Disaster Mgmt

POST-EARTHQUAKE LAND USE PLANNING

Draft Final Report

Pg 17

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National Science Foundation Grant
ENV 76-82756

July 1979

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All of the materials incorporated in this work were developed with the financial support of National Science Foundation Grant ENV 76-82756. However, any opinions, findings, conclusions, or recommendations expressed are those of the authors and do not necessarily reflect the views of the foundation.

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FOREWORD

This draft report results from almost two years of research on the prospects of making land use changes after damaging earthquakes to reduce future seismic risk. This version of the report presents conclusions and recommendations drawn by the interdisciplinary project team from investigations of recent U. S. and foreign experience in recovery from damaging earthquakes and selected other disasters.

The investigations included case studies of post-earthquake land use planning following the 1971 San Fernando, 1964 Alaska and 1969 Santa Rosa earthquakes plus a review of published accounts of reconstruction following selected other natural disasters. Summaries of reports of these investigations are included in this report. The full case study reports will be included as appendices in the final published version.

In its present form, the report is intended to serve as the basis for discussion among participants at a workshop scheduled for August 1 and 2, 1979 in Boulder, Colorado. Following the workshop, the report will be revised and prepared for publication. Thus, at this point, comments and suggestions for changes are welcome and will be considered in preparing the final report.

INTRODUCTION

History has shown that, after a damaging earthquake, economic, psychological and political pressures foster rebuilding as rapidly as possible. The prevailing attitude after an earthquake is a desire to help those who have suffered injuries, disruption of their lives and property damage. Given this attitude, actions to reduce future risk may be seen as interfering with rapid recovery. The overriding concern is with immediate needs, not with future disasters. Yet attention to hazards in planning and carrying out reconstruction can significantly reduce risk without unreasonable delay or hardship.

Improved safety in reconstruction after earthquakes has come primarily from rebuilding and repairing structures to better withstand shaking from future earthquakes. The increase in safety from improved structural characteristics can be very significant. However, little attention has been given to avoiding or restricting development or reconstruction in areas revealed by the earthquake as hazardous. An underlying concept of this project is that well-planned land use changes following an earthquake can effectively reduce risk from future earthquakes. The question is how to achieve these changes. An interdisciplinary research team was formed to investigate the problems and potentials of post-earthquake land use planning. The team includes members from the firms of Earth Sciences Associates, a geotechnical firm, H.J. Degenkolb and Associates, structural engineers, and William Spangle and Associates, Inc., city and regional planners. In addition, special consultants in public administration and law were retained. The team met frequently during the two-year project to shape the evolving content of the study. It was an exciting undertaking with a constantly unfolding story--many original assumptions proved unfounded, each case yielded its surprises, and in the give and take among the team members new perspectives on the problems and solutions emerged.

Perhaps the most notable lesson from the study is that ordinary land use planning and regulation are not very effective in shaping the course of reconstruction unless there is unusual political agreement on their use. What is effective, is the massive infusion of federal funds following major natural disasters. The success of a reconstruction program in reducing risk appears to require a unique blend of federal, state and local

efforts in the aftermath of an earthquake.

SCOPE

The study focuses on actions and decisions taken after an earthquake which lead to permanent reconstruction. To a considerable extent, these actions are different from the hazard mitigation measures that are appropriately and often adopted before an earthquake. At some point after an earthquake, however, the mitigation measures begin to focus more on the next event than the prior one. In the sense that post-earthquake decisions are viewed in terms of their impact on future seismic safety, they can be considered pre-earthquake hazard mitigation efforts. There is no clear distinction between post and pre-earthquake hazard mitigation.

The study deals with those aspects of reconstruction involving land use planning. Much has been written about the engineering aspects of seismic safety, but the role of land use planning in mitigating earthquake hazards has been largely ignored. Possible land use responses include changes in land use plans and regulations, changes in land use or occupancy, relocation of facilities, redevelopment, and land acquisition. A major effort was made to identify situations in which a land use response, as opposed to the more commonly invoked engineering or strictly structural response, is appropriate.

While the study is concerned principally with reconstruction after earthquakes, reconstruction after selected other natural disasters was reviewed. The objective of this review of other disasters was to identify lessons applicable to the post-earthquake situation. Findings from the review of other disasters appear to confirm conclusions derived from the study of earthquake disasters.

The study draws primarily on information from past U. S. earthquakes in order to arrive at recommendations appropriate to the governmental, economic, social, and institutional character of the United States. However, there have not been any recent major earthquakes which caused heavy destruction in metropolitan areas in the United States. Therefore, the project team reviewed two recent major foreign earthquakes to observe reconstruction problems in areas with extremely high damage. Information from the review of these foreign earthquakes was useful in analyzing the problems of

organization and timing in handling reconstruction after a large-scale disaster in a major metropolitan area.

METHODOLOGY

Three case studies were undertaken to identify the factors influencing post-earthquake land use planning: the 1971 San Fernando earthquake, the 1964 Alaska earthquake and the 1969 Santa Rosa earthquake. For each case, the project team reviewed available background material related to the earthquake, geologic and structural effects, and reconstruction efforts. Key people involved with the reconstruction were then interviewed to learn further what actions were taken and, to the extent possible, the factors that influenced the decisions made.

Each case study was handled somewhat differently. Each succeeding study build on the lessons learned from the prior studies. Each earthquake evaluated was different with distinctive seismic and geologic effects, structural damage and damage patterns. The affected areas also differed in the extent of urbanization, degree of isolation, resources to cope with recovery, and socio-economic characteristics.

Each case study report describes the geologic and seismic effects of the earthquake, the extent and nature of damage, the probability for future damaging earthquakes, the actions taken in reconstruction and the reasons for the actions. Finally, each report contains conclusions drawn from that particular case study.

Reconstruction experience following selected other domestic and foreign earthquakes and natural disasters was reviewed and summarized. This part of the study involved reviewing published accounts and other records of reconstruction following the tornadoes in Xenia, Ohio in 1974 and Omaha, Nebraska in 1975; the flood in Rapid City, South Dakota in 1972; the tsunami in Hilo, Hawaii in 1960; and the earthquakes in Managua, Nicaragua in 1972 and Skopje, Yugoslavia in 1963. The information was used to confirm or to raise questions about conclusions from the detailed case studies and to explore possible similarities between reconstruction problems after earthquakes and other disasters.

While the study was in process, a major landslide destroyed twenty-two homes in the City of Laguna Beach, California. Because some reconstruction problems were similar to those of a post-earthquake situation, the study was expanded to include Laguna Beach as a case study area. This case allowed observation of actions taken and problems encountered in the period immediately following a disaster and a first-hand tracing of reconstruction decisions. It is the only detailed case study of disaster response under present (1978-79) federal disaster relief legislation and regulations included in the project and, thus, provided an opportunity to evaluate the effectiveness of existing disaster response procedures.

A Discussion Group Panel composed of recognized experts in various aspects of post-disaster response met with the study team four times during the two-year study providing comments on the work program, case study reports, and the conclusions and recommendations emerging from the study. After completing the case studies, the project team assembled the comments of the Discussion Group Panel and other reviewers of the case study reports, reviewed the material on other earthquakes and disasters, and reassessed the conclusions and recommendations drawn from the case studies. From this evaluation, recommendations were developed for improving post-earthquake reconstruction, particularly with respect to land use planning.

This report presents the results in the form of conclusions and recommendations. Each case study and reviews of other disasters are summarized here and full reports are included in the appendices.

The project team recognizes that the three case studies are a small sample to illustrate the wide variety in possible conditions and problems pertaining to post-earthquake reconstruction. However, common threads were identified and reinforced by the review of reconstruction following other natural disasters and earthquakes. These commonalities form the basis for the conclusions and recommendations to improve post-earthquake land use planning which are presented as a first step to stimulate discussion and further investigation.

SUMMARIES OF INVESTIGATIONS

The research effort centered on case studies of the experience following three recent U.S. earthquakes--San Fernando, 1971, Alaska, 1964, and Santa Rosa, 1969. Each case study was based on a review of published reports and public records and on interviews with people who played key roles in reconstruction after the earthquakes. Information from these case studies was supplemented by information from a review of the experiences following other natural disasters including a landslide in Laguna Beach, California in 1978, the 1972 flood in Rapid City, South Dakota; tornadoes in Xenia, Ohio in 1974 and Omaha, Nebraska in 1975; the 1960 tsunami in Hilo, Hawaii and the major earthquakes in Managua, Nicaragua in 1972 and Skopje, Yugoslavia in 1963. The reports of these studies are summarized in the following sections.

SAN FERNANDO CASE STUDY

Shortly before dawn on February 9, 1971 an earthquake struck the San Fernando Valley in Los Angeles County, California. Registering 6.4 on the Richter scale, this moderate earthquake resulted in 64 deaths and $1/2 billion (1971 dollars) in property damage throughout the affected area of Southern California. Eighteen schools, four hospitals, 465 single-family homes, 62 apartment houses, and 372 commercial structures were posted as unsafe for occupancy. Highway bridges and utility lines were extensively damaged and the Lower San Fernando Dam nearly collapsed necessitating the emergency evacuation of 80,000 people from the downstream area. Federal aid including Small Business Administration loans, temporary housing, unemployment benefits as well as funds for reconstruction of public facilities totaled over $540 million.

For purposes of this study, an area centering on the City of San Fernando and encompassing the most severely damaged structures was selected (Figure 1). Within this area, damage patterns were related to a variety of geologic and structural factors. Old masonry buildings, particularly in downtown San Fernando, suffered extensive damage. Buildings, roads and utility lines in the area where the San Fernando fault ruptured were damaged. The San Fernando Valley Juvenile Hall, Olive View Hospital, Veterans Administration Hospital and other buildings, located in a zone along the base of the foothills on the north side of the valley where ground shaking was especially intense, collapsed or were

Figure 1. Map showing San Fernando study area, epicenter of the 1971 San Fernando earthquake, and relationship to Southern California cities.

severely damaged. In the foothills, landslides, rockfalls and shattered ground on ridgetops were common, but caused little damage because the area was largely undeveloped. Soil liquefaction apparently contributed to the failure of Juvenile Hall and the partial failure of Lower San Fernando Dam.

Following the earthquake, Los Angeles County and the cities of Los Angeles and San Fernando were declared a major disaster area by the President, releasing the flow of federal dollars for emergency work and reconstruction. Virtually every property owner whose building was damaged applied for and received Small Business Administration low-interest loans for repair. The U.S. Office of Emergency Preparedness funded the repair of public facilities and compensated local governments for property tax revenues lost because of lowered property values. The Department of Housing and Urban Development provided funds for temporary housing and grants for open space, historic preservation and comprehensive planning. In the City of San Fernando, the Army Corps of Engineers cleared debris, replaced the sewer and water systems and repaired streets.

Most reconstruction was completed, largely with federal funds, within two years of the earthquake. The only land use change made as a direct result of the earthquake was the relocation of the Veterans Administration Hospital and conversion of its former site to a county park. Other potential options for land use changes were either not considered or were rejected in favor of structural measures. No restrictions on development were considered in the inundation area below the Upper and Lower San Fernando Dams. A new dam has been constructed which is designed to withstand the effects of future earthquakes. Damaged single-family homes astride the San Fernando fault were repaired and reoccupied without restriction and the City of San Fernando's general plan, revised after the earthquake, retains the pre-earthquake single-family residential designation of most of the fault zone within the city. Repair and reconstruction of public facilities and homes in the heavily damaged Kagel Canyon area proceeded without restriction although the area is vulnerable to damage from floods and wildfire as well as from future earthquakes.

Where safety was increased, it was largely through improved structural design and construction. As a result of the damage experienced in this earthquake, the state adopted new design standards for construction of hospitals and highway bridges. Collapsed and

severely damaged masonry buildings in downtown San Fernando were replaced with buildings of more recent design and construction. The city had started a redevelopment project for a two and one-half block area of downtown in 1966. At the time of the earthquake, street work and landscaping had been completed. The availability of SBA loans after the earthquake spurred the redevelopment of private property in the area.

Relocation of the San Fernando Valley Juvenile Hall and Olive View Hospital complex was considered but rejected after intensive geologic and engineering studies indicated that proper site preparation and foundation and building design could provide for reasonably safe reconstruction on the original sites. Juvenile Hall was rebuilt on its old site and a new Olive View Hospital building is now (1978) under construction on its original site. Under provisions of the Disaster Relief Act of 1970, the federal government was authorized to pay for the repairing, restoring, reconstructing, or replacing of public facilities, but was not authorized to pay for acquiring new sites for relocation. This provided a strong incentive for rebuilding on the original sites.

Findings

From the San Fernando case study the study team drew the following conclusions:

1) Realistic options for land use change in post-earthquake reconstruction are limited by both the extent of damage and damage patterns. In this moderate earthquake in a metropolitan area, damage was scattered and, in most cases, related to building rather than site characteristics. The high public and private investments in the urban infrastructure and the established land use pattern preclude major changes unless an area is virtually destroyed and demonstrably unsafe for its pre-earthquake uses.

2) Federal funds are an essential element in reconstruction after an earthquake. Few property owners have earthquake insurance and local governments, faced with loss of revenue, are unlikely to be able to fund reconstruction of public facilities without outside assistance. Decisions to reconstruct or relocate structures are made on the basis of the availability of federal funds.

3) In the crisis atmosphere that prevails in the immediate aftermath of a damaging earthquake, important decisions might be made too quickly without adequate con-

sideration of the consequences. This does not seem to be the case in San Fernando. True, reconstruction did preceed rapidly in most damaged areas. But the decisions most important to future safety--those concerning reconstruction of major facilities in seemingly hazardous areas--were made only after careful study.

4) The most important actions reducing future risk of earthquake damage were replacement of damaged buildings with better designed and constructed structures and the adoption of more earthquake resistant design standards by the state for hospitals and highway bridges.

5) Rebuilding wood-frame single-family homes in areas subject to surface fault rupture may be defensible if the recurrence interval of damaging earthquakes on the fault is considered to be very long and the potential movement quite small. In making this finding, it is pointed out that loss of life has rarely been caused by the collapse of a single family wood-frame house due to surface ground rupture. Also, the amount of property damage to a wood frame single-family home, from fault offset, if it occurs once in a 200 year period, may be a reasonable risk. Hence, reconstruction of houses along the San Fernando fault, expected to produce an earthquake comparable to the 1971 event once every 200 years or so, was not necessarily unreasonable. However, no evidence was found that decisions to rebuild were based on an explicit consideration of risk.

ALASKA CASE STUDY

Late in the afternoon of Good Friday, March 27, 1964, the largest North American earthquake of the century (8.4 on the Richter scale) struck southeastern Alaska. At that time, Alaska was sparsely populated, only a few years into statehood and afflicted with a shaky public and private economy. The earthquake dealt a staggering blow to the fledgling state, killing 114 people causing over $300 million (1964 dollars) in property damage and crippling the economy of several towns. Federal assistance to public agencies and victims in Alaska after the earthquake totalling over $400,000,000, exceeded the amount of property damage.

Because of the extent of the damage relative to Alaska's resources for rebuilding, the federal government assumed the primary responsibility for reconstruction. Soon

after the earthquake, President Johnson appointed the Federal Reconstruction and Development Planning Commission, chaired by Senator Clinton P. Anderson, to coordinate the rebuilding effort and plan for the long term reconstruction and economic development of the state. Nine task forces were established to assist the Commission in its mission. The most important of these from a land use planning standpoint was the Scientific and Engineering Task Force, also called Task Force 9. Composed of structural engineers, engineering geologists and seismologists from the U.S. Geological Survey, U.S. Army Corps of Engineers and U.S. Coast and Geodetic Survey, Task Force 9 was established to advise the Commission where federal funds should be spent for stabilization, repair and complete reconstruction or relocation of facilities. The Task Force organized a field team to direct the geologic and engineering studies, recommend areas suitable for reconstruction and establish interim zoning design criteria to guide construction.

The efforts of the Task Force resulted in a series of maps for several Alaska communities showing areas of unstable ground in which federal funds were not to be used for reconstruction unless stabilization was achieved. These maps and the recommendations of the Task Force regarding construction standards, possible stabilization measures and further studies were adopted by the Federal Reconstruction Commission and guided the allocation of federal funds for reconstruction.

Our study focused on the reconstruction experience in three areas of Anchorage, Alaska's largest city and heart of its economy; Seward, a small port and southern terminus of the Alaska Railroad, and Valdez, a fishing and shipping port at the time of the earthquake and now terminus of the Alaska pipeline (Figure 2).

Anchorage

A large portion of the damage in Anchorage was caused by seismically-triggered landslides. The biggest and most damaging landslides were the Fourth Avenue, L Street and Turnagain slides--all along the bluff of Knik Arm (Figure 3).

The Fourth Avenue slide occurred in a commercial area near the heart of downtown Anchorage. The slide consisted of a 36 acre block of ground which moved horizontally

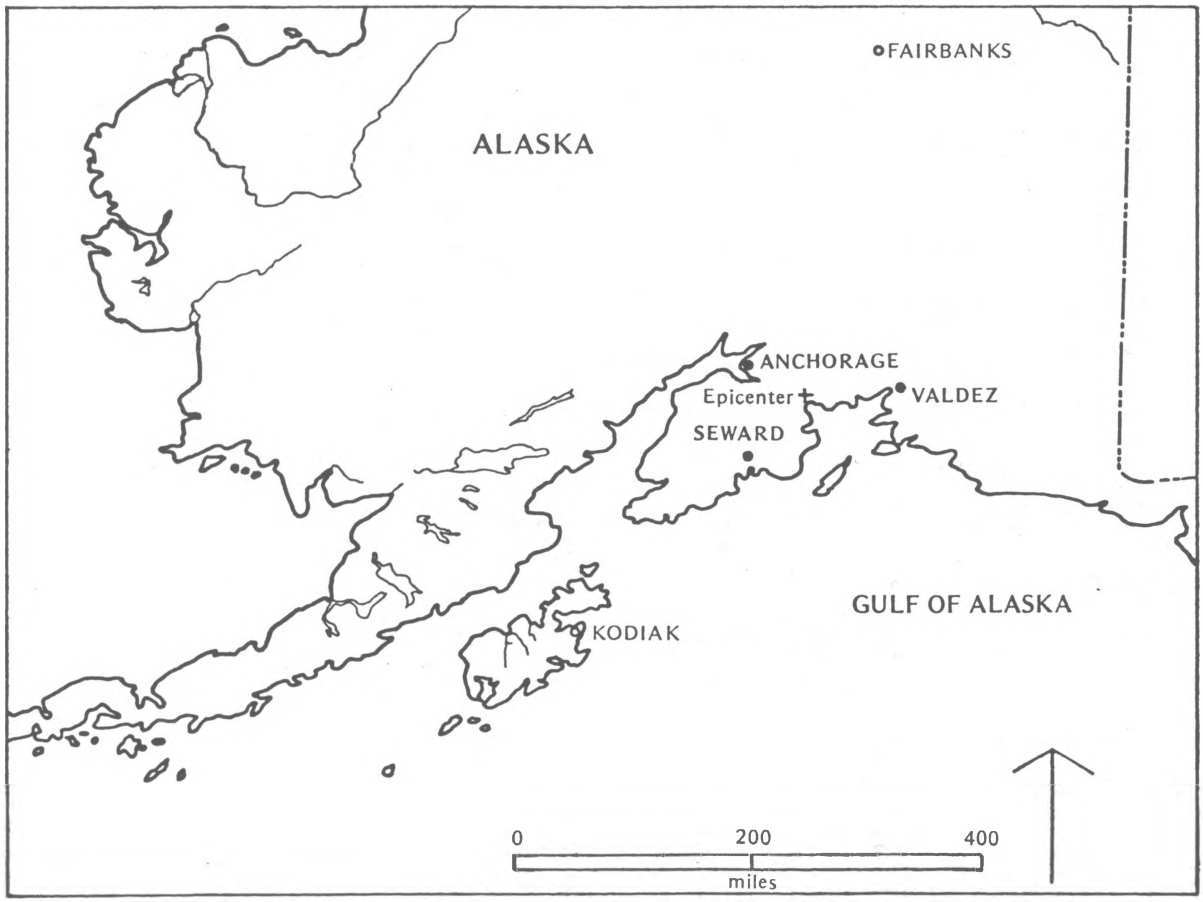


Figure 2. Map of Alaska showing location of Anchorage, Seward and Valdez and the epicenter of the 1964 Alaska earthquake

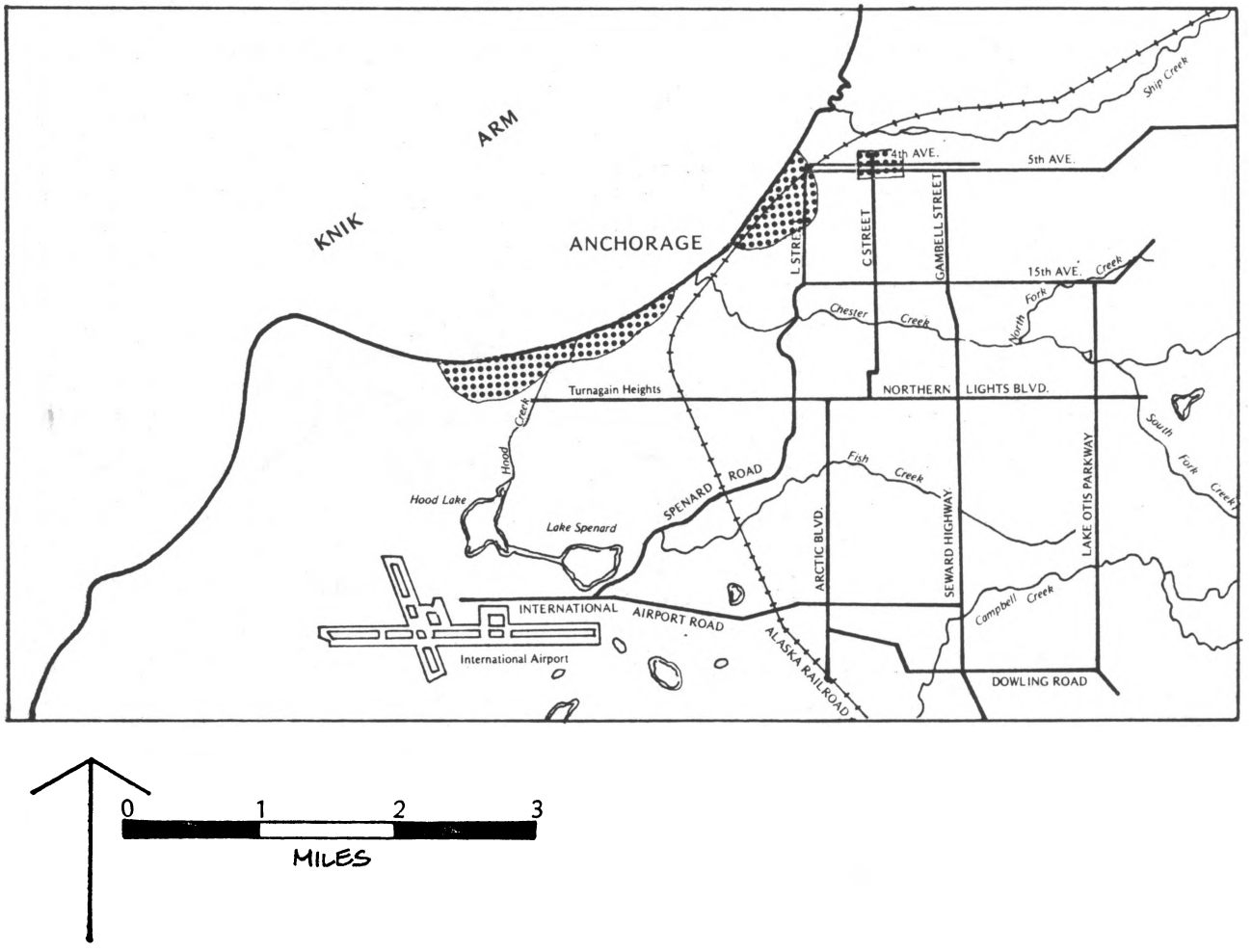


Figure 3. Map of a portion of Anchorage showing the location of the Fourth Avenue, L Street, and Turnagain landslides

about 17 feet toward the Arm leaving a graben (a depressed swath of land) up to 11 feet deep, 100 feet wide and 1,800 feet long along Fourth Avenue. Buildings along the north side of Fourth Avenue collapsed into this graben.

The Scientific and Engineering Task Force (Task Force 9) designated the slide area as unstable and recommended construction of an earthen buttress to achieve stabilization. Specific limitations on the depth of excavations and fills and the weight and height of buildings to be permitted on the stabilized slide were also recommended. Construction of the buttress was carried out as part of a federally-financed urban renewal project and completed in 1967. Private property needed for constructing the buttress was acquired and after the buttress was complete, parcels were sold for development of two shopping malls, a hotel and related development at the top of the buttress. The recommended grading and building restrictions are incorporated into the urban renewal plan and have generally been followed. The urban renewal project was completed in August 1978 at a total federal cost of about $9 million.

The L Street slide to the west of downtown occurred in an area of mixed residential and small office uses. It was a block slide involving 72 acres (30 city blocks) which moved, quite intact, 14 feet toward the bluff leaving a graben up to 250 feet wide and 7 to 10 feet deep. Buildings on the block were largely undamaged but those at the edges of the block were destroyed.

The Scientific and Engineering Task Force designated the slide and adjacent areas as unstable and recommended further engineering and economic studies of stabilization measures. It further recommended that, even if the area were stabilized, construction should be limited to light occupancy structures no more than two stories high. Plans, drawn up soon after the earthquake, to include the L Street area in an urban renewal project along with the Fourth Avenue area were not adopted by the Anchorage City Council. No additional studies were undertaken and no restrictions on rebuilding enacted. In fact, about a year after the earthquake, the Anchorage City Council rezoned the area to higher density residential and office use. New construction in or next to the area began soon after the earthquake, starting with the high-rise Captain Cook Hotel. Offices, apartment buildings, and even government buildings, many of them high-rise,

soon followed and today the L Street slide area, although not stabilized, is far more intensively developed than at the time of the earthquake. The construction has been financed by private financial institutions. The Federal Housing Administration (FHA) and other federally-insured mortgage funds have not been used for construction in the unstable areas designated by Task Force 9.

The Turnagain slide was the largest and most spectacular of the Anchorage landslides, involving about 130 acres of land and destroying 75 homes. It extended for 8,5000 feet along Knik Arm and as much as 1,200 feet inland. The bluff essentially disintegrated as successive blocks peeled off--some moving seaward up to 500 feet. The slide mass and a considerable area inland of the new bluff line was designated unstable by the Scientific and Engineering Task Force.

The Urban Renewal Administration authorized $633,872 for the U.S. Army Corps of Engineers to study methods of stabilizing the Turnagain slide as part of the feasibility study for a proposed urban renewal project. In 1966, the Corps concluded that the slide mass was stabilizing itself and forming a natural buttress against further bluff failure. In the opinion of the Corps, the natural buttress would be effective in preventing additional bluff failure in an earthquake of magnitude and duration similar to the 1964 earthquake if erosion of the toe of the slide were controlled. Even with erosion control, however, the natural buttress would experience differential movements and would be unsafe for building. An urban renewal plan calling for park and recreation uses of the slide area, a road along the shoreline and erosion control measures was prepared, but rejected by the Anchorage City Council in 1967.

The western portion of the slide, which was in public ownership at the time of the earthquake, was left in its post-earthquake condition as a city park, appropriately named Earthquake Park. To the east, the slide mass was bulldozed to bury debris from the destroyed houses. No replatting has occurred and, although most owners received lots elsewhere on state land at a nominal cost after the earthquake, the state failed to acquire title to the Turnagain lots in exchange.

By 1978, new houses had been constructed on the edge of the new bluff and a duplex

was under construction on the slide itself. No erosion control measures had been taken and as much as 400-500 feet of the toe of the slide had eroded away exposing previously buried debris from houses destroyed in 1964. The Anchorage Municipal Assembly (formerly the City Council) was wrestling with the question of whether to permit development on the slide. In April 1978, the Assembly passed an ordinance permitting development on the slide providing property owners are willing to pay for extension of roads and utility services into the area.

Seward

At the time of the earthquake, Seward was a small city of about 2300 people with a seasonal and declining economy based on shipping, fishing and tourism. Its importance as a port depended on links to the interior provided by the Anchorage-Seward Highway and the Fairbanks-Seward Alaska Railroad line, both of which were severed in the earthquake. The Seward waterfront was virtually destroyed by massive landsliding followed by a series of slide-induced waves and tsunamis. Thirteen people were killed, five injured and damage to public and private facilities surpassed $22 million (in 1964 dollars).

Much of the damaged waterfront was designated unstable by the Scientific and Engineering Task Force and stabilization was deemed infeasible. An urban renewal plan encompassing the entire city was prepared but later revised to include only the waterfront area in order to bring the cost of the project into line with funding authorized by Congress for post-earthquake urban renewal projects in Alaska. The revised plan called for relocation of the city dock, railroad dock and small boat harbor and use of much of the unstable waterfront for parks and recreation.

The Federal Housing Administration (FHA), in accord with the Federal Reconstruction Commission recommendations, did not insure loans for construction in the high-risk area and, because of declining economic opportunity and population, there was little incentive for local financial institutions to fund development in the area. As of 1978, the dock and harbor facilities had been relocated and the waterfront was largely free of structures. The city was hoping to get U.S. Coastal Energy Impact funds to develop recreational facilities along the waterfront.

Valdez

Valdez is Alaska's northernmost ice-free port and southern terminus of the Richardson Highway linking the city to Fairbanks and Alaska's vast interior. At the time of the earthquake, about 1,000 people lived in Valdez and were supported primarily by shipping and commercial and sport fishing. During the earthquake a large submarine slide and slide-induced waves destroyed Valdez' port facilities and much of its commercial area. Damage to port facilities alone exceeded $3.5 million (in 1964 dollars).

Almost immediately after the earthquake, geologists recognized that Valdez occupied a particularly hazardous site, subject to further sliding, ground cracking, wave damage and flooding. The Federal Reconstruction Commission, after considering abandonment of the city altogether, finally decided to relocate the city to a safer site about four miles away. In the process, the local people were offered the choice of relocating with most of the cost borne by the federal government or rebuilding at the old site at their own expense. The relocation of Valdez was essentially completed in late 1967 under two separate urban renewal projects -- one to acquire land and clear the old site at a federal cost of about $2.9 million; the other for public improvements at the new site at a federal cost of about $1.8 million.

In 1978, little evidence of the former city remained at the old site. The city's sewage treatment facility was there and part of the site was leased to Alyeska (the pipeline corporation) as a staging area for truck and ship transport. The long term use of the area appeared uncertain. The new city was expanding beyond its original boundaries, having grown dramatically during the boom years of the pipeline contruction. Fiscally, the city was in unusually good shape with tax revenues from the pipeline, terminal facilities, but with the completion of construction activities on the pipeline the private economy was depressed. The city was actively seeking development to bolster and stabilize the local private economy.

Findings

1) The experience following the 1964 Alaska earthquake strongly reinforces the conclusion from the San Fernando case study that federal funds dominate post-earth-

quake reconstruction. The actions taken were those that the federal government agreed to fund. Renewal projects were scaled to the available funds as were projects to rebuild public facilities, especially port, highway and the railroad facilities.

2) In Alaska, in contrast to San Fernando, several opportunities for land use changes to reduce future seismic risk were obvious immediately after the earthquake. Much of the damage was concentrated in areas of landsliding or wave runup which were vulnerable to future damage. Some land use changes were made, but many were not. The changes that were made were accomplished through publicly-funded redevelopment projects; changes were not made through conventional rezoning or land use controls.

3) In most cases, the timing of reconstruction in heavily damaged areas was determined by the commitment of federal funds. Initial plans for reconstruction or redevelopment were prepared within a few months of the earthquake. However, the plans were followed only to the extent that federal funds were committed to implement them.

4) The Federal Reconstruction Commission was effective in coordinating federal aid and quickly obtaining commitments to fund particular projects. When its recommendations were backed up with federal funds, they were followed. However, the Commission disbanded 6 months after the earthquake before firm decisions on the future of the Turnagain and L Street slide areas had been made.

5) The Scientific and Engineering Task Force accomplishments demonstrate the feasibility of bringing together scientists and engineers to quickly evaluate hazardous areas as a guide to reconstruction. The fact that Task Force 9's technical recommendations remain largely unchallenged to this day is a tribute to its success.

6) Redevelopment is an effective way to achieve land use change in heavily damaged areas.

7) Within an urbanized area which is experiencing even modest growth, pressures will eventually mount for rebuilding even in the most obviously hazardous areas, particularly if the land is left in private ownership and without adequate land use restrictions.

8) Decisions which effectively reduce seismic risk are most likely to be made when they are consistent with other community objectives. Even after an earthquake,

reducing seismic risk appears to have fairly low priority--certainly lower than quickly restoring the normal function of the community.

9) Major land use changes, such as the relocation of Valdez, are unlikely to occur without a strong federal hand--stronger than local governments normally consider acceptable.

SANTA ROSA CASE STUDY

Santa Rosa is located about fifty miles north of San Francisco in a valley underlain by deep alluvium (Figure 4). In the evening of October 1, 1969, this city of about 50,000 people was hit within two hours by two earthquakes (magnitudes 5.6 and 5.7 on the Richter scale). Almost all the $6 million (in 1969 dollars) or so in resulting property damage was caused by intense ground shaking. Many buildings, including numerous old, unreinforced masonry buildings in downtown Santa Rosa, were damaged. However, none collapsed. The city was not declared a major disaster area, but, under a federal declaration of emergency, Small Business Administration low-interest loans were available to property owners for repairs. Because damage to most structures was relatively light and because some property owners felt the application procedures were too cumbersome, few owners applied for this assistance.

The major hazard revealed by the earthquakes was that of old buildings, inadequately constructed to withstand the strong ground shaking that can be expected in the area. To address this hazard, the city used two approaches--redevelopment and requirements to abate existing structural hazards.

In 1961, Santa Rosa embarked on a redevelopment project covering part of the downtown area. Just prior to the earthquake, the city had adopted a central business district plan which covered an area adjacent to the redevelopment area. After the earthquake, this area, with a high percentage of damaged buildings was added to the original redevelopment area. With a federal contribution of about $5 million, properties were acquired and cleared for development of a major regional shopping center integrated with the rest of downtown. Construction of the shopping center began in late 1978 after the project survived a number of legal challenges.

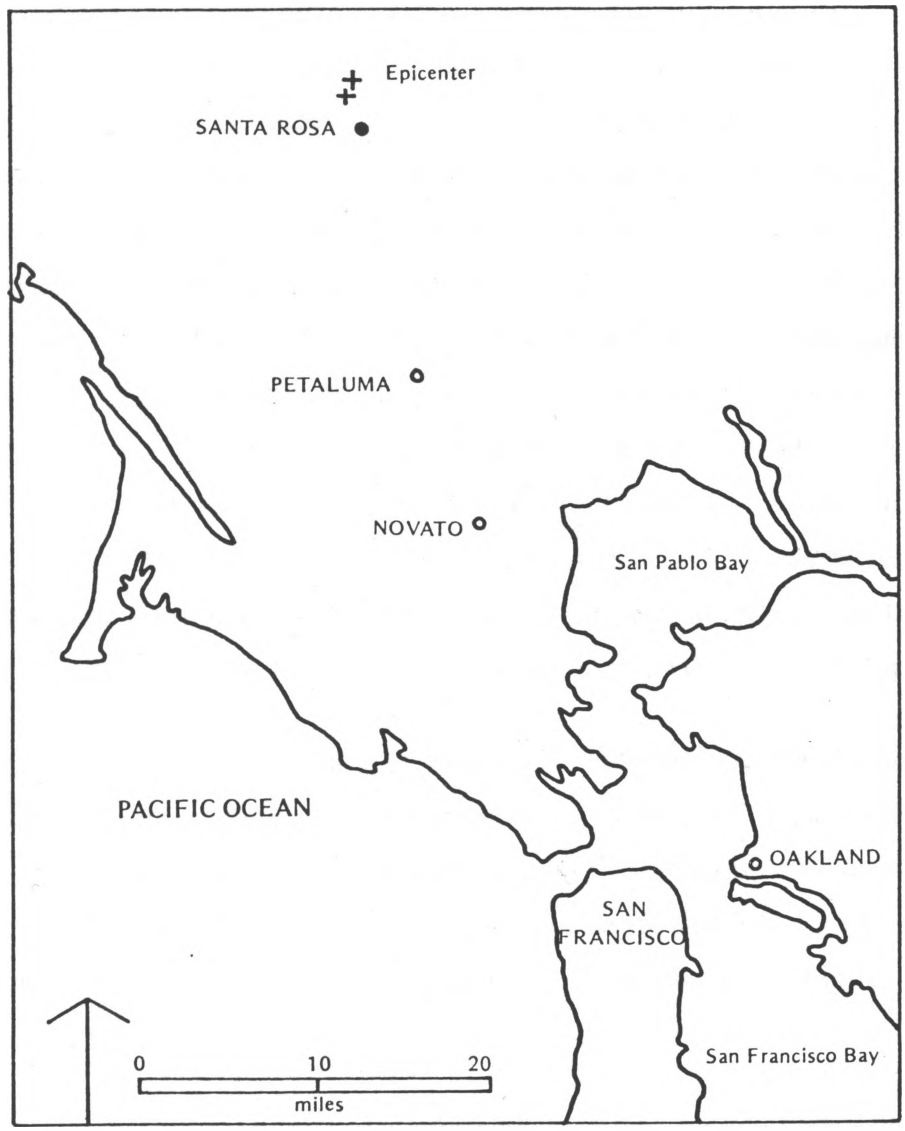


Figure 4. Map of a portion of the San Francisco Bay area showing location of Santa Rosa and epicenters of the 1969 earthquakes.

Requirements to abate structural hazards evolved over the two years following the earthquakes. In October 1971, the city council adopted Resolution 9820 requiring a preliminary structural inspection, at city expense, of all buildings in the city constructed before 1958 except public schools (which are governed by state requirements), one- and two-family dwellings, buildings with unreinforced masonry walls, and wood buildings located in Fire Zone 1. A priority system for review was set forth emphasizing high-occupancy structures and facilities needed for emergency response. Buildings were to be inspected for conformance with the 1955 Uniform Building Code. The 1955 Code, rather than the current code, was chosen to limit the economic burden on property owners and to encourage rehabilitation rather than demolition of old buildings, some of which had historical value. The owner of a building found to be substandard was required to engage a structural engineer to design and oversee structural modifications to meet the required standards.

In 1978, Resolution 9820 was slightly revised and added to the City Code as part of the building regulations. Since 1971, 200-250 buildings have been reviewed and many have been rehabilitated or replaced. The process, still on-going, is a lengthy one requiring tenacity, patience and flexibility on the part of the city staff to maintain political support for the program and encourage voluntary compliance of property owners.

Findings

1) The Santa Rosa experience illustrates that a moderately damaging earthquake can spur redevelopment of areas already in need of redeveloping and confirms the value of redevelopment as a method of improving seismic safety in conjunction with meeting other community objectives.

2) The Santa Rosa study points up the importance of experienced and dedicated staff and a sound on-going planning program.

3) Abatement of structural hazards in undamaged or slightly damaged buildings is possible, but it is a long-term, slow process requiring dedication, flexibility and professional expertise.

OTHER DISASTERS

Laguna Beach Landslide of 1978

On October 2, 1978, a 3.5 acre landslide occurred in a fully developed residential area of Bluebird Canyon in the City of Laguna Beach, California. Twenty-two houses, major portions of three roadways and all utilities within the landslide area were destroyed or damaged beyond repair, resulting in approximately $15 million in damages. Fortunately, no deaths and only minor injuries resulted from the early morning slide. In addition to the houses on the slide, some twenty houses next to the slide were evacuated, and remained unoccupied as of July 1979, because of the threat of renewed earth movement, nonexistent or unsafe access, or disrupted utility services. Furthermore, two additional houses were destroyed in a failure of the headscarp on April 23, 1979.

The Bluebird Canyon landslide is a reactivated portion of a larger, 5 acre, prehistoric landslide. Geologists retained by the City concluded the October movement was triggered by runoff from the heavy rains of February 1978 which infiltrated the slide mass and caused a creek to erode the toe of the ancient landslide.

Immediately after the slide, the area was cordoned off by Laguna Beach policemen to prevent injury and looting. The Mayor of Laguna Beach declared a disaster and requested aid from Orange County. The Governor of California also declared a disaster making state assistance available to Laguna Beach. On October 9, at the Governor's request, the President declared Laguna Beach a major disaster area making federal disaster assistance available. The declaration and subsequent federal-state agreement limited the federal assistance to emergency work needed to protect public property from further damage from sliding. Assistance to the landslide victims consisted of temporary housing assistance and low-interest Small Business Administration loans of up to $55,000 to rebuild destroyed homes.

Almost immediately after the landslide, the city hired an engineering geology firm to determine the cause of the landslide, chances for further movement and possible stabilization measures. Repeated movement of the slide in the days following the initial

slide made it apparent that immediate stabilization actions were needed to prevent the loss of additional homes and public improvements. The engineering geologists recommended that a drainage pipe be installed in the canyon at the bottom of the landslide to handle runoff from the expected winter rains, and that the destroyed houses be removed and the slide mass graded to control runoff and erosion. These emergency measures were complete in December 1978.

The engineering geologists evaluated several alternative methods of achieving "emergency" stabilization of the slide, that is, stabilization sufficient to prevent further damage to public facilities next to the slide. The most effective and least expensive alternative was the construction of two earth buttresses--one at the top and one at the bottom of the slide. At the top, a "shear key" buttress would prevent further failure of the slide's headscarp. At the bottom, a gravity buttress would prevent further movement of the slide mass and prevent damage to the drainage pipe and the access road to the area. The cost of the two buttresses was estimated at $650,000. After the design was completed, the project was calculated to provide a safety factor of 1.2, meaning that the forces holding the slide in place would exceed the force of gravity by 20%. According to the geologists, additional grading and stabilization work would be needed to achieve a safety factor of 1.5--the normal design factor for stabilizing an area for development.

The recommendation for buttressing the slide initiated discussion between officials of the Federal Disaster Assistance Administration (FDAA) and the City of Laguna Beach over whether the proposed buttresses constituted emergency work or work which would lead to permanent reconstruction in the area. Under terms of the disaster declaration, FDAA could fund only emergency work. On this basis, the agency questioned the emergency nature of the gravity buttress and refused to fund additional work that would provide a safety factor of 1.5. Finally, in February 1979, FDAA agreed to fund construction of both buttresses at the 1.2 safety factor levels and, as of July 1979, the work had been completed.

The question of future use of the slide area was not specifically considered in the debate over the buttressing project. The majority of victims expressed a strong desire to rebuild homes on the site and city officials appeared to act on the assumption that homes would be rebuilt in the area. The City and the property owners have implicitly decided that the safety factor of 1.2 is an acceptable risk. The major question was how to pay for the construction of roads and installation of utilities necessary for the reconstruction of the houses.

In June 1979, an agreement was reached between the California Office of Emergency Services and the City of Laguna Beach to share the cost of constructing public improvements on the slide, estimated at $300,000, on approximately a 50-50 basis. At the present time (July 1979), rough grading has been completed for reconstruction of the roads, public improvements are scheduled for completion in October 1979 and the city will accept applications from property owners for building permits to reconstruct homes on the landslide site. Lot lines and road rights of way will have exactly the same configuration as before the disaster. However, the geometry of the hillside is somewhat different as a result of the stabilization work.

Findings

1) Disagreement between FDAA and the city over whether the proposed buttressing project was emergency or permanent work appears to have been the major issue in the aftermath of the slide. Federal funds were eventually authorized for the project. The federal concern was limited to protecting public facilities next to the slide from damage from additional sliding. Federal officials did not address the question of future land use on the slide itself or possible risk of rebuilding on the slide.

2) Hazard evaluation was not a problem. Geologists quickly determined the cause of the slide, evaluated the potential for additional land failure and recommended measures to prevent further failures.

3) Those who lost their homes in the slide became a cohesive, and politically effective, group supporting Federal, state and local actions that would permit rebuilding of homes on the site. The desire of the victims to rebuild and community sympathy for their plight appear to be factors in limiting consideration by local gov-

ernment of land use changes or restrictions on rebuilding.

4) The timing of both emergency and reconstructive actions depended on federal decisions. No Federal representative was assigned to the local area and local officials had difficulty reaching federal officials with the authority to make decisions.

Rapid City Flood of 1972

On the evening of June 9 and the morning of June 10, 1972, torrential rains in western South Dakota resulted in a flash flood causing extensive damage in Rapid City, South Dakota. The number of dead and missing totaled 238, and 1,6000 buildings were severely damaged or destroyed, including the homes of some 3,000 families. Estimated property damage amounted to $80 million (1972 dollars).

Rapid City is located along Rapid Creek in southwestern South Dakota west of the Black Hills. At the time of the flood in 1972, Rapid City had a population of about 44,000 increasing from about 25,000 in 1950. Growth pressure following World War II led to urban development in the city's flood plain which before had been largely unoccupied.

The devastating 1972 flood was the last and most damaging of a series of floods occuring over several decades. The long history of flooding was paralleled by a history of flood protection investigations dating from the 1930's. These investigations were directed primarily towards structural solutions and resulted in two dams being built, which although inadequate to provide full protection, tended to encourage continued development of lands in the flood plain at Rapid City.

Investigation of nonstructural solutions to the flood problem began in the early 1960's when the city attempted to regulate against further flood plain encroachment. The effort failed because of local opposition. Most local interests favored structural solutions which would allow further development of the flood plain. Also, there was no specific state authorization for flood plain zoning.

In 1968, the city began an open space program to increase recreational land uses along Rapid Creek and decrease uses with high risk exposure. In 1971, the city entered the

federal flood insurance program after promising to enact suitable flood plain regulations as required by the program's rules. Action on the regulations was pending at the time of the flood.

On the eve of the disaster in 1972, structural flood protection measures proved to be completely inadequate to cope with the flood which exceeded the 100-year level. This inadequacy was demonstrated again one week later when a second flood occurred in the same area of Rapid City killing two people.

Following the disaster, new development within the flood plain was temporarily prohibited by the city and permits for repair of damaged buildings in the flood plain were temporarily withheld. Emergency response activities ended after about three weeks with the completion of debris removal and the final accounting for dead and missing persons. Most displaced families were relocated to temporary housing after about five months--mainly in trailers provided by the Department of Housing and Urban Development.

The city decided that the safety of future generations required major land use changes in the flood plain. Within seven weeks of the disaster, action began with the decision to acquire the entire flood plain through a Federally-funded urban renewal project. This project required the acquisition and removal of all remaining buildings, both damaged and undamaged, most of which were residential units. By October 1976, 95% of the area had been cleared of buildings, 50% of it developed for recreational use, and the final phase of redevelopment was in process.

Community attitudes and outside assistance were critical factors which affected post-disaster planning and decisions. A post-flood sample survey revealed, for instance, that seventy percent of the families from the flooded area did not wish to return to the area even if permitted to do so.

Funds for reconstruction were primarily from federal sources totalling over $150 million in loans and grants. The U.S. Department of Housing and Urban Development contributed funds for the floodway acquisition, provided housing grants, and supplied rent-

free mobile homes to flood victims; the Small Business Administration provided low-interest loans to flood victims; and the U. S. Bureau of Outdoor Recreation assisted in the development of the multi-million dollar recreational facilities within the flood plain. Twenty-seven houses and two businesses were insured against flooding by the Federal Insurance Administration, half of these sustained damage significant enough to warrant a claim.

Findings

1) In the absence of adequate upstream protection works, the failure of the city to enact flood plain regulations permitted flood risk to rise in Rapid City during the post-war period as development increased within the city's flood plain.

2) Following the flood of 1972, a number of factors influenced the city's decision to change land use policies for the flood plain. The availability of substantial financial assistance from the Federal government was of paramount importance. Without such assistance, it is unlikely that acquisition of the floodway and its conversion to recreational uses would have taken place because of the very high costs involved. Other factors likely influencing the city's decision to alter land use patterns within the floodway included:

a. The history of frequent flooding.
b. The attitude of flood victims who did not wish to reoccupy the flood plain
c. The relatively small portion of commercial and industrial property damaged. More extensive commercial-industrial development would have been difficult to remove from the flood plain because of high costs and probable negative effects on the local economy.

Xenia Tornado of 1974

On April 3, 1974, a devastating tornado struck the town of Xenia, Ohio. One-third of the town was either destroyed or damaged by the tornado which cut a swath of destruction three-quarters of a mile wide and four miles long through the city. Thirty-four people were killed, 500 were injured, 1,300 buildings were destroyed and several thousand more damaged. Estimated property damage was $100 million (1974 dollars).

Xenia, with a population of 27,500 at the time of the tornado, was a growing suburbanizing sub-center of the Dayton metropolitan area with a substantial but deteriorating core of residential and commercial structures, many dating from the period 1880-1910. Its central business district (CBD) was suffering from competition of commercial strip development and growth of nearby shopping centers. West of the CBD the flood plain along Shawnee Creek was heavily built up despite a long record of flooding.

The area devastated by the tornado included a heavily built up portion of the Shawnee Creek flood plain, a portion of the CBD, an area of low-income deteriorated housing west of the CBD, a portion of an older attractive neighborhood to the north, and relatively high-income housing in new subdivisions to the northeast. Nearly a thousand damaged buildings were removed by the Army Corps of Engineers within two months of the disaster. Because of the high vacancy rate in the Dayton area at the time, the Federal Disaster Assistance Administration quickly found temporary housing for tornado victims during the emergency period.

The Xenia City Commission recognized that the disaster gave them an opportunity to rectify existing zoning and land use incompatibilities and to avoid duplicating past mistakes in development. A partial moratorium on rebuilding in the heavily damaged downtown area was imposed while a plan for rebuilding was being prepared by the Miami Valley Regional Planning Commission (MVRPC) of which Xenia was a member.

The MVRPC plan was completed within sixty days presenting three alternative land use proposals, one of which was strongly recommended by MVRPC and adopted by the City Commission in late June 1974. This plan called for the development of a downtown shopping mall integrated with the remaining structures in the CBD; the construction of a variety of housing types in the devastated area adjacent to the CBD; and the development of a green belt along Shawnee Creek which would buffer the CBD from the highway-oriented commercial strip development on West Main Street and prevent rebuilding in the once built-up flood plain.

Soon after adoption of the MVRPC plan, disagreement arose over the design of the

downtown center and after debate the City Commission selected an outside firm to prepare a redevelopment project for the heavily damaged section of the CBD. This developer's plan provoked more debate and was rejected in June 1976. Six months later a new developer and a new plan was approved by the City Commission. The developer stated that speed was of the essence in completing the shopping mall in order to halt further spread of strip development on the city's two main arteries. However, decisions on tenants and construction details delayed construction for many months.

At the time of adopting the MVRPC Plan, the City Commission also approved "overlay zoning" which permitted exceptions to the plan through an appeal process. Dozens of appeals were approved in the months following the plan's adoption so that the plan became altered and pre-tornado land use patterns were permitted to reassert themselves in critical areas. Rebuilding was permitted in the Shawnee Creek flood plain. A number of automobile-oriented (rather than pedestrian-oriented) commercial uses were reestablished in the CBD. Even during the moratorium, several commercial establishments were allowed to rebuild in the CBD after threatening to leave the city if permission to rebuild was not granted. The planned construction of housing in the devastated residential area west of the CBD did not take place; instead, scattered commercial development resulted surrounded by large empty spaces. Following the tornado, there was very little new housing built in the low-income area whereas in other more affluent residential neighborhoods, reconstruction was rapid. As of June 1978, construction of the downtown shopping mall had not yet begun but was scheduled for later in the summer.

Federal agencies providing financial assistance to Xenia included the Economic Development Administration (EDA) and the Department of Housing and Urban Development (HUD). EDA provided a capital grant of $800,000 for development of an industrial park as a means of replacing industry destroyed by the tornado. HUD allocated $3.5 million for the $6.5 million downtown urban renewal project.

Findings

1) The city recognized the need to plan for changes beyond limits of the damaged area giving consideration to community-wide circulation and land-use relationships.

2) The overlay zoning was an ineffective tool for protecting the plan either because of inadequate criteria for administration or inadequate administration.

3) There appears to have been a need for some staging of development with high priority for relocation of businesses displaced by the plan and lower priority for new businesses.

4) Positive programs were needed, but not forthcoming, to rehouse low-moderate income families displaced by the disaster

5) Homeowners in Xenia with insurance were able to rebuild quickly.

6) Xenians saw the opportunity to rectify land-use problems in their town but were unsuccessful in implementing their reconstruction plan because delays on definitive actions by the city allowed the previous land-use pattern to emerge. Thus, in spite of outside dollars from the federal government for the redevelopment project, plan implementation was hindered by disagreement among Xenia's residents and members of the business community. Federal assistance, then, by itself was not enough to assure successful implementation of the plan; conditions on use of federal assistance were needed.

Omaha Tornado of 1975

On May 6, 1975 the City of Omaha, Nebraska, a community of about 350,000 residents, experienced one of the worst tornado disasters ever occurring in an urban area. It devastated a section of the city nine miles long and a quarter mile wide. Three people were killed, 150 were injured, 278 structures were destroyed and 2,650 were damaged. Estimated property damage was $120 million (1975 dollars).

City officials recognized the disaster presented opportunities to correct existing land use incompatabilities in the devastated section and to improve traffic circulation. One area zoned for industrial uses was recommended to be re-zoned for commercial uses. The Mayor and the City Council opposed this change, insisting that land owners in the area had experienced enough problems already and the industrial zoning was not changed.

In another area, local officials saw an opportunity to purchase severely damaged residential property fronting on a major arterial, where widening was proposed before the tornado. It was also suggested that additional damaged houses along the arterial be acquired to increase the size of an existing park to benefit the community at large and serve as a buffer between commercial and residential areas. Most owner occupants affected by the proposals were initially willing to consider selling their land for street widening or park expansion. However, delays were encountered because of state and Federal procedures including the need for appraisals before discussing purchase prices with owners. Consequently, the majority of owners lost interest in selling their properties because of lack of information on purchase prices. Because of their immediate need for housing, owners decided they could not afford to wait, began rebuilding, and the street widening and park expansion projects were not accomplished.

Findings

1) Omaha did not experience any major reconstruction problems because damage was largely confined to economically and socially stable areas of suburban commercial property and middle and upper-middle income residences, most of which were adequately insured against wind damage. Pre-disaster land uses in these areas quickly re-established themselves as the inclination to rebuild and the funds needed were present.

2) Outside assistance from regional, state, and national sources expedited cleanup operations and reconstruction activities during the post-disaster period. Omaha was declared a Federal disaster area thus making it eligible to receive Federal financial assistance. Four million dollars was allocated from the President's disaster fund, 254 home loans and 34 business loans were granted by the Small Business Administration, 82 families received grants under the Federal "408" program (designed for those who did not qualify for SBA loans).

3) Efforts to effect needed changes (such as the street widening) were hindered by state and Federal regulations which were not responsive to the disaster situation. The tornado victims were in need of immediate help and reassurance, and delays

imposed by Federal regulations and state procedures undermined their willingness to consider selling. The land use changes proposed by the officials might have been implemented under different conditions such as the following:

a. If a definite time frame for public decisions and actions regarding the proposed projects had been established as quickly as possible, the property owners might have been reassured and more willing to sell.
b. If clear guidelines for valuing properties to be acquired had been previously established, the uncertainties created by the state's reluctance to discuss property price estimates might have been reduced.
c. If the state had been willing or able to use "quick taking" procedures under eminent domain leaving only value questions to be settled through negotiations or court action (this may not be possible in Nebraska), the street widening probably could have been accomplished.
d. If suitable long-term temporary housing had been provided through governmental action, the owners of property affected by the proposed land use changes might have been willing to defer rebuilding on these sites.

Hilo Tsunami of 1960

On May 23, 1960, a tsunami struck Hilo, on the western shore of the island of Hawaii, wiping out structures in a 50+ acre area including the town's downtown area. Sixty-one people were killed, 288 structures demolished, and communication and transportation systems severed. Property damage was estimated to have been about $22 million (in 1960 dollars). Hilo's setting makes it unusually prone to tsunami damage, and the probability of future large tsunamis impacting the Hilo waterfront is extremely high. The business and residential area demolished in 1960 was only 15 years old, having been rebuilt after the 1946 tsunami which claimed 96 lives. Relocation of site occupants was discussed at that time, but not done. Instead a small buffer zone was established and a rock revetment placed near the shore. The revetment proved counterproductive. It was washed out in 1960 contributing debris to the tsunami waves.

Steps in replanning and redeveloping Hilo after the 1960 tsunami were as follows:

1. Hilo was declared a Federal disaster area paving the way for Federal disaster assistance and designation of most of the devastated area as a Federal Disaster Renewal Project to be administered by the Housing and Home Finance Agency (HHFA).
2. State and Federal agencies indicated they were unwilling to provide financial assistance for rebuilding in the tsunami runup area.
3. With people starting to return to the damaged area, Hawaii County restrained people from re-occupying structures which had sustained more then 60% damage; rehabilitation and new construction were prohibited in the damaged area for seven months while the redevelopment plan was being prepared.
4. Hawaii County established the Hawaii Redevelopment Agency in order to qualify for Federal funds and certified the damaged area as an area needing redevelopment.
5. The State authorized a $2.5 million bond issue to cover the local share of the renewal project and the Federal government authorized a grant of $6.68 million.
6. A consultant, Belt, Collins and Associates, was preparing a city plan for Hilo at the time of the tsunami, and was commissioned to do a renewal plan for the Federal Disaster Renewal Project.
7. Appraisals for land acquisition started in August 1960.
8. A Draft Urban Renewal Plan was submitted to the HHFA Regional Office for "information".
9. The Urban Renewal Plan was approved February 27, 1961.

The plan as subsequently amended to June 25, 1965, includes 349 acres within the Project Area. It provides for acquisition of real property for clearance and redevelopment except for public lands and properties under owner-participation agreements. The plan includes requirements designed to limit risk exposure by limiting intensity of use. All lands in the Project Area are placed in two categories: 1) elevated and 2) open, with appropriate uses designated for each category. Hazard avoidance and risk exposure are balanced, with maximum protection being given to high occupancy uses by restricting them to the elevated areas--presumably above the reach of most tsunamis. Elevated areas are restricted to commercial uses, a

civic center complex, bus terminals and public utility facilities. Open areas, the balance of the Project Area, include lands which were inundated by the May 1960 tsunami and are identified in the plan as being subject to possible inundation and damage by future tsunamis. Here, land uses are restricted to open uses, temporary non-conforming uses and, because of location requirements of pre-existing conditions, certain limited industrial and commercial uses in specifically designated locations. Industrial uses requiring water access such as boat service and repair, commercial fishing facilities and related services and supplies are also permitted within the open areas subject to conditions and requirements designed to reduce risk exposure. All structural uses in the open areas are subject to special conditions to protect health and safety.

Community attitudes after the disaster were apparently mixed. Some site occupants wanted to move back into the damaged area and some land owners wished to lease land for rebuilding in the run-up area, but public agencies did not want to incur the risk of again paying damages.

The feasibility of protecting the area by building a sea wall was studied by the U. S. Army Corps of Engineers and found to be too costly. The Corps wanted assurances from HHFA that the intensity of land use could be increased (i. e. changed from open space to such uses as commercial, hotel and other structural occupancies) if the sea wall tsunami barrier project was approved. HHFA, however, held very firm on Urban Renewal Manual provisions relating to precautions to be taken in areas subject to recurring disasters and took the position that change in use to more intensive use could be approved only when an effective protective device was actually installed. The Corps was then unable to include benefits for higher value, more intensive uses in its cost/benefit evaluation. HHFA also questioned whether uses in the proposed renewal plan would be suitable if the barrier were constructed since a wall would obstruct bay views. The Urban Renewal Plan (as amended to 1965) included a clause permitting the Hawaii Redevelopment Agency to redesignate permissible uses in the designated open areas if and when adequate protective measures were taken.

Public investment in Hilo's new "downtown" gave life to the project. Small Business Administration lease payment guarantees to landlords helped local merchants compete with major chains for space in the renewal area. State-owned lands in Hilo were made available for relocation of former residents of the redevelopment area.

Findings

1) Without Federal and State assistance, it is unlikely that Hawaii County could have redeveloped the devastated area or provided for relocation of residents and businesses.

2) Clear historic evidence of frequent tsunamis and the very recent prior event (1946) provided substantial impetus to decisions to relocate former uses out of the run-up area and to protect new uses.

3) Without the strong role of HHFA insisting on hazard mitigation measures as a prerequisite to Federal funding for the renewal project, post-disaster planning probably would have failed to respond adequately to tsunami hazards.

4) The pattern of land ownership in Hilo appears to have had significant impact on both the nature of the renewal plan and the execution of the plan. State lands provided space for relocation and a borrow pit for fill material needed to raise the level of the "Elevated Area." A number of established uses were recognized as non-conforming uses and permitted to continue even though this resulted in higher exposure to risk.

Skopje Earthquake of 1963

On July 26, 1963 Skopje, the capital city of Macedonia, was struck by an earthquake measuring 6.25 on the Richter Scale, which, because of inadequate building construction, resulted in almost complete destruction of a ten square kilometer area around the city's center. One thousand people were killed, 3,000 others injured, and 150,000 left homeless. Virtually all critical facilities were destroyed, but a large portion of the infrastructure and industrial base remained in working order.

The enormity of the disaster drew world-wide attention and within 36 hours massive aid from around the world began to arrive in Skopje--food, clothing, supplies, and technical assistance. The immediate local priorities were to meet human needs, coordinate outside help, prevent additional damage from aftershocks, and resume industrial production.

Initially, consideration was given to relocating the city to a safe site. In October 1963, following a preliminary investigation, a British earthquake engineer reported that there was no technical reason not to build on the same site provided that flooding problems were resolved, relatively small areas of high water table were avoided, and structures were designed for lateral forces. Somewhat later a panel of experts confirmed this view. However, the people of Macedonia apparently never had any doubt that the city must be rebuilt on the historic site--better, bigger, more glorious, and earthquake proof.

Within three days of the disaster, UNESCO sent the head of its Housing, Building and Planning Branch to Skopje to identify the assistance needed. His report, among other things, recommended a joint engineering, seismological, and planning mission with one expert from each of these fields to work with and advise local planners.

At the time of the earthquake, Skopje had in force a Town Plan prepared by the Skopje Institute of Town Planning and Architecture (ITPA) and administered by the City Council's Town Planning Committee. It soon became evident that neither the plan nor the normal procedures for administration were adequate to handle the emergency

circumstances. Within a few months, prefabs rehousing 35% of the displaced population were erected on sites which were selected on the basis of comparative service costs and were inconsistent with the Town Plan. A new plan was needed and it was evident that the ITPA needed technical assistance.

In response to a request for assistance from the Yugoslavian government (supported by petitions from 35 nations) the UN General Assembly unanimously resolved to provide aid for the reconstruction of Skopje. This action set in motion a massive planning program with participation of experts from many nations--a program described by some as one long, intensive international planning seminar. An important unifying element of the program was the International Consultant Group composed of experts in economics, urban planning, engineering, geology, seismology, and architecture. There were several stages in the post-earthquake planning-reconstruction program:

1. The emergency period during which attention was devoted to restoring essential services and industrial production and providing prefab housing in thirteen new outlying settlements.
2. Initial reconstruction starting with schools and shopping centers in these settlements and in parts of old Skopje. These projects fixed the location of major components of the utility and transport systems.
3. UN and local collaboration to centralize the diverse branches of functional planning as a part of a comprehensive planning effort and to monitor projects at weekly meetings. During this stage, scores of contracts were let to experts and institutions covering a range of subjects from engineering to sociology to housing to urban design.
4. Definition of issues and problems, with the advice of the experts, for consideration and decisions by the City Council. This decision-making period spanned several months.
5. Selection of major contractors to undertake detailed planning work. Poleservice (the official Polish agency for land use planning and construction) was selected to undertake a comprehensive social survey and the formulation of the City Master Plan and a regional plan. Doxiadis Associates was selected to conduct a survey

of the built up area, and prepare a housing program, transport projections and infrastructure studies.

The planning program was organized to be responsive to the continuing urgency for both long-term policy and quick decisions on construction of critically-needed facilities. A project manager provided overall direction and coordination, maintained liaison with his Yugoslav counterpart, and advised local planners and authorities on all planning matters. All development proposals were reviewed at the weekly meetings for their planning implications. Frequent meetings kept the planners in touch with local authorities, and provided a forum for resolving differences.

The planning methodology was, in essence, a circular process with each element of planning making a series of circuits through four segments of continuing activity; information, design study, economic analysis, and formal expression in plan documents. This planning process was designed to:

1. accommodate urgent day to day reconstruction needs without losing the opportunity to rationalize the whole city and regional structure;
2. show how to recoup within seven years the loss of over 50% of the city's infrastructure and buildings, redesign much of the city and concurrently meet demands of growth and new ambitious standards;
3. complete a comprehensive plan for the city in the shortest possible time (this took about 2 years);
4. be flexible and formative, practical and imaginative, and to guide daily administration as well as policy formulation.

Findings

1) The process of concurrent survey, analysis, plan formulation, project review, and reconstruction proved to be sound.

2) The process of project review with direct confrontation between project proponents and planners with quick decisions required was a key element in the planning-reconstruction process.

3) The International Consultant Panel was a very important ingredient. It

provided an unbiased review body for staff proposals; had members with sufficient stature to command respect at city, republic (Macedonia) and national levels and with international organizations providing funding and other assistance for the re-building of Skopje.

4) With properly staged planning and decision making there was ample time to develop geologic and seismic information.

Managua Earthquake of 1972

This summary is not included in this draft of the report.

CONCLUSIONS--MAJOR FACTORS AFFECTING POST-EARTHQUAKE LAND USE PLANNING

A central objective of this study has been to identify the factors influencing the use of land use changes during reconstruction following a damaging earthquake in order to reduce future seismic risk. A key finding is that realistic options for land use change after an earthquake are more limited than the study team expected at the outset of the study. Usually improved safety can be more easily achieved through improved structural design and construction than through land use change. However, in specific instances, changing land use is the best response. The major factors which influence whether land use changes are appropriate and feasible are:

cause and extent of damage
ability to evaluate hazards and assess risk
capabilities and attitudes of local government
availability of federal funds for reconstruction

CAUSE AND EXTENT OF DAMAGE

The need for land use change following an earthquake is determined by the cause and extent of damage. Depending on the earthquake effects, the need can range from virtually nil to very great. Rarely, if ever, will a U.S. city be leveled; areas are not equally hazardous and damage is likely to be scattered. Every major earthquake seems to yield its photograph of the totally collapsed building next to a seemingly similar one standing unscathed. Most damage in earthquakes is caused by ground shaking and the results can be extraordinarily capricious, related in some degree to ground conditions, but more importantly, to building design and condition. In addition, different earthquakes produce different ground shaking characteristics such as intensity, predominant frequency, and duration of motion, which result in correspondingly different effects on different types of structures. Damage from ground shaking alone rarely justifies a change in land use, because improving structural design and construction can usually reduce risk to an acceptable level.

An exception arises when heavy damage from ground shaking is concentrated in areas of older and poorly constructed buildings, particularly where unreinforced masonry is the most widely used building material. Often such areas are deteriorating, func-

tionally obsolescent, and in need of redevelopment before an earthquake. The earthquake presents the chance to move ahead with redevelopment as an integral part of reconstruction. However, even in such cases, reducing seismic risk is usually achieved through improvements in structural characteristics and not necessarily because of changes to less vulnerable land uses or occupancies.

Land use change is most likely to be appropriate in areas where ground failure has occurred, whether from surface fault rupture, landsliding, soil liquefaction, or other causes, and in areas where flooding has occurred, whether from seiche or tsunami runup or dam or dike failure. Reasonably safe reconstruction in such areas is often difficult and usually expensive to achieve. Where there is high risk of future ground movement, either the area must be stabilized to prevent further movement or structures designed and constructed to respond to adverse site conditions. Adequate protection against future flood damage requires construction of flood control works, flood-proofing or elevation of structures. In both cases, restricting land use and occupancy may be the most economical and effective method of reducing future risk.

Changing land uses in areas of ground failure and flooding may not only reduce future seismic risk but also contribute to other community objectives. These areas can often be beneficially used for park, or other low-intensity open space uses. Ground failure often occurs in steep hillsides, on coastal bluffs as well as in low-lying areas along rivers, streams, lakes and other bodies of water which may also be subject to flooding. Such areas may be eminently suitable for open space uses. These areas may also be subject to other natural hazards such as wild fires, high winds, non-seismic flooding or storm surges. Reducing intensity of land use in these areas after a damaging earthquake may not only avert future needs for disaster assistance because of earthquake damage, but also reduce exposure to damage from other natural hazards.

HAZARD AND RISK EVALUATION

Efforts to reduce risk from natural hazards through land use planning and regulation depend on the ability to delineate hazardous areas, define the probability of recurrence and evaluate the level of risk pertaining to those areas. The ability to define and eval-

uate hazardous areas both before and after natural disasters depends on the type of disaster. At one extreme is flooding. Flood-prone areas generally can be delineated with reasonable accuracy before a flood occurs. The 100-year flood has become a widely accepted standard for an unacceptable level of risk and specific public policies have been devised to reduce damage from floods with more than a 1% chance of occurrence in any given year. On the other hand, areas likely to sustain tornado damage can only be defined regionally with estimates of probability for the number of annual strikes within the region. It is not possible to say that one area of a city is more prone to a tornado strike than another. This limits the applicability of land use planning to reduce risk from tornadoes.

Earthquake hazards fall somewhere in between flood and tornado hazards. In some areas of the country, notably in California, areas subject to damage from particular earthquake effects are fairly well delineated. Many active faults have been mapped indicating at least where the likelihood of fault rupture is greater than in other areas. Slope stability maps and liquefaction potential maps are available for some parts of the state and "microzoning" efforts are being made to predict local variations in intensity of ground shaking. However, the probability of damage in a given location within a specified time period is uncertain. Many earthquake-prone areas of the country are subject to damage from earthquakes occurring on more than one fault. In addition, it is difficult to establish recurrence intervals for surface fault rupture on particular faults. The chance that a given unstable slope will fail or a given area will be subject to liquefaction in an earthquake is even more difficult to specify and, in addition, is subject to seasonal variations.

Even when hazardous areas are well defined, it is difficult to determine risk from earthquakes, that is the chance of loss of life, injury, and property damage. The effects of an earthquake vary depending on the nature of the earthquake, particularly the duration and period of ground shaking, as well as the location, design, type, construction details, and occupancy of particular structures. In short, identifying and evaluating areas hazardous in earthquakes and assessing risk is far more difficult and likely to yield less precise results than for flood-prone areas. This makes

it more difficult to plan for and support changes in land use for the sole purpose of reducing seismic risk.

Improved techniques of hazard evaluation and risk assessment, including advances in earthquake prediction, could reduce this uncertainty. By definition, an earthquake prediction reduces uncertainty about when an earthquake can be expected and its location and magnitude. This allows more precise definition of risk in areas known to be hazardous and more accurate assessment of the benefits or results of public actions to reduce those risks.

The actual occurrence of an earthquake can also reduce uncertainty about the level of risk in some areas. At the least, it is possible to delineate areas where the ground failed, the fault ruptured at the surface, and ground shaking was unusually intense or damaging. Usually these same areas are likely to be especially hazardous in future earthquakes. The improved ability to identify hazardous areas after an earthquake increases the potential for public actions to reduce future risk, and is an important distinction between the pre- and post-earthquake situation.

LOCAL CAPABILITIES

Local communities rarely have the fiscal or manpower resources to manage the enormous task of reconstructing after a major damaging earthquake. This fact is well-recognized and forms the basic rationale for federal and state disaster assistance. Less well-recognized, but equally important, is the effect of public attitudes on the exercise of normal local government functions such as land use planning and regulation. After an earthquake (or other disaster) local public officials and political bodies are understandably anxious to do everything possible to help disaster victims. Although local government has the power to impose limitations on rebuilding in hazardous areas, public sentiment is more likely to favor relaxing restrictions rather than increasing them. The desire to return quickly to normal usually overrides concerns about future safety unless strong incentives for change are present. These incentives usually are of two kinds -- first, strongly held community objectives which are consistent with actions to reduce seismic risk, and second, conditions attached to the use of disaster relief funds. Understanding community objectives helps predict where changes to achieve risk reduction are likely to

be most acceptable to a local community. The use of disaster relief funds offers the major opportunity to accomplish greater safety through reconstruction.

The post-earthquake performance of local government is largely determined by pre-earthquake actions. If a community has acted before an earthquake to adopt and enforce adequate building codes, abate structural hazards, locate critical facilities on safe sites, and prevent or appropriately control development in hazardous areas, then clearly it will suffer less damage and face less of a problem in recovery after an earthquake. These actions are of primary concern and have been gradually taken by many local governments. Less obvious are the pre-earthquake actions which, although they do not in themselves reduce damage from the next earthquake, assist a local government in managing reconstruction. These actions include:

1. preparing and keeping up-to-date realistic land use, circulation and public facilities plans. The community which has a well-established planning function, experienced planners and realistic plans is more likely to recognize and seize opportunities for community improvements during reconstruction than other communities. Having well-defined community development objectives helps public officials set reconstruction priorities and judge the public acceptability of potential land use changes or restrictions.
2. enacting and enforcing land use regulations, building codes and project review procedures. Experience in plan implementation and appreciation of the importance of consistent and equitably applied regulations can help a local government cope with the usual overload in building permit applications, requests for exemptions, and pressures to alter normal procedures after an earthquake.
3. establishing a redevelopment agency and carrying out redevelopment or rehabilitation projects. Such experience is invaluable after an earthquake if redevelopment is to be used in reconstruction. Pre-existing powers and familiarity with techniques of redevelopment planning, project execution and funding requirements make it easier for a local agency to use redevelopment in reconstruction after an earthquake. A community with up-to-date redevelopment plans or specific plans for older areas likely to be damaged in an earthquake is in an excellent position to move quickly into redevelopment, if needed, after the earthquake.

4. obtaining and using geologic and other natural hazard related information. Familiarity with the techniques and products of hazard evaluation will greatly assist the local government staff and public officials in making use of the technical information that will be forthcoming after a major earthquake. Less time will be needed to explain the nature of seismic hazards and the range of appropriate responses.

The effectiveness of local response will also be affected by factors such as the size of community, degree of isolation, existing land use pattern, economic health and a variety of social and cultural factors. These are factors that cannot be readily altered before a disaster, but which help define the options and problems of reconstruction. Changes of land use may be more difficult to achieve in a large metropolitan area with its complex and interdependent land uses and infrastructure than in a relatively small and isolated community. Opportunity for major relocation of all or part of a community is greater if the community is small and isolated than if it is an integral part of a metropolitan area. Isolation implies vacant land that may be available for relocation and the chance to contain the disrupting impacts of relocation. Relocation was a feasible option for the town of Valdez after the 1964 earthquake and for a portion of Hilo after the 1960 tsunami. The impacts of large scale relocation multiply with the size of the community and its degree of interdependence with surrounding communities.

The existing land use pattern, largely determined by local actions, is very important in defining options for land use change after an earthquake. The feasibility of relocating uses or structures is affected by the availability of suitable alternative sites and by the presence of reasonable alternative uses for the damaged site. The possible cost of engineered solutions to hazardous site conditions has to be weighed in terms of the importance of the location for a particular use or structure and realistic options for changing location.

A community with a growing economy may even benefit economically in the long run from a damaging earthquake with the stimulation provided by federal disaster relief funds, increased construction activity and, sometimes, the modernization of previously obsolete industrial and commercial operations. The fish processing plants destroyed in the Alaska earthquake were replaced by more modern and efficient facilities.

The effect of economic conditions on opportunities for land use change after an earthquake is mixed. In a growing economy, political pressures and the economic means to reconstruct quickly can act against efforts to reduce land use intensity in hazardous areas. This is seen in the privately-funded reconstruction and new high density construction in the L Street slide area in Anchorage. In a declining economy, the private economic incentive to rebuild is far less intense. In Seward, Standard Oil and Texaco and a fish processor chose not to rebuild their destroyed facilities in the town. Little economic pressure has developed for new building in the waterfront area. In spite of public investments in the Alaska Railroad terminal and small boat harbor, Seward's economy continues its pre-earthquake decline.

The Santa Rosa case illustrates another potential effect of economic conditions on response to an earthquake. The city's healthy and growing economy with concomitant increases in property values have made redevelopment an attractive and economically viable option and have provided a climate conducive to the abatement of structural hazards through privately-funded rehabilitation.

The contrast between the accomplishments of Anchorage and Santa Rosa, both with growing economies, illustrates an important point. With insufficient funds for stabilization or purchase of the L Street and Turnagain slide areas, Anchorage's only real option for reducing future risk was to prohibit or severely limit new development in these areas. In a growing economy with strong development pressures, this is difficult to achieve. In Santa Rosa, however, future risk could be reduced by gradually upgrading structural safety. This approach presents no direct challenge to development and can be aided rather than undermined by economic growth.

FEDERAL FUNDS FOR REBUILDING

The major conclusion derived from the study is that the availability of federal funds for post-earthquake recovery largely determines the actions and decisions of local governments. Financing recovery from a major earthquake is likely to be beyond the fiscal capacity of state governments and almost certainly of the affected local governments. Private funds may be available for reconstruction of private property, but such recon-

struction is often dependent on repair or restoration of public facilities, especially streets and utilities. Relatively few property owners carry earthquake insurance. The federal role in financing reconstruction has been crucial in past earthquakes and is likely to continue to be crucial in the foreseeable future.

The scope and limitations of federal aid to disaster victims and state and local governments are set forth in the Federal Disaster Relief Act of 1974 and regulations issued May 28, 1975. The major provisions of the Act are administered by the Federal Disaster Assistance Administration (FDAA) within the Department of Housing and Urban Development. Observations of the strengths and weaknesses of the federal role in the case study areas under prior legislation has provided a basis for evaluating the adequacy of the present legislation and regulations as they apply to earthquake disasters. Seven problems are identified.

1. Lack of specific authorization and funding for redevelopment projects

   In each case study area, publicly-funded redevelopment proved to be a particularly effective tool for achieving changes in land use and safe reconstruction in heavily damaged areas. The Federal Housing and Community Development Act of 1975 dismantled previous federal programs for urban renewal or redevelopment and replaced them with the Community Development Block Grant program. Block Grant funds are allocated on a formula basis to communities of over 50,000 people and urban counties for eligible projects. Limited funds are available for distribution to smaller cities. These funds may be used for redevelopment projects, but the emphasis in recent years has been on rehabilitation programs. Funds must be spent for projects benefiting mainly low and moderate income persons. It is unclear how this restriction would affect the use of Block Grant funds for post-earthquake redevelopment projects. A special fund has been set aside for use at the discretion of the Secretary of Housing and Urban Development for disaster-related projects. However, the present appropriation is a small percentage of this discretionary fund and likely to be inadequate to cover needed projects following a major earthquake in a metropolitan area.

2. Lack of requirements, procedures and funding for planning and implementing plans for long-term reconstruction

Title V of the Disaster Relief Act provides for establishment of a Recovery Planning Council to prepare a 5 year "recovery investment plan" recommending "revision, deletion, reprogramming, or additional approval of Federal-aid projects and programs within the area..." (Sec. 802). The main objective of the Title is to assist a disaster area in achieving long-term economic recovery. The Title has not been implemented and no federal agency has been assigned responsibility for carrying out its provisions.

Also, under Title V there is no planning requirement for use of federal funds in reconstruction of heavily damaged areas or specific authorization of funds for such planning and implementation of plans. Project applications for repair and reconstruction of public facilities are considered individually and there is no requirement for coordinating the restoration of public facilities and services with private repair and reconstruction. In the case study areas, some plans were prepared, usually as a prerequisite for approval of redevelopment projects; however, implementation of the plans depended on federal funding. A mechanism to link federal funding for reconstruction projects to an overall plan is needed.

3. Disincentives for relocating public facilities or repairing and reconstructing facilities to improved standards not in force at the time of the earthquake

Section 2205.54 of the Rules and Regulations states that the federal contribution for permanent repair or restoration of public facilities "shall not exceed the net eligible cost of restoring a facility based on the pre-disaster design of such facility and on the current codes, specifications, and standards in use by the applicant for similar facilities in the locality." The Regional Director of the Federal Disaster Assistance Administration may authorize relocation of a facility to a less hazardous site, but any additional cost much be borne by state or local government. If a jurisdiction chooses to relocate any facility, the regulations give the local government the option of receiving 90% of the amount they are eligible for to repair or restore the sum total of all damaged public facilities in its jurisdiction. The funds may then be used to repair or restore, relocate or build new public facili-

ties which the applicant deems necessary.

The effect of this provision is to discourage relocation of damaged facilities to less hazardous sites unless suitable, publicly-owned sites are available. After a damaging earthquake, local governments rarely have the financial resources to purchase new sites for relocation of public facilities and the tendency is to seek engineering solutions to hazardous site problems with little consideration of possible advantages of relocation.

4. Lack of guidelines for determining price to be paid for properties to be acquired as part of a post-earthquake redevelopment project or a planned relocation

Establishing criteria for determining the price to be offered for properties to be acquired for public purposes after an earthquake is a major issue. In several cases studied, the failure to come to terms on property value resulted in rejection of projects which would have significantly improved future safety. Essentially, the need is to set forth some reasonable criteria for establishing value somewhere between full pre-earthquake and post-earthquake property value.

5. Little consideration of long-term hazard mitigation in administrating disaster assistance

Although explicit consideration of hazard mitigation is required in Sec. 406 of the Act, no rules have been adopted to implement this section. Section 406 states:

> "As a further condition of any loan or grant made under the provisions of this Act, the State or local government shall agree that the natural hazards in the areas in which the proceeds of the grants or loans are to be used shall be evaluated and appropriate action shall be taken to mitigate such hazards, including safe land-use and construction practices, in accordance with standards prescribed or approved by the President after adequate consultation with the appropriate elected officials of general purpose local governments, and the State shall furnish such evidence of compliance with this section as may be required by regulation."

In April 1979, FDAA issued proposed rules for implementing this section of the Act following a major disaster declaration. The rules call for a Survey Team to be formed by Hazard Mitigation Coordinators (HMC's) from federal, state and local governments

to identify significant hazards, evaluate the impacts of the hazards and possible mitigation measures, and recommend appropriate mitigation measures. The recommended measures would be required by FDAA as a condition of receiving federal funds, authorized under Sec. 402 of the Act, for the repair, restoration, reconstruction or relocation of public facilities. The state would be responsible for verifying compliance of local governments with hazard mitigation requirements.

These proposed rules, if finally adopted, will help correct the present lack of consideration of hazard mitigation in reconstruction decisions after natural disasters. Because of the importance of federal funds in post-earthquake reconstruction, the proposed federal requirements are likely to be particularly effective in encouraging safer reconstruction after earthquakes.

6. Lack of explicit consideration in administering disaster assistance of opportunities to achieve other federal community development objectives

Federal community development objectives as set forth in the Housing and Community Development Act of 1977 (Sec. 101) are:

> (1) the elimination of slums and blight and the prevention of blighting influences and the deterioration of property and neighborhood and community facilities of importance to the welfare of the community, principally persons of low and moderate income;
>
> (2) the elimination of conditions which are detrimental to health, safety, and public welfare, through code enforcement, demolition, interim rehabilitation assistance, and related activities;
>
> (3) the conservation and expansion of the Nation's housing stock in order to provide a decent home and a suitable living environment for all persons, but principally those of low and moderate income;
>
> (4) the expansion and improvement of the quantity and quality of community services, principally for persons of low and moderate income, which are essential for sound community development and for the development of viable urban communities;

(5) a more rational utilization of land and other natural resources and the better arrangement of residential, commercial, industrial, recreational, and other needed activity centers;

(6) the reduction of the isolation of income groups within communities and geographical areas and the promotion of an increase in the diversity and vitality of neighborhoods through the spatial deconcentration of housing opportunities for persons of lower income and the revitalization of deteriorating or deteriorated neighborhoods to attract persons of higher income;

(7) the restoration and preservation of properties of special value for historic, architectural, or esthetic reasons, and

(8) the alleviation of physical and economic distress through the stimulation of private investment and community revitalization in areas with population outmigration or a stagnating or declining tax base.

Often after a major earthquake, reconstruction can be carried out in a way that significantly furthers one or more of these objectives, typically through redevelopment of heavily damaged areas. Such opportunities need to be considered in federal decisions to fund recovery projects. Successful projects are likely to be those clearly related to damaged areas and consistent with community needs and objectives. However, trying to accomplish too much or extending projects significantly beyond damaged areas is likely to be rejected locally unless the public is convinced the projects will not interfere with the return to normal and will lead to substantial benefits. Some redevelopment (or development) projects may be needed to accommodate uses displaced from high hazard areas.

7. Lack of flexibility in administering disaster assistance sometimes leading to federal/local conflict

In spite of the presumably altruistic nature of disaster relief efforts, there are elements of conflict in the relationship between federal and local officials in the post-disaster situation. Local people are striving to maximize assistance to victims and local governmental agencies, while the federal officials are anxious to minimize the cost of relief, insure that funds are spent only for authorized purposes and avoid any possible irregularities that might bring criticism at a later date. Even when officials have broad authority, there is a tendency to interpret

it narrowly. The effect of this conflict is to slow down the reconstruction effort and create uncertainties which can lead to private actions undercutting public attempts to reduce future risk. Procedures are needed to encourage sufficient flexibility in administering disaster assistance to take account of variations in local conditions and minimize chances for conflict.

RECOMMENDATIONS FOR POST-EARTHQUAKE LAND USE PLANNING

Land use planning after a damaging earthquake can be an effective tool to reduce future seismic risk. It can and should be a significant part of the total intergovernmental response to a major earthquake. Presently, when a damaging earthquake occurs, the governor of the affected state requests that the President of the United States declare a major disaster--a catastrophe of such severity and magnitude that effective response is beyond the capability of the state and the affected local governments. The request must include:

> (1) An estimate of the amount and severity of damage broken down by type, such as private non-agricultural, agricultural, and public.
> (2) A statement of actions pending or taken by the State or local legislative and governing authorities with regard to the disaster.
> (3) A certification that, for the current disaster, State and local government obligations and expenditures (of which State commitments must be a significant proportion) will constitute the expenditure of a reasonable amount of the funds of such State and local governments for alleviating the damage, loss, hardship, or suffering resulting from such disaster.....
>
> (4) An estimate of the extent and nature of Federal assistance needed within the State, broken down by category of public or individual assistance for each disaster affected area for which Federal assistance is requested and the estimated Federal funds required for each category.
> (5) As appropriate, other justification in support of the request.
>
> (Federal Disaster Assistance Administration, May 28, 1975, Rules and Regulations, Sec. 2205.41).

If the President declares a major disaster, a federal/state agreement, specifying the categories of federal assistance to be made available for recovery, is signed by federal and state representatives. Federal funds may be available for: temporary housing assistance, mortgage and rental payments, unemployment assistance, individual and family grants, food commodities, relocation assistance, emergency

public transportation, repair and restoration of public (and certain private) facilities, debris clearance and loans to cover substantial losses of local tax revenues. Less extensive assistance may be authorized for federally-declared "emergencies"--disasters of less severity and magnitude than the "major disasters."

The Presidential declaration formally inaugurates coordinated federal, state and local efforts in response to a disaster. The organization and procedures governing these efforts are complex and detailed and appear to be effective, particularly in handling emergency response. However, this study reveals a need for more explicit consideration of hazard mitigation in actions related to long-term recovery. Thus, the recommendations are presented in the form of suggested federal regulations and procedures to incorporate hazard evaluation, land use planning for hazardous areas and funding for plan implementation into the present framework for federal disaster assistance.

As recommended, the regulations would pertain only to recovery from earthquakes sufficiently damaging to be declared major disasters by the President. Smaller and less damaging earthquakes are admittedly more frequent and may be disruptive enough to warrant state, and in some cases, limited federal assistance for emergency work and repairs. However, significant opportunities for land use changes in post-earthquake recovery are much more likely to be found after major damaging earthquakes.

The recommendations define key elements of land use planning as a part of the total post-earthquake reconstruction process. These elements are: 1) identifying and evaluating hazardous areas which should be given particular attention in planning for post-earthquake land use changes, 2) revising community land use plans as needed to reflect changed conditions brought about by the earthquake, 3) preparing specific plans for reuse or reconstruction of hazardous areas, and 4) implementing plans for the hazardous areas. The study indicates that, after an earthquake, hazards are ordinarily identified and evaluated, plans prepared, and federal funds made available for reconstruction. The major problem has been in the linkages--that is, assuring that plans are responsive to the hazard evaluation, that funds are allocated

on the basis of the plan, and that appropriate mechanisms are in force to assure reconstruction in accordance with the plans.

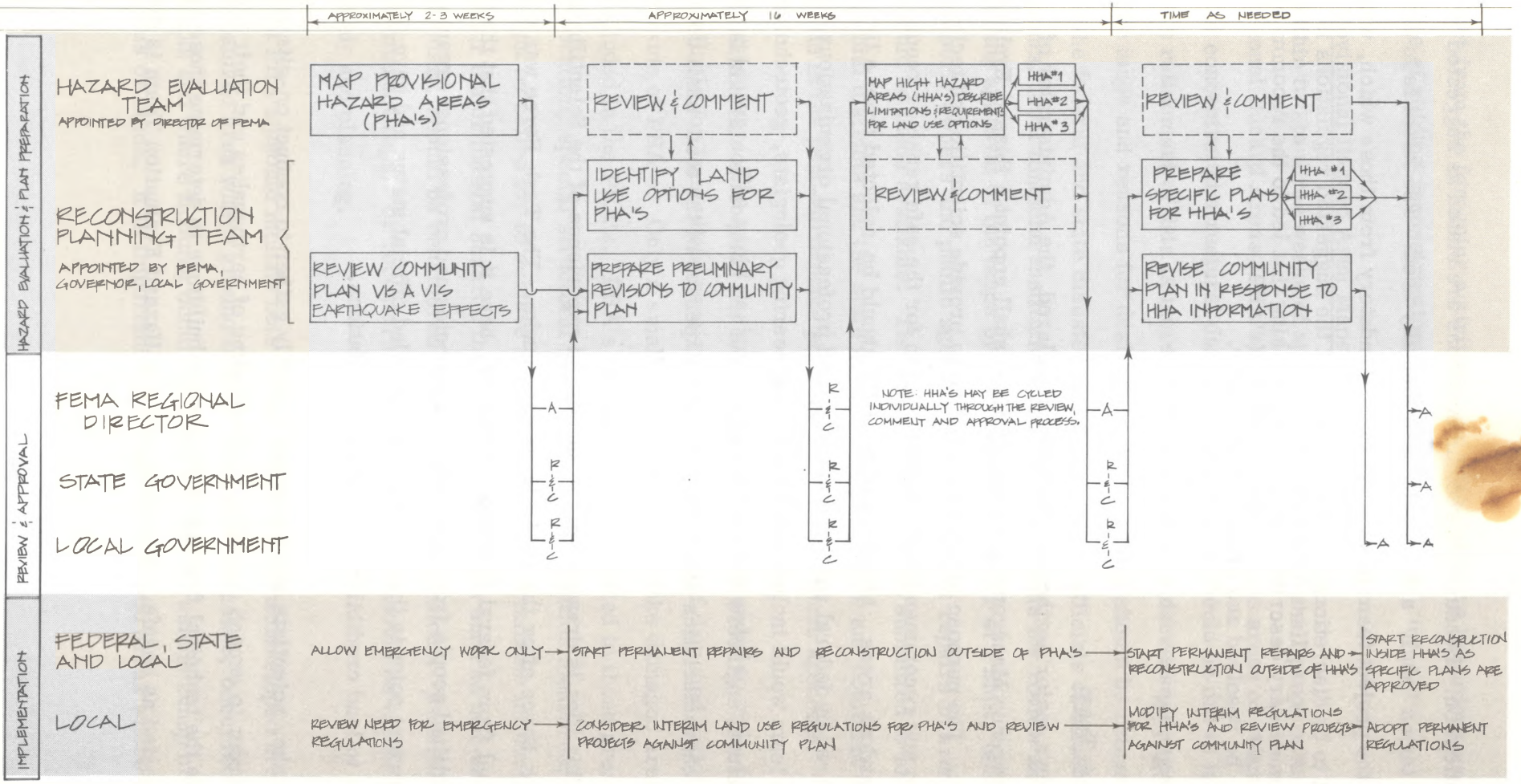
Figure 5 outlines the sequence and interrelationships of the governmental activities essential to land use planning in a post-earthquake context. The key functions, as shown on the left side of the diagram, are hazard evaluation and plan preparation, review and approval of maps and plans by officials at the appropriate governmental levels, and federal, state and local implementation of land use plans for hazardous areas.

The boxes in Figure 5 show the sequence of steps needed to provide hazard area information for use in preparing plans and for developing plans for reuse or reconstruction of hazardous areas within the framework of a community-wide plan. As shown in Figure 5, the functions of hazard evaluation and plan preparation are interrelated, but, because they are carried out by different teams, they are described separately in the text which follows. Nonetheless, the two teams would continually work together during reconstruction. Procedures for review and approval and implementation actions are described for each map or plan which emerges from the actions shown in the boxes.

Plan preparation is shown as a function of a Reconstruction Planning Team. It is likely that this would be but one function of this team. The team might be given broader responsibility for coordinating and planning for long-term recovery of the earthquake-damaged area. The following recommendations, however, deal only with the duties of the team directly related to planning for hazardous areas designated by the parallel team evaluating hazards.

The recommendations are presented as ideas for suggested federal regulations in order to illustrate as realistically as possible how they might be implemented. Considerable detail has been provided to stimulate discussion and focus attention on the issues that need to be resolved in order for the general ideas embodied in the recommendations to be translated into a regulatory framework. Specific terms are used to designate areas and groups pertinent to post-earthquake land use planning. They are used for convenience only; the concepts and activities associated with the terms should

POST-EARTHQUAKE LAND USE PLANNING
RECOMMENDED GOVERNMENTAL ACTIONS and INTERACTIONS



A = APPROVAL
R & C = REVIEW & COMMENT

THIS SEQUENCE IS INTENDED TO PROVIDE A FRAMEWORK FOR COORDINATING THE EFFORTS OF FEDERAL, STATE, AND LOCAL GOVERNMENTS AS THEY AFFECT LOCAL LAND USE PLANNING AND IMPLEMENTATION OF THOSE PLANS AFTER MAJOR EARTHQUAKES. THE DIAGRAM IS SIMPLIFIED IN ORDER TO ILLUSTRATE KEY RELATIONSHIPS. OF MAJOR CONCERN IS THE IDENTIFICATION OF "HIGH HAZARD AREAS" AND THE SUBSEQUENT CONTROL OF RECONSTRUCTION IN THESE AREAS. WHILE THE SCHEDULE INDICATES A TIME SEQUENCE FROM LEFT TO RIGHT, IN REALITY THE VARIOUS ACTIVITIES SHOWN WILL IN SOME CASES SPAN LONGER OR SHORTER PERIODS AND OVERLAP WITH OTHER ACTIVITIES. OF KEY IMPORTANCE, HOWEVER, ARE THE 2 WEEK AND 16 WEEK PERIODS IN WHICH HAZARD EVALUATIONS ARE COMPLETED AND AFTER WHICH FEDERAL FUNDS ARE RELEASED FOR RECONSTRUCTION PROJECTS OUTSIDE OF AREAS OF "PROVISIONAL" AND OF "HIGH" SEISMIC HAZARD.

be the focus of attention. Because the recommendations are stated as suggested regulations, the terms "shall" and "should" are liberally used. The intent is to distinguish actions the project team feels ought to be mandatory from those which, while desirable, ought to be discretionary. Each section of the suggested regulations is followed by a commentary describing some of the thinking that led to the recommendations, questions still to be resolved and areas of uncertainty.

HAZARD EVALUATION

Hazard Evaluation Team

Immediately after a major earthquake disaster is declared, the Administrator of the Federal Emergency Management Agency (FEMA) shall appoint a Hazard Evaluation Team (HET). The purpose of the HET shall be to provide scientific and technical information and recommendations needed to plan for the safe reuse or reconstruction of hazardous areas. Members of the HET should be selected from a list previously prepared by federal and state agencies and professional organizations. In most cases, the team would include geologists, engineering geologists, geotechnical engineers, structural engineers and seismologists, but the composition should be determined by the characteristics of the earthquake. Expenses of the team shall be paid by FEMA.

Commentary. This idea is drawn from the successful experience of the Scientific and Engineering Task Force after the 1964 Alaska earthquake. The Task Force was composed of personnel from federal agencies. However, here it is suggested that the team be formed of qualified people from governmental agencies and professional organizations. The important point is that the team be accorded official status and have sufficient expertise to lend credibility to its recommendations.

After an earthquake, scientists and engineers typically gather to conduct on-site investigations in order to expand scientific understanding of earthquakes and their effects. Others undertake the technical function of inspecting buildings to determine those to be demolished or posted as unsafe. The function of the Hazard Evaluation Team is dis-

tinct from the foregoing activities, and is to delineate hazardous areas for the purpose of guiding reconstruction planning.

Provisional Hazard Area Maps

Within two to three weeks of appointment, the HET shall prepare maps showing Provisional Hazard Areas (PHA's). PHA's shall include areas of ground failure, flooding and concentrated structural damage. The PHA's should be drawn large enough so that refinement of data is more likely to result in a decrease in size than an increase. The maps and reasons for designation of the PHA's should be released simultaneously to the federal and state disaster relief personnel, officials of affected local governments, local financial institutions and the news media for review and comment. Following approval of the maps by the Regional Director of FEMA, federal funds to assist property owners and public agencies with permanent repairs in areas outside the PHA's should be made available. The maps should also be submitted to local governments, special districts and the state government for review and comment and for use as a guide in the post-earthquake planning activities of these agencies.

Commentary. The rapid designation of PHA's is intended to make federal assistance available for immediate repair and reconstruction of damaged buildings and facilities outside of PHA's. Only a small part of the earthquake damaged area is likely to be included in the PHA's. PHA's are specifically limited to those areas in which reuse, relocation, special structural restrictions, stabilization measures, or redevelopment might be called for to achieve reasonable safety. Available information concerning other major natural hazards that occur in the PHA's such as non-earthquake related flooding, should be considered in making the designations. Federal assistance for permanent repair or reconstruction in these areas should be withheld pending further study and planning.

The PHA's should include both developed areas and undeveloped areas in or near an urbanized area where ground failure, whatever the cause, occurred during the earthquake and where flooding occurred from tsunami or seiche runup or the failure of dams or dikes. It is important to include undeveloped areas where the ground failed

or flooding occurred to prevent the relocation of buildings or location of temporary housing in these areas. The information is also needed by local governments to plan and regulate future growth in such areas.

All areas of concentrated structural damage should be designated as PHA's whether or not the cause of damage can be quickly determined. Designating PHA's requires consideration of the amount and severity of structural damage and the age and condition of buildings. The initial designation should be largely the responsibility of structural engineers on the HET working cooperatively with local building officials.

The suggested time limitation of two to three weeks to designate PHA's is intended to emphasize the importance and the feasibility of rapid initial assessment of earthquake hazards. Obviously, provisions are needed to provide flexibility to extend this time period, if needed, possibly at the discretion of the Regional Director.

The suggestion that PHA's be conservatively drawn is important in preserving the credibility and public acceptability of the process. It will be difficult to later expand the areas to include sites where repairs or reconstruction may have already been started. More important, however, is the overriding objective of the procedure to ensure safe reconstruction. If the safety of an area is in doubt based on preliminary evaluation, decisions concerning construction in the area should be deferred until further study confirms or contradicts the initial evaluation.

The release of the maps to all potentially affected public and private agencies, property owners and the general public is extremely important. Nothing destroys the credibility of a technical effort more effectively than the suspicion that results are being determined behind closed doors. Openness, clarity and completeness of communication to the public of the process and its results are absolutely essential. The reasons for the designations, probable accuracy, expected schedule for release of the final map, and specific constraints on rebuilding in the designated areas should be clearly stated. Non-federal agencies should use the maps as bases for their own actions. Local governments, for instance, could enact emergency legislation to limit reconstruction in

PHA's pending further investigation. Also, the maps should be given to the Reconstruction Planning Team for use in its work.

High Hazard Area Maps

After completion of the provisional hazard area maps, the Hazard Evaluation Team shall conduct, or call in appropriate experts to conduct, detailed evaluations of the PHA's to determine: 1) potential for damage in future earthquakes, 2) potential means of mitigating the hazard and estimated costs, 3) building design and construction standards, and 4) more exact boundaries of areas subject to high seismic hazard. In evaluating appropriate uses for the PHA's, the HET shall consider those uses identified by the Reconstruction Planning Team. Following the detailed evaluation, the HET shall issue a map delineating High Hazard Areas (HHA's) and final recommendations. This should be accomplished within 16 weeks of the disaster declaration. HHA's shall include the PHA's or those portions of the PHA's in which there is 1) a high probability for recurrence of ground failure or flooding, and 2) a need for redevelopment or reconstruction to improved building standards to achieve reasonable safety. Results shall be fully communicated to the public and to affected public and private agencies. Following review and comment by affected state and local governmental agencies, the Regional Director shall approve, with any modifications deemed necessary, the maps and the HET final recommendations. No federal funds shall be allocated for permanent repairs or reconstruction in the HHA's until plans for reuse or reconstruction have been adopted by local government and approved by state government and the Regional Director.

Commentary. The HET should investigate each PHA designated on the basis of ground failure or flooding to determine more exactly the boundaries of the areas likely to fail or be flooded in future earthquakes. For each area, the team should recommend appropriate uses, any needed remedial measures and design and construction standards to achieve an acceptable level of risk. In making these judgments, the HET should be guided by a scale of acceptable risks, such as the following:

Scale of Acceptable Risks

Level of Acceptable Risk	Kinds of Land Uses
1. Extremely low	Structures whose continued functioning is critical, or whose failure might be catastrophic: nuclear reactors, large dams, power intertie systems, plants manufacturing or storing explosives or toxic materials
2. Slightly higher than under level 1[1]	Structures whose use is critically needed after a disaster: important utility centers; hospitals; fire, police, and emergency communication facilities; fire stations; and critical transportation elements such as bridges and overpasses; also smaller dams
3. Lowest possible risk to occupants of the structure[2]	Structures of high occupancy, or whose use after a disaster would be particularly convenient: schools, churches, theaters, large hotels, and other high-rise buildings housing large numbers of people, other places normally attracting large concentrations of people, civic buildings such as fire stations, secondary utility structures, extremely large commercial enterprises, most roads, alternative or noncritical bridges and overpasses.
4. An "ordinary" level of risk to occupants of the structure[2,3]	The vast majority of structures: most commercial and industrial buildings, small hotels and apartment buildings, and single family residences.

[1] Failure of a single structure may affect substantial populations.
[2] Failure of a single structure would affect primarily the occupants.
[3] Ordinary risk: Resist minor earthquakes without damage; resist moderate earthquakes without structural damage, but with some non-structural damage; resist major earthquakes of the intensity or severity of the strongest experienced in California, without collapse, but with some structural as well as nonstructural damage. In most structures, it is expected that structural damage, even in a major earthquake, could be limited to repairable damage. (Structural Engineers Association of California).

Modified from Joint Committee on Seismic Safety, State of California, Meeting the Earthquake Challenge, 1974.

Particular attention should be given to the options for future used of the PHA's identified by the Reconstruction Planning Team. In many cases, the most important information needed from the HET will be an evaluation of the appropriateness of pre-earthquake uses in the areas revealed as hazardous by the earthquake.

Those PHA's designated solely on the basis of concentrated structural damage should be considered separately from those designated on the basis of ground failure or flooding With adequate building design and construction, these areas can be safely reconstructed. The decision to designate these areas as HHA's should be reached jointly by the HET and the Reconstruction Planning Team (RPT). The designation essentially is a decision to seek redevelopment of the area and involves consideration of planning factors in addition to extent and cause damage.

The time span of 16 weeks for the HET to issue the maps of HHA's and final recommendations seems to be achievable, but undoubtedly situations can arise warranting an extension. The Regional Director could be authorized to grant such extensions. In many cases, it may be possible and desirable to issue HHA designations sequentially as the evaluation is completed. It is important that the work of the HET be completed as quickly as possible to avoid unnecessary delays in recovery and forestall private actions to repair or rebuild in unsafe areas. The acceptability of the process will be enhanced if time schedules for important steps and decisions in the reconstruction effort are publicized and adhered to.

The maps and final recommendations of the HET should be released simultaneously to all affected governmental agencies and to the news media with recommendation for state and local governmental approval.

The HET is assigned a basically technical task and it can be argued that the team should be insulated from political pressures. However, the recommendations of the HET could have far-reaching consequences, particularly in the allocation of federal funds for reconstruction projects, and some mechanism for political approval of the recommendations is needed. It is suggested that the Regional Director be authorized to

approve, disapprove or modify the HET recommendations taking into consideration comments and objections raised by affected governmental agencies and property owners and other individuals. Local or state government approval should be encouraged but not required, because the major purpose of the maps is to guide the federal investment in reconstruction. In the case of major disagreement, appeal procedures already in place within FDAA could be used. Ultimately, however, any projects actually constructed would have to comply with local plans and regulation. Thus, the community land use plan and specific plans for HHA's would place a limitation on projects which could be undertaken.

Long-term Monitoring

Following submittal of its final recommendations, the HET should recommend follow-up procedures to monitor the reconstruction effort, to authorize changes in the boundaries of HHA's based on new information, to arrange for the installation and monitoring of any instruments needed in the HHA's; and to advise local officials concerning other potential hazards in future earthquakes.

Commentary. The need for long-term follow-up of land use and construction practices in HHA's and procedures to make use of new data is apparent. How this is handled will vary depending on local capabilities. If a local government has good geologic and engineering expertise available on a regular basis, it may easily assume this role, with the provision that important deviations from the HET's final recommendations are subject to federal approval. State assistance or more direct federal follow-up may be needed in other cases.

RECONSTRUCTION PLANNING

Formation of the Reconstruction Planning Team

Following a Presidential declaration of a major disaster for an earthquake, the Administrator of FEMA, the Governor, and the chief administrative officer of each affected local government shall each appoint a representative to form the Reconstruction Planning Team (RPT). The federal representative should be a FEMA staff mem-

ber who is conversant with the federal legislation, regulations and procedures pertaining to disaster relief and recovery. Similarly, the state representative should be from a state agency that deals with disaster response and should be conversant, not only with state authority and procedures concerning disaster relief, but with state programs and resources applicable to long-term reconstruction. Local government members of the RPT should be selected on the recommendation of the city manager or top administrative officer. The local representative should be the planning director or the staff member responsible for planning. Other professionals, such as experts in land use and redevelopment planning, land appraisal, property acquisition, finance, housing and economic development, should be called in to work with the team as needed to provide the expertise to address the particular situation.

The purpose of the RPT shall be to guide and assist local governments in 1) revising community land use plans which recognize altered conditions brought about as a result of the earthquake, and 2) preparing specific reuse or reconstruction plans for the HHA's designated by the HET, including relocation plans, if needed.

Commentary. The role of the RPT and the expertise needed will vary with the nature and extent of damage and local ability to respond. In communities with a well-established planning function and capability to plan for reconstruction, the RPT would serve primarily in an advisory role to local planners and officials to assure that the planning effort adequately addresses federal and state concerns about reconstruction in High Hazard Areas. In some situations, the RPT could, at the request of local authorities, actually assume full responsibility for the technical work needed to prepare the plan.

The federal and state representation on the RPT is intended to ensure that the subsequent federal and state investment in post-earthquake reconstruction is made in a manner that, to the extent reasonable, reduces the potential for future disaster assistance,and to the extent feasible, takes advantage of realistic opportunities to make significant community improvements.

Revised Community Land Use Plan

The first task of the RPT is to review existing land use and circulation, community plans and regulations and the location of critical or high-occupancy facilities in relation to the initial damage assessment. This review should be completed within two to three weeks of the disaster declaration. Following issuance of the maps of Provisional Hazard Areas, the RPT shall make preliminary revisions in the community land use plan to provide a community-wide perspective and framework for planning for the reconstruction or reuse of the PHA's, identify areas suitable for relocation of major facilities or for the location of temporary housing, identify specific problems related to reconstruction, particularly of critical and high-occupancy facilities and lifelines, outside the PHA's, and evaluate the land use and circulation relationships between the PHA's and the rest of the community.

The preliminary revisions should be reviewed by federal and state government representatives and the appropriate local legislative bodies and serve as a guide to further planning. Reconstruction projects outside of the PHA's should be reviewed for consistency with the preliminary revisions to the plan. The plan should be considered a working document to be progressively modified and refined as a guide to the reconstruction effort and specific planning for the PHA's. Following release of the maps of the HHA's and initial planning for the PHA's, the community land use plan should be revised as needed and such revisions adopted by the appropriate local government legislative bodies.

Commentary. The preparation or revision of a community land use plan is viewed as a local responsibility with the RPT providing technical assistance and advice as needed. The effort required to revise the community land use plan will depend on the quality of existing plans and their relevance to post-earthquake conditions. The extent of revision needed will also depend on the location, extent and causes of damage. If a local jurisdiction does not have a land use plan, the RPT and local officials will essentially have to start from scratch. In most cases, however, it is likely that a land use plan or a zoning map or even a map of pre-earthquake land uses will be available and can serve as a starting point in providing a framework to relate specific

reconstruction or reuse options to the entire community.

A preliminary plan or revisions to the existing plan should be prepared as quickly as possible so that impacts of potential changes in use of the PHA's on the areas outside, such as relocation of structures or realignment of lifelines or streets, can be anticipated before permanent repairs or new installations are made. However, it is not the intent of this recommendation that all repairs or reconstruction outside of the PHA's be held up until the plan is revised. Procedures should be established to assure coordination between the RPT and operating agencies at federal, state and local levels to assure that decisions will be made in accord with emerging information. Continuous interchange between the HET and RPT is needed to provide for early identification of potential problems. The local government should impose such restrictions on construction and repair as may be appropriate based on the plan.

Work on the community land use plan could continue in successive stages as appropriate with progressive refinements throughout the reconstruction process, particularly in response to the final recommendations of the HET and specific planning for the HHA's. As revisions to the plan are completed, they should be adopted by the local government. Specific reconstruction projects should then be consistent with the plan.

Options for PHA's

On release of maps of the PHA's, the RPT shall prepare a preliminary report outlining the options for reuse or reconstruction of each designated PHA. The preliminary community land use plan shall serve as a guide in defining the range of possible land use options. The report shall be used by the HET in determining the range of land uses which should be evaluated for potential reuse of the PHA's. It should also be used in establishing final boundaries of PHA's designated because of concentrated structural damage. The report shall also be used in preparing or revising the community land use plan.

Review and comments on the report shall be sought from the FEMA Regional Director, state government, local government and affected special districts.

Commentary. The major purpose of the report outlining options for the PHA's is to provide needed planning information to the HET in designating HHA's and to obtain federal, state, local and general public review and comment on ideas for reuse or reconstruction of the PHA's. The review process should serve to focus subsequent planning for the PHA's on realistic options.

Specific Plans for HHA's

As maps are released designating HHA's, the RPT shall prepare a specific plan for the reconstruction or reuse of each HHA. Each specific plan should include:

1. Map of the High Hazard Area.
2. Recommended land uses, regulations and building standards for each HHA.
3. Description of any recommended engineering or stabilization measures for each HHA.
4. Location, capacity and design standards for any public facilities, lifelines, critical or high occupancy structures to be repaired, reconstructed or relocated in a HHA.
5. Identification of properties to be acquired, demolished or rehabilitated.
6. Owner-participation options and relocation plans as needed.
7. Cost estimates and specification of federal, state and local share of costs for implementing each plan.
8. A time schedule for implementing each plan.

Each plan shall be adopted by the appropriate local legislative bodies and approved by the state government and Regional Director of FEMA. No federal or state funds for permanent repair of public facilities or non-emergency aid to private property owners in a High Hazard Area shall be committed until a plan has been adopted and approved. Adoption and approval shall represent a federal, state and local commitment to provide the specified share of funds needed for implementation. In redevelopment projects, covenants should be place in deeds to ensure continuity of the restrictions contained in the plan.

Commentary. Specific plans for the HHA's should be prepared in as much detail as necessary and should reflect the recommendations of the HET. Considerable interchange between the HET and RPT will be needed, particularly in relating possible

stabilization or other engineering measures to the proposed uses of the HHA's. The specific plans should be generally consistent with the community land use plan.

No time limit has been set for the completion and local adoption of the specific plans. The withholding of federal and state funds for any permanent reconstruction in these areas until the plans have been adopted is expected to provide sufficient incentive for expeditious action. Following local adoption of a specific plan, time limits should be placed on state and federal decisions to approve or disapprove the plan.

A central issue in the implementation of the specific plans for the HHA's is likely to be the basis for compensation of property owners for property recommended for acquisition for public purposes. The local acceptability of proposed redevelopment or relocation projects is highly sensitive as to whether or not affected property owners feel they will be fairly compensated. In some recent cases HUD has paid pre-flood property values to property owners being relocated out of the flood plain. Compromises between using full pre-earthquake values and post-earthquake values as a basis for negotiating with property owners need to be devised to recognize different conditions in each earthquake. Experience shows that land values are soon restored to pre-earthquake levels after an earthquake, thus lending weight to the arguments to pay values at or close to those of the pre-earthquake period.

SUMMARY

These recommendations are offered as a basis for study, discussion and action. The suggested regulations are intended to set the stage for effective federal, state and local decisions with respect to land use after a major damaging earthquake. Land use planning and regulation in the United States is primarily a local government function. The suggested regulations are designed to preserve local perogatives and state responsibilities while recognizing the federal dominance in financing post-disaster reconstruction and the consequent need to protect the federal investment in reconstruction. However, the overriding objective is to protect public safety and reduce the potential impact of future earthquakes.