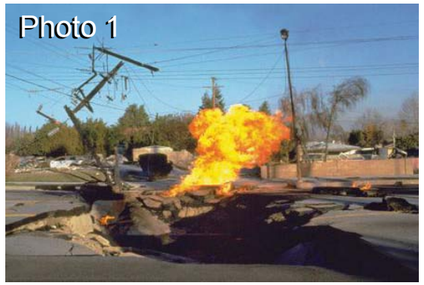
EARTHQUAKE-INDUCED GROUND FAILURE HAZARDS

Liquefaction—*as a geologic term, refers to the loss of strength of saturated soils during shaking. An earthquake can cause soil particles to shift and become buoyant, as pore spaces fill with water, weakening the ability of a soil to support structures on the surface. As shown in Photo 1, liquefaction caused damage to gas, water, and power utility lines in the San Fernando Valley during the 1994 Northridge Earthquake (Photo 1 from the U.S. Geological Survey).*



Surface rupture—*occurs when movement on a fault deep within the earth breaks through to the surface. Fault rupture almost always follows pre-existing faults, which are zones of weakness. Rupture may occur suddenly during an earthquake or slowly in the form of fault creep. Sudden ruptures are more damaging to structures because they are accompanied by shaking. As shown in Photo 3, there was over a meter of vertical diplacement of the ground surface caused by rupture of the San Fernando fault zone during the 1971 San Fernando Earthquake (Photo 3 from the U.S. Geological Survey).*

Landslides—*are the downhill movement of ground caused primarily by gravity acting on weakened rock or soil. Slopes are weakened by weathering, erosion, saturation, and the addition of weight in the form of artificial fill, structures, snow, or rock. Landslides that occur during earthquakes typically originate from these steep and weakened slopes. A number of landslides occurred in the coastal bluffs, as shown in Photo 2, and steep mountainous areas in Southern California during the 1994 Northridge Earthquake (Photo 2 by Pamela Irvine, California Geological Survey).*

Seismic Hazards Resources and Earthquake Education Information:

Regulatory Seismic Zonation Maps - www.consrv.ca.gov/cgs/geologic_hazards/regulatory_hazard_zones/index.htm
Earthquake Education Information - www.consrv.ca.gov/cgs/information/EdResCenter.htm

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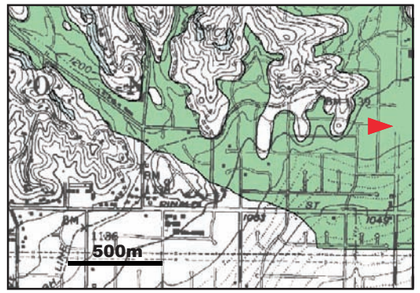
CALIFORNIA GEOLOGICAL SURVEY

REGULATORY EARTHQUAKE HAZARD ZONES

SOUTHERN CALIFORNIA REGION

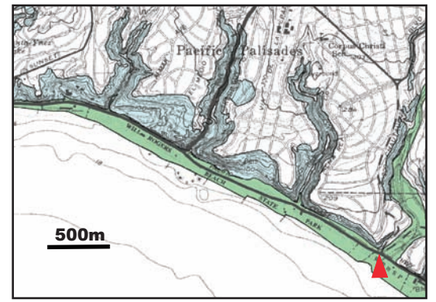
NOTE 54

The California Geological Survey (CGS) establishes zones that delineate areas where ground failure (due to liquefaction, landslides or surface fault rupture) is more likely to increase earthquake damage. (The hazard of strong earthquake shaking is addressed separately by the California Building Code.) These areas are commonly referred to as "Zones of Required Investigation" (**ZORI**). Cities and counties are required by state law to withhold building permits within these zones until geologic/geotechnical investigations are conducted to assess seismic hazards on a site-specific basis. If a liquefaction or earthquake-induced landslide hazard is identified, appropriate design and/or ground improvement measures must be applied in order to reduce the potential for structural failures. More restrictive measures are applied within earthquake fault zones, where proposed structures must avoid being placed across the trace of active faults. In all cases, sellers of real property are required to check seismic zonation maps produced by CGS to determine whether property being sold falls within a seismic hazard zone or earthquake fault zone. The seller is required to provide a "Natural Hazard Disclosure Statement" to the buyer.



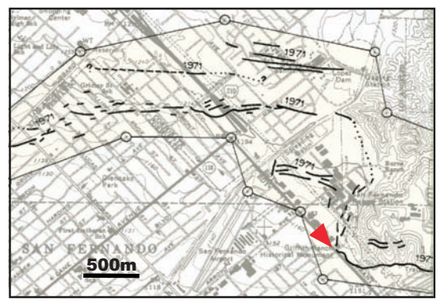
Seismic hazard ZORI for liquefaction (in green) for a portion of the San Fernando Valley (red arrow shows location and view direction of Photo 1 on back page).

CGS geologists delineate liquefaction zones by assessing the engineering behavior of soils based on surface geology and geomorphology, soil properties from subsurface borings, the potential degree of soil saturation, and the potential for such soils to liquefy under estimated levels of ground shaking from future earthquakes. Earthquake-induced landslide zones are based on a similar analysis that also includes mapping locations of existing landslides, and an analysis of rock strength, geologic structure and surface topography in order to assess the stability of slopes under future earthquake shaking. As of October 2007, CGS has released 113 official maps covering about 7,000 square miles. These maps show zones of liquefaction and earthquake-induced landslides. Eighty-eight of the completed maps cover parts of Los Angeles, Orange, Ventura, San Bernardino, and Riverside counties; these seismic hazard maps are compiled into one map inside this CGS Note.



Seismic hazard ZORI for earthquake-induced landslides (in blue) for a portion of Pacific Palisades (red arrow shows location and view direction of Photo 2 on back page).

Earthquake fault zones designated by CGS are delineated on a separate series of maps. CGS geologists place earthquake fault zones along traces of faults where mapping demonstrates surface fault rupture has occurred within the past 11,000 years (Holocene time). Construction within these zones cannot be permitted until a geologic investigation has been conducted to prove that a building planned for human occupancy will not be constructed across an active fault. These types of site evaluations address the precise location and recency of rupture along traces of the faults and typically are based on observations made in trenches excavated across fault traces. As of October 2007, CGS has released 547 official maps statewide.



Earthquake fault ZORI (in pale yellow) for a portion of the San Fernando fault zone that ruptured during the 1971 San Fernando Earthquake (red arrow shows location and view direction of Photo 3 on back page) .

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Seismic Hazard Zonation of Southern California

October 2007

MAP EXPLANATION

Zones of Required Investigation

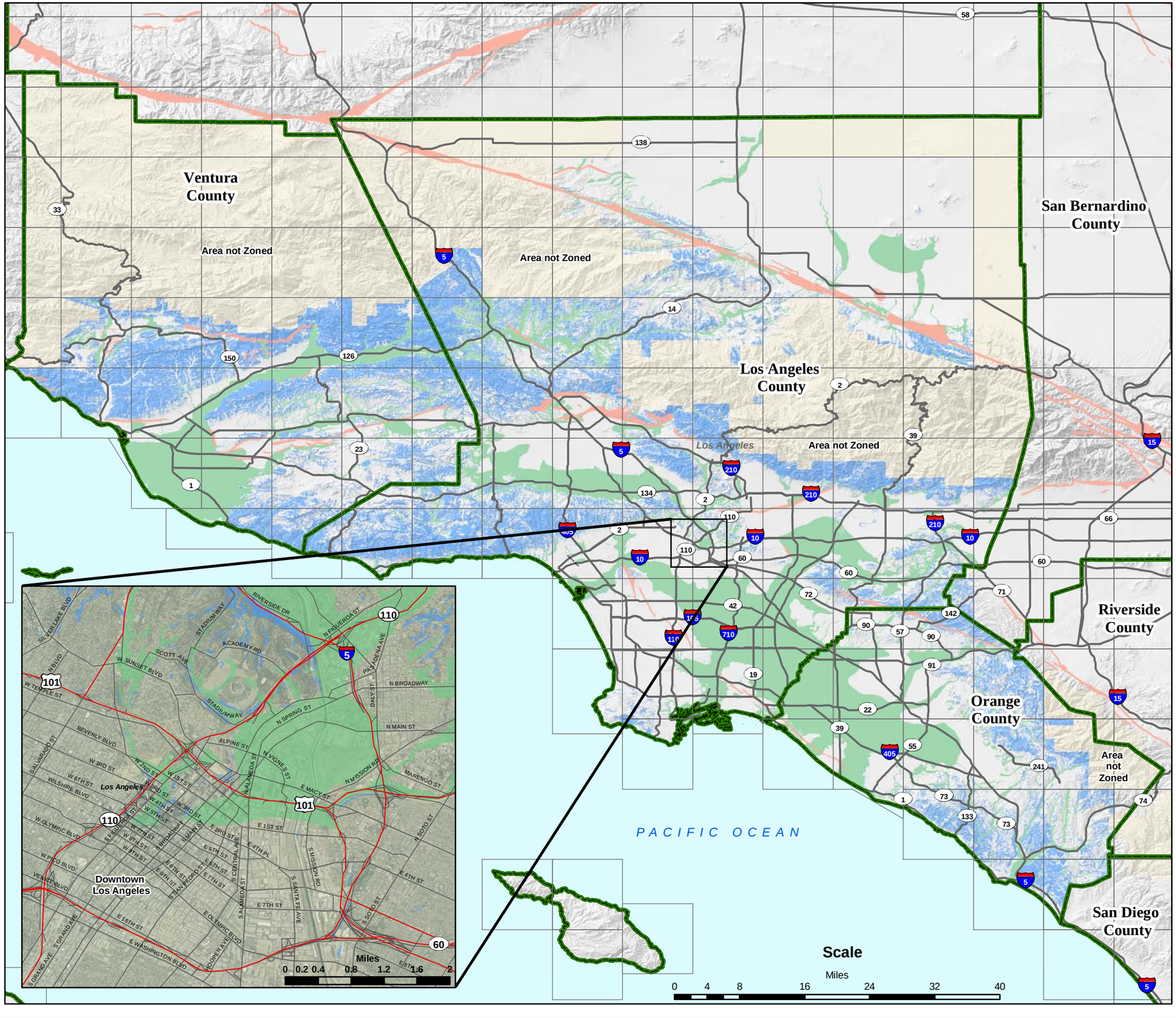
Liquefaction
Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater condtions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Earthquake-Induced Landslides
Areas where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Earthquake Fault Zone
Regulatory zones encompassing active faults wherein fault-rupture hazard investigations are required prior to building structures for human occupancy.

Area Not Zoned
Areas not zoned include land not likely to be developed within the National Forests and other remote areas.

Index Map



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