shut down
- Telecommunications, computer banks dependent on water for cooling

Specific Scenarios
Examined by the Water Supply Forum

Crustal Earthquake Faults



Shannon and Wilson 2013

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Earthquake Scenarios

- Cascadia Subduction Zone-M9.0
  - Return period-500 years
- Seattle Fault-M6.7
  - Return period-1,000 years
- South Whidbey Island Fault-M7.4
  - Return period-2,700 years
- Tacoma Fault
  - Return period 4,500 years

Results from the Technical Analysis by the Water Supply Forum and Members

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WSF Regional Resiliency Project WTP Expected Performance

	Cascadia Subduction Zone Earthquake	South Whidbey Island Fault	Seattle Fault	Tacoma Fault
SPU[2]/Cascade Water Alliance	• Minimal disinfection within 24 hours • Full treatment within 24 hours	• Minimal disinfection within 24 hours • Full treatment within 24 hours (Cedar) to possibly more than 72 hrs (Tolt)	• Minimal disinfection within 24 hours • Full treatment within 24 hours (Tolt) to possibly more than 72 hours (Cedar)	• Minimal disinfection within 24 hours • Full treatment within 24 hours (Tolt), possibly longer for Cedar
Tacoma Water	• Minimal disinfection within 72 hours • Full treatment within 72 hours	• Minimal disinfection within 24 hours • Full treatment within 24 hours	• Minimal disinfection within 72 hours • Full treatment within 24 hours	• Minimal disinfection within 24 hours • Full treatment within 72 hours
Everett Water	• Minimal disinfection within 24 hours • Full treatment within 24 hours	• Minimal disinfection within 3 days • Full treatment within 7 days	• Minimal disinfection within 24 hours • Full treatment within 24 hours	• Minimal disinfection within 24 hours • Full treatment within 24 hours

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WSF Regional Resiliency Project

Estimated Restoration Time for 90% Customers

Regional Water System	Cascadia Subduction Zone	South Whidbey Island Fault	Seattle Fault	Tacoma Fault
Everett Public Works[3]	7 days	30 days	see note 8	see note 8
Seattle Public Utilities, Cascade Water Alliance and Other SPU Wholesale Customers[4]	14 to 30 days	30 to 60 days	30 to 60 days	3 to 7 days
Tacoma Water[5, 6]	30 days	see note 8	see note 7	40 days

Notes:

7. Tacoma Water system was not analyzed for outages in the Seattle Fault event.
8. Greater than 90% of customers are expected to have water service immediately following the earthquake event.

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Economic Impact

(Just from Water Utility Loss)

Regional System[1]	Cascadia Subduction Zone	South Whidbey Island Fault	Seattle Fault	Tacoma Fault
Everett	$70M	$490M	$10M	$0
SPU/Cascade	$810M	$1,550M	$1,770M	$240M
Tacoma	$750M	$20M	not evaluated	$1,110M
Total Loss	$1,630M	$2,060M	$1,780M	$1,360M

What can UtilitiesDo

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Oregon Resilience Plan

System Function	Event Occurs	0-24 hours	1-3 days	3-7 days	1-2 weeks	2-4 weeks	1-3 months	3-6 monts	6-12 months
Potable water availalble at supply source		▲	●		◆			X	
Main transmission faciliites, pipes, pump stations and reservoirs operational		◆					X		
Water supply to critical facilities available		●	◆				X		
Water for fire suppression at key supply points		◆		X					
Water for fire suppression at fire hydrants				▲	●	◆			X
Water available at community distribution centers/points			●	◆	X				
Distribution system operational			▲	●	◆				X

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 ▲

Current state (90% operational) X

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What Can Utilities Do?

- Take on bite size pieces-20 and 50 year planning horizons
  - You will touch most facilities in your system within 50 years
- Integrate seismic performance into all replacement and rehab activities
- Establish a seismic design policy and standards
  - Code only addresses facilities used for fire suppression
  - Design new facilities and pipelines to meet system performance goals
  - After an earthquake, FEMA "will pay" for replacement to your design policy criteria
- Develop a recovery plan
  - Consider equipment needs for work arounds in the short term
- Invest in infrastructure
  - You have to maintain your investments in perpetuity