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Planning scenario for a major earthquake on the San Jacinto Fault in the San Bernardino area Item Preview remove-circle Share or Embed This Item.

Review Denied March 4, By petition of mandate, two water districts, city and conservation district in consolidated action sought to challenge decision of real party in interest water district to drill and operate two "de-watering" wells, purpose of which would be to pump groundwater from saturated pressure zone in aquifer under city. The trial court had granted preliminary injunction enjoining drilling of two wells and subsequently granted motion to dissolve injunction. The Court of Appeals granted stay of order dissolving injunction and issued alternative writ. The Court of Appeal, Campbell, P. John Woodhead, City Atty. No appearance for respondent. Cahill and Alan F. Ciamporcero, Sacramento, James W. Varner and John Nolan, San Bernardino, for real party in interest. The sole purpose of these wells would be to pump groundwater from the saturated pressure zone in the aquifer beneath the City of San Bernardino and then to discharge it into the Santa Ana River channel. Respondent trial court granted a preliminary injunction enjoining the drilling of the two wells and subsequently heard an extended motion to dissolve the injunction. The trial court heard evidence from one witness on each side, and reviewed the record. The court granted the motion to dissolve on March 31, , whereupon Western and all other petitioners came to this court for review of the order by petition for writ of mandate. The petition for the peremptory writ is now before us for disposition. This compaction forces the water upward and creates a top layer of virtual quicksand into which overlying structures may topple. The water table underlying a 10, acre area in San Bernardino County has been rising to the extent that in the event of a major earthquake, liquefaction might occur. Concern for liquefaction in an area containing public facilities and about half the population of the City of San Bernardino motivated SBVMWD to authorize the two dewatering wells. The Bunker Hill Basin, site of the rising water table, is an aquifer of approximately square miles which lies beneath the San Bernardino Valley and is bounded by two active earthquake faults, the San Jacinto and the San Andreas. The basin contains porous, alluvial soils to a depth of 1, feet. Soil tests, undertaken from to , have determined that these soils are particularly vulnerable to liquefaction if jarred and compressed during an earthquake. The magnitude of the potential danger from liquefaction rises when there is an increase in water saturation of the soil. There is no dispute that the groundwater was high in and In , a Scientific American article stated that an earthquake of 8. Real party concedes that it would take about six years using these two proposed wells to remove the 75, acre feet of water necessary to mitigate the perceived danger entirely. Nevertheless, according to real party, lowering the groundwater in any amount would significantly reduce the liquefaction threat. The parties hotly dispute this issue, but petitioners point to evidence showing that contaminated plumes of groundwater, which have already forced the closure of 11 wells in the basin, might be drawn into the domestic water supplies if the dewatering wells were drilled and operated. The trial court considered this pollution potential an "item [of] valid concern. In so doing, real party disregarded the recommendation of its own consultant, who, on June 17, , recommended that "a focused Environmental Impact Report EIR be prepared to address only the significant issues and concerns listed In opposition, real party parenthetically asserts unclean hands and statute of limitations defenses against Western. In addition, real party challenges the availability of mandate relief. City of Los Angeles v. Superior Court 51 Cal. Superior Court 28 Cal. Section in pertinent part provides: It is well established that CEQA is "to be interpreted Board of Supervisors 8 Cal. Local Agency Formation Com. The trial court recognized this principle of construction for CEQA, stating that the issue of statutory construction encompassed "the crux of the conflict. It is the courts of this state, not the parties, which have the obligation of interpreting statutes. City of Berkeley 65 Cal. As the Supreme Court stated in Bodinson, supra: It is likewise true that the administrative interpretation of a statute will be accorded great respect by the courts and will be followed if not clearly erroneous. In the context of CEQA, therefore, courts have defined the meaning of such terms as "project" and "on-going project," despite previous, conflicting administrativeinterpretations. See Friends of Mammoth, supra, 8 Cal. Yorty, 32 Cal. The "emergency" exception of section , subdivision b 4 is obviously extremely narrow. We particularly note that the definition limits an emergency to an "occurrence," not a condition, and that the occurrence must involve a "clear and imminent danger, demanding immediate action. The theory behind these exemptions is that if a project arises for which the lead agency simply cannot complete the requisite paperwork within the time constraints of CEQA, then pursuing the project without complying with the EIR requirement is justifiable. For example, if a dam is ready to burst or a fire is raging out of control and human life is threatened as a result of delaying a project decision, application of the emergency exemption would be proper. Loopholes in Need of Amendment? Although SBVMWD urges that "CEQA, including its environmental impact report requirements, shall not apply to specific actions necessary to prevent or mitigate earthquakes or other soil or geological movements," this interpretation is unsupported by the text of the exemption. Such a construction completely ignores the limiting ideas of "sudden," "unexpected," "clear," "imminent" and "demanding immediate action" expressly included by the Legislature and would be in derogation of the canon that a construction should give meaning to each word of the statute. See Pacific Legal Foundation v. Moreover, in the name of "emergency" it would create a hole in CEQA of fathomless depth and spectacular breadth. Indeed, it is difficult to imagine a large-scale public works project, such as an extensive deforestation project or a new freeway, which could not qualify for emergency exemption from an EIR on the grounds that it might ultimately mitigate the harms attendant on a major natural disaster. The result could hardly be intended by the careful drafting of the Legislature, and is unmistakably opposed to the policy of construing CEQA to afford the maximum possible protection of the environment. Judicial review of an agency decision under CEQA is governed by sections and City of Los Angeles 13 Cal. Moreover, footnote 6 of No Oil also establishes that where "the trial court has received additional evidence [as in the case at bench], the question before it is whether substantial evidence on the whole record, including the evidence presented to it, supports the determination that no EIR was required. Board of Supervisors Cal. Abuse of discretion is established if the agency has not proceeded in a manner required by law or if the determination or decision is not supported by substantial evidence. Superior Court Cal. City of Hayward Cal. The parties in this matter have focused on whether the evidence in the record supports a fair argument the project would have a significant environmental impact or whether there need be only substantial evidence of such an impact. However, the question of impact is irrelevant to the emergency exemption. The substantial evidence inquiry prescribed by section Stated differently, we conclude that where an agency seeks to avoid an EIR under section , subdivision b 4 , a reviewing court on petition for mandate must determine if there exists substantial evidence in the record to support the agency finding of an emergency. We observe that the emergency exemption differs from the negative declaration procedure in that there is no statutory requirement of a preliminary study attending an agency decision to use the exemption. However, our review discloses no substantial evidence that liquefaction is an imminent danger or that it demands immediate action. Indeed, although the court did not explicitly articulate a construction of the statute, it concluded, "if I were deciding from the record, I would say that [the record] does not support a finding of emergency. FN3 The trial court explained: The present cycle has been with us for five years, going on six. And the potential for severe seismic activity has been with us for quite awhile. Ever since the last big earthquake, I guess, they have been expecting the next one. But in any case, it is going forward. And that really is what the concern is about here, as I read the record. It was that set of circumstances, along with the evaluation of the potential damage because of extensive construction, if you will forgive me, [that] got [real party] excited. The generalities of its conclusions and the absence of conclusions regarding imminence are qualified, viz.: We would expect shaking strong enough to induce liquefaction to occur several times [in the entire Los Angeles region] but at different sites in a toyr time span, perhaps once every 6 to 8 yr somewhere within the region. The study concluded that liquefaction would occur in a large earthquake at many sites in San Bernardino. Conclusions regarding liquefaction in downtown San Bernardino included, for instance, "seismic shaking levels of less than 0. A year return rate is mathematically equivalent to an annual likelihood of 1. FN4 We are also aware of the declaration of Herbert Wessel, which asserts, "In my opinion, the high groundwater levels currently pose an emergency situation related to the occurrence of flooding, earthquake or other related geologic movements We hold that this evidence, even in aggregation, does not amount to substantial evidence of a "clear and imminent danger, demanding immediate action" as the exemption requires. Let a peremptory writ of mandate issue directing the court to vacate its order, and to enter a new and different order denying the motion to dissolve the preliminary injunction, consistent with the views expressed herein. The alternative writ is discharged. Assigned by the Chairperson of the Judicial Council.

Chapter 2 : Section Geologic Problems

Planning scenario for a major earthquake on the San Jacinto Fault in the San Bernardino area by Tousson R. Toppozada. Published by California Dept. of Conservation, Division of Mines and Geology in Sacramento, Calif. (K Street, MS , Sacramento).

The ranges are very rugged with high local relief and consist of folded and faulted sedimentary rocks to the west and block-faulted igneous and metamorphic rocks to the east. The ranges increase in elevation from west to east, from 4, feet in the Santa Ynez Mountains to over 11, feet in the San Bernardino Mountains. The Peninsular Ranges are north-northwest trending ranges with rugged, block-faulted granitic plutons dipping to the west. The ranges have characteristically high local relief and reach over 10, feet elevation in the San Jacinto Mountains at their northern edge, terminating just south of the San Bernardino Mountains. The plain is wedge shaped, with its apex inland to the east, and is about 20 miles north-to-south along the coast, and 20 miles from its apex to the coast. The plain consists of Late Quaternary and Holocene alluvium deposited by the Santa Clara and Calleguas Rivers and is currently divided between agricultural and urban land uses. The power plant sites are located on several hundred feet of Late Quaternary alluvium and Holocene beach and dune sand deposits and tidal marshes. These stream systems drain the eastern Transverse Ranges and northern Peninsular Ranges. The coastal stations that use ocean cooling waters are located predominantly on Holocene dune sand deposits and other very recent, unconsolidated alluvium that is up to several hundred feet in depth. A network of mostly northwest-trending faults traverse the basin until they transect the Santa Monica-Raymond Hill Fault that trends west along the southern margin of the Santa Monica Mountains. The Palos Verdes and the Foothill Faults define the southwestern and northeastern boundaries of the basin, respectively. The geology of the Los Angeles area is comprised of igneous and metamorphic Mesozoic crystalline basement to the east, Mesozoic-Tertiary pre-basin sedimentary rock, and Late Quaternary basin fill deposits. Late Cretaceous and Lower Miocene sedimentary deposits overlie the crystalline basement rocks. The Palos Verdes Hills consist of upfaulted metamorphic Catalina schist. Uplift and erosion, followed by renewed subsidence, led to marine deposition during the Miocene, Pliocene, and Pleistocene. As the basin filled, the surface rose above sea level and terrestrial deposition followed the receding shoreline southward. These alluvial and colluvial deposits are complexly interbedded sequences of clays, silts, sands, and gravels. Basement rocks are mostly metamorphic dating from Precambrian to younger, but also including granite rocks and volcanics. Intense deformation of the rocks occurred in the late Mesozoic and early Cenozoic with faulting in the tertiary to the present. The area is characterized by low block-faulted mountains interspersed with wide alluvial aprons. The Mojave Desert lacks thorough drainage, so that closed basins are formed in series over deep alluvial sediments. Regional Seismicity Southern California as a region is considered very seismically active. The California Division of Mines and Geology considers a fault segment active if it has experienced a displacement in the historical record last years or during the Holocene last 11, years. A fault segment is considered potentially active if there is evidence of a displacement during the Late Quaternary last , or the Quaternary last 1. Only one power plant, Alamitos, is located adjacent to an Alquist-Priolo Earthquake Hazard Zone earthquake fault zone, or EFZ , which is a designated active fault area prone to surface rupture, usually within 0. However, the regional network of designated Alquist-Priolo EFZs, and other active and potentially active faults place virtually all of Southern California at risk due to ground shaking, liquefaction, and other seismic hazards associated with major earthquake events. In general, the coastal power plants are located in areas more prone to liquefaction, lateral spreading, and intense shaking during an earthquake due to their location on unconsolidated sediments with shallow depths to groundwater. The coastal plants are also situated in tsunami hazard zones due to their low-lying oceanside locations. Much of the Los Angeles Basin and Coastal Plain and the Santa Barbara Channel offshore are underlain with a series of unmapped blind thrust faults that have no surface trace and can generate earthquakes of magnitude M 6. All these faults can generate earthquakes of magnitudes over 7. Within the Transverse Ranges, a series of smaller east-west-trending fault systems can generate major earthquakes with magnitudes on the order of 6. These tables should not be interpreted as the degree of risk of earthquake damage at any given site. Historical displacement along a fault is generally interpreted as the activity status of the fault but is not a direct indicator of potential future displacements. The selection of any 12 random points in Southern California could generate data similar to those in Tables 4. Proximity to an earthquake epicenter and the magnitude of the earthquake are only approximately related to the damage a structure incurs during an earthquake. The type, direction, and wavelength of the motion generated by the earthquake will have differential effects on structures located at a site. Also, the site-specific geologic setting is important for the transmission and amplication of shock waves. The underlying texture, depth, moisture content, and degree of consolidation of the bedrock or alluvium of the site and the depth to the water table are important site-specific influences on ground-shaking motions. Moreover, building construction and design are key site-specific factors in assessing risk from ground shaking. Most thermal electric generating plants in Los Angeles and Orange Counties are constructed to withstand lateral forces double that required for other structures. Relative to other structures, power plants are expected to behave very well in the strong ground motions of a major earthquake. Power plants are expected to suffer minimal or slight damage: In a Division of Mines and Geology planning scenario for a M 8. At all of the sites, it is estimated that damage would limit energy production for a maximum of only four to five days. All power plants under study are built to meet or exceed the Uniform Building Code standards in place at the time of their construction, which provide for earthquake- and other geologically-induced loading. Only one station Cool Water has been damaged by an earthquake, and the damage was minor and did not disrupt power generation. The coastal plain is a nearly flat to gently sloping alluvial fan surface of mixed, deep Quaternary sediment deposited by the Los Angeles, San Gabriel, and Santa Ana Rivers. The sediment sources are the largely sedimentary and igneous rocks of the eastern Transverse Ranges and northern Peninsular Ranges. The Alamitos power plant is adjacent to the estuarine reach of the San Gabriel River channel, approximately one mile inland from where the river enters San Pedro Bay. The San Gabriel River eroded the Alamitos water gap through Miocene and Pliocene age marine sediments during the Pleistocene, when sea levels were lower and stream competence greater. The gap was backfilled with Holocene alluvial floodplain, lagoonal, and tidal marsh deposits. The Alamitos power plant is situated on the recent, poorly consolidated sediments. The area is considered to have a high liquefaction and ground failure potential in a major earthquake. Geologic Hazards The southwest corner of the station property the corner of Westminister and Studebaker is within feet of the Seal Beach segment of the Newport-Inglewood Fault, a designated Alquist-Priolo. The fault trace trends northwest, roughly parallel to the coastline, to the west and southwest of the station. All of the generating units are within 0. Alamitos power plant is located four and seven miles east of active segments of the Palos Verdes and Cabrillo Faults, respectively. Cool Water Geologic Setting The Cool Water power plant is located on undifferentiated Holocene alluvium on a broad, gently sloping, slightly convex alluvial fan and river terrace. The terraces are above the Mojave River channel, which is approximately two miles north of the generating units. The low-lying fan surface is situated in a region of northwest-trending downfaulted basins and upfaulted mountain ranges. To the south and east, the ranges consist of largely Cretaceous and Jurassic quartz monzonite and granite, with some Mesozoic metavolcanic and basaltic rocks. To the north, the ranges consist of mostly nonmarine sedimentary rocks. The basins contain several hundred feet of Pleistocene and Holocene alluvium and Pleistocene lake deposits. Cool Water Station is situated on several hundred feet of sandy alluvial deposits interbedded with clay and silt lenses. The groundwater table occurs at a depth of feet, and the groundwater is of good quality. There is a low shrink-swell potential. The rapid infiltration capacity poses severe limits to pond or reservoir development. The soil characteristically has very rapid permeability 6. The sandy texture of the soil renders slopes and banks unstable. Geologic Hazards An unnamed fault 10 miles east near Troy Lake was the site of several earthquakes in The station is located on unconsolidated alluvium, which carries greater risks to ground shaking and other seismic hazards related to earthquakes. The risks of liquefaction may be somewhat moderate, however, due to great depth to the groundwater table. Ellwood Geologic Setting The Ellwood power plant is situated approximately feet above sea level on Quaternary, nonmarine, dissected alluvial terraces. The seacliffs south of the station consist of middle Miocene marine sediments, and the foothills of the Santa Ynez Mountains to the north consist of Oligocene nonmarine sedimentary rocks. The Santa Ynez Mountains are mostly Eocene marine sedimentary rocks. The Ellwood power plant is located on the Milpitas-Positas-Concepcion soil association, which is characteristically on nearly level to steep, moderately well-drained fine sandy loams on terraces. There are medium levels of runoff and moderate levels of drainage and erosion hazards. These soils are used for urban development, range, and orchard crops. Erosion and gullying can be a serious hazard where the top layer has been removed and the clay layer is exposed at the surface. There may be severe limitations to shallow excavations, the construction of small buildings without basements, and road construction because the very clayey subsoil has a high shrink-swell capacity and low strength. Geologic Hazards The station is located within 0. A fault evaluation report concluded that the fault is not sufficiently active nor well defined to warrant its zoning as an EFZ. The coastal plain is a nearly flat to gently sloping alluvial fan surface of mixed, deep Quaternary sediment deposited by the Los Angeles, San Gabriel, Ballona, and Santa Ana Rivers. The sediment sources are the largely sedimentary and igneous rocks of the eastern Transverse Ranges, such as the Santa Monica and San Gabriel Mountains. ESGS is approximately five miles south of the Ballona Rivermouth and eight miles north of the Wilmington anticline axis, which trends west-northwest from San Pedro Harbor and enters Santa Monica Bay approximately one mile south of the station. The El Segundo power plant is located on graded Holocene dune and beach sand deposits. The soils generally consist of fine- to medium-grain sands. The groundwater table occurs at mean sea level, which is approximately 30 feet below the graded surface of the site. The station is situated on Holocene dune sand deposits, immediately inland of the high tide line and active beach sand depositional and erosional areas. The young, unconsolidated dune sand deposits along the shore of Santa Monica Bay on which the station is situated have been identified as having a high liquefaction potential associated with ground shaking during an earthquake. Historical aerial photographs show that significant beach erosion has occurred since the construction of the station in the early s. The plant is not within this zone. Etiwanda Geologic Setting The Etiwanda power plant is located at approximately 1, feet elevation on Pleistocene alluvial fan deposits and recent Holocene wash deposits up to 1, feet in depth. The station is located approximately midway up broad coalescing gently south-sloping alluvial fans at the base of the San Gabriel Mountains, which rise sharply to the north of the station to elevations over 10, feet. The soils are generally well-graded sand and gravelly-sand to a depth of 40 feet. The San Gabriel Mountains consist mostly of plutonic granitic rocks, especially Cretaceous granites and quartz diorites. Large bodies of metasedimentary rocks, Black Belt Mylonite, and other high-grade metamorphic rocks also are prominent in the San Gabriel Mountains. The range is toward the southeastern extension of the Transverse Ranges, and its eastern terminus is at the confluence of the San Andreas and San Jacinto Fault Zones. The Etiwanda power plant is located on Hanford series coarse sandy loam and Tujunga series loamy sand, of the Hanford-Greenfield-San Emigdio and Tujunga Soboba Associations, respectively.

Chapter 3 : San Jacinto Fault Zone - Wikipedia

Full text of "Planning scenario for a major earthquake on the San Jacinto Fault in the San Bernardino area" See other formats.

Seismic Evaluation and Retrofit of Concrete Buildings. Existing Buildings Program Action Plan Seattle Fault Earthquake Scenario. Louis, MO, April Planning for Postdisaster Resiliency. Achieving sustainable development, mitigation and equity. Public-interest research and development in the electric and gas utility industries. Leson, II, and R. Political, Economic and Social Aspects of Katrina. Southern Economic Journal A framework to quantitatively assess and enhance the seismic resilience of communities. The diffusion of fear: Modeling community response to a terrorist strike. The Journal of Defense Modeling and Simulation: Applications, Methodology, Technology 4: Toward a Common Framework for Community Resilience. Planning Scenario for a Magnitude 8. Planning Scenario for a Magnitude 7. Page Share Cite Suggested Citation: Research, Implementation, and Outreach. The National Academies Press. Measuring improvements in the disaster resilience of communities. Transportation security and the role of resilience: A foundation for operational metrics. Cascadia Subduction Zone Earthquakes: Oregon Department of Geology and Mineral Industries. Geological Survey Open-File Report Demonstration of earthquake early warning using total displacement waveforms from real-time GPS networks. Seismological Research Letters 80 5: The Regionalization of Hazards and Disasters. Social vulnerability to environmental hazards. Social Science Quarterly Community and regional resilience: Perspectives from hazards, disasters, and emergency management. Oak Ridge National Lab. A place-based model for understanding community resilience to natural disasters. Global Environmental Change Disaster resilience indicators for benchmarking baseline conditions. Journal of Homeland Security and Emergency Management 7: Department of Homeland Security , National Infrastructure Protection Program. National Infrastructure Protection Plan: Partnering to Enhance Protection and Resiliency. Department of Homeland Security. The Human Side of Disaster. EarthScope Facility Operation and Maintenance: October 1, â€"September 30, Proposal to the National Science Foundation. Scenario for a 7. Defining Issues for an Action Plan. Securing Society against Catastrophic Earthquake Losses: Scenario for a Magnitude 6. Market insurance, self insurance and self protection. Journal of Political Economy National Oceanic and Atmospheric Administration. A bill to provide incentives to encourage private sector efforts to reduce earthquake losses, to establish a natural disaster mitigation program, and for other purposes. Presented to the Committee on Finance. Government Printing Office, pp. Techniques for the Seismic Rehabilitation of Existing Buildings. Quantification of Building Seismic Performance Factors. Weldon II, and C. Defying terrorism and mitigating natural resources. Open File Report Seismological Research Letters Fast and frugal heuristics: The tools of bounded rationality. Little, Brown and Company. Natural Hazards Review 4: Estimating the value of foresight: Aggregate analysis of natural hazard benefits and costs. Journal of Environmental Planning and Management Comparative approaches for assessing network connectivity and vulnerability. International Regional Science Review On the definition of resilience in system. Fujita and Ogawa revisited: Environment and Planning B: Planning and Design Monitoring Ground Deformation from Space. Live better by consuming less? Journal of Industrial Ecology 9: A study of the U. Geological Survey Open File Report 91â€" Seismological Society of America State of Knowledge and Guidelines for Implementation. Estimation of lifeline resilience factors based on empirical surveys of Japanese industries. Earthquake early warning in Japan: Warning the general public and future prospects. Seismology Research Letters When the Big One strikes againâ€"estimated losses due to a repeat of the San Francisco earthquake. Disasters are non-routine social problems. International Journal of Mass Emergencies and Disasters Organizational adaptation to disaster. Van den Bulte, Risk Analysis for Extreme Events: Economic Incentives for Reducing Future Losses. National Institute of Standards and Technology. Equity and justice in global warming policy. International Review of Environmental and Resource Economics 2 2: A Bayesian approach to the real-time estimation of magnitude from the early P and S wave displacement peaks.

Chapter 4 : Earthquake Scenario Publications

Additional Physical Format: Online version: Toppozada, Tousson R. Planning scenario for a major earthquake on the San Jacinto Fault in the San Bernardino area.

The red lines are simplified faults. Right-lateral direction of motion of the transform fault is shown pink arrows. The red rhombs are pull-apart basins ; the northern one is the site of the Niland geothermal field , the southern the Cerro Prieto geothermal field. The southern segment also known as the Mojave segment begins near Bombay Beach, California. Box Canyon, near the Salton Sea , contains upturned strata associated with that section of the fault. These mountains are a result of movement along the San Andreas Fault and are commonly called the Transverse Range. In Palmdale , a portion of the fault is easily examined at a roadcut for the Antelope Valley Freeway. This restraining bend is thought to be where the fault locks up in Southern California , with an earthquake-recurrence interval of roughly â€" years. Northwest of Frazier Park, the fault runs through the Carrizo Plain , a long, treeless plain where much of the fault is plainly visible. The Elkhorn Scarp defines the fault trace along much of its length within the plain. The southern segment, which stretches from Parkfield in Monterey County all the way to the Salton Sea , is capable of an 8. Such a large earthquake on this southern segment would kill thousands of people in Los Angeles, San Bernardino, Riverside, and surrounding areas, and cause hundreds of billions of dollars in damage. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed. December Learn how and when to remove this template message The Pacific Plate , to the west of the fault, is moving in a northwest direction while the North American Plate to the east is moving toward the southwest, but relatively southeast under the influence of plate tectonics. The rate of slippage averages about 33 to 37 millimeters 1. The effect is expressed as the Coast Ranges. The northwest movement of the Pacific Plate is also creating significant compressional forces which are especially pronounced where the North American Plate has forced the San Andreas to jog westward. This has led to the formation of the Transverse Ranges in Southern California, and to a lesser but still significant extent, the Santa Cruz Mountains the location of the Loma Prieta earthquake in Studies of the relative motions of the Pacific and North American plates have shown that only about 75 percent of the motion can be accounted for in the movements of the San Andreas and its various branch faults. The reason for this is not clear. Several hypotheses have been offered and research is ongoing. One hypothesis â€" which gained interest following the Landers earthquake in â€" suggests the plate boundary may be shifting eastward away from the San Andreas towards Walker Lane. Assuming the plate boundary does not change as hypothesized, projected motion indicates that the landmass west of the San Andreas Fault, including Los Angeles, will eventually slide past San Francisco, then continue northwestward toward the Aleutian Trench , over a period of perhaps twenty million years. Formation[edit] Tectonic evolution of the San Andreas Fault. The San Andreas began to form in the mid Cenozoic about 30 Mya million years ago. As the relative motion between the Pacific and North American Plates was different from the relative motion between the Farallon and North American Plates, the spreading ridge began to be "subducted", creating a new relative motion and a new style of deformation along the plate boundaries. These geological features are what are chiefly seen along San Andreas Fault. It also includes a possible driver for the deformation of the Basin and Range , separation of the Baja California Peninsula , and rotation of the Transverse Range. The main southern section of the San Andreas Fault proper has only existed for about 5 million years. This system added the San Gabriel Fault as a primary focus of movement between 10â€"5 Ma. Currently, it is believed that the modern San Andreas will eventually transfer its motion toward a fault within the Eastern California Shear Zone. Early years[edit] The fault was first identified in Northern California by UC Berkeley geology professor Andrew Lawson in and named by him after the Laguna de San Andreas , a small lake which lies in a linear valley formed by the fault just south of San Francisco. Eleven years later, Lawson discovered that the San Andreas Fault stretched southward into southern California after reviewing the effects of the San

Francisco earthquake. Large-scale hundreds of miles lateral movement along the fault was first proposed in a paper by geologists Mason Hill and Thomas Dibblee. This idea, which was considered radical at the time, has since been vindicated by modern plate tectonics. Following recorded seismic events in , , , , , and , scientists predicted that another earthquake should occur in Parkfield in It eventually occurred in Due to the frequency of predictable activity, Parkfield has become one of the most important areas in the world for large earthquake research. An array of sensors will be installed to record earthquakes that happen near this area. In particular, scientific research performed during the last 23 years has given rise to about 3, publications. Moreover, the risk is currently concentrated on the southern section of the fault, i. According to this study, a massive earthquake on that southern section of the San Andreas fault would result in major damage to the Palm Springs - Indio metropolitan area and other cities in San Bernardino , Riverside and Imperial counties in California, and Mexicali Municipality in Baja California. Older buildings would be especially prone to damage or collapse, as would buildings built on unconsolidated gravel or in coastal areas where water tables are high and thus subject to soil liquefaction. The information available suggests that the fault is ready for the next big earthquake but exactly when the triggering will happen and when the earthquake will occur we cannot tell [The ability to predict major earthquakes with sufficient precision to warrant increased precautions has remained elusive. That study predicted that a magnitude 7. Scientists believe quakes on the Cascadia subduction zone may have triggered most of the major quakes on the northern San Andreas within the past 3, years. The evidence also shows the rupture direction going from north to south in each of these time-correlated events. However the San Francisco earthquake seems to have been the exception to this correlation because the plate movement was moved mostly from south to north and it was not preceded by a major quake in the Cascadia zone. List of earthquakes in California The San Andreas Fault has had some notable earthquakes in historic times: Though it is known as the Fort Tejon earthquake, the epicenter is thought to have been located far to the north, just south of Parkfield. Two deaths were reported. The magnitude was about 7. The epicenter was near San Francisco. At least 3, people died in the earthquake and subsequent fires. The magnitude was estimated to be 7. Moment magnitude was about 6. This quake occurred on October 17, , at approximately 5: On September 28, at PDT, a magnitude 6. It was felt across the state, including the San Francisco Bay Area.

Chapter 5 : Model suggests San Andreas earthquake may have been set off by San Jacinto quake

The San Andreas historically has produced stronger earthquakes than the San Jacinto. But it's farther away from major development than the San Jacinto fault, which runs through San Bernardino.

The group consisted of more than three dozen seismologists, including Keiiti Aki and C. The paper was the third in a series of reports that was set in motion following the Landers earthquake in southern California with the intention of updating the data and the approach for calculating the probabilities for large earthquakes along the southern San Andreas and San Jacinto Fault zones. Both these fault zones were grouped together as having adequate paleoseismic data to assign conditional probabilities for future damaging earthquakes. The group then added the Coyote Creek and Superstition Mountain segments, defined the Anza segment to include the Clark and Casa Loma faults, and updated the slip rates for each segment. A series of moderate earthquakes affected this area in the s, though it is uncertain how many of these occurred specifically on the SJFZ. The Claremont strand has not had a major earthquake in the instrumental period, but paleoseismology indicates that its last surface rupturing event occurred in the early 19th century, and that comparable earthquakes occur on average of every to years. The Clark strand, which is separated from the Casa Loma by a small compressional step in the city of Hemet , continues southeastward out of the valley. This area was heavily damaged by the historic earthquakes of and The event is thought to have occurred within the valley, likely on the Casa Loma strand, while the event has been identified on the Clark strand between Hemet and Anza. A paleoseismic investigation on this segment at Hog Lake indicated three historical surface-rupturing events occurred around , , and with an average recurrence period for a magnitude 7. On November 23, the Working Group determined that the available information was still not adequate to assign year probabilities. On November 24, the fault ruptured, along with an unknown fault later named the Elmore Ranch fault. A trench investigation by Larry Gurrola and Thomas Rockwell near the north shore of ancient Lake Cahuilla dated the events to â€" By studying several moderate events and their aftershocks that occurred in 4. Were the entire fault segment to rupture in a single event, this newly modified length limited the potential of the segment to generate a magnitude 6. However, if the slip were to extend out of the Anza area, the earthquake could be up to, but not larger than 7. These events began with the San Jacinto earthquake and occurred at intermittent intervals culminating with the Superstition Hills and Elmore Ranch events. In a paper published in the journal Science , Christopher Sanders plotted the earthquakes of the SJFZ by time and location and found that a uniform pattern became apparent. One house was split apart in Ocotillo Wells with one bedroom becoming detached from the rest of the home. Taller buildings swayed in both Los Angeles and San Diego and power outages affected numerous areas, primarily in the cities of Imperial Valley. Power failures along with disruption to telephone service caused problems in the Hemet Valley area, and smaller power outages in Los Angeles and Orange Counties also occurred. A brick wall collapsed at a laundromat in Westmorland in the El Centro Metropolitan Area but no one was injured, and in the seaside neighborhoods of San Diego county several hundred windows were broken. The mainshock occurred at 6: Brawley Seismic Zone Two earthquakes in late November caused property damage totaling three million in Imperial County. The two events were separated by eleven hours and were located in the western Imperial Valley on the Superstition Hills Fault and a previously unknown fault. Damage in Westmoreland, Imperial, and El Centro consisted of collapsed chimneys, broken windows, and damaged highways. The Worthington Road bridge, at the New River , failed due to liquefaction and at the Desert Test Range Control Center, water tanks toppled into the building and other equipment crashed through a window. Activities were suspended there for several days due to the damage. On the Mexican side of the border, 50 injuries and two deaths were reported, and 44 were treated for their injuries in California. According to the spokesperson for the state of Baja California , a motor vehicle accident east of Mexicali that claimed the lives of a mother and her four-year-old son was blamed on the earthquake. Heaton , a USGS seismologist, stated that the faults in the area are difficult to track down because of the sediment deposited in the valley, which had been an intermittent drainage basin of the Colorado River. To the northeast are several cross faults that trend northeast. One of these faults ruptured during a large aftershock of the event and another slipped as the smaller of the two shocks during the November sequence. The first shock on what became known as the Elmore Ranch fault measured 6.

Chapter 6 : San Andreas Fault - Wikipedia

SP - - Planning Scenario for a Major Earthquake on the San Jacinto Fault in the San Bernardino Area - Toppozada, T.R., Borchardt, G., & Hallstrom, C.L. The proposed effects of a magnitude 7 earthquake along the San Jacinto Fracture Zone.

Chapter 7 : WESTERN MUN. WATER DIST. OF RIVERSIDE COUNTY v. SUPERIOR COURT

Planning scenario for a major earthquake on the San Jacinto Fault in the San Bernardino area by Tousson R. Toppozada, Glenn A. Borchardt, Claudia L. Hallstrom starting at $ Planning scenario for a major earthquake on the San Jacinto Fault in the San Bernardino area has 0 available edition to buy at Alibris.

Chapter 8 : Precariously balanced rocks suggest San Jacinto, San Andreas may have ruptured together

The NI fault is chosen for several reasons: it hosted the M Long Beach earthquake in (Hauksson and Gross,), causing serious damage in LA, and it is still considered the most probable.

Chapter 9 : A case for historic joint rupture of the San Andreas and San Jacinto faults

Back in a major earthquake struck southern California near what is now San Bernardinoâ€"modern study of damage from the quake suggested it was approximately a magnitude quake.