PB85-223642

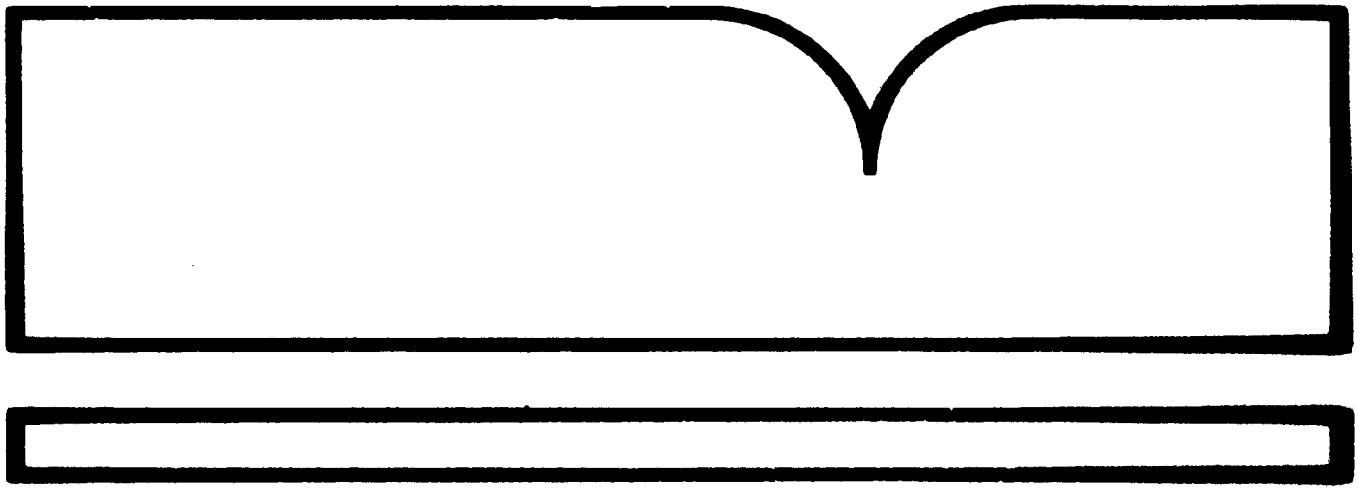
Earthquake Preparedness in the San Francisco Bay Region: An Inventory and Assessment of Current Programs and Activities and Recommendations for Future Comprehensive Earthquake Preparedness Projects

Bay Area Earthquake Study, Oakland, CA

Prepared for

California Seismic Safety Commission, Sacramento

Sep 84



BIBLIOGRAPHIC INFORMATION

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PERFORMER: Bay Area Earthquake Study, Oakland, CA.

SPONSOR: California Seismic Safety Commission, Sacramento.

Sponsored by Federal Emergency Management Agency, Washington, DC.

The report presents the findings of the needs assessment conducted. It includes a documentation and analysis of historic and current planning and preparedness activities in the Bay Region, and recommendations for programs and activities to support and upgrade the status of earthquake preparedness planning and response capability.

KEYWORDS: *State government, *Earthquakes, *Civil defense.

Available from the National Technical Information Service, SPRINGFIELD, VA. 22161

PRICE CODE: PC A07/MF A01

EARTHQUAKE PREPAREDNESS IN THE SAN FRANCISCO BAY REGION

An Inventory and Assessment of Current Programs and Activities

and

Recommendations for Future Comprehensive Earthquake Preparedness Projects

A Report by the

Bay Area Earthquake Study
California Seismic Safety Commission

in cooperation with

The Office of Emergency Services
and
The Department of Conservation, Division of Mines and Geology

September, 1984

THE BAY AREA EARTHQUAKE STUDY

Richard K. Eisner, AIA, AICP
Project Director

Larry Garrett
Emergency Services Coordinator
State Office of Emergency Services

Edward J. Bortugno, RG, CEG
Associate Geologist
California Division of Mines & Geology

Paula A. Schulz
Planning Officer
Southern California Earthquake
Preparedness Project
Liaison to BAES

Gertrude Holt
Secretary

BAES wishes to acknowledge the contribution to this work of the many local and state officials who participated in interviews. We are also indebted to the staffs of the Southern California Earthquake Preparedness Project, the California Seismic Safety Commission, the Office of Emergency Services, and the Division of Mines and Geology for their support of the Bay Area Earthquake Study.

We wish to specifically acknowledge the contributions of the following persons:

CALIFORNIA SEISMIC SAFETY COMMISSION

Dr. Bruce Bolt, Chairman 1984

Stanley Scott, Chairman 1981-1984

Kenneth Blackman

Richard A. Andrews, Executive Director

Paul J. Flores, Project Director
Southern California Earthquake Preparedness Project

OFFICE OF EMERGENCY SERVICES

John J. Kearns, Assistant Director, Plans and Preparedness

James J. Watkins, Chief, Preparedness Division

Jane Victoria Hindmarsh, Coordinator, Earthquake Programs

DIVISION OF MINES AND GEOLOGY

James Davis, Director and State Geologist

John Bennett, Associate Geophysicist

Brian Tucker, Geophysics Officer

Charles Real, Senior Seismologist

ASSOCIATION OF BAY AREA GOVERNMENTS

Revan A. F. Tranter, Executive Director

Jeanne Perkins, Manager, Earthquake Preparedness Program

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Origins of the Bay Area Earthquake Study

In September 1983 the California Seismic Safety Commission (SSC) entered into a Cooperative Agreement with the Federal Emergency Management Agency (FEMA), Region IX, to undertake a study of earthquake preparedness activities in the nine-county San Francisco Bay Region to "foster...comprehensive earthquake preparedness planning at the regional and local level in the Bay Area."

To meet this goal, the following objectives have been identified:

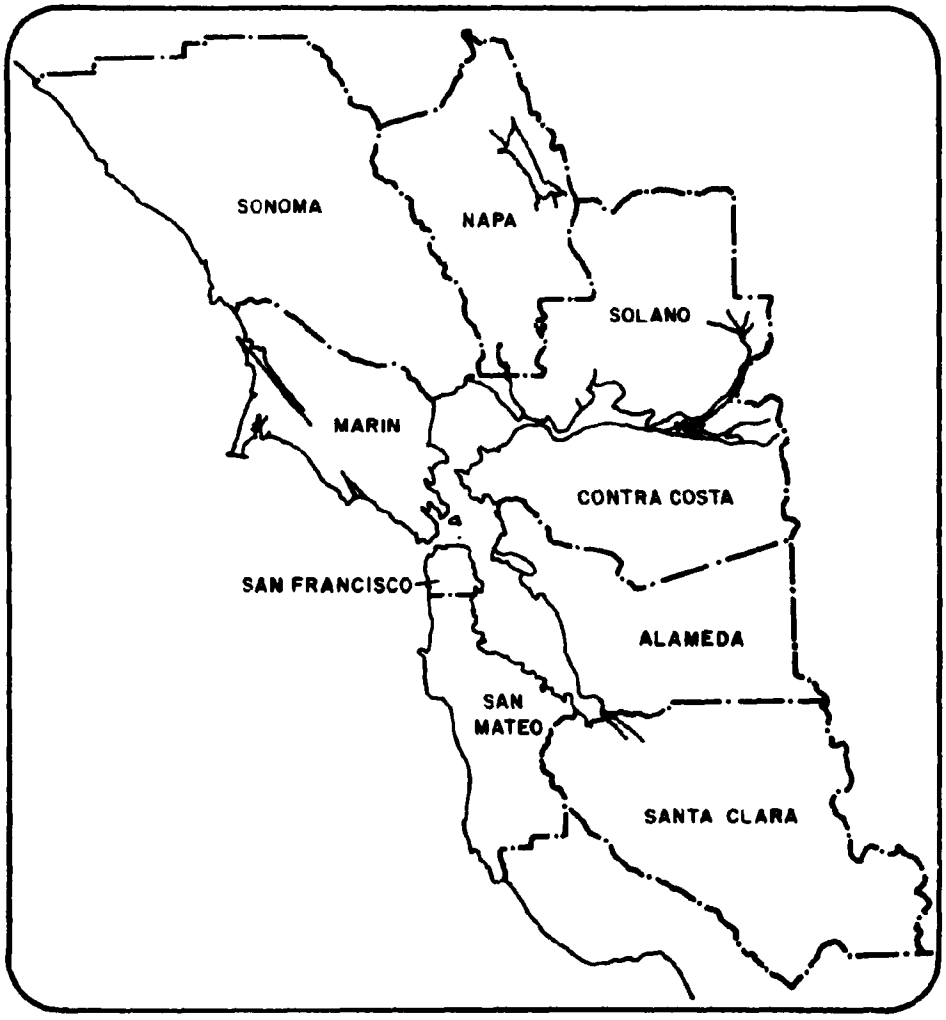
1. To propose policy and programs for local and regional earthquake preparedness planning;
2. To propose a regional preparedness planning approach that complements and supports local public and private programs and reinforces multi-jurisdictional preparedness planning for pre-event mitigation, response, and post-event recovery and reconstruction;
3. To build on the research and development activities of the Southern California Earthquake Preparedness Project (SCEPP), utilizing and adapting SCEPP's planning process, models, and prototype plans to the needs of the Bay Region;
4. To develop a constituency for regional and local earthquake preparedness planning in the Bay Region.

Organization of the Study

To meet the Objectives of the study, the following tasks were identified:

1. Inventory existing preparedness programs, including mitigation and technical programs, and evaluate their relevance to future comprehensive preparedness planning for the region;
2. Seek a scientific consensus of the probabilities of major damaging earthquakes in the project area, evaluate local awareness of the earthquake hazard, explore local opinion on the adequacy of existing programs and priorities, and seek local input on strategies that would be likely to result in improved earthquake hazard mitigation and preparedness planning by local governments, organizations, groups, and individuals;
3. On the basis of the products and materials developed in Tasks 1 and 2, develop a work program for earthquake hazard mitigation and disaster preparedness planning, and propose an administrative structure to implement such a program.

Task 1 was undertaken jointly by the SSC and the Office of Emergency Services (OES) with the assistance of the California Division of Mines and Geology (CDMG). Task 2 was undertaken by CDMG with the assistance of the SSC and OES. The SSC took primary responsibility for completing Task 3.



STUDY AREA -- BAY AREA EARTHQUAKE STUDY

SUMMARY OF FINDINGS AND RECOMMENDATIONS
BAY AREA EARTHQUAKE STUDY

FINDINGS

A review of current preparedness planning activities and documents, plus the results of interviews with local officials throughout the Bay Region, supports the following general conclusions with respect to earthquake preparedness activities in the nine-county region.

1. While seismic hazards are recognized as a significant problem with local and regional implications, there is at present no clearly defined regional role or planning activity.
2. Levels of awareness and concern, as well as quality of preparedness planning, vary significantly among local jurisdictions.
3. There are few examples in the region of comprehensive preparedness planning or of programs that include pre-earthquake planning for hazard mitigation, disaster response, recovery, and reconstruction.
4. Monetary and staff resources and skills at the local level are not adequate to meet the need for earthquake preparedness and hazard mitigation.
5. Little use is made of existing regional information resources, such as the Bay Area Spatial Information System (BASIS), and the CDMG Earthquake Planning Scenario (SP 61).
6. Local jurisdictions need technical assistance and guidance to formulate and implement preparedness plans,

interpret geologic data, assess damage, identify hazards, and develop mitigation programs.

RECOMMENDATIONS

In light of these findings, BAES recommends the development of a comprehensive earthquake preparedness program for the Bay Region. The program should have the following objectives:

1. Creation of regional resource and information systems to support preparedness activities.
2. Evaluation, adaptation, and dissemination of SCEPP products.
3. Development and dissemination of guidelines and methodologies for earthquake hazard mitigation and post-earthquake recovery and reconstruction planning.
4. Provision of appropriate technical assistance to local jurisdictions to help them improve their preparedness, response, and recovery capabilities, as well as their hazard mitigation efforts.
5. Participation in a broad spectrum of public education and information efforts to increase public awareness of earthquake hazards, as well as improve public understanding of the need for more effective preparedness and hazard mitigation.
6. Promotion of programs to encourage individual, family, institutional, and business preparedness and hazard mitigation, coordinated with other governmental preparedness and hazard mitigation efforts.

7. Encouragement in the effective use of all resources available to the region in developing comprehensive and integrated approaches to preparedness.

I. INTRODUCTION

Purpose

This report presents the findings of the needs assessment conducted during Task 1. It includes a documentation and analysis of historic and current planning and preparedness activities in the Bay Region, and recommendations for programs and activities to support and upgrade the status of earthquake preparedness planning and response capability.

BAES will produce two additional reports. The second report will document the earthquake risk to the Bay Region. The third report, to be based on the findings of this study, will propose a detailed work program, administrative structure, and program budget for a multiyear regional preparedness program.

Organization of this Report

This introductory section briefly describes BAES' organization and the purpose of this report. Part II presents an overview of the earthquake threat in the Bay Region, including a brief review of current theories and descriptions of probable earthquake events that could impact the region; a more detailed analysis of this threat will be included in the second BAES report. Parts III and IV present a history and assessment of planning activities in the Region, and Part V gives the findings of the Bay Area Earthquake Study, and recommendations for regional preparedness planning activities.

General Methodology of the Study

An integral part of the assessment process has been the review of the status of earthquake preparedness planning in the Bay Region. To complete an evaluation of response planning, OES has (1) established criteria and a process for plan review, including the assessment and evaluation of the planning process; (2) initiated a review of state guidances, earthquake response plans, selected state agency plans, and the San Francisco Bay Area earthquake plans and planning guides; and (3) initiated the review and evaluation of regional, county, and city response plans and planning processes.

This task has also involved BAES staff in an extensive series of interviews and meetings with local officials and private sector organizations, to identify their needs and solicit their recommendations regarding the objectives, structure, and content of a regional earthquake preparedness project. Interviews have been conducted with city and county managers; city planning directors; officials responsible for the response phase of a disaster, including representatives of OES headquarters and local offices; SCEPP director and staff; representatives of organizations with regional responsibilities including the Association of Bay Area Governments (ABAG), the Metropolitan Transportation Commission (MTC) and the Bay Area Council (BAC); representatives of FEMA, Region IX; local elected officials; members of the State Emergency Task Force on Earthquake Preparedness; and members of SSC. A detailed list of interviewees is appended to this report.

BAES staff members have also interviewed researchers knowledgeable in earthquake preparedness planning, mitigation, and response and recovery, including representatives from Building Systems Development, Inc.; William Spangle & Associates; and Dames & Moore.

The conclusions drawn from these interviews and an analysis of planning activities in the region are presented in Part V of this report.

II. THE NATURE OF THE EARTHQUAKE THREAT

Earthquakes are a fact of life in California. This is particularly true of the greater San Francisco Bay Region, an area that lies astride a broad complex of major active faults. The San Andreas fault is the best known, but it is by no means the only potential source of a major earthquake -- there are at least nine other known active faults in the region capable of producing strong, potentially damaging earthquakes. These faults (Figure 1) are all capable of producing a 6.0 Richter Magnitude (M6.0) or greater earthquake, and there may be other active faults in the region that are still unmapped.

Few members of the general population grasp the magnitude of the earthquake hazard. Recent decades have been seismically quiet compared to the late 1800s and the early years of this century, but forces that caused seismic activity then are still present, and there is in fact some evidence of a recent increase in activity (Toppozada, 1982). In any event, it is reasonable to expect even catastrophic earthquakes in the Bay Area at any time.

During the past 75 years, earthquake activity in the Bay Area has generally been confined to occasional small to moderate shocks (M less than 6.0) resulting in relatively localized, minor damage. Until the April 24, 1984, Morgan Hill earthquake (M6.2), the area had not been shaken by an event greater than M6 since 1911 (see Figure 2).

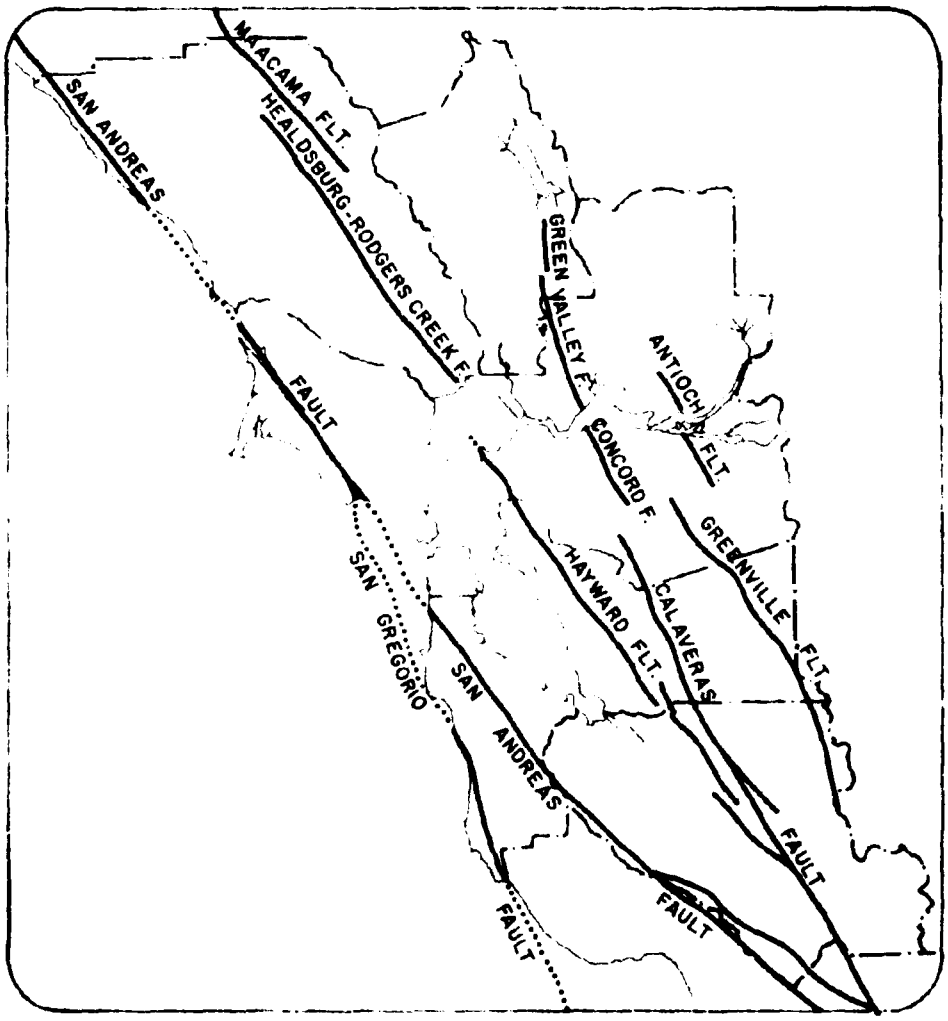


Figure 1 --Major Active Faults in the San Francisco Bay Region

FIGURE 2

HISTORICAL EARTHQUAKES OF
MAGNITUDE GREATER THAN 5.0
SAN FRANCISCO BAY REGION*
1850-1984

Date	Locality	Richter Magnitude
2 Jan 1856	Half Moon Bay	5.3
15 Feb 1856	Palo Alto	5.5
26 Nov 1858	Fremont	6.1
4 Jul 1861	Dublin	5.6
26 Feb 1864	West of Morgan Hill	5.9
5 Mar 1864	Dublin	5.7
21 May 1864	Fremont	5.3
24 May 1864	West of Morgan Hill	5.5
8 Oct 1965	West of San Jose	6.3
26 Mar 1866	Morgan Hill	5.4
15 Jul 1866	West of Patterson	5.8
21 Oct 1868	Hayward	6.8
17 Feb 1870	Scotts Valley	5.8
2 Apr 1870	Berkeley	5.3
10 Apr 1881	West of Patterson	5.9
26 Mar 1884	South of Half Moon Bay	5.9
19 May 1889	Antioch	6.0
31 Jul 1889	Oakland	5.2
2 Jan 1891	San Jose	5.5
12 Oct 1891	Napa	5.5
19 Apr 1892	Vacaville	6.4
21 Apr 1892	Winters	6.2
30 Apr 1892	Vacaville	5.5
9 Aug 1893	Santa Rosa	5.1
20 Jun 1897	Gilroy	6.2
31 Mar 1898	North of Vallejo	6.2
2 Jun 1899	Daly City	5.4
6 Jul 1899	East of Morgan Hill	5.8
19 May 1902	Vacaville	5.5
11 Jun 1903	Santa Clara	5.5
3 Aug 1903	San Jose	5.5
18 Apr 1906	San Francisco	8.3
11 Mar 1910	Watsonville	5.5
1 Jul 1911	Coyote	6.6
9 Nov 1914	Los Gatos	5.5
**24 Oct 1926	Santa Cruz	5.5
25 Apr 1954	Watsonville	5.3
5 Sep 1955	San Jose	5.5
24 Oct 1955	Antioch	5.4
22 Mar 1957	San Francisco	5.3
2 Mar 1959	Gilroy	5.3
18 Dec 1967	Watsonville	5.3
2 Oct 1969	Santa Rosa	5.7
6 Aug 1979	Gilroy	5.7
24 Jan 1980	Livermore	5.8
24 Apr 1984	Morgan Hill	6.2

References:

1850-1899 Toppozada, T., Real, C. and Parke D. (1981)
1900-1949 Toppozada, T. and Parke, D. (1982)
1950-1974 Real, C., Toppozada, T. and Parke, E. (1978)
1974-1984 Toppozada, T., California Division of Mines and Geology, personal communication

* - Region defined as: 37°-39° N. Lat.; 121°-124° W. Long.
** - Possible aftershock of 22 Oct 1926 M. 6.1 event located out of Region.

Seismic activity in this period contrasts sharply with the preceeding 50-60 years (approximately 1850-1911). In 1868 an (approximately) M7 quake on the Hayward fault caused severe damage to structures in the Bay Region. Damage occurred in the East Bay, San Francisco, and as far away as Gilroy to the south, and Santa Rosa to the north. Some 30 deaths were attributed to this earthquake, which--until 1906--was referred to as the "great San Francisco earthquake." The consequences of this event were considered so detrimental to the future growth of the area that a technical report discussing its effects was withheld from publication (Rodda, et al., 1983).

Other damaging earthquakes with M greater than 6 during this period in the Bay Region occurred near Fremont (1858), San Jose (1865 and 1911), Half Moon Bay (1884), Gilroy (1897), Vacaville-Winters (1892), and Mare Island (1898). Isoseismal maps of these events, which suggest damage distribution, follow this report (Appendix IV).

Following this series of M6-7 events, the Great San Francisco Earthquake, with an M of 8.3, occurred in 1906. Its epicenter was on the San Andreas fault near the Golden Gate. It produced surface fault rupture from near San Juan Bautista to Cape Mendocino, some 250 miles north of the city. This rupture and ruptures resultng from other recent earthquakes are illustrated in Figures 3 and 4.

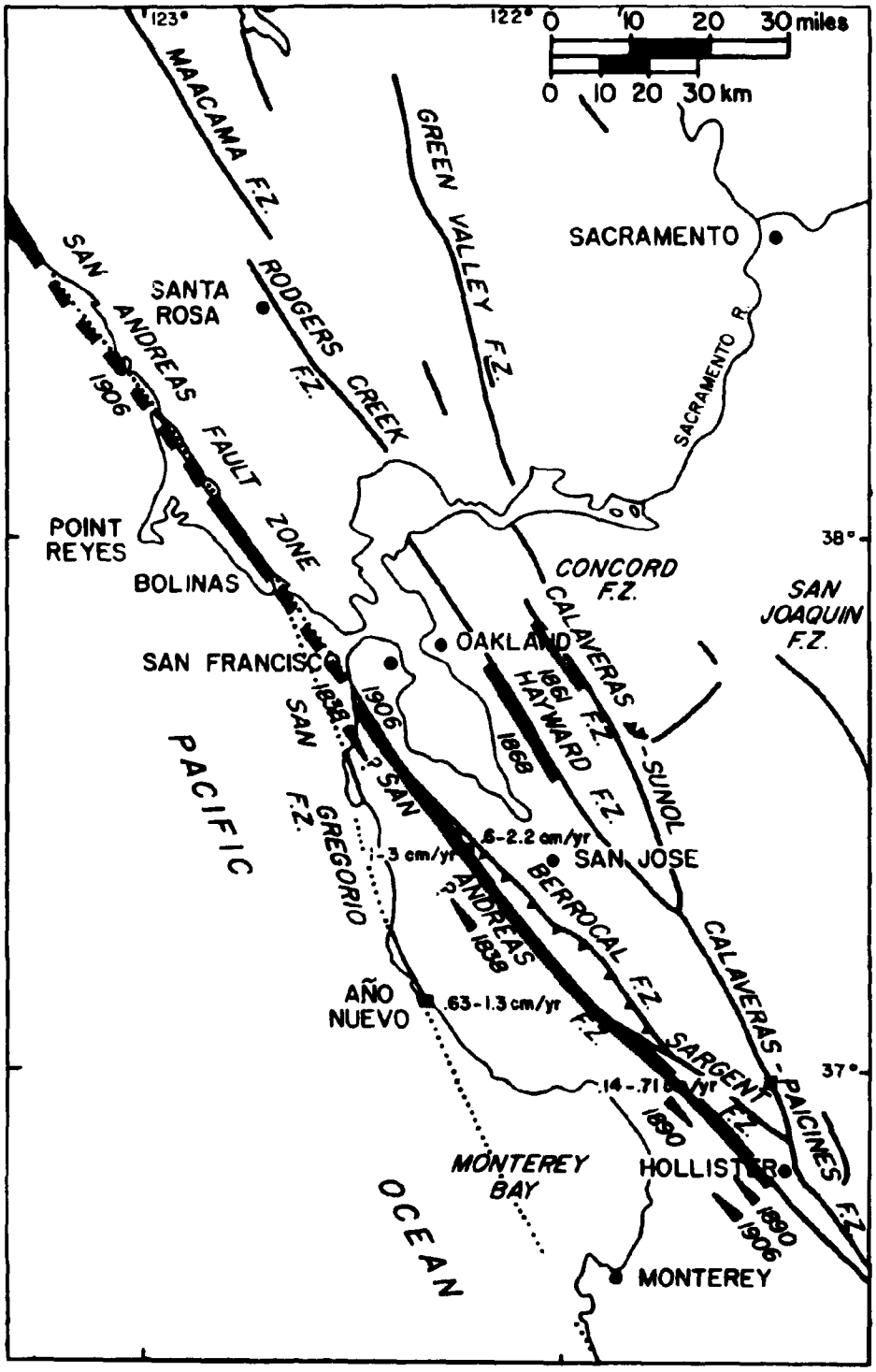


Figure 3 -- Principal recently active faults in San Francisco Bay Region, showing zones of surface rupture associated with historic earthquakes.

Figure 4 -- Historic surface fault displacements associated with earthquakes in the San Francisco Bay Region (2)

Date	Fault	Rupture length	Magnitude
Late June, 1838	San Andreas	Unknown	
July 3, 1861	Calaveras-Sunol	Unknown	
October 22, 1868	Hayward	>30 km	7±1/2 (estimated)
April 24, 1890	San Andreas	>10 km?	
April 18, 1906	San Andreas	≈430 km	8.3

(Reproduced from: PROGRESS ON SEISMIC ZONATION IN THE SAN FRANCISCO BAY REGION, 1979, E. E. Brabb, Ed., U.S. Geological Survey Circular 807, pp. 4-5)

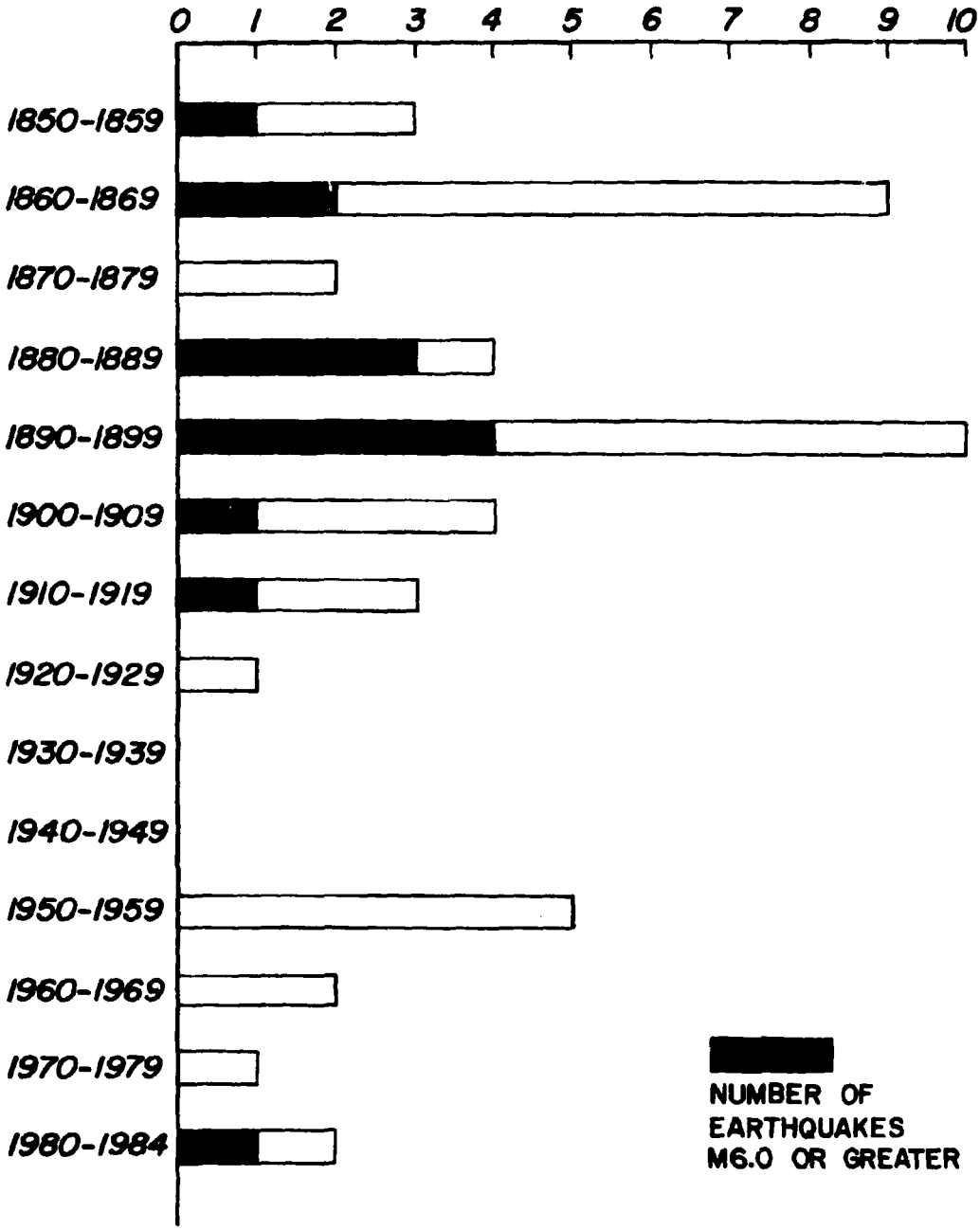
The historical record suggests that the Bay Region's large (greater than M6) earthquakes are not evenly distributed in time, but "cluster" decades before a "great" (1906-type) earthquake. This pattern, illustrated in Figure 5, has been observed elsewhere in the world. If this pattern is repeated in the Bay Region, the occurrence of moderate to large events over the next 50 years seems likely. And the cumulative effect of a series of moderate events could pose a threat as large as that of a single "great" earthquake.

Today, given the Bay Region's vastly increased population of nearly six million, its major buildings, and its elaborate and sophisticated transportation and utility systems, the occurrence of a moderate (M6) earthquake virtually anywhere in the area could cause significant damage and loss of life. For example, the moderate M5.7 Santa Rosa earthquake in 1969 caused many injuries and over $7 million in damage. The 1971 San Fernando earthquake (M6.6) took 58 lives, caused some 5,000 injuries and did nearly $500 million in damage. More recently, the moderate Coalinga and Morgan Hill earthquakes also caused millions of dollars in damage.

Losses from the Santa Rosa and San Fernando events were high primarily because they occurred in densely urbanized areas. Recurrence of the M7 1868 earthquake in the East Bay, now so densely populated, would cause widespread disruption and damage throughout much of the region and, undoubtedly, significant

NUMBER OF EARTHQUAKES—M5 OR GREATER

SAN FRANCISCO BAY REGION
1850-1984: BY DECADE



COMPILED FROM: Toppozada, Real and Parke (1981)
Toppozada and Parke (1982)
Real, Toppozada and Parke (1978)

FIGURE: 5

loss of life; FEMA (1980) has estimated that damage would amount to nearly 44 billion dollars in such an earthquake. Losses resulting from a recurrence of an event comparable to that of 1906, which are highly dependent on the time of day, are estimated at 3,000-11,000 deaths, 19,000-44,000 hospitalized, and damage possibly up to $40 billion (Figures 6, 7 and 8 at the end of this section provide more detailed casualty and loss estimates).

The probabilities of future damaging earthquakes in the Bay Region are difficult to compute because of limited data on fault behavior. The historical record in California is too brief to estimate repeat times of large earthquakes. Therefore, the data most useful in estimating probabilities is the history of displacement along the fault in question, as revealed by detailed geologic and geodetic investigations. Both the average annual amount of fault movement (slip-rate) and evidence of discrete offsets associated with pre-historic earthquakes are used to estimate recurrence times of large earthquakes; such investigations are currently funded by the U.S. Geological Survey through the Earthquake Hazard Reduction Program. However, the data obtained from these investigations are not yet adequate to forecast reliably. All of the principal Bay Region faults shown in Figure 1 must be thoroughly investigated and probabilities evaluated to attain a more complete understanding of the earthquake threat.

Figure 6 -- PROBABILITY OF MAJOR EARTHQUAKES IN CALIFORNIA

Region	Fault System	Richter Magnitude[1]	Current Annual Probability of Occurrence (Percent)	Likelihood of Occurrence in Next 20-30 Years
Los Angeles-San Bernardino	Southern San Andreas	8.3	2-5	High
San Francisco Bay Area	Northern San Andreas	8.3	1	Moderate
San Francisco Bay Area	Hayward	7.4	1	Moderate
Los Angeles	Newport-Inglewood	7.5	0.1	Moderate-Low
San Diego	Rose Canyon	7.0	0.01	Low
Riverside San Bernardino	Cucamonga	6.8	0.1	Moderate-Low
Los Angeles	Santa Monica	6.7	0.01	Low

[1] This is the estimated largest magnitude earthquake expected at a reasonable level of probability. The main shock can be expected to be followed by large aftershocks over a period of weeks or longer. Each large aftershock would be capable of producing additional significant damage and hampering disaster assistance operations.

Figure 6 -- Reproduced from: AN ASSESSMENT OF THE CONSEQUENCES AND PREPARATIONS FOR A CATASTROPHIC CALIFORNIA EARTHQUAKE: FINDINGS AND ACTIONS TAKEN, Prepared by the Federal Emergency Management Agency from an analysis carried out by the National Security Council Ad Hoc Committee on Assessment of Consequences and Preparations for a Major California Earthquake. Washington, D.C., 1980

Figure 7 -- ESTIMATES OF CASUALTIES FOR REPRESENTATIVE EARTHQUAKES IN CALIFORNIA [1]

Fault	Time	Dead	Hospitalized[2]
Northern San Andreas	2:30 a.m.	3,000	12,000
	2:00 p.m.	10,000	37,000
	4:30 p.m.	11,000	44,000
Hayward	2:30 a.m.	3,000	13,000
	2:00 p.m.	8,000	30,000
	4:30 p.m.	7,000	27,000
Southern San Andreas	2:30 a.m.	3,000	12,000
	2:00 p.m.	12,000	50,000
	4:30 p.m.	14,000	55,000
Newport-Inglewood	2:30 a.m.	4,000	18,000
	2:00 p.m.	21,000	83,000
	4:30 p.m.	23,000	91,000

[1] Uncertain by a possible factor of two to three.

[2] Injuries not requiring hospitalization are estimated to be from 15 to 30 times the number of deaths.

Figure 8 -- ESTIMATES OF PROPERTY LOSSES FOR REPRESENTATIVE EARTHQUAKES[1]

Fault	Loss to Building ($ in Billions)	Loss of Contents ($ in Billions)	Total Loss ($ in Billions)
Northern San Andreas	25	13	38
Hayward	29	15	44
Newport-Inglewood	45	24	69
Southern San Andreas	11	6	17

[1] Uncertain by a possible factor of two to three.

Figures 7 and 8 -- Reproduced from: AN ASSESSMENT OF THE CONSEQUENCES AND PREPARATIONS FOR A CATASTROPHIC CALIFORNIA EARTHQUAKE: FINDINGS AND ACTIONS TAKEN, Prepared by the Federal Emergency Management Agency from an analysis carried out by the National Security Council Ad Hoc Committee on Assessment of Consequences and Preparations for a Major California Earthquake. Washington, D.C., 1980

Current estimates of the likelihood of large, potentially damaging earthquakes on principal Bay Region faults in the next twenty years range from 1 in 20 to nearly 1 in 2. A repeat of 1906 Great San Francisco Earthquake may be decades away, but chances are high that one or more large (M7) earthquakes capable of inflicting severe damage and loss of life could occur in the region in the next few decades. With better slip-rate and recurrence interval data it may be possible to refine these rough estimates; this subject will be discussed more thoroughly in the second BAES report, "Probabilistic Long-Term Forecasts of Major Earthquakes in the San Francisco Bay Region."

III. DEVELOPMENT OF EARTHQUAKE PREPAREDNESS ACTIVITIES IN THE BAY REGION

Emergency preparedness activities have traditionally been the responsibility of public safety agencies. At the turn of the century the City of San Francisco initiated preparedness planning activities with the formation of several committees to prepare for "future" emergencies. Ironically, their first meetings were on the 17th of April, 1906, the day before the catastrophic San Francisco Earthquake (Bronson, 1959).

The events of April 18, 1906, confirmed what many had feared. The Bay Region was not prepared to respond to the earthquake hazard and the resulting secondary hazards of building collapse and fire. Unreinforced masonry structures collapsed throughout the area. In San Jose, masonry schools, wood-frame residential structures, and the new Hall of Justice were severely damaged. The Stanford University Campus in Palo Alto was devastated; the quake destroyed the library, Memorial Chapel, and many classroom and laboratory buildings.

Sixty miles to the north of San Francisco, in Santa Rosa, unreinforced masonry and wood-frame structures were severely damaged as a result of both the shaking and fires that immediately followed.

In San Francisco the impact of the earthquake and the resulting fires was devastating. Development patterns and construction practices had created a high-density mix of unreinforced masonry, wood-frame, and steel-frame structures. A 1905 report of the National Board of Fire Underwriters (Steinbrugge 1968) noted the potential for conflagration in the city:

> In view of the exceptionally large areas, great heights, numerous unprotected openings, general absence of firebreaks or stops, highly combustible nature of the buildings, many of which have sheathed walls and ceilings, frequency of light wells and the presence of interspersed frame buildings, the potential hazard is very severe.
>
> The above features combined with the almost total lack of sprinklers and absence of modern protective devices generally, numerous and mutually aggravating conflagration breeders, high winds, and comparatively narrow streets, make the probability feature alarmingly severe.
>
> In fact, San Francisco has violated all underwriting traditions and precedent by not burning up. That it has not done so is largely due to the vigilance of the fire department which cannot be relied upon indefinitely to stave off the inevitable.

The earthquake resulted in severe damage to both structures and lifelines. While there was little or no damage to the reservoirs serving the city, all three of the conduits connecting these reservoirs to the city's distribution reservoirs were destroyed or damaged where they crossed the San Andreas Fault. While water remained in the distribution reservoirs within the city, hundreds of pipe breaks in the city distribution system, caused by ground failure, shaking or structural collapse, hampered the firefighting effort. Steinbrugge (1968) estimates that nearly 80% of the damage resulted from the subsequent fire, including burning of the contents of noncombustible structures that survived the earthquake.

Documentation of the geologic effects of the earthquake and its impact on structures was extensive. Steinbrugge (1968) cites Andrew C. Lawson's report of the (California) State Earthquake Investigation Commission, "The California Earthquake of April 18, 1906" (1908-10), as providing detailed descriptions of the relationship between ground conditions and structural damage. The USGS report on the earthquake, "The San Francisco Earthquake And Fire of April 18, 1906" (Gilbert, et al., 1907) provides additional data on the regional impact of the earthquake.

The San Francisco earthquake, the first to be recorded on relatively sophisticated instrumentation and the first where the linkage between faults and seismicity was demonstrated, fostered early earthquake resistant design practices (CALIFORNIA GEOLOGY, March 1974).

The evolution of earthquake preparedness activities was not, however, a continuous process. It was not until after the 1933 Long Beach earthquake that seismic provisions were incorporated into building codes and the Field Act was passed to mandate seismic resistance in the design and construction of public primary and secondary schools.

RESPONSE PREPAREDNESS

While building practices were improving as a result of documentation of damage in earthquakes, and geologic studies were providing

additional data and understanding of the seismicity of the region, response preparedness remained nearly unchanged.

Civil defense activities in the early 1950s were the first step toward improving emergency response preparedness, but they focused primarily on war-related hazards. During the Christmas 1955 Marysville-Yuba City floods, civil defense (California National Guard) resources were first employed during a natural disaster. The results proved effective. Shortly thereafter natural disasters were incorporated into civil defense planning. This new strategy was termed "emergency management." The policy documents were all-hazard "basic emergency plans" (with war as a special section) and individuals and agencies involved became "emergency services."

The Alaskan earthquake in March 1964 was a major stimulus to the re-examination of California's state of readiness for a great earthquake. In December of that year a conference was held in San Francisco to discuss the implications for California of what had been learned from the Alaskan event. Participating in the conference were structural engineers, geologists, seismologists and others, including a few whose principal concerns were with public policy formulation. It was in this last capacity that Stanley Scott attended on behalf of the Institute of Governmental Studies (IGS) of the University of California,

Berkeley. The conference sparked Scott's interest in the unexplored policy aspects of seismic safety, and later in the decade this led to publication of IGS reports focusing on earthquake hazards in the San Francisco Bay Area (e.g. Steinbrugge 1968, Scott 1968). The interest aroused by the IGS publications, as well as related efforts by Karl Steinbrugge, Robert Olson, Scott, and a number of others, prompted State Senator Alfred Alquist (San Jose) to push for legislative action. Passage of Senate Concurrent Resolution No.128 in 1969 established the Joint Legislative Committee on Seismic Safety (Laurin, 1983).

The Joint Committee comprised members from both houses of the Legislature, and was assisted by five professional advisory committees numbering a total membership of about 90 experts in many fields. The Committee was charged to draft "seismic safety plans and policies and recommend to the Legislature any needed legislation to minimize the catastrophic effects upon the people, property, and operation of our economy should a major earthquake strike any portion of the State of California (1969, SCR No.128)." The Joint Committee thus provided a forum where structural engineers, earth scientists, land use planners, disaster-response personnel, and public policy experts could develop recommendations for improving the seismic safety of the state.

The Joint Committee and its advisors had been deliberating and reviewing earthquake safety issues for approximately two years when the San Fernando earthquake occurred in February 1971, and had laid the groundwork for major legislative changes made in 1972. These included the Hospital Act (modeled after the 1933 Field Act); and amendment to the state's planning law to add a seismic safety element to the list of mandated elements to city and county general plans; and the Alquist-Priolo Special Studies Zone Act, which provided for mapping active fault traces, plus local regulation of construction in designated fault zones; and inauguration of an inundation mapping and evacuation planning program for areas near major dams. In addition, The California Department of Transportation undertook a freeway structure retrofit program.

Moreover the San Fernando event caused the Legislature to allocate additional funds to the Joint Committee, directing it to give special attention to the lessons that California ought to be learning. The earthquake also prompted the Governor to establish an Earthquake Council to pursue an executive branch study of seismic safety and disaster preparedness.

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These legislative acts, coupled with a renewed interest in realizing the nearly 40-year-old mandate of the Field Act, initiated a number of activities which would attempt to mitigate the hazards caused by earthquakes through changes in governmental policy and programs.

Significant changes in response planning were also initiated at the federal level. In mid-1971, California's Congressional delegation held hearings to determine the causes of damage to recently constructed freeways and hospitals, and to determine why response agencies were not better prepared for the type of problems the San Fernando event created. The delegation determined that changes were needed in the emergency planning legislation, and that the concept of a basic emergency plan--a legal, administrative, enabling document with an "all-hazards" approach--was inadequate to provide for response to an urban-area earthquake. It was suggested that there was a need for operational plans to show how a jurisdiction should react to foreseeable conditions created by an earthquake.

Few jurisdictions had such operational plans, so these recommendations resulted in a significant reorientation of local preparedness to an emphasis on response or "operation-specific" contingency planning.

In 1973 the Defense Civil Preparedness Agency received funding for an "On-Site Emergency Operational Readiness Assistance Program" (abbreviated as On-Site Assistance, or OSA) to do contingency planning. OSA's two primary activities were:

1. Through multi- and single-jurisdiction workshops, identify operational requirements associated with credible threats and develop plans that tailor local capabilities to those requirements; and
2. Conduct Emergency Operation Simulation (EOS) tests, drills and exercises based on the developed plans.

At the same time, the Federal Disaster Assistance Administration (FDAA) had joined with the California OES to create and fund the Planning and Research Center (PRC) in San Mateo. Its purpose was to create a response plan for a major earthquake striking the nine Bay Region counties, using the 1972 National Oceanographic and Atmospheric Administration studies as a basis for damage and loss projections (NOAA, 1972). The OSA workshop and intensive technical assistance program would help each county and its sub-jurisdictions develop and implement the plans PRC would produce with local, state, federal, and private sector input.

PRC's tasks and OSA's methods were joined in the "Bay Area Project." The model regional plans resulted, in 1974,

in the development of county and city plans and the compilation of resource listings for each of the approximately 95 jurisdictions. These documents remain the basis for earthquake-specific response in the Bay Region today.

The second activity, Emergency Operations Simulations (EOS), was initiated in 1974. EOS provided federal and state funding and assistance to local jurisdictions for testing and evaluating emergency response plans and capability on a county-by-county basis. These Bay Area Exercises, known as "BASE," included local testing and exercises and post-exercise critiques and recommendations for improvement of capability. BASE continued for three years, until 1976, when federal funding ended. Unfortunately, the program did not provide support for development of training activities to solve the problems that were identified during the exercises.

In 1980, OES conducted a regional medical response exercise at Travis Air Force Base as a follow-up to BASE. The exercise was designed to test the concept of establishing a regional Disaster Support Area (DSA) to support medical activities after a regional earthquake disaster.

In 1974, federal agencies developed a site-specific Bay Region earthquake response plan but it never progressed past the first draft because of national policy uncertainties. Nevertheless, it served as the planning basis used by the Sixth Army to design support action.

In 1977, Congress passed the Earthquake Hazards Reduction Act (P.L. 95-124) which created the National Earthquake Hazard Reduction Program, allocating funds for earthquake related research and preparedness projects.

In late 1970 concern for seismic safety was focused on southern California, where the U.S. Geological Survey had reported an "uplift" along the San Andreas Fault near Palmdale. The February 13, 1976 announcement of the "Palmdale bulge" was followed within two months by a "qualified prediction for a potentially damaging earthquake in Los Angeles within a year" by Dr. James Whitcomb of California Institute of Technology. In November Henry Minturn, a self-proclaimed "seismologist," predicted an earthquake for Los Angeles within the year (Turner et al., 1981).

Within a short period of time, Whitcomb "withdrew" his prediction and Minturn was discredited, and the significance of the "Palmdale Bulge" is still not fully understood. But it shifted the attention of the scientific community and priorities for earthquake preparedness planning to southern California.

In January 1980 the Assembly Committee on Governmental Organization, chaired by Frank Vicencia, responding to scientific concern about the earthquake threat, initiated legislation that would

provide "for State participation in a joint federal, state, and local program to prepare a comprehensive program for responding to a major earthquake prediction (FEMA/NSC 1980)."

Approval by the California Legislature of Assembly Bill 2202 provided for the creation of the Southern California Earthquake Preparedness Project (SCEPP), under the California Seismic Safety Commission, to undertake earthquake preparedness planning activities in southern California. (Section 8897 of, to amend and renumber Section 8898 of, and to add Section 8895.1 to, the Government Code).

SCEPP has recently completed a three-year research and development effort with the publication of prototype plan guidelines covering key areas of earthquake preparedness and response, and is currently developing strategies for the transfer of its products to local jurisdictions throughout southern California.

The eruption of Mt. St. Helens in May 1980 also prompted a reevaluation of the level of earthquake preparedness activities in California. The November 1980 FEMA/NSC report provided the following summary to the threat:

> "..the Nation is essentially unprepared for the catastrophic earthquake (with a probability greater than 50 percent) that must be expected in California in the next three decades. While current response plans and preepredness measures may be adequate for moderate earthquakes, federal, state, and local officials agree that preparations are woefully inadequate to cope with the damage and casualties from a catastrophic earthquake,

> and with the disruptions in communications, social fabric, and governmental structure that may follow, because of the large concentration of population and industry, the impacts of such an earthquake would surpass those of any natural disaster thus far experienced by the Nation. Indeed, the United States has not suffered any disaster of this magnitude on its own territory since the Civil War." (FEMA/NSC, 1980)

The FEMA/NSC report stimulated activity at the state level. In January of 1981, Governor Brown formed, under the Office of Emergency Services, the Emergency Task Force on Earthquake Preparedness to focus the resources and expertise of the private sector on statewide issues of earthquake preparedness.

The Task Force has established statewide public-private earthquake preparedness constituencies and, through its Threat Assessment Advisory Committee, was instrumental in preparing and distributing the California Division of Mines and Geology (CDMG) scenarios for Southern and Northern California events (CDMG Special Publications 60 and 61).

Special Publication 61, the scenario for the Bay Region, describes the anticipated damage to lifelines that would be expected to occur as a result of a large-magnitude (8+R) earthquake. Included in the scenario are descriptions of possible damage to transportation facilities, communication and electrical power networks, water and waste disposal systems, and natural gas and petroleum pipelines that service the Bay Area.

The Task Force also sponsored several state agency exercises and provided research and information for the Southern San Andreas Earthquake Response Plan draft published by OES in mid-1983.

With local and state-level efforts well underway in Southern California, attention returned to the San Francisco Bay Area. On October 1, 1983, work began on a nine-month Bay Area Earthquake Study to evaluate current preparedness needs and the threat itself, determine how to best increase preparedness, and design a five-year work program to improve preparedness capability.

Conclusion:

Major earthquakes present complex planning dilemmas because they cause a series of simultaneous disasters. The magnitude of loss and disruption is difficult to accept and rationally encompass in the planning process. But that magnitude is a key reason for the National Security Council's alarm. As San Francisco learned in 1906, we cannot rely solely on day-to-day emergency services (such as police, fire, medical, and their supporting communication systems) to cope with major earthquakes. The magnitude of this particular threat dictates preparedness over and above that which most of us now routinely accept as necessary in our complex, technological environment. Past planning efforts that went no further than traditional response functions have left communities insufficiently prepared.

It is unrealistic to expect local entities to do such planning alone. A major earthquake is going to be a severe strain on all the United States. The 1980 FEMA/NSC report noted that the nation was unprepared for a California earthquake. In addition, many post-earthquake problems are multi-jurisdictional in scope. Regional and subregional planning efforts are required to solve them. Because of this, no significant increase in overall regionwide comprehensive earthquake preparedness has occurred without state and federal leadership and funds.

THREAT ASSESSMENT AND MITIGATION

Investigations of the 1906 San Francisco earthquake produced detailed analyses of both building damage and the relationship between building performance and site geology. Reports of both the State Earthquake Investigation Commission and the U.S. Geological Survey noted the correlation between severe structural damage and poor ground conditions:

> "As the distance from the fault trace increased, the violence of the disturbance in a general way diminished, but this statement must be modified by saying that in cities and towns built upon the alluvial soil of valleys the destruction was at its greatest, as, for instance, at Santa Rosa, about 20 miles east of the fault trace, in the Sonoma Valley. This city, built upon a deep, alluvial soil, was more severely shaken and suffered greater damage, in proportion to its size, than any other town in the State. Scarcely a brick or stone building in the town was left standing, and 80 people were killed.
>
> The destruction wrought by the earthquake amounted to little or nothing in well-built structures resting upon solid rock, and, all other things being equal, increased in proportion to the depth and incoherent

> quality of the foundation soil. Thus dwellings in Berkeley, upon the solid rock, were scarcely disturbed, while those on the level plain of Oakland, 4 miles distant, were severely shaken and injured, as, also, were the buildings at Leland Stanford Junior University 7 miles distant from the fault trace; at San Jose (Pls. XII, B; XIII, B), 13 miles distant; and at Agnew, 12 miles distant. The town of Salinas and the alluvial valley of Salinas River were also severely shaken." (USGS, 1907)

Figures 9 and 10, reproduced from Borcherdt (1975) illustrate the correlation between site geology and the intensity of ground shaking (R. D. Borcherdt, 1975, "Studies For Seismic Zonation Of The San Francisco Bay Region," Geological Survey Professional Paper 941-A, pp. A-3 and A-4).

Knowledge of this ground behavior did not, however, influence development patterns in the Bay Area. San Francisco, as well as Santa Rosa and San Jose, were rebuilt on their pre-earthquake sites, often reusing the debris from earthquake-damaged buildings.

Other communities also continued to put up unreinforced masonry buildings. In 1933, however, the Long Beach earthquake finally drove home the message that unreinforced masonry was unduly vulnerable to seismic forces. On March 10th, Long Beach was struck by a 6.3 Richter Magnitude earthquake. Although of only moderate magnitude, this was one of the most destructive California earthquakes, resulting in extensive damage to masonry structures. Many schools built of unreinforced masonry collapsed. Fires broke out as a result of the earthquake's damage, but were contained. (CSSC, 80-3)

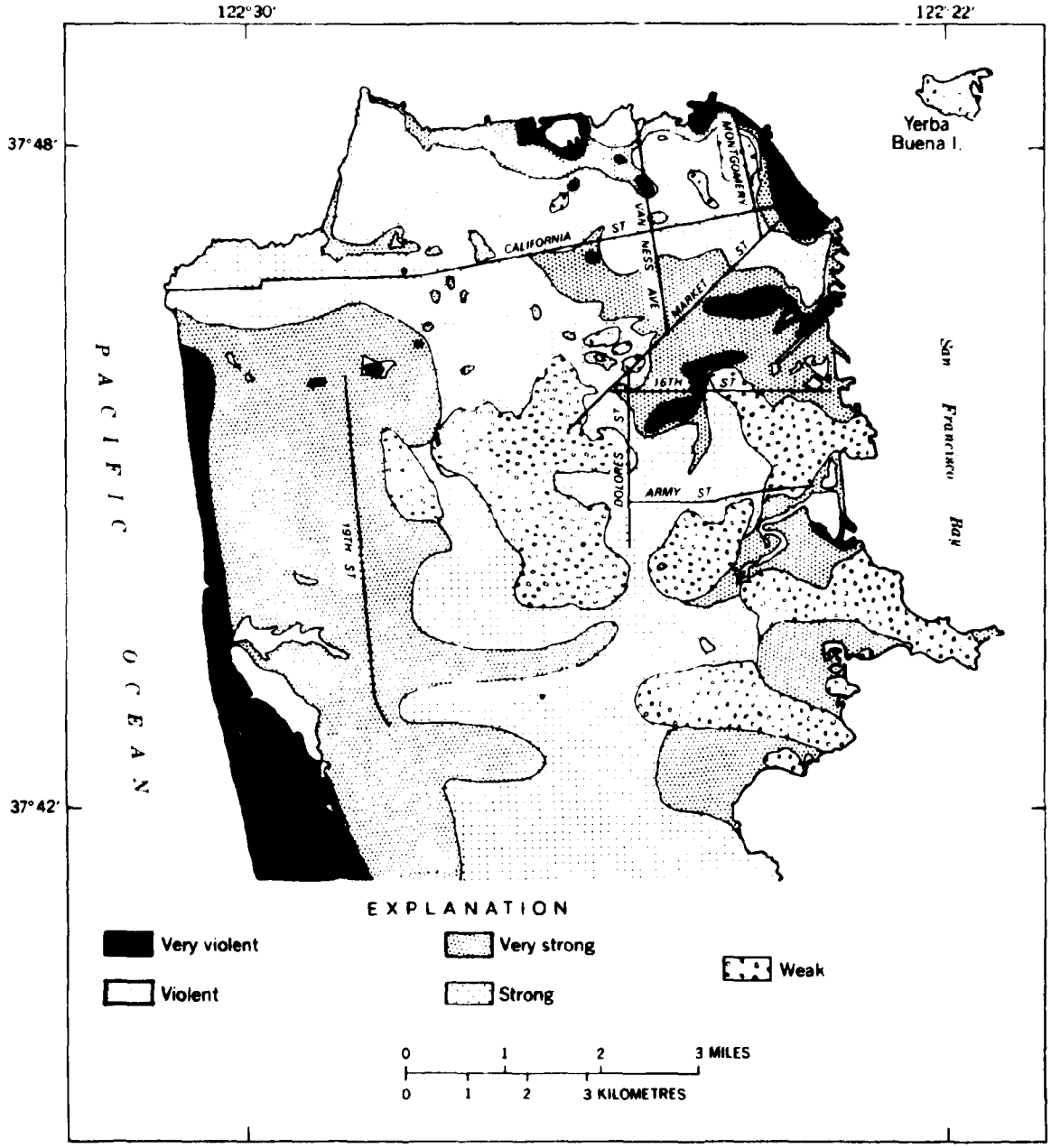

Figure 9 -- Distribution of apparent intensity of the 1906 earthquake in San Francisco, California (after Wood, 1908). Compare with Figure 10, which shows distribution of geologic report units.

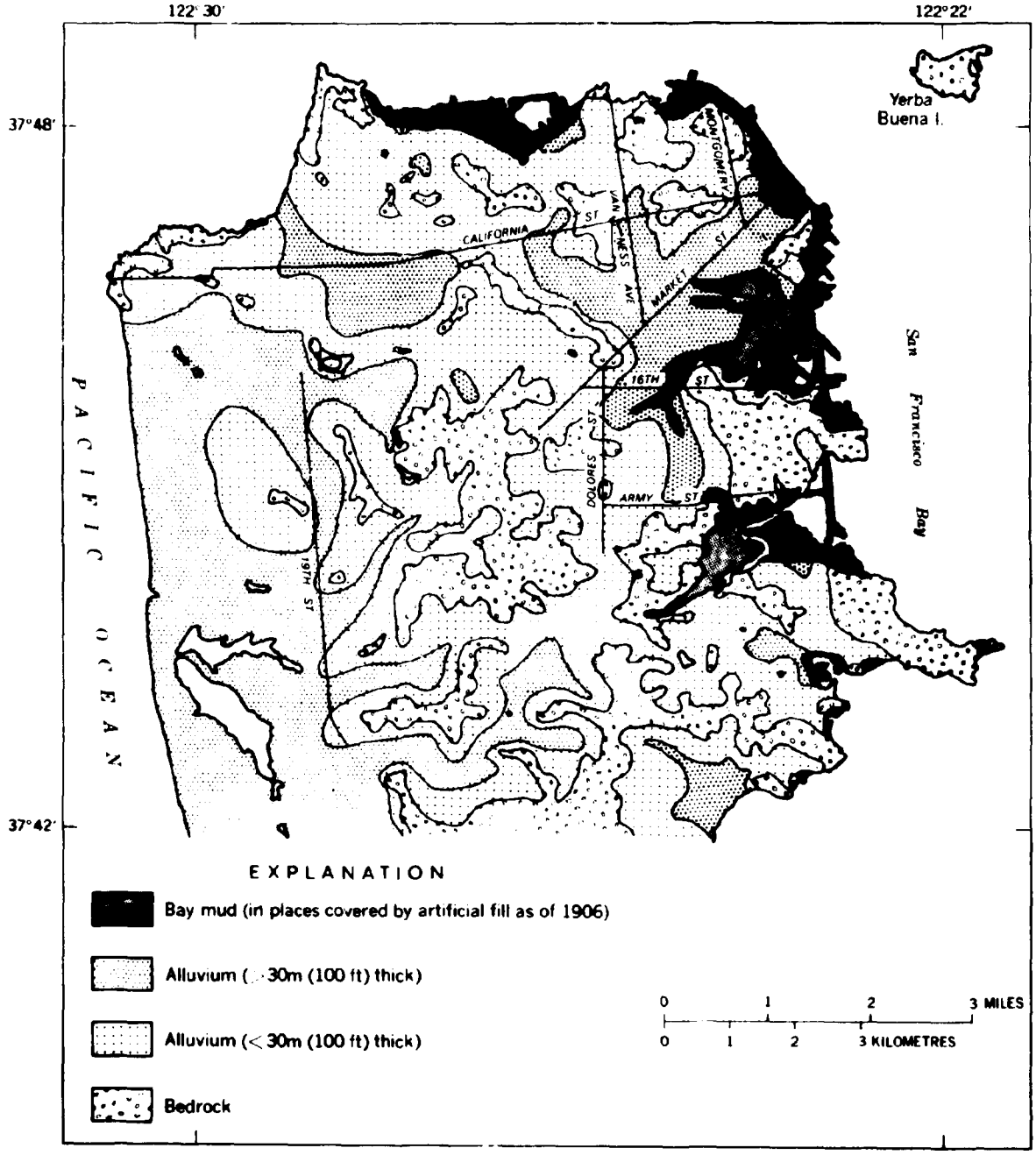

Figure 10 -- Generalized geologic map, San Francisco, California (compiled by K. R. Lajoie from data of Schlocker and others, 1958).

Earthquake Standards for Buildings

In the aftermath of the Long Beach event, the State of California took the lead in earthquake mitigation activities, passing both the Field and Riley Acts to improve the earthquake resistance of buildings. The Field Act established a system of state seismic design review and inspection of public schools. The Riley Act, based on strong motion data obtained in Long Beach, established minimum wind and seismic design criteria for all construction in the state--a step in the right direction, but inadequate in itself.

After the 1933 earthquake local jurisdictions throughout California began adding earthquake standards to their building codes, although for some local governments the process took many years. Meanwhile, at least for a time, the number of hazardous unreinforced masonry buildings continued to grow where jurisdictions still had no earthquake standards in their building codes, or where earthquake standards were not enforced. In due time, however, and with successive improvements in the Uniform Building Code, the construction of unreinforced masonry buildings became a thing of the past. Nevertheless many tens of thousands of these vulnerable structures had been built. While large numbers of such buildings have since been torn down (some after earthquake damage) an estimated 80,000 remain statewide, in both residential and commercial uses. (CSSC, Schwartz draft, 1984)

With the upgrading of the codes and with improvements in engineering knowledge and practice, the production of unsafe buildings was greatly reduced. But it was not eliminated, as demonstrated by the damage to such newly built structures as Olive View Hospital in Los Angeles (1971) or the Imperial County Services building (1979). The best assurance against unduly vulnerable structures is employment of the most modern "state-of-the-art" engineering practice in the design of every significant structure. Current regulations permit construction of several types of structures whose characteristics may dispose them to earthquake vulnerability, unless countered by such design measures. (CSSC, Wosser, draft, 1984)

Ordinances and Land Use Policy to Mitigate Earthquake Hazard

The past two decades have seen much fruitful thought, policy development, and experimentation in seeking better ways to deal with earthquake hazards. Some of this work has reached the stage of effective implementation in a number of jurisdictions, and many signs point to the likelihood of further widespread implementation of risk-reduction and hazard-mitigation measures in future years. Thus already a number of jurisdictions are developing and beginning to implement model ordinances to encourage and require rehabilitation of structures considered to be vulnerable.

A notable example is the City of Santa Rosa, which was struck by

two moderate earthquakes(5.6 and 5.7 Richter) on October 1, 1969. Located on deep alluvial soil approximately 20 miles from the San Andreas Fault, Santa Rosa had been badly damaged by the 1906 San Francisco earthquake. After that earlier quake, many of the downtown buildings were reconstructed of unreinforced masonry, using rubble from the demolished structures. The combination of deep alluvium and vulnerable design meant that Santa Rosa experienced particularly severe damage from the moderate 1969 earthquakes.

The city responded with systematic hazard-abatement efforts enacting a strong hazardous-buildings ordinance, and pushing a program of urban redevelopment for the central business district (CBD). Not only have hazardous buildings been strengthened or removed, but also--because of the unusual ground conditions (deep alluvium)--new construction is required to meet special code provisions that exceed the minimums in the Uniform Building Code. Santa Rosa's experience is documented by Spangle in LAND USE PLANNING AFTER EARTHQUAKES (1980), and provides a unique example of comprehensive post-disaster use of ordinances, urban renewal and land-use planning measures in reducing the hazard from future earthquakes.

Alquist-Priolo Special Studies Zones and Seismic Safety Elements

The San Fernando Earthquake of February 1971, like the earlier Long Beach event, produced significant changes in building and

planning procedures. As noted in an earlier section of this report, this moderate earthquake resulted in unexpectedly severe damage to structures designed to the most recent seismic codes. In the aftermath of San Fernando, there was a renewed effort to address hazard mitigation and land development patterns in areas subject to faulting.

In 1972, the legislature passed the Alquist-Priolo Special Studies Zones Act, requiring local government review of the geologic reports for development in the vicinity of active faults. The Legislature also revised the State Planning Law to make Seismic Safety Elements a mandatory element of local general plans. For the first time, local land use and development policy were required to address seismicity.

Seismic Safety Elements provided a means for local government to mitigate the potential damage from future earthquakes. George Mader, in a paper published in 1977, identified a range of activities that had been initiated in the Bay Area as a result of this state mandate (Mader, 1977, "Land Use Planning for Seismic Safety," in PROCEEDINGS OF THE SUMMER SEISMIC INSTITUTE FOR ARCHITECTURE FACULTY, AIA/RC, Washington, D.C.). For example, in Santa Clara County, the Seismic Safety Plan had been implemented through project review requirements and procedures, an approach that was particularly effective in areas experiencing growth and expansion.

In the City of San Francisco, where the hazards result from existing structures, plan policies have focused on the abatement of structural hazards in area where damage levels are expected to be the most severe. San Francisco has also developed policy to address the post-earthquake reconstruction of the city.

In the town of Portola Valley, a mountainous community bisected by the San Andreas Fault, planning had focused on avoiding damage resulting from ground rupture and landslides. The Santa Clara Baylands Plan aims at reducing the damage resulting from liquefaction and other ground failure.

Microzonation Studies for the Bay Region

While the state was addressing hazard mitigation and land development policies, the federal government undertook a major effort to provide a geologic data base that would delineate the potential of various areas for surface faulting, ground shaking, flooding, liquefaction, and landslide during future earthquakes. The need for this type of information was evident from the variations in ground shaking and damage noted by Wood (1908) and others in the 1906 San Francisco earthquake.

Several mapping projects were initiated after the 1964 Alaska Earthquake to create a data base adequate to support land

use planning. One of the early projects resulted in the first detail map of the entire San Andreas Fault.

In 1970, the need for geologic data to support regional land use planning fostered the San Francisco Bay Region Environment and Resources Planning Study (SFBRS). Funded by both the U.S. Geological Survey and the Department of Housing and Urban Development, the study focused on the nine-county, 7,400-square-mile Bay Region. The Association of Bay Area Governments participated in the study to provide a liaison to the region's counties and local governments. STUDIES FOR SEISMIC ZONATION OF THE SAN FRANCISCO BAY REGION (Borcherdt, 1975) documents the methods and research findings of the study's seismic microzonation experiments.

The SFBRS, completed in 1975, produced more than 100 reports and maps. Two conferences were held to review the scientific findings of the researchers. The First International Conference on Microzonation, held in Seattle in 1972, was followed five years later by a second conference in San Francisco.

The Association of Bay Area Governments provided a vital link between the scientists and local planners. It also developed the Bay Area Spatial Information System (BASIS) as a means of displaying the seismic data and combining various economic, geologic, social, and environmental parameters that would

facilitate analysis of complex planning issues by local decision-makers. (E. E. Brabb, Ed., 1979, PROGRESS ON SEISMIC ZONATION IN THE FRANCISCO BAY REGION, U.S. Geological Survey Circular 807.)

Evaluations of the SFBRS project conducted by the Geological Survey indicate that there is widespread knowledge of the availability and capability of the data base. Local planning officials have used SFBRS data in the preparation of hazard studies, seismic safety and public safety elements and in the preparation and evaluation of environmental impact studies (W.J. Kockelman 1975 and W.J. Kockelman 1976).

In addition, microzonation has been used by the cities of Mountain View, Novato, and San Francisco and the counties of Marin, Santa Clara, and San Mateo as a basis for general plans, seismic safety elements, and the drafting of development policies and ordinances (W.J. Kockelman and E. E. Brabb, in E. E. Brabb, 1979).

Conclusions:

Significant improvements were made after the 1906 earthquake to improve response planning and capability. A corresponding evolution of land use and development practices, in response to the recognition that the damage pattern reflected both geologic conditions and building construction practices did not occur at a similar pace.

The rapid changes in planning and development law and practice that occurred after the San Fernando Earthquake of 1971 must now be matched by improvements in plan implementation and the mitigation of existing hazards.

IV. INVENTORY AND ASSESSMENT OF CURRENT PREPAREDNESS ACTIVITIES

A number of earthquake preparedness activities have been initiated in the Bay Area by federal, state, and local governments and private organizations. The following list of programs and activities is based on information obtained from research and extensive interviews conducted by the staff of BAES with public and private officials in the region. It is included in this report to provide the reader with an overview of the type and range of activities that have been initiated and is not intended as an exhaustive inventory of all current activities and programs.

A. Federal Programs and Activities

The National Earthquake Hazards Reduction Program, established by the Earthquake Hazards Reduction Act of 1977 (PL 95-124), is still the major federal program for comprehensive preparedness. As the primary agency focusing federal efforts on all emergencies, the Federal Emergency Management Agency coordinates the program's six major objectives:

- o Coordinate federal agency programs;
- o Maintain comprehensive research and development activities for hazard mitigation and earthquake prediction;
- o Further develop, through the Federal Interagency Committee on Seismic Safety in Construction, standards for federal projects;

- o Develop federal earthquake response plans and help state and local jurisdictions to develop and improve theirs;
- o Analyze how finance and monetary systems/institutions could function after either a credible prediction or real event and how they could foster hazard reduction; and
- o Examine the insurance industry's mitigation role.

FEMA has initiated a number of programs to implement these objectives. At the national level, FEMA has completed a draft of a National Earthquake Response Plan. The FEMA regional offices are currently reviewing the draft plan with the assistance of state officials.

In FEMA Region IX, the agency has created a federal planning and coordinating group comprised of all major Bay Area federal agencies and t American Red Cross. This group meets periodically to insure interagency planning and coordination of the federal response. To support this activity, Region IX recently became the first FEMA region to have its own radio net for emergency alert and activation.

National and regional plans have adopted an important concept of decentralized delivery systems for federal disaster resources. Prior to 1980, the FEMA Regional Director received requests from the local level and requested a particular federal agency

to respond. Now, through Mission Assignment Letters, selected major agencies have pre-event assignments giving them responsibility for federal support to a response function. Requests to FEMA must still, however, come through state channels.

The National Science Foundation, as part of its charge under the Earthquake Hazard Reduction Program, has financed a number of earthquake studies in the Bay Area. The studies cover issues within the full range of comprehensive preparedness, from social behavior to structural design and response/recovery systems. These studies have provided a basis for many of the current mitigation and preparedness planning activities being implemented in the Bay Area.

The U.S. Geological Survey works with a number of California entities, including the Division of Mines and Geology and the Berkeley Seismological Station, in studies of the seismicity of the Bay Region. The USGS also continues to support the implementation of the microzonation studies conducted as part of the San Francisco Bay Environment Resources and Planning Study (SFBRS), and works with local public and private sector organizations to disseminate geologic and natural hazard data.

In summary, federal activity is focused primarly on threat anaylsis, mitigation measures, research, and response planning. They are also beginning to plan recovery efforts. Other

important federal projects, conducted jointly with the State of California, are included in the section describing state programs.

B. State Programs and Activities

Through continuing federal partnerships, several important preparedness activities have been implemented in California, contributing to a significant improvement in the ability of the state to respond to a major earthquake.

In 1980, FEMA and the State of California initiated the Southern California Earthquake Preparedness Project (SCEPP). The objective of SCEPP was to work with local government and the private sector to develop comprehensive preparedness guidelines for government, business and industry, schools, and voluntary organizations. After completing the research and development of plan guidelines, SCEPP has begun a process to disseminate their products throughout Southern California. This "transferability" process will be evaluated by BAES for Bay Area application.

SCEPP has produced a number of support documents in addition to their planning guidelines. The staff, in developing these products, has developed a high level of expertise in the field of preparedness planning. That expertise can serve as a resource to preparedness programs in other regions of the state and country.

The State is currently contracting with FEMA to complete the Bay Area Earthquake Study. The objective of the study is to develop a regional preparedness program that would support the development of local hazard mitigation and response activities. In formulating the work program for a Bay Area project, BAES will build upon the experience of SCEPP in southern California, and adapt their materials and plan guidelines where appropriate.

Other joint activities include:

- Federal membership on key Earthquake Task Force committees, including the Steering Committee.
- The Finance, Insurance, and Monetary Systems Advisory Committee of the State Earthquake Task Force provides the banking industry with legal research and support of policy and planning to reduce financial institutions' vulnerability to disruption in the aftermath of a major earthquake.
- Cooperation and cost sharing for microzonation studies, Bay Area landslide/mud-flow/other ground failure (liquefaction, etc.) studies and conferences, and determining the seismic safety implications of volcanic activity in the state.
- Federal/state exercises including California Earthquake Prediction Evaluation and Southern California Disaster Support Area Exercises (QEX-81, QEX-82-2).
- Western States Seismic Policy Council and National

Seismic Policy conference.

- California-Mexico Project for seismic preparedness.

The following state activities also contribute to preparedness in the region:

- CDMG Strong Motion Instrumentation Program (SMIP) of structures will provide data on structural performance during future earthquakes.
- Seismic Safety Commission studies -- Private School Earthquake Resistance, Hazardous Buildings, and Implementation of Seismic Safety Elements.
- OES--California Specialized Training Institute (CSTI) provides disaster/crisis management training for local public officials.
- Investigation by the Joint Legislative Committee on Fire, Police and Disaster Services into ways to improve disaster preparedness and response
- The California Earthquake Education Project (CALEEP), Lawrence Hall of Science, is in the process of developing curricula and teaching aids for use in secondary school science programs.

C. Regional Programs and Activities

There are a number of regional agencies that provide support for local preparedness activities in the Bay Area. Support and technical assistance for preparedness and response is

provided by the State of California Office of Emergency Services-Region II staff in Pleasant Hill. The staff of Region II are also available during disasters to assist in coordinating mutual aid requests and in providing State resources in support of local response. They are currently working with the Golden Gate Bridge Authority, private industry, and federal agencies to develop a water surface transport plan for the Bay Area.

The Association of the Bay Area Governments continues to be an active participant in regional earthquake preparedness activities. BASIS, the database system created as part of the USGS San Francisco Bay Environment Resources and Planning Study during the 1970's, has been maintained by ABAG through a contract with GEOGROUP. BASIS, now part of ABAG's Earthquake Preparedness Program, is currently capable of providing detailed geologic mapping of the Bay Region, and earthquake-hazard mapping including ground shaking, ground failure, liquefaction, and tsunami innundation. ABAG has received funding from the National Science Foundation to develop methods for the acquisition of building inventory data for use in earthquake damage assessment studies. As methodologies are developed, ABAG will incorporate building data into BASIS.

Additional resources for support of earthquake preparedness within the region are available from the following sources:

- o Earthquake Engineering Research Institute
- o Stanford Research Institute

- o Stanford University, Geology and Engineering Departments
- o University of California, Berkeley Seismological Lab
- o University of California Earthquake Engineering Research Center
- o University of California, Berkeley Institute for Governmental Studies
- o Lawrence Hall of Science (California Earthquake Education Program)
- o California Academy of Sciences
- o Many engineering and architectural firms that specialize in seismic research and design
- o USGS in Menlo Park
- o CDMG in San Francisco
- o Environmental Volunteers, Northern California Ecumenical Council, and other private groups with a history of preparedness leadership

D. Local Programs and Activities

1. Response

Local plans, training and exercise history, and local officials' opinions were the main components of the BAES review of local planning. This section reviews current local activities, including planning, and provides additional background on local plans and a summary of local earthquake response plans. A

detailed report of BAES plan review is included in Appendix III of this report.

Local emergency plans exist due to the civic responsibility of local officials, not as a result of any state or federal requirement. The California Emergency Services Act (Ch. 7, Div. 1, Title 2, Gov't. Code, Sect. 8550) makes the state, its agencies, and each of its political subdivisions subject to the Act's provisions, but does not require a plan. Instead the Act allows a jurisdiction to form a disaster council; if one is formed, that it "shall develop plans for meeting any emergency."

Figure 11 provides a numerical breakdown of plans and their planning bases. Six of the nine counties and five cities have earthquake-specific plans, all modeled on the 1974 Bay Area Regional Earthquake Response Plan or one of it derivatives. The remaining three counties and 79 cities that have plans use their basic emergency plans for earthquakes. (Those basic plans show earthquakes as one hazard but do not describe their specific impact on the jurisdiction nor the jurisdiction's plan or capability to cope with the impact.) When the 1974 Bay Area Regional Earthquake Response plan was used, little was changed to make the plan specific to the hazards of the locality. Rather, the regional "generic" effects were often repeated. Also, the checklists in the 1974 guide, intended as development aids, have sometimes been used as almost the entire response scenario, concept of operations, and assignments

of tasks and responsibilities; that was not the checklist's purpose. By using the guidance checklist, a jurisdiction may feel it has a good preparedness document, since it came from a good source. In fact, without tailoring the guide and its checklists to the jurisdiction's special problems and capabilities, much important information is omitted.

The eleven jurisdictions that use the 1974 guidance do have common terminologies, a common set of actions (even if only in checklist or summary form), and a common system of zone designations within their boundaries. With regular exercises and training, personnel could become familiar with these unifying concepts.

Only Sonoma County is judged to have a plan adequate for a major earthquake; others have not analyzed their specific post-event problems nor have they tailored their capabilities to meet them effectively. For small to moderate events, most are prepared.

Since the extensive planning and system exercises initiated in 1974, most local governments have tried to maintain their capability with varying degrees of success. There is little overall current activity, however, in part due to the allocation of limited local resources to addressing hazardous materials, proble. . and responding to other man-made and natural hazards.

Since November 1981, the Bay Area has had losses over $100 million due to floods, landslides, mud flows, high winds, and other effects from winter storms. The region's natural disaster response system worked well overall, and it should be expected that this capability will carry over to earthquake preparedness.

2. Planning and Mitigation

Many public and private sector programs currently address earthquake preparedness and hazard mitigation in the Bay Area. The following examples were identified during the initial research and interviews conducted by BAES staff.

Marin County

- o County Office of Emergency Services and the Red Cross provide coordination among public and private groups in an assessment of disaster preparedness by the private sector. The Red Cross received a three-month $24,000 grant from the San Francisco Foundation (Buck Trust) to carry out the evaluation.
- o San Anselmo School District has developed a comprehensive school plan for earthquake preparedness and response.
- o The communities of San Anselmo and Inverness have developed preparedness activities that emphasize self-help and the need for residents to recognize the unique aspects of their community environment in preparing for emergencies. These programs have been integrated into the preparedness planning of

public agencies and surrounding communities.

- The City of Novato has an ongoing program to dedicate as permanent open space those areas subject to landslides or ground failure.
- The City of Novato, with FEMA support, has developed a system of automatic detection to warn downstream residents of the imminent dangers of dam failure and inundation.

Contra Costa County

- The county's Office of Emergency Services participates in environmental review of development projects under the California Enivronmental Quality Act (CEQA) to determine potential risks and their impact on response capability.

Alameda County

- Alameda County has developed an index to geologic data being compiled by private sector engineers.
- The Sheriff's Department incorporates earthquake preparedness information into their "neighborhood watch" programs.
- The City of Oakland participated in a comparative study of earthquake preparedness practices in the U.S. and Japan. On the basis of this participation, the city has organized a Disaster Management Group of City department heads and initiated comprehensive disaster preparedness activities, completed a detailed

inventory of hazardous structures and materials, and developed methods for analysis of the earthquake hazard.

- The Oakland Fire Department has initiated an earthquake education program in the Oakland schools.
- The City of Hayward has prepared a downtown redevelopment plan recognizing the earthquake hazard and adjusting the pattern of development to avoid the fault rupture zone.
- The University of California has organized a Chancellor's Advisory Committee on Earthquake Preparedness to provide comprehensive preparedness planning. They hold annual Earthquake Day awareness activities on campus and in coordination with the City of Berkeley. The university has an ongoing program to strengthen its facilities and otherwise mitigate earthquake hazards at its facilities.
- The East Bay Municipal Utilities District (EBMUD) has developed comprehensive earthquake preparedness plans that include stockpiling replacement parts, building redundancy into systems, staff callback plans that preassign personnel to specific facilities and tasks, and ongoing personnel training and exercises.
- The Junior League makes earthquake preparedness presentations to community groups throughout the East Bay.

Santa Clara County

- The County Geologist has been active in earthquake preparedness activities and provides input to the planning process of the county and cities, as well as making public presentations on earthquakes and earthquake prediction.
- In cooperation with San Mateo County, County Emergency Services coordinates private sector earthquake preparedness and response planning through the Industrial Emergency Council (IEC). The IEC conducts hazardous material training with Raychem, for six years has conducted Business and Industry Emergency Preparedness Seminars, and has purchased its own hazardous materials response van.
- The Santa Clara Emergency Preparedness Council, representing elected officials from each of the county's jurisdictions, meets quarterly to provide direct communication between emergency planners and responders and elected policy makers.
- The City of Palo Alto has completed an inventory of hazardous buildings and researched the feasibility of ordinances to mitigate structural hazards. The City Council is currently considering alternative drafts of legislation that would require abatement of unreinforced masonry structures and other high risk building types.

- The City of Sunnyvale is in the process of updating the Seismic and Safety Elements of their General Plan. Their draft element addresses comprehensive preparedness and response in one document, including seismic hazards, post-earthquake fire, ground failure, flood, emergency organization, city planning and coordination, and the identification of community resources.
- A number of cities, including San Jose and Mountain View, have developed innovative approaches to implementing the policies of their Seismic Safety Elements.

San Mateo County

- In cooperation with Santa Clara County and other jurisdictions, the county participates in the Industrial Emergency Council.
- In cooperation with peninsula jurisdictions, the county participates in the Central Peninsula Civil Defense and Disaster Association, and association of city managers, police and fire chiefs, and other public officials who meet monthly to discuss disaster issues.
- The county provides emergency planning assistance through a District Administrator Program to those

cities unable to afford their own planning staff.

- The county has published the HANDBOOK ON DISASTER PLANNING FOR BUSINESS AND INDUSTRY and provides planning assistance to participating businesses.
- The San Mateo Area Rapid Telecommunciations System provides for communication of "hard-copy" messages among jurisdictions as a supplement to voice communications.
- The county Area Disaster Office has developed an inexpensive computer system and support software to serve as an "integrated management information tool" to support local emergency response decisionmakers. The software are capable of providing damage assessment, shelter management, resource listing and management programs.
- Redwood City enforces special design and construction standards in excess of those required by the Uniform Building Code in areas underlain by bay mud.

San Francisco

- In the mid 1970s San Francisco passed a strict parapet abatement ordinance. Unfortunately, conflicts between building owners, architectural historians and preservationists, and the city have slowed enforcement.
- The city has developed evacuation plans for residents of the Chinatown and Tenderloin communities to

designated mass care shelters. These two communities have dense concentrations of unreinforced masonry structures.

- The Fire Department has developed a backup radio repeater system using Sheriff's volunteers and fixed-wing aircraft.
- The Fire Department is participating in an earthquake education program with the city's schools, targeting minority and non-English speaking communities.

Private Sector Activities

- For the past five years the Golden Gate Chapter of the American Red Cross and the Mayor's Office of Emergency Services in San Francisco have conducted twice yearly Business and Industry Conferences on Earthquake Preparedness. To support the private sector planning activities the Red Cross has established a Business Disaster Resources Center containing samples of corporate preparedness plans and guidances. They have also published the SAN FRANCISCO CORPORATE DISASTER PLANNING GUIDE (Red Cross Disaster Resource Center, 1982).
- Several corporations in the Bay Area have developed their own preparedness plans, or are participating in joint planning efforts with local government.

The plans of the following firms are noteworthy:

Levi-Strauss, San Francisco

Wells-Fargo Bank, San Francisco

Woodward-Clyde, San Francisco and Walnut Creek

Fireman's Fund, San Rafael

IBM Corporation

- The Industrial Emergency Council, with over 150 members, is developing a private sector planning and response capability in Santa Clara and San Mateo Counties in coordination with county response units. In addition to planning, the IEC has acquired its own communications capability and hazardous spill response vehicle.
- Numerous volunteer organizations are active in earthquake preparedness and education. The Environmental Volunteers (EV) (Palo Alto) have produced earthquake education materials under contract to SCEPP, and have conducted community awareness programs in several cities. The Junior Leagues in San Francisco and Oakland have provided speakers to community groups interested in earthquake preparedness and self-help. The American Red Cross disseminates family preparedness information in addition to ongoing programs in first aid and cardiopulmonary resuscitation (CPR).
- A number of private sector firms have received funding from the National Science Foundation to conduct

research in areas of earthquake preparedness and response The following studies have been reviewed by BAFS:

- o Earthquake Damage Assessment
  - Association of Bay Area Governments
  - Dames and Moore (Dr. Charles Scawthorn)
  - Applied Technology Council
- o Non-Structural Damage
  - Scientific Services (Robert Reitherman)
  - Building Systems Development, Inc.
- o Planning Models
  - Building Systems Development, Inc.
  - Center for Environmental Design Research University of California, Berkeley
- o Recovery and Reconstruction
  - William Spangle and Associates
  - Building Systems Development, Inc.
- o Post-Earthquake Fire Spread
  - Dames and Moore (Dr. Charles Scawthorn)
- o Lifelines and Infrastructure Vulnerability
  - EQE, Inc.

V. FINDINGS AND RECOMMENDATIONS

The San Francisco Bay Region, site of one of the nation's most catastrophic earthquake events, has a long tradition of earthquake preparedness planning activities. Detailed geologic mapping studies have been undertaken, risk assessments and damage estimates have been produced and periodically updated, local and regional exercises held, and response planning guidances issued.

The charge of the Bay Area Earthquake Study is to document and evaluate the effectiveness of these previous and current preparedness activities, and to develop recommendations for local and regional preparedness that would build upon previous and current programs to support and improve the capability of the region's jurisdictions to prepare for, and respond to, the earthquake threat.

Recommendations contained in this report are based on a detailed evaluation of current plans and planning processes at the state, regional, and local levels. Additional information was provided by interviews by BAES staff with officials from the public and private sectors at the state and local levels as part of an assessment of local needs in the area of disaster preparedness.

Interviews with researchers and consultants assisted in the identification and evaluation of alternative models for earthquake preparedness planning and response, and helped to identify areas in which research findings could support and improve the "practice" of preparedness planning.

The recommendations have been divided into three categories. The first category defines the general approach to be taken in organizing a program to address the earthquake threat; the second outlines recommended priorities for a work program; and the third contains recommendations for the administrative organization for a project.

Within each category, the "Findings" are followed by a brief analysis of the issues with problems identified by BAES. The "Issue" discussion is then followed by one or more recommendations for action. These "Recommendations" will serve as the basis for structuring a proposal for a multi-year effort to advance the status of earthquake preparedness in the Bay Region.

I. APPROACH

II. WORK PROGRAM -- PRIORITY 1

PRIORITY 2

PRIORITY 3

III. PROJECT ORGANIZATION AND ADMINISTRATION

I. PROGRAM APPROACH

FINDING: LOCAL PREPAREDNESS PLANNING IS "UNEVEN," AND THERE ARE FEW EXAMPLES OF COMPREHENSIVE OR INTEGRATED EFFORTS.

ISSUE: Local earthquake preparedness planning rarely takes a comprehensive approach, integrating the work of government agencies, the private sector, and volunteer organizations into the planning process.

Accordingly, it is essential to capitalize on the many opportunities to incorporate seismic safety planning into local governmental policies and programs. The general policies and plans of local governments should be more closely coordinated with disaster-response and mitigation efforts, including disaster preparedness and response planning, the seismic safety elements of city and county general plans, hazard-abatement ordinances, Special Studies Zones overlays, and development plan review under the provisions of the California Environmental Quality Act (CEQA). Few jurisdictions have active programs to deal with the hazard-response issues identified in their general plan safety elements; nor have many provided the organizational linkages necessary

to intergrate disaster preparedness planning and seismic safety planning into the development review process (Mintier and Stromberg 1982; and CSSC PRELIMINARY SEISMIC SAFETY REPORT draft).

RECOMMENDATION: 1. Regional programs should promote and support the comprehensive and integrated earthquake preparedness planning at the local and regional level. These programs should incorporate planning processes similar to those of SCEPP, but adapted to the needs of the Bay Region and its local governments. This can help guide the activities of the private sector, volunteer organizations, neighborhood groups, and appropriate local agencies in well coordinated planning efforts.

FINDING: EARTHQUAKE PREPAREDNESS ACTIVITIES HAVE LACKED "FOLLOW-THROUGH." EXERCISES WERE NOT FOLLOWED BY EVALUATION CRITIQUES OR TRAINING PROGRAMS TO CORRECT SHORTFALLS IDENTIFIED BY THE EXERCISES.

ISSUE: The Bay Area has an extensive history of earthquake preparedness activities, including hazard identification studies, risk assessments, and response planning. Local and regional exercises have tested the response capabilities of many

jurisdictions. Unfortunately, however, the studies, exercises, and tests were not followed by training and other efforts to upgrade preparedness and response capability.

Current activities tend to be either (1) response drills devoted as much to attracting media attention as to training, or (2) "table top" exercises that have limited potential for training or testing. These activities must be complemented by other efforts aimed more directly at improving preparedness planning.

RECOMMENDATION: 2. The project should build on previous preparedness activities undertaken in the Bay area, paying special attention to the evaluation of the BASE program. Project activities should be related to and provide continuing guidance for training and skill-building.

3. Local and regional exercises should emphasize training and evaluation. Post-exercise training should evaluate the results of exercises and address capability shortfalls identified.

FINDING: PRIVATE EARTHQUAKE PREPAREDNESS ACTIVITIES ARE TYPICALLY NOT WELL INTEGRATED OR COORDINATED WITH LOCAL GOVERNMENT, NOR ARE THEY DESIGNED TO DEAL WITH THE MAGNITUDE OF THE VERY LARGE DISASTERS THAT MUST BE EXPECTED.

ISSUE: Moderate as well as catastrophic earthquakes in the Bay Region will overwhelm the governmental ability to respond, but there are few examples of disaster-response planning that recognize and try to deal with the magnitude of the threat, or that involve the private sector in emergency response planning. (One notable exception is the coordination of the activities of the Industrial Emergency Council with the preparedness planning functions of San Mateo and Santa Clara counties).

RECOMMENDATION: 4. Several existing programs, e.g., the Industrial Emergency Council in San Mateo and Santa Clara Counties, and the business and industry programs of San Francisco and the American Red Cross, should be used as models to promote private sector preparedness. These and other examples can provide guidance in further efforts to stimulate preparedness activities by the private sector, and to coordinate these activities with comprehensive preparedness programs at the local and subregional levels.

FINDING: PROJECTION OF PROBABLE FUTURE EARTHQUAKE DAMAGE AND SCENARIOS OF LIKELY DISASTERS ARE INCOMPLETE.

ISSUE: Current projections of damage that can be expected from potential eathquakes in the Bay Area are not adequate and do not provide local officials with a reasonably clear and convincing picture of the threat.

Both NOAA and FEMA have issued reports that discuss the impact of catastrophic earthquakes on the Bay Region (NOAA, 1972, and USGS 1981, FEMA 1981). While these reports provide an excellent basis for state and federal planning activities, their scale is inappropriate for local-level use. Moreover, they do not address the potential impacts of moderate events like the earthquakes that struck San Fernando (1971), Coalinga (1983), and Morgan Hill (1984). Such moderate earthquakes can cause extensive damage, however, and are far more frequent than large earthquakes. Consequently, the potential impact of moderate earthquakes on the San Andreas Hayward/Calaveras and other local fault systems should be of great concern to Bay region residents and decisionmakers.

RECOMMENDATION: 5. The project should support the completion and use of the Hayward fault earthquakes scenario by CDMG, and the development of moderate earthquake scenarios and damage estimates for the San Andreas fault, as well as for other active faults in the region.

6. The project should cooperate in the current damage estimate study being undertaken by the Association of Bay Area Governments as an augmentation of BASIS.

7. The studies and scenarios should focus on helping the local jurisdictions that are responsible for preparedness planning and hazard mitigation.

8. Earthquake scenarios and damage assessments should include information identifying the principal populations that are at risk, and should incorporate regional origin/destination transportation data.

FINDING: PREPAREDNESS PLANNING FOR LOW-FREQUENCY, HIGH-RISK EVENTS SUCH AS EARTHQUAKES HAS A LOW PRIORITY IN BUDGETING OF LOCAL GOVERNMENTS, WHICH ARE HARD-PRESSED TO FIND ADEQUATE FUNDING TO MEET REGULAR PUBLIC SAFETY AND SERVICE NEEDS.

ISSUE: Proposition 13's adverse impact on local public

services is well documented. As early as 1979 a Seismic Safety Commission study indicated that loss of local revenue had resulted in the reduction in staff assigned to disaster preparedness. In many cases, responsibility for preparedness was delegated to the local law enforcement or fire safety agency, and was saved from virtual elimination only by the limited federal funding available. BAES interview findings indicate that this situation has not improved significantly in the last five years.

In these circumstances local governments tend to view preparedness planning and mitigation activities as low-priority, high-cost budget items.

RECOMMENDATION: 9. Preparedness planning hazard mitigation activities proposed by the Project must be carefully designed for cost effectiveness, making prudent use of available resources. Cost-benefit analysis of alternative programs should be provided to guide local officials in comparing and evaluating proposed activities.

10. Additional resources should be sought--using innovative revenue sources and financing methods--to assist local jurisdictions in funding preparedness and mitigation activities.

FINDING: EXISTING RESOURCES THAT COULD FACILITATE DISASTER RESPONSE AND HAZARD MITIGATION ARE NOT ADEQUATELY USED.

ISSUE: A wealth of information and other resources is already available to local governments and emergency preparedness planners in the Bay Region. Examples include the Bay Area Spatial Information System (BASIS) geologic mapping system of ABAG, extensive fault and ground motion studies by the U.S. Geologic Survey, the seismic studies and earthquake planning scenarios by the California Division of Mines and Geology, and the guidance available from the State Office of Emergency Services. Unfortunately, relatively few jurisdictions avail themselves of these resources.

RECOMMENDATION: 11. The regional program should make special efforts to familiarize local officials with the available resources, suggesting ways in which these resources could be used to better advantage in preparedness planning and hazard-mitigation programs.

FINDING: FAMILIES AND INDIVIDUALS ARE LIKELY TO BE ISOLATED AND MAY HAVE TO BE SELF-SUPPORTING FOR A TIME AFTER A MAJOR EARTHQUAKE.

ISSUE: The geology of the Bay Region, the relative physical isolation of some communities, and the vulnerability of the region's communication and transportation networks may result in a post-earthquake period during which individuals and families will have to fend for themselves. This is likely to be exacerbated by demands for help which overwhelm capabilities of existing public safety and service organizations.

In short, individual and family preparedness will reduce distress on the part of persons affected by a major earthquake. In some cases their very survival could depend on such advance preparation. The recent experience of isolation by winter flooding has fostered the initiation of such individual preparedenss programs in Marin and Santa Cruz counties.

RECOMMENDATION: 12. The regional earthquake project should promote individual preparedness in homes and by businesses. Existing Bay Region programs that seem promising as prototypes should be evaluated and publicized if they prove effective in achieving community preparedness objectives.

Such programs should, to the extent feasible, be integrated into the preparedness planning programs of the region's local governments.

FINDING: NON-ENGLISH SPEAKING PERSONS AND THOSE WITH PHYSICAL DISABILITIES WOULD BE AT GREATER RISK DURING AND AFTER A MAJOR EARTHQUAKE.

ISSUE: Most of the region's communities have significant populations of persons who do not use the English language. These populations often include recent immigrants who may not be fluent in English, and who may also lack the skills and knowhow necessary to function effectively in a major emergency, or in a post-earthquake environment.

In many Bay Area communities, the non-English-speakers tend to live in the most hazardous structures or in the most hazardous neighborhoods. San Francisco's Chinatown, for example, contains a high proportion of old unreinforced masonry structures, sited along narrow and often comparatively inaccessible streets. The city's highest population density is found in this area. Such combinations of adverse factors increases the likelihood that an earthquake will have particularly dangerous and life-threatening consequences.

The elderly, or those with physical disabilities that limit their mobility, will also be subject to greater risks during such events.

The Bay region draws visitors from areas of the country and world who may be unfamiliar with the earthquake threat. Public information and education activities and local response planning do not provide for the special needs of these transient populations.

RECOMMENDATION: 13. Local programs should be developed that respond to the specific needs and conditions found within each jurisdiction. Particular attention should be placed on reaching non-English-speaking populations as well as other groups or individuals who might suffer especially severe impacts in an earthquake.

14. The needs of older persons, of those who are physically or mentally disabled, and of transient populations, should all be addressed in community preparedness programs.

FINDING: THE BAY REGION HAS NUMEROUS PRIVATE SCHOOLS, DAY-CARE CENTERS, AND BEFORE AND AFTER SCHOOL CARE FACILITIES. THE CONSTRUCTION OF THESE STRUCTURES IS NOT COVERED BY THE FIELD ACT, WHICH APPLIES ONLY TO PUBLIC SCHOOLS.

ISSUE: Private educational facilities not covered by the

Field Act have seen a steady increase in student enrollments. These school facilities are often potentially hazardous. In addition, buildings used for day care and before and after school programs are not covered by the act. State and local licensing often does not take seismic safety into account when reviewing adequacy of these facilities (CSSC, PRIVATE ELEMENTARY AND SECONDARY SCHOOLS AND EARTHQUAKE SAFETY, DRAFT, 1984 pp.3-4).

RECOMMENDATION: 15. The program should encourage local officials to review the seismic safety of private school facilities, and of other high occupancy facilities in their jurisdictions.

II. WORK PROGRAM TASKS -- PRIORITY 1

FINDING: THERE ARE PRESENTLY NO WELL-DEFINED REGIONAL APPROACHES TO EARTHQUAKE PREPAREDNESS PLANNING, MITIGATION, RESPONSE, OR RECOVERY AND RECONSTRUCTION

ISSUE: The earthquake threat is clearly of regional and larger scope, calling for regionally based preparedness plans and response capability, but appropriate administrative structures and processes do not exist at the present time.

RECOMMENDATION: 16. Prototype processes need to be developed to undertake preparedness activities at the regional level, supporting and supplementing local preparedness and response activities. This should be done in consultation with appropriate local, regional, and state governmental agencies.

FINDING: RESOURCES SKILLS, AND INFORMATION AVAILABLE AT THE LOCAL LEVEL ARE NOT ADEQUATE TO THE NEED.

ISSUE: Local-level earthquake preparedness has focused primarily on establishing a "command structure," and on completing "compliance" plans required to qualify for federal assistance. There are notable exceptions, e.g., the City and County of San Francisco, and Sonoma, Santa Clara, and San Mateo Counties, but in most communities

preparedness planning has been delegated to the operations section of police or fire departments, where such activities must compete for funds and attention with other urgent demands for police and fire service. Disaster response planning is thus not typically part of local agencies' top administration.

The inspection capabilities of many local building departments are not adequate to the need for qualified independent review and checking of building designs, or for careful inspection during the course of construction. On-the-job construction review by qualified personnel able to detect and correct errors of workmanship is often lacking.

Organizational isolation and comparative lack of support have contributed to the following unfortunate results:

1. An inability to attract and retain enough skilled and dedicated personnel.
2. Limited access to public policy decision-makers, and failure to secure adequate budgetary and personnel resources necessary to perform assigned disaster-response, hazard prevention and hazard mitigation roles.

3. Failure to integrate planning and response processes into the regular activities of all government departments.

RECOMMENDATION: 17. Technical support, training, and assistance are needed to encourage and aid in developing comprehensive, integrated preparedenss planning at the local level. A program of assistance to aid local agency staffs should be initiated, including help in reviewing and improving plans, in conducting operational audits, and in providing technical assistance, training, and consultation.

The building departments of many local governments could benefit greatly if their resources were augmented and their governing bodies encouraged to improve the quality and capabilities of personnel, pursue more aggressive recruitment policies, actively seek staff who are knowledgeable in earthquake-resistant design and construction, and promote inservice training programs emphasizing the best state-of-the-art in seismically sophisticated design and construction.

Technical assistance should be made available for:

1. geologic risk assessment;
2. hazard identification;
3. hazard mitigation program review and evaluation;

4. improving building department design review and
5. legal support (e.g., on liability issues);
6. training, testing, and exercises;
7. public information and education; and,
8. development of a preparedness planning process, with support documents.

FINDING: THERE IS LIMITED COMMUNICATION AMONG THE REGION'S DECISIONMAKERS WITH RESPECT TO THEIR EARTHQUAKE-PREPAREDNESS ACTIVITIES AND EXPERIMENTS.

ISSUE: Several experimental programs in the Bay Region are attempting to deal with earthquake preparedness planning, including business/industry councils and workshops, neighborhood preparedness/self-help programs, and other experimental preparedness planning efforts. There is, however, no forum for learning from these experiments, sharing ideas, or disseminating findings on successes or failures.

The region, like the state, lacks a central source of information on experimental efforts, model plans, and published resource data.

RECOMMENDATION: 18. A regional newsletter should be published, carrying information, ideas, and opinions that would help stimulate preparedness activity in the region. The primary focus of the newsletter would be on descriptions of innovative activities being carried out by various local jurisdictions, regional organizations, and private-sector

agencies.

19. A regional facility should be established to support the newsletter and to provide technical data, as well as information on prototype plans, research reports, and reference materials, to assist with local preparedness planning and mitigation

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FINDING: COMMUNICATIONS BETWEEN THE TECHNICAL COMMUNITY (ENGINEERS, ARCHITECTS, GEOLOGISTS, SEISMOLOGISTS, ETC.) AND THE PUBLIC PLAY A VERY LIMITED ROLE IN PUBLIC EDUCATION ON EARTHQUAKE HAZARDS.

ISSUE: There has been a communications gap between the scientific community and public officials and their constituencies. In the past it has been extremely difficult for the technical/scientific community to convey scientific knowledge about earthquake risk, structural hazards, mitigation needs, and the likely impact of earthquakes on the general population, on the economy, and on government.

RECOMMENDATION: 20. The program should encourage and support a broad spectrum of public information and education activities. These should focus on improved understanding of the earthquake risk, of the need for individual, family, community, and business preparedness, and of the kinds of practical emergency

preparedness, hazard-prevention, and hazard-mitigation measures that could be taken to improve earthquake safety.

These activities should include conferences and public presentations, dissemination of earthquake information through newsletters and news releases, exercises that help focus media attention on earthquake hazards, and other local and regional public activities of an educational nature to help inform the public.

FINDING: THE REGIONAL GEOLOGIC DATA BASE IS NOT ADEQUATELY UTILIZED.

ISSUE: In the 1970s and early 1980s, the Association of Bay Area Governments (ABAG) developed the Bay Area Spatial Information System (BASIS), with funding and other support from the Department of Housing and Urban Development and the United States Geological Survey. This computerized mapping system contains detailed geologic and land-use data on the Bay Region and can generate simulations of the general effects of ground shaking, liquefaction, slope failure,

and tsunami inundation, for use in alternative earthquake scenarios involving various Bay Area faults.

BASIS is currently being augmented by the addition of damage functions and jurisdiction-specific building inventories, an effort funded by the National Science Foundation. Unfortunately, funding has not been available to help ABAG with a "marketing" and dissemination program for BASIS. Consequently, relatively few jurisdictions are fully aware of the system's potential, and even fewer have contracted with ABAG for geologic risk mapping services. In short, the region's jurisdictions are not using this valuable resource effectively in the interest of earthquake preparedness planning and hazard mitigation.

RECOMMENDATION: 21. An informational and "marketing" program for the BASIS data system should be undertaken, focusing on local jurisdictions. This should include training on how the system can be used in preparedness planning and hazard mitigaton work at the local level.

FINDING: UNREINFORCED MASONRY BUILDINGS, AS WELL AS THOSE OF NON-DUCTILE REINFORCED CONCRETE, POSE POTENTIAL EARTHQUAKE HAZARDS IN MANY BAY AREA COMMUNITIES.

ISSUE: Pre-1933 unreinforced masonry buildings are widely known for their vulnerability in earthquakes. Moreover, pre-1975 non-ductile reinforced concrete structures have also performed poorly in moderate earthquakes (CSSC, EARTHQUAKE SAFETY: POTENTIALLY HAZARDOUS BUILDINGS, 1983 Draft). Both types of structures provide much housing for residential and commercial activities in the region. These kinds of potentially dangerous structures pose the greatest life-safety threat in damaging earthquakes. So far, very few communities in the Bay Area have moved ahead with programs to identify unsafe buildings and to reduce the hazard.

Programs to renovate, demolish, or change the occupancy of unreinforced masonry structures could cause the displacement of many economically marginal commercial enterprises that may be unable to afford rent increases. Such structures also provide shelter for many low-income persons who, unless given assistance, would probably be unable to secure safe alternative housing.

RECOMMENDATION: 22. The project should provide technical assistance, and otherwise support and encourage comprehensive local programs, to identify hazardous buildings, to develop hazard mitigation measures designed to strengthen unsafe structures, reduce their occupancy, or secure their demolition; and to provide financing for hazard mitigation and, where necessary, for relocating those displaced by mitigation.

II. WORK PROGRAM TASKS -- PRIORITY 2

FINDING: IN THE BAY AREA, PUBLIC AWARENESS OF THE EARTHQUAKE RISK HAS CLEARLY BEEN INCREASING, BUT THE SCOPE AND MAGNITUDE OF THE HAZARD IS NOT FULLY UNDERSTOOD.

ISSUE: According to a recent California Poll the general awareness of earthquake risk in the Bay Region is equal to or greater than in southern California--an area that has received much attention by earth scientists and planners in the past five years. The Bay Area's public awareness may not, however, be grounded in a fully informed understanding of the region's real hazards. All too often the public attributes the threat principally to the San Andreas Fault and thinks largely in terms of the impact on the City of San Francisco.

The general nature of the threat and the potential impact of seismic events on the Hayward/Calaveras systems and other faults in the region, as well as on the San Andreas may not be fully appreciated.

Local and regional officials reflect the general population's perceptions and lack an adequate appreciation of the potential regional impact of major damaging earthquakes in the Bay Region.

RECOMMENDATION: 23. A broad program of community education should familiarize the population with the earthquake threat in the Bay Area. Included should be general information to be used by the print and electronic media, presentations for use by community groups, organized programs for primary and secondary schools, and presentations to public officials. Earthquake preparedness information should be disseminated through the outreach activities of local government.

FINDING: THE REGION'S TRANSPORTATION AND UTILITY INFRASTRUCTURE IS EXTREMELY VULNERABLE.

ISSUE: The region's physical configuration makes its transportation and utility systems highly susceptible to extensive service disruption in moderate or great earthquakes. Recent experience with winter storms and hazardous spills emphasizes the vulnerability of such systems.

The systems funnel through narrow corridors, several of which cross the Hayward Fault. CDMG Special Publication 61 documents the potential impact of an earthquake on the San Andreas fault on these networks.

RECOMMENDATION: 24. The project should participate with ABAG, MTC, and other regional agencies in a study of the earthquake vulnerability of the region's infrastructure, and develop alternative strategies for transportation routes and backup delivery systems.

FINDING: EARTHQUAKE LIABILITY ISSUES ARE NOT CLEARLY DEFINED OR UNDERSTOOD AT THE LOCAL LEVEL

ISSUE: Local officials are often uncertain as to the legal implications of what they do--or do not do--with respect to preparedness planning and hazard mitigation. Of special concern is the potential liability of both local governments and individual public officials for either acting or failing to act in dealing with potentially hazardous buildings.

RECOMMENDATION: 25. The program should disseminate findings of liability studies by SCEPP and ABAG and explore other legal resources that may assist local jurisdictions in understanding their responsibilities and potential liabilities with respect to earthquake preparedness. Where research is found to be inadequate, legal resources should be sought to address the concerns of local officials.

II. WORK PROGRAM TASKS -- PRIORITY 3

FINDING: THERE ARE MANY OPPORTUNITIES FOR THE MEDIA TO PLAY A ROLE IN PUBLIC EDUCATION TO HEIGHTEN THE AWARENESS OF THE EARTHQUAKE THREAT. THESE OPPORTUNITIES, AS WELL AS THE ROLES AND RESPONSIBILITIES OF THE MEDIA DURING DISASTERS NEED TO BE MORE CLEARLY DEFINED.

ISSUE: The media can play an essential role in raising the public's awareness of the earthquake threat and of what can be done to mitigate hazards.

While the effectiveness of the print and electronic media in communicating scientific and technical information about the earthquake threat to the public has been limited, substantial improvements in awareness and attention to the earthquake phenomena have been noted.

During and immediately after an earthquake disaster, the media can provide vital intelligence and information for the general public, as well as for government officials, emergency personnel, and others with key responsibilities. However, the electronic and print media's demands for immediate on-the-scene reportage can result in conflicts between media personnel and local officials responding to disasters.

RECOMMENDATION: 26. The project should work with representatives of the media, key local officials, and emergency perparedness personnel in examining potential conflicts and developing guidelines for both the media and for local officials to minimize conflicts in disasters. Carefully designed guidelines should also facilitate the efforts of all parties to deal more effectively with disasters. In addition, a program of earthquake education should be promoted, including information on (1) the nature of the threat; (2) the probable impact of potential earthquakes; (3) what local jurisdictions can do and are doing; (4) what private-sector firms can do and are doing; and (5) what individuals should consider doing for themselves.

FINDING: THE EMERGENCY RESPONSE INFRASTRUCTURE IS EXTREMELY VULNERABLE TO DISRUPTION BY DAMAGING EARTHQUAKES.

ISSUE: Local emergency response capability depends heavily on communications systems that are highly vulnerable to disruption, and perhaps total failure, during and after an earthquake. The disruption of communication systems during recent winter storms as well as during the Coalinga and Morgan Hill earthquakes support this conclusion. Emergency

radio and surface communications systems are in many cases obsolete and have limited backup power supplies. Emergency access to radio frequencies is inadequate and the range of coverage is too limited.

Many jurisdictions rely on RACES (Radio Amateurs Civil Emergency Services) for backup communications during a disaster. In many cases, the RACES volunteers have greater communications capability than the local government agencies they serve.

RECOMMENDATION: 27. The project should support the development of more reliable regional communications systems to support local and regional activities during a disaster.

28. Funding sources should be identified to assist local governments in upgrading both communications equipment and staff skills.

29. Interjurisdiction and interagency communications should be facilitated.

III. PROJECT ORGANIZATION AND ADMINSTRATION

FINDING: **PROGRAM CONTINUITY IS ESSENTIAL.**

ISSUE: Earthquake preparedness planning activities in the Bay Region have been occasional, ad hoc, and sporadic, adversely affecting the development of potential support for regional and local participation. It is essential that programs promoted by the Bay Area Project receive local support and become part of the continuing preparedness activities of local governments, regional agencies, and private-sector institutions.

RECOMMENDATION: **30. The advice of local governments and of other appropriate organizations in the region, such as the Office of Emergency Services (Region II), the Association of Bay Area Governments, the Metropolitan Transportation Commission, and the Bay Area Council should be sought in establishing an administrative structure to manage the future work program. Alternative funding sources to provide for continuity of preparedness planning activities should be explored and evaluated.**

FINDING: AT THE LOCAL LEVEL THERE IS SUBSTANTIAL OPPOSITION TO DISASTER PREPAREDNESS PROGRAMS MANDATED BY THE STATE OR FEDERAL GOVERNMENTS.

ISSUE: Local government has had a limited number of contacts with the Federal government, and in disaster preparedness and response the relationships have often been fraught with difficulty. First with the civil defense and shelter programs promoted in the 1950s and 1960s, and more recently with Crisis Relocation Planning, political opposition to participation has prompted many local jurisdictions to reject federal support for disaster preparedness.

Several officials who were interviewed expressed distrust of federal disaster preparedness programs, and a reluctance to participate in a regional earthquake project if it were to emphasize traditional war-related and civil defense-related preparedness planning.

Federal/local contacts in the period following disasters have also been characterized by tension. Many local observers consider the federal support efforts slow, insensitive, and preoccupied with the paper documentation of losses.

RECOMMENDATION: 31. The Bay Area project should focus on the development of comprehensive, integrated earthquake preparedness planning. Federal, state, and local programs that are supportive of and consistent with the earthquake preparedness goals of the Project should be integrated into the Project's activities.

32. To ensure that the activities and programs initiated and promoted by the Project reflect and respond to the needs of local officials, it is recommended that during the initial period of program development and implementation, the Bay Area Project remain a semi-independent body, responsible to the Seismic Safety Commission and a regional policy advisory board.

FINDING: THE STATE EARTHQUAKE PREPAREDNESS TASK FORCE IS AN IMPORTANT RESOURCE.

ISSUE: In its three years of effort the State Earthquake Preparedness Task Force has provided a valuable link between government and the private sector for earthquake preparedness and response planning. The Task Force not only provided a network for reviewing governmental planning activities but also, and perhaps even more importantly, it

brought the expertise of the private sector to bear on critical earthquake preparedness problems.

RECOMMENDATION: 33. The project should draw on the expertise of the Task Force membership as a major source of guidance in solving emergency response and preparedness problems, and also as a constituency that can provide essential support for earthquake safety and preparedness planning.

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