



Lifelines and Utilities – LADWP Water

Los Angeles Department of Water and Power
ASCE TCLEE – Executive Committee Chair

January 16-17, 2014 - University of California, Los Angeles

Impacts – Water Systems

- 1994 Earthquake impacted numerous water systems in the San Fernando, Santa Clarita and Simi Valleys
 - Los Angeles Department of Water & Power
 - Metropolitan Water District of Southern California
 - Valencia, Newhall, Castaic Lake Water District
 - San Fernando
 - Calleguas Municipal Water District
 - and more
- Greatest impacts to LA Water System
- Presentation will focus on LADWP water system

LADWP Water System Overview

- Largest Municipal Utility in USA
- Founded 1902
- Serves 4.1-million people (3.8M in 1994)
- 712,000 water service connections
- 1214-square kilometer service area
- Receives water from:
 - 4 aqueducts
 - Local wells
- LADWP owns and operates the water and power systems

California Aqueduct

Los Angeles Aqueduct

Colorado River Aqueduct

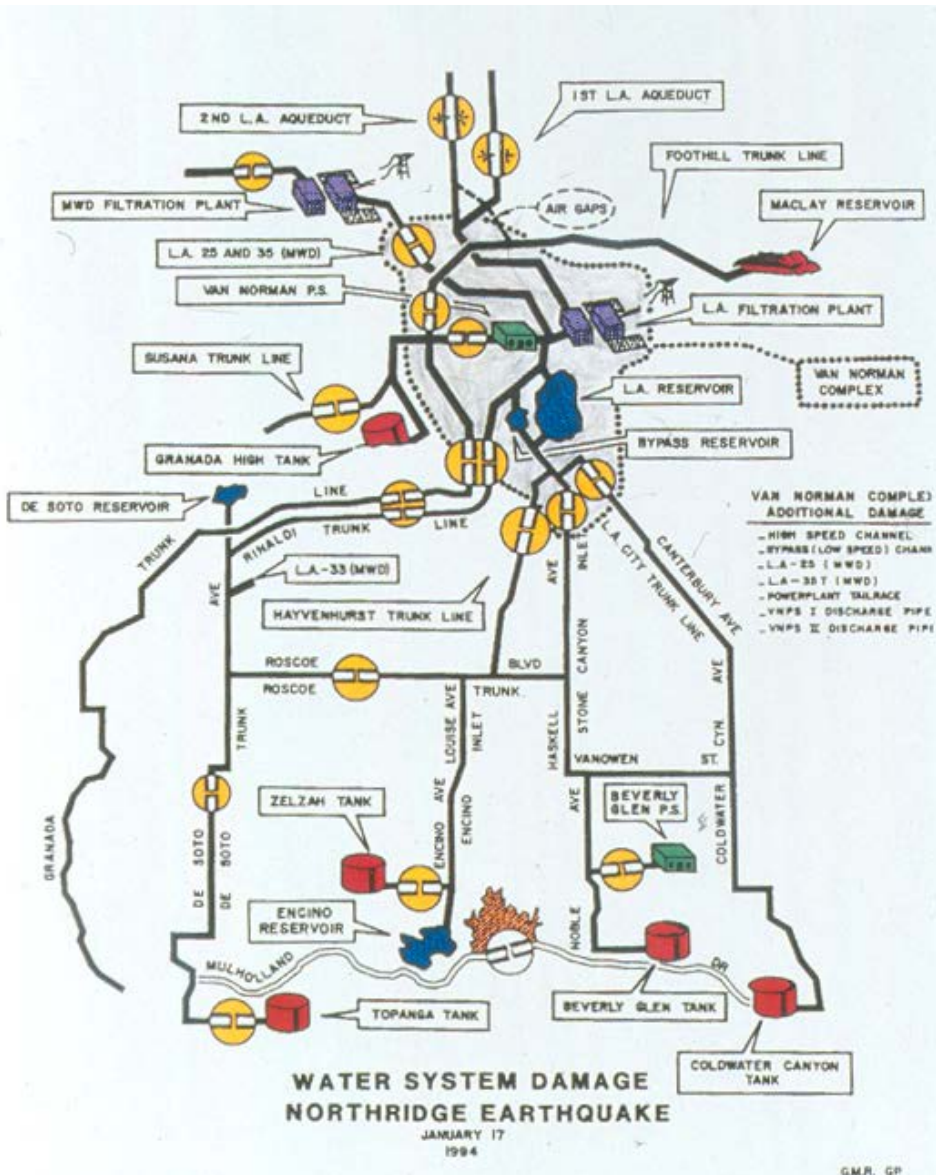
Hoover Dam

Colorado River

San Diego



Impacts LADWP Water System



- 14 repairs to raw water pipes
- 60 repairs transmission pipes
- 1013 repairs distribution pipes
- 200 service connection repairs
- 7 damaged reservoirs
- 1/2 treatment plant out of service
- Lost power up to 27 hrs
- Pump and chlorine stations were undamaged

Impacts – LADWP Water System

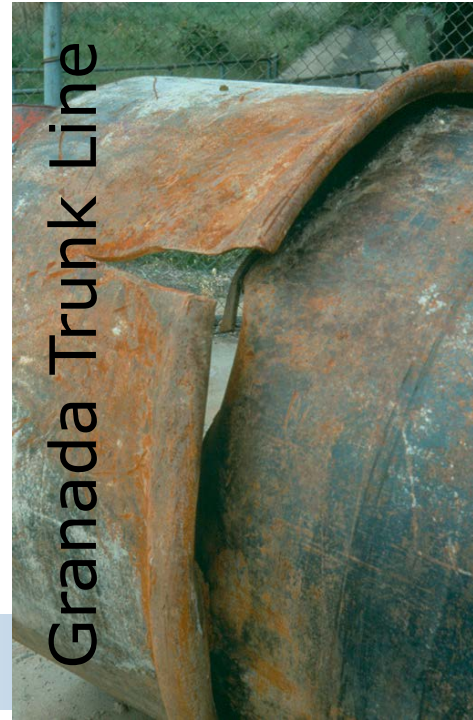
City Trunk Line



Granada Trunk Line
Balboa Blvd



Granada Trunk Line

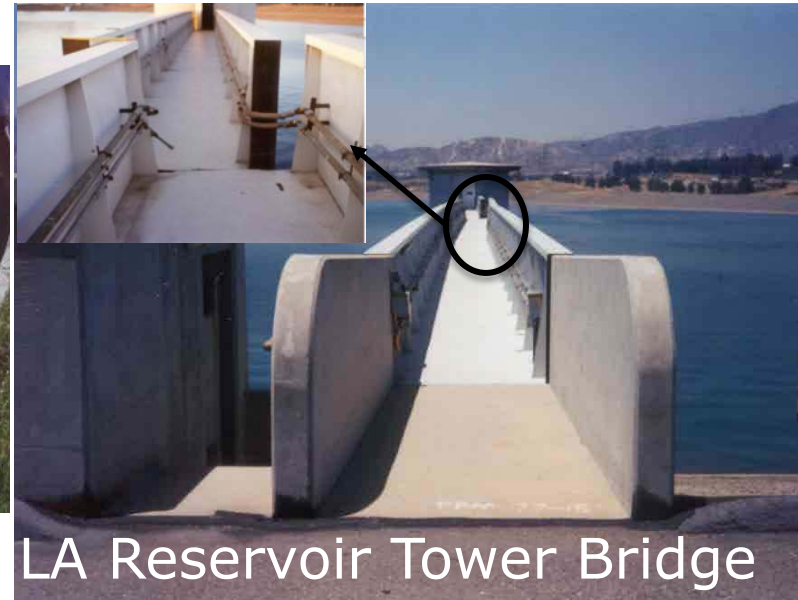


Second Los Angeles
Aqueduct



First Los Angeles Aqueduct

Impacts – LADWP Water System

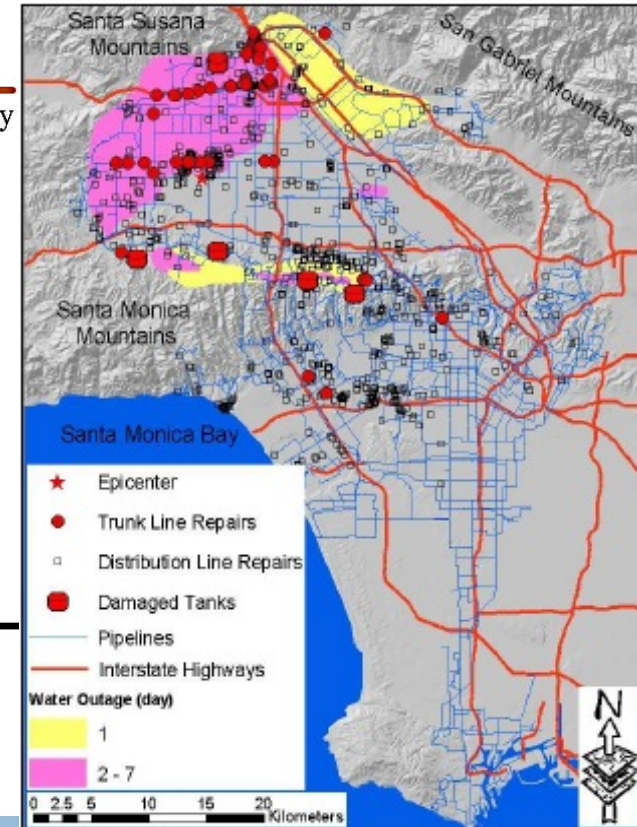
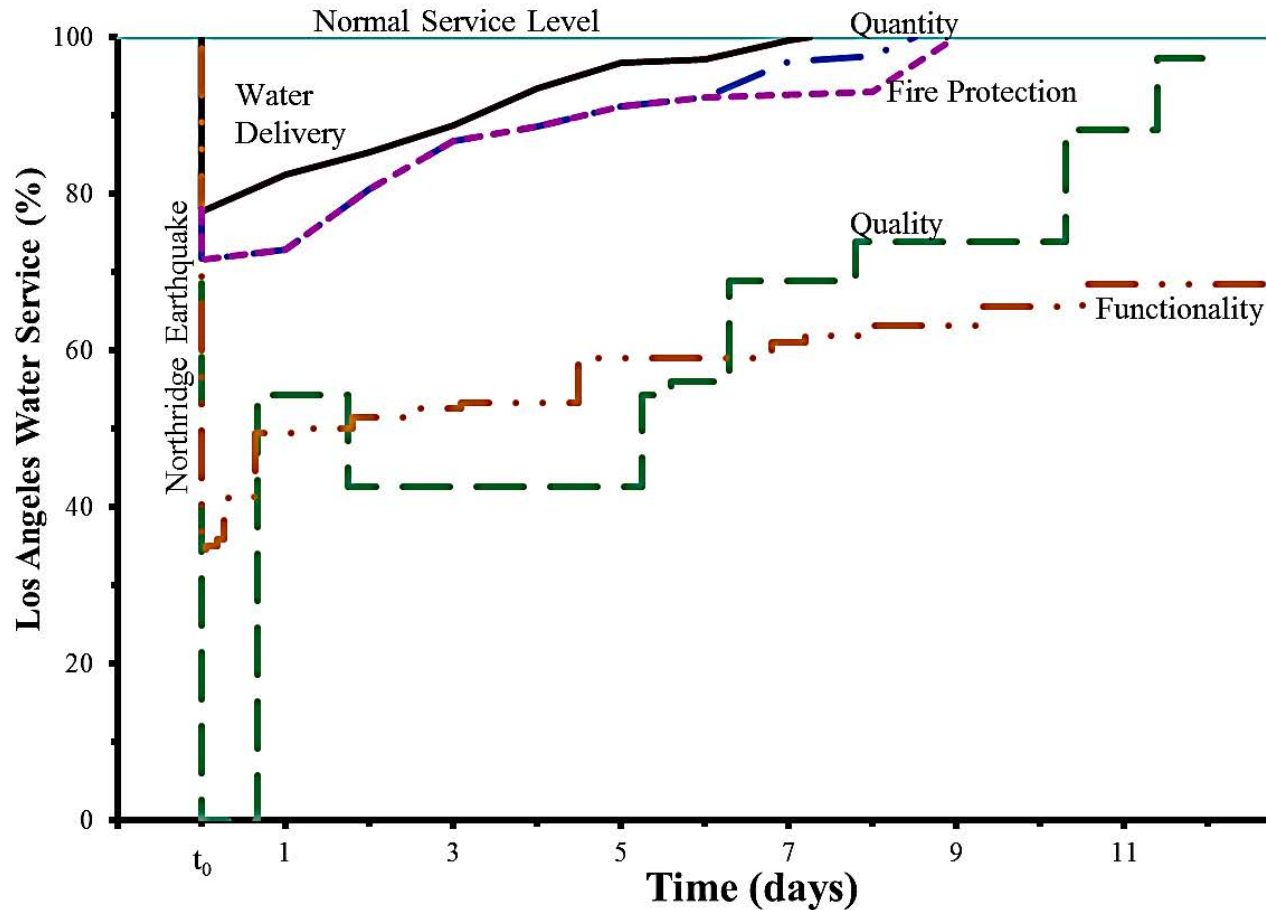


Water Services

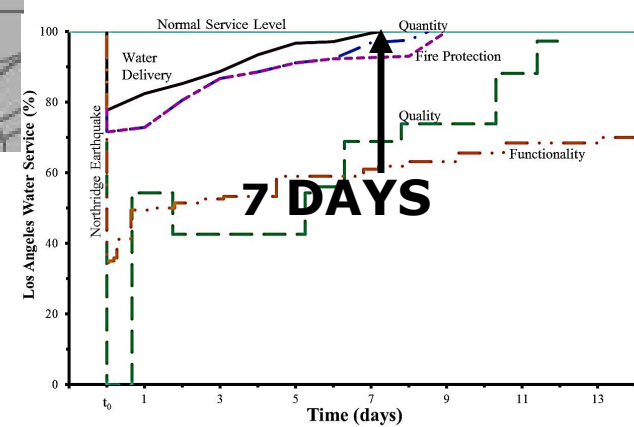
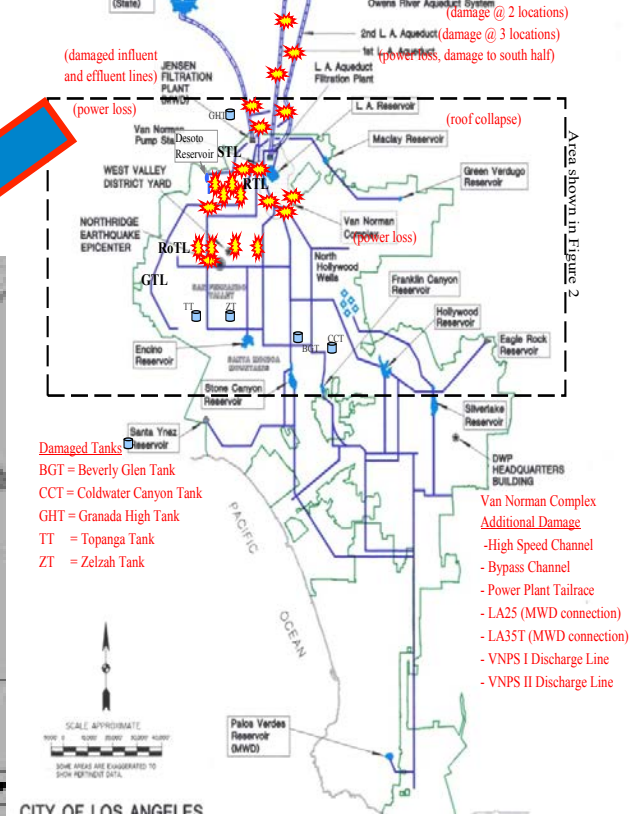
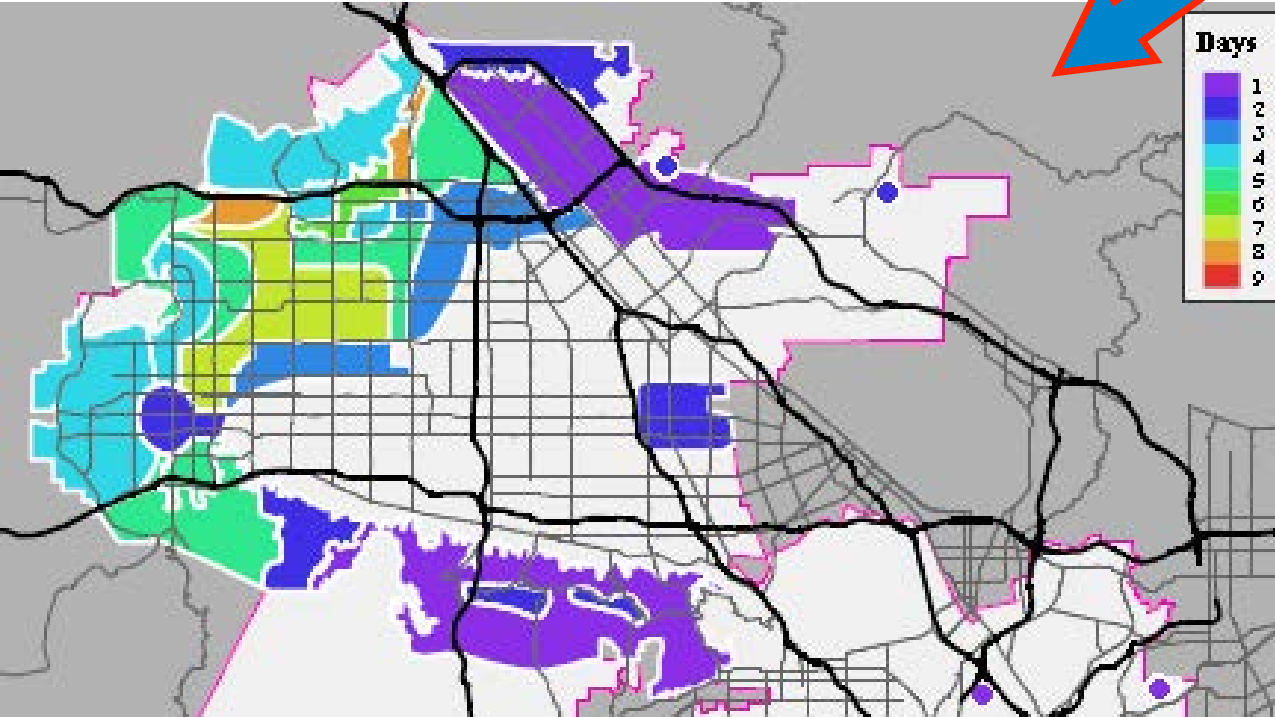
- Service restoration will be presented in the following categories:

Service Category	Description
Water Delivery	Able to distribute water to customers, but the water delivered may not meet water quality standards (requires water purification notice), pre-disaster volumes (requires water rationing), fire flow requirements (impacting fire fighting capabilities), or pre-disaster functionality (inhibiting system operations).
Quality	Water to customers meets health standards (water purification notices removed). This includes minimum pressure requirements.
Quantity	Water flow to customers meets pre-disaster volumes (water rationing removed).
Fire Protection	Able to provide pressure and flow of suitable magnitude and duration to fight fires. In many water distribution systems the minimum pressure required for fire protection is 20 psi (140 kPa), with flow quantities varying by neighborhood.
Functionality	System restored to meet or exceed pre-disaster functionality and reliability (operational constraints resulting from the disaster have been removed/ resolved) including pressures.

1994 NORTHRIDGE EARTHQUAKE L.A. WATER RESTORATIONS



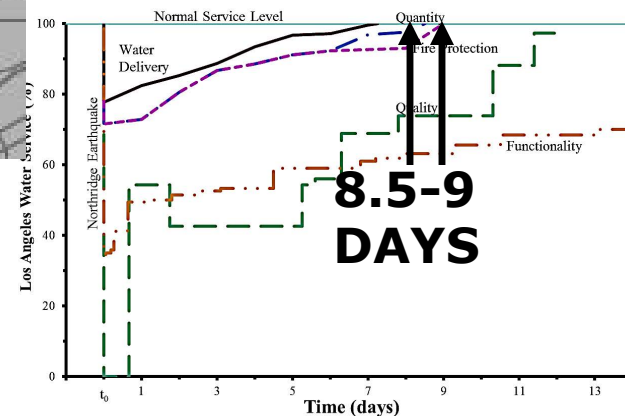
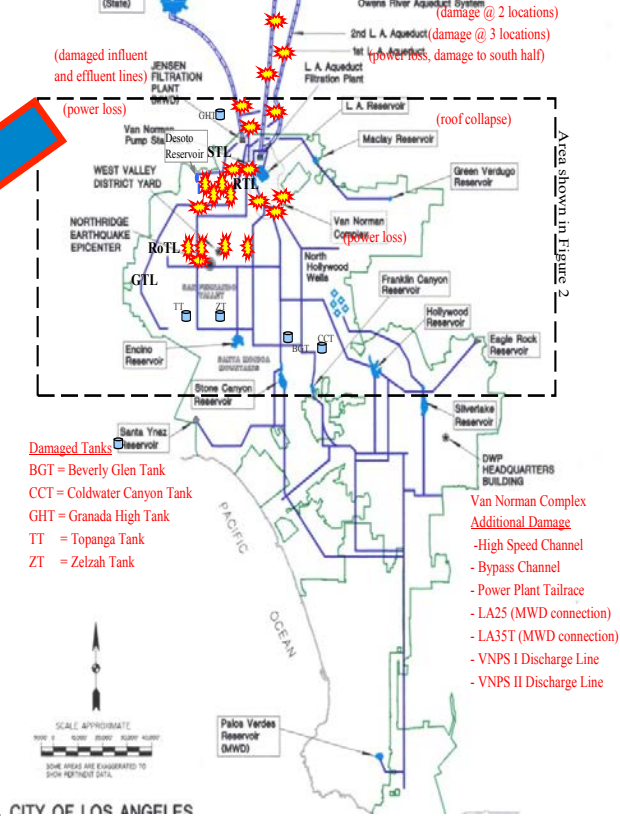
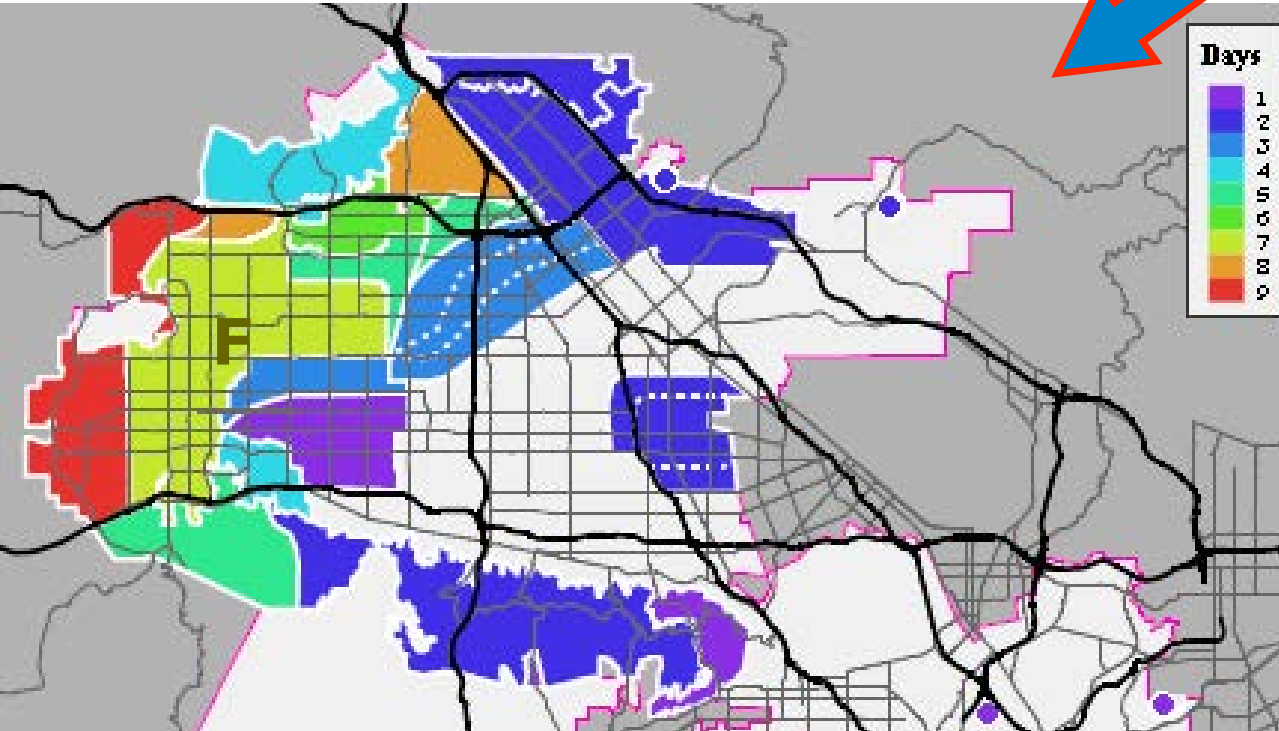
1994 L.A. Delivery Services



- 159,434 service connection outages
- 22% of all services
- ~670,000 residents
- Deployed water tankers
 - 15 locations

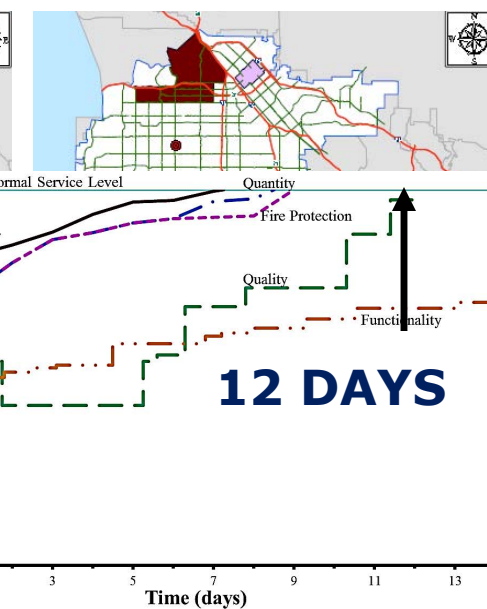
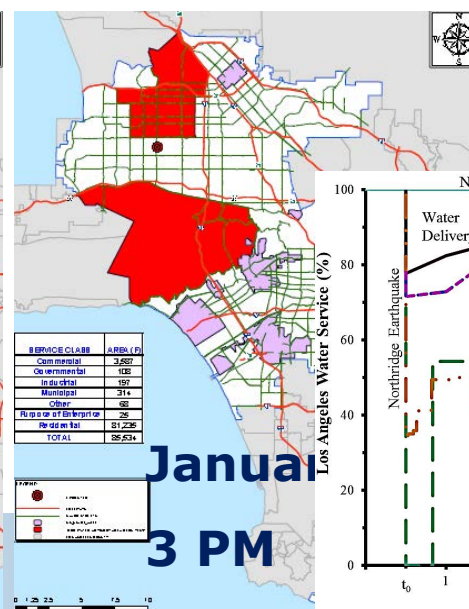
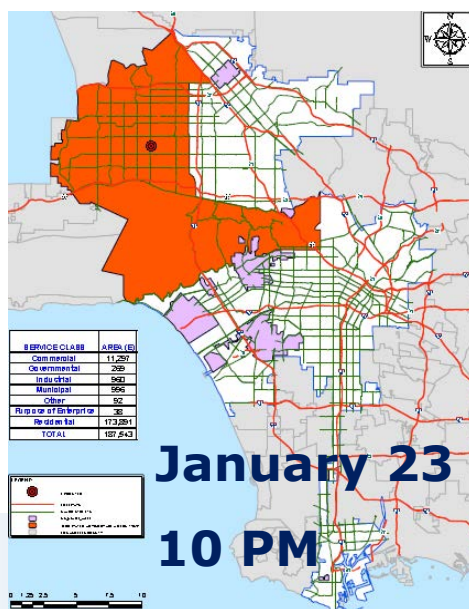
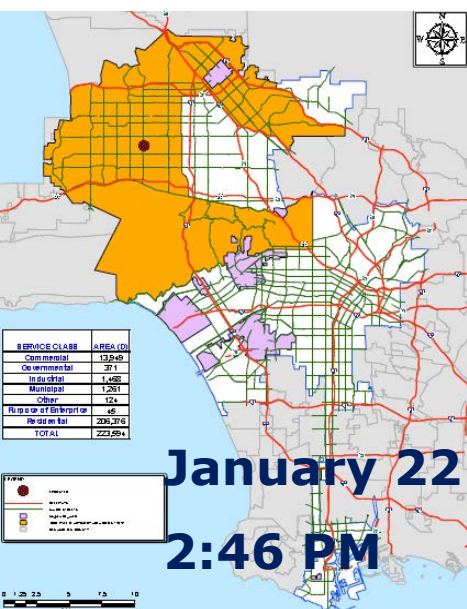
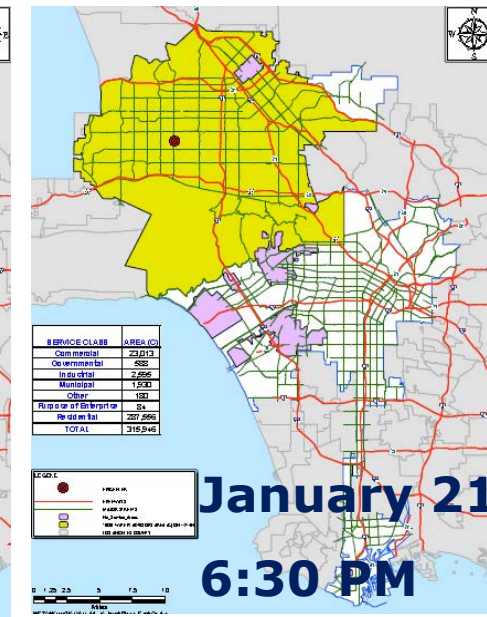
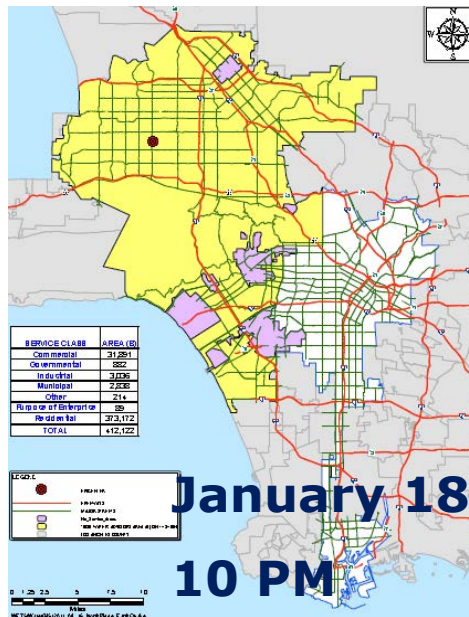
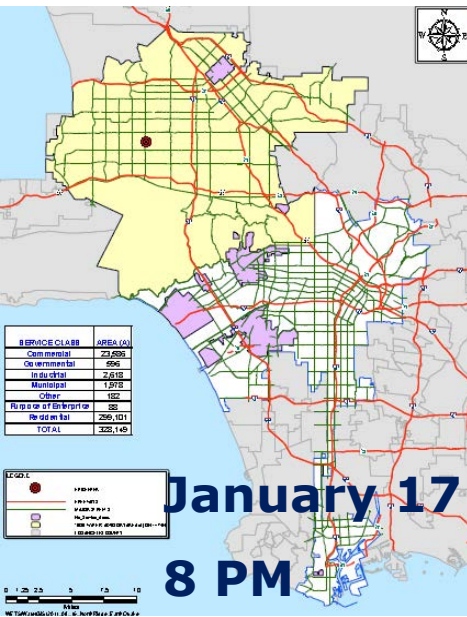


1994 L.A. Quantity and Fire Service



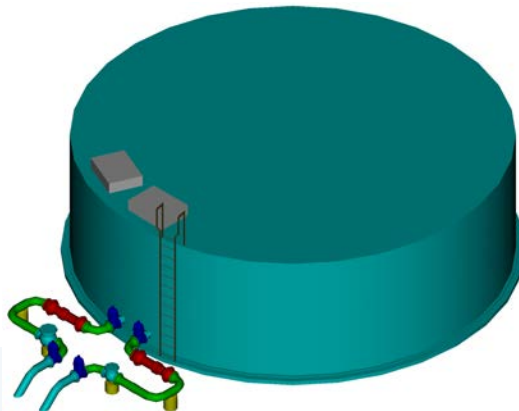
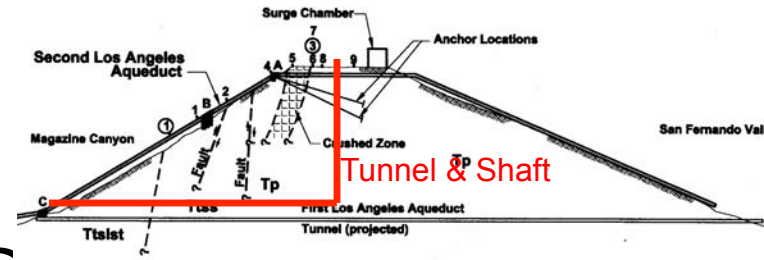
- 203,164 service connection outages
- 28% of all services
- ~850,000 residents
- All quantity restore in 8.5 days
- All fire flow restored in 9 days

1994 L.A. QUALITY RESTORATION



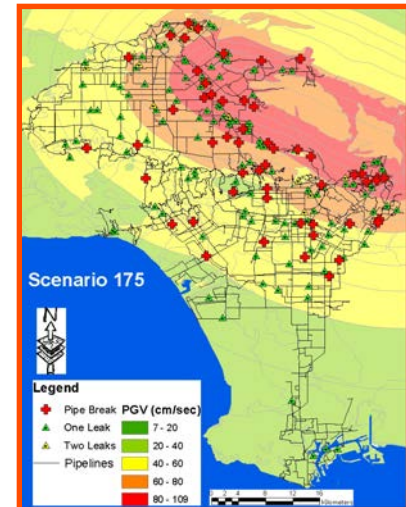
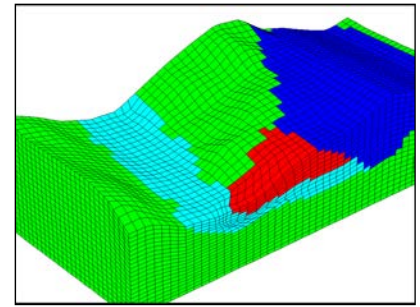
Improvements

- Pipe relocations (out of hazard zones)
 - Granada Trunk Line
 - SLAA at Terminal Hill
- Pipe Design Improvements
 - Fiber wrap
 - Base Isolation systems protecting against ground movement
- Tank Flexible connections



Improvements

- Dam Stability Re-Evaluations
 - Use improved geo- and seismo-technology
- System evaluation and Restoration Modeling
 - Worked closely with Researchers
 - GIRAFFE (Cornell Univ. – LADWP collaboration)
- Increased Seismic Instrumentation
- ShakeCast, CISN Display



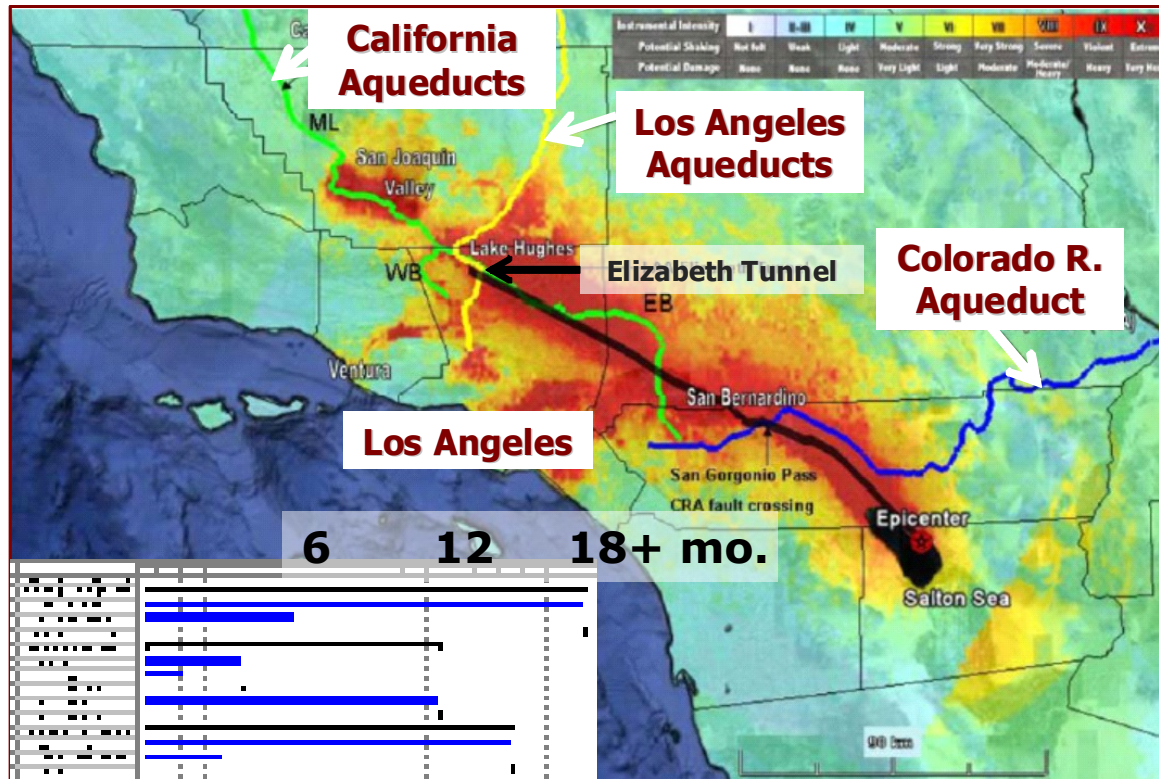
Pilot Project - Main Replacement Earthquake Resistant Ductile Iron Pipe

- Contour Drive
- LADWP replaced 1750' of 6" line
- Installation completed April 2013
- 4 more pilot project sites
- Positive results so far



ShakeOut Scenario

Regional M7.8 Earthquake Scenario on San Andreas Fault



Water Supply Results

- Aqueduct flow restoration > 18 mo.
- Insufficient supply
- Severe rationing
- Firefighting impacts
- Some w/o water for 6 months or more
- Greatest economic impact of all
 - >50% total BI
 - >25% total losses
 - >2/3 fire + water

Davis & O'Rourke, 2011, "ShakeOut Scenario: Water System Impacts from a Mw7.8 San Andreas Earthquake," EQS, 27:2, pp 459-476

Next Steps

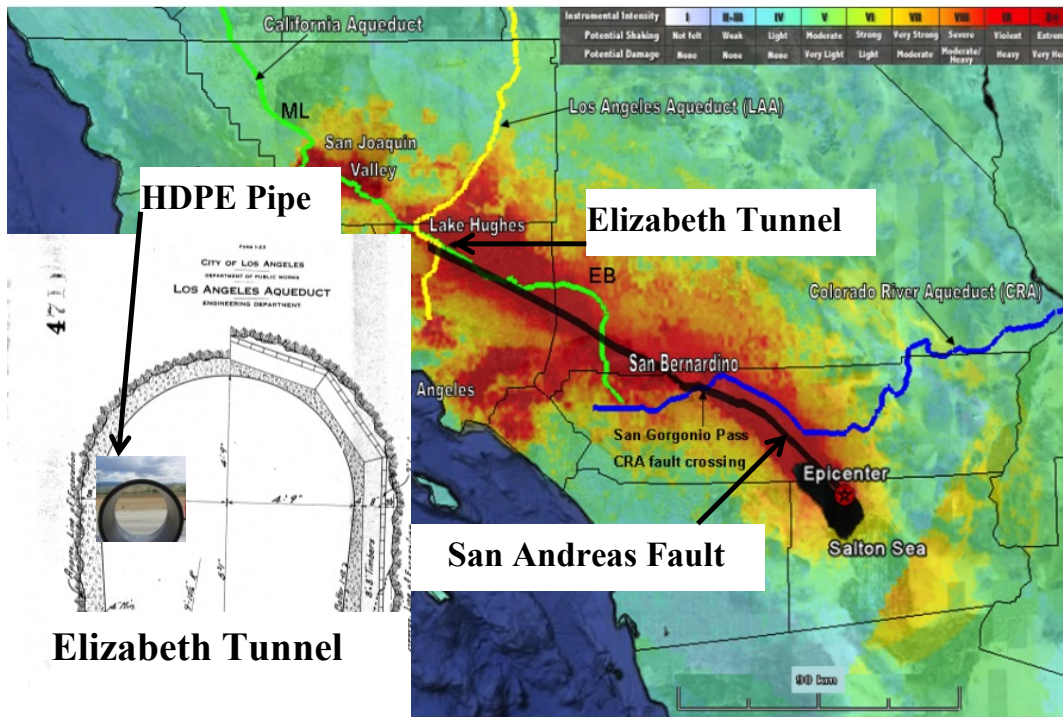
- Systems Evaluations
 - Supply, transmission, distribution systems
 - Identify & improve vulnerabilities
- Develop resilient distribution network
 - Use earthquake resistant pipes and designs
 - Allow for acceptable losses
- Incorporate lessons learned from recent disasters
 - Great East Japan
 - Christchurch New Zealand

Next Steps – Water Supply

- Improve local water supplies
 - Ground water (clean up contaminations)
 - Storm water capture
 - Reclamation
- Work with LAFD to improve post-earthquake fire water supply
- Work with LA EOC to improve post-earthquake water accessibility
- HDPE Elizabeth tunnel

Next Steps – Water Supply

■ Elizabeth tunnel Seismic Enhancement

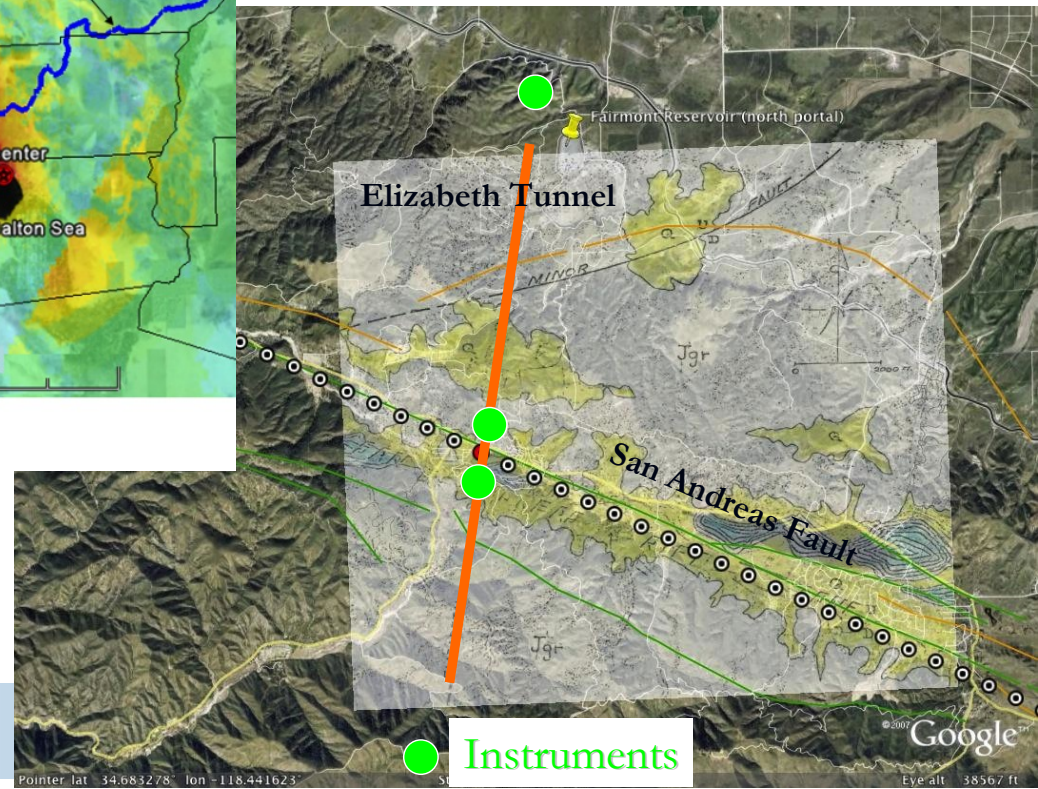


HDPE Pipe

Elizabeth Tunnel

San Andreas Fault

Elizabeth Tunnel



Instruments

Next Steps and Recommendations for Water Supply Systems

- Southern California Water Supply is too critical to fail, aqueduct water losses for minimum 12 to 18 months is too long!
 - A Water Supply Task Committee (WSTC) needs to be formed by the supply agencies (LADWP, MWD, DWR)
 - The WSTC should coordinate their efforts for
 - identifying water supply vulnerabilities,
 - how to mitigate, and
 - planning for emergency response and recovery

Recommendations

- Improve assessment of regional economic impacts from water system disruption
- Improve post-earthquake water system restoration modeling
- Develop water system restoration goals
- Maps identifying potential ground displacements need to be prepared and available for all to use
 - Ground Failure causes the greatest lifeline disruption – to all lifeline pipes and cables
- Develop uses for Earthquake Early Warning

Recommendations

- California Department of Public Health **change**
“**Boil Water Notice**”
 - We should not be encouraging the community to light fires in a disaster situation
 - The “Boil Water Notice” actually makes many recommendations for purification than boiling water
 - The LADWP has initiated this process by implementing a
“**Tap Water Purification Notice**”