II. Hazard Identification and Analysis

The United States and its communities are vulnerable to a wide array of natural and man-made hazards that threaten life, property and continuation of governmental services. Due to the geographic characteristics of each location, not all of the typical hazards that may affect other parts of the United States, or even California, are a threat in El Dorado County. This Section will address all of the typical hazards that can be encountered throughout much of the United States, but only in detail for those that truly present a threat to El Dorado County's infrastructure. Each of the primary hazards will be addressed first from a general, national perspective, followed by a local perspective. Where available, historical records will be used to help identify risk. Other analytical tools will also be used, whenever those are available. This section also provides maps that illustrate the location and spatial extent for those hazards within El Dorado County that have a recognizable geographic boundary (i.e., hazards that are known to occur in particular areas such as the 100-year floodplain). For those hazards not confined to a particular geographic area (such as earthquakes and storms), general information on their applicable intensity across the entire jurisdiction is provided.

This section provides a treatment for all of the typical natural and man-made hazards included on the list below. For each hazard, the general nature of the hazard will first be discussed, followed by a treatment of the local nature of that hazard. If that hazard is found in El Dorado County, and has the potential to affect the County's infrastructure, then that treatment will be extensive, and include an assessment of the location and spatial extent of the event as well as best available data regarding the impact on the County.

- **Wildfire**
- **Floods**
- **Dam/Levee Failure**
- **Seiche Wave**
- **Earthquakes, Sinkholes and Landslides**
- **Winter Storms**
- **Volcano**
- **Drought/Extreme Heat**
- **Erosion**
- **Severe Thunderstorms and Tornadoes**
- **Avalanche**
- **Terrorism**

Wildfire

Any fire occurring in vegetation areas regardless of ignition sources. A wildfire responds to the weather, topography, and fuels in its environment. Under extreme burning conditions, the behavior of a wildfire can be so powerful and unpredictable that fire protection agencies can only wait until conditions moderate before suppression actions can be taken. Since the fire itself, weather and topography can not be mitigated that leaves us with the fuel to mitigate. Wildland fire fuel can be anything from the forest, to residential structures and fortunately they can be modified to mitigate the wildland fire hazard.

Wildfire is our greatest concern as these disaster events have impacted our county on numerous occasions, and as recently as 2007 with the Angora fire in South Lake Tahoe. The Angora fire burned 3,400 acres of forest, and destroyed 254 homes before it was contained. Our wildland fire threat is so severe we devoted an entire section of this plan to that one specific hazard.
See section titled "Wildland Fire Hazard Mitigation Plan" submitted by the El Dorado County Fire Safe Council and AEU CAL FIRE for a comprehensive discussion of this hazard.

Floods

General Description of Flooding Hazard from National Perspective

Flooding is the most frequent and costly natural hazard in the United States, a hazard that has caused more than 10,000 deaths since 1900. Approximately 90 percent of presidentially declared disasters result from natural hazard events with flooding as a major component.

Floods are generally the result of excessive precipitation, and can be classified under two categories: general floods, precipitation over a given river basin for a long period of time; and flash floods, the product of heavy localized precipitation in a short time period over a given location. The severity of a flooding event is determined by the following: a combination of stream and river basin topography and physical geography; precipitation and weather patterns; recent soil moisture conditions; and the degree of vegetative clearing.

General floods are usually long-term events that may last for several days. The primary types of general flooding include riverine, coastal, and urban flooding. Riverine flooding is a function of excessive precipitation levels and water runoff volumes within the watershed of a stream or river. Coastal flooding is typically a result of storm surge, wind-driven waves, and heavy rainfall produced by hurricanes, tropical storms, nor'easters, and other large coastal storms. Urban flooding occurs where man-made development has obstructed the natural

Entire communities lie underwater for days—and in some cases weeks—as a result of Hurricane Floyd, which impacted the East Coast in September 1999 flow of water and decreased the ability of natural groundcover to absorb and retain surface water runoff.

Most flash flooding is caused by slow-moving thunderstorms in a local area or by heavy rains associated with hurricanes and tropical storms. However, flash flooding events can also occur from accelerated snow melt due to heavy rains, a dam or levee failure within minutes or hours of heavy amounts of rainfall, or from a sudden release of water held by an ice jam. Although flash flooding occurs often along mountain streams, it is also common in urbanized areas where much of the ground is covered by impervious surfaces. Flash flood waters move at very high speeds "walls" of water can reach heights of 10 to 20 feet. Flash flood waters and the accompanying debris can uproot trees, roll boulders, destroy buildings, and obliterate bridges and roads.

The periodic flooding of lands adjacent to rivers, streams, and shorelines (land known as floodplain) is a natural and inevitable occurrence that can be expected to take place based upon established recurrence intervals. The recurrence interval of a flood is defined as the average time interval, in years, expected between a flood event of a particular magnitude and an equal or larger flood. Flood magnitude increases with increasing recurrence interval.

Floodplains are designated by the frequency of the flood that is large enough to cover them. For example, the 10-year floodplain will be covered by the 10-year flood and the 100-year floodplain by the 100-year flood. Flood frequencies such as the 100-year flood are determined by plotting a graph of the size of all known floods for an area and determining how often floods of a particular size occur. Another way of expressing the flood frequency is the chance of occurrence in a given year, which is the percentage of the probability of flooding each year. For example, the 100-year flood has a 1 percent chance of occurring in any given year.

The flood loss information provided below can only be considered approximate.

In the table below, the data are for water years, starting in October and ending in September. The quality of the older data is subject to some question. The more recent data are generally more reliable, but while the damage amounts for individual years are not precise, they provide reasonable indications of relative changes over time.

The damage figures in the second column are in thousands of dollars. The second column provides "unadjusted" damage amounts. That is, the damage as reported in the year it occurred, not adjusted for inflation. The third column is a Construction Cost Index, used to adjust for inflation. The next column to the right is the adjustment factor applied to the unadjusted estimates to get the column damages estimates "adjusted" to 2007 dollars. The Construction Cost Index is obtained from McGraw Hill Construction; Engineering News-Record

Table 11-1. National Flood Damage by Fiscal Year (October-September

Year	Unadjusted Damages (thousands)	CCI Index	Adjustment Factor	Adjusted Damages (Billion)

1979	$3,500,000	3003	2.65	$9.275
1980	$1,500,000	3237	2.46	$3.690
1981	$1,000,000	3535	2.25	$2.250
1982	$2,500,000	3825	2.08	$5.200
1983	$4,000,000	4066	1.96	$7.840
1984	$3,750,000	4148	1.92	$7.200
1985	$500,000	4182	1.90	$0.950
1986	$6,000,000	4295	1.85	$11.100
1987	$1,444,199	4406	1.81	$2.614
1988	$225,298	4519	1.76	$0.397
1989	$1,080,814	4615	1.73	$1.870
1990	$1,636,431	4732	1.68	$2.749
1991	$1,698,781	4835	1.65	$2.803
1992	$762,762	4985	1.60	$1.220
1993	$16,370,010	5210	1.53	$25.046
1994	$1,120,309	5408	1.47	$1.647
1995	$5,110,829	5471	1.46	$7.462
1996	$6,121,884	5620	1.42	$8.693
1997	$8,730,407	5826	1.37	$11.961
1998	$2,496,960	5920	1.35	$3.371
1999	$5,455,263	6059	1.31	$7.146
2000	$1,338,735	6221	1.28	$1.714
2001	$7,309,308	6334	1.26	$9.210
2002	$1,211,339	6538	1.22	$1.478
2003	$2,482,230	6695	1.19	$2.954
2004	$13,970,646	7115	1.12	$15.647
2005	$42,010,435 see note below	7446	1.07	$44.951
2006	3,744,636	7751	1.03	$3.857
2007	2,609,160	7966	1.00	$2.609

IMPORTANT NOTE CONCERNING WY2005 DAMAGE ESTIMATES AND HURRICANES KATRINA AND RITA:

The devastation and loss of life associated with Hurricanes Katrina and Rita are extensive and hard to quantify. Determining the total damage caused by these storms, let alone allocating the portion due to flooding is extremely difficult. The following discussion is intended to provide the process involved in creating this best available estimate of flood damages caused by these storms.

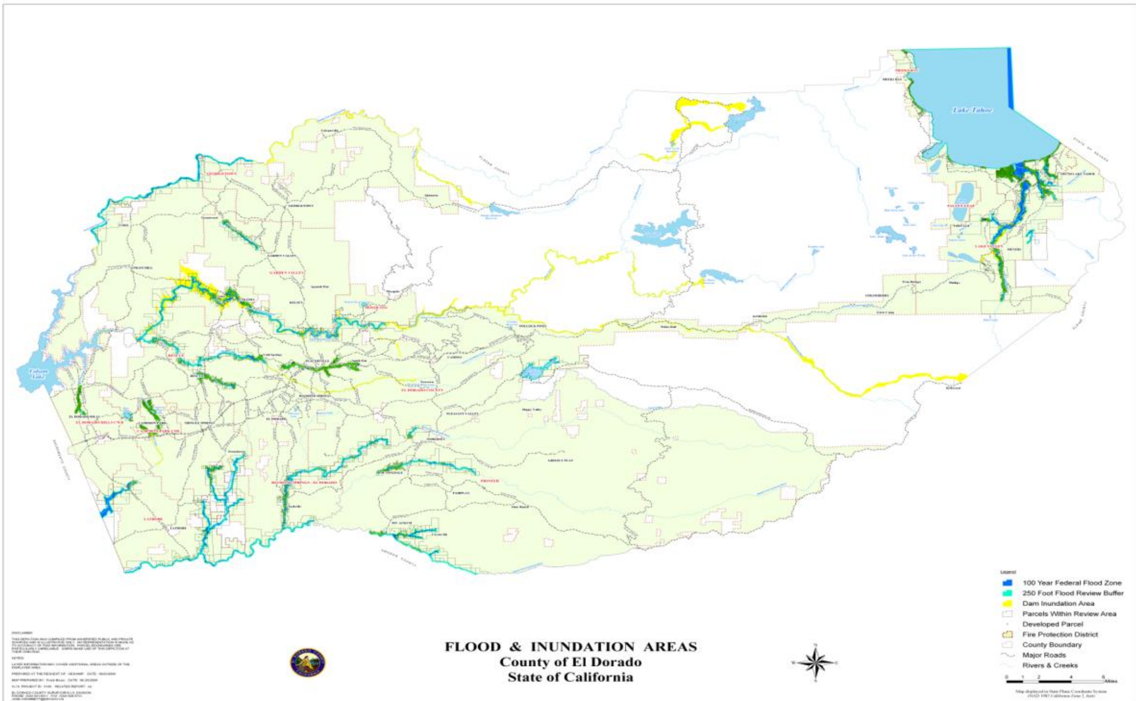
Estimates of losses caused by Katrina range from 100 billion to 150 billion, as compiled by the National Climatic Data Center (http://www.ncdc.noaa.gov/oa/reports/tech-report-200501z.pdf).

The National Hurricane Center has a lower estimate (http://www.nhc.noaa.gov/pdf/TCR-AL122005_Katrina.pdf). Additionally, Dr. Roger Pielke, Jr., who has done significant research concerning the determination of flooding related losses has an assessment of the damages between 100 and 150 billion (http://sciencepolicy.colorado.edu/prometheus/archives/disasters/000563part_ii_historical.html).

Source: National Weather Service
http://www.weather.gov/oh/hic/flood_stats/Flood_loss_time_series.shtml

Flood Hazard in El Dorado County

El Dorado County's flood potential is strongly affected by the physical geography of the County. Located on the western slope of the Sierra Nevada Mountain Range and in an area of moderate seasonal rainfall, the runoff characteristics of the watersheds strongly determine the possibility of flooding. The western areas of the county are made up mostly of rolling foothills. The eastern areas of the County are at higher elevations. The City of Placerville, the County Seat, is at about 2,000 feet above sea level, while the City of South Lake Tahoe is at about 6,500 feet elevation. Some mountain peaks in El Dorado County reach in excess of 10,000 feet. The elevation range for the County is 200 to 10,881 feet above sea level. Due to the elevation of much of the watersheds of El Dorado County, much of the precipitation is in the form of snowfall, which melts over a long duration with snow prevailing at the higher elevations long into the summer. The overall slope of the watersheds is relatively steep, and most of the higher elevations of the County is owned or controlled by Federal agencies, and therefore not subject to private ownership or development. The seven watersheds that form El Dorado County are Lake Tahoe, the upper Carson River, lower American River, North & South Forks of the American River, the upper Mokelumne River and the upper Cosumnes River. Most are dammed in the lower elevations along much of the streamcourses, and are mostly contained within government or special district ownership. Therefore, except for a few tributaries, the larger rivers and the immediate environs are not in areas where much private development can occur. In addition, due to the overall gradient of the streams and rivers, they reside within relatively steep canyons or valleys, where very little floodplain has been formed. The Federal Emergency Management Agency (FEMA) has published Flood Information Rate Maps (FIRM), which are available to local jurisdictions to indicate where modeling has shown the 100-year floodplains to be. The following graphic, Figure 11-2 indicates where the 100-year floodplains exist in El Dorado County.



Flood & Inundation Areas County of El Dorado, Revised 06-25-09 GIS project #5136

There have been examples of localized flash flooding, particularly where development has occurred in the watersheds without adequate improvement of drainage systems to accommodate the reduced infiltration and increased runoff that usually results. This typically occurs in the urbanized areas where there has been minor floodplain formation, or where natural runoff is blocked by inadequate culverts or other obstacles. These flash flooding events are directly related to significant rainfall events, usually during the winter or spring rainy season.

In the past five years, since the previous publication of the Hazardous Mitigation Plan, specific areas in El Dorado County have been identified and/or experienced infrastructure damage including public, commercial, and residential buildings, roadways, utility delivery systems, and other infrastructure damage and associated costs due to flooding and severe winter storms. These areas include:

2005 - Approximate dollar value loss $100,000.

City of South Lake Tahoe
South Lake Tahoe Basin
Myers
Mosquito

El Dorado
Coloma

2006 - Approximate dollar value loss 1.5 million dollars

City of South Lake Tahoe
City of Placerville
Meeks Bay
El Dorado
Deer Creek
Latrobe
Georgetown
Cameron Park
Nashville
Mount Aukum
Sly Park (EID Campground)
Rancho Ponderosa
Camino Heights
Pollock Pines
Cool
Garden Valley
El Dorado Irrigation facilities and distribution systems

2007 - No flood/winter storm damage reported.

2008 - Approximate dollar value loss $525,000.

City of South Lake Tahoe
City of Placerville
South Lake Tahoe Basin
Myers
Camino
Garden Valley
Pollock Pines
Grizzly Flat
Omo Ranch
Cameron Park
Georgetown

*In addition to dollar value loss, there was loss of human life of a utility worker while engaged in restoring power to the Georgetown area as a direct result of winter storm damage in 2008.

2009 - As of the date of preparation of this update document (7/01/09), there has been no reported damage caused by Flooding and/or Winter Storms for the 2009 year.

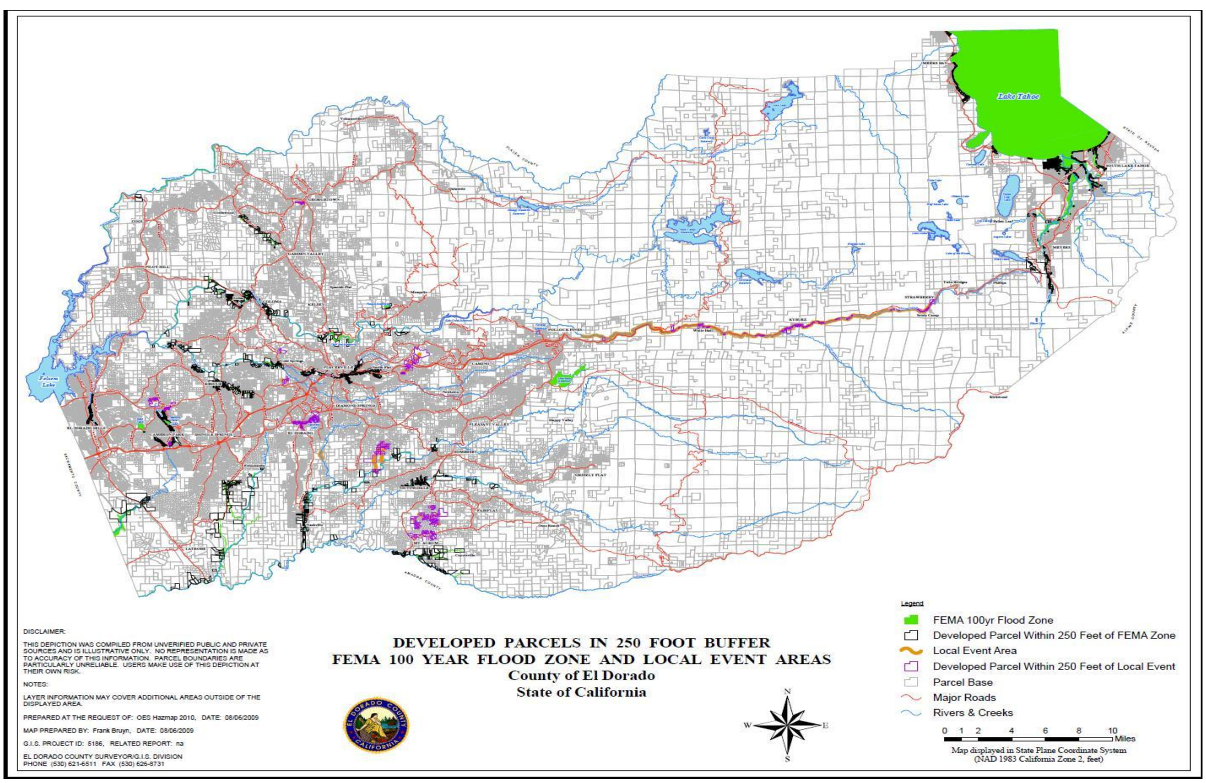
<u>Repetitive Losses-</u> The following properties experienced repetitive losses due to flooding during the listed years.

3361-3363 La Canada, Cameron Park, Ca	1995 / 1997	$8,398.25
5733 Stream wy, Somerset, Ca.	1996 / 2005	$204,472.17

The current FEMA Flood Areas Map of El Dorado County (2009) has been compared to data documented from prior flooding events in order to assess potential property damage. These additional areas, which are not currently on the FEMA Flood Areas Map, have been noted on the El Dorado County GIS map Project # 5186 map titled, “Developed Parcels In 250 Foot Buffer FEMA 100 Year Flood Zone And Local Event Areas”. This data was used in conjunction with the FEMA Flood Area Map to identify El Dorado County’s flood vulnerability and risk assessment. As part of El Dorado County’s zoning requirements, a 250 foot buffer zone is used to assemble potential flood zones. All of the developed parcels and critical infrastructure that could be impacted by these flood zones have been identified utilizing Assessor records for value of property and experts on potential critical infrastructure. It is estimated El Dorado County’s total dollar loss would be approximately $1.7 billion for these identified areas.

El Dorado County does participate in the National Flood Insurance Program and a certificate is currently on file within El Dorado County Planning Department.

The following graphic, Figure 11-2A (Developed Parcels In 250 Foot Buffer FEMA 100 Year Flood Zone & Local Event Areas, County of El Dorado, State of California, 8-06-09, GIS project #5186, El Dorado County Surveyor /G.I.S.) identifies the updated areas.

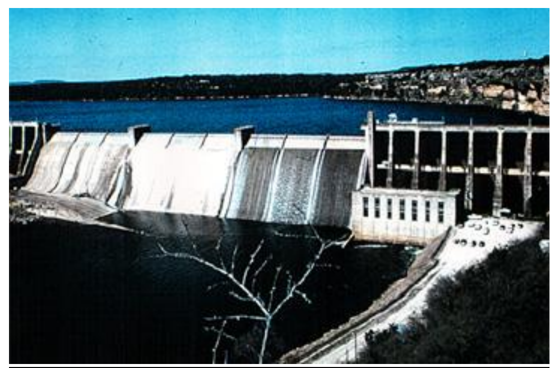


Dam/Levee Failure

General Description of Dam/Levee Hazard from National Perspective

Worldwide interest in dam and levee safety has risen significantly in recent years. Aging infrastructure, new hydrologic information, and population growth in floodplain areas downstream from dams and near levees have resulted in an increased emphasis on safety, operation and maintenance.

There are about 80,000 dams in the United States today, the majority of which are privately owned. Other owners include state and local authorities, public utilities, and federal agencies. The benefits of dams are numerous: they provide water for drinking, navigation, and agricultural irrigation. Dams also provide hydroelectric power, create lakes for fishing and recreation, and save lives by preventing or reducing floods.



Dam failure can result from natural events, human-induced events, or a combination of the two. Failures due to natural events such as hurricanes, earthquakes or landslides are significant because there is generally little or no advance warning. The most common cause of dam failure is prolonged rainfall that produces flooding.

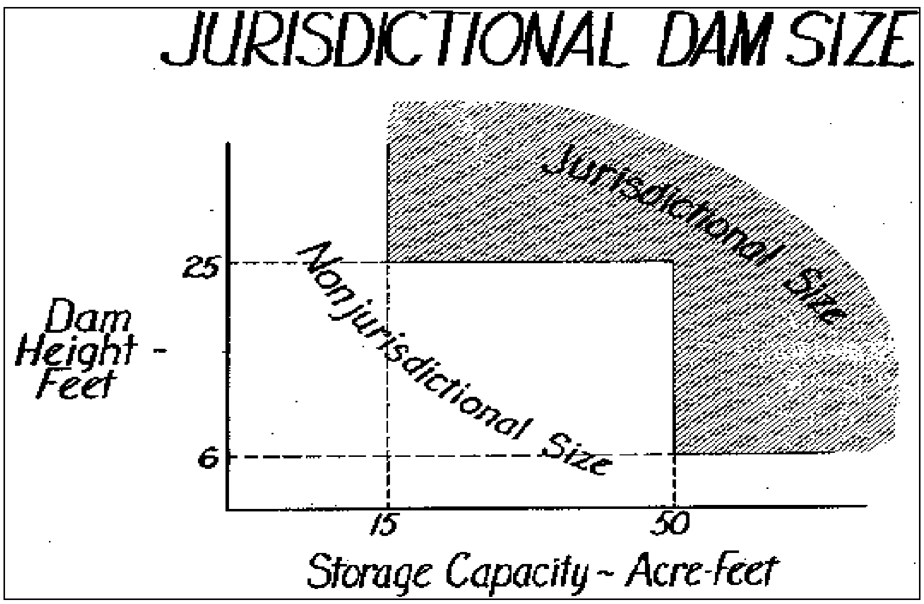
Though dams have many benefits, they also can pose a risk to communities if not designed, operated, and maintained properly. In the event of a dam failure, the energy of the water stored behind even a small dam is capable of causing loss of life and great property damage if development exists downstream of the dam. If a levee breaks, scores of properties are quickly submerged in floodwaters and residents may become trapped by this rapidly rising water. The failure of dams and levees has the potential to place large numbers of people and great amounts of property in harm's way.

Dam/Levee Failure Hazard in El Dorado County

El Dorado County has a significant number of large and small dam structures with impoundments, and one privately owned levee. Therefore, only the potential for dam failure will be considered further.

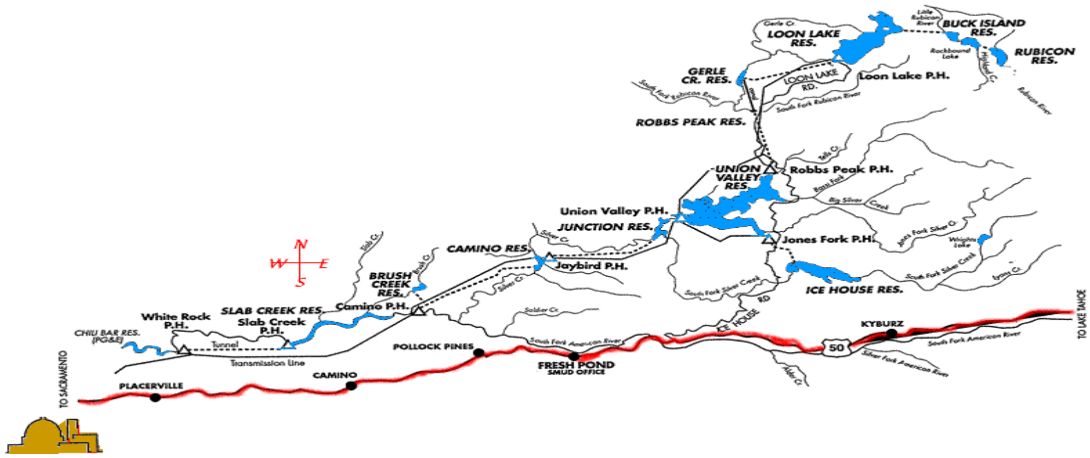
There is an historical record since the Gold Rush days of the mid 19th Century of the construction and use of dams as water reservoirs. During the Gold Rush, the water was used primary to wash placer gold deposits from the stream sediments, particularly during the summer months in the lower elevations when surface water was not normally available. Many of the dams were constructed of logs and other primitive construction, and there were failures of some of the impoundments with castastrophic results including loss of lives and property. Although remnants of the miners' water delivery system of canals and reservoirs are still in service, all of the impoundments have been subjected to modern engineering and regulation, and are no more prone to failure than any other dam and impoundment. The State Division of Safety of Dams regulates the construction, maintenance, and overall safety of all substantial impoundments that meet the minimum jurisdictional size threshold. The following graphic, Figure 11-3 shows the jurisdictional size:

Figure 11-3. Chart Indicating Jurisdictional Dam Size



There are 59 known dams in El Dorado County. These range from dams creating large reservoirs intended to provide sources for irrigation, water supply, or power generation, to smaller impoundments which are part of water distribution or treatment systems or intended to provide a recreational amenity for visitors or residents. The following Figure 11-4 shows the distribution of all of the larger impoundments found in El Dorado County and many of the smaller dams as well.

Figure 11-4 Location of: Larger Impoundments in El Dorado County



The modern design standards for dams include significant safety factors that make dam failure a very low risk.

Flood/Dam Failure and Inundation Hazard in El Dorado County

Flood hazards that may occur in El Dorado County include flooding caused by precipitation, dam failure, and seismic activities. Flooding hazards associated with the increase in development are discussed in this subsection. A flood has many implications for public safety. Hazards and damage caused by flooding includes loss of life, displacement or complete destruction of buildings, siltation, temporary loss of utilities, road and bridge damage resulting in transportation slowdowns, loss of goods and services, and the threat of waterborne diseases. Additionally, significant private and public costs are associated with flooding, particularly in urban areas.

In this subsection, the proposed policies and existing regulations are assessed for their effect on reducing impacts related to flooding and Seiches. The land use map for the General Plan were evaluated for the maximum land use density allowed within the 100-year floodplain and dam inundation areas, and the resulting potential for flood hazards area assessed in consideration with the General Plan policies and existing laws, regulations, and programs. The existing conditions, including existing laws, regulations, and programs, are discussed below.

Physical Environment

Flooding

Flood hazards can result from intense rain, snowmelt, cloudbursts, or a combination of the three, or from failure of a water impoundment structure, such as a dam. Floods from rainstorms generally occur between November and April and are characterized by high peak flows of moderate duration. Snowmelt floods combined with rain have larger volumes and last longer than rain flooding.

Flood-Prone Areas

Because of a lack of extensive low-lying areas and a great deal of upland areas, the majority of El Dorado County is not subject to flooding. The primary flood-prone areas on the west slope of the County are the following: South Fork, American River from Kyburz to Riverton and below Chili Bar Dam; Coloma Canyon Creek between Greenwood and Garden Valley; Weber Creek from Placerville to the American River, including Cold Springs, Dry; Creek, and Spring Creek tributaries; Shingle Creek from Shingle Springs to the Amador County line; Deer Creek from Cameron Park to Sacramento County line; Big Canyon Creek from El Dorado to the Cosumnes River, including the Slate, Little; Indian, and French Creek tributaries; New York Creek; Middle Fork of the Cosumnes River within the Somerset-Fairplay vicinity, and its confluence with the North Fork of the Cosumnes River; Cedar Creek from Omo Ranch to the Cosumnes River (FEMA 1996; Maurer, pers. comm., 2003)

Flood Control

Historically, the emphasis for flood management in California has been to control the flow of water. These types of flood control projects have included the construction of reservoirs in upstream areas to retain and gradually release water, the construction of levees to confine water to the channel or designated area, the improvement of channels to increase their water carrying capacity, and the establishment of bypasses or diversions.

There are no dams dedicated to flood control on the west slope or in the Lake Tahoe Basin. All existing reservoirs in El Dorado County are operated for power generation or water storage, not flood control purposes. There is only one known levee in El Dorado County (in El Dorado Hills near Carson Creek). However, this levee is privately owned and it is unknown whether this levee is certified for flood control purposes.

Dam Failure

A dam failure can occur as the result of an earthquake, as an isolated incident because of structural instability, or during heavy runoff that exceeds spillway design capacity. According to the California Department of Water Resources (DWR), El Dorado County does not have a history of major dam failure. Nine dams located within the County have been identified as having the potential of inundating habitable portions of the County in the unlikely event of dam failure. These nine dams are Echo Lake Dam (El Dorado Irrigation District [EID]), Union Valley Dam (Sacramento Municipal Utility District [SMUD]), Ice House Dam (SMUD), Chili Bar Reservoir (Pacific Gas and Electric Company [PG&E]), Stumpy Meadows Dam (Georgetown Divide Public Utility District [GDPUD]), Weber Creek Dam (EID), Slab Creek Dam (SMUD), Loon Lake Auxiliary Dam (SMUD), and Blakely Dam (EID).

In addition to these nine dams, the Caples Lake Dam (EID) and the Cameron Park Lake/Warren Hollister Dam (EID) have been identified by the County as having considerable potential to inundate inhabited areas in the unlikely event of dam failure. The maps showing the locations and inundation areas of these dams can be found at the County Office of Emergency Services.

Regulatory/Planning Environment

Federal Regulations

National Flood Insurance Act (1968)

The National Flood Insurance Act established the National Flood Insurance Program (NFIP), a Federal program administered by FEMA. The NFIP enables property owners in participating communities to purchase insurance as protection against flood losses in exchange for state and community floodplain management regulations that reduce future flood damages. Participation in the NFIP is based on an agreement between communities and the Federal Government.

National Dam Safety Program Act (1972)

The National Dam Safety Program was established in 1972 and is administered by FEMA. The primary purpose of the program is to provide financial assistance to the states for strengthening their dam safety programs.

Dam Safety and Security Act (2002)

The Dam Safety and Security Act was enacted to assist states in improving their dam safety programs, to support increased technical training for state dam safety engineers and technicians, to provide funding for dam safety research, and to maintain the National Inventory of Dams (ASDSO 2003).

State Regulation

Dam Safety Act

The Dam Safety Act was passed to establish procedures for emergency evacuation and control of populated areas below dams. The Dam Safety Act provides for the development of inundation maps by dam owners, map approval by OES, and development of emergency procedures by local governments to evacuate and control the risk areas. Emergency regulations to implement the Dam Safety Act became effective on April 2, 2002. These regulations require owners of state jurisdictional dams to file inundation maps and studies, and they include provisions for noncompliance that may include referral of the matter to the office of the Attorney General (EDCOES 2002).

County Ordinance and Plan

Flood Damage Prevention Ordinance (1986)

The County has enacted a floodplain ordinance that is compatible with FEMA guidelines in order to regulate development within the 100-year floodplain. This ordinance is applied in conjunction with the County's Zoning Ordinance. Under the Flood Damage Prevention Ordinance, development within the 100-year floodplain may occur; however, certain engineering and zoning standards apply in order to reduce injury and loss of life, to reduce structural damage caused by flooding, and to reduce public expenditures for additional flood control structures. Development within the floodway is also prevented unless no increase in flood elevation would result from the development.

Multi-Hazard Functional Emergency Operations Plan (1993)

The County's Emergency Operations Plan contains dam failure plans for those dams that qualify for mapping. The individual dam facility plans located at the County Department of Emergency Services include a description of the dams, direction of flood waters, responsibilities and actions of individual jurisdictions, and evacuation plans. The Emergency Operations Plan also contains response plans for floods resulting from periods of high rainfall or rapid snowmelt, which can cause flooding in the 100-year floodplain.

Agencies and Organizations

Federal Agencies

Federal Emergency Management Agency

As discussed above, FEMA administers the NFIP. FEMA also prepares the Flood Insurance Rate Maps (FIRMs).

Floodplain Designation and Mapping

The boundary of the 100-year floodplain is the basic planning criterion used to demarcate unacceptable public safety hazards. The 100-year floodplain boundary defines the geographic area having a 1% chance of being flooded in any given year. All streams are subject to areas within the 100-year flow and therefore, have a 100-year floodplain. However, many minor and intermittent streams do not have current FIRMs. Outside these boundaries, the degree of flooding risk is not considered sufficient to justify the imposition of floodplain management regulations. Some level of regulation is desired to protect public health, safety, and welfare within the 100-year floodplain.

The 100-year floodplain is divided into a floodway and floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that should be kept free of development so that the 100-year flood can pass through without an obstruction that would result in substantial increase in flood heights. Development within the floodway reduces the channel's floodwater carrying capacity, increases flood heights, and increases flood hazards beyond the border of the floodway. As a minimum standard, FEMA limits any increase in flood heights within the floodway to 1.0 foot or less provided that hazardous water velocities do not result from the increase in flood height.

The area between the floodway and the boundary of the 100-year floodplain is termed the floodway fringe and encompasses the portion of the floodplain that could be used for development without increasing the surface elevation of the 100-year flood more than 1.0 foot at any point.

Different development standards may be formulated for the floodway and the floodway fringe. These standards have two functions. First, they are designed to minimize loss of life and property damage by controlling the types of land uses permitted and by prescribing certain construction methods. Second, they are intended to preserve the ability of the floodway to discharge the 100-year flood. Failure of floodplain regulations to recognize this latter function by prohibiting encroachment of the floodway would result in an increase in the geographic area of the 100-year floodplain.

National Flood Insurance Program

El Dorado County is a participant in the NFIP, and, as required, the County has implemented an ordinance for 100-year flood protection. The U.S. Army Corps of Engineers (USACE), under contract to FEMA, prepared a flood insurance study report and a series of FIRMs that depict the location of the calculated 100-year flood, flood elevations, floodways, 500-year flood boundaries, and flood insurance rate zones. The most current land use information available at the time of the FIRM preparation, such as land use designation, are typically used to determine the maximum development density potential, which is used to estimate the peak flow and model the flood elevation.

The latest FIRM for El Dorado County was completed in 1995. The County participates in the NFIP by reviewing specific development proposals to ensure that structures that may be in a 100-year floodplain are protected from flood damages and that any changes in the floodplain do not cause unacceptable increases in the elevation of the 100-year water surface.

U.S. Army Corps of Engineers

The USACE assists FEMA in providing emergency response for floods. The USACE also inspects and inventories dams throughout the United States in its National Inventory of Dams.

National Inventory of Dams

The National Inventory of Dams currently includes information on approximately 77,000 dams throughout the United States that fit the following criteria: High Hazard Potential class dam; Medium[1] Hazard Potential class dam; Low Hazard Potential class dam that exceeds 25 feet in height and 15 acre-feet of storage; and Low Hazard Potential class dam that exceeds 50 acre-feet of storage and 6 feet in height.

Currently there are 59 dams in El Dorado County that are listed in the National Inventory of Dams. Of these, nine dams in the County are classified as High Hazard Potential and 35 dams are classified Medium Hazard Potential. This does not suggest dams will fail; only that if they do they could result in inundation hazards. In addition, one dam in Amador County classified as a High Hazard Potential class dam may inundate inhabitants in El Dorado County in the unlikely event of a dam failure.

State Agency

California Department of Water Resources Division of Dam Safety

The principal goal of the DWR Division of Dam Safety is to avoid dam failure and thus prevent loss of life and destruction of property. Finnon Dam has been identified by the Division of Dam Safety as potentially susceptible to damage from a seismic event because of its hydraulic fill construction method. After the San Fernando Earthquake of 1971, all dams of this construction type were flagged for review and inspection.

Regional Agencies

American River Authority

The American River Authority was established through a Joint Powers Agreement, made and entered into on June 8, 1982, between the County, Placer County, the El Dorado County Water Agency (EDCWA), and Placer County Water Agency. A Board of Directors conducts the business of the American River Authority. The purpose of the American River Authority Joint Powers Agreement is to study all water development project opportunities on the American River between Placer County Water Agency's Middle Fork American River Project and Folsom Lake. Collectively, the efforts described above comprise what is referred to as the American River Project.

Local Organizations and Agency

El Dorado County Sheriff Office of Emergency Services

The County's Office of Emergency Services, which is managed by the County Sheriff's Office, collaborates with the County's fire districts, emergency medical services agency, hospitals, schools, and public and private agencies to prepare, update, and implement the County's Emergency Operations Plan, which includes emergency response plans for flood and dam failure events. The County Office of Emergency Services also maintains emergency plans for dams that are prepared by utility companies.

El Dorado County Department of Transportation

As a part of the County Department of Transportation's ongoing program to develop a Capital Improvement Program (CIP) for drainage infrastructure, FEMA mapping has been updated for four specific drainages in the County: Deer Creek in Cameron Park, New York Creek in El Dorado Hills, Carson Creek in the El Dorado Hills Business Park, and the El Dorado Townsite. These drainage studies help to identify potential flood-prone areas and may be used to refine FEMA maps during subsequent FIRM updates.

South Fork of the American River Watershed Group

The mission of the South Fork of the American River Watershed Group is to protect and improve the health and condition of the South Fork of the American River watershed through stewardship and education to a measurable extent. With assistance from the County and Georgetown Divide Resource Conservation District, the group will coordinate with federal, state, and local government agencies, neighboring watershed groups, local community organizations, and private individuals to develop a Watershed Management Plan and

Stewardship Strategy for the watershed (SFARWG 2002).

Cosumnes River Task Force

The primary purpose of the Cosumnes River Task Force is to develop a Coordinated Resource Management Plan that stakeholders can use as a guide to identify resource concerns, plan and implement improvements, and collaborate on common goals to improve watershed health and flood management (CRTF 2002).

STORMWATER SYSTEMS

Physical Environment

Drainage Basins

The west slope of El Dorado County contains three major watersheds, each of which drains into one of these major rivers: the Middle Fork American River, the South Fork American River, and the Cosumnes River. These watersheds are further divided into smaller drainage basins that feed the tributaries of these three major rivers. Developed drainage infrastructure exists in many of the drainage basins, particularly in the following nine drainage basins (Spiegelberg, pers. comm., 2003): Coloma Canyon between Greenwood and Garden Valley (7.5 square miles); Finnon Reservoir drainage (4 square miles); Weber Creek from the Pollock Pines area to the American River, including the Cold Springs, Dry Creek, and Spring Creek tributaries (40 square miles); Deer Creek from Cameron Park to the Sacramento County line (72 square miles); Big Canyon Creek from El Dorado to the Cosumnes River, including the Slate, Little Indian, and French Creek tributaries (36 square miles); Middle Fork of the Cosumnes River within the Somerset/Fairplay vicinity (23 square miles); Cedar Creek from Omo Ranch to the Cosumnes River (37 square miles); Jenkinson Reservoir drainage (18 square miles); New York Creek (2.6 square miles); and Allegheny Creek (1.9 square miles).

Stormwater Hazards

Flooding is the primary hazard related to stormwater runoff. Urban development generally increases the amount of impervious surfaces. When rainfall or snowmelt exceeds the ground infiltration rate (i.e., the ability of the ground to absorb water), stormwater runs off and collects in drainage facilities, which may be in the form of roadways, storm drains, and natural creeks and rivers. The net effects of additional impervious surfaces are increases in the flow rate and volume of water in the drainage channels during and after a storm event. When the volume of water exceeds the capacity of the drainage channel to convey it, flooding can result. Hazards associated with localized flooding include the overtopping of roadways, inundation of areas near the drainage channels, and structural damage. Stormwater runoff may also contribute to regional flooding.

Other problems connected with increased stormwater runoff include erosion, sedimentation, and degradation of water quality. Stormwater can become polluted by eroded soil, pesticides, paint, fertilizers, animal waste, litter, oil and other automotive fluids, and household chemicals. Increased stormwater runoff can increase erosion and facilitate the movement of pollutants and soils into bodies of water. Increased sedimentation may be a detriment to aquatic wildlife habitats, and the use of downstream water bodies for beneficial uses (e.g., recreation, irrigation, water consumption) may be impaired (EMD 2002a).

Regulatory/Planning Environment

Federal Programs

National Flood Insurance Program

El Dorado County participates in the National Flood Insurance Program (NFIP), a federal program administered by the Federal Emergency Management Agency (FEMA). Under the NFIP, the County is required to regulate for 100-year flood protection. A 100-year flood is considered a severe flood with a reasonable possibility of occurrence for purposes of land use planning, property protection, and human safety. The U.S. Army Corps of Engineers (USACE), under contract to FEMA, prepared a flood insurance study report and a series of Flood Insurance Rate Maps (FIRMs) for numerous county waterways. The study and maps depict the location of calculated 100-year flood zones, flood elevations, floodways, 500-year flood boundaries, and flood insurance rate zones. The County participates in the NFIP by reviewing specific development proposals to ensure that structures that may be in a 100-year floodplain are protected from flood damage and that any changes in the floodplain do not cause unacceptable increases in the elevation of the 100-year water surface (HDR Engineering 1995).

National Pollutant Discharge Elimination System

The National Pollutant Discharge Elimination System (NPDES) permit program was established by the Clean Water Act of 1972 to regulate municipal and industrial discharges to surface waters of the United States. The discharge of wastewater to surface waters is prohibited unless an NPDES permit allowing that discharge has been issued. The NPDES permit program is overseen by the U.S. Environmental Protection Agency's (EPA's) stormwater program; the State of California is authorized to administer the NPDES program within California. Starting in 1990, Phase I of EPA's stormwater program required NPDES permits for stormwater runoff from all of the following (EPA 2002): "medium" and "large" municipal separate storm sewer systems (MS4s) generally serving populations of 100,000 or greater and denoted by EPA as MS4s; construction activity disturbing 5 acres of land or greater, and ten categories of industrial activity.

Phase II of the NPDES permit program was the next step in EPA's effort to protect water resources from polluted stormwater runoff. The Phase II program expands the Phase I program by requiring smaller operators of MS4s in urbanized areas and operators of small construction sites, through the use of NPDES permits, to implement programs and practices to control polluted stormwater runoff (EPA 2002). The County submitted an application for the NPDES Phase II permit and participated in the voluntary project which resulted in a Draft report of "Voluntary Domestic Well Assessment Project".
(http://www.waterboards.ca.gov/gama/docs/edc_draft120905version.pdf)

State Regulations

Subdivision Map Act (1907)

One of the powers granted to local jurisdictions by the Subdivision Map Act is the authority to impose drainage improvements or drainage fees and assessments. Specifically, local jurisdictions may require the provision of drainage facilities, proper grading and erosion control, dedication of land for drainage easements, or payment of fees needed for construction of drainage improvements. The types and applicable standards of the improvements may be specified in the local ordinance.

El Dorado County Regulation and Programs

County Grading, Erosion, and Sediment Control Ordinance

The County Grading, Erosion, and Sediment Control Ordinance (Grading Ordinance) (Chapter 15.14 of the County Code) establishes provisions for public safety and environmental protection associated with grading activities on private property. Section 15.14.090 of the Grading Ordinance, which has incorporated the recommended standards for drainage Best Management Practices (BMPs) from the High Sierra Resource Conservation and Development Council BMP guidelines handbook, prohibits grading activities that would cause flooding where it would not otherwise occur or would aggravate existing flooding conditions. The Grading Ordinance also requires all drainage facilities, aside from those in subdivisions that are regulated by the County's Subdivision Ordinance, be approved by the County Department of Transportation. Pursuant to the ordinance, the design of the drainage facilities in the County must comply with the County of El Dorado Drainage Manual, as described below.

El Dorado County Subdivision Ordinance

The County's Subdivision Ordinance (El Dorado County Code Title 16) requires the submission of drainage plans prior to the approval of tentative maps for proposed subdivision projects. The drainage plans must include an analysis of upstream, onsite, and downstream facilities and pertinent details, and details of any necessary offsite drainage facilities. The tentative map must include data on the location and size of proposed drainage structures. In addition, drainage culverts consistent with the drainage plan may be required in all existing drainage courses, including roads.

El Dorado County Department of Transportation Drainage Program

The County Department of Transportation has an ongoing drainage program with a goal of developing a Capital Improvement Program and funding mechanism for the construction of essential drainage infrastructure and to repair and/or replace inadequate drainage facilities throughout the county. The first phase of the drainage program, development of standard procedures for drainage system designs, was completed with the adoption of the *County of El Dorado Drainage Manual* in 1995.

The second phase of the drainage program involves updating FEMA mapping of four specific drainage basins in the county: Deer Creek in Cameron Park, New York Creek in El Dorado Hills, Carson Creek in the El Dorado Hills Business Park, and the El Dorado Townsite. Three of these basin studies have been completed and are discussed below. These basin studies provide area-specific analysis and identify areas where drainage improvements are required. The third phase of the drainage program is the development of funding mechanisms to address drainage problems in the study areas. With funding mechanisms in place, capital improvement and maintenance programs can be implemented.

The capital improvement program may establish methods of prioritizing existing and future drainage deficiencies and requirements with respect to potential damage, risk, and cost.

County of El Dorado Design and Improvement Standards Manual

The County's Design and Improvement Standards Manual was adopted in 1990 and provides required erosion and sediment control measures that are applicable to subdivisions, roadways, and other types of developments.

County of El Dorado Drainage Manual

The *County of El Dorado Drainage Manual* provides standard procedures for future designs of drainage improvements. The Drainage Manual supercedes the stormwater drainage system design standards in the County's *Design Improvements Standards Manual*. The Drainage Manual requires that a hydrologic and hydraulic analysis be submitted for all proposed drainage facilities. The analysis must include an introduction/background, location map/description, catchment description/delineation, hydrologic analysis, hydraulic and structural analysis, risk assessment/impacts discussion, unusual or special conditions, conclusions, and technical appendices. This analysis is usually required on projects undergoing discretionary review. However, under the Building Code and Grading Ordinance, the County also reviews ministerial development, including required drainage plans, to ensure that appropriate runoff design and controls are in place.

Drainage Basin Studies

Three regional drainage studies have been completed on the west slope. A study of the El Dorado townsite has not been completed.

Carson Creek Regional Drainage Study

The *Final Report of the Carson Creek Regional Drainage Study* (Bottorff 1996) was completed in 1996 for the 15-square-mile Carson Creek watershed, most of which is located in the southwestern portion of El Dorado County. The purpose of this drainage study is to provide a unified plan for stormwater management in the El Dorado County portion of the watershed. The study recognizes the drainage needs of individual projects, assesses the impacts of the proposed drainage improvements on the entire catchment area, and satisfies the requirements of the *County of El Dorado Drainage Manual*.

The Carson Creek Regional Drainage Study uses results from previous drainage studies within the watershed, as well as land use information and drainage improvements included in the previous studies, to develop a regional drainage model. The drainage study was based on the maximum development allowed by the 1996 General Plan, and development projects that were proposed at that time. The study assumes that the portion of the watershed in Sacramento County would remain as open space. The study concluded that runoff for the 100-year storm would result in minor downstream impacts in Sacramento County and that the increase in existing flood inundation areas would be negligible. The study recommended that future drainage improvements be designed and analyzed in context of the regional drainage model. Specific drainage improvements, such as culvert upgrades, channel improvements, and construction of a regional detention storage facility were also recommended. (Bottorff 1996.)

New York Creek Basin Drainage Study

The New York Creek Basin Drainage Study (Ensign & Buckley 1995) analyzes the watershed of New York Creek and its Governor Drive tributary. Assumptions for future land uses within the watershed were based on data from the El Dorado Hills Specific Plan and the El Dorado Hills/Salmon Falls Area Plan. The study concluded that in order to minimize the overtopping of roadways during the 100-year peak flow condition, improvements would be required at eight roadway crossings across New York Creek and the Governor Drive tributary. Even with the construction of these improvements and regular maintenance activities (e.g., channel clearing), flooding and overtopping may occur at roadway crossings. This drainage study also included cost estimates for the recommended improvements.

Cameron Park Drainage Study

The Cameron Park Drainage Study analyzed the flooding potential of a 72-square-mile area in the upper reaches of Deer Creek in order to identify needed drainage channel improvements. The option of using detention to reduce peak flow was not analyzed. The General Plan land use map available during the preparation of the drainage study in 1995 was the source of future land use data in the Cameron Park Drainage Study, the hydrologic and hydraulic analyses of which were based on the full build out of the watershed consistent with the land use designations. The study concluded that 16 roadway crossings at the build out of the 1995 draft General Plan may experience overtopping during a 100-year storm event if culvert or detention improvements were not implemented. The study included recommended culvert improvements while also recommending further studies regarding using detention to reduce the peak flow. This drainage study also included cost estimates for the recommended culvert improvements (Psomas and Associates 1995). In practice, the potential for flooding may be less than identified by the study. The drainage study was based on the draft General Plan in 1995, which was similar to the 1996 General Plan. Discretionary developments in the study area subsequent to the drainage study have constructed detention improvements as required by the County’s Drainage Manual (Pesses, pers. comm., 2003). Furthermore, some of the projects in the drainage study area have been built at lower densities than the maximum allowed; thereby decreasing the potential for flooding conditions (Spiegelberg, pers. comm., 2003).

El Dorado County Special Districts

California Government Code §25210 allows for the formation of county service areas in unincorporated areas, providing an alternative method of furnishing extended governmental services and the levy of taxes to pay for the extended services. The County has established Drainage Zones of Benefit, as well as Road and Drainage Zones of Benefit, that are managed by the County’s General Services Department for the purpose of generating funding for the construction of community drainage facilities.

Worldwide interest in dam and levee safety has risen significantly in recent years. Aging infrastructure, new hydrologic information, and population growth in floodplain areas downstream from dams and near levees have resulted in an increased emphasis on safety, operation and maintenance.

Seiche

A **Seiche** (pronounced "saysh") is a standing wave in an enclosed or partially enclosed body of water. Seiches and seiche-related phenomena have been observed on lakes, reservoirs, swimming pools, bays and seas. The key requirement for formation of a seiche is that the body of water be at least partially bounded, allowing the formation of the standing wave. The term was promoted by the Swiss hydrologist François-Alphonse Forel in 1890, who was the first to make scientific observations of the effect in Lake Geneva, Switzerland. The word originates in a Swiss French dialect word that means "to sway back and forth", which had apparently long been used in the region to describe oscillations in alpine lakes. The Great Lakes of North America have seen Sieche wave activity within the past 20 years ranging from one foot to ten feet waves with noted injuries and some deaths. Lakes in seismically active areas, such as Lake Tahoe in California/Nevada, are significantly at risk from seiches. Geological evidence indicates that the shores of Lake Tahoe may have been hit by seiches and tsunamis as much as 10 m (33 feet) high in prehistoric times, and local researchers have called for the risk to be factored into emergency plans for the region.

Risk for a Seiche wave for the area, as well as potential losses due to a Seiche Wave impact, is considered to be low relative to much of California. As indicated by the seismic activity map, Figure 111-12, the region of the state where El Dorado County is located, just east of Lake Tahoe, seldom suffers the effects of even a 2.5 magnitude earthquake. Given the fact that there are not many homes built at the current lake level or on the immediate shores of Lake Tahoe, a Seiche Wave would cause little damage to homes in the Un-incorporated areas of El Dorado County. There would be substantial damage to infrastructure such as county roads and two state highways that run through El Dorado County, Highway 50 and Highway 89.

Given this recognized area vulnerability, the State of California hosted a Functional Exercise involving a Seiche Wave (called Golden Guardian 2008) that impacted the South shore of Lake Tahoe. The exercise evaluated numerous local and state government agencies in response to such an event. The exercise details and detailed After Action report for Golden Guardian 2008 were reviewed and considered in this vulnerability assessment. The After Action report is attached as appendix. (GG08 Tahoe Region AAR_Final_032009.pdf)

Since there has not been a Seiche Wave on record in the Lake Tahoe area, it would be difficult to get an accurate estimate of damages such an event would cause. Some of the damages to infrastructure in this type of event would include repair and/or replace infrastructure such as roadways which would include manpower hours and resources to make the repairs. The size of the Seiche Wave would also dictate the amount of the debris removal cost to the County and/or State would incur.

A small (0.4-foot) wave surge was reported in Lake Tahoe during the 1966 Truckee earthquake, which had a Richter Scale magnitude of between 6.0 and 6.9.

Earthquakes, Sinkholes and Landslides

Earthquake

General Description of Earthquake Hazard from National Perspective

An earthquake is the motion or trembling of the ground produced by sudden displacement of rock in the Earth's crust. Earthquakes result from crustal strain, volcanism, landslides, or the collapse of caverns. Earthquakes can affect hundreds of thousands of square miles; cause damage to property measured in the tens of billions of dollars, result in loss of life and injury to hundreds of thousands of persons, and disrupt the social and economic functioning of the affected area.

Most property damage and earthquake-related deaths are caused by the failure and collapse of structures due to ground shaking. The level of damage depends upon the amplitude and duration of the shaking, which are directly related to the earthquake size, distance from the fault, site and regional geology. Other damaging earthquake effects include landslides, the down-slope movement of soil and rock (mountain regions and along hillsides), and liquefaction, in which ground soil loses the ability to resist shear and flows much like quick sand. In the case of liquefaction, anything relying on the substrata for support can shift, tilt, rupture, or collapse.

Most earthquakes are caused by the release of stresses accumulated as a result of the rupture of rocks along opposing fault planes in the Earth's outer crust. These fault planes are typically found along borders of the Earth's ten tectonic plates. These plate borders generally follow the outlines of the continents, with the North American plate following the continental border with the Pacific Ocean in the west, but following the mid-Atlantic trench in the east. As earthquakes occurring in the mid-Atlantic trench usually pose little danger to humans, the greatest earthquake threat in North America is along the Pacific Coast.

The areas of greatest tectonic instability occur at the perimeters of the slowly moving plates, as these locations are subjected to the greatest strains from plates traveling in opposite directions and at different speeds. Deformation along plate boundaries causes strain in the rock and the consequent buildup of stored energy. When the built-up stress exceeds the rocks' strength, a rupture occurs. The rock on both sides of the fracture is snapped, releasing the stored energy and producing seismic waves, generating an earthquake.

Earthquakes are measured in terms of their magnitude and intensity. Magnitude is measured using the Richter Scale, an open-ended logarithmic scale that describes the energy release of an earthquake through a measure of shock wave amplitude (see Table 11-5 below). Each unit increase in magnitude on the Richter Scale corresponds to a ten-fold increase in wave amplitude, or a 32-fold increase in energy. Intensity is most commonly measured using the Modified Mercalli Intensity (MMI) Scale based on direct and indirect measurements of seismic effects. The scale levels are typically described using roman numerals, with a I corresponding to imperceptible (instrumental) events, IV corresponding to moderate (felt by people awake), to XII for catastrophic (total destruction). A detailed description of the Modified Mercalli Intensity Scale of earthquake intensity and its correspondence to the Richter Scale is given in Table 11-6.

Table 11-5. Richter Scale

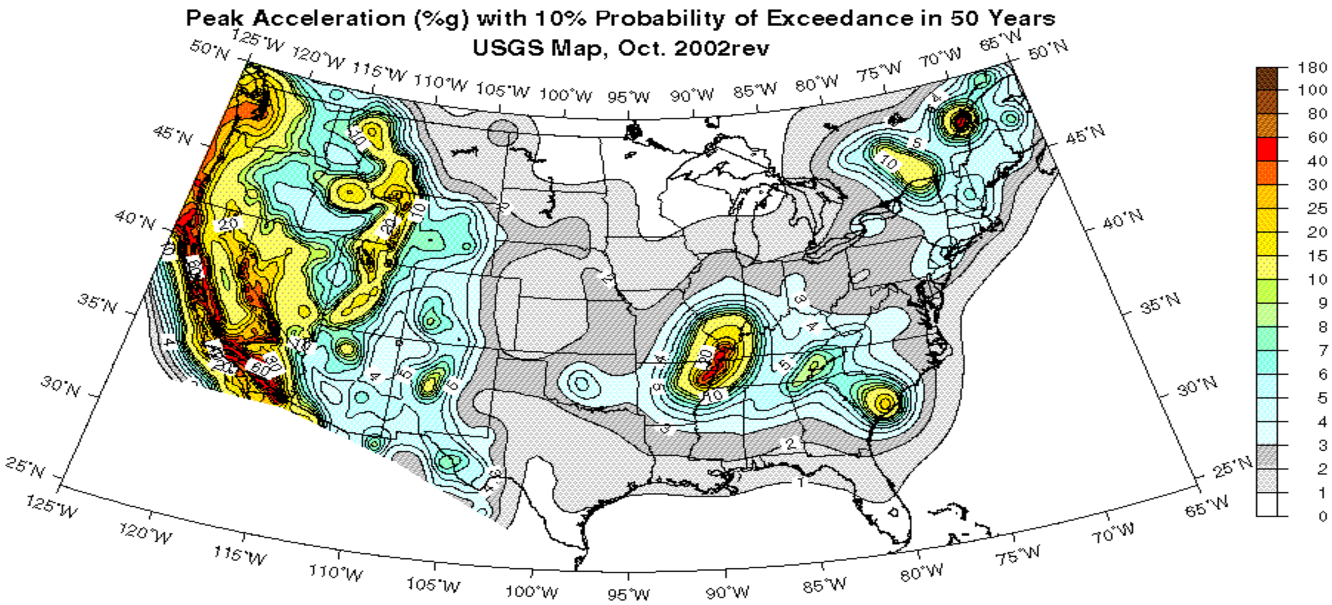
Richter Magnitudes	Earthquake Effects
Less than 3.5	Generally not felt, but recorded.
3.5-5.4	Often felt, but rarely causes damage.
Under 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1-6.9	Can be destructive in areas up to about 100 kilometers across where people live.
7.0-7.9	Major earthquake. Can cause serious damage over larger areas.
8 or greater	Great earthquake. Can cause serious damage in areas several hundred kilometers across.

Table 11-6. Modified Mercalli Intensity Scale for Earthquakes

Scale	Intensity	Description of Effects	Corresponding Richter Scale Magnitude
I	Instrumental	Detected only on seismographs	
II	Feeble	Some people feel it	<4.2
III	Slight	Felt by people resting; like a truck rumbling by	
IV	Moderate	Felt by people walking	
V	Slightly Strong	Sleepers awake; church bells ring	<4.8
VI	Strong	Trees sway; suspended objects swing, objects fall off shelves	<5.4
VII	Very Strong	Mild Alarm; walls crack; plaster falls	<6.1
VIII	Destructive	Moving cars uncontrollable; masonry fractures, poorly constructed buildings damaged	
IX	Ruinous	Some houses collapse; ground cracks; pipes break open	<6.9
X	Disastrous	Ground cracks profusely; many buildings destroyed; liquefaction and landslides widespread	<7.3
XI	Very Disastrous	Most buildings and bridges collapse; roads, railways, pipes and cables destroyed; general triggering of other hazards	<8.1
XII	Catastrophic	Total destruction; trees fall; ground rises and falls in waves	>8.1

Figure 11-7 shows the probability that ground motion will reach a certain level during an earthquake. The data show peak horizontal ground acceleration (the fastest measured change in speed, for a particle at ground level that is moving horizontally due to an earthquake) with a 10 percent probability of exceedance in 50 years. The map was compiled by the U.S. Geological Survey (USGS) Geologic Hazards Team, which conducts global investigations of earthquake, geomagnetic, and landslide hazards.

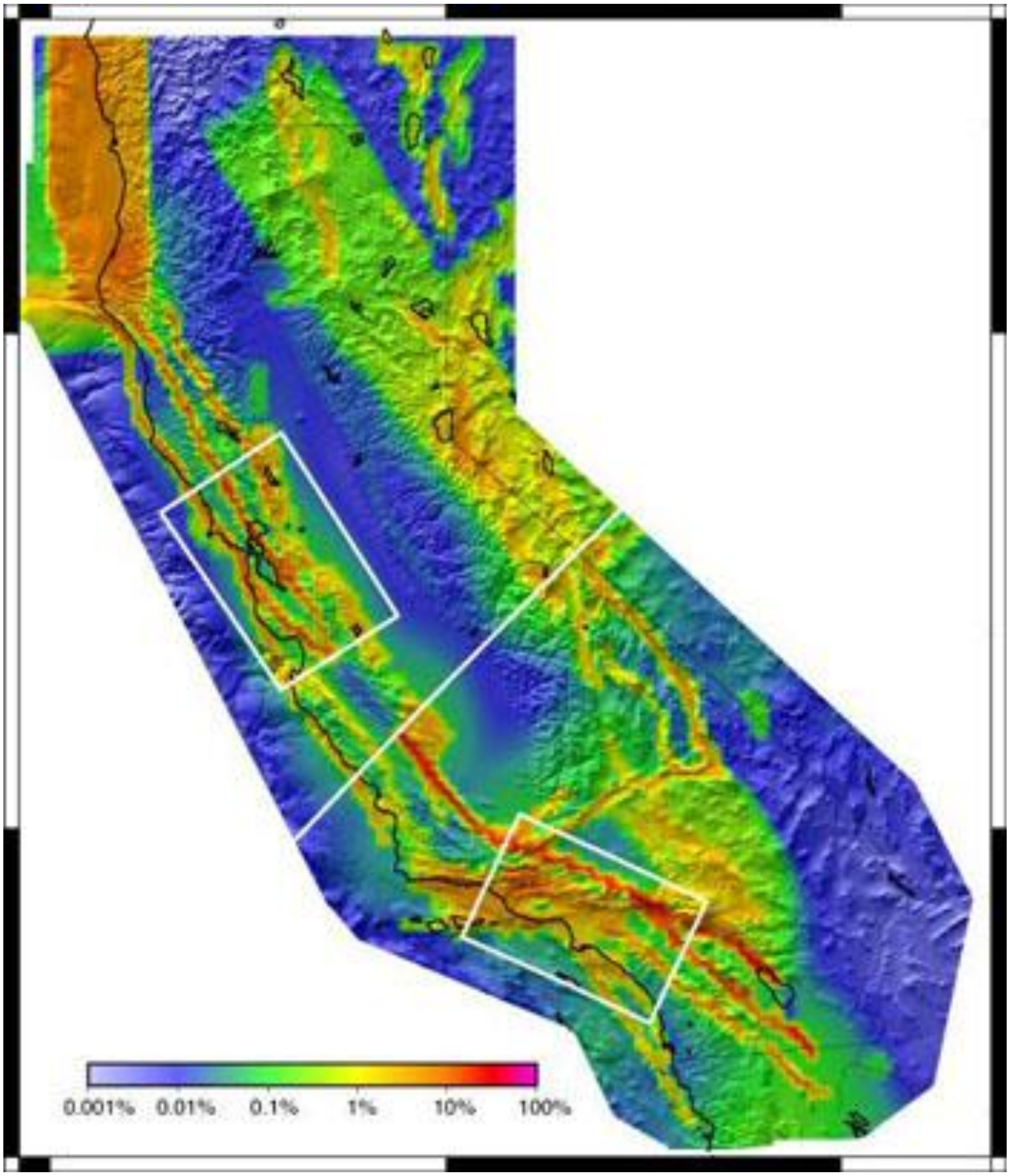
Figure II-7. Peak Acceleration with 10 Percent Probability of Exceedance in 50 Years (Nationwide)



Earthquake Hazard in El Dorado County

The above graphic from the USGS shows that the west coast in general, and California in particular, has an elevated level of risk from earthquake. As demonstrated by the following graphic, Figure 11-8, El Dorado County is one of the lowest risk areas in the State.

Figure 11-8. Level of Earthquake Hazard (California)[1]



The probability of a M>6.7 earthquake in the next 30 years calculated using the UCERF

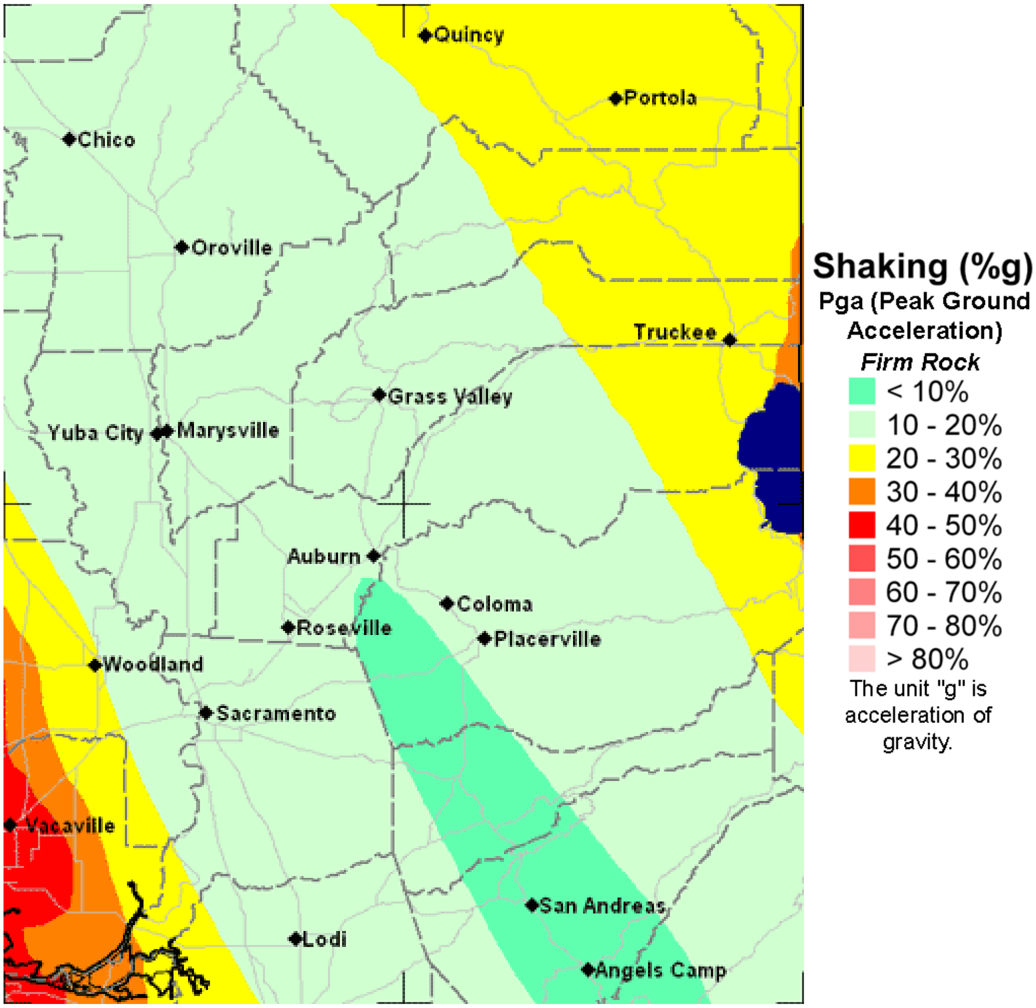


Figure 11-9 Peak Acceleration with 10 Percent Probability of Exceedance in 50 Years (El Dorado County and Vicinity)

The preceding graphic, Figure 11-9, gives a closer look at the El Dorado County area, and shows that the predicted peak acceleration for the developable portion of the County does not exceed 20% of gravity, which puts the County in the lowest potential for the State.

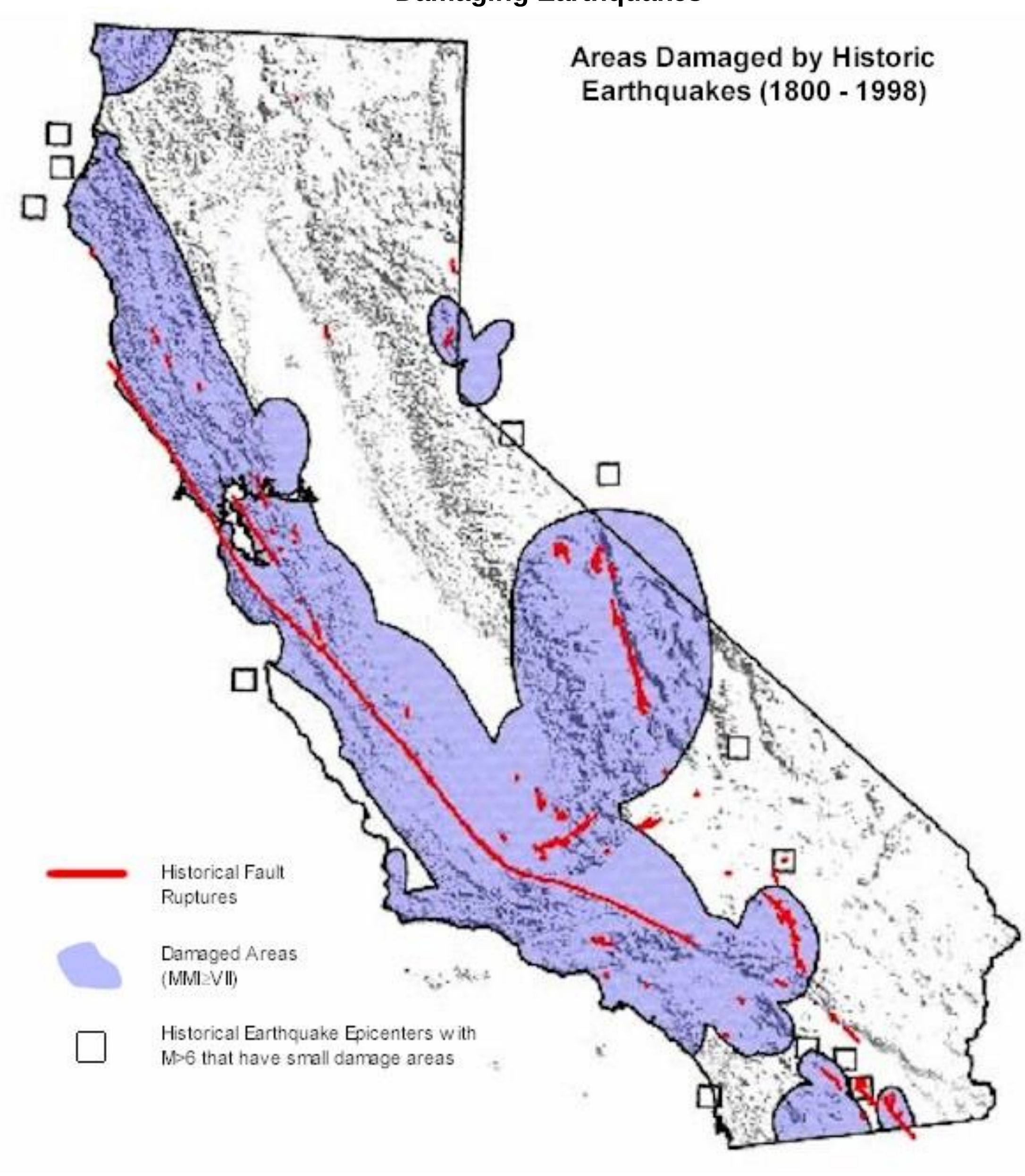
The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. This state law was a direct result of the 1971 San Fernando Earthquake, which was associated with extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures. Surface fault ruptures locations are known, and therefore improvements in these areas can be easily restricted.

The Alquist-Priolo Earthquake Fault Zoning Act's main purpose is to prevent the construction of buildings used for human occupancy on the surface trace of active faults. The Act only addresses the hazard of surface fault rupture and is not directed toward other earthquake hazards. The Seismic Hazards Mapping Act, passed in 1990, addresses non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides.

The law requires the State Geologist to establish regulatory zones (known as Earthquake Fault Zones) around the surface traces of active faults and to issue appropriate maps. The maps are distributed to all affected cities, counties, and state agencies for their use in planning and controlling new or renewed construction. That list does not include El Dorado County, due to its location being relatively distant from any known faults that meet the criteria of the mapping program. There is one fault zone on land under the County's jurisdiction, the Rescue Lineament Bear Mountain fault zone. This fault zone cuts across the western end of the County trending north to south. However, there has been no appreciable movement in this fault and no record of damages sustained.

The following graphics (Figure 11-10 and Figure 11-11) demonstrate the minimum number of times during the period 1800 to 1999 that various areas of the state have been subject to damaging shaking from earthquakes. El Dorado County lies within the portion of the State that has no record of damaging shaking events during that period.

Figure 11-10. Number of Times Areas of the State has Experienced Significantly Damaging Earthquakes



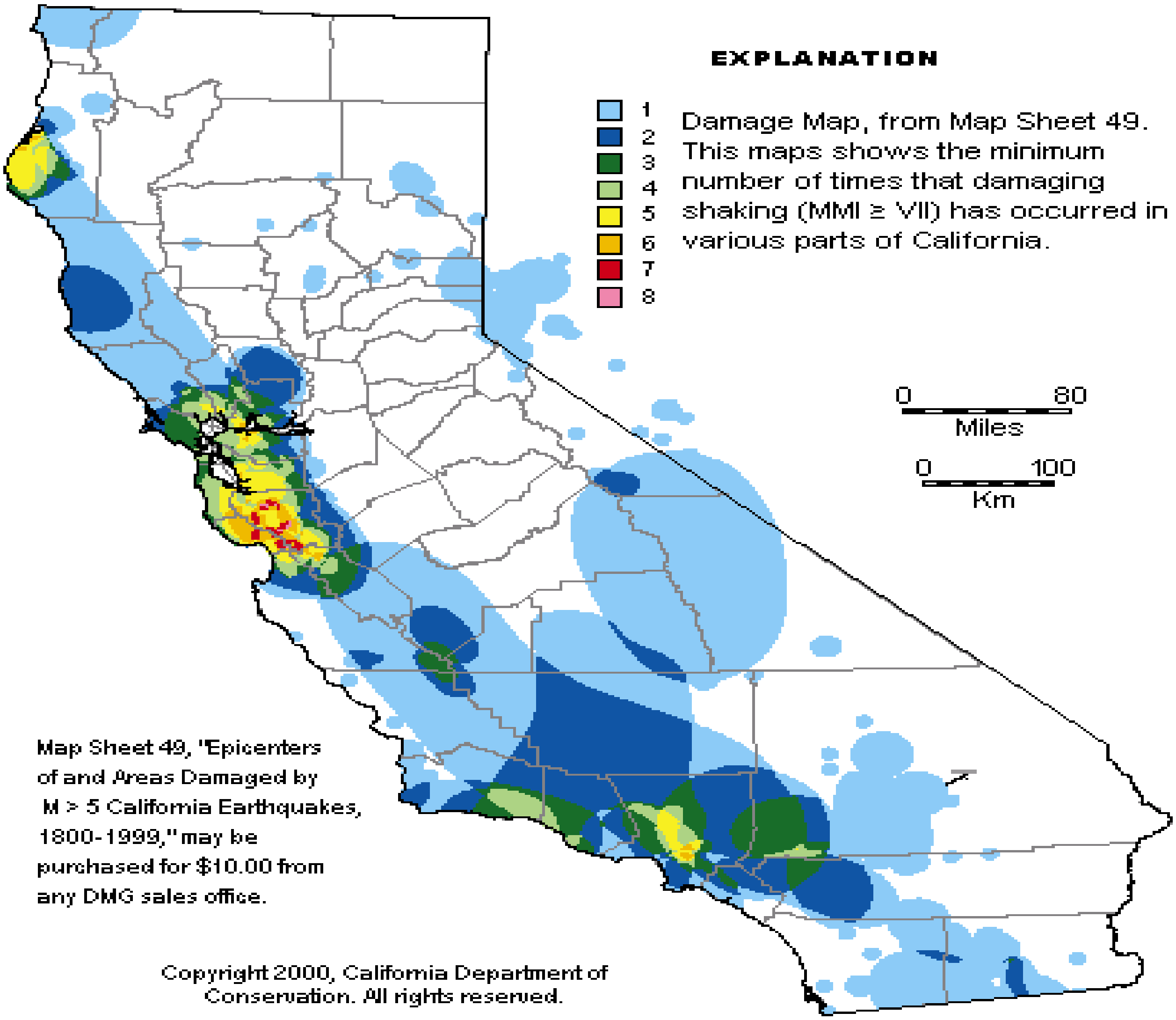


Figure 11-11 (Above) Epicenters of and Areas Damaged by M>5 California Earthquakes, 1800-1999

Sinkholes

General Description of Sinkhole Hazard from National Perspective

Sinkholes are a natural and common geologic feature in areas with underlying limestone and other rock types that are soluble in natural water. Most limestone is porous, allowing the acidic water of rain to percolate through their strata, dissolving some limestone and carrying it away in solution. Over time, this persistent erosional process can create extensive underground voids and drainage systems in much of the carbonate rocks. Collapse of overlying sediments into the underground cavities produces sinkholes.

The three general types of sinkholes are: subsidence, solution and collapse. Collapse sinkholes are most common in areas where the overburden (the sediments and water contained in the unsaturated zone, surficial aquifer system, and the confining layer above an aquifer) is thick, but the confining layer is breached or absent. Collapse sinkholes can form with little warning and leave behind a deep, steep sided hole. Subsidence sinkholes form gradually where the overburden is thin and only a veneer of sediments is overlying the limestone. Solution sinkholes form where no overburden is present and the limestone is exposed at land surface.

Sinkholes occur in many shapes, from steep-walled holes to bowl or cone shaped depressions. Sinkholes are dramatic because the land generally stays intact for a while until the underground spaces get too big. If there is not enough support for the land above the spaces, then a sudden collapse of the land surface can occur. Under natural conditions, sinkholes form slowly and expand gradually. However, human activities such as dredging, constructing reservoirs, diverting surface water, and pumping groundwater can accelerate the rate of sinkhole expansions, resulting in the abrupt formation of collapse sinkholes.

Although a sinkhole can form without warning, specific signs can signal potential development:

- Slumping or falling fence posts, trees, or foundations;
- Sudden formation of small ponds;
- Wilting vegetation;
- Discolored well water; and/or
- Structural cracks in walls or floors.

Collapses, such as the sudden formation of sinkholes, may destroy buildings, roads, and utilities.

Sinkhole formation is aggravated and accelerated by urbanization. Development increases water usage, alters drainage pathways, overloads the ground surface, and redistributes soil. According to FEMA, the number of human-induced sinkholes has doubled since 1930 and insurance claims for damages as a result of sinkholes has increased 1,200 percent from 1987 to 1991, costing nearly $100 million.

Sinkhole Hazard in El Dorado County

Sinkholes in El Dorado County could be of natural or man-made origin. The naturally occurring sinkholes could be a result of solution of limestone or related carbonate bedrock, resulting in the formation of sinkholes.

There is some geologic expression of carbonate bedrock and formation of solution holes or caverns in El Dorado County. A large amount of the area was subject to hydraulic mining techniques of the 19th Century, which blasted the soil from the bedrock in a attempt to extract placer gold. Much of the area was affected by the hydraulic mining, resulting in a difficult landscape of large boulders or outcrops surrounded by depressions. The elevation of the remaining surface can vary as much as 20 feet over a few feet of horizontal distance.

Development has been difficult in these areas, as initial land leveling can be expensive to create a buildable area. Although development has occurred in these parts of the County, there have not been any documented instances of sinkholes or other karst features developing or causing any significant damage.

Man-made “sinkholes” can be from subsidence due to previous deep mining activity. Gold mining in the past has resulted in tunnels, stopes (large underground rooms excavated to extract the gold ore, usually backfilled with waste as other areas of the same underground complex are excavated), and shafts, which can cause depressions or holes to develop on the ground surface. The primary area affected by underground mining is the Mother Lode area and smaller gold ore deposits have been mined in several other smaller areas of the County.

Landslides

General Description of Landslide Hazard from National Perspective

A landslide is the downward and outward movement of slope-forming soil, rock, and vegetation, which is driven by gravity. Landslides may be triggered by both natural and human-caused changes in the environment, including heavy rain, rapid snow melt, steepening of slopes due to construction or erosion, earthquakes, volcanic eruptions, changes in groundwater levels, and deforestation caused by wildland fires.

There are several types of landslides: rock falls, rock topple, slides, and flows. Rock falls are rapid movements of bedrock, which result in bouncing or rolling. A topple is a section or block of rock that rotates or tilts before falling to the slope below. Slides are movements of soil or rock along a distinct surface of rupture, which separates the slide material from the more stable underlying material. Mudflows, sometimes referred to as mudslides, mudflows, lahars or debris avalanches, are fast-moving rivers of rock, earth, and other debris saturated with water. They develop when water rapidly accumulates in the ground, such as heavy rainfall or rapid snowmelt, changing the soil into a flowing river of mud or "slurry." Slurry can flow rapidly down slopes or through channels, and can strike with little or no warning at avalanche speeds. Slurry can travel several miles from its source, growing in size as it picks up trees, cars, and other materials along the way. As the flows reach flatter ground, the mudflow spreads over a broad area where it can accumulate in thick deposits.

Landslides are typically associated with periods of heavy rainfall or rapid snow melt and tend to worsen the effects of flooding that often accompany these events. In areas burned by forest and brush fires, a lower threshold of precipitation may initiate landslides. Some landslides move slowly and cause damage gradually, whereas others move so rapidly that they can destroy property and take lives suddenly and unexpectedly.

Landslides can damage or destroy roads, railroads, pipelines, electrical and telephone lines, mines, oil wells, buildings, canals, sewers, bridges, dams, seaports, airports, forests, parks, and farms.

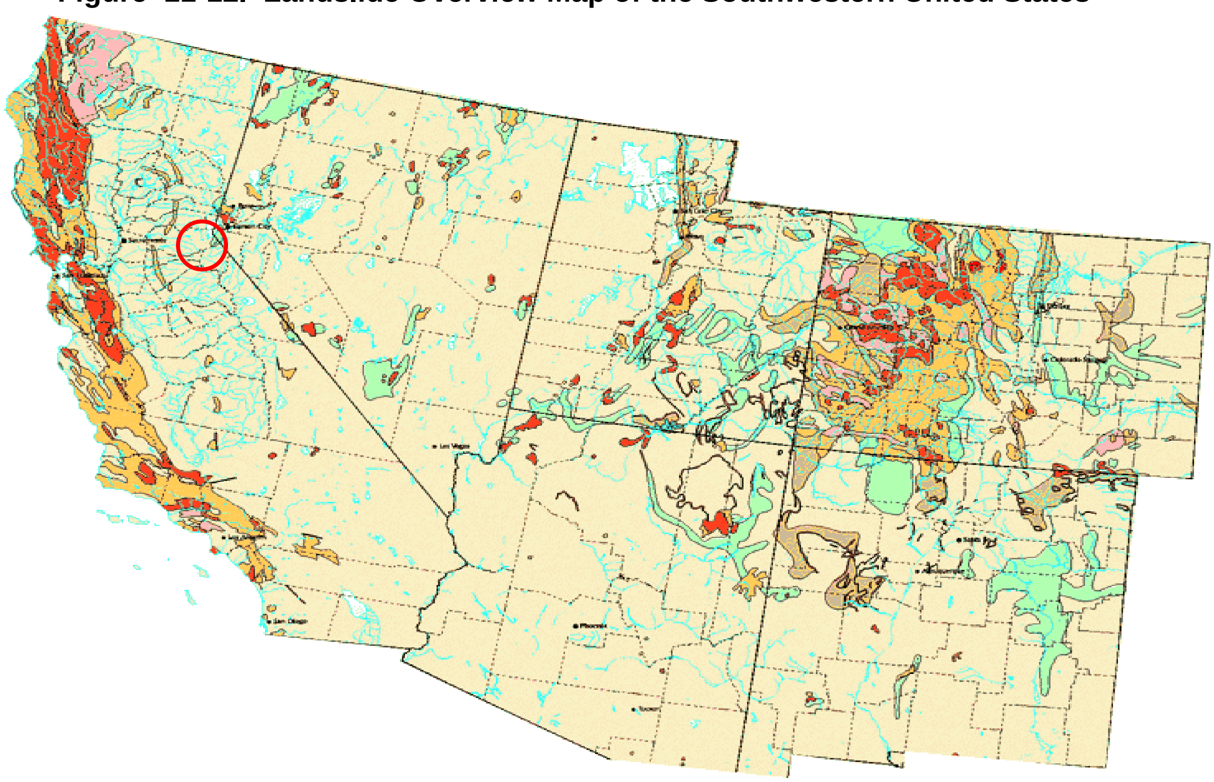
Among the most destructive types of debris flows are those that accompany volcanic eruptions. A spectacular example in the United States was a massive debris flow resulting from the 1980 eruptions of Mount St. Helens, Washington. Areas near the bases of many volcanoes in the Cascade Mountain Range of California, Oregon and Washington are at risk from the same types of flows during future volcanic eruptions.

Areas that are generally prone to landslide hazards include previous landslide areas, the bases of steep slopes, the bases of drainage channels, and developed hillsides where leach-field septic systems are used. Areas that are typically considered safe from landslides include areas that have not moved in the past, relatively flat-lying areas away from sudden changes in slope, and areas at the top or along ridges which are set back from the tops of slopes.

In the United States, it is estimated that landslides cause up to $2 billion in damages and from 25 to 50 deaths annually. Globally, landslides cause billions of dollars in damage and thousands of deaths and injuries each year.

Figure 11-12 identifies areas where large numbers of landslides have occurred and areas which are susceptible to landsliding in the southwestern United States. This map layer is provided in the U.S. Geological Survey Professional Paper 1183. The red circle on the image was added to identify the location of El Dorado County on the relatively small-scale map.

Figure 11-12. Landslide Overview Map of the Southwestern United States



EXPLANATION

LANDSLIDE INCIDENCE

- Low (less than 1.5% of area involved)
- Moderate (1.5%-15% of area involved)
- High (greater than 15% of area involved)

LANDSLIDE SUSCEPTIBILITY/INCIDENCE

- Moderate susceptibility/low incidence
- High susceptibility/low incidence
- High susceptibility/moderate incidence

Susceptibility not indicated where same or lower than incidence. Susceptibility to landsliding was defined as the probable degree of response of [the areal] rocks and soils to natural or artificial cutting or loading of slopes, or to anomalously high precipitation. High, moderate, and low susceptibility are delimited by the same percentages used in classifying the incidence of landsliding. Some generalization was necessary at this scale, and several small areas of high incidence and susceptibility were slightly exaggerated.

Landslide Hazard in El Dorado County

The topography of El Dorado County displays a wide range of landforms ranging from vertical cliffs to gently undulating foothills. Combined with often times complex underlying geology that gives rise to a wide range of surficial soil types, native topography can provide a challenging environment for safe development.

In general, the greater the existing slope the greater the overall threat of landslide. The El Dorado County Geohazards Maps indicate general areas of the developable properties that has slopes in excess of 30%. It is to be expected that areas of greater than 30% slope will exist outside the delineated areas as will areas of less than 30% slope exist inside the delineated areas due to constraints imposed by the general nature of the USGS topographic maps that were used in the compilation of slopes. Local mapping of project areas is recommended in conjunction with geologic interpretation prior to the development of slopes in excess of 30%.

The diverse geology of El Dorado County includes areas underlain by serpentine. This generic rock type is particularly prone to slope failure as evidenced by native slope failures and failure of man-made slopes such as those experienced along the Highway 50 Corridor in the vicinity between Riverton and Strawberry. Slope failure of the steep slopes along the American River have littered the adjacent slopes with boulders and other debris. Typically limited to the slopes along the upper American River, development in this area should be done only after carefully considering appropriate setbacks from the break point where the topography dramatically changes. It is important to note that slope failure along Highway 50, as evidenced in January of 1997 even though within the boundaries of El Dorado County fell under Caltrans jurisdiction.

Downslope development on relatively flat land at the base of steep cliffs should occur only after the potential for rockfall is evaluated. Surface mapping of rock exposures along with observation of conditions in the local area of a project assists in the determination of site-specific areas subject to rockfall damage.

The above discussion concerning areas with potential landslide hazard is limited to certain areas near cliff-like features or on very steep slopes, none of which are often subject to development. There have been reported incidents of landslides and general slope failure in isolated portions of the County, but this is a very uncommon occurrence with no defined history of significant damages. Although the above discussion shows that portions of the privately owned and potentially developable land of El Dorado County can include areas where landslide could occur, it is not common to most areas. Overall, the hazard is much less than can be expected to occur in much of the more densely developed portions of the State (see Figure 11-12), where the geologic conditions are much more prone to landslide and general instability.

Winter Storms

General Description of Winter Storm Hazard from National Perspective

A winter storm can range from a moderate snow over a period of a few hours to blizzard conditions with blinding wind-driven snow that lasts for several days. Some winter storms may be large enough to affect several states, while others may affect only a single community. Many winter storms are accompanied by low temperatures and heavy and/or blowing snow, which can severely impair visibility.

Winter storms may include snow, sleet, freezing rain, or a mix of these wintry forms of precipitation. Sleet – raindrops that freeze into ice pellets before reaching the ground – usually bounce when hitting a surface and do not stick to objects; however, sleet can accumulate like snow and cause a hazard to motorists. Freezing rain is rain that falls onto a surface with a temperature below freezing, forming a glaze of ice. Even small accumulations of freezing rain can cause a significant hazard, especially on power lines and trees. An ice storm occurs when freezing rain falls and freezes immediately upon impact. Communications and power can be disrupted for days, and even small accumulations of ice may cause extreme hazards to motorists and pedestrians.

A heavy layer of ice was more weight than this tree in Kansas City, Missouri could withstand during a January 2002 ice storm that swept through the region, bringing down trees, power lines and telephone lines.

A freeze is weather marked by long periods of sustained low temperatures, especially when below the freezing point (zero degrees Celsius or thirty-two degrees Fahrenheit). Agricultural production is seriously affected when temperatures remain below the freezing point.

Winter Storm Hazard in El Dorado County

El Dorado County is subject to a variety of winter or seasonal storm hazards due to the elevation changes in different parts of the County. Typical storms associated with the rainy season (late fall, winter, early spring) cause different problems depending on elevation. A warm storm with relatively mild temperatures usually brings rain to the lower elevations, and snow to the higher elevations. Often the "snow line" is above 3,000 feet above sea level, and a smaller percentage of the County population is directly affected by the snow and freezing conditions. However, meteorological conditions can be different, and can change radically during an actual storm event, resulting in snowfall down to 1,000 foot elevation, affecting a much greater range of the County's population. Low snowfall events also greatly affect the transitory tourist population or day visitors to the County, many of whom are ill prepared for winter weather. Cold storms can also be accompanied by freezing rain and wet heavy snow, making driving treacherous and causing more infrastructure damage with felled trees and powerlines. Some storms deposit significant amounts of rainfall in a small geographic area where the ditches, creeks and bridges are overwhelmed by the runoff. Storms can also be associated with strong pressure changes with resultant winds that bring down trees unable to support themselves in saturated soils.

Damage-causing storms can occur during any time of year, but usually occur during the rainy season, which generally runs from mid-fall through spring. Snow at the lower elevations can occur during the entire rainy season, but more frequently occurs in winter and early spring. A summertime monsoon flow of tropical moisture can bring thunderstorms to the high elevations in the extreme east and northeast of the County, but seldom brings any significant rainfall to the lower elevations.

Storm-related damage to properties and infrastructure varies depending on the nature of the storm. Intense localized rainfall causes washouts of roadways and bridge damage, or localized flooding of structures that lack the storm-drain capacity to remove the water. Snowfall and freezing rain can temporarily paralyze transportation, but also result in power distribution damage and power outages that can take extended periods to restore. Heavy snow and ice can fell trees that block roadways. Snowfall and felled trees are more likely to cause significant damage in the higher elevations of El Dorado County, but localized flooding from intense rainfall can occur anywhere.

Due to the strong correlation of winter storms and flooding all of the prior incidents that caused reportable damage were documented in the earlier section of "Floods"

The May 18, 1980 eruption of Mount Saint Helens created an eruptive cloud that rose to an altitude of more than 12 miles in 10 minutes. Nearly 550 million tons of ash fell over a 22,000 square mile area.

Volcano

General Description of Volcano Hazard from National Perspective

Over 75 percent of the Earth's surface above and below sea level, including the seafloors and some mountains, originated from volcanic eruption. Emissions from these volcanoes formed the Earth's oceans and atmosphere. Volcanoes can also cause tsunamis, earthquakes, and dangerous flooding.

Volcanoes are vents in the Earth's crust that emit molten rock and steam. They are evidence that the physical makeup of our planet is ever-changing. Volcanoes are relatively site specific, but the molten rock, ash, steam, and other gases they release can have an impact on much larger areas.

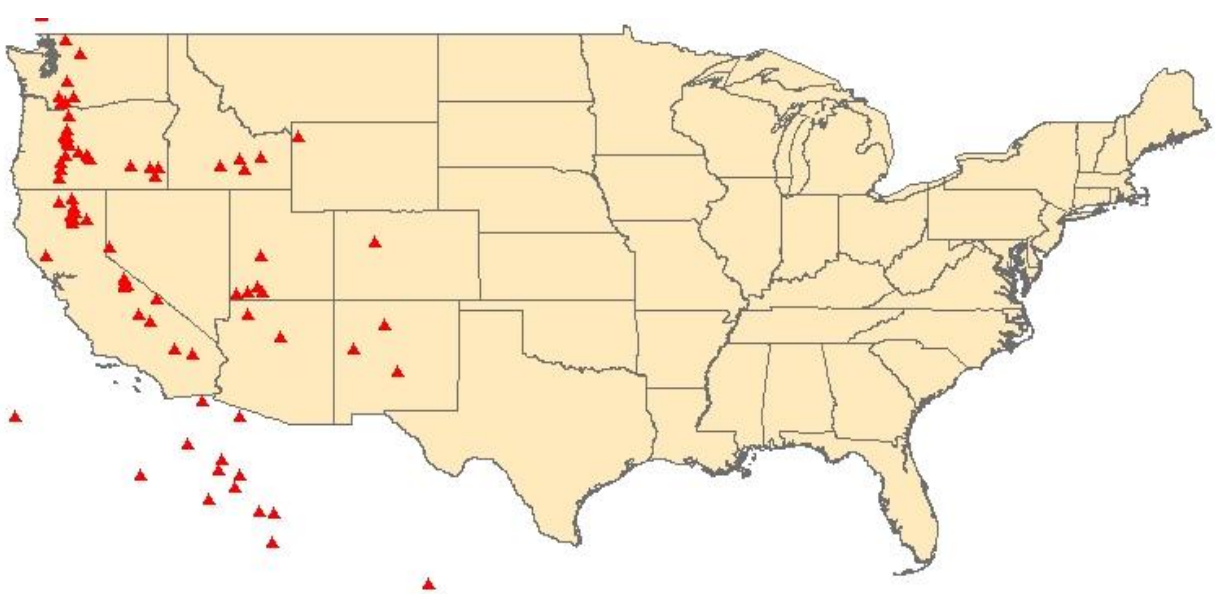
Lahar is the mudflow of debris and water caused by a volcano. It is also known as debris flow or volcanic mudflow. Lahar is most often triggered by rainfall washing down the debris from the slopes of volcanoes. However, lahar flows can also be triggered by rapidly melting snow and ice, debris avalanches and breakouts of lakes that were dammed by volcanic debris.

Tephra is the general term used to describe the ash and other materials that are released into the air after a volcanic eruption. Tephra ranges in size from fine powder to larger rock-sized debris. Volcanic ash pollutes the air, can contaminate water supplies, cause electrical storms, collapse roofs, and may affect people hundreds of miles away.

Volcanic explosions which are directed sideways are called lateral blasts. Lateral blasts can throw large pieces of rock at very high speeds for several miles. These explosions can kill by impact, burial or heat and may have enough force to knock down entire forests of trees. The majority of deaths attributed to the Mount St. Helens volcano eruption in 1980 were a result of lateral blast and tree blow-down.

There are more than 500 active volcanoes in the world. More than half of these volcanoes are part of the "Ring of Fire," a region that encircles the Pacific Ocean. More than 50 volcanoes in the United States have erupted one or more times in the past 200 years. The most volcanically active regions of the nation are in Alaska, Hawaii, California, Oregon, and Washington (Figure 11-13). The danger area around a volcano covers approximately a 20-mile radius. Some danger may exist 100 miles or more from a volcano.

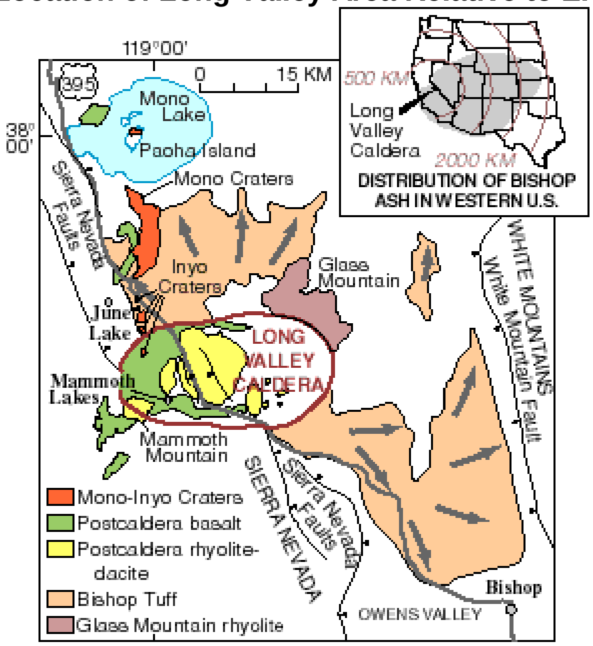
Figure 11-13. Known Volcano Locations in the United States



Volcano Hazard in El Dorado County

The volcano hazard of El Dorado County is presented by the relative proximity to the Long Valley Volcanic Field. As shown in Figure 11-14 the extreme northwest corner of the Long Valley area reaches the most extreme southeastern corner of El Dorado County.

Figure 11-14. Location of Long Valley Area Relative to El Dorado County



The Long Valley Caldera was formed by a catastrophic eruption about 730,000 years ago. Most of the major landforms of the complex were created then or soon thereafter, associated with a major eruption of ash and subsequently lava flows. Most of the more recent events were of a smaller scale, and some did result in ash events that affected areas to the east of the complex. Tephra, or ash falling from the sky after volcanic events, can cause impacts ranging from inconvenience to equipment failure and large-scale property and agricultural losses, depending on the amount of ash being deposited and the duration of the event. The movement of ash is subject to the normal jet stream effects of air masses moving in general from west to east. This reduces the risk of a significant ash event from affecting El Dorado County.

Drought/Extreme Heat

Over the past 150 years, conditions of drought/extreme heat in El Dorado County have caused significant crop loss. Various apple orchards and wineries have been impacted by these adverse weather conditions. A recent El Dorado County Crop Report states the following on the impact of the weather on agriculture.

The El Dorado County gross crop value for 2008 was $35.4 million which is an overall decrease of 33.5% from the 2007 values. The decline in total value was mainly due to weather related damage caused by low springtime temperatures and a dramatic decrease in timber harvesting. Specifically, timber values saw a precipitous 67.6% decrease from the prior year while many of the other crops experienced lower harvests of higher quality fruits.

Historically, El Dorado County has been included in disaster proclamations for drought in 2008, and 2009. The County Agriculture Department is currently determining the cost of the crop losses in the recent years.

We are currently operating under a disaster declaration from the U.S. Small Business Administration for contiguous counties for agricultural losses caused by drought that occurred January 1, 2004, and continuing. Further analysis, and mitigation measures are currently under development. Updates to this plan, will include a complete analysis of this hazard at a future date.

Erosion

General Description of Erosion Hazard from National Perspective

Erosion is the gradual breakdown and movement of land due to both physical and chemical processes of water, wind and general meteorological conditions. Natural, or geologic, erosion has occurred since the Earth's formation and continues at a very slow and uniform rate each year.

There are two types of soil erosion: wind erosion and water erosion. Wind erosion can cause significant soil loss. Winds blowing across sparsely vegetated or disturbed land can pick up soil particles and carry them through the air, thus displacing them. Water erosion can occur over land or in streams and channels. Water erosion that takes place over land may result from raindrops, shallow sheets of water flowing off the land, or shallow surface flow, which is concentrated in low spots. Stream channel erosion may occur as the volume and velocity of water flow increases enough to cause movement of the streambed and bank soils. Major storms such as hurricanes may cause significant erosion by combining high winds with heavy surf and storm surge to significantly impact the shoreline.

An area's potential for erosion is determined by four factors: soil characteristics, vegetative cover, climate or rainfall and topography. Soils composed of a large percentage of silt and fine sand are most susceptible to erosion. As the content of these soils increases in the level of clay and organic material, the potential for erosion decreases. Well-drained and well-graded gravels and gravel-sand mixtures are the least likely to erode. Coarse gravel soils are highly permeable and have a good capacity for absorption, which can prevent or delay the amount of surface runoff. Vegetative cover can be very helpful in controlling erosion by shielding the soil surface from falling rain, absorbing water from the soil and slowing the velocity of runoff. Runoff is also affected by the topography of the area including size, shape and slope. The greater the slope length and gradient, the more potential an area has for erosion. Climate can affect the amount of runoff, especially the frequency, intensity and duration of rainfall and storms. When rainstorms are frequent, intense or of long duration, erosion risks are high. Seasonal changes in temperature and rainfall amounts define the period of highest erosion risk of the year.

During the past 20 years, the importance of erosion control has gained the increased attention of the public. Implementation of erosion control measures consistent with sound agricultural and construction operations is needed to minimize the adverse effects associated with increasing settling out of the soil particles due to water or wind. The increase in government regulatory programs and public concern has resulted in a wide range of erosion control products, techniques and analytical methodologies in the United States. The preferred method of erosion control in recent years has been the restoration of vegetation.

Erosion Hazard in El Dorado County

The soils in El Dorado County can be generally considered to be shallow. The diverse underlying geology along with agents of weathering such as erosion, soil chemistry, and cultural activities all play a part in the soil type. Clays exist both as a weathering product and as native sediments. Clays have the potential for expansion and contraction when they go through wet/dry cycles. Foundations based on clay soils have the potential for being affected by the associated changes in soil volumes over time. These phenomena can be most directly observed by areas of roadway failure that are commonly evidenced by repeated patching over the years (although patching is often due not only to clay soils but also to the presence of inadequate drainage of the subbase beneath the pavement).

When clay soils are noted as present in a development, the clays in areas of proposed roadways are tested for shrink/swell potential and the test results considered in the structural design.

Grading, either by natural agents such as erosion or the activities of man, has the potential for creating unstable slopes. Erosion control can be accomplished on critical slopes being affected by natural agents. Proper investigation of the soils underlying proposed areas of grading in conformance with the mandates of the Uniform Building Code can assist in delineating potential areas of concern and provide information to the project engineer which will allow for the design of remedial measures. Concurrent testing, in conformance with the recommendations of the Uniform Building Code and the project engineer can ensure a grading project has the highest possible potential for avoiding future problems with stability or erosion.

Erosion is a natural process where soil is removed by water, wind or gravity from one location to another. The process of removal and deposition changes the topography toward a condition of equilibrium. It is a natural process that when aided by man can result in undesirable consequences. Grading activities remove the natural vegetative cover that protects the soil from erosion agents. Grading plans should be accompanied by erosion control plans that have a specific time line for implementation.

The potential for erosion of soils increases as a function of the steepness of the slope. The areas in El Dorado County in excess of 30% are considered as having a high potential for erosion.

The vast majority of development in El Dorado County is not in proximity to cliff-like areas, nor has it often occurred on steep slopes in excess of 30%. Erosion problems are generally limited to restricted areas where grading has oversteepened slopes, or deposited fill in areas where it has not stabilized or where improper grading practices have not included provisions to seed or otherwise protect fresh slopes from eroding. There have also been other examples of burned areas being eroded prior to reestablishment of vegetation to protect the slopes from degrading. Otherwise, compared to many areas of the State such as the coastal mountains, erosion has proven to be a modest hazard in El Dorado County.

Severe Thunderstorms and Tornadoes

General Description of Thunderstorm/Tornado Hazard from National Perspective

According to the National Weather Service, more than 100,000 thunderstorms occur each year, though only about 10 percent of these storms are classified as "severe." Although thunderstorms generally affect a small area when they occur, they are very dangerous because of their ability to generate tornadoes, hailstorms, strong winds, flash flooding, and damaging lightning. While thunderstorms can occur in all regions of the United States, they are most common in the central and southern states because atmospheric conditions in those regions are most ideal for generating these powerful storms.

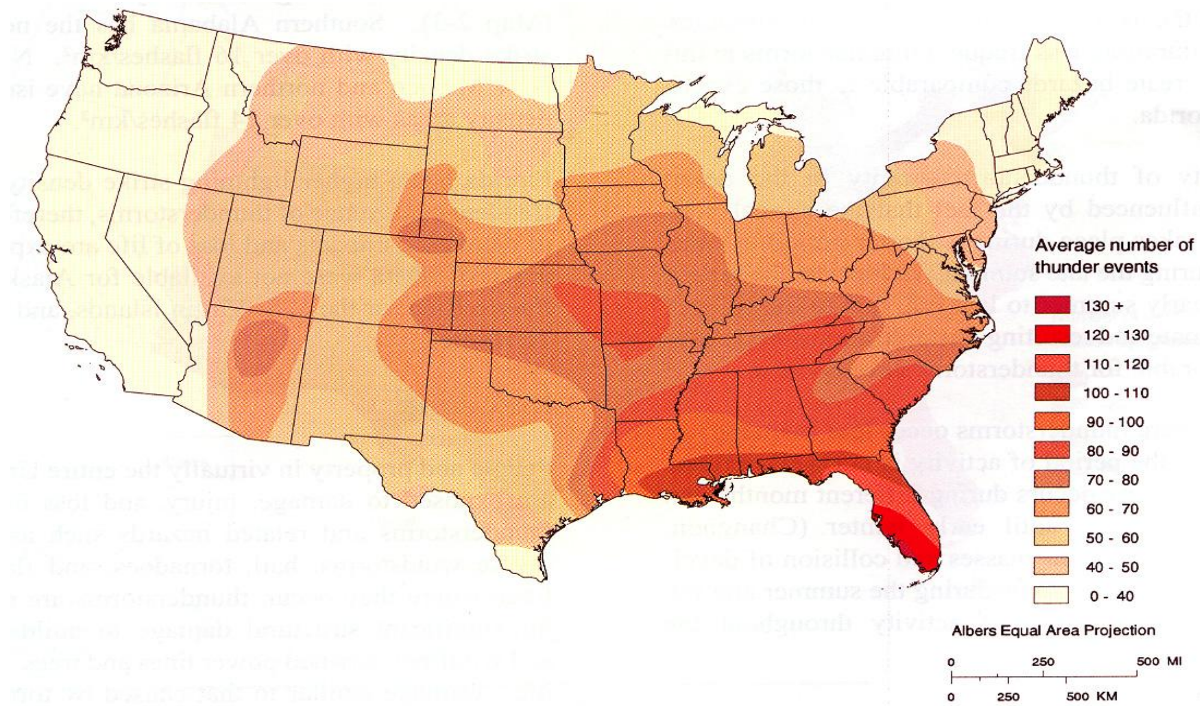
Multiple cloud-to-ground and cloud-to-cloud lightning strikes observed during a nighttime thunderstorm.

Thunderstorms are caused when air masses of varying temperatures meet. Rapidly rising warm moist air serves as the "engine" for thunderstorms. These storms can occur singularly, in lines or in clusters. They can move through an area very quickly or linger for several hours.

Lightning is a discharge of electrical energy resulting from the buildup of positive and negative charges within a thunderstorm, creating a "bolt" when the buildup of charges becomes strong enough. This flash of light usually occurs within the clouds or between the clouds and the ground. A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit. Lightning rapidly heats the sky as it flashes, but the surrounding air cools following the bolt. This rapid heating and cooling of the surrounding air causes thunder. On average, 89 people are killed each year by lightning strikes in the United States.

The National Weather Service collected data on the number days with thunderstorms, number and duration of thunder events and density of lightening strikes for the 30-year period from 1948 to 1977. The most significant of these data sets was the annual average number of thunder events, or storms that resulted in thunder, and it was used to create a map that follows as Figure 11-15.

Figure 11-15. Annual Average Number of Thunder Events



A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud extending to the ground.

The most comprehensively observed tornado in history, this tornado south of Dimmitt, Texas developed June 2, 1995 curving northward across Texas Highway 86 where it entirely removed 300 feet of asphalt from the road, tossing it more than 600 feet into an adjacent field.

Tornadoes are most often generated by thunderstorm activity (but sometimes result from hurricanes and other coastal storms) when cool, dry air intersects and overrides a layer of warm, moist air forcing the warm air to rise rapidly. The damage caused by a tornado is a result of the high wind velocity and wind-blown debris, also accompanied by lightning or large hail. According to the National Weather Service, tornado wind speeds normally range from 40 to more than 300 miles per hour. The most violent tornadoes have rotating winds of 250 miles per hour or more and are capable of causing extreme destruction and turning normally harmless objects into deadly missiles.

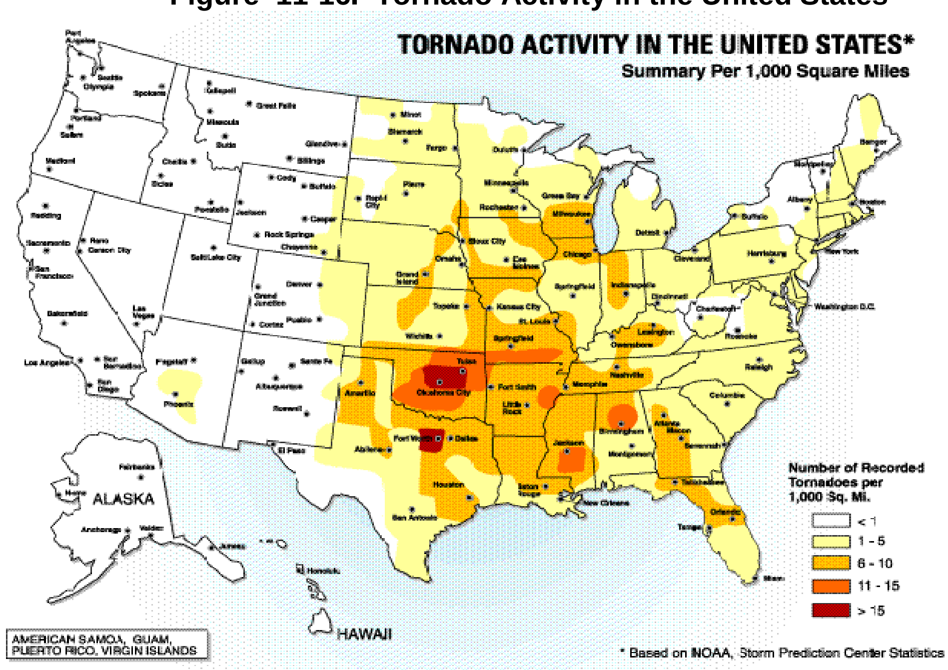
Each year, an average of over 800 tornadoes is reported nationwide, resulting in an average of 80 deaths and 1,500 injuries (National Oceanographic and Atmospheric Administration, 2002). They are more likely to occur during the spring and early summer months of March through June and can occur at any time of day, but are likely to form in the late afternoon and early evening. Most tornadoes are a few dozen yards wide and touch down briefly, but even small short-lived tornadoes can inflict tremendous damage. Highly destructive tornadoes may carve out a path over a mile wide and several miles long.

Waterspouts are weak tornadoes that form over warm water and are most common along the Gulf Coast and Southeastern states. Waterspouts occasionally move inland, becoming tornadoes that cause damage and injury. However, most waterspouts dissipate over the open water, causing threats only to marine and boating interests. Typically a waterspout is weak and short-lived and, because they are so common, most go unreported unless they cause damage.

The destruction caused by tornadoes ranges from light to inconceivable depending on the intensity, size, and duration of the storm. Typically, tornadoes cause the greatest damages to structures of light construction such as residential homes (particularly mobile homes) and tend to remain localized in impact.

According to the National Oceanographic and Atmospheric Administration (NOAA) Storm Prediction Center (SPC), the highest concentration of tornadoes in the United States has been in Oklahoma, Texas, Kansas and Florida respectively. Although the Great Plains region of the Central United States does favor the development of the largest and most dangerous tornadoes (earning the designation of "tornado alley"), Florida experiences the greatest number of tornadoes per square mile of all U.S. states (SPC, 2002). Figure 11-16. shows tornado activity in the United States based on the number of recorded tornadoes per 1,000 square miles.

Figure 11-16. Tornado Activity in the United States



The tornadoes associated with tropical cyclones are most frequent in September and October when the incidence of tropical storm systems is greatest. This type of tornado usually occurs around the perimeter of the storm, and most often to the right and ahead of the storm path or the storm center as it comes ashore. These tornadoes commonly occur as part of large outbreaks and generally move in an easterly direction.

Figure 11-17 shows how the frequency and strength of extreme windstorms vary across the United States. The map was produced by the Federal Emergency Management Agency and is based on 40 years of tornado history and over 100 years of hurricane history. Zone IV, the darkest area on the map, has experienced both the greatest number of tornadoes and the strongest tornadoes. As shown by the map key, wind speeds in Zone IV can be as high as 250 miles per hour.

Figure 11-17. Wind Zones in the United States

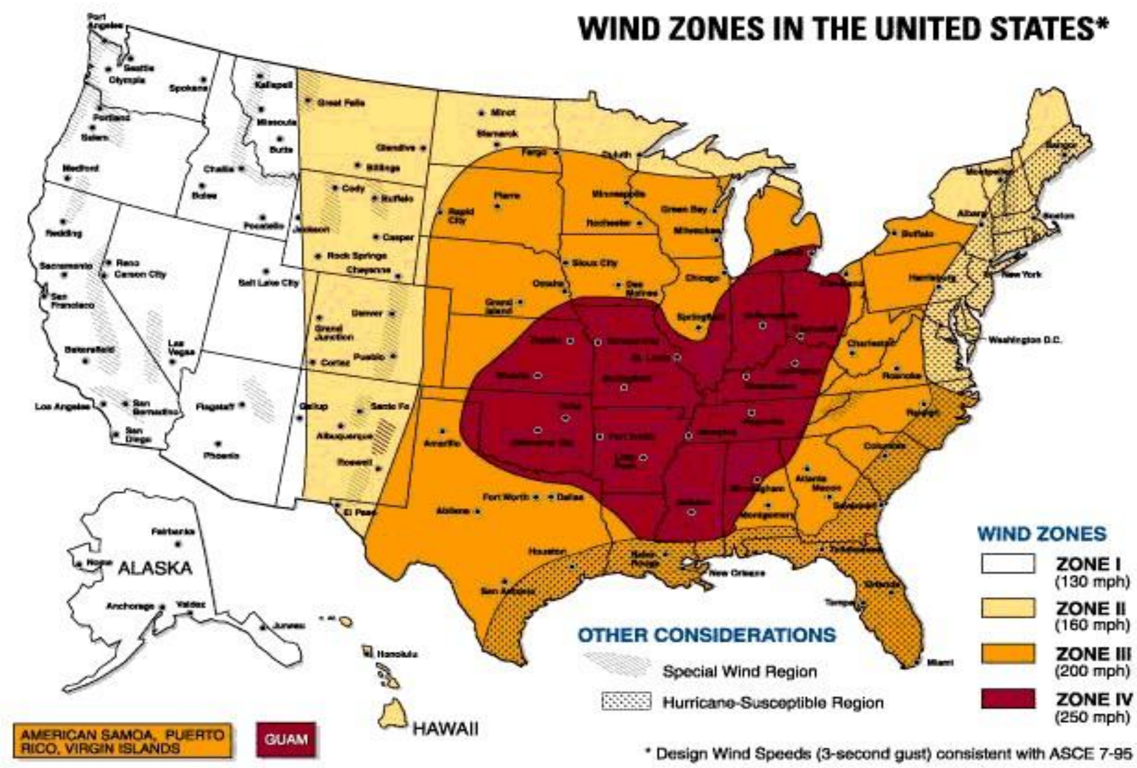


Figure I.2 **Wind zones in the United States**

Source: Federal Emergency Management Agency

Thunderstorm/Tornado Hazard in El Dorado County

As shown by the graphics in the section above, El Dorado County is not located in an area of these types of extreme meteorological events. With these types of wind and storm events associated with summer or fall warm air masses, El Dorado County and the surrounding regions have no history of hazards from these types of events. Strong winds, snow and ice associated with winter or winter season storms are considered in the "winter/seasonal storm" section, as are localized flooding as a result of thunderstorms or similar intense rainfall events. Because there is otherwise no history of damage from thunderstorms or tornadoes, there will be no further discussions related to these in this document.

Hurricanes and Tropical Storms

General Description of Hurricane / Tropical Storm Hazard from National Perspective

Hurricanes, tropical storms, nor'easters and typhoons, also classified as cyclones are any closed circulation developing around a low-pressure center in which the winds rotate counter-clockwise in the Northern Hemisphere (or clockwise in the Southern Hemisphere) and whose diameter averages 10 to 30 miles across. A tropical cyclone refers to any such circulation that develops over tropical waters. Tropical cyclones act as a "safety-valve," limiting the continued build-up of heat and energy in tropical regions by maintaining the atmospheric heat and moisture balance between the tropics and the pole-ward latitudes. The primary damaging forces associated with these storms are high-level sustained winds, heavy precipitation and tornadoes. Coastal areas are also vulnerable to the additional forces of storm surge, wind-driven waves and tidal flooding which can be more destructive than cyclone wind.

Wind and rain from Hurricane Lili damage road signs along I-10 in Louisiana on October 3, 2002

The key energy source for a tropical cyclone is the release of latent heat from the condensation of warm water. Their formation requires a low-pressure disturbance, warm sea surface temperature, rotational force from the spinning of the earth and the absence of wind shear in the lowest 50,000 feet of the atmosphere. The majority of hurricanes and tropical storms form in the Atlantic Ocean, Caribbean Sea and Gulf of Mexico during the official Atlantic hurricane season, which encompasses the months of June through November. The peak of the Atlantic hurricane season is in early to mid-September and the average number of storms that reach hurricane intensity per year in that basin is about six (6).

A storm surge is a large dome of water often 50 to 100 miles wide and rising anywhere from four to five feet in a Category 1 hurricane up to 20 feet in a Category 5 storm. The storm surge arrives ahead of the storm's actual landfall and the more intense the hurricane is, the sooner the surge arrives. Water rise can be very rapid, posing a serious threat to those who have not yet evacuated flood-prone areas. A storm surge is a wave that has outrun its generating source and become a long period swell. The surge is always highest in the right-front quadrant of the direction in which the hurricane is moving. As the storm approaches shore, the greatest storm surge will be to the north of the hurricane eye. Such a surge of high water topped by waves driven by hurricane force winds can be devastating to coastal regions, causing severe beach erosion and property damage along the immediate coast.

Storm surge heights, and associated waves, are dependent upon the shape of the continental shelf (narrow or wide) and the depth of the ocean bottom (bathymetry). A narrow shelf, or one that drops steeply from the shoreline and subsequently produces deep water close to the shoreline, tends to produce a lower surge but higher and more powerful storm waves.

Hurricane Floyd brought a devastating 15 feet of storm surge that damaged or destroyed hundreds of houses along the ocean front of Long Beach on Oak Island, North Carolina in September 1999. A prime example of successful hazard mitigation, the elevated home (right) survived while the older, ground-level block foundation of the home on the left was crushed.

Damage during hurricanes may also result from spawned tornadoes and inland flooding associated with heavy rainfall that usually accompanies these storms.

The National Oceanic and Atmospheric Administration's Hurricane Research Division has accumulated data from 1944 to 1999 that counts hits when a tropical storm or hurricane was within approximately 100 miles (165 km) of each location. That data show that all of the "named storms" make landfall in the southeastern or eastern United States, with none having significant effects on this part of the Country.

Hurricane/Tropical Storm Hazard in El Dorado County

Due to the nature of most hurricanes and tropical storms being a phenomenon of the southeastern/southern area of the United States, El Dorado County has never experienced major problems related to these hazards. There have been conditions related to tropical moisture originating from the more southerly parts of Pacific Ocean, known as "monsoons" or similar storms that bring humid air into the Sierra that can result in thunderstorms and intense rainfall. This could result in localized floods and those related hazards are discussed in the "Winter or Seasonal Storms" section of this document.

Avalanche

General Avalanche Hazard from National Perspective

An avalanche is a rapid flow of snow down a slope, from either natural triggers or human activity. Typically occurring in mountainous terrain, an avalanche can mix air and water with the descending snow. Powerful avalanches have the capability to entrain ice, rocks, trees, and other material on the slope; however avalanches are always initiated in snow, are primarily composed of flowing snow, and are distinct from mudslides, rock slides, rock avalanches, and serac collapses from an icefall. In mountainous terrain avalanches are among the most serious objective hazards to life and property, with their destructive capability resulting from their potential to carry an enormous mass of snow rapidly over large distances.

In the United States, 514 avalanche fatalities have been reported in 15 states from 1950 to 1997. Each year, avalanches claim more than 150 lives worldwide, a number that has been increasing over the past few decades. Thousands more are caught in avalanches, partly buried or injured. One of the major reasons for increasing avalanche fatalities is the boom in mountain industries and recreation. Skiing, hiking and other winter sports draw millions of people to the mountains. To support these activities, more roads, buildings, and towns are forced into avalanche prone areas.

Although avalanches can occur on any slope given the right conditions, in the United States certain times of the year and certain locations are naturally more dangerous than others. Wintertime, particularly from December to April, is when most avalanches will "run" (slide down a slope). However, avalanche fatalities have been recorded for every month of the year.

A large avalanche in North America might release 300,000 cubic yards of snow, the equivalent of 20 football fields filled 10 feet deep with snow. Slab avalanches are the most common and most deadly avalanches, where layers of a snowpack fail and slide down the slope. Since 1950, 235 people in the U.S. have been killed in slab avalanches.

Several factors may affect the likelihood of an avalanche, including weather, temperature, slope steepness, slope orientation (whether the slope is facing north or south), wind direction, terrain, vegetation and general snowpack conditions. Different combinations of these factors can create low, moderate or extreme avalanche conditions.

Avalanches are most likely to run either during or immediately after a storm where there has been significant snowfall. The 24 hours following a heavy snowstorm are the most critical. The extra weight of new snow alone can cause a slab to break off and fall down the slope. Snowfall amounts of one foot or more (frequent in mountainous areas) create the most hazardous situations, producing avalanches that are often large enough to block highways and cause major destruction. Snow amounts of six to twelve inches pose some threat, particularly to skiers and recreationists. Snow amounts less than six inches seldom produce avalanches.

Perhaps the most significant factor (but not the only one) is how the snowpack has developed over the season. Only the surface and maybe the top few layers of snow are visible, but layers of snow several feet deep may ultimately determine whether the slope will fail.

Snowpack conditions are extremely important because many layers of snow build up over the winter season. Each layer is built up under different weather conditions and will bond differently to the subsequent layers. Snowflakes, or snow crystals, within the snowpack eventually become more rounded due to melting/re-freezing and settlement. This metamorphism allows them to compress and generally form stronger bonds.

Between snows, the temperature may rise and melt the exposed surface layers, which when they re-freeze create a smoother, less stable surface for the next snowfall. Failure is much more likely to occur during or after the next few snowfalls. Rain between snows creates a slicker surface as well, and can weaken the bonds between snow layers.

Most avalanches occur on slopes between 30 and 45 degrees, but can occur on any slope angles given the right conditions. Very wet snow will be well lubricated with water, meaning it might avalanche on a slope of only 10 to 25 degrees

Avalanche Hazard in El Dorado County

Typically limited to the steeper slopes of the Sierra Nevada Mountains, the majority of the land in this "avalanche zone" is owned by the Federal Government. Private ownership development, when allowed, is done only after carefully considering appropriate setbacks from the known avalanche starting zones, tracks and runout zones. Generally the roadways running through this "avalanche zone" are also privately owned and therefore not a significant hazard for El Dorado County.

The above discussion concerning areas with potential avalanche hazard is limited to certain areas along the Eastern edge of the County in the higher elevations. There have been reported incidents of avalanches in isolated portions of the County, but this is a very uncommon occurrence with no defined history of significant damages. Although the above discussion shows that small portions of privately owned and potentially developable land and therefore roads of El Dorado County can include areas where avalanche could occur, it is not common to most areas.

Avalanche control along the mountain passes of Highway 50, the main east-west roadway through El Dorado County, is a 24-hour a day, seven-day a week job for Caltrans from November, when the first snow normally falls, until Spring. Caltrans monitors slope conditions determining when any particular slope is ripe for an avalanche. By triggering smaller, controlled avalanches, Caltrans reduces the potential for a large wall of snow from cascading down onto the highway, trapping motorists and causing injuries or deaths. These controlled "mini" avalanches are triggered by a projectile fired into the suspect slope from a LoCAT, a compressed air launcher, sending the unstable snow down the slope where Caltrans teams wait to clear the highway.

Terrorism

Terrorism is the calculated use of unlawful violence or threat of unlawful violence to inculcate fear; intended to coerce or to intimidate governments or societies in the pursuit of goals that are generally political, religious, or ideological. (FBI definition)

- Domestic terrorism is the unlawful use, or threatened use, of force or violence by a group or individual based and operating entirely within the United States or Puerto Rico without foreign direction committed against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof in furtherance of political or social objectives.
- International terrorism involves violent acts or acts dangerous to human life that are a violation of the criminal laws of the United States or any state, or that would be a criminal violation if committed within the jurisdiction of the United States or any state. These acts appear to be intended to intimidate or coerce a civilian population, influence the policy of a government by intimidation or coercion, or affect the conduct of a government by assassination or kidnapping. International terrorist acts occur outside the United States or transcend national boundaries in terms of the means by which they are accomplished, the persons they appear intended to coerce or intimidate, or the locale in which their perpetrators operate or seek asylum.

Terrorist events in the United States 2002-2005

In keeping with a longstanding trend, domestic extremists carried out the majority of terrorist incidents during this period. Twenty three of the 24 recorded terrorist incidents were perpetrated by domestic terrorists. With the exception of a white supremacist's firebombing of a synagogue in Oklahoma City, Oklahoma, all of the domestic terrorist incidents were committed by special interest extremists active in the animal rights and environmental movements. The acts committed by these extremists typically targeted materials and facilities rather than persons. The sole international terrorist incident in the United States recorded for this period involved an attack at the El Al ticket counter at Los Angeles International Airport, which claimed the lives of two victims.
Source-http://www.fbi.gov/publications/terror/terrorism2002_2005.htm#page_7

Terrorist events in El Dorado County

Possible Earth Liberation Front (ELF) action at Tahoe Ski Resort
On Tuesday, August 25, 2001 Authorities were called to investigate Heavenly Valley Ski Resort's new gondola in South Lake Tahoe after a 2x16-inch stick was found wired to a steel cable. Safety sensors that had been wired to the gondola cable were broken, and the letters ELF were formed with wire at the base of one of the support towers.

United States Forest Service Genetics Lab in Camino
In January 2006 three suspects were arrested by FBI agents for plotting to blow up the Forest Services Institute of Forest Genetics in Camino.

Two El Dorado County men arrested in December of 1999 by FBI.
Two anti- government militia members from El Dorado County were arrested by the FBI while planning to blow up a 24 million gallon liquefied propane storage facility located in Elk Grove.