Disaster Preparedness Workshop

Earthquake

April 16, 2019

Agenda

- History
- Science
- Potential impacts/losses
- Mitigation efforts
- Preparedness activities
- Response and Short-Term Recovery
- Next steps

Objectives

1. Provide an **overview of earthquake hazards**, mitigation, preparedness, and response capabilities
2. Discuss **how stakeholder agencies will monitor and respond**
3. Identify potential **future actions to mitigate and prepare** for earthquake hazard

Preface

- Disasters are complicated and challenging
- Action Item from 2017 Wildfires After Action Report

Overview

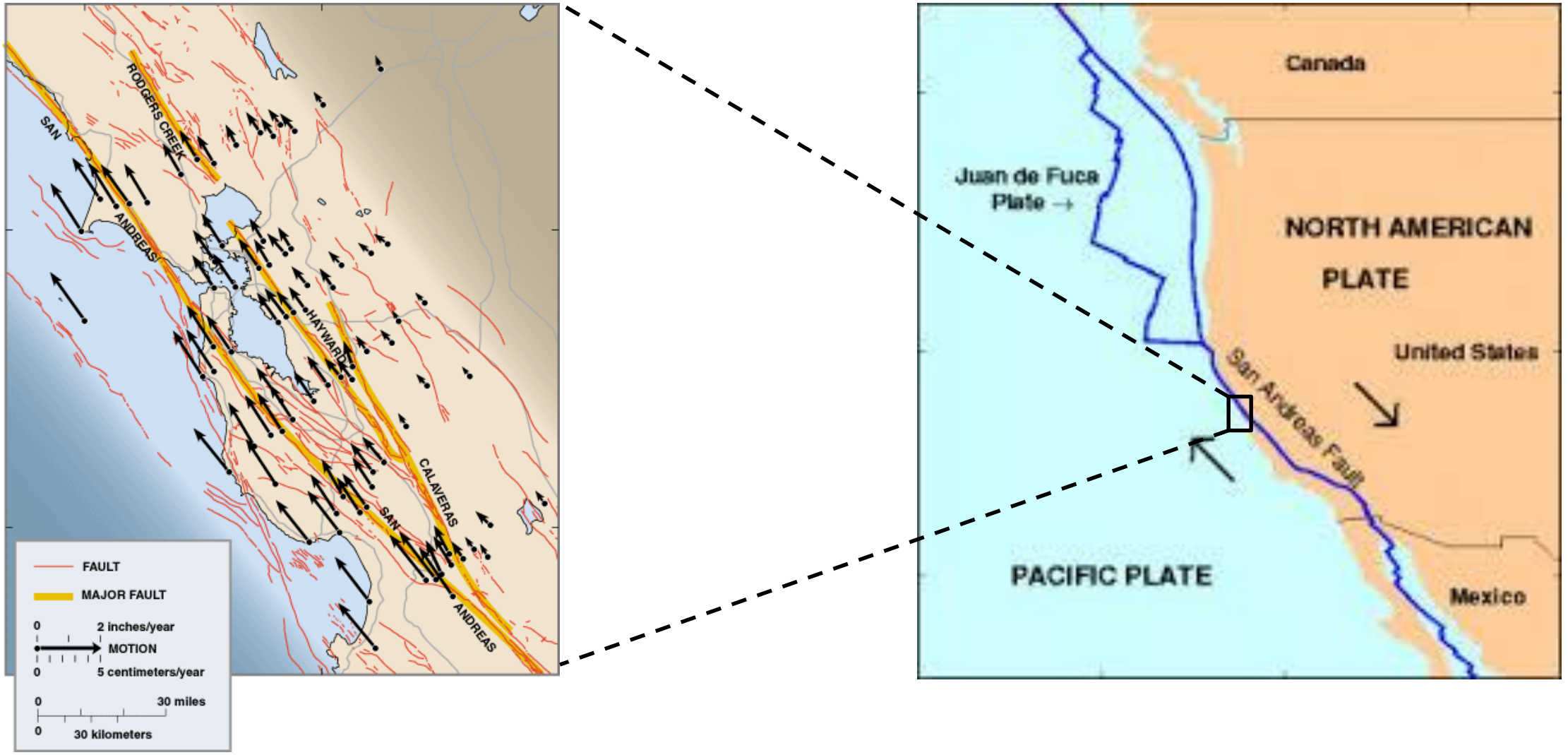
Earthquakes

- Low probability, high impact
- 101 Corridor
- Significant hidden and long-term effects
- Primary and secondary impacts

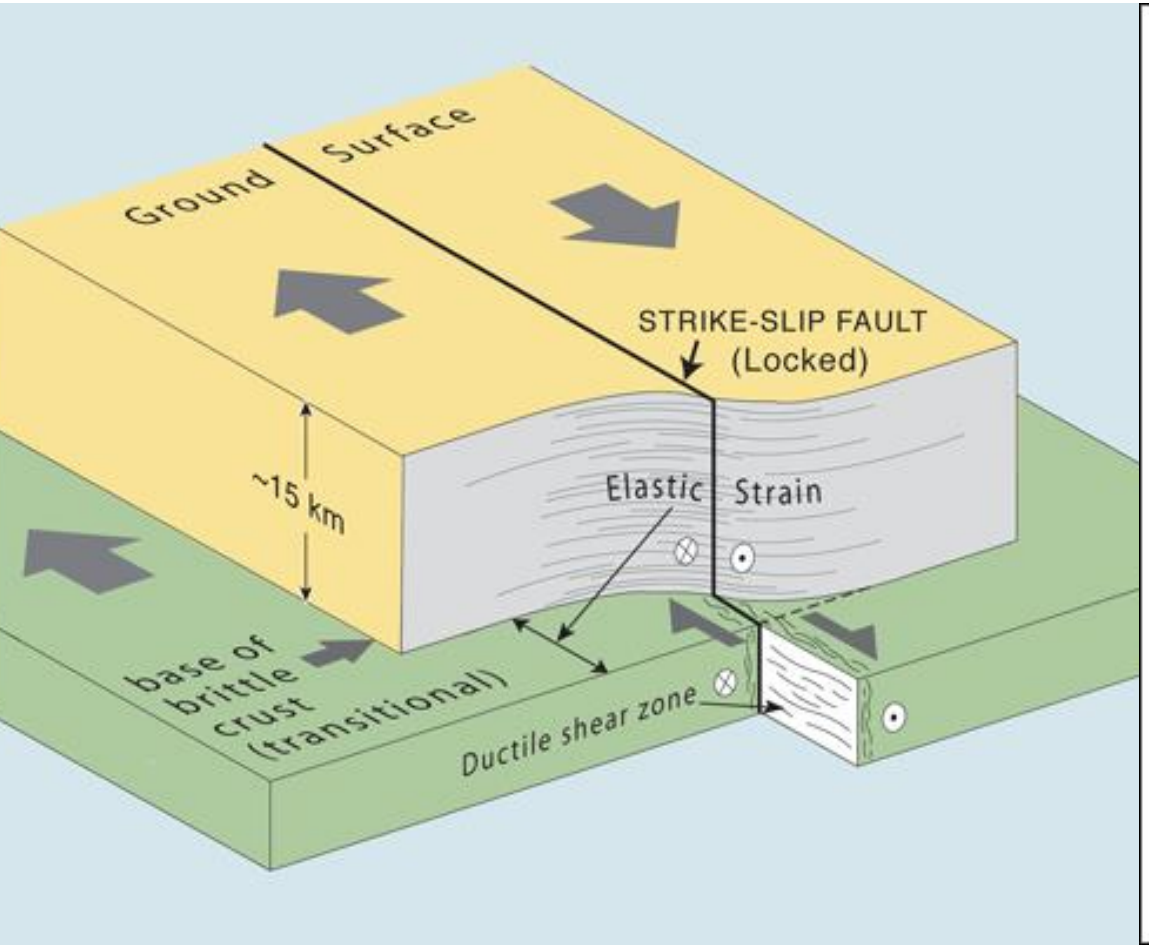
Earthquake History in Sonoma County

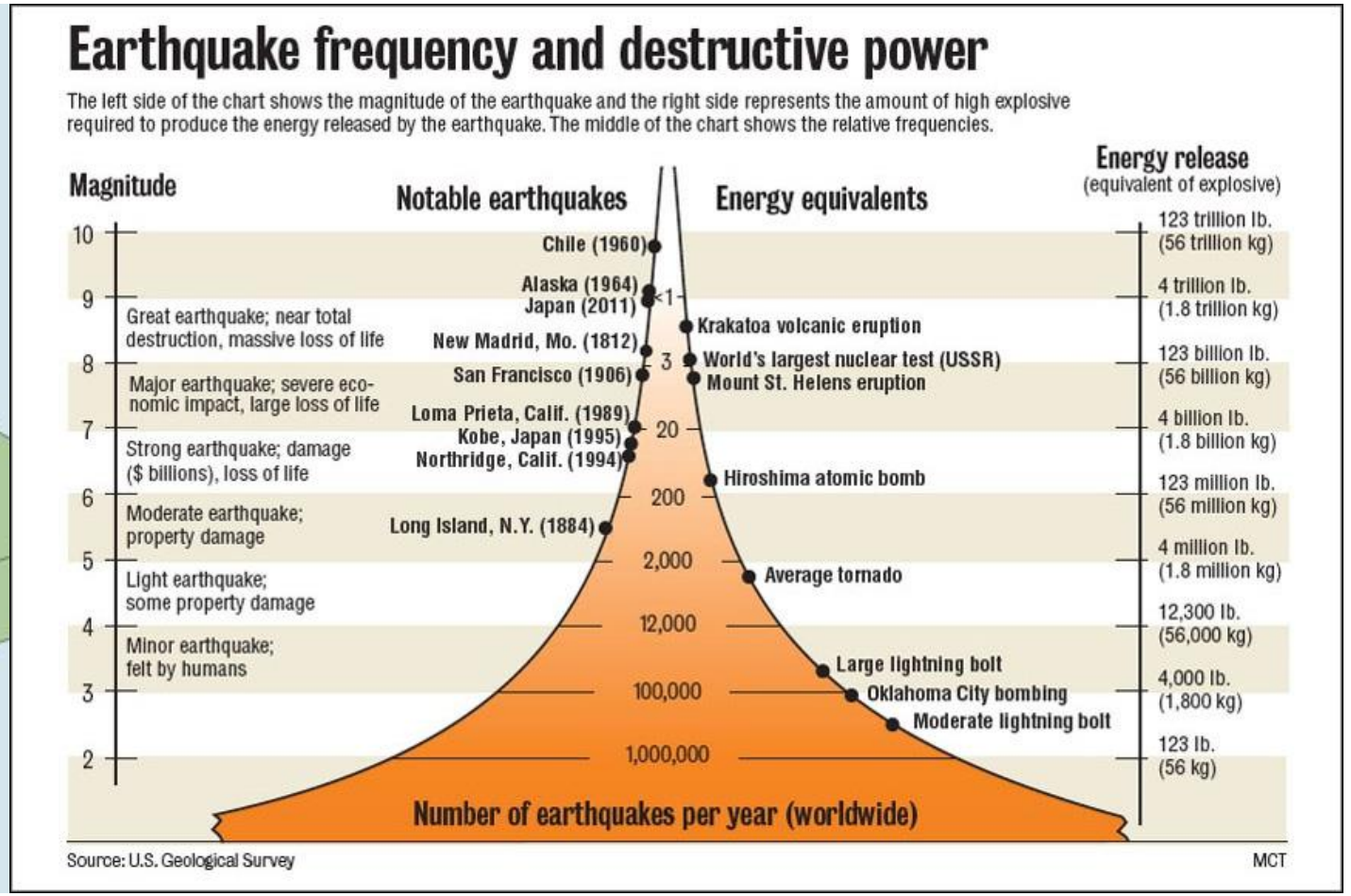
- 1898
- 1906
- 1969
- 2014 Napa

Tectonic Setting

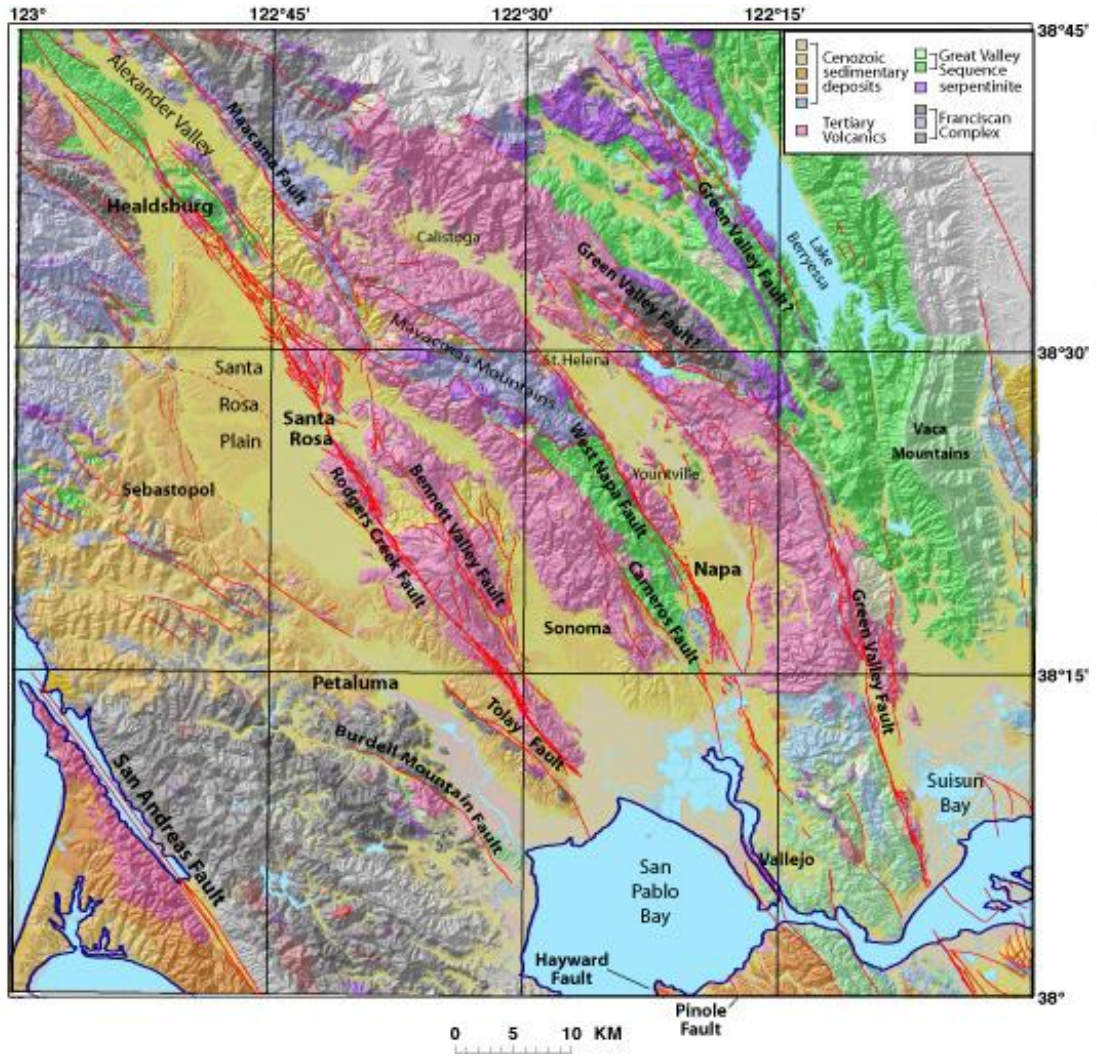


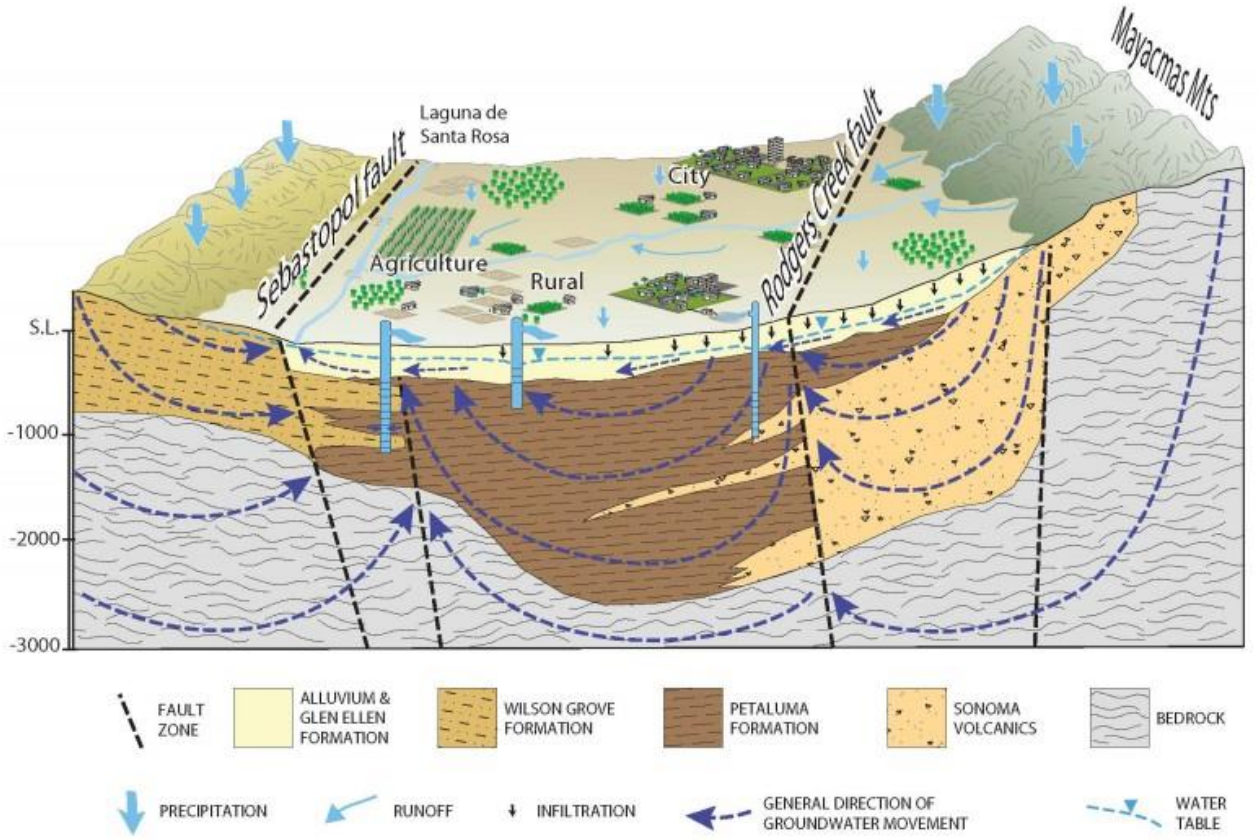
Faulting and Earthquakes





Geologic Structure





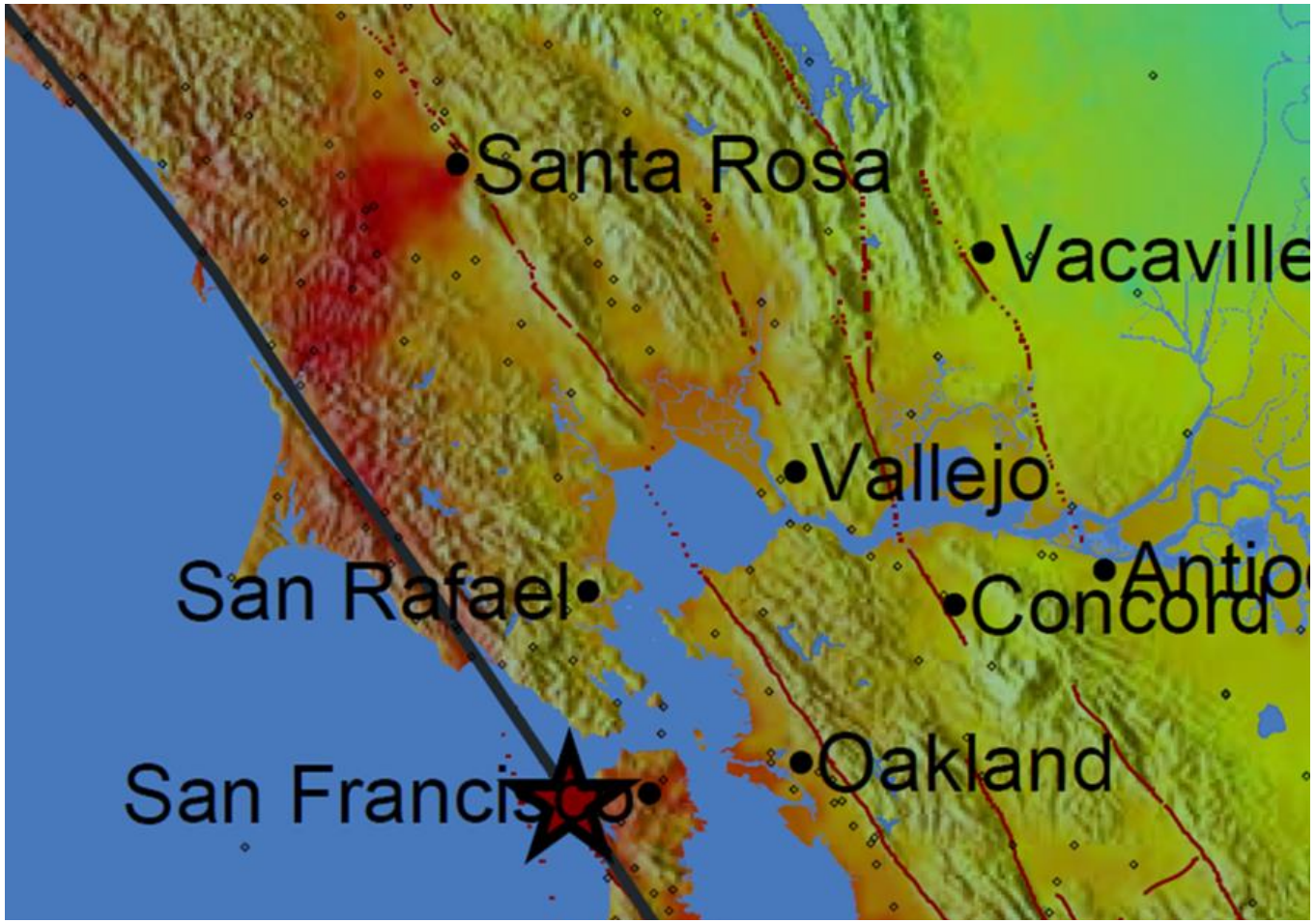
Hydrologic and Geochemical Characterization of the Santa Rosa Plain Watershed, Sonoma County, California
U.S. Geological Survey Scientific Investigations Report 2013-5118

Seismic Hazards

- **Ground shaking**
- Ground failure (liquefaction)
- Seismic induced landslides
- Surface fault rupture

Ground Shaking

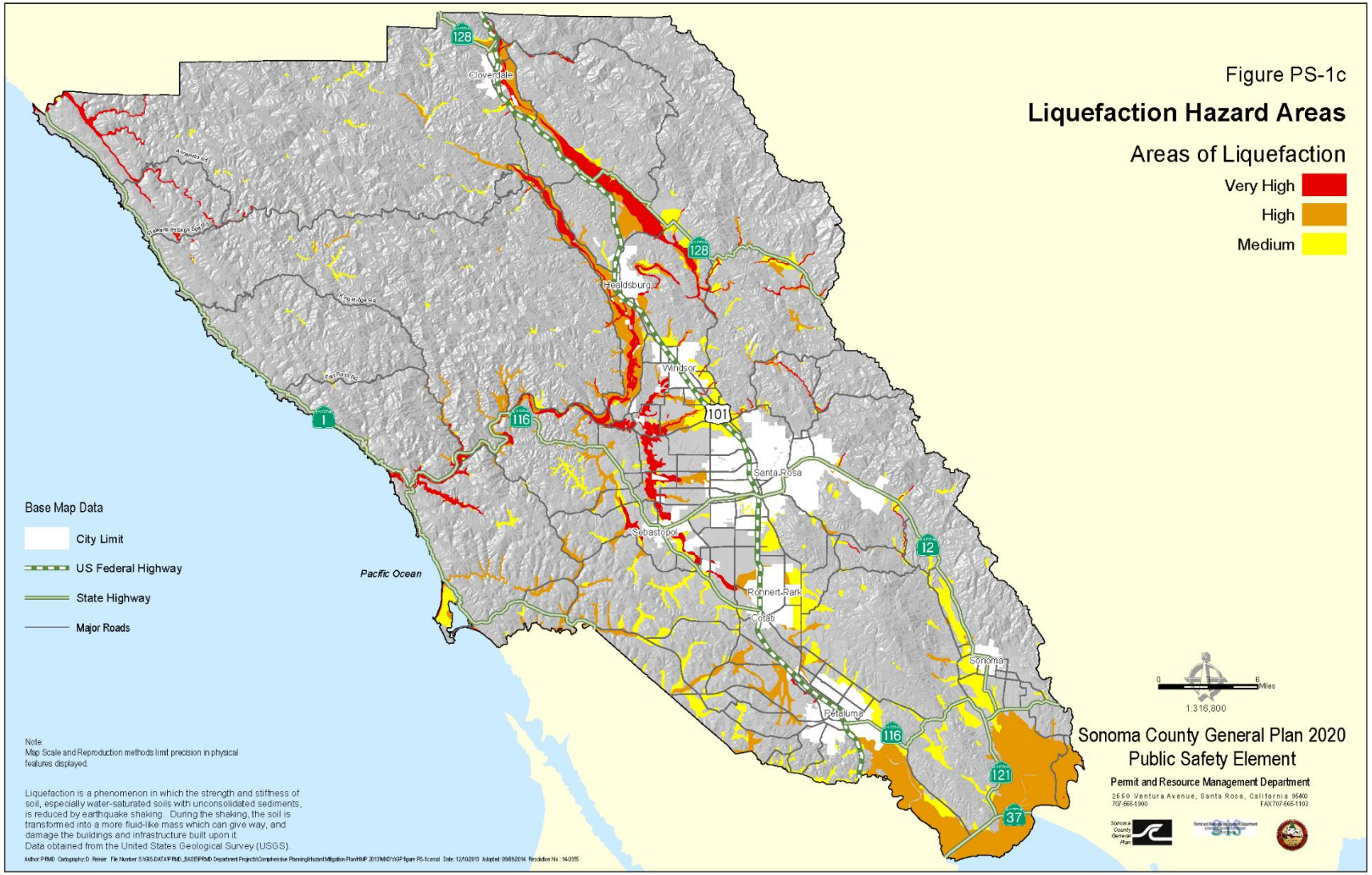
- More intense shaking near the fault rupture
- More intense shaking in areas of unconsolidated sediment
- Amplification in alluvial sediments



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

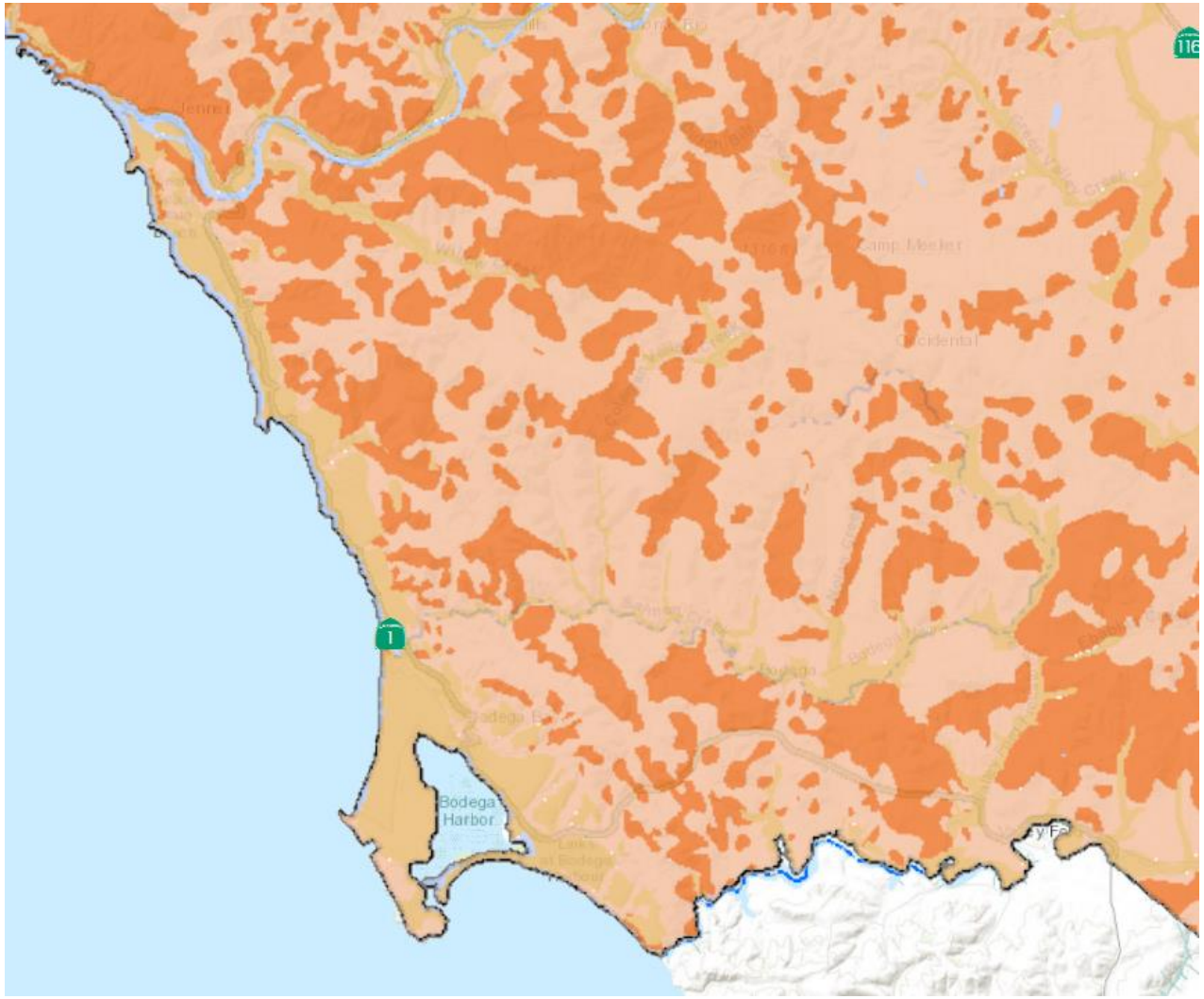
Liquefaction

- Loss of soil strength induced by shaking
- Weak saturated sediments
- Loose sandy soils



Earthquake Induced Landslide

- Areas with existing active or inactive slides
- Hilly terrain
- Saturated conditions

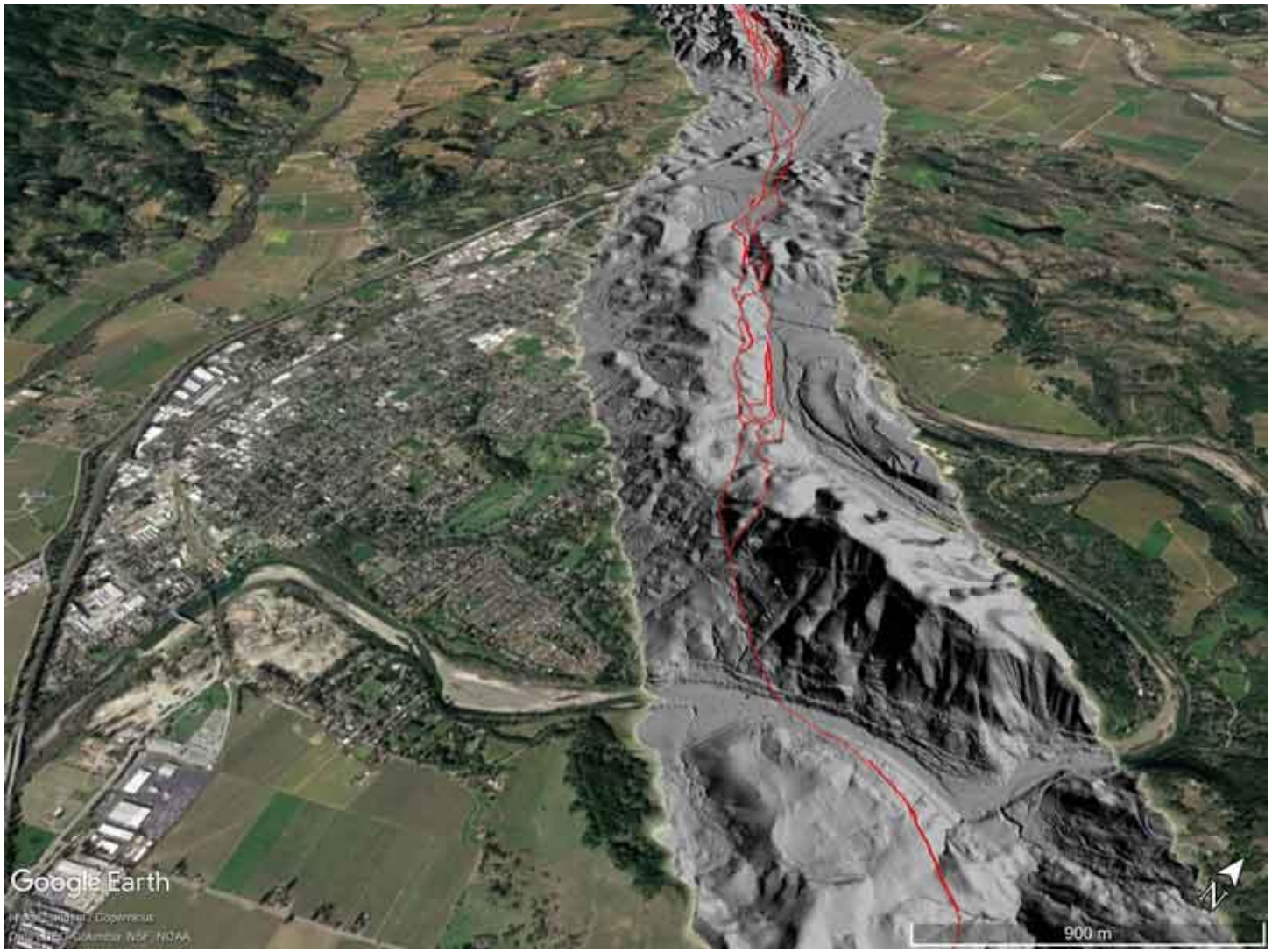


Surface Fault Rupture

- Limited to earthquake fault zones
- Most easily avoided seismic hazard
- Relatively low density near faults (County jurisdiction)

Recent Research of the Rodgers Creek Fault

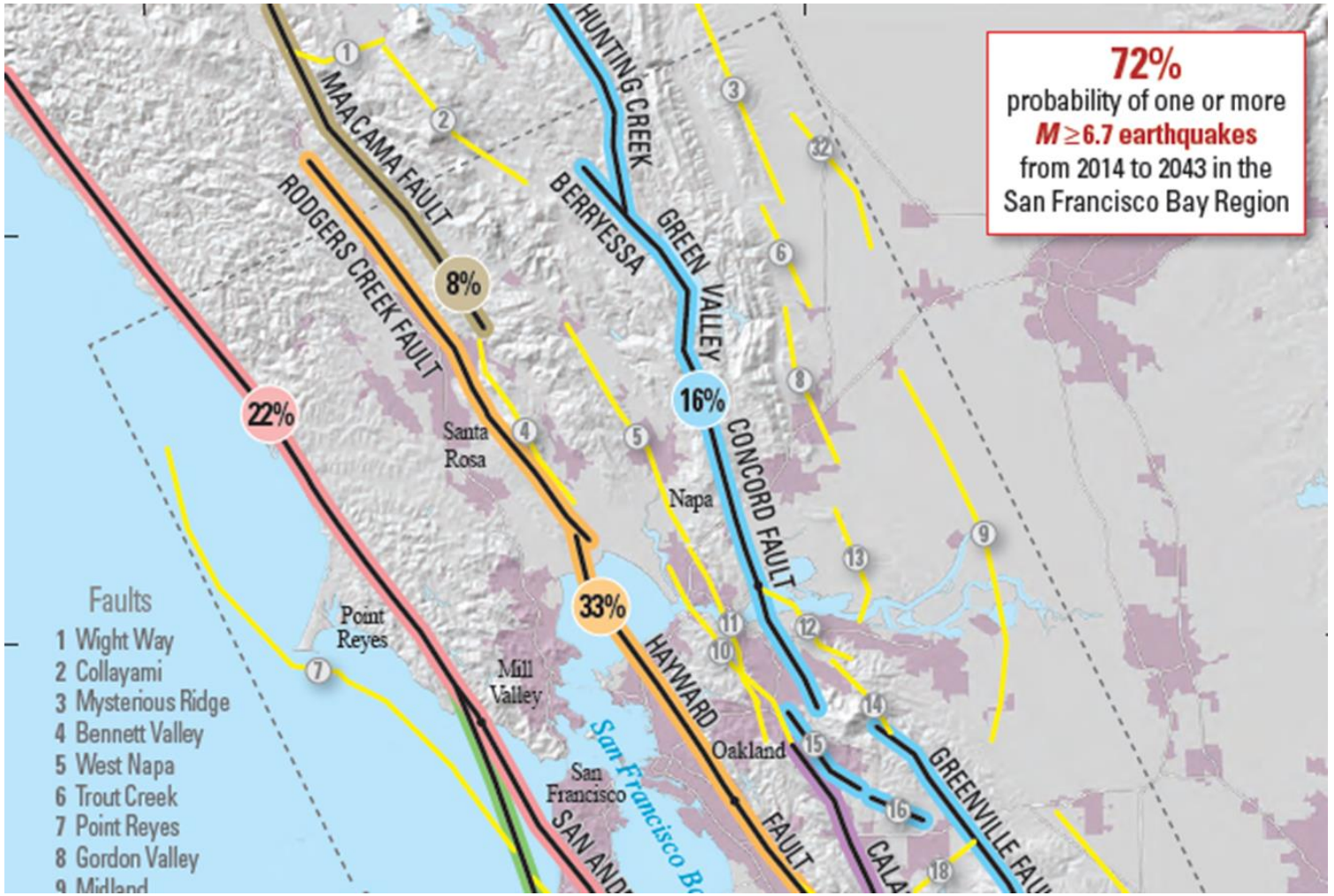
- Fault Zone is wider, longer and more complex
- Rodgers Creek and Hayward Faults connect beneath San Pablo Bay
- Rodgers Creek fault is creeping north of Santa Rosa

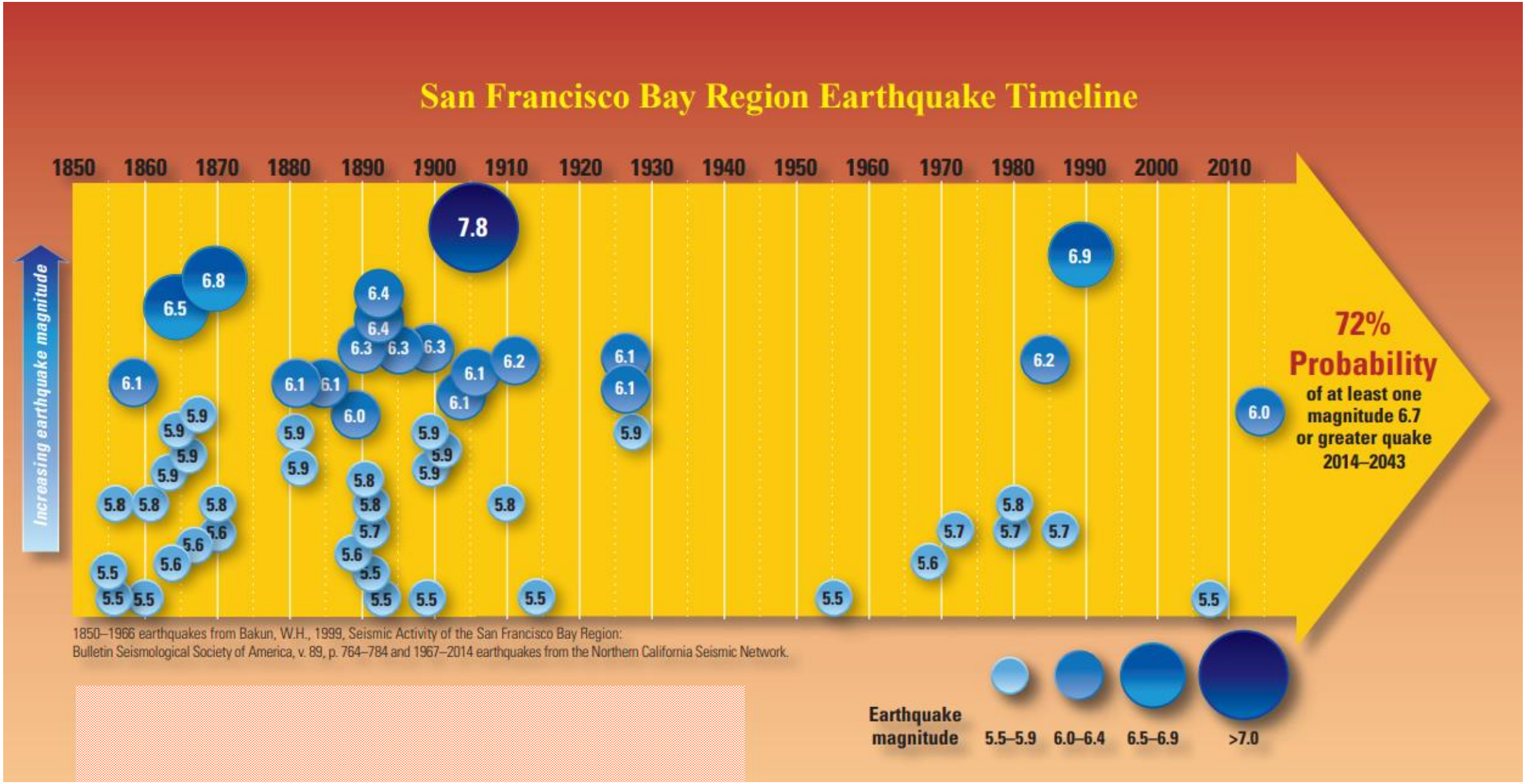


Earthquake Probability

Rodgers Creek Fault

- Highest probability
- Highest hazard




San Francisco Bay Region Earthquake Timeline
1850 1860 1870 1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010
Increasing earthquake magnitude
72%
Probability
of at least one
magnitude 6.7
or greater quake
2014–2043
1850–1966 earthquakes from Bakun, W.H., 1999, Seismic Activity of the San Francisco Bay Region:
Bulletin Seismological Society of America, v. 89, p. 764–784 and 1967–2014 earthquakes from the Northern California Seismic Network.
Earthquake magnitude
5.5–5.9
6.0–6.4
6.5–6.9
>7.0

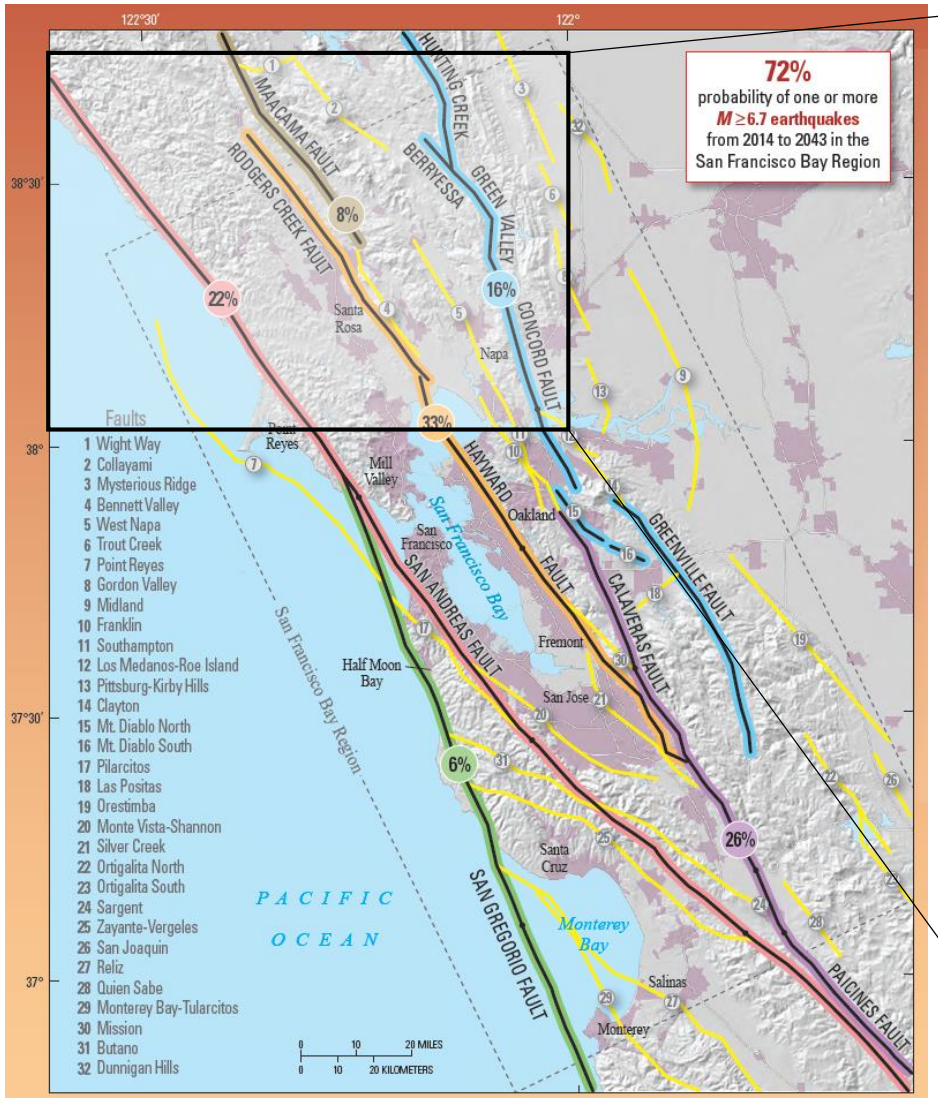
Earthquake Fault Zoning and Seismic Hazard Zoning for Sonoma County

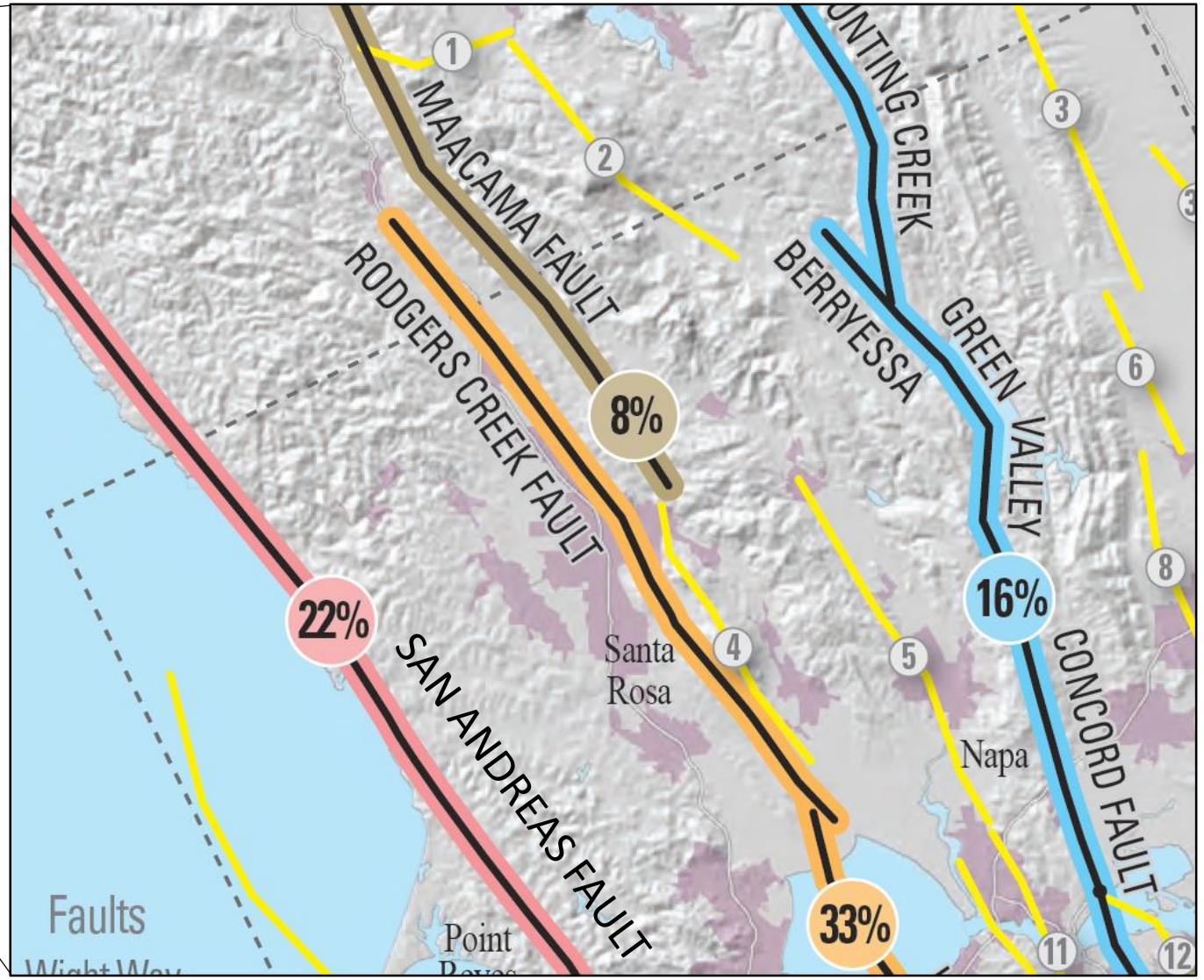
Outline

- Earthquake Fault and Seismic Hazard Zones Overview
- In Progress Alquist-Priolo (A-P) Earthquake Fault Zoning Evaluations
- Planned Seismic Hazard Zones

Tim Dawson
Senior Engineering Geologist
California Geological Survey

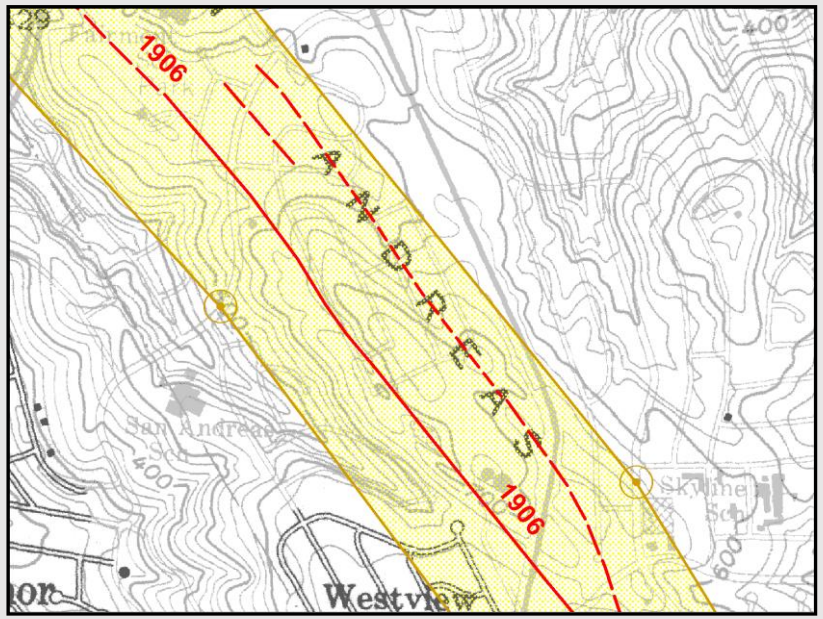
Seismic Hazards in Sonoma County





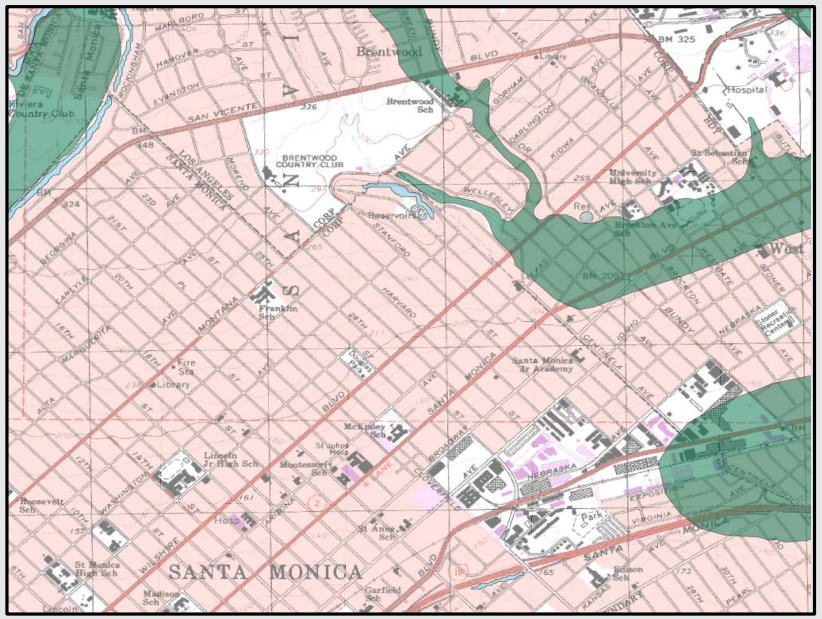
Seismic Ground Failure Zonation

Alquist-Priolo Earthquake Fault Zoning Act of 1972



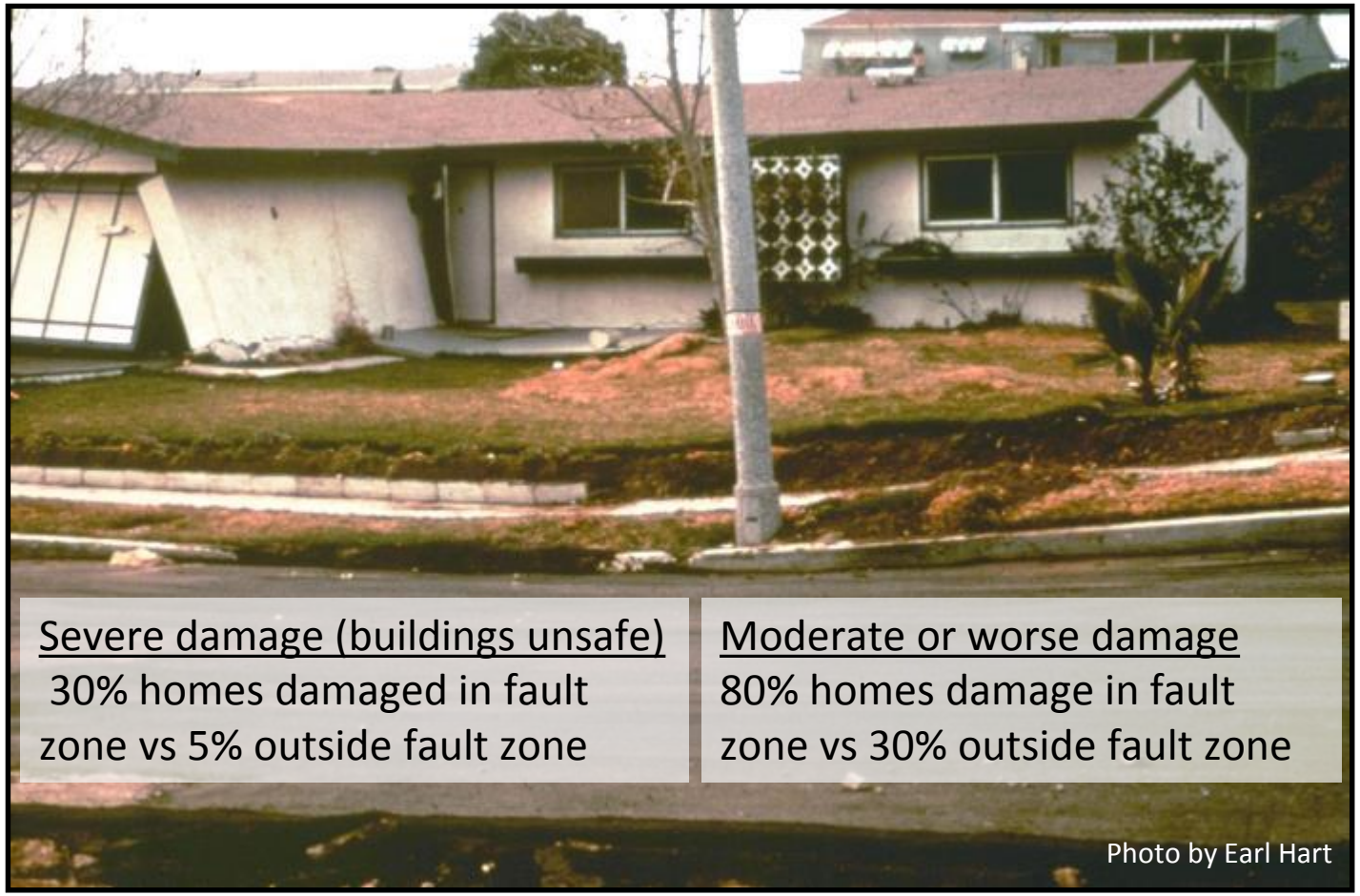
Surface fault rupture

Seismic Hazards Mapping Act of 1990



Liquefaction and seismically-induced landslides

1971 Mw 6.6 San Fernando earthquake fault rupture



Lessons: 1.) Damage localized near fault zones

2.) Fault location could have been identified had studies been conducted prior to the earthquake. (Yerkes, 1973)

The intent of the A-P Act is to prohibit building structures for human occupancy across the trace of an active fault, thus avoiding the hazard of surface fault rupture.

1992 Mw 7.3 Landers Earthquake

Photo by W. Bryant

1999 Mw 7.4 Izmit (Turkey) Earthquake

Photo by T. Dawson

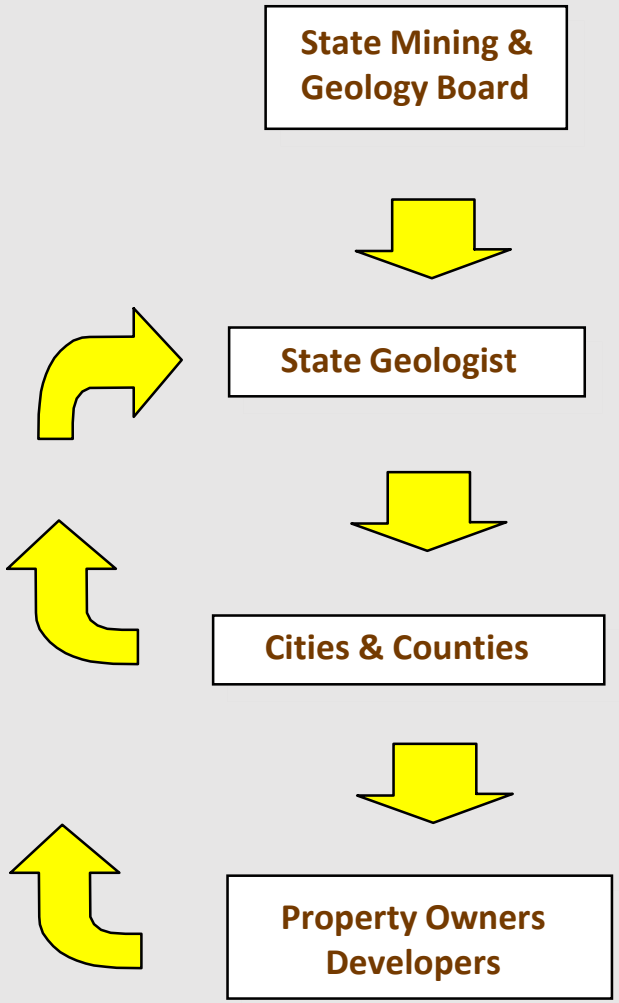
1999 Chi Chi (Taiwan) Earthquake

Photo by K. Kelson

2016 Kaikoura Earthquake

GNS Science

A-P Act: Roles and Responsibilities



- Establishes Policies and Criteria
- Receives Review Comments
- Provides Technical Advice

  - Evaluates Faults
  - Designates Earthquake Fault Zones
  - Approves Waivers
  - Provides Advisory Services

  - Updates General Plans
  - Requires Site Investigations
  - Reviews and Approves Projects
  - Applies for Waivers

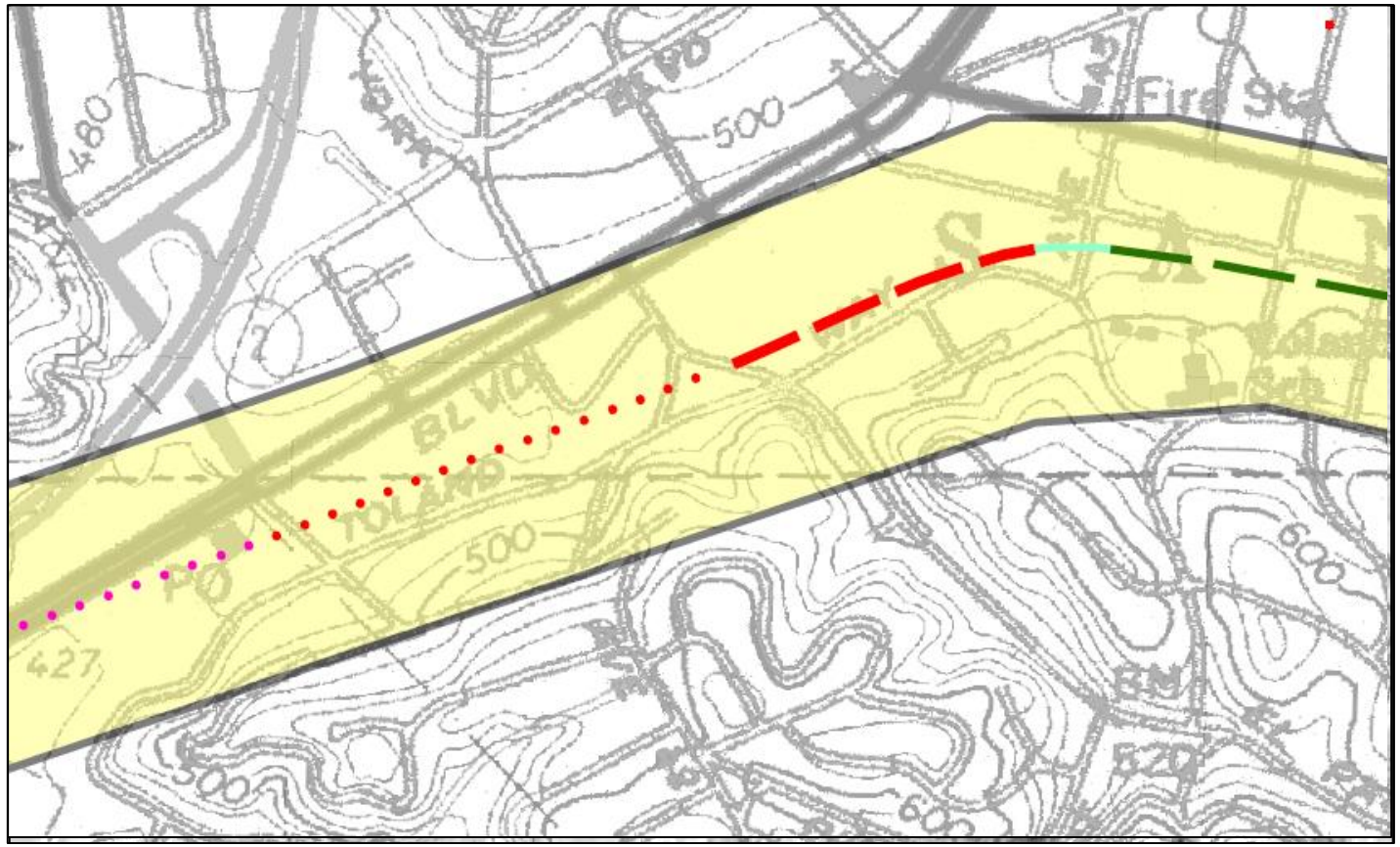
- Determines if Hazard Present
- Avoids Hazard
- Discloses during property transactions

California Geological Survey Fault Evaluations

AP Act directs State Geologist to establish Earthquake Fault Zones [CPR § 2622.(a)] encompassing … *faults…the State Geologist determines to be sufficiently active and well-defined.*

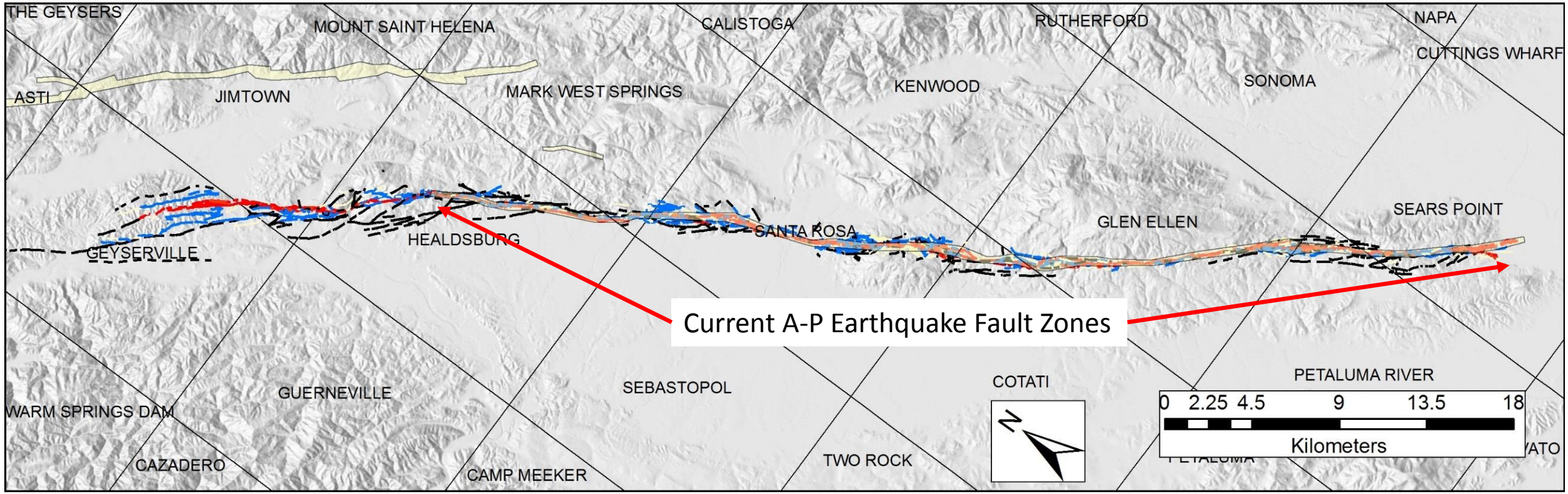
Fault Evaluations conducted using:

- Published literature and geologic mapping
- Original geomorphic mapping from aerial imagery, lidar, field reconnaissance
- Site-specific fault and geotechnical investigations
- Other available sub-surface data including groundwater observations and geophysics



Data synthesized to provide scale-appropriate fault trace(s) that EFZs (~1000 feet wide) surround

Rodgers Creek – Healdsburg Fault Zone



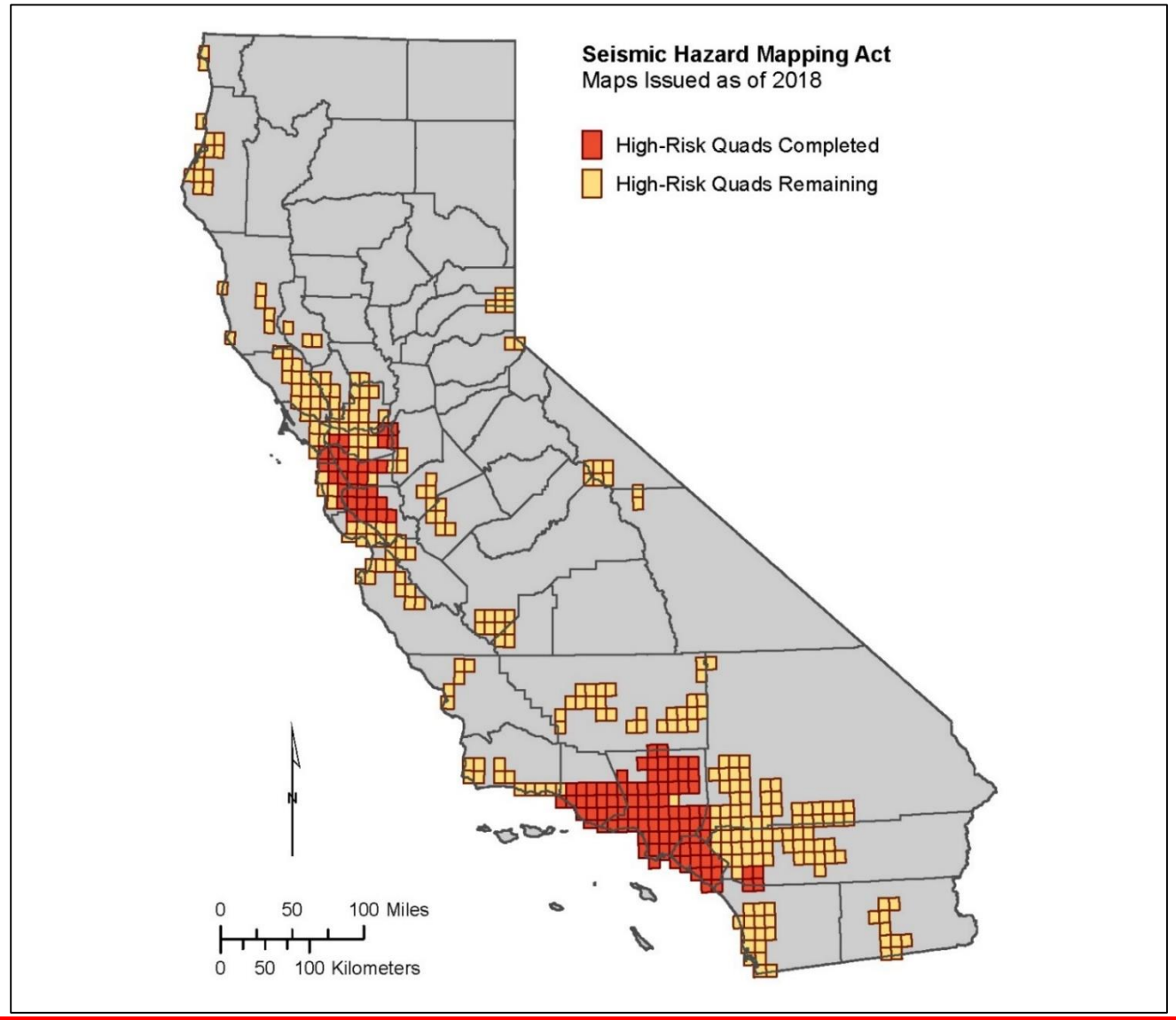
Other Seismic Hazards: Liquefaction and EQ-induced Landsldies

1989 Loma Prieta Earthquake

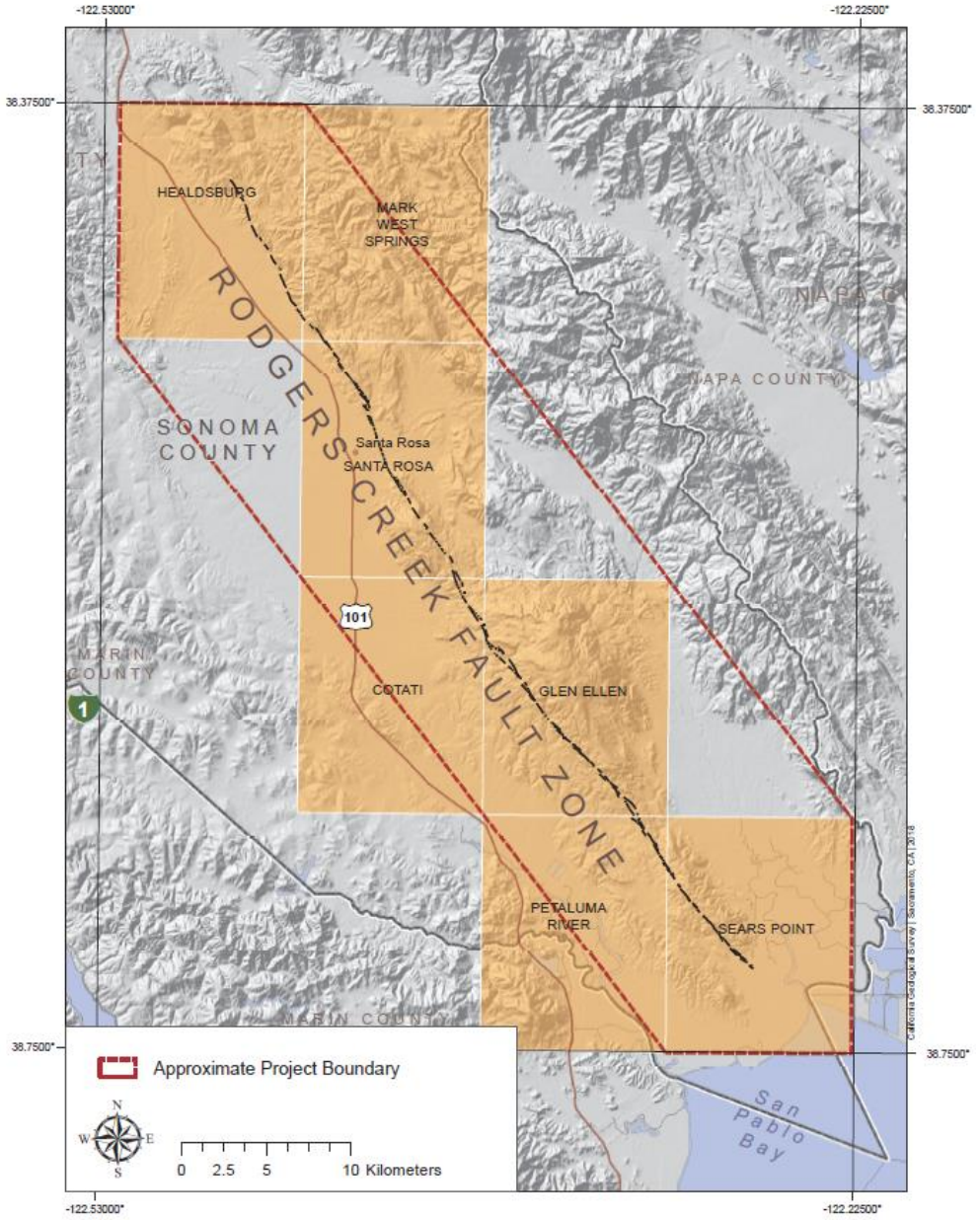
Statewide LQ/LS Zoning Priority and Progress

Zoning priorities based on:

- Areas of high ground motion
- High population density
- Areas with development pressure



Sonoma County
Seismic Hazards Zoning Priorities (Liquefaction and EQ-induced Landslides)



Seismic Hazards Mapping Act Guidance Documents

Special Publication 118

SPECIAL PUBLICATION 118

RECOMMENDED CRITERIA FOR
DELINEATING
SEISMIC HAZARD ZONES
IN CALIFORNIA

May 1992
Revised April 2004

CALIFORNIA CONSERVATION

THE RESOURCES AGENCY
MICHAEL CHRISMAN
SECRETARY FOR RESOURCES

STATE OF CALIFORNIA
ARNOLD SCHWARZENEGGER
GOVERNOR

DEPARTMENT OF CONSERVATION
DARRYL YOUNG
DIRECTOR

Special Publication 117

CGS
CALIFORNIA GEOLOGICAL SURVEY

SPECIAL PUBLICATION 117A

GUIDELINES FOR
EVALUATING AND MITIGATING
SEISMIC HAZARDS
IN CALIFORNIA

2008

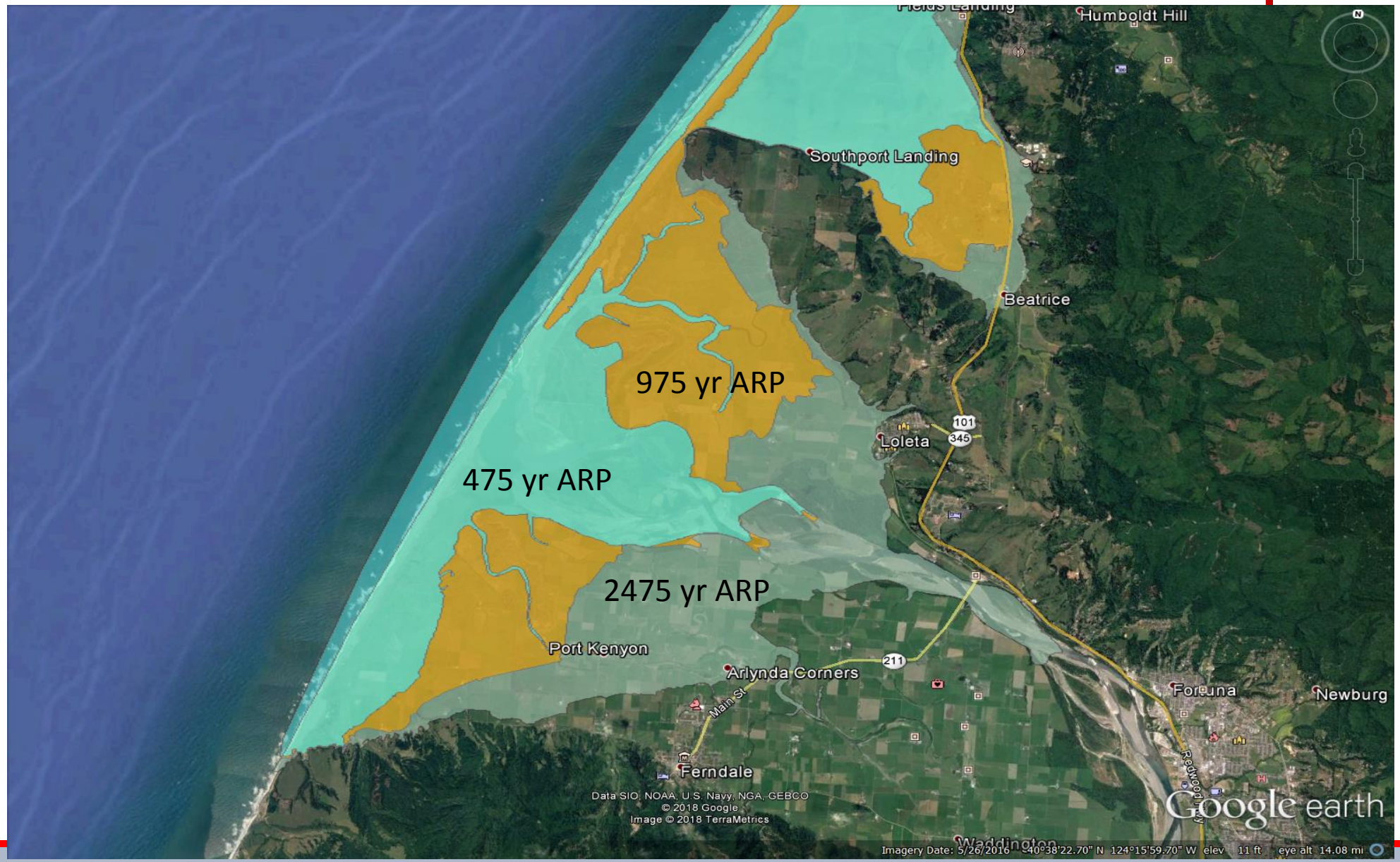
THE RESOURCES AGENCY
MIKE CHRISMAN
SECRETARY FOR RESOURCES

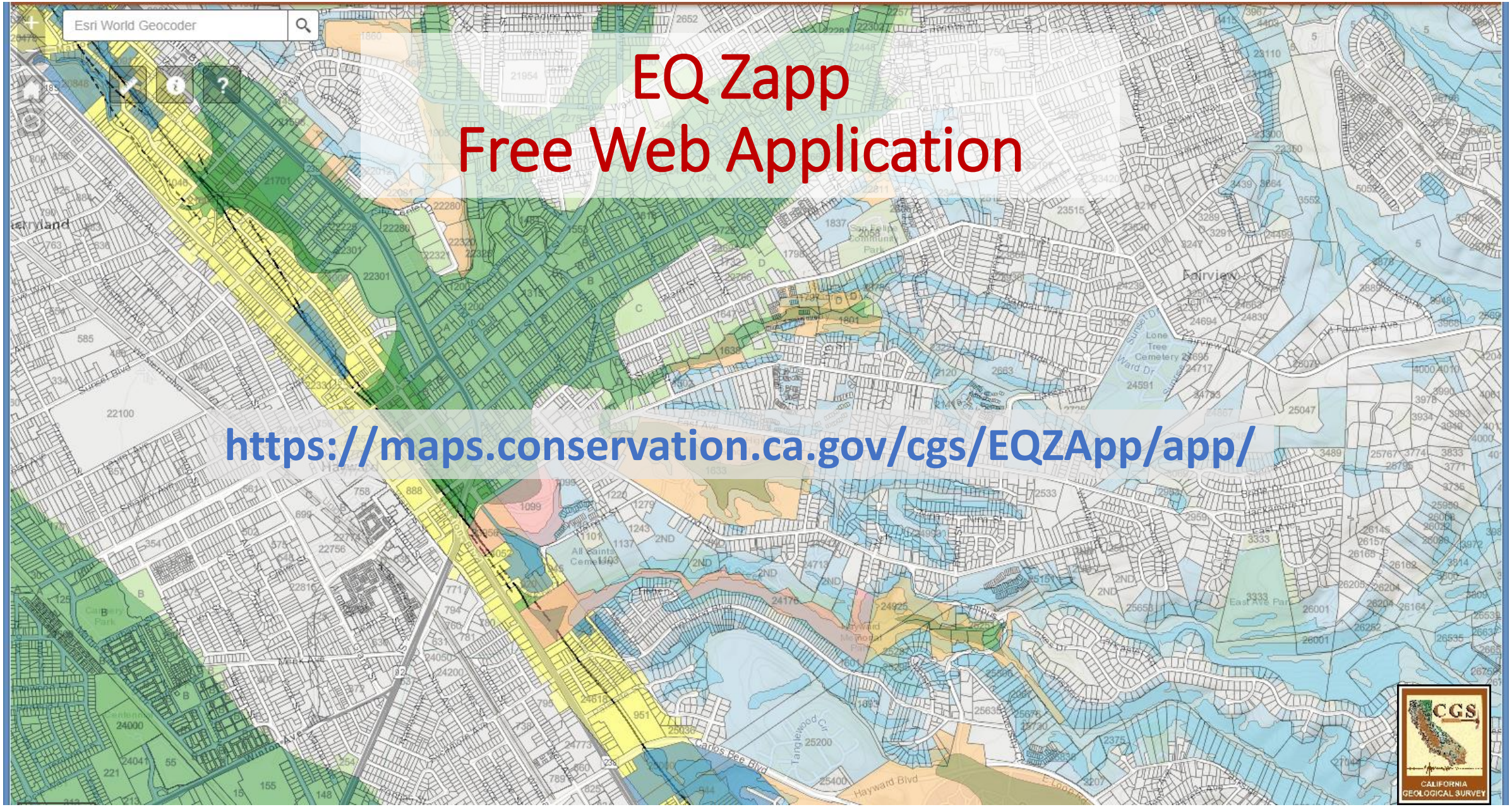
STATE OF CALIFORNIA
ARNOLD SCHWARZENEGGER
GOVERNOR

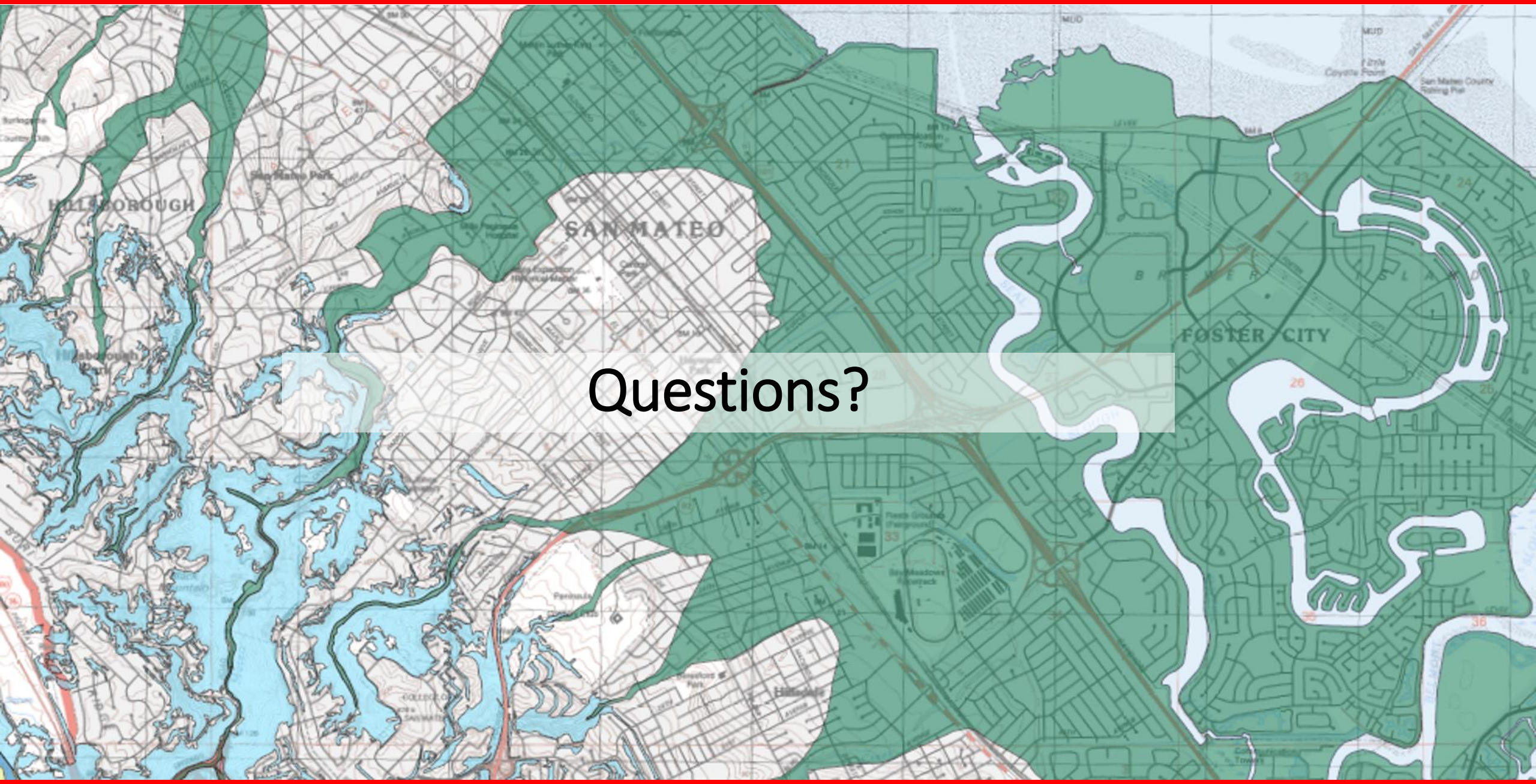
DEPARTMENT OF CONSERVATION
BRIDGETT LUTHER
DIRECTOR

COMING SOON TO A COASTAL COMMUNITY NEAR YOU

Probabilistic Tsunami Inundation Maps




Esri World Geocoder
EQ Zapp
Free Web Application
https://maps.conservation.ca.gov/cgs/EQZApp/app/
CGS
CALIFORNIA GEOLOGICAL SURVEY

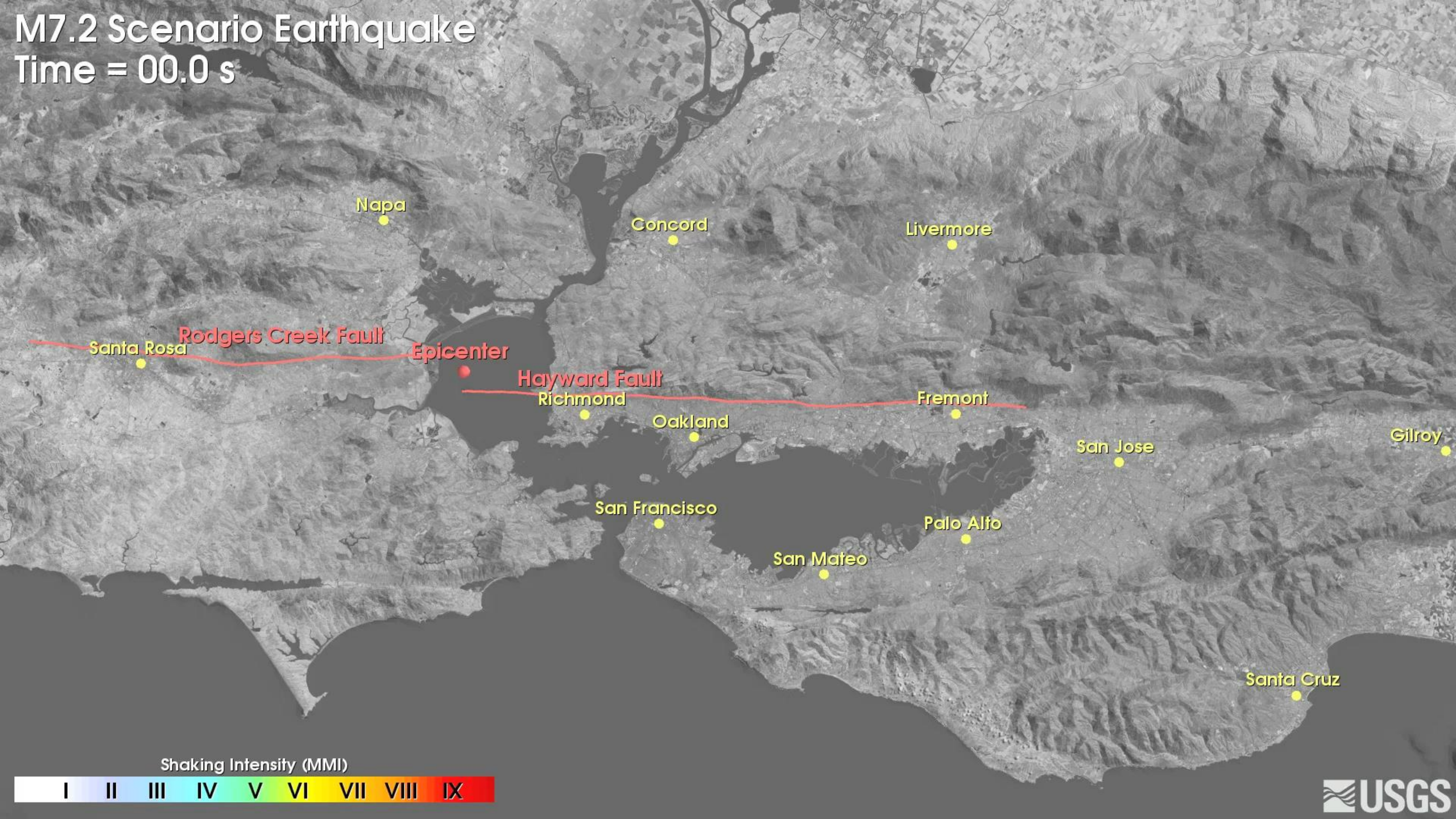


Questions?

Estimated Impacts and Losses

- Modeling
- Multiple scenarios
- Impact variables

M7.2 Roger's Creek


M7.2 Scenario Earthquake
Time = 00.0 s
Napa
Concord
Livermore
Rodgers Creek Fault
Santa Rosa
Epicenter
Hayward Fault
Richmond
Fremont
Oakland
San Jose
Gilroy
San Francisco
Palo Alto
San Mateo
Santa Cruz
Shaking Intensity (MMI)
I II III IV V VI VII VIII IX
USGS

Estimated Impacts and Losses

- 42 deaths
- 972 injuries
- Structures with moderate to complete damage:
  - 11,000 single family homes w/
  - 11,400 multi-residential units damaged
  - 3,600 commercial
- Thousands w/o power or water for days/weeks
- $565M loss in income
- $3B in capital stock losses
- Other

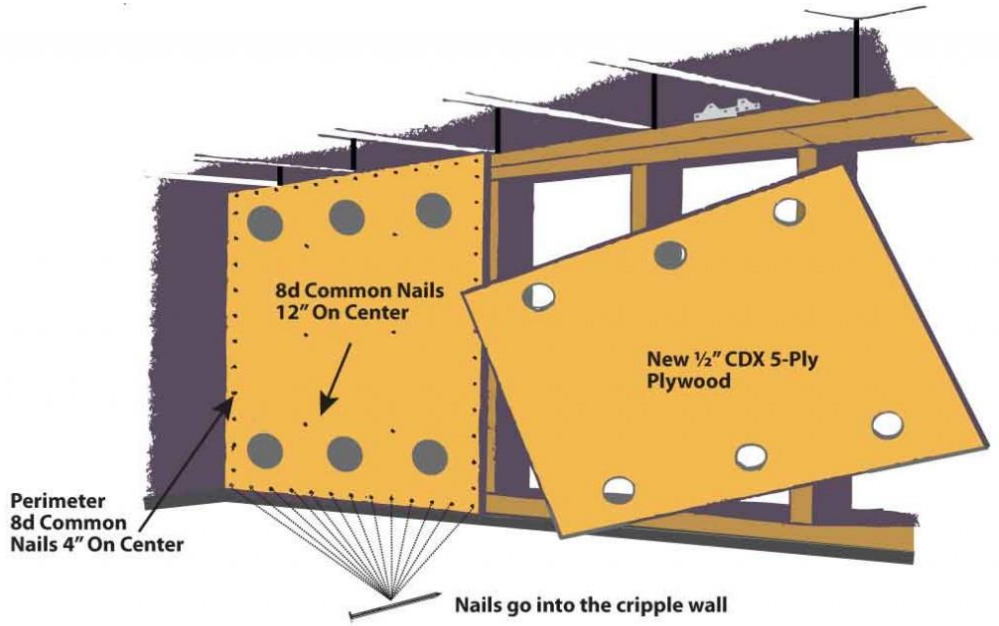
Mitigation

Mitigation: Current Efforts

- Alquist-Priolo Exclusion Zone
- California Building Code

Mitigation: Potential Future Efforts

- FEMA Retrofit Grant
- Unreinforced Masonry (URM) Buildings Ordinance

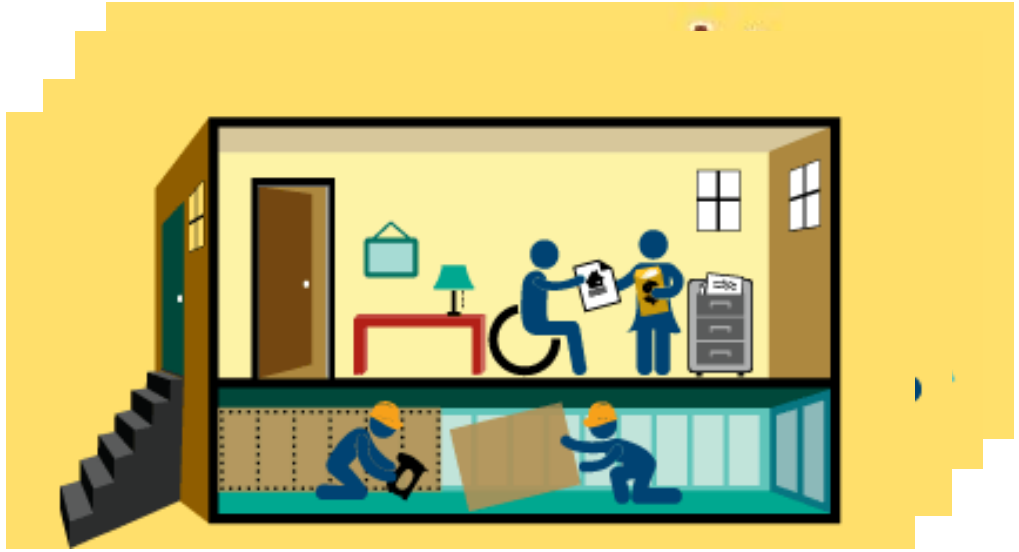


California Seismic Safety Commission

Preparedness

Community Preparedness

- Secure your space
- Plan to be safe
- Organize disaster supplies
- Minimize financial hardship



SoCoEmergency.org

Preparedness Activities

- Planning
- Training
- Exercises

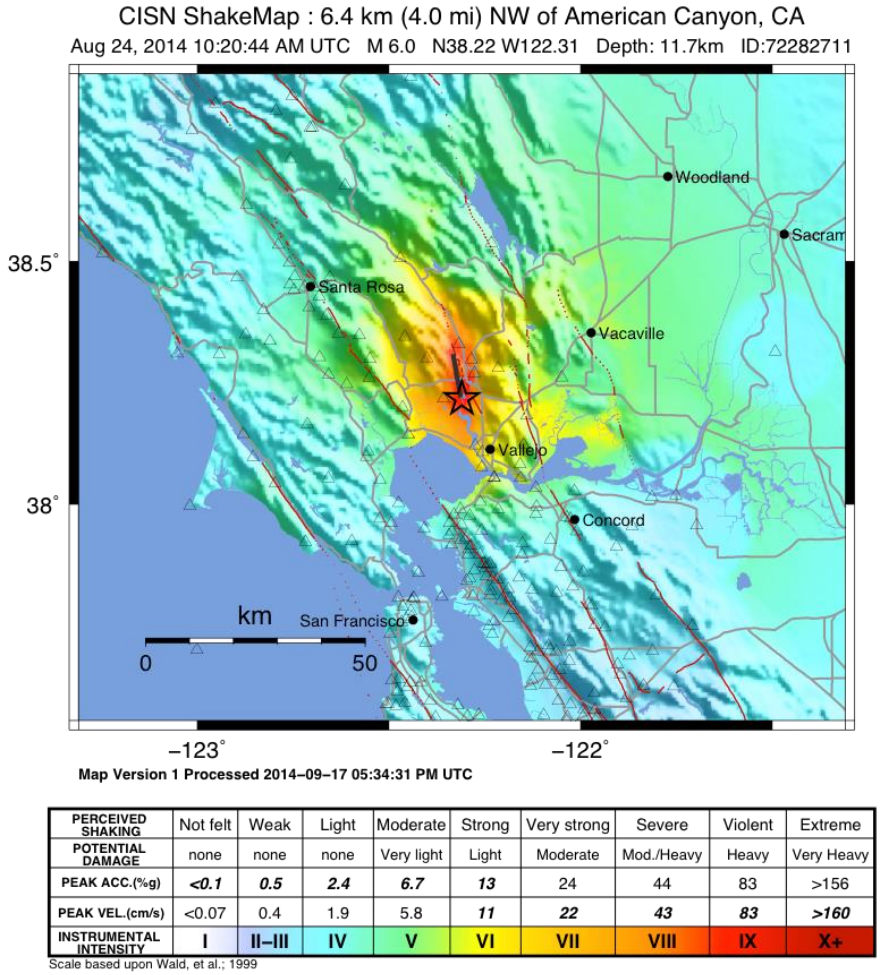
Recovery Framework Initiatives

- Community awareness
- Hardening infrastructure
- Alert & Warning program
- Enhance 2-1-1 system

Response

Situational Awareness: Seismic events

- USGS
  - ShakeMap
  - ShakeCast
- HAZUS



Response Plans

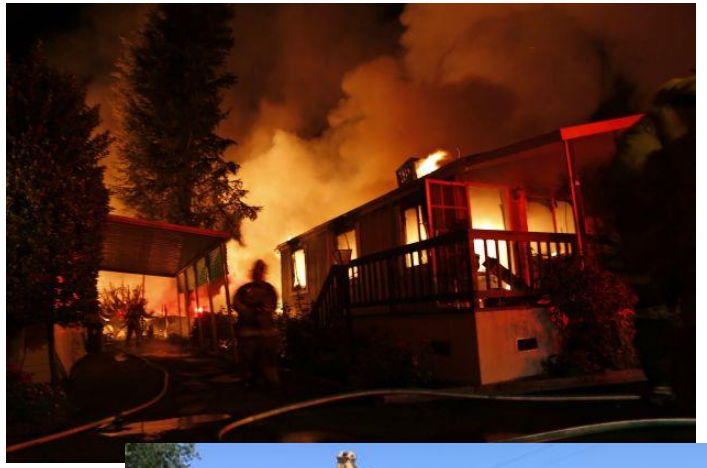
- Emergency Operations Plan (EOP)
- State/Federal Bay Area Catastrophic EQ

Response Coordination

- Multi-Disciplinary
- Multi-Jurisdictional
- Operational Area
- Regional / State

Response Resources/Activities

- Fire Agencies / EMS
- Law Enforcement
- Transportation & Public Works
- Utilities
- Human Services
- Health Services



Chronicle / Mark Costantini

Response Resources

- Emergency Contracting Procedures
- County Supervisors Engagement

Short-Term Recovery

- Safety Assessment
- Debris Management
  - Disaster Debris Management Plan

Questions/Discussion