VENTURA COUNTY GENERAL PLAN

HAZARDS APPENDIX

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Ventura County General Plan
HAZARDS APPENDIX

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2. HAZARDS APPENDIX

2.1 Introduction

The purpose of this appendix is to provide additional background information and technical details regarding individual hazards addressed in the General Plan Goals, Policies and Programs. The physical, social and other effects of the hazards are discussed, and more detailed information is provided regarding the location of hazards zones and areas. Where appropriate, the factors that cause or produce certain hazards are discussed. In the case of geologically related hazards, the tectonic and other geologic forces that produce such hazards are described. Information regarding the local history of specific hazards is included where appropriate, and any pertinent ongoing research is also mentioned. Measures used or recommended for alleviation of individual hazards are also included. In some cases, table and other data, as well as copies of pertinent documents, have also been appended.

The following hazards are discussed in this appendix, in the order shown:

2.2 Fault Rupture

2.3 Ground Shaking

2.4 Liquefaction

2.5 Seiche

2.6 Tsunami

2.7 Landslides/Mudslides

2.8 Subsidence

2.9 Expansive Soils

2.10 Flood Hazard

2.11 Inundation from Dam Failure

2.12 Coastal Wave and Beach Erosion

2.13 Fire Hazards

2.14 Transportation Related Hazards

2.15 Hazardous Materials and Waste

2.16 Noise

2.17 Civil Disturbance

The first five hazards in the above list are so grouped because they all tend to be seismically related, although it should be recognized and understood that some hazards not associated with earthquakes may be triggered or exacerbated by earthquakes.

2.2 Fault Rupture

An earthquake resulting in catastrophic effects, having a magnitude (M) of 8.3 on the south-central San Andreas fault is likely before the end of the twenty-first century and is estimated to have a current annual probability of occurrence between two and five per cent. It is based on a repeat occurrence of the great Ft. Tejon earthquake of January 9, 1857, and other geophysical observations. As geologists know, at least eight major earthquakes have occurred in this area, with an average spacing in time of 140 years, plus or minus 30 years. New faults within the region are continuously being discovered. Scientists have identified almost 100 faults in the Los Angeles area known to be capable of a magnitude 6.0 or greater earthquake. The January 17, 1994 magnitude 6.7 Northridge Earthquake (thrust fault), which produced severe ground motions, caused 57 deaths, 9,253 injuries and left over 20,000 displaced. Scientists have stated that such devastating shaking should be considered the norm near any large thrust earthquake.

Recent reports from scientists of the U.S. Geological Survey and the Southern California Earthquake Center say that the Los Angeles Area could expect one earthquake every year of magnitude 5.0 or more for the foreseeable future.

A major earthquake occurring in or near this jurisdiction may cause many deaths and casualties, extensive property damage, fires and hazardous material spills and other ensuing hazards. The effects could be aggravated by aftershocks and by the secondary affects of fire, hazardous material/chemical accidents and possible failure of the waterways and dams. The time of day and season of the year would have a profound effect on the number of dead and injured and the amount of property damage sustained. Such an earthquake would be catastrophic in its affect upon the population and could exceed the response capabilities of the individual cities, Los Angeles County Operational Area and the State of California Emergency Services. Damage control and disaster relief support would be required from other local governmental and private organizations, and from the state and federal governments.

Extensive search and rescue operations would be required to assist trapped or injured persons. Injured or displaced persons could require emergency medical care, food and temporary shelter. Identification and burial of many dead persons would pose difficult problems; public health would be a major concern. Mass evacuation may be essential to save lives, particularly in areas downwind from hazardous material releases. Many families would be separated particularly if the earthquake should occur during working hours, and a personal inquiry or locator system could be essential to maintain morale. Emergency operations could be seriously hampered by the loss of communications and damage to transportation routes within, and to and from, the disaster area and by the disruption of public utilities and services.

The economic impact on the County of Ventura from a major earthquake would be considerable in terms of loss of employment and loss of tax base. Also, a major earthquake could cause serious damage and/or outage of computer facilities. The loss of such facilities could curtail or seriously disrupt the operations of banks, insurance companies and other elements of the financial community. In turn, this could affect the ability of local government, business and the population to make payments and purchases.

2.2.1 General Effects of the Hazard

Nearly all man-made structures are susceptible to damage ranging from severe to total when affected by displacement along faults passing beneath their foundations. The San Fernando Earthquake of 1971 has shown that no structures designed under present standards are safe from severe damage or destruction as a result of surface fault displacement of foundations. It is widely acknowledged that design of most structures, such as single-family homes or larger structures, roads, bridges, pipelines, or other conduits, to resist fault displacement is generally not feasible. Only massive earth structures such as earth fill dams can be designed to remain functional after several feet of displacement along an underlying fault.

Permanent effects of surface displacement along faults also can include:

1. Abrupt elevation or depression of ground surfaces of several feet for distances of many hundreds of feet along the fault;
2. Disruption of surface drainage;
3. Changes in groundwater levels in wells;
4. Blockage and surface seepage of groundwater flow;
5. Changes in survey benchmark elevations;
6. Dislocations of street alignments and property lines of many feet if lateral (horizontal) displacement also occurs along a fault;
7. Displacement of drainage channels and drains.

Secondary effects of surface displacements along faults within an urban area could include:

1. Disruption of movement along roadways due to abrupt depressions or elevation of pavement surfaces;
2. Possible flooding due to disruption of drainage channel and storm drain flow;
3. Disruption of utility services such as water, gas, fuel, telephone and electric power lines;
4. Temporary impact on industry and commerce similar to that resulting from the occurrence of most kinds of regional natural catastrophic events such as hurricanes or floods.

2.2.2 General Inventory of the Hazard

The State Division of Mines and Geology (CDMG)[1] indicates that on a statewide basis the potential hazard to structures from the surface displacement of faults is low compared to other geologic phenomena such as earthquake ground shaking and landslides (*Urban Geology Master Plan for California*, 1973, Bull. 198).

Although questions remain regarding distributed, aseismic deformation, moment balance and slip rate calculations indicate that most of the motion in the upper 15 kilometers of the Southern California plate boundary zone occurs as earthquakes on active faults (Stein, R.S. & Hanks, T.C., 1999). Major structural losses due to fault displacement within Southern California occurred during the San Fernando Earthquake of 1971. As a result of these losses, the enactment of the Alquist-Priolo Earthquake Fault Zoning Act occurred in 1972. Structural losses due to fault displacement in other major earthquakes in California are unknown but were probably small. Most of the losses incurred during the 1994 Northridge earthquake were a result of ground shaking. The Northridge earthquake was a surprise to geologists in two ways: first, it occurred on a previously unknown thrust fault and second, it produced virtually no surface rupture.

The greatest potential for fault rupture is along any of the active faults that lie within the several major fault systems that transect Ventura County from east to west. The 1971 San Fernando Earthquake and the previously unknown blind thrust fault responsible for the 1994 Northridge earthquake occurred along two of these major fault systems and illustrate the high level of activity that some faults within these systems may have, and they also suggest a potential for the occurrence for other such earthquakes in the Los Angeles and Ventura regions.

The San Fernando earthquake of 1971 is an example of the typical surface rupture that could occur along some of the east-west trending faults that transect Ventura County. It is most likely that surface fault displacement within the County will be sudden, occurring in less than one minute. The surface displacement would be accompanied by severe ground shaking lasting perhaps several tens of seconds.

[1] The CDMG has recently changed its name to the California Geological Survey (CGS) and for the purposes of this appendix CDMG and CGS are the same State Agency and references to CDMG and CGS are dependent on the date of the reference relative to the name change date.

The Northridge earthquake of 1994 resulted in a different type of surface rupture resulting from ground deformation. Blind thrust faults, so-called because they lack surface fault rupture, may be accompanied by fault-propagation folds or fault-bend folds. Fault-propagation folds are folds within the rock that are caused by the growth of buried fault(s) toward the surface. Fault-bend folds are folds within the rock that are caused by the change in inclination of the fault surface. Blind thrust faults have gained recognition as damaging earthquake sources within the Southern California region since the 1987 Whittier Narrows earthquake and have been highlighted by the 1994 Northridge earthquake.

Many of the faults in the County are associated with major fault systems extending beyond County boundaries. For example, the recent 1994 Northridge earthquake in the San Fernando Valley, Los Angeles County, is interpreted to be an eastward continuation of the Oakridge Fault from the Ventura Basin. The Ventura Basin is considered a large syncline (trough) that extends east-west, from the San Gabriel Mountains to the Pacific Ocean. The portion of the basin east of the San Gabriel Fault is referred to as the Soledad Basin. The Ventura Basin is geologically noted for a remarkably thick section of marine sedimentary rocks that total more than 58,000 feet. The axis of the trough generally coincides with the Santa Clara River valley and the offshore Santa Barbara Channel. The northern boundary of the basin is the Santa Ynez Fault and the southern boundary is the Simi Hills, Mountclef Ridge, and along the western edge of the Santa Monica Mountains into the Pacific Ocean. Several of the fault systems, and blind thrust systems are considered active, but additional information must be assembled to determine the potential for, as well as the nature of, activity of most of the fault~~s~~ systems within Ventura County.

Unfortunately, the majority of new earthquake information is developed following an earthquake with the coordination of earthquake science in Southern California by several government agencies and the Southern California Earthquake Center (SCEC). These data will provide consistent scientific judgments for public policy decisions in earthquake risk management. The present level of knowledge of the recency of surface or near surface movement along the faults and fault systems within Ventura County does not provide sufficient data on which to base a determination of the "degree" of fault activity. There is some evidence that some of the known faults have displaced at least late Quaternary terrace sediments, indicating possible movement younger than 11,000 years ago. This is the primary basis for designating the faults as “active”, as these could have the higher potential of future surface rupture.

All of the fault designations within the County are subject to change as further evidence is received, providing either clearer proof of potential for activity or convincing geologic evidence of inactivity. The Simi-Santa Rosa, Springville, and Camarillo faults have been zoned as “active” under the State of California Alquist-Priolo Earthquake Fault Zoning Act. The following is a description of the major active and potentially active faults and fault systems within Ventura County (also see Figures 2.2.1a and 2.2.1b).

Malibu Coast Fault System

The Malibu Coast Fault system is considered as the southern boundary of the Transverse Ranges and this fault system includes the Malibu Coast, Santa Monica and Hollywood Faults. This fault system is believed to consist of a series of major north- dipping reverse or thrust faults that extend from offshore along the southern Ventura County coast and onshore in Los Angeles County for a total of over 40 miles and perhaps a much greater distance offshore in the Santa Barbara Channel. It begins in the Hollywood area and extends along the southern base of the Santa Monica Mountains and passes offshore a few miles west of Point Dume.

Geologic evidence for activity of the fault system during recent geologic time up through the present are faulted terrace and near surface sedimentary deposits, and the 1973 Point Mugu earthquake, which is believed to have originated on this fault system.

The fault system is an oblique left lateral reverse fault with a slip rate of 0.1 to 0.5 mm/yr, a potential maximum moment magnitude of 6.7 and a recurrence interval of 2908 years (CGS, 1996). The faults within this system are considered active. This fault is zoned by the State of California as active and details pertaining to the fault designation may be obtained by reviewing the State of

California Division of Mines and Geology, Fault Evaluation Report FER 229 (Treiman, 1994) for onshore portions of the fault within Los Angeles County.

Simi-Santa Rosa Fault System

This fault system extends from the Santa Susana Mountains westward along the northerly margin of the Simi and Tierra Rejada Valleys, along the south slope and crest of the Las Posas Hills to their westerly termination. The presence of the Springville and Camarillo Faults, short distances to the north and south, respectively, of the westerly projection of Simi-Santa Rosa Fault could be considered branches of the Simi-Santa Rosa Fault and project into the Oxnard Plain along the same trend.

Surface evidence north of Simi Valley and within the Santa Rosa Valley indicates that this fault has been active during Holocene time (0 to 11,000 years before present). This fault is zoned by the State of California as an active fault.

The Simi-Santa Rosa fault system is a reverse fault with a slip rate of 1.0 mm/yr, a potential maximum moment magnitude of 6.7 and a recurrence interval of 933 years (CDMG, 1996).

This fault is zoned by the State of California as active and details pertaining to the fault designation may be obtained by reviewing the State of California Division of Mines and Geology, Fault Evaluation Report FER 244 (Treiman, 1998).

Bailey Fault

This fault marks the boundary between the western Santa Monica Mountains and the Oxnard Plain. It extends from the Mugu Lagoon area northerly to an apparent intersection with the Camarillo Fault near Calleguas Creek and State Highway 101. The presence of the fault is based primarily upon water well data.

No evidence of surface expression of the fault is known nor have any earthquakes been recorded as having originated on it. The fault trace is obscured by geologically young alluvium over its entire length. Available information is insufficient to conclude that the fault has not been active during Pleistocene or more recent time.

The fault is considered as potentially active until more information is available for evaluation. Information pertaining to this fault is anticipated to be difficult to obtain because the depth of the Oxnard Plain surficial sediments.

Camarillo Fault

This fault extends in an east-west direction immediately south of Camarillo from Calleguas Creek to Camarillo Airport. The present of the fault is based primarily upon the abrupt uplifted sediments along the north side of the fault that resulted in the long linear hill of the southern portion of Camarillo just south of the 101 Freeway.

The apparent uplift along the north side of the fault is believed to be a surface expression of fault propagation folds. The fault surface trace, however, is obscured by geologically young alluvium over its entire length.

Sycamore Canyon and Boney Mountain Faults

These faults are the most prominent of a series of northeast trending breaks extending from the Point Mugu and south coast area to the Thousand Oaks area. Surface evidence of displacement of sedimentary and volcanic rocks of Miocene age indicates that these faults have been active after the formation of these rocks. Rocks younger than Miocene age are not known to have been displaced by the faults. However, no detailed specific investigations have been conducted for the purposes of addressing the activity of these faults. Special areas of concern would be in the Potrero, Conejo, and Hidden Valleys and the Thousand Oaks area.

The faults are considered as potentially active until more information is available for evaluation.

Oak Ridge Fault System

The Oak Ridge Fault System is a steep (65-degrees) southerly-dipping reverse fault that extends from the Santa Susana Mountains where it has been overridden by the north-dipping Santa Susana Thrust Fault, westward along the southerly side of the Santa Clara River Valley and thence into the Oxnard Plain. The relationship of possible westerly extension of the fault to the McGrath and offshore faults is unclear and may be complex. None of the faults beyond the westerly terminus of South Mountain have surface expression nor have any been shown to cut near-surface sediments (alluvium). It is conceivable that past movement of these faults in the Oxnard Plain area has not resulted in surface displacements but, instead, has resulted in only broad warping or tilting of the near-surface alluvial sediments. The lack of surface evidence of fault displacement in the Oxnard Plain is not necessarily indicative of activity in the recent geologic past as surface features could easily have been obscured by fluvial processes (erosion or deposition of alluvium). Several recorded earthquake epicenters in the offshore as well as mainland area during historic time may have been associated with the Oak Ridge Fault System or within close proximity and associated with it.

The Oak Ridge Fault System probably contains many branching faults and is believed to be associated with one or more faults of similar trend present in the Santa Barbara Channel west of the Oxnard Plain. The system is over 50 miles long on the mainland and may extend an equal or greater distance offshore.

The rugged, steep terrain of the north slope of South Mountain as well as displacement of young alluvial sediments indicates that portions of the Oak Ridge Fault System are active.

The Oak Ridge Fault System is a reverse fault with a slip rate of 4.0 mm/yr, a maximum moment magnitude of 6.9 and a recurrence interval of 299 years (CDMG, 1996).

The faults within this system are considered active. Portions of this fault are zoned by the State of California as active and details pertaining to the fault designation may be obtained by reviewing the State of California Division of Mines and Geology, Fault Evaluation Report FER 54 (Smith, T.C., 1977 and FER 219 and 2 Supplements dated 1998 and 1999 (Treiman, 1990).

Ventura and Pitas Point Faults

The Ventura-Pitas Point Fault extends along the base of the foothills on the north side of the Santa Clara River from Santa Paula westerly to the mouth of the Ventura River, thence westerly into the Santa Barbara Channel area. The fault is a north dipping reverse fault.

Evidence for the existence of the Ventura Fault is based mainly upon minor faulting of terrace deposits north of San Buenaventura and evidence of faulting from the Tidewater Oil Company corehole #5. The fault is believed to be north-dipping.

The Ventura-Pitas Point fault system is an oblique left lateral reverse fault with a slip rate of 1.0 mm/yr, a maximum moment magnitude of 6.8 and a recurrence interval of 1,112 years (CDMG, 1996).

San Cayetano-Red Mountain--Santa Susana Fault System

This fault system consists of a major series of north-dipping reverse faults that extend over 150 miles from Santa Barbara County into Los Angeles County.

The San Cayetano fault is a major, north dipping reverse fault that extends for 40 km along the northern portion of the Ventura Basin. The fault has been mapped in detail both at the surface and in the subsurface and can be separated into two sections defined by a right step in the fault zone near the City of Fillmore. The eastern section surface trace of the San Cayetano fault dies out several km east of the Town of Piru, where the details regarding the mechanics of slip transfer are unclear, but slip may be transferred onto the Santa Susana Fault (Dolan and Rockwell, 2000). The western surface trace lies well above the base of the slope of the Sespe Mountains and the surface trace ends just east of the City of Ojai. The western section may transfer slip onto the Sisar blind thrust fault and then ultimately to the Red Mountain fault.

Geologic evidence that each of the fault systems are considered active throughout their length is shown by location of earthquake epicenters (including the San Fernando Earthquake of 1971), groundwater barriers, and displaced alluvial sediments. In addition, age determinations from detrital charcoal recovered from faulted sections of the San Cayetano fault indicate surface rupture occurred after A.D. 1660 (Dolan and Rockwell, 2000). This event was on the eastern section of the fault and generated at least 4.3 m of surface displacement.

The Red Mountain Fault, San Cayetano, and Santa Susana fault systems are zoned by the State of California as active faults.

The Red Mountain fault system is a reverse fault with a slip rate of 2.0 mm/yr, a maximum moment magnitude of 6.8 and a recurrence interval of 507 years (CDMG, 1996).

The San Cayetano fault system is a reverse fault with a slip rate of 6.0 mm/yr, a maximum moment magnitude of 6.8 and a recurrence interval of 150 years (CDMG, 1996). Recent studies (Dolan, J.F. and Rockwell, T.K., 2000), suggest the San Cayetano fault system is capable of producing a moment magnitude greater than 7 with reverse slip rates over the past million years of 10-12 mm/yr.

The Santa Susana fault system is a reverse fault with a slip rate of 5.0 mm/yr, a maximum moment magnitude of 6.6 and a recurrence interval of 138 years (CDMG, 1996).

Lion Mountain-Big Canyon-Sisar Fault System

These faults and several others present in the eight-mile gap between the Red Mountain and San Cayetano Faults dip southerly beneath Sulphur Mountain. The general area is complexly broken and folded by faulting which may be associated with the high fluid pressures present in the Ventura Oil Field to the south.

Although the general area of these faults has not experienced earthquake activity during historic time, their position within the San Cayetano-Red Mountain-Santa Susana Fault System and the possible displacement of terrace deposits (Pleistocene time) indicates that they should be considered at least potentially active.

Mission Ridge-Arroyo Parida-Santa Ana Fault System

This fault system extends from Montecito, Santa Barbara County, to the Ventura River and probably along the south side of Ojai Valley, Ventura County.

Although no earthquake activity has been recorded during historic time, the fault does apparently form a groundwater barrier in the alluvium beneath the Ventura River. On this basis, it should be considered potentially active. Future information may require reclassification.

Santa Ynez Fault

This fault extends from Point Conception in Santa Barbara County, across the central portion of Ventura County, to near the east County line. It is considered to be one of the major faults in the region and is about 90 miles long. Past displacement has been about 10,000 feet of relative uplifting of the south side of the fault. The fault lies about 4 miles north of Ojai.

Left lateral displacement of streams crossing this fault has been cited as evidence for recent fault movement. Several earthquake epicenters have been located along this fault and one or two of these were in Ventura County. The 1927 earthquake centered west of Point Conception may have originated on the westerly, offshore extension of this fault.

This fault is considered potentially active until additional information is available for evaluation.

Faults Between the Santa Ynez and North County Line

Several large faults occur in the mountainous area north of the Santa Ynez Fault and within Ventura County. The most significant of these faults are the Tule Creek, Munson Creek, Agua Blanca, Frazier Mountain and Big Pine Faults. Of these the more important appear to be the Pine Mountain Thrust and Big Pine Faults (9 and 16 miles north of Ojai, respectively). The Pine Mountain Thrust is north-dipping and favorably oriented for generating earthquakes in response to the north-south compressive forces which have triggered activity along such similar faults as the Malibu, San Fernando and San Cayetano.

Terrace deposits and stream channels have been offset by geologically recent movement along the Big Pine Fault. More importantly, it is reported to have ruptured the ground surface for a distance of 30 miles along its length during the northern Ventura County earthquakes of November 1852.

Both of these faults are considered active. The rest of the faults in the north half are in the Potentially Active Fault Hazard Zone.

San Andreas Fault

The San Andreas is the longest and most important fault in California. Due to clearly established historical earthquake activity, this fault has been designated as active by the State Division of Mines and Geology. The last major earthquake on this fault near the County was in 1857. The earthquake is estimated to have been on the order of magnitude 8.0 (Richter Scale) and would have caused considerable damage if there had been structures in the southern County area. The occurrence of another such major earthquake along this fault is considered possible within the near future.

2.2.3 Local Resources Affected By The Hazard

Movement along faults may substantially impact the unincorporated areas of the County. The effects are summarized in the accompanying table (Figure 2.2.2), following the text. All transmission lines from power sources cross or enter into at least one fault zone. In addition, all oil and gas transmission pipelines, fiber optic cables, telephone transmission lines, some cellular tower antennas, and oil and gas processing and production facilities are within or cross fault zones.

One school is in the Mission Ridge-Arroyo Parida-Santa Ana Fault Zone, as is the water transmission line from Lake Casitas to Ventura and the Ojai area, which also crosses the fault zone. Sewer mains in the Meiners Oaks area and in Villanova Road are also located in the fault zone.

The Red Mountain-Padre Juan Fault System extends from Highway 33 near Canada Larga Road to the north coastal area of the County into the Pacific Ocean and Santa Barbara County. The coastal communities of La Conchita and Solimar are located along this zone, as is a county fire station on Highway 101 that is very close to or on the Padre Juan fault. Power transmission lines going to Santa Barbara County cross this fault zone as do many major gas lines, oil pipelines, fiber optic cables, oil and gas processing and production facilities, communication towers, water transmission pipes, sewer mains, Highway 101 and the Ventura-Santa Barbara road lines.

North of Red Mountain-Padre Juan Fault System extends another secondary potentially active fault zone encompassing a portion of Highway 33, power transmission lines to Santa Barbara County and their associated substations in the area, gas mains, oil and gas pipelines and storage tanks, water transmission lines and sewer mains between Ventura and Ojai.

The Lion Mountain Fault Zone is located between Lake Casitas and the San Cayetano fault zone east of Ojai. This zone contains the major portion of the Oak View Community including Oak View and Sunset schools and a County fire station. Major electrical transmission lines, gas mains, water transmission lines, telecommunication lines and towers, and sewer mains between Oak View and Ojai transverse this zone. The major gas transmission line from Kern County also crosses this fault zone.

The San Cayetano Fault Zone is located between Ojai and the Los Angeles County Line extending north of Santa Paula and Fillmore and entering into portions of Piru. Summit and Piru Schools are located in the fault zone as well as a fire station near Summit School on Highway 150 and portions of Highway 150 itself. The State Fish Hatchery east of Fillmore is also within the hazard zone. Main power lines from Los Angeles County to the Santa Clara Transmission Station enter into this fault zone, as well as gas mains, water transmission lines, and sewer mains east of the cities of Ojai and Fillmore that are in the hazard zone. Portions of Highway 126 near Piru are also located along the fault. There are major oil/gas pipelines, processing, production, and storage facilities within this zone. Telecommunication lines and towers are also nearby.

The Big Canyon-Sisar Fault System extends west of the San Cayetano Fault Zone, south of Highway 150. Because it is located in hilly portions of the County, resources affected by this fault hazard include oil/gas pipelines and production, water and communication transmission lines.

Few major resources are located in the Santa Susana Fault Zone, which is between the Oak Ridge Fault Zone and the Los Angeles County Line. However, major electrical transmission lines from Los Angeles County to Moorpark and a 34" gas main penetrates the fault zone. There are also oil and gas pipelines, production, processing and storage facilities near this zone.

The Simi Fault Zone extends from the Los Angeles County Line, north of Simi Valley and ends up in the Virginia Colony area. A portion of a housing development is located within the fault zone as well as major power lines, gas mains north of Simi Valley, a water transmission line to Moorpark and a sewer main west of Simi Valley. Also, the Simi Valley Adventist Hospital is located within the fault zone. There is a sewer treatment plant and landfills within the area as well as communication lines and towers, and utilities (water, sewer, and gas).

No major resources are located within the Canada de la Brea Fault Zone, which reaches out from the Simi Fault. However, power transmission lines, an 8" gas main and a sewer line do enter into an extension fault zone of the Canada de la Brea fault. The extension of a landfill is also planned into this fault zone.

Another fault exists between Moorpark and Fillmore with Highway 23 bisecting the zone. Besides the roadway, only a six-inch gas line is located within the fault zone.

The Sycamore Canyon Fault rises from the Pacific Ocean near Mugu Lagoon, through the Santa Monica Mountains to Newbury Park, past the 101 Freeway into Thousand Oaks. Going through the Newbury Park area, four schools plus several utility facilities such as power lines to Lake Sherwood, gas mains near the 101 Freeway and Lynn Road, water transmission lines, communication lines and towers, and sewer mains for housing developments are located in the fault zone.

The eastern extension breaks from the Sycamore Canyon Fault south of Borchard Road, touching Ventu Park Road and continuing on past the 101 Freeway further into Thousand Oaks. Except for the general urban area that is located within the fault, there appear to be no major resources located within the area.

No major resources except for a power line to the Thousand Oaks sub-station appear to lie in the Boney Mountain Fault Zone, which is located south of the eastern extension of the Sycamore Canyon Fault. Utility lines (water, gas, sewer) and communication lines are located in this area.

The Bailey Fault Zone extends from Mugu Lagoon towards Camarillo and intersects the Santa Rosa fault zone east of that city. Major power lines from Ormond Beach power plant, as well as gas lines, water transmission pipes, and the Camrosa Wastewater Treatment Plant mains east of Camarillo are situated within the fault zone.

An extension fault zone is located due east of the Bailey Fault through the California State University, Channel Islands, (formerly Camarillo State Hospital), into surrounding hills.

The Santa Rosa Fault Zone starts east of the Springville Fault at Las Posas Road, following the north side of the Santa Rosa Valley and along the north side of Simi Valley to meeting the Santa Susana Fault at the County of Ventura Line. Within the unincorporated areas, major power lines from Ormond Beach power plant as well as utility (gas, water, sewer) mains, and communication lines and towers are located in this fault zone.

The Springville Fault Zone extends along the base of the Camarillo Hills north of Camarillo, through Oxnard to the Pacific Ocean. Near Camarillo, two schools are located within the fault zone as well as the Mandalay Power plant in Oxnard. Utility (water, sewer, gas) and electric lines cross the fault zone. Oil/gas production and storage facilities and water storage tanks are located near the zone.

The Oak Ridge Fault basically follows the Santa Clara River bed with a southern deviation near Fillmore. Due to this, utilities such as power, water, gas and sewer lines are resources that cross the zone. Oil/gas production, processing, and storage facilities are located nearby. Communication lines and towers are also within the fault zone.

The accompanying table (Figure 2.2.2), "Resources Affected by Faults and Fault Zones," summarizes the information presented above.

2.2.4 Definition Of Fault Hazard Zones

The "fault hazard zones" define a boundary where active or potentially active faults are believed to be located.

Locally Identified Fault Hazard Zones

The Fault Hazard Zones identified by the Alquist-Priolo Earthquake Fault Zoning Act are designated "active" by the State of California and based on available geologic mapping and judgment of the County Engineering Geologist. Other faults and extensions of the active faults are shown on Figures 2.2.1a and 2.2.1b.

The extent of Fault Hazard Zone boundaries are controlled by the traces of active faults that are based on the best data available at the time the map was compiled (January, 2002). However, the faults shown on the maps were not field-checked during the map compilation.

In many places the zone boundaries have been tentatively extended beyond the mapped limits of faults, such as occurs westerly of Camarillo and westerly of Saticoy. These zone extensions are considered necessary because, even though faults have not been mapped in these areas, it is considered likely that extensions of known faults or branches of faults do extend into these area. Future investigation or studies would be required for confirmation of any fault extensions.

The earthquake fault hazard zone designates areas that are believed to contain active faults. The potentially active fault hazard zones include those faults for which less evidence is available concerning their potential for activity, however, their approximate surface trace has been mapped. No degree of relative potential for future surface displacement or degree of hazard is implied for the faults shown.

A "fault" is defined as a fracture or zone of closely associated fractures along which rocks on one side have been displaced with respect to those on the other side. Most faults are the result of repeated displacement that may have taken place suddenly and/or by slow creep. A "fault zone" is a zone of related faults that commonly are braided and subparallel, but may be branching and divergent. It has significant width (with respect to the scale at which the fault is being considered, portrayed, or investigated), ranging from a few feet to several miles.

State Special Studies Zones

In 1972, the California State Legislature enacted to the Alquist-Priolo Special Studies Zones Act. Pursuant to this act, the "State Geologist shall delineate...special studies zones to encompass all potentially and recently active traces of the San Andreas, Calaveras, Hayward, and San Jacinto Faults, and such other faults...(that) constitute a potential hazard to structures from surface faulting or fault creep."

The Act also requires the State Geologist to compile maps of special studies zones and submit them to local jurisdictions. The State Earthquake Fault Hazards Zones are shown on Figures 2.2.3a and 2.2.3b. Special Studies Zones are delineated on topographic base maps at a scale of 1:24,000 (1 inch equals 2000 feet).

Faults other than those depicted on the maps may be present within the Special Studies Zones. The zone boundaries delimit the area that the State Geologist believes warrants special geologic investigations to detect the presence or absence of active faults.

The State of California Earthquake Fault Hazard Maps are on file in the County Planning Division.

The intent of the zone is to provide for public safety from the hazard of fault rupture by avoiding, to the extent possible, the construction of structures for human occupancy across active faults. The California Geologic Survey has adopted policies and criteria for development within these zones. The complete text of the Policies and Criteria is included herein. Its most significant criterion is that no habitable structure may be built across the trace of an active fault. Furthermore, the area within fifty feet of an active fault shall be assumed to be underlain by active branches and therefore, before any structure can be built within the zone, a geologic investigation and submission of a report by a Registered Geologist in the State of California is required. In addition, the County may impose more restrictive policies. Upon approval of the report, the County is required to submit a copy of the report to the State Geologist.

Uses and Limitations of the Earthquake Fault Hazard Zones

The best use of the fault zones is to define areas where special geologic studies would be required prior to building structures for human occupancy. Such a criterion may require a developer or builder to evaluate specific sites within the zone to determine if a potential hazard from any fault exists with regard to proposed structures.

Such studies are required for Earthquake Fault Hazard Zones. The County Geologist may require fault evaluation based on more recent data or for fault areas for which little information is presently known. Future studies could result in the designation of some of these areas to active fault zones.

Users of the maps should be fully aware that the zones are delineated to define those areas within which special studies may be required prior to building structures for human occupancy. Traces of all faults are shown on the maps mainly to justify the locations of zone boundaries and to provide fault data beyond zone boundaries. These fault traces are plotted as accurately as the sources of data permit; yet the plots are not sufficiently accurate to be used as the basis for setback requirements.

The fault information shown on the map is not sufficient to meet the requirement for special studies. It is the County's responsibility to require the developer to evaluate specific sites within the Earthquake Fault Hazard Zones to determine if a potential hazard from fault rupture, exists with regard to proposed structures and their occupants.

Fault studies should, however, continue to be made of any fault suspected of recent activity or to be an extension off faults already zoned prior to approval of any individual residential or other permanent developments which may be proposed over or in the near vicinity of this fault.

2.2.5 Nature of the Information

The geologic information relating to the location of faults and their potential for activity is based largely upon regional geologic studies conducted by Universities, Petroleum and Engineering Geologists, as well as information compiled by the California Geological Survey and the County Department of Public Works.

The evaluative system utilized in estimating the potential or past activity of individual faults and fault systems is discussed under "General Inventory of the Hazard." The basis and method of designation of the Earthquake Fault Hazard Zones is similar to that used by the California Geological Survey in establishing the Earthquake Hazard Zones along active faults within the State.

Research and experience dealing with the nature and mechanism of faults movement and fault activity is being conducted by various Federal and State agencies as well as by universities and professional organizations. Much of this work is being conducted on a statewide basis; however, indirect benefit to Ventura County will be gained through developed technology. Additional investigation is being conducted on a continuing basis by:

- Private Geologic Consultants who conduct and provide original information during investigations for public and private developments.
- Ventura County Public Works Agency that provides review and evaluation of Geologic and Soils and Foundation Engineering reports prepared for private projects within the unincorporated area of the County.

Presently, there is no way to prevent or accurately predict when an earthquake and surface displacement may occur along a fault. The state of the art is such that at best only the recency of past activity can be determined along some faults. In the southern California area, those faults that have general east-west trends or are associated with the northwesterly-trending San Andreas Fault are considered the most active.

2.2.6 Alleviation of the Hazard

Alleviation of the hazard is largely accomplished through land use controls. The agencies, departments and legislative bodies making land use decisions have the primary responsibility for alleviating the hazard. Decisions concerning adoption of these recommendations within the unincorporated areas of the County of Ventura rest ultimately with the Planning Commission and the Board of Supervisors. Other bodies making land use decisions include Port Districts and their associated cities, redevelopment agencies, and special districts.

Alleviation of existing hazards can be effected by removal of structures located over active faults. Determination of whether structures are hazardously located would require detailed investigation of geologic conditions and of the potential for activity along any faults found.

Present information is not considered sufficiently accurate to warrant special investigation for most existing development. Consideration should, however, be given to reconfirming the safety of critical facilities, including public structures and those where large numbers of people may gather, where such facilities are over or near known faults. Future, more detailed information on fault locations may indicate that further evaluation of some existing structures or facilities is warranted.

Structures which could be considered for evaluation include hospitals, rest homes, churches, large commercial buildings, important industrial structures, schools, residential or commercial buildings over two stories in height and critical utility facilities.

2.2.7 Conclusion

Available geologic information indicates that the potential for the occurrence of surface displacement along one or more of the major east-west trending faults within the County and within the life of existing structures is high compared to the potential hazard Statewide. Major development along most of the east-west faults within the County should be carefully considered until such time as adequate information is available to conclude that such faults are not active or potentially active.

Experience has shown that when sudden surface displacement occurs along faults, structures located over those faults are almost totally destroyed. Although the hazard is considered real within the County, the effect of the hazard is low compared to the likelihood of greater losses that could occur as a result of strong ground shaking.

In the event of surface displacement along a fault transecting one of the urbanized or industrialized areas of the County, loss of life and property damage could occur both in the unincorporated and incorporated areas.

Much of the existing land development occurred many years ago, before the full potential danger of concealed or obscure faults was recognized and, therefore, little subsurface investigation of geologic conditions was conducted. In general, little is known of the recency of past movement along most of the faults within the County, or whether any related fault branches may be present. Several recent investigations for private development in the vicinity of some of the faults have indicated no fault disturbance of near-surface earth materials. Nonetheless, future investigations could however reveal that some segments and branches, or extensions of faults within the zones are active.

The information in this section has been updated since the original information was compiled. This section reflects current knowledge, as of 2002, particularly with respect to precise fault locations and potential for activity. This section will, however, be updated periodically as part of future updates of the Hazards Appendix. Additionally, fault maps will be updated periodically as new data from future investigations is obtained, future earthquakes occur, and the California Geological Survey issues revised maps. The policies of the State Earthquake Fault Zoning Act, in conjunction with available State and local fault information, are considered an adequate method to reduce fault rupture hazards.

Figure 2.2.1a
Earthquake Faults Map - North Half

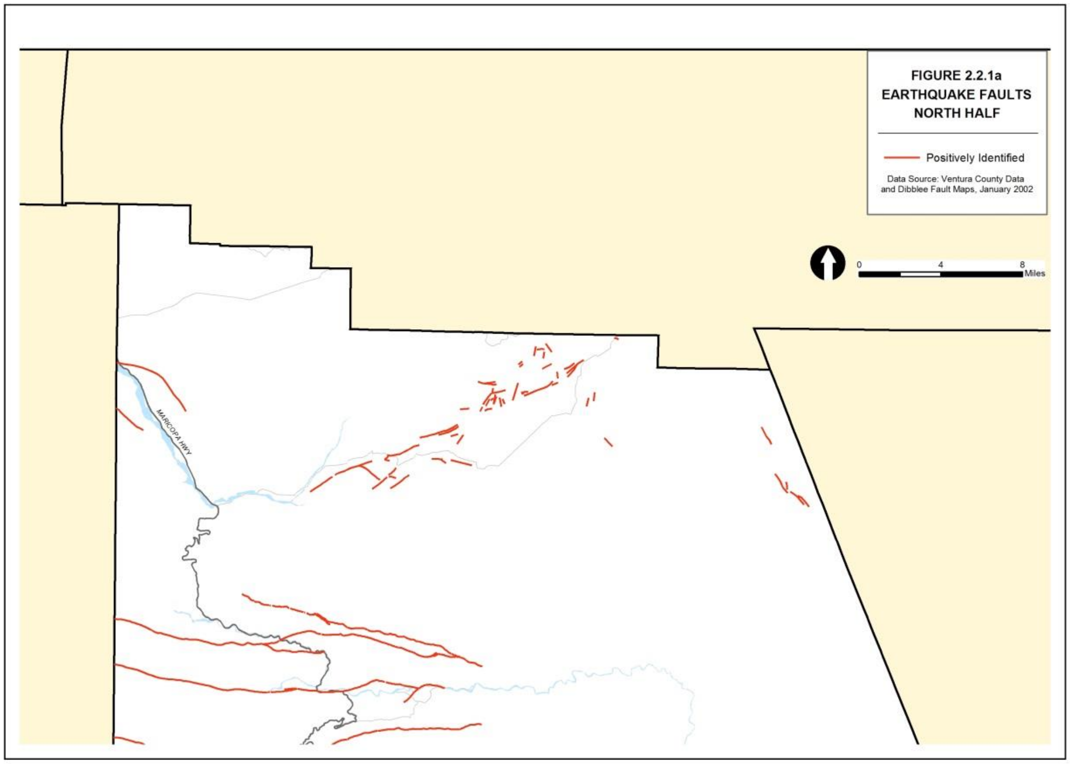


Figure 2.2.1b
Earthquake Faults Map - South Half

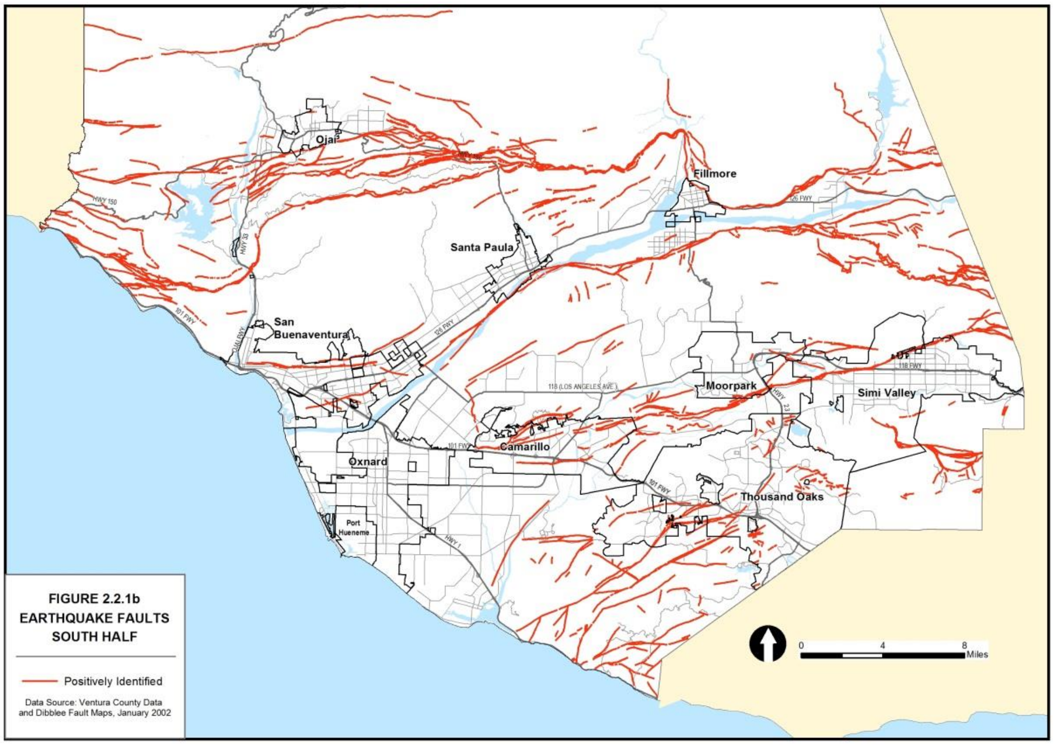


Figure 2.2.2
Resources Affected By Faults and Fault Zones

FAULT	SINGLE-FAMILY	SCHOOLS	FIRE STATIONS	SEWER	WATER	GAS	ELEC-TRICITY	MAJOR ROADS	OTHER
Mission Ridge-Arroyo Parida-Santa Ana Fault System		(1)		●	●			●	
Red Mountain Fault	●		●	●	●	●	●	●	
Lion Mountain Fault	●	(2)	●	●	●	●	●	●	
San Cayetano Fault	●	(3)	●	●	●	●	●	●	●
Fault East of Moorpark	●			●	●	●	●		
Fault North of Moorpark						●			
Sycamore Canyon Fault				●	●	●	●	●	
Fault West of Sycamore Canyon	●			●	●				
Santa Susana Fault						●	●		
Simi Fault	●			●	●	●	●		
Boney Mountain Fault						●			
Bailey Fault				●	●	●	●		
Fault Northeast of. California State University, Channel Islands		(1)					●		(5)
Santa Rosa Fault				●	●	●	●		●
Springville Fault		(4)		●	●	●	●		●
Oak Ridge Fault			●	●		●	●		
Oak Ridge Extension				●	●				
Camarillo Fault				●			●		

(1) Villanova Prep. School

(2) Oak View and Sunset Schools

(3) Summit and Piru Schools

(4) Camarillo Heights Elem. School

(5) California State University, Channel Islands

Note: This table deals only with resources in unincorporated territory

Figure 2.2.3a
Earthquake Fault Hazard Zones Map- North Half

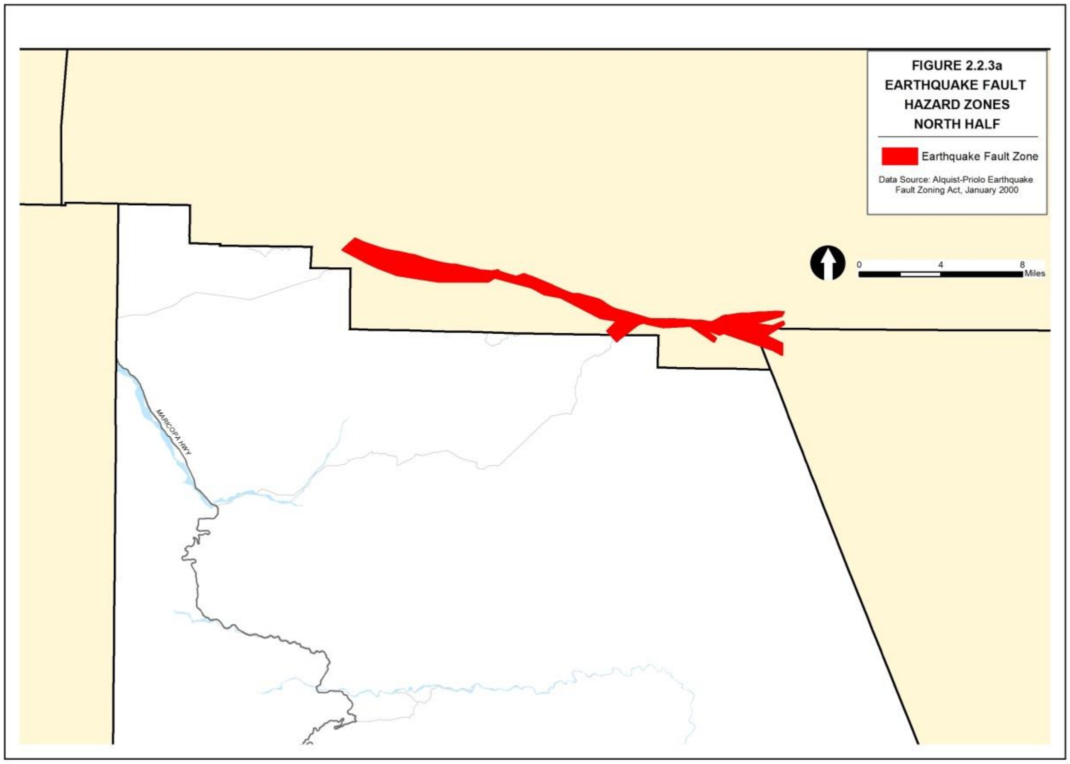
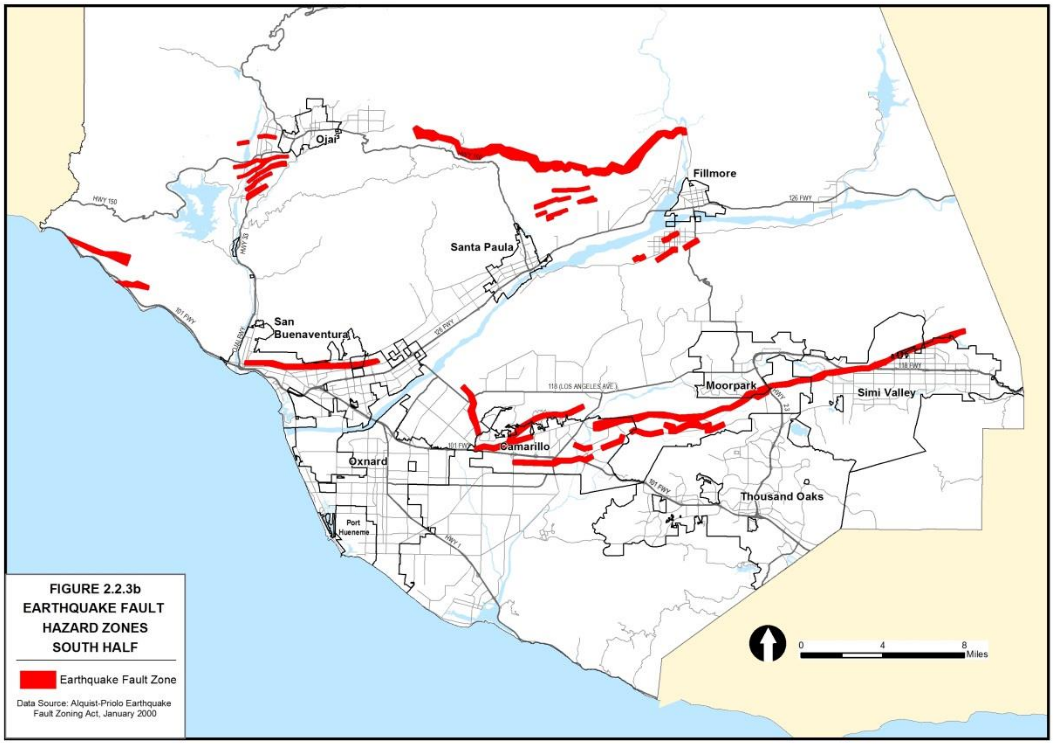


Figure 2.2.3b
Earthquake Fault Hazard Zones Map - South Half



2.3 Ground Shaking

2.3.1 General

"Ground shaking" is the physical movement of the land surface due to seismic waves caused by earthquakes. When a fault breaks, the accumulated strain energy is released as seismic waves that travel outward in all directions from the earthquake focus (the point of first release of tectonic stress located below the earth's surface, causing ground shaking). Seismic waves travel through the ground like the ripples from a pebble dropped into a pond. The intensity of the ground shaking depends on the quake magnitude (size of pebble) and the distance from the fault (ripples get smaller as they radiate outward). Seismograms (records of earthquake motion) indicate that earthquakes create several kinds of motions, or seismic waves. These waves exhibit different types and directions of movement. Each type of wave can affect buildings differently depending on many diverse variables. This is due to the Earth's crust not being homogeneous like water, but rather a complex mixture of rocks and sediments of varying types that respond to the shaking in different ways. The combined effect of these waves makes up the ground-shaking component of an earthquake. In a single earthquake, the shaking at one site could be 10 times stronger than the shaking at a neighboring site even though the distance to the ruptured fault is the same.

Two separate indexes, or scales, are commonly used in describing seismic or earthquake events. The qualitative rating of the degree of earthquake shaking based upon feeling and visual observation is indicated by an intensity scale (Mercalli). The size or energy release of earthquakes is measured by a magnitude scale (Richter).

Measurement of the radiated energy released by an earthquake was originally proposed by C. F. Richter in 1932. This method assigns a number to the calculated energy release (magnitude), and can rank earthquakes and compare them to one another. By this method, an earthquake is rated independently of the place of observation. The Richter Scale is logarithmic, and is not limited, either at top or bottom. Each magnitude step on the scale represents an increase of ten times in measured wave amplitude of the earthquake, and 30 times the amount of energy released as seismic waves. A magnitude 2 is about the smallest earthquake that can be felt by human beings.

The index used to measure earthquake intensity (as opposed to magnitude) is the modified Mercalli Intensity Scale, with intensity scales ranging from I for earthquakes barely perceptible by human beings to XII for "the ultimate catastrophe." The scale is a description of the physical effects of earthquakes. There is only a rough correlation between the magnitude of an earthquake and the intensity.

The intensity of ground shaking during an earthquake depends in large part on various characteristics of local geologic conditions (i.e., the thickness and physical properties of the materials comprising the upper several hundred feet beneath the area). By combining observations from past earthquakes with computer-based predictions, geologist (seismologists) found that the two most important characteristics are the softness of the ground and the total thickness of sediments below a particular site. Seismic waves travel faster through hard rock than through soft rock and sediments. As the waves pass from harder to softer materials and slow down, they must increase in amplitude to carry the same amount of energy. Thus the shaking tends to be stronger at sites with softer surface materials. In general, the greatest amplitudes and longest durations of ground shaking usually occur on thick, unconsolidated alluvial sediments. Other variations in earthquake shaking depend on the specific details of the earthquake, such as orientation of the fault, irregularities of the rupturing fault surface, and the scattering of waves as they bounce off of subsurface changes. Other factors that may contribute significantly to the damage potential of structures include: magnitude of the earthquake, distance and direction from the epicenter and causative fault, duration of shaking, the structural integrity of buildings before the earthquake, and many others. Each earthquake provides additional data to review and help improve the understanding of seismic hazards.

2.3.2 Location of the Hazard

The ground-shaking hazard exists throughout Ventura County, as well as, all of California. Certain areas may have increased ground shaking due to local geologic conditions, as well as, the location and orientation of the earthquake fault. The approximate peak horizontal acceleration for uniform soft rock site conditions is shown on Figure 2.3a and 2.3b. These maps provide the anticipated ground acceleration for a site with a 10 percent probability of exceedance in 50 years. This data is based on the California Geological Survey Open File Report 96-08, and the ground acceleration is a percentage of gravity (g).

The highest amplification of ground shaking occurs in areas with the greatest potential for long period wave shaking. Basically, this is the San Andreas Fault zone in the northern part of the County and the Oakridge Fault zone in the southern part of the County.

The areas with the greatest amplification of short period shaking are along the base of the hills, in minor river valleys and in the broken bedrock along fault lines such as the San Cayetano, Oak Ridge and Simi-Santa Rosa Faults. Slight to moderate amplification of short period oscillations may occur on terrace deposits or soft bedrock, however, certain locations may experience higher than normal ground shaking due to boundary effects or wave propagations. These materials are found in young hill areas such as South Mountain, Oak Ridge, Sulphur Mountain, and the north coastal hill lands and the Piru area in the south half of the County. In the north half of the County, these are along the margins of the valley areas such as Hungry and Lockwood Valleys and north of Cuyama.

In addition to the forces causing horizontal movement, such as those that predominant along the San Andreas Fault, Ventura County and portions of adjacent areas are subject to compressional forces acting in north-south directions. These forces tend to compress or shorten the distance from the San Andreas Fault south to the coast. These compressional forces caused the San Fernando Earthquake of 1971, resulting in the thrusting of the southern margin of the San Gabriel Mountains several feet southward over the north margin of the San Fernando Valley. These forces also resulted in the 1994 Northridge Earthquake. Several faults in Ventura County have been formed by and are related to these same forces. These fault systems are described in the Fault Rupture section.

Southern Ventura County

The south half of the County is considered that portion southerly of the east-west projection of Nordoff Ridge located immediately north of Ojai Valley. Even though the historic record indicates that no strong earthquakes or surface displacement have occurred along the faults within the south half, the likelihood of the occurrence of one or more of such events within the next 50 to 100 years is not remote. The San Fernando Earthquake of 1971 occurred along a fault having little historic record of activity. Several of the faults within the south half of the County, such as Santa Susana and San Cayetano, are subject to similar tectonic forces as those that caused the San Fernando Earthquake. Crustal deformation (shortening) resulting in earthquakes will continue into the indefinite future. It is probable that earthquakes of magnitude 6 or larger will occur in the south half of the County area, in the nearby offshore areas, and along the San Andreas in the northern portion of the County.

According to the "Geology and Mineral Resources Study of Southern Ventura County" (1972) prepared by the State Division of Mines and Geology in cooperation with the Ventura County Department of Public Works, the earthquake history of the south half of the county is dominated by small to moderate shocks. No earthquake greater than magnitude 4.7 has been recorded in Ventura County, or the immediate offshore area, since 1934, when adequate instrumental records became available. These relatively minor shocks have caused local damage but no recorded loss of life. A review of the earlier less accurate record from 1769 to 1934 suggests a similar history for the south half, although there were significant earthquakes in 1812, 1857, 1925, 1971, and 1994 that caused structural damage in specific areas of the south half of the County.

Northern Ventura County

The most important faults in the vicinity of the northern County area are the San Andreas, Big Pine, San Gabriel, and Frazier Mountain Thrust, all of which converge at the northeast corner of Ventura County. All of these faults, except perhaps the Frazier Mountain Thrust, are considered to be active, i.e., are potential focal points for the occurrence of earthquakes and displacement of the ground surface. Other mapped and unknown faults within the north half may also prove to be active by future displacement or detailed investigations. The earthquakes of November 1852 were accompanied by about 30 miles of surface faulting in Lockwood Valley. The exact location of the surface breaks is unknown, but geologic evidence and reports indicate that it may have been along the Big Pine Fault, a major left-lateral fault with some oblique slip (subject to both horizontal and vertical displacement).

Several other faults found in the Lockwood Valley area have had recent movement identified by virtue of their cutting of terrace deposits and offset of other faults. These faults range from several hundred to a few thousand feet in length. Some of them indicate the region has recently undergone, and is probably still undergoing compression along north-south directions.

Geologic and survey evidence indicate that stress is building up along the San Andreas Fault to the north. It is just a question of time until the fault in this area again displaces; the resulting earthquake will probably be severe. Prediction of when displacement will occur is not possible at this time; however, it is likely that it will occur within 100 years and possibly much sooner.

Earthquakes and strong to severe ground shaking originating along faults within the north half is highly possible, but again, prediction of when this will happen is not possible. The historic record shows that the north half has experienced several severe shocks originating along faults both within and immediately outside of the county.

2.3.3 Conclusion

Individual site investigation to provide detailed estimates of ground shaking sufficient for design purposes are presently performed by two methods: a Deterministic Seismic Hazard Analysis (DSHA), and a Probabilistic Seismic Hazard Analysis (PSHA).

The DSHA analysis considers a specific scenario earthquake (with a magnitude and location) and the ground motion is computed for the particular site based applicable attenuation equations. The deterministic assessment of the causative earthquake is specific in terms of its magnitude and distance to the site. There still is a large potential range of ground motions that could occur due to the various attenuation relations utilized. Most deterministic approaches consider the median (50^{th} percentile) or median plus-one standard deviation (84^{th} percentile) for design.

The PSHA approach considers multiple potential earthquakes, that is, all of the magnitudes and locations believed to be applicable to the potential sources are included in the analysis. The PSHA also considers the rate of earthquake occurrence, and the probabilities of earthquake magnitudes, locations, and rupture dimensions. The PSHA approach yield a description of how likely it is the different levels of ground motion will be exceeded at the site within a given period of time.

There are considerable misunderstandings of the relationship of deterministic to probabilistic analyses. DSHA are most often thought to provide a “Worst Case” ground motion, although the magnitude of any particular earthquake is correlated to the length or rupture area of the causative fault.

Ground motion provisions of the Uniform Building Code (UBC), which forms the basis for most building design in Ventura County, are based loosely on probabilistically derived accelerations that have a 10 percent probability of exceedance in 50 years. This equates to a return period of 475 years. Ground Motion Maps are in the process of being created for the County of Ventura by the California Geologic Survey (CGS). The maps show ground motion as a maximum horizontal acceleration (MHA) having a 10 percent probability of being exceeded in a 50-year period in keeping with the UBC hazard level. The color images of seismic hazard zone maps, and the text of associated evaluation are accessible at the CGS (formerly CDMG) web site address: http://www.consrv.ca.gov/dmg/shezp/map/data.htm.

Mitigation of the potential ground-shaking hazard is generally by the implementation of the UBC in the design and construction of structures.

Figure 2.3a
Ground Shaking Map - North Half

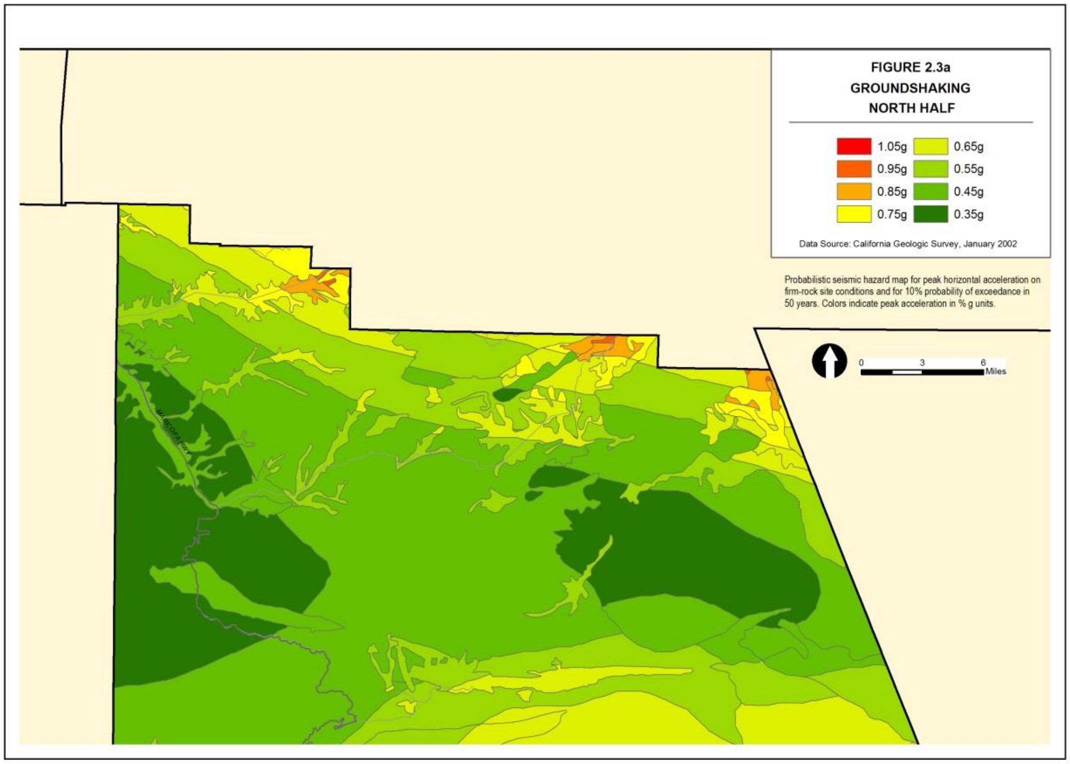
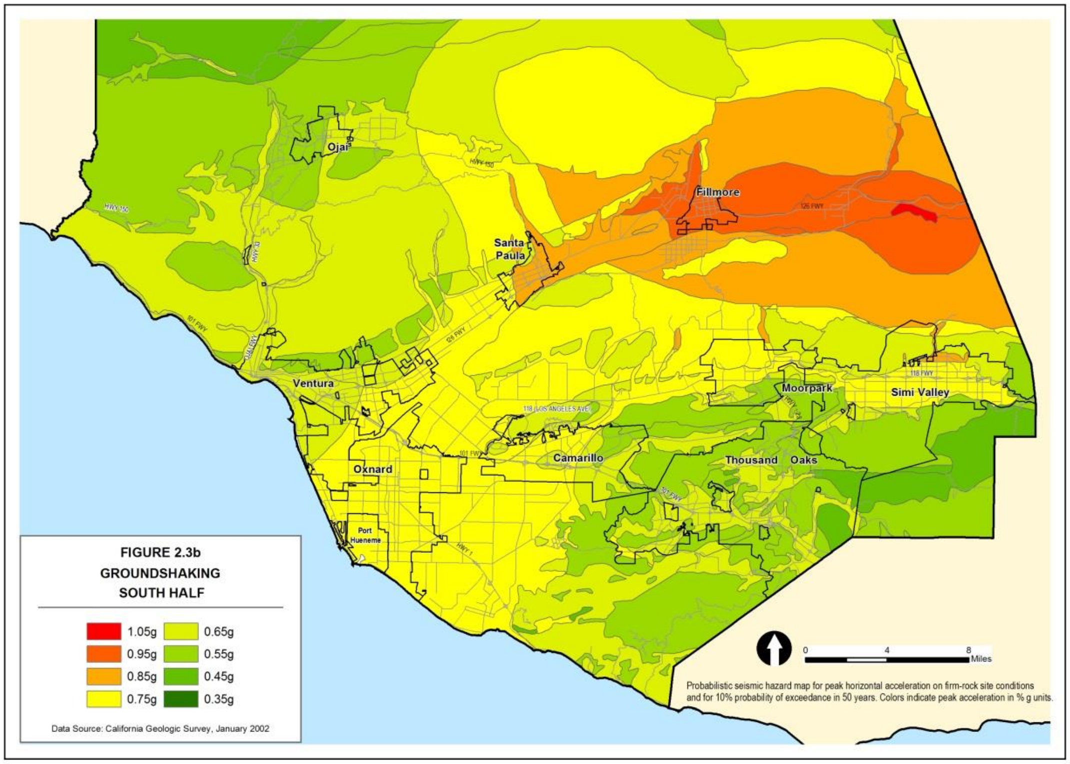


Figure 2.3b
Ground Shaking Map - South Half



2.4 Liquefaction

2.4.1 General

During earthquakes or shortly after, shaking of the ground may cause a loss of strength or stiffness that result in the settlement of buildings, formation of landslides, failure of earth dams, and other hazards. The process that leads to the loss of strength is a widespread term called "liquefaction." Recent examples of liquefaction damage are the 1989 Loma Prieta, 1994 Northridge, 1995 Kobe, and the 1999 Turkey Earthquakes. Liquefaction areas resulting from the 1994 Northridge Earthquake within Ventura County occurred near the mouth of the Santa Clara River in Oxnard/Ventura, in Simi Valley, and along the Santa Clara River between Fillmore and Newhall (Barrows et al., 1995). Past liquefaction-related events with unusual patterns of ground shaking and localized damage in alluvial areas have occurred within Ventura County as interpreted from historical reports by Weber, Jr., and Kiessling, 1976. Please note that liquefaction is generally thought of in reference to earthquakes, however, other methods of groundshaking such as blasts or explosions may result in local areas of liquefaction.

The potential for liquefaction to occur depends on both the susceptibility of a soil to liquefy and the opportunity for ground motions (shaking) to exceed a specified threshold level. Simply stated, "liquefaction" is a process by which loose, water-saturated granular materials behave for a short time as a fluid rather than as a solid mass. Liquefaction can occur at any level in the ground, but usually occurs within the first 50–80 feet. Depending upon specific soil conditions, such as density, uniformity of grain size, confining pressure and saturation of the soil materials, a certain intensity of groundshaking is required to trigger liquefaction. Ground shaking intensity depends on the magnitude, distance and direction from the site, depth, and type of earthquake, the soil and bedrock conditions beneath the site, and the topography of the site and vicinity. The duration of the shaking and/or the repeatable intensity of the ground motion is also important, as it takes a certain number of cycles of ground shaking for sufficient pore pressure to build-up and liquefaction to occur.

The liquefaction phenomenon is typically associated with medium to fine-grained sands in a fairly loose to medium-dense condition. If the material is finer-grained (clays) rather than fine sand or silt, it is generally not prone to liquefaction. The size fraction that is below 0.005 mm and makes up greater than 30 percent of the material within any specific layers is considered not to be prone to liquefaction. This inhibits liquefaction, since the bonding of the grains to one another prevents the loss of contact between them. Therefore, most silty clays and clays may not liquefy.

Knowledge concerning liquefaction and its effects has come from mainly three efforts. These are:

1. Field observations during and following earthquakes;
2. Laboratory experiments on saturated soil samples and models of foundations and earth structure;
3. Theoretical studies.

Fine-grained soils in a saturated state are so widespread in their distribution, and earthquake vibrations extend over such large areas, that liquefaction phenomena have been a part of every large earthquake that has been closely studied. In some earthquakes it has been a major factor in the damage and destruction caused. Liquefaction phenomena played a part in massive soil movements in Alaska in 1964. Also in 1964, in Niigata, Japan, liquefaction caused major disruption of services and utilities as well as giving rise to substantial building settlements and displacements. In the San Fernando Earthquake of 1971, liquefaction of material in the San Fernando Dam caused a landslide of the upstream portion of the dam structure. Slumping and displacement of other slopes and embankments in this earthquake have also been attributed to liquefaction (Bolt, et al., *Geological Hazards,* 1977).

2.4.2 General Effects of the Hazard

There are two types of liquefaction. The first type is where surface or near-surface liquefaction of soils occurs. Structures with foundations located within such a liquefaction zone lose support under part or all of their foundations, which causes them to tilt or settle into the ground surface. If a building is not designed to take this amount of stress, the entire building may collapse. A partially liquefied layer can also flow out from under the weight of the foundation with similar settling effects. In addition, the liquefied layer may exceed the design capacity of retaining walls and result in failure of the wall. Near surface manifestations of liquefaction include sand boils, lateral spread failures, loss of bearing capacity and ground settlement, buoyant rise of buried structures, and failure of retaining walls. Differential settlement may affect almost any structure and the ground surface.

Following the 1994 Northridge earthquake, portions of southeastern Simi Valley experienced liquefaction evidenced by sand boils, sand craters, and/or fissures. These features were observed in areas with very shallow ground water (<10 feet in depth) and areas situated in fill material overlying the predevelopment course of the Arroyo Simi (CDMG Special Publication 116, 1995).

The second type of liquefaction occurs when the liquefiable soil layer is below the surface. Structures with foundations above the liquefiable zone may be subject to increased ground oscillations. Liquefaction beneath a firm soil may result in a decoupling of the upper soil layers causing fissures to form and different impacts between the soil blocks (settlement and tilting, etc.), as well as, between the liquefied area and the adjacent non-liquefied area (reference). The higher susceptible areas for damage occur at the boundary between these zones.

All engineered structures including roadways, bridges, dams, single family housing and utility lines (water, gas, sewer) as well as, oil and gas pipeline and production, processing and storage facilities are subject to the potential damage resulting from liquefaction.

If the subsurface liquefaction occurs on a slope, the liquefied layer can act as a lubricated plane for the layer(s) above it to respond to gravity and move downhill. This type of liquefaction is one common cause of earthquake-induced landslides. Structures built within and across the edges of the slide are torn apart in much the same manner as if they were located on a fault; a good example of this occurred in the 1971 San Fernando Earthquake, where an area of almost 163 acres moved down a 2.5% slope. Movement down a slope with such a low gradient had not previously been recorded, but such effects must be considered in future earthquakes.

Liquefaction occurred in Calleguas Creek, Mugu Lagoon and the lower Santa Clara River during the February 21, 1973, Point Mugu Earthquake. The effects were mainly the development of minor ephemeral features such as shallow cracks and sand boils, but as Morton and Campbell point out in their report (see Bibliography), if the shaking had been more severe, such effects might well have been widespread and could have resulted in significant agricultural crop losses. The effects on structures could also have been significant. Eyewitness reports of the effects of the 1857 Fort Tejon Earthquake (magnitude ~ 8.0) on the San Andreas Fault suggest liquefaction occurred along the Santa Clara River, along with other damage.

Liquefaction often causes settlement of the soil. In Niigata, Japan, after the 1964 earthquake, settlement of over 3 feet was common. In Alaska, the ground around one wellhead settled 4.5 feet; there were also numerous bridge foundation settlings. Liquefaction can also destroy or disrupt much of the infrastructure (i.e., gas lines, water, sewer, roads, etc.) in an area. Pipelines could be broken either by being floated to the surface or by landslide displacement. Bridge abutments could suffer differential settlement, cutting off roads. The settlement of large areas of land could drop some areas below sea level and produce a new shoreline, or at least require reconstruction to re-establish continuity of roads, etc. (see Subsidence Hazard). Roadways may be disrupted by uneven surface.

2.4.3 General Inventory of the Hazard

A liquefaction threat may exist in the entire hazard zone identified on Figures 2.4a and 2.4b. This map is a compilation of the quadrangle maps prepared by State of California Geologic Survey and/or Division of Mines and Geology that include the areas of potential liquefaction. Liquefaction may have occurred in these areas and can be expected to occur whenever an earthquake of sufficient intensity occurs.

Large areas of the County have a surface layer of unconsolidated sand deeper than 40 feet. Therefore, the primary variable factor for liquefaction in the County is the depth of the water table. The highest historic water level is used as the basis for all liquefaction analysis. This is reasonable in urbanized areas where the water table is usually rising due to a number of factors, including curtailment of agricultural pumping, importation of increased amounts of water, reduced evaporation due to paving, heavy irrigation from watering of yards, percolation of sewage, etc. Long-term changes may also result from the cumulative effects of the above factors, as well as extended periods of above or below normal rainfall. The threat posed by this hazard also varies depending upon the seasonal water level in some areas.

Structures proposed for human occupancy within the zone of potential liquefaction will require a geotechnical investigation to determine the liquefaction potential, potential effects of liquefactions, and to provide mitigation recommendations.

In terms of loss of lives or injury occurring from liquefaction hazards, the predominant threat exists in the Oxnard Plain, Santa Rosa and Pleasant Valley, the Ventura and Santa Clara River flood plains and portions of Ojai, Thousand Oaks, Simi Valley, and Newbury Park. In addition, those communities located in the Ventura River flood plain having concentrations of people, especially in single-family homes, may be affected. A number of schools could be affected by liquefaction, although they are in the moderate hazard zone, including DeAnza Junior High and all of the schools of Rio School District, and Rio Mesa High School. The Briggs Road Industrial Park is located in the high hazard zone, as are the nearby industries in the County areas of Saticoy. Other areas that could be affected include: (1) Ormond Beach Generating Plant and most of the high voltage transmission lines on the Oxnard Plain and crossing the Santa Clara and Ventura Rivers; (2) most of the oil facilities along Ventura Avenue, and (3) the entire Naval Base Ventura County, Point Mugu. There are also numerous pipelines and other underground utilities that could be affected on the Oxnard Plain and near the rivers.

Simi Valley appears to have a high liquefaction potential in the southern part of both the east and west basins. Most of the remainder of the Calleguas Creek areas appear to have adequate drainage to avoid the hazard, except for the lower Arroyo Conejo. Higher groundwater elevations may be present in the lower Arroyo Conejo due to the discharge from the City of Thousand Oaks Hill Canyon Wastewater Treatment Plant. This plant may contribute to higher groundwater levels in the western Santa Rosa Valley area and along Calleguas Creek further to the west. Thousand Oaks may have problems in the low-lying valley areas, including Hidden Valley, because of their alluvial nature.

The information used to define the hazard zones on Figures 2.4a and 2.4b was the best available at the time the maps were prepared. Also, the boundary lines represent a transition zone that may fluctuate seasonally, with changes in water supply.

2.4.4 Nature of the Information

Data on the water surface level was taken from the extensive well records maintained by the Ground Water Section of the Ventura County Watershed Protection and Water Resources Department. These well records include up to 50 years of actual measurements at approximately one-month intervals. However, certain areas did not have usable well records. So special reports were used or actual field data was collected. As a first approximation, the Quaternary geology of Ventura County was mapped in detail by William Lettis and Associates (William Lettis, 2001). This map defines the areas of the County that have younger sediments. The State of California utilized these maps, as well as, well records for material type and density, highest groundwater elevation, to produce the Seismic Hazard Maps for Liquefaction. The Lettis maps also include a range of low to very high liquefaction potential areas, however, the use of this data is limited to surface mapping and age of deposits. The State of California Seismic Hazard Maps should be utilized for all determinations for liquefaction potential.

The groundwater levels in alluvial areas were arrived at by taking the highest figure measured from the records of the Ground Water Section of the County Flood Control and Water Resources Department and the Leaking Underground Fuel Tank (LUFT) Section of the Environmental Health Division. The estimated effects of liquefaction may vary greatly within a given zone during a given earthquake. Any specific conclusions should be reached on the basis of detailed site-specific soils and geologic studies. The California Geological Survey Special Publication 117 provides recommended guidelines for the evaluation of the potential for liquefaction.

2.4.5 Conclusion

Liquefaction was a damaging hazard in Simi Valley during the 1994 Northridge Earthquake and it remains the biggest seismic threat in the County.

The hazard exists wherever there are certain soils, particularly loose sands that are constantly or seasonally saturated with water. This might include most of the river valleys and the low-lying plains areas that have poor drainage. Since subsurface soil properties are not precisely known, it is necessary to assume that all alluvial areas having high groundwater may be subject to liquefaction during strong ground shaking. If general surface liquefaction were to occur, most structures in the hazard zone could be affected to a greater or lesser degree.

There is little that can feasibly be done to reduce the regional liquefaction hazard. Important or critical structures can utilize special designs to alleviate the effects of the hazard, except possibly in areas subject to landsliding. Land use controls are the only other methods available to reduce the threat to life and property.

Special attention should be given to the liquefaction potential in evaluating the adequacy of existing critical or essential facilities in the high hazard areas, since the threat may be quite severe, especially to larger buildings.

Figure 2.4a
Liquefaction Areas Map - North Half

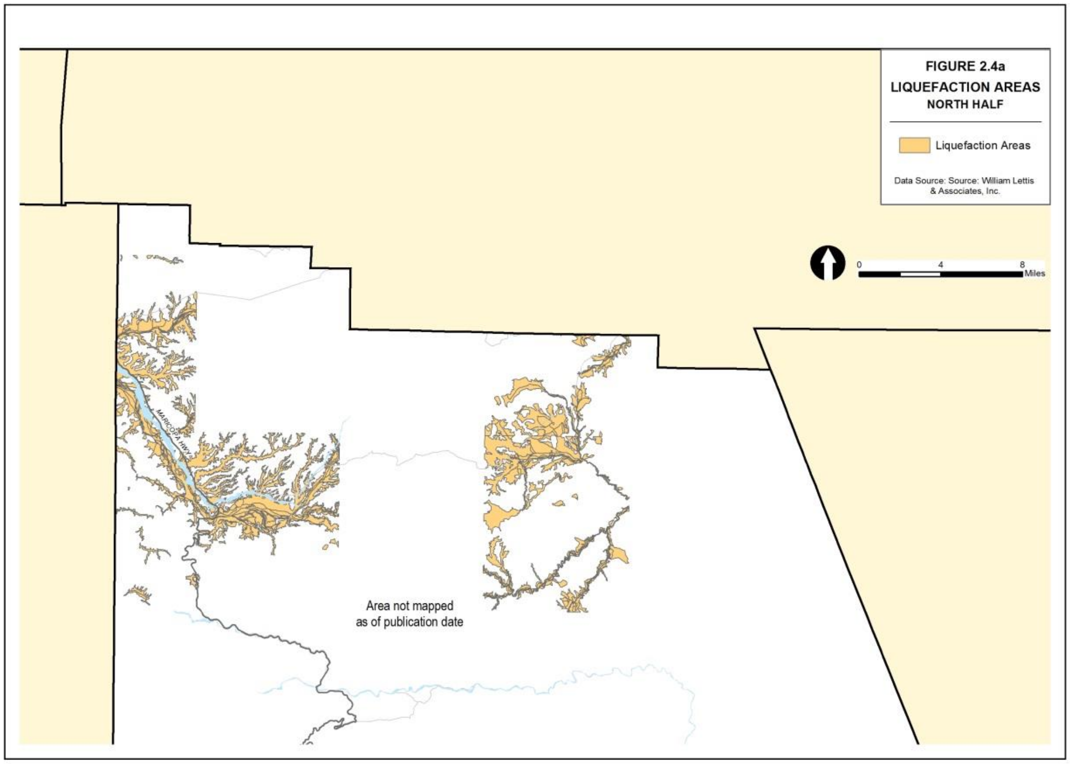
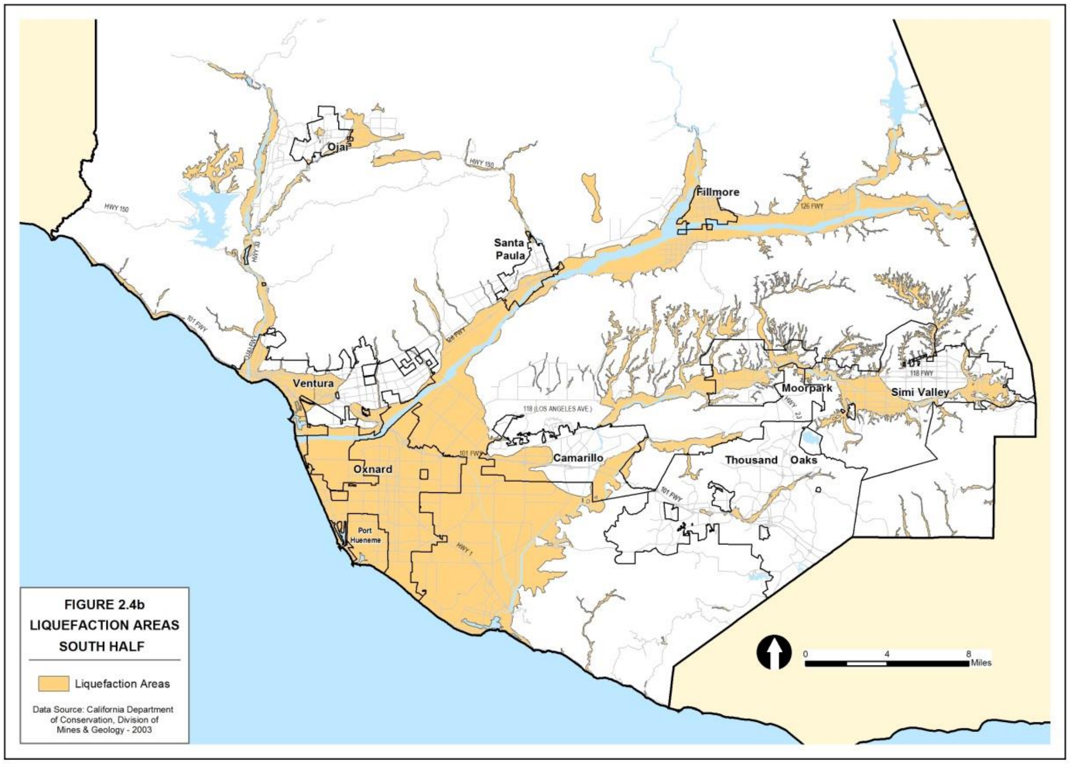


Figure 2.4b
Liquefaction Areas Map - South Half



2.5 Seiche

2.5.1 Nature of the Hazard

A seiche can be considered very similar to a tsunami with the difference being that the water waves are generated in a closed or restricted body of water such as a lake or within a harbor. The most common seiche experienced by County residents in most swimming pools occurred during the 1994 Northridge earthquake. The shaking of an earthquake (or other vibration) can result in large and destructive oscillations that produce waves tens of feet above normal lake (water) level. In harbors (such as Ventura Harbor, Mandalay Bay and the Park of Hueneme) and closed or restricted bays, these waves can destroy harbor and shore facilities. Indirectly, tsunamis, by causing a rapid change in sea level or more commonly by the wave itself, can set up smaller internal oscillations in bays and harbors. These seiches are very similar to tsunamis, but the waves are usually smaller and of lower energy. The trigger mechanism for seiche waves is similar to tsunamis wave generation.

The extent of most seiches is small, usually no more than ten to twenty feet above water level, and the duration is short, usually only a few minutes. However, a landslide can displace a wave that could travel hundreds of feet up the opposite shore of a body of water. Also, tsunami-caused seiches can last for many hours due to the possible rejuvenation of the seiche by each passing tsunami crest; however, each seiche would last only a few minutes and be of decreasing severity.

2.5.2 History of the Hazard

There is no record of a seiche occurring in Ventura County. Nevertheless, the worldwide history of the phenomenon illustrates the damage that seiches can do, and that seismic disturbances at great distances from this County could have an effect here. The Lisbon Earthquake of 1755 caused seiches in canals and lakes as far away as Holland, Switzerland, Sweden and Scotland, while on the Firth of Forth in Scotland, the water rose quickly eight inches or more soon after the time of the earthquake, and boats rocked at their moorings for three or four minutes (Bolt, et al., *Geologic Hazards*, 1977).

In Italy, in 1963, a landslide into Vaiont Reservoir caused a seiche that traveled up 800 feet on the opposite bank of the lake and swept over both abutments of the dam (the world's highest thin-arch concrete dam) to a height of 328 feet. The water completely destroyed the town of Longarone below the dam, killing almost 3,000 people.

The 1964 Alaskan Earthquake led to the agitation of wells as far away as the coast of the Gulf of Mexico. Seiche surges along the Louisiana and Texas coasts commenced between 30 and 40 minutes after the earthquake origin, or about the time the surface waves were passing through the area. Minor damage was widespread, with parting of barge moorings in the Mississippi River (Bolt, et al., Op. cit).

2.5.3 Conclusion

It appears that the actual threat that is posed by seiches in Ventura County is small, in that it is probably the most remote of the hazards studied, although it may not be the least severe.

There is no way to alleviate the effects of possible seiches except by prohibiting construction within the hazard area. The project geologist and geotechnical engineers evaluate mitigation of potential seiche effects during the preliminary design for structures located near known seiche areas. Typically, where practical, the structure is moved to a slightly higher elevation to reduce the damage potential and amount. Due to the indefinite nature of the triggering mechanisms, it seems doubtful that enough information will ever be known for general prediction of the hazard or predicting accurate seiche uprush limits for planning purposes.

2.6 Tsunami

2.6.1 Local History

Tsunamis are geologic hazards that can be the result of both ground shaking forces and forces other than ground shaking. *Tsunami* hazards remain the same regardless of whether caused by an earthquake event or not associated with an earthquake.

A tsunami (pronounced “soo-nahm'ee”) is a series of waves generated by an undersea disturbance such as an earthquake. From the area of the disturbance, the waves will travel outward in all directions, much like the ripples caused by throwing a rock into a pond. The time between wave crests may be from 5 to 90 minutes, and the wave speed in the open ocean will average 450 miles per hour.

Tsunamis reaching heights of more than 100 feet have been recorded. As the waves approach the shallow coastal waters, they appear normal and the speed decreases. Then as the tsunami nears the coastline, it may grow to great height and smash into the shore, causing much destruction.

1. Tsunamis are caused by an underwater disturbance - usually an undersea earthquake. Landslides, explosions, volcanic eruptions, and even impact of cosmic bodies (meteorites) can also generate a tsunami.
2. Tsunamis can originate hundreds or even thousands of miles away from coastal areas. Local geography may intensify the effect of a tsunami. Areas at greatest risk are less than 50 feet above sea level and within one mile of the shoreline.
3. People who are near the seashore during a strong earthquake should listen to a radio for a tsunami warning and be ready to evacuate at once to higher ground. Coastal residents experiencing heavy ground shaking for more than 20 seconds should not wait for local government to issue a warning, but move to high ground immediately and wait for further instructions.
4. Rapid changes in the water level are an indication of an approaching tsunami.
5. Tsunamis arrive as a series of successive “crests” (high water levels) and “troughs” (low water levels). These successive crests and troughs can occur anywhere from 5 to 90 minutes apart. They usually occur 10 to 45 minutes apart.

The worst recorded tsunami to hit California was in 1812. An earthquake occurred in the Santa Barbara Channel, and the resulting waves are reported by some disputed sources to have been up to 50 feet above sea level at Gaviota (Richter, Pg 113). The waves were probably at least 15 feet above sea level at Ventura.

In Crescent City, widespread damage and some loss of life occurred in 1964 as a result of a tsunami caused by the Alaska Earthquake. This tsunami caused more than $84 million in damage in Alaska and a total of 123 fatalities. The tsunami from that earthquake also caused approximately $35,000 damage to the marinas in Ventura County. This damage was mainly to the marinas’ channel banks and was caused by the rapid change in sea level.

In April 2010, a major earthquake off the coast of Chile generated a tsunami, whose effects in Ventura County were felt approximately 12 hours after the earthquake. A rapid change in sea level caused over $200,000 damage to structures and vessels in Ventura Harbor.

The historic record indicates that there is a small probability of occurrence of a major tsunami in Ventura County. Statistically it has been over 170 years since the last major tsunami, but many smaller, unrecorded tsunamis may have occurred.

Most deaths during a tsunami are a result of drowning. Associated risks include flooding, polluted water supplies, and damaged gas lines.

2.6.2 Location of the Hazard

All of the coastal and near coastal river areas in Ventura County are susceptible to tsunamis. A tsunami from the north Pacific could move down the Santa Barbara Channel and affect the northerly coastal areas; one from the South Pacific or from South America could strike the County coastal areas from the south to southwest; or a tsunami generated along one of the faults within the Santa Barbara Channel could affect much of the County coastal areas. The Channel Islands do not provide protection for the County coastal area, but in fact could either be the source of a locally generated event or reflect waves generated by a local source event. A submarine landslide near Santa Barbara is the likely source of the 1812 tsunami that caused significant damage in both Santa Barbara and Ventura Counties.

Tsunamis can also proceed up rivers for many miles if the gradient of the river is shallow. The effects of the waves are most noticeable on man-made features, but the waves can also change river channels and modify coastal landforms and these effects are noticeable for many years. The watercourses for the Ventura and Santa Clara Rivers and Calleguas Creek could be altered by a tsunami, and their biosystems temporarily damaged. There are likely to be similar effects on Mugu Lagoon.

In 2009-2010, a joint effort of the California Emergency Management Agency (CalEMA), California Geologic Survey (CGS), the Ventura County Sheriff's Office of Emergency Services (OES) and the University of Southern California (USC) (as a contractor) used updated and enhanced mapping information to evaluate the tsunami inundation zone. Additionally, historic tsunami information was reviewed to determine the "worst case" area, which is depicted in Figure 2.6. The joint team physically checked more than 60 individual sites to confirm the mapping product. The resulting product was coordinated with local jurisdiction, and reflects a coordinated approach to alert, warning and evacuation procedures throughout the County.

The recommended areas of evacuation in the event of a tsunami are all areas below the aforementioned elevations or within a mile of shore (whichever is of the greatest inland extent), and two miles inland on the Santa Clara River, Ventura River, and Calleguas Creek. The reason for extension of the zone two miles upstream from the mouths of these watercourses is that tsunami can generate a wall of water called a "bore", and the breaking waterfront can cause great damage.

There are a number of small communities within the county whose residents could be affected by a major tsunami. These include, on the north coast (west to east), Rincon, Del Mar (Bates Point), La Conchita (Punta), Mussel Shoals (Punta Gorda), Seacliff, Faria and Solimar (Deulah). The areas of Hollywood-by-the-Sea and Silver Strand, as well as scattered multiple dwellings on the south coast, could suffer damage. During the summer months, many people camp at several parks within the hazard zone. These include: Hobson, Faria, Emma Wood, McGrath State Beach and Point Mugu State Park.

All or portions of the cities of Port Hueneme and Oxnard, the Naval Base Ventura County, Point Mugu, and the Port Hueneme Seabee base are within a tsunami hazard area. More specifically, the Ventura Police Department on Ventura Avenue and the Fire Station on Santa Clara Street are also in the hazard zone, as are Pierpont School and sewage treatment plants. In a major tsunami, the Holiday Inn, parking structure and County of Ventura Fairgrounds could be damaged. The San Buenaventura State Park could be disrupted and be flooded in places, and the railroad and both highway bridges could be damaged.

2.6.3 Alleviation of the Hazard

The threat to human life can be nearly eliminated by an effective warning system when advance notice is available. The County territory as well as the Cities of Oxnard and Port Hueneme have an efficient warning system in effect, which can alert the entire affected population, if enough warning time is available.

As part of an international cooperative effort to save lives and protect property, the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service operates two tsunami-warning centers. The Alaska Tsunami Warning Center ATWC) in Palmer, Alaska, serves as the regional Tsunami Warning Center for Alaska, British Columbia, Washington, Oregon, and California. Subsequent to the 2004 Indonesia Earthquake and Tsunami, the system of warning buoys (DART) was expanded, and staffing was increased at both Tsunami Warning Centers.

The Pacific Tsunami Warning Center in Ewa Beach, Hawaii, serves as the regional Tsunami Warning Center for Hawaii and as a national/international warning center for tsunamis that pose a Pacific-wide threat. This international warning effort became a formal arrangement in 1965 when PTWC assumed the international warning responsibilities of the Pacific Tsunami Warning System (PTWS). The PTWS is composed of 26 international Member States that are organized as the International Coordination Group for the Tsunami Warning System in the Pacific.

Tsunami Watch and Warning Determination

The objective of the PTWS is to detect, locate, and determine the magnitude of potentially tsunamigenic earthquakes occurring in the Pacific Basin or its immediate margins. Seismic stations operated by PTWC, ATWC, the U.S. Geological Survey's National Earthquake Information Center and international sources provide earthquake information. If the location and magnitude of an earthquake meet the known criteria for generation of a tsunami, a tsunami warning is issued to warn of an imminent tsunami hazard. The warning includes predicted tsunami arrival times at selected coastal communities within the geographic area defined by the maximum distance the tsunami could travel in a few hours. A tsunami watch with additional predicted tsunami arrival times is issued for a geographic area defined by the distance the tsunami could travel in a subsequent time period. If a significant tsunami is detected by sea-level monitoring instrumentation, the tsunami warning is extended to the entire Pacific Basin. Sea-level (or tidal) information is provided by NOAA's National Ocean Service, PTWC, ATWC, university monitoring networks and other participating nations of the PTWS. The International Tsunami Information Center, part of the Intergovernmental Oceanographic Commission, monitors and evaluates the performance and effectiveness of the Pacific Tsunami Warning System. This effort encourages the most effective data collection, data analysis, tsunami impact assessment and warning dissemination to all TWS participants.

Tsunami Warning Dissemination

Tsunami watch, advisory warning, and information bulletins are disseminated to appropriate emergency officials and the general public by a variety of communication methods.

- Tsunami watch, advisory warning and information bulletins issued by PTWC and ATWC are disseminated to local, state, national and international users as well as the media. These users, in turn, disseminate the tsunami information to the public, generally over commercial radio and television channels.
- The NOAA Weather Radio System, based on a large number of VHF transmitter sites, provides direct broadcast of tsunami information to the public.
- The US Coast Guard also broadcasts urgent marine warnings and related tsunami information to coastal users equipped with medium frequency (MF) and very high frequency (VHF) marine radios.
- Local authorities and emergency managers are responsible for formulating and executing evacuation plans for areas under a tsunami warning. The County of Ventura and City of Ventura have installed telephonic notification systems, which can be used to notify residents and businesses in the potential evacuation areas. Depending on the availability of time, vehicle-mounted public address systems may also be used. The public should stay tuned to the local media for evacuation orders should a tsunami warning be issued, and the public should not return to low-lying areas until the tsunami threat has passed and the local authorities announce the "all clear."

The above material was modified from the National Tsunami Hazard Mitigation Program at website: http://www.pmel.noaa.gov/tsunami-hazard/.

These advisories and warnings are transmitted by National Oceanic and Atmospheric Administration satellite to the California Emergency Management Agency (CalEMA). The Warning

Control Officer and Director of CalEMA evaluate these warnings, and if necessary a statewide warning is issued to the local sheriffs, along with the estimated time of arrival of the wave. Ultimately, the Sheriff has the responsibility to decide whether to alert the coastal areas. If it is decided that an evacuation is necessary, the Sheriff will call the Police Departments of Oxnard, Ventura and Port Hueneme; the Highway Patrol; Fire Department; and the Director of Disaster Services. After this is accomplished, appropriate jurisdictions and departments are alerted. It is the responsibility of each jurisdiction to decide whether or not the effected population will be alerted. The alerting agencies can only warn people of the hazard; they cannot force evacuation. However, they can control re-entry into a hazard area.

Unfortunately, neither the Seismic Sea Wave Warning System nor any other known means of monitoring can provide sufficient warning time to all for evacuation of coastal areas should a tsunami be generated along one of the faults within the Santa Barbara Channel. The arrival time for such a wave at any point on the coast would only be a matter of minutes. The only warning prior to arrival of a possible earthquake generated tsunami would be the ground shaking experienced from the earthquake. Such shaking would be felt in advance of the tsunami's arrival and, if heeded, could serve to alert people to move to higher ground.

2.6.4 Ongoing Research

Research on tsunami hazards is continuing on virtually all levels of government. UNESCO's International Oceanographic Commission has established an International Tsunami Information Center in Honolulu, to promote further research and exchange of information concerning tsunamis. The National Ocean Survey (NOS) and U.S. Coast and Geodetic Survey of the National Oceanic and Atmospheric Administration are the primary investigators of tsunamis in the U.S. The U.S. Geologic Survey is also assisting in the basic research of processes involved in the generation of tsunamis. The California Geological Survey and the State Office of Emergency Services is investigating the extent of hazard to California.

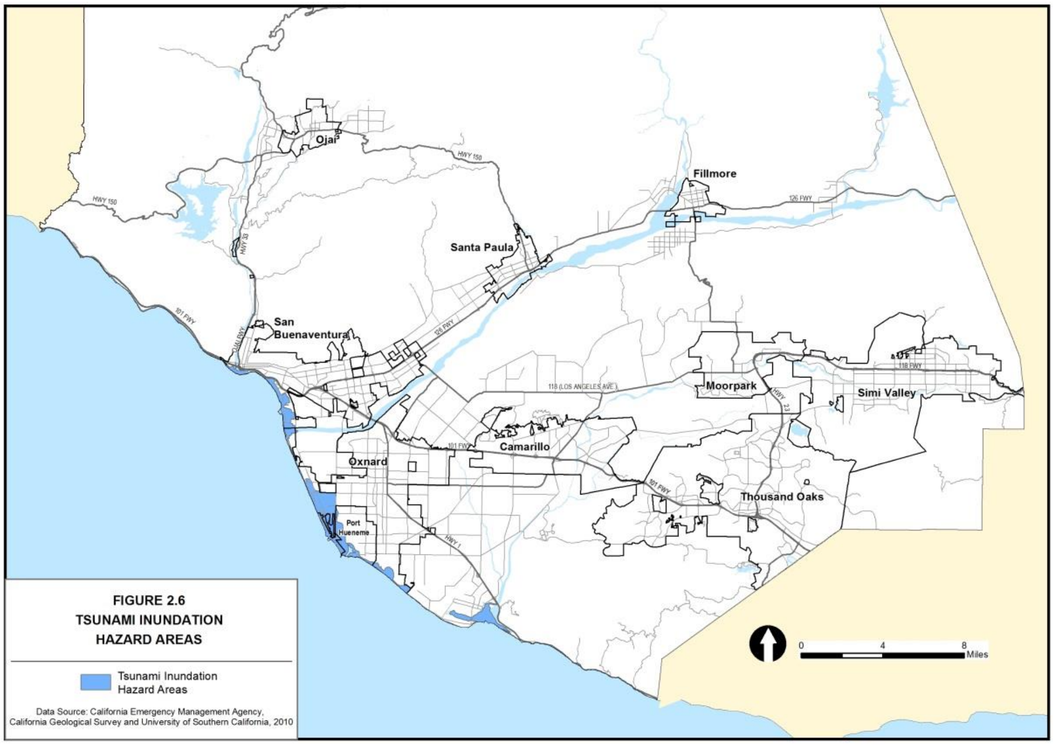
The University of Southern California (USC) has a tsunamis research group that is actively involved with all aspects of tsunami research; field surveys, numerical and analytical modeling, as well as hazard mitigation and planning. The web site is: http://www.usc.edu/dept/tsunamis/.

The use of the Internet has contributed to real time posting of potential tsunamis warnings. The National Oceanic Atmospheric Administration, National Weather Service, West Coast and Alaska Tsunamis Warning Center post recent events that may trigger tsunamis. The web site address is: http://wcatwc.arh.noaa.gov/message.htm.

2.6.5 Conclusion

Because of the small possibility of a major tsunami occurring in Ventura County it is not reasonable to prohibit all development near beaches, nor is it practical to recommend drastic measures to protect existing coastline development. In addition, the warning systems and evacuation plans that are in place are considered to provide adequate protection in the event of a major tsunami being generated beyond the Santa Barbara Channel.

Figure 2.6
Tsunami Inundation Hazard Areas Map



2.7 Landslides/Mudslides

2.7.1 General

"Landslide" is a general term for the dislodging and fall of a mass of soil or rocks along a sloped surface, or the dislodged mass itself. A "mudslide" is a flow of very wet rock and soil. Landsliding can be considered a major hazard in any hillside area. Most destructive landslides have resulted from the indiscriminate modification of sloping ground or creation of cut and/or fill slopes in areas of unstable or adverse geologic conditions. Many of these landslides could have been prevented by recognition of potentially unstable or adverse geologic conditions through adequate investigation and incorporation of design safeguards prior to grading or construction.

The hazard of landslides, however, is not always confined to areas commonly considered hilly or mountainous. Under certain soil and ground moisture conditions landsliding can occur in areas of nearly level ground. This was clearly demonstrated by landsliding triggered during the San Fernando earthquake of 1971 which resulted in destructive lateral ground movement over large areas with regional slopes of as little as 1½ percent. Conditions that could result in similar lateral spreading or low-angle landsliding may exist in some areas of Ventura County.

The following simplified classification system is modified from *Geological Hazards* (Bolt, et al., 1977) and Cruden, D.M., and Varnes, D. J. (1996):

Movement	**Material Behavior**	**Type**	**Rate**	**Names**
Fall	Brittle	Rock, Ice, Cemented Soils	Rapid	Rockfall, Icefall, Soilfall
Topple	Brittle	Rock, Debris, Soils	Rapid	Rock Topple, Debris Topple, Earth Topple
Slide	Unstable	Rock, Soil Snow	Rapid to Slow	Rotational slump Planar block glide Lateral spreading Slab Avalanche
Spread	Unstable to Stable	Rock, Soil	Rapid to Slow	Rock Spreads, Earth Spreads, Liquefaction Spreads
Flow	Stable	Rock Fragments,	Rapid to Slow	Rock Flow Sand Run
		Sand, Silt, Clay, Snow		Earth Flow Mud flow Avalanche

The rate of movement of the landslide is also classified into seven velocity classes that range from 1 to 7. Velocity class 1 is movement on the order of 16 mm/year up to class 7, which is movement on the order of 5 m/second. (Cruden, D.M. and Varnes, J.D. 1996). If the flow is taking place extremely slowly, the movement is referred to as creep, which is an extremely common phenomenon, probably occurring on every hillside in the world. Creep is imperceptible in the majority of these cases unless very precise measurements are performed.

In general, most landslides within the county are shallow, ranging up to perhaps 100 feet in depth and limited in extent, generally less than 100 acres. Most are not presently in motion (active), but have moved down slope to positions of “apparent” stability. The most notable landslide within Ventura County is the La Conchita landslide that occurred in 1995. In 2005, following a 15-day period of record or near record rainfall in southern California, the southeast portion of the 1995 landslide remobilized into a highly fluid, rapidly moving debris flow. This debris flow destroyed 13 houses and resulted in 10 confirmed fatalities. This landslide is a portion of an older landslide and reactivated in March of 1995. Another landslide area in Ventura County is along Ventura Avenue on the east side of the Ventura River.

Many of the existing landslides can be reactivated and downslope movement renewed after exceptionally heavy rainfall periods or as a result of an earthquake or combination of events. Landslides that occurred after the Northridge Earthquake in the north side of Simi Valley released sufficient quantities of dust that contained another danger, valley fever.

Since the advent of grading equipment and the continuing development of valleys and plain areas, hillside and coastal areas in Southern California have come under increasing pressure for urban development. As a result, man's activities involving cutting, filling, drainage diversions, irrigation, use of on-site sewage disposal systems and stripping of vegetation from slopes have also become major factors in the formation of new landslides and the reactivation of previously stable ones. Grading codes are changing to counteract man’s influence upon the development of landslides.

The construction of highways, hillside housing developments, dams, reservoirs, drainage and utility structures normally involve the movement of substantial amounts of soil or rock on slopes. Operations that include the addition of material to the top of a slope or the removal of soil or rock from its base encourage slope failure.

Man-made slides may occur during grading operations or after grading operations in hillside development. Those that occur during grading operations are generally not as hazardous nor as expensive to repair as slides that occur after development. Slides that occur after grading are an indication that the problem was not detected during grading, that sufficient corrective and preventive measures were not taken, or that stable conditions were modified after grading (*Man-Made Landslides,* F. B. Leighton, 1966).

According to Bolt, et al. (op. cit., 1977), "In extreme cases, landslides take place during or immediately following the construction process, but the effects of construction can be very subtle in many circumstances. The placement of fill material for a road across a hillside...may interfere with the natural regime of water flow and drainage through the soil or rock. In this way the weight of the material is perhaps increased or the water pressure is changed in the pores of the soil or in the rock interstices. Either consequence can give rise to a slide which occurs months to years after the completion of construction."

2.7.2 Nature of the Information

The known or mapped landslide areas within the County were detected mainly by aerial photographic interpretation. The information is considered to be fairly accurate for planning purposes to require additional detailed studies. Knowledge of the geology of many locales, especially within or adjacent to areas of urban development, was gained through experience in the particular area, field checking of some areas, and review of submitted consultant reports for new development or repair of landslides.

The present information is the best available to date and is considered adequate for general planning purposes. It will, however, need to be supplemented with more detailed mapping or studies for any proposed development.

2.7.3 General Inventory of the Hazard

The widespread landsliding and slope instability throughout much of Ventura County can be related to a great degree to the intensity of past faulting and folding of strata and to weak rock and/or the clay content of certain sedimentary formations, as well as subsurface moisture content. In general, the highest propensity for landsliding is found in weak rock formations along the more prominent fault zones, near anticlinal folds, and in areas of the younger geologic formations. It is apparent that the combination of these three factors has resulted in relatively intense areas of landsliding such as along the Rincon and hillsides south of the Santa Clara River.

Landslides and potentially unstable slopes are especially common in weak rock formations in hillside areas underlain by sedimentary bedrock of the Pico, Santa Barbara, Monterey/Modelo and Rincon Formations. These formations are generally soft and contain abundant silt and clay strata.

Many landslides are also associated with steep slopes that have been undercut by erosion (such as the several landslides along the easterly side of Big Sycamore Canyon northeast of Point Mugu) and downslope inclination of bedding planes (such as in the Ventura Anticline area). The presence of subsurface water is also a contributing factor to slope instability in the great majority of landslide occurrences.

Landslides and slope instability are widespread throughout the hillside areas. In general, most mapped landslides are shown on Figures 2.7.1a and 2.7.1b. They are subject to potential renewal movement if triggered by poorly planned grading, earthquake ground motions, or increases in ground moisture by any one of numerous factors including, sewage disposal, irrigation, rainfall, etc. The areas of landsliding are, in general, confined to the areas of weak or clay bedrock and adverse geologic structure (such as bedding, joints or fracture planes dipping in downslope directions).

Figure 2.7.1a and 2.7.1b are composite maps showing landslide hazards within the southern County area. The Map sources include the Dibblee Quadrangle Maps, Public Works Agency files, and the California Geologic Survey (California Division of Mines and Geology) Landslide Evaluation maps.

The Landslides shown on Figures 2.7.1a and 2.7.1b should be distinguished from the potential earthquake induced landslide hazard areas shown on the State of California Seismic Hazard Maps (See Figure 2.7.2). The potential earthquake induced landslide areas shown on the State of California Maps are those areas that may be subject to landsliding during or shortly following an earthquake. The mapped landslides are landslides or areas that have been mapped by various geologists as being an area with geomorphic features suggestive of landsliding.

Landsliding is not believed to present any significant hazard in the northern county area because dense population areas that may be affected by landslides are not present. However, the region is extremely mountainous with steep slopes and local relief in most areas ranges from hundreds to thousands of feet. Faulting and folding of bedrock strata are common and this creates adverse geologic conditions. Another widespread condition that may affect the overall stability of the hillsides is the general aggressive downcutting of stream channels and bank erosion (see Figure 2.7.1a).

The strength of the older bedrock throughout this region, in spite of the rugged physiography, has been the prime factor resisting the incidence of widespread landsliding. However, many hillsides and existing landslide features are only marginally stable and only slight changes in conditions, either temporary such as earthquake ground motion or intense rainfalls, or more long term such as grading and irrigation could trigger landsliding. In other words, the stability of many slopes is fragile and could, upon geotechnical investigation, be shown to be inadequately stable for most types of development without some remedial work to increase the stability.

2.7.4 Conclusion

Existing landslides should be recognized and, in general, their boundaries and immediate adjacent areas should not be developed, unless detailed geologic and geotechnical studies demonstrate adequate factors of safety or provide recommendations to be implemented with development to increase the factor of safety of landsliding to acceptable levels. However, these studies may indicate that it is feasible to stabilize some of these features by buttressing, etc., and thereby utilize the landslide for some form of appropriate development. Present requirements of the Uniform Building Code and Grading Code do not place an acceptable factor of safety on slope stability analysis; however, the County utilizes the common standard within the geotechnical community of 1.5 for static conditions and 1.1 for pseudo-static (earthquake) conditions.

Construction in hillside areas could, of course, result in formation of new landslides or reactivation of existing landslides if the grading or development design in such areas do not take into consideration potentially adverse conditions; either existing or created by the proposed development. Improper or poorly supervised grading projects, long term irrigation and onsite sewage disposal effects in areas underlain by ancient landslides or prone to slope instability could trigger movement.

Most areas of landslides and adjacent marginally stable slopes may not be feasible to develop because of the amount of grading necessary to increase stability to acceptable levels. However, with property values increasing, marginal areas will likely be investigated and may be improved to acceptable levels for development. Such grading may involve~~s~~ the reduction of hilltop~~s~~ and ridge~~s~~ elevations, and the placement of engineered compacted fill of intervening valleys and canyons. Depending on site constraints, economic variables, and development restrictions, landslides may be stabilized to allow development.

Approximately 75% of the total area of Ventura County can be considered as mountainous or hillside areas. Even the southern half of the County, which includes the Oxnard Plain, consists of about 60% hillside or sloping ground. Residential development has extended to some hillside areas within the county. Much of this development occurred prior to establishment of many of the present grading ordinance requirements concerning evaluation of hillside stability and incorporation of design provisions to safeguard against landsliding. The hazard will increase as more development occurs in hillside areas unless adequate geologic and geotechnical investigations of hillside areas are conducted and stability considerations are incorporated into development plans.

Development of County Subdivision and Grading Ordinances, land development policies and building codes over the past several years has progressively resulted in greater public safety. The present requirements are considered equivalent to, or exceed, those of other counties in California, and are considered adequate to ensure that areas of landsliding or areas prone to landsliding are not indiscriminately developed and that adequate measures are incorporated in grading and building design to ensure that landsliding will not occur. However, most incorporated Cities within the County have adopted more stringent requirements to protect against landsliding.

Figure 2.7.1a
Mapped Landslides Map - North Half

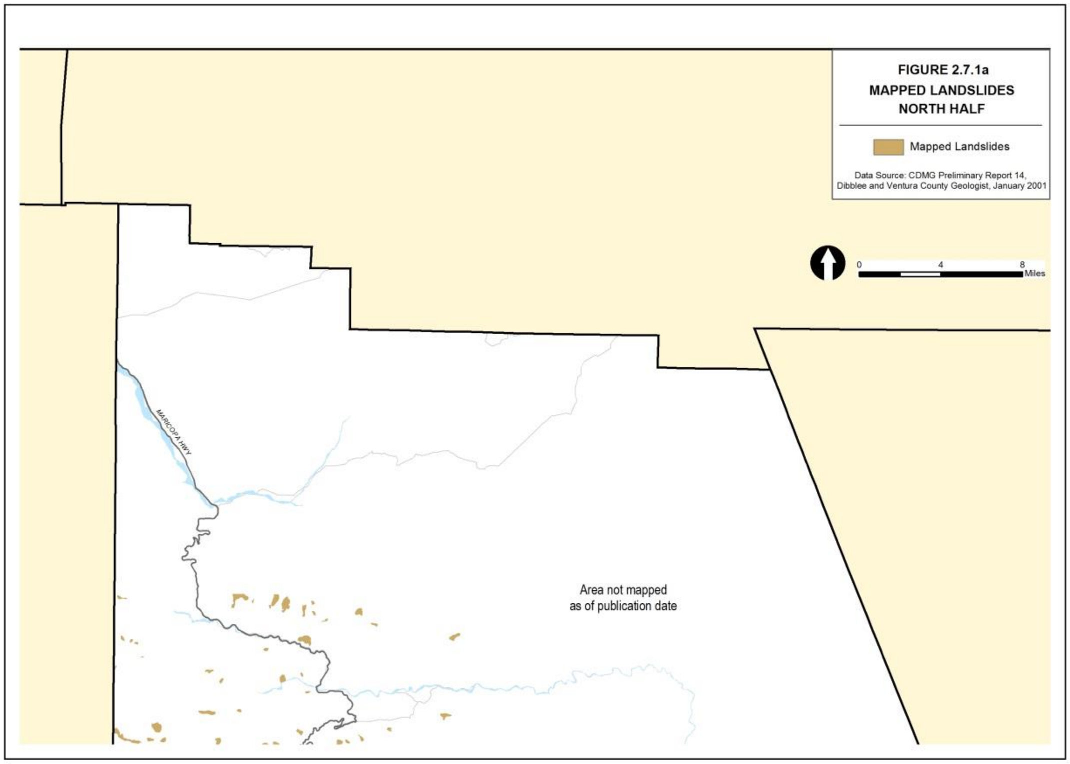


Figure 2.7.1b
Mapped Landslides Map - South Half

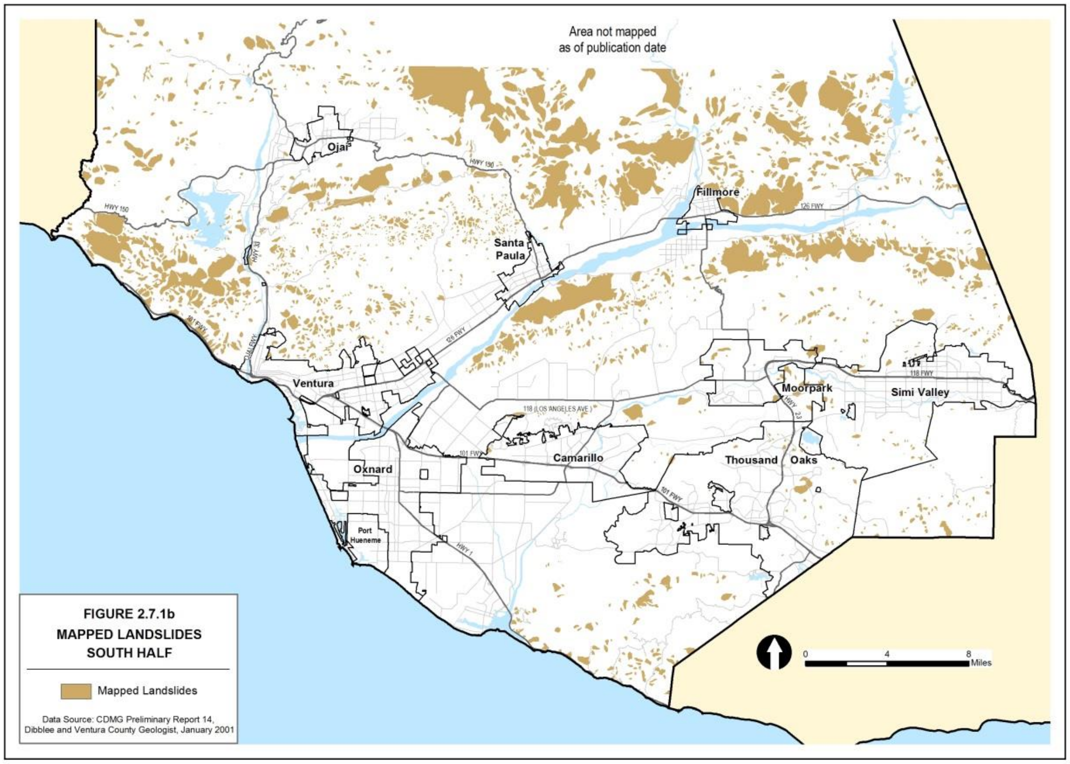
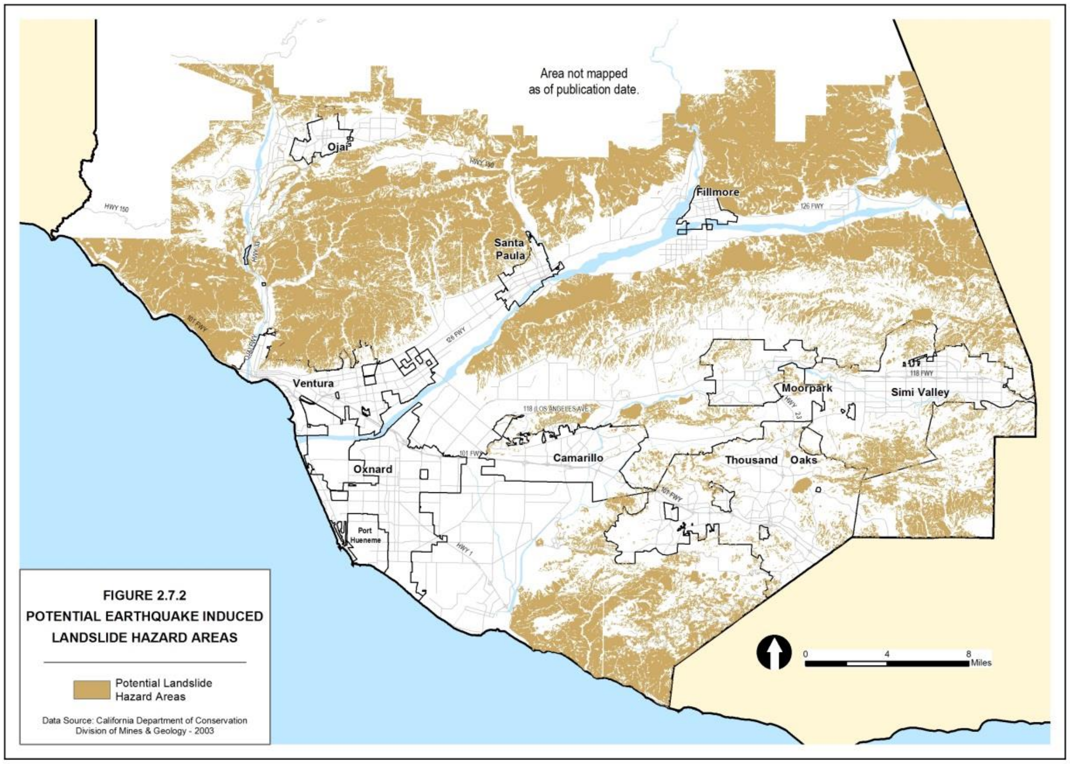


Figure 2.7.2
Potential Earthquake Induced Landslide Areas Map



2.8 Subsidence

2.8.1 Location of the Hazard

"Subsidence" is any settling or sinking of the ground surface over a regional area arising from surface or subsurface causes, such as earthquakes or groundwater and/or oil extraction. A very significant area in Ventura County, the Oxnard Plain, is experiencing subsidence. Data suggests that groundwater has been extracted from the aquifers underlying the Oxnard Plain at a rate that exceeds the rate of replenishment; this is referred to as "overdraft." Overdraft of water for agricultural, domestic and industrial uses increased from about 32,000 acre-feet per year in 1959 to about 44,000 acre-feet per year in the mid-1970s; overdraft for 1986 was estimated at about 33,000 acre-feet. The water table has dropped as much as 55 feet below sea level as a result of this continuous overdraft. The U.S. Coast and Geodetic Survey have monitored this situation since the 1930's. Up to 1965, one large area was subject to subsidence of between 0.04 and 0.05 feet per year. A single point located at Hueneme Road and Highway 1 has dropped 1 1/2 feet in just 21 years. Records to 1968 show a dozen benchmarks that indicate that the ground may have settled a foot in a fifteen to twenty-year period.

The Fox Canyon Groundwater Management Agency (GMA) was created in 1988 and has implemented Groundwater Extraction Ordinance No. 5.3. The 2002 overdraft figures of the Oxnard Plain are estimated at 18,000 to 23,000 acre-feet per year. Thus GMA efforts have reduced overdraft of the Oxnard Plain aquifers by 30-45 percent since the GMA was created. The GMA has adopted a goal of eliminating overdraft of Oxnard Plain aquifers by 2010.

The Santa Clara River poses another problem. It is building up sediments within its present course while no longer adding deposits to the remainder of the Oxnard Plain. If the old deposition sites have hydro-compacted due to sediment load and a local gradient difference is established, a flood could inundate the lower land. Extraction of fluids could increase the potential for this possibility.

Figure 2.8 shows the limits of the subsidence zones. The most severe area of subsidence reaches roughly from Pierpont in the north to the Mugu Lagoon in the south and extends east on the Oxnard Plain to the junction of Highways 1 and 101. The last two categories extend inland from the more severe subsidence on the Oxnard Plain ultimately up through the Santa Clara River Valley to a point just east of Piru. The subsidence zones are based on the figures from the 1973 Hazards appendix and were not updated due to a lack of geodetic survey data in the locations of potential subsidence. It is, however, the best available data.

2.8.2 General Effects of the Hazard

The damage caused by subsidence is generally not of an immediate or violent nature. Except when prompted by seismic shaking, the compaction of alluvium and settling of the land surface is a process that occurs over several tens to thousands of years and over a large area.

Subsidence that results from groundwater withdrawal can be responsible for numerous structural effects. Most seriously affected are long, linear surface infrastructure facilities that are sensitive to slight changes in gradient or slope.

Drainage courses, roads, rail lines, wells, oil/gas pipelines, and utility (water, gas, power, and sewer) lines are potentially the most vulnerable to damage. Basically, the process by which this most important type of subsidence occurs involves the extraction of a large quantity of water from an unconsolidated aquifer. As water is removed from the aquifer, the total weight of the overburden that the water used to help to support is placed on the alluvial structure; the overburden can then become compressed. If fine-grained silts and clays make up portions of the aquifer, the additional load can squeeze the water out of these layers and into the coarser grained portions of the aquifer. All of this compaction produces a net loss in volume and hence a depression in the land surface.

Subsidence caused by oil and gas extraction is similar in effect to that caused by water extraction. In one example, oil extraction was responsible for $100,000,000 in damages to various facilities and structures in the Long Beach area. Present day oil and gas extraction procedures are such that surface subsidence is maintained at a minimum by the replacement of the extracted fluid with another fluid.

Potential inundation must also be viewed as a potential secondary effect of subsidence in the County. Both the ocean and the Santa Clara River could flood into depressed areas of the Oxnard Plain. If a naturally low area is further depressed by subsidence, it is reasonable to assume that the damage will be more severe than if the subsidence had not occurred. In the case of the coastal portion of the Oxnard Plain, beach erosion could extend further inland due to the additional loss of elevation caused by subsidence.

Numerous other secondary effects can be identified. Most of these are related to the disruption of services provided by various structures that might be damaged by subsidence. Loss of life would probably occur only as a secondary effect of subsidence, say as the result of localized flooding.

2.8.3 Nature of the Information

Forecasting the extent, rate and magnitude of subsidence is difficult. A series of benchmarks must be established to measure any vertical change. This will, over time, provide information regarding the location of subsiding land and indicate which areas are subsiding fastest. Core samples can then be taken and compaction-tested to determine probable future consolidation. Combining this information with fluid withdrawal rates (if any extraction is occurring) can make prediction of future subsidence possible. From this point, the desirability of either planning for the subsidence in terms of regulated land use or counter-measures to halt the subsidence could be assessed.

Thus far, the only information available on subsidence in Ventura County has to do with its approximate rate and extent. No reports are available on causes or damage. The U.S. Geologic Survey (USGS), California Department of Water Resources (DWR) and the California Division of Oil and Gas (DOG) have investigated subsidence resulting from oil and gas extraction. In addition, studies of water withdrawal subsidence have been conducted by the USGS and the DWR.

Definite and detailed establishment of the rate and/or cause of subsidence in Ventura County has not been made. Public Works information indicates four possible causes: natural consolidation of alluvium, tectonic deformation, water extraction, and/or oil extraction. An analysis would necessitate detailed investigations over a five- to ten-year period into such areas as fluid withdrawal -both amounts extracted and types of formation withdrawn from. If, as a result of this analysis, it was found that human activities were responsible for the subsidence, then measures could be taken to halt or even reverse the process.

2.8.4 Alleviation of the Hazard

Adverse effects are moderated to some degree by State and Federal projects that provide surface water for injection into areas with dropping groundwater tables. In areas where such assistance is not available or where a project does not make up all of the groundwater deficit, then control of the problem is the responsibility of local water conservation districts. Presently, proper management for fluid withdrawal and replacement fluid injection helps to prevent continuing damage.

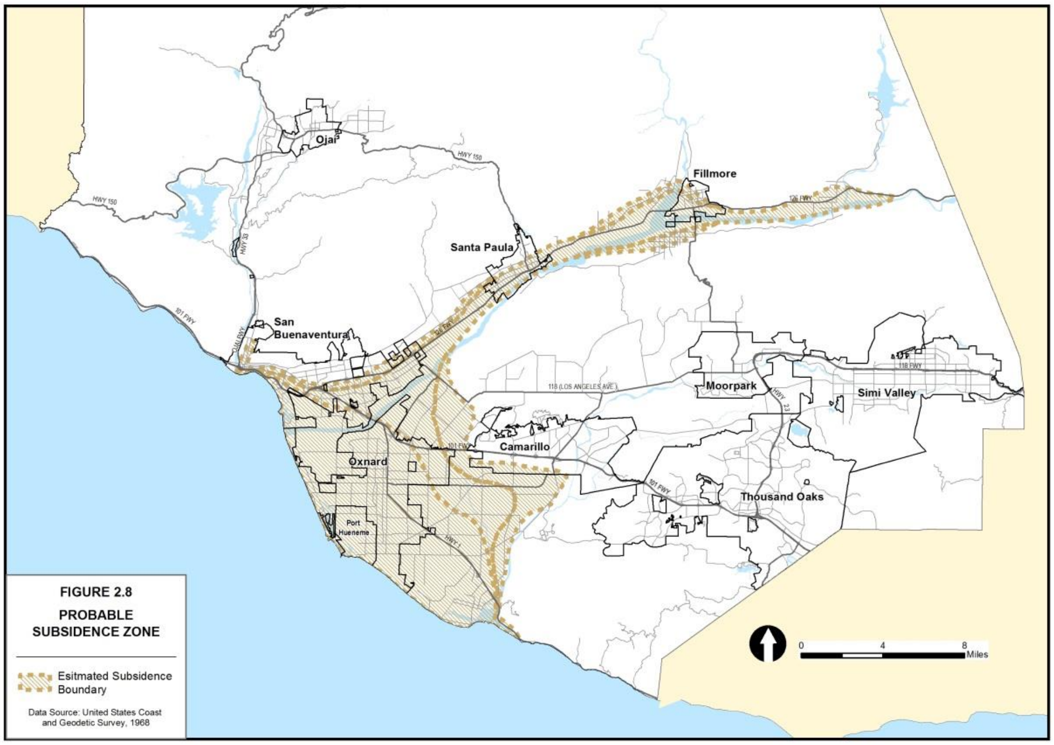
Since the removal of groundwater has been determined to cause or contribute to subsidence in other areas of California, consideration should be given to curtailing the further removal of groundwater at rates exceeding the natural recharge rate of the groundwater system. Experience in other parts of the State indicates that reductions in the extraction of groundwater can significantly reduce the rate of subsidence. In areas of unconfined aquifers, reduced withdrawal or increased recharge through water spreading is necessary. Confined aquifers or oil-bearing zones must be re-pressured by injection wells in order to alleviate subsidence. This is a costly procedure. (A confined aquifer has an impervious layer above it; an unconfined aquifer does not).

2.8.5 Conclusion

Most of the subsidence damage will occur at the boundary between the subsiding area and the adjacent non-subsiding area. The prediction of the boundary areas is difficult and relates to many different parameters that are presently not known. Some potential subsidence damage can be controlled. Such controls, however, must await the definite determination of the cause or causes of subsidence, as well as the rate of this subsidence. Until this information is fully developed, little can be done to plan for or respond to this hazard. If human activity, such as extraction of fluids, is determined to be the principal cause, then regulatory action could halt the subsidence. However, if natural processes are responsible, control is much less easily exercised.

In the meantime, efforts to reduce the rate of overdraft of aquifers should continue, and construction of gradient dependent structures in subsidence hazard areas should be properly evaluated for effects of subsidence prior to permit issuance. The collection of geodetic data on rates of subsidence will help to refine subsidence knowledge, and will also help in the search for solutions.

Figure 2.8
Subsidence Zones Map



2.9 Expansive Soils

2.9.1 General

"Expansive soils" are soils that expand when wet and contract when dry. Historically, expansive soils have caused considerable damage in Ventura County. In the early 1960's, numerous homes were razed and many more were severely damaged in the Shadow Oaks Tract, adjacent to the City of Thousand Oaks. This area experienced soil expansion that cracked many two-inch-thick concrete slabs. As the damage started to appear in the new homes of this tract, many of them were vacated. Other houses were rented; a transient group of people occupied these and the neighborhood generally declined. In time, repairs saved some homes while others were replaced using sturdier construction techniques. The Shadow Oaks case was primarily responsible for the establishment of more stringent building code requirements. Since the initial damage in the 1960s, engineering studies have resulted in design techniques and procedures that provide for safe and economical construction on expansive soils. Local building ordinances have incorporated these techniques and procedures. This has allowed construction even in areas where the hazard is severe.

2.9.2 General Inventory of the Hazard

The resources most often affected by expansive soils are structures. Even though expansive soils are scattered throughout the County, their potential impact on structures is limited to just a few developed areas: portions of the Ojai Valley, the Camarillo Hills and areas around the community of Moorpark. The presence of expansive soils in these developed areas presents no threat, however, because soils tests and engineering solutions can overcome the dangers of expansive soils.

The only phenomenon that must continue to receive special attention, with regard to expansive soils, is down slope soil creep in hillside areas. As expansive soil expands and contracts, it tends to move down slope in response to gravity. This condition may require flatter slopes, soil removal and special landscaping and irrigation treatment.

General information concerning the shrink-swell potential of the county's soils has been provided in the 1970 Soil Survey by the Soil Conservation Service. This investigation shows a scattering of such soils and thus indicates the necessity for individual investigations of local soil conditions.

A soils test at the specific site is necessary because this hazard is so localized in nature. Otherwise, it appears that no further information is needed about the general occurrence of expansive soil in the County, and the only action necessary to prevent damage is a process that requires the appropriate soils information be developed and applied to the specific site for the proposed structure. Through proper investigation and design, the potential for damage can be eliminated. Because the Uniform Building Code requires a soils report to address and mitigate the potential effects of expansive soils, the entire County is considered to have expansive soils to some degree and no delineation of the hazard is necessary.

2.9.3 Alleviation of the Hazard

It is generally accepted that the expertise exists both to identify the problem and provide solutions. Soils engineers can locate problem areas and provide foundation recommendations to mitigate the hazard. A geotechnical report is required by the present building code to obtain a building permit for the construction of structures. In lieu of a geotechnical report, the applicant may utilize the highest expansive soil type and design to mitigate the effects of that soil.

Numerous agencies have established standards to eliminate the potential for structural damage due to expansive soils. Both the Uniform Building Code (UBC) and the California Building Code (CBC) have requirements to be followed if expansive soils are present. The United States Department of Agriculture in conjunction with the University of California Agricultural Extension Station has recommendations based on their Soil Survey of Ventura County. In addition, the State Subdivision Map Act exerts control in all permit applications. Among the measures that might be employed are various foundation construction techniques, grading techniques during the initial phase of construction, and proper site surface drainage away from structures. The degree of expansiveness, as revealed in the expansion test, dictates the type of foundation design.

2.9.4 Conclusion

The resources most often affected by expansive soils are unequally loaded structures and rigid flatwork.

The County Building and Safety Division oversees the building permit and inspection processes. These processes, which have effectively ended the dangers of expansive soils, include representative soils tests at each construction site and the enforcement of building standards keyed to varying degrees of expansive soils. Through proper investigation and design, the potential for damage can be eliminated.

2.10 Flood Hazards

2.10.1 General Effects of the Hazard

The primary effect of flooding is the threat to life and property. People and animals may drown; structures and their contents may be washed away or destroyed; roads, bridges, and railroad tracks may be washed out; and crops may be destroyed. The amount of damage caused by a flood depends on the depth of inundation, the velocity of flow, the duration of the flood, the debris production of the watershed, and the erodibility of the bed and banks of the watercourse.

The severe erosion which results from fast-moving flood waters causes much of the property damage from floods. Serious damage can also be caused by the floating debris and sediment carried by floodwaters. Floating debris (including parts of buildings, trees, etc.) can obstruct the flood flow, resulting in increased flood heights and overflow areas. Debris can also damage structures and bridges, and can damage or plug flood control channels. Mineral and organic debris and sediment deposited on land create a serious cleanup problem and health hazard, and can destroy crops and croplands. Floods may also create health hazards due to the discharge of raw sewage from damaged septic tank leach fields, sewer lines, and sewage treatment plants, and due to flammable, explosive, or toxic materials being transported by flood waters. In addition, vital public service may be disrupted.

2.10.2 Local History

Damaging floods in Ventura County were reported as early as 1862; on average, floods have occurred every five years since then.

The largest and most damaging recorded natural floods in the Santa Clara and Ventura watersheds occurred in 1969. In 1969, the 50- and 100-year peak discharges were approximated in many channels. The combined effects of the 1969 flood were disastrous: thirteen people lost their lives, and property damage estimated at 60 million (1969) dollars occurred. Homes in Casitas Springs, Live Oak Acres, and Fillmore were flooded and 3,000 residents in Santa Paula and several families in Fillmore were evacuated twice. A break in the Santa Clara levee threatened the City of Oxnard. Much agricultural land, primarily citrus groves, was seriously damaged or destroyed. All over the County, transportation facilities, including roads, bridges, and railroad tracks, were damage. The Fillmore, Oak View, and Ventura sewage treatment plants were severely damaged, dumping raw sewage into the Santa Clara and Ventura Rivers and polluting beaches. In addition, sewer trunk lines were broken along San Antonio Creek and the Ventura River.

2.10.3 Location of the Hazard

Floodplain limits (1% annual chance floodplain, formerly referred to as the 100-year floodplain) are established by the Federal Emergency Management Agency (FEMA) and calculated using the latest available topographical information and hydrologic and hydraulic data through detailed Flood Insurance Studies (see Figure 2.10). These delineations reflect existing conditions; changes in topography or land uses could affect the limits. The floodplains of many watercourses in the County have not been mapped by FEMA to date due to budget and other resource constraints. These specific watercourses have been mapped as ‘A Zones’ and are technically referred to in the National Flood Insurance Program as “Approximate A Zones.” As proposals come forward to develop along these watercourses, it will be the applicant’s responsibility to finance and submit to the County Public Works Agency the detailed engineering analyses necessary for calculating the limits of the one percent annual chance floodplain and the regulatory floodway as well as the one percent annual chance flood elevation referred to as the base flood elevation.

2.10.4 Alleviation of the Hazard

The flood hazard may be alleviated through a variety of measures, some corrective and some preventive. Corrective measures include warning and relief programs, flood proofing of existing structures, and the construction of flood control works (channel improvements, levees, and dams). Flood warnings are issued by the U.S. Weather Bureau and relayed to the public through the local news media and Sheriff and Police departments.

Structural works are the traditional means of alleviating flood hazards through prevention; but such facilities are extremely costly and are rarely able to keep up with development. The cost of structurally containing all the channels in the County Watershed Protection District's comprehensive plan has been estimated at over 300 million (1969) dollars (VCFCD, *The Great Floods of 1969*, p.2).

Other preventive measures for alleviating the hazard include public acquisition of flood plain lands, public information programs, development policies and regulations. The most effective means of preventing flood damage appears to be flood plain management (i.e., the regulation of the types of activities permitted in flood hazard areas). Flood plain management addresses the problems encountered in the utilization of flood plains and considers the total spectrum of possible solutions to problems involving possible future land uses. Flood plain management cannot, however, protect all existing development. Therefore, to provide for the maximum alleviation of the flood hazard, a combination of corrective and preventive measures is necessary.

The issue of flood plain management is dealt with in several sets of regulations. Pertinent regulations are contained in the Subdivision Ordinance and Building Code, which require that buildings and improvements be protected from flood damage. The County Planning and Building and Safety, based on the recommendations of the Public Works Agency, enforce this provision. The standard condition imposed on development is that the homes be protected (by elevation, channel improvement, dikes, or flood-proofing) from the 100-year flood (see Figure 2.10). Further regulation is provided by the County's Flood Plain Management Ordinance (Ordinance No. 3841).

The Ventura County Watershed Protection District, which is governed by the Board of Supervisors, has the authority to maintain and construct flood control facilities on the channels shown on the District's Comprehensive Plan. Consolidated Ordinance WP1, adopted January 12, 2010, requires that a permit from the Watershed Protection District be obtained for most activities in, on, over, under, or across the bed, banks, and overbank areas of these channels.

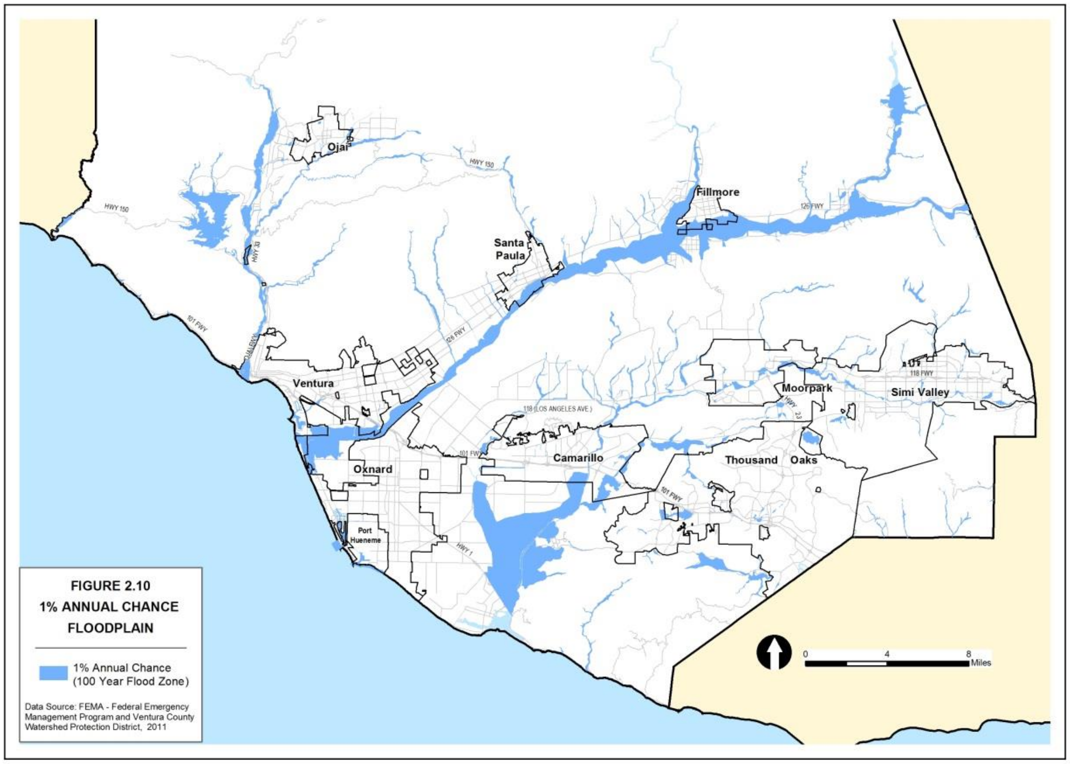
Outside of these limits, the prime responsibility for regulating activities in flood hazard areas lies with local governments. The regulations of the National Flood Insurance Program, which is administered by the Federal Emergency Management Agency, require that communities adopt land use restrictions for the 100-year flood plain in order to qualify for federally subsidized flood insurance. The type of restrictions communities must adopt are listed in some detail in Title 44 Code of Federal Regulations, Sections 59 through 70, which includes a requirement that habitable and non-habitable structures be elevated a minimum of one-foot of freeboard above the base flood elevation of the one percent annual chance flood and be flood-proofed. Participation in the National Flood Insurance Program is virtually mandatory, since flood insurance (within identified "special flood hazard" areas) is a prerequisite for receiving mortgages or construction loans from federally regulated lending institutions. Disaster assistance is not available to public agencies in hazard areas if they do not participate in this Program. Thus, the County must be, and is, a participating community in the National Flood Insurance Program in order to qualify for disaster assistance in the event of a declared natural disaster.

2.10.5 Conclusion

Floods are natural occurrences whose frequency and magnitude depend on the rainfall and drainage patterns. There is a one percent chance that the floodplain will be completely inundated every year. Also, a property located within a floodplain has a 26 percent chance of being flooded over a 30-year period, and is five times more likely to be damaged by a flood than by a severe fire. Past floods indicate that loss of life, property damage and loss of economic production could be extensive. In addition, funding for flood damage is limited and is costly to the public in general.

The most appropriate uses for flood plains are open space uses such as greenbelts, parks and some types of agriculture.

Figure 2.10
One-Percent Annual Chance Floodplain



2.11 Inundation from Dam Failure

2.11.1 Nature of the Hazard

The need for dam failure disaster planning was locally demonstrated by the midnight collapse in March 1928 of the St. Francis Dam in Los Angeles County. A major disaster occurred after the newly constructed cement arched dam was completely filled for the first time. The ensuing flooding from the dam's total collapse resulted in the loss of over 400 lives in Ventura County as floodwaters washed out homes and structures along the banks of the Santa Clara River. The communities of Piru, Fillmore, Santa Paula, Bardsdale, Saticoy, Montalvo and El Rio sustained extensive life and property loss from the flood.

More recently, the San Fernando Earthquake in 1971 resulted in ground shaking in the vicinity of the Van Norman Dam in Los Angeles County. As a result of the earthquake, structural damage threatened the dam's immediate collapse. Approximately 80,000 residents in the San Fernando Valley had to be evacuated to areas of safety in the midst of many other earthquake-related emergencies.

The lessons learned from these events and others are outlined in California's Dam Safety Act (Section 8589.5 California Emergency Services Act). This legislation requires the preparation of dam inundation maps showing areas of potential flooding in the event of sudden or total dam failure as well as emergency procedures for notification and evacuation of nearby residents.

In Ventura County, disaster coordination and planning is the responsibility of the Sheriff's Department through its Office of Emergency Services (OES). The OES serves as the depository for the County's Dam Inundation Maps and is charged with ongoing maintenance of the County's Dam Failure Response Plan which was adopted by the Board of Supervisors on September 13, 1983. The Dam Failure Response Plan is currently being updated by the OES.

2.11.2 Conclusion

While the prospects of dam failure are generally considered remote, the possibility of such an event cannot be taken lightly in view of the widespread potential for damage and loss of life.

A list of dams with inundation potential in Ventura County is attached (see Figure 2.11.1). Areas subject to inundation in the event of a dam failure are depicted on Figure 2.11.2; this map is for illustrative purposes only and does not indicate specific areas that may be affected by failure of specific dams. Detailed information of the latter type may be obtained from the agency that owns the dam in question or the California Department of Water Resources, Division of Safety of Dams

Figure 2.11.1
Dams With Inundation Potential Table

DAM/RESERVOIR NAME	OWNER	CAPACITY ACRE-FEET	TYPE	FLOOD ROUTE	IMPACTED AREAS IN VENTURA COUNTY	SPECIAL FEATURES
Bard Reservoir (Wood Ranch)	Calleguas Municipal Water District	11,000	Earth	Arroyo Simi	Simi Valley, Moorpark, Camarillo	
Bouquet Canyon	Los Angeles City Dept. of Water and Power (DWP)	36,500	Earth	Santa Clara River	Fillmore, Bardsdale, Santa Paula, El Rio, Oxnard, Pt. Mugu, Pierpont Bay	Dam near S.A. Fault Zone (5 miles)
Casitas Dam	Bureau of Reclamation	254,000	Earth Fill	Coyote Creek Ventura River	Casitas Springs, Ventura Ave.	Short Time for Warning
Castaic Dam	California Department of Water Resources (CDWR)	325,000	Earth	Santa Clara River	Piru, Fillmore, Bardsdale, Santa Paula, Oxnard Plain	High Potential for Debris
Drink Water Reservoir*	Los Angeles City DWP	80	Earth	San Francisquito Canyon	Santa Clara River	River Drainage
Dry Canyon*	Los Angeles City DWP	1,140 (Maintained Empty)	Hydrofill	Santa Clara River	Immediate Vicinity of River	Hydrofill
Elderberry Flood Basin*	Los Angeles City DWP	33,000	Earth	Santa Clara River	Fillmore, etc.	Drains into Lake Castaic
Ferro Debris Basin*	V.C. Watershed Protection District	7,900	Earth	Beardsley Wash Revlon Slough	Agricultural Area, Highway 118	
Lake Eleanor	Conejo Open Space and Conservation Agency	128	Constant Radius Arch	Eleanor Creek	Westlake Blvd. to Westlake	Concrete Arch (1881) Short time for Warning
Lake Sherwood	Murdock Development Company	2,694	Constant Radius Arch	Potrero Creek	Westlake area of Thousand Oaks	Concrete Arch (1904) Short time for Warning
Las Llajas Reservoir	V.C. Watershed Protection District	1,250	Earth	Las Llajas Canyon	Simi Valley (midsection)	
Las Posas Estates Debris Basin*	V.C. Watershed Protection District	42	Earth	Beardsley Wash		

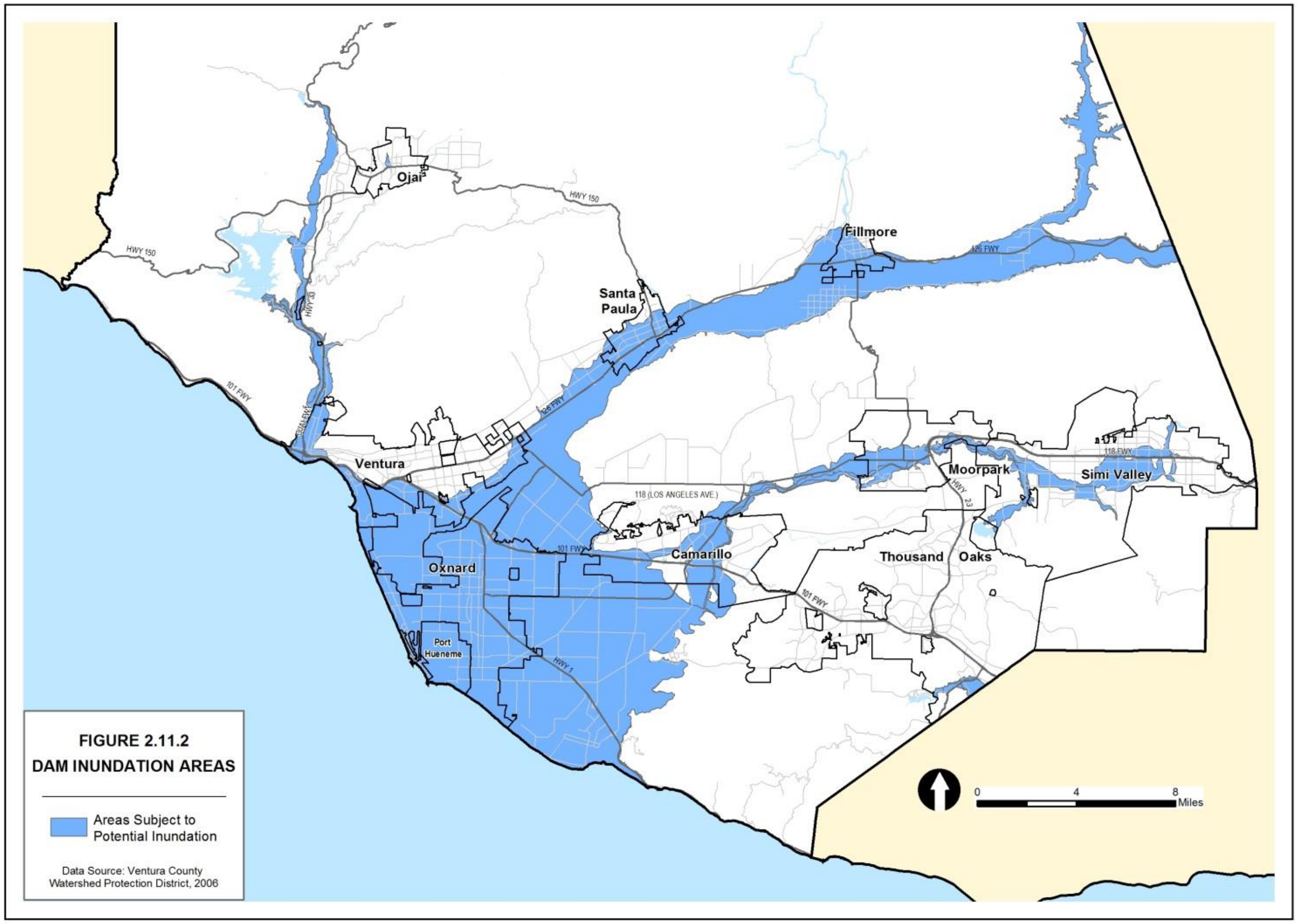
Figure 2.11.1
Dams With Inundation Potential Table (cont'd)

DAM/RESERVOIR NAME	OWNER	CAPACITY ACRE-FEET	TYPE	FLOOD ROUTE	IMPACTED AREAS IN VENTURA COUNTY	SPECIAL FEATURES
Matilija Dam	V.C. Watershed Protection District	1,800	Variable Radius Arch	Matilija Creek Ventura River	Matilija Hot Springs, Friends Ranch, County Dump, Live Oak Acres, County Honor Farm, Casitas Springs, and Ventura Riverbed	Dam Declared unsafe (Notch reduces storage capacity, monitored quarterly by VCFCD)
Meiners Oaks*	Meiners Oaks County Water District	15 (out of service)	Earth			
Sycamore Canyon*	V.C. Watershed Protection District	890	Earth	Arroyo Simi	Simi Valley	Inundated by Bard (Wood Ranch)
Pyramid Dam	CDWR	179,000	Earth Fill	Piru Creek, Santa Clara River	Piru, Bardsdale, Fillmore, Santa Paula, Oxnard Plain	Flows into Lake Piru (Santa Felicia Dam)
Runkle Debris Basin	V.C. Watershed Protection District	100	Earth	Runkle Canyon	Simi Valley (Midsection)	
Santa Felicia Dam (Lake Piru)	United Water Conservation District	100,000	Earth	Piru Creek, Santa Clara River	Piru, Bardsdale, Fillmore, Santa Paula, Montalvo, Ventura, Oxnard, Pt. Hueneme	Short time to Piru
Senior Canyon Reservoir	Senior Canyon Mutual Water Co.	78	Earth	Senior Canyon, San Antonio Creek	Ojai	
Sinaloa Lake	Sinaloa Lake Home Owners Association	200	Earth	Oak Canyon Arroyo Simi	Simi Valley	Inundated by Bard (Wood Ranch)

Compiled by Ventura County Office of Emergency Services from information obtained from Ventura County Watershed Protection District, State Division of Safety of Dams, and Dam Owners.

Exempted by State Office of Emergency Services (OES) from preparing Dam Inundation Plans or Inundation Maps for Ventura County.

Figure 2.11.2
Dam Inundation Areas Map



2.12 Coastal Wave and Beach Erosion

2.12.1 General Inventory of the Hazard

A beach responds with great sensitivity to the forces that act upon it - waves, currents, and winds. Beaches are deposits of material in transition, either alongshore or off and onshore. Ocean beach erosion is therefore a natural phenomenon, as beaches receive or lose sediment from rivers and cliff erosion and through alongshore currents that transport sand along the coast. Man has interfered with these natural coastal processes with the construction of harbors, marinas and jetties. Often these man-made structures can drastically alter the natural process of beach erosion and rebuilding, resulting in costly engineering efforts to restore the natural balance.

Beach erosion occurs when the "demand" for littoral material (the amount of material being removed by prevailing conditions) exceeds the "supply." The demand may become excessive as a result of an increase in wave energy, decrease in the source of supply, or a loss of beach material out of the littoral zone. When the demand exceeds the supply, the deficit is made up by the removal of existing beach deposits. Loss of sediment supply to the littoral zone may be due to construction of inland dams on rivers or developments on floodplains. The sediment supply of the major rivers in the Santa Barbara "littoral cell", of which Ventura County is a primary component, has been substantially reduced by upstream dam development on the Ventura and Santa Clara riversheds.

A "littoral cell" is a stretch of ocean shoreline containing a complete cycle of littoral transportation and deposition of sediment. A typical cell begins with a stretch of rocky coast where the supply of sand is limited. In a down-coast direction, determined by prevailing waves and currents, the beaches become gradually wider and the coastline straightens where streams supply a more abundant amount of sand. Submarine canyons or "sinks" may terminate the cell by capturing the supply of sand, thus causing the next littoral cell to begin with a rocky coast nearly devoid of beaches. Because each littoral cell is a closed system, any proposed development on the beach upriver may well have an effect on the sand "budgets" of the beaches down drift. Thus, the impact of an inland dam is limited principally to the littoral cell fed by the dammed river, so that reducing the amount of sand supplied by the Santa Maria River, for example, would not affect the amount of sand at Ventura.

The local Santa Barbara littoral cell extends from Point Conception to Point Mugu, with some sand migration from north of Point Conception where the Santa Maria Cell lies. The main tributaries to the Santa Barbara Cell are several small coastal streams in Santa Barbara County, coastal bluff erosion and landslides, Rincon area runoff, and the three major Ventura County rivers: the Ventura, the Santa Clara, and Calleguas. Of these, the majority of sand "nourishment" arrives from the Santa Clara River, which drains a vast area of the Transverse Range and associated Ventura Basin lowlands. The Santa Barbara Cell terminates in the Hueneme and Mugu submarine canons. Approximately 800,000 cubic yards of sand is lost down the Hueneme submarine canyon in any given year, representing two-thirds of the littoral drift in this area. Many of the beaches south of Point Mugu are "pocket beaches," supplied primarily with sand from cliff erosion

Alluvial and erosion sediments are transported to the shore, where breaking waves pick them up. The alongshore movement of sand is caused by the alongshore component of wave energy, which is a function of wave height, shoaling coefficient (a measurement of a wave's ability to deposit material on the beach), refraction coefficient (a measurement of the bending of the wave's direction as it reaches shallow water), and the angle at which the wave strikes the beach. More importantly, transport depends on wave period (time between wave crests) and steepness (ratio of wave height to length). During summer, wave periods are long and wave steepness is small, allowing for sand build-up. During winter, this is reversed and sand is moved offshore, exposing the underlying gravels to increased wave energy and erosion. Sand dynamics also depend on the alongshore drift fluctuating between up-drift and down-drift. Submarine canyons, projecting headlands, or engineering structures may also trap sand and induce erosion of down-drift beaches. Sand is also lost from the beach by the action of the wind.

Although wave and beach erosion are natural processes which tend to balance out over time, human action has altered this situation by reducing the natural fluvial transport of sediment through construction of inland dams, sand and gravel mining, and development of floodplains. The ability of the large rivers in our area to maintain a sand budget equilibrium may be seriously impaired by the interception of sediments by dams and sand and gravel mining. Other man-made causes of erosion include the construction of seawalls, groins, jetties, breakwaters and harbors. With the exception of harbors, these engineering devices are considered to be erosion control devices. However, their long-term effect may be to exacerbate the beach erosion problem.

Areas subject to wave and beach erosion are identified in the Local Coastal Plan. The Central Coastal region is not considered especially vulnerable to beach erosion because of the extensive sand replenishment projects located in this section (Ventura River to Ormond Beach). In the North Coast section (from Rincon Point to the Ventura River), the following areas are subject to beach erosion hazards:

- Mussel Shoals: This beach exhibits seasonal fluctuations in the amount of sand. A seawall had to be constructed during the 1978 winter storms. Erosion is gradual now, but may accelerate later.
- Seacliff: Homes in this area flood during storms and high tides. Construction of the U.S. Highway 101 overpass north of the colony obstructed sand transport and beach replenishment.
- Hobson County Park: Severe beach erosion prompted Caltrans to build a revetment at this beach. The intensity of wave action in the area has led to concerns about the wall's structural adequacy; it may need additional improvements.
- Faria Beach Park: This beach area has been severely damaged by erosion at the rate of about 1.3 feet of shoreline per year, and the park has been closed several times because of storm debris. The Department of Navigation and Ocean Development (DNOD) has also classified this area as "Present Use Critical". At the current rate of erosion, protective structures will be needed to preserve the recreation area.
- Faria Beach Colony: Erosion and flooding at high tide are continuing problems here. Seawalls are being undermined. The Department of Navigation and Ocean Development sees this area as "Future Use Critical".
- Solimar Beach Colony: Erosion is weakening the existing seawalls in this area. If homes are to be protected, then improvements will have to be made. This area is "Present Use Critical".
- Old Coast Highway: Waves top the revetment and create intermittent hazards for motorists.
- Emma Wood State Beach: This beach is eroding 0.6 feet annually, and recent winter storms have caused extensive damage and led to closure. DNOD recognizes a portion of the park as "Future Us Critical" and another segment as "Present Use Critical".

On the South Coast, both Point Mugu State Park and the Solromar area are threatened with severe erosion problems.

2.12.2 Alleviation of the Hazard

There are several techniques that can be utilized to alleviate the hazard of beach erosion. In addition, this problem is addressed in the County's Coastal Plan, and by the Beach Erosion Authority for Control Operations and Nourishment (BEACON).

Traditional Methods

Solutions to wave and beach erosion require an understanding of both the mechanisms of the Santa Barbara Littoral Cell and of the man-made actions noted above. It is important to note that the primary concern with loss of beach sand is that the sand acts as a buffer, protecting the coastal land from wave erosion. In areas where cliffs back the beach, as on the coast south of Point Mugu or on the Rincon, this may result in erosion of the cliffs. Where the beach is adjacent to flat land, sand depletion may lead to inundation of inland areas.

A related problem is the erosion of coastal bluffs in our North and South Coast areas. Erosion of these bluffs is also a natural phenomenon that, on its positive side, contributes to sand formation. However, transportation and housing in these coastal bluff areas is severely impacted by bluff erosion. Bluff erosion is caused by chemical weathering, mechanical action of waves, undercutting by waves, and by drainage from various sources of runoff.

Management of coastal wave, beach and bluff erosion requires a variety of engineering responses. Some of the techniques that are in use or envisioned include:

- Dredging sand from offshore sand deposits;
- Dredging accumulated sand from our marinas and harbors;
- Dredging accumulated sediment behind local dams and transporting it to the beach;
- Dredging from Hueneme or Mugu submarine canyons and transporting sand back up the coast;
- Mining sand from inland sources, such as sand dunes or flood plains, and transporting to the beach;
- Construction of groins to reduce the rate of littoral transport of sand; and
- Use of seawalls, riprap, jetties and breakwaters.

All of these techniques involve potential environmental impacts that must be weighted against their positive benefits. With respect to bluff erosion, the most important preventive measures involve the avoidance of artificial watering, increased surface runoff, and placement of structural loads near bluff edges.

Problems with riprap and seawalls relate to their cost and to their tendency simply to transfer beach erosion down-coast. They also require expensive periodic maintenance and reduce to some extent the aesthetic qualities of the beach. Groins and jetties act to interrupt transfer of sand down-coast until such a time as their placement has reached equilibrium, having built up the up-coast beach and caused beach reduction down-coast, when alongshore sand transport resumes. Again, problems emerge which may result in costly dredging operations. Breakwaters are offshore riprap structures that are designed to dissipate wave energy. They work well at beach erosion control, but require very careful design with relationship to distance from shore.

Local Coastal Program

The State-mandated Plan for the Coastal Zone sets forth a variety of policies related to beach erosion, and requires strict conformance with the State Coastal Act. Erosion control structures, which are discussed above, are assessed for environmental impacts and reviewed by County agencies with respect to structural soundness and effect on adjacent and downstream structures, net littoral or alongshore drift, and down-coast beach profiles. In addition, the Coastal Plan requires engineering reports detailing potential impacts with respect to the aforementioned structures, as well as provisions providing for guaranteed public beach access.

Beach Erosion Authority for Control Operations and Nourishment

In response to the continuing threat of wave and beach erosion, local agencies have formed a common group to address these problems. The Beach Erosion Authority for Control Operations and Nourishment (BEACON), consisting of the cities of Carpinteria, Oxnard, Port Hueneme, Santa Barbara and Ventura; Ventura and Santa Barbara Counties; Ventura County Watershed Protection District and Santa Barbara County Flood Control District; Santa Barbara County-City Area Planning Council; Ventura Port District Channel Islands Harbor District, Channel Islands Beach Community Service District; California Coastal Commission;

State Parks and Recreation and Boating and Waterways Departments; and the U.S. Army Corps of Engineers, was formed to provide regionally coordinated shoreline protection measures for the area between Point Conception and Point Mugu. In September 1987, BEACON received a State grant of $400,000 to study sand accumulation near harbors and offshore basins, areas in need of sand replenishment, quantities of sand needed, and potential source of replenishment.

BEACON has established the following goals based on the shared needs and concerns of its member agencies:

- Develop an understanding of the processes controlling shoreline changes along the South Coast, and a means to predict future changes as a function in incident wave climate and shoreline development.
- Develop a regionally coordinated program to manage existing sand resources in a manner that is both economical and environmentally sound.
- Identify and develop regionally coordinated mitigation measures to prevent future damage to coastal resources.
- Develop viable methods to fund needed studies and economically feasible mitigation measures on an ongoing basis.
- Develop an education/outreach program directed at increasing the public awareness of the regional nature and interrelatedness of beach erosion problems.

The agenda of BEACON is directed at achieving these goals. Representatives from the participating agencies and jurisdictions meet bimonthly. Although the Group has no authority to establish regional beach erosion control policy, it has made considerable progress toward achieving its goals by working with interested individuals, organization, and government representatives.

2.12.3 Conclusion

In the long term, wave and beach erosion hazards will continue to plague the Ventura County coastline. Attempts to develop local and regional control measures to alleviate beach erosion are absolutely essential if we are to maintain our coastline and its many uses. However, long-term sea level changes threaten further progress in this area. Because of this, a continuing program of monitoring of beach erosion problems and mitigation to avoid severe erosion losses is necessary and will remain an important task facing all County agencies with a stake in maintenance of our Ventura County beaches.

2.13 Fire Hazards

2.13.1 Nature of the Hazard

Ventura County is subject to a wide range of fire hazards throughout the year. From a planning perspective, wildfires in natural areas cause the most extensive damage, and are therefore the main subject of this section.

Ventura County is characterized by a Mediterranean-type climate, featuring wet winters and very dry summers. In addition, the local meteorological phenomenon of Santa Ana winds contributes to the high incidence of wildfires in Ventura County. These winds originate during the summer months in the hot, dry interior deserts to the east of Ventura County. They often sweep west into Ventura County, bringing with them extremely dry air masses that can exacerbate existing fires and further desiccate the chaparral and sage plant communities during the period of the year when the constituent species have very low moisture content. Figure 2.13.1 lists County fires since 1953 that have burned over 1,000 acres. Figures 2.13.3a and 2.13.3b illustrate Ventura County fire history since 1898.

The three most important factors influencing flammability of chaparral and sage are the moisture content of both living and dead plant matter; fuel loading, which refers to total plant biomass in a given area; and the ratio of dead to living plant matter. Moisture levels are high during the winter rainy season and progressively lower through the dry summer months. When the ratio of dead fuel to living fuel increases and when moisture content is low, fire susceptibility increases dramatically. In addition, the history of plant succession in a particular area is important in predicting fire susceptibility. For several years after a fire, easily flammable herbaceous species predominate and increase the likelihood of new fires. When the woody species become re-established, they contribute to a lower overall level of fire susceptibility for approximately the next ten years. After this, the slow aging plant community becomes ever more likely to burn due to increased levels of dead plant material and lowered plant moisture levels. Other factors influencing the likelihood of fire include the ratio of herbaceous species to woody species (grass burns more readily than manzanita) and slope exposure (southern exposure slopes tend to be drier and more fire-prone).

2.13.2 General Effects of the Hazard

The primary effects of fires are generally well known. Fires can cause loss of life, injury, and the destruction of buildings, as well as the destruction of wildlife, both plant and animal. Fires can also have a number of secondary effects:

- Fires often strain public utilities. For example, water supplies can be depleted, power lines can be downed and telephone systems can be disrupted;
- Flood control facilities may be severely taxed by the increased flow from the denuded hillsides and the resulting debris that washes down;
- Recreation areas that have been affected must also be forced to close or operate at a reduced scale; and
- Buildings that are destroyed by fires are usually eligible for re-assessment, which reduces income to local governments from property taxes.

The wildfires themselves usually last only a few days, but their effects can last much longer. If a grassland area has been burned it will re-sprout the following spring. If a chaparral community has been burned, however, it takes three to five years to recover. An oak woodland wildfire, in which most of the seedlings and saplings can be destroyed by the fire, will require at least five to ten years for a new crop to start. Most susceptible to long-term damage are coniferous timber stands. It may take fifty to a hundred years for a coniferous forest to re-establish itself.

Erosion is another secondary effect of wildfires. The removal of vegetation by fire leaves the soil bare and open to erosion when the rains begin in the fall and winter seasons. The wildfire kills the surface vegetation, allowing the raindrops to hit the surface with undiminished impact, splashing particles of soil loose that move downhill and are carried away by running water. The wildfire also destroys most of the roots that hold the soil in place, which allows running water to wash the soil away. Mudslides and mudflows are the results of these processes.

2.13.3 Fire Hazard Management

Fire hazard management is an integrated approach to fire suppression, controlled burning, and the related problems of watershed management and the retention of healthy, deep-rooted vegetative growth. With regard to maintenance of vegetative cover, a primary goal is to encourage vigorous, multi-aged stands of chaparral/sage that can respond favorably to periodic fire episodes. In addition, a strong, well-managed vegetative cover is essential for landslide control, especially with slopes ranging from 25° to 45° (beyond which rockslides are most common).

The primary purpose of fire hazard management is to minimize the chance of fire damage to public property, private property, and wildlife habitats. The specific management tools employed are often quite simple. For example, Ventura County's Fire Protection District requires an annual 100-foot brush clearance around structures in areas characterized by chaparral/sage. The authority for this requirement is the California Public Resources Code Section 4291 and the California Government Code Sections 51175-51189*.* Additionally, the Ventura County Fire Protection District adopted the Ventura County Fire Code (VCFC) that is based upon the International Fire Code, the California Fire Code and local amendments.

Another important management tool is the Ventura County Waterworks Manual *(Sec. 2.33)*, which includes requirements for minimum fire flow rates for water mains to help ensure adequate fire flow during a fire emergency. Appendix B of the Ventura Fire Code regulates commercial and industrial projects. Also, the County Road Standards Manual specifies (in the Fire Protection District's access standards) minimum road widths for access by fire protection crews and equipment. All County road width requirements are considered adequate to allow fire access. The minimum width for a cul-de-sac or loop street is 32 feet, and a cul-de-sac must have a minimum radius of 40 feet. The minimum road width for a minor residential road is 36 feet; all other roads have larger minimum widths.

Planning Division zoning standards for minimum distances between structures also are an effective fire protection tool to help contain a structural fire and limit damage to adjacent structures. When the Planning Division reviews a discretionary project, issues such as minimum road widths, maximum dead-end road lengths, and other access factors are considered to determine whether access routes for emergency vehicles and escape routes for residents will be adequate during a fire emergency. The Ventura County General Plan, maintained by the Planning Division, is also an effective management tool because it limits development capacity within most unincorporated areas of the County that are subject to wildland fire.

The Healthy Forest Restoration Act (HFRA) enacted by the U.S. Congress on Jan 7, 2003 established a protocol for the creation of a type of document that articulated a wildfire safety plan for communities at risk from wildland fires – a Community Wildfire Protection Plan (CWPP). The Ventura County Fire Department has prepared a CWPP for all of Ventura County. As specified by the HFRA, the Ventura County CWPP was developed in collaboration with local, county, state and federal agencies as well as various community organizations within the county. The CWPP identifies wildfire risks and clarifies priorities for funding and programs to reduce impacts of wildfire on the communities at risk within Ventura County.

Effective wildfire management in a large county such as Ventura County requires appropriate equipment and facilities. The Fire Protection District has a five-year plan for construction of new facilities that will better serve the growing urban fringe areas, which in most cases are being built within the chaparral/sage fire hazard areas of the County.

Another aspect of fire hazard management in Ventura County was the creation of a prescribed burn program as mandated by Senate Bill 1704 (Vegetation Management Program). This program has been proven effective since its inception. One of the most notable successes of this program occurred during the Ranch Fire in Upper Ojai in December of 1999 in which many homes were saved due to fuel modifications made through prescribed burning around the homes. This program aims at selective burn-off of limited areas of the chaparral/sage in order to prevent future large, uncontrolled wildfires. It also aims at encouraging the natural vegetation cycle of seed germination engendered by natural burns. The natural areas of Ventura County contain extensive chaparral and sage plant communities, which are fire-adapted and depend on fire for germination and sprouting. During the germination process, new sprouts grow from the roots and root crowns of many species. Other benefits from prescribed burns include range, watershed and wildlife habitat improvement. All things considered, controlled burning seems to be the best fuel management method currently available, although fuel and firebreaks are also used.

Cooperation among agencies is an integral part of the County's fire hazard management program. The County Sheriff and Fire Protection District cooperate in establishing wildfire response and evacuation plans, as envisioned in the Ventura County Hazard Mitigation Plan (2010). Other agencies involved in cooperative planning with regard to fire hazards include Building and Safety (property address coordination); Public Works (street naming coordination); and Planning (review of fire hazard issues during the review process for discretionary permits).

The County Fire Protection District maintains the *Fire Hazard Reduction Program* that, among other things, requires mandatory 100-feet of brush clearance around structures located in or adjacent to High Fire Hazard Areas. Failure to comply with the program by the annual, June 1 deadline can result in the Fire District completing the work and assessing a fee to the homeowner through a tax lien on their property. The role of individual property owners in responding to fire hazards is probably the most critical. Because of the large size of the County and the preference of many homeowners to build within or adjacent to High Fire Hazard Areas, these individuals must assume responsibility for the prevention of conditions, that may result in property damage during the fire season. Measures that may be taken by property owners, include the planting of fire-resistant landscaping, landscape maintenance, mandatory clearance of brush around structures, and site design.

Landscaping for fire hazard avoidance requires a compromise between minimizing fuel volume and maximizing root depth. This often involves interspersing herbaceous species having low fuel volume and short root systems with woody shrubs having greater root depth and higher fuel volume. Drought tolerance and sprouting ability are also important in fire resistant landscaping. Most of Ventura County's native herbaceous and woody plants, when properly spaced, are ideal for fire-resistant landscaping, since they require little water and can tolerate difficult sprouting conditions. The Ventura County Water Conservation Management Plan (July, 1987) contains further suggestions for low-water-using landscape materials which are also effective for fire hazard avoidance.

With respect to site design, new housing should be sited to avoid the path of advancing wildfires. Avoidance of narrow canyons and saddles or the juncture of canyons and ridge tops is suggested. Also, houses on ridge tops need to be set back from hillside edges to avoid fires spreading up the hillside to ignite a structural fire. Structures built in High Fire Hazard Areas should avoid wooden shingle roofs, or exposed wood sliding. Stucco metal siding, brick, concrete block, and rock are much better materials for fire avoidance, although with some of these materials, earthquake damage problems may be of some concern. In past fires, the least damage has occurred where structures:

- Have nonflammable roofs;
- Have brush cleared from around the structure;
- Have on-site pumps or other water supplies; and
- Are not located directly adjacent to brush areas.

Other fire prevention design features are available and are included in the Building and Safety Division plan-check process.

2.13.4 Emergency Response

Outside of the boundaries of Santa Paula, Fillmore, Oxnard, San Buenaventura, and the Los Padres National Forest, the Ventura County Fire Protection District has responsibility for wildfire suppression on all private land. The County has mutual aid and automatic aid agreements with the four city fire departments, the surrounding counties and cities, and local military bases. These mutual aid agreements obligate the departments to help each other in case of a major fire, if such help is requested. Automatic aid agreements obligate the nearest fire company to respond to a fire regardless of the jurisdiction. The State Office of Emergency Service can be called upon for further aid, if necessary, as can Federal agencies, including the Department of Agriculture, the Department of the Interior, and, in extreme cases, the Department of Defense. Private companies and individuals have also assisted.

The Ventura County Fire Protection District constantly monitors the fire hazard in the County, and has ongoing programs for the investigation and alleviation of hazardous situations. In case of a major wildfire, owners of homes and inhabitants of communities in the path of the flames are warned of the threat. Evacuation is recommended if the threat is imminent. The responsibility for warning and evacuation is in the hands of the law enforcement agencies, primarily the Sheriff's Department, since most fire hazards exist on unincorporated county territory. Evacuation can only be recommended, not ordered, since no one can force a person to leave their house. Formal evacuation routes are not predetermined, due to the unpredictability of a fire. Thus, law enforcement agencies react according to the needs of each situation.

Responsible public agencies in California, in general, and Ventura County in particular, have developed elaborate systems for fighting brush fires. When weather conditions become severe, all fire fighting personnel are put on alert. When a fire starts, all available personnel are rushed to the scene to keep the fire from developing into a major blaze. If the fire does get out of control and more than the County's own resources are required, mutual aid agreements are put into effect. If the situation becomes a major problem, State and even Federal aid is available for suppression of the fire.

The County has prepared an Emergency Operations Plan (EOP) for use by all county employees in the event of a major disaster or other emergency event. The plan outlines the Ventura County Operational Area’s strategic and coordinated response by all employees, and it assigns specific responsibilities in the event the plan is activated (Government Code § 8610; County Ordinance 4410, Article 2, Section 5325).

Ventura County is vulnerable to a wide range of human-caused, technological and natural disasters including earthquakes, floods, fires, hazardous material incidents, dam failures, civil unrest, transportation accidents, tsunamis, terrorism, and public health and agricultural emergencies. The Ventura County agency responsible for the day-to-day administration of the County's emergency preparedness, mitigation, response and recovery programs is the Sheriff's Office of Emergency Services (OES). The OES is responsible for the following:

- Development and maintenance of the Ventura County Operational Area Emergency Operations Plan (EOP);
- Maintenance of the County's Emergency Operations Center (EOC); and
- Coordination of EOC activities during a disaster.

OES staff also oversees the County's Disaster Service Worker Program (DSW), which includes the Auxiliary Communications Services (ACS), Disaster Assistance Response Teams (DART), and the Sheriff’s Search and Rescue (SAR) Team.

Within California's emergency management organizational structure, each county serves as an operational area. The Ventura County Operational Area includes the County and all political subdivisions within the County area. In this role, Ventura County Sheriff's OES acts as an agent between State OES and the cities, special districts and unincorporated areas of Ventura County.

During a disaster, this includes gathering information on the County's emergency response needs, assessing county and state resources, and facilitating the acquisition, coordination and use of those resources. For more information, a link to the County's preparedness and disaster information website can be found at http://www.vcsd.org/sub-office-er.php.

2.13.5 High Fire Hazard Areas

Figures 2.13.2a and 2.13.2b below are based on State Department of Forestry and Fire Protection (CAL FIRE) criteria, and these maps indicate areas of Ventura County that are most prone to hazards from wildfires. The degree of hazard is largely based on type of ground cover and slope. It is important to note that with the exception of flat farmlands in the Oxnard Plain and certain other areas, all areas of Ventura County are subject to periodic wildfire episodes. Additionally, Figures 2.13.3a and 2.13.3b show areas that have burned historically (since 1898) and recently (since 1993).

The Ventura County Fire Department also maintains guidance documents to assist homeowners that live in, or live adjacent to, High Fire Hazard Areas (aka Wildland Urban Interface areas) in preparing for wildfires. The *Wildfire Action Plan* (titled *Ready, Set, Go!*) consists of information and checklists for homeowners to prepare themselves and to make their home resistant to wildfires and prepare their families to leave early and safely. This information is available on the Ventura County Fire Department website.

2.13.6 Conclusion

Those communities located adjacent to fire hazard areas could be at risk, but there are few critical facilities located in the hazard zone that are not adequately protected. There are, however, some particularly hazardous lightly populated locations that could be severely damaged in case of a major fire. The areas that have high brush and that have not been burned for quite some time are probably the most susceptible. Most areas of high hazard have burned at least once within the last fifty years. Therefore, these areas could be expected to burn again in the next fifty years unless some method of fuel management is undertaken.

Due to distances of such properties from County fire stations, there may be considerable response time lag for structural fire protection on private lands within the National Forest boundaries. Zoning ordinances and building codes should be directed toward making structures inherently firesafe in these areas.

The hazard of major fires will continue in the County as long as people interact with the natural vegetation. An effective ongoing fuel management program can reduce the hazard. It is more reasonable to expend the funds to control hazardous areas before a conflagration occurs than to expend larger sums to fight the inevitable fire, with the resulting threat to life and property.

The various fire agencies will make every possible effort to save structures during a fire, but their effectiveness depends upon the preventive measures taken before the fire. If the brush has been cleared around the structure, a fire resistant roof installed, a sufficient supply of water is available and access is provided for the fire equipment, then there is an excellent chance to avert major damage. The chances decrease proportionately if any of these precautions are not taken.

After a fire, efforts must be made to reduce the risk from mudslides. This could include reseeding areas by the State Department of Forestry and Fire, the Ventura County Watershed Protection District, or the individual homeowners. Even if reseeding has been undertaken, precautionary measures should be taken to protect communities and individual structures from mudslides.

Figure 2.13.1
1953 To 2013 Fires Over 1,000 Acres

“Name” of Fire	Date Start	Acres Affected In County
Warring Canyon	9/14/52	2,153
Ventu Park	11/7/55	13,840
Hoffman (Red Mtn.)	8/31/55	1,200
Sexton Canyon	12/26/56	2,500
Little Sycamore	12/27/56	1,617
Lake Sherwood	12/28/56	7,747
Conejo Grade	6/18/57	1,000
Santa Susana Pass	7/3/57	1,482
Boulder Creek	8/27/57	3,987
Calumet Canyon	10/21/58	17,000
Broome Ranch	11/26/59	1,350
Doncon & Fletcher	1/15/61	2,700
Culbert Lease	12/4/62	5,525
Warring Canyon	8/28/67	3,808
Sence Ranch	10/15/67	17,431
Ditch Road	10/16/67	1,120
Parker Ranch	10/16/67	25,000
Timber Canyon	10/16/67	11,448
Torrey Canyon	11/20/69	1,800
Ventura City Foothill	9/25/70	5,241
Mayo Brush	9/26/70	4,390
Goodenough Road	10/5/71	2,100
Potrero	9/26/73	12,214
Sence Ranch	9/26/73	1,008
South Mountain	11/13/75	6,500
Potrero	12/28/75	2,773
Los Robles	6/22/76	2,000
Santa Susana	9/18/79	1,003
Creek Road	9/18/79	32,000
Hill Canyon	10/28/80	8,700
South Mountain	10/29/80	3,600
Loma	6/15/81	1,331
Oat Mountain	10/31/81	6,005
Matilija	7/7/83	4,600
Grimes	5/7/84	11,164
Squaw Flat	10/15/84	6,010
Wheeler	7/1/85	118,000
Black Mountain	7/5/85	1,025
Peach Hill	10/14/85	1,861
Pioneer	10/14/85	1,238
South Tapo	10/14/85	16,995
Ferndale	10/14/85	47,064
Rocky Peak (Hummingbird)	10/14/85	1,983
Fish	10/0287	4341
Peppertree – controlled	11/11/87	1088
Hall-Barlow - controlled	05/26/88	2227
Piru	09/03/88	12068
Kuehner	09/04/88	3761
Grimes	5/7/84	11,164
Squaw Flat	10/15/84	6,010
Wheeler	7/1/85	118,000
Black Mountain	7/5/85	1,025
Peach Hill	10/14/85	1,861
Pioneer	10/14/85	1,238
South Tapo	10/14/85	16,995
Pacific	10/29/89	3153
Los Padres	1991	2849
Broome Ranch - controlled	07/23/92	1310
Green Meadow	10/26/93	38477
Steckel	10/27/93	27088
Dragnet	10/27/93	1962
Wheel	10/27/93	1475
Boundary I	07/13/95	1010
Aliso II	11/12/96	1200
Sexton II - controlled	09/24/96	1273
Grand	07/02/96	10949
Hopper - controlled	08/05/97	1500
Hopper	08/05/97	24793
Piru	10/19/88	12613
Ranch	12/21/99	4371
Leslie - controlled	06/17/99	1087
Bradley	12/04/99	3332
Holser	07/17/99	2525
Piru	10/03	63,991
Simi Valley	10/03	108,204
Topanga	09/05	24,175
School	11/05	3,891
Day	09/06	162,702
Shekell	12/06	13,600
Ranch**	10/07	58,401
Guiberson	09/09	17,500
Spring	05/2/13	24,125

Source: Cal FIRE 2013.

** Fire occurred in both Ventura and Los Angeles counties.

Figure 2.13.2a
Fire Hazard Map - North Half

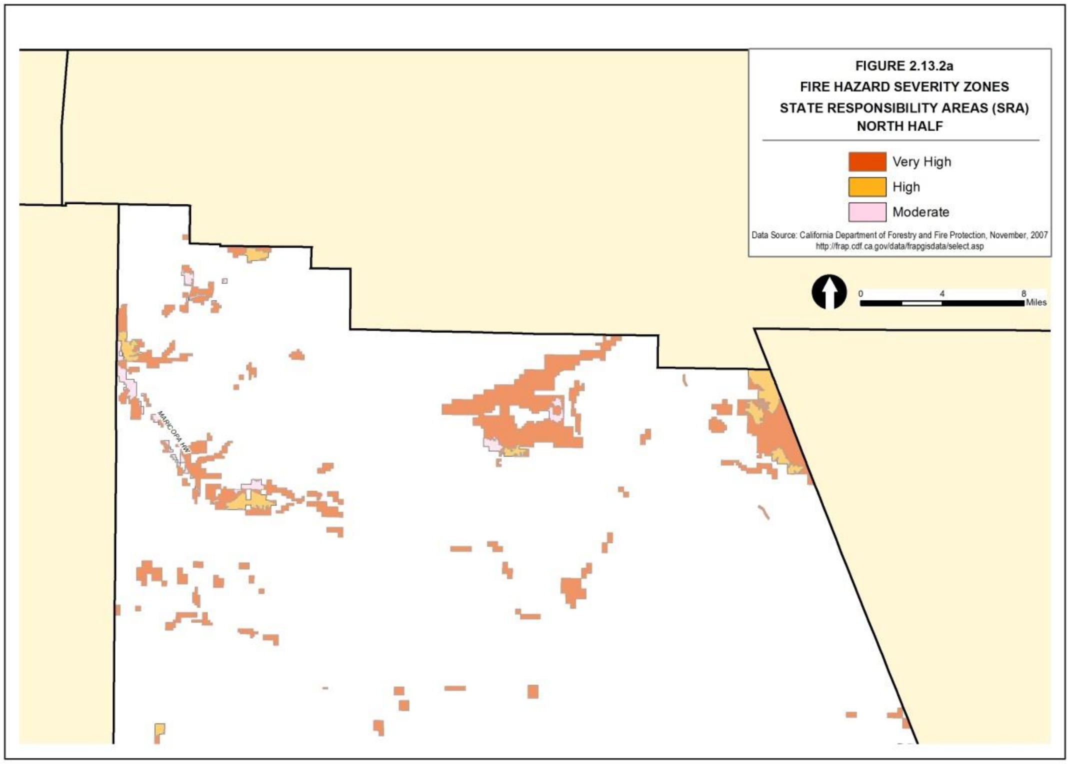


Figure 2.13.2b
Fire Hazard Map - South Half

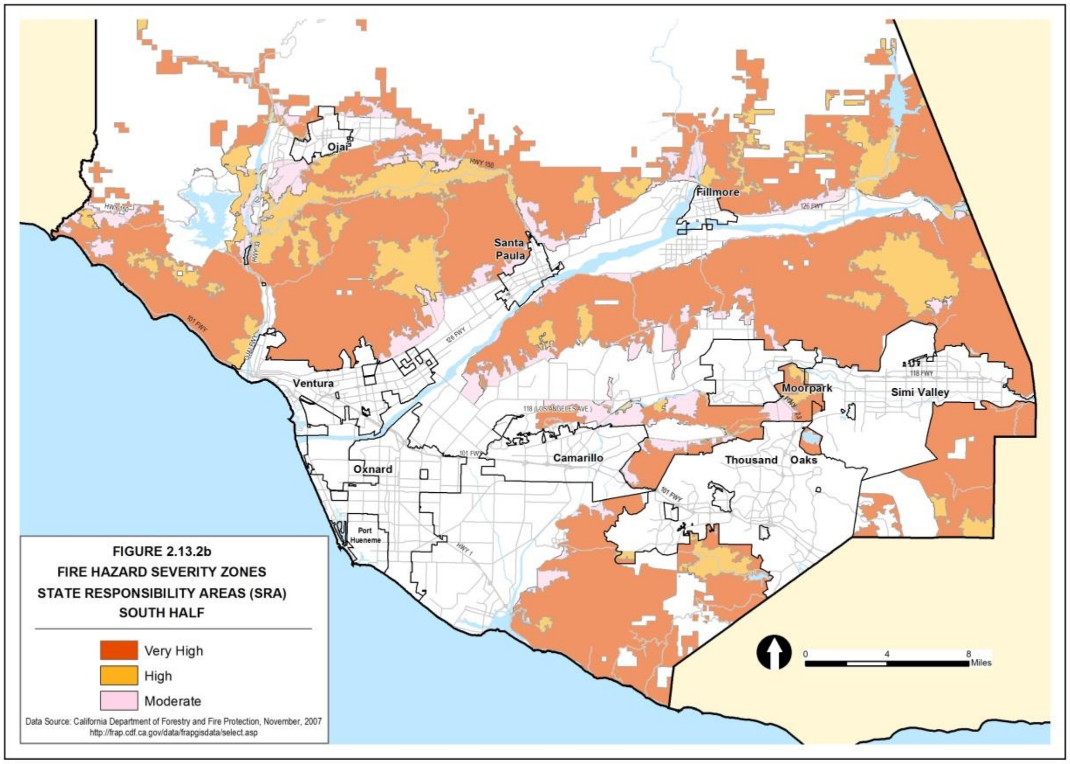


Figure 2.13.3a
Fire History Map - North Half

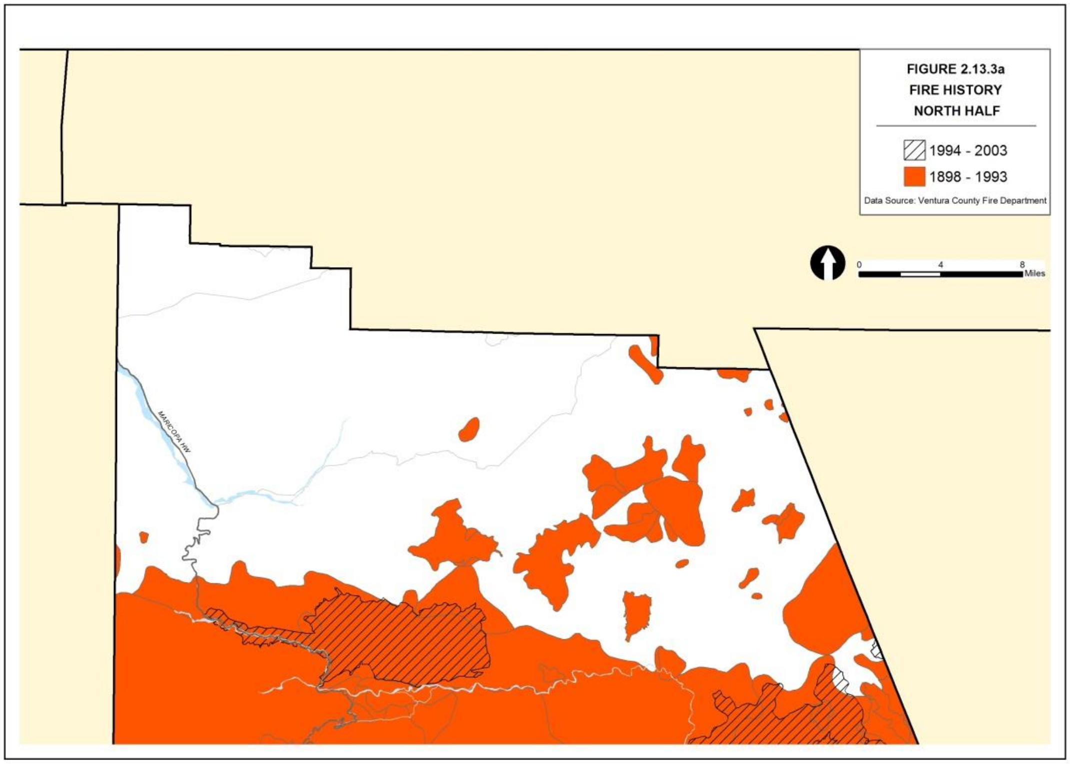
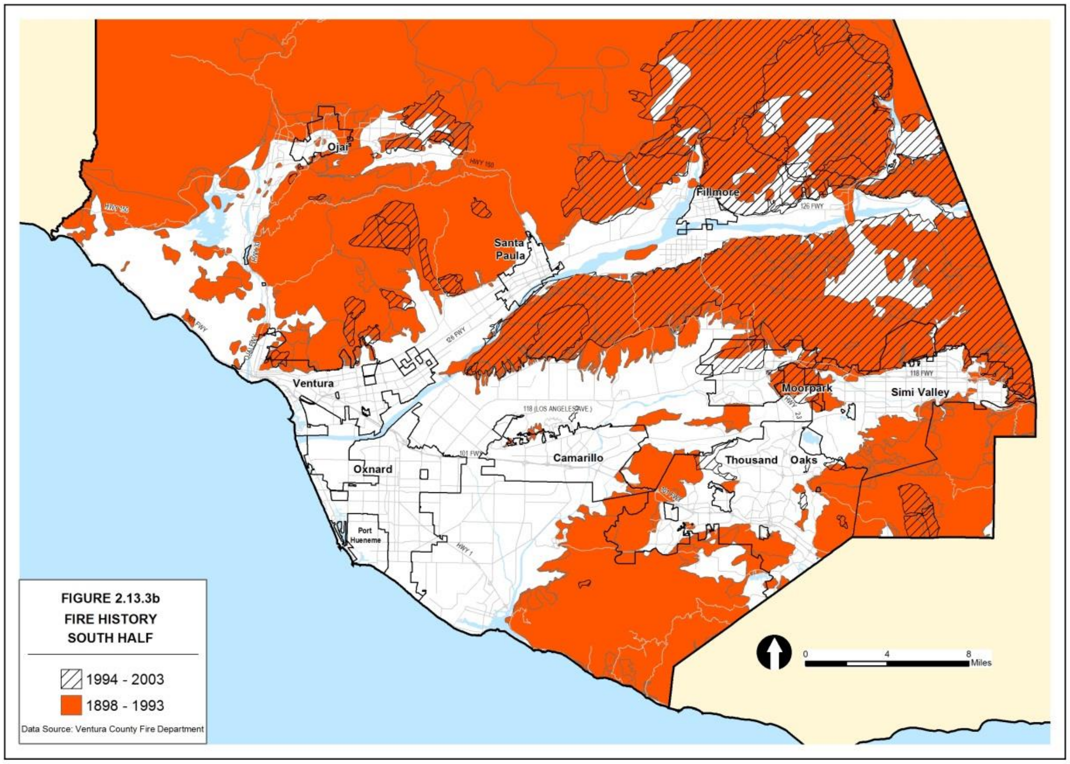


Figure 2.13.3b
Fire History Map - South Half



2.14 Transportation Related Hazards

Hazards associated with movement of goods and people or conveyance of hazardous materials have been grouped together and are addressed below. These include aircraft incidents, railroad incidents, trucking incidents, marine oil spills, and onshore oil pipeline spills.

2.14.1 General Effects of the Hazard

Aircraft Incident

Increasingly heavy air traffic over the greater Los Angeles metropolitan area and Ventura County's Naval Base Ventura County, Point Mugu are constant reminders of the possibility of aircraft accidents in the County of Ventura. While there is no major local airport, the Ventura County airports at Oxnard and Camarillo are very active, as well as the privately operated Santa Paula Airport. Aircraft crashes may occur anywhere within the county, therefore residential areas, business districts, and industrial areas are all equally in jeopardy. The attacks upon the World Trade Center and Pentagon have forced the consideration of the use of aircraft as weapons, and the coordination of responsibilities and actions with terrorism activities as discussed in chapter 17.

The airports nearest to Ventura County which handle the greatest amount of air traffic are as follows:

- Los Angeles International Airport (LAX) **-** The fourth busiest airport in the world and has experienced a four percent air traffic growth rate. Planes arrive and depart at a rate of one per minute.
- Burbank Airport **-** Is ranked 53rd busiest airport nationally in terms of air traffic that it handles and has experienced a 9.4 percent growth rate since 1993.
- Ventura County Airport at Oxnard **–** Is oriented toward general aviation.
- Camarillo Airport – Is designated as a general aviation field for use by private aircraft along with charter, agricultural and government flying activities. An aircraft control tower has been installed in order to monitor flight patterns and to assist in safe flying activities.
- Naval Base Ventura County, Point Mugu - Is a federal installation. The Navy is currently in the process of updating its Accident Prevention zone mapping for the Point Mugu facility.

Oxnard and Camarillo airports had a combined total of over 270,000 annual aircraft operations in 2003. With an additional 80,000 aircraft operations at Naval Base Ventura County, Point Mugu and an estimated 70,000 at Santa Paula Airport, the airspace in which these airborne activities are conducted can be, at times, heavily congested. While there will always be the potential for accidents, those historically involving serious or fatal injuries have been few in number. The Camarillo and Oxnard airports have FAA-staffed Air Traffic Control Towers providing positive control over aircraft in the respective areas from 7:00 am to 9:00 pm local time. Additionally, the tower at Point Mugu is active from 7:00 a.m. to 10:00 p.m.

The primary effects on the ground of aircraft accidents are injuries to people and damage to property in the area of impact. The severity of accidents varies greatly, depending on the weight, speed, and fuel load of the aircraft. The amount of destruction resulting from an accident also depends on the land uses in the impact area. Fewer lives would be threatened by a crash into a single-family house than by a crash into a school.

The secondary effects of aircraft accidents are more difficult to assess. It appears that some residents in the areas under flight patterns are often fearful of planes crashing into their houses. Combined with the problems of noise, this fear can result in pressures from residents to end or restrict airport operations.

The most critical stages of the flight of an aircraft are takeoff and landing; a significant proportion of aircraft accidents occur during these stages. The initial climb, which involves the greatest thrust of power, may lead to mechanical failure. During the landing phase, accidents may result from the misjudgment of the angle of approach or speed, or the inability to prevent a premature touchdown by increasing power and thrust. Such problems are mitigated by the use of instruments and visual landing guides. If a pilot experiences engine failure or other catastrophic problem and must crash-land off the runway, he will generally attempt to direct the aircraft away from structures and land in a clearing. Thus the purpose of the hazard zones depicted on Figure 2.14.1 is to delineate areas where there should be minimal construction, thus reducing the potential for human injury and property damage in the event of a crash-landing or other accident. Discouraging construction in these zones also has the effect of limiting the number of people who will be exposed to the high noise levels generated by aircraft operations.

Aircraft flying over Ventura are generally in Class E airspace. As such, they are not required to communicate with Air Traffic Control (ATC) unless flying above 18,000 feet, flying in instrument meteorological conditions, or flying in Class D airspace. Class D airspace is a circular area of specific height surrounding each of the Camarillo, Oxnard, and Point Mugu airports where communication with ATC is required. Outside of those areas, pilots operating small aircraft are not required to talk to ATC but often do as a best practice for safe operations. Pilots often rely on geographical landmarks as well as aeronautical charts and electronic signals to indicate their locations. If a pilot is unfamiliar with the geographical landmarks of the Southern California basin, he/she may misinterpret a particular landmark and inadvertently enter into Class D or other controlled airspace and create a safety hazard.

In incidents involving civilian aircraft, investigators from the National Transportation and Safety Board and the Ventura County Medical Examiners Office have short-term jurisdiction over the crash area, and their investigations will be completed before the area is released for clean up. The military has jurisdiction over any incident involving military aircraft. The clean-up operation may consist of the removal of large debris, clearing of roadways, demolishing unsafe structures and towing of demolished vehicles.

It can be anticipated that the mental health needs of survivors and the surrounding residents will greatly increase due to the trauma associated with such a catastrophe. A coordinated response team, comprised of mental health professionals, should take a proactive approach toward identifying and addressing mental health needs stemming from any traumatic disaster.

Railroad Incident

Rail lines currently extend from Santa Barbara County along the coast to Ventura, Oxnard and Port Hueneme and inland to Santa Paula, Fillmore and Piru and to Camarillo, Moorpark, Simi Valley and extending east to Los Angeles County (See Figure 2.14.2b). These rail lines present a potential hazard zone for rail accidents involving hazardous materials and military ordinance. Because these rail lines traverse populated areas there is a continual threat that a railroad incident could occur that might involve hundreds of people. The increased passenger train traffic created by commuter rail services also opens the possibility of an incident involving large numbers of people.

Rail incidents would occur on or near the Union Pacific or Ventura County Railway rights-of-way (Figure 2.14.2b).

The Federal Railroad Administration (FRA) (part of the Department of Transportation) is responsible for the investigation of all railroad accidents and should by notified immediately.

Trucking Incident

A major truck incident that occurs in a heavily populated industrial area or residential area can result in considerable loss of life and property. Potential hazards could be overturned tank trailers, direct impact either into a residence or industrial building, or interference with the normal flow of traffic. As with rail incidents described above, truck transport can also result in fires, explosions or spills of hazardous materials. Trucking incidents can occur on or near any thoroughfare, but are most likely to occur on truck routes. Designated truck routes in Ventura County include US 101, one of the two major North-South routes in California. Additionally, designated truck routes include several major State Highways that connect other routes and cities, including Highway 33, Highway 118, and Highway 126 (see Figures 2.14.2a and 2.14.2b).

Marine Oil Spill

Oil spills, many of which occur naturally, are readily apparent in the environment. Marine oil spills present as slicks or sheens, dependant on the type and weight of oil. Being lighter than water, virtually every type of oil floats until broken down into fractional components by nature or the intervention of man. Floating (or sinking oil fractionates) are a hazard to the marine environment. When ingested by animals, poisoning and death can occur. Oil coating of plants or animals can interfere with bodily functions, leading to death or severe illness. An offshore spill can result in oil-contaminated beaches. Oil washing ashore can also lead to health and safety issues, as well as economic impacts caused by loss of use (of recreational assets) or damage during efforts to clean or protect sensitive areas.

The potential exists for offshore oil accidents and spills in Ventura County involving petroleum products due to the oil and gas development, transportation of liquid bulk products by tanker ships, and other vessel traffic carrying petroleum products for fuel. The major potential sources of offshore spills are separated into the following categories: oil production platforms, vessel traffic along the coast, sub-sea pipelines and marine terminals.

In February 1990, the American Trader spilled approximately 9,500 barrels of oil off Huntington Beach in Southern California. In March 1989, the Exxon Valdez spilled 26,000 barrels of oil in Prince William Sound in Alaska. In September 1987, the Pac Baroness left Long Beach for Japan carrying 8-9,000 barrels of bunker fuel. Approximately 14 miles west of Point Conception, the carrier collided with the Atlantic Wing, a Panamanian freighter carrying 3,451 automobiles en route to Long Beach. Approximately 12 hours after collision, the Pac Baroness sank within 7 miles of Platform Hermosa. Estimates of the oil released as a result of the sinking ranged from 4,000 gallons to 40,000 gallons with the resulting slick covering an area 10 miles by 3 to 4 miles within 24 hours.

Platforms have relatively small amount of oil (a few thousand barrels) stored on them. Historically spills from platforms only involve a few barrels. The platforms are equipped with spill response equipment to contain and cleanup any small spills. Given the worst case that a platform is somehow completely destroyed (e.g., rammed by a vessel or from a significant seismic event) the oil on the platform and the oil in the risers running from the sea floor to the platform could be released. Because of the safety equipment beneath the sea floor on the free-flowing wells, the release would not include oil from the wells themselves. The maximum release would only be a few thousand barrels.

Onshore Oil Pipeline Spill

Onshore oil pipelines gather oil and gas from individual oil field operations throughout the County. Onshore pipelines also transport oil and gas from offshore and onshore production sites through Ventura County to refineries in Los Angeles and into the Southern California Gas Company's distribution system. Such pipelines in Ventura County can be found buried or suspended, in both rural and suburban areas. Pipelines may run in conjunction with other public/private rights of way, or may be in separate paths running cross-country. This section deals only with oil spill hazards as a result of ruptures or breaches associated with pipelines. Similar to a marine oil spill, an onshore oil pipeline spill can be a serious hazard to surface and groundwater resources, ocean water and marine life, property, animals and human life. An onshore oil pipeline spill can result in oil-contaminated lakes, as occurred with the 1993 McGrath Lake spill, oil-contaminated rivers and streams, as occurred with oil pipeline spills adjacent to the Santa Clara River, and oil-contaminated property and injury to animal and human life. As a result of seismic activity onshore oil and gas pipelines can break, erosion and flooding can expose lines and compromise structural integrity.

2.14.2 Alleviation of the Hazard

Aircraft Incident

It is expected that few, if any, airline passengers can survive a major air crash. The intense fires, until controlled, limit search and rescue operations. Police barricades are needed to block off the affected area. The crowds of onlookers and media personnel have to be controlled. Injured or displaced persons require emergency medical care, food and temporary shelter. Many families may be separated, particularly if the crash occurs during working hours.

The Federal Aviation Administration sets standards for the height of structures near airports. These standards are aimed at preventing accidents by assuring a clear airspace. The FAA can only enforce its regulations at public airports, but the State Department of Aeronautics, which has similar standards, can refuse certification to private airports used by the public.

Projects identified in the Environmental Impact Report (EIR) for the Camarillo Airport Noise Control and Land Use Compatibility Study will accommodate greater numbers of aircraft on the airfield, and enable aircraft operations to increase. This will also increase the potential for accidents. However, completion of the following projects have enhanced safety by providing pilots with more information: the construction of an air traffic control tower, visual navigation air improvements (based on specially-designed lighting systems), and the installation of one of two alternative state-of-the-art landing systems.

Three projects identified in the Environmental Impact Report for the Oxnard Airport Noise Control and Land Use Compatibility Study will have the effect of improving safety: removal of the 756-foot displacement threshold at the western end of Runway 7-25, the addition of taxiway lights on the south side of the parallel taxiway for the same runway, and the acquisition of the extended runway safety area located immediately east of Runway 25 and across Ventura Road.

The Naval Base Ventura County, Point Mugu is a Federal government installation, and is therefore not subject to County planning controls. Moreover, local jurisdictions are not required to prepare plans for land use around military airports (Public Utilities Code, Sec. 21675[b]). Nevertheless, the County will continue to apply the same limitations on construction within the hazard zone of this airport that are applied to other airport hazard zones. (Note: The Hazard zones used for the Naval Base Ventura County, Point Mugu are based on the Navy's accident potential zones, which were developed from an analysis of all Navy aircraft accidents for 5 years). A thorough analysis of conditions at Point Mugu is contained in the Air Installation Compatible Use Zone Study, dated 1977.

Portions of this Airport Hazards section have been excerpted from the Oxnard and Camarillo Airport plans. These plans and their EIRs should be consulted for further information on these airports. (The Santa Paula Airport and the hazard zone around it are located within the City of Santa Paula).

Railroad Incident

New discretionary development within Urban, Existing Communities and Rural designations should be conditioned to minimize, to the maximum extent practical, through site design or setbacks, the risk for exposure to railroad hazards. Additionally, new discretionary development within Open Space and Agriculture designations should also be conditioned to minimize, to the greatest extent practical, through site design or setbacks, the risk for exposure to railroad hazards.

Trucking Incident

New discretionary development within Urban, Existing Communities and Rural designations should be conditioned to minimize, to the maximum extent practical, through site design or setbacks, the risk for exposure to trucking hazards. Additionally, new discretionary development within Open Space and Agriculture designations should also be conditioned to minimize, to the greatest extent practical, through site design or setbacks, the risk for exposure to trucking hazards.

Marine Oil Spill

Oil production and transportation in and through Ventura County, and off the coast, will continue for the foreseeable future. Local, State and Federal regulations have been generated to reduce the potential for spills. Construction standards for vessels and facilities have been strengthened, and new construction requires additional protection for the environment.

Both regulators and owner/operators conduct routine inspections of vessels, facilities and pipelines, with the aim being to reduce the possibility of release to the environment.

The County of Ventura participates in planning and exercises with local, state, federal and private agencies.

Onshore Oil Pipeline Spill

Onshore oil production and pipeline transport of oil and gas will continue into the foreseeable future. Local, State and Federal regulations have been generated to reduce the potential for pipeline spills. The County of Ventura participates in planning exercises with local, state, federal and private agencies for emergency response including the Sheriff's Office of Emergency Services, County Environmental Health, State Fire Marshal, State Division of Oil/Gas and Geothermal Resources, and State Fish and Game/Office of Spill Prevention and Response among others. Oil and gas transport lines have been mapped on the County's Geographic Information System to allow improved response to spills in the event of pipeline system failure or a seismic event. Although available to emergency responders and planners, GIS information on the location of these transport lines is proprietary and contact must first be made with the California State Fire Marshal.

2.14.3 Conclusion

Aircraft Incident

The airports and their users in Ventura County have excellent safety records, and therefore the degree of risk associated with airport and aircraft hazards is minimal. Airport management and safety are thoroughly dealt with in the plans for each individual airport. The County will continue to promote safety in airport hazard zones by prohibiting high-intensity development in these areas and encouraging cities adjacent to county airports to do the same.

Railroad Incident

A major train derailment that occurs in a heavily populated industrial area can result in considerable loss of life and property. Potential hazards could be overturned rail cars, direct impact into an industrial building or entering into normal street traffic.

Each of these hazards encompasses many threats, such as a hazardous materials incident, fire, severe damage to either adjacent buildings or vehicles and loss of life of those in either adjacent buildings or vehicles and pedestrians.

Land uses adjacent to railroad rights-of-way could be planned and regulated to reduce the potential effects of this potential hazard.

Trucking Incident

Local law enforcement agencies and the California Highway Patrol are constantly looking for means to prevent, mitigate or lessen the impact of truck-related accidents. Such accidents, while currently on the decline, may be expected to become more frequent as traffic levels continue to increase.

Marine Oil Spill

While regulation, construction standards, and exercises can mitigate the effects of spills, until we cease the use of oil, there will be the possibility of oil spills. Natural seepage continues on and offshore of the County, and will probably continue for many years. Constant vigilance and adherence to safety regulations will reduce or mitigate the effects of accidental spillage, and allow for expeditious response and cleanup. The County should review and analyze all permit applications for compliance with local, state and federal oil spill prevention regulations.

Onshore Oil Pipeline Spill

Similar to Marine Oil Spill, regulation, construction standards, and exercises can mitigate the effects of pipeline oil spill but there remains the possibility of a future spill. Adherence to safety regulations, maintenance of pipelines and equipment will reduce the effects of spillage and allow for expeditious response and cleanup. Oil and gas pipelines in particular have been a concern because of the considerable network of collector or gathering lines in Ventura County. Many of these pipelines were not readily available or electronically mapped. With the use of GIS a shared system is now possible whereby oil pipelines, facilities and transport can be analyzed with respect to seismic hazards and transportation routes and provided to operators and emergency responders.

Figure 2.14.1
Airport Hazard Zones Map

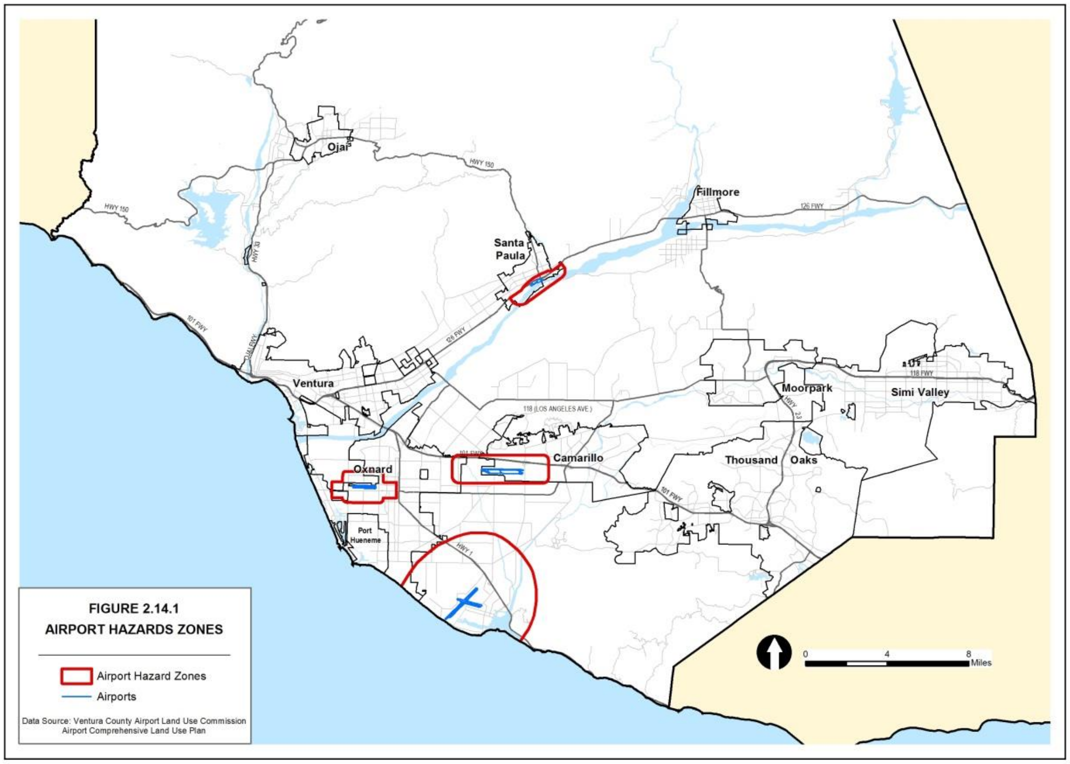


Figure 2.14.2a
Railroads and Truck Routes Subject to Heavy Loads and Hazardous Materials Map - North Half

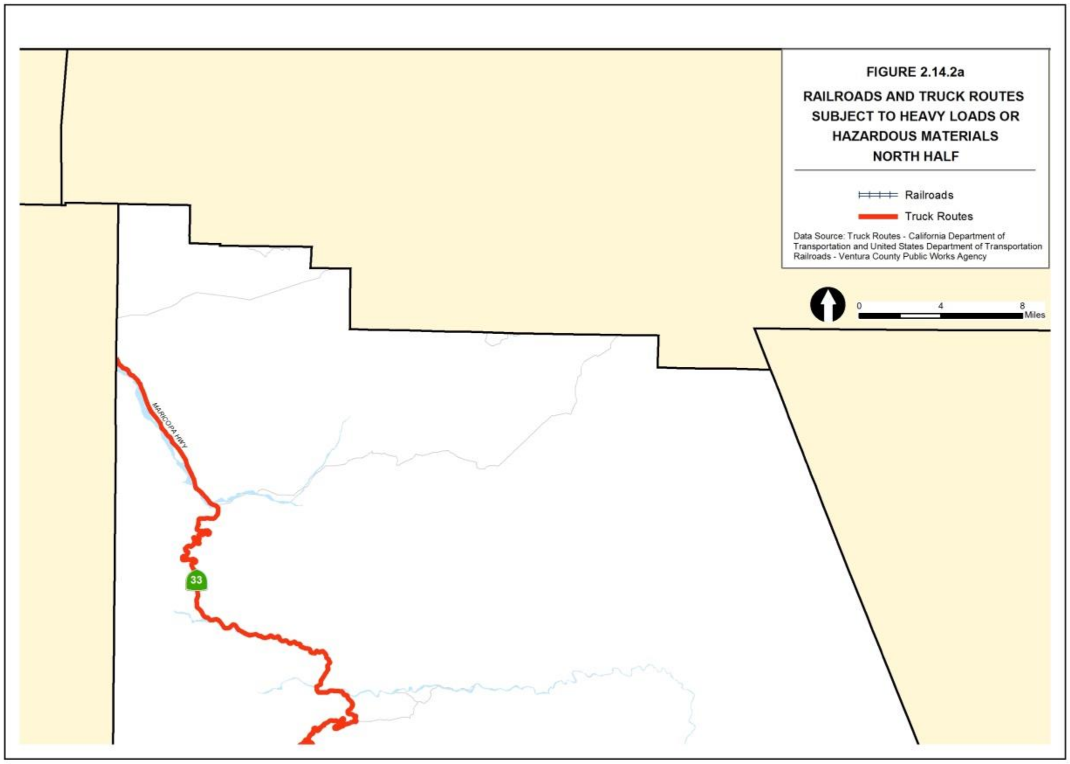


Figure 2.14.2b
Railroads and Truck Routes Subject to Heavy Loads and Hazardous Materials Map - South Half

2.15 Hazardous Materials and Waste

2.15.1 General Inventory of the Hazard

Hazardous material is any material that, because of its quantity, concentration, physical or chemical characteristics poses a significant present or potential hazard to human health and safety or to the environment if released into the workplace or the environment. Hazardous materials include, but are not limited to, hazardous substances, hazardous waste, and any material that the administering agency (Certified Unified Program Agency - CUPA) determines to be potentially injurious to the health and safety of persons or harmful to the environment if released into the workplace or the environment.

The growing magnitude of the need for proper management of hazardous materials and wastes is demonstrated by the fact that an estimated 264 million metric tons of hazardous waste were generated nationwide in 1981 according to a national survey conducted by the Environmental Protection Agency. The Southern California Region generated a total of between two and three million tons of hazardous waste in 1983, and it is estimated that this amount increased by 40 percent by the year 2000 for the Southern California region. Currently there are over 3,000 facilities in Ventura County using and storing hazardous materials. Of these, approximately 39 are using materials identified as being “acutely hazardous”.

Ventura County generated approximately 21,000 tons of hazardous waste in 1988. That waste was taken to off-site disposal facilities. Because of the wide diversity in agricultural and industrial operations in Ventura County, there exists a corresponding diversity in the types of hazardous materials being used.

Contaminated soils represent more than 1-1/2 times the total volumes generated by industrial processes in 1986. They accounted for approximately 52 percent (11,000 tons) of total hazardous waste volume in 1988. Contaminated soils are the result of hazardous waste site cleanup operations including underground tank leaks, accidental spills, abandoned sites, and oil field sites (drilling muds, gas scrubber sludge and tank bottom solids). Drilling muds, gas scrubber sludge and tank bottom solids generated by oil and gas production significantly decreased in 1986 due to market conditions. Drilling muds are dense colloidal slurries or a gel circulated through well bores to facilitate oil and gas drilling. Gas scrubber sludge is the liquid or slushy waste remaining after wet gas is put through a water or chemical wash to remove impurities and debris such as silt and clay. Tank bottom solids are clay and other solids that separate out of well fluid components.

The greatest volumes of waste generated by industry in 1986 were alkaline solutions solvents, waste oil and sludge. Solvents and waste oils amounted to about 3,470 tons in 1987 and about 4,600 tons in 1988. These types of waste can be further reduced and treated prior to offsite disposal. A large portion of these wastes are now recycled.

2.15.2 Nature of the Hazard

An example of how industrial chemicals can contaminate the environment, especially groundwater, occurred in Santa Clara County in 1981. Investigations began when a Northern California electronics firm excavated an area and noticed and unusual smell and color in the soil. It was found that a tank containing 1,1,1-Trichloroethane was leaking. Further investigation revealed that the chemical had entered local domestic groundwater supplies at a concentration of 29 times the California State Drinking Water Standards of 200 parts per billion. The health impacts of ingestion of this chemical are damage to the central nervous system and to the cardiovascular system, loss of coordination, eye irritation and dizziness, depending on exposure. It was also found that the area served by the contaminated domestic water well also experienced a high rate of birth defects and miscarriages in the late 1970’s and early 1980’s. Accordingly, the California Department of Health Services (DHS) conducted two epidemiological studies of the link between birth defects and the contaminated water. One study found three times the number of birth defects when compared to a control neighborhood. DHS officials concluded that the high incidence of birth defects was unlikely to be explained by chance alone.

In addition to potential health threats, the economic impacts associated with the cleanup of contaminated groundwater continue to escalate. So far Santa Clara County industries have spent over $80 million for site cleanup and improved storage facilities. These costs have continued to escalate as many more leaking storage tanks have been discovered.

Spills, leaks, accidents and collisions involving hazardous materials have taken place in virtually every part of Ventura County. Transportation, recreation, environmentally sensitive areas, business operations, tourism and the personal lives of the county's residents have all been impacted by the release of hazardous materials.

Materials being transported, stored and used include such toxic gases as Ammonia, Chlorine, Methyl Bromide, Sulfur Dioxide and Vikane. Hazardous liquids such as flammable petroleum products, toxic ethylene glycol and agricultural products are abundant. Flammable, toxic and/or reactive solids such as Ammonium Nitrate, metallic Sodium and pesticides can be found in all parts of Ventura County.

In 1983, Ventura County officials found that 10,000 gallons of gasoline had leaked from seven underground storage tanks, and had contaminated groundwater supplies. The fact that one gallon of gasoline can contaminate one million gallons of drinking water to an unsafe level illustrates the extent of the problem and the need for rigorous monitoring of storage tanks.

A look at some of the other major incidents to take place in recent history in Ventura County is good illustration of the wide geographical impacts that are possible as a result of a release of hazardous materials:

- Chlorine gas release, Simi Valley, 1989 - Minor environmental damage. Several thousand people evacuated. Moderate disruption to business.
- Train Derailment, Seacliff, 1991 - Moderate environmental damage. Considerable property damage. Closure of major freeway and rail line systems.
- Cleanup of contamination, Rocketdyne - Santa Susanna, ongoing - Major environmental impacts.
- Crude oil spill, McGrath Lake, 1993
- Pipeline break, Piru, early 1990's

2.15.3 Hazardous Materials/Waste Planning

The following agencies have responsibilities associated with hazardous materials and waste planning:

Environmental Health Division

The Environmental Health Hazardous Materials Program is a Certified Unified Program Agency (CUPA). The CUPA is a single local agency designated by the California Environmental Protection Agency as having regulatory authority for six environmental programs. These programs are Hazardous Waste, Hazardous Waste On-site Treatment, Spill Prevention Countermeasure Plan (aboveground tanks), Underground Storage Tanks, Hazardous Materials Business Plan and Inventory, and Risk Management Plan. The Ventura County CUPA enforces those programs throughout the County, except for the City of Oxnard. In addition to the CUPA Program, staff responds whenever there is an accidental release of hazardous materials.

The Ventura County CUPA has two Participating Agencies (PA). The Ventura City Fire Department is a PA for Underground Storage Tank, Hazardous Materials Business Plan and Inventory, Risk Management Plan, and the Spill Prevention Countermeasure Control Plan programs. Santa Paula Fire Department is a PA for Hazardous Materials Business Plan and Inventory, Risk Management Plan and the Spill Prevention Countermeasure Control Plan programs.

The program also includes the Leaking Underground Fuel Tank (LUFT) Program that oversees cleanup of leaky underground tank sites under contract to the State Water Board. EHD Reference Documents include the following:

California Health and Safety Code, Division 20

California Code of Regulations, Title 19, Title 22 and Title 23

Ventura County Ordinance, Chapter 5

Ventura County Environmental Health Division

Fire Protection District

The Ventura County Fire Protection District is responsible in conjunction with an Automatic Aid Agreement to provide hazardous materials response capability to the cities and unincorporated areas of the county (with the exception of the cities of Santa Paula and Fillmore).

The Prevention Bureau enforces provisions of the Uniform Fire Code (Articles 79 and 80) as they relate to hazardous materials occupancies and the storage, handling and use of hazardous materials. The Bureau also processes business applications, permits and plans reviews for new and existing businesses with hazardous materials.

Prevention Bureau inspectors, Engine companies, the Hazardous Materials Response Unit and the Hazardous Materials Officer make periodic inspections for compliance with regulations, code, safety requirements, permit provisions as well as familiarization with hazardous materials facilities.

The Ventura County Fire Protection District participates on a variety of committees and working groups whose focus is pre-planning, preparation, and grant coordination for terrorism events and hazardous materials response.

Public Health Officer

Appointed by the County Board of Supervisors, the county health officer shall enforce and observe all of the following in the unincorporated area of the county: (a) Orders and ordinances of the board of supervisors pertaining to public health and sanitary matters; (b) Orders including quarantine and other regulations prescribed by the department; and (c) Statutes related to public health. The county health officer may take any preventive measure that may be necessary to protect and preserve the public health from any public health hazard during any "state of war emergency," "state of emergency," or "local emergency," as defined by Section 8558 of the Government Code, within his or her jurisdiction. "Preventive measure" means abatement, correction, removal or any other protective step that may be taken against any public health hazard that is caused by a disaster and affects the public health.

After the declaration of a health emergency or a county health emergency, the director or local health officer may do any or all of the following: (1) Require any person or organization that the director or local health officer shall specify to furnish any information known relating to the properties, reactions, and identity of the material that has been released, spilled, or escaped. The director or local health officer may require information to be furnished, under penalty of perjury, by the person, company, corporation, or other organization that had custody of the material, and, if the material is being transferred or transported, by any person, company, corporation, or organization that caused the material to be transferred or transported. This information shall be furnished to the director or local health officer upon request in sufficient detail, as determined by the director or local health officer, as required to take any action necessary to abate the health emergency or county health emergency or protect the health of persons in the county, or any area thereof, who are, or may be affected. However, the burden, including costs, of furnishing the information shall bear a reasonable relationship to the need for the information and the benefits to be obtained there from; (2) Provide the information, or any necessary portions thereof, or any other necessary information available to the director or local health officer to state or local agencies responding to the health emergency or county health emergency or to medical and other professional personnel treating victims of the local health emergency; and/or (3) Sample, analyze, or otherwise determine the identifying and other technical information relating to the health emergency or county health emergency as necessary to respond to or abate the county health emergency and protect the public health.

If the calamity creates an immediate menace to the public health, the local health officer may close the area where the menace exists, and request the assistance of local or state law enforcement to affect an evacuation or exclusion area.

Environmental & Energy Resources Department

Assembly Bill 2948 (Tanner, 1986), required counties within California to prepare a County Hazardous Waste Management Plan (CHWMP). Ventura County's CHWMP was approved by the State Department of Health Services in January 1990. The purpose of the CHWMP is to serve as the primary planning document for hazardous waste management in the County. The Environmental and Energy Resources Department (EERD) is responsible for the household hazardous waste portion of the CHWMP as it pertains to the unincorporated area of the County and participating cities.

Office of Emergency Services

The Sheriff, as Director of the Office of Emergency Services (OES), is responsible for population protection activities. The Sheriff’s OES, a non-sworn component of the Sheriff’s Department, carries out the functions of emergency management, planning and exercise development for response and recovery activities related to hazardous materials and other natural and man-made disasters.

Coordination of Hazardous Waste/Material Planning and Response

The Ventura County Board of Supervisors authorized preparation of the County Hazardous Waste Management Plan (CHWMP) in April 1986. The plan was prepared by the County and was subsequently approved by the Department of Health Services on January 8, 1990. Although many programs concerning hazardous waste management have been established, or are ongoing, they have not been addressed in one integrated plan. Locally, the ten cities, Fire Departments, Sheriff, Police, California Highway Patrol and the County Environmental Health Division are each involved in hazardous waste management in some way through their response to emergency spills and illegal dumping. Given the many diverse programs under the responsibility of several different agencies and governmental entities, CHWMP is intended to coordinate all of these programs to minimize inconsistencies and to ensure that all issues are adequately addressed in one document.

The CHWMP’s primary purpose is the topic of hazardous waste management. The intent of the Plan is to provide the public and decision makers with a document that contains information and policies for management of hazardous wastes Countywide. The Plan contains two documents. One is a technical document that presents information and background on the countywide programs for regulation and management of hazardous wastes, and it discusses the issues and problems. The other volume is the actual Plan and Policy document that contains the recommended solutions, policies, implementation schedules, siting criteria and general areas for facilities developed as a result of the CHWMP planning effort.

Preparation of the CHWMP was authorized with the passage of Assembly Bill 2948 (Tanner 1986). The CHWMP was prepared in 1990. The bill required the preparation of such plans under the guidance of the Department of Health Services (DHS). The Tanner Bill required the following to be included in a Hazardous Waste Management Plan:

1. Analysis of hazardous waste streams generated in the County, including an accounting of the volumes of hazardous waste produced in the County by type of waste, and projection of the expected rates of hazardous waste production by type of waste;
2. Description of existing hazardous waste facilities that treat, handle, recycle and dispose of the hazardous wastes produced in the County, including facility capacity;
3. Analysis of recycling potential for hazardous waste and volume reduction of hazardous waste at the generation source;

4. Consideration of the need to manage small volumes of hazardous waste produced by small businesses and households;
5. Determination of the need for additional hazardous waste facilities to properly manage the volumes of hazardous waste currently produced or that are produced during the planning period;
6. Identification of existing hazardous waste facilities that can be expanded to accommodate projected needs and an identification of general areas or specific sites for new hazardous waste facilities that are determined to be needed;
7. Goals, objectives, policies and criteria for siting new hazardous waste facilities and for the general management of hazardous waste;
8. Time schedule for implementation of the Plan by the County and the cities.

Efforts to pre-plan, train, equip and exercise are coordinated. Ventura County's Environmental Health Division maintains a database of hazardous materials storage locations in the county, which is a useful response and pre-planning tool. Environmental Health is also responsible for updating the Ventura County Hazardous Materials Area Plan every three years. The Fire Protection District is active in reviewing plan submittals for new construction, modifications to existing businesses and chemical inventory information as they relate to hazardous materials occupancies in the county. The Fire Protection District's Prevention Bureau is responsible for ensuring that businesses are in compliance with the hazardous materials articles of the Uniform Fire Code. Plans reviews, permit applications and site inspections are used to determine compliance.

Although the release of a hazardous material is never planned, the response to a release must be anticipated and planned for. The Ventura County Fire Protection District entered into an automatic aid agreement for hazardous materials response in 1997. The County's hazardous materials response team along with the other three equipped, staffed and trained response teams in the county (Oxnard Fire Department, Ventura City Fire Department, Federal Fire Department) mutually respond to hazardous materials incidents in the county as needed.

2.15.4 Conclusion

Although Ventura County generates a relatively small proportion of the hazardous waste generated in Southern California, this amount still contributes to the need for hazardous waste treatment and disposal facilities. There are problems with ground and surface water contamination, as well as with air quality. As stated in the CHWMP (1989), hazardous waste treatment, transfer disposal, recycling and incineration facilities are needed for Ventura County wastes. However, not all needed facilities will be located in Ventura County; therefore, the County supports the Joint Powers Agreement among the counties to support facility siting which may serve more than one county's needs. In addition, the primary goal of Ventura County is the support of a Waste Reduction Policy (hierarchy) whereby hazardous waste is managed with first priority given to source reduction, followed by recycling, treatment, and lastly, disposal. The primary goal of hazardous waste management programs is to reduce the amount of hazardous wastes through recycling and on-site treatment to a point where off-site disposal is minimal.

Most areas of the household hazardous waste section of the Tanner Plan were implemented in Ventura County by the year 2000 deadline. Two ABOP (Antifreeze, Batteries, Oil and Paint) recycling centers were established in Ventura (Gold Coast) and Oxnard (Del Norte). A permanent HHW facility was permitted in Camarillo (MSE Environmental) and a permanent HHW facility was permitted (2001) at the Pollution Prevention Center in the unincorporated area of the County. Temporary HHW collections are also held in cities of Ventura, Thousand Oaks and Simi Valley on a regular basis. Conditionally Exempt Small Quantity Generator (CESQG) waste is also accepted at these facilities and events. Over seventy percent of the waste collected at these sites is recycled.

While the quantity of hazardous materials being used, transported and stored in Ventura County is relatively small, the variety of materials inventoried in the county is an indication of the diversity in the businesses and industries located here. There are several county agencies tasked with the collecting of chemical inventory data, inspecting facilities using and storing hazardous materials, reviewing plans for new businesses or existing businesses with modifications, enforcing permit requirements and responding to hazardous materials incidents. Ventura County responds to contemporary potential for hazardous materials releases in such acts as terrorism by creating task forces to address those concerns and pre-plan for such incidents.

2.16 Noise

2.16.1 Introduction

Noise has become an increasingly pervasive pollutant in the urban and suburban environment, owing largely to the increased mechanization of society and expanded transportation systems.

California Government Code Section 65302(f) requires the inclusion of a Noise Element in the General Plan of each city and county. The requirements of the Noise Element are as follows:

"A noise element...shall identify and appraise noise problems in the community. The noise element shall recognize the guidelines established by the Office of Noise Control in the State Department of Health Services and shall analyze and quantify, to the extent practicable, as determined by the legislative body, current and projected noise levels for the following sources:

1. Highways and freeways.
2. Primary arterials and major local streets.
3. Passenger and freight on-line railroad operations and ground rapid transit systems.
4. Commercial, general aviation, heliport, helistop and military airport operations, aircraft overflights, jet engine test stands and all other ground facilities and maintenance functions related to airport operation.
5. Local industrial plants including, but not limited to, railroad classification yards.
6. Other ground stationary noise sources identified by local agencies as contributing to the community noise environment."

The State Code requires that existing and projected noise contours be determined for these sources, in minimum increments of 5 dB down to 65 dB(A), with Community Noise Equivalent Level (CNEL) as the currently preferred metric. Because of the very large area encompassed within the County, noise contours have been presented in two forms. First, contours for all ground transportation sources have been calculated individually for existing and projected conditions and the results presented in tabular form. Second, the CNEL 60 contours have been calculated for projected conditions only and plotted on GIS stored electronic files. Details of the computational techniques, assumptions and limitations are discussed in a subsequent section. Advanced Engineering Acoustics compiled the tables and technical data for this section of the Hazards Appendix.

This chapter will:

1. Provide a general discussion of acoustics.
2. Review the current state of noise regulations and exposure criteria.
3. Present the findings of a Countywide noise survey and noise exposure calculation.
4. Discuss current and projected noise conflicts within the County.
5. Propose strategies for containment and/or alleviation of noise impacts within the County.

2.16.2 Definitions

The following is not intended as a comprehensive glossary of acoustic terminology, but will provide, in approximately logical order, information sufficient to allow a lay person to understand the technical language in the document.

Decibel (dB) - A unit division on a logarithmic scale whose base is the tenth root of ten, used to represent ratios of quantities proportional to power. In acoustics, the decibel is the common unit of measurement of the sound pressure level (Lp) and sound power level (Lw) with respect to their standardized references, 20 micropascal and 1 picowatt, respectively.

Sound Pressure Level (Lp - dB) - The magnitude of sound pressure, expressed in decibels, equal to 10 times the logarithm (base 10) of the ratio of the mean squared sound pressure to the square of the reference pressure, 20 micropascal. The sound pressure level is always associated with a specific location or distance from a sound source.

Sound Power Level (Lw - dB) - The magnitude of sound power, expressed in decibels, equal to 10 times the logarithm (base 10) of the ratio of the acoustic power to the reference power, 1 picowatt. The sound power level is a property of a sound source and is independent of location.

A-weighted Sound Level (LpA - dB(A)) - Sound pressure level measured using the A-weighting network, a filter which discriminates against low and very high frequencies in a manner similar to the human hearing mechanism at moderate sound levels (ref. ANSI SI.4).

Time Average Sound Level (L_{eqT} - dB) - The level, in decibels, of the mean squared sound pressure averaged over time period T. This is often referred to as the “energy average sound level” and "equivalent sound level" and hence the "eq" subscript. The "equivalence" is to a sound of constant level which has the same total acoustic energy content.

Day-Night Average Noise Level (L_{dn} - dB(A)) - The long-term time average sound level, weighted as follows:

- Frequency response is filtered using the A-weighting network.
- Sounds occurring between 10 p.m. and 7 a.m. are increased by 10 dB (in effect, the number of noise events is multiplied by 10).

Community Noise Equivalent Level (CNEL - dB(A)) - The long term time average sound level, weighted as follows:

- Frequency response is filtered using the A-weighting network.
- Sounds occurring between 7 p.m. and 10 p.m. are increased by 5 dB (in effect, the number of noise events is multiplied by 3.15).
- Sounds occurring between 10 p.m. and 7 a.m. are increased by 10 dB (in effect, the number of noise events is multiplied by 10).

Percentile or Exceedance Sound Level (Lxx - dB) - The sound level (usually A-weighted) which is exceeded xx percent of a specified time period.

One-Third Octave Sound Pressure Level (dB) - The sound pressure level measured using a bandpass filter whose upper cutoff frequency is the cube root of two times the lower cutoff frequency, and which is identified by the nominal geometric center frequency of the pass band. Three 1/3 octave bands make up a full octave band.

Sound Spectrum - The representation of an acoustic signal in terms of its level as a function of frequency. The most common method for determining the sound spectrum is with an analyzer consisting of a series or bank of contiguous one-third octave or octave filters and a bar-graph or numerical table display, known as a real-time analyzer.

Ambient Noise - The noise which results from the combination of all sources, near and far. The ambient noise level may be expressed using any acoustic metric, such as Leq(T), Ldn or CNEL, as judged appropriate to the situation.

Background Noise - The steady noise level which characterizes a given environment in the absence of transient sources. The background noise is usually expressed as $L_{90'}$ the noise level which is exceeded 90% of the specified time period.

Intrusive Noise - Noise from an identifiable source which causes a discernible change in the existing acoustic environment. Noises can be intrusive by virtue of excessive overall level, or as the result of unusual spectral (pitch or frequency of the noise) or temporal (timing) characteristics.

Noise Contour - A line on a map which indicates locations of constant ambient sound level near or around known sources of noise. In practice, noise contours are often shown as calculated for the noise from the source of concern only and the combined noise source and ambient noise.

Sound Transmission Class (STC) - A single number rating of the noise-isolating capability of a building construction element (ref. ASTM E90, E336 and E413).

Attenuation (dB) - Reduction of sound intensity by any or all of the following mechanisms:

- *Wave spreading losses* - nominally 6 dB per doubling of distance from a point source or point source element in an array. For simple arrays, such as a line, the combined influence of the source elements is easily determined (3 dB per distance doubling for an infinite line, 0 dB for an infinite surface). For general arrays, no simple law applies unless the distance is very large compared to the source dimensions, in which case a point source approximation is usually adequate.

- *Absorptio*n - As sound passes through the atmosphere or over an absorptive surface, a small fraction of the sound energy is lost by internal molecular vibration and friction heating. The loss is expressed in dB per unit distance (e.g. dB per km or dB per 1,000 ft.). At large distances over an absorptive surface, this loss is usually more important than wave spreading losses.

- *Reflection/Diffraction* - A barrier or enclosure placed between sound source and reception points reflects a portion of the acoustic energy away from the receiver. For an infinite barrier plane or an enclosure, the loss is determined by the construction details of the barrier, usually primarily by its surface density. The loss provided by a barrier of finite length and height is determined by the extent of the barrier relative to the characteristic transmission distances, approximately in accordance with Fresnel diffraction theory.

- *Refraction* - Under thermal lapse conditions or when sources are downwind of receptors, the effective speed of sound decreases with altitude resulting in an upward bending of sound propagation paths and creation of a shadow zone near the ground. This can result in very high effective attenuation rates at distances of a few hundred feet or more. Atmospheric conditions which lead to shadow zone formation are more likely during the day than at night. When sources are upwind of receptors, a downward bending of sound propagation paths occurs. This can result in very poor attenuation rates at distances of a few hundred feet or more and can seriously degrade or negate the excess attenuation due to all other influences discussed above.

2.16.3 Noise Characteristics

Complex environmental sounds are described in terms of physical parameters, appropriately weighted combinations of which can be used to assess subjective perceptions or reactions.

Physically, sound consists of pressure disturbances that propagate through an elastic medium, such as air. Any medium which is compressible and of finite density will support sound propagation. Sound propagates at a speed that is inversely proportional to the square root of the product of the density and compressibility of the medium. In air at the standard temperature of 68 degrees F, this speed is approximately 1,100 ft. per second.

On a most fundamental level, sound is described by:

- *Amplitude* - the actual pressure or force per unit area of the sound. The amplitude of the faintest discernible sound (0 dB) is approximately 1/5,000,000,000th of a *standard atmosphere* (14.7 pounds per square inch). The *standard reference pressure*, which corresponds approximately to the minimum discernible sound pressure, is 20 micropascals. The amplitude of the highest reasonably tolerable long-term average community sound (60 dB) is approximately 1 million times this minimum discernible value. The subjective manifestation of amplitude is loudness, but this is dependent upon other factors as well. The human ear acts as a signal compressor, were a factor of 3 in sound level amplitude results in a factor of only 2 in perception of loudness. Thus, a change in sound level of 3 dB is just barely perceptible under ideal listening conditions, a change of 5 dB is clearly detectable by most people and a change of 10 dB is usually judged to be a 2-fold change in the loudness (twice as loud for a 10 dB increase or half as loud for a 10 dB decrease).

- *Frequency* - the rate at which the sound pressure fluctuates between values above and below the static pressure, in cycles per second. The unit hertz (Hz) is defined as one cycle per second. Subjectively, frequency defines pitch. One octave of pitch corresponds to a 2 to 1 ratio of frequencies, and "middle C" is approximately 256 Hz. The normal range of human hearing is nominally 20 Hz to 20,000 Hz, but, particularly at low frequencies, this is very dependent upon the amplitude of the sound.
- *Level* - as discussed in the Definitions section, sound amplitudes are more conveniently described on a decibel scale. A pressure amplitude ratio of 10 corresponds to a level difference of 20 dB. By using 0 dB to represent an rms amplitude of 20 micropascal, the range of normally encountered sound amplitudes covers the level range 0 to 120 dB.

Subjective parameters of loudness and pitch have been mentioned above. Pitch has been adequately addressed. Loudness is dependent upon amplitude and frequency in a complicated way. For simple sounds called pure tones (consisting of one frequency at a time), the relationship is described by Fletcher-Munson Curves. Each of the curves defines a constant loudness line. It can be seen that at low frequencies and very high frequencies, the sound pressure level must be substantially higher for a given loudness level than at the frequency range 1,000-4,000 Hz or so. The shape of the curve at 40 phon (the phon is the unit of loudness level) is the approximate basis of the A-weighting network used for most environmental acoustic measurements.

Environmental sounds (or noises) are made up of many components, each with a different frequency, time history and amplitude. It is necessary to be able to predict the level of the total signal. The correct method for summing any combination of uncorrelated signals is to add the squares of the amplitudes. This is done by dividing the sound levels by 10, summing the antilogs of the results, and then computing ten times the logarithm of the total sum. This is a simple procedure with a pocket calculator or a computer. Examples: 50 dB + 50 dB = 53 dB, 60 dB + 60 dB = 63 dB and 60 dB + 50 dB = 60.4 dB.

Description of a complex sound is in terms of level, spectrum and temporal signature.

Spectrum was discussed in the Definitions section. It describes the acoustic signal in terms of the relative concentrations of sound energy as a function of frequency. Noises in which energy is concentrated within a narrow frequency range tend to be more readily discerned and therefore potentially more annoying than sounds with a more uniform broadband frequency distribution. On the other hand, broadband noises have a greater impact on speech communication.

The temporal signature relates how the noise level varies as a function of time. Three broad categories of temporal signature are described:

- *Steady* - the noise level and spectrum remain approximately constant or vary slowly over a characteristic time of several minutes to several hours. Examples are distant traffic noise and air conditioner noise.
- *Intermittent* - the noise level and/or spectrum fluctuates over a range of several dB with a characteristic time of several seconds to several minutes. Examples are aircraft flyover noise, nearby traffic noise and railroad train noise.
- *Impulsive* - the noise has an abrupt onset and short duration. Isolated impulsive noises include explosions or chance heavy equipment impacts. Repetitive impulsive noise includes pile driver noise, helicopter blade slap, railroad trucks passing over rail joints and impact wrenches.

2.16.4 Noise Effects

Noise can be annoying and physically harmful to human beings and to nonhuman animals. Human exposure to intense noise can result in irreversible hearing damage, and has been linked to other physiological effects including headaches, nausea, irritability, constriction of peripheral blood vessels, changes in heart and respiratory rates, nystagmus, changes in glandular and gastrointestinal activity, increased muscular tension and even vertigo. The effects of noise exposure in residential environments can include coughs, hoarseness, lesions and pain in the throat caused by the strain of shouting above the noise. Noise can also affect accuracy at work, and can act as a distracting stimulus. High noise levels have also been found to be linked to job-related accidents and absenteeism.

High levels of noise can have effects on animals that are similar to those on humans, in terms of tissue damage, changes in blood pressure and chemistry, and hormonal changes. Hatching failures (in birds) and other changes in reproductive processes have also been reported. Additional effects on wildlife can include panicking, disruption of breeding and nesting behavior, birth defects, changes in migratory patterns, and even changes in the size of bodily organs. A report by E. W. Shaw in 1950 indicated that adult condors an extremely endangered species, were very sensitive to noise and abandoned their nests when disturbed by blasting, sonic booms and even traffic noise. Noise can also mask animals' auditory signals and interfere with some animals' communication of necessary information, such as danger, distress, recognition of a mate or of young, and warnings about territorial boundaries. Adverse effects of noise on farm animals can include changes in milk production, incubation behavior, egg hatchability, mating behavior, and animal size and weight.

Noise can also have adverse effects on materials and structures, particularly as a result of sonic booms and related very loud aircraft noises. These very high level aircraft-generated noises can excite buildings to vibrate and can break windows and crack plaster.

Noise can also have adverse economic effects. A study by the City of Inglewood, for example, found that residential land values were 50 percent higher in areas where aircraft noise was below 80 PNdB (perceived noise level which includes temporal considerations), and that vacancy rates were 50 percent lower in such areas (R. Hurlburt, "Aircraft Noise Effects on Property Values," Department of Planning and Development, City of Inglewood, February 1972.

2.16.5 Noise Criteria, Measurement and Evaluation

Noise measurements must be taken in a manner that will allow the results to be evaluated in terms of appropriate noise exposure or emission criteria. The criteria are of two types: emission criteria and exposure criteria.

Noise Exposure Criteria

Commonly applied noise exposure criteria are based on an overall rating of the acoustical environment for land use compatibility purposes and on workplace noise levels for hearing conservation purposes. The workplace criteria are controlled by applicable Federal and State codes, and will not be discussed in this document. Land use compatibility criteria are most often used to assess the acceptability of land for residential, recreational and other noise sensitive uses, although some areas have adopted noise exposure limits for commercial activities as well. Some of the more commonly applied noise exposure criteria are listed below.

Federal

The U.S. Department of Housing and Urban Development (HUD) has established the following criteria for residential land use acceptability in order for projects to qualify for HUD funding (ref. 24 CFR Part 51):

L_{dn}	Classification
65 or below	Acceptable - no special requirements
65 – 75	Normally Unacceptable - special approvals needed, environmental reviews, and 5 - 10 dB of additional attenuation required
Above 75	Unacceptable - special approvals, environmental reviews and individually approved attenuation required

The Environmental Protection Agency has set noise exposure goals (not standards), with an adequate margin of safety (5 dB), which will result in freedom from hearing damage risk, reliable speech communication and a low annoyance potential. These are shown in the following table:

Effect	**Level- dB(A)**	**Affected Area**
Hearing Loss	$L_{eq24H} < 70$	All areas
Outdoor Living	$L_{dn} < 55$	Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use.
	$L_{eq24H} < 55$	Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Indoor Living	$L_{eq24H} < 45$	Indoor residential areas.
	$L_{eq24H} < 55$	Other indoor areas with human activities such as schools, etc.

The Federal Highway Administration (FHWA) has established a matrix of land use compatibility for various uses relative to highway traffic noise. The following table presents FHWA criteria for the hourly time average sound level and the L10 for the peak traffic hour. These are levels to which noise from Federally funded highway construction projects must be limited. As an aid to the reader for comparison to other criteria, it may be noted that the peak hour Leq and the CNEL are usually within approximately 1 dB of being equal.

Category	L_{eq1H}	L_{10}	**Location**	**Description of Land**
A	57	60	Exterior	Tracts of land in which serenity and quiet are of extraordinary significance and serve an important public need, i.e., amphitheaters, parks and open space
B	67	70	Exterior	Picnic areas, recreation areas, playgrounds, active sport areas and pars not included in Category A and residences, schools, churches, libraries and hospitals
C	72	75	Exterior	Developed lands, properties or activities not included in the above categories
E	52	55	Interior	Residences, motels, hotels, public meeting rooms, churches, libraries, hospitals and auditoriums.

State

Title 24, T-25, Chapter 1, Subchapter 1, Article 4, Section 1092 of the California Administrative Code, "Noise Insulation Standards" places noise control requirements on multiple residence structures, while detached single family residences are specifically exempted from this criterion. The interior noise level in any habitable room, resulting from exterior sources, must be limited to CNEL 45 with doors and windows closed. If exterior noise exposure exceeds CNEL 60, an acoustical analysis is required demonstrating compliance. If windows and doors must be closed to meet the criterion, alternate ventilation or other means must be incorporated to provide an acceptable indoor environment.

California Code of Regulations, Title 21, Public Works, Division 2.5, Division of Aeronautics (Department of Transportation), Chapter 6, "Noise Standards," has established CNEL 65 as the land use compatibility criterion for residential, school and hospital uses relative to aircraft noise.

The exception is high-rise apartment structures which are acoustically treated to achieve CNEL 45 or below indoors.

A comprehensive land-use compatibility guideline in graphic form, developed by the former California Office of Noise Control, is presented in Figure 2.16.1. In most cases, overlapping ranges are provided to allow adaptation to specific community needs and characteristics. For residential sensitive uses, CNEL 60-65 is the suggested outdoor noise criterion and CNEL 45 is the mandated indoor noise criterion.

Noise Emission Criteria

State and Federal criteria apply to aircraft noise emissions and motor vehicle noise emissions. These regulations will not be reproduced in this report.

Local agencies are normally responsible for enacting and enforcing noise emission regulations for sources other than transportation-related. These sources include mechanical equipment, construction activities, industrial and commercial activities, etc.

Since the mid-1980’s, Ventura County has dealt with two such sources of noise: oil drilling/production and sand/gravel mining. Noise standards ranging from 40 to 60 dB(A) have been applied, depending upon time of day and location. The general concept of the sections is in accord with the latest thinking in the acoustical profession - measurement of time average sound level for a period of one hour - as opposed to some concepts based approximately on percentile exceeded noise levels.

Noise exposure regulatory criteria are concerned largely with controlling location of new residences in existing environments. More stringent subjective criteria may be applicable to the case of introducing noise sources into existing noise-sensitive areas. The following are the types of factors that bear consideration:

Temporary Noises - Noise impacts may be determined to be insignificant if their effects are for a limited period of time and reasonable care is exercised to minimize levels and annoying or harmful characteristics.

Unusual Spectral Content - Intruding noises which contain narrow band or "pure tone" spectral components which are clearly audible have a high subjective annoyance potential even if overall levels are within the normally acceptable range. As an objective measure of this, if the noise level in any one-third octave frequency band exceeds the arithmetic average of the level in the two adjacent bands by more than 5 dB, a 5 dB increase is typically applied to the overall level for purposes of assessing impacts.

Unusual Temporal Characteristics - Impulsive or percussive noises will have an annoyance potential which exceeds that predicted by long-term average measures such as CNEL or L_{dn}. A 5 dB increase is typically applied if such characteristics are "audible."

Substantial Increase in Background Level - If the intruding noise results in an increase of more than approximately 5 dB in the background noise level (L_{90}), a subjective awareness of a degradation in environmental quality is very likely. It is common to adopt an ambient base level, typically in the range 40 to 45 dB(A), or the prevailing level, whichever is higher. Continuous noise sources that cause this level to be exceeded by more than 5 dB are then judged as excessive.

Noise Measurement

For planning and zoning purposes, characterizing sound levels in terms of overall A-weighted time-averaged levels is appropriate. Measurements should be taken using an integrating sound level meter, capable of true linear averaging over periods of not less than 15 minutes, and preferably for periods of one hour.

For situations where both daytime and nighttime exposures are important and sleep interference or other residential impact is a consideration, CNEL is an appropriate descriptor. This can be calculated from hourly time-averaged levels using the 5 dB evening and 10 dB nighttime weighting factors, adding the levels using the decibel addition technique discussed above, and then subtracting 13.8 dB (the equivalent of dividing by 24 hours to take the average).

Situations where unusual spectral or temporal characteristics are an issue require measurement with spectrum analyzers, statistical distribution analyzers and impulse sound level meters. Field measurements in support of this Noise Chapter were taken using a fully detailed measurement system during autumn of 1987, which is documented in the Measurements section of this document.

Noise Evaluation

Various measurement and data interpretation schemes have emerged over the past two or three decades in an attempt to find the "perfect" predictor of subjective reaction to noise. Most of these involve detailed spectral and/or temporal analysis, and except in extreme cases are found to correlate only slightly better with subjective judgments than do overall A-weighted measurement levels.

For purposes of County noise enforcement and evaluation, codes should be based on the hourly time-averaged sound level or the CNEL, with a penalty factor of 5dB for severe spectral irregularities and/or impulsive temporal characteristics.

2.16.6 Noise In Ventura County

Noise sources contributing to the acoustical environment in Ventura County are:

1. Motor vehicle traffic.
2. Aircraft, primarily from Camarillo Airport, Oxnard Airport, Point Mugu Naval Air Station, Santa Paula Airport and secondarily from overflights of aircraft from the Los Angeles International and Hollywood-Burbank Airports.
3. Railroad traffic, primarily from the Union Pacific main line, secondarily from the Santa Paula Branch line (owned by the Ventura County Transportation Commission) and the Ventura County Railroad (a.k.a. the Port access route).
4. Industrial operations, primarily gravel and sand quarries and oil drilling and production facilities.
5. Agricultural operations, including plowing and harvesting equipment, anti-frost fans, greenhouse heaters and irrigation pumps.
6. Miscellaneous sources, such as a shooting range in Holser Canyon and a motocross facility near Piru.

Noise-sensitive uses in the County include:

1. Residences; sensitive both indoors and out for 24 hours per day.
2. Parks and other recreation areas; sensitive outdoors, primarily during the day.
3. Schools, churches and libraries, prisons and correctional facilities, and group shelters; sensitive indoors during the day.

The objective of this section of the Noise Chapter is to determine, through calculations and reference to existing noise studies and measurements, noise levels resulting from the sources for existing and year 2020 projected conditions, and to assess the impacts of those levels on the noise sensitive uses.

Calculation of Traffic Noise Contours

Noise levels for State Routes, County Roads and Future Roadways were computed using elements of the Federal Highway Administration, FHWA-RD-77-108 Traffic Noise Prediction Model using the California Vehicle Emission Noise (CALVENO) data. The model was used in conjunction with information provided by District 7 of the California Department of Transportation (Caltrans), the Ventura County Transportation Department and the Ventura County Transportation Commission

(VCTC) relative to present and projected traffic flows, truck mixtures and road configurations. The calculated noise contours are presented in two formats:

First, the noise contours were computed for each roadway segment individually, using the following simplifying assumptions:

(1) Noise emission levels are the functions of speed given by using the CALVENO data in the FHWA model for Autos, Medium Trucks and Heavy Trucks, without corrections for grades, stop-go conditions, roadway curvature or road surface conditions. In most instances, these assumptions result in minimal error.

(2) No account is taken for the effects of landforms or existing structures on sound propagation. This will tend to result in an over prediction of levels, since terrain and structures generally act as shielding barriers. The reason for this simplification is that detailed mapping of sound fields in complex geometrical environs is very difficult and time-consuming, and would require a three-dimensional presentation to be meaningful. Such detailed computation is best done on a site-by-site basis.

(3) After visual inspection of the areas surrounding most of the roadways, the consultant opted to use the FHWA "Soft Site" propagation model. This model assumes that for acoustically absorptive ground conditions, as would characterize the agricultural lands flanking most of the roadways, losses are 4.5 dB per distance doubling. The alternative is the "Hard Site" model, which allows no consideration for ground or atmospheric absorption losses. Use of the "Soft Site" model helps compensate for potential effects of landforms and structures.

The results of the calculations are presented in the tables beginning with Figure 2.16.7, which list the assumed ADT and the computed noise contour locations relative to the center of the roadway for each segment considered. Space did not allow inclusion of truck mixture data on the tables. Cases where ADT and contour location trends appear to disagree result from disparate truck mixtures.

IMPORTANT NOTE: Computers and digital-readout measuring equipment have promoted a trend toward high-precision acoustic data reporting which is not justified based on the accuracy of prediction models and input data. For example, contour locations in the tables were computed using a root-finder routine with an acceptance error margin of 0.01 dB, while the accuracy specification on acoustic calibrators is only 0.3 dB and the scatter in the noise emission data used for the FHWA model is several dB. High-precision computations are desirable to provide an internally consistent set of output values. However, reporting of a contour at a distance of several thousand feet to the nearest foot is a computational artifact. Even under the most ideal conditions, the accuracy of the contour locations is no better than +/-10%. Under real conditions and at distances greater than a few hundred feet, the probability of measuring a CNEL within 1 dB of the predicted value would be very low. Hence, it is very important to recognize that the contours should be used as guidelines and general indications of trends only. Noise control designs should always be based on actual site data for any condition where the CNEL contour exceeds 65 dB.

The second computation was done to place noise exposure contours on a County map. Again, the FHWA model with CALVENO emissions was used, and effects of landforms and structures ignored. This attenuation rate is based on "average" atmospheric conditions or 65°F, 50% relative humidity and the A-weighted traffic noise spectrum. The strength of the point source at each segment is computed from the CALVENO emission levels, the speed of the traffic and the CNEL-weighted numbers of autos and trucks that pass per day.

For a single, straight road, results are comparable to those produced by the FHWA model. For the case of multiple roadways affecting a given area, contour shapes are correctly determined.

A reduced map showing Countywide 2020 collective noise contours for the South Half of the County is included herein; Figure 2.16.6. Greater detail is provided on the maps electronically on file with the Ventura County Planning Division.

Railroad Noise

Railroad noise is characterized by infrequent periods of noise levels that exceed the normal ambient noise level by several to several tens of decibels, with typical durations ranging from 30 to 150 seconds. The actual noise level depends upon a number of factors:

Distance from the tracks - Typically the average noise level drops off at a 3 to 4 dB per distance doubling rate. The peak noise level drops off at a 3 to 4 dB per distance doubling rate. The peak noise level, which results from concentrated sources, drops off at 6dB per distance doubling rate. At a distance of 50 ft., typical levels for "cruise speed" trains are 90-100 dB(A) for peak engine noise, 80-85 dB(A) for car wheel noise and 100-115 dB(A) for crossing horns.

Speed of the train - Rail car noise is approximately proportional to the cube of the speed (doubling the speed increases the noise level 9 dB).

Number of locomotives and cars - Individual train noise is most conveniently expressed in terms of peak noise and Sound Exposure Level (SEL). The SEL for a noise event of duration T seconds is equal to the L_{eqT} plus 10 Log(T). It is approximately directly proportional to the number of cars and locomotives (doubling the number of cars and locomotives increases the SEL by 3dB). The CNEL, L_{dn}, L_{eq}, etc., can be computed directly from the SEL and the weighted average number of trains.

Condition of the tracks - Welded rail reduces noise levels an average of 7dB relative to jointed rail, and also reduces induced ground vibration.

Crossing horn in operation or not.

[ref. C. Harris (ed.) Handbook of Noise Control, 2nd Edition, R. Lotz & L. Kurzwell, "Rail Transportation Noise," pp. 33-1 -33-6].

Amtrak, Metrolink, Fillmore and Western Railway, Union Pacific Railroad and Ventura County Railroad Company all affect portions of the County. Many years of experience measuring trains in Ventura County have resulted in the following average values for SEL for the various types of trains at a 50 ft. reference distance:

Main Line UPRR Freight	109 dB SEL
Amtrak Passenger Train	107
Santa Paula Spur and VCRR	101-105

Amtrak passenger rail service operates the Coast Starlight between Los Angeles and Seattle, Washington. It also runs six trains weekly between San Diego, through Los Angeles, to either Santa Barbara or San Luis Obispo and eight trains daily between Los Angeles and Santa Barbara between the hours of 7:30 a.m. and 8:00 p.m.. Additionally, Metrolink, a five county public transportation consortium, operates eighteen commuter trains Monday through Friday between the hours of 5:30 a.m. and 7:00 p.m. to various Ventura County locations. The Fillmore and Western Railway operates passenger excursion service between Fillmore and Santa Paula on the Santa Paula Branch Line that runs from Montalvo to Piru. Although this railway has the potential for commuter service, the track requires extensive repairs and would need to be extended to Valencia. Main line freight trains run on a quasi-random schedule, with no fixed number or time on any given day. On average, there are approximately 10 freight trains per day. On the Santa Paula Branch Line and the Ventura County Railroad, there are an average of two small freight trains per day, usually during daytime hours.

CNEL and L_{eq24H} noise level contours were computed for the main line. (L_{eq24H} is of interest because it illustrates, by comparison, the severe nighttime weighting imposed by CNEL. This weighting is of questionable validity for assessing noise levels in outdoor living spaces). For the smaller lines, daytime-only operation results in CNEL and L_{eq24H} being identical.

Distance in Feet to Train Noise Contour from Centerline of Tracks

Noise Level	Main CNEL	Main L_{eq24H}	Spur Line
45	3,400	2,020	410
50	2,210	1,230	170
55	1,380	680	65
60	770	310	26
65	370	130	10
70	155	50	4
75	60	20	2

As was the case for the highway noise contours, these are generalizations. Detailed site analyses for specific locations could demonstrate levels which differ from these by several dB.

Aircraft Noise

For Oxnard and Camarillo Airports, Coffman Associates completed ANLUC Studies in 1998 which produced CNEL contour maps for a variety of airport development options. The Ventura County Transportation Commission (VCTC), in its capacity as the Regional Airport Land Use Authority, used that base data in development of noise contour maps for these two airports in creation of the regional Airport Land Use Plan. The Long-Range Forecast contour maps from VCTC are reproduced on Figures 2.16.2 and 2.16.3. The 1992 AICUZ study for Naval Air Weapons Station (NAWS) Point Mugu, produced CNEL contours for that facility. Those contours are reproduced in Figure 2.16.4, most of which lie in unincorporated County territory.

County areas impacted by noise levels in excess of CNEL 60 from Camarillo and Oxnard Airports are currently occupied by agricultural uses. The NAS noise impact zones encompass on-base activities including housing, and low-density residential and commercial uses along eastern Hueneme Road and Lewis Road. California State University, Channel Islands, occupying the site of the former Camarillo State Hospital, is exposed to approximately CNEL 50.

Outdoor recreational areas in the form of private duck hunting clubs are located immediately to the northwest of the main runway for the NAWS Point Mugu, in the CNEL 70-75 zone. An interview with one club member indicated that although the noise was unnerving the first two or three times he visited, he became rapidly acclimated.

Touch-and-go operations occur at Santa Paula Airport on weekdays, with aircraft circling the airport to the southeast, affecting low-density residences along South Mountain Road. The VCTC Airport Land Use Plan developed CNEL 60 and 65 noise contours for Santa Paula Airport which have been reproduced on Figure 2.16.5. These indicate that the CNEL 60 is essentially contained within the Santa Paula City Limits. Measurements of noise levels outside the city are included in the Measurements section of the report, reflecting the 1987 data.

Industrial Noise Sources

Major industrial noise sources have been identified as follows:

- *Concrete Express Batch Plant on Ventura Avenue*. Noise exposure is to residences on Norway Drive on the opposite side of Highway 33, which acts as a noise barrier. The plant operates from 6:00 a.m. until approximately 2:00 p.m. Noise levels were measured at a distance of 150 feet in front of the plant and in the potentially affected community. At the nearby position, the typical noise level during truck loading was 73 dB(A). The background noise level in the residential community was increased from approximately 46 dB(A) to approximately 51 dB(A) when the plant was started at 6:00 a.m. However, the ambient noise was dominated by traffic on Highway 33. One resident was interviewed, and stated that noise from the plant was not noticeable due to the high traffic noise. Approximate noise contours for the plant are included on the 1" = 2000' scale maps. The CNEL would be 1.5 dB lower due to the limited hours of operation.

- *Pepsi Cola and oil supply facilities on Ventura Avenue near Bard Lane.* The primary impact from the Pepsi Cola Facility (and numerous unspecified other industrial facilities on Ventura Avenue) is from delivery trucks. These are included in the traffic noise calculations. At the oil supply yard off the end of Bard Lane, numerous pipe storage racks were noted, but no activities were observed. It is probable that residences on the east side of Ventura Avenue are exposed to impulsive noises when pipe is loaded or off-loaded at the facility.

- *Rock plants, concrete batch plant and General Foods processing plant on the northwest side of Vineyard Avenue near the Santa Clara River.* Primary noise impact is on residences at the east corner of Vineyard and Central Avenues. The General Foods facility appears to operate 24 hours per day. It produces a noise level of 41 dB(A) at the residences and school at the north end of Joan Road.

- *Sand/gravel mine and batch plant at end of Bixby Road.* The facility operates between 6:30 a.m. and 3:30 p.m., and is remotely located in rough terrain. The principal impact is from truck noise in Balcom Canyon and Bradley Roads. This affects low-density residences, and is included in the noise contour calculations.

- *Sand/gravel mine and batch plant at end of Happy Camp Road.* The facility operates between 6:30 a.m. and 3:30 p.m., and is remotely located in rough terrain. The principal impact is from truck noise on Walnut Canyon, Broadway and Happy Camp Road. Truck traffic is determined to be approximately one truck per minute during the 6 a.m. to 7 a.m. and 11 a.m. to noon hours. This affects low-density residences. A brief interview with a resident from the north end of Walnut Canyon indicated no strong reaction to the frequent truck passage noise.

- *Rock and Batch Plants at End of Tapo Canyon Road*. Near its northern terminus, Tapo Canyon splits into two branches. The western branch is Bennett Road, at the north end of which is a large complex, including san and gravel quarries and concrete batch plants. The eastern branch remains Tapo Canyon Road and leads up to Gillibrand Canyon, which also houses a sand and gravel supply operation.

Noise-sensitive uses potentially affected by the industrial facilities and vehicles that service them are:

- Two residences at the Big Sky Ranch on Bennett Road, one of which is located approximately 50 feet from the roadway and one of which is located approximately 150 feet from the roadway.

- A group of residences located near the entrance to the facilities at the end of Tapo Canyon Road. Setbacks range from approximately 70 to several hundred feet.

- Scattered residences and mobile homes along Tapo Canyon Road south of the branch. Setbacks are several hundred feet.

The industrial facilities are located behind hills at a distance of 3000-4000 feet from the residences. A-weighted acoustic measurements were taken at several locations in the area, selected on the basis of apparent closest to line-of-sight transmission from the facility. In the absence of nearby traffic noises, these measurements showed background noise levels in the range 31 to 38 dB(A). At a point near the Big Sky Ranch, the measured background noise level was 38 dB(A), and mechanical noises from the direction of the Bennett Road industrial facility were faintly audible. At the other locations, there was no subjective awareness of the industrial activities.

Motor vehicle traffic associated with the facilities begins at approximately 5:30 - 6:00 a.m., with workers and truck drivers arriving via Tapo Canyon and Bennett Roads. Beginning at 6:15 a.m., double trailer dump trucks and ready-mix concrete trucks arrive in and exit the area at a rate of approximately one every four minutes at the Bennett Road facility and approximately one every ten minutes at the Tapo Canyon Facility, with operations ceasing approximately 3:00 p.m. Because of the narrow, winding roads to both facilities, the vehicle speeds are slow, estimated at 25-30 mph.

Early morning noise measurements were taken at the Big Sky Ranch area at a distance of 50 feet from the center of Bennett Road, representing the noise exposure at the nearest of the residences. The results, for a one-hour sample taken between 6:00 and 7:00 a.m., were Leq 63, Lmin 30 and Lmax 87 dB(A). The CNEL corresponding to the measured levels is 60 dB(A), based on exposure for one "nighttime" hour and 8 daytime hours, weekdays only. This would be a marginally significant noise impact with a CNEL 60 community noise criterion, insignificant with a CNEL 65 criterion. Peak noise levels from individual truck passings will result in temporary interference with communication and possible early awakening, although no evidence of this was observed during the measurements.

Agricultural Noise Sources

Three basic types of noise sources have been identified as associated with agricultural activities in the County. These are (in addition to pickup and delivery truck noise, which is included with the transportation noise analysis):

- Cultivation and harvesting equipment
- Irrigation and domestic water pumps
- Anti-frost equipment (wind generators)

In most instances, noise from these sources affects primarily the producers of the noise, i.e., the farmers on whose land the equipment is operating. Occasionally, however, the cultivation/harvesting equipment will be operating on portions of farms near property lines and will therefore have a potential noise impact on neighbors. Several instances have been observed where large irrigation pumps are located near property boundaries, in some cases within 100 or 200 feet of residences. Wind machines are located atop tall towers, and, depending on the type of machine, can produce noise that is audible for several thousands of feet. These noise sources are described in more detail in the following paragraphs:

Cultivation/Harvesting Equipment - Tractors and similar mechanized equipment of size used on Ventura County sized farms will produce noise levels in the range 75-85 dB(A) at a distance of 50 feet. Therefore, equipment that produces noise near the upper end of this range will cause some degree of interference with communication at distances of approximately 350 feet. Since the equipment is expected to be operating within this distance of neighbors for only a small fraction of the time, the noise impact would generally be temporary and insignificant. However, cases could occur wherein equipment was used in an unusually loud manner or repeatedly in a specific area which was near to a neighbor. These cases could produce significant noise impacts and should be covered by the Noise Ordinance.

Operating procedures and equipment maintenance are the best practical means of minimizing this noise impact.

Water Pumps - Water pumps generally produce a high-pitched whine and overall noise levels in the range 50 to 65 dB(A) at 50 feet, depending upon the size of the pump. At a distance of 100 feet, a proximity within which adjacent residences have been observed, a large continuously operating pump could produce CNEL 65. This would be a significant noise impact, as well as an annoying condition, due to the tonal character of the noise. These noise impacts should be covered by Mechanical Equipment Noise sections of the Noise Ordinance.

Control of the noise could be accomplished readily by erecting a lightweight impervious barrier around the side(s) of the pump that will block line-of-sight noise transmission to noise-sensitive receptors. This would not need to include more than three sides of the pump, so that ventilation would not be impeded.

Wind Machines - Agricultural wind machines are typically two-blade propeller fans atop a tubular or lattice tower, which are driven by one of three methods:

a. An electric motor atop the tower;

b. A gasoline, diesel or propane engine mounted in an enclosure at the bottom of the tower, with a drive shaft in the tower;

c. A gasoline, diesel or propane engine mounted in an enclosure at the top of the tower. (A rarely encountered fourth approach is a propeller driven by small ram jets at the blade tips).

Noise levels produced are a function of the type of drive system employed, the size of the blade, the tip design of the blades, the rotating speed, and the operating condition of the unit. A well designed fan, with subsonic tip velocity and for which the blade noise is dominant, would produce noise levels in the range 75-80 dB(A) at 100 feet slant distance. Machines with supersonic tip speeds and/or poorly muffled internal combustion engine (or ramjet) drives could produce levels 10 to 20 dB in excess of this.

Wind machines are typically used only when temperatures drop below freezing by several degrees. This is only a few days per year. However, the infrequency of use can amplify the subjective impact on the unacclimated receptor. A study group consisting of interested parties (ranchers, residents, technical advisors) should be formed to develop a section in the Noise Ordinance which will promote the use of minimum noise machines and proper equipment maintenance.

Miscellaneous Noise Sources

Other noise sources not discussed above include:

Shooting Range in Holser Canyon - The facility is open during daytime hours only, Tuesdays through Sundays. The target ranges are separated from the surrounding area by hills, which block line of sight sound transmission. There is one off-site residence located to the south of the range at a distance of approximately 3000 ft. from the nearest target range area.

Acoustic measurements were taken at a distance of approximately 100 ft. from the residence, in the direction of the range, while several of the target ranges were in use, including large caliber pistol shooting at the range nearest the residence. Results of the measurements are included with the figures and in the Summary table. The background noise level in the area is very low, approximately 30-35 dB(A), so that any intrusive noise will have a high probability of being audible. Over the course of a 15-minute measurement sample, audible gunshots were noted with maximum sound levels (using the rms-fast detector of the analyzer) as shown in the table:

Maximum Sound Level	Number of Shots
45-50	18
50-55	13
55-60	4
60-65	1

Also during the 15-minute measurement, five aircraft (two jet airliners and three propeller-driven private planes) flew over the test area. Peak levels ranged from 50 to 63 dB(A) and durations ranged from of 20 to 80 seconds, for a total SEL of approximately 72 dB(A). [Note that SEL represents the product of sound intensity and time duration, and is therefore not a sound level in the usual sense]. By contrast, the gunshot durations are a tenth of a second or less, for a total SEL of 59 dBA(A). Therefore, the aircraft noise contributes approximately 20 times as much to the overall acoustic environment than does the gunshot noise.

A brief interview with the residents indicated that the noise from the Shooting Range was sometimes audible but not annoying.

The conclusion regarding this source is that although it produces noise which is clearly audible at the nearest residential use, the noise is produced during daytime hours only and is substantially less significant than noise from other transient environmental sources.

Motocross facility near the community of Piru - Began operations in spring of 2002. No readings are available.

Surf noise - Residences along Highway 1 are exposed to a combination of traffic and surf noise. On an average surf level day, noise at a distance equivalent to that of residences ranged from 45 to 60 dB(A). Traffic noise peaks were well above 70 dB(A).

2.16.7 Acoustic Measurements

The environment within Ventura County ranges from wilderness to heavy industrial zones. A noise measurement program has been undertaken to sample the acoustical properties of this variety of environs.

Measurement Procedure

All field measurements were taken using a Larson-Davis Laboratories type 3100A precision integrating 1/3-octave real time analyzer. This instrument was used in conjunction with a portable computer to perform the following concurrent functions:

(1) Compute the time-averaged (L_{eq}) 1/3-octave spectrum and overall noise levels (A-weighted, C-weighted and unweighted) for a 15-minute continuous measurement sample.

(2) Sample the A-weighted sound level ten times per second and store the samples on magnetic disks.

(3) Following the measurement, plot the A-weighted level-versus-time and the cumulative statistical distribution of the data.

Measurement Results

The plots of time histories and cumulative statistical distributions are appended to the report (Data generated by Bruce Walker Consulting and Research in Acoustics, Fall 1987). The A-weighted L_{eq} is the primary datum of interest, and the maximum and background levels are of secondary interest. These are summarized in the following table:

	Daytime			Nighttime		
Position #[1]	**L_{eq}**	**L90**	**L1**	**L_{eq}**	**L90**	**L1**
1	--	--	--	67	57	77
2	72	53	82	66	50	79
3	--	--	--	47	31	60
4	63	50	76	54	41	68
5	60	40	70	--	--	--
6	51	39	62	44	43	46
7	--	--	--	46	41	54

[1] (1) *Highway 1 at Yerba Buena* - Surf and highway traffic.
(2) *Highway 118 at North Street* - Heavy trucks.
(3) *Santa Rosa Road at Yucca Street* - Sporadic traffic.
(4) *Ventura Avenue at Bard Lane* - Local and Highway 33 traffic, crickets at night.
(5) *North end of Walnut Canyon* - Sand, gravel and cement trucks.
(6) *Villanova Road at Loma Street* - Crickets at night, local traffic daytime.
(7) *North end Joan Street* - General Foods plant, trucks on Vineyard.
(8) *Walnut Canyon and Broadway intersection* - Heavy trucks.
(9) *Norway Drive at Garland Street* - Highway 33 traffic, concrete batch plant.
(10) *Ventura Avenue at batch plant* - Batch plant noise and heavy delivery trucks.
(11) *Highway 126 west of Wells Road* - Auto and truck traffic.
(12) *South Mountain Road at Santa Paula Airport* - Local auto traffic, glider tow aircraft.
(13) *La Conchita neighborhood, corner of Surfside Street and Bakersfield Avenue*. - Traffic on Highway 101, short freight train, occasional local traffic.

8	69	46	80	69	43	79
9	--	--	--	56	49	64
10	--	--	--	73	70	79
11	66	57	70	--	--	--
12	61	40	73	--	--	--
13	71	63	82	65	59	71

2.16.8 Noise Impacts

The County Planning Division has identified areas of concentrated noise sensitive uses. Based on the measurements and computations, noise levels at these locations have been tabulated together with existing and year 2020 projected noise levels.

Increases in noise levels between the present and the year 2020 will be caused primarily by increases in traffic levels. Figures 2.16.7 and 2.16.8 provide an inventory of 2020 noise contours for all State highways and County roadways that will exceed 3000 ADT (the level beyond which noise is likely to be a problem) in 2020. These tables were used in conjunction with land use designations of the Area Plans and "existing communities" to identify 2020 traffic noise, based on the assumption that noise-sensitive uses are most likely to be located in one of these two types of geographical areas. The results of this analysis are presented in the table below (see Figure 2.16.6 for a diagrammatic representation of the 2020 Noise Contours).

In terms of existing development, the table shows that the greatest number of noise-sensitive uses will be impacted by growth in traffic levels along Wendy Drive, Ventura Avenue (Holt Street area), Camino Dos Rios, and Santa Ana Road (at Burnham Road); but the actual number of dwellings affected is relatively small (fewer than 100).

The roadway segments listed in the table below are adjacent to existing communities that are developed to urban and rural densities. The table summarizes the impacts of the 2020 noise contours (as calculated by the County's noise consultant) on such existing development. The noise-sensitive uses in the right-hand column can be expected to experience higher noise levels (e.g. from 55-60 dB to +/-65 dB).

ROADWAY SEGMENT	2020 ADT	USES IMPACTED	CNEL RANGE
Kanan Rd., N of County Line	27,000	Numerous home on both sides of road for 5 or 6 blocks along the road	66-78
La Luna Ave., S of Lomita Ave.	5,000	Homes on La Luna Ave.	56-66
Santa Ana Rd. at Santa Ana Blvd.	5,000	Mobile homes at corner of Santa Ana and Burnham Roads	60-65
Main St., Piru, N of Camulos St.	5,000	Residences along both sides of Main St.	62-64
Wendy Drive S of US 101	21,000	Numerous SF dwellings on both sides of Wendy Dr.	55-70
Telegraph Rd., West Santa Paula Community	8,000	SF dwellings on Telegraph Rd.	64-66
Lewis Rd., Somis, btwn. North and Rice Streets	18,000	Dwellings on both sides of Lewis Rd.	67-69
Ventura Ave., Holt St. area	15,000	Homes on sides of Ventura Ave.	65-67
Camino Dos Rios	9,000	Several homes on both sides of road	63-68
US 101 at Lynn Ranch Community	193,000-200,000	Several homes on Calle Arroyo	67-69
Santa Susana Pass Rd. at Clear Spring Rd. (S side)	5,000	Homes	66-70
Rt. 33, near Holt St. area	26,000	Mobile homes on east side	65-74
Rt. 33 north of Casitas Vista Rd., to Rt. 150	24,000	Homes in Casitas Springs and btwn. Santa Ana Blvd. and Encino Dr.; Oak View Library;	70-73

ROADWAY SEGMENT	2020 ADT	USES IMPACTED	CNEL RANGE
		mobile homes on west side just south of Rt. 150	
Rt. 33 south of Canada Larga Rd.	26,000	Homes on west side of Norway Dr.	62-70
US 101 btwn. city limits of Buenaventura and Santa Barbara County Line	91,000	Small single-family and communities at Solimar Beach, Sea Cliff, Mussel Shoals and La Conchita	71-76
Central Ave. btwn. Rose Ave. and Vineyard Ave.	4,000	Rio Mesa High School; several homes on northeast side, just south of Vineyard	63-68
Rt. 1, south coast, near Los Angeles County Line	12,000	Single-family and multi-family development	61-72
Rt. 1 btwn. Wood Rd. and Las Posas Rd.	13,000	NBVC base housing	62-64
Santa Rosa Rd. E. of Yucca Dr.	19,000	Small pockets of single-development at Yucca Dr., Holiday Pines Land, Charisma Court and Pradera Lane	56-66
Santa Clara Ave. S. of Friedrich	20,000	Several homes on east side, south of Friedrich	66-68
Rose Ave. north of US 101	18,000	Several homes on west side; junior high school on east side	61-66
Vineyard Ave. north of US 101	23,000	Homes on east side in El Rio area	69-71
Victoria Ave., just north of US 101	60,000	Several homes on east side	75-80

The following roadway segments will tend to become noisier as 2020 approaches. The segments have vacant lands adjacent to them that could develop at urban or rural densities pursuant to adopted plants and/or zoning. Future development in these areas should take account of the highway noise. Noise-sensitive uses should be set back beyond the 65dB contour line, or incorporate sound-attenuating measures such as masonry walls, earth berms, and the like.

a. La Luna Ave., south of Lomita Avenue (zoning: R-E, R-E-20, R-E-1Ac, R-E-2Ac).

b. Main Street, Piru; east side, south of railroad (R-P-D-6U).

c. The eastern portion of Santa Rosa Road (designated Existing Community).

d. The Somis area, near the junction of Lewis Road and Highway 118 (designated Existing Community).

e. Kanan Road, east of Thousand Oaks city limits. Note, however, that plans already submitted for this area incorporate sound-attenuating measures such as earth berms, masonry walls and increased building setbacks.

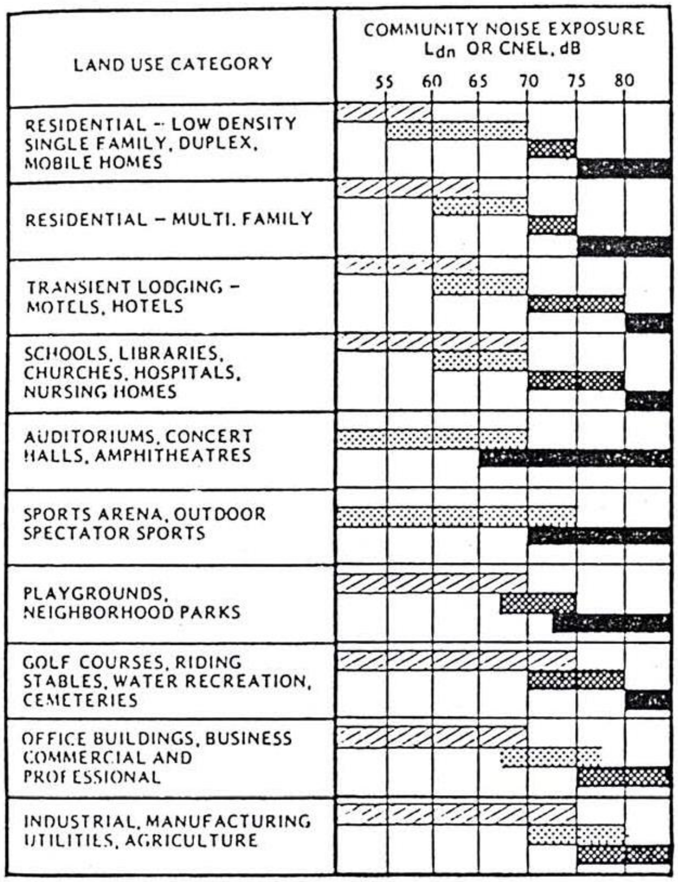
In addition, several new highway links have been proposed for the County. Noise contours have been estimated for these links for the year 2020, and these estimates are presented in tabular form in Figure 2.16.9.

2.16.9 Mitigation Strategies

The following strategies may be used individually or collectively to mitigate noise impacts, and to minimize the number of people exposed to high levels of noise.

- Maximize separation of industrial and residential uses.
- Maximize separation of residential uses and truck routes.
- Restrict trucking hours through existing residential areas.
- Minimize stop signs and signals along truck routes through residential areas, but enforce a speed limit of 35-40 mph in such areas (motor vehicle noise is a strong function of speed).
- Lobby for enforcement of vehicle noise emission codes.
- Restrict operation of industrial facilities to hours that are compatible with sleep patterns of nearby residential areas. Although 7 a.m. is the "official" end of nighttime, the observation from the measurement trips is that most people in areas near industrial uses are awake by 6:00 or 6:30 a.m.
- Establish a County Noise Ordinance, limiting intrusive noise levels ($L_{eq(1H)}$) at noise-sensitive land uses to the ambient level (or a presumed ambient-base level) plus 3 to 5 dB. The Board of Supervisors should determine the presumed ambient-base levels, with recommendations from Planning Staff and their consultants.
- Adopt a County Noise Exposure Ordinance, requiring mitigation of outdoor living space noise to CNEL or L_{eq24H} 60 or 65 and indoor living space noise to CNEL 45 in new residential construction.
- Require that an acoustical site analysis and noise control specification be undertaken for noise-sensitive projects located within the CNEL 60 or 65 contour of any roadway, railroad, airport or industrial use as identified in this or subsequent studies.

Figure 2.16.1
California Noise Control Guidelines



INTERPRETATION

NORMALLY ACCEPTABLE

Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.

CONDITIONALLY ACCEPTABLE

New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and needed noise insulation features included in the design. Conventional construction, but with closed windows and fresh air supply systems or air conditioning will normally suffice.

NORMALLY UNACCEPTABLE

New construction or development should generally be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirements must be made and needed noise insulation features included in the design.

CLEARLY UNACCEPTABLE

New construction or development should generally not be undertaken.

CONSIDERATIONS IN DETERMINATION OF NOISE–COMPATIBLE LAND USE

A. NORMALIZED NOISE EXPOSURE INFORMATION DESIRED

Where sufficient data exists, evaluate land use suitability with respect to a "normalized" value of CNEL or L_{dn}. Normalized values are obtained by adding or subtracting the constants described in Table 1 to the measured or calculated value of CNEL or L_{dn}.

B. NOISE SOURCE CHARACTERISTICS

The land use-noise compatibility recommendations should be viewed in relation to the specific source of the noise. For example, aircraft and railroad noise is normally made up of higher single noise events than auto traffic but occurs less frequently. Therefore, different sources yielding the same composite noise exposure do not necessarily create the same noise environment. The State Aeronautics Act uses 65 dB CNEL as the criterion which airports must eventually meet to protect existing residential communities from unacceptable exposure to aircraft noise. In order to facilitate the purposes of the Act, one of which is to encourage land uses compatible with the 65 dB CNEL criterion wherever possible, and in order to facilitate the ability of airports to comply with the Act, residential uses located in Community Noise Exposure Areas greater than 65 dB should be discouraged and considered located within normally unacceptable areas.

C. SUITABLE INTERIOR ENVIRONMENTS

One objective of locating residential units relative to a known noise source is to maintain a suitable interior noise environment at no greater than 45 dB CNEL of L_{dn}. This requirement, coupled with the measured or calculated noise reduction performance of the type of structure unuer consideration, should govern the minimum acceptable distance to a noise source.

D. ACCEPTABLE OUTDOOR ENVIRONMENTS

Another consideration, which in some communities is an overriding factor, is the desire for an acceptable outdoor noise environment. When this is the case, more restrictive standards for land use compatibillty, typically below the maximum considered "normally acceptable" for that land use category, may be appropriate.

Figure 2.16.2
Oxnard Airport CNEL Map

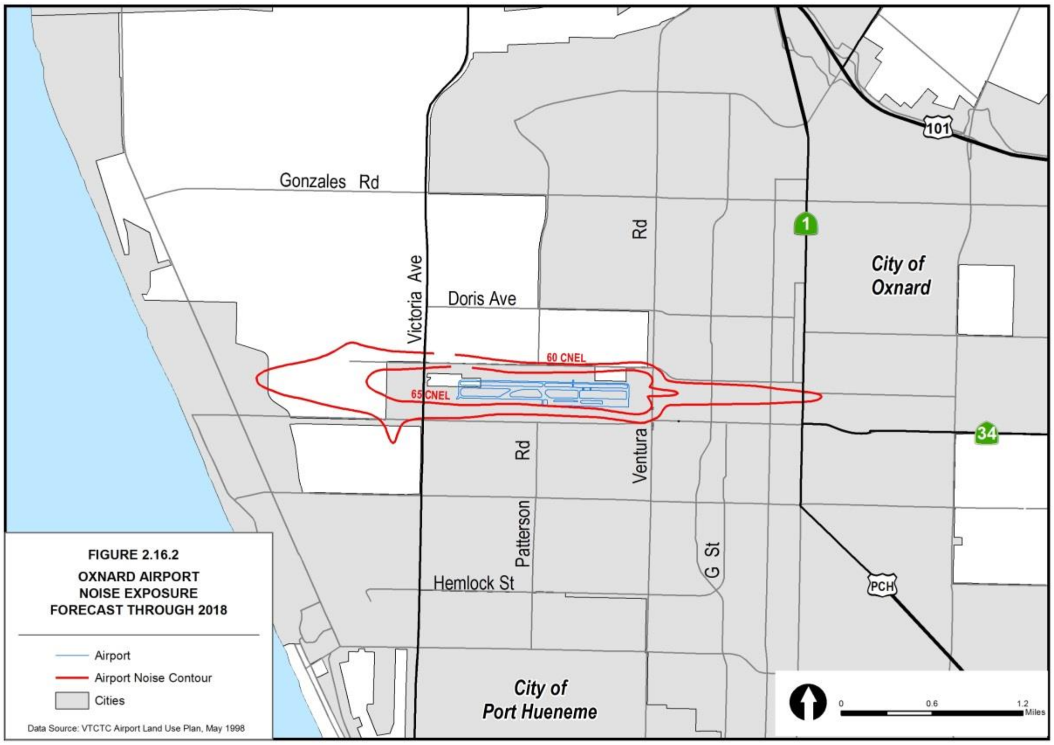


Figure 2.16.3
Camarillo Airport CNEL Map

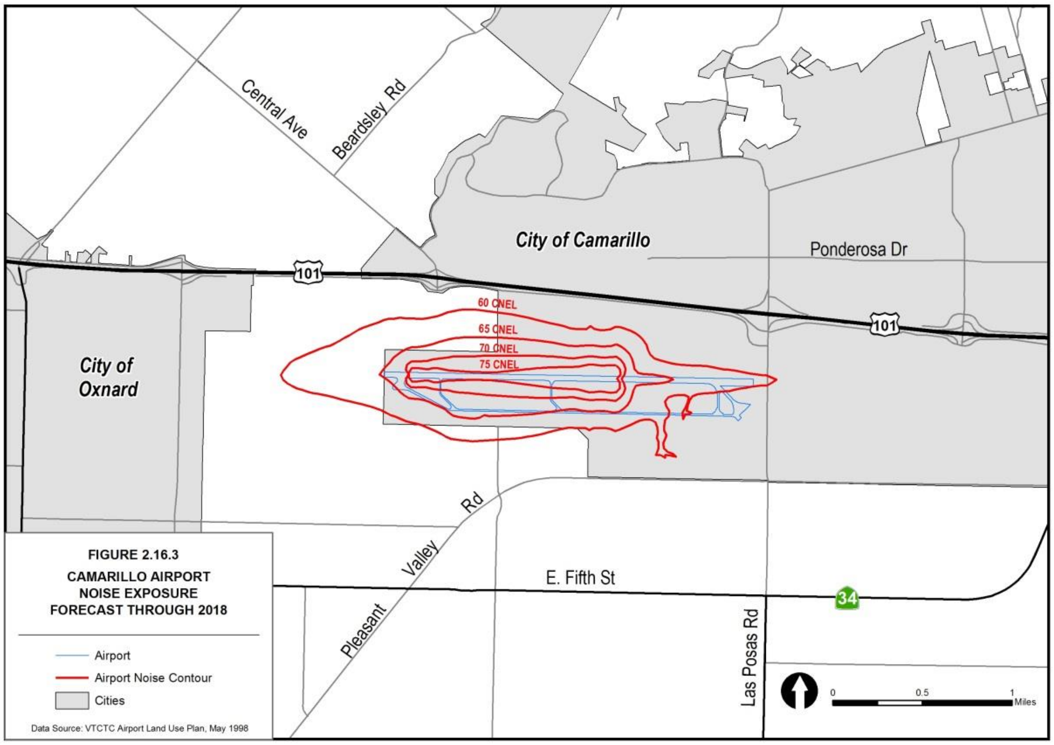


Figure 2.16.4
NAWS Point Mugu CNEL Map

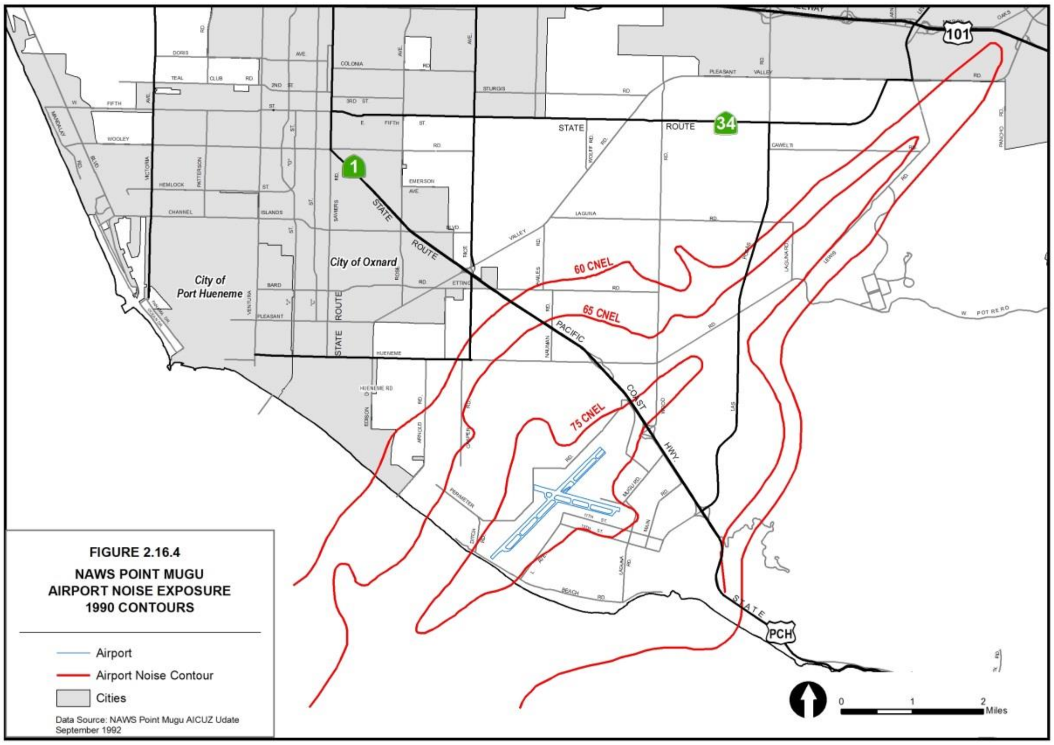


Figure 2.16.5
Santa Paula Airport CNEL Map

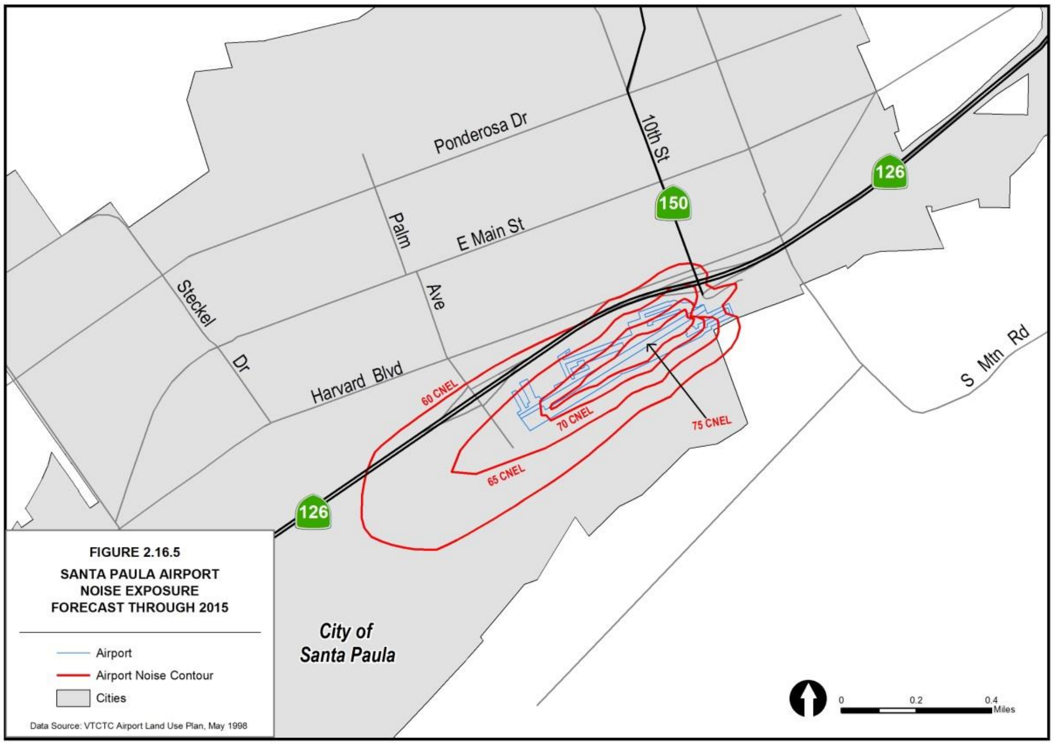


Figure 2.16.6
2020 Noise Contours Map for Regional Road Network

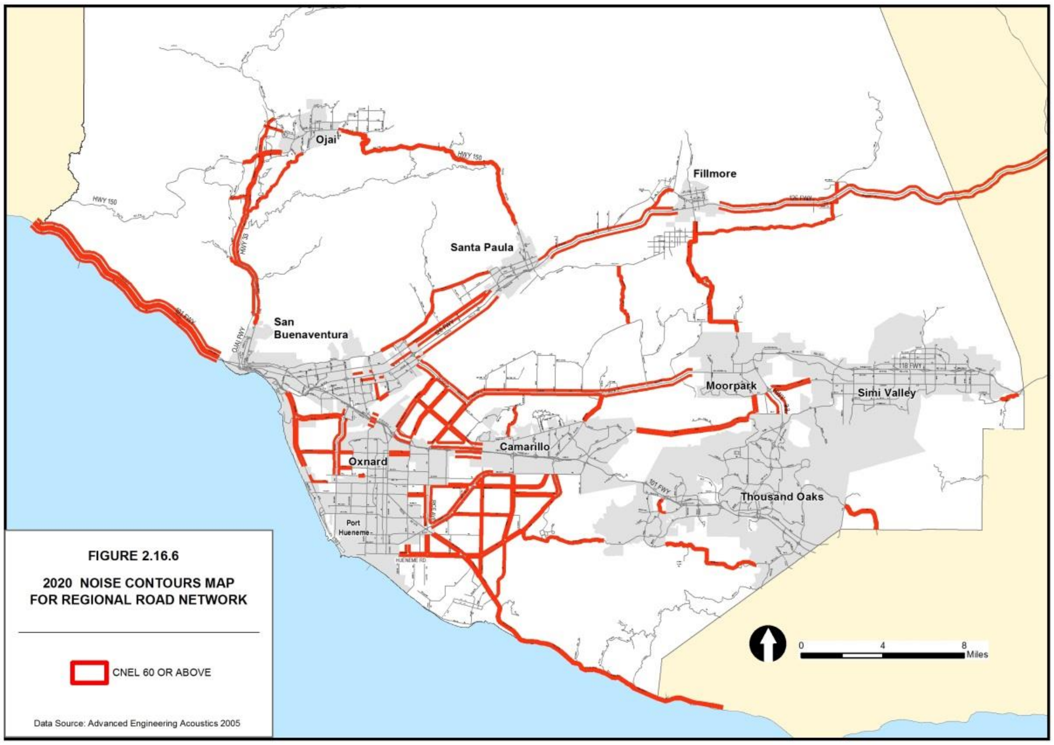


Figure 2.16.7
Current and Year 2020 CNEL Noise Contours for Highways in the County

Highways	CURRENT ADT	CURRENT CNEL[1] Distance From Roadway Centerline, Ft.						2020 ADT	YEAR 2020 CNEL[1] Distance From Roadway Centerline, Ft.					
		50 CNEL	55 CNEL	60 CNEL	65 CNEL	70 CNEL	75 CNEL		50 CNEL	55 CNEL	60 CNEL	65 CNEL	70 CNEL	75 CNEL
State Route 1														
Los Angeles County to Calleguas Creek	10,700	870	435	215	105	55	--	12,000	1,065	540	265	130	70	--
Calleguas Creek to Las Posas Rd.	10,700	870	440	220	120	75	60	12,000	1,065	540	270	140	85	65
Las Posas Rd. to Wood Rd.	12,700	960	490	245	130	80	60	13,000	1,115	570	285	150	90	65
Wood Rd. to Hueneme Rd.	16,500	1,120	570	285	150	85	65	16,000	1,255	645	325	165	95	65
Hueneme Rd. to Nauman Rd.	18,100	1,180	600	300	155	90	65	18,000	1,340	690	345	175	100	70
Nauman Rd. to Oxnard City Limit	18,400	1,190	610	305	160	95	65	18,000	1,340	690	345	175	100	70
State Route 23														
Tierra Rejada Rd. to 3,000 ft. north of Olsen Rd.	59,000	2,880	1,590	830	425	220	130	64,000	3,530	1,995	1,060	545	280	160
Broadway to Fillmore City Limit	6,400	730	360	175	85	--	--	9,000	1,150	585	290	140	65	--
State Route 33														
Shell Rd. to Canada Larga Rd.	29,500	1,620	845	420	205	100	--	26,000	1,800	945	475	230	110	55
Canada Larga Rd. to Casitas Vista Rd.	29,000	1,605	840	425	215	120	80	25,000	1,835	970	490	250	135	85
Casitas Vista Rd. to Creek Rd.	27,500	1,560	810	405	195	95	--	24,000	1,720	900	450	220	105	50
Creek Rd. to Santa Ana Blvd.	27,500	1,560	810	405	195	95	--	23,000	1,680	880	440	215	100	--
Santa Ana Blvd. to Encino Dr.	23,500	1,100	560	275	135	65	--	21,000	1,305	670	330	160	75	--
Encino Dr. to State Route 150 Junction	23,100	1,090	555	270	130	60	--	24,000	1,410	725	360	175	85	--
State Route 150 Junction to Loma Dr.	17,000	915	460	225	105	50	--	19,000	1,235	630	310	150	70	--
Loma Dr. to Ojai City Limit (SW)	18,000	945	475	230	110	55	--	20,000	1,270	650	320	155	75	--
Ojai City Limit (NW) to Fairview Rd.	3,000	320	155	75	--	--	--	4,000	495	240	115	55	--	--
Fairview Rd. to Los Padres National Forest	< 3,000	--	--	--	--	--	--	3,000	415	200	95	--	--	--
State Route 34														
Rice Rd. to Pleasant Valley Rd.	15,200	800	400	195	90	--	--	19,000	1,095	555	270	130	65	--
Pleasant Valley Rd. to Wood Rd.	12,700	720	355	175	80	--	--	19,000	1,165	595	290	140	70	--
Wood Rd. to Las Posas Rd.	12,500	715	355	170	80	--	--	19,000	1,165	595	290	140	70	--
Las Posas Rd. to Camarillo City Limit (S)	8,500	565	280	135	65	--	--	14,000	980	495	240	115	55	--
Camarillo City Limit (NE) to State Route 118	11,800	830	415	200	95	--	--	18,000	1,130	575	280	135	65	--
US Highway 101														
Santa Barbara County to Ventura City Limit	66,000	3,095	1,720	905	460	240	140	91,000	4,050	2,330	1,260	650	330	180
Ventura City Limit to Oxnard City Limit	111,000	3,835	2,190	1,175	605	305	160	138,000	4,685	2,870	1,585	825	420	215
Oxnard City Limit to Camarillo City Limit	140,000	4,302	2,495	1,355	700	355	180	186,000	5,510	3,315	1,860	985	500	255

[1] Divide by 3.2808 to obtain contour distance in meters.

Highways	CURRENT ADT	CURRENT CNEL[1] Distance From Roadway Centerline, Ft.						2020 ADT	YEAR 2020 CNEL[1] Distance From Roadway Centerline, Ft.					
		50 CNEL	55 CNEL	60 CNEL	65 CNEL	70 CNEL	75 CNEL		50 CNEL	55 CNEL	60 CNEL	65 CNEL	70 CNEL	75 CNEL
State Route 118														
Telephone Rd. to Vineyard Ave.	34,000	1,575	820	410	200	100	55	42,000	2,670	1,465	760	380	185	95
Vineyard Ave. to Pacific Milling Rd.	18,800	1,355	695	345	165	80	--	26,000	2,380	1,285	660	325	155	75
Pacific Milling Rd. to Rose Ave.	18,800	1,210	615	205	145	70	--	26,000	2,215	1,190	605	300	145	70
Rose Ave. to Santa Clara Ave.	18,800	1,355	695	345	165	80	--	27,000	2,425	1,310	675	335	160	75
Santa Clara Ave. to La Vista Ave.	14,600	1,370	705	350	170	80	--	17,000	2,045	1,090	550	270	130	60
La Vista Ave. to Center School Rd.	14,600	1,370	705	350	170	80	--	17,000	2,045	1,090	550	270	130	60
Center School Rd. to North St.	14,600	1,370	705	350	170	80	--	17,000	2,045	1,090	550	270	130	60
North St. to Somis Rd.	17,300	1,500	780	780	185	90	--	16,000	1,845	975	490	240	115	55
Somis Rd. to Balcom Canyon Rd	17,300	1,500	780	390	185	90	--	29,000	2,680	1,465	760	375	185	85
Balcom Canyon Rd. to Grimes Canyon Rd.	17,300	1,500	780	390	185	90	--	28,000	2,635	1,440	745	370	180	85
Grimes Canyon Rd. to Moorpark City Limit	17,300	1,500	780	390	185	90	--	29,000	2,680	1,465	760	375	185	85
State Route 126														
Wells Rd. to Briggs Rd.	31,000	2,180	1,170	600	300	155	90	64,000	3,790	2,160	1,160	590	295	150
Briggs Rd. to Santa Paula City Limit	40,000	2,415	1,310	675	335	170	95	65,000	3,940	2,260	1,215	625	310	160
Santa Paula City Limit to Old Telegraph Rd.	28,500	1,965	1,045	530	260	125	65	41,000	2,830	1,560	810	405	200	95
Old Telegraph Rd. Jct. to Fillmore City Limit	26,500	1,735	910	460	225	110	60	37,000	2,690	1,475	765	380	185	95
Fillmore City Limit to Cavin Rd.	19,800	1,485	770	380	185	90	--	33,000	2,705	1,480	770	380	185	90
Cavin Rd. to Torrey Rd.	19,800	1,485	770	380	185	90	--	27,000	2,585	1,410	730	360	175	85
Torrey Rd. to Center St.	17,300	1,500	780	385	185	90	--	31,000	2,770	1,520	790	395	190	90
Center St. to Los Angeles County	18,900	1,575	820	410	200	95	--	31,000	2,770	1,520	790	395	190	90
State Route 150														
State Route 33 to La Luna Ave.	5,200	555	270	130	65	--	--	8,000	1,055	535	260	125	60	--
La Luna Ave. to Burnham Rd.	5,200	555	270	130	65	--	--	6,000	890	445	215	105	50	--
Burnham Rd. to Santa Ana Rd.	< 3,000	--	--	--	--	--	--	3,000	590	290	140	70	--	--
Santa Ana Rd. to Santa Barbara County	< 3,000	--	--	--	--	--	--	3,000	590	290	140	70	--	--
Santa Paula City Limit to Bridge Rd.	3,400	435	210	100	--	--	--	4,000	645	320	155	75	--	--
Bridge Rd. to Sulphur Mountain Rd.	< 3,000	--	--	--	--	--	--	5,000	770	380	185	90	--	--
Sulphur Mountain Rd. to Reeves Rd.	< 3,000	--	--	--	--	--	--	4,000	675	335	160	75	--	--
Reeves Rd. to Ojai City Limit	7,000	935	460	230	110	50	--	7,000	935	470	230	110	50	--
State Route 232 (Vineyard Ave.)														
US Highway 101 to Stroube St.	32,500	1,030	520	25	125	60	--	24,000	1,115	565	280	135	65	--
Stroube St. to Central Ave.	18,400	1,140	580	28	140	70	--	23,000	1,525	795	395	190	95	--
Central Ave. to State Route 118	21,000	1,205	615	305	145	75	--	19,000	1,375	710	350	170	85	--

Figure 2.16.8
Current and Year 2020 CNEL Noise Contours for County Roads

COUNTY ROADWAY	CURRENT ADT	CURRENT CNEL Distance From Roadway Centerline, Ft.						2020 ADT	YEAR 2020 CNEL Distance From Roadway Centerline, Ft.					
		50 CNEL	55 CNEL	60 CNEL	65 CNEL	70 CNEL	75 CNEL		50 CNEL	55 CNEL	60 CNEL	65 CNEL	70 CNEL	75 CNEL
Borchard Rd.														
212 W/O Wendy Dr. to Thousand Oaks City	21,000	865	435	215	105	55		22,500	900	455	220	110	60	--
Bristol Rd.														
Union Pacific RR to Ventura City Limit	8,000	600	295	140	65	--	--	14,000	835	415	200	95	--	--
Casitas Vista Rd.														
Santa Ana Rd. to Ventura Ave.	3,000	280	135	65	--	--	--	3,500	310	150	70	--	--	--
Cawelti Rd.														
Las Posas Rd. to Lewis Rd.	< 3,000	--	--	--	--	--	--	18,000	1,340	690	345	170	85	50
Central Ave.														
State Route 232 to Rose Ave.	10,600	685	335	165	75	--	--	13,100	775	385	190	90	--	--
Rose Ave. to Santa Clara Ave.	7,300	795	395	190	90	--	--	13,800	1,155	585	290	140	70	--
Santa Clara Ave to Camarillo City Limit	14,500	1,185	605	295	145	65	--	22,000	1,495	775	385	190	90	--
Channel Islands Bl.														
Oxnard City Limit to Rice Ave.	12,000	1,065	540	265	130	60	--	22,500	1,515	790	395	195	100	55
Creek Rd.														
State Route 33 to Ojai City Limit	< 3,000	--	--	--	--	--	--	< 3,000	--	--	--	--	--	--
Doris Ave.														
Victoria Ave. to Oxnard City Limit	4,200	515	250	120	55	--	--	8,100	765	380	185	85	--	--
El Roblar Dr.														
La Luna Ave. to State Route 33	8,000	260	125	60	--	--	--	9,900	300	145	70	--	--	--
Fairway Dr.														
Valley Vista Dr. to Center School Rd.	5,800	255	120	60	--	--	--	6,400	285	135	65	--	--	--
Foothill Rd.														
Ventura City Limit to Wells Rd.	3,500	500	245	115	55	--	--	4,600	590	290	140	65	--	--
Wells Rd. to Santa Paula City Limit	< 3,000	--	--	--	--	--	--	3,200	470	230	110	50	--	--
Gonzales Rd.														
Harbor Blvd. to Oxnard City	5,100	580	285	135	65	--	--	6,400	665	325	160	75	--	--
Grimes Canyon Rd.														
State Route 118 to Broadway	< 3,000	--	--	--	--	--	--	5,000	1,075	545	265	130	60	--
Guiberson Rd.														
State Route 23 to Torrey Rd.	< 3,000	--	--	--	--	--	--	< 3,000	--	--	--	--	--	--

Figure 2.16.8 - continued
Current and Year 2020 CNEL Noise Contours for County Roads

	CURRENT	CURRENT CNEL Distance From Roadway Centerline, Ft.						2020	YEAR 2020 CNEL Distance From Roadway Centerline, Ft.					
COUNTY ROADWAY	ADT	50 CNEL	55 CNEL	60 CNEL	65 CNEL	70 CNEL	75 CNEL	ADT	50 CNEL	55 CNEL	60 CNEL	65 CNEL	70 CNEL	75 CNEL
Harbor Blvd.														
Ventura City Limit to Gonzales Rd.	17,600	1,250	640	315	150	70	--	24,400	1,500	780	390	190	100	60
Gonzales Rd. to Oxnard City Limit	15,000	1,145	580	285	135	65	--	24,400	1,500	780	390	190	100	60
Hueneme Rd.														
Oxnard City Limit to Rose Ave.	10,700	1,020	515	250	120	60	--	17,900	1,370	705	350	175	90	55
Rose Ave. to Rice Ave.	10,700	1,020	515	250	120	60	--	17,900	1,370	705	350	175	90	55
Rice Ave. to State Route 1	10,400	1,005	505	245	120	55	--	18,800	1,405	725	360	175	85	--
State Route 1 to Wood Rd.	10,400	1,005	505	245	120	55	--	18,800	1,405	725	360	175	85	--
Wood Rd. to Las Posas Rd.	10,000	985	495	240	115	55	--	18,800	1,405	725	360	175	85	--
Las Posas Rd. to West Potrero Rd.	10,800	1,030	520	255	120	60	--	25,800	1,275	655	320	155	75	--
Kanan Rd.														
Lindero Cyn. Rd. to Los Angeles County	22,000	1,130	575	280	140	70	--	20,000	1,070	540	265	130	65	--
La Luna Ave.														
State Route 150 to El Roblar Dr.	3,700	320	155	75	--	--	--	5,000	385	185	90	--	--	--
El Roblar Dr. to State Route 33	4,000	280	135	65	--	--	--	5,000	325	155	75	--	--	--
Laguna Rd.														
Pleasant Valley Rd. to Wood Rd.	< 3,000	--	--	--	--	--	--	< 3,000	--	--	--	--	--	--
Wood Rd. to Las Posas Rd.	< 3,000	--	--	--	--	--	--	< 3,000	--	--	--	--	--	--
Las Posas Rd. to Hueneme Rd.	< 3,000	--	--	--	--	--	--	< 3,000	--	--	--	--	--	--
Las Posas Rd.														
State Route 1 to Hueneme Rd.	4,300	555	270	130	60	--	--	9,300	380	185	85	--	--	--
Hueneme Rd. to Laguna Rd.	13,800	1,125	570	280	135	65	--	17,700	1,295	665	325	160	75	--
Laguna Rd. to Cawelti Rd.	9,400	900	450	220	105	50	--	17,700	1,295	665	325	160	75	--
Cawelti Rd. to Fifth St. (SR 34)	9,400	900	450	220	105	50	--	17,700	1,295	665	325	160	75	--
Lewis Rd.														
Hueneme Rd. to CSUCI	7,300	730	360	175	85	--	--	7,300	730	365	180	95	55	--
University Dr. to Pleasant Valley Rd.	9,300	945	475	230	110	50	--	30,000	1,715	900	450	225	110	--
Lomita Ave.														
S. La Luna Ave. to El Roblar Dr.	5,200	240	115	55	--	--	--	4,000	205	100	--	--	--	--
New Moorpark Rd.														
Santa Rosa Rd. to Tierra Rejada Rd.	13,600	1,305	670	330	160	75	--	20,200	1,390	715	355	170	85	--
Old Telegraph Rd.														
State Route 126 to Fillmore City Limit	< 3,000	--	--	--	--	--	--	5,000	570	280	135	65	--	--

Figure 2.16.8 - continued
Current and Year 2020 CNEL Noise Contours for County Roads

	CURRENT	CURRENT CNEL Distance From Roadway Centerline, Ft.						2020	YEAR 2020 CNEL Distance From Roadway Centerline, Ft.					
COUNTY ROADWAY	**ADT**	**50 CNEL**	**55 CNEL**	**60 CNEL**	**65 CNEL**	**70 CNEL**	**75 CNEL**	**ADT**	**50 CNEL**	**55 CNEL**	**60 CNEL**	**65 CNEL**	**70 CNEL**	**75 CNEL**
Olivas Park Dr.														
Seaborg Ave. to Victoria Ave.	7,000	790	395	190	90	65		18,500	1,395	720	355	175	85	--
Victoria Ave. to Telephone Rd.	12,900	1,125	570	280	135	65	--	22,000	1,515	785	390	190	90	--
Telephone Rd. to Harbor Blvd.	7,700	835	415	200	95	65	--	22,000	1,515	785	390	190	90	--
Patterson Rd.														
Teal Club Rd. to Doris Ave.	< 3,000	--	--	--	--	--	--	< 3,000	--	--	--	--	--	--
Pleasant Valley Rd.														
Oxnard City to Wood Rd.	11,100	1,070	545	265	125	60	--	30,000	1,855	980	495	245	120	65
Wood Rd. to Las Posas Rd.	17,800	1,205	615	305	145	70	--	34,000	1,725	905	455	225	110	60
Potrero Rd.														
Hueneme Rd. to Thousand Oaks City Limit	< 3,000	--	--	--	--	--	--	5,300	595	295	145	75	--	--
Thousand Oaks City to Lake Sherwood Dr.	6,900	510	250	125	--	--	--	13,200	755	375	185	95	50	--
Lake Sherwood Dr. to Thousand Oaks City limit	6,900	510	250	125	65	--	--	10,200	650	320	155	80	--	--
Rice Ave.														
Hueneme Rd. to Oxnard City Limit	--	--	--	--	--	--	--	19,000	1,325	685	345	175	100	70
Pleasant Valley Rd. to Channel Island Bl.	16,800	1,565	815	405	200	100	55	31,800	2,195	1,175	600	300	150	80
Channel Islands Bl. to Wooley Rd.	26,200	1,985	1,055	535	265	130	70	41,800	2,520	1,370	710	135	175	90
Wooley Rd. to State Route 34	31,900	2,375	1,285	660	325	160	80	41,800	2,720	1,495	775	385	190	100
Rose Ave.														
Oxnard City Limit to Central Ave.	11,400	870	435	215	105	60	--	17,000	1,095	555	275	135	70	--
Central Ave. to State Route 118	6,900	770	385	185	90	--	--	15,200	1,220	620	305	145	70	--
Santa Ana Blvd.														
Santa Ana Rd. to State Route 33	< 3,000	--	--	--	--	--	--	3,000	305	145	70	--	--	--
Santa Ana Rd.														
Santa Ana Blvd. to Casitas Vista Rd.	3,000	305	145	70	--	--	--	< 3,000	--	--	--	--	--	--
Santa Ana Blvd. to State Route 150	3,000	305	145	70	--	--	--	< 3,000	--	--	--	--	--	--
Santa Clara Ave.														
Oxnard City Limit. to Central Ave.	8,900	705	350	170	80	--	--	20,100	1,130	575	285	140	70	--
Central Ave. to State Route 118	13,300	1,130	575	280	135	65	--	23,700	1,560	810	405	200	100	55
Santa Rosa Rd.														
Camarillo City Limit to E. Las Posas Rd.	15,700	1,140	580	285	135	65	--	25,000	1,480	765	380	185	95	50
E. Las Posas Rd. to Moorpark Rd.	16,300	1,165	595	290	140	70	--	25,000	1,480	765	380	185	95	50

Figure 2.16.8 - continued
Current and Year 2020 CNEL Noise Contours for County Roads

COUNTY ROADWAY	CURRENT ADT	CURRENT CNEL Distance From Roadway Centerline, Ft. 50 CNEL	55 CNEL	60 CNEL	65 CNEL	70 CNEL	75 CNEL	2020 ADT	YEAR 2020 CNEL Distance From Roadway Centerline, Ft. 50 CNEL	55 CNEL	60 CNEL	65 CNEL	70 CNEL	75 CNEL
Santa Susana Pass Rd.														
Simi Valley City Limit to Lilac Ln.	5,800	595	290	140	65	--	--	8,500	745	370	180	85	--	--
Teal Club Rd.														
2020 feet to 612 west of Ventura Rd.	< 3,000	--	--	--	--	--	--	3,500	485	235	115	55	--	--
Telegraph Rd.														
Ventura City Limit to Santa Paula City Limit	4,900	485	235	115	55	--	--	8,000	650	320	160	80	--	--
Santa Paula City Limit to Hallock Dr.	4,700	470	230	110	50	--	--	8,000	650	320	160	80	--	--
Tierra Rejada Rd.														
Moorpark City to Simi Valley City Limit	14,000	1,210	620	305	150	75	--	22,000	1,555	810	405	200	100	55
Torrey Rd.														
Guiberson Rd. to State Route 126	< 3,000	--	--	--	--	--	--	3,000	450	205	95	--	--	--
Valley Vista Dr.														
Camarillo City Limit to Fairway Dr.	5,800	255	120	60	--	--	--	6,600	275	135	65	--	--	--
Ventura Ave.														
Ventura City Limits to Casitas Vista Rd.	7,600	450	220	105	50	--	--	13,000	590	290	140	70	--	--
Victoria Ave.														
Oxnard City Limit to Gonzales Rd.	36,000	1,850	975	490	240	120	65	55,000	2,305	1,245	635	315	155	80
Gonzales Rd. to Olivas Park Dr.	32,000	1,735	910	460	225	110	60	60,600	2,410	1,305	670	335	165	90
Wendy Dr.														
N/O Borchard Rd. to Thousand Oaks City Limit	13,500	510	250	120	60	--	--	23,000	705	350	170	85	--	--
Wooley Rd.														
Oxnard City Limit to Rice Ave.	5,000	920	460	225	105	50	--	13,000	1,115	565	275	135	65	--

Figure 2.16.9
Year 2020 CNEL Noise Contours for Proposed Roadways and Modifications

COUNTY ROADWAY	CURRENT ADT (N/A)	CURRENT CNEL(Not Applicable) Distance From Roadway Centerline, Ft.						2020 ADT	YEAR 2020 CNEL Distance From Roadway Centerline, Ft.					
		50 CNEL	55 CNEL	60 CNEL	65 CNEL	70 CNEL	75 CNEL		50 CNEL	55 CNEL	60 CNEL	65 CNEL	70 CNEL	75 CNEL
State Route 33														
Casitas Springs Bypass	--	--	--	--	--	--	--	24,000	1,565	815	410	200	105	60
Ahmanson Ranch Blvd.														
Thousand Oaks Blvd. to Victory Blvd.	--	--	--	--	--	--	--	25,200	1,105	560	280	140	75	--
Rose Ave. Extension														
Oxnard City Limit to Hueneme Rd.	--	--	--	--	--	--	--	18,000	1,285	660	325	160	80	--

2.17 Civil Disturbance

2.17.1 General Effects of the Hazard

Civil unrest, terrorism, and national security emergency hazards are forms of civil disturbance, which are of major public concern and necessitate a planned and coordinated response by a number of public agencies.

Civil Unrest

Civil unrest is the spontaneous disruption of normal, orderly conduct and activities in urban areas, or outbreak of rioting or violence that is of a large-scale nature. Civil unrest can be spurred by specific events, such as large sporting events or criminal trials, or can be the result of long-term disfavor with authority. Civil unrest is usually noted by the fact that normal on-duty police and safety forces cannot adequately deal with the situation until additional resources can be acquired. This is the time period when civil unrest can grow to large proportions.

Threats to law enforcement and safety personnel can be severe and bold in nature. Securing of essential facilities and services is necessary. Looting and fires can take place as a result of perceived or actual non-intervention by authorities.

Terrorism

Terrorism is defined as the use of fear for intimidation, usually for political goals. Terrorism is a crime where the threat of violence is often as effective as the commission of the violent act itself. Terrorism affects us through fear, physical injuries, economic losses, psychological trauma, and erosion of faith in government. Terrorism is not an ideology. Terrorism is a strategy used by individuals or groups to achieve their political goals.

The following information from the Terrorism Response Plan describes in general potential terrorist targets in Ventura County:

Chemical and Industrial - There are over 3,000 facilities within Ventura County that store and use Industrial and hazardous materials, maintain above and underground hazardous storage tanks, and produce hazardous wastes. Of these approximately 3,000 facilities there are 39 sites that use Acutely Hazardous Materials such as chlorine, ammonia, methyl bromide, sulfur dioxide and flammables. These sites participate in the County's Risk Management and Prevention Program, administered by the Ventura County Environmental Health Division. In addition, there are two toxic gas distributors and four propane distributors that are non-CalARP sites.

Recognizing that terrorism events by their nature tend to affect large numbers of people, the Ventura County Fire Protection District designed a Mass Decontamination trailer. This trailer, its equipment and the mass decon-procedures utilized by specially trained fire district personnel will provide the county with the capability to address the decontamination of victims of terrorist acts prior to their treatment and/or transport.

Transportation Infrastructure - US Highway 101 traverses Ventura County, which is one of the two major north south routes in California. There are also several major State Highways that connect other routes and cities, including Highway 33, Highway 118, and Highway 126.

Union Pacific Railroad’s rail line from Los Angeles to San Francisco runs through the County. Many of the trains that run on this railway are carrying chemicals that, if released, could pose a threat to the community.

California’s major coastal shipping lane lies just off the Ventura County coast.

There are four airports within the County: Ventura County Airport at Oxnard, Ventura County airport at Camarillo, Santa Paula Airport, and Point Mugu.

Military Installations - Ventura County is home to Navy Base Ventura County, which is comprised of the Naval Base Ventura County, Point Mugu, the Naval Construction Battalion Center at Port Hueneme, and the Air National Guard Base that is adjacent to Point Mugu.

In addition to being potential targets for terrorism, these facilities make Ventura County vulnerable to a nuclear attack. According to the Nuclear Attack Planning Base – 1990, published by the Federal Emergency Management Agency, the County is classified as a High-Risk area.

Civilian Facilities and Tourist Attractions - Within County of Ventura there are numerous governmental facilities and tourist attractions that could be targeted for a terrorist attack. These include:

- More than 20 federal agency offices
- At least 13 state agency offices
- County Government Center
- Ventura County Fair Grounds
- Two major retail outlet centers
- Three major shopping malls
- Eight hospitals
- Schools, churches & religious centers
- Two research facilities
- Electrical Facilities and Power Plants
- Water and Wastewater Facilities, Dams
- Bridges and Overpasses

Telecommunications - There are a number of critical telecommunication facilities in Ventura County, including numerous mountain top repeater sites. There are also a number of important telephone service facilities.

Within the United States there are a wide variety of individuals and groups who are highly dissatisfied with the Federal government. Some of those individuals engage in their own brand of resistance by refusing to: possess a driver's license; possess a social security number; or pay taxes. Many of these people are referred to as part of the Patriot, Freeman, Sovereign Citizen, or militia movements. Some of the militia type groups engage in various degrees of preparation for what is considered to be the eventual armed conflict with the Federal government and/or foreign troops. Southern California has a number of groups and individuals that espouse a variety of anti-Federal government rhetoric.

National Security Emergency

A national security emergency is defined as the potential use of or threat of use of weapons of mass destruction (WMD) whether by terrorists, insurgents, or a foreign government. A WMD is any device, material, or substance used in a manner, in a quantity or type, or under circumstances evidencing intent to cause death or serious injury to persons or significant damage to property.

The existence of the Naval Base facilities at Point Mugu and Port Hueneme, the Rocketdyne Facility in Simi Valley, and Vandenberg Air Force Missile Base near Lompoc make Ventura County vulnerable to a potentially dangerous nuclear attack. According to the Nuclear Attack Planning Base - 1990, published by the Federal Emergency Management Agency, Ventura County is classified as a High-Risk area.

Effects of nuclear detonation include: blast (overpressure), thermal radiation (heat & light), ionizing radiation, initial and persistent radiation contamination, fallout, and electromagnetic effects (EMP).

2.17.2 Nature of the Hazard

Civil Unrest

Available resources and equipment may be allocated and reallocated based on changing conditions and priorities. This process alone mandates participation by all entities within the operational area. Incident Command System (ICS) is a united team effort that allows all agencies that have responsibility for the incident, either jurisdictional or functional to jointly provide management direction to an incident through a common set of incident objectives and strategies established at the command level. This is accomplished without losing or abdicating agency authority, responsibility or accountability. Each agency is fully aware of the plans and actions of all others and the combined efforts of all agencies are optimized as they perform their respective assignments.

The activation of the Emergency Operations Center (EOC) and ICS unified command will provide the wherewithal to manage dynamic fast-moving incidents in a proactive manner while minimizing the negative impacts normally associated with multi-agency jurisdiction events.

In our area, disturbances may be precipitated or manifested in a number of different ways:

- Spontaneous reactions to whatever verdict is rendered or sporting event outcome (retaliation or celebration)
- Organized reactions or demonstrations
- Targeting of public facilities
- Targeting of private highly visible establishments
- Local population demonstrations
- Transient population demonstrations
- Hit and run tactics
- Diversion tactics masking other motives
- Indiscriminate acts of arson and vandalism

Less certain are the extent and type of activity that we will experience. The potential for widespread acts of multiple disturbances or violence is very real. The fact that these types of operations are labor intensive amplifies the need for preplanning and aggressive organizational techniques.

Terrorism

Terrorists espouse a wide range of causes. They can be for or against almost any issue, religious belief, political position, or group of people of one national origin or another. Because of the tremendous variety of causes supported by terrorists and the wide variety of potential targets, there is no place that is truly safe from terrorism. Throughout California there is nearly limitless number of potential targets, depending on the perspective of the terrorist. Some of these targets include: abortion clinics, religious facilities, government offices, public places (such as shopping centers), schools, power plants, refineries, utility infrastructures, water storage facilities, dams, private homes, prominent individuals, financial institutions and other businesses.

National Security Emergency

As a result of the recent restructuring of the Soviet Union, the likelihood of nuclear war is significantly reduced. Therefore, identifying likely targets in the event of a nuclear war is not pertinent. However, terrorist activities and radiological materials accidents are still likely. Terrorist activities could result in nuclear weapons being detonated.

The following is provided for information and planning purposes:

Air Burst - An air burst, by definition, is when a nuclear weapon is detonated and the fireball does not touch the surface of the earth. Usually, the weapon is set to detonate at a height of between 5,000 and 15,000 feet. Airbursts are generally selected for their capability to generate high over-pressure and shock effect over large areas, as well as to ignite fires for great distances. Neither radiation nor radioactive fallout is considered to be a significant factor in the event of an air burst.

Surface Burst - A nuclear detonation is considered to be a surface burst when the fireball generated touches the surface of the earth. Surface bursts could include water bursts, under-water bursts and underground bursts. Surface bursts produce large amounts of radioactive fallout. Therefore, some targets may be selected not only for the purpose of destroying facilities, but to also use the downwind fallout to prevent access or restrict movement in large geographical areas. Detonation of a nuclear bomb can produce various damaging effects. Included are blast and over-pressure, intense heat and light, nuclear radiation (fission and fusion), electromagnetic pulse, and for surface bursts, radioactive fallout.

Blast - When the weapon is detonated, a tremendous pressure is developed. This over-pressure rapidly expands outward in all directions, creating extremely high winds. The expansion continues until the over-pressure is reduced to normal pressure. The rapid outward expansion of air creates a vacuum that must equalize. The winds then reverse to the opposite direction and continue until the air pressure is equalized. Damage and injury are caused not only by the outward expansion phase of the wind and pressure, but also in the opposite direction when the air is rushing back to fill the vacuum. It is believed that an ordinary California home would be destroyed at about 1.5 to 2 psi, often 2 to 5 miles from the detonation.

NOTE: Over-pressure is rated in pounds per square inch (psi). Normal pressure at sea level is 14.7 pounds per square inch. Therefore, if the pressure is increased to 15.7 psi, the over-pressure would be 1 psi.

Thermal Radiation - A burst of intense light and heat. This phenomenon can initiate fires as well as produce casualties. A one-megaton explosion can produce flash-blindness up to 13 miles on a clear day, or 53 miles on a clear night. Thermal radiation can cause skin and retinal burns many miles from the point of detonation. A one-megaton explosion can cause first-degree burns at distances of approximately 7 miles, second-degree burns at approximately 6 miles, and third- degree burns at approximately 5 miles from ground zero. Detonation of a single thermonuclear weapon could cause many thousands of burn casualties.

Initial Radiation - Defined as that radiation emitted during the first minute after detonation, it is comprised of gamma rays and neutrons. For large yield weapons, the range of the initial radiation is less than that of the lethal blast and thermal radiation effects. However, with respect to small yield weapons, the initial radiation may be the lethal effect with the greatest range.

Fallout - Produced by surface debris drawn into and irradiated by the fireball, then rising into the atmosphere and eventually returning to earth. When a nuclear detonation occurs, fission products and induced radioactive material from the weapon casing and debris that was pulled up into the fireball returns to earth as fallout. A source of ionizing radiation, fallout may be deposited miles from the point of detonation and thus affect people otherwise safe from the other effects of the weapon. The radiation danger associated with fallout decreases as the radioactive material decays. Decay rates range from several minutes to several years.

Electromagnetic Pulse (EMP) - Intense electric and magnetic fields that can damage unprotected electronic equipment. This effect is most pronounced in high altitude bursts (above 100,000). Surface bursts typically produce significant EMP up to the 1-psi over-pressure range, while airbursts produce somewhat less. No evidence exists suggesting that EMP produces harmful effects in humans. The approximate nighttime population at risk in the County is 669,000. A current fallout shelter listing is no longer kept by the County Office of Emergency Services. A review of previous listings designated approximately 141 available shelter facilities with the total number of 196,898 shelter spaces. If it is determined that shelter from a nuclear incident be required, information on expedient shelter designs and on shelter reactivation and upgrading techniques will be disseminated through the Public Information Officer and the Radiological Defense Officer. Area vendors will provide food, water, medical supplies, and sanitation measures. Shelter monitor kits and shelter monitors will be dispersed by the County Office of Emergency Services to each designated Public Fallout Shelter. A complete listing of monitors and monitor kits in the county is maintained by the Sheriff's Office of Emergency Services.

2.17.3 Alleviation of the Hazard

Civil Unrest

Intelligence regarding any potential for civil unrest or disorder will be shared with the affected law enforcement agencies as soon as it is known. Without the compromise of sensitive information, or the disclosure of sources, information will be shared with other emergency response agencies as soon as possible. Law enforcement agencies will utilize all available resources at the outbreak of disorder to suppress the outbreak and restore the peace.

Terrorism

The Ventura County Sheriff established the Terrorism Working Group (TWG) (consisting of local, state and federal law enforcement agencies, public health officials and emergency responders) in October 1998 in response to a growing concern about terrorism at the federal and state level. At that time, the President had already signed two Presidential Decision Directives addressing terrorism and the budgets for federal programs aimed at combating terrorism had increased dramatically. In addition, the Governor's Office of Emergency Services has published the "Local Planning Guidance on Terrorism Response," which encourages local agencies to establish both a threat analysis group and a working group to assist with development of a plan. Ventura County's TWG has generated such a plan for Ventura County, and is continuing to develop scenarios and response resources to apply during a terrorist act.

National Security Emergency

Ventura County will continue to participate in all elements of the National Alert and Warning System, and provide as much warning and direction to the County's population as is available.

Response activities to the nuclear materials threat will consist of in-place protection measures, relocation and spontaneous evacuation.

The County Sheriff's Department Office of Emergency Services will annually review and revise the Multihazard Functional Plan's National Security Emergency section.

2.17.4 Conclusion

Civil Unrest

The entire County, consisting of residential, industrial and commercial properties, is vulnerable to the effects of civil unrest. Law Enforcement Agencies in Ventura County have an active intelligence gathering and sharing network, whose primary purpose is to ensure the safety and tranquility of the County. Should disturbances break out, it is the policy of law enforcement to apply all available resources at the onset of the incident to prevent its spread or continuation. The Sheriff, as Law Enforcement Mutual Aid Coordinator, has established a Mutual Aid Plan and procedures for response with all local law enforcement agencies.

Terrorism

The area surrounding the County of Ventura is known to have persons who are interested and involved in the patriot/militia movements. There is no reason to conclude, at this time, that the County of Ventura is any more likely to experience domestic terrorism than any other southern California community.

National Security Emergency

While the threat of nuclear attack decreased after the end of the "Cold War," the number of countries that have gained the ability to create and deliver nuclear weapons has increased. Terrorist groups have actively attempted to develop or acquire the technology and means to use nuclear weapons as tools. The use of "dirty bombs" (nuclear or biological materials dispersed by conventional explosives) is also considered a threat.

Local, state and federal intelligence resources have as one of their primary missions the location, identification and prevention of the use of such weapons. Ventura County both receives and contributes to the intelligence gathering effort, and will continue to do so.

Bibliography

General

Armstrong, Dean, Project Director. (Tri-Cities Seismic Safety and Environmental Resources Study) Seismic Safety Study for the General Plan. September, 1973.

Association of Engineering Geologists. Engineering Geology in Southern California, Special Publication, 1966.

Association of Engineering Geologists. Geology and Earthquake Hazards, prepared by the Southern California Section, 1973.

Bolt, B. A., Horn, W. L. Macdonald, G. A. and Scott, R. F., Geological Hazards, Springer-Verlag, 1977.

California Department of Water Resources. Crustal Strain and Fault Movement Investigation. Bulletin 116-2, 1964.

California Division of Mines and Geology. Geology and Mineral Resources Study of Southern Ventura County. Preliminary Report 14, 1973 (prepared in cooperation with the County of Ventura).

California Division of Mines. Geology of Southern California. Bulletin 170, 1954.

California State Legislature, Joint Committee on Seismic Safety. Meeting the Earthquake Challenge (Final Report to the Legislature, Pursuant to the Provisions of Senate Concurrent Resolution 128), January 1974.

California Council on Intergovernmental Relations. General Plan Guidelines. September, 1973.

Longwell, Chester R. and Richard F. Flint. Introduction to Physical Geology. 2nd Edition. New York: John Wiley & Sons, Inc. 1962.

Los Angeles County Earthquake Commission. San Fernando Earthquake, February 9, 1971. 1971

Ventura County Department of Public Works. "Engineering Geology Report - North Half Phase II Study and Lockwood Valley Fault Trace Zoning and Land Use Study." Prepared for the Ventura County Planning Department, 1972.

Ventura County Department of Public Works. "Geologic Information -County Resources Plan and Program, South Half of Ventura County." Prepared for the Ventura County Planning Department, 1973.

Ventura County Department of Public Works. "Reconnaissance Engineering Geology Report - Coastal Study." Prepared for the Ventura County Planning Department, 1973.

U.S. Office of Emergency Preparedness. Disaster Preparedness Report to the Congress, January, 1972.

National Academies of Sciences and Engineering. The San Fernando Earthquake of February 9, 1971. 1971.

Quick, G.L. "Preliminary Microzonation for Surface Faulting in Ventura, California Area," Geology, Seismicity and Environmental Impact, Association of Engineering of Geologists, Special Publication, 1973.

Fault Rupture

California Division of Mines and Geology. Geology of the Lockwood Valley Area. Special Report 81, 1964.

California Resources Agency. Earthquake and Geologic Hazards. Conference Proceedings, San Francisco, 1964.

Executive Office of the President, Office of Science and Technology. Earthquake Hazard Reduction - Task Force Report. 1970.

Housner, G.W. Earthquakes and Building Vibrations. American Concrete Institute Seminar. 1972+.

Iacopi, R. Earthquake Country. Menlo Park, California: a Sunset Book, Lane Books, 1971.

U.S. Department of Commerce. Engineering Aspects of the 1971 San Fernando Earthquake. Building Science Series 40, (Stock No. 0303-0940), 1971.

U.S. Department of Housing and Urban Development. Environmental Planning and Geology. Washington: Superintendent of Documents, (Stock No. 2300-1195), 1972.

U.S. Geological Survey. The San Fernando, California, Earthquake of February 9, 1971. Professional Paper 733. 1971.

U.S. Geological Survey. Seismic Hazards and Land Use Planning. Geological Survey Circular 690, 1974.

U.S. Office of Emergency Preparedness. Geologic Hazards and Public Problems. Conference Proceedings, Region Seven. 1969.

Wallace, R.E. "Geologic Factors in Earthquake Damage," Journal of the American Institute of Architects, Volume XLX, July 1968.

Ground Shaking

Albee, A.L. and Smith, J.L. "Geologic Site Criteria for Nuclear Power Plant Location." Transactions of the Society of Mining Engineers. 1967.

Association of Engineering Geologists. Geology, Seismicity and Environmental Impact. Special Publication, 1973.

Association of Engineering Geologists. Geology, Seismicity and Environmental Impact. Symposium proceedings, National Meeting, 1973.

California Department of Water Resources. Crustral Strain and Fault Movement Investigation. Bulletin 116-2, 1964.

California Division of Highways. The San Fernando Earthquake. Research Report No. M & R 632119, 1971.

California Division of Highways. Seismicity and Dynamic Response Analysis, Proposed Highway Interchange State Routes 1-101-232. Report by Woodward-McNeill and Associates, 1973.

California Division of Mines and Geology. Faults and Earthquakes in California. Seismic Safety Information 72-7, 1972.

California Institute of Technology. Research Papers Submitted to Fifth World Conference on Earthquake Engineering, Rome, Ital. Pasadena: California Institute of Technology, 1973.

Executive Office of the President, Office of Science and Technology. Earthquake Hazard Reduction - Task Force Report. 1970.

Hileman, J.A., Clarence, R.A. and Nordquist, J.M. Seismicity of the Southern California Region. Pasadena: California Institute of Technology, 1973.

Jennings, Paul C. The Effect of Local Site Conditions on Recorded Strong Earthquake Motions. California Institute of Technology.

Seed, H.B. and Schnable, P.B. "Soil and Geologic Effects On Site Responses During Earthquakes," paper presented at Microzonation Conference, California, 1972.

Takahashi, S.K. and Schniete, W.E. Preliminary Investigation of Structural Damage from Point Mugu, California Earthquake of February 21, 1973. Port Hueneme, California: Naval Civil Engineering Laboratory, Technical Note N-1307, 1973.

United States Department of Housing and Urban Development. Environmental Planning and Geology. Washington: Superintendent of Documents, (Stock No. 2300-1195) 1972.

United States Geological Survey. Geology, Petroleum Development, and Seismicity of the Santa Barbara Channel Region. California Geological Survey Professional Paper 679, 1969.

United States Geological Survey. The San Fernando, California, Earthquake of February 9, 1971. Professional Paper 733, 1971.

United States Geological Survey. Seismic Hazards and Land Use Planning. Geological Survey Circular 690, 1974.

United States Office of Emergency Preparedness. Geologic Hazards and Public Problems. Conference Proceedings, Region Seven, 1962.

Williams, Jr., J.H. "Designing Earthquake - Resistant Structures," Technology Review (M.I.T.) Oct./Nov. 1973.

Wood, H.O. "The 1857 Earthquake in California," Seismological Society of America Bulletin, Vol. 45, No. 1.

Tsunami

Ventura County Sheriff's Department and Office of Civil Defense and Disaster Relief, Basic Plan-Tidal Wave Warning-Evacuation. 1963.

U.S. Coast and Geodetic Survey. Tsunami: The Story of the Seismic Sea-Wave Warning System. U.S. Department of Commerce, 1965.

Seiche

Kiersch, George A. "The Vaiont Reservoir Disaster," Mineral Information Service, Vol. 18:7, July 1965, p.129.

Liquefaction

California Legislature Joint Committee on Seismic Safety. Public Hearings on Seismic Hazards of High Rise Buildings in the San Francisco Bay Area. Minutes: October 24, 1972.

City of Hayward, Planning Commission. Hayward Earthquake Study. City of Hayward, April 1972.

Ellsworth, W.l., et. al. "Point Mugu California Earthquake of 21 February 1973 and Its Aftershocks," Science: 182. 14 December 1973, p. 1127.

Morton, D.M. and R.H. Campbell. "Some Features Produced by the Earthquake of 21 February 1973 Near Point Mugu, California," California Geology 26: December 1973, p. 287.

National Academy Press, “Liquefaction of Soils During Earthquakes”, 1985, Washington D.C., National Research Council

Office of the Engineer, General Headquarters, Far East Command. The Fukui Earthquake, Hokuriku Region, Japan, 28 June 1948. Geology; Geological Surveys Branch, February 1949.

Seed, H. Bolton. The Influence of Local soil Conditions on Earthquake Damage. Reprint Soil Dynamics Specialty Conference, Mexico City, 1969.

Seed, H. Bolton and I.M. Idriss. "A Simplified Procedure for Evaluating Soil Liquefaction Potential,: Earthquake-Resistant Design of Engineering Structures. University of California Berkeley, June 1972.

Youd, T.L. "Landsliding in the Vicinity of the Van Norman Lakes," The San Fernando, California, Earthquake of February 9, 1971. U.S. Geological Survey and National Oceanic and Atmospheric Administration; U.S. Geological Professional Paper 733, 1971.

Woodward-McNeill & Associates. Seismicity and Dynamic Response Analysis, Proposed Highway Interchange State Routes 1-101-232, Oxnard, California. California Department of Transportation, April 1973.

Subsidence

Abstract: Tentative Water Quality Control Plan Santa Clara River Basin (4A). State Water Resources Control Board, California Regional Water Quality Control Board Los Angeles Region (4), June 1974, p. 27.

Miller, R.E. "Land Subsidence in Southern California," Engineering Geology in Southern California. Association of Engineering Geologists, 1966, p. 273.

Nichols, D.R. Seismic Hazards and Land Use Planning. Geological Survey Circular 690, U.S. Geologic Survey, Washington, D.C., 1974

"Rate of Land Subsidence," California Geology. August 1971, P. 148.

Expansive Soils

Building Regulations, County of Ventura, Department of Building & Safety, Revised May 1974.

Jones, D. Earl, "Expansive Soils - The Hidden Disaster," Civil Engineering, August 1973, Vol. 43, P. 49.

State Division of Mines and Geology. Urban Geology: Master Plan for California, Phase I. December 1971.

U.S. Department of Agriculture, Soil Conservation Services. Soil Survey, Ventura Area. April 1970.

Landslide/Mudslide

Association of Engineering Geologists. Geology and Urban Development. Special Publication, 1965.

California Department of Conservation. Environmental Impact of Urbanization on the Foothill and Mountainous Lands of California. 1971.

California Division of Mines and Geology. Analysis of Mudslide Risk in Southern Ventura County. Prepared for the United States Department of Housing and Urban Development, 1971.

California Resources Agency. Landslide and Subsidence. Geologic Hazards Conference (Proceedings), Los Angeles, 1965.

Cleveland, G.B. Regional Landslide Prediction. California Division of Mines and Geology) prepared for the United States Department of Housing and Urban Development, 1971.

Converse, Davis and Associates. Ondulando Area Studies, Phase I and Phase II. for the County of Ventura. 1967.

Highway Research Board. Landslide and Engineering Practice. Special Report 29, 1958.

Pipkin, Bernan J.W. and Michael Pluessel. Coastal Landslides in Southern California. University of Southern California. Sea Grant Publication.

Airport Hazards

Assembly Commission on Natural Resources & Conservation. Aircraft Accidents in the Vicinity of Airports. (prepared by James L. McElroy, Air Safety Pubs., January 2, 1973).

"County Plane Crashes Raise Airport Queries," Ventura County Star Free Press. April 23, 1974, pg. 1-2. Garbell, Maurice A., Inc. A Study on Airport Safety for Santa Clara County. May 1973.

Gillfillan, Walter E. California Airports, Facilities Inventory Air Traffic, and Land Use Protection. Inst. of Transportation and Traffic Engineering, University of California, Berkeley, 1965.

Office of the Asst. Secretary of Defense (Installations & Logistics). Final EIR, Proposes Dept. of Defense Policy on Air Installations Compatible Use Zones. June 1973.

Santa Clara County Airport Land Use Commission. Land Use Plan for Area Surrounding Santa Clara County Airports. August 1973.

Southern California Aviation Council, Inc. Southern California Airport Planning.

Southern California Regional Airport System. Recommendations of the Citizens Hearing Board. June 14, 1973.

State Department of Transportation. Advisory Guidelines for Land Use Planning in the Vicinity of Airports. 1973.

State of Wisconsin, Department of Resource Development. State Airport System Plan: Technical Supplement. Madison, Wisconsin, 1966.

Ventura County Planning Department. Ventura County Multimodal Transportation Study Land Use Forecast. 1974.

Vest, Gary D. Airport Environs Land Use Compatibility. American Institute of Planners. 1973.

Coastal Wave and Beach Erosion

Bascom, Willard. Waves and Beaches. New York: Doubleday and Co., 1964.

California Coastal Zone Conservation Commission, South Central Coast Regional Commission. Geology. Santa Barbara, California, April 1964.

California Department of Water Resources, Southern District, Interim Report on Study of Beach Nourishment Along the Southern California Coastline. July, 1969.

Prelicharz, Joseph A., Civil Engineer, Port Hueneme Naval Civil Engineering Laboratory, personal communication, July 1974.

Moffat & Nichols, Engineers. Shore Protection Study, Oxnard Shores, California. Long Beach, California, August 1972.

Munk, W.H. & Taylor M.A. "Refraction of Ocean Waves: A Process Linking Underwater Topography to Beach Erosion," The Journal of Geology, 5 (1), January 1947.

Norris, R.M. "Dams and Beach Sand Supply in California," Papers in Marine Geology. New York: McMillan Co., 1964.

Orange County Planning Department. The Physical Environment of Orange County. Santa Ana, California, November 1971.

Orme, Anthony, Professor of Geography, UCLA, personal communication, July 1974.

Oxnard Planning Department. Environmental Impact Statement, Tract 2264. Oxnard, California, September 1972.

Permanent International Association of Navigation Congresses, 23rd Congress, Section II. Means of Controlling Littoral Drift to Protect Beaches, Dunes, Estuaries and Harbro Entrances. Brussels, Belgium, 1973.

Soucie, Gary. "Where the Beaches Have Been Going: Into the Ocean," Smithsonian, Y (3), June 1973.

Southern California Association of Governments. An Evaluation of the Health of the Benthic Marine Biota of Ventura, Los Angeles, and Orange Counties. Los Angeles, California, February 1972.

Southern California Coastal Water Research Project. The Ecology of the Southern California Blight: Implications for Water Quality Management. El Segundo, California, March 1973.

U.S. Army Corps of Engineers, Coastal Engineering Research Center. Land Against the Sea. Miscellaneous Paper No. 4-64, Washington, D.C., May 1964.

U.S. Army Corps of Engineers, Los Angeles District. Coast of Southern California - Special Interim Report on the Ventura Area, Cooperative Beach Erosion Control Study. Appendix VII. Washington D.C., April 1961.

- Cooperative Research and Data Collection Program - Coast of Southern California. Los Angeles, California, December 1970.
- Draft Environmental Statement, Surfside-Sunset and West Newport Beach, Orange County, California. Los Angeles, California, May 1972.
- Environmental Statement, Las Tunas Beach Park, Los Angeles. County of Los Angeles, California, August 1972.
- Environmental Statement: Navigation Improvement for Ventura Marina, Ventura County, California. Los Angeles, California, September 1970.
- Harbor and Shore Protection in the Vicinity of Port Hueneme, California. Los Angeles, California, October 1948.

U.S. Army Corps of Engineers, National Shoreline Study. Shore Protection Guidelines. Washington, D.C., August 1971.

U.S. Congress. Coast of Southern California-Special Interim Report on the Ventura Area, Cooperative Beach Erosion Control Study. House Document 458, 87th Congress, 2nd Session, Washington D.C., May, 1962.

U.S. Congress. Coast of Southern California-Special Interim Report on the Ventura Area, Cooperative Beach Erosion Control Study. House Document 458, 87th Congress, 2nd Session, Washington D.C., May, 1962.

U.S. Water Research Council. Regulation of Flood hazard Areas to Reduce Flood Losses. Washington, D.C., August 1971.

Ventura County Beach Erosion Study, Citizens Advisory Committee, Minutes of Meeting, July 12, 1973.

Ventura County Department of Public Works. The Great Floods of 1969. Ventura, California, September 1969.

- Report of Beach Erosion and Damages to the Ventura County Shoreline. Ventura, California, June 1972.

Ventura County Planning Department. Environmental Impact Report for Southern Pacific Milling Co., Ventura River Operation. Ventura, California, July 1974.

Ventura Port District. Preliminary Report, Proposed Small Boat and Recreational Harbor at Pierpont Bay. Ventura, California, August 1953.

Watts, G.M. Sediment Discharge to the Coast as Related to Shore Processes. Federal Interagency Sedimentation Conference, Jackson, Mississippi, 1963.

Flood Hazards

An Analysis of the Santa Paula Creek Channelization Project. The Sierra Club, January 1974.

California Department of Water Resources. Information & Regulations for the Administration of the Cobey-Alquist Flood Plain Management Act. May 1967.

Davis, Richard, et. al. Flood Plain Management: An Approach for Ohio. Ohio Department of Natural Resources, August 1971.

Kusler, Jon A. and Thomas M. Lee. Regulations for Flood Plains. Chicago: American Society of Planning Officials Planning Advisory Service Report No. 277, February 1972.

Southeastern Wisconsin Regional Planning Commission. Floodland & Shoreland Development Guide. November 1968.

Tulare County Planning Department. Tulare County Flood Plain Management Study. March 1, 1970.

U.S. Department of Housing & Urban Development. National Flood Insurance Program Regulations.

Ventura County Flood Control District. The Great Floods of 1969. September 1969.

Ventura County Flood Control District. Ventura County Flood Plain Regulation Program. November 1971.

Fire Hazards

Berry, L.J. California's Wildlands - An Asset or a Liability. University of California, Agricultural Extension Service, 1972.

California Division of Forestry. An Evaluation of Efforts to Provide Fire Safety to Development and Occupancy within the Wildlands of California. Sacramento: The Resources Agency, 1973.

- California Aflame, September 22-October 4, 1970. Sacramento: The Resources Agency, 1971.
- A Fire Hazard Severity Classification for California's Wildlands. Sacramento: The Resources Agency, 1973.
- Recommendations to Solve California's Wildland Fire Problem. Sacramento: The Resources Agency, 1972.

Cleveland, George B. "Fire & Rain Mudslide Big Sur 1972" California Geology 26:6 June 1973, P. 127.

County of Los Angeles, Departments of Arboreta and Botanic Gardens, Forester and Fire Warden. Fire Retardant Plants for Hillside Areas Los Angeles: Forestry Division, 1970.

Executive Office of the President, Office of Emergency Preparedness. Disaster Preparedness (Report to the Congress). Washington D.C.: Government Printing Office, 1972.

International Conference of Building Officials and Western Fire Chiefs' Association. Uniform Fire Code, 1973 Edition.

Ventura County Fire Department. How to Protect Your Home When Brush Fires Threaten. Ventura County of Ventura.

Ventura County Flood Control District. Homeowners Guide for Debris and Erosion Control. Ventura: County of Ventura, 1970.

U.S. Department of Agriculture, Forest Service. "Protecting the Forests from Fire," Agriculture Information Bulletin, No. 130. Washington, D.C., Government Printing Office, 1969.

University of California Agricultural Extension Service. Landscape for Fire Protection. Los Angeles: County of Los Angeles Fire Department, 1970.

Transportation Related Hazards

Ventura County Airport Land Use Commission, Ventura County Airport Comprehensive Land Use Plan, July 2000

Environmental Impact Report: Camarillo Airport Noise Control and Land Use Compatibility Study, 1986

Hazardous Materials and Waste

Ventura County Solid Waste Management Department, Ventura County Hazardous Waste Management Plan, January 1990

Noise

County of Ventura, Public Works Agency, Transportation Department

U.S. FHWA. Federal-Aided Program Manual, Volume 7, Right-of-Way and Environment; Chapter 7, Environment; Section 3, Procedures for Abatement of Highway Traffic Noise and Construction Noise (FHPM 7-7-3). 1982.

Reagan, J.A. and C.A. Grant. FHWA Highway Construction Noise: Measurement, Prediction and Mitigation. May 1977.

U.S. FHWA Highway Traffic Noise Prediction Model, FHWA-RD-77-108. December 1978.

State of California. General Plan Guidelines. Appendix A, November 1990.

State of California. Department of Transportation, District 7, Planning Division

State of California. Department of Transportation, Division of Traffic Operations

Ventura County Transportation Commission

Dr. Marlund Hale, Advanced Engineering Acoustics

Civil Disturbance

Governor's Office of Emergency Services, California Terrorism Response Plan, February 2001

Ventura County Sheriff's Department, Ventura County Law Enforcement Mutual Aid Manuel, May 2003

Ventura County Sheriff's Department, Office of Emergency Services, Multi-Hazard Functional Plan, (Draft) 2002

Ventura County Sheriff's Department, Terrorism Working Group, Ventura County Terrorism Response Plan, December 2001