Lifelines

• Water and Wastewater
• Electric Power and Communication
• Gas and Liquid Fuels
• Transportation
  – Highways and Bridges
  – Railways and transit
  – Airports and Harbors
Seismic Mitigation and Emergency Response

Water Systems

Le Val Lund, P.E. M. AWWA
Outline

- Seismic Hazards
- Damage
- Vulnerability Assessment
- Mitigation
- Emergency Response
- Emergency water
Earthquakes

- 1857 Ft. Tejon
- 1872 Owens Valley
- 1906 San Francisco
- 1925 Santa Barbara
- 1933 Long Beach
- 1940 El Centro
- 1952 Tehachapi
- *1971 San Fernando
- 1965 Coalinga
- 1992 Cape Mendocino
- 1992 Landers-Big Bear
- 1994 Northridge
- 1999 Hector Mine
Earthquake Shaking Potential for California
Spring, 2003

This map shows the relative intensity of ground shaking and damage in California from an isolated future earthquake. Although the greatest hazard is in the area of highest intensity, shown in red, some areas within the state have intermediate or low potential for earthquake damage. Expected damages in California in the next 30 years exceed $38 billion.

Important messages about earthquake risk for Californians to remember:

1. Earthquakes have occurred over $65 billion in losses in California since 1906. The next large earthquake may produce severe ground shaking, especially in the San Francisco Bay area and in the higher intensity zones.
2. A large earthquake or series of events such as the one that occurred in 1989 in the San Francisco Bay area, may result in serious economic disruptions and require assistance from state and federal agencies.
3. Current and future building codes substantially reduce the costs of damage from earthquakes, but the reductions are not sufficient to prevent significant losses of life by keeping the buildings from collapsing and to prevent the loss of services.
4. If the Northridge or Los Angeles earthquakes had occurred closer to a major population center, they would have killed thousands, and the economic losses would have been much greater than they actually were.
5. After a large earthquake, residents should be prepared to stay in their homes for several days and to be prepared to move to a safer area on their own, and by others, until assistance is available.
6. Maps of the shaking intensity after the next major earthquake will be available within minutes of the event.
7. The agencies and government programs that were successful in reducing the impact of future earthquakes.

Level of Earthquake Hazard

- High: Very high seismic danger, often associated with highly susceptible building structures, major highway infrastructure, and high population centers.
- Moderate: Moderate seismic activity, associated with some susceptible building structures and minor highway infrastructure.
- Low: Low seismic activity, associated with low population centers.
- Very low: Very low seismic activity, associated with remote areas.

Source: California Earthquake Authority
VULNERABLE LIFELINE SYSTEMS

• Earthquake damaged lifeline systems (transportation, communication, and utility networks) may impede the provision of necessary utility functions, or access to the building site in the postearthquake aftermath.

Bay Bridge Collapse, Loma Prieta Earthquake of 1989
Magnitude: 7.1

Collapse of sections of Interstate Highway 5, Northridge Earthquake of 1994
Magnitude: 6.7

Street collapse near port, Kobe Earthquake of 1995
Magnitude: 6.9
Northridge, California
Year: 1994
Magnitude: 6.7
Killed 63 people
Property Damage: $20 billion
Over 30% of the building failures could be attributed to flawed construction.
Seismic Hazards

- Fault Rupture
- Shaking
- Liquefaction
- Landslides
- Lateral Spreading
Fault Rupture
San Andreas –Wallace Creek
Alquist-Priolo Earthquake Fault Zones
Shaking
Liquefaction
Landslides
Landslides

Earthquakes push up the mountains and the rain (and gravity) brings them back down
The fires lead to debris flows

- Christmas 2003
- Debris flows from at least 80 burned basins
- 16 dead
Submarine landslides cause tsunamis

Age = 7500 years
Tsunami height > 8 m
Lateral Spreading
Lateral Spreading
Geology and Seismic References

- USGS-United States Geological Survey
- CGS-California Geological Survey
- SCEC-Southern California Earthquake Center
- NEHRP-National Earthquake Hazards Reduction Program
- University, Consultants, etc.
Water System Damage
Water System Damage
Elephant’s Foot Buckling

Photo by LeVal Lund
Kobe Earthquake Buried Pipe Damage
TREATMENT FACILITIES – CLARIFIERS AND SEDIMENTATION BASINS

• Sloshing

Photo by LeVal Lund
Plant Piping
Office
Colocation
Component Assessment

System Analysis
Component Assessment
Vulnerability Assessment

- Inventory
- Field Inspection
- Damage Assessment
- Mitigation plan
- Budget
- Design
- Construct
Personnel

- Field Staff
- Engineers
- Consultants
Component Assessment

Site
- Landslides
- Ground Deformation

Building
- Age, Design code, condition
- Concrete, masonry, frame
- Roof structure
- Safety Hazards-
  – Fire Extinguishers
  – Freestanding cabinets and Racks
Component Assessment (Cont.)

Anchorage Deficiencies
– Batteries
– Piping Flexibility
– Transformers-Pole Top/Ground
– Electrical/Communication Equipment
– Cylinders-2 ton, 150 pound

Recommend evaluation for structural adequacy
Prioritize

Priority 1 Low cost-O&M

Priority 2 Moderate cost-Budget

Priority 3 Higher cost-Further study-Budget
Implementation

- O & M
- Scheduling
- Budget
- Construction
System Analysis
System Analysis

- Geology
- Seismicity
- Inventory
- System Importance Factor
- Maintenance Record
- Mitigation Cost
- Emergency Power Supply
- Shaking
- Ground deformation

![Graph showing reliability versus PGA (g's)]
HAZUS-MH

Federal Emergency Management Agency

www.fema.gov/hazus

Proprietary Programs by Consultants
Prioritize

Priority 1 Low cost-O&M

Priority 2 Moderate cost-Budget

Priority 3 Higher cost-Further study-Budget
Implementation

• O & M
• Scheduling
• Budget
• Construction
Analysis References

• MCEER-Multi Disciplinary Center
• MAE-Mid America Center
• PEER-Pacific Earthquake Center
• ASCE-Technical Council Lifeline Earthquake Engineering
• EERI-Earthquake Engineering Research Institute
• ALA-American Lifelines Alliance
• NEHRP, universities, consultants, etc.
Mitigation
Above Ground Pipeline Upgrade Example
Little Mountain Reservoir Seismic Upgrade
Inadequate Anchorage
Little Mountain Reservoir Seismic Upgrade
Prestressed Concrete Tanks
Elevated Tank Upgrade – Energy Dissipation
Elevated Tank Seismic Isolation/Structural Upgrade
Gas Cylinders

Not Good

Good
Plant Piping
Chlorine Cylinders

Not Good

Better
Hazardous Materials Storage

Not Good

Better,
Miscellaneous Hazards

Not Good

Good
Miscellaneous Hazards (cont)
Emergency Response
Outline

- Develop Plan
- Conservation
- Water Quality
- Emergency Operations Center
- Emergency Water Supply
- Materials/Equipment
- SEMS, WARN, MARS, and CISN
- Implementation
Develop Plan

• Work group-Use available resources
• Work and home plan (on & off duty)
• Contact list (wallet size)
• Inventory (contractors, materials & equipment)
• Coordinate with ER organizations (SEMS)(WARN)(MARS)
• Training and exercise plan
Conservation

- Water supply demand
- Phase(s) (percent reduction)
- Voluntary or mandatory
- Who authorizes?
- Automatic activation
- Outreach program
Water Quality

- Field & Laboratory testing (CoAlert)
- Water Purification Notice
  (Electronic, printed, door to door)
- System restoration, chlorination & laboratory testing
- Health Department approval
COLILERT™ ... The Breakthrough in COLIFORM TESTING

SIMPLY
1. ADD WATER
2. INCUBATE
   35-37°C
3. READ
   Check for yellow -
   • No yellow - coliform negative
   • Yellow - coliform positive
   If yellow, view under UV light -
   • No fluorescence - E. coli negative
   • Fluorescence - E. coli positive

SIMULTANEOUSLY—
Detect, identify, and confirm total coliforms and E. coli.
• In the same container
• With a single inoculation
• In 24 hours or less
• With less than 2 minutes hands-on time

Viewed in:
Daylight
UV light

Coliform
Negative
E. coli
Negative

Positive

Positive
Emergency Operations Center

- Secure location with emergency power
- Communications facilities
- Resources (Data, TV, SCADA, etc.)
- Food, water, sleeping, cash, etc.
- Links with other EOC’s
- SEMS, WARN and CISN capability
- Staffing and training
Emergency Water Supply

• Local EOC Water Coordinator
  - EOC Primary contact for water
  - Water system status and mutual aid
  - Obtains emergency situation information from water and health agencies
  - Documents costs, contracts, resources
Methods for Emergency Water Supply

- Fire Suppression/Potable supply
  Pools, cisterns, interagency connections, fire engine pumpers, PWSS, AWWS, etc.
  Bulk, bottled, construction tanks, wells, fire hydrants, portable treatment, portable hoses and pipes, etc.
Materials/Equipment

• Spare pipe
• Repair clamps
• Small medical water tank
• Portable chlorinator
• Portable pump
• Excavator/dump truck
• Gasoline pump /emergency generator
SEMS

- Standardized Emergency management System (SEMS)
- Modeled after fire service Incident Command System (ICS)
- Standardizes language and hierarchy
- Local government responsible for potable water procurement/distribution
- State OES coordinates if needed
WARN

Water Agencies Response Network

Regional water agencies
Mutual Aid
Communication Links
MARS

Member Agencies Response System

MWDSC
Mutual Aid
Communications Link
CISN

- California Integrated Seismic Network
- Shake maps
  - Loma Prieta 1989
  - Northridge 1994
The CISN Š Who we are?

Founding Members
- OES
- USGS
- CGS
- UC Berkeley
- Caltech

Contributing Members
- Other Universities
- Regional Utilities
- Other Gov. Agencies

ANSS Member
- CA Component of Nationwide Initiative

ANSS Member
- CA Component of Nationwide Initiative

http://www.cisn.org
CISN Seismic Network
CISN

California Integrated Seismic Network
www.cisn.org

Caltech Earthquake Research Affiliates
www.caltech-era.org
Implementation

- Exercise plan (table top, single function, full scale)
- Designate Emergency Preparedness week/month
- Coordinate with other EOC’s
- Evaluate and update
Emergency Response

- Activate EOC
- Reporting procedures
- Family welfare
- Emergency power
- Emergency water
- Water quality “Purification Notice”
Ft. Tejon Earthquake

- M 7.9
- 1857
- 150th Anniversary
- USGS “Dare to Prepare”
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