City of Rancho Palos Verdes
&
City of Rolling Hills Estates

JOINT NATURAL HAZARDS MITIGATION PLAN

R.H. E. adopted on September 28, 2004
R. P. V. adopted on October 5, 2004

Prepared under contract with:

Emergency Planning Consultants
San Diego, California

Acknowledgements

The Disaster Management Area Coordinators (DMAC) of Los Angeles County prepared a model plan that was utilized by the City of Rancho Palos Verdes and the City of Rolling Hills Estates in preparing this Joint Natural Hazards Mitigation Plan. The DMAC model plan was based on the Mitigation Plan from Clackamas County, Oregon. The City is grateful to DMAC and the Clackamas County Natural Hazards Mitigation Committee for their contributions to this project.

Special Thanks & Acknowledgments
Multi-Jurisdictional Planning Team:
- City of Rancho Palos Verdes
- City of Rolling Hills Estates
- Palos Verdes Peninsula Unified School District
- County of Los Angeles Sheriff's Department
- County of Los Angeles Fire Department
- Verizon California
- Southern California Edison
- The Gas Company
- Office of Disaster Management, Area G
- Palos Verdes Peninsula Chamber of Commerce

Mapping
Except where noted, the Cities of Rancho Palos Verdes and Rolling Hills Estates provided all of the maps included in this plan.

Consulting Services
Project management and planning services for this project were provided under contract by Emergency Planning Consultants.

- Project Management Services:	Carolyn J. Harshman, President
- Planning Services:	Carolyn J. Harshman, President
	Timothy Harshman, Intern

List of Tables, Maps and Figures

#	Type of Table, Map or Figure	Section of the Plan
Map 1-1	Base Map of Planning Area	Section 1: Introduction
Table 3-1	Planning Area Demographics	Section 3 - Area Profile
Table 3-2	Land Use and Housing in Planning Area	Section 3 - Area Profile
Table 3-3	Employment and Industry in Planning Area	Section 3 - Area Profile
Table 4-1	Federal Criteria for Risk Assessment	Section 4: Risk Assessment
Table 4-2	Planning Area Critical Facilities	Section 4: Risk Assessment
Table 4-3	Planning Area Essential Facilities	Section 4: Risk Assessment
Table 5-1	Earthquake In Southern California Region	Section 5: Earthquake
Figure 5-1	Types and Characteristics of Earthquakes Faults in Southern California	Section 5: Earthquake
Map 5-1	Seismic Zones in California	Section 5: Earthquake
Map 5-2	Major Active Surface Faults in Southern California	Section 5: Earthquake
Map 5-3	Seismic Hazard Zones – Torrance Quadrangle	Section 5: Earthquake
Map 5-4	Seismic Hazard Zones – Redondo Quadrangle	Section 5: Earthquake
Map 5-5	Seismic Hazard Zones – San Pedro Quadrangle	Section 5: Earthquake
Map 5-4	RHE Palos Verdes Reservoir Inundation Area	Section 5: Earthquake
Table 5-2	Partial List of the Over 200 California Laws on Earthquake Safety	Section 5: Earthquake
Table 6-1	October 2003 Firestorm Statistics	Section 6: Wildfire
Table 6-2	Large Historic Fires in California 1961-2003	Section 6: Wildfire
Table 6-3	National Fire Suppression Costs	Section 6: Wildfire
Table 6-4:	Sample Hazard Identification Rating System	Section 6: Wildfire
Map 6-1	Very High Fire Severity Zone	Section 6: Wildfire
Map 6-2	RPV Wildland/Urban Interface Areas	Section 6: Wildfire
Map 7-1	RHE Probable Landslide Areas	Section 7 - Landslide
Map 7-2	RPV Areas With Consideration for Public Hearth and Safety	Section 7 - Landslide
Table 8-1	Tsunami Event in California 1930-2004	Section 8 - Tsunami
Figure 8-1	Tsunami Formation Following an Earthquake	Section 8 - Tsunami
Table 8-2	Landslide Induced Tsunami Simulation Parameters	Section 8 - Tsunami
Figure 8-2	Tsunami Simulation Wave Breaking	Section 8 - Tsunami
Figure 8-3	Tsunami Simulation Maximum Wave Height	Section 8 - Tsunami
Figure 8-4	Tsunami Simulation Sediment Movement	Section 8 - Tsunami
Figure 8-5	Tsunami Simulation Structure Damage	Section 8 - Tsunami
Figure 8-6	Tsunami Simulation Ship Movement	Section 8 - Tsunami

Note: Unless otherwise indicated, the maps in this plan were provided by the City of Rancho Palos Verdes and the City of Rolling Hills Estates. Care was taken in the creation of these maps, but they are provided "as is". The Cities cannot accept any responsibility for any errors, omissions or positional accuracy, and therefore, there are no warranties that accompany these products (the maps). Although information from land surveys may have been used in the creation of these products, in no way does this product represent or constitute a land survey. Users are cautioned to field verify information on this product before making any decisions.

Joint Natural Hazards Mitigation Plan

Index

Title Page i

Acknowledgments........ ii

List of Tables, Maps and Figures........ iii

Index iv

Executive Summary........Executive Summary - 1

Part I: Hazard Analysis

Section 1: Introduction........ Introduction-1
Section 2: History of Natural Disasters in the Planning Area History-1
Section 3: Planning Area Profile........ Profile-1
Section 4: Risk Assessment .... Risk Assessment-1
Section 5: Earthquake Earthquake-1
Section 6: Wildfire........ Wildfire-1
Section 7: Earth Movement (Landslides & Debris Flow) .... Earth Movement-1
Section 8: Tsunami Tsunami-1

Part II: Mitigation Actions

Section 9: Mitigation Actions Matrix .... Mitigation Actions Matrix-1
Section 10: Plan Maintenance........ Plan Maintenance-1

Part III: Resources

Appendix A: Plan Resource Directory ....Appendix A-1
Appendix B: Public Participation Process ....Appendix B-1
Appendix C: Benefit Cost Analysis........Appendix C-1
Appendix D: List of Acronyms........Appendix D-1
Appendix E: Glossary ....Appendix E-1

Executive Summary

Table of Contents

Executive Summary .... page 3

Introduction .... page 3

How is the Plan Organized? .... page 3

Who Participated in Developing the Plan? .... page 3

What is the Plan Mission? .... page 4

What are the Plan Goals? .... page 5

How are the Action Items Organized? .... page 6

How will the Plan be Implemented, Monitored and Evaluated? .... page 6

Plan Adoption .... page 7

Coordinating Body .... page 7

Covener .... page 7

Implementation Through Existing Programs .... page 7

Economic Analysis of Mitigation Programs .... page 8

Formal Review Process .... page 8

Continued Public Involvement .... page 8

Executive Summary

Introduction

To encourage local communities to undertake more pre-disaster mitigation planning, Congress passed the Disaster Mitigation Act of 2000 (DMA2K). This legislation requires all city, county and state jurisdictions to prepare a Natural Hazard Mitigation Plan by November 1, 2004. This process includes: 1) conducting an assessment of the potential natural hazards; 2) determining the financial impact of these identified hazards; 3) creating a plan to mitigate the hazards; and 4) implementing a plan to reduce the impacts of natural disasters. Jurisdictions that do not have a certifiable plan in place by the November 1, 2004 deadline will be ineligible to receive post-disaster funding from FEMA.

The Joint Natural Hazards Mitigation Plan includes resources and information to assist the Cities of Rancho Palos Verdes and Rolling Hills Estates (the "planning area"), their residents, public and private sector organizations, and others interested in participating in planning for natural hazards. The mitigation plan provides a list of activities that may assist the Cities in reducing risk and preventing loss from future natural hazard events. The action items address multi-hazard issues, as well as activities for earthquake, wildfire, earth movement (landslide & debris flow), and tsunami.

How is the Plan Organized?

The Mitigation Plan contains a Mitigation Actions Matrix, background on the purpose and methodology used to develop the mitigation plan, a profile of the City of Rancho Palos Verdes and the City of Rolling Hills Estates, sections on four natural hazards that occur within the Cities, and a number of appendices. All of the sections are described in detail in Section 1, Introduction.

Who Participated in Developing the Plan?

The Joint Natural Hazards Mitigation Plan is the result of a collaborative planning effort between the two city governments, their citizens, other public agencies, non-profit organizations, the private sector, and regional and state organizations. Public participation played a key role in development of goals and action items. Interviews were conducted with stakeholders in both cities, and public outreach activities were conducted to include residents in plan development. A Joint Planning Team guided the process of developing the plan.

The Joint Planning Team was comprised of the following representatives:

City of Rancho Palos Verdes	Carolynn Petru, City Manager's Office
	Mark Campbell, Building & Safety Division
	Kit Fox, Planning Department

	Kathryn Downs, Finance Department
	Dennis McLean, Finance Department & IT
	Nicole Jules, Public Works Department
	Sonali Tambe, Palos Verdes on the Net
City of Rolling Hills Estates	Greg Grammer, City Manager's Office
	Niki Cutler, Planning Department
	Ed Acosta, Building & Safety
	Rafael Bernal, Building & Safety
County of Los Angeles	David Rozas, Sheriff's Department
	Alex Solis, Fire Department
Southern California Edison	Scott Gobble
The Gas Company	Marcella Low
California Water Service Company	Peter Akhotnikoft
	Ross Moilan
Verizon California	Frank Uribe
	Rich Olsen
Palos Verdes Peninsula CERT (LASD)	John Douglass
Palos Verdes Peninsula Chamber of Commerce	Jerry Jeffe
Palos Verdes Peninsula Unified School District	Peter Lyons
Office of Disaster Management, Area G	Mike Martinet
Emergency Planning Consultants	Carolyn J. Harshman, President

What is the Plan Mission?

The mission of the Joint Natural Hazards Mitigation Plan is to promote sound public policy designed to protect citizens, critical facilities, infrastructure, private property, and the environment from natural hazards. This can be achieved by increasing public awareness, documenting the resources for risk reduction and loss-prevention, and identifying activities to guide the Cities toward building a safer, more sustainable community.

What are the Plan Goals?

The plan goals describe the overall direction that Cities of Rancho Palos Verdes and Rolling Hills Estates agencies, organizations, and citizens can take to work toward mitigating risk from natural hazards. The goals are stepping-stones between the broad direction of the mission statement and the specific recommendations outlined in the Mitigation Actions Matrix.

Protect Life and Property

Implement activities that assist in protecting lives by making homes, businesses, infrastructure, critical facilities, and other property more resistant to losses from natural hazards.

Reduce losses and repetitive damages for chronic hazard events while promoting insurance coverage for catastrophic hazards.

Improve hazard assessment information to make recommendations for addressing new development in high hazard areas and encouraging preventative measures for existing development in areas vulnerable to natural hazards.

Public Awareness

Develop and implement education and outreach programs to increase public awareness of the risks associated with natural hazards.

Provide information on tools; partnership opportunities, and funding resources to assist in implementing mitigation activities.

Natural Systems

Balance natural resource management, and land use planning with natural hazard mitigation to protect life, property, and the environment.

Preserve, rehabilitate, and enhance natural systems to serve natural hazard mitigation functions.

Partnerships and Implementation

Strengthen communication and coordinate participation among and within public agencies, citizens, non-profit organizations, business, and industry to gain a vested interest in implementation.

Encourage leadership within public and private sector organizations to prioritize and implement local and regional hazard mitigation activities.

Emergency Services

Establish policy to ensure mitigation projects for critical facilities, services, and infrastructure.

Strengthen emergency operations by increasing collaboration and coordination among public agencies, non-profit organizations, business, and industry.

Coordinate and integrate natural hazard mitigation activities, where appropriate, with emergency operations plans and procedures.

How Are the Action Items Organized?

The action items are a listing of activities in which City agencies and citizens can be engaged to reduce risk. Each action item includes an estimate of the timeline for implementation (see Executive Summary, Attachment 1: Mitigation Actions Matrix).

The action items are organized within a matrix (see Section 9: Mitigation Actions Matrix), which lists all of the multi-hazard and hazard-specific action items included in the mitigation plan. Data collection and research and the public participation process resulted in the development of these action items (see Appendix B: Public Participation). The Matrix includes the following information for each action item:

Coordinating Organization. The coordinating organization is the public agency with regulatory responsibility to address natural hazards, or that is willing and able to organize resources, find appropriate funding, or oversee activity implementation, monitoring, and evaluation. Coordinating organizations may include local, county, or regional agencies that are capable of or responsible for implementing activities and programs.

Timeline. Action items include both short and long-term activities. Each action item includes an estimate of the timeline for implementation.

Plan Goals Addressed. The plan goals addressed by each action item are included as a way to monitor and evaluate how well the mitigation plan is achieving its goals once implementation begins. The plan goals are organized into the following five areas:

Protect Life and Property
Public Awareness
Natural Systems
Partnerships and Implementation
Emergency Services

How Will the Plan be Implemented, Monitored, and Evaluated?

The Plan Maintenance Section (Section 10) of the Plan details the formal process that will ensure that the Joint Natural Hazards Mitigation Plan remains an active and relevant document.. The plan maintenance process includes a schedule for monitoring and evaluating the Plan annually and producing a plan revision every five years. This section describes how the Cities will integrate public participation throughout the plan maintenance process. Finally, this section includes an explanation of how both City governments intend to incorporate the mitigation strategies outlined in this Plan into existing planning mechanisms such as the City's General Plan, Capital Improvement Plans, and Building & Safety Codes.

Plan Adoption

Adoption of the Natural Hazards Mitigation Plan by the local jurisdictions governing bodies is one of the prime requirements for approval of the plan. Once the plan is completed, the City Councils will be responsible for adopting the Joint Natural Hazards Mitigation Plan. The local agency governing bodies have the responsibility and authority to promote sound public policy regarding natural hazards. The City Councils will periodically need to re-adopt the plan as it is revised to meet changes in the natural hazard risks and exposures in the community. The approved Joint Natural Hazards Mitigation Plan will be significant in the future growth and development of the communities.

Coordinating Body

The RPV/RHE Hazard Mitigation Committee will be responsible for coordinating implementation of Plan action items and undertaking the formal review process. The City Councils (or their designees) will assign representatives from City agencies, including, but not limited to, the current Joint Natural Hazards Mitigation Planning Team members.

Convener

The City Councils will adopt the Joint Natural Hazards Mitigation Plan and the RPV/RHE Hazard Mitigation Committee will take responsibility for plan implementation. The City Managers will serve as conveners to facilitate the RPV/RHE Hazard Mitigation Committee meetings, and will assign tasks such as updating and presenting the Plan to the members of the Committee. Plan implementation and evaluation will be a shared responsibility among all of the RPV/RHE Hazard Mitigation Committee members.

Implementation through Existing Programs

Both cities address statewide planning goals and legislative requirements through their General Plans, Capital Improvement Plans, and City Building & Safety Codes. The Joint Natural Hazards Mitigation Plan provides a series of recommendations that are closely related to the goals and objectives of these existing planning programs. The cities will have the opportunity to implement recommended mitigation action items through existing programs and procedures.

Economic Analysis of Mitigation Projects

The Federal Emergency Management Agency's approaches to identify costs and benefits associated with natural hazard mitigation strategies or projects fall into two general categories: benefit/cost analysis and cost-effectiveness analysis. Conducting benefit/cost analysis for a mitigation activity can assist communities in determining whether a project is worth undertaking now, in order to avoid disaster-related damages later. Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. Determining the economic feasibility of mitigating natural hazards can provide decision makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects.

Formal Review Process

The Plan will be evaluated on an annual basis to determine the effectiveness of programs, and to reflect changes in land development or programs that may affect mitigation priorities. The evaluation process includes a firm schedule and time line, and identifies the local agencies and organizations participating in plan evaluation. The convener will be responsible for contacting the RPV/RHE Hazard Mitigation Committee members and organizing the annual meeting. Committee members will be responsible for monitoring and evaluating the progress of the mitigation strategies in the Plan.

Continued Public Involvement

The City of Rancho Palos Verdes and the City of Rolling Hills Estates are dedicated to involving the public directly in the continual review and updates of the Joint Natural Hazards Mitigation Plan. Copies of the plan will be catalogued and made available at both City Halls and the Peninsula Center main public library in Rolling Hills Estates and the Miraleste branch public library in Rancho Palos Verdes. The existence and location of these copies will be publicized in City newsletters and posted on City websites. The plan also includes the address and the phone number of the Cities' contact person responsible for keeping track of public comments on the Plan. In addition, copies of the Plan and any proposed changes will be posted on the Cities' websites. These sites will also contain email addresses and phone numbers to which people can direct their comments and concerns.

Introduction

Table of Contents

Introduction..page 3

Disaster Mitigation Act of 2000 ....page 3

Why Develop a Mitigation Plan?...page 3

Whom Does the Mitigation Plan Affect?...page 4

Natural Hazard Land Use Policy in California...page 6

Support for Natural Hazard Mitigation...page 6

Plan Methodology...page 6

Stakeholder Input..page 6

State and Federal Guidelines and Requirements for Mitigation Plans.......................page 6

Public Input..page 9

How is the Plan Used?...page 9

Section 1:

Introduction

Disaster Mitigation Act of 2000

Since 1993, the Federal Emergency Management Agency (FEMA) has spent more than $20 billion in over 5,000 counties on disaster recovery. The residents of Southern California were recently reminded of the high cost of natural disasters during the wildfires that raged through the counties of San Diego, Riverside, Ventura, Los Angeles and San Bernardino in October 2003, and the 6.5 earthquake that jolted the Paso Robles in December 2003.

To encourage local communities to undertake more pre-disaster mitigation planning, Congress passed the Disaster Mitigation Act of 2000 (DMA2K). This legislation requires all city, county and state jurisdictions to prepare a Natural Hazard Mitigation Plan by November 1, 2004. This process includes: 1) conducting an assessment of the potential natural hazards; 2) determining the financial impact of these identified hazards; 3) creating a plan to mitigate the hazards; and 4) implementing a plan to reduce the impacts of natural disasters.

Jurisdictions that do not have a certifiable plan in place by the November 1, 2004 deadline will be ineligible to receive post-disaster funding from FEMA.

Why Develop a Mitigation Plan?

The planning area maintains some of the lowest population densities in Los Angeles County, and offers the benefits of living in a Mediterranean type of climate. The area is characterized by the unique and attractive landscape, magnificent views and a semi-rural/coastal environment, that makes the area so popular. However, as discussed in the previous section, the potential impacts of natural hazards associated with the terrain make the environment and population vulnerable to natural disasters.

As the cost of damage from natural disasters continues to increase, the communities have realized the importance of identifying effective ways to reduce vulnerability to disasters. Natural hazard mitigation plans assist communities in reducing risk from natural hazards by identifying resources, information, and strategies for risk reduction, while helping to guide and coordinate mitigation activities throughout the Cities.

The planning area is subject to wildfire, earthquake, earth movement, and tsunami. It is impossible to predict exactly when these disasters will occur, or the extent to which they will affect the planning area. However, with careful planning and collaboration among public agencies, private sector organizations, and citizens within the community, it is possible to minimize the losses that can result from these natural disasters.

The plan provides a set of action items to reduce risk from natural hazards through education and outreach programs and to foster the development of partnerships, and implementation of preventative activities such as land use programs that restrict and control development in areas subject to damage from natural hazards.

The resources and information within the Mitigation Plan:

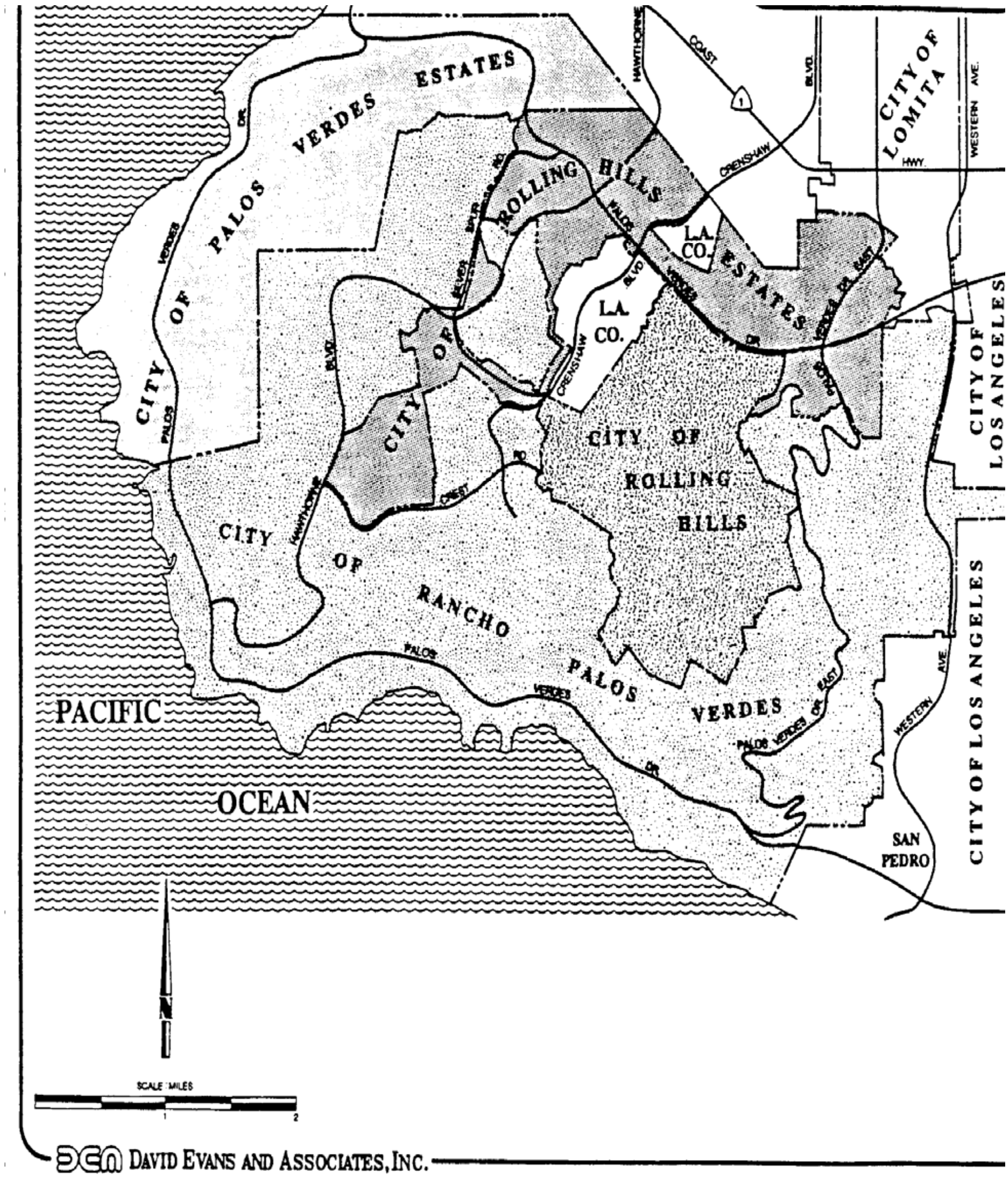
(1) establish a basis for coordination and collaboration among agencies and the public in Rancho Palos Verdes and Rolling Hills Estates
(2) identify and prioritize future mitigation projects; and
(3) assist in meeting the requirements of federal assistance programs.

The mitigation plan works in conjunction with other City plans, including the Multi-Hazard Functional Plans.

Whom Does the Mitigation Plan Affect?

The Joint Natural Hazards Mitigation Plan affects the entire planning area. Map 1-1 shows major roads in the planning area. This plan provides a framework for planning for natural hazards. The resources and background information in the plan is applicable area-wide, and the goals and recommendations can lay groundwork for other local mitigation plans and partnerships.

Map 1-1: Base Map of the Planning Area (Source: Rolling Hills Estates General Plan)



Natural Hazard Land Use Policy in California

Planning for natural hazards should be an integral element of any City's land use planning program. All California cities and counties have General Plans and the implementing ordinances that are required to comply with the statewide planning regulations.

The continuing challenge faced by local officials and state government is to keep the network of local plans effective in responding to the changing conditions and needs of California's diverse communities, particularly in light of the very active seismic region in which we live.

This is particularly true in the case of planning for natural hazards where communities must balance development pressures with detailed information on the nature and extent of hazards.

Planning for natural hazards, calls for local plans to include inventories, policies, and ordinances to guide development in hazard areas. These inventories should include the compendium of hazards facing the community, the built environment at risk, the personal property that may be damaged by hazard events and most of all, the people who live in the shadow of these hazards.

Support for Natural Hazard Mitigation

All mitigation is local, and the primary responsibility for development and implementation of risk reduction strategies and policies lies with local jurisdictions. Local jurisdictions, however, are not alone. Partners and resources exist at the regional, state and federal levels. Numerous California state agencies have a role in natural hazards and natural hazard mitigation. Some of the key agencies include:

∃ The Governor's Office of Emergency Services (OES) is responsible for disaster mitigation, preparedness, response, recovery, and the administration of federal funds after a major disaster declaration;

∃ The Southern California Earthquake Center (SCEC) gathers information about earthquakes, integrates this information on earthquake phenomena, and communicates this to end-users and the general public to increase earthquake awareness, reduce economic losses, and save lives;

∃ The California Division of Forestry (CDF) is responsible for all aspects of wildland fire protection on private, state, and administers forest practices regulations, including landslide mitigation, on non-federal lands;

∃ The California Division of Mines and Geology (DMG) is responsible for geologic hazard characterization, public education, the development of partnerships aimed at reducing risk, and exceptions (based on science-based refinement of tsunami inundation zone delineation) to state mandated tsunami zone restrictions; and

∃ The California Division of Water Resources (DWR) plans, designs, constructs, operates, and maintains the State Water Project; regulates dams; provides flood protection and assists in emergency management. It also educates the public, serves local water needs by providing technical assistance.

Plan Methodology

Information in the Mitigation Plan is based on research from a variety of sources. Staff from the City of Rancho Palos Verdes and the City of Rolling Hills Estates conducted data research and analysis, participated in Planning Team meetings and public outreach activities, and developed the final mitigation plan. The research methods and various contributions to the plan include:

Stakeholder Input

The Joint Planning Team convened four times to guide development of the Mitigation Plan. The Team played an integral role in developing the mission, goals, and action items for the Mitigation Plan. The Team consisted of representatives of eleven organizations, including:

City of Rancho Palos Verdes
City of Rolling Hills Estates
Palos Verdes Peninsula Unified School District
Palos Verdes Peninsula Chamber of Commerce
Palos Verdes Peninsula CERT
Los Angeles County Sheriff's Department
Los Angeles County Fire Department
Verizon California
Southern California Edison
The Gas Company
California Water Service Company
Office of Disaster Management, Area G

Staff from both Cities distributed copies of the draft Plan draft to the above referenced agencies and organizations, which are interested in natural hazards planning. The data and support gained from the review process was very valuable to the overall planning effort. A complete listing of all stakeholders (reviewers) is located in Appendix B: Public Participation.

State and Federal Guidelines and Requirements for Mitigation Plans

Following are the Federal requirements for approval of a Natural Hazards Mitigation Plan:

∃ Open public involvement, with public meetings that introduce the process and project requirements;

∃ The public must be afforded opportunities for involvement in: identifying and assessing risk, drafting a plan, and public involvement in approval stages of the plan;

∃ Community cooperation, with opportunity for other local government agencies, the business community, educational institutions, and non-profits to participate in the process; and

∃ Incorporation of local documents, including the local General Plans, the Zoning Ordinances, the Building Codes, and other pertinent documents.

The following components must be part of the planning process:

∃ Complete documentation of the planning process;

∃ A detailed risk assessment on hazard exposures in the community. In the case of multi-jurisdictional plans, the hazard analysis must assess each jurisdiction's risks where they vary from the risks facing the entire planning area;

∃ A comprehensive mitigation strategy, which describes the goals & objectives, including proposed strategies, programs & actions to avoid long-term vulnerabilities;

∃ A plan maintenance process, which describes the method and schedule of monitoring, evaluating and updating the plan and integration of the Natural Hazards Mitigation Plan into other planning mechanisms;

∃ Formal adoption by both of the City Councils; and

∃ Plan Review by both State OES and FEMA.

These requirements are spelled out in greater detail in the following plan sections and supporting documentation.

Public participation opportunities were created through use of local media, the jurisdictional websites and local cable channel and the public hearings. In addition, the makeup of the multi-jurisdictional planning team insured a constant exchange of data and input from outside organizations.

Through its consultant, Emergency Planning Consultants, the Cities had access to numerous existing mitigation plans from around the country, as well as current FEMA Hazard Mitigation Planning Standards (386 series).

Other reference materials consisted of county and city mitigation plans, including:

Clackamas County (Oregon) Natural Hazards Mitigation Plan
Six County (Utah) Association of Governments
Upper Arkansas Area Risk Assessment and Hazard Mitigation Plan
Urbandale-Polk County, Iowa Plan
Hamilton County, Ohio Plan
Natural Hazard Planning Guidebook from Butler County, Ohio

Hazard specific research: Jurisdictional staffs collected data and compiled research on four hazards: earthquake, wildfire, earth movement, and tsunami. Research materials came from the City General Plans, the Threat Assessments (contained in the Multi-Hazard Functional Plans), and state agencies including OES and CDF. The staffs conducted research by referencing historical local newspapers, interviewing long time residents, long time City employees and locating information contained in historical documents.

Both jurisdictions identified current mitigation activities, resources and programs, and potential action items from research materials and stakeholder interviews.

Public Input

The Multi-Jurisdictional Planning Team encouraged public participation and input in the Joint Natural Hazards Mitigation Plan by posting its activities in the media and on the Internet. Articles about the preparation of the joint plan were included in the newsletters published by both Cities and mailed to each household in the planning area to increase public awareness of the plan and to encourage public input into the planning process. Citizens were encouraged to review copies of the Plan Draft available at the City Halls and local public libraries, as well as both City websites. In addition, the public was encouraged to participate in the advisory boards and City Council public meetings described in Appendix B, which includes a summary of the public comments gathered during the public meetings and hearings.

The resources and information cited in the mitigation plan provide a strong local perspective and helped to identify strategies and activities to make the planning area more disaster resistant.

How Is the Plan Used?

Each section of the mitigation plan provides information and resources to assist people in understanding the region and the hazard-related issues facing citizens, businesses, and the environment. Combined, the sections of the plan work together to create a document that guides the mission to reduce risk and prevent loss from future natural hazard events.

The structure of the plan enables people to use a section of interest to them. It also allows the local governments to review and update sections when new data becomes available. The ability to update individual sections of the mitigation plan places less of a financial burden on the Cities. Decision-makers can allocate funding and staff resources to selected pieces in need of review, thereby avoiding a full update, which can be costly and time-consuming. New data can be easily incorporated, resulting in a natural hazards mitigation plan that remains current and relevant to both cities.

The mitigation plan is organized into three Parts. Part I contains an executive summary, Mitigation Actions Matrix, introduction, and plan maintenance section. Part II contains a planning area profile, risk assessment, and hazard-specific sections. Part III includes the appendices. Each section of the plan is described below.

Executive Summary

The Executive Summary provides an overview of the mitigation plan's mission and goals. It also describes the planning process used to create the joint mitigation plan, and how it will be applied and updated in the future.

Part I: Hazard Analysis

Section 1: Introduction

The Introduction describes the background and purpose of developing the joint mitigation plan and how the plan is organized.

Section 2: History of Natural Disasters in the Planning Area

This section provides a historical perspective of natural hazards that have occurred in the region.

Section 3: Planning Area Profile

This section presents the climate, geography, demographics, and socio-economics of the planning area.

Section 4: Risk Assessment

This section provides information on hazard identification, vulnerability and risk associated with natural hazards in the planning area.

Sections 5-8: Hazard Specific Information

Hazard-Specific Information on the four chronic hazards is addressed in this plan. Chronic hazards occur with some regularity and may be predicted through historic evidence and scientific methods. The chronic hazards addressed in the plan include:

Section 5: Earthquake
Section 6: Wildfire
Section 7: Earth Movement
Section 8: Tsunami

Each of the hazard-specific sections includes information on the history, hazard causes and characteristics, hazard assessment, goals and action items, and local, state, and national resources.

Part II: Mitigation Actions

Section 9: Mitigation Actions Matrix

The plan action items are included in this section, and address multi-hazard issues, as well as hazard-specific activities that can be implemented to reduce risk and prevent loss from future natural hazard events.

Section 10: Plan Maintenance

This section provides information on plan implementation, monitoring, and evaluation.

Part III: Resources

The plan appendices are designed to provide users of the Joint Natural Hazards Mitigation Plan with additional information to assist them in understanding the contents of the mitigation plan, and potential resources to assist them with implementation.

Appendix A: Plan Resource Directory

The resource directory includes local, county, regional, state, and national resources and programs that may be of technical and/or financial assistance to the planning area during plan implementation.

Appendix B: Public Participation

This appendix includes specific information on the various public processes used during development of the plan.

Appendix C: Benefit Cost Analysis

This section describes FEMA's requirements for benefit cost analysis in natural hazards mitigation, as well as various approaches for conducting economic analysis of proposed mitigation activities.

Appendix D: List of Acronyms

This section provides a list of acronyms for local, county, regional, state, and federal agencies and organizations that may be referred to within the Joint Natural Hazards Mitigation Plan.

Appendix E: Glossary

This section provides a glossary of terms used throughout the plan.

History of Natural Disasters in the Planning Area

Table of Contents

History of Natural Disasters in the Planning Area..page 3

Earthquake ....page 3

Land Movement ....page 4

Wildfire ....page 6

Tsunami...page 6

Section 2:

History of Natural Disasters in the Planning Area

Throughout history, the residents of the planning area have dealt with the various natural hazards affecting the area. The earliest inhabitants of the Palos Verdes Peninsula, the Tongva Indians, were careful to locate their villages on high ground for safety from winter floods (source: Fink: Palos Verdes Peninsula: Time and the Terraced Land, 1987). Although there were far fewer people in the area prior to 1900, the natural hazards adversely affected the lives of those who depended on the land and climate conditions for food and welfare. For example, the drought of 1862-64 devastated local cattle ranching operations on the peninsula (source: Fink, 1987). As the population of the area has continued to increase over time, particularly in the last 50 years, the exposure to natural hazards creates an even higher risk than previously experienced.

Although this plan only analyzes and provides mitigation for the Cities of Rancho Palos Verdes and Rolling Hills Estates, this section discusses natural disasters that have affected the entire Palos Verdes Peninsula. Because it is a single geographic landform, natural disasters that have occurred in other parts of the Peninsula in the past have a high likelihood to impact the planning area in the future.

Earthquake

In terms of earthquakes, historically the planning area has been extremely lucky. Like the majority of the Los Angeles basin, the Palos Verdes Peninsula was largely uninhabited rangeland during the 7.9M Fort Tejon Earthquake in 1857. Articles in the Palos Verdes News indicate that the planning area sustained only minor property damage and no loss of life as a result of the major earthquakes that have occurred in the Los Angeles area since the area first began to develop rapidly following World War II.

The earliest report of any local earthquake-related damage comes from an article that appeared in the Palos Verdes News on April 10, 1968. The newspaper reported on two shocks, 6M and 7.25M in strength, respectively, that occurred a few days earlier broke a water pipe in a drug store located in the City of Palos Verdes Estates; consequently flooding the store’s basement and causing an estimated $4,000 to $5,000 in damage. On February 10, 1971, the Palos Verdes News reported that the 6.6M San Fernando Earthquake resulted in 900 homes being without power in the Highridge area north of Crest road in Rancho Palos Verdes for about an hour. Similarly, an article that appeared in the paper on October 3, 1987 reported that the 5.9M Whittier Narrows Earthquake damaged a bank building in the Peninsula Shopping Center in Rolling Hills Estates, although the extent of the damage was not indicated. In addition, the article mentioned that cellular telephone service was disrupted most of the morning, but no power outages occurred.

The 6.9M Northridge Earthquake of 1994 caused the most widespread, although still relatively minor damage within the planning area. On January 20, 1994, the Palos

Verdes News reported that local damage consisted of fire and smoke damage to a liquor store on Western Avenue in Rancho Palos Verdes caused by liquor bottles falling from shelves and then igniting when a refrigeration unit sparked. In the same area, a long section of retaining wall along Western Avenue and Delasonde Drive collapsed onto the public sidewalk. In Rolling Hills Estates, scores of books fell from the shelves at the main library and several shops in the Peninsula Shopping Center in Rolling Hills Estates lost a day of business cleaning up fallen merchandise in the wake of the temblor. Additionally, in the adjacent community of City of Palos Verdes Estates, a portion of the road at Via Valmonte at Via Azalea buckled, breaking a natural gas line under the street. (Palos Verdes News, 1937-2004)

Earth Movement

In terms of avoiding the hazards of earth movement, the planning area has been far less fortunate. Although geologic maps of the Palos Verdes Peninsula made in the 1930's and published in 1946 clearly depict several ancient landslides, they were apparently not considered or discounted in later construction activities (Woodring, W.P., N. Bramlette and W.S.W. Kew: Geology and Paleontology of the Palos Verdes Hills, Geologic Survey Professional Paper 207, U.S. Department of the Interior, 1946).

The first and largest landslide to occur in the planning area was the Portuguese Bend Landslide. The slide area encompasses approximately 270 acres. The weight of the moving material is estimated to be about 60 million tons, with a maximum thickness calculated to be 250 feet. The slide began in August 1956 in conjunction with a County roadway project to extend Crenshaw Boulevard from Crest Road to Palos Verdes Drive South. Initially, movement was 3 to 4 inches per day, quickly slowing to 1 inch per day a month later. The reactivation of this ancient landslide resulted in the loss of 134 residential dwellings, which were damaged beyond repair and razed. Relocation to safer ground saved a few homes. (The Palos Verdes Peninsula: A Geologic Guide and More, by Martin Reiter, Kendall/ Hunt Publishing Company, 1984) The slide also destroyed the Portuguese Bend Beach Club (Reiter, 1984), a private recreational facility that included a large clubhouse, saltwater pool, boating pier, tennis courts and volleyball courts (PV News, 1948 & 1952). Between 1962 and 1970, movement slowed to ½ inch per day (Reiter, 1984). Today, movement is approximately 3 feet per year, depending on the amount of rainfall the previous season. Nearly all of the remaining homes in the active slide area have been placed on elevated or so-called "floating" foundations that can be adjusted as the earth continues to slowly move and buckle beneath the homes.

Reactivation of the 80-acre Abalone Cove Landslide was first noted at the shoreline in February 1974. At the time, Abalone Cove was a private beach club. Slow movement continued between the shoreline and Palos Verdes Drive South until 1978, but only impacted vacant land. In late April or early May 1978, following one of the rainiest seasons on record (29.61 inches fell during 1977-78 compared to an average annual rainfall of 11.38 inches), the slide began to accelerate and cracking was seen in the roadway. The slide reached its maximum inland extent in February 1980, following 7.75 inches of rain during a 10-day period. Because the Abalone Cove Landslide started along the coastline and progressed landward, it was not triggered by drag from the abutting Portuguese Bend Landslide. The major factors attributed to reactivation of the slide appear to be rainfall and rising groundwater levels (Rieter, 1984). Although no homes were destroyed as a result of this slide, the visitor's center at the landmark Wayfarers Chapel was severely damaged and closed to the public in 1982. All but a small portion of the original structure was razed in 1995 and a new visitors center was constructed west of the slide scarp in 1999 (Daily Breeze, June 26, 1999).

A third landslide in the planning area that deserves mention is the Klondike Canyon Landslide. This landslide is located adjacent to the coastline and to the east of the much larger Portuguese Bend Landslide. Like the Portuguese Bend and the Abalone Cove Landslides, Woodring published the location of the ancient "Beach Club Landslide" in 1946. However, by that time, both Yacht Harbor Drive (in 1927) and Palos Verdes Drive South (in 1937) had been constructed across this landslide. Development of the two roadways was followed in the late 1940's by the construction of the Portuguese Bend Club and grading for the Seaview tract landward of Palos Verdes Drive South was completed in late 1956. Following record-breaking rainfall in 1977-1978, the first indications of movement of the Klondike Canyon Landslide were noted in September 1979 at the intersection of Dauntless Drive and Exultant Drive in the Seaview tract. Heavy rainfall continued during 1979-1980 and 1982-1983, accelerating land movement, which damaged local roads and eventually destroyed one home in the Seaview tract. In 1982, the Klondike Canyon Landslide Geologic Abatement District was formed and began installing dewatering wells to lower the ground water table within the slide mass. (Kerwin, Scott, "Land Stability in the Klondike Canyon," Moore and Taber professional report, no date but probably 1981 or 1982) The dewatering efforts have been successful in stabilizing the area and additional landslide abatement efforts have continued since that time, such as drainage improvements in Klondike Canyon and the installation of a private sewer system in the Portuguese Bend Beach Club.

Unlike the slower moving landslides in the Portuguese Bend area, the planning area most recently experienced two fast-moving earth failures that each caused a considerable amount of property damage. In March 1997, two office buildings located in the 900 block of Indian Peak Road in Rolling Hills Estates toppled and slid down a hillside, causing damage to another building at 655 Deep Valley Drive. In June 1999, the entire 18th fairway of the Ocean Trails Golf Course slid into the ocean, just a week prior to the course's scheduled grand opening, taking approximately 12 acres of land with it.

In its 31-year history, the City of Rancho Palos Verdes has only declared a local emergency on two occasions, both related to earth movement caused by severe weather. On March 8, 1979, the City of Rancho Palos Verdes declared a local emergency due to severe land movement resulting from heavy and unusual rains. Rancho Palos Verdes again declared a local emergency on January 17, 1995 due to severe El Nino rainstorms that caused flooding and sliding throughout the community.

Wildfire

With its many steep canyons and open scrub-covered hillsides, the planning area has always been vulnerable to the hazards associated with brush fires. The earliest newspaper report of a wildfire on the Palos Verdes Peninsula was in October 1923, in which the Los Angeles Examiner reported a brush fire on the Palos Verdes Hills that burned an estimated 4,000 acres. Although no people were injured or killed and no structures were destroyed, a considerable amount of livestock perished in the fire, including 18 horses, 500 rabbits and an unspecified number of chickens. In September 1945, the Peninsula News reported on a grass fire near Crest Road (in probably what is now the City of Rolling Hills) that destroyed one home and caused an estimated $50,000 worth of property damage. In June 1967, the Peninsula News reported that 45 acres had burned in the Portuguese Bend area. Although no residences were damaged in this incident, "considerable farm land was destroyed as fire trucks and other equipment had to cross the fields in order to fight the flames."

While hardly a year goes by when there isn't at least one small brush fire in the planning area, by far the most destructive wildland fire to ravage the area to date occurred in June 1973. As reported in the Peninsula News, the fire was started accidentally on Friday, June 22, 1973 at approximately 2:30 PM by two youths playing with fireworks flash powder near the intersection of Whitley Collins Drive and Crenshaw Boulevard in Rancho Palos Verdes. An empty field at the time, this area has since been developed with housing (The Island View tract). The day was unusually warm, with temperatures in the 90's and wind speeds of 10 to 20 miles per hour. Fueled by the gusting and shifting winds, the fire spread east to the federal radar dome facility at what is now Del Cerro Park, narrowly bypassed this facility and continued to move into the City of Rolling Hills, where it completely destroyed 9 homes. When the winds shifted to west, the fire burned into the Portuguese Bend area of Rancho Palos Verdes and destroyed 3 more homes. In all, the 1973 fire consumed a total of 900 acres and raged for 28 hours before it was finally extinguished. Fortunately, no human lives were lost. However, in addition to the 12 homes that were destroyed, the conflagration also damaged 12 other structures. All told, the disaster caused $1.3 million in private property damage in Rolling Hills and an additional $130,000 worth of damage in Rancho Palos Verdes. The Peninsula News also noted that the fire narrowly missed the Wayfarers Chapel, but did destroy several Edison power poles in McCarrell's Canyon on the western margin of the fire. It appears that the Fire of 1973 is second only to the Portuguese Bend Landslide as the most devastating natural disaster that has ever befallen the planning area.

Tsunami

A search through the historic records failed to produce any reports that the coastline in the planning area (Rancho Palos Verdes) has been impacted by tsunami events. Reports of high waves were most often found in conjunction with tropical storms that occasionally move through the area and the damage caused by them is usually associated with canyon flooding and failed drainage infrastructure (Ackerman, Jones, "Newspaper Reports of Weather on the Palos Verdes Peninsula From 1914 to 1997," personal research paper, no date but probably 1997 or 1998). However, because of more recent scientific study of this natural phenomenon and the fact that Rancho Palos Verdes has several public recreational areas and private residential development along its coastline, it has been determined that tsunamis are worthy of evaluation in this mitigation plan.

Planning Area Profile

Table of Contents

Planning Area Profile....................page 3

Why Plan for Natural Hazards?....................page 3

Geography and the Environment....................page 3

Human Settlement of the Planning Area....................page 3

Hydrology....................page 4

Climate....................page 4

Geology and Soils....................page 5

Population and Demographics....................page 8

Land and Development....................page 10

Housing and Community Development....................page 10

Employment and Industry....................page 11

Traffic and Commuting Patterns....................page 11

Section 3:

Planning Area Profile

Why Plan for Natural Hazards?

Natural hazards impact citizens, property, the environment, and the economy of both the City of Rancho Palos Verdes and the City of Rolling Hills Estates. Earthquake, wildfire, earth movement, and tsunami have either occurred in the past or have a high potential to expose planning area residents and businesses to the financial and emotional costs of recovering after natural disasters. Even in those communities that are essentially "built-out" i.e., have little or no vacant land remaining for development, the risk associated with natural hazards increases as existing residents improve their properties and new residents move to areas affected by natural hazards.

The inevitability of natural hazards and the continuing activity within the area create an urgent need to develop strategies, coordinate resources, and increase public awareness to reduce risk and prevent loss from future natural hazard events. Identifying the risks posed by natural hazards, and developing strategies to reduce the impact of a hazard event can assist in protecting life and property of citizens and communities. Local residents and businesses can work together with the Cities to create a natural hazards mitigation plan that addresses the potential impacts of hazard events.

Geography and the Environment

The planning area is on the Palos Verdes Peninsula is approximately 20 miles south of Central Los Angeles. The total size of the planning area is 17.78 square miles. The City of Rancho Palos Verdes has an area of 13.6 square miles, while the City of Rolling Hills Estates has an area of 4.18 square miles.

The Palos Verdes Peninsula has a unique physiography, formed over millions of years of submerging and lifting from the Pacific Ocean. Once an island, the Peninsula is nine miles wide by four miles deep, now rises above the Los Angeles Basin, with the highest elevation at 1480 feet. The terrain of much of the planning area is rolling hills, steep slopes, canyons and coastal bluffs.

The planning area is bounded on the north by Torrance, Rolling Hills, and Palos Verdes Estates; on the south and west by the Pacific Ocean; and on the east by Lomita and San Pedro (Los Angeles).

Human Settlement of the Planning Area

The earliest human inhabitants of the Palos Verdes Peninsula were the tribes of Tongva Indians who were first described by the Spanish explorer Cabrillo in 1542. The area was taken under Spanish rule by the armies under Cortez and remained so, virtually undisturbed, until Mexico won its independence from Spain in 1822. In 1827, the

Governor of Mexican California rewarded Don Jose Dolores Sepulveda for his military service by giving him a land grant of the "Rancho de los Palos Verdes (Ranch of the Green Trees)." The Sepulveda family operating a flourishing cattle ranch on the land until the great drought of 1862-64 decimated the herds and boundary litigation resulted in the great rancho being awarded to Jotham Bixby in 1882.

In addition to improving the cattle herds, Bixby's ranch manager, Harry Phillips introduced farming to the Palos Verdes Peninsula in the early 1900's. He leased land to Japanese farmers on the south slope of the Peninsula to cultivate vegetables, while Caucasian families principally grew grains on the drier northern slopes. In 1913, a group of New York investors purchased most of the peninsula intending to develop a community of large estates for the wealthy. It was not until 1921, however, that Frank A. Vanderlip, Sr., one of the New York investors, and E.G. Lewis, a real estates promoter, founded the Palos Verdes Project and the first houses first appeared on the hillsides in 1924.

Although the rate of development was slow through the decades of the Great Depression and World War II, the economic and population boom that occurred in the post-war years precipitated the most rapid period of growth on the Palos Verdes Peninsula during the 1950's and 1960's. The pace of development has been much slower over the last three decades, with the majority of the remaining open tracts of land either being developed for low-density residential projects or preserved as permanent open space. (Source: Palos Verdes Peninsula: Time and the Terraced Land by Augusta Fink, Western Tanager Press, 1987) Rolling Hills Estates was incorporated in 1957 in order to preserve and protect a rural community atmosphere. Rancho Palos Verdes was incorporated in 1973 in order to gain control over the increasing number of high-density residential projects being approved by the County and to return to predominately single-family residential development pattern in the community.

Hydrology

All surface waters in the planning area originate from precipitation falling directly on the land. There are no major continuing streamway systems. This is a result of the peninsula being a single hill formation divided by a central ridge, creating a drainage pattern that is dispersed in a number of small watersheds systems. The majority of the runoff in Rancho Palos Verdes flows directly into the ocean. The majority of runoff in Rolling Hills Estates flows into storm drain systems in adjacent communities, such as Torrance and Lomita, which also eventually empty into the ocean. As a result, the adverse impacts of flooding in the planning area are more often related to erosion damage, particularly in properties located next to canyons and other drainage areas, rather than by inundation.

Climate

Temperatures in the Peninsula range from 56.1 degrees in the winter months to 69.7 degrees in the summer months. However the temperatures can vary over a wide range, particularly when the Santa Ana winds blow, bringing higher temperatures and very low humidity. Temperatures rarely exceed 85° in the summer months (June - September), and rarely drop below 45.3° in the winter months (November-March). In September 1955, the highest temperature was recorded at 110° in lower Rolling Hills. The lowest temperature of 21° was in December 1990 at the Botanic Gardens in Rolling Hills Estates. (Peninsula News, 1997)

It is rare to have wind speeds over 30 mph in the planning area. This is largely due to phenomenon created by the peninsula's natural landform. Winds tend to split and go around a hill such as Palos Verdes, with its highest elevation at San Pedro Hill at 1,480 feet about sea level. Thus, the prevailing winds from the Pacific Ocean by-pass the coast from Malaga Cove in the adjacent community of Palos Verdes Estates to the Portuguese Bend area in Rancho Palos Verdes. (Ackerman, 1997)

Rainfall in the planning area averages 13.57 inches of rain per year. Due to the Peninsula's topography, the south and west slopes tend to receive less rain than the north and east slopes. Furthermore, actual rainfall in Southern California tends to fall in large amounts during sporadic and often heavy storms rather than consistently during storms at somewhat regular intervals. In short, rainfall in Southern California might be characterized as feast or famine within a single year. Since 1970, the driest seasonal rainfall was 1975-1976 when Lunada Bay in Palos Verdes Estates received only 4.32 inches or rain. The wettest season was 1977-1978 when Miraleste Plaza on the east side of Rancho Palos Verdes had 41.5 inches and the Monaco tract on the west side of the City had 25.4 inches of rain. January 1995 was the wettest single month with 21.43 inches at the Botanic Gardens in Rolling Hills Estates. The wettest single day during this period was 6 inches. Incidentally, in 1932, 1940 and 1949, the local newspaper ran pictures of the 4 to 6 inches of snowfall on the Palos Verdes Peninsula during those years. (Peninsula News, 1997)

Geology and Soils

The characteristics of the geology and soils present in planning area indicate that potential types of hazards that may occur. Due to the Palos Verdes Peninsula's rugged topography, the weak layers exist within the folded sedimentary rock that chiefly underlies the area, and fact that the peninsula is bounded by two subparallel earthquake faults, the planning area is prone to geologic hazards, such as landslides, earthquakes and liquefaction.

The oldest rocks on the peninsula date to the Jurassic period, a geologic age some 150 million years ago. These rocks are Catalina schist, a metamorphic rock created under great heat and pressure, which form the "basement rock" layer on which all of the peninsula's sedimentary rocks are overlain. During the Miocene period, geologists estimate that the Palos Verdes Peninsula was above and below sea waters a total of three times. While the Palos Verdes Peninsula was under water, sedimentary layers were deposited on the sea floor from the erosion of the higher mountains surrounding the Los Angeles Basin. The last emergence of the peninsula started 30,000 years ago and occurred in intervals, perhaps 1,000 years apart. Each uplift exposed more land, with a new shoreline being exposed to erosion by ocean waves. A total of thirteen such eroded terraces have been documented, although only five are clearly discernable today. Sediments on the Palos Verdes Peninsula are mostly Monterey Shale, a crumbly brown rock locally designated as Altamira Shale, Valmonte Diatomite and Malaga Mudstone (from oldest to youngest). (Source: Handbook of Wildflowers, Weeds, Wildlife and Weather of the South Bay and Palos Verdes Peninsula by Donald Moore Gales, Foldaroll Company, 1988)

Areas within Rancho Palos Verdes also have intrusions of basalt from volcanic activity sending lava through the sedimentary layers to the surface, where it hardened. Some inland areas contain layers of tuff, which is volcanic ash that has turned into rock. Other earth materials on the peninsula include sandstone shales between limestone layers, the latter creating the beautiful white Palos Verdes stone often used locally as landscaping accents and decorative masonry. In addition to Palos Verdes stone, from the late 1940's to the late 1950's, several types of minerals were extracted at various locations within the planning area through commercial quarrying operations, including sand, basalt, and diatomaceous earth. Due to high land values favoring residential development, there are no current commercial mining operations within the planning area. (Source: Gales, 1988)

The top layer of earth in most ungraded areas is heavy, black adobe clay resulting from weathering of rock debris and other materials. In graded areas, imported topsoil has generally been added over the exposed sterile diatomite and Altamira shale subsoils to support ornamental landscaping associated with development. (Source: Gales, 1988)

Landslides

Altamira Shale is found widely within the Monterey formation on the peninsula and consists largely of thinly bedded shaley rocks, along with numerous layers of tuff (volcanic ash) that have been largely altered into weak clays. Consequently, it is the chief causal factor in terms of slope stability and the main failure surface of most landslides in the planning area. Most of the landslides that have occurred in the past are the result of the following factors: presence of weak clayey layers and a combination of fairly steep slopes and a downslope dip of the bedding planes (roughly parallel to the land surface). Other factors include the introduction of water into the subsurface that weakens the clay beds and seismic shaking (some slides may have first formed during earthquakes). Human development has also resulted in the formation of new slides and the reactivation of old ones because of such activities as introducing cut slopes in critical areas, loading of upslope areas by the placement of fill, introduction of ground water from septic tanks, lawn watering, etc. The removal of material at the base of a slope by sea cliff erosion or storm water erosion at the base of a canyon is also a factor in triggering new slides or reactivating existing ones. (Source: City of Rancho Palos Verdes General Plan, 1975)

Several landslide areas have been prominent in the news from time to time, as homes and other structures have been damaged or destroyed. The best known is the 290-acre Portuguese Bend Landslide located on the south slope of Rancho Palos Verdes, which began sliding in 1956 and resulted in the loss of 150 homes. Since the initial landslide, movement has continued at a rate of up to three feet per year, requiring the placement of some of the remaining homes on “floating” foundations, frequent road repairs and locating all utilities above ground. (Source: “Geologic Hazard Abatement Districts” by Robert B. Olshansky, California Geology Magazine, July 1986) Although no additional residential structures have been lost since the late 1950’s, over the years a variety of methods have been used to slow the progress of the slide, including pumping out of groundwater, regrading the area to improve drainage and replacing the septic tank systems with an above-ground sanitary sewer system. (Source: City staff, 2004)

There have been a number of smaller landslides that have occurred adjacent to the larger Portuguese Bend Landslide complex, including the 90-acre Abalone Cove Landslide that began in 1974, the 100-acre Klondike Canyon Landslide that began in 1981 and the Flying Triangle Landslide that began in 1983 (and is actually located in the adjacent City of Rolling Hills but has migrated downhill into the City of Rancho Palos Verdes). Fortunately, no homes were lost as a result of these landslides, but they have required residents and the City of Rancho Palos Verdes to support on-going landslide abatement efforts. In contrast, the Ocean Trails Golf Course Landslide that occurred in June 1999 destroyed the 18th fairway when acres of the bluff edge suddenly slid into the ocean. The repair has taken five years and approximately $26 million dollars to complete. Likewise, the Peninsula Center Landslide in the City of Rolling Hills Estates in 2001 destroyed two commercial office buildings and severely damaged another. (Sources: City staff, 2004)

Earthquakes

The planning area, like most of the Los Angeles Basin, lie over the area of one or more known earthquake faults, and potentially many more unknown faults, particularly so-called lateral or blind thrust faults.

The major faults that have the potential to affect the greater Los Angeles Basin are the:

San Andreas
Newport Inglewood
Palos Verdes
Puente Hills
Whittier
Santa Monica

The Los Angeles Basin has a history of powerful and relatively frequent earthquakes, dating back to the powerful 8.0+ San Andreas earthquake of 1857, which did substantial damage to the relatively few buildings that existed at the time. Paleoseismological research indicates that large (8.0+) earthquakes occur on the San Andreas fault at intervals between 45 and 332 years with an average interval of 140 years[1]. Other lesser faults have also caused very damaging earthquakes since 1857. Notable earthquakes include the Long Beach earthquake of 1933, the San Fernando Earthquake of 1971, the 1987 Whittier Earthquake and the 1994 Northridge earthquake.

---

[1] Peacock, Simon M., http://aamc.geo.lsa.umich.edu/eduQuakes/EQpredLab/EQprediction.peacock.html

Liquefaction
In addition, many areas in the Los Angeles Basin have sandy soils that are subject to liquefaction. The City of Rolling Hills Estates has liquefaction zones in the northeast portion of the city, as shown on USGS Seismic Hazard Maps (see Section 5: Earthquake).

Population and Demographics

The planning area has a total population of about 48,821 (RPV 41,145 and RHE 7,676). The planning area includes an area of approximately 17.78 square miles (RPV 13.6 square miles and RHE 4.18 square miles). The population of planning area slowly decreased from 1990 to 2000 according to the 2000 Census.

According to the City's General Plan, Rolling Hills Estates is almost fully urbanized with lower density residential neighborhoods and scattered concentrations of commercial land uses. Vacant parcels are mostly steep slope areas and canyons. A network of equestrian trails and other equestrian facilities provide a major recreational resource for residents. Growth in the City has been very slow, with the limited increase in single-family dwelling units accompanied by a decrease in household sizes. Rancho Palos Verdes is almost entirely built-out with predominately single-family residential development and has scattered concentrations of multi-family residential and commercial development. The remaining vacant parcels are mostly steep slopes, canyons and areas impacted by land movement. Several active park sites and an extensive amount of preserved natural open space and passive parkland, particularly along the City's coastline, provide the majority of recreational resources for residents. Since the City's incorporation, growth has proceeded at a slow pace. Although the number of dwelling units increased between 1990 and 2000 from 15,468 to 15,709, the City's population has decreased slightly from 41,659 to 41,145, commensurate with a decrease in average household size from 2.76 to 2.66. (Source: 1990 and 2000 Census)

The semi-rural character of the planning area creates more community exposure, and changes how agencies prepare for and respond to natural hazards. For example, more people living on the urban fringe face an increase risk of fire. Wildfire has an increased chance of starting due to human activities in the urban/rural interface, and has the potential to injure more people and cause more property damage. But an urban/wildland fire is not the only exposure to the planning area. In the 1987 publication, Fire Following Earthquake issued by the All Industry Research Advisory Council, Charles Scawthorn explains how a post-earthquake urban conflagration would develop. The conflagration would be started by fires resulting from earthquake damage, but made much worse by the loss of pressure in the fire mains, caused by either lack of electricity to power water pumps, and /or loss of water pressure resulting from broken fire mains. Furthermore, the geography of the area can affect risk. For example, winding and narrower streets are more difficult for emergency service vehicles to navigate, the dispersed development patterns dictated by the hilly topography and limited access routes affects emergency response times, and homes located adjacent to canyons and extensively landscaped with trees and other vegetation increases the chances of fires spreading.

Natural hazards do not discriminate, but the impacts in terms of vulnerability and the ability to recover vary greatly among the population. According to Peggy Stahl of the Federal Emergency Management Agency (FEMA) Preparedness, Training, and Exercise Directorate, 80% of the disaster burden falls on the public, and within that number, a disproportionate burden is placed upon special needs groups: women, children, minorities, and the poor.[2] Other vulnerable populations, including seniors, disabled citizens and non-English speaking residents may be disproportionately impacted by natural hazards.

According the 2000 census figures, the demographic make up of the Cities is as follows:

Table 3-1: Planning Area Demographics

	RPV	RHE
Caucasian	67.2	73.9
Hispanic	5.7	4.8
African American	2.0	1.2
Asian	25.9	20.3
Native American	.2	.3
Other	4.7	4.4

The 2000 Census showed that the population over 5 years old that speaks English less than "very well" is 32% in RPV and 24% in RHE. This factor, in combination with an unknown portion of the planning area's daytime populations that may not be proficient in the English language, poses a challenge in planning for and mitigating natural disasters. The ethnic and cultural diversity suggests a need to address multi-cultural needs and services.

Although the Cities do not have data on the number of disabled residents living in the planning area, the 2000 Census indicated that the population over 65 years in age is 18.7% in RPV and 18.9% in RHE, which is higher than the state's average of 10.6%

The percentage of poverty in RPV is 2.9% and RHE is 1.7%, both are considerably less than the state's average of 14.2%.

Examining the reach of hazard mitigation policies to special needs populations may assist in increasing access to services and programs. FEMA's Office of Equal Rights addresses this need by suggesting that agencies and organizations planning for natural disasters identify special needs populations, make recovery centers more accessible, and review practices and procedures to remedy any discrimination in relief application or assistance.

The cost of natural hazards recovery can place an unequal financial responsibility on the general population when only a small proportion may benefit from governmental funds

[2] www.fema.gov

used to rebuild private structures. Discussions about natural hazards that include local citizen groups, insurance companies, and other public and private sector organizations can help ensure that all members of the population are a part of the decision-making processes.

Land and Development

Development in Southern California from the earliest days was a cycle of boom and bust. The Second World War however dramatically changed that cycle. Military personnel and defense workers came to Southern California to fill the logistical needs created by the war effort. The available housing was rapidly exhausted and existing commercial centers proved inadequate for the influx of people. Immediately after the war, construction began on the freeway system, and the face of Southern California was forever changed. Home developments and shopping centers sprung up everywhere and within a few decades the central basin of Los Angeles County was virtually built out. This pushed new development further and further away from the urban center.

The General Plans of the two cities address the use and development of private land, including residential and commercial areas. This plan is one of the City's most important tools in addressing environmental challenges including transportation and air quality; growth management; conservation of natural resources; clean water and open spaces. Although the planning area is distinct from most of the surrounding areas in Los Angeles County due to its unique topography and low density pattern of development, it exposure to natural hazards is largely the same than those that affect all of Southern California.

Housing and Community Development

Following is a distribution of the development and housing types in the planning area (Source: General Plans and 2000 Census):

Table 3-2: Land Use and Housing in the Planning Area

	RPV	**RHE**
Development Type		
Residential	71%	49.1%
Commercial/Industrial	9%	5%
Open Space	20%	8%
Housing Type		
Single-Family	77.2	78.6%
Multi-Residential (20+ units)	9.8%	0%
Mobilehomes	0%	.1%
Housing Statistics		
Total Available Housing Units	15,709	2,880
Owner-Occupied Housing	81.65%	91.1%
Average Household Size	2.67	2.73

Demand for medium to high priced homes continues to be strong. According to Land America Gateway Title Company, the median home price on the Peninsula in May 2004 was $486 per square foot, compared to the median in Los Angeles County of $292 per square foot.

Employment and Industry

The follow table indicates the employment and industry statistics for the planning area (Source: 2000 Census):

Table 3-3: Employment and Industry in the Planning Area

	RPV	RHE
Principal Employment Activities		
Management (professional and related occupations)	62.9%	64.4%
Service Occupations	5.0%	5.7%
Sales and Office Occupations	24%	21.8%
Construction	3.2%	2.8%
Production, Transportation, and Material Moving	4.8%	5.3%
Major Industries		
Education, Health & Social Services	21.3%	24%
Manufacturing	14.5%	15.4%
Retail Trade	8.3%	7.9%
Finance, Insurance, Real Estate	9.5%	11.4%

Mitigation activities are needed at the business level to ensure the safety and welfare of workers and limit damage to industrial infrastructure. Employees are highly mobile, commuting from surrounding areas to industrial and business centers. This creates a greater dependency on roads, communications, accessibility and emergency plans to reunite people with their families. Before a natural hazard event, large and small businesses can develop strategies to prepare for natural hazards, respond efficiently, and prevent loss of life and property.

Transportation and Commuting Patterns

Private automobiles are the dominant means of transportation in Southern California and even more so in the planning area. However, the Peninsula does support MTA Lines 225, 226 and 444 as its means of public transportation. MTA (Metropolitan Transportation Authority) provides both Cities with bus services to various points in the Los Angeles County metropolitan area. In addition to the MTA, The Peninsula Verdes Peninsula Transit Authority (PVPTA) provides six fixed bus routes throughout the Peninsula, which operate primarily on school days and connect with the MTA lines. The PVPTA also provides a dial-a-ride service for seniors and disabled citizens. MAX (Municipal Area Express) is a commuter bus service for South Bay residents who work in the El Segundo employment center. One of MAX's three routes serves the Peninsula and operates during the morning and afternoon peak commuting hours.

The planning area's road system consists primarily of residential streets serving the various single-family neighborhoods. For example, in Rancho Palos Verdes there are 103.38 centerline miles of residential street, 2.97 miles of collector streets and 36.47 centerline miles of arterial roadways. There are no bridges in the planning area. According to the 2000 Census, the City of Rancho Palos Verdes population was 41,145 with a daytime population estimated at around 15,000 (Source: MHFP Threat Summary). The daytime population for City of Rolling Hills Estates is not known at this time. The mean travel time to work for the residents of both cities is 33.1 minutes.

Major external routes serving the planning area include the Harbor Freeway, San Diego Freeway, and Pacific Coast Highway to the north. According to the Rancho Palos Verdes General Plan, the major arterials (provides connections with other arterials and may eventually link-up with major highways) are Hawthorne Boulevard, Western Avenue, Palos Verdes Drive West, and Palos Verdes Drive South. According to the Rolling Hills Estates General Plan, the major arterials are Crenshaw Boulevard, Hawthorne Boulevard, and Palos Verdes Drive North. The planning area is served by the 110 and 405 freeways, which connect the Cities to adjoining parts of Los Angeles County.

Localized flooding and earth movement can render roads unusable. A severe winter storm has the potential to disrupt the daily driving routine of hundreds of thousands of people in Los Angeles County. Natural hazards can disrupt automobile traffic and shut down local and regional transit systems.

Risk Assessment

Table of Contents

Risk Assessment ....page 3

What is Risk Assessment? ....page 3

Federal Requirements for Risk Assessment ....page 4

Critical and Essential Facilities..page 5

Summary ....page 7

Section 4:

Risk Assessment

What is a Risk Assessment?

Conducting a risk assessment can provide information: on the location of hazards, the value of existing land and property in hazard locations, and an analysis of risk to life, property, and the environment that may result from natural hazard events. Specifically, the five levels of a risk assessment are as follows:

1) Hazard Identification

This is the description of the geographic extent, potential intensity and the probability of occurrence of a given hazard. Maps are frequently used to display hazard identification data. The Joint Planning Team identified four major hazards that affect this geographic area. These hazards – earthquakes, wildfires, earth movement, and tsunami - were identified through an extensive process that utilized input from the Joint Planning Team. The geographic extent of each of the identified hazards has been identified by the Team utilizing the maps contained in the General Plans and MHFP Threat Assessments, and are illustrated in the tables, maps, and photos listed on page iii.

2) Profiling Hazard Events

The maps help to describe the causes and characteristics of each hazard and what part of the planning areas population, infrastructure, and environment may be vulnerable to each specific hazard. A profile of each hazard discussed in this plan is provided in each hazard section. For a full description of the history of hazard specific events, please see the appropriate hazard-specific chapter.

3) Vulnerability Assessment/Inventorying Assets

This is a combination of hazard identification with an inventory of the existing (or planned) property development(s) and population(s) exposed to a hazard. Critical facilities are of particular concern because these entities provide essential products and services to the general public that are necessary to preserve the welfare and quality of life in the planning area and fulfill important public safety, emergency response, and/or disaster recovery functions. The critical facilities have been identified and are illustrated in Table 4-2. A description of the critical facilities in the planning area is also provided in this section. In addition, this plan includes a community issues summary in each hazard section to identify the most vulnerable and problematic areas in the planning area, including critical facilities and essential facilities.

4) Risk Analysis

Estimating potential losses involves assessing the damage, injuries, and financial costs likely to be sustained in a geographic area over a given period of time. This level of analysis involves using mathematical models. The two measurable components of risk analysis are magnitude of the harm that may result and the likelihood of the harm occurring. Describing vulnerability in terms of dollar losses provides the community and the state with a common framework in which to measure the effects of hazards on assets.

5) Assessing Vulnerability/ Analyzing Development Trends

This step provides a general description of land uses and development trends within the community so that mitigation options can be considered in land use planning and future land use decisions. This plan provides comprehensive description of the character of the planning area in the Planning Area Profile. This description includes the geography and environment, population and demographics, land use and development, housing and community development, employment and industry, and transportation and commuting patterns. Analyzing these components of the planning area can help in identifying potential problem areas and can serve as a guide for incorporating the goals and ideas contained in this mitigation plan into other community development plans.

Hazard assessments are subject to the availability of hazard-specific data. Gathering data for a hazard assessment requires a commitment of resources on the part of participating organizations and agencies. Each hazard-specific section of the plan includes a section on hazard identification using data and information from Local, County, Regional, State, or Federal agency sources.

Regardless of the data available for hazard assessments, there are numerous strategies the City can take to reduce risk. These strategies are described in the action items detailed in each hazard section of this Plan. Mitigation strategies can further reduce disruption to critical services, reduce the risk to human life, and alleviate damage to personal and public property and infrastructure. Action items throughout the hazard sections provide recommendations to collect further data to map hazard locations and conduct hazard assessments.

Federal Requirements for Risk Assessment

Recent federal regulations for hazard mitigation plans outlined in 44 CFR Part 201 include a requirement for risk assessment. This risk assessment requirement is intended to provide information that will help communities to identify and prioritize mitigation activities that will reduce losses from the identified hazards. There are four hazards profiled in the mitigation plan, including earthquake, wildfire, earth movement, and tsunami. The Federal criteria for risk assessment and information on how the Joint Natural Hazards Mitigation Plan meets those criteria are outlined in Table 4-1 below.

Table 4-1: Federal Criteria for Risk Assessment

Section 322 Plan Requirement	How is this addressed?
Identifying Hazards	Each hazard section includes an inventory of the best available data sources that identify hazard areas. To the extent data are available; the existing maps identifying the location of the hazard were utilized. The Executive Summary and the Risk Assessment sections of the plan include a list of the hazard maps.
Profiling Hazard Events	Each hazard section includes documentation of the history, and causes and characteristics of the hazard in the planning area.
Assessing Vulnerability: Identifying Assets	Where data is available, the vulnerability assessment for each hazard addressed in the mitigation plan includes an inventory of all publicly owned land within hazardous areas. Each hazard section provides information on vulnerable areas in the planning area in the Community Issues section. Each hazard section also identifies potential mitigation strategies.
Assessing Vulnerability: Estimating Potential Losses:	The Risk Assessment Section of this mitigation plan identifies key critical facilities in the planning area and includes a map of these facilities. Vulnerability assessments have been completed for the hazards addressed in the plan, and quantitative estimates were made for each hazard where data was available.
Assessing Vulnerability: Analyzing Development Trends	The Profile Section of this plan provides a description of the development trends in the planning area, including the geography and environment, population and demographics, land use and development, housing and community development, employment and industry, and transportation and commuting patterns.

Critical and Essential Facilities

Facilities critical to government response and recovery activities (i.e., life safety and property and environmental protection) include: 911 centers, emergency operations centers, police and fire stations, public works facilities, communications centers, sewer and water facilities, hospitals, bridges and roads, and shelters. Also, facilities that, if damaged, could cause serious secondary impacts may also be considered "critical." A hazardous material facility is one example of this type of critical facility.

Essential facilities are those facilities that are vital to the continued delivery of key government services or that may significantly impact the public’s ability to recover from the emergency. These facilities may include: buildings such as the jail, law enforcement center, public services building, community corrections center, the courthouse, and juvenile services building and other public facilities such as schools.

The following tables illustrate the critical and essential facilities within the planning area.

Table 4-2: Critical Facilities

Earthquake	Fire	Earth Movement	Tsunami	Facility	Address
X	X			RPV City Hall/EOC and Public Works Yard	30940 Hawthorne Blvd., RPV
X	X			RHE City Hall and Council Chambers/EOC	4045 Palos Verdes Dr. North, RHE
X				RHE Maintenance Yard	25851 Hawthorne Blvd., RHE
X				Los Angeles County Sheriff's Station	26123 Narbonne Ave., Lomita
X			X	Los Angeles County Fire Station No. 53	6124 Palos Verdes Drive South, RPV
X				Los Angeles County Fire Station No. 83	83 Miraleste Plaza, RPV
X				Los Angeles County Fire Station No. 106	413 Indian Peak Rd., RHE
X				Los Angeles County Communications Tower	5741 Crestridge Road, RPV
X				Southern California Edison Substation	Crestridge Road, RPV
X	X	X		Southern California Edison Substation	Tarragon Road, RPV
X	X			FAA Radar Domes	E. Crest Road, RPV
X				Cox Communications	43 Peninsula Center, RHE
X		X		Palos Verdes Reservoir	Palos Verdes Dr. North/Palos Verdes Dr. East (SW corner), RHE
X	X			California Water Service Reservoir	3960 E. Crest Road, RPV
X				California Water Service Reservoir	5837 W. Crest Road, RPV
X	X			California Water Service Reservoir	4405 Palos Verdes Drive East, RPV
	X	X		Palos Verdes Drive South	Between Narcissa Dr. and Schooner Dr.
	X	X		Palos Verdes Drive East	Between P.V.D.S. and Ganado Drive.
X	X			Miraleste Intermediate School	29323 Palos Verdes Dr. East, RPV
X				Palos Verdes Peninsula High School	27118 Silver Spur Rd., RHE

Table 4-3: Essential Facilities

Earthquake	Fire	Earth Movement	Tsunami	Facility	Address
X	X			Marymount College	30800 Palos Verdes Dr. East, RPV
X				Crestmont College (Salvation Army)	30840 Hawthorne Boulevard, RPV
X				Ridgecrest Intermediate School	28915 Northbay Road, RPV
X				Dodson Middle School	28014 Montereina Drive, RPV
X				Cornerstone Elementary School	6069 Groveoak Place, RPV
X				Crestwood Elementary School	1946 Crestwood Street, RPV
X				Mira Catalina Elementary School	30511 Lucania Drive, RPV
X				Miraleste Elementary School	6245 Via Canada, RPV
X				Point Vicente Elementary School	30540 Rue de la Pierre, RPV
X				Silver Spur Elementary School	5500 Ironwood Street, RPV
X				Soleado Elementary School	27800 Longhill Drive, RPV
X				Vista Grande Elementary School	7032 Purpleridge Drive, RPV
X				Dapplegray Elementary School	3011 Palos Verdes Dr. North, RHE
X				Rancho Vista Elementary School	4323 Palos Verdes Dr. North, RHE
X				Post Office – Main Branch	955 Deep Valley Dr., RHE
X				Peninsula Center Library	650 Deep Valley Dr., RHE

Summary

Natural hazard mitigation strategies can reduce the impacts concentrated at large employment and industrial centers, public infrastructure, and critical facilities. Natural hazard mitigation for industries and employers may include developing relationships with emergency management services and their employees before disaster strikes, and establishing mitigation strategies together. Collaboration among the public and private sector to create mitigation plans and actions can reduce the impacts of natural hazards.

Earthquake Hazards in the Joint Planning Area

Table of Contents

Why Are Earthquakes a Threat to the Planning Area?..page 3

History of Earthquake Events in Southern California ....page 3

Types and Characteristics of Earthquakes in Southern California ....page 5

Earthquake Related Hazards ....page 6

Earthquake Hazard Assessment ....page 8

Hazard Identification ....page 8

Vulnerability Assessment ....page 10

Risk Analysis ....page 15

Community Earthquake Issues ....page 15

What is Susceptible to Earthquakes? ....page 13

Existing Mitigation Activities...page 20

Section 5:

Why Are Earthquakes a Threat to the Planning Area?

Since seismologists started recording and measuring earthquakes, there have been tens of thousands of recorded earthquakes in Southern California, most with a magnitude below three. No community in Southern California is beyond the reach of a damaging earthquake.

History of Earthquake Events in Southern California

The most significant recent earthquake event affecting Southern California was the January 17, 1994 Northridge Earthquake. At 4:31 A.M. on Monday, January 17th, a moderate but very damaging earthquake with a magnitude of 6.7 struck the San Fernando Valley. In the following days and weeks, thousands of aftershocks occurred, causing additional damage to affected structures. 57 people were killed and more than 1,500 people seriously injured. For days afterward, thousands of homes and businesses were without electricity; tens of thousands had no gas; and nearly 50,000 had little or no water. Approximately 15,000 structures were moderately to severely damaged, which left thousands of people temporarily homeless. 66,500 buildings were inspected. Nearly 4,000 were severely damaged and over 11,000 were moderately damaged. Several collapsed bridges and overpasses created commuter havoc on the freeway system. While ground shaking caused extensive damage, the earthquake also triggered liquefaction and dozens of fires also caused additional severe damage. This extremely strong ground motion in large portions of Los Angeles County resulted in record economic losses.

However, the earthquake occurred early in the morning on a holiday. This circumstance considerably reduced the potential effects. Many collapsed buildings were unoccupied, and most businesses were not yet open. The direct and indirect economic losses ran into the 10's of billions of dollars.

Historical and geological records show that California has a long history of seismic events. Southern California is probably best known for the San Andreas Fault, a 400 mile long fault running from the Mexican border to a point offshore, west of San Francisco. “Geologic studies show that over the past 1,400 to 1,500 years large earthquakes have occurred at about 130 year intervals on the southern San Andreas Fault. As the last large earthquake on the Southern San Andreas occurred in 1857, that section of the fault is considered a likely location for an earthquake within the next few decades.”[1]

Dr. Kerry Sieh of Cal Tech has investigated the San Andreas Fault at Pallett Creek. “The record at Pallett Creek shows that rupture has recurred about every 130 years, on average, over the past 1500 years. But actual intervals have varied greatly, from less than 50 years to more than 300. The physical cause of such irregular recurrence remains unknown.” [2] Damage from a great quake on the San Andreas would be widespread throughout Southern California.

But San Andreas is only one of dozens of known earthquake faults that crisscross Southern California. Some of the better known faults include the Newport-Inglewood, Whittier, Chatsworth, Elsinore, Hollywood, Los Alamitos, Puente Hills, and Palos Verdes faults. Beyond the known faults, there are a potentially large number of "blind" faults that underlie the surface of Southern California. One such blind fault was involved in the Whittier Narrows earthquake in October 1987.

Although the most famous of the faults, the San Andreas, is capable of producing an earthquake with a magnitude of 8+ on the Richter scale, some of the "lesser" faults have the potential to inflict greater damage on the urban core of the Los Angeles Basin. Seismologists believe that a 6.0 earthquake on the Newport-Inglewood would result in far more death and destruction than a "great" quake on the San Andreas, because the San Andreas is relatively remote from the urban centers of Southern California.

For decades, partnerships have flourished between the USGS, Cal Tech, the California Geological Survey and universities to share research and educational efforts with Californians. Tremendous earthquake mapping and mitigation efforts have been made in California in the past two decades, and public awareness has risen remarkably during this time. Major federal, state, and local government agencies and private organizations support earthquake risk reduction, and have made significant contributions in reducing the adverse impacts of earthquakes. Despite the progress, the majority of California communities remain unprepared because there is a general lack of understanding regarding earthquake hazards among Californians.

Table 5-1: Earthquakes in Southern California Region (Magnitude 5.0 or Greater)

1769	Los Angeles Basin	1916	Tejon Pass Region
1800	San Diego Region	1918	San Jacinto
1812	Wrightwood	1923	San Bernardino Region
1812	Santa Barbara Channel	1925	Santa Barbara
1827	Los Angeles Region	1933	Long Beach
1855	Los Angeles Region	1941	Carpenteria
1857	Great Fort Tejon Earthquake	1952	Kern County
1858	San Bernardino Region	1954	W. of Wheeler Ridge
1862	San Diego Region	1971	San Fernando
1892	San Jacinto or Elsinore Fault	1973	Point Mugu
1893	Pico Canyon	1986	North Palm Springs
1894	Lytle Creek Region	1987	Whittier Narrows
1894	E. of San Diego	1992	Landers
1899	Lytle Creek Region	1992	Big Bear
1899	San Jacinto and Hemet	1994	Northridge
1907	San Bernardino Region	1999	Hector Mine
1910	Glen Ivy Hot Springs	2003	Paso Robles

Source: http://geology.about.com/gi/dynamic/offsite.htm?site=http%3A%2F%2Fpasadena.wr.usgs.gov%2Finfo%2Fcahist_eqs.html

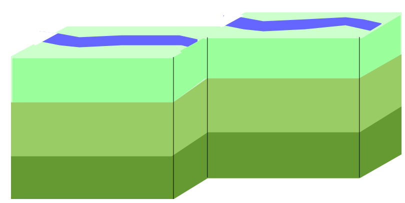
To better understand the earthquake hazard, the scientific community has looked at historical records and accelerated research on those faults that are the sources of the earthquakes occurring in the Southern California region. Historical earthquake records can generally be divided into records of the pre-instrumental period and the instrumental period. In the absence of instrumentation, the detection of earthquakes is based on observations and felt reports, and is dependent upon population density and distribution. Since California was sparsely populated in the 1800s, the detection of pre-instrumental earthquakes is relatively difficult. However, two very large earthquakes, the Fort Tejon in 1857 (7.9) and the Owens Valley in 1872 (7.6) are evidence of the tremendously damaging potential of earthquakes in Southern California. In more recent times two 7.3 earthquakes struck Southern California, in Kern County (1952) and Landers (1992). The damage from these four large earthquakes was limited because the occurred in areas which were sparsely populated at the time they happened. The seismic risk is much more severe today than in the past because the population at risk is in the millions, rather than a few hundred or a few thousand persons.

Types and Characteristics of Earthquake Faults in Southern California

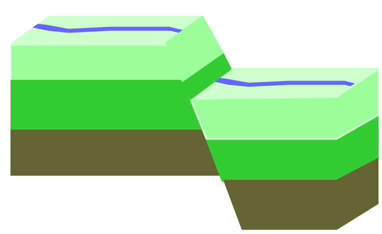
Figure 5-1 describes the types and characteristics of earthquake faults that have affected Southern California.

Figure 5-1: Types and Characteristics of Earthquake Faults in Southern California

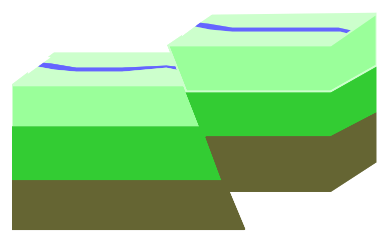
Earthquake Faults
A fault is a fracture along between blocks of the earth's crust where either side moves relative to the other along a parallel plane to the fracture.



Strike-slip
Strike-slip faults (top) are vertical or almost vertical rifts where the earth's plates move mostly horizontally. From the observer's perspective, if the opposite block looking across the fault moves to the right, the slip style is called a right lateral fault; if the block moves left, the shift is called a left lateral fault.



Dip-slip
Dip-slip faults are slanted fractures where the blocks mostly shift vertically. If the earth above an inclined fault moves down, the fault is called a normal fault (middle), but when the rock above the fault moves up, the fault is called a reverse fault (bottom). Thrust faults have a reverse fault with a dip of 45 ° or less.



Earthquake Related Hazards

Ground shaking, landslides, liquefaction, and amplification are the specific hazards associated with earthquakes. The severity of these hazards depends on several factors, including soil and slope conditions, proximity to the fault, earthquake magnitude, and the type of earthquake.

Ground Shaking

Ground shaking is the motion felt on the earth's surface caused by seismic waves generated by the earthquake. It is the primary cause of earthquake damage. The strength of ground shaking depends on the magnitude of the earthquake, the type of fault, and distance from the epicenter (where the earthquake originates). Buildings on poorly consolidated and thick soils will typically see more damage than buildings on consolidated soils and bedrock.

Earthquake-Induced Landslides

Earthquake-induced landslides are secondary earthquake hazards that occur from ground shaking. They can destroy the roads, buildings, utilities, and other critical facilities necessary to respond and recover from an earthquake. Many communities in Southern California have a high likelihood of encountering such risks, especially in areas with steep slopes.

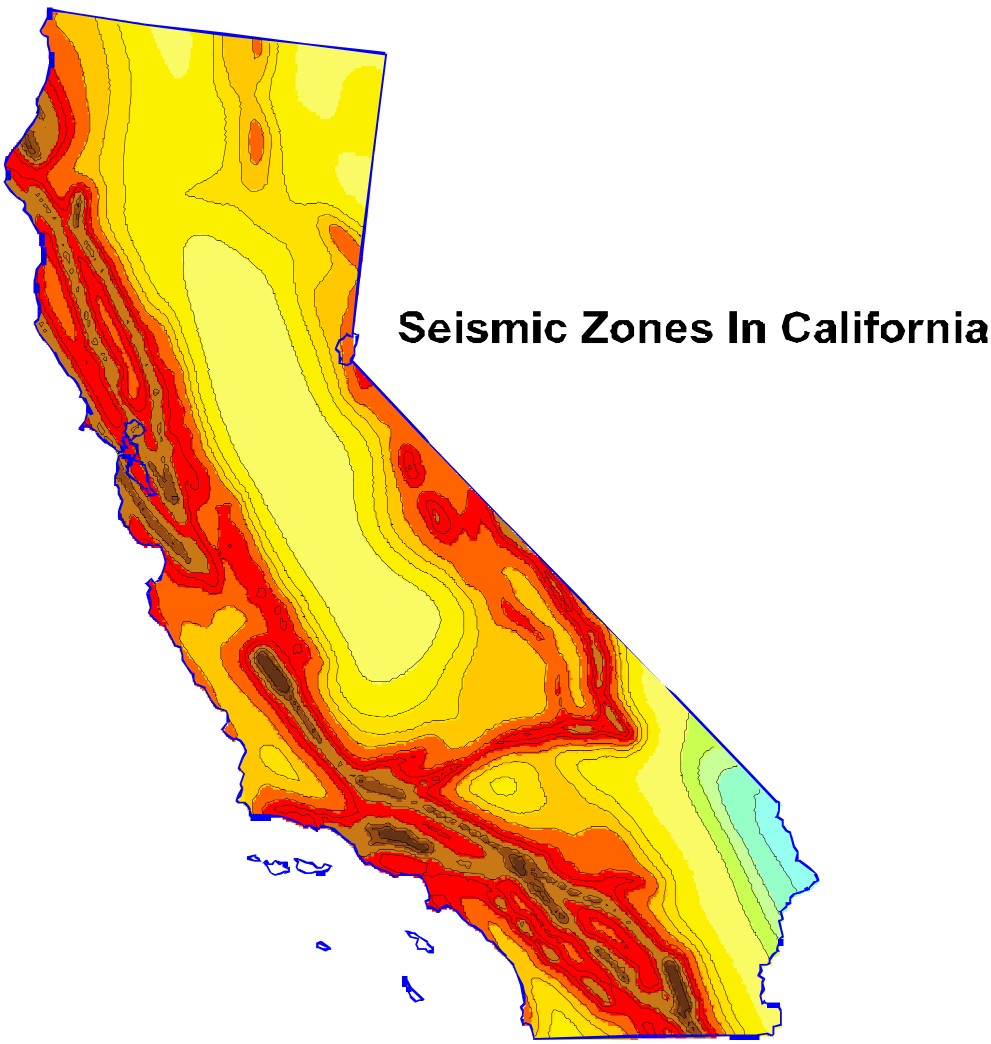
Liquefaction

Liquefaction occurs when ground shaking causes wet granular soils to change from a solid state to a liquid state. This results in the loss of soil strength and the soil's ability to support weight. Buried tanks may float to the surface and objects above the liquefaction strata may sink. Pipelines passing through liquefaction materials typically sustain a relatively large number of breaks during an earthquake. Buildings and their occupants are at risk when the ground can no longer support these buildings and structures. Many communities in Southern California are built on ancient river bottoms and have sandy soil. In some cases this ground may be subject to liquefaction, depending on the depth of the water table.

Amplification

Soils and soft sedimentary rocks near the earth's surface can modify ground shaking caused by earthquakes. One of these modifications is amplification. Amplification increases the magnitude of the seismic waves generated by the earthquake. The amount of amplification is influenced by the thickness of geologic materials and their physical properties. Buildings and structures built on soft and unconsolidated soils can face greater risk.[3] Amplification can also occur in areas with deep sediment filled basins and on ridge tops.

Map 5-1: Seismic Zones in California



Darker Shaded Areas indicate Greater Potential Shaking

Source: USGS Website

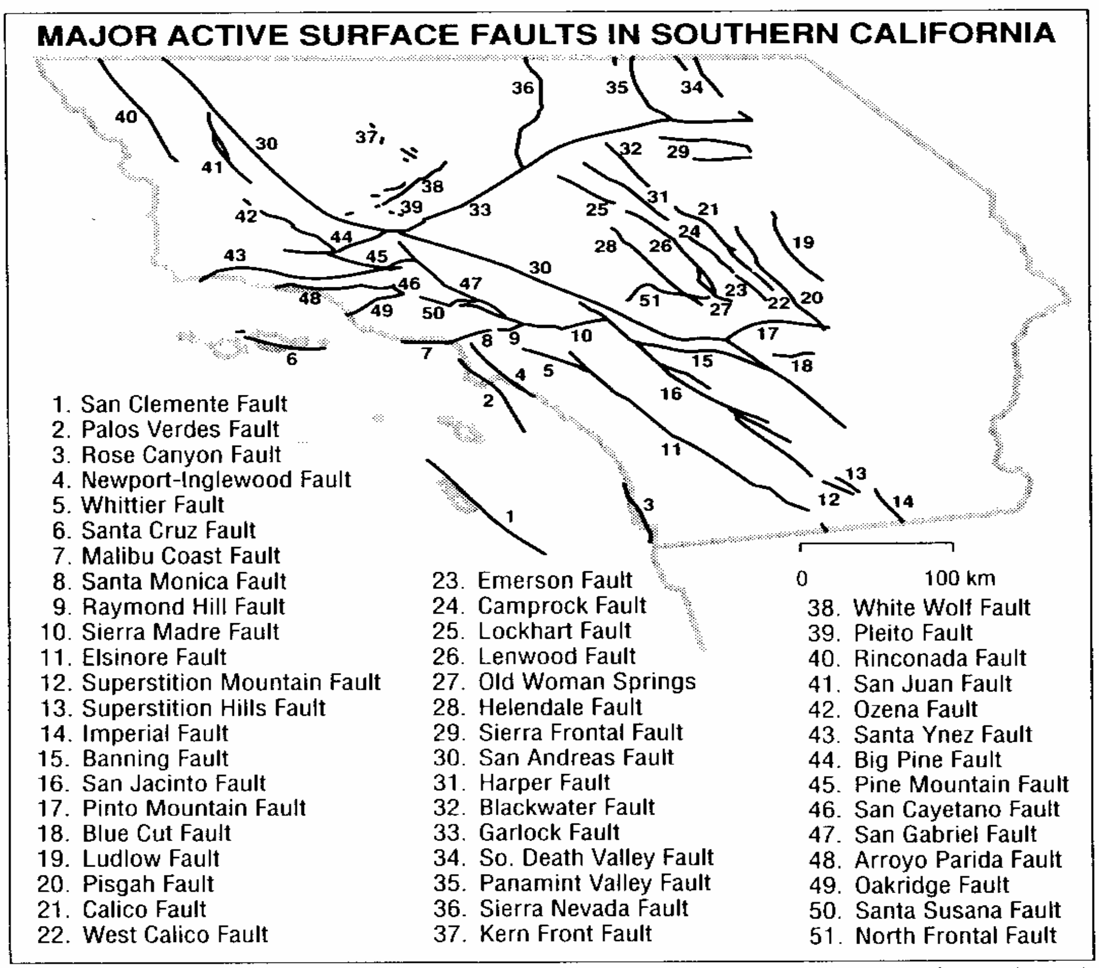
Earthquake Hazard Assessment

Hazard Identification

In California, many agencies are focused on seismic safety issues: the State's Seismic Safety Commission, the Applied Technology Council, Governor's Office of Emergency Services, United States Geological Survey, Cal Tech, the California Geological Survey as well as a number of universities and private foundations.

These organizations, in partnership with other state and federal agencies, have undertaken a rigorous program in California to identify seismic hazards and risks including active fault identification, bedrock shaking, tsunami inundation zones, ground motion amplification, liquefaction, and earthquake induced landslides. Seismic hazard maps have been published and are available for many communities in California through the State Division of Mines and Geology. Map 5-2 illustrates the known earthquake faults in Southern California.

Map 5-2: Major Active Surface faults in Southern California



Source: Adapted from the map of major active Southern California surface faults published in "Seismic Hazards in Southern California: Probable Earthquakes, 1994-2024," Southern California Earthquake Center.

According to the MHFP Threat Assessments for both cities, the Peninsula is in the vicinity of several known active and potentially active earthquake faults including the San Andreas, the San Jacinto, Whittier-Elsinore, and the Newport-Inglewood. New faults within the region are continuously being discovered. In the mid 1990's, it was determined by scientists that the Palos Verdes fault, once thought to be a minor threat, could have a significant impact on the Peninsula and South Bay/Long Beach area. Scientists have identified almost 100 faults in the Los Angeles area known to be capable of a magnitude 6.0 or greater earthquake. The January 17, 1994 magnitude 6.7 Northridge Earthquake (thrust fault), which produced severe ground motions, caused 57 deaths, 9,253 injuries and left over 20,000 displaced. Scientists have stated that such devastating shaking should be considered the norm near any large thrust earthquake.

Recent reports from scientists of the U.S. Geological Survey and the Southern California Earthquake Center say that the Los Angeles Area could expect one earthquake every year of magnitude 5.0 or more for the foreseeable future.

A major earthquake occurring in or near this jurisdiction may cause many deaths and casualties, extensive property damage, fires and hazardous material spills and other ensuing hazards. The effects could be aggravated by aftershocks and by the secondary affects of fire, hazardous material/chemical accidents and possible failure of the waterways and dams. The time of day and season of the year would have a profound effect on the number of deaths and injuries and the amount of property damage sustained. Such an earthquake would be catastrophic in its affect upon the population and could exceed the response capabilities of the individual cities, Los Angeles County Operational Area and the State of California Emergency Services. Damage control and disaster relief support would be required from other local governmental and private organizations, and from the state and federal governments.

Extensive search and rescue operations would be required to assist trapped or injured persons. Emergency medical care, food and temporary shelter could be required by injured or displaced persons. Identification and burial of the deceased would pose difficult problems; public health would be a major concern. Mass evacuation may be essential to save lives, particularly in areas downwind from hazardous material releases. Many families would be separated particularly if the earthquake should occur during working hours, and a personal inquiry or locator system could be essential to maintain morale. Emergency operations could be seriously hampered by the loss of communications and damage to transportation routes within, and to and from, the disaster area and by the disruption of public utilities and services.

The economic impact on the Peninsula from a major earthquake would be considerable in terms of loss of employment and loss of tax base. Also, a major earthquake could cause serious damage and/or outage of computer facilities. The loss of such facilities could curtail or seriously disrupt the operations of banks, insurance companies and other elements of the financial community. In turn, this could affect the ability of local government, business and the population to make payments and purchases.

Newport-Inglewood Fault[3]

Nearest Communities: Culver City, Inglewood, Gardena, Compton, Signal Hill, Long Beach, Seal Beach, Huntington Beach, Newport Beach, Costa Mesa
Most Recent Major Rupture: March 10, 1933, M6.4 (but no surface rupture)
Interval Between Major Ruptures: unknown
Probable Magnitudes: M6.0 - 7.4
This represents a worst-case earthquake that could affect the urban areas of Central - South Eastern Los Angeles County.

Palos Verdes Fault Zone[4]
Nearby Communities: San Pedro, Rancho Palos Verdes, Rolling Hills Estates, Rolling Hills, Palos Verdes Estates, Torrance, Redondo Beach
Most Recent Surface Rupture: Holocene, offshore; Late Quaternary, onshore
Interval Between Major Ruptures: unknown
Probable Magnitudes: M6.0 - 7.0 (or greater?); fault geometries may allow only partial rupture at any one time. Depending on which segments, or combination of segments rupture, the damage to the Peninsula could be moderate to severe.

In California, each earthquake is followed by revisions and improvements in the Building Codes. The 1933 Long Beach resulted in the Field Act, affecting school construction. The 1971 San Fernando earthquake brought another set of increased structural standards. Similar re-evaluations occurred after the 1989 Loma Prieta and 1994 Northridge earthquakes. These code changes have resulted in stronger and more earthquake resistant structures.

The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. This state law was a direct result of the 1971 San Fernando Earthquake, which was associated with extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures. Surface rupture is the most easily avoided seismic hazard.[5]

The Seismic Hazards Mapping Act, passed in 1990, addresses non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides.[6] The State Department of Conservation operates the Seismic Mapping Program for California. Extensive information is available at their website:
http://gmw.consrv.ca.gov/shmp/index.htm

Vulnerability Assessment

The effects of earthquakes span a large area, and large earthquakes occurring in many parts of the Southern California region would probably be felt throughout the region. However, the degree to which the earthquakes are felt, and the damages associated with them may vary. At risk from earthquake damage are large stocks of old buildings and bridges; many high tech and hazardous materials facilities; extensive sewer, water, and natural gas pipelines; earth dams; petroleum pipelines and other critical facilities; and private property located in the county. The relative or secondary earthquake hazards, which are liquefaction, ground shaking, amplification, and earthquake-induced landslides, can be just as devastating as the earthquake.

The California Geological Survey has identified areas most vulnerable to liquefaction and earthquake-induced landslides. In the planning area, liquefaction is likely to occur in areas below canyons, coastal areas, and near landslide areas. Also, liquefaction can occur in residential tracks that used “cut and fill” grading techniques. Liquefaction may cause a structure to tilt, sink, and/or otherwise be structurally affected so as to become unsound.

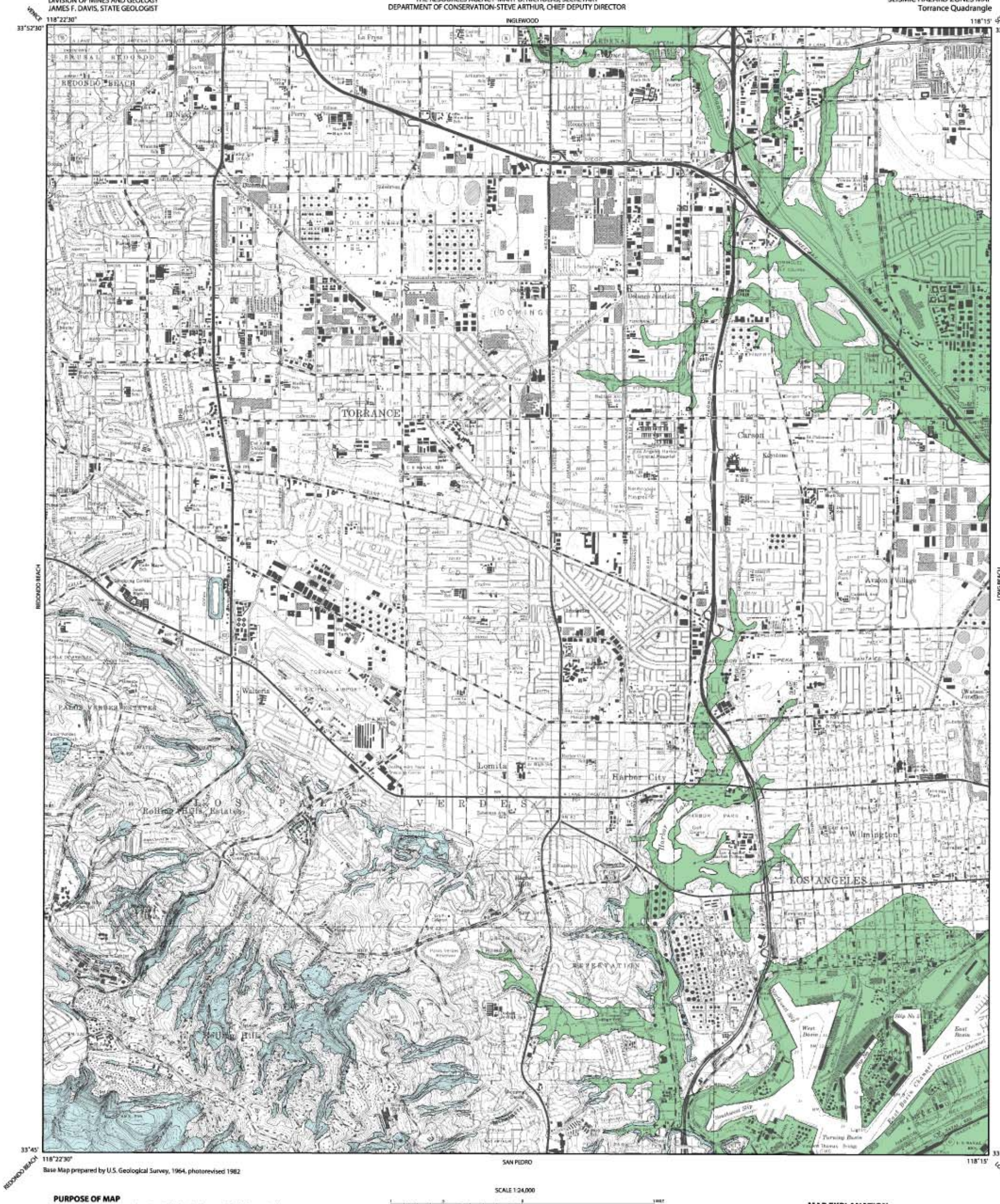
Southern California has many active landslide areas, and a large earthquake could trigger accelerated movement in these slide areas, in addition to jarring loose other unknown areas of landslide risk. The results of this type of earth movement during an earthquake or after shock can block or collapse roadways, damage utility lines and even destroy buildings. In the planning area earthquake-induced landslides are likely to occur in canyons, along the coastal bluffs and in areas that have a history of land movement, such as the Portuguese Bend Landslide, South Shores Landslide or Silver Spur Landslide,

Maps 5-3, 5-4 and 5-5 on the next three pages excerpts from the State of California Seismic Hazard Zones Map for the planning area indicating the liquefaction prone areas (green) and the earthquake-induced landslide prone areas (blue).

DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA-GRAY DAVIS, GOVERNOR
THE RESOURCES AGENCY-MARY D. NICHOLAS, SECRETARY
DEPARTMENT OF CONSERVATION-STEVE ARTHUR, CHIEF DEPUTY DIRECTOR

SEISMIC HAZARD ZONES MAP
Torrance Quadrangle



Base Map prepared by U.S. Geological Survey, 1964, photorevised 1982

SCALE 1:24,000

PURPOSE OF MAP

This map will assist cities and counties in fulfilling their responsibilities for protecting the public safety from the effects of earthquake-triggered ground failure as required by the Seismic Hazards Mapping Act (Public Resources Code Sections 2690-2699.6).

For information regarding the scope and recommended methods to be used in conducting the required site investigations, see DMG Special Publication 117, Guidelines for Evaluating and Mitigating Seismic Hazards in California.

For a general description of the Seismic Hazards Mapping Program, the Seismic Hazards Mapping Act and regulations, and related information, please refer to the draft User's Guide (see http://www.consrv.ca.gov/dmg/shezp/userguid/).

Production of this map was funded by the Federal Emergency Management Agency's Hazard Mitigation Program and the Department of Conservation in cooperation with the Governor's Office of Emergency Services.

IMPORTANT - PLEASE NOTE

1) This map may not show all areas that have the potential for liquefaction, landsliding, strong earthquake ground shaking or other earthquake and geologic hazards. Also, a single earthquake capable of causing liquefaction or triggering landslide failure will not uniformly affect the entire area zoned.

2) Liquefaction zones may also contain areas susceptible to the effects of earthquake-induced landslides. This situation typically exists at or near the toe of existing landslides, downslope from rockfall or debris flow source areas, or adjacent to steep stream banks.

3) This map does not show Alquist-Priolo earthquake fault zones, if any, that may exist in this area. Please refer to the latest official map of earthquake fault zones for disclosures and other actions that are required by the Alquist-Priolo Earthquake Fault Zoning Act. For more information on this subject and an index to available maps, see DMG Special Publication 42.

4) Landslide zones on this map were determined, in part, by adapting methods first developed by the U.S. Geological Survey (USGS). A new generation of landslide hazard maps being prepared by the USGS (Jibson and Harp, in preparation) uses an experimental approach designed to explore new methods to assess earthquake-induced landslide hazards. Although aspects of this new methodology may be incorporated in future seismic hazard zone maps, the experimental USGS maps should not be used as substitutes for these official earthquake-induced landslide zone maps.

5) U.S. Geological Survey base map standards provide that 90 percent of cultural features be located within 40 feet (horizontal accuracy) at the scale of this map. The identification and location of liquefaction and earthquake-induced landslide zones are based on available data. However, the quality of data used is varied. The zone boundaries depicted have been drawn as accurately as possible at this scale.

6) Information on this map is not sufficient to serve as a substitute for the geologic and geotechnical site investigations required under Chapters 7.5 and 7.8 of Division 2 of the Public Resources Code.

7) DISCLAIMER: The State of California and the Department of Conservation make no representations or warranties regarding the accuracy of the data from which these maps were derived. Neither the State nor the Department shall be liable under any circumstances for any direct, indirect, special, incidental or consequential damages with respect to any claim by any user or any third party on account of or arising from the use of this map.

STATE OF CALIFORNIA
SEISMIC HAZARD ZONES
Delineated in compliance with Chapter 7.8, Division 2 of the California Public Resources Code (Seismic Hazards Mapping Act)

TORRANCE QUADRANGLE

OFFICIAL MAP

Released: March 25, 1999

STATE GEOLOGIST

MAP EXPLANATION

Zones of Required Investigation:

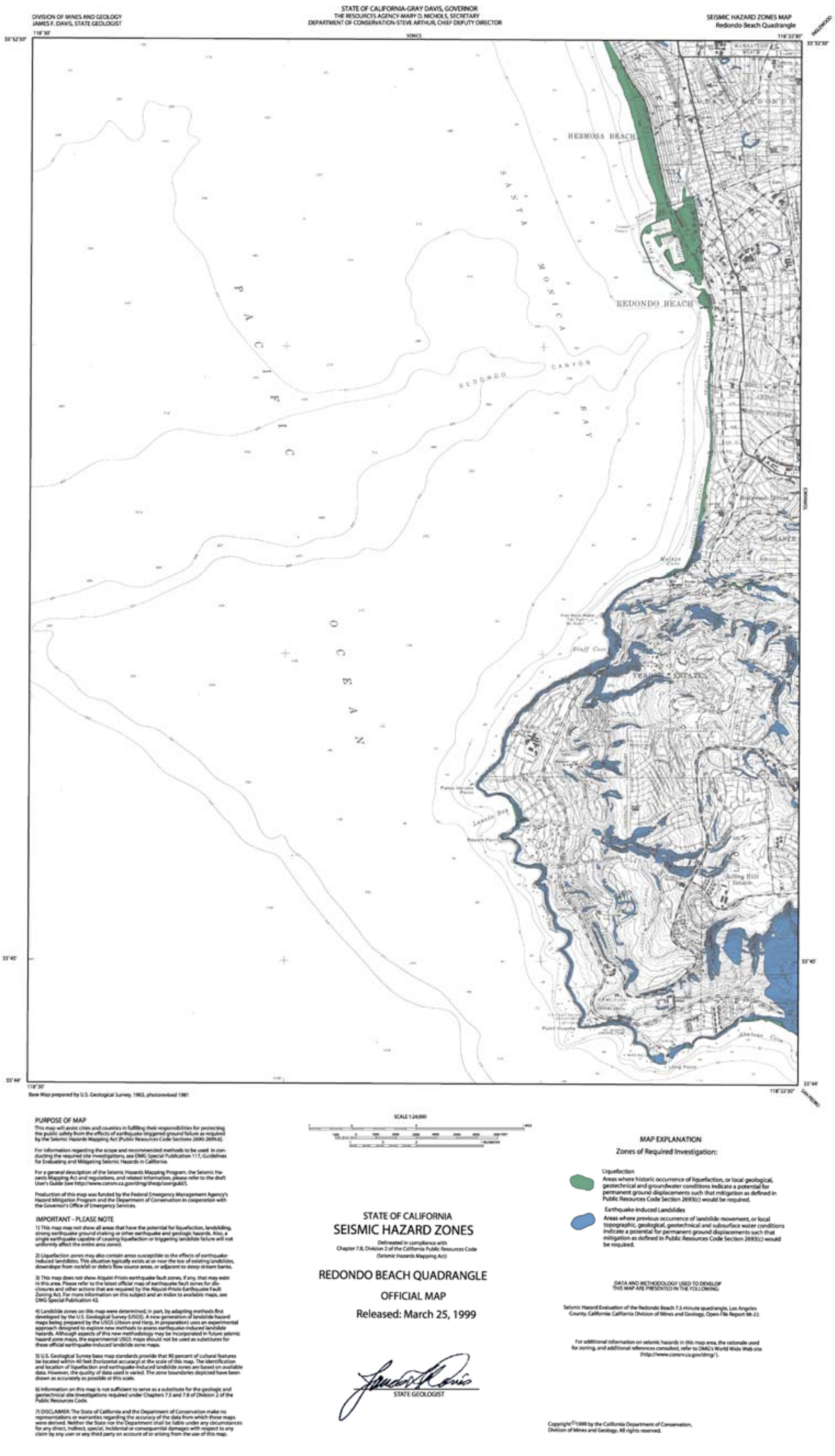
Liquefaction
Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Earthquake-Induced Landslides
Areas where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

DATA AND METHODOLOGY USED TO DEVELOP THIS MAP ARE PRESENTED IN THE FOLLOWING:

Seismic Hazard Evaluation of the Torrance 7.5 minute quadrangle, Los Angeles County, California: California Division of Mines and Geology, Open-File Report 98-26.

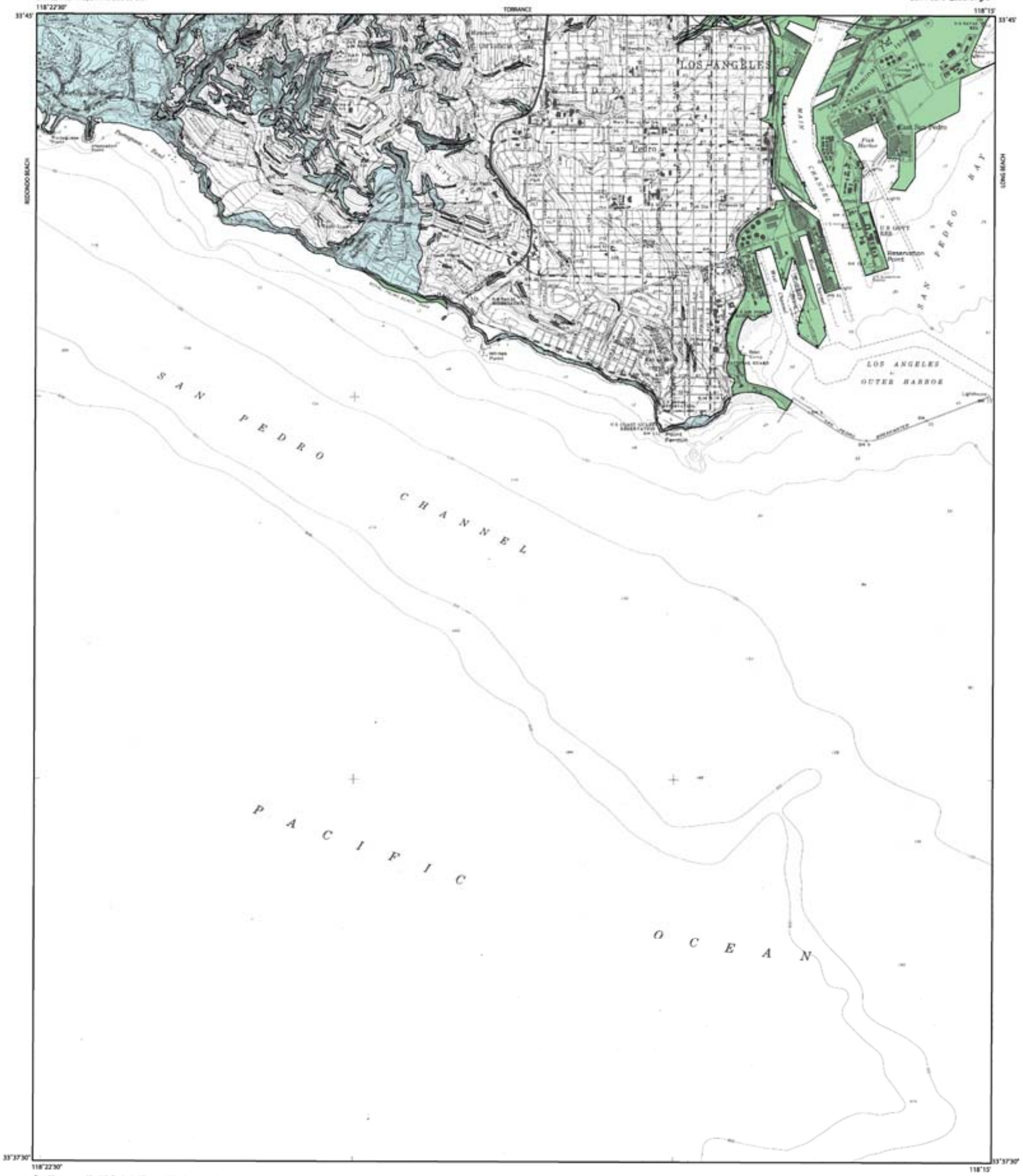
For additional information on seismic hazards in this map area, the rationale used for zoning, and additional references consulted, refer to DMG's World Wide Web site (http://www.consrv.ca.gov/dmg/).


DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST
STATE OF CALIFORNIA-GRAY DAVIS, GOVERNOR
THE RESOURCES AGENCY-MARY D. NICHOLS, SECRETARY
DEPARTMENT OF CONSERVATION-STEVE ARTHUR, CHIEF DEPUTY DIRECTOR
SEISMIC HAZARD ZONES MAP
Redondo Beach Quadrangle
VENICE
HERMOSA BEACH
REDONDO BEACH
PACIFIC OCEAN
SANTA MONICA BAY
REDONDO CANYON
Base Map prepared by U.S. Geological Survey, 1963, photorevised 1981
PURPOSE OF MAP
This map will assist cities and counties in fulfilling their responsibilities for protecting the public safety from the effects of earthquake-triggered ground failure as required by the Seismic Hazards Mapping Act (Public Resources Code Sections 2690-2699.6).
For information regarding the scope and recommended methods to be used in conducting the required site investigations, see DMG Special Publication 117, Guidelines for Evaluating and Mitigating Seismic Hazards in California.
For a general description of the Seismic Hazards Mapping Program, the Seismic Hazards Mapping Act and regulations, and related information, please refer to the draft User's Guide (see http://www.consrv.ca.gov/dmg/shezp/userguid/).
Production of this map was funded by the Federal Emergency Management Agency's Hazard Mitigation Program and the Department of Conservation in cooperation with the Governor's Office of Emergency Services.
IMPORTANT - PLEASE NOTE
1) This map may not show all areas that have the potential for liquefaction, landsliding, strong earthquake ground shaking or other earthquake and geologic hazards. Also, a single earthquake capable of causing liquefaction or triggering landslide failure will not uniformly affect the entire area zoned.
2) Liquefaction zones may also contain areas susceptible to the effects of earthquake-induced landslides. This situation typically exists at or near the toe of existing landslides, downslope from rockfall or debris flow source areas, or adjacent to steep stream banks.
3) This map does not show Alquist-Priolo earthquake fault zones, if any, that may exist in this area. Please refer to the latest official map of earthquake fault zones for disclosures and other actions that are required by the Alquist-Priolo Earthquake Fault Zoning Act. For more information on this subject and an index to available maps, see DMG Special Publication 42.
4) Landslide zones on this map were determined, in part, by adapting methods first developed by the U.S. Geological Survey (USGS). A new generation of landslide hazard maps being prepared by the USGS (Jibson and Harp, in preparation) uses an experimental approach designed to explore new methods to assess earthquake-induced landslide hazards. Although aspects of this new methodology may be incorporated in future seismic hazard zone maps, the experimental USGS maps should not be used as substitutes for these official earthquake-induced landslide zone maps.
5) U.S. Geological Survey base map standards provide that 90 percent of cultural features be located within 40 feet (horizontal accuracy) at the scale of this map. The identification and location of liquefaction and earthquake-induced landslide zones are based on available data. However, the quality of data used is varied. The zone boundaries depicted have been drawn as accurately as possible at this scale.
6) Information on this map is not sufficient to serve as a substitute for the geologic and geotechnical site investigations required under Chapters 7.5 and 7.8 of Division 2 of the Public Resources Code.
7) DISCLAIMER: The State of California and the Department of Conservation make no representations or warranties regarding the accuracy of the data from which these maps were derived. Neither the State nor the Department shall be liable under any circumstances for any direct, indirect, special, incidental or consequential damages with respect to any claim by any user or any third party on account of or arising from the use of this map.
SCALE 1:24,000
STATE OF CALIFORNIA
SEISMIC HAZARD ZONES
Delineated in compliance with Chapter 7.8, Division 2 of the California Public Resources Code (Seismic Hazards Mapping Act)
REDONDO BEACH QUADRANGLE
OFFICIAL MAP
Released: March 25, 1999
STATE GEOLOGIST
MAP EXPLANATION
Zones of Required Investigation:
Liquefaction
Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.
Earthquake-Induced Landslides
Areas where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.
DATA AND METHODOLOGY USED TO DEVELOP THIS MAP ARE PRESENTED IN THE FOLLOWING:
Seismic Hazard Evaluation of the Redondo Beach 7.5 minute quadrangle, Los Angeles County, California: California Division of Mines and Geology, Open-File Report 98-22.
For additional information on seismic hazards in this map area, the rationale used for zoning, and additional references consulted, refer to DMG's World Wide Web site (http://www.consrv.ca.gov/dmg/).
Copyright ©1999 by the California Department of Conservation, Division of Mines and Geology. All rights reserved.

DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA-GRAY DAVIS, GOVERNOR
THE RESOURCES AGENCY-MARY D. NICHOLS, SECRETARY
DEPARTMENT OF CONSERVATION-STEVE ARTHUR, CHIEF DEPUTY DIRECTOR

SEISMIC HAZARD ZONES MAP
San Pedro Quadrangle



Base Map prepared by U.S. Geological Survey, 1964, photorevised 1981

PURPOSE OF MAP

This map will assist cities and counties in fulfilling their responsibilities for protecting the public safety from the effects of earthquake-triggered ground failure as required by the Seismic Hazards Mapping Act (Public Resources Code Sections 2690-2699.6).

For information regarding the scope and recommended methods to be used in conducting the required site investigations, see DMG Special Publication 117, Guidelines for Evaluating and Mitigating Seismic Hazards in California.

For a general description of the Seismic Hazards Mapping Program, the Seismic Hazards Mapping Act and regulations, and related information, please refer to the draft User's Guide (see http://www.consrv.ca.gov/dmg/shezp/userguid/).

Production of this map was funded by the Federal Emergency Management Agency's Hazard Mitigation Program and the Department of Conservation in cooperation with the Governor's Office of Emergency Services.

IMPORTANT - PLEASE NOTE

1) This map may not show all areas that have the potential for liquefaction, landsliding, strong earthquake ground shaking or other earthquake and geologic hazards. Also, a single earthquake capable of causing liquefaction or triggering landslide failure will not uniformly affect the entire area zoned.

2) Liquefaction zones may also contain areas susceptible to the effects of earthquake-induced landslides. This situation typically exists at or near the toe of existing landslides, downslope from rockfall or debris flow source areas, or adjacent to steep stream banks.

3) This map does not show Alquist-Priolo earthquake fault zones, if any, that may exist in this area. Please refer to the latest official map of earthquake fault zones for disclosures and other actions that are required by the Alquist-Priolo Earthquake Fault Zoning Act. For more information on this subject and an index to available maps, see DMG Special Publication 42.

4) Landslide zones on this map were determined, in part, by adapting methods first developed by the U.S. Geological Survey (USGS). A new generation of landslide hazard maps being prepared by the USGS (Jibson and Harp, in preparation) uses an experimental approach designed to explore new methods to assess earthquake-induced landslide hazards. Although aspects of this new methodology may be incorporated in future seismic hazard zone maps, the experimental USGS maps should not be used as substitutes for these official earthquake-induced landslide zone maps.

5) U.S. Geological Survey base map standards provide that 90 percent of cultural features be located within 40 feet (horizontal accuracy) at the scale of this map. The identification and location of liquefaction and earthquake-induced landslide zones are based on available data. However, the quality of data used is varied. The zone boundaries depicted have been drawn as accurately as possible at this scale.

6) Information on this map is not sufficient to serve as a substitute for the geologic and geotechnical site investigations required under Chapters 7.5 and 7.8 of Division 2 of the Public Resources Code.

7) DISCLAIMER: The State of California and the Department of Conservation make no representations or warranties regarding the accuracy of the data from which these maps were derived. Neither the State nor the Department shall be liable under any circumstances for any direct, indirect, special, incidental or consequential damages with respect to any claim by any user or any third party on account of or arising from the use of this map.

SCALE 1:24,000

STATE OF CALIFORNIA

SEISMIC HAZARD ZONES

Delineated in compliance with
Chapter 7.8, Division 2 of the California Public Resources Code
(Seismic Hazards Mapping Act)

SAN PEDRO QUADRANGLE

OFFICIAL MAP

Released: March 25, 1999

STATE GEOLOGIST

MAP EXPLANATION

Zones of Required Investigation:

Liquefaction
Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Earthquake-Induced Landslides
Areas where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

DATA AND METHODOLOGY USED TO DEVELOP
THIS MAP ARE PRESENTED IN THE FOLLOWING:

Seismic Hazard Evaluation of the San Pedro 7.5 minute quadrangle, Los Angeles County, California: California Division of Mines and Geology, Open-File Report 98-24.

For additional information on seismic hazards in this map area, the rationale used for zoning, and additional references consulted, refer to DMG's World Wide Web site (http://www.consrv.ca.gov/dmg/).

Risk Analysis

Risk analysis is the third phase of a hazard assessment. Risk analysis involves estimating the damage and costs likely to be experienced in a geographic area over a period of time[7] . Factors included in assessing earthquake risk include population and property distribution in the hazard area, the frequency of earthquake events, landslide susceptibility, buildings, infrastructure, and disaster preparedness of the region. This type of analysis can generate estimates of the damages to the region due to an earthquake event in a specific location. FEMA's software program, HAZUS, uses mathematical formulas and information about building stock, local geology and the location and size of potential earthquakes, economic data, and other information to estimate losses from a potential earthquake.[8] The HAZUS software is available from FEMA at no cost.

For greater Southern California there are multiple worst case scenarios, depending on which fault might rupture, and which communities are in proximity to the fault. But damage will not necessarily be limited to immediately adjoining communities. Depending on the hypocenter of the earthquake, seismic waves may be transmitted through the ground to unsuspecting communities. In the 1994 Northridge Earthquake, Santa Monica suffered extensive damage, even though there was a range of mountains between it and the origin of the earthquake.

Damages for a large earthquake almost anywhere in Southern California are likely to run into the billions of dollars. Although building codes are some of the most stringent in the world, ten's of thousands of older existing buildings were built under much less rigid codes. California has laws affecting unreinforced masonry buildings (URM's) and although many building owners have retrofitted their buildings, hundreds of pre-1933 buildings still have not been brought up to current standards. To the best of the City staff's knowledge, the Cities of Rancho Palos Verdes and Rolling Hills Estates have no unreinforced masonry buildings.

Non-structural bracing of equipment and contents is often the most cost-effective type of seismic mitigation. Inexpensive bracing and anchoring may be the most cost effective way to protect expensive equipment. Non-structural bracing of equipment and furnishings will also reduce the chance of injury for the occupants of a building.

Community Earthquake Issues

What is Susceptible to Earthquakes?

Earthquake damage occurs because humans have built structures that cannot withstand severe shaking. Buildings, airports, schools, and lifelines (highways and utility lines) suffer damage in earthquakes and can cause death or injury to humans. The welfare of homes, major businesses, and public infrastructure is very important. Addressing the reliability of buildings, critical facilities, and infrastructure, and understanding the potential costs to government, businesses, and individuals as a result of an earthquake, are challenges faced by the cities.

Dams

There are a total of 103 dams in Los Angeles County, owned by 23 agencies or organizations, ranging from the Federal government to Homeowner Associations.[9] These dams hold billions of gallons of water in reservoirs. Releases of water from the major reservoirs are designed to protect Southern California from flood waters and to store domestic water. Seismic activity can compromise the dam structures, and the resultant flooding could cause catastrophic flooding. Following the 1971 Sylmar earthquake the Lower Van Norman Dam showed signs of structural compromise, and tens of thousands of persons had to be evacuated until the dam could be drained. The dam has never been refilled.

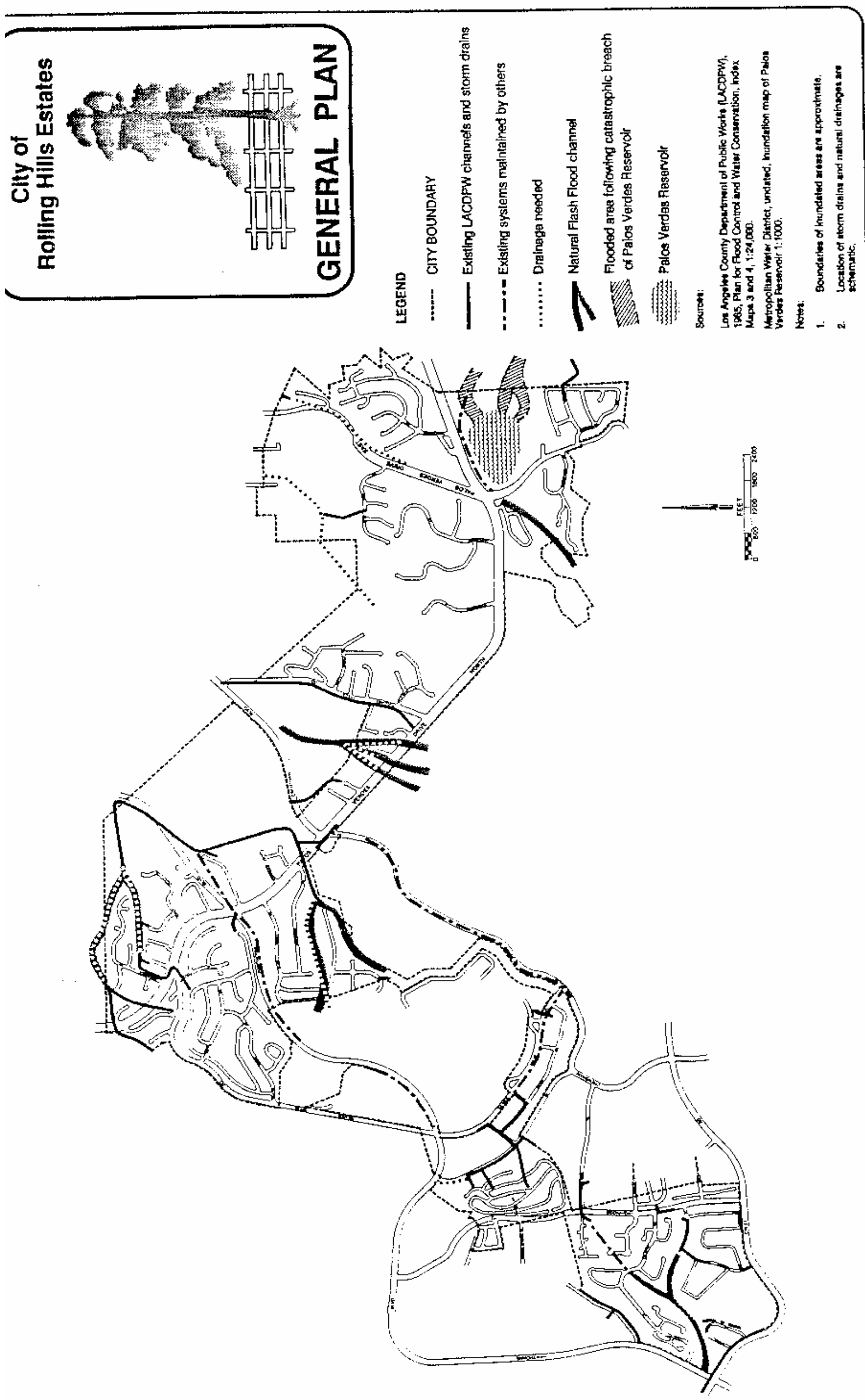
Because of the current design and construction practices and ongoing programs of review and modification, catastrophic dam failure is considered unlikely. However, it is expected that many flood control channels could suffer damage. Also, pumping stations in coastal communities are expected to fail due to liquefaction.

The Metropolitan Water District of Southern California owns and maintains the Palos Verdes Reservoir, located at the southeast corner of Palos Verdes Drive East and Palos Verdes Drive North. Although not a dam by definition, the reservoir poses a similar threat as a “dam”. The reservoir is constructed of steel reinforced concrete with earth-fill reinforcement banked around the perimeter and lined with an impervious rubber liner. It has an approximate capacity of 1,000 acre feet. A ravine leads from the west spill gate to an underground flood control channel following the natural terrain to the east through Green Hills Memorial Park. The Memorial Park is bordered by residential areas.

According to the RPV MHFP, the most populated residential streets affected by a sudden dam failure could be the following residential streets: Avenida Feliciano, Tarrassa, Alvesta, Bandra, Avenida Del Mesa, and Redondela. Western Avenue might be affected between John Montgomery Drive and Avenida Aprenda. Areas expected to be inundated, should failure occur, are shown on the dam inundation map.

The RHE General Plan Safety Element states that dam failure is not a severe safety threat to the City of Rolling Hills Estates because only open space and a parking lot are in the inundation path.

Map 5-6 Palos Verdes Reservoir Inundation Area


City of
Rolling Hills Estates
GENERAL PLAN
LEGEND
CITY BOUNDARY
Existing LACDPW channels and storm drains
Existing systems maintained by others
Drainage needed
Natural Flash Flood channel
Flooded area following catastrophic breach of Palos Verdes Reservoir
Palos Verdes Reservoir
Sources:
Los Angeles County Department of Public Works (LACDPW), 1965, Plan for Flood Control and Water Conservation, Index Maps 3 and 4, 1:24,000.
Metropolitan Water District, undated, Inundation map of Palos Verdes Reservoir 1:1000.
Notes:
1. Boundaries of inundated areas are approximate.
2. Location of storm drains and natural drainages are schematic.

Buildings
The built environment is susceptible to damage from earthquakes. Buildings that collapse can trap and bury people. Lives are at risk and the cost to clean up the damages is great. In most California communities, including those in the planning area, many buildings were built before 1993 when building codes were not as strict. In addition, retrofitting is not required except under certain conditions and can be expensive. Therefore, the number of buildings at risk remains high. The California Seismic Safety Commission makes annual reports on the progress of the retrofitting of unreinforced masonry buildings. Fortunately, there are very few buildings in the planning area that were constructed prior to 1933. The bulk of development that has occurred in both Cities took place after World War II.

Because the planning area is comprised primarily of low and medium residential dwellings, it is anticipated that most dwellings would not suffer severe structural damage unless they are in an area of instable soil. However, the combination of severity and length of the shaking could still produce dramatic effects.

Infrastructure and Communication
Residents in the planning area commute frequently by automobiles and public transportation such as buses and light rail. An earthquake can greatly damage bridges and roads, hampering emergency response efforts and the normal movement of people and goods. Damaged infrastructure strongly affects the economy of the community because it disconnects people from work, school, food, and leisure, and separates businesses from their customers and suppliers.

Bridge Damage
Even modern bridges can sustain damage during earthquakes, leaving them unsafe for use. Some bridges have failed completely due to strong ground motion. Bridges are a vital transportation link - with even minor damages making some areas inaccessible. Because bridges vary in size, materials, location and design, any given earthquake will affect them differently. Bridges built before the mid-1970' s have a significantly higher risk of suffering structural damage during a moderate to large earthquake compared with those built after 1980 when design improvements were made.

There are no bridges located within the planning area. However, there are several bridges that provide access to the planning area which are state, county or privately owned (including railroad bridges). Much of the interstate highway system was built in the mid to late 1960's. Caltrans has retrofitted most bridges on the freeway systems; however there are still some county maintained bridges that are not retrofitted. The FHWA requires that bridges on the National Bridge Inventory be inspected every 2 years. Caltrans checks when the bridges are inspected because they administer the Federal funds for bridge projects.

Damage to Lifelines
Lifelines are the connections between communities and outside services. They include water and gas lines, transportation systems, electricity, and communication networks. Ground shaking and amplification can cause pipes to break open, power lines to fall, roads and railways to crack or move, and radio and telephone communication to cease. Disruption to transportation makes it especially difficult to bring in supplies or services. Lifelines need to be usable after earthquake to allow for rescue, recovery, and rebuilding efforts and to relay important information to the public.

Disruption of Critical Services
Critical facilities include police stations, fire stations, hospitals, shelters, and other facilities that provide important services to the community. According to the MHFP's for the planning area cities, severe shortages are projected for hospital beds, communications systems, electrical power, fire resources, natural gas, petroleum fuels, railroad services, sanitation systems, and water supply. These facilities and their services need to be functional after an earthquake event.

Businesses
Seismic activity can cause great loss to businesses, both large-scale corporations and small retail shops. When a company is forced to stop production for just a day, the economic loss can be tremendous, especially when its market is at a national or global level. Seismic activity can create economic loss that presents a burden to large and small shop owners who may have difficulty recovering from their losses.

Forty percent of businesses do not reopen after a disaster and another twenty-five percent fail within one year according to the Federal Emergency Management Agency (FEMA). Similar statistics from the United States Small Business Administration indicate that over ninety percent of businesses fail within two years after being struck by a disaster.[10]

Individual Preparedness
Because the potential for earthquake occurrences and earthquake related property damage is relatively high in the planning area, increasing individual preparedness is a significant need. Strapping down heavy furniture, water heaters, and expensive personal property, as well as being earthquake insured, and anchoring buildings to foundations are just a few steps individuals can take to prepare for an earthquake.

Death and Injury
Death and injury can occur both inside and outside of buildings due to collapsed buildings falling equipment, furniture, debris, and structural materials. Downed power lines and broken water and gas lines can also endanger human life.

Fire
Downed power lines or broken gas mains may trigger fires. When fire stations suffer building or lifeline damage, quick response to extinguish fires is less likely. Furthermore, major incidents will demand a larger share of resources, and initially smaller fires and problems will receive little or insufficient resources in the initial hours

after a major earthquake event. Loss of electricity may cause a loss of water pressure in some communities, further hampering fire fighting ability.

Debris
After damage to a variety of structures, much time is spent cleaning up bricks, glass, wood, steel or concrete building elements, office and home contents, and other materials. Developing a strong debris management strategy is essential in post-disaster recovery. Disasters do not exempt the Cities in the planning area from compliance with the state's AB 939 solid waste reduction regulations.

Existing Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by county, regional, state, or federal agencies or organizations.

City Codes
Implementation of earthquake mitigation policy most often takes place at the local government level. The City Building and Safety Departments enforce the following Uniform Building Codes pertaining to earthquake hazards:

1605.2.1 (Distribution of Horizontal Shear)
1605.2.2 (Stability against Overturning)
1626-1629 (Seismic)
1605.2.3 (Anchorage)

Both Cities have Planning Departments that enforce the zoning and land use regulations relating to earthquake hazards.

Generally, these codes seek to address development in areas that could be prone to flooding, landslide, wildfire and/or seismic hazards; and where development is permitted, that the applicable construction standards are met. Developers in hazard-prone areas may be required to retain a qualified professional engineer to evaluate level of risk on the site and recommend appropriate mitigation measures.

Coordination among Building Officials
The City Building Codes set the minimum design and construction standards for new buildings. In 2002 the City of Rancho Palos Verdes and the City of Rolling Hills Estates adopted the most recent seismic standards in its building code, which requires that new and remodeled buildings be built at a higher seismic standard.

Since November 8, 1987, the Cities have also required that site-specific seismic hazard investigations be performed for new essential facilities, major structures, hazardous facilities, and special occupancy structures such as schools, hospitals, and emergency response facilities.

Businesses/Private Sector
Natural hazards have a devastating impact on businesses. In fact, of all businesses which close following a disaster, more than forty-three percent never reopen, and an additional 29% close for good within the next two years.[11] The Institute of Business and Home Safety has developed "Open for Business", which is a disaster planning toolkit to help guide businesses in preparing for and dealing with the adverse affects natural hazards. The kit integrates protection from natural disasters into the company's risk reduction measures to safeguard employees, customers, and the investment itself. The guide helps businesses secure human and physical resources during disasters, and helps to develop strategies to maintain business continuity before, during, and after a disaster occurs.

Hospitals
"The Alfred E. Alquist Hospital Seismic Safety Act ("Hospital Act") was enacted in 1973 in response to the moderate Magnitude 6.6 San Fernando Earthquake in 1971 when four major hospital campuses were severely damaged and evacuated. Two hospital buildings collapsed killing forty seven people. Three others were killed in another hospital that nearly collapsed.

In approving the Act, the Legislature noted that: "Hospitals, that house patients who have less than the capacity of normally healthy persons to protect themselves, and that must be reasonably capable of providing services to the public after a disaster, shall be designed and constructed to resist, insofar as practical, the forces generated by earthquakes, gravity and winds." (Health and Safety Code Section 129680)

When the Hospital Act was passed in 1973, the State anticipated that, based on the regular and timely replacement of aging hospital facilities, the majority of hospital buildings would be in compliance with the Act's standards within 25 years. However, hospital buildings were not, and are not, being replaced at that anticipated rate. In fact, the great majority of the State's urgent care facilities are now more than 40 years old.

The moderate Magnitude 6.7 Northridge Earthquake in 1994 caused $3 billion in hospital-related damage and evacuations. Twelve hospital buildings constructed before the Act were cited (red tagged) as unsafe for occupancy after the earthquake. Those hospitals that had been built in accordance with the 1973 Hospital Act were very successful in resisting structural damage. However, nonstructural damage (for example, plumbing and ceiling systems) was still extensive in those post-1973 buildings.

Senate Bill 1953 ("SB 1953"), enacted in 1994 after the Northridge Earthquake, expanded the scope of the 1973 Hospital Act. Under SB 1953, all hospitals are required, as of January 1, 2008, to survive earthquakes without collapsing or posing the threat of significant loss of life. The 1994 Act further mandates that all existing hospitals be seismically evaluated, and retrofitted, if needed, by 2030, so that they are in substantial compliance with the Act (which requires that the hospital buildings be reasonably capable of providing services to the public after disasters). SB 1953 applies to all urgent care facilities (including those built prior to the 1973 Hospital Act) and affects approximately 2,500 buildings on 475 campuses.

SB 1953 directed the Office of Statewide Health Planning and Development ("OSHPD"), in consultation with the Hospital Building Safety Board, to develop emergency regulations including "…earthquake performance categories with sub gradations for risk to life, structural soundness, building contents, and nonstructural systems that are critical to providing basic services to hospital inpatients and the public after a disaster." (Health and Safety Code Section 130005)

In 2001, recognizing the continuing need to assess the adequacy of policies, and the application of advances in technical knowledge and understanding, the California Seismic Safety Commission created an Ad Hoc Committee to re-examine the compliance with the Alquist Hospital Seismic Safety Act. The formation of the Committee was also prompted by the recent evaluations of hospital buildings reported to OSHPD that revealed that a large percentage (40%) of California's operating hospitals are in the highest category of collapse risk.".[12]

California Earthquake Mitigation Legislation
California is painfully aware of the threats it faces from earthquakes. Dating back to the 19th Century, Californians have been killed, injured, and lost property as a result of earthquakes. As the State's population continues to grow, and urban areas become even more densely developed, the risk will continue to increase. For decades the legislature has passed laws to strengthen the built environment and protect the citizens. Table 5-2 on the following page provides a sampling of some of the 200 plus laws in the State's codes.

Table 5-2: Partial List of the Over 200 California Laws on Earthquake Safety

Government Code Section 8870-8870.95	Creates Seismic Safety Commission.
Government Code Section 8876.1-8876.10	Established the California Center for Earthquake Engineering Research.
Public Resources Code Section 2800-2804.6	Authorized a prototype earthquake prediction system along the Central San Andreas Fault near the City of Parkfield.
Public Resources Code Section 2810-2815	Continued the Southern California Earthquake Preparedness Project and the Bay Area Regional Earthquake Preparedness Project.
Health and Safety Code Section 16100-16110	The Seismic Safety Commission and State Architect, will develop a state policy on acceptable levels of earthquake risk for new and existing state-owned buildings.
Government Code Section 8871-8871.5	Established the California Earthquake Hazards Reduction Act of 1986.
Health and Safety Code Section 130000-130025	Defined earthquake performance standards for hospitals.
Public Resources Code Section 2805-2808	Established the California Earthquake Education Project.
Government Code Section 8899.10-8899.16	Established the Earthquake Research Evaluation Conference.
Public Resources Code Section 2621-2630 2621.	Established the Alquist-Priolo Earthquake Fault Zoning Act.
Government Code Section 8878.50-8878.52 8878.50.	Created the Earthquake Safety and Public Buildings Rehabilitation Bond Act of 1990.
Education Code Section 35295-35297 35295.	Established emergency procedure systems in kindergarten through grade 12 in all the public or private schools.
Health and Safety Code Section 19160-19169	Established standards for seismic retrofitting of unreinforced masonry buildings.
Health and Safety Code Section 1596.80-1596.879	Required all child day care facilities to include an Earthquake Preparedness Checklist as an attachment to their disaster plan.
Source: http://www.leginfo.ca.gov/calaw.html	

Earthquake Education

Earthquake research and education activities are conducted at several major universities in the Southern California region, including Cal Tech, USC, UCLA, UCSB, UCI, and UCSB. The local clearinghouse for earthquake information is the Southern California Earthquake Center located at the University of Southern California, Los Angeles, CA 90089, Telephone: (213) 740-5843, Fax: (213) 740-0011, Email: SCEinfo@usc.edu, Website: http://www.scec.org. The Southern California Earthquake Center (SCEC) is a community of scientists and specialists who actively coordinate research on earthquake hazards at nine core institutions, and communicate earthquake information to the public. SCEC is a National Science Foundation (NSF) Science and Technology Center and is co-funded by the United States Geological Survey (USGS).

In addition, Los Angeles County along with other Southern California counties, sponsors the Emergency Survival Program (ESP), an educational program for learning how to prepare for earthquakes and other disasters. Many school districts have very active emergency preparedness programs that include earthquake drills and periodic disaster response team exercises.

End Notes

[1] http://pubs.usgs.gov/gip/earthq3/when.html

[2] http://www.gps.caltech.edu/~sieh/home.html

[3] Planning for Natural Hazards: The California Technical Resource Guide, Department of Land Conservation and Development (July 2000)

[4] http://www.data.scec.org/fault_index/palos.html

[5] http://www.consrv.ca.gov/CGS/rghm/ap/

[6] Ibid

[7] Burby, R. (Ed.) Cooperating with Nature: Confronting Natural Hazards with Land Use Planning for Sustainable Communities (1998), Washington D.C., Joseph Henry Press.

[8] FEMA HAZUS http://www.fema.gov/hazus/hazus2.htm (May 2001).

[9] Source: Los Angeles County Public Works Department, March 2004

[10] http://www.chamber101.com/programs_committee/natural_disasters/DisasterPreparedness/Forty.htm

[11] Institute for Business and Home Safety Resources (April 2001),

[12] http://www.seismic.ca.gov/pub/CSSC_2001-04_Hospital.pdf

Wildland/Urban Interface Fire Hazards in the Joint Planning Area

Table of Contents

Why are Wildfires a Threat to Southern California?…………………………….page 3

Wildfire Characteristics………………………..……………………………page 5

Wildfire Hazard Assessment……………….…………………………………page 8

Wildfire Hazard Identification………………………………………………...page 8

Vulnerability and Risk…………………………………………………………page 11

Community Wildfire Issues………………………………………… ……...page 12

What is Susceptible to Wildfire?……………………………………...….page 12

Section 6:

Why are Wildfires a Threat to Southern California?

For thousands of years, fires have been a natural part of the ecosystem in Southern California. However, wildfires present a substantial hazard to life and property in communities built within or adjacent to hillsides and mountainous areas. There is a huge potential for losses due to wildland/urban interface fires in Southern California. According to the California Division of Forestry (CDF), there were over seven thousand reportable fires in California in 2003, with over one million acres burned.[1] According to CDF statistics, in the October 2003 Firestorms, over 4,800 homes were destroyed and 22 lives were lost.[2]

The 2003 Southern California Fires

The fall of 2003 marked the most destructive wildfire season in California history. In a ten day period, 12 separate fires raged across Southern California in Los Angeles, Riverside, San Bernardino, San Diego and Ventura counties. The massive "Cedar" fire in San Diego County alone consumed of 2,800 homes and burned over a quarter of a million acres.

Table 6-1: October 2003 Firestorm Statistics

County	Fire Name	Date Began	Acres Burned	Homes Lost	Homes Damaged	Lives Lost
Riverside	Pass	10/21/03	2,397	3	7	0
Los Angeles	Padua	10/21/03	10,446	59	0	0
San Bernardino	Grand Prix	10/21/03	69,894	136	71	0
San Diego	Roblar 2	10/21/03	8,592	0	0	0
Ventura	Piru	10/23/03	63,991	8	0	0
Los Angeles	Verdale	10/24/03	8,650	1	0	0
Ventura	Simi	10/25/03	108,204	300	11	0
San Diego	Cedar	10/25/03	273,246	2,820	63	14
San Bernardino	Old	10/25/03	91,281	1,003	7	6
San Diego	Otay / Mine	10/26/03	46,000	6	11	0
Riverside	Mountain	10/26/03	10,000	61	0	0
San Diego	Paradise	10/26/03	56,700	415	15	2
Total Losses			**749,401**	**4,812**	**185**	**22**

Source: http://www.fire.ca.gov/php/fire_er_content/downloads/2003LargeFires.pdf

Historic Fires in Southern California

Large fires have been part of the Southern California landscape for millennia.

> "Written documents reveal that during the 19th century human settlement of southern California altered the fire regime of coastal California by increasing the fire frequency. This was an era of very limited fire suppression, and yet like today, large crown fires covering tens of thousands of acres were not uncommon. One of the largest fires in Los Angeles County (60,000 acres) occurred in 1878, and the largest fire in Orange County's history, in 1889, was over half a million acres."[3]

Table 6-2: Large Historic Fires in California 1961-2003

20 Largest California Wildland Fires (Structures Destroyed)

	Fire Name	Date	County	Acres	Structures	Deaths
1	Tunnel	October 1991	Alameda	1,600	2,900	25
2	Cedar	October 2003	San Diego	273,246	2,820	14
3	Old	October 2003	San Bernardino	91,281	1,003	6
4	Jones	October 1999	Shasta	26,200	954	1
5	Paint	June 1990	Santa Barbara	4,900	641	1
6	Fountain	August 1992	Shasta	63,960	636	0
7	City of Berkeley	September 1923	Alameda	130	584	0
8	Bel Air	November 1961	Los Angeles	6,090	484	0
9	Laguna Fire	October 1993	Orange	14,437	441	0
10	Paradise	October 2003	San Diego	56,700	415	2
11	Laguna	September 1970	San Diego	175,425	382	5
12	Panorama	November 1980	San Bernardino	23,600	325	4
13	Topanga	November 1993	Los Angeles	18,000	323	3
14	49er	September 1988	Nevada	33,700	312	0
15	Simi	October 2003	Ventura	108,204	300	0
16	Sycamore	July 1977	Santa Barbara	805	234	0
17	Canyon	September 1999	Shasta	2,580	230	0
18	Kannan	October 1978	Los Angeles	25,385	224	0
19	Kinneloa	October 1993	Los Angeles	5,485	196	1
19	Grand Prix	October 2003	San Bernardino	59,448	196	0
20	Old Gulch	August 1992	Calaveras	17,386	170	0

http://www.fire.ca.gov/FireEmergencyResponse/HistoricalStatistics/PDF/20LSTRUCTURES.pdf

"Structures" is meant to include all loss - homes and outbuildings, etc.

During the 2002 fire season, more than 6.9 million acres of public and private lands burned in the US, resulting in loss of property, damage to resources and disruption of community services.[4] Taxpayers spent more than $1.6 billion[5] to combat more than 88,400 fires nationwide. Many of these fires burned in wildland/urban interface areas and exceeded the fire suppression capabilities of those areas. Table 6-3 illustrates fire suppression costs for state, private and federal lands.

Table 6-3: National Fire Suppression Costs

Year	Suppression Costs	Acres Burned	Structures Burned
2000	$1.3 billion	8,422,237	861
2001	$0.5 billion	3,570,911	731
2002	$1.6 billion	6,937,584	815

http://research.yale.edu/gisf/assets/pdf/ppf/wildfire_report.pdf

Wildfire Characteristics

There are three categories of interface fire:[6] The classic wildland/urban interface exists where well-defined urban and suburban development presses up against open expanses of wildland areas; the mixed wildland/urban interface is characterized by isolated homes, subdivisions and small communities situated predominantly in wildland settings; and the occluded wildland/urban interface exists where islands of wildland vegetation occur inside a largely urbanized area. Certain conditions must be present for significant interface fires to occur. The most common conditions include: hot, dry and windy weather; the inability of fire protection forces to contain or suppress the fire; the occurrence of multiple fires that overwhelm committed resources; and a large fuel load (dense vegetation). Once a fire has started, several conditions influence its behavior, including fuel topography, weather, drought and development.

Southern California has two distinct areas of risk for wildland fire. The foothills and lower mountain areas are most often covered with scrub brush or chaparral. The higher elevations of mountains also have heavily forested terrain. The lower elevations covered with chaparral create one type of exposure.

> "Past fire suppression is not to blame for causing large shrub land wildfires, nor has it proven effective in halting them." said Dr. Jon Keeley, a USGS fire researcher who studies both southern California shrub lands and Sierra Nevada forests. "Under Santa Ana conditions, fires carry through all chaparral regardless of age class. Therefore, prescribed burning programs over large areas to remove old stands and maintain young growth as bands of firebreaks resistant to ignition are futile at stopping these wildfires."[7]

The higher elevations of Southern California's mountains are typically heavily forested. The magnitude of the 2003 fires is the result of three primary factors: (1) severe drought, accompanied by a series of storms that produce thousands of lightning strikes and windy conditions; (2) an infestation of bark beetles that has killed thousands of mature trees;

and (3) the effects of wildfire suppression over the past century that has led to buildup of brush and small diameter trees in the forests.

> "When Lewis and Clark explored the Northwest, the forests were relatively open, with 20 to 25 mature trees per acre. Periodically, lightning would start fires that would clear out underbrush and small trees, renewing the forests. Today's forests are completely different, with as many as 400 trees crowded onto each acre, along with thick undergrowth. This density of growth makes forests susceptible to disease, drought and severe wildfires. Instead of restoring forests, these wildfires destroy them and it can take decades to recover. This radical change in our forests is the result of nearly a century of well-intentioned but misguided management."[8]

The Interface

One challenge Southern California faces regarding the wildfire hazard is from the increasing number of houses being built on the urban/wildland interface. Every year the growing population has expanded further and further into the hills and mountains, including forest lands. The increased "interface" between urban/suburban areas and the open spaces created by this expansion has produced a significant increase in threats to life and property from fires and has pushed existing fire protection systems beyond original or current design and capability. Property owners in the interface are not aware of the problems and threats they face. Therefore, many owners have done very little to manage or offset fire hazards or risks on their own property. Furthermore, human activities increase the incidence of fire ignition and potential damage.

Fuel

Fuel is the material that feeds a fire and is a key factor in wildfire behavior. Fuel is classified by volume and by type. Volume is described in terms of "fuel loading", or the amount of available vegetative fuel.

The type of fuel also influences wildfire. Chaparral is a primary fuel of Southern California wildfires. Chaparral habitat ranges in elevation from near sea level to over 5,000' in Southern California. Chaparral communities experience long dry summers and receive most of their annual precipitation from winter rains. Although chaparral is often considered as a single species, there are two distinct types; hard chaparral and soft chaparral. Within these two types are dozens of different plants, each with its own particular characteristics.

"Fire has been important in the life cycle of chaparral communities for over 2 million years; however, the true nature of the "fire cycle" has been subject to interpretation. In a period of 750 years, it generally thought that fire occurs once every 65 years in coastal drainages and once every 30 to 35 years inland."[9]

> "The vegetation of chaparral communities has evolved to a point it requires fire to spawn regeneration. Many species invite fire through the

> production of plant materials with large surface-to-volume ratios, volatile oils and through periodic die-back of vegetation. These species have further adapted to possess special reproductive mechanisms following fire. Several species produce vast quantities of seeds which lie dormant until fire triggers germination. The parent plant which produces these seeds defends itself from fire by a thick layer of bark which allows enough of the plant to survive so that the plant can crown sprout following the blaze. In general, chaparral community plants have adapted to fire through the following methods; a) fire induced flowering; b) bud production and sprouting subsequent to fire; c) in-soil seed storage and fire stimulated germination; and d) on plant seed storage and fire stimulated dispersal."[10]

An important element in understanding the danger of wildfire is the availability of diverse fuels in the landscape, such as natural vegetation, manmade structures and combustible materials. A house surrounded by brushy growth rather than cleared space allows for greater continuity of fuel and increases the fire's ability to spread. After decades of fire suppression "dog-hair" thickets have accumulated, which enable high intensity fires to flare and spread rapidly.

Topography
Topography influences the movement of air, thereby directing a fire course. For example, if the percentage of uphill slope doubles, the rate of spread in wildfire will likely double. Gulches and canyons can funnel air and act as chimneys, which intensify fire behavior and cause the fire to spread faster. Solar heating of dry, south-facing slopes produces up slope drafts that can complicate fire behavior. Unfortunately, hillsides with hazardous topographic characteristics are also desirable residential areas in many communities. This underscores the need for wildfire hazard mitigation and increased education and outreach to homeowners living in interface areas.

Weather
Weather patterns combined with certain geographic locations can create a favorable climate for wildfire activity. Areas where annual precipitation is less than 30 inches per year are extremely fire susceptible.[11] High-risk areas in Southern California share a hot, dry season in late summer and early fall when high temperatures and low humidity favor fire activity. The so-called "Santa Ana" winds, which are heated by compression as they flow down to Southern California from Utah, create a particularly high risk, as they can rapidly spread what might otherwise be a small fire.

Drought
Recent concerns about the effects of climate change, particularly drought, are contributing to concerns about wildfire vulnerability. The term drought is applied to a period in which an unusual scarcity of rain causes a serious hydrological imbalance. Unusually dry winters, or significantly less rainfall than normal, can lead to relatively drier conditions and leave reservoirs and water tables lower. Drought leads to problems with irrigation and may contribute to additional fires, or additional difficulties in fighting fires.

Development

Growth and development in scrubland and forested areas is increasing the number of human-made structures in Southern California interface areas. Wildfire has an effect on development, yet development can also influence wildfire. Owners often prefer homes that are private, have scenic views, are nestled in vegetation and use natural materials. A private setting may be far from public roads, or hidden behind a narrow, curving driveway. These conditions, however, make evacuation and fire fighting difficult. The scenic views found along mountain ridges can also mean areas of dangerous topography. Natural vegetation contributes to scenic beauty, but it may also provide a ready trail of fuel leading a fire directly to the combustible fuels of the home itself.

Wildfire Hazard Assessment

Wildfire Hazard Identification

Wildfire hazard areas are commonly identified in regions of the wildland/urban interface. Ranges of the wildfire hazard are further determined by the ease of fire ignition due to natural or human conditions and the difficulty of fire suppression. The wildfire hazard is also magnified by several factors related to fire suppression/control such as the surrounding fuel load, weather, topography and property characteristics. Generally, hazard identification rating systems are based on weighted factors of fuels, weather and topography.

Table 6-4 illustrates a rating system to identify wildfire hazard risk (with a score of 3 equaling the most danger and a score of 1 equaling the least danger.)

Table 6-4: Sample Hazard Identification Rating System

Category	Indicator	Rating
Roads and Signage	Steep; narrow; poorly signed	3
	One or two of the above	2
	Meets all requirements	1
Water Supply	None, except domestic	3
	Hydrant, tank, or pool over 500 feet away	2
	Hydrant, tank, or pool within 500 feet	1
Location of the Structure	Top of steep slope with brush/grass below	3
	Mid-slope with clearance	2
	Level with lawn, or watered groundcover	1
Exterior Construction	Combustible roofing, open eaves, Combustible siding	3
	One or two of the above	2
	Non-combustible roof, boxed eaves, non-combustible siding	1

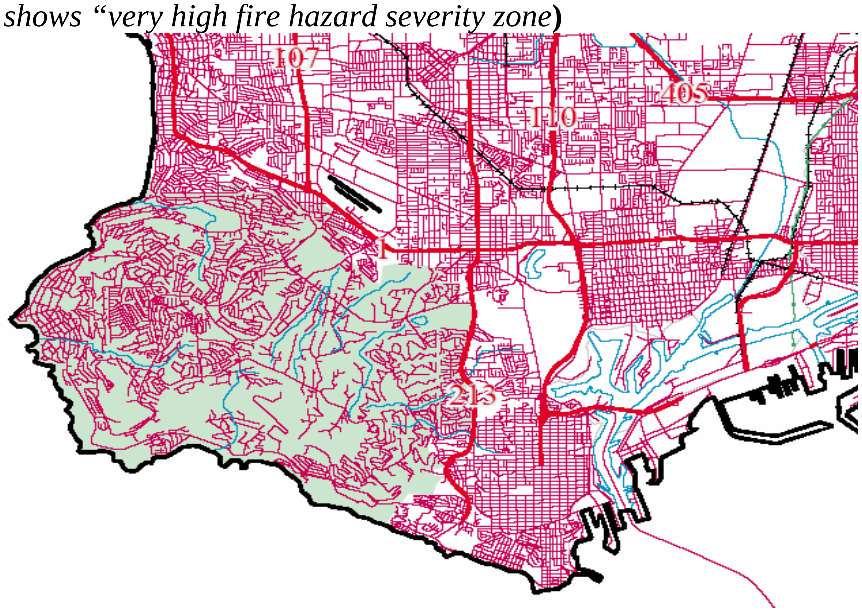
In order to determine the "base hazard factor" of specific wildfire hazard sites and interface regions, several factors must be taken into account. Categories used to assess the base hazard factor include:

Topographic location, characteristics and fuels
Site/building construction and design
Site/region fuel profile (landscaping)
Defensible space
Accessibility
Fire protection response
Water availability

The use of Geographic Information System (GIS) technology in recent years has been a great asset to fire hazard assessment, allowing further integration of fuels, weather and topography data for such ends as fire behavior prediction, watershed evaluation, mitigation strategies and hazard mapping.

In response to the disastrous 1991 Oakland Hills fire in the Bay Area, Assembly Bill 337 (the so-called "Bates bill"), as codified in Sections 51175-51189 of the California Government Code, required the Director of California Department of Forestry (CDF) to identify and designate Very High Fire Hazard Severity Zones (VHFHSZs) in certain specified counties (including Los Angeles County) by January 1, 1995, and in all remaining California counties by January 1, 1996. Both Cities, and in fact the entire Palos Verdes Peninsula, are designated as a VHFHSZ by the State, based upon information obtained from the California Department of Forestry and Fire Protection (CDF) website.

Map 6-1 California Division of Forestry and Fire Protection – January 2000.
(*Shaded area shows "very high fire hazard severity zone***)**



The designation of property as being located within a VHFHSZ imposes certain obligations for property maintenance upon property owners "in any mountainous area, forest-covered land, brush-covered land, grass-covered land, or any land that is covered with flammable material." Pursuant to Government Code Section 51182, these property owners are required to:

- Maintain around and adjacent to the dwelling or structure a firebreak made by removing and clearing away, for a distance of not less than 30 feet on each side thereof or to the property line, whichever is nearer, all flammable vegetation or other combustible growth. This paragraph does not apply to single specimens of trees, ornamental shrubbery, or similar plants that are used as ground cover, if they do not form a means of rapidly transmitting fire from the native growth to any dwelling or structure.

- Maintain around and adjacent to the occupied dwelling or occupied structure additional fire protection or firebreaks made by removing all brush, flammable vegetation, or combustible growth that is located from 30 feet to 100 feet from the occupied dwelling or occupied structure or to the property line, whichever is nearer, as may be required by the local agency if the local agency finds that, because of extra hazardous conditions, a firebreak of only 30 feet around the occupied dwelling or occupied structure is not sufficient to provide reasonable fire safety. Grass and other vegetation located more than 30 feet from the dwelling or structure and less than 18 inches in height above the ground may be maintained where necessary to stabilize the soil and prevent erosion.

- Remove that portion of any trees that extends within 10 feet of the outlet of any chimney or stovepipe.

- Maintain any tree adjacent to or overhanging any building free of dead or dying wood.

- Maintain the roof of any structure free of leaves, needles, or other dead vegetative growth.

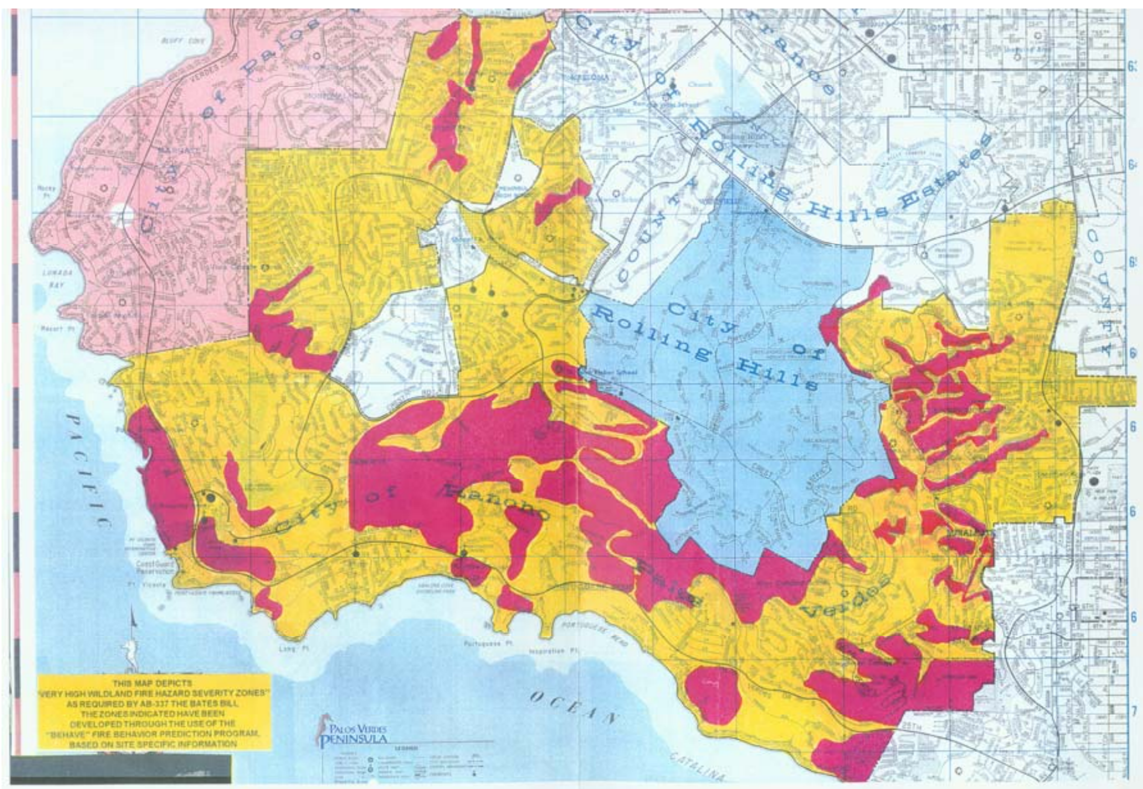
- Provide and maintain at all times a screen over the outlet of every chimney or stovepipe that is attached to any fireplace, stove, or other device that burns any solid or liquid fuel. The screen shall be constructed and installed in accordance with the California Building Standards Code.

It should be noted that Government Code Section 51184 provides an exemption from Section 51182 for property maintained as habitat for endangered and threatened species, and other sensitive open space and natural areas. In addition, upon sale or transfer of property located within a VHFHSZ, Government Code Section 51183.5 requires disclosure of this fact by the transferor of real property.

In addition to the attached County and Peninsula maps obtained from the CDF website, the City maintains a map that appears to have been prepared by the County Fire Department, which breaks down the City of Rancho Palos Verdes into Wildland Urban Interface (WUI) areas and Buffer Zones. The WUI areas generally correspond with undeveloped open areas and canyons, while the Buffer Zones consist of the built-out portions of the City. Given this, the property maintenance requirements delineated in Government Code Section 51182 are most likely to apply within the WUI areas that are not subject to the exemption under Government Code Section 51184 (see discussion above). Staff believes that these requirements are consistent with and at least as strict as the general brush-clearance requirements imposed by the County Fire Department.

Staff regularly provides copies of this VHFHSZ map to the public upon request. However, this map is more than nine years old and could be updated to reflect recent development within some of the WUI areas, most notably the *Oceanfront* and *Seabreeze* neighborhoods. Otherwise, it appears to be generally consistent with the CDF map of VHFHSZs.

Map 6-2: Rancho Palos Verdes Wildland Urban Interface Areas and Buffer Zones



Vulnerability and Risk

Southern California residents are served by a variety of local fire departments as well as county, state and federal fire resources. Data that includes the location of interface areas in the county can be used to assess the population and total value of property at risk from wildfire and direct these fire agencies in fire prevention and response.

Key factors included in assessing wildfire risk include ignition sources, building materials and design, community design, structural density, slope, vegetative fuel, fire occurrence and weather, as well as occurrences of drought.

The National Wildland/Urban Fire Protection Program has developed the Wildland/Urban Fire Hazard Assessment Methodology tool for communities to assess their risk to wildfire. For more information on wildfire hazard assessment refer to http://www.Firewise.org.

Community Wildfire Issues

What is Susceptible to Wildfire?

Growth and Development in the Interface

The hills and mountainous areas of Southern California are considered to be interface areas. The development of homes and other structures is encroaching onto the wildlands and is expanding the wildland/urban interface. The interface neighborhoods are characterized by a diverse mixture of varying housing structures, development patterns, ornamental and natural vegetation and natural fuels.

In the event of a wildfire, vegetation, structures and other flammables can merge into unwieldy and unpredictable events. Factors important to the fighting of such fires include access, firebreaks, proximity of water sources, distance from a fire station and available firefighting personnel and equipment. Reviewing past wildland/urban interface fires shows that many structures are destroyed or damaged for one or more of the following reasons:

Combustible roofing material
Wood construction
Structures with no defensible space
Fire department with poor access to structures
Subdivisions located in heavy natural fuel types
Structures located on steep slopes covered with flammable vegetation
Limited water supply
Winds over 30 miles per hour

Disruption of Critical Services

Critical facilities include police stations, fire stations, hospitals, shelters, and other facilities that provide important services to the community. These facilities and their services need to be functional during a wildfire event.

Road Access

Road access is a major issue for all emergency service providers. As development encroaches into the rural areas of the county, the number of houses without adequate turn-around space is increasing. In many areas, there is not adequate space for emergency vehicle turnarounds in single-family residential neighborhoods, causing emergency workers to have difficulty doing their jobs because they cannot access houses. As fire trucks are large, firefighters are challenged by narrow roads and limited access when there is inadequate turn around space, the fire fighters can only work to remove the occupants, but cannot safely remain to save the threatened structures.

Water Supply

Fire fighters in remote and rural areas are faced by limited water supply and lack of hydrant taps. Rural areas are characteristically outfitted with small diameter pipe water systems, inadequate for providing sustained fire fighting flows.

Summary

Periodically, the historical losses from wildfires in Southern California have been catastrophic, with deadly and expensive fires going back decades. Continued development into the interface areas will have growing impacts on the wildland/urban interface. Fire protection in the interface areas may rely more heavily on the landowner’s personal initiative to take measures to protect his or her own property. Therefore, public education and awareness may play a greater role in interface areas. In those areas with strict fire codes, property owners who are resistant to maintaining the minimum brush clearances may be cited for failure to clear brush. The continued growth and development increases the public need for natural hazards mitigation planning in Southern California.

Wildfire Endnotes

---

1 http://www.fire.ca.gov/php/2003fireseasonstats_v2.asp

2 http://www.fire.ca.gov/php/fire_er_content/downloads/2003LargeFires.pdf

3 http://www.usgs.gov/public/press/public_affairs/press_releases/pr1805m.html

4 http://www.nifc.gov/stats/wildlandfirestats.html

5 http://research.yale.edu/gisf/assets/pdf/ppf/wildfire_report.pdf

6 Planning for Natural Hazards: The Oregon Technical Resource Guide, (July 2000) Department of Land Conservation and Development

7 http://www.usgs.gov/public/press/public_affairs/press_releases/pr1805m.html

8 Overgrown Forests Require Preventive Measures, By Gale A. Norton (Secretary of the Interior), USA Today Editorial, August 21, 2002

[9] http://www.coastal.ca.gov/fire/ucsbfire.html

[10] Ibid

[11] Planning for Natural Hazards: The Oregon Technical Resource Guide, (July 2000), Department of Land Conservation and Development

Earth Movement (Landslides & Debris Flow) in the Joint Planning Area

Table of Contents

Why Are Landslides a Threat to the Planning Area?..page 3

Historic Southern California Landslides...page 3

Landslide Characteristics.....………………..page 5

What is a Landslide?...page 5

What is a Debris Flow................……………………...page 6

Landslide Impacts……………………..page 6

Landslide Conditions...page 7

Landslide Hazard Assessment ....page 9

Hazard Identification...page 9

Vulnerability and Risk...page 12

Community Landslide Issues...page 12

What Is Susceptible to Landslides? ....page 12

Landslide Mitigation Activities ....page 13

Community Issues Summary...page 14

Section 7:

Why are Landslides a Threat to the Planning Area?

Landslides are a serious geologic hazard in almost every state in America. Nationally, landslides cause 25 to 50 deaths each year.[1] The best estimate of direct and indirect costs of landslide damage in the United States range between $1 and $2 billion annually.[2] As a seismically active region, California has had significant number of locations impacted by landslides. In the planning area, this threat is exacerbated by local geologic conditions. Some landslides result in private property damage; other landslides impact transportation corridors, fuel and energy conduits, and communication facilities. They can also pose a serious threat to human life.

Landslides can be broken down into two categories: (1) rapidly moving (generally known as debris flows), and (2) slow moving. Rapidly moving landslides or debris flows present the greatest risk to human life, and people living in or traveling through areas prone to rapidly moving landslides are at increased risk of serious injury. Slow moving landslides can cause significant property damage, but are less likely to result in serious human injuries.

Historic Southern California Landslides

1928 St. Francis Dam failure, Los Angeles County
The dam gave way on March 12, and its waters swept through the Santa Clara Valley toward the Pacific Ocean, about 54 miles away. Sixty five miles of valley was devastated, and over 500 people were killed. Damages were estimated at $672.1 million (year 2000 dollars).[3]

1956 Portuguese Bend, Los Angeles County
Landslides have been active here for thousands of years, but recent landslide activity has been attributed in part to human activity. The Portuguese Bend landslide began its modern movement in August 1956, when displacement was noticed at its northeast margin during construction of the Crenshaw Boulevard extension from Crest Road to Palos Verdes Drive South. Movement gradually extended downslope so that the entire eastern edge of the slide mass was moving within 6 weeks. By the summer of 1957, the entire slide mass was sliding towards the sea.[4] Cost, $14.6 million (2000 dollars)

1958-1971 Pacific Palisades, Los Angeles County
This landslide damaged California Highway 1 and many house located upslope from the roadway.[5] Cost: $29.1 million (2000 dollars)

1961 Mulholland Cut, Los Angeles County
On Interstate 405, 11 miles north of Santa Monica, Los Angeles County.[6] Cost: $41.5 million (2000 dollars).

1963 Baldwin Hills Dam Failure, Los Angeles County
On December 14, the 650 foot long by 155 foot high earth fill dam gave way and sent 360 million gallons of water in a fifty foot high wall cascading onto the community below, killing five persons, and damaging 50 million (1963 dollars) of dollars in property.

1969 Glendora, Los Angeles County
175 houses were damaged, mainly by debris flows.[7] Cost: $26.9 million (2000 dollars).

1969 Seventh Ave., Los Angeles County
This landslide took place on California Highway 60.[8] Cost: $14.6 million (2000 dollars).

1970 Princess Park, Los Angeles County
This landslide took place on California Highway 14, 10 miles north of Newhall, near Saugus, in northern Los Angeles County.[9] Cost: $29.1 million (2000 dollars).

1971 Upper and Lower Van Norman Dams, Los Angeles County
The earthquake of February 9, 1971 (magnitude 7.5 in San Fernando, California), severely damaged the Upper and Lower Van Norman Dams.[10] Cost: $302.4 million (2000 dollars).

1971 Juvenile Hall, Los Angeles County
Landslides caused by the February 9, 1971, San Fernando, California, earthquake damaged the San Fernando Juvenile Hall. In addition, this 1.2 km-long slide damaged trunk lines of the Southern Pacific Railroad, San Fernando Boulevard, Interstate Highway 5, the Sylmar, California electrical converter station, and several pipelines and canals.[11] Cost: $266.6 million (2000 dollars).

1977-1980 Monterey Park & Repetto Hills, Los Angeles County
100 houses damaged in 1980 due to debris flows.[12] Cost: $14.6 million (2000 dollars).

1978 Bluebird Canyon, Orange County
On October 2, 1978, 60 houses were destroyed or damaged. Unusually heavy rains in March of 1978 may have contributed to initiation of the landslide. Although the 1978 slide area was approximately 3.5 acres, it is suspected to be a portion of a larger, ancient landslide.[13] Cost: $52.7 million (2000 dollars).

1979 Big Rock, California, Los Angeles County
This rockslide damaged California Highway 1.[14] Cost: approximately $1.08 billion (2000 dollars).

1980 Southern California slides
Heavy winter rainfall in 1979-80 caused damage in six Southern California counties. In 1980, the rainstorm started on February 8. A sequence of 5 days of continuous rain and 7 inches of precipitation had occurred by February 14. Slope failures were beginning to develop by February 15 and then very high-intensity rainfall occurred on February 16. As

much as 8 inches of rain fell in a 6 hour period in many locations. Records and personal observations in the field on February 16 and 17 showed that the mountains and slopes literally fell apart on those 2 days.[15] Cost: $1.1 billion in damage (2000 dollars).

1983 San Clemente, Orange County
This landslide involved California Highway 1. Litigation at that time involved approximately $43.7 million (2000 dollars).[16] Cost: $65 million (2000 dollars).

1983 Big Rock Mesa, Los Angeles
This event resulted in the condemnation of 13 houses, and 300 more threatened by rockslide caused by rainfall. [17] Cost: $706 million (2000 dollars) in legal claims.

1978-1979, 1980, San Diego County
Experienced major damage from storms in 1978, 1979, and 1979-80, as did neighboring areas of Los Angeles and Orange County, California. One hundred and twenty landslides were reported to have occurred in San Diego County during these 2 years. Rainfall for the rainy seasons of 78-79 and 79-80 was 14.82 and 15.61 inches (37.6 and 39.6 cm) respectively, compared to a 125-year average (1850-1975) of 9.71 inches (24.7 cm). Significant landslides occurred in the Friars Formation, a unit that was noted as slide-prone in the Seismic Safety Study for the City of San Diego. Of the nine landslides that caused damage in excess of $1 million, seven occurred in the Friars Formation, and two in the Santiago Formation in the northern part of San Diego County.[18]

1994 Northridge earthquake landslides, Los Angeles County
As a result of the magnitude 6.7 Northridge, California, earthquake, more than 11,000 landslides occurred over an area of 10,000 km2. Most were in the Santa Susana Mountains and in mountains north of the Santa Clara River Valley. The landslides destroyed dozens of homes, blocked roads, and damaged oil-field infrastructure. Also caused deaths from Coccidioidomycosis (valley fever) the spore of which was released from the soil by the landslide activity and blown toward the coastal populated areas.[19]

March 1995, Los Angeles and Ventura Counties
Above normal rainfall triggered damaging debris flows, deep-seated landslides, and flooding. Several deep-seated landslides were triggered by the storms, the most notable was the La Conchita landslide, which in combination with a local debris flow, destroyed or badly damaged 11 to 12 homes in the small town of La Conchita, about 20 km west of Ventura. There also was widespread debris-flow and flood damage to homes, commercial buildings, and roads and highways in areas along the Malibu coast that had been devastated by wildfire 2 years before.[20]

Landslide Characteristics

What is a landslide?

“A landslide is defined as, the movement of a mass of rock, debris, or earth down a slope. Landslides are a type of “mass wasting” which denotes any down slope movement of soil and rock under the direct influence of gravity. The term “landslide” encompasses events such as rock falls, topples, slides, spreads, and flows. Landslides can be initiated by rainfall, earthquakes, volcanic activity, changes in groundwater, disturbance and change of a slope by man-made construction activities, or any combination of these factors. Landslides can also occur underwater, causing tidal waves and damage to coastal areas. These landslides are called submarine landslides.”[21]

The size of a landslide usually depends on the geology and the initial cause of the landslide. Landslides vary greatly in their volume of rock and soil, the length, width, and depth of the area affected, frequency of occurrence, and speed of movement. Some characteristics that determine the type of landslide are slope of the hillside, moisture content, and the nature of the underlying materials. Landslides are given different names, depending on the type of failure and their composition and characteristics.

Slides move in contact with the underlying surface. These movements include rotational slides where sliding material moves along a curved surface, and translational slides where movement occurs along a flat surface. These slides are generally slow moving and can be deep. Slumps are small rotational slides that are generally shallow. Slow-moving landslides (inches per year) can occur on relatively gentle slopes and can cause significant property damage, but are far less likely to result in serious injuries than rapidly moving landslides.[22]

What is a Debris Flow?

A debris or mud flow is a river of rock, earth and other materials, including vegetation that is saturated with water.

“Failure of a slope occurs when the force that is pulling the slope downward (gravity) exceeds the strength of the earth materials that compose the slope. They can move slowly, (millimeters per year) or can move quickly and disastrously, as is the case with debris-flows. Debris-flows can travel down a hillside of speeds up to 200 miles per hour (more commonly, 30 – 50 miles per hour), depending on the slope angle, water content, and type of earth and debris in the flow. These flows are initiated by heavy, usually sustained, periods of rainfall, but sometimes can happen as a result of short bursts of concentrated rainfall in susceptible areas. Burned areas charred by wildfires are particularly susceptible to debris flows, given certain soil characteristics and slope conditions.”[23]

The high percentage of water gives the debris flow a very rapid rate of movement down a slope. Debris flows typically have speeds greater than 20 mile per hour, and can often move much faster.[24] This high rate of speed makes debris flows extremely dangerous to people and property in its path.

Landslide Impacts

Landslides are a common hazard in California. Weathering and the decomposition of geologic materials produces conditions conducive to landslides and human activity further exacerbates many landslide problems. Many landslides are difficult to mitigate, particularly in areas of large historic movement with weak underlying geologic materials. As communities continue to modify the terrain and influence natural processes, it is important to be aware of the physical properties of the underlying soils as they, along with climate, create landslide hazards. Even with proper planning, landslides will continue to threaten the safety of people, property, and infrastructure, but without proper planning, landslide hazards will be even more common and more destructive.

The increasing scarcity of build-able land, particularly in urban areas, increases the tendency to build on geologically marginal land. Additionally, hillside housing developments in Southern California are prized for the view lots that they provide.

Rock falls occur when blocks of material come loose on steep slopes. Weathering, erosion, or excavations, such as those along highways, can cause falls where the road has been cut through bedrock. They are fast moving with the materials free falling or bouncing down the slope. In falls, material is detached from a steep slope or cliff. The volume of material involved is generally small, but large boulders or blocks of rock can cause significant damage.

Earth flows are plastic or liquid movements in which land mass (e.g. soil and rock) breaks up and flows during movement. Earthquakes often trigger flows.[25] Debris flows normally occur when a landslide moves downslope as a semi-fluid mass scouring, or partially scouring soils from the slope along its path. Flows are typically rapidly moving and also tend to increase in volume as they scour out the channel.[26] Flows often occur during heavy rainfall, can occur on gentle slopes, and can move rapidly for large distances.

Landslide Conditions

Landslides are often triggered by periods of heavy rainfall. Earthquakes, subterranean water flow and excavations may also trigger landslides. Certain geologic formations are more susceptible to landslides than others. Human activities, including locating development near steep slopes, can increase susceptibility to landslide events. Landslides on steep slopes are more dangerous because movements can be rapid.

Although landslides are a natural geologic process, the incidence of landslides and their impacts on people can be exacerbated by human activities. Grading for road construction and development can increase slope steepness. Grading and construction can decrease the stability of a hill slope by adding weight to the top of the slope, removing support at the base of the slope, and increasing water content. Other human activities effecting landslides include: excavation, drainage and groundwater alterations, and changes in vegetation.[27]

Wildland fires in hills covered with chaparral are often a precursor to debris flows in burned out canyons. The extreme heat of a wildfire can create a soil condition in which the earth becomes impervious to water by creating a waxy-like layer just below the ground surface. Since the water cannot be absorbed into the soil, it rapidly accumulates on slopes, often gathering loose particles of soil in to a sheet of mud and debris. Debris flows can often originate miles away from unsuspecting persons, and approach them at a high rate of speed with little warning.

Natural Conditions
Natural processes can cause landslides or re-activate historical landslide sites. The removal or undercutting of shoreline-supporting material along bodies of water by currents and waves produces countless small slides each year. Seismic tremors can trigger landslides on slopes historically known to have landslide movement. Earthquakes can also cause additional failure (lateral spreading) that can occur on gentle slopes above steep streams and riverbanks.

Particularly Hazardous Landslide Areas
Locations at risk from landslides or debris flows include areas with one or more of the following conditions:

1. On or close to steep hills;
2. Steep road-cuts or excavations;
3. Existing landslides or places of known historic landslides (such sites often have tilted power lines, trees tilted in various directions, cracks in the ground, and irregular-surfaced ground);
4. Steep areas where surface runoff is channeled, such as below culverts, V -shaped valleys, canyon bottoms, engineered slopes with bench drains and swales, and steep stream channels; and
5. Fan-shaped areas of sediment and boulder accumulation at the outlets of canyons.
6. Canyon areas below hillside and mountains that have recently (within 1-6 years) been subjected to a wildland fire.

Impacts of Development
Although landslides are a natural occurrence, human impacts can substantially affect the potential for landslide failures in the planning area. Proper planning and geotechnical engineering can be exercised to reduce the threat of safety of people, property, and infrastructure.

Excavation and Grading
Slope excavation is common in the development of home sites or roads on sloping terrain. Grading these slopes can result in some slopes that are steeper than the pre-existing natural slopes. Since slope steepness is a major factor in landslides, these steeper slopes can be at an increased risk for landslides. The added weight of fill placed on slopes can also result in an increased landslide hazard. Small landslides can be fairly common along roads, in either the road cut or the road fill. Landslides occurring below new construction sites are indicators of the potential impacts stemming from excavation.

Drainage and Groundwater Alterations
Water flowing through or above ground is often the trigger for landslides. Any activity that increases the amount of water flowing into landslide-prone slopes can increase landslide hazards. Broken or leaking water or sewer lines can be especially problematic, as can water retention facilities that direct water onto slopes. However, even lawn irrigation in landslide prone locations can result in damaging landslides. Ineffective storm water management and excess runoff can also cause erosion and increase the risk of landslide hazards. Drainage can be affected naturally by the geology and topography of an area; Development that results in an increase in impervious surface impairs the ability of the land to absorb water and may redirect water to other areas. Channels, streams, ponding, and erosion on slopes all indicate potential slope problems.

Road and driveway drains, gutters, downspouts, and other constructed drainage facilities can concentrate and accelerate flow. Ground saturation and concentrated velocity flow are major causes of slope problems and may trigger landslides.[28]

Changes in Vegetation
Removing vegetation from very steep slopes can increase landslide hazards. Areas that experience wildfire and land clearing for development may have long periods of increased landslide hazard. Also, certain types of ground cover have a much greater need for constant watering to remain green or those with shallow root systems that have limited ability to hold the slope in wet conditions. Changing away from native and/or drought tolerant ground cover plants may also increase the risk of landslide.

Landslide Hazard Assessment

Hazard Identification

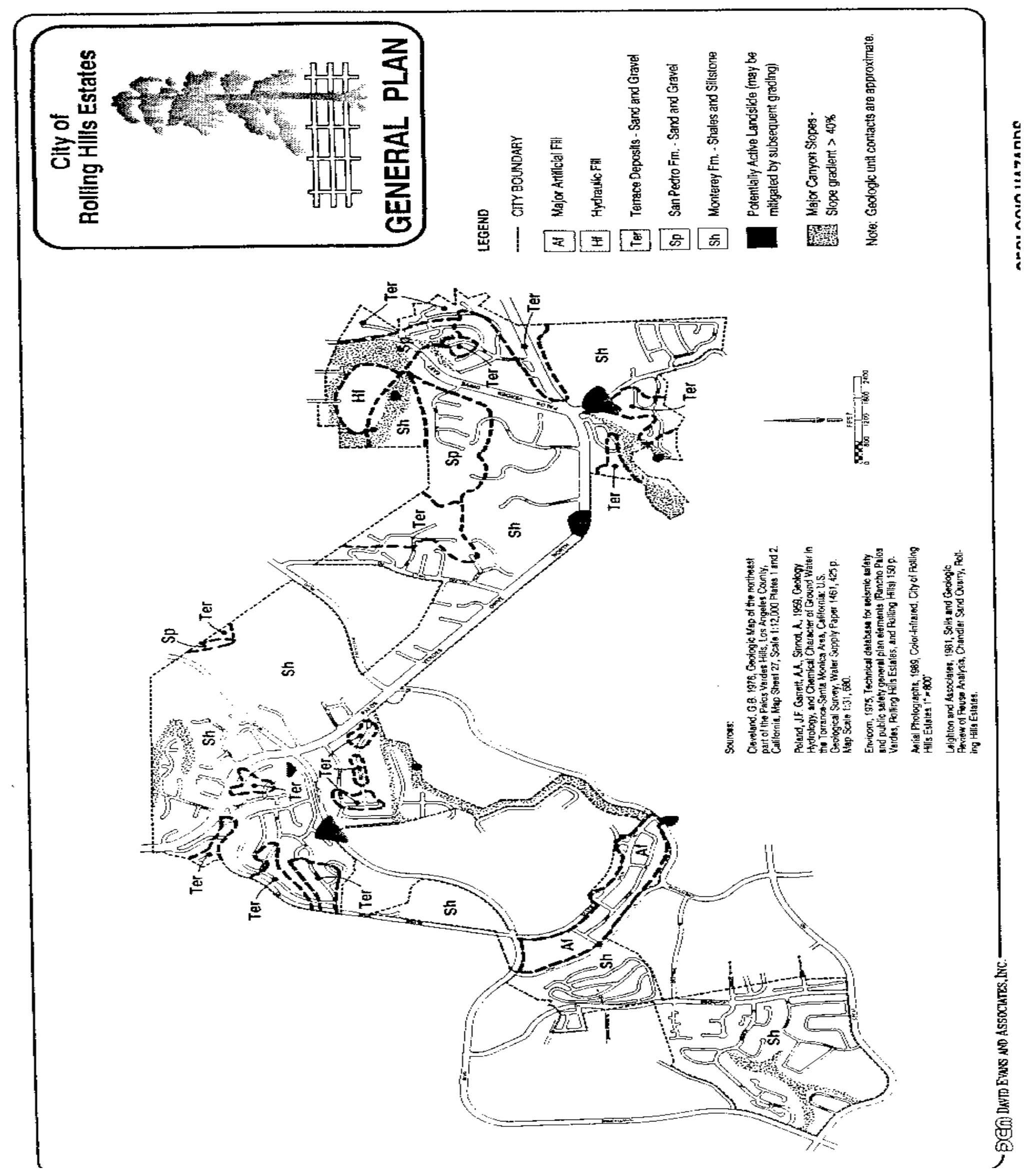
Identifying hazardous locations is an essential step towards implementing more informed mitigation activities.

According to the RHE General Plan (August 1992), the majority of the Peninsula is underlain by shale and siltstone units of the Monterey Formation. These interbedded units have planes of weakness that are conducive to landsliding and slope instability. RHE has not experienced the type of massive landslides that have taken place in RPV (i.e. Portuguese Bend) and the adjacent City of Rolling Hills (i.e. Flying Triangle). Nevertheless, the RHE General Plan states that small landslides in the canyon areas and one large postulated landslide complex northeast of the Peninsula Center area do exist.

Slope modification during grading can render slopes unstable. Slope instability occurs when bedding planes intersect the slope face of either natural slopes or designed cut slopes. Site specific investigations are necessary to determine potential slope instability problems at specific sites.

Map 7-1 shows the distribution of probable landslides in RHE, some of which may have been subsequently verified and stabilized through grading activity. Landslides are considered “potentially active”, meaning they could be reactivated in the future, either by excessive rainfall, introduction of artificial water in the slope (landscaping irrigation/broken water or sewage lines), or improper site design or grading practices. Grading activities must consider these geologic constraints as a condition of project approval. The County of Los Angeles Public Works Department acts as reviewer for the City of Rolling Hills Estates to ensure all potential geologic problems are addressed.

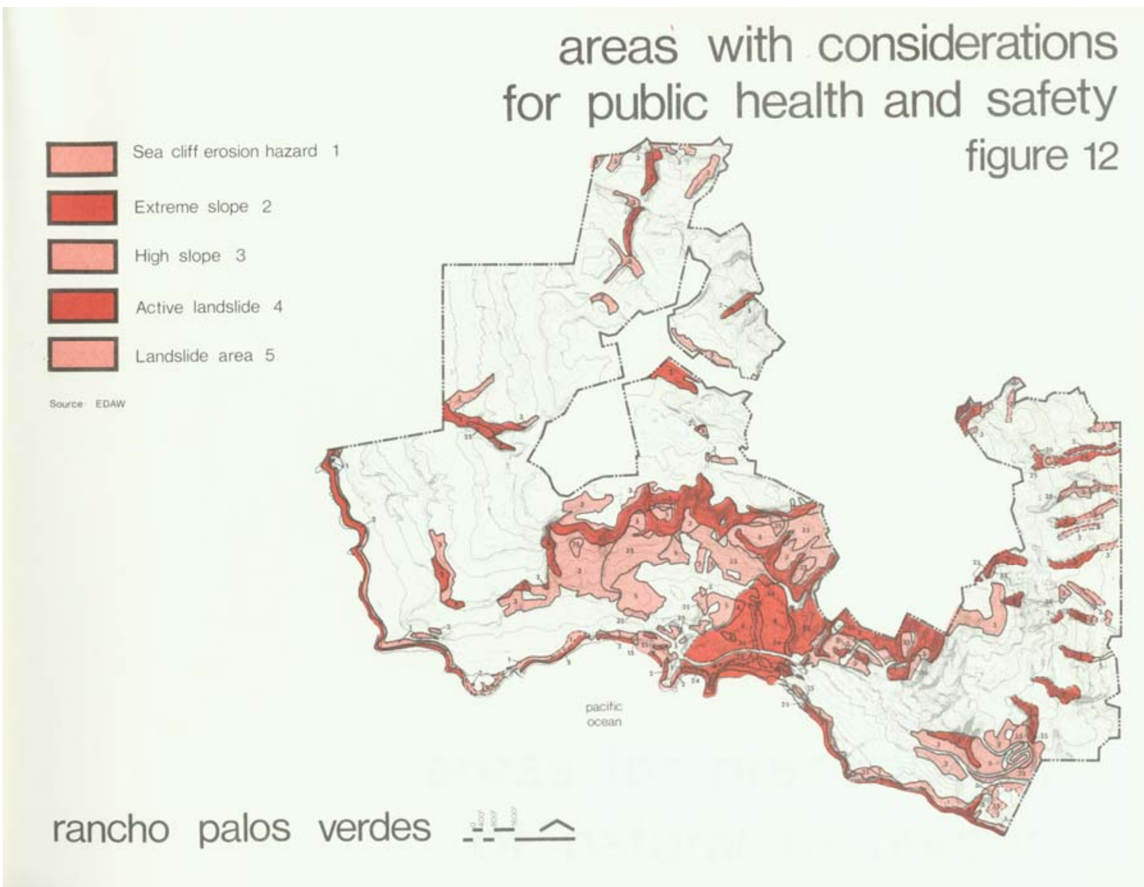
MAP 7-1 RHE Probable Landslide Areas (Source RHE General Plan)



The RHE General Plan identifies the Silver Spur Landslide Complex (northwest-southeast trending valley along Silver Spur Road) as possibly extending as far northeast as Palos Verdes Drive North and at least as far east as Crenshaw Boulevard.

In its Natural Environment Element, the RPV General Plan (June 1975) discusses the significance slope stability on development patterns and public safety in the community. In determining which areas within RPV are susceptible to earth movement, the RPV General Plan identifies several key factors, including active landslide areas, potential landslide areas, areas with high slopes (between 25% and 35% in steepness), areas with extreme slopes (35% or greater) and areas prone to sea cliff erosion hazard. Although each of these factors is mapped separately in the City's document, a composite map of these five factors called "Areas for Consideration of Public Health and Safety" is also included in the RPV General Plan. That composite map is presented below as Map 7-2.

MAP 7-2 RPV Areas for Consideration of Public Health and Safety (Source RPV General Plan)



Seismic Hazard Zones Map No. SHZF9, as published by the California Department of Conservation, Division of Mines and Geology, identifies those areas in both Cities that have the potential of seismic induced liquefaction and landslide. Specific geologic and geotechnical reports are required in those areas identified as vulnerable (see Section 5: Earthquake).

Vulnerability and Risk

Vulnerability assessment for landslides will assist in predicting how different types of property and population groups will be affected by a hazard.[29] Data that includes specific landslide-prone and debris flow locations in the planning area can be used to assess the population and total value of property at risk from future landslide occurrences.

Both Cities use percent of slope as a general indicator of hill slope stability. The City of Rancho Palos Verdes uses a 35% or greater threshold, and the City of Rolling Hills Estates uses a 33.3% or greater threshold to identify potentially unstable hill slopes.

While a quantitative vulnerability assessment (an assessment that describes number of lives or amount of property exposed to the hazard) has not yet been conducted for the planning area landslide events, there are many qualitative factors that point to potential vulnerability. Landslides can impact major transportation arteries, blocking residents from essential services and businesses.

Past landslide events have caused major property damage or significantly impacted city residents, and continuing to map city landslide and debris flow areas will help in preventing future loss.

Factors included in assessing landslide risk include population and property distribution in the hazard area, the frequency of landslide or debris flow occurrences, slope steepness, soil characteristics, and precipitation intensity. This type of analysis could generate estimates of the damages to the city due to a specific landslide or debris flow event. At the time of publication of this plan, data was insufficient to conduct a risk analysis and the software needed to conduct this type of analysis was not available.

Community Landslide Issues

What is Susceptible to Landslides?

Landslides can affect utility services, transportation systems, and critical lifelines. Communities may suffer immediate damages and loss of service. Disruption of infrastructure, roads, and critical facilities may also have a long-term effect on the economy. Utilities, including potable water, wastewater, telecommunications, natural gas, and electric power are all essential to service community needs. Loss of electricity has the most widespread impact on other utilities and on the whole community. Natural gas pipes may also be at risk of breakage from landslide movements as small as an inch or two.

Roads

Losses incurred from landslide hazards in the planning area have been associated with roads. RPV uses a private contractor and RHE uses the Los Angeles County Public Works Department for responding to slides that inhibit the flow of traffic or are damaging a road. The Cities do their best to communicate with residents impacted by landslides, but can usually only repair the road itself, as well as the areas adjacent to the slide where the Cities have the right of way.

It is not cost effective to mitigate all slides because of limited funds and the fact that some historical slides are likely to become active again even with mitigation measures. The Cities alleviate problem areas by grading slides, and by installing new drainage systems on the slopes to divert water from the landslides. This type of response activity is often the most cost-effective in the short-term, but is only temporary. Unfortunately, many property owners are unaware of slides and the dangers associated with them.

Lifelines and Critical Facilities
Lifelines and critical facilities should remain accessible, if possible, during a natural hazard event. The impact of closed transportation arteries may be increased if the closed road or bridge is critical for hospitals and other emergency facilities. Therefore, inspection and repair of critical transportation facilities and routes is essential and should receive high priority. Losses of power and phone service are also potential consequences of landslide events. Due to heavy rains, soil erosion in hillside areas can be accelerated, resulting in loss of soil support beneath high voltage transmission towers in hillsides and remote areas. Flood events can also cause landslides, which can have serious impacts on gas lines that are located in vulnerable soils.

Landslide Mitigation Activities

Landslide mitigation activities include current mitigation programs and activities that are being implemented by local or city organizations.

Landslide Building/Zoning Codes
The planning area Building/Zoning Codes address development on steep slopes in subsection 1806.1.1 of the 2002 Los Angeles County Building Code. This section outlines standards for steep slope hazard areas on slopes of 33.3% or more. Generally, the ordinance requires soils and engineering geologic studies for developments proposed on slopes of 33.3% or greater. More detailed surface and subsurface investigations shall be warranted if indicated by engineering and geologic studies to sufficiently describe existing conditions. This may include soils, vegetation, geologic formations, and drainage patterns. Site evaluations may also occur where stability might be lessened by proposed grading/filling or land clearing.

Landslide Mitigation Action Items
The landslide mitigation action items provide direction on specific activities that the city, organizations, and residents in the planning area can undertake to reduce risk and prevent loss from landslide events. Each action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation.

Community Issues Summary

Landslides are a problem in the both Cities in the planning area, often impacting public infrastructure as well as private property. Known landslide hazard areas have been mapped and continuing to be studied. Both Cities use geologic reviews, building restrictions and landslide abatement activities in order to protect public infrastructure and reduce private property losses. Continued public education is important to inform residents on methods to protect their own properties from the hazards of earth movement.

Landslide Endnotes

1. Mileti, Dennis, *Disasters by Design: A Reassessment of Natural Hazards in the United States* (1999) Joseph Henry Press, Washington D.C.

2. Brabb, E.E., and B.L Harrod. (Eds) *Landslides: Extent and Economic Significance. Proceedings of the 28th International Geological Congress Symposium on Landslides.* (1989) Washington D.C., Rotterdam: Balkema.

3. Highland, L.M., and Schuster, R.L., *Significant Landslide Events in the United States.* (No Date) USGS, Washington D.C., http://landslides.usgs.gov.html_files/pubs/report1/Landslides_pass_508.pdf

4. Ibid.

5. Ibid.

6. Ibid.

7. Ibid.

8. Ibid.

9. Ibid.

10. Ibid.

11. Ibid.

12. Ibid.

13. Ibid.

14. Ibid.

15. Ibid.

16. Ibid.

17. Ibid.

18. Ibid.

19. Ibid.

20. Ibid.

21. Landslide Hazards, U.S. Geological Survey Fact Sheet 0071-00, Version 1.0, U.S. Department of the Interior - U.S. Geological Survey, http://pubs.usgs.gov/fs/fs-0071-00/

22. Interagency Hazard Mitigation Team, *State Hazard Mitigation Plan* (2000) Oregon Emergency Management

23. Ibid.

24. Barrows, Alan and Smith, Ted, DMG Note 13, http://www.consrv.ca.gov/cgs/information/publications/cgs_notes/note_33/

25. Robert Olson Associates, *Metro Regional Hazard Mitigation and Planning Guide* (June 1999) Metro

26. Ibid.

27. Planning For Natural Hazards: *The Oregon Technical Resource Guide*, Department of Land Conservation and Development (2000), Ch 5.

28. *Homeowners Guide for Landslide Control, Hillside Flooding, Debris Flows, Soil Erosion*, (March 1997)

29. Burby, R. (Ed.) *Cooperating With Nature* (1998) Washington, D.C.: Joseph Henry Press.

`

Tsunami Hazards in the Joint Planning Area

Table of Contents

What Are Tsunamis?....3

Why Are Tsunamis a Threat to the Planning Area?....3

History of Tsunami Events....3

What Causes Tsunamis?....6

Tsunami Characteristics....9

Tsunami Hazard Assessment....9

Vulnerability and Risk....10

Community Tsunami Issues....14

What Is Susceptible to Tsunami?....14

Section 8:

What are Tsunamis?

The natural phenomenon called “tsunami” (soo-NAH-mee) is a series of traveling ocean waves of extremely long length generated primarily by earthquakes occurring below or near the ocean floor. Underwater volcanic eruptions and landslides can also generate tsunamis. In the deep ocean, the tsunami waves move across the deep ocean with a speed exceeding 500 miles per hour, and a wave height of only a few inches. Tsunami waves are distinguished from ordinary ocean waves by their great length between wave crests, often exceeding 60 miles or more in the deep ocean, and by the time between these crests, ranging from 10 minutes to an hour.

What makes tsunamis a natural hazard is the fact that, as they reach the shallow waters of the coast, the waves slow down and the water can pile up into a wall of destruction up to 30 feet or more in height. The effect can be amplified where a bay, harbor or lagoon funnels the wave as it moves inland. Large tsunamis have been known to rise over 100 feet. Even a tsunami 1-3 feet high can be very destructive and cause many deaths and injuries.

Why Are Tsunamis a Threat to the Planning Area?

“Since 1812, the California coast has had 14 tsunamis with wave heights higher than three feet; six of these were destructive. The Channel Islands were hit by a big tsunami in the early 1800s. The worst tsunami resulted from the 1964 Alaskan earthquake and caused 12 deaths and at least $17 million in damages in northern California.”[1]

History has shown that the probability of a tsunami in the planning area is a relatively low threat. However, the planning area has 7 ½ miles of coastline in the City of Rancho Palos Verdes. If a tsunami should occur, the consequences would be great. The impact could cause loss of life, destroy many high priced homes along the bluffs and greatly affect City’s many coastal public parks and commercial businesses, such as the Ocean Trails Golf Course and the proposed Long Point Resort Hotel project. Even if all residents and visitors were safely evacuated, the damage to property would still be tremendous.

History of Tsunami Events

Tsunamis can be categorized as Pacific-wide and “local.” Typically, a Pacific-wide tsunami is generated by major vertical ocean bottom movement in offshore deep trenches. A ”local” tsunami can be a component of the Pacific-wide tsunami in the area of the earthquake or a wave that is confined to the area of generation within a bay or harbor and caused by movement of the bay itself or landslides.

Pacific-wide and Regional Tsunamis

The last large tsunami that caused widespread death and destruction throughout the

Pacific was generated by an earthquake located off the coast of Chile in 1960. It caused loss of life and property damage not only along the Chile coast but also in Hawaii and as far away as Japan. The Great Alaskan Earthquake of 1964 killed 106 people and produced deadly tsunami waves in Alaska, Oregon and California.

In July 1993, a tsunami generated in the Sea of Japan killed over 120 people in Japan. Damage also occurred in Korea and Russia but spared other countries since the tsunami wave energy was confined within the Sea of Japan. The 1993 Japan Sea tsunami is known as a "regional event" since its impact was confined to a relatively small area. For people living along the northwestern coast of Japan, the tsunami waves followed the earthquake within a few minutes.

During the 1990's, destructive regional tsunamis also occurred in Nicaragua, Indonesia, the Philippines, Papua New Guinea, and Peru, killing thousands of people. Others caused property damage in Chile and Mexico. Some damage also occurred in the far field in the Marquesas Islands (French Polynesia) from the July 30, 1995, Chilean and February 21, 1996, Peruvian tsunamis.

In less than a day, tsunamis can travel from one side of the Pacific to the other. However, people living near areas where large earthquakes occur may find that the tsunami waves will reach their shores within minutes of the earthquake. For these reasons, the tsunami threat to many areas such as Alaska, the Philippines, Japan and the United States West Coast can be immediate (for tsunamis from nearby earthquakes which take only a few minutes to reach coastal areas) or less urgent (for tsunamis from distant earthquakes which take from three to 22 hours to reach coastal areas).

Local

The local tsunami may be the most serious threat as it strikes suddenly. When associated with earthquakes, sometimes the tsunami can hit the coastline before the earthquake shaking stops. Alaska has had six serious local tsunamis in the last 80 years and Japan has had many more.

Tsunamis have been documented extensively in California since 1806. Although the majority of tsunamis have occurred in Northern California, Southern California has been impacted as well. In the 1930's, four tsunamis struck the LA, Orange County, and San Diego coastal areas. In Orange County the tsunami wave reached heights of 20 feet or more above sea level. In 1964, following the Alaska 8.2 earthquake, tidal surges of approximately 4 feet to 5 feet hit the Huntington Harbor area causing moderate damage. Two eyewitness accounts of the tsunami that hit the Huntington Harbor in 1964 are recounted below:

Personal Interview

Name:	Bill Richardson (paraphrased by Glorria Morrison)
Title:	City of Huntington Beach Lifeguard
Year:	1964 – Alaska Good Friday Earthquake and Tsunami

I was the lifeguard in the tower on the pier. We received warning by phone from the Fire Department who had received information from the National Weather Service. We were told to tell folks on the pier and beach that if the situation escalated they would be advised to evacuate the area and that they should be prepared to move quickly.

I witnessed heavy title surges on the beaches. The tide changed in 10 minutes from what it normally was to a very different tide. Normally it takes six hours to change and in 10 minutes it sucked water out and when it came in, it went over the berm, ¾ of the way across the beach. The accelerated tide within one hour came and went twice. The highs were extreme and the lows were extreme, very like our astronomical tides. I monitored the radio and heard of all the docks breaking loose in the harbor. The current was so strong and movement of water that the radio was being overwhelmed with calls for response. Only the two islands of Admiralty and Gilbert existed at the time.

Personal Interview

Name:	Walt Snyder (paraphrased by Glorria Morrison)
Title:	City of Huntington Beach City Lifeguard Lt.
Year:	1964 – Alaska Good Friday Earthquake and Tsunami

I was called out at daybreak due to the tidal surges in the Huntington Harbor. I got in the City's only rescue boat. The tidal surges were huge and making whirlpools. They were moving at a much faster and higher rate than normal tide.

When the surges would come in, they would tear the boats away from their moorings. Then when the surges would go out, they would take the boats through the bridge at Pacific Coast Highway to the Seal Beach (Anaheim Landing Bridge) and when they hit the pilings it would tear the boats apart. The high tides were carrying the boats into the weapons station. When surges retreated, the boats would end up on dry land at the weapons station --- high and dry and broken up.

In 1964 there were only about 200-300 boats in the harbor and today. Walt estimated there are 3,500 plus boats. There were only 300-400 homes then and now he estimates an excess of 5,000. This occurred during a low tide. The sea wall in Huntington Harbor is 9'. Had this occurred during a high tide, Walt stated the surges would have easily gone over the sea walls and damaged many homes.

Table 8-1 below summarizes tsunami events that have occurred in California since 1930:

Table 8-1: Tsunami Events In California 1930-2004

Date	Location	Maximum Run up*(m)	Earthquake Magnitude
08/31/1930	Redondo Beach	6.10	5.2
08/31/1930	Santa Monica	6.10	5.2
08/31/1930	Venice	6.10	5.2
03/11/1933	La Jolla	0.10	6.3
03/11/1933	Long Beach	0.10	6.3
08/21/1934	Newport Beach	12.00	Unknown
02/09/1941	San Diego	Unknown	6.6
10/18/1989	Monterey	0.40	7.1
10/18/1989	Moss Landing	1.00	7.1
10/18/1989	Santa Cruz	0.10	7.1
04/25/1992	Arena Cove	0.10	7.1
04/25/1992	Monterey	0.10	7.1
09/01/1994	Crescent City	0.14	7.1
11/04/2000	Point Arguello	5.00	
Source: Worldwide Tsunami Database www.ngdc.noaa.gov			

* Maximum Run up (M)-The maximum water height above sea level in meters. The run-up is the height the tsunami reached above a reference level such as mean sea level. It is not always clear which reference level was used.

What Causes Tsunamis?

There are many causes of tsunamis, but the most prevalent is earthquakes. In addition, landslides, volcanic eruptions, explosions, and even the impact of cosmic bodies, such as meteorites, can generate tsunamis.

Plate Tectonics

Underwater earthquakes can be caused by volcanic activity, but most are generated by movements along fault zones associated with the plate boundaries. Plate Tectonic theory is based on an earth model characterized by a small number of lithospheric plates, 40 to 150 miles thick, which float on a viscous under-layer called the asthenosphere. These plates, which cover the entire surface of the earth and contain both the continents and sea floor, move relative to each other at rates of up to several inches per year. The region where two plates come in contact is called a plate boundary, and the way in which one plate moves relative to another determines the type of boundary: spreading, where the two plates move away from each other; subduction, where the two plates move toward each other and one slides beneath the other; and transform, where the two plates slide horizontally past each other. Subduction zones are characterized by deep ocean trenches, and the volcanic islands or volcanic mountain chains associated with the many subduction zones around the Pacific Rim are sometimes called the "Ring of Fire."

Most strong oceanic earthquakes, representing 80% of the total energy released worldwide by earthquakes, occur in subduction zones where an oceanic plate slides under a continental plate or another younger oceanic plate. However, not all earthquakes generate tsunamis. To generate a tsunami, the fault where the earthquake occurs must be underneath or near the ocean, and cause vertical movement of the sea floor over a large area, hundreds or thousands of square miles. "By far, the most destructive tsunamis are generated from large, shallow earthquakes with an epicenter or fault line near or on the ocean floor."[2] The amount of vertical and horizontal motion of the sea floor, the area over which it occurs, the simultaneous occurrence of slumping of underwater sediments due to the shaking, and the efficiency with which energy is transferred from the earth's crust to the ocean water are all part of the tsunami generation mechanism. The sudden vertical displacements over such large areas, disturb the ocean's surface, displace water, and generate destructive tsunami waves.[3] Although all oceanic regions of the world can experience tsunamis, the most destructive and repeated occurrences of tsunamis are in the Pacific Rim region.

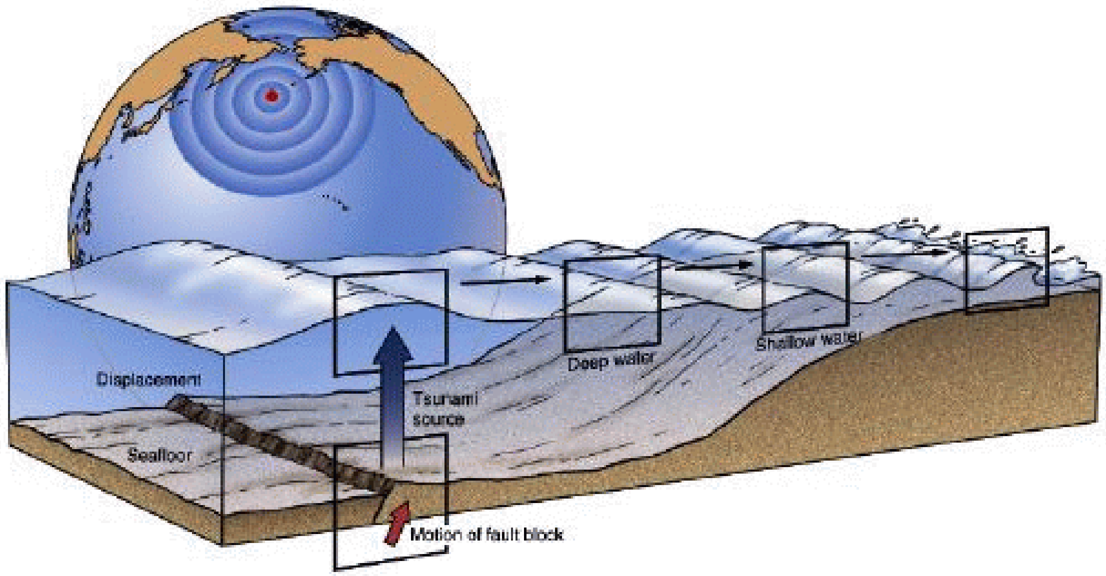
Tsunami Earthquakes

The September 2, 1992 earthquake (magnitude 7.2) was barely felt by residents along the coast of Nicaragua. Located well off-shore, the severity of shaking on a scale of I to XII, was mostly II along the coast, and reached III at only a few places. Twenty to 70 minutes after the earthquake occurred, a tsunami struck the coast of Nicaragua with wave amplitudes up to 13 feet above normal sea level in most places and a maximum run-up height of 35 ft. The waves caught coastal residents by complete surprise and caused many casualties and considerable property damage.

This tsunami was caused by a "tsunami earthquake," an earthquake that produces an unusually large tsunami relative to the earthquake magnitude. Tsunami earthquakes are characterized by a very shallow focus, fault dislocations greater than several meters, and fault surfaces that are smaller than for a normal earthquake.

Tsunami earthquakes are also slow earthquakes, with slippage along the fault beneath the sea floor occurring more slowly than it would in a normal earthquake. The only known method to quickly recognize a tsunami earthquake is to estimate a parameter called the seismic moment using very long period seismic waves (more than 50 seconds/cycle). Two other destructive and deadly tsunamis from tsunami earthquakes have occurred in recent years in Java, Indonesia (June 2, 1994) and Peru (February 21, 1996).

Figure 8-1: Tsunami Formation Following an Earthquake



Landslides
Although less common worldwide, tsunami waves can be generated from the displacement of water resulting from rock falls, icefall and sudden submarine landslides. These types of events may be caused spontaneously from the instability and sudden failure of submarine slopes. The ground motions of a strong earthquake can also sometimes trigger them. In the 1980's, earth moving and construction work of an airport runway along the coast of Southern France, triggered an underwater landslide, which generated destructive tsunami waves in the harbor of Thebes, Egypt.[4]

According to the Rancho Palos Verdes General Plan, the Palos Verdes Peninsula was uplifted above sea level by movement on two sub-parallel bounding faults, the Palos Verdes Fault on the northeast and the San Pedro Fault offshore on the southwest. Similar geologic phenomenon created the Channel Islands that lie offshore from the Peninsula. Submarine topographic mapping of the San Pedro Channel and Redondo Beach Trench have reveled that, similar to the marine terraces that form the Peninsula, there are a series of steep slopes between the Peninsula coastline and Catalina Island. Similar to the ancient landslides that have been documented on the Peninsula, some of these slopes show evidence of failure. Therefore, it is conceivable that a local tsunami could be generated by an underwater landslide or avalanche.

Tsunami Characteristics

How Fast?

Unnoticed tsunami waves can travel at the speed of a commercial jet plane, over 500 miles per hour. They can move from one side of the Pacific Ocean to the other in less than a day. This great speed makes it important to be aware of the tsunami as soon as it is generated. Scientists can predict when a tsunami will arrive at various places by knowing the source characteristics of the earthquake or other event that generated the tsunami and the characteristics of the sea floor along the paths to those places. Tsunamis travel much slower in more shallow coastal waters where their wave heights begin to increase dramatically.

How Big?

Offshore and coastal features can determine the size and impact of tsunami waves. Reefs, bays, entrances to rivers, undersea features and the slope of the beach all help to modify the tsunami as it attacks the coastline. When the tsunami reaches the coast and moves inland, the water level can rise many feet. In extreme cases, water level has risen to more than 50 feet for tsunamis of distant origin and over 100 feet for tsunami waves generated near the earthquake's epicenter. The first wave may not be the largest in the series of waves. One coastal community may see no damaging wave activity while in another nearby community destructive waves can be large and violent. The flooding can extend inland by 1,000 feet or more, covering large expanses of land with water and debris.

How Frequent?

Since scientists cannot predict when earthquakes and landslides will occur, they cannot determine exactly when a tsunami will be generated. However, by looking at past historical tsunamis and run-up maps, scientists know where tsunamis are most likely to be generated. Past tsunami height measurements are useful in predicting future tsunami impact and flooding limits at specific coastal locations and communities.

Tsunami Hazard Assessment

Hazard Identification

Several agencies are studying tsunami safety issues: National Oceanic and Atmospheric Administration's (NOAA) National Weather Service, Alaska Tsunami Warning Center in Palmer, Alaska, Governor's Office of Emergency Services, Los Angeles County Office of Emergency Services, University of Southern California and private institutions, such as Applied Fluids Engineering in Long Beach, California.

These organizations have undertaken efforts to identify tsunami hazards and risks, including earthquake fault and probable landslide area mapping, raising public awareness and education about tsunami hazards and preparing computer models to predicted wave height, inundation zones, wave turbulence, ship movement and erosion.

Vulnerability and Risk

Tsunamis cause damage in three ways: inundation, wave impact, and erosion.

> "Strong, tsunami-induced currents lead to the erosion of foundations and the collapse of bridges and sea walls. Flotation and drag forces move houses and overturn railroad cars. Considerable damage is caused by the resultant floating debris, including boats and cars that become dangerous projectiles that may crash into buildings, break power lines, and may start fires. Fires from damaged ships in ports or from ruptured coastal oil storage tanks and refinery facilities can cause damage greater than that inflicted directly by the tsunami. Of increasing concern is the potential effect of tsunami draw down, when receding waters uncover cooling water intakes of nuclear power plants."[5]

A United States Government study reports that, "Local earthquakes will not generate a tsunami, in this area." Dangerous Pacific-wide tsunamis would most likely originate from large offshore earthquakes in the Aleutian and Chilean offshore submarine trenches. The City of Rancho Palos Verdes has some southwestern facing beaches that are vulnerable to Pacific tsunamis or tidal surges from the south and from the west.

Predicted wave heights in Southern California generated by a Pacific-wide tsunami, exclusive of tide and storm generated wave heights, are:

For a 100 year occurrence	For a 500 year occurrence
4.0 feet minimum	6.8 feet minimum
6.6 feet average	11.4 feet average
9.2 feet maximum	16.0 feet maximum

An ocean landslide occurring in the San Pedro Channel or Redondo Beach Trench would be the most likely source of a local tsunami impacting the Palos Verdes Peninsula coastline.

Applied Fluids Engineering, a private research firm, has prepared a computer simulation of an ancient submarine landslide that occurred in the San Pedro Channel and the impacts that the resulting local tsunami would have along the southern coast of the planning area, as well as the Los Angeles and Long Beach Harbors. The simulation is based on a historical submarine landslide event parameters summarized in the table below:

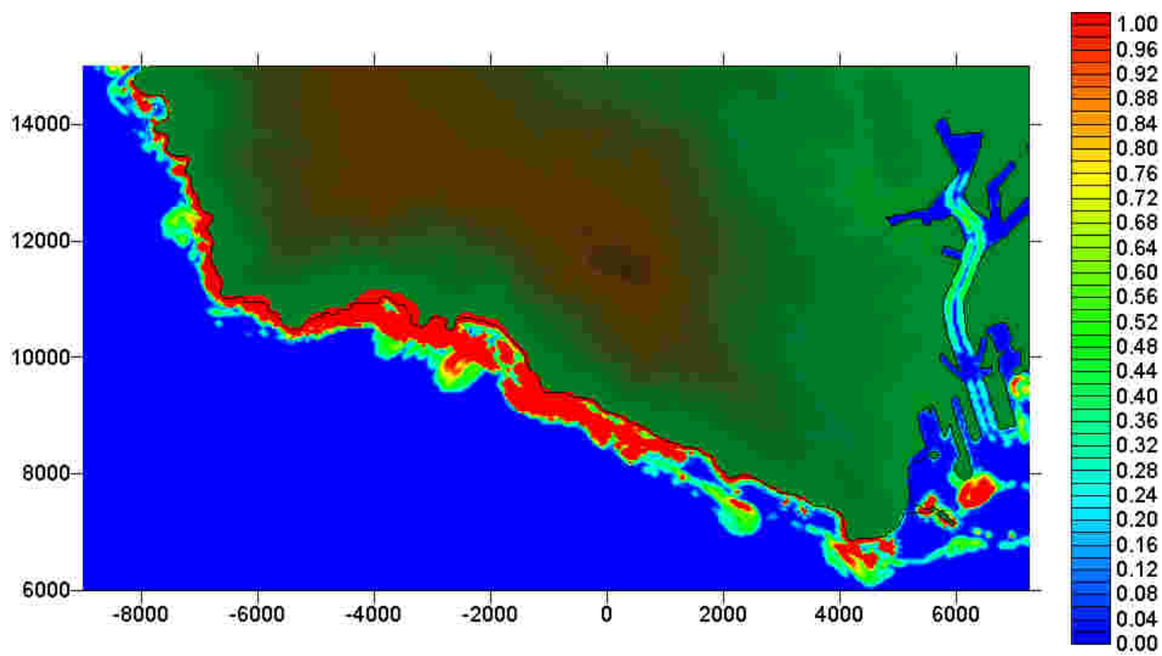
Table 8-2: Landslide Induced Tsunami Simulation Parameters

Mean Depth of Slide	410 m
Age of Slide	~7500 years
Dimensions (Length x Width x Thickness)	L=4100m W=2800m T=70m
Slide headwall location	~3500m south of Portuguese Bend
Source: Locat et al., 2003[6]	

The simulation was run using the historical slide data in conjunction with modern topography and bathymetry, to indicate what would happen if this event were to occur today.

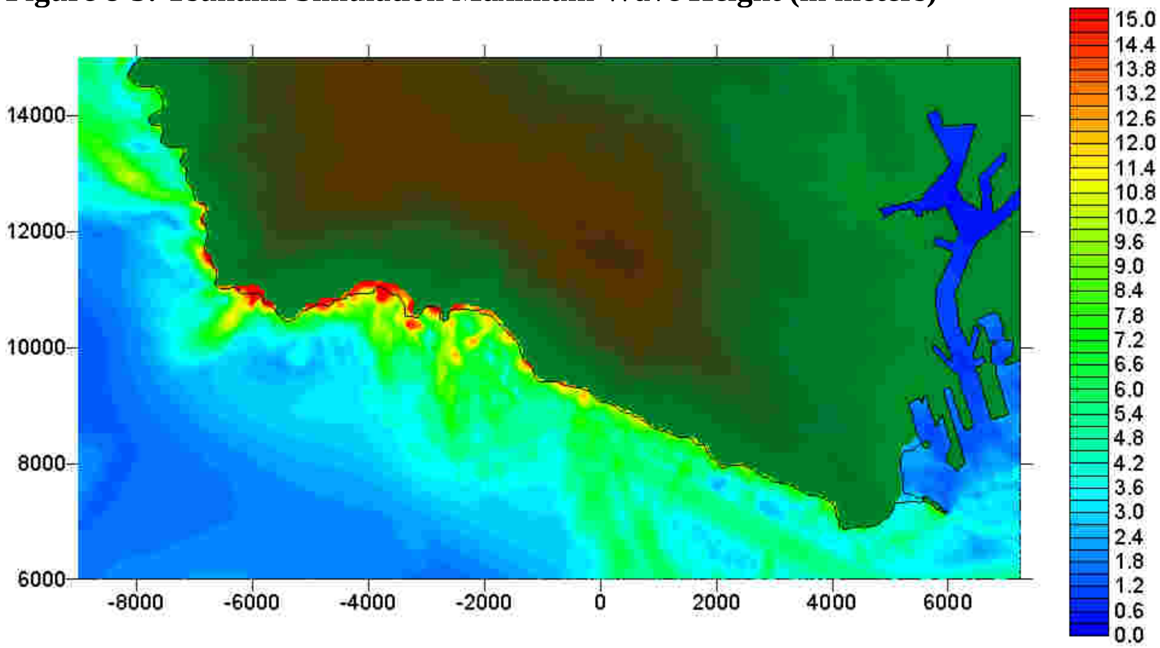
The initial elevation waves arrive at the coast around Long Point 6 minutes after the event initiates, and have reached as far as Cabrillo Beach after 10 minutes have passed. Wave activity continues for an hour or more after the event, as a result of reflections and resonance. Wave heights generated by this event are highly localized, as is the hallmark of a near-field event. Because it is in the direct path of the initial waves, the Abalone Cove-Long Point area sees the largest run up, which ranges from 55-70 ft to the east of Long Point and reach 78 ft near the Coast Guard station on the Western side of Long Point. Portuguese Bend is struck by waves reaching 46 ft, while the shoreline to the east is hit by waves that reach around 30 ft. To the north of Point Vicente, waves exceed 50 ft in places, but are mostly in the 15 to 30 ft range.

Figure 8-2: Tsunami Simulation Wave Breaking



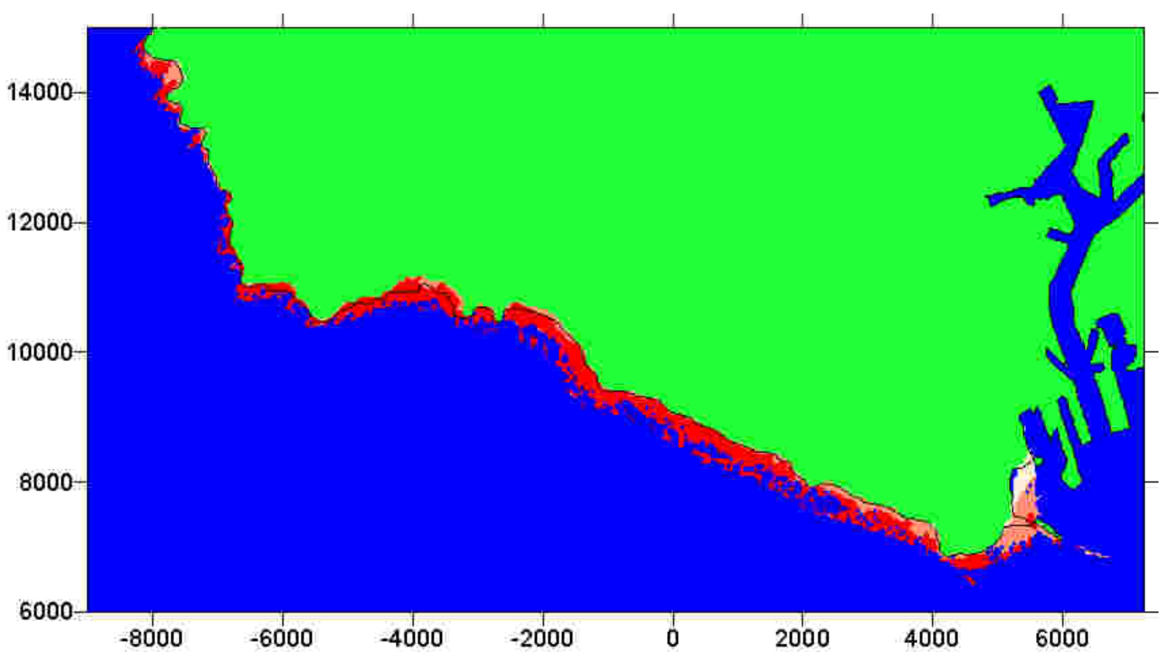
Values greater than 1 indicate energetic wave breaking

Figure 8-3: Tsunami Simulation Maximum Wave Height (in meters)



Within Rancho Palos Verdes, direct wave damage is certainly the primary concern arising from this scenario. Many of the slopes in this area are prone to landslides, and a significant wave event of this magnitude could potentially undercut the shoreline, leading to severe earth movement in the hours and days after this event. This is an area in which additional research is called for.

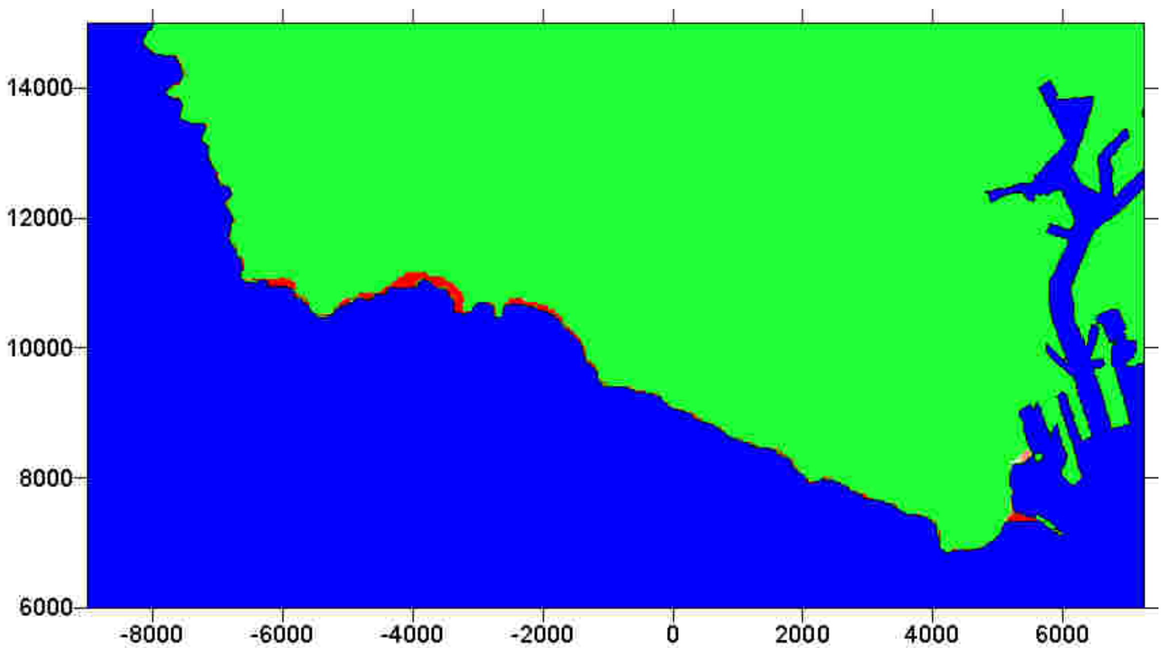
Figure 8-4: Tsunami Simulation Sediment Movement



White indicates sediment moved that is .02 meters in size, pink indicates rocks moved that are .2 meters in size and red indicates rocks moved that are 2 meters in size.

Areas along the Ranch Palos Verdes coastline where structures would most likely be damaged include the homes in the Portuguese Bend Beach Club, the nursery school at Abalone Cove Shoreline Park, the homes in the Lower Abalone Cove neighborhood (Seacove Drive), the existing Catalina Room banquet facility at Long Point and the proposed resort hotel improvements along the southeast edge of the property, which include a portion of the main hotel building, casitas and a large pool area. Additionally, if there are any boats or other vessels traveling or moored along the City's coastline at the time of a tsunami event, they could be moved as much as 100 meters horizontally and could potentially cause significant damage if they are pushed onshore, colliding with the bluff face or a developed area.

Figure 8-5: Tsunami Simulation Structure Damage

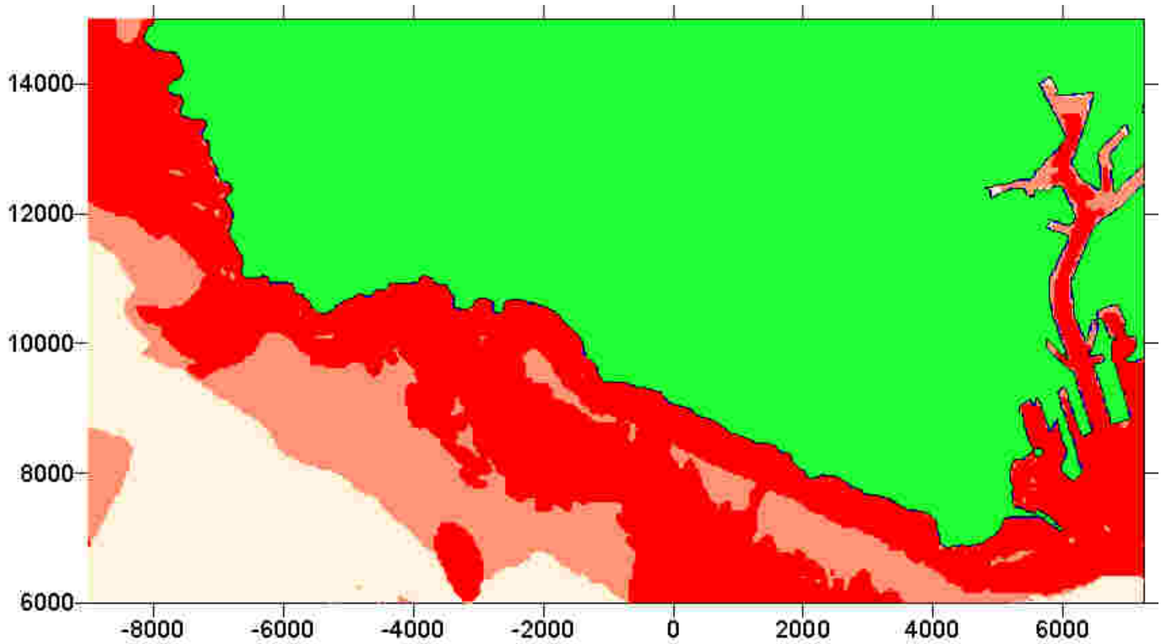


Red indicates areas were structure damage is expected.

Applied Fluids modeling indicates impact from this event would be felt in areas outside of Rancho Palos Verdes, notably the nearby Ports of LA and Long Beach, which risk potential disaster. Any ships moored offshore or at an outer pier risk breaking loose and running aground, colliding with another vessel, a pier, or even the federal breakwater. In addition, the Long Beach area is inundated by waves of around 3 m to 4 m, and the Seal Beach Naval Weapons Station and the City of Newport Beach both experience potentially damaging run up.

Based on the U.S. Government study and the computer simulation prepared by Applied Fluids Engineering, the coastline in Rancho Palos Verdes could be significantly to severely impacted by either a Pacific-wide or a local tsunami. Based on this analysis, it can be deduced that the common tsunami impact areas will include impacts on life, property, infrastructure and transportation.

Figure 8-6: Tsunami Simulation Ship Movement



Light pink indicates horizontal ship movement of 4 meters, pink indicates 20 meters and red indicates 100 meters.

Community Tsunami Issues

What is Susceptible to Tsunami?

Life and Property
Considering the "local" history events of tsunamis and the predicted wave heights from a landslide induced tsunami in the San Pedro Channel, it can be concluded that the area seaward of Palos Verdes Drive South and Palos Verdes Drive West in the City of Rancho Palos Verdes would be heavily impacted by a tsunami event. According to the RPV Coastal Specific Plan (December 1978), this area contains 903 acres and represents approximately 10% of the City's land area. The largest impact on the community from a tsunami event would be from loss of life and property.

Residential
Residential property along the coast could also be devastated. City of Rancho Palos Verdes is an affluent community with expensive homes, especially for those located in the highly desirable area along the coastline. A large tsunami could potentially destroy or damage hundreds of homes situated along the bluff tops and spread debris throughout the coastal zone. Any residential structure with weak reinforcement would be susceptible to damage or could be impacted by significant coastal erosion.

Commercial
Throughout the year the coastline attracts a large number of visitors to the Ocean Trails

Golf Course and Clubhouse. The Long Point property is slated to be developed at a 450-room resort hotel with conference center, spa and golf academy. Currently, the site is a popular location for large weddings and banquets and is frequently used for large-scale commercial filming. A tsunami event would impact these businesses by damaging property and by interrupting business and services. Any commercial structure with weak reinforcement would be susceptible to damage or could be impacted by significant coastal erosion.

Recreational
The Peninsula's picturesque coastline and marine resources is a public treasure. During the summer months, the City of Rancho Palos Verdes attracts a large number of visitors to its coastal parks and beaches. The City owns approximately 376 acres of parkland seaward of Palos Verdes Drive. The types of development on these public parklands range in intensity from bluff top hiking trails to a regional interpretive museum. In addition, the City's offshore areas are popular for many types of marine recreational activities, including sun bathing, scuba diving, surfing, kayaking, fishing and sailing. If a tsunami were to occur on a peak holiday weekend, of example, it could devastate the entire coastal area and result in a significant loss of life.

Infrastructure
Tsunamis (and earthquakes) can damage buildings, power lines, and other property and infrastructure due to flooding. Tsunamis can result in collapsed or damaged buildings or blocked roadways, damaged traffic signals, streetlights, and parks, among others. Damage to public water and sewer systems, transportation networks, and flood channels would greatly impact daily life for residents throughout the community.

Roads blocked by objects during a tsunami may have severe consequences to people who are attempting to evacuate or who need emergency services. Emergency response operations can be complicated when roads are blocked or when power supplies are interrupted. Industry and commerce can suffer losses from interruptions in electric services and from extended road closures. They can also sustain direct losses to buildings, personnel, and other vital equipment. There are direct consequences to the local economy resulting from tsunamis related to both physical damages and interrupted services.

Tsunami Endnotes

---

1. http://education.sdsc.edu/optiputer/htmlLinks/california_tsunami.html

2. http://www.prh.noaa.gov/itic/library/about_tsu/faqs.html#1

3. Ibid

4. Ibid

5. Ibid

[6] Locat, J., H.J. Lee, P. Locat, and J. Imran, Numerical analysis of the mobility of the Palos Verdes debris avalanche, California, and its implication for the generation of tsunamis, Marine Geology, 203, 269-280, 2003.

Mitigation Actions Matrix

City of Rancho Palos Verdes and City of Rolling Hills Estates
Mitigation Action Items

Natural Hazard	Action Item	Coordinating Organization	Timeline	Plan Goals Addressed: Protect Life and Property	Public Awareness	Natural Systems	Partnerships and Implementation	Emergency Services
Multi-Hazard Action Items								
MH #1-1	Integrate the goals and action items from the RPV/RHE Natural Hazards Mitigation Plan into existing regulatory documents and programs, where appropriate.	Hazard Mitigation Planning Committee	Ongoing	X	X	X	X	X
MH #1-2	Identify and pursue funding opportunities to develop and implement local mitigation activities.	City Manager's Office	Ongoing	X	X	X	X	X
MH #1-3	Establish a formal role for the RPV/RHE Hazard Mitigation Planning Committee to develop a sustainable process for implementing, monitoring, and evaluating regional mitigation activities.	Hazard Mitigation Planning Committee	Ongoing				X	

City of Rancho Palos Verdes and City of Rolling Hills Estates
Mitigation Action Items

Natural Hazard	Action Item	Coordinating Organization	Timeline	Plan Goals Addressed				
				Protect Life and Property	Public Awareness	Natural Systems	Partnerships and Implementation	Emergency Services
Multi-Hazard Action Items								
MH #1-4	Identify, improve, and sustain collaborative programs focusing on, public and private sector organizations, and individuals to avoid activity that increases risk to natural hazards.	RPV/RHE Planning Departments and City Manager's Office	Ongoing	X	X		X	
MH #1-5	Develop public and private partnerships to foster natural hazard mitigation program coordination and collaboration in RPV/RHE Hazard Mitigation Planning Team.	City Manager's Office	Ongoing	X	X		X	
MH #1-6	Develop inventories of critical facilities and infrastructure, assess structural vulnerability to the identified hazards and prioritize mitigation projects.	Public Works, Building & Safety and City Manager's Office	1-2 Years	X			X	

City of Rancho Palos Verdes and City of Rolling Hills Estates
Mitigation Action Items

Natural Hazard	Action Item	Coordinating Organization	Timeline	Plan Goals Addressed				
				Protect Life and Property	Public Awareness	Natural Systems	Partnerships and Implementation	Emergency Services
Multi-Hazard Action Items								
MH #1-7	Strengthen emergency services preparedness and response by coordinating emergency services with natural hazard mitigation programs and enhancing public education on a regional scale.	RPV/RHE City Manager's Office	Ongoing					X
MH #1-8	Develop, enhance, and implement education programs aimed at mitigating natural hazards, and reducing the risk to citizens, public agencies, private property owners, businesses, and schools.	RPV/RHE City Manager's Office	Ongoing	X	X			
MH #1-9	Use technical knowledge of natural ecosystems and events to link natural resource management and land use organizations to mitigation activities and technical assistance.	RPV/RHE Planning and Public Works Departments	Ongoing			X		

City of Rancho Palos Verdes and City of Rolling Hills Estates
Mitigation Action Items

Natural Hazard	Action Item	Coordinating Organization	Timeline	Plan Goals Addressed				
				Protect Life and Property	Public Awareness	Natural Systems	Partnerships and Implementation	Emergency Services
Multi-Hazard Action Items								
MH #1-10	Evaluate current hazard warning systems to ensure effectiveness and efficiency and increase coordination between local jurisdictions and emergency service providers.	RPV/RHE Planning Departments	2-3 years	X			X	X
MH #1-11	Update and Incorporate the Regional Evacuation Routes into appropriate planning documents.	City Manager's Office and Planning Department	2 years	X				X
MH #1-12	Review priorities for restoration of the community's infrastructure and vital public facilities following a disaster.	Public Works	Ongoing	X				

City of Rancho Palos Verdes and City of Rolling Hills Estates
Mitigation Action Items

Natural Hazard	Action Item	Coordinating Organization	Timeline	Plan Goals Addressed: Protect Life and Property	Public Awareness	Natural Systems	Partnerships and Implementation	Emergency Services
Multi-Hazard Action Items								
MH #1-13	Develop policy for government to determine what reconstruction criteria should be applied to structures damaged during a disaster. Develop additional zoning, building and reconstruction policies and requirements in the local government development and building codes for post-disaster situations.	Building & Safety Division and Planning Department	2 years	X				
MH #1-14	Develop and implement programs to coordinate maintenance and mitigation activities to reduce risk to public infrastructure from severe weather events.	Public Works and Building and Safety Division	5 years	X				

City of Rancho Palos Verdes and City of Rolling Hills Estates
Mitigation Action Items

Natural Hazard	Action Item	Coordinating Organization	Timeline	Plan Goals Addressed				
				Protect Life and Property	Public Awareness	Natural Systems	Partnerships and Implementation	Emergency Services
Multi-Hazard Action Items								
MH #1-15	Place information on RPV and RHE websites and cable access channels to include information specific to residents, building code information, and educational information on damage prevention. Encourage reduction of nonstructural and structural earthquake hazards in homes, schools, businesses, and government offices.	City Manager's Office, Planning Department, and Building & Safety Division	1 year/On going	X				
MH #1-16	Establish policy to ensure mitigation projects are in place to safeguard critical facilities. Incorporate the building inventory into the hazard assessment.	Public Works and Building and Safety Division	5 years	X				X
MH #1-17	Educate City staffs on federal cost-share & grant programs, Fire Protection Agreements, and other related federal programs so the full array of assistance available is understood.	City Manager's Office	2 years				X	

City of Rancho Palos Verdes and City of Rolling Hills Estates
Mitigation Action Items

Natural Hazard	Action Item	Coordinating Organization	Timeline	Plan Goals Addressed				
				Protect Life and Property	Public Awareness	Natural Systems	Partnerships and Implementation	Emergency Services
Multi-Hazard Action Items								
MH #1-18	Determine the economic feasibility of mitigating natural hazards that can provide decision-makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects.	City Manager's Office	2 years	X				
MH #1-19	Coordinate with the Los Angeles County Sanitation Districts to ensure that an appropriate mitigation action plan and disaster response plan is in place for the Palos Verdes Landfill.	City Manager's Office	2 years	X			X	
MH #1-20	Consider expanding the Joint Natural Hazards Mitigation Plan to include other natural disasters, such as severe weather or drought, in conjunction with future updates.	City Manager's Office	5 years	X				

City of Rancho Palos Verdes and City of Rolling Hills Estates
Mitigation Action Items

Natural Hazard	Action Item	Coordinating Organization	Timeline	Plan Goals Addressed				
				Protect Life and Property	Public Awareness	Natural Systems	Partnerships and Implementation	Emergency Services
Earthquake Action Items								
EQ #2-1	Integrate new earthquake hazard mapping data and improve technical analysis of earthquake hazards using GIS technology.	RHE City Manager's Office and RPV Finance and IT Department	2 years	X			X	
EQ #2-2	Identify funding sources for structural and nonstructural retrofitting of structures that are identified as seismically vulnerable for private property owners and businesses.	RPV/RHE Hazard Mitigation Planning Committee	Ongoing		X		X	
EQ #2-3	Encourage seismic strength evaluations of critical facilities and public infrastructure in the City to meet current seismic standards.	Building and Safety Departments	5 years	X				X
EQ #2-4	Encourage reduction of nonstructural and structural earthquake hazards in homes, businesses, and government offices.	RPV/RHE Hazard Mitigation Planning Committee and City Managers office	Ongoing	X	X			

City of Rancho Palos Verdes and City of Rolling Hills Estates
Mitigation Action Items

Natural Hazard	Action Item	Coordinating Organization	Timeline	Plan Goals Addressed				
				Protect Life and Property	Public Awareness	Natural Systems	Partnerships and Implementation	Emergency Services
Wildfire Action Items								
WF #3-1	Encourage development and dissemination of information relating to the fire hazard to help educate and assist builders & homeowners in being engaged in wildfire mitigation activities, and to help guide emergency services during response.	LA County Fire Department, Building and Safety Division, and City Manager's Office	1-3 years	X				
WF #3-2	Increase communication, coordination & collaboration between wildland/urban interface property owners, local planners and fire prevention crews & officials to address risks, existing mitigation measures, and federal assistance programs.	RHE/RPV Hazard Mitigation Planning Committee	Ongoing	X	X		X	X
WF #3-3	Encourage implementation of wildfire mitigation activities in a manner consistent with the goals of promoting sustainable ecological management & community stability.	LA County Fire and Planning Departments	Ongoing			X		

City of Rancho Palos Verdes and City of Rolling Hills Estates
Mitigation Action Items

Natural Hazard	Action Item	Coordinating Organization	Timeline	Plan Goals Addressed				
				Protect Life and Property	Public Awareness	Natural Systems	Partnerships and Implementation	Emergency Services
Landslide Mitigation Actions Items								
LS #4-1	Improve knowledge of landslide hazard areas and understanding of vulnerability and risk to life and property in hazard-prone areas.	Planning and Building & Safety Divisions	Ongoing	X	X			
LS #4-2	Address construction and subdivision design within steep slopes to reduce the potential adverse impacts from development.	Planning and Building & Safety Divisions	Ongoing	X			X	
LS #4-3	Regulate activities and provide public outreach in identified potential and historical landslide areas.	Planning and Building Department	Ongoing	X	X			
LS #4-4	Develop public information programs regarding proper maintenance of steep slopes and surface drainage structures located on private property.	Planning and Building Departments	Ongoing	X	X			

City of Rancho Palos Verdes
Mitigation Action Items

Natural Hazard	Action Item	Coordinating Organization	Timeline	Plan Goals Addressed: Protect Life and Property	Public Awareness	Natural Systems	Partnerships and Implementation	Emergency Services
Tsunami Action Items								
TS #1-1	Improve knowledge of tsunami hazards to develop a better understanding of vulnerability and risk to life and property in hazard-prone areas.	City Manager's Office	Ongoing	X		X		
TS #1-2	Explore opportunities to participate in scientific and academic research projects regarding local tsunami hazards.	City Manager's Office	Ongoing	X			X	
TS #1-3	Encourage development and dissemination of information related to tsunami hazards to assist residents and the general public in hazard-prone areas to prepare for and/or respond to tsunami events.	City Manager's Office	1-2 years	X	X			X
TS #1-4	Identify and investigate types and funding sources for tsunami warning systems for both public and private property	City Manager's Office	1-2 years	X	X			X

Plan Maintenance

Table of Contents

Plan Maintenance ....page 3

Monitoring and Implementing the Plan ....page 3

Plan Adoption ....page 3

Coordinating Body ....page 3

Covener ....page 4

Implementation Through Existing Programs ....page 4

Economic Analysis of Mitigation Programs ....page 5

Evaluating and Updating the Plan...page 5

Formal Review Process...page 5

Continued Public Involvement ....page 6

Section 10:

Plan Maintenance

The Plan Maintenance Section of this document details the formal process that will ensure that the Natural Hazards Mitigation Plan remains an active and relevant document. The plan maintenance process includes a schedule for monitoring and evaluating the Plan annually and producing a plan revision every five years. This section describes how the Cities will integrate public participation throughout the plan maintenance process. Finally, this Section includes an explanation of how the City of Rancho Palos Verdes and the City of Rolling Hills Estates governments intend to incorporate the mitigation strategies outlined in this Plan into existing planning mechanisms such as the General Plans, Capital Improvement Plans, and Building and Safety Codes.

Monitoring and Implementing the Plan

Plan Adoption

The City Councils will be responsible for adopting the Natural Hazards Mitigation Plan. These governing bodies have the authority to promote sound public policy regarding natural hazards. Once the plan has been adopted, the Cities' Emergency Preparedness Coordinators will coordinate the submission to the State Hazard Mitigation Officer at The Governor's Office of Emergency Services. The Governor's Office of Emergency Services will then submit the plan to the Federal Emergency Management Agency (FEMA) for review. This review will address the federal criteria outlined in FEMA Interim Final Rule 44 CFR Part 201. Upon acceptance by FEMA, the Cities will gain eligibility for Hazard Mitigation Grant Program funds.

Coordinating Body

The RPV/RHE Hazard Mitigation Committee will be responsible for coordinating implementation of plan action items and undertaking the formal review process. The City Councils (or designees) will assign representatives from City agencies, including, but not limited to, the current Multi-Jurisdictional Planning Team members.

In order to make this Committee as broad and useful as possible, the City Managers may engage other relevant organizations and agencies in hazard mitigation. Potential members of the Committee could include:

An elected official
A representative from the City Manager's Office
Representatives from Other City Departments
Representatives from Utility Companies
A representative from the Chamber of Commerce
A representative from the School District
A representative from County Disaster Area G

A representative from transit agencies
A former local elected official

The Committee will meet on an as-needed basis, but no less than twice a year. These meetings will provide an opportunity to discuss the progress of the action items and maintain the partnerships that are essential for the sustainability of the Mitigation Plan.

Convener

The City Councils will adopt the Joint Natural Hazards Mitigation Plan, and the Hazard Mitigation Committee will take responsibility for plan implementation. The City Managers (or designees) will serve as a convener to facilitate the Hazard Mitigation Committee meetings, and will assign tasks such as updating and presenting the Plan to the members of the Committee. Plan implementation and evaluation will be a shared responsibility among all of the Committee members.

Implementation through Existing Programs

The Cities address statewide planning goals and legislative requirements through their General Plans, Capital Improvement Plans, and City Building and Safety Codes. The Joint Natural Hazards Mitigation Plan provides a series of recommendations - many of which are closely related to the goals and objectives of existing planning programs. The Cities will have the opportunity to implement recommended mitigation action items through existing programs and procedures.

The Building and Safety Departments are responsible for administering the Building & Safety Codes. In addition, the Committee will work with other agencies at the state level to review, develop and ensure Building & Safety Codes that are adequate to mitigate or prevent damage by natural hazards. This is to ensure that life-safety criteria are met for new construction.

The goals and action items in the mitigation plan may be achieved through activities recommended in the Capital Improvement Plans (CIP). Various City departments develop CIP plans, and review them on an annual basis. Upon annual review of the CIPs, the Hazard Mitigation Committee will work with the City departments to identify action items in the Joint Natural Hazards Mitigation Plan consistent with CIP planning goals and integrate them where appropriate.

The recommendations in Section 9 will be incorporated into the process of existing planning mechanisms at the City level after formal adoption of the Mitigation Plan. The meetings of the Hazard Mitigation Committee will provide an opportunity for Committee members to report back on the progress made on the integration of mitigation planning elements into the City's planning documents and procedures. The adopted Mitigation Plan will be shared with the Cities appointed Committees, Commissions and Task Forces.

Economic Analysis of Mitigation Projects

FEMA's approaches to identify the costs and benefits associated with natural hazard mitigation strategies, measures, or projects fall into two general categories: benefit/cost analysis and cost-effectiveness analysis.

Conducting benefit/cost analysis for a mitigation activity can assist communities in determining whether a project is worth undertaking now, in order to avoid disaster-related damages later.

Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. Determining the economic feasibility of mitigating natural hazards can provide decision-makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects.

Given federal funding, the Hazard Mitigation Committee will use a FEMA-approved benefit/cost analysis approach to identify and prioritize mitigation action items. For other projects and funding sources, the Hazard Mitigation Committee will use other approaches to understand the costs and benefits of each action item and develop a prioritized list. For more information regarding economic analysis of mitigation action items, please see Appendix C: Benefit/Cost Analysis.

Evaluating and Updating the Plan

Formal Review Process

The Joint Natural Hazards Mitigation Plan will be evaluated on an annual basis to determine the effectiveness of programs, and to reflect changes in land development or programs that may affect mitigation priorities. The evaluation process includes a firm schedule and timeline, and identifies the local agencies and organizations participating in plan evaluation. The convener or designee will be responsible for contacting the Hazard Mitigation Committee members and organizing the annual meeting.

Committee members will be responsible for monitoring and evaluating the progress of the mitigation strategies in the Plan.

The Committee will review the goals and action items to determine their relevance to changing situations in the Cities, as well as changes in State or Federal policy, and to ensure they are addressing current and expected conditions. The Committee will also review the Risk Assessment portion of the Plan to determine if this information should be updated or modified, given any new available data. The coordinating organizations responsible for the various action items will report on the status of their projects, the success of various implementation processes, difficulties encountered, success of coordination efforts, and which strategies should be revised.

The convener will assign the duty of updating the plan to one or more of the Committee members. The designated members will have three months to make appropriate changes to the Plan before submitting it to the Committee, and presenting it to the City Councils. The Committee will also notify all holders of the Mitigation Plan when changes have been made. Every five years the updated Plan will be submitted to the State Hazard Mitigation Officer and the Federal Emergency Management Agency for review.

Continued Public Involvement

The City is dedicated to involving the public directly in review and updates of the Joint Natural Hazards Mitigation Plan. The Committee members are responsible for the annual review and update of the plan.

The public will also have the opportunity to provide feedback about the Plan. Copies of the plan will be catalogued and made available at both City Halls and the Peninsula Center main public library in Rolling Hills Estates and the Miraleste branch public library in Rancho Palos Verdes. The existence and location of these copies will be publicized in City newsletters and posted on City websites. The plan also includes the address and the phone number of the Cities' contact person responsible for keeping track of public comments on the Plan. In addition, copies of the Plan and any proposed changes will be posted on the Cities' websites. These sites will also contain email addresses and phone numbers to which people can direct their comments and concerns.

A public meeting will also be held after each annual evaluation or as deemed necessary by the Committee. The meetings will provide the public a forum for which they can express its concerns, opinions, or ideas about the Plan. The Cities' Emergency Preparedness Coordinators will be responsible for using City resources to publicize the annual public meetings and maintain public involvement through the government access cable channel, websites, and local newspapers.

Appendix A - Resources

Master Resource Directory

The Resource Directory provides contact information for local, regional, state, and federal programs that are currently involved in hazard mitigation activities. The RPV/RHE Hazard Mitigation Planning Committee may look to the organizations on the following pages for resources and technical assistance. The Resource Directory provides a foundation for potential partners in action item implementation.

The RPV/RHE Hazard Mitigation Planning Committee will continue to add contact information for organizations currently engaged in hazard mitigation activities. This section may also be used by various community members interested in hazard mitigation information and projects.

American Public Works Association			
Level: National	Hazard: Multi	http://www.apwa.net	
2345 Grand Boulevard		Suite 500	
Kansas City, MO 64108-2641		Ph: 816-472-6100	Fx: 816-472-1610
Notes: The American Public Works Association is an international educational and professional association of public agencies, private sector companies, and individuals dedicated to providing high quality public works goods and services.			
Association of State Floodplain Managers			
Level: Federal	Hazard: Flood	www.floods.org	
2809 Fish Hatchery Road			
Madison, WI 53713		Ph: 608-274-0123	Fx:
Notes: The Association of State Floodplain Managers is an organization of professionals involved in floodplain management, flood hazard mitigation, the National Flood Insurance Program, and flood preparedness, warning and recovery			
Building Seismic Safety Council (BSSC)			
Level: National	Hazard: Earthquake	www.bssconline.org	
1090 Vermont Ave., NW		Suite 700	
Washington, DC 20005		Ph: 202-289-7800	Fx: 202-289-109
Notes: The Building Seismic Safety Council (BSSC) develops and promotes building earthquake risk mitigation regulatory provisions for the nation.			

Appendix A - Resources

California Department of Transportation (CalTrans)			
Level: State	Hazard: Multi	http://www.dot.ca.gov/	
120 S. Spring Street			
Los Angeles, CA 90012		Ph: 213-897-3656	Fx:
Notes: CalTrans is responsible for the design, construction, maintenance, and operation of the California State Highway System, as well as that portion of the Interstate Highway System within the state's boundaries. Alone and in partnership with Amtrak, Caltrans is also involved in the support of intercity passenger rail service in California.			

California Resources Agency			
Level: State	Hazard: Multi	http://resources.ca.gov/	
1416 Ninth Street		Suite 1311	
Sacramento, CA 95814		Ph: 916-653-5656	Fx:
Notes: The California Resources Agency restores, protects and manages the state's natural, historical and cultural resources for current and future generations using solutions based on science, collaboration and respect for all the communities and interests involved.			

California Division of Forestry (CDF)			
Level: State	Hazard: Multi	http://www.fire.ca.gov/php/index.php	
210 W. San Jacinto			
Perris CA 92570		Ph: 909-940-6900	Fx:
Notes: The California Department of Forestry and Fire Protection protects over 31 million acres of California's privately-owned wildlands. CDF emphasizes the management and protection of California's natural resources.			

California Division of Mines and Geology (DMG)			
Level: State	Hazard: Multi	www.consrv.ca.gov/cgs/index.htm	
801 K Street		MS 12-30	
Sacramento, CA 95814		Ph: 916-445-1825	Fx: 916-445-5718
Notes: The California Geological Survey develops and disseminates technical information and advice on California’s geology, geologic hazards, and mineral resources.			

Appendix A - Resources

California Environmental Resources Evaluation System (CERES)			
Level: State	Hazard: Multi	http://ceres.ca.gov/	
900 N St.		Suite 250	
Sacramento, Ca. 95814		Ph: 916-653-2238	Fx:
Notes: CERES is an excellent website for access to environmental information and websites.			

California Department of Water Resources (DWR)			
Level: State	Hazard: Flood	http://wwwdwr.water.ca.gov	
1416 9th Street			
Sacramento, CA 95814		Ph: 916-653-6192	Fx:
Notes: The Department of Water Resources manages the water resources of California in cooperation with other agencies, to benefit the State's people, and to protect, restore, and enhance the natural and human environments.			

California Department of Conservation: Southern California Regional Office			
Level: State	Hazard: Multi	www.consrv.ca.gov	
655 S. Hope Street		#700	
Los Angeles, CA 90017-2321		Ph: 213-239-0878	Fx: 213-239-0984
Notes: The Department of Conservation provides services and information that promote environmental health, economic vitality, informed land-use decisions and sound management of our state's natural resources.			

California Planning Information Network			
Level: State	Hazard: Multi	www.calpin.ca.gov	
		Ph:	Fx:
Notes: The Governor's Office of Planning and Research (OPR) publishes basic information on local planning agencies, known as the California Planners' Book of Lists. This local planning information is available on-line with new search capabilities and up-to-the- minute updates.			

Appendix A - Resources

EPA, Region 9			
Level: Regional	Hazard: Multi	http://www.epa.gov/region09	
75 Hawthorne Street			
San Francisco, CA 94105		Ph: 415-947-8000	Fx: 415-947-3553
Notes: The mission of the U.S. Environmental Protection Agency is to protect human health and to safeguard the natural environment through the themes of air and global climate change, water, land, communities and ecosystems, and compliance and environmental stewardship.			

Federal Emergency Management Agency, Region IX			
Level: Federal	Hazard: Multi	www.fema.gov	
1111 Broadway		Suite 1200	
Oakland, CA 94607		Ph: 510-627-7100	Fx: 510-627-7112
Notes: The Federal Emergency Management Agency is tasked with responding to, planning for, recovering from and mitigating against disasters.			

Federal Emergency Management Agency, Mitigation Division			
Level: Federal	Hazard: Multi	www.fema.gov/fima/planhowto.shtm	
500 C Street, S.W.			
Washington, D.C. 20472		Ph: 202-566-1600	Fx:
Notes: The Mitigation Division manages the National Flood Insurance Program and oversees FEMA's mitigation programs. It has of a number of programs and activities of which provide citizens Protection, with flood insurance; Prevention, with mitigation measures and Partnerships, with communities throughout the country.			

Floodplain Management Association			
Level: Federal	Hazard: Flood	www.floodplain.org	
P.O. Box 50891			
Sparks, NV 89435-0891		Ph: 775-626-6389	Fx: 775-626-6389
Notes: The Floodplain Management Association is a nonprofit educational association. It was established in 1990 to promote the reduction of flood losses and to encourage the protection and enhancement of natural floodplain values. Members include representatives of federal, state and local government agencies as well as private firms.			

Gateway Cities Partnership			
Level: Regional	Hazard: Multi	www.gatewaycities.org	
7300 Alondra Boulevard		Suite 202	
Paramount, CA 90723		Ph: 562-817-0820	Fx:
Notes: Gateway Cities Partnership is a 501 C 3 non-profit Community Development Corporation for the Gateway Cities region of southeast LA County. The region comprises 27 cities that roughly speaking extends from Montebello on the north to Long Beach on the South, the Alameda Corridor on the west to the Orange County line on the east.			

Governor's Office of Emergency Services (OES)			
Level: State	Hazard: Multi	www.oes.ca.gov	
P.O. Box 419047			
Rancho Cordova, CA 95741-9047		Ph: 916 845- 8911	Fx: 916 845- 8910
Notes: The Governor's Office of Emergency Services coordinates overall state agency response to major disasters in support of local government. The office is responsible for assuring the state's readiness to respond to and recover from natural, manmade, and war-caused emergencies, and for assisting local governments in their emergency preparedness, response and recovery efforts.			

Greater Antelope Valley Economic Alliance			
Level: Regional	Hazard: Multi		
42060 N. Tenth Street West			
Lancaster, CA 93534		Ph: 661-945-2741	Fx: 661-945-7711
Notes: The Greater Antelope Valley Economic Alliance, (GA VEA) is a 501 (c)(6) nonprofit organization with a 501(c)(3) affiliated organization the Antelope Valley Economic Research and Education Foundation. GA VEA is a public-private partnership of business, local governments, education, non-profit organizations and health care organizations that was founded in 1999 with the goal of attracting good paying jobs to the Antelope Valley in order to build a sustainable economy.			

Appendix A - Resources

Landslide Hazards Program, USGS			
Level: Federal	Hazard: Landslide	http://landslides.usgs.gov/index.html	
12201 Sunrise Valley Drive		MS 906	
Reston, VA 20192		Ph: 703-648- 4000	Fx:
Notes: The NLIC website provides good information on the programs and resources regarding landslides. The page includes information on the National Landslide Hazards Program Information Center, a bibliography, publications, and current projects. USGS scientists are working to reduce long-term losses and casualties from landslide hazards through better understanding of the causes and mechanisms of ground failure both nationally and worldwide.			
Los Angeles County Economic Development Corporation			
Level: Regional	Hazard: Multi	www.laedc.org	
444 S. Flower Street		34th Floor	
Los Angeles, CA 90071		Ph: 213-236-4813	Fx: 213- 623-0281
Notes: The LAEDC is a private, non-profit 501 (c) 3 organization established in 1981 with the mission to attract, retain and grow businesses and jobs in the Los Angeles region. The LAEDC is widely relied upon for its Southern California Economic Forecasts and Industry Trend Reports. Lead by the renowned Jack Kyser (Sr. Vice President, Chief Economist) his team of researchers produces numerous publications to help business, media and government navigate the LA region's diverse economy.			
Los Angeles County Public Works Department			
Level: County	Hazard: Multi	http://ladpw.org	
900 S. Fremont Ave.			
Alhambra, CA 91803		Ph: 626-458-5100	Fx:
Notes: The Los Angeles County Department of Public Works protects property and promotes public safety through Flood Control, Water Conservation, Road Maintenance, Bridges, Buses and Bicycle Trails, Building and Safety, Land Development, Waterworks, Sewers, Engineering, Capital Projects and Airports			

Appendix A - Resources

National Wildland/Urban Interface Fire Program			
Level: Federal	Hazard: Wildfire	www.firewise.org/	
1 Batterymarch Park			
Quincy, MA 02169-7471		Ph: 617-770-3000	Fx: 617 770-0700
Notes: FIREWISE maintains a Website designed for people who live in wildfire- prone areas, but it also can be of use to local planners and decision makers. The site offers online wildfire protection information and checklists, as well as listings of other publications, videos, and conferences.			

National Resources Conservation Service			
Level: Federal	Hazard: Multi	http://www.nrcs.usda.gov/	
14th and Independence Ave., SW		Room 5105-A	
Washington, DC 20250		Ph: 202-720-7246	Fx: 202-720-7690
Notes: NRCS assists owners of America's private land with conserving their soil, water, and other natural resources, by delivering technical assistance based on sound science and suited to a customer's specific needs. Cost shares and financial incentives are available in some cases.			

National Interagency Fire Center (NIFC)			
Level: Federal	Hazard: Wildfire	www.nifc.gov	
3833 S. Development Ave.			
Boise, Idaho 83705-5354		Ph: 208-387- 5512	Fx:
Notes: The NIFC in Boise, Idaho is the nation’s support center for wildland firefighting. Seven federal agencies work together to coordinate and support wildland fire and disaster operations.			

National Fire Protection Association (NFPA)			
Level: National	Hazard: Wildfire	http://www.nfpa.org/catalog/home/index.asp	
1 Batterymarch Park			
Quincy, MA 02169-7471		Ph: 617-770-3000	Fx: 617 770-0700
Notes: The mission of the international nonprofit NFPA is to reduce the worldwide burden of fire and other hazards on the quality of life by providing and advocating scientifically-based consensus codes and standards, research, training and education			

National Floodplain Insurance Program (NFIP)			
Level: Federal	Hazard: Flood	www.fema.gov/nfip/	
500 C Street, S.W.			
Washington, D.C. 20472		Ph: 202-566-1600	Fx:
Notes: The Mitigation Division manages the National Flood Insurance Program and oversees FEMA's mitigation programs. It has of a number of programs and activities providing citizens Protection, with flood insurance; Prevention, with mitigation measures and Partnerships, with communities throughout the country.			
National Oceanic /Atmospheric Administration			
Level: Federal	Hazard: Multi	www.noaa.gov	
14th Street & Constitution Ave NW		Rm 6013	
Washington, DC 20230		Ph: 202-482-6090	Fx: 202-482-3154
Notes: NOAA's historical role has been to predict environmental changes, protect life and property, provide decision makers with reliable scientific information, and foster global environmental stewardship.			
National Weather Service, Office of Hydrologic Development			
Level: Federal	Hazard: Flood	http://www.nws.noaa.gov/	
1325 East West Highway		SSMC2	
Silver Spring, MD 20910		Ph: 301-713-1658	Fx: 301-713-0963
Notes: The Office of Hydrologic Development (OHD) enhances National Weather Service (NWS) products by: infusing new hydrologic science, developing hydrologic techniques for operational use, managing hydrologic development by NWS field office, providing advanced hydrologic products to meet needs identified by NWS customers			
National Weather Service			
Level: Federal	Hazard: Multi	http://www.nws.noaa.gov/	
520 North Elevar Street			
Oxnard, CA 93030		Ph: 805-988- 6615	Fx:
Notes: The National Weather Service is responsible for providing weather service to the nation. It is charged with the responsibility of observing and reporting the weather and with issuing forecasts and warnings of weather and floods in the interest of national safety and economy. Briefly, the priorities for service to the nation are: 1. protection of life, 2. protection of property, and 3. promotion of the nation's welfare and economy.			

San Gabriel Valley Economic Partnership			
Level: Regional	Hazard: Multi	www.valleynet.org	
4900 Rivergrade Road		Suite A310	
Irwindale, CA 91706		Ph: 626-856-3400	Fx: 626-856-5115
Notes: The San Gabriel Valley Economic Partnership is a non-profit corporation representing both public and private sectors. The Partnership is the exclusive source for San Gabriel Valley-specific information, expertise, consulting, products, services, and events. It is the single organization in the Valley with the mission to sustain and build the regional economy for the mutual benefit of all thirty cities, chambers of commerce, academic institutions, businesses and residents.			

Sanitation Districts of Los Angeles County			
Level: County	Hazard: Flood	http://www.lacsd.ora/	
1955 Workman Mill Road			
Whittier, CA 90607		Ph:562-699-7411 x2301	Fx:
Notes: The Sanitation Districts provide wastewater and solid waste management for over half the population of Los Angeles County and turn waste products into resources such as reclaimed water, energy, and recyclable materials.			

Santa Monica Mountains Conservancy			
Level: Regional	Hazard: Multi	http://smmc.ca.gov/	
570 West Avenue Twenty-Six		Suite 100	
Los Angeles, CA 90065		Ph: 323-221-8900	Fx:
Notes: The Santa Monica Mountains Conservancy helps to preserve over 55,000 acres of parkland in both wilderness and urban settings, and has improved more than 114 public recreational facilities throughout Southern California.			

South Bay Economic Development Partnership			
Level: Regional	Hazard: Multi	www.southbaypartnership.com	
3858 Carson Street		Suite 110	
Torrance, CA 90503		Ph: 310-792-0323	Fx: 310-543-9886
Notes: The South Bay Economic Development Partnership is a collaboration of business, labor, education and government. Its primary goal is to plan an implement an economic development and marketing strategy designed to retain and create jobs and stimulate economic growth in the South Bay of Los Angeles County.			

South Coast Air Quality Management District (AQMD)			
Level: Regional	Hazard: Multi	www.aqmd.gov	
21865 E. Copley Drive			
Diamond Bar, CA 91765		Ph: 800-CUT-SMOG	Fx:
Notes: AQMD is a regional government agency that seeks to achieve and maintain healthful air quality through a comprehensive program of research, regulations, enforcement, and communication. The AQMD covers Los Angeles and Orange Counties and parts of Riverside and San Bernardino Counties.			

Southern California Earthquake Center (SCEC)			
Level: Regional	Hazard: Earthquake	www.scec.org	
3651 Trousdale Parkway		Suite 169	
Los Angeles, CA 90089-0742		Ph: 213-740-5843	Fx: 213/740-0011
Notes: The Southern California Earthquake Center (SCEC) gathers new information about earthquakes in Southern California, integrates this information into a comprehensive and predictive understanding of earthquake phenomena, and communicates this understanding to end-users and the general public in order to increase earthquake awareness, reduce economic losses, and save lives.			

Southern California Association of Governments (SCAG)			
Level: Regional	Hazard: Multi	www.scag.ca.gov	
818 W. Seventh Street		12th Floor	
Los Angeles, CA 90017		Ph: 213-236-1800	Fx: 213-236-1825
Notes: The Southern California Association of Governments functions as the Metropolitan Planning Organization for six counties: Los Angeles, Orange, San Bernardino, Riverside, Ventura and Imperial. As the designated Metropolitan Planning Organization, the Association of Governments is mandated by the federal government to research and draw up plans for transportation, growth management, hazardous waste management, and air quality.			

State Fire Marshal (SFM)			
Level: State	Hazard: Wildfire	http://osfm.fire.ca.gov	
1131 "S" Street			
Sacramento, CA 95814		Ph: 916-445-8200	Fx: 916-445-8509
Notes: The Office of the State Fire Marshal (SFM) supports the mission of the California Department of Forestry and Fire Protection (CDF) by focusing on fire prevention. SFM regulates buildings in which people live, controls substances which may, cause injuries, death and destruction by fire; provides statewide direction for fire prevention within wildland areas; regulates hazardous liquid pipelines; reviews regulations and building standards; and trains and educates in fire protection methods and responsibilities.			

The Community Rating System (CRS)			
Level: Federal	Hazard: Flood	http://www.fema.gov/nfip/crs.shtm	
500 C Street, S.W.			
Washington, D.C. 20472		Ph: 202-566-1600	Fx:
Notes: The Community Rating System (CRS) recognizes community floodplain management efforts that go beyond the minimum requirements of the NFIP. Property owners within the County would receive reduced NFIP flood insurance premiums if the County implements floodplain management practices that qualify it for a CRS rating. For further information on the CRS, visit FEMA's website.			

United States Geological Survey			
Level: Federal	Hazard: Multi	http://www.usgs.gov/	
345 Middlefield Road			
Menlo Park, CA 94025		Ph: 650-853-8300	Fx:
Notes: The USGS provides reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.			

U.S. Army Corps of Engineers			
Level: Federal	Hazard: Multi	http://www.usace.army.mil	
P.O. Box 532711			
Los Angeles CA 90053- 2325		Ph: 213-452- 3921	Fx:
Notes: The United States Army Corps of Engineers work in engineering and environmental matters. A workforce of biologists, engineers, geologists, hydrologists, natural resource managers and other professionals provide engineering services to the nation including planning, designing, building and operating water resources and other civil works projects.			

Appendix A - Resources

USDA Forest Service			
Level: Federal	Hazard: Wildfire	http://www.fs.fed.us	
1400 Independence Ave. SW			
Washington, D.C. 20250-0002		Ph: 202-205-8333	Fx:
Notes: The Forest Service is an agency of the U.S. Department of Agriculture. The Forest Service manages public lands in national forests and grasslands.			
USGS Water Resources			
Level: Federal	Hazard: Multi	www.water.usgs.gov	
6000 J Street		Placer Hall	
Sacramento, CA 95819-6129		Ph: 916-278-3000	Fx: 916-278-3070
Notes: The USGS Water Resources mission is to provide water information that benefits the Nation's citizens: publications, data, maps, and applications software.			
Western States Seismic Policy Council (WSSPC)			
Level: Regional	Hazard: Earthquake	www.wsspc.org/home.html	
125 California Avenue		Suite D201, #1	
Palo Alto, CA 94306		Ph: 650-330-1101	Fx: 650-326-1769
Notes: WSSPC is a regional earthquake consortium funded mainly by FEMA. Its website is a great resource, with information clearly categorized - from policy to engineering to education.			
Westside Economic Collaborative C/O Pacific Western Bank			
Level: Regional	Hazard: Multi	http://www.westside-Ia.or	
120 Wilshire Boulevard			
Santa Monica, CA 90401		Ph: 310-458-1521	Fx: 310-458-6479
Notes: The Westside Economic Development Collaborative is the first Westside regional economic development corporation. The Westside EDC functions as an information gatherer and resource center, as well as a forum, through bringing business, government, and residents together to address issues affecting the region: Economic Diversity, Transportation, Housing, Workforce Training and Retraining, Lifelong Learning, Tourism, and Embracing Diversity.			

Appendix B:

The Public Participation Process

Public participation is a key component to any strategic planning process. It is very important that such broad-reaching plans not be written in isolation. Agency participation offers an opportunity for impacted departments and organizations to provide expertise and insight into the planning process. Citizen participation offers citizens the chance to voice their ideas, interests, and opinions. The Federal Emergency Management Agency also requires public input during the development of mitigation plans.

The Cities of Rancho Palos Verdes and Rolling Hills Estates integrated a cross-section of public input throughout the planning process. To accomplish this goal, the Hazard Mitigation Planning Team developed a public participation process through four components: (1) developing a Planning Team comprised of knowledgeable individuals representative of the Cities agencies, as well as the DMAC Area G Coordinator, Peninsula CERT, and Chamber of Commerce; (2) soliciting the assistance of local media representatives and community newsletters to announce the progress of the planning activities and to announce the availability of the Draft Joint Natural Hazards Mitigation Plan; (3) creating opportunities for the citizens and public agencies to review the Draft Joint Natural Hazards Mitigation Plan; (4) conducting public hearings at the Planning Commission (RHE), Emergency Preparedness Committee (RPV) and City Council (RHE/RPV) where the public had an opportunity to express their views concerning the Draft Joint Natural Hazards Mitigation Plan.

Integrating public participation during the development of the Joint Natural Hazards Mitigation Plan has ultimately resulted in increased public awareness. Through public involvement, the mitigation plan reflects community issues, concerns, and new ideas and perspectives on mitigation opportunities and plan action items.

Planning Team

Hazard mitigation in the Cities will be overseen by the RPV/RHE Hazard Mitigation Planning Committee, which consists of representatives from various city departments. The members have an understanding of how the community is structured and how residents, businesses, and the environment may be affected by natural hazard events. The Committee will implement the work of the Planning Team which was responsible for guiding the development of the Plan, and assisting in developing plan goals and action items, identifying stakeholders and plan reviewers, and sharing local expertise to create a more comprehensive plan. During the planning process, members of the Planning Team participated in five meetings:

<u>Meeting #1: Pre-Training January 15, 2004</u>

The meeting was held at the City of Carson's Community Center and was jointly sponsored by the Los Angeles County Disaster Management Area Coordinators (DMAC) and the Los Angeles County Office of Emergency Management. The training consisted of an overview of the

Disaster Mitigation Act of 2000, discussion of the types of natural disasters that could potentially be covered in the Natural Hazards Mitigation Plan based on a community's particular characteristics and instruction on the various components that are required to be included in the Plan. The plan template developed by the DMACs, and has been used as the basis to prepare this joint plan, was distributed to the attendees at this meeting. This pre-training session lasted for approximately six hours.

Meeting #2: Pre-Training April 29, 2004

The meeting was held at Rancho Palos Verdes City Hall. Emergency Planning Consultants delivered pre-training to the Joint Planning Team. The pre-training consisted of the history of the Disaster Mitigation Act of 2000, the purpose and role of hazard mitigation, and the planning process. The Pre-Training lasted approximately 1.5 hours.

Meeting #3: Kick-Off Meeting April 29, 2004

EPC facilitated a workshop where participants had an opportunity to learn about various natural hazards, assess and rank the local threats, examine hazard maps, and complete the FEMA Worksheets contained in FEMA 386-2 Understanding Your Risks. Part of the discussion included a presentation by EPC of historical disaster events across the country. Those slides served as a backdrop for discussing potential mitigation activities.

There was an extensive discussion on various methods of engaging the public in the mitigation process. The Joint Planning Team prepared a draft media release and discussed a public opinion survey provided by EPC. EPC committed to revising the media release and survey and distributing electronic copies to each of the Joint Planning Team entities. The Kick-Off Meeting lasted approximately 5 hours.

Meeting #4 Pre-Training: Mitigation June 7, 2004

The meeting was held at Rancho Palos Verdes City Hall. EPC delivered pre-training to the Joint Planning Team. The pre-training consisted of the concepts and issues related to developing mitigation actions. The pre-training lasted approximately 1 hour.

Meeting #5 Mitigation Actions June 7, 2004

EPC delivered the Draft Hazard Analysis and the Joint Planning Team discussed missing information, data, and maps. EPC distributed copies of the Mitigation Actions Planning Tools to assist the Team in developing Goals and Action Items appropriate to their natural hazards. The Planning Tools provided a process for collecting the mitigation actions presently in practice in the Cities, as well as identifying future mitigation actions.

A brainstorming process was then conducted to develop the goals for the Plan. Throughout the planning process and wor4kshop the planning team consultant reminded the team of the importance of considering benefits/costs issues. The Joint Planning Team discussed sample goal language then finalized the goal language. Following a discussion of alternative ranking techniques, the Team agreed to cluster the rankings of the Mitigation Actions by type of actions as follows: #1 Multi-Hazard, #2 Earthquakes, #3 Wildfire, #4 Earth Movement, #5 Tsunami.

The next task was to examine a FEMA-approved Mitigation Plan to get an idea of how mitigation actions are written. Each of the jurisdictions was pleased to announce the broad range of mitigation actions already being practiced. The Planning Tools, developed by EPC, consisted of nearly 300 mitigation actions gathered from dozens of Mitigation Plans across the country. The Planning Team broke into individual jurisdictions to develop their own mitigation actions, utilizing the sample plans and Planning Tools list. Because of the plan samples and Tools, the process of identifying appropriate mitigations actions was accomplished in a very efficient manner.

Public Awareness
A variety of methods were used to increase the public's awareness of the natural disaster mitigation planning process and to encourage public participation in the preparation and review of the draft document. The Peninsula *News* has a circulation of 15,000 on Thursday and 6,400 on Saturday, primarily within the four incorporated cities and the unincorporated area on the Palos Verdes Peninsula. The RPV and RHE City Newsletters are mailed to every household within their jurisdiction, 15,709 and, 2,880, respectively.

Peninsula *News*, February 5, 2004, "City to Create Natural Disaster Plan." This article concerned the City of Rancho Palos Verdes' search for a consultant to prepare its mitigation plan and provides an overview of the federal law.

Peninsula *News*, February 28, 2004, "City Begins Disaster Mitigation Plan." Although this article concerned the efforts of the adjacent City of Palos Verdes Estates, it helped to reinforce the message of the earlier article.

Peninsula *News*, April 22, 2004, "Cities Band Together to Prepare for the Worst." This article highlighted the efforts of the Cities of Rolling Hills Estates and Rancho Palos Verdes to prepare a Joint Natural Hazards Mitigation Plan and the importance of this planning effort.

Peninsula *News*, September 27, 2004, "School District Readies for Disasters." Although this article concerned the Palos Verdes Peninsula Unified School District's adoption of its Natural Hazards Plan, like the February 28th article listed above, it helped to reinforce the message that to the public that the local jurisdictions were actively engaged in mitigation planning.

Rolling Hills Estates City Newsletter, Summer 2004, "RHE Teams Up with Neighboring City to Prepare Natural Hazards Mitigation Plan." This article provides an overview of the federal law and outlined how the City of Rolling Hills Estates was cooperating with the City of Rancho Palos Verdes to prepare a Joint Plan, what the Joint Plan with encompass and the anticipated public review schedule.

Rancho Palos Verdes City Newsletter, Summer 2004, "RPV Partners with RHE to Mitigate Natural Disasters." This article presented similar information to that which appeared in the City of Rolling Hills Estates' City Newsletter concerning the preparation of the Joint Plan.

Review of the Draft Plan
To inform the public about the availability of the draft Plan and to invite both written and oral public comments on the document, the Cities published an advertisement in the Saturday, September 11, 2004 and Thursday, September 16, 2004 editions of the Peninsula *News*, notices were mailed to all homeowner associations, a notice was posted on the local government cable access channel and emails were sent out using the RPV website email list serve as "Breaking News" and to persons who had expressed an interest in emergency preparedness-related issues.

Copies of the draft Joint Natural Hazards Mitigation Plan were made available for public inspection at the Peninsula Center Main Branch Public Library in Rolling Hills Estates, the Miraleste Public Library in Rancho Palos Verdes and both City Halls. In addition, electronic versions of the document were posted on each City's website.

Public Meetings
The Cities conducted four public meetings where the Draft Joint Natural Hazards Mitigation Plan was presented and discussed. RPV presented the plan to its Emergency Preparedness Committee (September 20, 2004) and the City Council (October 5, 2004). RHE presented the plan to the Planning Commission (September 20, 2004) and the City Council (September 28, 2004).

Invitation Process
To inform the community about the public hearings to consider the draft Plan and to encourage participation at the meetings, the Cities published an advertisement in the Saturday, September 11, 2004 and Thursday, September 16, 2004 editions of the Peninsula *News*, notices were mailed to all homeowner associations, a notice was posted on the local government cable access channel and emails were sent out using the City's website email list serve as Breaking News and to persons who had expressed an interest in emergency preparedness-related issues.

Results
The RPV Emergency Preparedness Committee and the RHE Planning Commission held public meetings and reviewed the Draft Joint Plan simultaneously on September 20, 2004. The RHE City Council conducted a public hearing and unanimously adopted the Joint Draft Plan on September 28, 2004. Similarly, the RPV City Council conducted a public hearing and unanimously adopted the Joint Draft Plan on October 5, 2004. The input received during the public review process included both written and oral comments on the Draft Joint Plan. Apart from minor grammatical changes and typographical corrections, the public input process resulted in the inclusion of several factual additions to the text of the document, modification to two of proposed mitigation measures and the addition of three new mitigation measures.

Appendix C:

Economic Analysis of Natural Hazard Mitigation Projects

Benefit/Cost Analysis is a key mechanism used by the California Office of Emergency Services (OES), the Federal Emergency Management Agency, and other state and federal agencies in evaluating hazard mitigation projects, and is required by the Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 93-288, as amended.

This Appendix outlines several approaches for conducting economic analysis of natural hazard mitigation projects. It describes the importance of implementing mitigation activities, different approaches to economic analysis of mitigation strategies, and methods to calculate costs and benefits associated with mitigation strategies. Information in this section is derived in part from: Federal Emergency Management Agency Publication 331, Report on Costs and Benefits of Natural Hazard Mitigation.

This section is not intended to provide a comprehensive description of benefit/cost analysis, nor is it intended to provide the details of economic analysis methods that can be used to evaluate local projects. It is intended to (1) raise benefit/cost analysis as an important issue, and (2) provide some background on how economic analysis can be used to evaluate mitigation projects.

Why Evaluate Mitigation Strategies?
Mitigation activities reduce the cost of disasters by minimizing property damage, injuries, and the potential for loss of life, and by reducing emergency response costs, which would otherwise be incurred.

Evaluating natural hazard mitigation provides decision-makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects. Evaluating mitigation projects is a complex and difficult undertaking, which is influenced by many variables. First, natural disasters affect all segments of the communities they strike, including individuals, businesses, and public services such as fire, police, utilities, and schools.

Second, while some of the direct and indirect costs of disaster damages are measurable, some of the costs are non-financial and difficult to quantify in dollars. Third, many of the impacts of such events produce “ripple-effects” throughout the community, greatly increasing the disaster’s social and economic consequences.

While not easily accomplished, there is value, from a public policy perspective, in assessing the positive and negative impacts from mitigation activities, and obtaining an instructive benefit/cost comparison. Otherwise, the decision to pursue or not pursue various mitigation options would not be based on an objective understanding of the net benefit or loss associated with these actions.

What are Some Economic Analysis Approaches for Mitigation Strategies?
The approaches used to identify the costs and benefits associated with natural hazard mitigation strategies, measures, or projects fall into two general categories: benefit/cost analysis and cost-effectiveness analysis. The distinction between the two methods is the way in which the relative costs and benefits are measured. Additionally, there are varying approaches to assessing the value of mitigation for public sector and private sector activities.

Benefit/Cost Analysis
Benefit/Cost Analysis is used in natural hazards mitigation to show if the benefits to life and property protected through mitigation efforts exceed the cost of the mitigation activity. Conducting benefit/cost analysis for a mitigation activity can assist communities in determining whether a project is worth undertaking now, in order to avoid disaster related damages later. Benefit/cost analysis is based on calculating the frequency and severity of a hazard, avoided future damages, and risk.

In benefit/cost analysis, all costs and benefits are evaluated in terms of dollars, and a net benefit/cost ratio is computed to determine whether a project should be implemented (i.e., if net benefits exceed net costs, the project is worth pursuing). A project must have a benefit/cost ratio greater than 1 in order to be funded.

Cost-Effectiveness Analysis
Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. This type of analysis, however, does not necessarily measure costs and benefits in terms of dollars. Determining the economic feasibility of mitigating natural hazards can also be organized according to the perspective of those with an economic interest in the outcome. Hence, economic analysis approaches are covered for both public and private sectors as follows.

Investing in public sector mitigation activities
Evaluating mitigation strategies in the public sector is complicated because it involves estimating all of the economic benefits and costs regardless of who realizes them, and potentially to a large number of people and economic entities. Some benefits cannot be evaluated monetarily, but still affect the public in profound ways. Economists have developed methods to evaluate the economic feasibility of public decisions that involve a diverse set of beneficiaries and non-market benefits.

Investing in private sector mitigation activities
Private sector mitigation projects may occur on the basis of one of two approaches: it may be mandated by a regulation or standard, or it may be economically justified on its own merits. A building or landowner, whether a private entity or a public agency, are required to conform to a mandated standard may consider the following options:

1. Request cost sharing from public agencies;
2. Dispose of the building or land either by sale or demolition;
3. Change the designated use of the building or land and change the hazard mitigation compliance requirement; or

4. Evaluate the most feasible alternatives and initiate the most cost effective hazard mitigation alternative.

The sale of a building or land triggers another set of concerns. For example, real estate

> Estimating the costs and benefits of a hazard mitigation strategy can be a complex process.
>
> Employing the services of a specialist can assist in this process.

disclosure laws can be developed which require sellers of real property to disclose known defects and deficiencies in the property, including earthquake weaknesses and hazards to prospective purchasers. Correcting deficiencies can be expensive and time consuming, but their existence can prevent the sale of the building. Conditions of a sale regarding the deficiencies and the price of the building can be negotiated between a buyer and seller.

How can an Economic Analysis be Conducted?

Benefit/cost analysis and cost-effectiveness analysis are important tools in evaluating whether or not to implement a mitigation activity. A framework for evaluating alternative mitigation activities is outlined below:

1. Identify the Alternatives: Alternatives for reducing risk from natural hazards can include structural projects to enhance disaster resistance, education and outreach, and acquisition or demolition of exposed properties, among others. Different mitigation project can assist in minimizing risk to natural hazards, but do so at varying economic costs.

2. Calculate the Costs and Benefits: Choosing economic criteria is essential to systematically calculating costs and benefits of mitigation projects and selecting the most appropriate alternative. Potential economic criteria to evaluate alternatives include:

- Determine the project cost. This may include initial project development costs, and repair and operating costs of maintaining projects over time.

- Estimate the benefits. Projecting the benefits or cash flow resulting from a project can be difficult. Expected future returns from the mitigation effort depend on the correct specification of the risk and the effectiveness of the project, which may not be well known. Expected future costs depend on the physical durability and potential economic obsolescence of the investment. This is difficult to project. These considerations will also provide guidance in selecting an appropriate salvage value. Future tax structures and rates must be projected. Financing alternatives must be researched, and they may include retained earnings, bond and stock issues, and commercial loans.

- Consider costs and benefits to society and the environment. These are not easily measured, but can be assessed through a variety of economic tools including existence value or contingent value theories. These theories provide quantitative data on the value people attribute to physical or social environments. Even without hard data, however, impacts of structural projects to the physical environment or to society should be considered when implementing mitigation projects.

- Determine the correct discount rate. Determination of the discount rate can just be the risk-free cost of capital, but it may include the decision maker's time preference and also a risk premium. Including inflation should also be considered.

3. Analyze and Rank the Alternatives: Once costs and benefits have been quantified, economic analysis tools can rank the alternatives. Two methods for determining the best alternative given varying costs and benefits include net present value and internal rate of return.

- Net present value. Net present value is the value of the expected future returns of an investment minus the value of expected future cost expressed in today's dollars. If the net present value is greater than the project costs, the project may be determined feasible for implementation. Selecting the discount rate, and identifying the present and future costs and benefits of the project calculates the net present value of projects.

- Internal Rate of Return. Using the internal rate of return method to evaluate mitigation projects provides the interest rate equivalent to the dollar returns expected from the project. Once the rate has been calculated, it can be compared to rates earned by investing in alternative projects. Projects may be feasible to implement when the internal rate of return is greater than the total costs of the project.

Once the mitigation projects are ranked on the basis of economic criteria, decision-makers can consider other factors, such as risk; project effectiveness; and economic, environmental, and social returns in choosing the appropriate project for implementation.

How are Benefits of Mitigation Calculated?

Economic Returns of Natural Hazard Mitigation

The estimation of economic returns, which accrue to building or land owner as a result of natural hazard mitigation, is difficult. Owners evaluating the economic feasibility of mitigation should consider reductions in physical damages and financial losses. A partial list follows:

- Building damages avoided

- Content damages avoided
- Inventory damages avoided
- Rental income losses avoided
- Relocation and disruption expenses avoided
- Proprietor's income losses avoided

These parameters can be estimated using observed prices, costs, and engineering data. The difficult part is to correctly determine the effectiveness of the hazard mitigation project and the resulting reduction in damages and losses. Equally as difficult is assessing the probability that an event will occur. The damages and losses should only include those that will be borne by the owner. The salvage value of the investment can be important in determining economic feasibility. Salvage value becomes more important as the time horizon of the owner declines. This is important because most businesses depreciate assets over a period of time.

Additional Costs from Natural Hazards

Property owners should also assess changes in a broader set of factors that can change as a result of a large natural disaster. These are usually termed "indirect" effects, but they can have a very direct effect on the economic value of the owner's building or land. They can be positive or negative, and include changes in the following:

- Commodity and resource prices
- Availability of resource supplies
- Commodity and resource demand changes
- Building and land values
- Capital availability and interest rates
- Availability of labor
- Economic structure
- Infrastructure
- Regional exports and imports
- Local, state, and national regulations and policies
- Insurance availability and rates

Changes in the resources and industries listed above are more difficult to estimate and require models that are structured to estimate total economic impacts. Total economic impacts are the sum of direct and indirect economic impacts. Total economic impact models are usually not combined with economic feasibility models. Many models exist to estimate total economic impacts of changes in an economy. Decision makers should understand the total economic impacts of natural disasters in order to calculate the benefits of a mitigation activity. This suggests that understanding the local economy is an important first step in being able to understand the potential impacts of a disaster, and the benefits of mitigation activities.

Additional Considerations

Conducting an economic analysis for potential mitigation activities can assist decision-makers in choosing the most appropriate strategy for their community to reduce risk and prevent loss from natural hazards. Economic analysis can also save time and resources from being spent on inappropriate or unfeasible projects. Several resources and models are listed on the following page that can assist in conducting an economic analysis for natural hazard mitigation activities.

Benefit/cost analysis is complicated, and the numbers may divert attention from other important issues. It is important to consider the qualitative factors of a project associated with mitigation that cannot be evaluated economically. There are alternative approaches to implementing mitigation projects. Many communities are looking towards developing multi-objective projects. With this in mind, opportunity rises to develop strategies that integrate natural hazard mitigation with projects related to watersheds, environmental planning, community economic development, and small business development, among others. Incorporating natural hazard mitigation with other community projects can increase the viability of project implementation.

Resources

CUREe Kajima Project, Methodologies For Evaluating The Socio-Economic Consequences Of Large Earthquakes, Task 7.2 Economic Impact Analysis, Prepared by University of California, Berkeley Team, Robert A. Olson, VSP Associates, Team Leader; John M. Eidinger, G&E Engineering Systems; Kenneth A. Goettel, Goettel and Associates Inc.; and Gerald L. Horner, Hazard Mitigation Economics Inc., 1997.

Federal Emergency Management Agency, Benefit/Cost Analysis of Hazard Mitigation Projects, Riverine Flood, Version 1.05, Hazard Mitigation Economics Inc., 1996.

Federal Emergency Management Agency Report on Costs and Benefits of Natural Hazard Mitigation. Publication 331, 1996.

Goettel & Horner Inc., Earthquake Risk Analysis Volume III: The Economic Feasibility of Seismic Rehabilitation of Buildings in The City of Portland, Submitted to the Bureau of Buildings, City of Portland, August 30, 1995.

Goettel & Horner Inc., Benefit/Cost Analysis of Hazard Mitigation Projects Volume V, Earthquakes, Prepared for FEMA's Hazard Mitigation Branch, October 25, 1995.

Horner, Gerald, Benefit/Cost Methodologies for Use in Evaluating the Cost Effectiveness of Proposed Hazard Mitigation Measures, Robert Olson Associates, Prepared for Oregon State Police, Office of Emergency Management, July 1999.

Interagency Hazards Mitigation Team, State Hazard Mitigation Plan, (Oregon State Police – Office of Emergency Management, 2000).

Risk Management Solutions, Inc., Development of a Standardized Earthquake Loss Estimation Methodology, National Institute of Building Sciences, Volume I and II, 1994.

VSP Associates, Inc., A Benefit/Cost Model for the Seismic Rehabilitation of Buildings, Volumes 1 & 2, Federal Emergency Management Agency, FEMA, Publication Numbers 227 and 228, 1991.

VSP Associates, Inc., Benefit/Cost Analysis of Hazard Mitigation Projects: Section 404 Hazard Mitigation Program and Section 406 Public Assistance Program, Volume 3: Seismic Hazard Mitigation Projects, 1993.

VSP Associates, Inc., Seismic Rehabilitation of Federal Buildings: A Benefit/Cost Model, Volume 1, Federal Emergency Management Agency, FEMA, Publication Number 255, 1994.

Appendix D:
Acronyms

Federal Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ATC	Applied Technology Council
b/ca	benefit/cost analysis
BFE	Base Flood Elevation
BLM	Bureau of Land Management
BSSC	Building Seismic Safety Council
CDBG	Community Development Block Grant
CFR	Code of Federal Regulations
CRS	Community Rating System
DOE	Department of Energy
EDA	Economic Development Administration
EPA	Environmental Protection Agency
ER	Emergency Relief
EWP	Emergency Watershed Protection (NRCS Program)
FAS	Federal Aid System
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance (FEMA Program)
FTE	Full Time Equivalent
GIS	Geographic Information System
GNS	Institute of Geological and Nuclear Sciences (International)
GSA	General Services Administration
HAZUS	Hazards U.S.
HMGP	Hazard Mitigation Grant Program
HMST	Hazard Mitigation Survey Team
HUD	Housing and Urban Development (United States, Department of)
IBHS	Institute for Business and Home Safety
ICC	Increased Cost of Compliance
IHMT	Interagency Hazard Mitigation Team
NCDC	National Climate Data Center
NFIP	National Flood Insurance Program
NFPA	National Fire Protection Association
NHMP	Natural Hazard Mitigation Plan (also known as "409 Plan")
NIBS	National Institute of Building Sciences
NIFC	National Interagency Fire Center
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NWS	National Weather Service

SBA	Small Business Administration
SHMO	State Hazard Mitigation Officer
TOR	Transfer of Development Rights
UGB	Urban Growth Boundary
URM	Unreinforced Masonry
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USFA	United States Fire Administration
USFS	United States Forest Service
USGS	United States Geological Survey
WSSPC	Western States Seismic Policy Council

California Acronyms

A&W	Alert and Warning
AA	Administering Areas
AAR	After Action Report
ARC	American Red Cross
ARP	Accidental Risk Prevention
ATC20	Applied Technology Council20
ATC21	Applied Technology Council21
BCP	Budget Change Proposal
BSA	California Bureau of State Audits
CAER	Community Awareness & Emergency Response
CalARP	California Accidental Release Prevention
CalBO	California Building Officials
CalEPA	California Environmental Protection Agency
CalREP	California Radiological Emergency Plan
CALSTARS	California State Accounting Reporting System
CalTRANS	California Department of Transportation
CBO	Community Based Organization
CD	Civil Defense
CDF	California Department of Forestry and Fire Protection
CDMG	California Division of Mines and Geology
CEC	California Energy Commission
CEPEC	California Earthquake Prediction Evaluation Council
CESRS	California Emergency Services Radio System
CHIP	California Hazardous Identification Program
CHMIRS	California Hazardous Materials Incident Reporting System
CHP	California Highway Patrol
CLETS	California Law Enforcement Telecommunications System
CSTI	California Specialized Training Institute
CUEA	California Utilities Emergency Association
CUPA	Certified Unified Program Agency

DAD	Disaster Assistance Division (California Office of Emergency Services)
DFO	Disaster Field Office
DGS	California Department of General Services
DHSRHB	California Department of Health Services, Radiological Health Branch
DO	Duty Officer
DOC	Department Operations Center
DOF	California Department of Finance
DOJ	California Department of Justice
DPA	California Department of Personnel Administration
DPIG	Disaster Preparedness Improvement Grant
DR	Disaster Response
DSA	Division of the State Architect
DSR	Damage Survey Report
DSW	Disaster Service Worker
DWR	California Department of Water Resources
EAS	Emergency Alerting System
EDIS	Emergency Digital Information System
EERI	Earthquake Engineering Research Institute
EMA	Emergency Management Assistance
EMI	Emergency Management Institute
EMMA	Emergency Managers Mutual Aid
EMS	Emergency Medical Services
EOC	Emergency Operations Center
EOP	Emergency Operations Plan
EPEDAT	Early Post Earthquake Damage Assessment Tool
EPI	Emergency Public Information
EPIC	Emergency Public Information Council
ESC	Emergency Services Coordinator
FAY	Federal Award Year
FDAA	Federal Disaster Assistance Administration
FEAT	Governor's Flood Emergency Action Team
FEMA	Federal Emergency Management Agency
FFY	Federal Fiscal Year
FIR	Final Inspection Reports
FIRESCOPE	Firefighting Resources of Southern California Organized for Potential Emergencies
FMA	Flood Management Assistance
FSR	Feasibility Study Report
FY	Fiscal Year
GIS	Geographical Information System
HAZMAT	Hazardous Materials
HAZMIT	Hazardous Mitigation
HAZUS	Hazards United States (an earthquake damage assessment prediction tool)
HAD	Housing and Community Development
HEICS	Hospital Emergency Incident Command System

HEPG	Hospital Emergency Planning Guidance
HIA	Hazard Identification and Analysis Unit
HMEP	Hazardous Materials Emergency Preparedness
HMGP	Hazard Mitigation Grant Program
IDE	Initial Damage Estimate
IA	Individual Assistance
IFG	Individual & Family Grant (program)
IRG	Incident Response Geographic Information System
IPA	Information and Public Affairs (of state Office of Emergency Services)
LAN	Local Area Network
LEMMA	Law Enforcement Master Mutual Aid
LEPC	Local Emergency Planning Committee
MARAC	Mutual Aid Regional Advisory Council
MHFP	Multi-Hazard Functional Plan
MHID	Multi-Hazard Identification
MOU	Memorandum of Understanding
NBC	Nuclear, Biological, Chemical
NEMA	National Emergency Management Agency
NEMIS	National Emergency Management Information System
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Association
NPP	Nuclear Power Plant
NSF	National Science Foundation
NWS	National Weather Service
OA	Operational Area
OASIS	Operational Area Satellite Information System
OCC	Operations Coordination Center
OCD	Office of Civil Defense
OEP	Office of Emergency Planning
OES	California Governor's Office of Emergency Services
OSHPD	Office of Statewide Health Planning and Development
OSPR	Oil Spill Prevention and Response
PA	Public Assistance
PC	Personal Computer
PDA	Preliminary Damage Assessment
PIO	Public Information Office
POST	Police Officer Standards and Training
PPA/CA	Performance Partnership Agreement/Cooperative Agreement (FEMA)
PSA	Public Service Announcement
PTAB	Planning and Technological Assistance Branch
PTR	Project Time Report
RA	Regional Administrator (OES)
RADEF	Radiological Defense (program)
RAMP	Regional Assessment of Mitigation Priorities
RAPID	Railroad Accident Prevention & Immediate Deployment

RDO	Radiological Defense Officer
RDMHC	Regional Disaster Medical Health Coordinator
REOC	Regional Emergency Operations Center
REPI	Reserve Emergency Public Information
RES	Regional Emergency Staff
RIMS	Response Information Management System
RMP	Risk Management Plan
RPU	Radiological Preparedness Unit (OES)
RRT	Regional Response Team
SAM	State Administrative Manual
SARA	Superfund Amendments & Reauthorization Act
SAVP	Safety Assessment Volunteer Program
SBA	Small Business Administration
SCO	California State Controller's Office
SEMS	Standardized Emergency Management System
SEPIC	State Emergency Public Information Committee
SLA	State and Local Assistance
SONGS	San Onofre Nuclear Generating Station
SOP	Standard Operating Procedure
SWEPC	Statewide Emergency Planning Committee
TEC	Travel Expense Claim
TRU	Transuranic
TTT	Train the Trainer
UPA	Unified Program Account
UPS	Uninterrupted Power Source
USAR	Urban Search and Rescue
USGS	United States Geological Survey
WC	California State Warning Center
WAN	Wide Area Network
WIPP	Waste Isolation Pilot Project

Appendix E

Glossary

Acceleration	The rate of change of velocity with respect to time. Acceleration due to gravity at the earth's surface is 9.8 meters per second squared. That means that every second that something falls toward the surface of earth its velocity increases by 9.8 meters per second.
Asset	Any manmade or natural feature that has value, including, but not limited to people; buildings; infrastructure like bridges, roads, and sewer and water systems; lifelines like electricity and communication resources; or environmental, cultural, or recreational features like parks, dunes, wetlands, or landmarks.
Base Flood	Flood that has a 1 percent probability of being equaled or exceeded in any given year. Also known as the 100-year flood.
Base Flood Elevation (BFE)	Elevation of the base flood in relation to a specified datum, such as the National Geodetic Vertical Datum of 1929. The Base Flood Elevation is used as the standard for the National Flood Insurance Program.
Bedrock	The solid rock that underlies loose material, such as soil, sand, clay, or gravel.
Building	A structure that is walled and roofed, principally above ground and permanently affixed to a site. The term includes a manufactured home on a permanent foundation on which the wheels and axles carry no weight.
Coastal High Hazard Area	Area, usually along an open coast, bay, or inlet that is subject to inundation by storm surge and, in some instances, wave action caused by storms or seismic sources.
Coastal Zones	The area along the shore where the ocean meets the land as the surface of the land rises above the ocean. This land/water interface includes barrier islands, estuaries, beaches, coastal wetlands, and land areas having direct drainage to the ocean.
Community Rating System (CRS)	An NFIP program that provides incentives for NFIP communities to complete activities that reduce flood hazard risk. When the community completes specified activities, the insurance premiums of policyholders in these communities are reduced.
Computer-Aided Design And Drafting (CADD)	A computerized system enabling quick and accurate electronic 2-D and 3-D drawings, topographic mapping, site plans, and profile/cross-section drawings.
Contour	A line of equal ground elevation on a topographic (contour) map.

Critical Facility	Facilities that are critical to the health and welfare of the population and that are especially important following hazard events. Critical facilities include, but are not limited to, shelters, police and fire stations, and hospitals.
Debris	The scattered remains of assets broken or destroyed in a hazard event. Debris caused by a wind or water hazard event can cause additional damage to other assets.
Digitize	To convert electronically points, lines, and area boundaries shown on maps into x, y coordinates (e.g., latitude and longitude, universal transverse mercator (UTM), or table coordinates) for use in computer applications.
Displacement Time	The average time (in days) which the building's occupants typically must operate from a temporary location while repairs are made to the original building due to damages resulting from a hazard event.
Duration	How long a hazard event lasts.
Earthquake	A sudden motion or trembling that is caused by a release of strain accumulated within or along the edge of earth's tectonic plates.
Erosion	Wearing away of the land surface by detachment and movement of soil and rock fragments, during a flood or storm or over a period of years, through the action of wind, water, or other geologic processes.
Erosion Hazard Area	Area anticipated being lost to shoreline retreat over a given period of time. The projected inland extent of the area is measured by multiplying the average annual long-term recession rate by the number of years desired.
Essential Facility	Elements important to ensure a full recovery of a community or state following a hazard event. These would include: government functions, major employers, banks, schools, and certain commercial establishments, such as grocery stores, hardware stores, and gas stations.
Extent	The size of an area affected by a hazard or hazard event.
Extratropical Cyclone	Cyclonic storm events like Nor'easters and severe winter low-pressure systems. Both West and East coasts can experience these non-tropical storms that produce gale-force winds and precipitation in the form of heavy rain or snow. These cyclonic storms, commonly called Nor'easters on the East Coast because of the direction of the storm winds, can last for several days and can be very large – 1,000-mile wide storms are not uncommon.

Fault	A fracture in the continuity of a rock formation caused by a shifting or dislodging of the earth's crust, in which adjacent surfaces are differentially displaced parallel to the plane of fracture.
Federal Emergency Management Agency (FEMA)	Independent agency created in 1978 to provide a single point of accountability for all Federal activities related to disaster mitigation and emergency preparedness, response and recovery.
Fire Potential Index (FPI)	Developed by USGS and USFS to assess and map fire hazard potential over broad areas. Based on such geographic information, national policy makers and on-the-ground fire managers established priorities for prevention activities in the defined area to reduce the risk of managed and wildfire ignition and spread. Prediction of fire hazard shortens the time between fire ignition and initial attack by enabling fire managers to pre-allocate and stage suppression forces to high fire risk areas.
Flash Flood	A flood event occurring with little or no warning where water levels rise at an extremely fast rate.
Flood	A general and temporary condition of partial or complete inundation of normally dry land areas from (1) the overflow of inland or tidal waters, (2) the unusual and rapid accumulation or runoff of surface waters from any source, or (3) mudflows or the sudden collapse of shoreline land.
Flood Depth	Height of the flood water surface above the ground surface.
Flood Elevation	Elevation of the water surface above an established datum, e.g. National Geodetic Vertical Datum of 1929, North American Vertical Datum of 1988, or Mean Sea Level.
Flood Hazard Area	The area shown to be inundated by a flood of a given magnitude on a map.
Flood Insurance Rate Map (FIRM)	Map of a community, prepared by the Federal Emergency Management Agency that shows both the special flood hazard areas and the risk premium zones applicable to the community.
Flood Insurance Study (FIS)	A study that provides an examination, evaluation, and determination of flood hazards and, if appropriate, corresponding water surface elevations in a community or communities.
Floodplain	Any land area, including watercourse, susceptible to partial or complete inundation by water from any source.

Frequency	A measure of how often events of a particular magnitude are expected to occur. Frequency describes how often a hazard of a specific magnitude, duration, and/or extent typically occurs, on average. Statistically, a hazard with a 100-year recurrence interval is expected to occur once every 100 years on average, and would have a 1 percent chance – its probability – of happening in any given year. The reliability of this information varies depending on the kind of hazard being considered.
Fujita Scale of Tornado Intensity	Rates tornadoes with numeric values from F0 to F5 based on tornado wind speed and damage sustained. An F0 indicates minimal damage such as broken tree limbs or signs, while and F5 indicated severe damage sustained.
Functional Downtime	The average time (in days) during which a function (business or service) is unable to provide its services due to a hazard event.
Geographic Area Impacted	The physical area in which the effects of the hazard are experienced.
Geographic Information Systems (GIS)	A computer software application that relates physical features on the earth to a database to be used for mapping and analysis.
Ground Motion	The vibration or shaking of the ground during an earthquake. When a fault ruptures, seismic waves radiate, causing the ground to vibrate. The severity of the vibration increases with the amount of energy released and decreases with distance from the causative fault or epicenter, but soft soils can further amplify ground motions
Hazard	A source of potential danger or adverse condition. Hazards in this how to series will include naturally occurring events such as floods, earthquakes, tornadoes, tsunami, coastal storms, landslides, and wildfires that strike populated areas. A natural event is a hazard when it has the potential to harm people or property.
Hazard Event	A specific occurrence of a particular type of hazard.
Hazard Identification	The process of identifying hazards that threaten an area.
Hazard Mitigation	Sustained actions taken to reduce or eliminate long-term risk from hazards and their effects.
Hazard Profile	A description of the physical characteristics of hazards and a determination of various descriptors including magnitude, duration, frequency, probability, and extent. In most cases, a community can most easily use these descriptors when they are recorded and displayed as maps.

HAZUS (Hazards U.S.)	A GIS-based nationally standardized earthquake loss estimation tool developed by FEMA.
Hurricane	An intense tropical cyclone, formed in the atmosphere over warm ocean areas, in which wind speeds reach 74-miles-per-hour or more and blow in a large spiral around a relatively calm center or "eye." Hurricanes develop over the north Atlantic Ocean, northeast Pacific Ocean, or the south Pacific Ocean east of 160°E longitude. Hurricane circulation is counter-clockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.
Hydrology	The science of dealing with the waters of the earth. A flood discharge is developed by a hydrologic study.
Infrastructure	Refers to the public services of a community that have a direct impact on the quality of life. Infrastructure includes communication technology such as phone lines or Internet access, vital services such as public water supplies and sewer treatment facilities, and includes an area's transportation system such as airports, heliports; highways, bridges, tunnels, roadbeds, overpasses, railways, bridges, rail yards, depots; and waterways, canals, locks, seaports, ferries, harbors, dry docks, piers and regional dams.
Intensity	A measure of the effects of a hazard event at a particular place.
Landslide	Downward movement of a slope and materials under the force of gravity.
Lateral Spreads	Develop on gentle slopes and entail the sidelong movement of large masses of soil as an underlying layer liquefies in a seismic event. The phenomenon that occurs when ground shaking causes loose soils to lose strength and act like viscous fluid. Liquefaction causes two types of ground failure: lateral spread and loss of bearing strength.
Liquefaction	Results when the soil supporting structures liquefies. This can cause structures to tip and topple.
Lowest Floor	Under the NFIP, the lowest floor of the lowest enclosed area (including basement) of a structure.
Magnitude	A measure of the strength of a hazard event. The magnitude (also referred to as severity) of a given hazard event is usually determined using technical measures specific to the hazard.
Mitigation Plan	A systematic evaluation of the nature and extent of vulnerability to the effects of natural hazards typically present in the state and includes a description of actions to minimize future vulnerability to hazards.

National Flood Insurance Program (NFIP)	Federal program created by Congress in 1968 that makes flood insurance available in communities that enact minimum floodplain management regulations in 44 CFR §60.3.
National Geodetic Vertical Datum of 1929 (NGVD)	Datum established in 1929 and used in the NFIP as a basis for measuring flood, ground, and structural elevations, previously referred to as Sea Level Datum or Mean Sea Level. The Base Flood Elevations shown on most of the Flood Insurance Rate Maps issued by the Federal Emergency Management Agency are referenced to NGVD.
National Weather Service (NWS)	Prepares and issues flood, severe weather, and coastal storm warnings and can provide technical assistance to Federal and state entities in preparing weather and flood warning plans.
Nor'easter	An extra-tropical cyclone producing gale-force winds and precipitation in the form of heavy snow or rain.
Outflow	Follows water inundation creating strong currents that rip at structures and pound them with debris, and erode beaches and coastal structures.
Planimetric	Describes maps that indicate only man-made features like buildings.
Planning	The act or process of making or carrying out plans; the establishment of goals, policies and procedures for a social or economic unit.
Probability	A statistical measure of the likelihood that a hazard event will occur.
Recurrence Interval	The time between hazard events of similar size in a given location. It is based on the probability that the given event will be equaled or exceeded in any given year.
Repetitive Loss Property	A property that is currently insured for which two or more National Flood Insurance Program losses (occurring more than ten days apart) of at least $1000 each have been paid within any 10-year period since 1978.
Replacement Value	The cost of rebuilding a structure. This is usually expressed in terms of cost per square foot, and reflects the present-day cost of labor and materials to construct a building of a particular size, type and quality.
Richter Scale	A numerical scale of earthquake magnitude devised by seismologist C.F. Richter in 1935.
Risk	The estimated impact that a hazard would have on people, services, facilities, and structures in a community; the likelihood of a hazard event resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate or low likelihood of sustaining damage above a particular threshold due to a specific type of hazard event. It also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Riverine	Of or produced by a river.
Scale	A proportion used in determining a dimensional relationship; the ratio of the distance between two points on a map and the actual distance between the two points on the earth's surface.
Scarp	A steep slope.
Scour	Removal of soil or fill material by the flow of flood waters. The term is frequently used to describe storm-induced, localized conical erosion around pilings and other foundation supports where the obstruction of flow increases turbulence.
Seismicity	Describes the likelihood of an area being subject to earthquakes.
Special Flood Hazard Area (SFHA)	An area within a floodplain having a 1 percent or greater chance of flood occurrence in any given year (100-year floodplain); represented on Flood Insurance Rate Maps by darkly shaded areas with zone designations that include the letter A or V.
Stafford Act	The Robert T. Stafford Disaster Relief and Emergency Assistance Act, PL 100-107 was signed into law November 23, 1988 and amended the Disaster Relief Act of 1974, PL 93-288. The Stafford Act is the statutory authority for most Federal disaster response activities, especially as they pertain to FEMA and its programs.
State Hazard Mitigation Officer (SHMO)	The representative of state government who is the primary point of contact with FEMA, other state and Federal agencies, and local units of government in the planning and implementation of pre- and post-disaster mitigation activities.
Storm Surge	Rise in the water surface above normal water level on the open coast due to the action of wind stress and atmospheric pressure on the water surface.
Structure	Something constructed. (See also Building)
Substantial Damage	Damage of any origin sustained by a structure in a Special Flood Hazard Area whereby the cost of restoring the structure to its before-damaged condition would equal or exceeds 50 percent of the market value of the structure before the damage.
Super Typhoon	A typhoon with maximum sustained winds of 150 mph or more.
Surface Faulting	The differential movement of two sides of a fracture – in other words, the location where the ground breaks apart. The length, width, and displacement of the ground characterize surface faults.

Tectonic Plate	Torsionally rigid, thin segments of the earth's lithosphere that may be assumed to move horizontally and adjoin other plates. It is the friction between plate boundaries that cause seismic activity.
Topographic	Characterizes maps that show natural features and indicate the physical shape of the land using contour lines. These maps may also include manmade features.
Tornado	A violently rotating column of air extending from a thunderstorm to the ground.
Tropical Cyclone	A generic term for a cyclonic, low-pressure system over tropical or subtropical waters.
Tropical Depression	A tropical cyclone with maximum sustained winds of less than 39 mph.
Tropical Storm	A tropical cyclone with maximum sustained winds greater than 39 mph and less than 74 mph.
Tsunami	Great sea wave produced by submarine earth movement or volcanic eruption.
Typhoon	A special category of tropical cyclone peculiar to the western North Pacific Basin, frequently affecting areas in the vicinity of Guam and the North Mariana Islands. Typhoons whose maximum sustained winds attain or exceed 150 mph are called super typhoons.
Vulnerability	Describes how exposed or susceptible to damage an asset is. Vulnerability depends on an asset's construction, contents, and the economic value of its functions. Like indirect damages, the vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power – if an electric substation is flooded, it will affect not only the substation itself, but a number of businesses as well. Often, indirect effects can be much more widespread and damaging than direct ones.
Vulnerability Assessment	The extent of injury and damage that may result from a hazard event of a given intensity in a given area. The vulnerability assessment should address impacts of hazard events on the existing and future built environment.
Water Displacement	When a large mass of earth on the ocean bottom sinks or uplifts, the column of water directly above it is displaced, forming the tsunami wave. The rate of displacement, motion of the ocean floor at the epicenter, the amount of displacement of the rupture zone, and the depth of water above the rupture zone all contribute to the intensity of the tsunami.

Wave Run-up	The height that the wave extends up to on steep shorelines, measured above a reference level (the normal height of the sea, corrected to the state of the tide at the time of wave arrival).
Wildfire	An uncontrolled fire spreading through vegetative fuels, exposing and possibly consuming structures.
Zone	A geographical area shown on a Flood Insurance Rate Map (FIRM) that reflects the severity or type of flooding in the area.