STATE OF NEVADA

AD HOC PANEL

ON

SEISMIC HAZARD MITIGATION

REPORT

ON

CONCLUSIONS, RECOMMENDATIONS AND FINDINGS

Governor's Office of Planning Coordination

June 1979

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STATE OF NEVADA
GOVERNOR'S OFFICE OF PLANNING COORDINATION
Robert Hill, State Planning Coordinator

SEISMIC HAZARD MITIGATION - AD HOC PANEL
John A. Bonell, Chairman

June, 1979

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FOREWORD

This report on seismic hazards in Nevada is the result of deliberations over the past ten months by a group of approximately sixty-five individuals under the auspices of the Ad Hoc Panel on Seismic Hazard Mitigation. This Panel was appointed by Governor Mike O'Callaghan in August, 1978 to address the question of how well Nevada was prepared to cope with a major earthquake. The effort was funded in part by The Four Corners Regional Commission. This report sets forth the Panel's conclusions, recommendations, and findings. Much remains to be accomplished in achieving adequate seismic safety in Nevada. With preparation of this report the Panel now gives to the Governor and Legislature, the responsibility of determining what actions should be taken in the public interest.

John A. Bonell,
Chairman
Ad Hoc Panel on Seismic Hazard Mitigation

III.

STATE OF NEVADA

AD HOC PANEL ON SEISMIC HAZARD MITIGATION

MEMBERSHIP

Prof. John A. Bonell, Panel Chairman Civil Engineering Department University of Nevada - Reno Reno, Nevada 89507	(Panel Rep. to Work Group on Prediction and Warning)
Dr. John W. Batdorf Rancho-Charleston Medical Center 901 Rancho Lane, Suite 105 Las Vegas, Nevada 89106	(Panel Rep. to Work Group on Preparedness and Response)
Mr. Fred J. Daniels, Jr., P.E. Daniels Engineering, Ltd. 907 Thompson Street Carson City, Nevada 89701	(Panel Rep. to Work Group on Building Codes)
Mr. J. Clark Gribben, P.E. J. Clark Gribben Consulting Engineers, Ltd. 20 Vine Street Reno, Nevada 89503	(Panel Rep. to Work Group on Risk/Hazard Mapping)
Mr. Cal Holland, Executive Assistant Mineral County Board of Commissioners 1st and A Streets Hawthorne, Nevada 89415	(Panel Rep. to Work Group on Land Use)
Mr. Russell W. McDonald 3170 W. Plumb Lake Reno, Nevada 89509	(Panel Rep. to Work Group on Legislation)
Mr. Otto McFarland, Chief Fire Services Division City of Las Vegas Las Vegas, Nevada 89108	(Panel Rep. to Work Group on Education, Information and Planning)
Dr. Fred Preston, Sociology Department University of Nevada - Las Vegas 4505 So. Maryland Parkway Las Vegas, Nevada 89154	(Panel Rep. to Work Group on Socio-Economic and Political Consideration)
Dr. David B. Slemmons, Geology Department University of Nevada - Reno Reno, Nevada 89507	(Panel Rep. to Work Group on Research and Data Collection and Critical Facilities)
Mr. Gary M. Soule, Vice-President Engineering Sierra Pacific Power Co. 100 E. Moana Lane Reno, Nevada 89502	(Panel Rep. to Work Group on Utilities, Communication and Transportation)

Staff

Dr. Gilbert F. Cochran - August 1978- February 1979

Ms. Merrily Kronberg - October 1978 - June 1979

IV.
WORKGROUPS

CHAIRMEN (Ch)
PANEL REPRESENTATIVES (Pr)
MEMBERS

LEGISLATIVE

Russ McDonald (Ch, Pr)
Mike McDonald
Wm. Johnston
Bill Parrisch
Lynn Krupp
Hal Smith
Walter Reid

BUILDING CODES

Wm. Adams (Ch)
Fred Daniels (Pr)
Richard Vandenburg
Wm. Hancock
John Madole
Paul Ferrari

RISK MAPPING

Tom Cordova (Ch)
J. C. Gribben (Pr)
Dick Allen
John Bell
David Weide

RESEARCH & DATA COLLECTION

Burt Slemmons (Pr, Ch)
Bruce Douglas
Robert Wallace
Alan Ryall
Elaine E. Bell
Stan Mosher
Jim Richardson

EARTHQUAKE PREDICTION

Richard Harris (Ch)
John Bonell (Pr)
Robert Wallace
Richard Bisset
Doug Van Wormer
Gerald Ginsburg

LIFELINES UTILITIES

Robert Churn (Ch)
Gary Soule (Pr)
John MacDonald
Pete Krenkel
Brian Randall
James Zornes

DISASTER PREP. & RESPONSE

Bill Farr (Ch)
John Batdorf (Pr)
Bob Gregory
Bob Edmundson
Otto Ravenholt
Dave Brandness

LAND USE

Stan Ott (Ch)
Cal Holland (Pr)
Dennis Bryan
Dick Allen
Bob Rigsby
Fred Weldon
Bob Erickson

SOCIO-ECON-POLITICAL CONSIDERATIONS

Fred Preston (Ch, Pr)
Al Wilcox
Bernard Malamud
Roger Loff
Jordon Crouch

CRITICAL FACILITIES

Hal Enderlin (Ch)
D. Burt Slemmons (Pr)
Tom Huddleston
Brian Randall
Bob Howell
Kiyoshi Nishikawa

INFORMATION, EDUCATION & TRAINING

Glen Martin (Ch)
Otto McFarland (Pr)
James Mennath
John Trent
Don Fabbi
Steve Frady
Chris Chrystal

V.
CONCLUSIONS AND RECOMMENDATIONS

The Nevada Ad Hoc Panel on Seismic Hazard Mitigation, through the work of its own members and the members of the Panel's several Work Groups, has come to several broad conclusions with regard to seismic hazards in Nevada as enunciated below.

Conclusion No. 1: The citizens of Nevada face a very real and growing earthquake hazard. Nevada is in a region of seismic activity which, even during the course of the Panel's activities, experienced several minor earthquakes; August 3, 1978, in Pleasant Valley - Richter magnitude 2.8; September 4, 1978 in Diamond Valley (2 shocks) - Richter magnitudes 4.3 & 4.6; February 13, 1979 in Carlin - Richter magnitude 3.6; February 22, 1979 in Doyle, California - Richter magnitude 5.0. The extent of the hazard posed is growing, not because of increased seismicity, but because of our rapidly expanding population which is being housed and working in structures that may not be adequately designed for the earthquake hazard.

Conclusion No. 2: With limited exception, earthquake hazard related planning in Nevada is inadequate. The relatively high potential for a major damaging earthquake in, or near, one of Nevada's urban centers, particularly in western Nevada, demands effective plans for disaster preparedness, disaster response, effects mitigation and land use. Clark County has the best disaster plan but it is weak in its seismic coverage. Washoe County seems to have progressed further with seismic land use considerations, but the program seems to have little impact. No community seems to have an earthquake mitigation program or plan. Of the major utilities, the telephone companies appear to have the most sophisticated disaster contingency plans but in general such "lifeline" plans are "ad hoc" with little apparent coordination. The overall planning situation should be rectified to insure minimization of public official liability.

Conclusion No. 3: There is no overall program or plan that focuses seismic research and data collection to areas of high state or local priority. Significant seismic research is being conducted within the University System, but most of it is financed by the federal government and as such is responsive to the federal perspectives on research needs. There is little state or local agency input to the process. Data collection through installation of strong motion recorders in high-rise structures is "run" by local building departments under provisions of the Uniform Building Code.

This is a hap-hazard and ineffective program that lacks direction or maintenance and in its current state is a waste of developer and taxpayer money. These data are valuable and the program should be properly recognized and cared for.

Conclusion No. 4: There is no focal point in Nevada for communication or coordination of programs related to earthquake hazards either among public and private entities within Nevada, or between Nevada and other states, and the federal government. The Ad Hoc Panel provided a temporary focal point, and its activities served to highlight just how serious the communication and coordination problem is. Earthquakes affect and involve a broad spectrum of disciplines and agencies with divergent objectives and programs. Because of this diversity, a mechanism for communication and coordination is required.

Conclusion No. 5: The manner and extent to which the State of Nevada, its political subdivisions, and private enterprise, address and deal with the earthquake hazard problem, is inadequate. The State Legislature and the Executive Branch should give serious consideration to this matter and take appropriate actions. Failure to do so may, in the event of a major damaging earthquake, subject the State, its agencies, local entities, and public officials to significant questions or threat of liability.

The preceeding five conclusions represent a synthesis of the many findings made by the Panel during the course of its ten-month investigation and study. These findings, which are extensively discussed in the main body of this report, have also formed the basis for several Panel Recommendations. It is believed that immediate action on these recommendations is warranted and that such action by the Legislative and Executive Branches would go a long way toward developing what the Panel believes to be an adequate "earthquake hazard mitigation program". These recommendations are as follows:

* Recommendation No. 1: The State of Nevada should establish an independent and interdisciplinary Seismic Safety Council to continue the efforts initiated by the Ad Hoc Panel on Seismic Hazards Mitigation.

This Council should have interdisciplinary and expert representation and because of the fundamental importance of seismic hazards to society, the Council should be independent from any agency currently dealing with aspects of the problem. The need for such an entity is not now being met by any state organization other than the Ad Hoc Panel. The Panel has developed a draft of legislation for consideration by the Governor and Legislature for implementing this recommendation. (See Appendix A)

In as much as the 1979 Nevada Legislature adjourned without addressing the question of seismic hazards or holding any sort of hearing on the above recommendation, the Panel strongly urges as an interim measure, that Governor List officially continue the Ad Hoc Panel. Formal continuation should provide the Panel with authority to seek Federal or other funds to support its activities.

- Recommendation No. 2: The 1981 Session of the Nevada Legislature should revise NRS 278.160 to require preparation of a "Seismic Safety Plan" as an element of city, county or regional master plans.

The Panel believes that the seismic hazards of Nevada are of sufficient concern to warrant the mandatory preparation of seismic safety plans. The Panel recognizes such a requirement will place burdens on some jurisdictions that may necessitate State assistance of both a technical and financial nature. Ability to prepare such plans, however, will be dependent upon availability of basic geological and seismological information and data that define the nature and extent of seismic hazards in any given locale. These data are not now available for the vast majority of the State's urban areas. This problem is the subject of the next recommendation.

- Recommendation No. 3: The State of Nevada should substantially increase the next biennial appropriation to the Nevada Bureau of Mines and Geology and authorize increased staff for the express purpose of accelerating the Bureau's Seismic Hazard Mapping Program.

The Nevada Bureau of Mines and Geology Seismic Hazard Mapping Program appears to be of excellent quality but it is seriously under-funded and understaffed. As of June, 1979, only three such maps have been published, two are in open file status and four others are in various stages of preparation. If the State is to initiate a serious program to reduce earthquake hazards, these data must be made available. In the long run, one of the most effective means of reducing seismic risks lies in adoption of adequate land use plans, and for these, this type of data is requisite. Given the rapid rate of population growth and urbanization in Nevada, the time for development of such plans is now, if in fact not overdue. An estimate of costs that will be required to bring this mapping program up to an acceptable and realistically accomplishable level has been prepared at the Panel's request by the Director of The Nevada Bureau of Mines and Geology. (See Appendix B)

- Recommendation No. 4: The State of Nevada should adopt as State Law the "seismic" provisions of the 1979 edition of the Uniform Building Code as promulgated by the International Conference of Building Officials and require its application without exception in all political subdivisions of the State.

The Uniform Building Code is currently used by most, but not all, local jurisdictions. However, most have adopted it with exceptions to its provisions. The Panel believes that with respect to earthquake hazards there should be no exceptions and that all structures in the State must be designed and built to these minimum seismic safety standards.

- Recommendation No. 5: The State of Nevada should establish within the Nevada Bureau of Mines and Geology a "Center for Seismic Hazard Assessment Data" in order to archive and make available all such data developed by all public and private entities within Nevada.

A large amount of valuable seismic hazard data is being developed by consultants on a day-to-day basis in support of all types of public and private construction and development activities. The preponderance of these data are contained in consultant reports but never enter the public domain even though they are developed to support activites for which government permits are required. A mechanism is needed to make these data publicly available to enhance our mitigation of seismic hazards. A precedent exists in the State Water Law related to "well logs" for requiring submittal of such types of data for use by the general public. The proposed Center should be established and the Nevada Bureau of Mines and Geology charged during the coming biennium with developing an efficient mechanism for getting the data and developing "rules and regulations" pertaining to the types and format for data submission. This mechanism and related rules and regulations should be subject to public hearing before their adoption. Funding during the first two years should cover only the cost of the above items. Implementation funding should be delayed until such time as an operable program is defined. Old data should be subject to inclusion and furthermore, contributors of data should not be held liable for any subsequent use of that data.

- Recommendation No. 6: The Nevada Seismic Safety Council should give high priority to "Alquist-Priolo" type of legislation to identify hazardous areas and require that proper detailed studies be prepared to characterize and delineate the problem areas, and to use proper planning and development procedures for the safe utilization of these areas.

The presence of active faults and of zones of potential ground failure in or near the urbanized centers of the State create places of high seismic risk. The mitigation of seismic hazards is most effectively accomplished by establishing an organized and legal procedure for locating and defining these areas, and for developing guidelines that will permit the seismically safe development and utilization of these hazardous areas. The primary goal of such legislation is to protect the public and to minimize the natural and legal hazards to the individuals and organizations responsible for the use of these areas. The effective conduct of this type of program will, in part, depend on the conduct of geologic, seismologic and engineering research of these regions.

- Recommendation No. 7: The State of Nevada should substantially increase the seismographic station distribution, and the accuracy of earthquake epicenter locations within all parts of Nevada, in order to make it possible to provide a rapid epicenter location of future earthquakes in any part of the State, and to improve seismic zoning in all parts of Nevada, including the southern and eastern parts of the State.

The present mission and region of study of the University of Nevada Seismological Laboratory is limited to coverage of the northwestern and northcentral parts of the State. The lack of any agency having a long-term commitment to provide a similar program of instrumentation and location for earthquake activity in the southern and eastern parts of the State makes it impossible to properly assess earthquake hazards and risks in Nevada. The mission of the Seismological Laboratory of the University of Nevada, Reno, should be broadened and the appropriation of funds increased to include a statewide basis for location and evaluation of earthquake epicenters, and to provide a seismologic basis for identifying seismically active faults of the region.

The above program can be implemented by an increase in the Building Permit fee. This funding would also support the maintenance of the Nevada strong motion network (see Recommendation No. 8), but not the purchase of strong motion instruments.

- Recommendation No. 8: The State of Nevada should establish a statewide program of instrumentation, data storage and interpretation of strong motion seismographic records of Nevada earthquakes to provide a basis for assessing future earthquake design and structural response of engineered structures in Nevada.

The present programs of acquiring strong motion data for earthquakes and the response of engineering structures to Nevada earthquakes is scattered in many governmental and cooperating organizations. The stations are biased toward nuclear test events and not to natural earthquakes that are likely to occur within the region. Many instruments are not continuously operational, due to problems of maintenance or their primary objective to support only nuclear detonation programs. The general lack of recordings for normal faulting earthquakes, the most prevalent type of earthquake phenomenon in Nevada, show a special Nevada need to acquire records that would be representative of the type of earthquakes that characterize this region for all world-wide data. Present indirect data suggests many Nevada structures may be overdesigned for the reverse-slip and strike-slip type of earthquakes that are representative of other parts of the world.

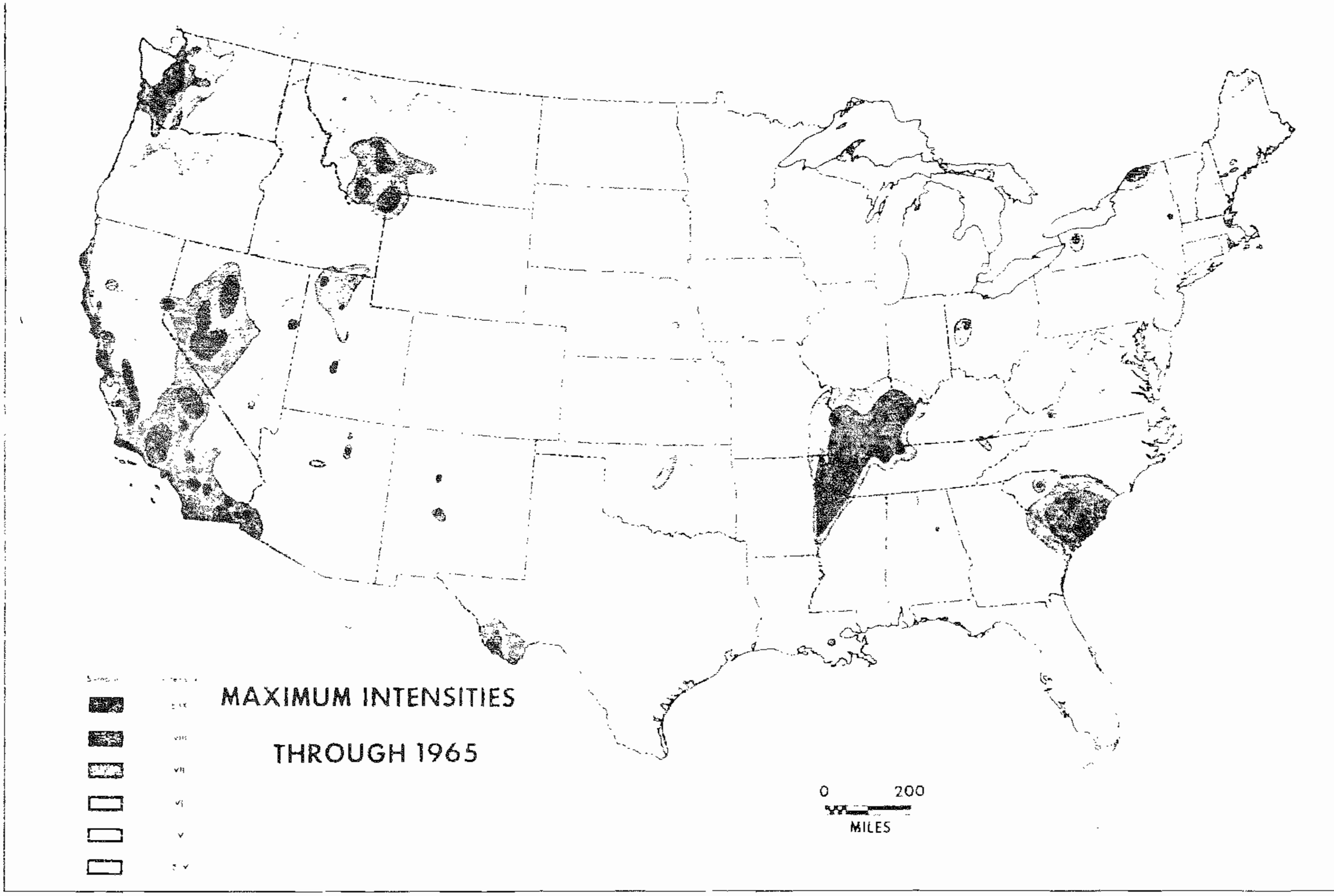
The State should designate UNR Seismological Laboratory to conduct a unified program of siting, instrumentation, maintenance and collection of data from existing and new strong motion stations within the state, that can provide the basis for proper seismic design of important engineering structures within the State. The building permit for large engineering structures shall include a fee for purchase by an appropriate agency of three sets of strong motion instruments to be installed at sites to be selected by the Seismic Safety Council or regional advisory groups. If the sites are within the structure, space and utilities are to be provided by the owner.

VI.
INTRODUCTION

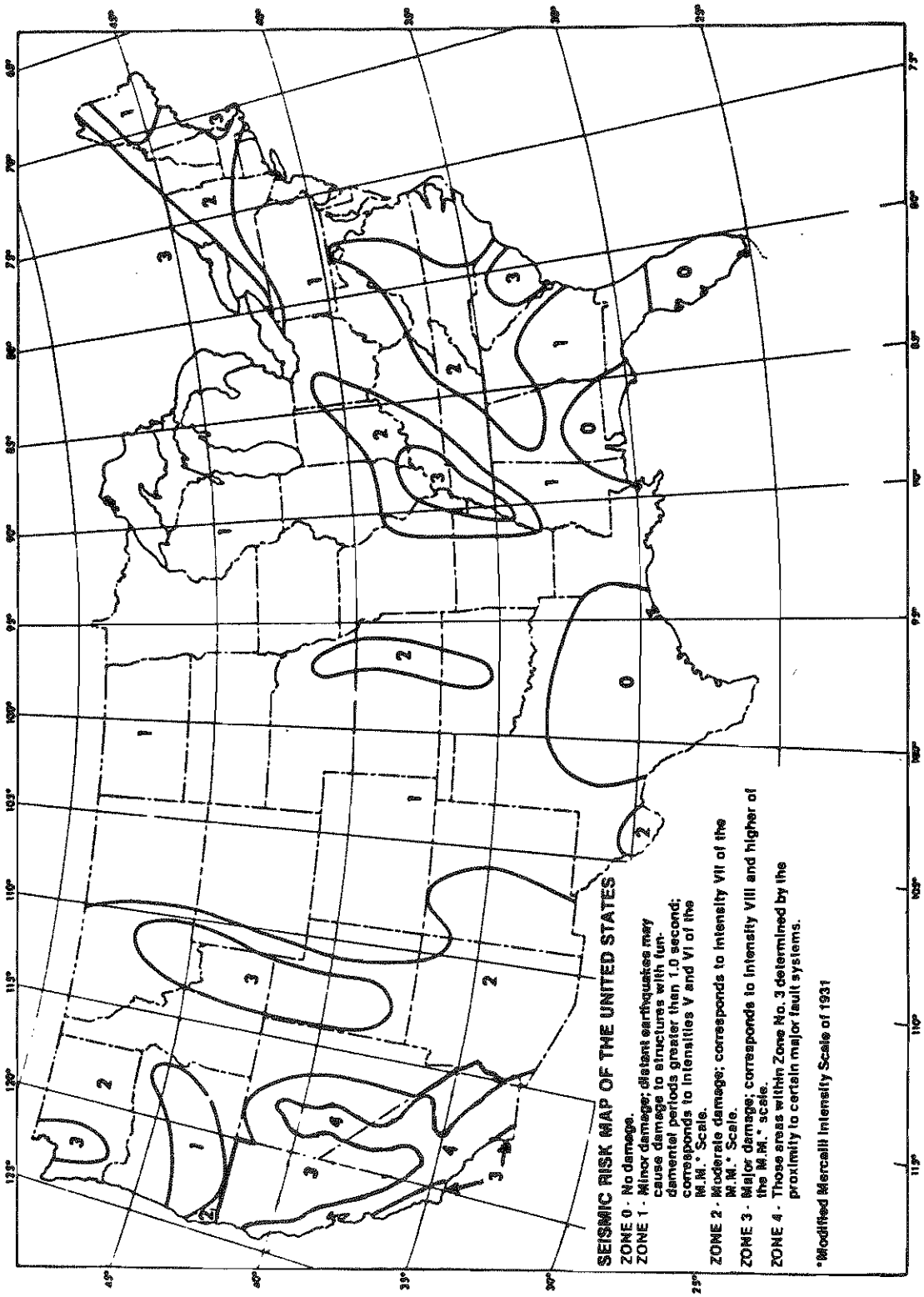
Earthquakes are natural hazards with the potential for devastating impacts in terms of destruction of property, economic loss, human life and suffering. The magnitude of such devastation is amply demonstrated by the 1976 Chinese earthquake that resulted in loss of over 600,000 lives and untold damage to buildings, transportation systems and related human constructions. No place in the world is totally immune to the potential occurrence of earthquakes, though some regions face much higher probability of occurrence than others. Figure 1 is a map of the coterminous states that display intensity of historical earthquakes through 1965 and as can be seen, the western states have had their share. Based on analysis of geologic data, historical earthquake occurrence and related data, the U.S. has been divided into seismic "risk zones", with zone values ranging from 0 (least risk) to 4 (highest risk). These risk zones are shown in Figure 1 and Figure 2, and as can be seen, most of western Nevada is classed as zone 3 and 4 and the balance as zone 2. Figure 3 is a provisional map of active faults in Nevada that gives an indication of earthquake activity over geologic time. The occurrence of earthquakes since 1854 is shown in Figure 4. The last major Nevada earthquake was in 1954 and occurred in the Dixie Valley area. Because of its remote location, little damage was done, but had it happened in one of our urban areas that would not have been the case. Our neighbors in California have not been so fortunate. The 1971 San Fernando earthquake resulted in loss of 58 lives and nearly half a billion dollars worth of damage. Had the Lower Van Norman Dam failed in that earthquake (as it very nearly did) the loss of human life might have been counted in the thousands.

As far as is known, there is no way to prevent or reduce the severity of an earthquake though research on this is being carried out. While we cannot prevent earthquakes, there is much that we can do to reduce the hazards they pose to human life and property. Successful hazard reduction will depend, among other factors, on: 1) development of the ability to predict when and where an earthquake will strike and what its probable magnitude will be; 2) design and construction of earthquake resistant structures; 3) zoning and land use restrictions to prevent certain types of construction or facilities in extremely high risk areas; 4) development of adequate disaster plans to deal with the aftermath of an earthquake; and 5) education of the public about what to do during and after an earthquake.

Many of the potential hazard reduction activities pose significant problems and costs themselves - in particular



Maximum Modified Mercalli intensities throughout the United States - all historical data through 1965 (From Algermissen, 1969 "Seismic Risk Studies in the United States", Proc. 4th World Conference on Earthquake Engineering, V.1, Santiago, Chile)



—SEISMIC ZONE MAP OF THE UNITED STATES

For areas outside of the United States see Appendix Chapter 23

from the

UNIFORM BUILDING CODE

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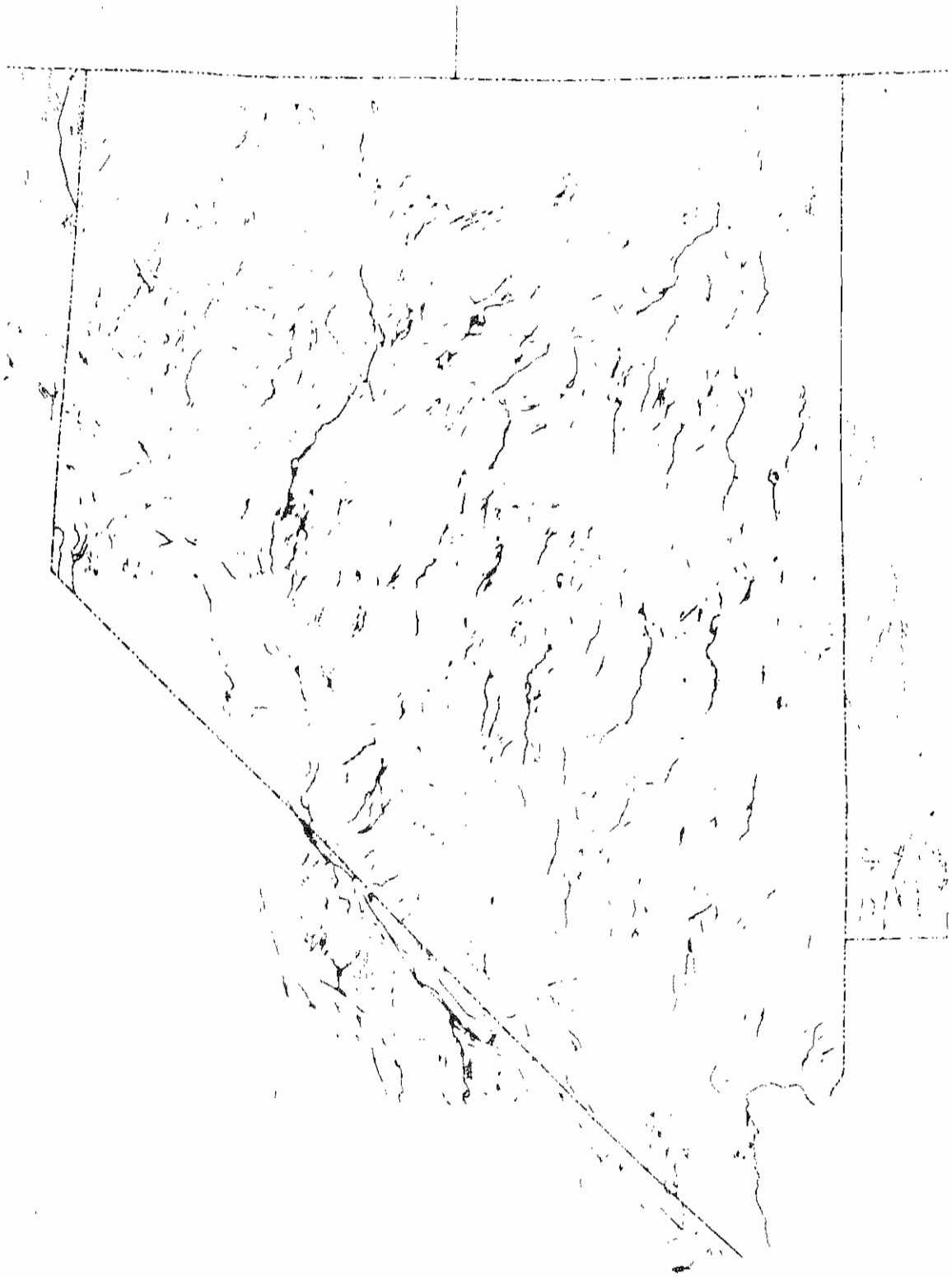
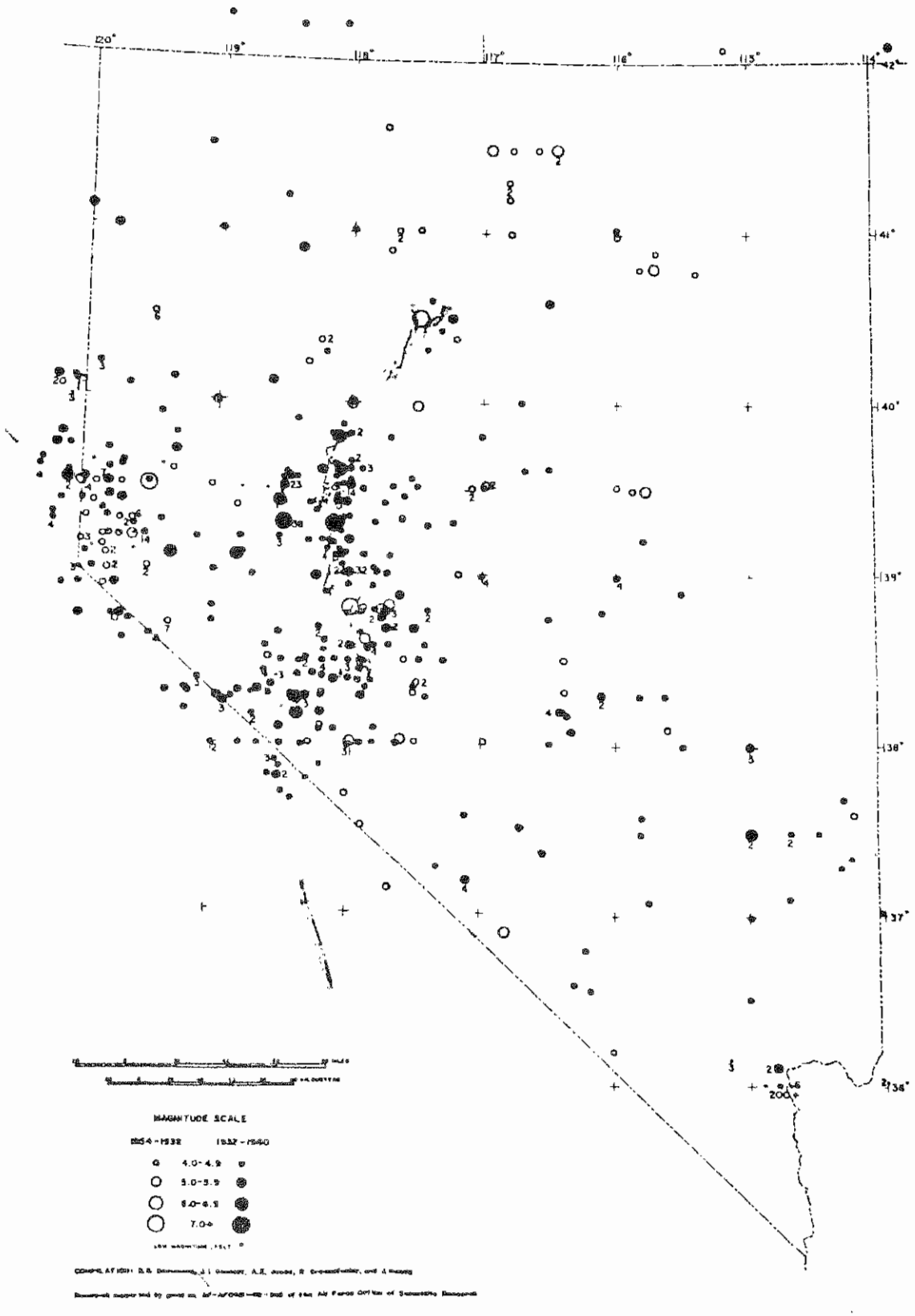


Provisional map of active faults in the Nevada region.
(From Slemmons, 1967, "Pliocene and Quaternary Crustal movements of the Basin and Rangee Province, USA",
J. of Geoscience, Osaka City University V.10)

Figure 4



Nevada Earthquakes, 1854-1960
(From Slemmons, D.B.; University Of Nevada, Reno)

earthquake prediction, earthquake resistant building designs, and zoning and land use. We do not currently have the technology to predict an earthquake, though a great deal of research is being conducted and advances are being made. When this ability is developed, it will pose some serious questions about how predictions are handled and what the social and economic consequences of such predictions might be. If an earthquake prediction is made and the affected community suffers economic depression as a result, are there legal liabilities for the pre-earthquake losses? Questions such as these need to be addressed and resolved.

Programs in seismological and geological research are needed to provide the data base for selection of optimum sites for major construction programs that may have future economic importance to the State. Examples might be nuclear power facilities, nuclear and hazardous waste disposal, aqueducts, dams, MX missile sites, etc.

Because of rapid growth of population in our western states, where the seismic risk potential is high, the potential for devastating earthquake damage has also grown rapidly. This growing hazard potential resulted in the passage by the U.S. Congress of the "Earthquake Hazards Reduction Act of 1977" (P.L. 95-124). In response to this Act, the President, on June 22, 1978, announced the administration's plans for a National Earthquake Hazards Reduction Program." To be succesful, this program will require the active participation and leadership of the individual states.

On August 4, 1978, Governor Mike O'Callaghan created a ten member panel to study how to lessen the damage that could occur from earthquakes in Nevada. The Panel was given six specific charges as follows:

1. Review and evaluate current status of earthquake disaster contingency planning and develop recommendations for improving preparedness.
2. Review, evaluate and make recommendations regarding seismic hazard mitigation procedures, policies and standards in the areas of building codes, zoning, and land use.
3. Analyze and provide recommendations concerning the need for continuing communication and coordination relative to seismic hazard mitigation and how this might best be accomplished.
4. Develop new, or modifications to exisiting, legislation deemed necessary to resolve any identified deficiencies or problems.
5. Identify and make recommendations concerning needed information and educational programs relative to seismic hazards.
6. Identify and establish priorities for needed research and data collection programs within the scope of State or local jurisdictions.

After its appointment, the Panel convened its first meeting in Carson City on August 26 and 27, 1978. At this first meeting, the Panel discussed its charge and how it might best discharge that responsibility. Given the ambitiousness of the charge and shortness of time in which to produce its findings, the Panel decided that a series of work groups should be established to independently address specific topics and report their findings back to the Panel as a whole for deliberation. To this end, eleven work groups were appointed involving over fifty additional knowledgable individuals on a volunteer basis from around the State.

Subsequent to the first panel meeting, the work groups convened in a series of meetings around the State and began working on their assigned tasks. Each work group was to prepare a brief report summarizing its findings and preliminary recommendations for consideration by the Panel at its second meeting.

The second panel meeting was held October 28th in Las Vegas at which time reports on the activities of all the Work Groups were presented. Three of the Work Groups had not yet met and two had met but had not come to the point of summarizing their findings or formulating recommendations. The remaining six presented reports with recommendations. Work Group activities were discussed by the Panel and additional direction provided. Interim reports from all Work Groups were requested for consideration at the Panel's next meeting.

The third panel meeting was held December 8, 1978, in Reno. Reports were presented by eight of the Work Groups with panel discussion on their findings and recommendations. The Work Groups had identified a total of over forty items for consideration by the Panel in formulating its recommendations to the Governor and Legislature. These were discussed individually and reorganized into nine separate categories.

The Panel, in preparing its draft Interim Report, selected five items to be recommended to Governor List and members of the Nevada State Legislature. On December 26, 1979, the Draft Interim Report and Recommendations were distributed, and on January 19, 1979, the Panel met for the fourth time to give final approval to that report. Three additional recommendations were accepted during the 4th meeting, bringing the total number of Panel recommendations to eight.

The Panel held two public briefings, one in Carson City on January 11, 1979 and the other in Reno on February 14, 1979. The briefings provided a non-technical overview of the nature and extent of earthquake hazards and problems in Nevada.

The Panel's fifth meeting, held in Reno on March 24, 1979, convened primarily to discuss how the Panel would prepare its final report due June 30, 1979, and what additional items needed to be addressed by the Panel. A presentation on the State's lack of contingency planning in banks created some concern over the insuring of economic stability following a destructive earthquake.

The Western State's Conference on Seismic Safety, held in Sparks, Nevada on March 30-31, 1979, provided an opportunity for seismic officials to discuss earthquake problems and to develop a mechanism of continued communication coordination among the Western States. That mechanism is the establishment of the "Western Council of Seismic Hazard Officials" to be sponsored in 1980 by the California Seismic Safety Commission.

The Panel's sixth and last meeting was held in Carson City on June 1-2, 1979, and several items concerning revisions to recommendations were examined and accepted for inclusion in the final report. The Panel broke up into six sessions to prepare their findings on the following issues: status of contingency planning, hazard mitigation, information and education programs, research and data needs, communication and coordination, needed legislation and predictions and warnings.

Although the Panel concludes its activites on June 30, 1979 there remains many unanswered questions that should be considered by some entity. The balance of this Final Report is devoted to the Panel's Findings and selected Work Group reports.

VII.

FINDINGS

A. STATUS OF EARTHQUAKE CONTINGENCY

B. HAZARD MITIGATION

C. EDUCATION AND INFORMATION

D. RESEARCH AND DATA COLLECTION PROGRAMS

E. COMMUNICATION AND COORDINATION

F. NEEDED LEGISLATION

G. PREDICTIONS AND WARNINGS

A. STATUS OF EARTHQUAKE CONTINGENCY AND RESPONSE PLANNING

Because much of Nevada is in an area of high seismic risk, there is a strong probability of a severe seismic occurrence in a populated area. Throughout the State of Nevada, there is inadequate planning for seismic disaster. Through adequate disaster preparedness, significant reduction in property damage, loss of life, and social and economic impact, due to the geologically inevitable seismic occurrence can be achieved. A suggested Model Disaster Prepardness Plan (MDPP), adopted by the Panel is presented in the appendix. The MDPP includes both contingency planning and response planning, and it is recommended that the County Civil Defense agencies be responsible for implementation of the Model Disaster Preparedness Plan.

Response planning is post-disaster operations. There are several post-disaster operations plans in existence throughout the State, however, plans are usually uncoordinated or marginally effective. Examples of existing response plans include individual utilities, public agencies and certain Civil Defense programs. It appears Clark County has a better level of response planning for disaster, although the seismic hazard is not adequately addressed in these plans.

- It is the Panel's opinion that the Clark County plans, with the improvement of seismic disaster planning, be considered as models for post-disaster plans in the rest of the State.

Review of disaster plans for utilities operating in the State's major urban areas indicates that there are severe deficiencies. There appears to be few standards against which to develop such plans, and further, the regulatory agencies have not required development of plans. Some of the publicly owned utilities are largely self-regulating which compounds the problem.

In general, these programs exist concurrently with little or no overall coordination and under a MDPP, a satisfactory level of area-wide response would be achieved. This situation could be further remedied by requiring that plans be periodically tested which provides the training necessary to carry out those plans effectively.

Contingency planning can be characterized as pre-disaster planning designed to mitigate the effects of a seismic occurrence. As an example, potentially dangerous structures can be identified and corrective measures instituted to reduce their seismic susceptibility. (See Part B, Mitigation)

- Plans for economic adjustment to seismic hazards as prepared by banking associations need to be examined and utilized as appropriate by the Nevada financial institutions.

The economic consequences of a major earthquake disaster could be extreme both on a short and long term basis. The State's financial institutions should develop contingency plans to insure that necessary funds and credit would be available for reconstruction and development activities. Such plans should be responsive to the needs of not re-creating conditions that led to the prior losses. A program entitled "Risk Analysis and Management Program", has been developed by International Security Technology, Inc., and may be useful in this effort.

The State's Natural Disaster Plan, Annex F, a part of the State of Nevada Emergency Plan (SONEP), has recently been revised and updated. The plan includes an analysis of the earthquake hazards in the State but estimates of casualties and damage are unknown. These estimates could be used as a basis for coordinated Federal, State, and local earthquake response plans. The Panel has reviewed this issue, and it was generally felt that forecasting damage and casualties may be considered highly speculative. Instead, alternative measures based on effective mitigation and response should provide the necessary means of lessening the effects of a moderate to severe earthquake.

B. HAZARD MITIGATION

Mitigation of earthquake hazards involves prevention of new hazards and elimination of existing hazards as part of an overall disaster preparedness response planning process. The hazards may be related to unsafe structures, inadequately designed or constructed utility systems or unstable geological conditions. The hazards can be remedied by utilizing methods of mitigation namely: building code requirements, the mapping of geologic hazards, land use planning, zoning, insurance and assessing of economic impacts. The objective of trying to eliminate existing hazards will be large and should be approached in a rational manner, concentrating first on the most serious problems and then over time, gradually eliminating the rest.

- Structures and their utilities should be inventoried for earthquake response by local building officials, public works officials, planning department personnel and/or other qualified persons at relatively small cost. The inventory should start with the following types of buildings: 1) Vital; 2) Critical; 3) Crucial; 4) Dangerous (old, overhanging facades, unsound parapets, etc.).

It is suggested that the remedial process could be keyed into the building permit process of local building departments. Permits for remodeling could be used as the trigger for correcting deficiencies.

It is further suggested that the unsafe situation of existing dangerous structures can be partially mitigated by the local jurisdictions charging an annual rental fee (added to the property tax?) for the protrusion of structures and appurtences into the public space. Currently, building foundations falling within the public way are charged a fee by some jurisdictions. The use of public way, particularly air space, by building facades, signs, etc., could be similarly and appropriately charged annually.

Building codes represent minimum design and construction standards intended to ensure public health and safety. In this regard, the Panel has concerned itself primarily with those structures and facilities that affect large numbers of people and which might be considered vital, critical, or crucial, or dangerous in the event of an earthquake disaster. The definition being used by the Panel of these four terms (vital, critical, crucial and dangerous) is presented in Appendix C. Types of facilities that fit into each category are also presented. The Panel has identified major issues related to codes, qualifications, the lack thereof, and their implementation.

- Local and State governing bodies need to adopt and require enforcement of the seismic provisions in the latest edition of the Uniform Building Code as published by the International Conference of Building Officials.

Most, but not all, of the major political subdivisions in Nevada have adopted the Uniform Building Code (UBC) for control of building construction. However, each entity has adopted it with exceptions and thus it is not uniformly applied. The State Public Works Board also uses the UBC. Therefore, the Panel believes that, at a minimum, the State should itself adopt and require local entities to adopt the seismic provision of the UBC.

- There is a lack of seismic design standards for both public and private utilities and a lack of seismic performance criteria for critical facilities which should be remedied.

The Uniform Building Code covers most, but not all structures. It does not address "systems" or utilities such as for water or electricity distribution. The degree to which seismic standards are applied to utilities varies tremendously depending upon whether it is public or private and which agency or agencies provide regulatory authority. Development of such standards is beyond the scope of the Panel's charge. The quesion at hand should be more thoroughly addressed and remedial measures suggested.

- Local and state governing bodies need to require all buildings and structures erected in their areas, exclusive of state-owned buildings, to be inspected during construction by the building inspection unit within that jurisdiction.

- Local review and advisory boards need to be authorized and established to examine and inspect sites and buildings that fall outside the expertise of the local building department.

A structure designed to meet seismic criteria will not meet those standards without proper construction practices and careful implementation of the design configuration. For this reason, careful inspection is required. However, it is the Panel's observation that too often this inspection is not carried out. A related concern of the Panel is the degree to which local inspectors are qualified. This latter problem is further addressed under the heading of "Education".

- Local and State governing bodies should require all plans for structures to be used as vital, critical, or crucial facilities to be designed by licensed architects or engineers, and further that all appurtenances to these facilities be designed by licensed engineers.

- Local and State governing bodies should require all sites and routes for vital, critical, crucial and dangerous structures to have a geological investigation by a licensed geologist or engineering geologist prior to the initial or remodeled design.

For facilities falling into these categories that affect the safety and well-being of large numbers of people it is important to insure that seismic concerns are addressed by qualified individuals.

- On-site geological surveys and appropriate seismic hazard interpretations are needed for all existing and proposed critical facilities within the State.

Design of critical facilities on the basis of using large-scale maps depicting "seismic risk zones" is inadequate. Actual on-site investigation of seismic hazards is needed to insure integrity of such structures in the event of an earthquake. Studies of existing facility sites for which this was not done should be undertaken to allow design and implementation of remedial measures.

Site specific studies are essential for evaluating seismic hazards prior to the approval of plans and designs especially with regard to critical and vital facilities. The State should therefore insure and maintain technical and professional standards of persons responsible for evaluating geologic and seismic hazard related conditions. The Panel found that not all geologists or engineers are trained in this somewhat technologically new and specialized field. Geologists, geophysicists and engineering geologists must be qualified for on-site analysis of geologic hazards. The following findings have precipitated from Panel discussions regarding the question of qualifications:

- There is a need for the State to require that geologists, geophysicists and engineering geologists be tested and certified to perform site specific studies for geologic hazard assessment, and a program for certification is needed.

* The qualifications of the professionals who make and interpret geological surveys should be under the surveillance of a state agency with authority to grant licenses.

The Nevada Bureau of Mines and Geology seismic hazard mapping program appears to be of excellent quality but it is seriously underfunded and under-staffed. To date, only three such maps have been issued, and four others are in various stages of preparation. In the long run, one of the most effective means of reducing seismic risks lies in adoption of adequate land use plans, and to accomplish this requires availability of these types of data. Given the rapid rate of population growth and urbanization in Nevada, the time for development of such plans is now, if in fact not overdue.

The mere preparation of a seismic hazard map must not be interpreted as development of policy. Policies based on these data must be formulated by the appropriate agencies. Not to do so places an inappropriate burden and responsibility on the scientists who collect and interpret geologic hazard data. Measures needed to improve this situation are as follows:

* Mapping represents the scientific data base for decision making and policy development, but must not be directly identified as policy because that is the domain of appropriate governmental units (i.e., cities, counties and the State).

* The State of Nevada should substantially increase the next biennial appropriation to the Nevada Bureau of Mines and Geology and authorize increased staff for the express purpose of accelerating the Bureau's seismic hazards mapping program.

An estimate of costs that will be required to bring this mapping program up to an acceptable and realistically accomplishable level was prepared by the Director of the Nevada Bureau of Mines and Geology at the request of the Panel. (See Appendix)

* There is a need to revise NRS 278.160 to make mandatory, on a state-wide basis, the seismic hazard element of local comprehensive land use plans.

Appropriate land use controls can significantly reduce the creation of new earthquake hazards. However, the development of these plans will place additional burdens on local political subdivisions and the State should thus consider providing necessary technical assistance through the State Land Use Planning Office. Effective and timely implementation of

seismic hazard plan elements will also be dependent upon the degree to which the State bolsters the current seismic hazard mapping program at the Nevada Bureau of Mines and Geology.

- Reduction of earthquake hazards would be advanced if the State of Nevada adopted "Alquist-Priolo" type legislation but with full cognizance and advantage of California's difficulties in implementing some provisions of that act.

Among other things, the Alquist-Priolo Act requires delineation of special study zones with high seismic risk and in those zones requires specific geological engineering studies and local authority evaluation with respect to real estate development of structures for human occupancy. This Act should be examined in terms of its application to Nevada and recommendations concerning a similar Nevada program should be considered. (Introduction to Alquist-Priolo Geologic Hazard Zones Act, California S.B. 520, See Appendix D).

- A thorough study is needed of the potential role of insurance in the problem of hazard reduction and of the political and economic implications of alternatives to the current system of voluntary earthquake insurance.

Earthquake insurance is available in Nevada by either extending the fire insurance policy or by converting the fire policy into an earthquake policy. Approximately $35,000 in earthquake premiums was reported in 1977 for Nevada. When compared to the amount of premiums paid for other types of property insurance in the State, approximately 53.8 million dollars, the earthquake coverage is negligible.

The question of insurance is closely related to that of seismic hazard land use planning elements. This type of approach has been adopted in the area of flood hazard reduction and may be equally applicable to earthquake hazard mitigation. This approach and others are presented in Appendix E.

A large earthquake that occurs in the middle of Nevada is a scientifically interesting geological phenomena. If that same earthquake were to occur in one of our major urban areas it would represent a serious social and economic disaster. Major earthquakes are low probability events and as such have received little attention in our State despite their catastrophic nature. With the rapid rate of urbanization being experienced in Nevada the potential for serious damage is increasing proportionately. Aside from attempting to institute sound land use practices that take cognizance of the hazards and construction of safe structures a great deal of emphasis has recently been placed on the potential for predicting major

earthquakes. The potential ability, which is probably about ten years in the future, to predict an earthquake raises some significant socio-economic problems and concerns. For this reason the Panel has devoted a fair amount of time to the topic and offers the following findings without further comment:

- The highest priority in responding to earthquake prediction should be assigned to saving lives, with secondary attention to minimizing social and economic disruption and property loss, provided the costs of specific measures are within the limits that society is willing to accept.

- Prediction should be used in conjunction with a complete program of earthquake hazard reduction, and not as a substitute for any of the procedures in current use.

- High priority should be assigned to develop a standby anticipatory research capability to be utilized as future earthquake predictions are issued. The standby research plan should include comprehensive examination of the social, economic, legal, and political effects of the prediction and of the actual quake.

- Continuing investigation should be made of experiences in utilizing earthquake prediction in countries such as Japan, the Soviet Union, and China, and of the effect of introducing prediction technology in other countries, such as developing nations where earthquake risk is high.

- As an essential feature of advance planning, legal determinations and clarifying legislation ought to be sought to minimize the legal ambiguities that otherwise will hamper officials in making constructive response to earthquake prediction.

- Prediction should be developed, assessed, and issued to the public by scientists rather than by political officials. Procedures need to be developed to insure the free and timely flow of information concerning predictions to all segments of the public. Legislation may be required to assure that information that an earthquake will occur at a given location and time will be made available to the general public in an appropriate manner.

- Circumstances influencing the credibility of earthquake predictions and warnings, and techniques for improving their credibility, need more careful study.

- Scenarios have been developed which reflect public reaction to an earthquake prediction and these should be studied further by successor groups to this Panel in order to fully evaluate the socio-economic effects, not only of predictions, but of the occurrence of actual earthquakes.

C. EDUCATION AND INFORMATION

Various sectors of Nevada's populace need certain kinds of education, training and information before they can understand, prepare for and respond effectively to the threat or occurrence of a major earthquake. Local elected and appointed officials need an adequate knowledge of the seismic problems, so that they understand the need for appropriate mitigation measures and emergency response plans. A basic premise is that all residents should have an appreciation and awareness of the fact there are earthquake hazards in Nevada and should know how to respond in the event of a disaster. The building inspector or plan checker must have adequate training to ensure that structures meet code requirements. And the structural engineer or geophysicist must have the professional knowledge to design facilities or carry out studies that ensure public safety. The Panel has to this point concentrated its efforts on the public information aspects of seismic hazard mitigation. There is a recognized need to improve the qualifications of individuals in most public works and building departments throughout the State, however, the Panel has not had the opportunity to examine means by which the necessary training might be implemented. Another observation is that in Nevada there are many engineers, engineering geologists, and geologists and geophysicists whose professional education was received at universities where seismic hazards, seismic design and related topics are not a major consideration within the curricula. There is a need to assure that the professional education of these individuals is adequate to properly deal with the seismic risks inherent in Nevada. Beyond these latter two concerns all the Panel's conclusions at this point deal with public information.

- There is a need to develop professional and technical education and training programs to assure that seismic hazards are appropriately dealt with at these levels.

Continuing education programs are a necessary part of every professional's career to update and maintain their knowledge with respect to new technological developments. Training is also a vital aspect of assuring that individuals in the technical ranks are capable of properly discharging their responsibilities. Serious consideration will have to be given by the educational community, basically the University System, in developing curricula and programs to meet recognized needs in the seismic hazards area.

- Production of a film or television tapes depicting Nevada's earthquake problems with some emphasis on safety tips would be useful.

The people of Nevada would better understand the earthquake problem in this state if there were a media presentation depicting Nevada. In the past, emphasis has been placed on California's historical events, faults and research endeavors leaving Nevada residents to believe the earthquake problem belongs solely to California.

- A portable demonstrator (trailer) equipped with seismic demonstrations, exhibits and brochures to be shown in shopping mall parking lots, schools, exhibits, conferences, etc., would be effective for providing public awareness.

A mobile demonstrator would be a useful mechanism in disseminating information while creating an interest in the science and technology of earthquakes and related hazard phenomena. Resource information and visual models are available from the Nevada Bureau of Mines and Geology, the UNR Seismological Laboratory and other federal and state agencies. A mobile demonstrator, for example, could be equipped with geologic hazard and epicenter maps, instrumentation models, low-sun-angle aerial photographs (used for fault interpretation), shake-table demonstrations, etc. A mobile presentation would be especially useful in rural areas.

- An "Earthquake Park(s)" could be developed that depicts prehistoric and historic seismic activity for use by students and the general public as part of the Nevada State Parks System.

Because of Nevada's unique geologic characteristics, coupled with enthusiasm for public outdoor recreation, the Panel has discussed such a potential program with the State Division of Parks together with the possibility of initiating a seismic hazard interpretive program. A need has been expressed for preserving a portion of the Genoa Fault (bordering the eastern slope of the Sierras) for scientific research as well as for educational purposes. Development and quarrying operations are slowly covering up or altering the nearly perfect exposures that indicate direction of fault movement and degree of displacement. The close proximity of this fault to Northern Nevada's urban areas provides the stage for geology field trips and, if presented in a manner appropriate for public inspection, the results may be very favorable.

- There is a need for an "Earthquake Disaster Awareness Week" to include public service announcements, a community disaster exercise, school participation (earthquake drills, films, slide, brochures and demonstrations) and emergency preparation review of public (city, state and federal), and privately-owned facilities (hotels, warehouses, etc.).

Often there is a lack of concern on the part of the public for low-frequency events such as major earthquakes. An Earthquake Awareness Week, held annually, might be an effective method by which the media (newspapers, radio, television and films), schools and public and private agencies and institutions serve in a coordinated effort of disseminating information - information that can be instrumental in saving lives in the event of a major earthquake.

D. RESEARCH AND DATA COLLECTION PROGRAMS

Existing Programs

Basic research is being conducted into many aspects of active faulting and geotechtonics, seismology, seismic regionalization, strong earthquake motion, and earthquake design. This research is largely being conducted by University of Nevada personnel within the departments of Civil Engineering, Geological Science, the Seismological Laboratory and the Nevada Bureau of Mines and Geology. Nearly all of this research has been supported by intermittent Federal funding with widely varying funding levels and changing missions or goals. Most federal support is for research; federal support of data collection is limited or non-existent. In Nevada, there are major gaps in present fields of research.

Data collection for evaluation of regional seismic hazard and strong earthquake motion has improved greatly in recent years, but is still almost entirely dependent on federal funding mainly for specialized seismological studies. There is no single agency responsible for compiling and evaluating statewide data in a systematic, long-term program. Federal agencies provide support to operate seismic networks for specific research goals, but tend to regard the operation of regional networks as a state responsiblity. Currently, the Seismological Laboratory operates a modern seismological network and strong motion stations in northwest Nevada, but adequate coverage of southern and eastern Nevada is lacking.

Need for Future Research and Data Collection.

Advances in our ability to understand earthquake mechanisms and hazards have come through scientific research and data collection. Earthquake prediction research is still in an embryonic state of development and is primarily supported at the national level. Much more research is needed not only in the area of earthquake prediction, but also in engineering design, human response to disasters or disaster predictions, institutional mechanisms to cope with earthquake hazards, disaster relief and many related topics. Support of such research programs at a modest level is within the scope of State and local jurisdictions. The Panel's principal finding is that:

- There is a need for the State of Nevada to plan and support a long-term integrated program of basic and applied seismological research and data collection.

The basis for assessment and evaluation of earthquake hazards, and eventually prediction, lies in the development and maintenance of a reliable data base on geological and seismological conditions, events, and phenomena. In this regard, there are three elements of primary concern stated below:

- The State of Nevada needs a permanent, state supported basic seismic network to provide uniform coverage of earthquakes in the State, with capability for rapid epicenter and magnitude determination.

Earthquake epicenter locations, magnitudes, and ground acceleration are basic data in the study of seismic hazards, and the rapid determination of those factors are important to alert Civil Defense and other disaster agencies of changes in activity that could warn of an impending large earthquake. The University of Nevada, Reno, Seismological Laboratory now maintains a limited seismograph network focused on northern Nevada. However, over 85% of the support for that effort is dependent upon Federal grants and contracts, and the program is therefore subject to the uncertainties and vagaries of shifting Federal Programs. The Panel believes that this program should be strengthened through greater State participation and support. The Director of the Seismological Laboratory has prepared a statement of what could be accomplished with greater state support. (Appendix F)

- There is a need for the State of Nevada to promote the development of an adequate statewide strong motion instrumentation and analysis program for major or structures for various types of ground and bedrock conditions.

Strong motion instruments provide a record of the response of structures to earth motion induced by earthquakes. This record integrates factors of the structural design, local soil and bedrock condtions, and the magnitude and duration of ground motion. These data are important to the design of seismically safe structures, analysis of structural damage following an earthquake, and the study of geological and geophysical factors important to seismic hazards. The Uniform Building Code requires installation of strong motion instruments in buildings of certain size and in consequence many have been installed in the Reno and Las Vegas areas. However, the indiscriminant requirement for these is ineffective in terms of assuring appropriate geographic distribution. A related problem is associated with the qualifications of individuals responsible for selection of the type and quality of instruments, since the UBC is silent on this important factor. Furthermore, there is no program for maintenance of instruments or analysis of the data. A program is necessary to make this

a fruitful endeavor. It has been suggested that such a program could be financed through a surcharge on building permit fees to assure equitable distribution of costs.

* Significant benefits would be realized if the State of Nevada established a public repository for archiving basic geological, geotechnical, and geophysical data developed to assess seismic hazards or design criteria in relation to construction and building activities.

The siting or design of buildings or other structures generally involves study and investigation of the site to detect presence of earthquake faults, or to determine soil conditions. This generally involves shallow borings to determine soil properties and, in the case of major structures, can include trenching to locate and log faults, and seismic velocity studies. All of these data are critical to increasing our general knowledge of seismic activity and assessing earthquake hazards. A large amount of valuable seismic hazard data is being developed by consultants on a day-to-day basis in support of all acttivities. The preponderance of these data, contained in consultant reports, never enter public domain even though they are developed to support activities for which government permits are required. On the other hand, a precedent exists in the State Water Law related to "well logs" for requiring submittal of such types of data for use by the general public.

There is no single agency responsible, or active in collecting, evaluating, and compiling statewide or regional data in a systematic, long-term program. Federal agencies regard this as a state responsibility.

The proposed center should be established, and a mechanism is needed to make data publicly available to enhance our mitigation of seismic hazards. The Nevada Bureau of Mines and Geology should be charged during the coming biennium with developing and efficient mechansism for getting the data and developing "rules and regulations" pertaining to the types and format for data submission.

Geotechnical studies made to discover information relative to earthquake and seismic risk or hazard, or earthquake engineering design data from which interpretations and conclusions are formulated, should be provided to the Center. Such data should include, but not be limited to, fault maps, exploratory trench profiles and cross-sections, test borings, and geophysical base data such as seismic refraction or reflection records. Data related to mineral, oil and gas, and geothermal resources or exploration can be depositied in the Nevada Bureau of Mines and Geology general data files at the discretion of the originator. Old data should be subject to inclusion and furthermore, contributors of data should not be held liable for any subsequent use of that data. The mechanism and related rules and

regulations should be subject to public hearing before their adoption. Funding during the first two years should cover only the cost of the above items. Implementation funding should be delayed until such time as an operable program is defined.

Research Priorities

To date, the State has had minimal participation in a number of research areas that are critical to an adequate program of earthquake hazard reduction in Nevada.

Foremost among these is the statewide seismic network which has, over the last 15 years, received support primarily from federal research contracts and has therefore been subject to continual shifting of priorities within the federal program.

A second program of vital importance is the strong motion instrumentation program which, at the present time, lacks central direction or State funding. Other areas of the overall research program in order of their priority are: acquisition of high resolution aerial photography and archiving of basic research data.

- The State of Nevada should support a permanent, basic seismograpic network operated by the Seismological Laboratory to provide statewide coverage of earthquake epicenters and Richter magnitudes to be telemetered to the Laboratory for rapid and effective analysis for disaster evaluation and response, and archiving for detailed or specialized studies.

- The State should support a program of strong motion instrumentation of major or vital engineering structures, and of various types of ground and bedrock conditions on a statewide basis to develop an adequate strong motion program.

- The State should initiate, perhaps with the federal government and adjoining states, a program of remote sensing data including high resolution photography with low-sun angle U-2 photography that will assist in mapping and evaluating the distribution and characteristics of active faults, and stable tectonic blocks of Nevada.

- Basic geological data should be archived to prepare an integrated State of Nevada program of research and data collection that will provide essential earthquake information and analysis that will satisfy local and statewide needs.

E. COMMUNICATION AND COORDINATION

Prior to creation of the Ad Hoc Panel there was no state or local entity or program providing communication and coordination with respect to seismic hazards or, in fact, addressing the full spectrum of seismic hazards. The Nevada Civil Defense and Disaster Agency had a limited program that addressed natural hazards disaster planning and largely through the efforts of a single individual, provided programs to elementary schools around the state. Within the University, the Bureau of Mines and Geology, the Seismological Laboratory and Civil Engineering Department, all had specific programs dealing with seismic hazard mapping, seismographic network and research, and seismic structural research, respectively. Most of these efforts, while important, were disciplinary in nature. Basically, the Civil Defense program was the only program that involved individuals from different governmental levels.

The Panel provided the first effort that brought together the many interested disciplines, governmental levels and the private sector to address the seismic hazard problem. This interdisciplinary mixing of individuals with different responsibilities served to expose the severe lack of coordination and communication. As well, it brought to light numerous problems that should be addressed and rectified to enhance public safety in a potentially disastrous earthquake.

It is the Panel's firm conviction that the State of Nevada must establish some sort of coordination vehicle to enhance the effectiveness of all exisiting relevant programs and to identify and promote needed new initiatives. To this end the Panel has developed draft legislation to establish a "Nevada Seismic Safety Council". This draft legislation (See Appendix A), is patterned after Utah's legislation which in turn used California legislation as a model. In both Utah and California, the established seismic safety groups have served to effectively provide coordination and leadershp. These groups have not attempted to usurp existing agency programs, but rather have strengthened and supplemented those efforts. The same affect can and should be possible in Nevada.

Not only is there a very real need for such a "council" to address Nevada problems, but also to provide a focal point for communication and coordination with other states and the federal government. In March, 1979, a "Western States Seismic Safety Council" was created at a joint meeting of seismic safety officials from California, Nevada, Utah, Arizona, Montana, Washington and Colorado. The object of the WSSSC is to promote cooperative programs and provide a more unified front to deal with Federal agencies and programs, not only to hold off undesirable programs but to mold necessary activities.

Because of the Panel's perception of the need for a seismic safety focal point, they reiterate the following:

- The State of Nevada should establish an independent and interdisciplinary Seismic Safety Council to continue the efforts initiated by the Ad Hoc Panel on Seismic Hazards Mitigation.

In as much as the 1979 Nevada Legislature adjourned without addressing the question of seismic hazards or holding any sort of hearing on the above recommendation, the Panel strongly urges as an interim measure, that Governor List officially continue the Ad Hoc Panel. Formal continuation should provide the Panel with authority to seek Federal or other funds to support its activities.

F. NEEDED LEGISLATION

In addressing the question of earthquake hazard reduction, the Panel considered several programs which will require enabling legislation or legislative direction for program development and implementation. Many of the items have been discussed in previous sections of this report and are highlighted as follows:

- The State of Nevada should establish an independent and interdisciplinary Seismic Safety Council to continue the efforts initiated by the Ad Hoc Panel on Seismic Hazards Mitigation.

This Council should have broad representation on both a disciplinary and functional basis and, because of the cross-cutting nature of Seismic Hazards, should be independent from any agency currently dealing with aspects of the problem. The need for such an entity is not now being met by any state organization other than the Ad Hoc Panel. The Panel has developed a draft of legislation for consideration by the Governor and Legislature for implementing this recommendation. The legislation adopted by Utah on this subject at this time appears to be a good model and has formed the basis for the Panel's draft. The proposed Act is included as Appendix A of this report.

- The 1981 Session of the Nevada Legislature should revise NRS 278.160 to make mandatory, on a statewide basis, the seismic hazard element of local comprehensive land use plans.

There is virtually no legislation within Nevada Revised Statutes that addresses the problem of seismic safety or hazards. The sole exception to this statement seems to be NRS 278.160 which allows for development of "seismic safety" as part of county or city general land use plans.

The Panel believes that the seismic hazards of Nevada are of sufficient concern to warrant the mandatory preparation of seismic safety plans. The Panel recognizes such a requirement will place burdens on some jurisdictions that may necessitate State assistance of both a technical and financial nature. Ability to prepare such plans, however, will be dependent upon availability of basic geological and seismological information and data that define the nature and extent of seismic hazards in any given locale. These data are not now available for the vast majority of the State's urban areas. This problem is the subject of the following proposed legislative considerations:

- State legislation is needed to require local jurisdictions to adopt the seismic provisions of the Uniform Building Code.

- Nevada should provide enabling legislation to establish a State entity with responsibility for a uniform system of strong-motion and seismicity instrumentation and the needed monitoring of such. A fee structure should be explored to provide a basis for long-term financing of installation, operation and maintenance of instrumentation systems for seismicity and strong motion. (See Appendix G)

- Legislation is needed to provide a registration or certification program to assure that qualifications are established for professionals charged with addressing seismic concerns.

- Legislation should be devised affording liability protection for the Governor and other State and local officials charged with responsibility for issuing warnings regarding impending seismic events.

G. EARTHQUAKE PREDICTIONS AND WARNINGS

There are two barriers to effective prediction of earthquakes and dissemination of warnings to the public. The first obstacle is technololgical: at present there are no accurate and consistent methods for predicting seismic events. The State of Nevada can do very little to overcome this problem aside from encouraging further University System research. The State should also cooperate with the U.S. Geological Survey and other scientific organizations which might provide information, however tentative, about a possible seismic event in Nevada.

The second obstacle to a system of earthquake prediction and warning is legal deterrence. Simply put, the present system of liability discourages reputable scientists and public officials from issuing warnings that may prove to be inaccurate. The recent trend of court decisions is to assess damages against local and state governments that were once immune from suit. Such liability results from a new found disregard for the "Act-of-God" defense, higher standards of care for public officials, and a desire to spread the catastrophic effects of individual loss among the general public. For these reasons it is no longer safe to ignore the problem of earthquakes; governmental bodies must make at least a minimal effort to mitigate seismic hazards.

To encourage responsible and constructive government action it is absolutely necessary to create a form of immunity for state and local officials and any reputable person who supplies data to them. It is also vital to establish a system for evaluation and dissemination of earthquake predictions.

As a preliminary step in establishing a system for seismic prediction and warning, the Panel offers the following:

- The State of Nevada should establish a procedure whereby (1) responsible scientists, engineers, and other persons can furnish data concerning a potential seismic event to a single agency, (2) those data can be evaluated by qualified persons to determine when and whether a warning should be issued to the public, and (3) the person or agency responsible for issuing the warning and the means of giving warning are clearly delineated.

- The State Legislature should enact a law providing immunity to the State, its agencies and officials, and all other persons involved in the system established for prediction, evaluation and warning. Such immunity would absolve these persons and entities

from legal liability for personal injury, death or property damage (including injury to commercial and business interests) caused by the issuance or non-issuance of an earthquake warning. Immunity would also extend to any acts or omissions involved in fact gathering, evaluation, and other activities leading up to issuance or non-issuance of a warning.

VIII

APPENDICES

A. AD HOC PANEL ON SEISMIC HAZARD MITIGATION PROPOSED SEISMIC SAFETY LEGISLATION

B. EARTHQUAKE HAZARD MAPPING PROGRAM FUNDING STATEMENT

C. WORK GROUP REPORT ON CRITICAL FACILITIES

D. FAULT HAZARD ZONES IN CALIFORNIA

E. EARTHQUAKE INSURANCE

F. STATE SEISMIC NETWORK FUNDING STATEMENT

G. STRONG MOTION INSTRUMENTATION

H. WORK GROUP REPORT ON BUILDING CODES

I. BUILDING CODE WORK GROUP REPORT ON DISASTER PREPAREDNESS

Appendix A

AD HOC PANEL ON SEISMIC HAZARD MITIGATION

PROPOSED SEISMIC SAFETY LEGISLATION

1979

AN ACT RELATING TO SEISMIC SAFETY; PROVIDING A STATEMENT OF PURPOSE; CREATING A SEISMIC SAFETY COUNCIL; ESTABLISHING CURRENT MEMBERSHIP, DUTIES, TERMS OF OFFICE, ADMINISTRATIVE ORGANIZATIONS AND COMPENSATION; AND APPROPRIATING FUNDS FOR PURPOSES OF THE COUNCIL.

The People of the State of Nevada, represented in Senate and Assembly, do enact as follows:

Section 1. The legislature finds that a preponderance of evidence indicates that most communities in Nevada are in a high seismic risk area. There is a pressing need to provide a consistent policy framework and a means for educating the public and private sectors. There must be a means of coordinating the earthquake-related programs of agencies at all governmental levels and their relationships with elements of the private sector involved in practices important to seismic safety. This need is not now being met by any state government organization.

Section 2. There is created a state seismic safety council, which shall report annually to the governor and the Legislative Council Bureau on its findings and recommendations relating to earthquake hazard reduction.

Section 3. (1) The council shall consist of 16 members appointed by the governor. The seismic safety council shall elect biennially from its membership its own chairperson and vice-chairperson and may replace them with other members by majority vote.

(2) The council shall adopt by-laws to govern conduct of the business of the council.

Section 4. The governor shall appoint one member each from the Senate and the Assembly of the Nevada Legislature, one member each from lists supplied by the Nevada League of Cities and the Nevada Association of County Commissioners, and shall appoint the director, Seismological Laboratory, University of Nevada and the director, Nevada Bureau of Mines and Geology. Nine members of the council shall be appointed by the governor, one each from the fields of geology, geological engineering, civil engineering, structural engineering, architecture, planning, public utilities, socio-economics and emergency preparedness. Where appropriate these appointments should be made from lists solicited from the concerned professional organizations or societies. One member shall be appointed from the public at large.

Section 5. (1) The members of the seismic safety council shall serve without compensation but shall receive the travel and subsistence allowances fixed by law for state officers and employees.

(2) The council shall meet at least quarterly and additionally as scheduled or at the call of the chair.

Section 6. The council in the discharge of its responsibilities may:

(1) Apply for, receive and disburse grants, contributions and appropriations from public agencies, private foundations, individuals, or any other source to carry out provisions of this act;

(2) Appoint committees from its membership, appoint advisory committees from interested public and private groups, and appoint ex-officio members, who shall not be entitled to vote, to advise the council;

(3) Contract for and employ, with the approval of the State Budget Director, any professional services and research required by the council or required for the performance of necessary work and services, which in the council's opinion, cannot be satisfactorily performed by its officers and employees or by other state or federal or local government agencies;

(4) Sponsor, organize and hold on its own or in cooperation with other organizations such seminars, conferences or meetings that will further the goals of improving seismic safety and reducing earthquake hazards.

Section 7. An executive director shall be appointed by the council and be responsible for managing the affairs of the council subject to the direction and policies of the council. The executive director shall appoint such employees as may be necessary to carry out the functions of the council.

Section 8. The council shall be responsible for the following in connection with earthquake hazard reduction:

(1) Providing for the governor a review and analysis of the scientific basis and validity of earthquakes predicted for Nevada by any government agency, individual scientist or other person. Such review and analysis shall be provided before notification to the public by the governor or a predicted earthquake or the issuance of an earthquake warning;

(2) Suggesting goals and priorities in the public and private sectors;

(3) Requesting appropriate state agencies to devise criteria to promote seismic safety;

(4) Recommending program changes to state agencies, local agencies and the private sector where such changes would reduce earthquake hazards.

(5) Recommending (a) methods for improving building standards and compliance with standards; (b) siting and design policy for important facilities such as power plants, natural gas storage reservoirs, dams, water and waste water facilities, hospitals, and schools;

(c) methods and policies for the delineation of fault zones for which special investigation, regulation and reporting procedures may be required.

(6) Recommending training to improve the competence of specialized enforcement and other technical personnel.

(7) Assisting the coordination of seismic safety activities of government at all levels , and the private sector.

Section 9. The council shall:

(1) Review state budgets and receive information concerning proposals for earthquake-related grants and advise the governor and legislature thereon;

(2) Review proposed earthquake-related legislation, advise the governor and legislature concerning such proposals, and propose needed legislation;

(3) Recommend the addition, deletion, or changing of state and federal agency standards when, in the council's view, the existing situation creates an undue seismic hazard, or when new developments would promote seismic safety, and conduct public hearings, as deemed necessary, on the subjects.

Section 10. All officers, boards, commissions, councils, departments, divisions, bureaus, districts and any other unit of government, including the political subdivisions of this state, shall upon request of the state seismic safety council provide the council with any information they may have concerning any aspect of seismic safety and earthquake hazard reduction and shall otherwise cooperate in every possible manner to assist the council in carrying out its duties under the law.

Section 11. There is hereby appropriated for purposes of this act a sum of ninety thousand dollars for fiscal year 1979-80 and a sum ninety-eight thousand dollars for fiscal year 1980-81.

Section 12. This act becomes effective upon passage.

Section 13. This act expires by limitation on June 30, 1985.

The terms of all 16 members appointed shall expire June 30, 1985. All appointments shall be made before July 1, 1979. Any vacancies occurring shall be immediately filled by the appointing power for the unexpired portion of the term.

PROPOSED NEVADA SEISMIC SAFETY COUNCIL MEMBERSHIP LIST:

1. Member from League of Cities
2. County Commissioner
3. Director Seismological Lab
4. Architect (A.I.A.)
5. Director of Nevada Bureau of Mines and Geology
6. Civil Engineer
7. Geological Engineer
8. Planner
9. Utilities/Lifeline Representative
10. Emergency Preparedness
11. State Senator
12. State Assemblyman
13. Sociologist/Economist
14. Geologist
15. Structural Engineer
16. At Large

Appendix B
Earthquake Hazard Mapping Program
Funding Statement
developed by
Nevada Bureau of Mines and Geology

The purpose of this statement is for accelerating earthquake hazard related studies. At present, earthquake hazard studies are generated through three sources:

1. State-supported, N.B.M.G. activities.

   The N.B.M.G. Engineering Geologist devotes part of his time to producing geologic and earthquake hazard maps as part of the Environmental or Urban Folio Program. Annual Cost = $13,000 (salary and operating).

2. State-supported, U.S. Geological Survey activities.

   The N.B.M.G. directs and supervises a co-operative cost-sharing program with the Branch of Western Environmental Geology, U.S. Geological Survey, for the production of geologic and earthquake hazard maps. Annual cost = $25,000 (State Funds)
   $25,000 (matching U.S.G.S. Funds)

3. Federally-supported, N.B.M.G. activities.

   The N.B.M.G. has for several years received U.S.G.S. Earthquake Hazard Reduction Grant monies. This money supports several months of earthquake hazard work by the N.B.M.G. Research Associate, but is granted to us only on an annual basis and has no guarantee of continuing in the future.
   Annual cost FY 77-78 = $28,000 (Includes overhead which is
   FY 78-79 = $44,000 not available to do the work).

If the Nevada Bureau of Mines and Geology were to accelerate the production of earthquake hazard data, a significantly large increase in funding would be necessary. The attached list of quadrangles is considered a minimum degree of coverage for the urban areas of the State, and the production of geologic and earthquake hazard maps for these quadrangles will cost approximately $1.72 million. To accomplish this within the 4-year period, which appears unrealistic, it may be more beneficial to use a more long-range program, or (less satisfactorily) to cut the number of quads.

As the attached cost estimates indicate, each geologic and earthquake hazard map will cost about $20,000. Each geologic map will require 6 man (geologist)-months and each hazard map 4 man (geologist)-months for completion. These maps are normally done in pairs (i.e., a geologic and a derivative hazard map for the same quad), but it may be more productive to concentrate on producing geologic maps first since they contain a major portion of the data eventually placed on the hazard map, and users could develop their own hazard maps.

The Director of the Bureau of Mines and Geology feels the best approach would be to have a long-term program -- one additional geologist -- rather than a very expensive crash program. And maybe cut down the number of quadrangles covered.

In addition to the urban geologic mapping, studies should also be promoted on a regional basis. This research can be group into two categories: 1) regional mapping, and 2) topical studies. The funding requirements for these projects are listed on the attachments. Both categories would each require one new geologist position on a permanent basis.

Cost Estimate for One Geologic Map

1.	Salary	
	Geologist - 6 mos. @ $1850/mo.	$ 11,100
	Drafting	1,800
2.	Operating	
	Vehicle and Per Diem 60 field days @ $75/day	4,500
3.	Supplies	
	Topographic bases, aerial photographs	900
4.	Printing	1,400
	Total cost per map =	$ 19,700
	One-time capital outlay:	
	1 vehicle per geologist	Approx. $ 8,000

Cost Estimate for One Earthquake Hazard Map

1.	Salary	
	Geologist - 4 mos. @ $1850/mo.	$ 7,400
	Technician - 2 mos. @ $1000/mo.	2,000
	Drafting	1,800
2.	Operating	
	Vehicle and Per Diem 60 days @ $75/day	4,500
3.	Field Expenses	
	Trenching, age-dating	3,000±
4.	Supplies	
	Topographic bases, aerial photographs	900
5.	Printing	1,000
	Total cost per map =	$ 20,600
	One-time capital outlay:	
	1 Signal Enhancement Engineering Seismograph	Approx. $ 15,000

Cost Estimate for Regional Mapping

Proposed fault zone mapping:

a) East flank Carson Range
b) Walker Lane
c) Olinghouse fault zone
d) Las Vegas shear zone
e) Central Nevada Seismic Belt
f) Furnace Creek fault zone

Salary	
Each one of the above zones would require 1 man-year	$ 22,000
Operating	
Vehicle and Per Diem - 120 field days/year	9,000
Supplies	
Drafting, aerial photos, age-dating	3,000
Total for each zone per year	$ 34,000

Cost Estimate for Topical Studies

Proposed studies to cover recurrence interval determinations, ground-motion, liquefaction problems, soil column response, wave attenuation, etc.

Salary	
1 man-year	$ 22,000
Operating	
20 field days/year	1,500
Supplies	1,500
Total per year	$ 25,000

Quadrangle Coverage

Reno-Carson City Area

Reno * +
Vista *
Mt. Rose NE * +
Steamboat *
Reno NW *
Carson City * +
New Empire * +
Washoe City + +
Verdi
Reno NE
Spanish Springs Valley NW/1
Spanish Springs Valley SE/1
Wadsworth SW/1
Wadsworth SE/1
Wadsworth NE/1
Genoa
McTarnahan Hill
Minden
Gardnerville
Virginia City
Dayton NE/1
Nixon SW/1
Nixon SE/1

Lake Tahoe Area

South Lake Tahoe * +
Glenbrook
Marlette Lake

Las Vegas Area

Las Vegas SE * +
Las Vegas SW *
Las Vegas NW
Las Vegas NE
Henderson
Frenchman Mt.
Boulder Beach
Boulder City
Boulder City NW
Boulder City SW
Boulder City SE
Blue Diamond SE
Blue Diamond NE
Tule Springs Park
Gass Peak SW
Valley

Elko Area

Elko East
Elko West

Other Areas

Fallon NE/1
Ely
East Ely
Winnemucca NW/1
Battle Mountain NW/1
Hawthorne/1
Lovelock NW/1
Yerington NW/1

* Geologic map completed or currently funded.

\+ Earthquake hazard map completed or currently funded.

/1 7 1/2-minute topographic map not presently available.

Appendix C
Work Group Report
on
Critical Facilities

I. INTRODUCTION

Facilities are considered to be critical if their failure would have severe impact on safety, public well being, property damage and ability to carry on vital services. The purpose of this report is to propose ways by which the seismic hazards of such facilities can be mitigated.

II. PRESENT SITUATION

Areas where there is a likelihood of damage being caused by earthquakes are commonly delineated on "Seismic Risk Maps". One map shows five zones of seismic action numbered from 0 (least risk) to 4 (highest risk). Most of western Nevada is classified on zones 3 and 4 and the balance of the State on zone 2. It therefore is evident that critical facilities in Nevada at sometime in the future are to be expected to be subjected to substantial seismic stresses. The extent of damage to a structure caused by seismic ground motion of a given intensity will depend on how well the structure was designed to resist the induced forces. Tall or unusual structures are particularly vulnerable to earthquake damage. How well existing facilities meet modern criteria for earthquake resistant design is not known. There are insufficient hard data available on site geology and structural design of many existing critical facilities in Nevada to know generally how they will respond to earthquake loads. Past designs can be classified into these three categories:

(1) Those where no special consideration was given to seismic loads;

(2) Those where a seismic risk zone was recognized and an arbitrary increase in the gravitational forces applies;

(3) Those where a site geological survey assessed the geologic features and provided data for estimating the forces resulting from strong ground motions.

Designs of many old structures did not recognize seismic loads. In recent years, the use of seismic risk zones to establish earthquake loads has been in common use. This approach has been incorporated into building codes and is being enforced by building officials for structures under their cognizance. On site seismic assessments are performed when called for by the designers of permit issuers of important structures. Public policy in general does not require their use except in certain high risk cases such as atomic power plants and water storage dams above populated areas.

In addition to concern for structural integrity of facilities after earthquake shocks, there is also concern for the integrity of appurtenances, auxiliaries and stand-by back-up equipment. For facilities to remain functional and fulfill their purpose after a severe earthquake, the electrical, mechanical and hydraulic appurtenances also must remain functional. It is equally important that these systems remain functional after other disastrous events such as fires, floods, high winds and blasts. Those facilities, with emergency stand-by electric generators, auxiliary water supplies, etc., are tested regularly by designated public officials. That such equipment is operational under normal conditions is readily determined. To be able to determine whether such equipment will be operational after an earthquake is another matter. Officials responsible for testing stand-by equipment generally are not qualified to judge the adequacy of designs to resist earthquake shock. Designers of the mechanical,

electrical and hydraulic systems, both regular and stand-by, must also consider such earthquake effects as shifting generators, capsizing watertanks, dislocated transformers and control panels and ruptured conduits.

Trained and experienced professionals are required to determine the likely earthquake effects, whether the facilities are adequately earthquake resistant and also what must be done to correct deficiencies. Through the licensing and registering of professional engineers, the State exercises surveillance over the qualifications of those professions that deal with all design features once the likely ground motions are predicted. There is no similar surveillance of the qualifications of the persons who make the geological surveys and interpret the likely earthquake action.

III. PROBLEMS IDENTIFIED

Several problems require solution before there can be assurance that critical facilities will remain serviceable after an earthquake disaster. First, it is necessary to define those facilities whose service is sufficiently important to warrant public surveillance of their integrity against earthquake shock.

Second, there is need to establish guidelines for how earthquake loads will be determined and minimum resistance for these loads.

Third, there is need to establish qualifications of professional scientists and engineers that evaluate sites and determine the probable seismic forces.

The problem of mitigating earthquake hazards of critical facilities can be divided into two parts;

(1) Proposed new facilities

(2) Existing facilities

Exercising quality control over construction of new facilities is a problem. Most construction is controlled by building officials and licensing agencies. They can set earthquake hazard mitigation requirements and deny construction permits if design requirements are not met.

Determining whether existing facilities meet new standards of seismic resistance, and bringing to standard those that are deficient is a much more perplexing problem. A program of evaluating existing facilities and correcting deficiencies to meet new standards will require new legislation and new authorities. Such a program will be a cost to owners and to responsible government agencies. In that Nevada has not had a disastrous earthquake in highly developed urban areas, many persons will question the need for such a costly program. Owners may be financially unable to engage the required technical services and make necessary structural changes. There will be cases where the benefit/cost ratio will be less than unity. Means should be developed to appraise the benefits when required changes are necessary. Perhaps benefits could be quantified in terms of prevention of personal injury and property damage, and prevention of loss of life or loss of services. Numerous alternate solutions may need to be considered, such as limiting use and occupancy, restricting the services provided and providing passive defense against likely hazards.

Establishing a program of earthquake hazard mitigation in Nevada will be a serious and costly undertaking. It must be practical, fair to all concerned and conducted on the highest professional level. In that earthquake induced loads are based on estimated earthquake actions, it follows that geological determinations are the heart of the entire hazard mitigation program. The qualifications of those who develop the geologic data are of paramount importance if the public interest

is to be properly served. We believe at present the State of Nevada does not exercise the kind of jurisdiction over geologists' qualifications as is necessary to insure a meaningful seismic hazard evaluation program.

IV. PROPOSED SOLUTIONS

In any area subject to earthquake shocks, structures should be designed to withstand expected ground motion without major structural damage. For ordinary facilities such design requirements are incorporated into the building codes. There are certain facilities which require a more "failsafe" consideration because their failure will not be tolerated by our society. Such facilities are generally "critical" but in this report they are further categorized as "vital", "critical" and "crucial". It is the conclusion of this work group that all three of these categories require site information and design criteria beyond that included in the building codes. This report outlines the kinds of site data required to evaluate response to strong ground motion. Hazards can be mitigated on proposed facilities by considering alternate sites and using site treatment followed by proper designs. The options for retrofitting deficient existing facilities include site treatments and structural modification. Adequacy of new construction and modifications can be controlled by the permit process. Existing facilities that are sub-standard present a perplexing problem. Experience in other states indicates legislation of standards in itself does not solve the problem. Incentive cost sharing by state and federal agencies has been effective in retrofitting publicly owned facilities such as schools and hospitals. Holding responsible public officials liable for damage resulting from deficient public facilities has been effective in one state in expediting needed retrofitting. Owners of private facilities must evaluate the hazards under the present state of the arts then mitigate these hazards to acceptable limits.

V. RECOMMENDATIONS FOR IMPLEMENTATION

1. Critical facilities should be defined as outlined in this Work Group Report, Exhibit A.
2. On site geological surveys and appropriate interpretations should be made for all critical facilities (existing and proposed) as outlined in Exhibit B. .
3. Criteria should be developed for the proper performance of critical facilities under the predicted seismic loads.
4. A state agency should be given authority for general surveillance of a program of earthquake hazard mitigation in Nevada.
5. The qualifications of the professionals who make and interpret the geological surveys should be under the surveillance of a state agency with authority to grant licenses.
6. All existing critical facilities should be checked against established criteria and deficiencies noted.
7. A program should be developed to:
   (a) see that new construction meets the established standards, and
   (b) bring all deficient facilities up to the minimum requirements.

EXHIBIT A

CRITICAL FACILITIES DEFINED

Categories of Facilities:

The two work groups considering building codes and critical facilities agreed on the following categories of facilities:

(a) Vital Facilities - those required to sustain life and property during and after a seismic condition.

1. Hospitals
2. Fire stations
3. Police stations
4. Communication centers
5. Disaster recovery centers

Secondary Units:

6. Administration centers
7. Major repair centers
8. Major storage centers
9. Major data processing centers

(b) Critical Facilities - those required to continue life and protect property with the vital facilities intact.

1. Dams
2. High voltage power lines and plants
3. Highway bridges and viaducts
4. Liquefied natural gas plants
5. Natural gas pipelines
6. Nuclear power plants
7. Nuclear processing sites
8. Nuclear waste and radioactive waste storage sites
9. Railroad lines and bridges
10. Water and sewage plants and pipelines
11. Airport buildings and runways

(c) Crucial Facilities - those required for life protection as they will be centers of population.

1. All school and college buildings and sites
2. Any building, regardless of occupancy, having floors used for human occupancy located more than 75 feet above the lowest level of fire department vehicle access.

(d) Ordinary Facilities

1. Facilities required for shelter of people and property. To include all other structures and appurtenances.
2. Dangerous facilities having old overhanging facades, unbound parapets, etc.

Explanation:

It is recognized in fire and building codes that rescue and fire-fighting efforts can only be effective up to the 75 foot level of any building due to ladder reach. Additionally, it is felt that buildings above 75 feet will be most susceptible to violent seismic stress.

(c) 3. Any building housing an A-1, A-2, A-2.1, or A-4 occupancy defined in the Uniform Building Code, and as follows:

A-1 Any assembly building with a stage and an occupant load of 1,000 or more in the building

A-2 Any building or portion of a building having an assembly room with an occupant load of less than 1,000 and a stage

A-2.1 Any building or portion of a building having an assembly room with an occupant load of 300 or more without a stage, including such buildings used for educational purposes and not classed as a Group E or Group B, Division 2 Occupancy

A-4 Stadiums, reviewing stands (permanent), and amusement park structures (permanent), not included within Group A-1 nor Divisions 2, 2.1, and 3 of Group A Occupancies.

Buildings housing the defined occupancies present two potentials: the large scale loss of life due to violent seismic activity, which of course we wish to mitigate; and large areas that can be utilized to house, feed and provide medical care to citizens after the fact of violent seismic activity.

EXHIBIT B

SITE SPECIFIC DATA REQUIREMENTS

The following list of site selection and evaluation items apply to Vital facilities, Critical facilities and Cricual facilities as described in Exhibit A. Portions of these items could be applied to Ordinary facilities depending on the importance and nature of the structure. The following information outlines procedures for developing the data required to evaluate specific sites. When there are a number of sites to be evaluated in close proximity to each other, a portion of the information required may apply to more than one site. This would apply to regional geologic and seismological studies and may apply to site response where site specific parameters are similar. The extent to which information should be extrapolated is a function of the geologic complexity of the region and the similarity of construction. In any case the appropriateness of applying regional parameters to specific sites should be verified at each site.

Geotechnical Criteria for Site Selection or Evaluation

I. Determination for regional geology - Relationship of site to known faults and epicenters of past earthquakes.

   A. Review of available geologic literature and seismological information. List all known earthquakes including epicenter locations and magnitudes and intensities for events affecting the site.

   B. Locate and evaluate major faults which could affect the site and discuss significance to the proposed construction or existing facilities.

      NOTE: It may be necessary to perform aerial and field reconnaissance to obtain the necessary information

in areas where limited geologic literature is available.

II. Determine site geology - Investigate site for presence of faults or other geologic hazards. Thoroughness and intensities of study should be commensurate with importance of the existing facility or proposed construction and the geologic complexity of the site.

A. Features that should be identified and discussed include fault offsets, sag ponds, springs, vegetation or groundwater variations, offset drainage systems, truncated alluvial fans, scarps or other indications of past fault activity on the site. It may be necessary to perform subsurface exploration and/or geophysical studies to determine sufficient information about site to substantiate opinions about potential fault activity at site.

B. Identify and discuss existence or potential of landslides, soil creep, rock falls, tsunamis, seiches, subsidence or other potential geologic hazards.

C. For existing facilities, structural plans and specifications should be obtained along with construction documents such as change orders, testing and inspection reports. As-built foundations should be verified, and any structural distress or modifications not shown on plans be noted.

III. Investigate the site soil conditions - Evaluate suitability of site soils for proposed construction.

A. Determine engineering properties of soil types present on the site. Depth of exploration should be commensurate with type of proposed construction and should be sufficient to

determine soil properties for both static and dynamic considerations. Soil properties that should be identified and discussed include classification of soil types, in-place soil moisture content and density, soil shear strength, consolidation and swell potential. Dynamic properties that should be considered include soil shear wave velocity, evaluation of potential for lateral earth movement induced by seismic motions, liquification, densification, groundmotion amplification or other soil behavior that may occur in the event of an earthquake.

B. Provide recommendations and soils engineering criteria for design of proposed construction or for evaluating existing structures to mitigate potential hazards.

IV. Evaluate site seismicity and determine parameters of design earthquakes for project design or structural evaluation.

A. Perform statistical evaluation of site seismicity and determine magnitude, maximum acceleration and maximum displacements of potential earthquakes as a function of specified recurrence probability.

B. Determine appropriate return period for maximum probable and maximum credible earthquakes for site design. Site response for the design earthquakes should be determined by methods appropriate to the nature of the proposed construction and to methods used in analysis of structures. Site response analysis should include as a minimum, soil amplification factors, site predominate period and any other factors required for analysis and design of the proposed construction. Determination of site response design factors

for Vital, Critical or Crucial facilities should conform to state-of-the-art standards appropriate to the importance of the proposed construction.

V. The results and conclusions of the above study, together with all information gathered, should be compiled in a written report suitable for review. The report should be signed by both a Geologist competent in Engineering Geology and by a Registered Civil Engineer qualified to practice in the field of Geotechnical Engineering.

Appendix D

FAULT HAZARD ZONES IN CALIFORNIA

By Earl W. Hart

INTRODUCTION

The Alquist-Priolo Geologic Hazard Zones Act, SB 520, was signed by Governor Ronald Reagan on December 22, 1972, and went into effect March 7, 1973. The purpose of the Act is to provide for public safety in hazardous fault zones. The Act requires the delineation of potential damage areas, called "Special Studies Zones", along known active faults throughout California. It requires local governments to withhold approval of construction permits in those zones until geologic investigation has determined, using the available evidence and up-to-date methods, that the site is not threatened by surface displacement from future faulting.

This Special Publication describes the actions taken to implement the Act from its inception to the present; the status of Special Studies Zones already delineated; and the expected future course of actions to be taken under the Act. This is basically a progress report, because the program to delineate Special Studies Zones along as-yet-unzoned potentially active faults will continue for some years, and because details of the various requirements of the Act are still undergoing modification and refinement.

Since its enactment, the Alquist-Priolo Special Studies Zones Act (new name) has been amended four times. The complete text of the Act is Appendix A of the report "Fault Hazard Zones in California".

Information presented here is intended to provide information concerning the Alquist-Priolo Special Studies Zones Act and the special studies zones delineated pursuant to that Act. Data contained in this report are based on several informal documents prepared since 1973 by this author and by others. Faults shown on the index maps were compiled by staff geologists, and the maps were largely drafted by Robert A. Switzer, all of the California Division of Mines and Geology's San Francisco District staff. The assistance of Thomas E. Gay, Jr., Rudolph G. Strand, Trinda L. Bedrossian, Carl J. Hauge, and other staff members of the Division's Geologic Data Group in organizing and assembling this report is gratefully acknowledged.

Table 1. Summary of Official Responsibilities and Functions Required Under the Alquist-Priolo Special Studies Zones Act.

State Geologist (Chief, California Division of Mines and Geology)

1. Delineates Special Studies Zones; compiles and issues maps.

a. Preliminary Review Maps.
b. Official Maps.

2. Reviews new data.

   a. Revises existing maps.
   b. Compiles new maps.

3. Approves requests for waivers by cities and counties.

State Mining and Geology Board

1. Formulates policies and criteria to guide cities and counties.

2. Serves as Appeal Board for appeals that cannot be coped with locally.

3. Advises State Geologist; establishes policy.

Cities and Counties

1. Responsible for local implementation of Act within the delineated Special Studies Zones.

2. Approve permits for development.

3. Collect fees for building and development permits to cover administrative costs.

State Agencies

Implied responsibility for safe siting of State structures within Special Studies Zones.

Appendix E
Earthquake Insurance

A. Statement of Problem:

Earthquake insurance is available, however, the loss frequency is not regarded high enough to be creditable. The most clearly recognized disaster having no available insurance program revolves around earth movement, either landslides or subsidence.

B. Methods of Providing Disaster Insurance Coverage:

There are several approaches which might be pursued (4):

(1) Voluntary coverage using a graded rating system. This results in high premiums because there is only a limited number of potential buyers.

(2) Require each property owner to purchase an "All Risk" policy. There is no way to require the purchase of such insurance. Such a procedure would require some type of State compensation funding in order to work.

(3) An Assigned-risk program requiring all insurance companies to sell policies covering individual hazards. This is debated because:

(a) Landslides, etc., result only in the loss of physical property; does not include innocent third parties so ...society does not have an obligation.

(b) Companies would not be required to insure high risk properties that perhaps should not have been constructed in the first place.

(c) This would probably not work unless companies were allowed to rate risks. Rates for serious risks would no doubt be prohibited.

(4) Insurance Programs (ex: National Flood Insurance Act of 1968) which are cooperative between public agencies and private concerns.

Legislation would probably be required to implement some of these possible programs. A cooperative program between private insurance companies and private agencies may be the best solution. Thus, it appears that the private section of the economy may not be able to sustain some types of catastrophic losses without government aid in providing necessary reserve funds.

1. The insurance industry should provide disaster insurance. Insurance companies have the capacity and capability but are not using it. (Capacity in insurance terms is the dollars that a company has available to place at risk in order to insure an exposure.)

Collecting premiums and putting them aside in a catastrophe reserve over a period of years, eg. chronological stabilization reinsurance, could create a process by which insurance companies could offer our society disaster insurance. Insurance companies lack the motivation. The element of profit is not there.

It is necessary for parties outside the insurance industry to stimulate interest in entering the field of disaster insurance. At this time they do not have the incentive.

2. Government should provide disaster insurance.

Program Cost Fantastically High:

The financing of disaster insurance, i.e. landslide perils, is not a profitable situation. Insurance companies are in the business of making money, and there are many more attractive places to put their capacity than in rebuilding homes subject to natural occurrences such as landslides. The private sector would handle it if it were profitable.

Appendix F
State Seismic Network
Funding Statement
developed by
University of Nevada Seismological Laboratory

BACKGROUND

Over the last 15 years, the Seismological Laboratory has taken the lead in research on seismic risk in Nevada. The Laboratory has published more than 90 reports, bulletins, maps and theses, and most of these have dealt with problems related to seismic hazards in this region (Attachment A). The Laboratory now operates 30 telemetering seismic stations in northern Nevada and eastern California, including dense arrays of instruments in the Truckee Meadows and Mina areas. These instruments record several thousand small earthquakes per year, of which more than a thousand are subjected to detailed analysis. In addition, the Laboratory operates field instruments for studies of aftershocks and investigations of the structure of the earth's crust and upper mantle; stations which monitor rock strain related to tectonic processes; and digital seismographs for basic research on source mechanisms of earthquakes and explosions. The current configuration of the seismic telemetry network is shown in Figure 1. An intensive effort is now under way to correlate small earthquakes with mapped surface faults and with lineaments on satellite photographs, particularly in areas where clustering of earthquake activity indicates high stress and therefore the potential for moderate-to-large earthquakes in the future.

Routine analysis of data from the seismic network is published in the form of a semi-annual Bulletin of the Seismological Laboratory, which describes the network operation and tabulates information on earthquakes that have occurred during a given 6-month period. The Bulletin is distributed on a regular basis to planning officials, engineering firms, State and Federal agencies, libraries and other laboratories around the world, and it represents the primary data base for probabilistic estimates of future seismic activity in the State.

The Laboratory has been a focal point for coordination of research and public information related to seismic problems in Nevada, and has compiled special reports in connection with large construction projects, nuclear power plant siting and nuclear waste disposal. During the past year, Laboratory staff members have served on advisory panels of the National Academy of Sciences, the Air Force Office of Scientific Research and the Defense Advanced Research Projects Agency, in addition to coordinating with other State and local agencies. Laboratory staff members are frequently asked to present talks on seismic risk to government, industrial and other groups in the Reno-Carson City area.

Funding for the Laboratory's research program has come mainly from federal grants and contracts -- from the U.S. Geological Survey, Air Force, Department of Energy and National Science Foundation. Total support for FY 1980 will be in excess of $400,000, of which about 1/8 is regular University support.

PROPOSED PROGRAM

In the following paragraphs, a program of instrumental research on Nevada earthquakes is described at three levels of State support (in terms of 1979 dollars): (1) current level, $51,000, (2) enhanced level, $100,000, (3) optimum level, $300,000.

(1) Current level, $51,000. The current level of support provides for 2.0 full-time employee positions and some operating money. This State support will be supplemented with $84,000 of research funds from the U.S. Geological Survey's Earthquake Hazard Reduction Program, earmarked for studies of seismic risk in the Nevada region. Other research grants and contracts are for projects not directly related to earthquake hazards. The Geological Survey funds are awarded annually, on the basis of research proposals; there is no guarantee of continued funding in the future. (In large part because of the Laboratory's dependence on "soft" money, it has had considerable difficulty in attracting and keeping highly qualified professional personnel.)

With the current level of Geological Survey support, the Laboratory can continue to operate the 30-station seismic network, analyze the data, issue the Laboratory Bulletin and carry out a modest program of research on earthquake hazard in the Nevada region. This level of support does not, however, provide for replacement of old pieces of equipment, improvement of the system or expansion of the network into areas that are not adequately covered now. Reconfiguration of the network to provide more even coverage would reduce the capability to study earthquake activity around centers of population (Reno, Tahoe and Carson City), and as a result could lessen the Laboratory's chances of obtaining Geological Survey support. If the U.S.G.S. contract support were to terminate, the Laboratory could not continue to operate a seismic network in Nevada.

(2) Enhanced level, $100,000. If the seismology program were supported by the State at the level of $100,000 per year, there would be some flexibility that does not exist now. Initially, most of the additional funds would be used to replace items of equipment that are almost worn out (tape recorders, chart recorders), and to provide some additional coverage in areas like northwest Nevada, Elko and Ely. Later on, part of the increased funds would be used to support increased analysis and professional positions. The research program would still, however, be dependent on federal support, our investigation of seismic risk would remain at a modest level and instrumental coverage of the State would not include southern Nevada.

(3) "Optimum" level, $300,000. A modest program of seismological research that would be independent of federal funding would require $300,000 or more per year in State support. At this level, the network could be expanded to provide even coverage of the State, old equipment could be replaced, the system could be gradually upgraded to include advanced digital equipment and additional staff could be hired to expand the research effort. More effort would be directed at detailed field

investigations of areas that have been tentatively pinpointed as having relatively high potential for large earthquakes in the future. Equipment in these areas would be supplemented to provide for measurements of geophysical parameters that have been associated with successful earthquake predictions in China and the Soviet Union. All analysis would be kept current, as opposed to the Laboratory's present backlog of about a year in routine analysis. Permanent support for two or more professionals would enable us to hire and retain highly qualified researchers.

JUSTIFICATION

The University Seismological Laboratory is the only State agency charged with responsibility for instrumental studies of earthquakes and seismic risk. The level of State support for this program is far less than in any other state with a comparable seismological research program (Alaska, California, Utah, for example). The instrumental data base is an absolutely essential ingredient of risk assessment -- without it there would be no way to assign higher or lower probabilities of rupture to the thousands of potentially active faults that are distributed rather evenly over most of the Nevada region. Near-real-time analysis of data from a telemetering network of instruments around the State is essential to alert Civil Defense and other disaster agencies of changes in activity that could presage a large earthquake.

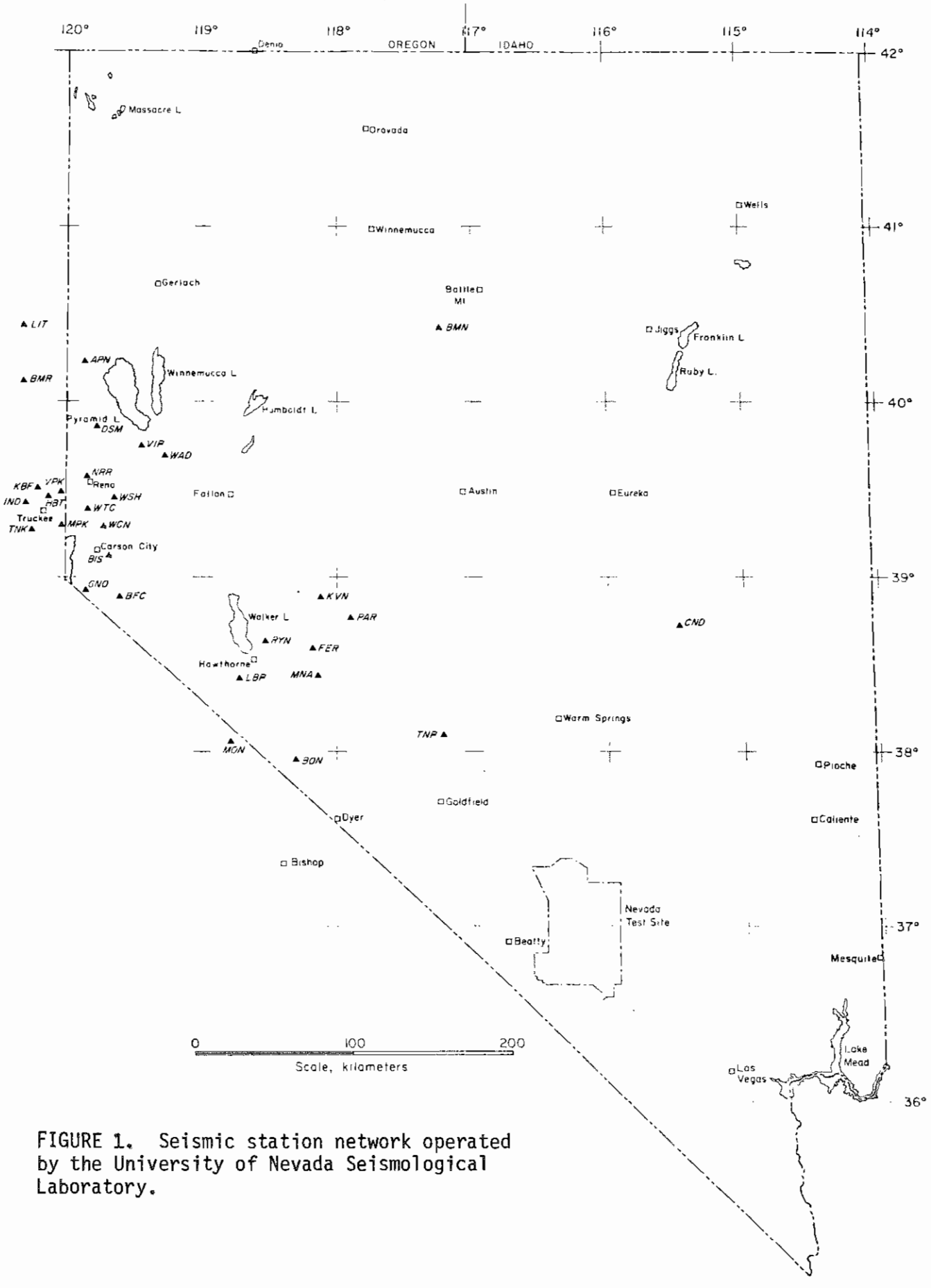


FIGURE 1. Seismic station network operated by the University of Nevada Seismological Laboratory.

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Appendix G

STRONG MOTION INSTRUMENTATION

Strong motion accelerographs are instruments usually used to measure the response of a structure to earthquake motions. They are activated by the earthquake itself as opposed to the accelerographs used in the seismic networks which run continuously. The strong motion accelerograph is usually set to be activated by only the stronger earthquakes which produce significant response in the structure.

Section 2312(l) of the 1976 UBC requires the installation of 3 strong motion accelerographs in certain buildings, with maintenance to be provided by the owner. This system is deficient in the following respects:

1. By requiring installation in all buildings of the specified type and size it is probable that records would be obtained from buildings of similar types and located in certain small areas of a municipality. Thus there could be duplication of results which would not provide optimum return on the investment.

2. To be serviceable the instruments must be properly maintained by qualified people, a service that could be provided much more efficiently by one agency than by a multitude of owners.

3. Response records from structures other than those specified by UBC may be desirable.

It is suggested that the purchase, installation and maintenance of the instruments be placed under the authority of the building jurisdiction. This would permit locating them such that maximum results would be obtained from a number of sites and from different types of buildings. This would, of course, require some additional financing for the building jurisdiction.

To accomplish this the following sentence could be added to paragraph 1 of Section 2312(l) in UBC, 1976 Edition:

> "The owners of these buildings may choose to provide the jurisdiction authorities with the appropriate space of the monetary value of the accelerographs plus a yearly maintenance fee."

This would be an acceptable approach and would allow the authorities to space the units in a definite design pattern to accurately record the motions in the area.

Once the units are installed and for those existing, it will be necessary to have a fund to cover the costs of collecting the data and maintaining all units.

To establish this maintenance fund, the authorities could adopt a policy of taking as additional fee twenty-five cents (25¢) for each $1,000 valuation on a permit. This would be a usable sum each year and would come directly from the construction industry. To verify this the following list shows the possibilities.

	Construction Valuation for 1978	Fund @ 25¢/$1000
Clark County	$392,510,560	$ 98,127
Henderson	69,302,150	17,326
Las Vegas	194,406,203	48,602
North Las Vegas	11,890,267	2,973
Total	$668,109,180	$167,028

Appendix H
Work Group Report
on
Building Codes

I. INTRODUCTION

The task placed before the work group was to review the building code requirements and enforcement procedures and to provide an analysis of those requirements and procedures as to their effectiveness of prevention of seismic hazard mitigation.

II. DISSERTATION

The evolvement of this report came from constructive criticism of four major issues. The task outlined in the introduction became the focus of discussions. It was at this point the issues became concrete and were the subject of both written and oral reports.

The issues as delineated in this dissertation are 1) codes as related to seismic mitigation, 2) contractor involvement, 3) preparedness plan hinged on code enforcement, and 4) preservation of underground utilities through codes and enforcement. The relationship of the issues will expose the problems to be faced by the work groups and ultimately to the major committee with inevitable recommendations forthcoming upon the report's conclusion.

A. Building Code Considerations

A great majority of the political subdivisions in the State of Nevada have adopted the Uniform Building Code as published by the International Conference of Building Officials. This code is developed and enforced by local government officials, all of whom are members of the Conference. This code, by utilizing the expertise and recommendations of the Structural Engineers Association of California, has strong emphasis on seismic design provisions. Of

the major building codes, the U.B.C. has the best provisions in this design area.

With the rapid growth throughout the State, consideration should be given to adopting the U.B.C. by legislation to serve as a statewide standard. Care should be taken to provide sufficient flexibility to allow modifications, particularly in administrative procedures.

The National Electric Code and the Uniform Plumbing Code have been adopted by State law. A provision in the statutes requires modification to the Uniform Plumbing Code to be reviewed by the State Public Works Board. A similar provision could be established if the U.B.C. is adopted statewide.

The other codes in existence, i.e., Uniform Mechanical Code, Uniform Fire Code, National Fire Prevention Code and Uniform Solar Energy Code have not been widely adopted within the State, but might well have an effect on seismic mitigation.

Successful application of the U.B.C. to seismic design requires: 1) design by qualified architects and engineers, 2) detailed plan checks by qualified architects and engineers, and 3) rigorous field enforcement of construction. The Nevada Statutes now require all public works facilities costing in excess of $15,000 to be designed by registered architects or engineers. This law would generally cover vital and critical facilities such as schools, fire stations, hospitals, etc. It might be expanded to specify other facilities that should likewise be covered. In addition, plans checking could be required for any or all vital and critical facilities. The plans checking can be done by local building departments, or as in the State jurisdiction by contract with private architects or engineers. This is one of the principal features of the Field Act of California that has been successful in achieving good seismic design of school facilities. Inspection

of construction is equally important. This could be done by local building inspectors and certifying them as technically competent. While some states require state inspection of certain facilities, it is not to be considered necessary if local government inspectors could be reinforced by education, training and certification.

In addition to new construction, consideration has to be given to eliminate the hazards of existing structures. Legislation would be required to eliminate the hazards in existing buildings. This could be accomplished when there were proposed new additions, remodeling or a change in business licenses. This should be in accordance with a preconceived plan whereby the hazards would be constantly monitored. Good judgment should prevail so as to minimize the costs involved. One idea would be to establish repair zones similar to fire zones where an upgrading would be necessary. The function and occupancy of the buildings would be a major consideration in the elimination of hazards. These should all be inspected by local building officials. The State and Federal officials should inspect their own building unless assistance of the local officials is requested.

Emphasis should be directed to words implementing the provisions of the Uniform Building Code in the design of all public and private buildings, the inspection of the construction of these new buildings by qualified personnel and the strengthening of existing buildings deemed to be vital or critical facilities.

B. Contractor Involvement

During a local or regional state of disaster which could be caused by a major earthquake, Nevada contractors participate in a prearranged emergency relief plan coordinated through the Nevada Chapter, Associated General Contractors. Because contractors utilize

a large amount of heavy equipment and skilled personnel which would be needed in a natural disaster, any disaster relief plan developed should include contractor participation. The A.G.C. plan, called "Plan Bulldozer", works in conjunction with local and State civil defense agencies, and provides a central contact for needed heavy equipment. An A.G.C. Disaster Relief Committee is responsible for administering the plan and updating equipment inventories and personnel lists annually. When a disaster strikes, government disaster agencies contact the A.G.C. office with information on equipment needed and location so that it may be dispatched to the site without delay.

"Plan Bulldozer" includes not only A.G.C. members, but nonmember contractors and other businesses owning heavy equipment as well. This plan has been in existence for more than 20 years, and has been implemented most frequently in Nevada for forest and range fires during summer months.

Meetings are held annually between the A.G.C. Disaster Relief Committee and Forest Service and Bureau of Land Management representatives to discuss any necessary changes and to familiarize contractors with any particular requirements of the various governmental agencies regarding the processing of paperwork, etc. These agencies are furnished with a list of business and home telephone numbers for the contractor members of the Disaster Relief Committee so that someone can be reached at any time of day or night.

Because this plan has been effectively utilized for a number of years for forest fires and floods, it is recommended that it be expanded to encompass additional natural disasters such as earthquakes. Any necessary details can be worked out with the appropriate disaster relief agencies, and the plan should be continuously updated so that it may be ready to be used for any disaster that may occur.

C. Preparedness Plan

Legislation will be required to provide for particular plans with the State for preparedness. This will include both State and local consideration. These plans must be directly keyed to the use of the building code, inspection force and available contractor assistance.

Such a sample plan is attached to this report as Exhibit A.

D. Preservation of Underground Utilities

In this area two points become evident immediately. First, very little attention is given to the fact that an earthquake would generally destroy all utilities, and second to modify the existing construction methods could create economic chaos unless proper judgment was used.

Many of the present day utility codes, i.e. plumbing and electrical, make no consideration to seismic conditions within their text. Changes would need to be made either locally or nationwide within the codes themselves. Certain portions of the utility system does receive seismic consideration when it falls under the rule of the building code. This would pertain to tanks and buildings primarily.

The following items should be considered for possible code changes to facilitate elimination of some hazards.

1. Use of reinforced concrete vaults for carrying the piping and wiring in buildings.
2. Use of expansion looping in the underground facilities.
3. Use of continuous weld piping systems where possible and practical.
4. Use of flexible joint systems in piping.
5. Use of construction water tank trucks and construction oil trucks after a disaster.

6. That all tank sites, generating stations, etc. receive seismic studies.
7. Use one or more separate piping and wiring systems to vital and critical facilities.
8. Provide for onsite storage of water, oil and other facts for vital facilities.
9. Require alternate emergency generation equipment at vital facilities.

These would undoubtedly become costly but it might be necessary for preservation of operating facilities in the aftermath of a major seismic event.

III. Conclusions

The history of the State of Nevada indicates that some severe earthquakes have occurred. The intensity has been large yet varied and the locations have been scattered throughout the State. Geological studies lend credence to the fact that earthquake activity will continue.

The major effect of earthquakes is damage to structures that serve as shelters and places of employment for the population of the State. In addition the places of aid and recreation and devices for furnishing light, power, heat and water may be destroyed. Not only does this damage threaten the lives of citizens, but it could possibly cause irreplaceable loss to various properties relating to the State's livelihood.

The hazards related to seismic conditions can be reduced through proper land use controls, deliberate geological investigations, comprehensive seismic design, sound construction practices and knowledgeable construction inspection. In addition, a fully considered plan of action to cover the needs and necessities of the population after any such occurrence must be devised and implemented.

IV. Recommendations

1. That local and state governing bodies adopt and require enforcement of the seismic provisions in the latest edition of the Uniform Building Code as published by the International Conference of Building Officials.
2. That local and State governing bodies require all buildings and structures erected in their areas, exclusive of State-owned buildings, to be inspected during construction by the building inspection unit within their jurisdiction.
3. That local and State governing bodies require all plans for structures to be used as vital, critical and crucial facilities to be designed by licensed architects or engineers, and further that appurtenances to these facilities be designed by licensed engineers.
4. That local and State governing bodies require all sites and routes for vital, critical and crucial facilities to have a geological investigation by a licensed geologist or engineering geologist prior to design and further that a copy of this investigation be forwarded by the reviewing governing body the University of Nevada.
5. That the State governing body authorize and direct the University of Nevada to establish and maintain a library of geological findings within the State and to allow the use of the material by all licensed persons involved in geological investigations.
6. That the local and State governing bodies cause an inventory of all vital, critical and crucial facilities within their jurisdiction to be incorporated within a plan to eliminate seismic hazards on all new and remodeled construction. This is to be

accomplished under the direction of a disaster preparedness organization created by ordinance and/or statute.

Exhibit A

Preparedness Plan

MODEL DISASTER PREPAREDNESS PROGRAM

PRE-DISASTER PLANNING

Administration

Legislation

1. Accept BOCA plan
2. Legal authorization for the Disaster Committee
3. Procedures for obtaining & implementing bids for debris removal & hazardous structures removal
4. Liability protection and injury insurance for all volunteers.

Investigation

1. Research pre-1950's type of construction
2. Parapet & facade seismic response and safety.
3. Obtain research grants

Planning

1. Establish inspection areas.
2. Catalogue vital structures and services.
3. Pinpoint hazardous structures.
4. Obtain equipment & funding.

Maintenance & Action

1. Establish methods to remedy pinpointed hazards as the structures are remodeled, renovated, or used for a new occupancy.
2. Code enforcement and interpretation regarding seismic survivability for buildings and services.
3. Establish disaster control centers
4. Coordinate disaster services & agencies
   (a) Civil Defense
   (b) BOCA mutual aid
   (c) Military Reserve
   (d) Civil Air Patrol
5. Training
   (a) Classes on post disaster procedures
   (b) First Aid

POST-DISASTER OPERATIONS

Damage Assessment

1. Establish boundaries of disaster & seriousness of damage.
2. Survey teams, using facilities priority lists, inventory damage to vital facilities.
3. Decision if outside assistance is needed.

Inspect & Post Structures

1. Determine degree of damage to structures in affected area.
2. Post all structures with appropriate hazard designation signs.
3. Begin degree removal and demolition of hazardous structures.

Repair & Reconstruction

1. Apply for reconstruction loans.
2. License contractors to participate in reconstruction
3. Issue press release regarding the obtaining of building permits.
4. Assign inspectors to follow up repairs. Repairs are based on the damage noted in the Damage Inspection Report.

Appendix I
BUILDING CODE WORK GROUP REPORT
ON
DISASTER PREPAREDNESS

I. INTRODUCTION

Disaster preparedness can be defined as effective, well-organized pre-disaster planning which enables post-disaster operation to proceed in an orderly, efficient manner, insuring the continuity of communications and services during and after the occurrence of a disaster. The direction and needs of the pre-disaster planning are directly related to the requirements imposed by the post-disaster operations. Pre-disaster planning should be designed to support post-disaster operations through administrative, legislative, and investigative avenues. The following paragraphs suggest a model post-disaster operation and the pertinent pre-disaster planning needed to implement it.

II. POST-DISASTER OPERATIONS

Post-disaster operations as defined in this text do not include rescue and medical services; they are designed to provide the framework for a community to establish the magnitude and location of damage, direct relief efforts, insure continuity of communications and services, and provide a basis for reconstruction and repair. The Building Officials and Code Administrators International (B.O.C.A.) has prepared an excellent disaster operations plan; it is divided into three stages: Stage One, establish the amount, seriousness, and location of damage; Stage Two, inspect and post all structures; Stage Three, repair and reconstruction.

A. STAGE ONE - DAMAGE ASSESSMENT

Stage One is an assessment phase; boundaries of the disaster are established and the seriousness of the damage determined. Disaster survey teams proceed immediately to assigned geographical areas and, using their facilities priority list, inventory the damage to structure housing such vital emergency facilities as hospitals, schools (evacuation sites), and communications and transportation services, establishing their usability in the post-disaster relief efforts. This procedure allows immediate referral of injured to hospitals that are still functioning, and the evacuation of displaced people to schools and other buildings that are structurally sound and capable of serving as relief centers; safety from aftershock damage is greatly enhanced by this procedure. Once the scope of the disaster has been established, a decision can be made whether to request additional manpower from outside sources.

B. STAGE TWO - INSPECT AND POST STRUCTURES

Stage Two involves the inspection and posting of all structures and services in the disaster area. Using a B.O.C.A. Disaster Damage Inspection Report, survey teams make a preliminary inspection of structures, filling out the top portion of the form; as soon as possible, the top portion of the form

is returned to the disaster operations command post. The Inspection Report helps to define the scope of the disaster by geographic limits; it provides statistics on the number of damaged structures and locates immediate hazards and the status of vital facilities. These documents also provide a fast monetary damage estimate that is required before certain types of Federal government relief programs can be requested; they also will provide a basis for obtaining Federal loans and subsidies for reconstruction.

Each building is then posted with signs indicating the degree of damage or safety for habitation, based on the Damage Inspection Report. The color-coded inspection signs range from "safe for occupancy" to "habitable-repairs necessary" to "keep out-uninhabitable". An approval or disapproval to reconnect utilities is also posted. At this juncture, demolition of hazardous structures and emergency debris removal is begun. Procedures for authorization of hazardous building demolition and contracts for debris removal are set in pre-disaster planning.

C. STAGE THREE - REPAIR AND RECONSTRUCTION

When the immediate effects of a disaster have been dealt with, implementation of Stage Three procedures, reconstruction and repair, begin. Administrative authorities are supplied with press releases regarding the registration of contractors and the procedures for procuring building permits for reconstruction work. The permit process insures the quality of the reconstruction and assures public safety; the reconstruction permit is issued based on the damage inventoried in the Disaster Damage Inspection Report (after the priority top half of the Report has been filled out and returned to the disaster operations command post, a more detailed follow-up inspection is made on the structure and recorded on the Report, categorizing general areas of needed repair). As the situation eases, inspectors are assigned to follow up the repairs, based on the Damage Report. Stage Three is also used to obtain Federal long term loans and individual rebuilding assistance.

Every community has numerous agencies that perform vital emergency functions; the Civil Defense has contingency plans providing for region-wide mobilization of disaster resources. A disaster preparedness plan should be designed so that it can be integrated in total into Civil Defense plans. The disaster preparedness plan should be multidimensional so that many varieties of disasters can be similarly handled under this plan.

III. PRE-DISASTER PLANNING

Effective pre-disaster planning is essential to the success of post-disaster operations; once the form of the post-disaster operations has been determined, proper administrative, legislative and investigative functions must be established.

A. PRE-DISASTER ADMINISTRATION

1. Administration Planning

The Administrative Planning steps required in pre-disaster planning are:

a. Subdivide the planning area into geographical zones.

b. Catalog vital structures and services in each zone (e.g., hospitals, schools, etc.).

c. Locate potentially dangerous structures in each zone.

d. Establish inspection priorities for vital facilities and hazardous structures in each zone.

Pre-disaster administrative planning is based on the realization that certain structures and services are indispensable to post-disaster recovery operations. During a disaster, their exact state of usefulness must be quickly and accurately determined. Dividing a preparedness region into geographical areas and assigning a survey team to that area is an efficient, simple method of obtaining the required information. The cataloging of vital structures, services and hazardous buildings in each area means that, in the event of a disaster, the survey teams could inspect each structure according to the priority list and inform the disaster operations command post of their usefulness. This results in the injured being sent to hospitals and medical facilities that are still capable of functioning, displaced people being referred to evacuation, shelters that will provide them with a refuge safe from collapse due to after shocks, and emergency vehicles being routed on freeways and bridges that are still standing and sound. The strength of these administrative planning procedures is reflected in its spontaneity and independence. No orders need be given or received; trained personnel know their duties and areas, and, at the start of a disaster, independently carry out their assignments. Command posts and communications frequencies are predesignated and equipment and materials stockpiled for ready access.

2. Administration Planning and Maintenance

If the framework of a disaster preparedness program is provided by post-disaster operations, and the substance to the framework is pre-disaster administrative planning, then the impetus that makes the program viable is administrative maintenance and action. Unless a preparedness program is continually updated, maintained and ongoing, the program will only be a hollow shell of what it could be and should be. Administrative maintenance and action involve hazard mitigation, service coordination and training.

3. Hazard Mitigation

Hazard Mitigation is a continuous program to recognize hazards as buildings are renovated or removed. An ongoing examination of each preparedness area should be conducted to pinpoint structures and services that could pose a greater than normal threat in a disaster; structures such as pre-1950, unreinforced masonry buildings, early 1900 brick structures laid

up with lime mortar, and buildings with ornate facades and unstable parapets are prime locations for potential tragedy. These sites will probably be where a majority of the casualties and service disruptions occur, and, as such, should be the prime targets for renovation. This portion of administrative maintenance is related to legislative action, necessary ordinances must be voted to provide the legal authority for redressing this problem. The hazard mitigation portion of administrative maintenance should not only pinpoint these potentially dangerous structures, it should provide the required bookkeeping. This ongoing file should not only be used to recommend removal or repair of imminently dangerous structures, but it should be used to address those situations constructed prior to code requirements and the development of seismic design state-of-the-art. Prime examples of inherited situations are under-reinforced parapets and inadequately attached ornate building facades; during a seismic event these constructions could rain debris on people in the street below. The file that is kept on these types of situations, combined with appropriate enabling legislation, would allow these hazards to be remedied as any structure is remodeled, renovated or used for a different occupancy. It would create a "grandfather" exemption for these "shadow hazards" and would demand mitigation as these buildings are renovated or reused, mitigating the hazard increasing with time.

4. Service Coordination

The Service Coordination aspect of pre-disaster administrative maintenance and action involves coordination of all potential relief services and agencies and aggressive code enforcement and interpretation regarding seismic effects on buildings and services.

If the damage is widespread or special skills are required, volunteers may have to be integrated into the plan. To do this, local mutual aid programs must be established as part of the pre-disaster planning. A mutual aid program is a reserve list of qualified people who are willing to donate their skills during an emergency. As an example, local engineers are essential in an aid program; if conditions warrant, they can be assigned as expert advisors to assist the field survey teams. The B.O.C.A. has a mutual aid assistance program where disaster help is provided, on a mutual basis, from unaffected communities bordering the disaster area.

Also, coordination among civil defense, military reserve agencies and the Civil Air Patrol should be effected. Establishment and provisioning of a disaster command post is of the utmost importance as it is the procurement of the needed equipment for the field survey teams. Federal help in equipment procurement should be sought through grants and loans. Communication equipment is of the utmost importance.

5. Training

The Training aspect of administrative action insures the proficiency required to perform the post-disaster operations. Training classes and seminars should be held to qualify inspectors on how to perform their field

duties. The prime function of the survey team is to perform a structural damage inventory of buildings in their area; to be proficient, classes on building construction and damage evaluation are a necessity. Also, since survey teams may be the first emergency crews in an affected area, classes in first aid and rescue techniques are of great benefit. (It should be noted, however, that rescue and first aid are secondary functions of the survey teams.) Training in the use of emergency forms and office procedures assures smooth function in time of disasters. For overall training effectiveness, an emergency situation simulation is unparalleled.

B. LEGISLATION

The legislative aspect of pre-disaster planning also includes the establishment of the proper legislative acts necessary for the implementation of the preparedness program. The establishment of a model disaster preparedness program is contingent on providing a proper legal framework; emergency powers must be defined and assigned by ordinance. Legal authorization is necessary to allow public officials to contract bid prices for debris removal and building demolition before a disaster and during post-disaster operations to order their use. The procedures, criteria and authority for ordering demolition of heavily damaged structures should be established by ordinance. The B.O.C.A. post-disaster operations plan and the disaster operations committee needed to implement it should be approved and recognized legally. Also, some sort of legal disclaimer for any liability incurred should be passed for volunteers serving during the disaster as well as an N.I.C. type of automatic insurance coverage. All emergency powers that may be needed to deal with the disaster should be established by legislative action in advance because it may be impractical or impossible to establish these powers during a disaster.

C. INVESTIGATION

The final area of pre-disaster planning involves research and investigation of pre-code construction methods to determine an empirical way of assessing the strength of a particular construction. Today's structural mechanics and strength of materials state-of-the-art does not deal with construction methods used after the turn of the century to the early 1950's. Examples of these construction methods are unreinforced brick laid up with lime mortar, wythe construction (a bearing wall composed of three layers of brick with all but the exterior brick layer composed of inferior adobe-type brick) and rubble foundation walls. Most of the pre-1950 construction in existence today was designed prior to the introduction of earthquake-induced lateral load state-of-the-art. As a result, the lack of roof diaphragms and a ledger chord to connect the walls to the roof, combined with heavy, unreinforced masonry walls and ornate parapets results in a structure with a high injury and death potential in a seismic event.

When potentially hazardous structures are catalogued in the survey areas during pre-disaster planning, structures of this construction surely have to be acknowledged. The problem occurs when these buildings are remodeled or renovated--with no accurate way to perform a structural analysis

on them, there is no way to gauge their potential hazard. Research grants from governments and foundations would supply the means to supply the basic research data so a method of analysis can be synthesized for these materials and construction techniques. Armed with this research information, engineers will be able to accurately determine a buildings disaster potential which can result in better pre-disaster planning and increased public safety.

IV. IMPLEMENTATION

In the final assessment, any preparedness program is people, and the effectiveness of the program is only as good as the people who implement it. The first step in the implementation of the disaster program is the creation of a Disaster Committee; the Committee should be composed of the highest elected area official, the area's highest administrator, liaison official from the regional Civil Defense, appropriate government department heads and government engineers, a representative from the military reserves, local engineers from private practice, a governmental communications expert, a governmental legal official, a liaison representative from the Seismic Committee, and any other people who would be needed. This Disaster Committee is responsible for the management of the Disaster Preparedness Program, and would meet on a regular interval to review and assess the status of the program. The Committee would be present at the Disaster Control Center during a disaster, and would administer the Disaster Program during the emergency; they would be directly responsible to the local, elected governing body, with the highest area elected official and chief administrator acting as liaison between the Disaster Committee and the elected, governing body. The elected governing body would have to legally accept the Disaster Preparedness Program as part of the pre-disaster legislative planning.

The implementation of the administrative aspects of the pre-disaster planning would have to be done in the framework of local governmental agencies; the two governmental agencies most suited for this task would be the Building Department and the Department of Public Works. These Departments have several important resources to offer the community in the implementation of a Disaster Preparedness Program; trained personnel, communications, transportation, and an organizational framework. These Department personnel would provide the nucleus for a disaster reaction team; they can be trained and equipped by the government, and supplemented by a reserve list of qualified volunteers (mutual aid program). For example, inspectors from these departments would be assigned as the core of the survey team for each survey area and would be "on call" in case of a disaster. Also, under the auspices of government, command posts are pre-designated, communication frequencies assigned, and equipment and material stockpiled for ready access. Training classes and seminars can also be sponsored by the government to qualify inspectors to perform their field duties. It should be noted that the Police and Fire Departments, along with utility and telephone companies are integral parts of any Disaster Program, however, they all have their own unique emergency functions to perform independently, and would not be generally available for use in the B.O.C.A. Disaster Plan.

The administrative planning, maintenance, and action subsections of pre-disaster planning is ideally suited to governmental departments. For example,

the Building Department would be the logical choice to administer the location and mitigation of hazardous structure. With the Departments right of access, buildings could be legally inspected. Since the Building Departments issue building permits, keeping track of hazardous structures being remodeled would be simplified; when the permit to remodel a structure pinpointed as hazardous is applied for, elimination of the hazards cataloged in the building will be required.

As part of the implementation process, funding and additional staffing of governmental departments administering and participating in the plan must be accomplished; the disaster plan would be a burden on the normal operation of these departments unless the additional aid is procured.

V. SUMMARY AND CONCLUSION

In any disaster situation, a simple fact surfaces; a few trained professionals familiar with an established disaster program are worth hundreds of untrained volunteers. Effective and efficient leadership immediately following a disaster, utilizing personnel trained for specific tasks, is essential to bring quick relief to a disaster area. Earthquakes, floods, major fires, and tornadoes occur with little or no warning, often resulting in loss of life, extensive property damage, and general disorientation of entire areas. A Model Disaster Preparedness Program can provide the necessary guidelines to insure continuity of communications and services during and after the occurrence of a disaster. People trained in needed skills and familiar with the disaster plan are the key to the survivability of a community.

Proper pre-disaster planning combined with training and coordination will form the basis of efficient post-disaster operations. It is hoped that communities will never have to utilize this Disaster Preparedness Plan; however, Disaster Preparedness Programs are planned, disasters are not.

Merrily Kronberg / Graham
flying-fox-colors@worldnet.attnet
att.net
Vancouver, WA