Contra Costa County
Hazard Mitigation Plan Update
Volume 1: Planning-Area-Wide Elements

July 2011

Prepared by

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Contra Costa County

HAZARD MITIGATION PLAN UPDATE
VOLUME 1: PLANNING-AREA-WIDE ELEMENTS

JULY 2011

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Hazard Mitigation Plan Update;
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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Contra Costa County and a partnership of local governments within the county have developed a hazard mitigation plan to reduce future losses resulting from disasters. Hazard mitigation is the use of long- and short-term strategies to reduce the loss of life, personal injury, and property damage that can result from a disaster. It involves planning efforts, policy changes, programs, capital projects, and other activities that can mitigate the impacts of hazards.

The federal Disaster Mitigation Act (DMA) requires proactive pre-disaster planning as a condition of receiving certain financial assistance under the Robert T. Stafford Act. The DMA encourages state and local authorities to work together on pre-disaster planning, and it promotes “sustainable hazard mitigation,” which includes the sound management of natural resources, local economic and social resiliency, and the recognition that hazards and mitigation must be understood in the largest possible social and economic context. The enhanced planning network called for by the DMA helps local governments accurately assess mitigation needs, resulting in faster allocation of funding and more cost-effective risk reduction projects.

The responsibility for hazard mitigation lies with private property owners; business and industry; and local, state and federal government. It is impossible to predict exactly when and where disasters will occur or the extent to which they will impact an area; but with careful planning and collaboration among public agencies, stakeholders and citizens, it is possible to minimize losses that disasters can cause.

PLAN UPDATE

Federal regulations require hazard mitigation plans to include a plan for monitoring, evaluating, and updating the hazard mitigation plan. An update provides an opportunity to reevaluate recommendations, monitor the impacts of actions that have been accomplished, and determine if there is a need to change the focus of mitigation strategies. DMA compliance is contingent on meeting the plan update requirement. A jurisdiction covered by a plan that has expired is not able to pursue funding under the Robert T. Stafford Act for which a current hazard mitigation plan is a prerequisite.

Initial Response to the DMA in Contra Costa County

In 2004, The Association of Bay Area Governments (ABAG) led a regional effort to address hazard mitigation planning for jurisdictions within its planning area. This regional template was utilized by numerous counties and cities within the ABAG planning area to achieve initial compliance under the DMA. The ABAG process equipped local governments with tools to complete individual planning processes that met their needs, while pooling resources and eliminating redundant planning efforts. Seventeen local governments in Contra Costa County used the ABAG tools to achieve DMA compliance.

The Contra Costa County Planning Effort

Recognizing limitations in the ABAG planning effort, Contra Costa County Department of Public Works and the County Office of Emergency Services (OES) have teamed together to prepare an updated county-wide hazard mitigation plan that would better suit the needs and capabilities of the County and its planning partners. The Department of Public Works pursued grant funding under the Federal Emergency Management Agency’s (FEMA’s) Pre-Disaster Mitigation Grant program, and OES took the lead on assembling a planning partnership. The grant was awarded in the fall of 2007. The ensuing planning process developed a new plan for the County and its planning partners from scratch, using lessons learned from the prior planning effort. While this plan is an update for many of the planning partners, it is the initial plan for others. The updated plan differs from the initial plan for a variety of reasons:

- The plan has been totally re-structured as a countywide regional plan, focusing only on Contra Costa County. The risk assessment is not a subset of a larger regional effort. It is isolated to Contra Costa County and focuses on hazards of concern for the county.
- The plan was expanded to include special purpose districts as planning partners.
- The risk assessment has been formatted to better support future grant applications by providing risk and vulnerability information that will directly support the measurement of "cost-effectiveness" required under FEMA mitigation grant programs.
- Newly available data and tools provide for a more detailed and accurate risk assessment. The initial plan did not use tools such as FEMA's Hazards U.S. Multi-Hazard (HAZUS-MH) computer model or new data such as FEMA's countywide Digital Flood Insurance Rate Maps (DFIRMs).
- The plan will meet program requirements of the Community Rating System (CRS), providing the additional benefit of reducing flood insurance premiums in participating jurisdictions.
- This planning process will create the opportunity for all municipal planning partners to meet the requirements of California Assembly Bill 2140, which requires integration of hazard mitigation plans into general plans.
- The update gave the County and its planning partners an opportunity to engage local citizens and gauge their perception of risk and support for risk reduction through mitigation.

PLAN UPDATE METHODOLOGY

A partnership of local governments in Contra Costa County collaborated on the development of this hazard mitigation plan update. This partnership followed a five-phase planning process over 24 months that resulted in a document that will provide a blueprint for hazard risk reduction in Contra Costa County for the next five years.

Phase 1—Organize and Review

A planning team was assembled to provide technical support for the plan update, consisting of key County staff from the Department of Public Works and OES, as well as a technical consultant. The first step in developing the plan update was to organize the planning partnership. The County and 10 municipal governments committed to this update process. With special-purpose districts included, plan coverage was expanded to include 36 planning partners as shown in Tables ES-1 and ES-2. All 36 planning partners committed to the process by providing letters of intent to participate and agreeing to planning partner expectations.

**TABLE ES-1.
MUNICIPAL PLANNING PARTNERS**

Antioch	Brentwood	Danville	El Cerrito
Martinez	Pinole	Pleasant Hill	Richmond
San Ramon	Walnut Creek	Contra Costa County	

TABLE ES-2.
SPECIAL-PURPOSE DISTRICT PARTNERS

- Antioch Unified School District
- Bethel Island Municipal Improvement District
- Brentwood Union School District
- Canyon Elementary School District
- Central Contra Costa Sanitary District
- Contra Costa County Fire Protection District
- Contra Costa County Flood Control and Water Conservation District
- Contra Costa Community College District
- Contra Costa County Office of Education
- Delta Diablo Sanitation District
- Diablo Water District
- East Contra Costa Fire Protection District
- Ironhouse Sanitary District
- Kensington Fire Protection District
- Kensington Police Protection and Community Services District
- Knightsen Community Services District
- Liberty Union High School District
- Mt. Diablo Unified School District
- Pleasant Hill Recreation and Park District
- Reclamation District 800 (Byron Tract)
- Reclamation District 830 (Jersey Island)
- Rodeo-Hercules Fire Protection District
- San Ramon Valley Fire Protection District
- Walnut Creek School District
- West Contra Costa Unified School District

A 14-member steering committee was assembled to oversee the development of the plan, consisting of planning partner staff, citizens, and other stakeholders in the planning area. A key function of the Steering Committee was to confirm a guiding principal, goals and objectives for this updated plan. Full coordination with other county, state and federal agencies involved in hazard mitigation occurred from the onset of the plan update process.

A multi-media public involvement strategy centered on a hazard preparedness questionnaire was also implemented under this phase, as well as a comprehensive review of the previous plan and the State of California Hazard Mitigation Plan. Additionally, a comprehensive review was performed of existing programs that may support or enhance hazard mitigation actions.

Phase 2—Update the Risk Assessment

Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from natural hazards. This process assesses the vulnerability of people, buildings and infrastructure to natural hazards. It focuses on the following parameters:

- Hazard identification and profiling
- The impact of hazards on physical, social and economic assets
- Vulnerability identification
- Estimates of the cost of potential damage or costs that can be avoided through mitigation.

The risk assessment for this hazard mitigation plan meets requirements outlined in Chapter 44 of the Code of Federal Regulations (44CFR). Phase 2 occurred simultaneously with Phase 1, with the two efforts using information generated by one another to create the best possible risk assessment. This was the most comprehensive phase of the plan update process. All facets of the risk assessment of the plan were visited by the planning team and updated with the best available data and technology.

Phase 3—Engage the Public

A public involvement strategy was developed by the Steering Committee that maximized the capabilities of the planning partnership. This strategy was implemented by the planning team and included four public meetings early in the plan update process, two public meetings to review the draft plan, distribution of a hazard mitigation survey, a County-sponsored website dedicated to the plan update, and multiple media releases throughout the process.

Phase 4—Assemble the Updated Plan

The planning team and Steering Committee assembled key information from Phases 1, 2 and 3 into a document to meet the DMA requirements for all planning partners. Under 44CFR, a local hazard mitigation plan must include the following:

- A description of the planning process
- Risk assessment
- Mitigation strategy
  - Goals
  - Review of alternatives
  - Prioritized “action plan”
- Plan maintenance section
- Documentation of adoption.

The updated plan contains two volumes. Volume 1 contains all components that apply to all partners and the broader planning area (plan process, outreach strategy, plan maintenance, risk assessment, goals, objectives and countywide initiatives). Volume 2 contains all components that are jurisdiction-specific (ranking of risk, capability assessment, an action plan, prioritization of that action plan and a status report on prior actions). Each planning partner has a dedicated chapter in Volume 2.

Phase 5—Plan Adoption/Implementation

The final adoption phase will begin once pre-adoption approval is granted by California Emergency Management Agency (Cal EMA) and FEMA. Each partner will adopt the updated plan individually.

A plan implementation and maintenance section included in this document details the formal process for ensuring that the plan remains active and relevant. The plan maintenance process includes a schedule for monitoring and evaluating the plan’s progress annually and producing a plan revision every 5 years. Throughout the life of this plan, a steering committee representative of the original committee will provide a consistent source of guidance and oversight.

The plan adoption phase includes strategies for continued public involvement and incorporation of the recommendations of this plan into other planning mechanisms within the planning area, such as general plans, capital improvement plans, building codes, and emergency management plans.

MITIGATION GUIDING PRINCIPLE, GOALS AND OBJECTIVES

The following principle guided the Steering Committee and the planning partnership in selecting the initiatives contained in this plan update:

> Guiding Principle—To reduce the vulnerability from natural hazards within the county in a cost-effective manner, within the capabilities of the partnership.

The Steering Committee and the planning partnership established the following goals for the plan update:

- Goal 1—Save [or protect] lives and reduce injury
- Goal 2—Increase resilience of infrastructure and critical facilities
- Goal 3—Avoid [minimize, or reduce] damage to property
- Goal 4—Encourage the development and implementation of long-term, cost-effective and environmentally sound mitigation projects
- Goal 5—Build and support capacity to enable local government and the public to prepare, respond and recover from the impact of natural hazards.

Plan objectives were developed via a facilitated exercise that focused on finding objectives that meet multiple goals. The objectives are listed in Table ES-3.

MITIGATION INITIATIVES

Mitigation initiatives are activities to reduce or eliminate losses resulting from natural hazards. Mitigation initiatives are the key element of the hazard mitigation plan update. By implementing these initiatives, the planning partnership will strive to become disaster-resistant through sustainable hazard mitigation.

Although adoption of this plan makes the planning partners eligible for FEMA grant funding, the purposes of the plan go beyond grant eligibility. It was important to the planning partnership and the Steering Committee to look at initiatives that will work through all phases of emergency management. Some of the initiatives outlined in this plan are not grant eligible but were chosen for their effectiveness in achieving the goals of the plan. A series of countywide initiatives were identified, as summarized in Table ES-4. Jurisdiction-specific initiatives are listed in Volume 2 of this plan.

IMPLEMENTATION

Full implementation of the recommendations of this plan will require time and resources. Specific recommendations and plan review protocols are provided to evaluate changes in vulnerability and action plan prioritization after the plan is adopted. The true measure of the plan’s success will be its ability to adapt to the changing climate of hazard mitigation. Funding resources are always evolving, as are state and federal mandates. Contra Costa County and its planning partners have a long-standing tradition of proactive response to issues that may impact local citizens. Each local government will assume responsibility for adopting the recommendations of this plan and committing resources toward implementation. The framework established by this plan identifies a strategy that maximizes the potential for implementation based on available and potential resources. It commits all planning partners to pursue initiatives when the benefits of a project exceed its costs. The planning partnership developed this plan with extensive public input, and public support of the actions identified in this plan will help ensure the plan’s success.

TABLE ES-3.
OBJECTIVES FOR NATURAL HAZARD MITIGATION PLAN UPDATE

Objective Number	Objective Statement	Goals for Which It Can Be Applied
O-1	Increase resilience of (or protect and maintain) infrastructure and critical facilities	2, 3, 5
O-2	Sustain reliable local emergency operations and facilities during and after a disaster	1, 5
O-3	Educate the public on the risk from natural hazards and increase awareness, preparation, mitigation, response, and recovery activities	1, 3, 5
O-4	Minimize the impacts of natural hazards on current and future land uses by providing incentives for hazard mitigation	1, 3, 5
O-5	Prevent (or discourage) new development in hazardous areas or ensure that if building occurs in high-risk areas that it is done in such a way as to minimize risk	1, 3, 5
O-6	At the local government level, continually improve understanding of the location and potential impacts of natural hazards, utilizing the best available data and science.	1, 2, 3, 4, 5
O-7	Ensure all structures meet minimum standards for life safety	1, 2, 3, 5
O-8	Monitor plan progress annually to integrate local hazard mitigation plans and the results of disaster- and hazard-specific planning efforts	1, 2, 3, 5
O-9	Lower cost of flood insurance premiums through CRS program	3, 4, 5
O-10	Provide/improve flood protection with flood control structures, and drainage maintenance plans	2, 3, 4
O-11	Strengthen codes, and their enforcement, so that new construction can withstand the impacts of natural hazards and lessen the impact of that development on the environment's ability to absorb the impact of natural hazards.	1, 3
O-12	Consider the impacts of natural hazards in all planning mechanisms that address current and future land uses within the planning area.	1, 3
O-13	Eliminate or minimize disruption of local government operations caused by natural hazards	1, 3, 4
O-14	Consider open space land uses within identified high-hazard risk zones	1, 2, 3, 4, 5
0-15	Retrofit, acquire or relocate identified high-risk structures, including those known to experience repetitive losses.	1, 3, 4
0-16	Establish a partnership among all levels of government and the business community to improve and implement methods to protect property	1, 2, 3, 4, 5

TABLE ES-4.
ACTION PLAN—COUNTYWIDE MITIGATION INITIATIVES

Hazards Addressed	Lead Agency	Possible Funding Sources or Resources	Time Line[a]	Objectives
CW-1—Continue to maintain a Countywide hazard mitigation website that will house the plan and provide the public an opportunity to monitor plan implementation progress. Each planning partner can support this initiative by including an initiative in its action plan of creating a link to the County Hazard Mitigation webpage.				
All Hazards	OES	OES operational budget	Short term/ongoing	3, 6, 16
CW-2—Leverage public outreach partnering capabilities (such as CERT) within the planning area to promote a uniform and consistent message on the importance of proactive hazard mitigation.				
All Hazards	OES, CERT	OES operational budget	Short term/ ongoing	2, 3, 6 ,16
CW-3—Coordinate mitigation planning and project efforts within the planning area to leverage all resources available to the planning partnership.				
All Hazards	OES, Public Works	FEMA mitigation grant funding will reimburse for grant application preparation. General fund allocations of all planning partners.	Short term	6, 16
CW-4—Where appropriate, support retrofitting, purchase, or relocation of structures located in hazard-prone areas to protect structures from future damage, with repetitive and severe repetitive loss properties as a priority. Seek opportunities to leverage partnerships within the planning area in these pursuits.				
All Hazards	OES, Public Works	FEMA Mitigation Grant funding	Long-term/ depends on funding	7, 15, 16
CW-5—Continue to update hazard mapping with best available data and science as it evolves within the capabilities of the partnership. Support FEMA's Risk MAP Initiative.				
All Hazards	Public Works	FEMA Mitigation Grant Funding, FEMA's CTP program, County CIP funding	Long-term/ depends on funding	3, 6, 16
CW-6—To the extent possible based on available resources, provide coordination and technical assistance in the application for grant funding that includes assistance in cost vs. benefit analysis for grant eligible projects.				
All Hazards	OES, Public Works	FEMA mitigation grant funding will reimburse for grant application preparation. General fund allocations of all planning partners.	Short term	6, 16
CW-7—A steering committee will remain as a viable body over time to monitor progress of the hazard mitigation plan, provide technical assistance to Planning Partners and oversee the update of the plan according to schedule. This body will continue to operate under the ground rules established at its inception.				
All Hazards	OES, Public Works	Public Works and OES operational budgets	Short term/ ongoing	8, 16

TABLE ES-4 (CONTINUED).
ACTION PLAN—COUNTYWIDE MITIGATION INITIATIVES

Hazards Addressed	Lead Agency	Possible Funding Sources or Resources	Time Line[a]	Objectives
CW-8—Amend or enhance the Contra Costa County Hazard Mitigation Plan on an "as needed" basis to seek compliance with state or federal mandates (i.e., CA. Assembly Bill # 2140) as guidance for compliance with these programs become available.				
All Hazards	OES, DCD, Public Works	County General Fund	Short term/ ongoing	5, 6, 14
CW-9—Utilize information contained within the Contra Costa County Hazard Mitigation Plan to support updates to other emergency management plans in effect within the planning area.				
All Hazards	OES	Possible DHS funding, General funds of all planning partners	Long term, depends on funding	2, 13, 16
CW-10—Continue to coordinate emergency management and hazard mitigation planning functions with the Association of Bay Area Governments to leverage resources and information on the planning area to support/enhance these activities for the Contra Costa County planning partnership.				
All Hazards	OES	OES operational budget	Short term/ ongoing	2, 13, 16
CW-11—Sponsor the formation and training of Community Emergency Response Team (CERT) training through partnerships with local businesses				
All Hazards	All Municipal Planning Partners, OES	General Funds	Short term/ ongoing	2, 3, 6 ,16

a. Short term = 1 to 5 years; Long Term= 5 years or greater

OES = Sheriff's Office of Emergency Services; DCD = Contra Costa County Department of Conservation and Development

PART 1—THE PLANNING PROCESS

CHAPTER 1.
INTRODUCTION TO THE PLANNING PROCESS

1.1 WHY PREPARE THIS PLAN?

1.1.1 The Big Picture

Hazard mitigation is defined as a way to reduce or alleviate the loss of life, personal injury, and property damage that can result from a disaster through long- and short-term strategies. It involves strategies such as planning, policy changes, programs, projects, and other activities that can mitigate the impacts of hazards. The responsibility for hazard mitigation lies with many, including private property owners; business and industry; and local, state, and federal government.

The federal Disaster Mitigation Act (DMA) of 2000 (Public Law 106-390) required state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. Prior to 2000, federal disaster funding focused on disaster relief and recovery, with limited funding for hazard mitigation planning. The DMA increased the emphasis on planning for disasters before they occur.

The DMA encourages state and local authorities to work together on pre-disaster planning, and it promotes sustainability for disaster resistance. "Sustainable hazard mitigation" includes the sound management of natural resources and the recognition that hazards and mitigation must be understood in the largest possible social and economic context. The enhanced planning network called for by the DMA helps local governments articulate accurate needs for mitigation, resulting in faster allocation of funding and more cost-effective risk reduction projects.

1.1.2 Bay Area Response to the DMA

The Association of Bay Area Governments (ABAG) is the official comprehensive planning agency for the San Francisco Bay region. ABAG's mission is to strengthen coordination among local governments in order to address social, environmental, and economic issues that transcend local borders. The Bay Area is defined as nine counties: Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano and Sonoma. The 101 cities and nine counties in the Bay Area are voluntary members of ABAG, representing nearly all of the region's population.

In 2004, ABAG led a regional effort to establish a framework for hazard mitigation planning that would meet the local mitigation planning requirements of Title 44 of the Code of Federal Regulations (44CFR; Section 201.6) for jurisdictions within its planning area. The ABAG process provided local governments with tools to complete individual plans that meet their needs, while pooling resources and eliminating redundant planning activities. Numerous counties and cities in the planning area used the ABAG template to achieve initial compliance with the DMA, including the following local governments in Contra Costa County:

- Cities/County:
  - Contra Costa County
  - Clayton
  - Concord
  - Danville

- El Cerrito
- Lafayette
- Moraga
- Orinda
- Pleasant Hill
- Richmond
- San Pablo
- San Ramon
- Walnut Creek

- Special Purpose Districts:
  - Moraga/Orinda Fire District
  - San Ramon Valley Fire Protection District
  - Contra Costa Water District
  - Bethel Island Municipal Improvement District

1.1.3 Purposes for Planning

Contra Costa County and its planning partners have a long-standing tradition of proactive planning and program implementation that is enhanced by the development of a hazard mitigation plan. Elements and strategies in this plan were selected because they meet a program requirement and because they best meet the needs of the planning partners and their citizens. This hazard mitigation plan identifies resources, information, and strategies for reducing risk from natural hazards. It will help guide and coordinate mitigation activities throughout Contra Costa County. The plan was developed to meet the following objectives:

- Meet or exceed requirements of the DMA.
- Enable all planning partners to continue using federal grant funding to reduce risk through mitigation.
- Meet the needs of each planning partner as well as state and federal requirements.
- Create a risk assessment that focuses on Contra Costa County hazards of concern.
- Create a single planning document that integrates all planning partners into a framework that supports partnerships within the County, and puts all partners on the same planning cycle for future updates.
- Create an opportunity for local governments in the County not included in the initial ABAG effort to gain DMA compliance.
- Meet the planning requirements of FEMA’s Community Rating System (CRS), allowing planning partners that participate in the CRS program to maintain or enhance their CRS classifications.
- Coordinate existing plans and programs so that high-priority initiatives and projects to mitigate possible disaster impacts are funded and implemented.

1.2 WHO WILL BENEFIT FROM THIS PLAN?

All citizens and businesses of Contra Costa County are the ultimate beneficiaries of this hazard mitigation plan. The plan reduces risk for those who live in, work in, and visit the County. It provides a viable planning framework for all foreseeable natural hazards that may impact the County. Participation in development of the plan by key stakeholders in the County helped ensure that outcomes will be mutually beneficial. The resources and background information in the plan are applicable countywide, and the plan's goals and recommendations can lay groundwork for the development and implementation of local mitigation activities and partnerships.

1.3 HOW TO USE THIS PLAN

One of the benefits of multi-jurisdictional planning is the ability to pool resources and eliminate redundant activities within a planning area that has uniform risk exposure and vulnerabilities. The Federal Emergency Management Agency (FEMA) encourages multi-jurisdictional planning under its guidance for the DMA. This plan has been set up in two volumes so that elements that are jurisdiction-specific can easily be distinguished from those that apply to the whole planning area:

- **Volume 1**—Volume 1 meets the requirements of all elements of Section 201.6 of 44CFR that apply to the entire planning area. This includes the description of the planning process, public involvement strategy, goals and objectives, countywide hazard risk assessment, countywide mitigation initiatives, and a plan maintenance strategy.
- **Volume 2**—Volume 2 includes all jurisdiction-specific elements required by Section 201.6 of 44CFR. Jurisdictions that make up the planning partnership include cities, the County and special purpose districts. Jurisdiction-specific elements are included in annexes for each planning partner participating in this process and adopting this plan. Volume 2 also includes a description of the participation requirements established by the Steering Committee, as well as instructions and templates that the partners used to complete their annexes. Volume 2 also includes "linkage" procedures for eligible, jurisdictions that did not participate in development of this plant but wish to adopt it in the future.

All planning partners will adopt Volume 1 in its entirety and at least the following parts of Volume 2: Part 1; each partner's jurisdiction-specific annex; and the appendices.

The following appendices provided at the end of the plan include information or explanations to support the main content of the plan:

- Appendix A—A glossary of acronyms and definitions
- Appendix B—Public outreach information, including the hazard mitigation questionnaire and summary and documentation of public meetings.
- Appendix C—A template for progress reports to be completed as this plan is implemented
- Appendix D—Plan Adoption Resolutions from Planning Partners

CHAPTER 2.
PLAN UPDATE—WHAT HAS CHANGED

2.1 THE ABAG PLAN

Seventeen jurisdictions in Contra Costa County were covered under the 2005 ABAG regional planning effort. The planning process used to develop the initial ABAG plan was as follows:

- In the summer of 2004, ABAG held one planning workshop in each of the nine counties in the San Francisco Bay Area. At these meetings, ABAG staff discussed the general format and scope of work for its plan, demonstrated proposed Internet-based hazard mapping capabilities, and described the types of risk assessments to be performed. The workshops identified the key hazards to be addressed and a draft list of hazard maps to be prepared. The workshops also led to a decision to organize the ABAG plan by functional area rather than by hazard (e.g., by health, housing, education, etc., rather than by fire, earthquake, flood, etc.)
- Local governments reviewed the technical information used to develop the plan and provided ABAG with relevant information. Many relevant flooding, landsliding, and wildfire data sets and reports were provided to ABAG following outreach to state and federal agencies and to professional organizations. The result was an extensive library of publications, including plans, studies, reports, and technical data.
- ABAG staff developed a draft overall goal and eight basic commitments for the plan. These general policies were approved by ABAG's Executive Board and Regional Planning Committee.
- ABAG's Earthquake and Hazards Outreach Committee and Lifelines Infrastructure and Hazards Review Committee helped to develop sections of the plan that address housing safety, business risk, and lifeline issues. ABAG staff drafted an outline of mitigation strategies and circulated the strategies to all participating local government agencies and to professional organizations. The latter were asked to provide feedback and assistance in drafting mitigation strategies that could be incorporated into the general outline of the eight key commitments of the plan.
- The draft ABAG Plan was released for public comment in October 2004. ABAG then held focused workshop on issues identified as needing further work. Based on the comments received, the Plan was revised, and the revised plan was forwarded to FEMA Region IX and the California Office of Emergency Services (subsequently merged into the California Emergency Management Agency (Cal EMA)). Comments from Cal EMA, FEMA, and professional organizations were incorporated into another version, which was distributed for a final round of comment in early 2005. All comments received were reviewed and most were incorporated in the plan. All changes to the mitigation portion of this plan were finalized on January 28, 2005.

2.2 WHY UPDATE?

44CFR stipulates that hazard mitigation plans must present a schedule for monitoring, evaluating, and updating the plan. This provides an opportunity to reevaluate recommendations, monitor the impacts of actions that have been accomplished, and determine if there is a need to change the focus of mitigation strategies. A jurisdiction covered by a plan that has expired is not able to pursue elements of federal funding under the Robert T. Stafford Act for which a current hazard mitigation plan is a prerequisite.

2.4 THE UPDATED PLAN—WHAT IS DIFFERENT?

Although Contra Costa County's initial hazard mitigation plan was prepared under the ABAG process, the Contra Costa County Department of Public Works and Sheriff's Office of Emergency Services (OES) determined that a new countywide hazard mitigation plan would better suit the needs and capabilities of the County and its planning partners than an update under ABAG. The Department of Public Works pursued grant funding under FEMA's Pre-Disaster Mitigation Grant program, and OES took the lead on assembling a planning partnership. The grant was awarded in the fall of 2007. The ensuing planning process strived to create a new plan for the County and its planning partners from scratch, using lessons learned from the prior planning effort. While this plan is an update for many of the planning partners, it is also the initial plan for others. Therefore, it was important to establish a planning process that was consistent for all partners. Chapter 3 outlines the methodology used to accomplish this objective. The updated plan differs from the initial plan in a variety of ways:

- The plan has been totally restructured as a countywide regional plan, focusing only on Contra Costa County. The risk assessment is not a subset of a larger regional effort. It is isolated to Contra Costa County and focuses on the hazards of concern for the County.
- The risk assessment has been prepared to better support future grant applications by providing risk and vulnerability information that will directly support the measurement of "cost-effectiveness" required under FEMA mitigation grant programs
- Newly available data and tools provide for a more detailed and accurate risk assessment. The initial plan did not use tools such as FEMA's Hazards U.S. Multi-Hazard (HAZUS-MH) computer model or new data such as FEMA's countywide Digital Flood Insurance Rate Maps (DFIRMs).
- The plan meets program requirements of the Community Rating System (CRS), thus reducing flood insurance premiums in participating jurisdictions.
- The planning process creates the opportunity for all municipal planning partners to meet the requirements of California Assembly Bill 2140 (AB 2140), state legislation that requires integration of hazard mitigation plans into general plans.
- The plan is more user-friendly because it is confined to one package.
- The update created an opportunity for the County and planning partners to engage citizens directly in a coordinated approach to gage their perception of risk and support of the concept of risk reduction through mitigation.
- The plan identifies actions rather than strategies. Strategies provide direction, but actions are fundable under grant programs. This plan replaces strategies with a guiding principal, goals and objectives. The identified actions meet multiple objectives that are measurable, so that each planning partner can measure the effectiveness of their mitigation actions.

Given the extent of changes in this update, reviewers should consider this to be a new plan. When relevant, the update discusses correlations with the initial plan, especially when data or information is being carried over to the update. Table 2-1 indicates the major changes between the two plans as they relate to 44CFR planning requirements.

TABLE 2-1.
PLAN CHANGES CROSSWALK

44CFR Requirement	ABAG Plan	Updated Plan
Requirement §201.6(b): In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: (1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval; (2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and (3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.	Appendix A of the ABAG Plan includes a description of the planning process. This includes detail of coordination with other agencies, and review of existing information.	The plan development process deployed under this update was completely different from that of the ABAG plan. Volume 1 Chapters 3, 4 and 5 describe the planning process for this updated plan.
§201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.	Appendix C of the ABAG plan includes a risk assessment for 6 hazards (earthquake, severe weather, flood, wildfire, landslide and tsunami) for the nine-county regional area.	Volume 1 Part 2 presents a risk assessment of seven hazards of concern: Dam failure, drought, earthquake, flood, landslide, severe weather, and wildfire. These hazards are profiled as they impact Contra Costa County. Potential impacts of climate change are discussed for each hazard.
§201.6(c)(2)(i): [The risk assessment shall include a] description of the … location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.	Appendix C of the ABAG plan includes a risk assessment for 6 hazards (earthquake, severe weather, flood, wildfire, landslide and tsunami) for the nine-county regional area.	Volume 1 Part 2 presents a risk assessment of each hazard of concern. Each chapter includes the following components: • Hazard profile-including maps of extent and location, historical occurrences, frequency, severity and warning time. • Secondary hazards • Climate change impacts • Exposure of people, property, critical facilities and environment. • Vulnerability of people, property, critical facilities and environment. • Future trends in development • Scenarios • Issues

TABLE 2-1 (continued).
PLAN CHANGES CROSSWALK

44CFR Requirement	Initial Plan	Updated Plan
§201.6(c)(2)(ii): [The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i). This description shall include an overall summary of each hazard and its impact on the community	Utilizing existing studies and documents, the ABAG plan discussed vulnerability with an emphasis on exposure and land use. There was extensive discussion on the vulnerability to the earthquake hazard. The ABAG risk assessment attempts to estimate potential damage from future events. ABAG concluded that HAZUS was not an adequate tool for planning purposes.	Vulnerability was assessed for all hazards of concern. The HAZUS-MH computer model was used for the dam failure, earthquake and flood hazards. These were Level 2 analyses using city and county data. Site-specific data on County-identified critical facilities was entered into the HAZUS model. HAZUS outputs were generated for other hazards by applying an estimated damage function to an asset inventory was extracted from HAZUS-MH.
§201.6(c)(2)(ii): [The risk assessment] must also address National Flood Insurance Program insured structures that have been repetitively damaged floods	The ABAG plan includes summary information by county on identified repetitive losses. The plan includes a link to a website that includes more detailed information on repetitive losses. The data is aggregated by county, and not broken down by city. There is no delineation of repetitive loss areas, no inventory on the number and types of structures in these areas, no descriptions of the causes of repetitive flooding, and no maps that illustrate extent and location of the repetitive loss areas.	The plan includes a comprehensive analysis of repetitive loss areas that includes an inventory of the number and types of structures in the repetitive loss area. Repetitive loss areas are delineated, causes of repetitive flooding are cited, and these areas are reflected on maps.
Requirement §201.6(c)(2)(ii)(A): The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.	The focus of the ABAG plan is on existing land use with no real discussion on future land use. There is no consistent inventory of the number and types of structures exposed to each hazard of concern. The Plan does provide an inventory of identified critical facilities.	A complete inventory of the numbers and types of buildings exposed was generated for each hazard of concern. The Steering Committee defined "critical facilities" for the planning area, and these were inventoried by exposure. Each hazard chapter provides a discussion on future development trends.
Requirement §201.6(c)(2)(ii)(B): [The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) and a description of the methodology used to prepare the estimate.	The ABAG plan relied on creating regional correlations from past observed damage to create estimates of future losses from the hazards of concern. Appendix F assesses vulnerability by providing private building and value exposure estimates for earthquake.	Loss estimations in terms of dollar loss were generated for all hazards of concern. These were generated by HAZUS-MH for the dam failure, earthquake and flood hazards. For the other hazards, loss estimates were generated by applying a regionally relevant damage function to the exposed inventory. In all cases, a damage function was applied to an asset inventory. The asset inventory was the same for all hazards and was generated in HAZUS.

**TABLE 2-1 (continued).
PLAN CHANGES CROSSWALK**

44CFR Requirement	Initial Plan	Updated Plan
Requirement §201.6(c)(2)(ii)(C): [The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.	A strong component of the ABAG plan is its look at existing land use in hazard areas, especially for earthquake. Appendix E provides additional detail on existing land use, with a brief discussion of future land use (through 2030) by county.	There is a discussion on future development trends as they pertain to each hazard of concern. This discussion looks predominantly at the existing land use and the current regulatory environment that dictates this land use.
§201.6(c)(3): The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.	The ABAG plan has identified a comprehensive list of mitigation strategies for each planning partner to consider when creating annexes to the plan. These strategies were created via a facilitated process chronicled in the plan.	The plan contains a guiding principal, goals, objectives and actions. The guiding principal, goals and objectives are regional and cover all planning partners. The actions are jurisdiction-specific and strive to meet multiple objectives. The objectives of this plan are broad, similar to the strategies identified in the ABAG plan. All objectives meet multiple goals and stand alone as components of the plan. Each planning partner was asked to complete a capability assessment that looks at its regulatory, technical and financial capabilities.
Requirement §201.6(c)(3)(i): [The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.	The ABAG plan has identified one overall goal and 8 basic "commitments" for the plan.	The Steering Committee identified a guiding principal, five goals and 16 objectives, as described in Chapter 5. These are completely new goals and objectives targeted specifically for this hazard mitigation plan. They were not carried over from any other planning document and were identified based upon the capabilities of the planning partnership.
Requirement §201.6(c)(3)(ii): [The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.	The ABAG plan provides no discussion on alternatives considered in identifying the strategies for the plan. There is discussion on the process used to generate the mitigation strategies, but it does include an alternatives review.	Chapter 18 includes a hazard mitigation catalog that was developed through a facilitated process. This catalog identifies actions that manipulate the hazard, reduce exposure to the hazard, reduce vulnerability, and increase mitigation capability. The catalog further segregates actions by scale of implementation. A table in the action plan section analyzes each action by mitigation type to illustrate the range of actions selected.

**TABLE 2-1 (continued).
PLAN CHANGES CROSSWALK**

44CFR Requirement	Initial Plan	Updated Plan
Requirement: §201.6(c)(3)(ii): [The mitigation strategy] must also address the jurisdiction's participation in the National Flood Insurance Program, and continued compliance with the program's requirements, as appropriate.	Strategy Land-c-4 deals with maintaining compliance and good standing in the National Flood Insurance Program as well as the CRS program.	All municipal planning partners that participate in the National Flood Insurance Program have identified an action stating their commitment to maintain compliance and good standing under the National Flood Insurance Program. Communities that participate in the Community Rating System have identified actions to maintain or enhance their standing under the CRS program.
Requirement: §201.6(c)(3)(iii): [The mitigation strategy shall describe] how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.	Under the ABAG plan, Priorities are organized based on the following categories – • Existing • Existing/underfunded • Very High • High • Moderate • Under study • Not applicable • Not yet considered	Each of the recommended initiatives is prioritized using a qualitative methodology that looked at the objectives the project will meet, the timeline for completion, how the project will be funded, the impact of the project, the benefits of the project and the costs of the project. This prioritization scheme is detailed in Chapter 19.
Requirement §201.6(c)(4)(i): [The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.	Appendix B of the ABAG plan contains a plan maintenance and update process.	Chapter 7 details a plan maintenance strategy similar to that of the initial plan. However, there is additional detail addressing deficiencies observed during the initial performance period of the plan. This includes a more defined role for the Steering Committee in annual review of the plan.
Requirement §201.6(c)(4)(ii): [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.	Appendix B of the ABAG plan contains dialogue on integration of the plan into other planning mechanisms.	Chapter 7 details recommendations for incorporating the plan into other planning mechanisms such as: • Comprehensive Plan • Emergency response plan • Capital Improvement Programs • Municipal code • Stormwater Master Plan

**TABLE 2-1 (continued).
PLAN CHANGES CROSSWALK**

44CFR Requirement	Initial Plan	Updated Plan
Requirement §201.6(c)(4)(iii): [The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.	The ABAG plan contains no discussion on how each jurisdiction will continue public participation in the plan maintenance process. Some of the local government annexes contain this discussion. However, there is no consistent discussion of any detail.	Chapter 7 details a strategy for continuing public involvement
Requirement §201.6(c)(5): [The local hazard mitigation plan shall include] documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County Commissioner, Tribal Council).	All agencies utilizing the ABAG tools submitted to the State and FEMA individually. The ABAG plan does not include documentation of adoption	36 planning partners will seek DMA compliance for this plan. Appendix D contains the resolutions of all planning partners that adopted this plan

CHAPTER 3.
PLAN UPDATE METHODOLOGY

To develop the Contra Costa County Hazard Mitigation Plan Update, the County followed a process that had the following primary objectives:

- Secure grant funding
- Form a planning team
- Establish a planning partnership
- Define the planning area
- Establish a steering committee
- Coordinate with other agencies
- Review existing programs
- Engage the public.

Chapter 4 describes the public involvement. The other objectives are discussed in the following sections.

3.1 GRANT FUNDING

This planning effort was supplemented by a grant from FEMA's Pre-Disaster Mitigation Grant Program, which funds pre-disaster hazard mitigation projects and plans. Funds are appropriated to this program annually by Congress. The County's Department of Public Works was the applicant agent for the grant. The grant was applied for in 2006, and funding was appropriated in the fall of 2007. It covered 75 percent of the cost for development of this plan update; the County and its planning partners covered the balance through in-kind contributions.

3.2 FORMATION OF THE PLANNING TEAM

The County hired Tetra Tech, Inc. to assist with development and implementation of the plan update. The Tetra Tech project manager assumed the role of the lead planner, reporting directly to a County-designated project manager from the Department of Public Works. A planning team was formed to lead the planning effort, made up of the following members from Public Works, OES, and Tetra Tech:

- Rich Lierly (Public Works)—Senior Civil Engineer, project oversight
- Greg Connaughton (Public Works)—Assistant Chief Engineer
- Chris Boyer (OES)—Emergency Services Manager
- Suzan Roseberry (OES)—Emergency Planning Coordinator
- Rob Flaner (Tetra Tech)—Lead project planner
- Laura Hendrix (Tetra Tech)—Public policy lead
- Ed Whitford (Tetra Tech)—HAZUS/GIS lead
- Cara Murphy (Tetra Tech)—HAZUS/GIS support
- Dan Portman (Tetra Tech)—Lead editor.

3.3 ESTABLISHMENT OF THE PLANNING PARTNERSHIP

Contra Costa County opened this planning effort to all eligible local governments within the County. The planning team reached out to all special taxing districts in the County to solicit their participation. The team made a presentation at a stakeholder meeting organized by the County OES on June 5, 2008 to introduce the mitigation planning process and solicit planning partners. A follow-up to the initial stakeholder meeting was held on August 25, 2008 with potential planning partners. Key meeting objectives were as follows:

- Provide an overview of the Disaster Mitigation Act
- Explain the response to the DMA in Contra Costa County (The ABAG plan)
- Provide an overview of the ABAG plan
- Describe the reasons for a plan update
- Outline the County work-plan
- Outline planning partner expectations
- Seek commitment to the planning partnership
- Seek volunteers for the Steering Committee.

Each jurisdiction wishing to join the planning partnership was asked to provide a “letter of intent to participate” that designated a point of contact for the jurisdiction and confirmed the jurisdiction’s commitment to the process and understanding of expectations. Some jurisdictions in the County decided either to create their own plans or to participate in the ABAG regional planning effort. Linkage procedures have been established (see Volume 2 of this plan) for any jurisdiction wishing to link to the Contra Costa County plan in the future. Contra Costa County and its planning partners are committed to supporting risk reduction through proactive mitigation as directed by this plan, as well as supporting the strategies of the ABAG plan as regional stakeholders. The municipal planning partners covered under this Plan are shown in Table 3-1. The special purpose district planning partners are shown in Table 3-2.

3.4 DEFINING THE PLANNING AREA

The planning area consists of all of Contra Costa County (this is also referred to by Cal EMA as the Contra Costa County “operational area”). All partners to this plan have jurisdictional authority within this planning area. The Eastbay Municipal Utility District (MUD) initially committed to this process as a full planning partner, but because its service area extends beyond the county, it was determined that the District would be better severed by the ABAG regional planning effort. Eastbay MUD did contribute to this planning effort as a stakeholder representative on the Steering Committee.

3.5 THE STEERING COMMITTEE

Hazard mitigation planning enhances collaboration and support among diverse parties whose interests can be affected by hazard losses. Stakeholders can create partnerships that pool resources to achieve a common vision for the community. A steering committee was formed to oversee all phases of the plan update. The members of this committee included key planning partner staff, citizens, and other stakeholders from within the planning area. The planning team assembled a list of candidates representing interests within the planning area that could have recommendations for the plan or be impacted by its recommendations. The partnership confirmed a committee of 14 members at the August 25, 2008 kickoff meeting. Table 3-3 lists the committee members.

**TABLE 3-1.
CITY/COUNTY PLANNING PARTNERS**

Jurisdiction	Point of Contact	Title
Antioch	John Vanderklugt	Police Lieutenant
Brentwood	Brian Strock	Police Captain
Danville	Greg Gilbert	Emergency Services Manager
El Cerrito	Michael Bond	Battalion Chief/Fire Marshall
Martinez	Eric Ghisletta	Commander/ Police Department
Pinole	Jim Parrott	Fire Chief
Pleasant Hill	Roderick Wui	Planner
Richmond	Kieron Slaughter	Assistant Planner
San Ramon	Ray Riordan	Emergency Preparedness Manager
Walnut Creek	Steve Waymire	Planner
Contra Costa County	Susan Roseberry	Emergency Planning Coordinator

**TABLE 3-2.
SPECIAL DISTRICT PLANNING PARTNERS**

District	Point of Contact	Title
Antioch Unified School District	Timothy Forrester	Executive Director-Operations
Bethel Island Municipal Improvement District	Marguerite Lawry	President, Board of Directors
Brentwood Union School District	Scott Anderson	Chief Business Official
Canyon Elementary School District	Brian Coyle	School District Board
Central Contra Costa Sanitary District	Shari Deutsch	Safety & Risk Management Administrator
Contra Costa County Fire District	Rich Grace	Assistant Fire Chief
Contra Costa County Flood Control and Water Conservation District	Rich Lierly	Senior Civil Engineer
Contra Costa Community College District	Teddy Terstegge	Emergency Services Coordinator
Contra Costa County Office of Education	John F. Hild	Director, General Services
Delta Diablo Sanitation District	Steve Laren	Safety Officer
Diablo Water District	Paul Urenda	Superintendent of Operations
East Contra Costa Fire District	Brian Helmmick	Battalion Chief
Ironhouse Sanitary District	Dennis Nunn	Administrative Services Manager
Kensington Fire Protection District	Michael Bond	Fire Marshall
Kensington Police Protection and Community Services District	Gregory E. Harmon	General Manager/Chief of Police
Knightsen Community Services District	Linda Weeks	Board member
Liberty Union High School District	Wayne Reeves	Director of Project Development
Mt. Diablo Unified School District	Pete Pedersen	Director of Maintenance & Operations

**TABLE 3-2 (continued).
SPECIAL DISTRICT PLANNING PARTNERS**

District	Point of Contact	Title
Pleasant Hill Recreation &Park District	Bob Bergren	General Manager
Reclamation District 800 (Byron Tract)	Jeffrey D. Conway	District Manager
Reclamation District 830 (Jersey Island)	Dennis Nunn	Trustee/Treasurer
Rodeo-Hercules Fire District	Alan Biagi	Battalion Chief
San Ramon Valley Fire Protection District	Mike Piccard	Battalion Chief
Walnut Creek School District	Stuart House	Director of Construction & Maintenance
West Contra Costa Unified School District	Bill Savidge	District Engineering Officer

**TABLE 3-3.
STEERING COMMITTEE MEMBERS**

Name	Title	Jurisdiction/Agency	Representing
Jim Parrott (Chair)	Fire Chief	City of Pinole	Planning Partner
Curtis Lindskog (Vice-chair)		Greater Concord Area Chamber of Commerce	Stakeholder
Susan Roseberry	Emergency Planning Coordinator	Contra Costa County Office of Emergency Services	Planning Partner
Rich Lierly	Senior Civil Engineer	Contra Costa County Flood Control District	Planning Partner
Jim Bonato		CERT	Citizen
Richard Brown		CERT	Citizen
Steven Frew	Manager, Security & Emergency Preparedness	Eastbay MUD	Stakeholder
Shari Deutsch	Safety & Risk Management Administrator	Central Contra Costa Sanitary District	Planning Partner
Tim Galli	Director of New Construction	Pittsburg Unified School District	Stakeholder
Greg Harman	General Manager/Chief of Police	Kensington Police Protection and Community Services District	Planning Partner
Steven Spedowfski	Senior Analyst	City of San Ramon	Planning Partner
Greg Gilbert	Emergency Services Manager	City of Danville	Planning Partner
Tracy Johnson		Bay Area Rapid Transit (BART)	Stakeholder
Teddy Terstegge	Emergency Services Coordinator	Contra Costa Community College District	Stakeholder

Leadership roles and ground rules were established during the Steering Committee's initial meeting on February 3, 2009. The Steering Committee agreed to meet monthly as needed throughout the course of the plan's development. The planning team facilitated each Steering Committee meeting, which addressed a set of objectives based on the work plan established for the update. The Steering Committee met 12 times from February 2009 through February 2011. Meeting agendas, notes and attendance logs are available for review upon request. All Steering Committee meetings were open to the public and agendas and meeting notes were posted to the hazard mitigation plan website (see Chapter 4).

3.6 COORDINATION WITH OTHER AGENCIES

44CFR requires that opportunities for involvement in the planning process be provided to neighboring communities, local and regional agencies involved in hazard mitigation, agencies with authority to regulate development, businesses, academia, and other private and nonprofit interests (Section 201.6.b.2). This task was accomplished by the planning team as follows:

- **Steering Committee Involvement**—Agency representatives were invited to participate on the Steering Committee.
- **ABAG Notification**—The Association of Bay Area Governments was notified of this planning effort and invited to participate in the update process by receiving notification of all Steering Committee meetings and public meetings. ABAG participated in the initial "kick-off" meeting held on August 25, 2008.
- **Agency Notification**—The following agencies were invited to participate in the update process from the beginning and were kept apprised of plan development milestones:
  - FEMA Region IX
  - California Emergency Management Agency (Cal EMA)
  - California Department of Water Resources
  - Cities of: Concord, Clayton, Pittsburg, Lafayette, Orinda, Moraga, Hercules and Oakley

  These agencies received meeting announcements, meeting agendas, and meeting minutes by e-mail throughout the plan update process. These agencies supported the effort by attending meetings or providing feedback on issues.
- **Pre-Adoption Review**—All the agencies listed above were provided an opportunity to review and comment on this plan update, primarily through the hazard mitigation plan website (see Chapter 4). Each agency was sent an e-mail message informing them that draft portions of the plan were available for review. In addition, the complete draft plan was sent to FEMA Region IX, Cal EMA, and the Insurance Service Office (ISO) for a pre-adoption review to ensure program compliance.

3.7 REVIEW OF EXISTING PROGRAMS

44CFR states that hazard mitigation planning must include review and incorporation, if appropriate, of existing plans, studies, reports and technical information (Section 201.6.b(3)). Chapter 9 of this plan provides a review of laws and ordinances in effect within the planning area that can affect hazard mitigation initiatives. In addition, the following programs can affect mitigation within the planning area:

- Contra Costa County General Plan (2005)
- The general plans for each of the incorporated city planning partners
- California State Hazard Mitigation Plan, October 8, 2007

- ABAG Hazard Mitigation Plan (2005)
- Contra Costa County Emergency Management Plan.

An assessment of all planning partners' regulatory, technical and financial capabilities to implement hazard mitigation initiatives is presented in Chapter 19 and in the individual jurisdiction-specific annexes in Volume 2. Many of these relevant plans, studies and regulations are cited in the capability assessment.

One of the Steering Committee's first action items was to review the California State Hazard Mitigation Plan. The Steering Committee identified hazards listed in the state plan to which the Contra Costa County planning area is susceptible, in order to determine if there was a need to expand the scope of the risk assessment. The committee also reviewed the goals, objectives and strategies of the state plan in order to select goals, objectives and actions for the plan that are consistent with those of the state.

Additionally, the Steering Committee performed a review of the ABAG Hazard Mitigation Plan to identify possible opportunities to collaborate with the ABAG plan update effort.

3.8 PLAN DEVELOPMENT CHRONOLOGY/MILESTONES

Table 3-4 summarizes important milestones in the development of the plan update.

**TABLE 3-4.
PLAN DEVELOPMENT CHRONOLOGY/MILESTONES**

Date	Event	Milestone	Attendance
2007			
01/05	County submits Pre-Disaster Mitigation Grant application	Seek funding for plan update process	N/A
08/05	County receives notice of Pre-Disaster Mitigation grant award	Funding secured.	N/A
12/14	County initiates contractor procurement process	Seek a planning contractor to facilitate the process	N/A
2008			
3/12	County selects Tetra Tech, Inc. to facilitate the plan development process	Facilitation contractor secured	N/A
5/19	Planning team identified	Formation of the planning team	N/A
6/5	Stakeholder meeting	Presentation made on plan process to potential planning partners at a stakeholders meeting.	17
8/25	Planning partner kickoff meeting	A second meeting with potential planning partners. All eligible local governments in the County were invited to this meeting. Attendees were advised of planning partner expectations and asked to formally commit to the process. Volunteers for the Steering Committee were solicited.	31

TABLE 3-4 (continued).
PLAN DEVELOPMENT CHRONOLOGY/MILESTONES

Date	Event	Milestone	Attendance
2008 (continued)			
12/15	Planning partnership finalized	Deadline for submittal of letters of intent to participate in the planning effort.	N/A
12/30	Steering Committee formed	Planning partners nominated potential committee members. The planning team received commitments from 14 members, finalizing the formation of the SC.	N/A
2009			
2/3	Steering Committee Meeting #1	• Review purposes for update • Introduction to HAZUS • Organize Steering Committee • Discuss plan review • Public involvement strategy	17
2/25	Steering Committee Meeting #2	• Confirm Steering Committee ground rules • Comment on plan review • Determine "hazards of concern" to be addressed by the plan • Public involvement strategy-Phase 1 • Critical facilities-what are they?	14
3/25	Steering Committee meeting #3	• Define critical facilities • Public involvement strategy-Phase 1 • Identify a guiding principal	12
4/13	Public Outreach	Hazard mitigation plan website established on the County OES web page at: http://www.contracosta.ca.gov/index.aspx?NID=2302	N/A
4/22	Steering Committee Meeting #4	• Confirm critical facilities definition • Confirm mission statement • Public involvement strategy-Phase 1: Questionnaire, public meeting schedule	16
5/19	Steering Committee Meeting #5	• Finalize questionnaire content, dissemination methods • Identify public meeting schedule • Review goals	12
6/24	Planning Partner / SC Meeting #6	• HAZUS update • Finalize questionnaire content, dissemination methods • Identify public meeting schedule • Review goals	31
7/6	Public Outreach	A hazard mitigation questionnaire was deployed on-line via the hazard mitigation plan website. Additionally, 5000 hard copies of the questionnaire were printed. All 5,000 copies were distributed to planning partners for dissemination to the public.	N/A
7/23	Public Meeting Press releases	County distributed a press release to all media outlets advertising the public Open Houses.	N/A
7/29	Steering Committee Meeting #7	• HAZUS update • Goal setting • Coordinate public meeting • Questionnaire update	11

**TABLE 3-4 (continued).
PLAN DEVELOPMENT CHRONOLOGY/MILESTONES**

Date	Event	Milestone	Attendance
2009 (continued)			
7/29	Public Meeting # 1	A public open house was held in Martinez at the central Contra Costa Sanitary District Facilities. Presentation was taped for re-broadcast on County cable channel.	17
7/30	Public Meeting #2	A public open house was held in the City of Pinole. Presentation was taped for re-broadcast on City of Pinole cable channel.	29
8/5	Public Outreach	The July 29 public meeting was rebroadcast on Contra Costa Television (CCTV) Channel 27 at 7 PM	N/A
8/7	Public Outreach	The July 29 public meeting was rebroadcast on CCTV Channel 27 at 10 AM.	N/A
8/11	Public Meeting #3	A public open house was held in the City of San Ramon.	31
8/13	Public Meeting #4	A public open house was held in the City of Antioch.	34
8/26	Steering Committee Meeting #8	• HAZUS update • Public meeting review • Finalize goals • Review objectives	14
9/23	Steering Committee Meeting #9	• Finalize HAZUS results • Select objectives • Review mitigation catalog • Schedule planning partner workshops	12
10/7	Jurisdictional Annex Workshops (Round 1)	Mandatory session for all planning partners. Workshop focused on how to complete the jurisdictional annex template. Two sessions were held. One for municipal governments and one for special purpose districts.	24
10/29	Jurisdictional Annex Workshops (Round 2)	A second opportunity to attend this mandatory workshop was provided for all planning partners. Once again, two sessions were held, one for municipalities and one for districts.	15
2010			
3/24	Steering Committee Meeting # 10	• Where are we? • What is next? • Planning partner status • County-wide initiatives • Plan maintenance strategy	14
12/2	Steering Committee Meeting #11	• Re-engage the process • Update on status of plan development • What is next?	14

TABLE 3-4 (continued).
PLAN DEVELOPMENT CHRONOLOGY/MILESTONES

Date	Event	Milestone	Attendance
2011			
3/30	Draft Plan	Internal review draft provided by planning team to Steering Committee	N/A
4/14	California Environmental Quality Act Process	Notice of Public review and intent to adopt a proposed negative declaration posted	N/A
5/4	Steering Committee Meeting #12	• Provide comments on draft plan • Schedule adoption process • Final public meeting	11
5/6	Public Comment Period	Initial public comment period of draft plan opens. Draft plan posted on mitigation plan website with press release notifying public of plan availability	N/A
6/28	Public Outreach	Final public meetings on draft plan. First meeting with County Board of Supervisors, second meeting with San Ramon City Council.	Over 50
7/1	Adoption	Adoption window of final plan opens	N/A
7/15	Plan approval	Final draft plan submitted to Cal EMA for review and approval	N/A
TBD	Plan Approval	Final plan approved by FEMA Region IX	N/A

CHAPTER 4.
PUBLIC INVOLVEMENT

Broad public participation in the planning process helps ensure that diverse points of view about the planning area's needs are considered and addressed. 44CFR requires that the public have opportunities to comment on disaster mitigation plans during the drafting stages and prior to plan approval (Section 201.6.b.1). The Community Rating System expands on these requirements by making CRS credits available for optional public involvement activities.

4.1 STRATEGY

Since this planning process involved an update for some planning partners (update from the ABAG plan), and a first-time planning for others, the Steering Committee developed a comprehensive new outreach strategy, using multiple media sources available to the County. The strategy for involving the public in this plan update emphasized the following elements:

- Include members of the public on the Steering Committee.
- Use a questionnaire to determine if the public's perception of risk and support of hazard mitigation has changed since the initial planning process.
- Attempt to reach as many planning area citizens as possible using multiple media.
- Identify and involve planning area stakeholders.

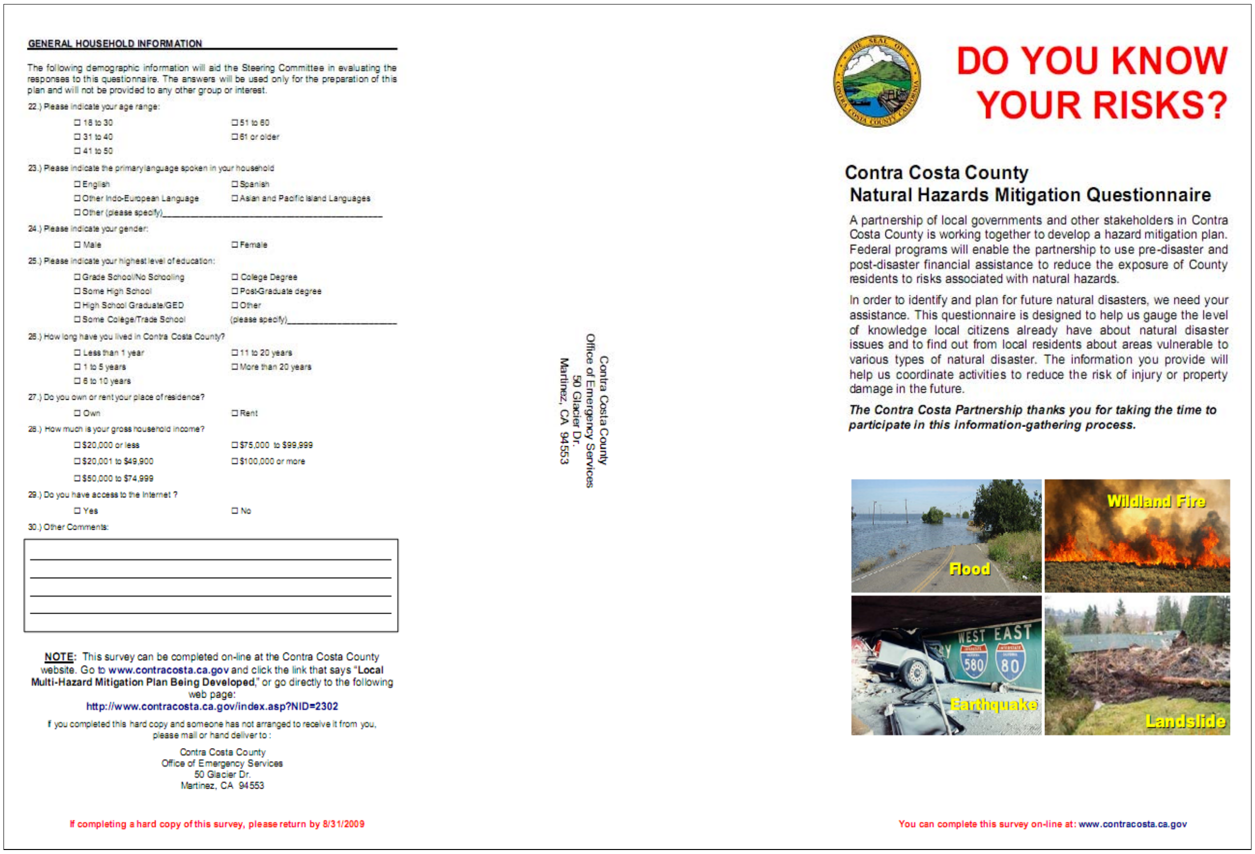
4.1.1 Stakeholders and the Steering Committee

Stakeholders are the individuals, agencies and jurisdictions that have a vested interest in the recommendations of the hazard mitigation plan, including planning partners. The effort to include stakeholders in this process included stakeholder participation on the Steering Committee.

All members of the Steering Committee live or work in Contra Costa County. Two members of the committee represented Contra Costa County citizen and property owner interests, and five members represented private sector interests. The Steering Committee met 12 times during the course of the plan's development, and all meetings were open to the public. Protocols for handling public comments were established in the ground rules developed by the Steering Committee.

4.1.2 Questionnaire

A Hazard Mitigation Plan questionnaire (see Figure 4-1) was developed by the planning team with guidance from the Steering Committee. The questionnaire was used to gauge household preparedness for natural hazards and the level of knowledge of tools and techniques that assist in reducing risk and loss from natural hazards. This questionnaire was designed to help identify areas vulnerable to one or more natural hazards. The answers to its 29 questions helped guide the Steering Committee in selecting goals, objectives and mitigation strategies. Over 5,000 hard copies of the questionnaires were disseminated throughout the planning area by multiple means. Additionally, a web-based version of the questionnaire was made available on the hazard mitigation plan website. Over 4,040 questionnaires were completed during the course of this planning process. The complete questionnaire and a summary of its findings can be found in Appendix B of this volume.



GENERAL HOUSEHOLD INFORMATION

The following demographic information will aid the Steering Committee in evaluating the responses to this questionnaire. The answers will be used only for the preparation of this plan and will not be provided to any other group or interest.

22.) Please indicate your age range:
- ☐ 18 to 30
- ☐ 51 to 60
- ☐ 31 to 40
- ☐ 61 or older
- ☐ 41 to 50

23.) Please indicate the primary language spoken in your household
- ☐ English
- ☐ Spanish
- ☐ Other Indo-European Language
- ☐ Asian and Pacific Island Languages
- ☐ Other (please specify)________________________

24.) Please indicate your gender:
- ☐ Male
- ☐ Female

25.) Please indicate your highest level of education:
- ☐ Grade School/No Schooling
- ☐ College Degree
- ☐ Some High School
- ☐ Post-Graduate degree
- ☐ High School Graduate/GED
- ☐ Other
- ☐ Some College/Trade School
- (please specify)________________

26.) How long have you lived in Contra Costa County?
- ☐ Less than 1 year
- ☐ 11 to 20 years
- ☐ 1 to 5 years
- ☐ More than 20 years
- ☐ 6 to 10 years

27.) Do you own or rent your place of residence?
- ☐ Own
- ☐ Rent

28.) How much is your gross household income?
- ☐ $20,000 or less
- ☐ $75,000 to $99,999
- ☐ $20,001 to $49,900
- ☐ $100,000 or more
- ☐ $50,000 to $74,999

29.) Do you have access to the Internet ?
- ☐ Yes
- ☐ No

30.) Other Comments:

NOTE: This survey can be completed on-line at the Contra Costa County website. Go to **www.contracosta.ca.gov** and click the link that says "**Local Multi-Hazard Mitigation Plan Being Developed**," or go directly to the following web page:
http://www.contracosta.ca.gov/index.asp?NID=2302

f you completed this hard copy and someone has not arranged to receive it from you, please mail or hand deliver to :

Contra Costa County
Office of Emergency Services
50 Glacier Dr.
Martinez, CA 94553

If completing a hard copy of this survey, please return by 8/31/2009

Contra Costa County
Office of Emergency Services
50 Glacier Dr.
Martinez, CA 94553

DO YOU KNOW YOUR RISKS?

Contra Costa County
Natural Hazards Mitigation Questionnaire

A partnership of local governments and other stakeholders in Contra Costa County is working together to develop a hazard mitigation plan. Federal programs will enable the partnership to use pre-disaster and post-disaster financial assistance to reduce the exposure of County residents to risks associated with natural hazards.

In order to identify and plan for future natural disasters, we need your assistance. This questionnaire is designed to help us gauge the level of knowledge local citizens already have about natural disaster issues and to find out from local residents about areas vulnerable to various types of natural disaster. The information you provide will help us coordinate activities to reduce the risk of injury or property damage in the future.

The Contra Costa Partnership thanks you for taking the time to participate in this information-gathering process.

You can complete this survey on-line at: www.contracosta.ca.gov

Figure 4-1. Sample Page of Questionnaire Distributed to the Public

4.1.3 Opportunity for Public Comment

Public Meetings

The Steering Committee divided the planning area into quadrants (central, east, west and south) and scheduled public meetings for each area. Open-house public meetings were held on July 29, 2009 in Martinez, on July 30, 2009 in Pinole, on August 11, 2009 in San Ramon, and on August 13, 2009 in Antioch (see Figures 4-2 through 4-5). Each ran from 6:00 to 9:00 p.m.

The meeting format allowed attendees to examine maps and handouts and have direct conversations with project staff. Reasons for planning and information generated for the risk assessment were shared with attendees via a PowerPoint presentation. Tables were set up for each of the primary hazards to which the County is most vulnerable. A HAZUS-MH workstation allowed citizens to see information on their property, including exposure and damage estimates for dam failure, earthquake, flood and tsunami hazard events. Participating property owners were provided printouts of this information for their properties. This tool was effective in illustrating risk to the public. Planning partners and the planning team were present to answer questions. Each citizen attending the open houses was asked to complete a questionnaire, and each was given an opportunity to provide written comments to the Steering Committee. Local media outlets were informed of the open houses by a press release from the County.

Two of these public meetings were recorded for re-broadcast over the County cable TV channel, CCTV (Comcast Channel 27, and Astound Channel 32). These sessions were aired on Wednesday, August 5, 2010 at 7:00 p.m. and on Friday August 7, 2010 at 10:00 a.m. Citizens could also view these recordings on the CCTV website at www.contracostatv.org .

Figure 4-2. Public Meeting, Martinez

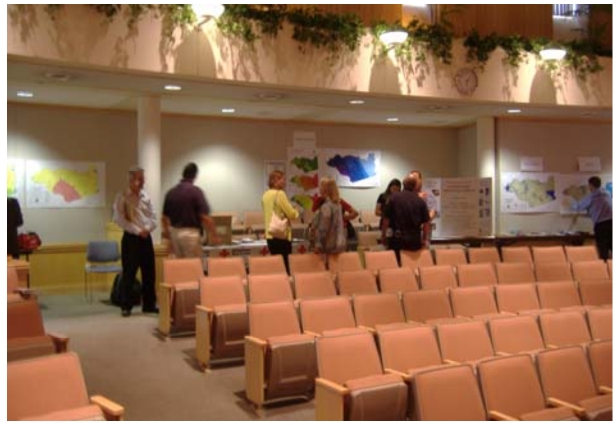


Figure 4-3. Public Meeting, Pinole

Figure 4-4. Citizens review maps at open house in San Ramon

Figure 4-5. HAZUS-MH Workstation Used at Open Houses

After the draft plan was assembled, a comment period to receive public input was held from May 6, 2011 through June 28, 2011. The principal means provided for the public to provide comment was via the hazard mitigation plan website. Two final public meetings were held in conjunction with a presentation on the draft plan to the County Board of Supervisors and the San Ramon City Council on June 28, 2011. Notice of these meetings was provided to all media outlets via a press release from the County as well as being posted on the County website. The Board of Supervisors meeting was broadcast on CCTV. Copies of presentation materials are available upon request.

Press Releases

Press releases were distributed over the course of the plan's development as key milestones were achieved and prior to each public meeting. The planning effort received the following press coverage:

- The *Contra Costa Times*, ran an article on June 2, 2009 on the new flood hazard maps for the county
- The *Contra Costa Times* ran a full-length article on the plan and the public meetings on July 28, 2009 (see Figure 4-6).
- *The San Ramon Express* ran an article on the public open house meetings on August 5, 2010. (http://www.sanramonexpress.com/news/show_story.php?id=193)

TUESDAY, JULY 28, 2009 BAY AREA • CALIFORNIA 205 BAY AREA NEWS GROUP A9

County calls on locals in disaster plan

■ Mitigation plan could lead to federal funding for work such as retrofitting

By Robert Salonga
rsalonga@bayareanewsgroup.com

MARTINEZ — County emergency planners will hold the first of four public meetings Wednesday as they put together a plan to be ready for the next earthquake, flood or other large-scale natural disaster.

Among the scenarios that will be covered in the plan is a magnitude 7.1 earthquake along the Hayward Fault, which officials estimate could cause $3.5 billion in damage and displace people in about 1,300 Contra Costa households.

Agencies including the county Office of Emergency Services and the county Flood Control District are spearheading the meetings and formation of the County-wide Multi-Hazard Mitigation Plan. Once completed, the plan will identify potential disaster zones and suggest ways to prepare buildings and the people who lived in them.

In advance of the public meetings, the county has produced computer-generated models of fault lines, flood zones and areas prone to wildfires, which will be put on display. But officials hope that people who come to the meetings can offer firsthand knowledge of potential disaster areas that have not been identified by county software.

"There might be an area that isn't on our map, and a person can say, 'We get flooded every year,'" said Rich Lierly, flood plain and watershed manager for the Flood Control District.

If all goes according to plan, the efforts could be backed with federal dollars: Completion of the new mitigation plan would make the county eligible for funding from the Federal Emergency Management Agency for projects like retrofitting buildings or helping defray the cost of flood damage.

Susan Roseberry, emergency planning coordinator for the county OES, said BART's mitigation plans made it eligible for more than $1 million in FEMA funding that the transit agency used to retrofit the Rockridge and Fruitvale stations.

The public meetings and formation of the disaster plan is funded by a FEMA grant and a 20 percent matching contribution from the county, totaling about $250,000.

Reach Robert Salonga at 925-943-8013.

MEETING DATES

Public meetings gathering input for the countywide multi-hazard mitigation plan will be held from 6 p.m. to 9 p.m. at the following dates and locations:

■ Wednesday, Central Contra Costa Sanitary District multipurpose room, 5019 Imhoff Place, Martinez

■ Thursday, Council Chamber/Community Center, 880 Tennent Ave., Pinole

■ Aug. 11, San Ramon Community Center, 12501 Alcosta Blvd., San Ramon

■ Aug. 13, Antioch Police Department community room, 300 L St., Antioch

Figure 4-6. Contra Costa Times News Article on Plan Update Process

Internet

At the beginning of the update process, a website was created to keep the public posted on plan development milestones and to solicit relevant input (see Figure 4-7):

> http://www.co.contra-costa.ca.us/index.aspx?nid=2302

The site was part of the County's web site, under the Sheriff's web page. The page was retrievable from the County home page (http://www.co.contra-costa.ca.us) by using the search engine (searching for "*hazard mitigation plan*"), and the address was publicized in all press releases, mailings, questionnaires and public meetings. Information on the plan update process, the Steering Committee, the questionnaire and phased drafts of the plan was made available to the public on the site throughout the process. The County intends to keep a website active after the plan's completion to keep the public informed about successful mitigation projects and future plan updates.

California Environmental Quality Act

An Initial Study Negative Declaration (IS/ND) was prepared for the project pursuant to Public Resources Code Section 21080(c) and Article 6 of the California Environmental Quality Act (CEQA) guidelines. Noticing was conducted according to Section 15072 of the CEQA Guidelines and the IS/ND was circulated for a 30-day public review period beginning on April 14, 2011. Upon completion of the public review period, the IS/ND was brought before the Contra Costa County Board of Supervisors for adoption. Within five days of adoption, a Notice of Determination was filed with the County Clerk and State Clearinghouse and the applicable California Department of Fish and Game fee was paid.

Figure 4-7. Sample Page from Hazard Mitigation Plan Web Site

4.2 PUBLIC INVOLVEMENT RESULTS

By engaging the public through the public involvement strategy, the concept of mitigation was introduced to the public, and the Steering Committee received feedback that was used in developing the components of the plan update. Details of attendance and comments received are summarized in Table 4-1.

**TABLE 4-1.
SUMMARY OF PUBLIC MEETINGS**

Date	Location	Number of Citizens in Attendance	Number of Comments Received	Number of Questionnaires Received
7/29/2009	Martinez	17	4	6
7/30/2009	Pinole	29	2	12
8/11/2009	San Ramon	31	5	15
8/13/2009	Antioch	34	9	5
6/28/2011	Martinez	50+	0	N/A
6/28/2011	San Ramon	42	0	N/A
Total		**203**	**20**	**38**

CHAPTER 5.
GUIDING PRINCIPLE, GOALS AND OBJECTIVES

5.1 BACKGROUND

44CFR requires hazard mitigation plans to identify goals for reducing long-term vulnerabilities to identified hazards (Section 201.6.c(3i)). The Steering Committee felt that a new set of goals and objectives was needed because the goals identified in the initial plan did not meet the objectives established for performance of the hazard mitigation plan. The Steering Committee established a mission statement, a set of goals and measurable objectives for this update, based on data from the preliminary risk assessment and the results of the public involvement strategy. Once a clear definition of mitigation was agreed upon by the Steering Committee, a list of issues that this plan should address was identified:

- Potential damage to existing buildings
- New growth and development in identified hazard areas
- Environmental impacts
- Pooling resources
- Reduction of repetitive losses
- Economic impact of hazard events.

The mission statement, goals, objectives and actions are in this plan all support each other. Goals were selected to support the mission statement. Objectives were selected that met multiple goals. Actions were prioritized based on the action meeting multiple objectives.

5.2 MISSION STATEMENT

A mission statement provides a vision for a process. It is not a goal because it does not describe a hazard mitigation outcome, and it is broader than a hazard-specific objective. The mission statement for the Contra Costa County Hazard Mitigation Plan Update is as follows:

> To reduce the vulnerability from natural hazards within the operational area in a cost-effective manner, within the capabilities of the partnership.

5.3 GOALS

The following are the mitigation goals for this plan update:

- Goal 1—Save (or protect) lives and reduce injury
- Goal 2—Increase resilience of infrastructure and critical facilities
- Goal 3—Avoid (minimize, or reduce) damage to property
- Goal 4—Encourage the development and implementation of long-term, cost-effective and environmentally sound mitigation projects
- Goal 5—Build and support capacity to enable local government and the public to prepare for, respond to and recover from the impact of natural hazards.

Achievement of these goals defines the effectiveness of a mitigation strategy.

5.4 OBJECTIVES

The selected objectives meet multiple goals, as listed in Table 5-1. Therefore, the objectives serve as a stand-alone measurement of the effectiveness of a mitigation action, rather than as a subset of a goal. The objectives also are used to help establish priorities.

TABLE 5-1.
OBJECTIVES FOR NATURAL HAZARD MITIGATION PLAN UPDATE

Objective Number	Objective Statement	Goals for Which It Can Be Applied
O-1	Increase resilience of (or protect and maintain) infrastructure and critical facilities	2, 3, 5
O-2	Sustain reliable local emergency operations and facilities during and after a disaster	1, 5
O-3	Educate the public on the risk from natural hazards and increase awareness, preparation, mitigation, response, and recovery activities	1, 3, 5
O-4	Minimize the impacts of natural hazards on current and future land uses by providing incentives for hazard mitigation	1, 3, 5
O-5	Prevent (or discourage) new development in hazardous areas or ensure that if building occurs in high-risk areas that it is done in such a way as to minimize risk	1, 3, 5
O-6	At the local government level, continually improve understanding of the location and potential impacts of natural hazards, utilizing the best available data and science.	1, 2, 3, 4, 5
O-7	Ensure all structures meet minimum standards for life safety	1, 2, 3, 5
O-8	Monitor plan progress annually to integrate local hazard mitigation plans and the results of disaster- and hazard-specific planning efforts	1, 2, 3, 5
O-9	Lower cost of flood insurance premiums through CRS program	3, 4, 5
O-10	Provide/improve flood protection with flood control structures, and drainage maintenance plans	2, 3, 4
O-11	Strengthen codes, and their enforcement, so that new construction can withstand the impacts of natural hazards and lessen the impact of that development on the environment's ability to absorb the impact of natural hazards.	1, 3
O-12	Consider the impacts of natural hazards in all planning mechanisms that address current and future land uses within the planning area.	1, 3
O-13	Eliminate or minimize disruption of local government operations caused by natural hazards	1, 3, 4
O-14	Consider open space land uses within identified high-hazard risk zones	1, 2, 3, 4, 5
0-15	Retrofit, acquire or relocate identified high risk structures, including those known to experience repetitive losses.	1, 3, 4
0-16	Establish a partnership among all levels of government and the business community to improve and implement methods to protect property	1, 2, 3, 4, 5

CHAPTER 6.
PLAN ADOPTION

Section 201.6.c.5 of 44CFR requires documentation that a hazard mitigation plan has been formally adopted by the governing body of the jurisdiction requesting federal approval of the plan. For multi-jurisdictional plans, each jurisdiction requesting approval must document that is has been formally adopted. This plan will be submitted for a pre-adoption review to both Cal EMA and FEMA prior to adoption. Once pre-adoption approval has been provided by Cal EMA and FEMA, all planning partners will formally adopt the plan update. All partners understand that DMA compliance and its benefits cannot be achieved until the plan is adopted. Copies of the resolutions adopting this plan for all planning partners can be found in Appendix D of this volume.

CHAPTER 7.
PLAN MAINTENANCE STRATEGY

44CFR requires a hazard mitigation plan to present a plan maintenance process that includes the following (Section 201.6.c.4):

- A section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan over a 5-year cycle
- A process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate
- A discussion on how the community will continue public participation in the plan maintenance process.

This chapter details the formal process that will ensure that the Contra Costa County Hazard Mitigation Plan remains an active and relevant document and that the planning partners maintain their eligibility for applicable funding sources. The Plan maintenance process includes a schedule for monitoring and evaluating the plan annually and producing an updated plan every five years. This chapter also describes how public participation will be integrated throughout the plan maintenance and implementation process. It also explains how the mitigation strategies outlined in this Plan will be incorporated into existing planning mechanisms and programs, such as comprehensive land-use planning processes, capital improvement planning, and building code enforcement and implementation. The Plan's format allows sections to be reviewed and updated when new data become available, resulting in a plan that will remain current and relevant.

7.1 PLAN IMPLEMENTATION

The effectiveness of the hazard mitigation plan depends on its implementation and incorporation of its action items into partner jurisdictions' existing plans, policies and programs. Together, the action items in the Plan provide a framework for activities that the Partnership can implement over the next 5 years. The planning team and the Steering Committee have established goals and objectives, and have prioritized mitigation actions that will be implemented through existing plans, policies, and programs.

The Contra Costa County Department of Public Works and the Sheriff's OES will share lead responsibility for overseeing the Plan implementation and maintenance strategy. Plan implementation and evaluation will be a shared responsibility among all planning partnership members and agencies identified as lead agencies in the mitigation action plans (see planning partner annexes in Volume 2 of this plan).

7.2 STEERING COMMITTEE

The Steering Committee is a total volunteer body that oversaw the development of the Plan and made recommendations on key elements of the plan, including the maintenance strategy. It was the Steering Committee's position that an oversight committee with representation similar to the initial Steering Committee should have an active role in the Plan maintenance strategy. Therefore, it is recommended that a steering committee remain a viable body involved in key elements of the Plan maintenance strategy. The new steering committee should strive to include representation from the planning partners, as well as other stakeholders in the planning area, at the discretion of Public Works and OES.

The principal role of the new steering committee in this plan maintenance strategy will be to review the annual progress report and provide input to Public Works and OES on possible enhancements to be considered at the next update. Future plan updates will be overseen by a steering committee similar to the one that participated in this update process, so keeping a steering committee intact will provide a head start on future updates. Completion of the progress report is the responsibility of each planning partner, not the responsibility of the steering committee. It will simply be the steering committee's role to review the progress report in an effort to identify issues needing to be addressed by future plan updates.

7.3 ANNUAL PROGRESS REPORT

The minimum task of each planning partner will be the evaluation of the progress of its individual action plan during a 12-month performance period. This review will include the following:

- Summary of any hazard events that occurred during the performance period and the impact these events had on the planning area
- Review of mitigation success stories
- Review of continuing public involvement
- Brief discussion about why targeted strategies were not completed
- Re-evaluation of the action plan to determine if the timeline for identified projects needs to be amended (such as changing a long-term project to a short-term one because of new funding)
- Recommendations for new projects
- Changes in or potential for new funding options (grant opportunities)
- Impact of any other planning programs or initiatives that involve hazard mitigation.

The planning team has created a template to guide the planning partners in preparing a progress report (see Appendix C). The plan maintenance steering committee will provide feedback to the planning team on items included in the template. The planning team will then prepare a formal annual report on the progress of the plan. This plan maintenance strategy recommends that this report be used as follows:

- Posted on the County website page dedicated to the hazard mitigation plan
- Provided to the local media through a press release
- Presented to planning partner governing bodies to inform them of the progress of actions implemented during the reporting period
- For those planning partners that participate in the Community Rating System, the report can be provided as part of the CRS annual re-certification package. The CRS requires an annual recertification to be submitted by October 1 of every calendar year for which the community has not received a formal audit. To meet this recertification timeline, the planning team will strive to complete progress reports between June and September each year.

Uses of the progress report will be at the discretion of each planning partner. Annual progress reporting is not a requirement specified under 44CFR. However, it may enhance the planning partnership's opportunities for funding. While failure to implement this component of the plan maintenance strategy will not jeopardize a planning partner's compliance under the DMA, it may jeopardize its opportunity to partner and leverage funding opportunities with the other partners. Each planning partner was informed of these protocols at the beginning of this planning process (in the "Planning Partner Expectations" package provided at the start of the process), and each partner acknowledged these expectations when with submittal of a letter of intent to participate in this process.

7.4 PLAN UPDATE

44CFR requires that local hazard mitigation plans be reviewed, revised if appropriate, and resubmitted for approval in order to remain eligible for benefits under the DMA (Section 201.6.d.3). The Contra Costa County partnership intends to update the hazard mitigation plan on a 5-year cycle from the date of initial plan adoption. This cycle may be accelerated to less than 5 years based on the following triggers:

- A Presidential Disaster Declaration that impacts the planning area
- A hazard event that causes loss of life
- A comprehensive update of the County or participating city's general plan

It will not be the intent of future updates to develop a complete new hazard mitigation plan for the planning area. The update will, at a minimum, include the following elements:

- The update process will be convened through a steering committee.
- The hazard risk assessment will be reviewed and, if necessary, updated using best available information and technologies.
- The action plans will be reviewed and revised to account for any initiatives completed, dropped, or changed and to account for changes in the risk assessment or new Partnership policies identified under other planning mechanisms (such as the general plan).
- The draft update will be sent to appropriate agencies and organizations for comment.
- The public will be given an opportunity to comment on the update prior to adoption.
- The partnership governing bodies will adopt their respective portions of the updated plan.

7.5 CONTINUING PUBLIC INVOLVEMENT

The public will continue to be apprised of the plan's progress through the County website and by providing copies of annual progress reports to the media. Each planning partner has agreed to provide links to the County hazard mitigation plan website on their individual jurisdictional websites to increase avenues of public access to the plan. OES has agreed to maintain the hazard mitigation plan website. This site will not only house the final plan, it will become the one stop shop for information regarding the plan, the partnership and plan implementation. Copies of the plan will be distributed to the Contra Costa County Library system. Upon initiation of future update processes, a new public involvement strategy will be initiated based on guidance from a new steering committee. This strategy will be based on the needs and capabilities of the planning partnership at the time of the update. At a minimum, this strategy will include the use of local media outlets within the planning area.

7.6 INCORPORATION INTO OTHER PLANNING MECHANISMS

The information on hazard, risk, vulnerability, and mitigation contained in this plan is based on the best science and technology available at the time this update was prepared. The Contra Costa County General Plan and the general plans of the partner cities are considered to be integral parts of this plan. The County and partner cities, through adoption of general plans and zoning ordinances, have planned for the impact of natural hazards. The Plan update process provided the County and the cities with the opportunity to review and expand on policies contained within these planning mechanisms. The planning partners used their general plans and the hazard mitigation plan as complementary documents that work together to achieve the goal of reducing risk exposure to the citizens of the Contra Costa County. A comprehensive update to a general plan may trigger an update to the hazard mitigation plan.

All municipal planning partners are committed to maintaining compliance with the provisions of California Assembly Bill 2140 (AB 2140) by creating a linkage between the hazard mitigation plan and their individual general plans by identifying a mitigation initiative as such and giving that initiative a high priority. Other planning processes and programs to be coordinated with the recommendations of the hazard mitigation plan include the following:

- Partners' emergency response plans
- Capital improvement programs
- Municipal codes
- Community design guidelines
- Water-efficient landscape design guidelines
- Stormwater management programs
- Water system vulnerability assessments
- Master fire protection plans.

Some action items do not need to be implemented through regulation. Instead, these items can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation. As information becomes available from other planning mechanisms that can enhance this plan, that information will be incorporated via the update process.

PART 2—RISK ASSESSMENT

CHAPTER 8.
RISK ASSESSMENT METHODOLOGY AND GENERAL CONCEPTS

Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from natural hazards. It allows emergency management personnel to establish early response priorities by identifying potential hazards and vulnerable assets. The process focuses on the following elements:

- Hazard identification—Use all available information to determine what types of disasters may affect a jurisdiction, how often they can occur, and their potential severity.
- Vulnerability identification—Determine the impact of natural hazard events on the people, property, environment, economy and lands of the region.
- Cost evaluation—Estimate the cost of potential damage or cost that can be avoided by mitigation.

The risk assessment for this hazard mitigation plan evaluates the risk of natural hazards prevalent in Contra Costa County and meets requirements of the DMA (44CFR, Section 201.6(c)(2)).

8.1 METHODOLOGY

Chapters 10 through 16 describe the risks associated with each hazard of concern identified for Contra Costa County. Each chapter describes the hazard, the planning area's vulnerabilities, and probable event scenarios. The following steps were used to define the risk of each hazard:

- Identify and profile each hazard—The following information is given for each hazard:
  - Geographic areas most affected by the hazard
  - Event frequency estimates
  - Severity estimates
  - Warning time likely to be available for response.
- Determine exposure to each hazard—Exposure was determined by overlaying hazard maps with an inventory of structures, facilities, and systems to determine which of them would be exposed to each hazard. The available Contra Costa County geographical information system (GIS) database contains extensive coverage of general building stock, critical facilities and critical infrastructure.
- Assess the vulnerability of exposed facilities—Vulnerability of exposed structures and infrastructure was determined by interpreting the probability of occurrence of each event and assessing structures, facilities, and systems that are exposed to each hazard. Tools such as GIS and FEMA's hazard-modeling program called HAZUS-MH were used to perform this assessment for the flood, dam failure and earthquake hazards. Outputs similar to those from HAZUS were generated for other hazards, using maps generated by the HAZUS program.

8.2 IDENTIFIED HAZARDS OF CONCERN

For this update, the Steering Committee considered the full range of natural hazards that could impact the planning area and then ranked the hazards that present the greatest concern. The process incorporated review of the *California State Enhanced Hazard Mitigation Plan* and the *ABAG Hazard Mitigation Plan.* Also considered were local, state and federal information on the frequency, magnitude and costs associated with hazards that have impacted or could impact the planning area. Qualitative or anecdotal information regarding natural hazards and the perceived vulnerability of the planning area's assets to them was also used. Based on the review, this plan update addresses the following hazards of concern:

- Dam failure
- Drought
- Earthquake
- Flooding
- Landslide and other mass movements
- Severe weather
- Wildfire.

With the exception of dam failure, technological hazards, such as hazardous material incidents, and human-caused hazards, such as terrorist acts, are not addressed in this plan. The DMA regulations do not require consideration of such hazards, and the planning partnership chose not to include them in this plan. A profile of dam failure is provided for informational purposes only.

8.3 RISK ASSESSMENT TOOLS

8.3.1 Dam Failure, Earthquake and Flood—HAZUS-MH

Overview

In 1997, FEMA developed the standardized Hazards U.S., or HAZUS, model to estimate losses caused by earthquakes and identify areas that face the highest risk and potential for loss. HAZUS was later expanded into a multi-hazard methodology, HAZUS-MH, with new models for estimating potential losses from wind (hurricanes) and flood (riverine and coastal) hazards.

HAZUS-MH is a GIS-based software program used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data, such as demographics, building stock, critical facility, transportation and utility lifeline, and multiple models to estimate potential losses from natural disasters. The program maps and displays hazard data and the results of damage and economic loss estimates for buildings and infrastructure. Its advantages include the following:

- Provides a consistent methodology for assessing risk across geographic and political entities.
- Provides a way to save data so that it can readily be updated as population, inventory, and other factors change and as mitigation planning efforts evolve.
- Facilitates the review of mitigation plans because it helps to ensure that FEMA methodologies are incorporated.
- Supports grant applications by calculating benefits using FEMA definitions and terminology.
- Produces hazard data and loss estimates that can be used in communication with local stakeholders.
- Is administered by the local government and can be used to manage and update a hazard mitigation plan throughout its implementation.

The version used for this plan was HAZUS-MH MR3, released by FEMA in September 2007. New data and tools released with MR3 include the following:

- Building valuations were updated.
- Building counts for single-family dwellings and manufactured housing are based on census counts instead of calculations.
- New tools in the flood model enable the user to import user-supplied flood maps and flood depth grids or generate a flood depth grid using specified Digital Flood Insurance Rate Map (DFIRM) floodplain boundaries and digital elevation grids.

Levels of Detail for Evaluation

HAZUS-MH provides default data for inventory, vulnerability and hazards; this default data can be supplemented with local data to provide a more refined analysis. The model can carry out three levels of analysis, depending on the format and level of detail of information about the planning area:

- **Level 1**—All of the information needed to produce an estimate of losses is included in the software's default data. This data is derived from national databases and describes in general terms the characteristic parameters of the planning area.
- **Level 2**—More accurate estimates of losses require more detailed information about the planning area. To produce Level 2 estimates of losses, detailed information is required about local geology, hydrology, hydraulics and building inventory, as well as data about utilities and critical facilities. This information is needed in a GIS format.
- **Level 3**—This level of analysis generates the most accurate estimate of losses. It requires detailed engineering and geotechnical information to customize it for the planning area.

Application for This Plan

The following methods were used to assess specific hazards for this plan:

- **Flood**—A Level 2, general building stock analysis was performed. GIS building and assessor data (replacement cost values and detailed structure information) were loaded into HAZUS-MH. An updated inventory was used in place of the HAZUS-MH defaults for essential facilities, transportation and utilities. Current Contra Costa County DFIRMs were used to delineate flood hazard areas and estimate potential losses from the 100- and 500-year flood events. Using the DFIRM floodplain boundaries and Contra Costa County 2008 Ortho Imagery Project LIDAR data, a county-wide digital elevation model (DEM) and flood depth grid were generated and integrated into the model. Flood depth-damage functions were updated with U.S. Army Corps of Engineers damage functions for residential building stock to better correlate HAZUS results with FEMA benefit-cost analysis models.

  Dam Failure—Dam failure inundation mapping for Contra Costa County was collected where available. This data was imported into HAZUS-MH and a modified Level 2 analysis was run using the flood methodology described above.

- **Earthquake**—A Level 2 analysis was performed to assess earthquake risk and exposure. Earthquake shake maps and probabilistic data prepared by the U.S. Geological Survey (USGS) were used for the analysis of this hazard. An updated general building stock inventory was developed using replacement cost values and detailed structure information from assessor tables. An updated inventory of essential facilities, transportation and utility features was used in place of the HAZUS-MH defaults. A modified version of the California

Department of Conservation National Earthquake Hazard Reduction Program (NEHRP) soils inventory was used. Two scenario events and two probabilistic events were modeled:

– The scenario events were a Magnitude-6.9 event on the Calaveras Fault and a Magnitude-7.0 event on the Hayward-Rodgers Creek Fault. These two events were selected by County OES as the faults of concern for the Contra Costa County planning area.

– The standard HAZUS analysis for the 100- and 500-year probabilistic events was run.

8.3.3 Landslide, Severe Weather, and Wildfire

For most of the hazards evaluated in this risk assessment, historical data was not adequate to model future losses. However, HAZUS-MH is able to map hazard areas and calculate exposures if geographic information is available on the locations of the hazards and inventory data. Areas and inventory susceptible to some of the hazards of concern were mapped and exposure was evaluated. For other hazards, a qualitative analysis was conducted using the best available data and professional judgment. County-relevant information was gathered from a variety of sources. Frequency and severity indicators include past events and the expert opinions of geologists, emergency management specialists and others. The primary data source was the Contra Costa County GIS database, augmented with state and federal data sets. Additional data sources for specific hazards were as follows:

- **Landslide**—A dataset of steep slopes was generated using a 1/3-arcsecond digital elevation model. Two slope classifications were created: 15 to 30 percent; and greater than 30 percent.
- **Severe Weather**—Severe weather data was downloaded from the Natural Resources Conservation Service and the National Climatic Data Center.
- **Wildfire**—Information on wildfire hazards areas was provided by the California Department of Forestry and Fire Protection (CAL FIRE). CAL FIRE has been directed by California code to map areas of significant fire hazard based on fuels, terrain, weather and other relevant factors. These zones are referred to as Fire Hazard Severity Zones. These classifications define the application of various mitigation strategies to reduce risk associated with wildfires.

8.3.4 Drought

The risk assessment methodologies used for this update focus on damage to structures. Because drought does not impact structures, the risk assessment for drought was more limited and qualitative than the assessment for the other hazards of concern.

8.3.5 Limitations

Loss estimates, exposure assessments and hazard-specific vulnerability evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

- Approximations and simplifications necessary to conduct a study
- Incomplete or outdated inventory, demographic or economic parameter data
- The unique nature, geographic extent and severity of each hazard
- Mitigation measures already employed
- The amount of advance notice residents have to prepare for a specific hazard event.

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate. The results do not predict precise results and should be used only to understand relative risk. Over the long term, Contra Costa County and its planning partners will collect additional data to assist in estimating potential losses associated with other hazards.

8.4 CLIMATE CHANGE

Climate includes patterns of temperature, precipitation, humidity, wind and seasons. Climate plays a fundamental role in shaping natural ecosystems, and the human economies and cultures that depend on them. "Climate change" refers to changes over a long period of time. It is generally perceived in the emergency management profession that climate change will have a measurable impact on the occurrence and severity of natural hazards around the world. Impacts include:

- Sea ice and snow cover losses will continue, and declining snowpack will affect snow-dependent water supplies and stream flow levels around the world.
- Sea level is projected to rise 7 to 23 inches during the 21st century due to melting snow and ice on land and thermal expansion of ocean waters.
- The risk of drought and the frequency, intensity, and duration of heat waves are expected to increase.
- More extreme precipitation is likely, increasing the risk of flooding.
- If the world's average temperature warms only an additional 2.7ºF to 4.5ºF above pre-industrial levels, an estimated 20 to 30 percent of known plant and animal species would be at increasingly high risk of extinction.

Climate change will affect communities in a variety of ways. Impacts could include an increased risk for extreme events such as drought, storms, flooding, and forest fires; more heat-related stress; the spread of existing or new vector-born disease into a community; and increased erosion and inundation of low-lying areas along coastlines. In many cases, communities are already facing these problems to some degree. Climate change changes the frequency, intensity, extent, and/or magnitude of the problems.

This hazard mitigation plan addresses climate change as a subset, or secondary impact, for each identified hazard of concern. Each chapter addressing one of the hazards of concern includes a section with a qualitative discussion on the probable impacts of climate change for that hazard. While many models are currently being developed to assess the potential impacts of climate change, there are currently none available to support hazard mitigation planning. As these models are developed in the future, this risk assessment may be enhanced to better measure these impacts.

8.5 PRESIDENTIAL DISASTER DECLARATIONS

Presidential disaster declarations are typically issued for events that cause more damage than state and local governments can handle without assistance from the federal government, although no specific dollar loss threshold has been established for these declarations. A presidential disaster declaration puts federal recovery programs into motion to help disaster victims, businesses and public entities. Some of the programs are matched by state programs. Contra Costa County has experienced 18 events since 1950 for which presidential disaster declarations were issued. These events are listed in Table 8-1.

Review of these events helps identify targets for risk reduction and ways to increase a community's capability to avoid large-scale events in the future. Still, many natural hazard events do not trigger federal disaster declaration protocol but have significant impacts on their communities. These events are also important to consider in establishing recurrence intervals for hazards of concern.

**TABLE 8-1.
PRESIDENTIAL DISASTER DECLARATIONS FOR HAZARD EVENTS IN CONTRA COSTA COUNTY**

Type of Event	Disaster Declaration #	Date
Swine flu (statewide)		04/28/2009
Drought (statewide)		2/27/2009
Oil spill		11/9/2007
Winter storms		05/10/2006
Winter storms/flooding	DR1628	12/15/2005
Severe flooding/landslides	DR 1203	02/02/1998
Severe winter storms	DR1046	01/10/1995
Severe winter storms	DR1044	01/13/1995
Winter storms (snow, rain, high winds)	DR979	01/15/1993
Earthquake (Loma Prieta)	DR845	11/17/1989
Winter storms (rain, wind, flooding, landslides)	DR758	02/18/1986
Winter storms	DR682	02/09/1983
Winter storms	DR651	01/07/1982
Delta levee break	0378-EM-CA	01/23/1980
Winter storms	DR253	1/26/1969
Flood/rainstorms	DR138	10/24/1962
Winter storm/flood damage (statewide)	DR82	04/04/1958
Floods (statewide)	DR47	12/23/1955

8.6 CRITICAL FACILITIES AND INFRASTRUCTURE

Critical facilities and infrastructure are those that are essential to the health and welfare of the population. These become especially important after a hazard event. Critical facilities typically include police and fire stations, schools and emergency operations centers. Critical infrastructure can include the roads and bridges that provide ingress and egress and allow emergency vehicles access to those in need, and the utilities that provide water, electricity and communication services to the community. Also included are "Tier II" facilities and railroads, which hold or carry significant amounts of hazardous materials with a potential to impact public health and welfare in a hazard event. During this update process, the Steering Committee chose to enhance the definition of critical facilities for the updated plan as follows:

> Any facility, whether publicly or privately owned, which includes infrastructure that is vital to the Contra Costa County planning area's ability to provide essential services and protect life and property. Damage to such infrastructure that may cause a short or long-term loss of a critical facility would likely result in a severe economic, health and welfare, life-sustainment or other catastrophic impact. "Critical Facilities" can be segregated into three categories:
>
> – Facilities that are essential to the ability to respond to, mitigate and recover from the impacts of natural hazards
>
> – Facilities that need early warning to enable them to prepare for and respond to the impacts of natural hazards

- Facilities that by the nature of their operations, produce, manufacture or store materials that create an exposure to secondary hazards of concern.

Under the Contra Costa County hazard mitigation plan definition, critical facilities include but are not limited to the following:

- Police stations, fire stations, city/county government facilities (including those that house critical information technology and communication infrastructure), vehicle and equipment storage facilities, and emergency operations centers needed for disaster response before, during, and after hazard events
- Public and private utilities and infrastructure vital to maintaining or restoring normal services to areas damaged by hazard events. These facilities include but are not limited to:
  - Public and private water supply infrastructure, water and wastewater treatment facilities and infrastructure, potable water pumping, flow regulation, distribution and storage facilities and infrastructure
  - Public and private power generation (electrical and non-electrical), regulation and distribution facilities and infrastructure
  - Data and server communication facilities
  - Structures that manage or limit the impacts of natural hazards such as regional flood conveyance systems, potable water trunk main interconnect systems and redundant pipes crossing fault lines and reservoirs
  - Major road and rail systems including bridges, airports and marine terminal facilities
- Educational facilities, including K-12 and community college.
- Community gathering places, such as libraries, community centers, senior centers, veterans halls, and the County fairground
- Hospitals, nursing homes, and housing likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a hazard event
- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic, and/or water-reactive materials.

The HAZUS critical facility data base was updated using the Critical Infrastructure/Key Resource database created by the County as part of its National Infrastructure Protection Plan. Over 1,900 user-defined facilities were entered into the HAZUS Comprehensive Data Management System. Map 8-1 shows the location of critical facilities in unincorporated areas of the county. Critical facilities within the cities participating in this plan are shown in maps for each city provided in Volume 2 of the plan. Due to the sensitivity of this information, a detailed list of facilities is not provided. The list is on file with each planning partner. Tables 8-2 and 8-3 provide summaries of the general types of critical facilities and infrastructure, respectively, in each municipality and unincorporated county areas. All critical facilities/infrastructure were analyzed in HAZUS to help rank risk and identify mitigation actions. The risk assessment for each hazard qualitatively discusses critical facilities with regard to that hazard.

TABLE 8-2.
CONTRA COSTA COUNTY CRITICAL FACILITIES EXPOSED TO THE EARTHQUAKE HAZARD

City	Medical and Health	Government Functions	Protective Functions	Schools	Hazmat	Other Critical Functions	Total
Antioch	3	2	5	27	3	3	**43**
Brentwood	3	2	3	28	0	0	**36**
Clayton	0	2	1	4	0	0	**7**
Concord	4	0	16	55	1	0	**76**
Danville	0	0	3	21	0	0	**24**
El Cerrito	0	0	3	15	0	0	**18**
Hercules	0	1	2	8	0	0	**11**
Lafayette	0	0	4	13	0	0	**17**
Martinez	1	3	14	11	4	1	**34**
Moraga	0	0	3	8	0	0	**11**
Oakley	0	2	3	15	2	0	**22**
Orinda	0	0	5	13	0	0	**18**
Pinole	1	0	2	7	0	0	**10**
Pittsburg	1	2	5	25	41	3	**77**
Pleasant Hill	0	0	4	15	0	0	**19**
Richmond	5	1	19	51	103	5	**184**
San Pablo	1	0	2	11	6	0	**20**
San Ramon	3	0	8	20	0	0	**31**
Walnut Creek	2	0	8	26	0	0	**36**
Unincorporated	3	0	40	52	126	34	**255**
Total	**27**	**15**	**150**	**425**	**286**	**46**	**949**

**TABLE 8-3.
CONTRA COSTA COUNTY CRITICAL INFRASTRUCTURE EXPOSED TO THE EARTHQUAKE HAZARD**

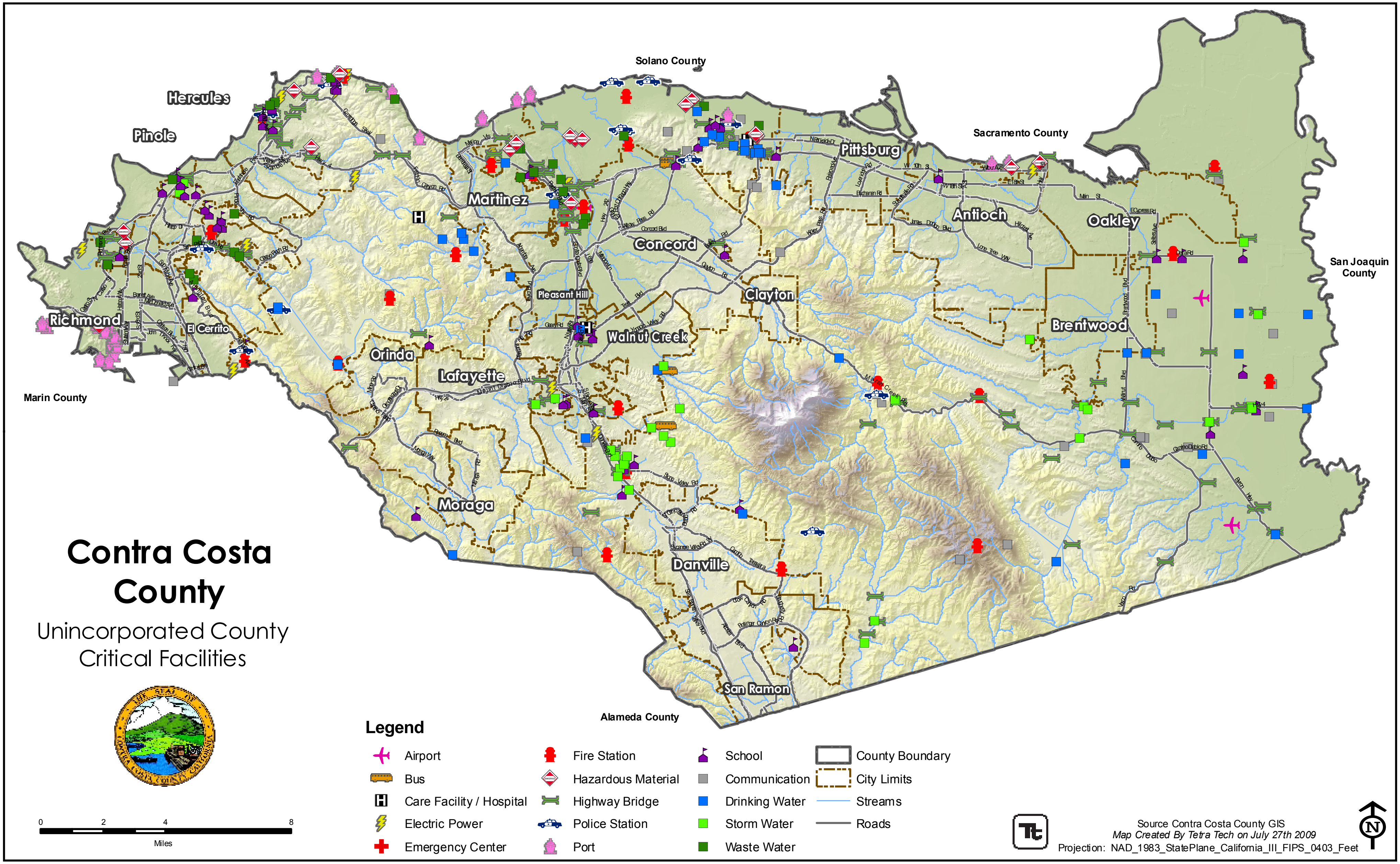
City	Bridges	Water Supply	Wastewater	Power	Communications	Other	**Total**
Antioch	28	29	4	1	25	2	**89**
Brentwood	8	1	1	0	11	4	**25**
Clayton	0	1	0	0	0	0	**1**
Concord	71	16	2	8	8	19	**124**
Danville	27	3	0	0	2	15	**47**
El Cerrito	3	0	1	4	6	0	**14**
Hercules	8	1	1	1	3	0	**14**
Lafayette	36	2	0	0	2	4	**44**
Martinez	20	19	4	3	3	5	**54**
Moraga	3	0	1	0	1	0	**5**
Oakley	0	12	1	0	6	2	**21**
Orinda	0	3	8	5	2	1	**19**
Pinole	12	0	4	0	0	2	**18**
Pittsburg	13	6	2	6	19	2	**48**
Pleasant Hill	19	4	0	1	0	6	**30**
Richmond	42	1	11	6	2	0	**62**
San Pablo	8	0	0	1	0	0	**9**
San Ramon	10	1	1	0	0	3	**15**
Walnut Creek	45	14	1	3	0	6	**69**
Unincorporated	124	51	25	13	35	39	**287**
Total	**477**	**164**	**67**	**52**	**125**	**110**	**995**

8.7 FUTURE TRENDS IN DEVELOPMENT

Contra Costa County and its municipal planning partners are subject California’s General Planning Law. The County and its cities have adopted general plans, including safety elements, pursuant to this law. These processes govern land use decision and policy making within Contra Costa County. Decisions on land use will be governed by these well-established, state-mandated programs, and not by this plan. This plan will work together with these programs to support wise land use in the future by providing vital information on the risk associated with natural hazards in Contra Costa County.

All municipal planning partners will incorporate by reference the Contra Costa County Hazard Mitigation Plan in the safety elements of their general plans, pursuant to California Assembly Bill 2140 (AB 2140). This will assure that all future trends in development can be established with the benefits of the information on risk and vulnerability to natural hazards identified in this plan.

Map 8-1.



Contra Costa County
Unincorporated County Critical Facilities
Solano County
Sacramento County
San Joaquin County
Marin County
Alameda County
Hercules
Pinole
Richmond
El Cerrito
Martinez
Concord
Pittsburg
Antioch
Oakley
Brentwood
Clayton
Pleasant Hill
Walnut Creek
Orinda
Lafayette
Moraga
Danville
San Ramon
Legend
Airport
Bus
Care Facility / Hospital
Electric Power
Emergency Center
Fire Station
Hazardous Material
Highway Bridge
Police Station
Port
School
Communication
Drinking Water
Storm Water
Waste Water
County Boundary
City Limits
Streams
Roads
0
2
4
8
Miles
Source Contra Costa County GIS
Map Created By Tetra Tech on July 27th 2009
Projection: NAD_1983_StatePlane_California_III_FIPS_0403_Feet
N

CHAPTER 9.
CONTRA COSTA COUNTY PROFILE

Contra Costa County is located in the east bay area of central California (see Figure 9-1). Although the county is just east of the major metropolitan populations of San Francisco and Oakland, about 70 percent of Contra Costa County's land is designated as non-urban. The County seat is the City of Martinez, in the northwest part of the county.

Figure 9-1. Main Features of Contra Costa County

Contra Costa County is the ninth most populous county in the state. The major population centers include Antioch, Concord and Richmond. The western and northern coastlines are highly urbanized, while the interior regions are primarily residential areas with commercial development and light industry. Educational services, health care and social assistance services are important base industries; the county is home to several educational institutions and health care facilities.

Although there is considerable development in Contra Costa County, much of the land is rural, providing access to natural resource attractions. Many areas offer recreation opportunities. The county is bounded to the north and west by water features, such as the bays of San Francisco, San Pablo and Suisun, and to the east by the San Joaquin River. Bayside alluvial plains, wildlife refuges, dunes, regional park districts and the trails of the Diablo range attract tourists and residents.

9.1 HISTORICAL OVERVIEW

In the past, a number of Native American tribes populated the region now recognized as Contra Costa County. Although the indigenous people's recorded history is limited, the known settled populations were hunter-gatherer societies that fashioned embellished utilitarian crafts for everyday use, particularly woven reed baskets. Tribes traded local materials like obsidian for arrowheads across the region. These tribes did not incorporate warfare into their culture, generally cooperating with one another. Since early settlers did not record much about the culture of the natives, most of what is known comes from artifacts and from inter-generational knowledge passed down by outlying northern tribes of the larger region.

Spaniards and Portuguese first visited the region in the eighteenth century and settled there in the early nineteenth century. The immigrants settled in areas inhabited by natives whom they called Costanoans, or Coast People. The typical Portuguese immigrants were from the Azores and often began life in Contra Costa as simple farm laborers. Many of the new arrivals were illiterate, but through hard labor the immigrants were able to lease and eventually purchase farms with crop earnings. These immigrants eventually became important in the northern California dairy industry. Spanish colonization and influence throughout this region was heavy, with the King of Spain awarding extensive land grants to his army of veterans and favored settlers. Spanish missions and military establishments were also developed throughout the region, though no missions were established in what is now Contra Costa County.

As Mexico gained independence from Spain in 1821, the reorganization of held lands soon followed. The Mexican War of Independence resulted in secularization of the area missions with the reallocation of their boundaries and established a new system of land grants under the Mexican Federal Law of 1824. Eighteen substantial land grants, known as Ranchos, were made in what would become Contra Costa County. Ranchos retained their given Hispanic names and were occupied by thousands of heads of cattle managed by Hispanic families. Mission lands were extended throughout the Bay Area and included portions of Contra Costa County.

Exclusive Hispanic land ownership ended with the discovery of gold in the foothills of the Sierra Nevada in 1848. People of various ethnicities came to mine the gold, though most were unsuccessful. Many stayed in the East Bay area and founded new cities and towns bearing their European names. Hispanic land-grantee names, such as Pacheco, Martinez and Moraga, are also reflected in community names and in business parks, streets and subdivisions.

One of the original counties of California, Contra Costa County was created in 1850 at the time of statehood. The East Bay area was originally referred to as Contra Costa, meaning the "opposite coast." The county was initially to be named Mt. Diablo County, after the prominent peak in the central region of the county, but the name was changed prior to incorporation. A few southern sections of the county's original territory, including all of the bayside portions opposite San Francisco and northern portions of Santa Clara County, were given up to form Alameda County in March 25, 1853.

Contra Costa County was historically divided into three regions. Agriculture dominated the south, where plentiful farms provided food for the larger northern and western cities. The urban central area became home to the University of California. Shipping and international industry occupied the northern economy, where oil refining is still a stronghold. The northern area of the county was also home to Port Chicago, a naval weapons depot and munitions ship loading facility. During World War II, Port Chicago was the site of a deadly explosion that occurred as munitions were being loaded onto ship. The site is now a national memorial dedicated to the hundreds of sailors and civilians who lost their lives in the explosion.

The post-war era brought the expansion of suburban living in Contra Costa County. Large rural cattle ranches and farms were converted to inexpensive quarter-acre lots with tract housing. Suburbia continued to proliferate as a result of the decaying of larger urban areas in San Francisco and Alameda County.

9.2 JURISDICTIONS AND ATTRACTIONS

Contra Costa County is bounded on the north by Solano and Sacramento Counties (San Pablo Bay and Suisun Bay), on the east by San Joaquin County, on the south by Alameda County, and to the west by the San Francisco Bay and the counties of Marin and San Francisco. The county covers 802 square miles, of which about 10 percent is water.

The western part of Contra Costa County includes the cities of El Cerrito, Hercules, Pinole, Richmond, and San Pablo and is home to the Richmond Inner Harbor at San Francisco Bay. Communities in the central area include Clayton, Concord, Danville, Lafayette, Martinez, Moraga, Orinda, Pleasant Hill, San Ramon and Walnut Creek. Central Contra Costa County also hosts the Port Chicago National Memorial and the Concord Naval Weapons Station, along with California State University-East Bay, Mount Diablo State Park, the John Muir National Historic Site and the Eugene O'Neill National Historic Site. Eastern incorporated communities of the County include Antioch, Brentwood, Pittsburg and Oakley. Several reservoirs, the Antioch Dunes National Wildlife Refuge and the San Joaquin River system also occupy the eastern areas of Contra Costa County.

Contra Costa County features abundant open space. The county's physical geography is punctuated by the bayside alluvial plain, the Oakland-Berkeley Hills and the Diablo Range of hills. The San Joaquin-Sacramento River Delta area provides boating, fishing and other water recreation activities. At 3,849 feet, Mount Diablo is an isolated upthrust peak within the Diablo Range that offers trails, picnic areas and other recreational opportunities for area residents and visitors. The East Bay Regional Park District is one of the largest regional park districts in the United States, with over 96,000 acres in 65 area parks.

9.3 PHYSICAL SETTING

9.3.1 Geology

The bay region of California is characterized by a series of northwest trending mountains and valleys formed by tectonic plate movement. The region has a complex geologic history of folding, faulting, uplift, sedimentation, volcanism and erosion.

The primary bedrock in Contra Costa County includes sedimentary rocks, volcanic rock intrusions and alluvial deposits. Regional basement rocks consist of the highly deformed Great Valley Sequence, which include massive beds of marine sandstone intermixed with siltstone and shale, and marine sandstone and shale overlain by soft non-marine units**.** Unconsolidated alluvial deposits, artificial fill and estuarine deposits underlie the marginal areas along the San Pablo Bay, Carquinez Straight and Suisun Bay. Landslides in the region typically occur in weak, easily weathered bedrock on relatively steep slopes. Bedrock geology for the area is not entirely mapped. Lack of detailed mapping in most cases precludes determining specific site stability without a site investigation. However, it may be valid to conclude varying degrees of relative risk based on general mapping of rock units when averaged over time.

Two distinct depositional environments exist in Contra Costa County. Since much of the county is mountainous with steep, rugged topography, a sequence of alluvial fan and fan-delta deposits have developed in most of the western part of the county. The second environment is a combination of eolian dune and river delta deposits in the San Joaquin Valley in eastern Contra Costa County.

9.3.2 Soils

Contra Costa County is in California's Central Coast Range, with northwest trending mountain ranges and valleys. Alluvium, terrace deposits and bay mud, primarily composed of sand, silt, clay and gravel, are prevalent in the lowlands. The intermountain valleys and foothills contain alluvial soils and terrace deposits. In the east, north and northwest parts of the county, the soils generally consist of bay muds. Mapping units and maps presented in the Natural Resources Conservation Service's soil survey for this region describe the prevailing soils and include information about parent rock materials, soil depth, erosion, and slope. Contra Costa County's soils may be classified into three general categories:

- **Lowland Soil Associations**—Six characteristic Lowland Soil associations range from nearly level to strongly sloping landscapes. They also range from somewhat excessively drained to poorly drained soils typically found in valley fill, low terraces, basins, floodplains and on alluvial fans. Lowland soils are also slowly permeable, highly expansive and corrosive, with slight erosion hazards. They make up 25 percent of the soils in Contra Costa County.
- **Tidal Flat-Delta-Marsh Lowland Associations**—Three Tidal Flat-Delta-Marsh Lowland soil associations are described as being poorly drained on level land within deltas, floodplains, saltwater marshes and tidal flats. Formed in mineral alluvium and from the remains of hydrophytic plants, these soils are clay loam, muck, silty clay and clay. Tidal Flat-Delta-Marsh Lowland soils make up 10 percent of the county's soils. Soils of these associations are highly expansive due to the clay content and are highly corrosive.
- **Upland Soil Associations**—Five Upland Soil groups make up 64 percent of Contra Costa County's soils. Upland soils are located on level terraces or steep mountain uplands and range from being moderately well drained to excessively drained. These soils range from loams to clays and form in weakly consolidated alluvial sediments, weathered sedimentary rock interbeds and some igneous rock. Upland soils are typically highly expansive and corrosive, with slow to moderate permeability.

Soils have varying levels of susceptibility to erosion, but each soil type benefits from conservation management techniques to prevent erosion. Soil erosion in Contra Costa County occurs as a result of intensive land use, wind and water erosion. Erosion may be most severe where urbanization, development, recreational activities, logging and agricultural practices take place. Extreme rainfall events, lack of vegetative cover, fragile soils and steep slopes combine to accelerate erosion. Wind erosion is the primary factor for soil losses in the river delta areas. Agricultural crops are subject to the erosive forces of water and hillside grazing pastures have been strained by reduced root structure due to years of drought conditions. The conversion of agricultural lands to housing and other development may cause exposed soils to become susceptible to erosion. With proper drainage and landscaping techniques, these altered soils may return to pre-construction stability.

9.3.3 Seismic Features

Much of the San Francisco Bay Area contains both active and potentially active faults and is considered a region of high seismic activity. The U.S. Geological Survey (USGS) Working Group on California Earthquake Probabilities has evaluated the probability of one or more earthquakes of Richter magnitude 6.7 or higher occurring in the San Francisco Bay Area within the next 30 years. The result of the evaluation indicated a 70-percent likelihood for such an earthquake event.

The Hayward Fault runs through the western part of the county, from the Kensington area to Richmond. The Calaveras Fault extends in the south-central part of the county from Alamo to San Ramon. Parts of Concord and Pacheco contain the Concord Fault and the Clayton-Marsh Creek-Greenville Fault extends from Clayton to an area near Livermore. These right lateral moving slip-strike faults and the Diablo thrust fault near Danville are all capable of resulting in destructive earthquakes. Several smaller but adjacent faults in the area cross critical infrastructure such as water, natural gas, and petroleum product pipelines as well as roads, highways and railway corridors including the Bay Area Rapid Transit (BART) system. Seismic hazards include ground shaking, liquefaction, lateral spreading, differential settlement, landslides and lake or coastal inundation by encroaching waves (tsunami and seiches).

9.3.4 Climate

Contra Costa County is an area of relatively mild temperatures and moderate precipitation. Average temperatures near San Pablo Bay vary only about 15ºF from summer to winter, although a greater temperature range is found over inland areas. Coastal temperatures near Richmond average 58ºF and range from about 50ºF during winter to the low 70s in summer. Annual average temperatures near Antioch are about 60ºF, with average summer temperatures in the mid 70s, although the mean daily maximum temperature in July reaches 90ºF. Higher inland elevations near Mount Diablo average 58ºF. Temperatures typically range from 39ºF in January to 85ºF in July.

Rainfall is experienced during each month of the year in Contra Costa County, with the majority of precipitation occurring during the winter. Most of this is associated with storm fronts that move in from the Pacific Ocean. A few thunder showers develop in the mountains during the summer, but they are infrequent. Annual precipitation near Richmond exceeds 23 inches, while Antioch experiences drier conditions, with rainfall totals around 13 inches. Mount Diablo's slopes and foothills experience about 24 inches of precipitation, most of it in the form of winter snowfall.

The average relative humidity near the coastal communities is higher due to the moist air influence of the Pacific Ocean and San Pablo Bay. The adjoining coastal area has a moderate, stable temperature regime. With increasing distance from the ocean, the marine influence is less pronounced, so inland areas experience wider variations of temperature and lower humidity.

The heat produced by inland temperatures, combined with the cool waters of the Bay and Pacific Ocean and the winds coming in from the water, provide suitable conditions for East Bay area fog. Fog tends to creep into lowlands at night to cool down hot summer temperatures. Farther east from the coast, less fog is present. Inland areas like Walnut Creek receive very little cool down from what some Bay Area weathermen call the "fair weather maker" of fog.

9.4 DEMOGRAPHICS

Some populations are at greater risk from hazard events because of decreased resources or physical abilities. Elderly people, for example, may be more likely to require additional assistance. Research has shown that people living near or below the poverty line, the elderly (especially older single men), the disabled, women, children, ethnic minorities and renters all experience, to some degree, more severe effects from disasters than the general population. These vulnerable populations may vary from the general population in risk perception, living conditions, access to information before, during and after a hazard event, capabilities during an event, and access to resources for post-disaster recovery. Indicators of vulnerability—such as disability, age, poverty, and minority race and ethnicity—often overlap spatially and often in the geographically most vulnerable locations. Detailed spatial analysis to locate areas where there are higher concentrations of vulnerable community members would assist the County in extending focused public outreach and education to these most vulnerable citizens.

9.4.1 Contra Costa County Population Characteristics

Knowledge of the composition of the population and how it has changed in the past and how it may change in the future is needed for making informed decisions about the future. Information about population is a critical part of planning because it directly relates to land needs such as housing, industry, stores, public facilities and services, and transportation. Contra Costa County is the ninth largest of California's 57 counties. The California Department of Finance estimated Contra Costa County's population at 1.06 million as of January 1, 2009.

Population changes are useful socio-economic indicators. A growing population generally indicates a growing economy, while a decreasing population signifies economic decline. Figure 9-2 shows the growth rate of Contra Costa County from 1990 to 2005 compared to that of the State of California. Between 1990 and 2005, California's population grew by 21.44 percent (about 1.4 percent per year) while Contra Costa County's population increased by 23.87 percent (1.59 percent per year). This is indicative of a stable, growing economy. The County's population increased an average of 1.25 percent per year between 2000 and 2009 and a total of 11.4 percent during that period.

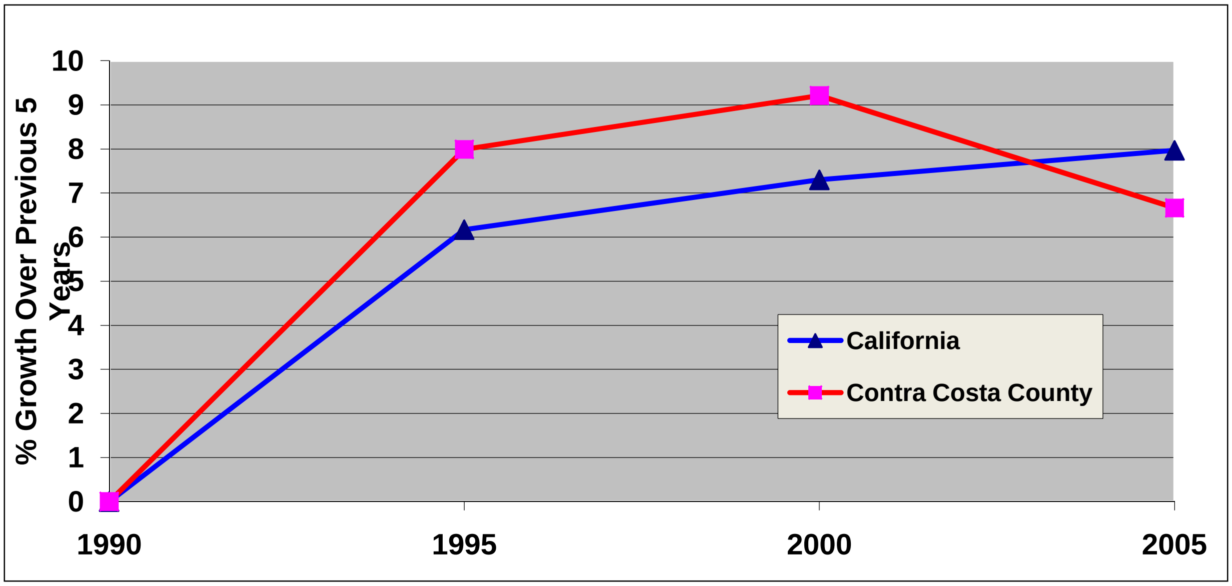


Figure 9-2. California and Contra Costa County Population Growth Rates 1990-2005

Table 9-1, inserted at the end of this chapter, shows the population of incorporated municipalities and the combined unincorporated areas in Contra Costa County from 1990 to 2009. In 2009, only about 16 percent of Contra Costa County's residents lived outside incorporated areas. Overall growth in incorporated areas was 37 percent from 1990 to 2009, while the unincorporated areas of the county grew about 11 percent during the same timeframe. Three of the county's 19 incorporated cities have estimated populations over 100,000: Antioch, Concord and Richmond. Clayton, Moraga, Orinda and Pinole are the county's smallest cities, with populations under 20,000.

9.4.2 Income

In the United States, individual households are expected to use private resources to prepare for, respond to and recover from disasters to some extent. This means that households living in poverty are automatically disadvantaged when confronting hazards. Additionally, the poor typically occupy more poorly built and inadequately maintained housing. Mobile or modular homes, for example, are more susceptible to damage in earthquakes, tsunamis and floods than other types of housing. In urban areas, the poor often live in older houses and apartment complexes, which are more likely to be made of un-reinforced masonry, a building type that is particularly susceptible to damage during earthquakes. Furthermore, residents below the poverty level are less likely to have insurance to compensate for losses incurred from natural disasters.

This means that residents below the poverty level have a great deal to lose during an event and are the least prepared to deal with potential losses. The events following Hurricane Katrina in 2005 illustrated that personal household economics significantly impact people's decisions on evacuation. Individuals who cannot afford gas for their cars will likely decide not to evacuate.

Based on U.S. Census Bureau estimates, per capita income in Contra Costa County in 2005 was $48,618, and the median household income was $78,619 (in 2008 dollars, adjusted for inflation). It is estimated that about 19 percent of households receive an income between $100,000 and $149,999 per year and over 19 percent of the county's household incomes are above $150,000 annually. According to 2006-2008 survey estimates, about 14 percent of the households in Contra Costa County make less than $25,000 per year and are therefore below the poverty level. As defined by the Office of Management and Budget and updated for inflation using the Consumer Price Index, the weighted average poverty threshold for a family of four in 2008 was $22,025; for a family of three, $17,163; for a family of two, $14,051; and for unrelated individuals, $10,991.

9.4.3 Age Distribution

As a group, the elderly are more apt to lack the physical and economic resources necessary for response to hazard events and are more likely to suffer health-related consequences making recovery slower. They are more likely to be vision, hearing, and/or mobility impaired, and more likely to experience mental impairment or dementia. Additionally, the elderly are more likely to live in assisted-living facilities where emergency preparedness occurs at the discretion of facility operators. These facilities are typically identified as "critical facilities" by emergency managers because they require extra notice to implement evacuation. Elderly residents living in their own homes may have more difficulty evacuating their homes and could be stranded in dangerous situations. This population group is more likely to need special medical attention, which may not be readily available during natural disasters due to isolation caused by the event. Specific planning attention for the elderly is an important consideration given the current aging of the American population.

Children under 14 are particularly vulnerable to disaster events because of their young age and dependence on others for basic necessities. Very young children may additionally be vulnerable to injury or sickness; this vulnerability can be worsened during a natural disaster because they may not understand the measures that need to be taken to protect themselves from hazards.

The overall age distribution for Contra Costa County is illustrated in Figure 9-3. Based on U.S. Census data estimates for 2006-2008, 11.9 percent of Contra Costa County's population is 65 or older, slightly higher than the state average of 11.0 percent. According to the 2000 U.S. Census data, 39.6 percent of the County's over-65 population has disabilities of some kind and 6.1 percent have incomes below the poverty line. Children under 18 account for nearly 12 percent of individuals who are below the poverty line. It is also estimated that 20.1 percent of the County's population is 14 or younger, slightly less than the state average of 21.2 percent.

9.4.4 Race, Ethnicity and Language

Research shows that minorities are less likely to be involved in pre-disaster planning and experience higher mortality rates during a disaster event. Post-disaster recovery can be ineffective and is often characterized by cultural insensitivity. Since higher proportions of ethnic minorities live below the poverty line than the majority white population, poverty can compound vulnerability. According to the U.S. Census, the racial composition of Contra Costa County is predominantly white, at about 61.7 percent. The largest minority populations are Asian at 13.4 percent and Hispanic at 22.4 percent. Figure 9-4 shows the racial distribution within Contra Costa County.

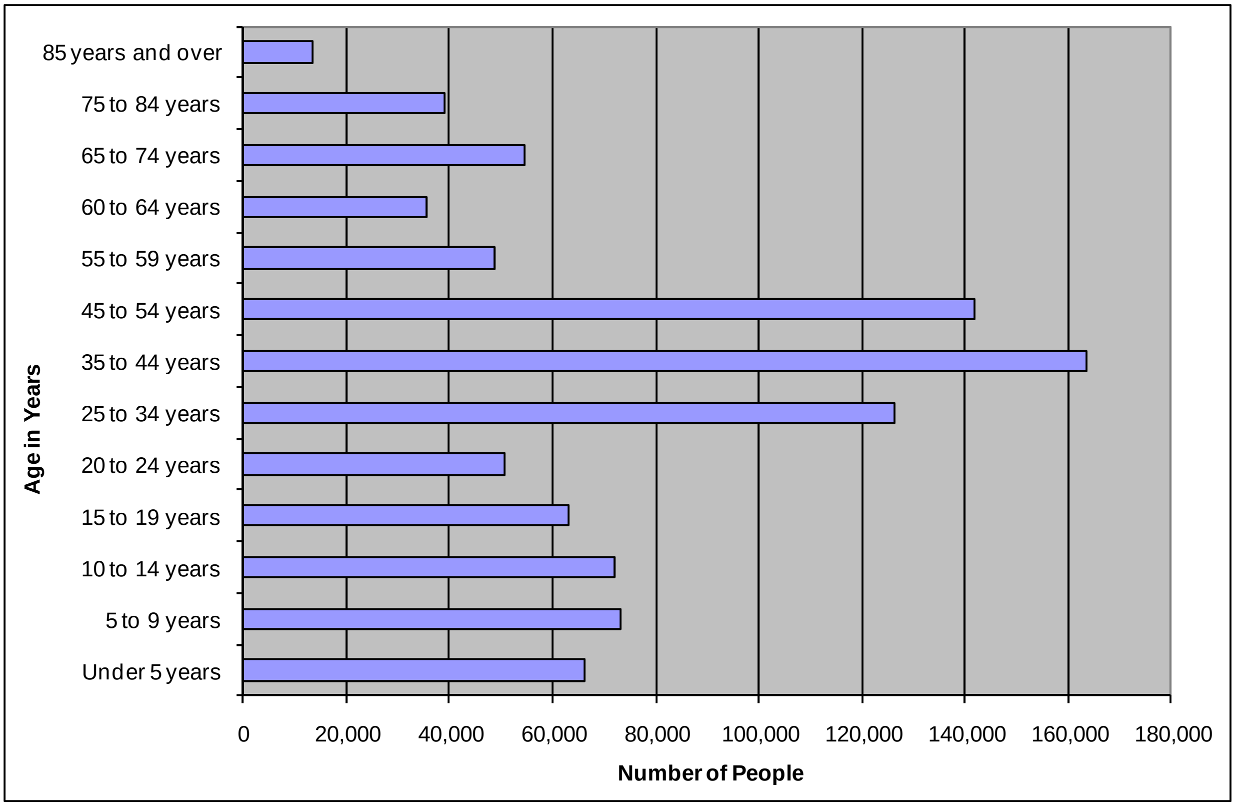


Figure 9-3. Contra Costa County Age Distribution

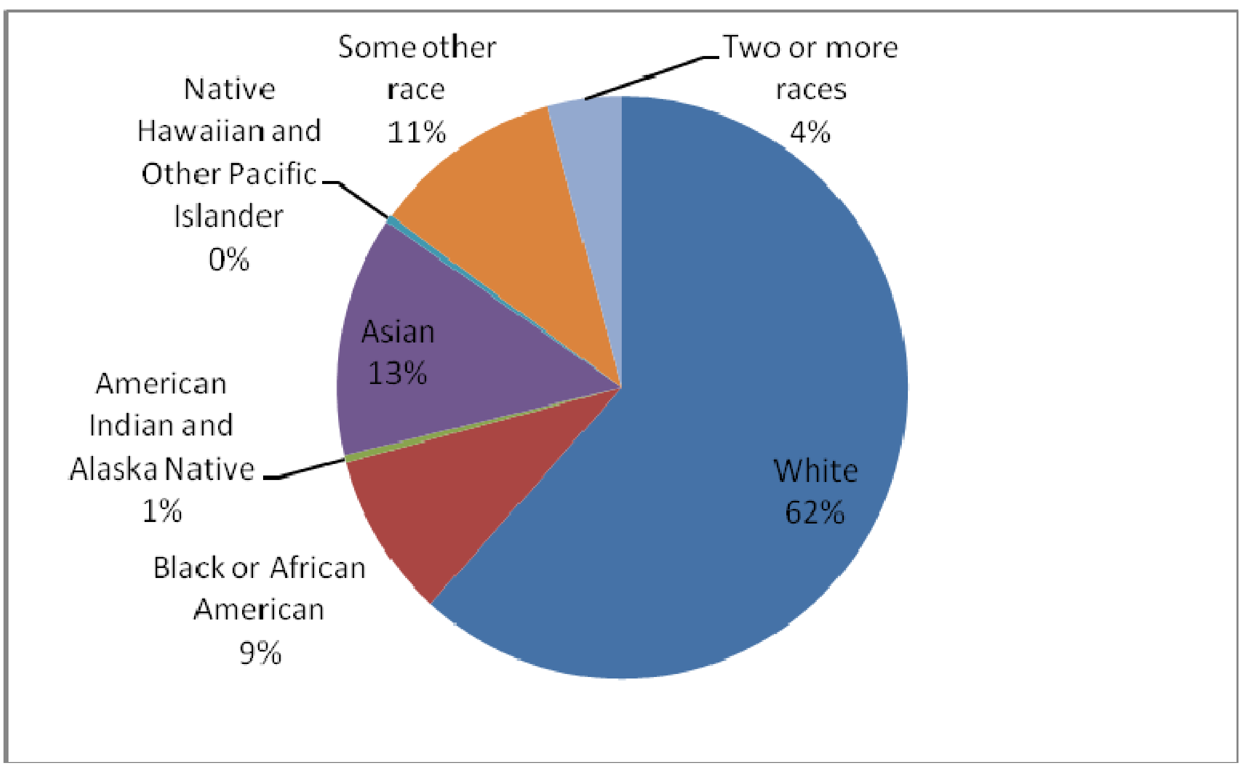


Figure 9-4. Contra Costa County Race Distribution

Contra Costa County has a 23.6-percent foreign-born population with the majority born in Latin America or Asia. Other than English, the most commonly spoken language in Contra Costa County is Spanish. The census estimates 13.5 percent of the county's residents speak English "less than very well."

9.4.5 Disabled Populations

People living with disabilities are significantly more likely to have difficulty responding to a hazard event than the general population. According to U.S. Census figures, roughly one-fifth of the U.S. population lives with a disability. Disabled populations are increasingly integrated into society. This means that a relatively large segment of the population will require assistance during the 72 hours after a hazard event, the period generally reserved for self-help. Disabilities can vary greatly in severity and permanence, making populations difficult to define and track. There is no "typical" disabled person, which can complicate disaster-planning processes that attempt to incorporate them. Disability is likely to be compounded with other vulnerabilities, such as age, economic disadvantage and ethnicity, all of which mean that housing is more likely to be substandard.

While the percentage of disabled people in Contra Costa County does not differ much from that of the state as a whole, the overall numbers are significant and warrant special attention from planners and emergency managers (see Table 9-1). According to U.S. Census data, 16.8 percent of the County's population over the age of 5 has a disability.

TABLE 9-1.
DISABILITY STATUS OF NON-INSTITUTIONALIZED POPULATION

Age	Persons with a Disability	Percent of Age Group
Age 5 to 15 years	7,425	4.7
Age 16 to 64 years	98,941	16.1
Age 65 years and over	41,206	39.6

9.5 ECONOMY

Contra Costa County's economy is strongly based in the services industry, followed by the trade industry (wholesale and retail) and the finance, insurance and real estate businesses. According to the California Department of Finance, there are over 10,000 service-based establishments in the county. Forestry, fishing, hunting and agricultural support make up the smallest source of the county's economy. Diversifying the county's businesses and industries could improve the county's economic base and provide a broad range of employment opportunities for county residents.

With major corporate headquarters, such as Chevron, PMI Group Inc., Bio-Rad and AAA Nevada, Utah and Northern California, Contra Costa County is home to a variety of enterprises. Other major businesses include AT&T, ConocoPhillips, Wells Fargo, Shell Refinery, Safeway, Tesoro, Bank of America, Dow Chemical, and PG&E. The county benefits from a variety of business activity, ranging from heavy industrial/manufacturing to significant professional expertise to financial services and innovation.

As part of the San Francisco Bay Area, Contra Costa County is home to some of the nation's top educational and research institutions such as Saint Mary's College, California State University East Bay-Concord Campus, John F. Kennedy University and the Joint Genome Institute. The result is one of Contra Costa's greatest strengths, a highly educated, skilled workforce.

9.5.1 Employment Trends

According to the American Community Survey, about 65 percent of Contra Costa County's population is in the labor force. Of the working-age population group (ages 20-64), 85.1 percent of men and 71.4 percent of women are in the labor force.

Contra Costa County's unemployment trends have closely mirrored the state's pattern; though the county's unemployment rates are slightly lower (Figure 9-5). Contra Costa County's unemployment rates were lowest in 2001 at 4.1 percent. Unemployment rates again dipped to 4.3 percent in 2006, but have since been on an upward trend and are expected to rise.

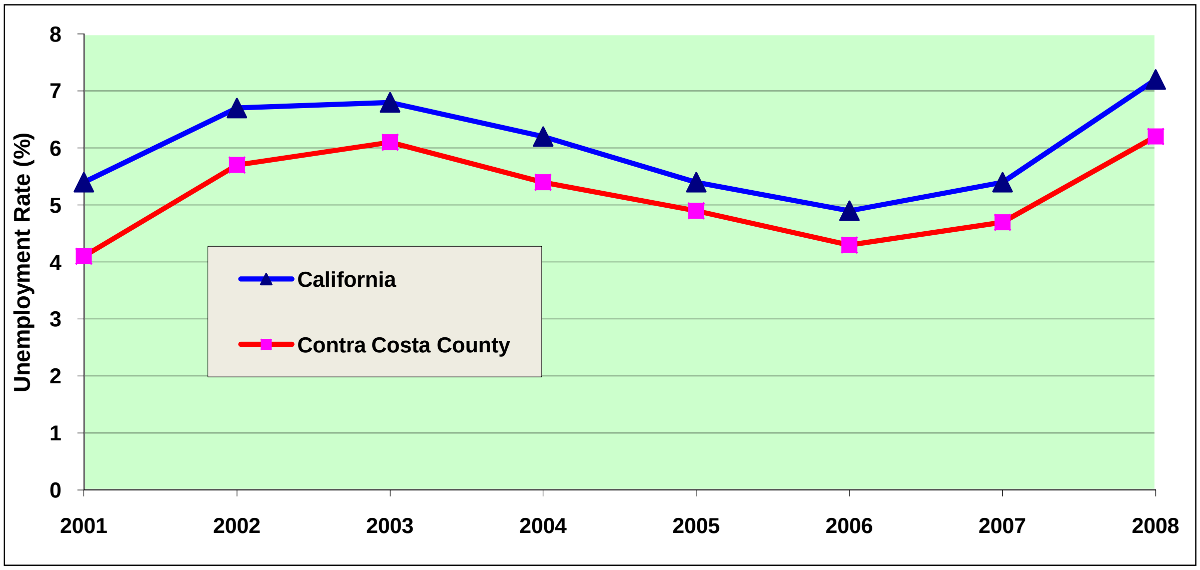


Figure 9-5. California and Contra Costa County Unemployment Rate, 2001-2008

9.5.2 Industry

The dominant industry (20 percent) in Contra Costa County is educational services, health care and social assistance (see Figure 9-6). This dominance is due to the abundance of educational institutions and health care facilities in the county. About 14 percent of the county's industry is in professional, scientific, management, administrative and waste management services. Less than 1 percent is involved with the resource-based industries of agriculture, forestry, fishing, hunting and mining.

9.5.3 Occupation

Management and professional occupations make up 41 percent of the jobs in Contra Costa County. The largest employer in the county is the AT&T Corporation, with 8,500 employees, followed by Contra Costa County, which employs over 7,500. Government workers (including federal, state and local) make up 13.9 percent of the county's working population. Other major occupations are sales and office (28 percent) and service-related (13.4 percent). Only about 0.2 percent of the employment in Contra Costa County is in farming, forestry, fishing and related occupations (see Figure 9-7).

The U.S. Census estimates that over 70 percent of Contra Costa County workers commute alone (by car, truck or van) to work, and mean travel time to work is 34 minutes (the state average is 27 minutes). This suggests that the work force in the county lives relatively far from the workplace.

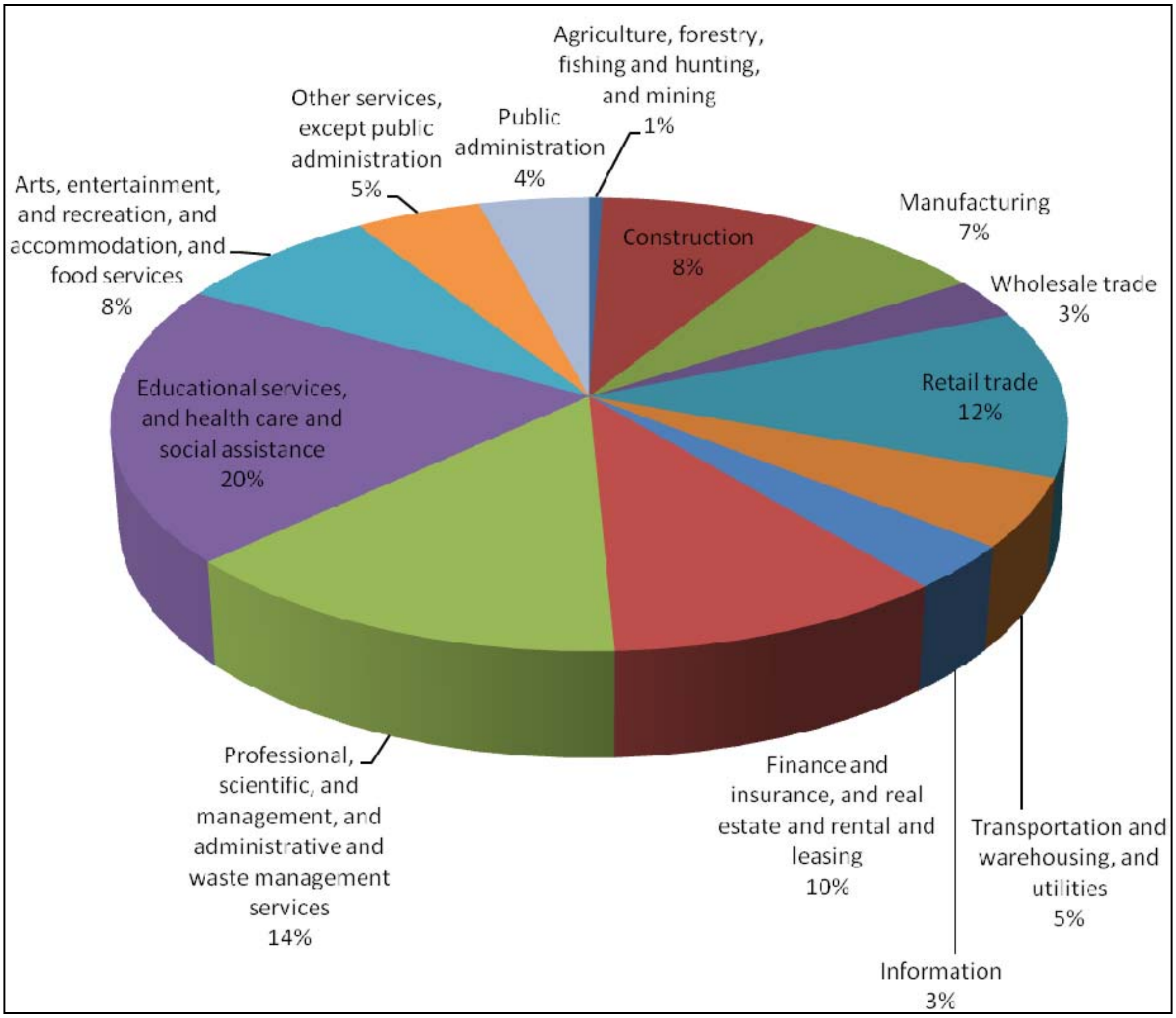


Figure 9-6. Industry in Contra Costa County

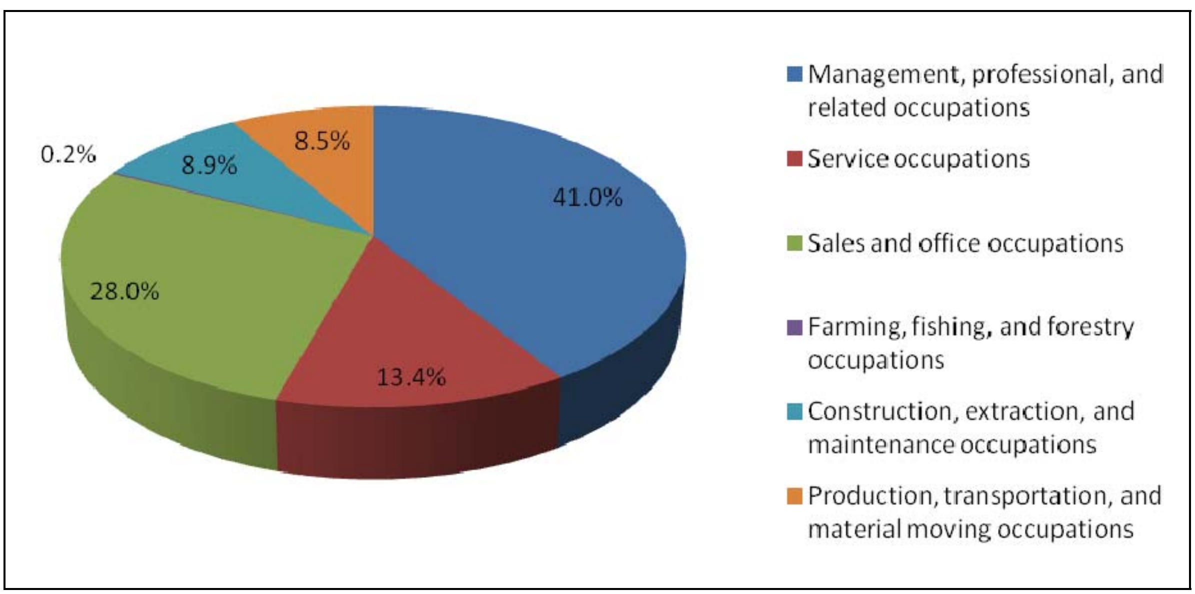


Figure 9-7. Occupations in Contra Costa County

9.6 LAWS AND ORDINANCES

Existing laws, ordinances and plans at the federal, state and local level can support or impact hazard mitigation initiatives identified in this plan. Hazard mitigation plans are required by 44CFR to include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information as part of the planning process (Section 201.6.b(3)). Pertinent federal and state laws are described below. Each planning partner has individually reviewed existing local plans, studies, reports, and technical information in its jurisdictional annex, presented in Volume 2.

9.6.1 Federal

Disaster Mitigation Act

The DMA is the current federal legislation addressing hazard mitigation planning. It emphasizes planning for disasters before they occur. It specifically addresses planning at the local level, requiring plans to be in place before Hazard Mitigation Grant Program funds are available to communities. This Plan is designed to meet the requirements of DMA, improving the planning partners' eligibility for future hazard mitigation funds.

Endangered Species Act

The federal Endangered Species Act (ESA) was enacted in 1973 to conserve species facing depletion or extinction and the ecosystems that support them. The act sets forth a process for determining which species are threatened and endangered and requires the conservation of the critical habitat in which those species live. The ESA provides broad protection for species of fish, wildlife and plants that are listed as threatened or endangered. Provisions are made for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The ESA outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species and contains exceptions and exemptions. It is the enabling legislation for the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Criminal and civil penalties are provided for violations of the ESA and the Convention.

Federal agencies must seek to conserve endangered and threatened species and use their authorities in furtherance of the ESA's purposes. The ESA defines three fundamental terms:

- **Endangered** means that a species of fish, animal or plant is "in danger of extinction throughout all or a significant portion of its range." (For salmon and other vertebrate species, this may include subspecies and distinct population segments.)
- **Threatened** means that a species "is likely to become endangered within the foreseeable future." Regulations may be less restrictive for threatened species than for endangered species.
- **Critical habitat** means "specific geographical areas that are…essential for the conservation and management of a listed species, whether occupied by the species or not."

Five sections of the ESA are of critical importance to understanding it:

- **Section 4: Listing of a Species**—The National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries) is responsible for listing marine species; the U.S. Fish and Wildlife Service is responsible for listing terrestrial and freshwater aquatic species. The agencies may initiate reviews for listings, or citizens may petition for them. A listing must be made "solely on the basis of the best scientific and commercial data available." After a listing has been proposed, agencies receive comment and conduct further scientific reviews for 12 to 18 months, after which they must decide if the listing is warranted. Economic impacts cannot be considered in this decision, but it may include an evaluation of the adequacy of local and state protections. Critical habitat for the species may be designated at the time of listing.

- **Section 7: Consultation**—Federal agencies must ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed or proposed species or adversely modify its critical habitat. This includes private and public actions that require a federal permit. Once a final listing is made, non-federal actions are subject to the same review, termed a "consultation." If the listing agency finds that an action will "take" a species, it must propose mitigations or "reasonable and prudent" alternatives to the action; if the proponent rejects these, the action cannot proceed.
- **Section 9: Prohibition of Take—**It is unlawful to "take" an endangered species, including killing or injuring it or modifying its habitat in a way that interferes with essential behavioral patterns, including breeding, feeding or sheltering.
- **Section 10: Permitted Take**—Through voluntary agreements with the federal government that provide protections to an endangered species, a non-federal applicant may commit a take that would otherwise be prohibited as long as it is incidental to an otherwise lawful activity (such as developing land or building a road). These agreements often take the form of a "Habitat Conservation Plan."
- **Section 11: Citizen Lawsuits**—Civil actions initiated by any citizen can require the listing agency to enforce the ESA's prohibition of taking or to meet the requirements of the consultation process.

With the listing of salmon and trout species as threatened or endangered, the ESA has impacted most of the Pacific Coast states. Although some of these areas have been more impacted by the ESA than others due to the known presence of listed species, the entire region has been impacted by mandates, programs and policies based on the presumption of the presence of listed species. Most West Coast jurisdictions must now take into account the impact of their programs on habitat.

The Clean Water Act

The federal Clean Water Act (CWA) employs regulatory and non-regulatory tools to reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's surface waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water."

Evolution of CWA programs over the last decade has included a shift from a program-by-program, source-by-source, pollutant-by-pollutant approach to more holistic watershed-based strategies. Under the watershed approach, equal emphasis is placed on protecting healthy waters and restoring impaired ones. A full array of issues are addressed, not just those subject to CWA regulatory authority. Involvement of stakeholder groups in the development and implementation of strategies for achieving and maintaining water quality and other environmental goals is a hallmark of this approach.

National Flood Insurance Program

The National Flood Insurance Program (NFIP) provides federally backed flood insurance in exchange for communities enacting floodplain regulations. Participation and good standing under NFIP are prerequisites to grant funding eligibility under the Robert T. Stafford Act. The County and most of the partner cities for this update participate in the NFIP and have adopted regulations that meet the NFIP requirements. At the time of the preparation of this update, all participating jurisdictions in the partnership were in good standing with NFIP requirements.

9.6.2 State

California General Planning Law

California state law (Cal. Gov. Code §65300 et seq.) requires that every county and city prepare and adopt a comprehensive long-range plan to serve as a guide for community development. The general plan expresses the community's goals, visions, and policies relative to future public and private land uses. The general plan forms the basis for most local government land use decision-making. It must consist of an integrated and internally consistent set of goals, policies, and implementation measures. It must focus on issues of the greatest concern to the community and be written in a clear and concise manner. Local government actions—such as those relating to land use allocations, annexations, zoning, subdivision, design review, redevelopment and capital improvements—must be consistent with the plan.

California Environmental Quality Act

The California Environmental Quality Act (CEQA) was passed in 1970 to institute a statewide policy of environmental protection. CEQA requires state and local agencies in California to follow a protocol of analysis and public disclosure of the potential environmental impacts of development projects. CEQA makes environmental protection a mandatory part of every California state and local agency's decision-making process.

For any project under CEQA's jurisdiction with potentially significant environmental impacts, agencies must identify mitigation measures and alternatives by preparing an environmental impact report and may approve only projects with no feasible mitigation measures or environmentally superior alternatives.

Assembly Bill 162: Flood Planning

This California State Assembly Bill passed in 2007 requires cities and counties to address flood-related matters in the land use, conservation, and safety and housing elements of their general plans. The land use element must identify and annually review the areas covered by the general plan that are subject to flooding as identified in floodplain mapping by either FEMA or the California Department of Water Resources (DWR). Upon the next revision of the housing element, the conservation element of the general plan must identify rivers, creeks, streams, flood corridors, riparian habitat, and land that may accommodate floodwater for the purposes of groundwater recharge and stormwater management. The safety element must identify information regarding flood hazards including:

- Flood hazard zones
- Maps published by FEMA, DWR, the U.S. Army Corps of Engineers, the Central Valley Flood Protection Board, Cal EMA, etc.
- Historical data on flooding
- Existing and planned development in flood hazard zones.

The general plan must establish goals, policies and objectives to protect from unreasonable flooding risks including:

- Avoiding or minimizing the risks of flooding new development
- Evaluating whether new development should be located in flood hazard zones
- Identifying construction methods to minimize damage.

Assembly Bill 162 establishes procedures for the determination of available land suitable for urban development, which may exclude lands where FEMA or DWR has determined that the flood management infrastructure is not adequate to avoid the risk of flooding.

Assembly Bill 2140: General Plans: Safety Element

This bill provides that the state may allow for more than 75 percent of public assistance funding under the California Disaster Assistance Act only if the local agency is in a jurisdiction that has adopted a local hazard mitigation plan as part of the safety element of its general plan. The local hazard mitigation plan needs to include elements specified in the legislation. In addition this bill requires Cal EMA to give federal mitigation funding preference to cities and counties that have adopted such plans. The intent of the bill is to encourage cities and counties to create and adopt hazard mitigation plans.

Assembly Bill 70: Flood Liability

This bill provides that a city or county may be required to contribute a fair and reasonable share to compensate for property damage caused by a flood to the extent that it has increased the state's exposure to liability for property damage by unreasonably approving new development in a previously undeveloped area that is protected by a state flood control project, unless the city or county meets specified requirements.

Assembly Bill 32: The California Global Warming Solutions Act

Assembly Bill 32 establishes a state goal of reducing greenhouse gas emissions to 1990 levels by 2020 (a reduction of approximately 25 percent from forecast emission levels) with further reductions to follow. The law requires the state Air Resources Board to do the following:

- Establish a program to track and report greenhouse gas emissions.
- Approve a scoping plan for achieving the maximum technologically feasible and cost-effective reductions from sources of greenhouse gas emissions.
- Adopt early reduction measures to begin moving forward.
- Adopt, implement and enforce regulations—including market mechanisms such as "cap and-trade" programs—to ensure that the required reductions occur.

The Air Resources Board recently adopted a statewide greenhouse gas emissions limit and an emissions inventory, along with requirements to measure, track, and report greenhouse gas emissions by the industries it determined to be significant sources of greenhouse gas emissions.

Senate Bill 97: Guidelines for Greenhouse Gas Emissions

Senate Bill 97, enacted in 2007, amends the CEQA to clearly establish that greenhouse gas emissions and their effects are appropriate subjects for CEQA analysis. It directs the Governor's Office of Planning and Research to develop draft CEQA guidelines for the mitigation of greenhouse gas emissions or their effects and directs the California Natural Resources Agency to certify and adopt the CEQA guidelines.

California State Building Code

California Code of Regulations Title 24 (CCR Title 24), also known as the California Building Standards Code, is a compilation of building standards from three sources:

- Building standards that have been adopted by state agencies without change from building standards contained in national model codes

- Building standards that have been adopted and adapted from national model code standards to meet California conditions
- Building standards authorized by the California legislature that constitute extensive additions not covered by the model codes, adopted to address particular California concerns.

The state Building Standards Commission is authorized by California Building Standards Law (Health and Safety Code Sections 18901 through 18949.6) to administer the processes related to the adoption, approval, publication, and implementation of California's building codes. These building codes serve as the basis for the design and construction of buildings in California. The national model code standards adopted into Title 24 apply to all occupancies in California except for modifications adopted by state agencies and local governing bodies. Since 1989, the Building Standards Commission has published new editions of Title 24 every three years.

Standardized Emergency Management System

CCR Title 19 establishes the Standardized Emergency Management System (SEMS) to standardize the response to emergencies involving multiple jurisdictions. SEMS is intended to be flexible and adaptable to the needs of all emergency responders in California. It requires emergency response agencies to use basic principles and components of emergency management. Local governments must use SEMS in order to be eligible for state funding of response-related personnel costs under CCR Title 19 (Sections 2920, 2925 and 2930). Individual agencies' roles and responsibilities contained in existing laws or the state emergency plan are not superseded by these regulations.

California State Hazard Mitigation Plan

Under the DMA, California must adopt a federally approved state multi-hazard mitigation plan in order to be eligible for certain disaster assistance and mitigation funding. The intent of the *California State Hazard Mitigation Plan* is to reduce or prevent injury and damage from hazards through the following:

- Documenting statewide hazard mitigation planning in California
- Describing strategies and priorities for future mitigation activities
- Facilitating the integration of local and tribal hazard mitigation planning activities into statewide efforts
- Meeting state and federal statutory and regulatory requirements.

The plan is an annex to the State Emergency Plan, and it identifies past and present mitigation activities, current policies and programs, and future mitigation strategies. The plan will be updated annually to reflect changing conditions and new information, especially information on local planning activities.

Governor's Executive Order S-13-08

Governor's Executive Order S-13-08 enhances the state's management of climate impacts from sea level rise, increased temperatures, shifting precipitation and extreme weather events. There are four key actions in the executive order:

- Initiate California's first statewide climate change adaptation strategy to assess expected climate change impacts, identify where California is most vulnerable, and recommend adaptation policies by early 2009. This effort will improve coordination within state government so that better planning can more effectively address climate impacts on human health, the environment, the state's water supply and the economy.

- Request that the National Academy of Science establish an expert panel to report on sea level rise impacts in California, to inform state planning and development efforts.
- Issue interim guidance to state agencies for how to plan for sea level rise in designated coastal and floodplain areas for new projects.
- Initiate a report on critical infrastructure projects vulnerable to sea level rise.

9.6.3 Cities and County

Each planning partner has prepared a jurisdiction-specific annex to this plan (see Volume 2). In preparing these annexes, each partner completed a capability assessment that looked at its regulatory, technical and financial capability to carry out proactive hazard mitigation. Refer to these annexes for a review of regulatory codes and ordinances applicable to each planning partner.

TABLE 9-1.
CITY AND COUNTY POPULATION DATA

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Antioch	62,195	64,157	66,914	70,185	73,291	75,805	77,925	80,662	83,550	86,408	90,532	93,148	96,597	98,729	100,277	100,039	99,376	99,357	99,994	100,957
Brentwood	7,563	7,965	8,512	9,227	9,888	11,015	12,528	13,795	16,108	19,064	23,302	26,181	29,956	34,055	38,325	41,954	45,752	48,667	50,584	51,908
Clayton	7,317	7,750	7,828	8,096	8,239	8,439	9,033	9,653	10,103	10,545	10,762	10,938	10,962	10,953	10,990	10,906	10,788	10,728	10,778	10,864
Concord	111,308	111,950	112,906	113,496	114,663	114,896	115,409	116,702	118,338	120,133	121,872	123,433	124,408	124,435	124,833	124,578	123,380	122,923	123,700	124,599
Danville	31,306	31,986	32,803	33,907	34,821	36,168	37,569	38,948	39,907	40,742	41,715	42,700	42,942	43,105	42,243	42,975	42,515	42,447	42,602	43,043
El Cerrito	22,869	22,799	22,694	22,905	22,940	22,886	22,803	22,871	22,992	23,125	23,171	23,414	23,478	23,470	23,398	23,244	23,178	23,081	23,306	23,440
Hercules	16,829	17,470	17,914	18,318	18,547	18,501	18,664	18,756	18,910	19,084	19,488	19,827	20,111	20,438	21,706	23,200	23,535	23,859	24,309	24,480
Lafayette	23,366	23,255	23,210	23,266	23,372	23,281	23,235	23,372	23,577	23,799	23,908	24,136	24,376	24,339	24,297	24,148	23,887	23,836	23,948	24,087
Martinez	31,810	31,776	31,888	34,186	34,536	34,436	34,358	34,637	35,086	35,460	35,866	36,318	36,664	36,800	36,804	36,570	36,138	36,009	36,122	36,348
Moraga	15,987	15,824	16,041	16,155	16,109	15,944	15,865	15,890	15,943	16,076	16,290	16,460	16,486	16,475	16,442	16,334	16,153	16,094	16,128	16,204
Oakley	—	—	—	—	—	—	—	—	—	—	25,619	26,011	26,981	27,676	28,368	28,961	29,341	31,747	33,189	34,468
Orinda	16,642	16,550	16,728	16,857	16,894	16,901	16,926	17,064	17,255	17,461	17,599	17,774	17,807	17,784	17,757	17,671	17,470	17,428	17,529	17,669
Pinole	17,460	17,855	17,970	18,023	18,172	18,252	18,283	18,486	18,689	18,894	19,039	19,327	19,401	19,480	19,539	19,469	19,222	19,149	19,260	19,383
Pittsburg	47,607	48,507	49,347	50,275	50,815	51,337	51,544	52,473	53,743	54,826	56,769	57,968	59,825	60,912	61,480	62,172	62,192	62,696	63,352,	63,771
Pleasant Hill	31,583	31,305	31,298	31,327	31,430	31,263	31,188	31,308	32,169	32,532	32,837	33,189	33,313	33,592	33,618	33,408	33,046	32,957	33,357	33,547
Richmond	86,019	87,765	91,116	92,288	93,008	93,015	93,499	94,781	96,291	97,823	99,216	100,370	100,932	101,129	101,657	102,309	102,188	103,327	103,899	104,513
San Pablo	25,158	25,852	26,738	26,716	27,055	27,558	27,855	28,285	28,995	29,644	30,256	30,567	30,600	30,725	31,032	31,130	30,830	30,816	31,172	31,808
San Ramon	35,303	35,436	35,623	38,014	38,535	39,315	39,914	41,288	42,521	43,607	44,722	45,880	46,750	46,940	48609	50,672	56,234	59,501	61,187	63,176
Walnut Creek	60,569	60,333	61,258	61,423	61,704	61,618	61,602	62,092	62,720	63,428	64,296	65,555	65,789	65,830	66,137	66,047	65,293	65,070	65,266	65,860
Unincorporated County	152,841	156,045	161,441	163,923	166,944	168,546	169,870	171,567	173,934	175,831	151,557	152,899	154,236	156,899	157,166	160,620	164,991	165,630	168,560	170,310
Contra Costa County Total	**805,722**	**816,571**	**834,221**	**850,580**	**862,957**	**871,171**	**880,066**	**894,627**	**912,829**	**930,481**	**950,816**	**968,096**	**983,616**	**995,769**	**1,006,682**	**1,018,412**	**1,027,515**	**1,037,329**	**1,050,250**	**1,062,444**

CHAPTER 10.
DAM FAILURE

10.1 GENERAL BACKGROUND

10.1.1 Causes of Dam Failure

Dam failures in the United States typically occur in one of four ways (see Figure 10-1):

- Overtopping of the primary dam structure, which accounts for 34 percent of all dam failures, can occur due to inadequate spillway design, settlement of the dam crest, blockage of spillways, and other factors.
- Foundation defects due to differential settlement, slides, slope instability, uplift pressures, and foundation seepage can also cause dam failure. These account for 30 percent of all dam failures.
- Failure due to piping and seepage accounts for 20 percent of all failures. These are caused by internal erosion due to piping and seepage, erosion along hydraulic structures such as spillways, erosion due to animal burrows, and cracks in the dam structure.
- Failure due to problems with conduits and valves, typically caused by the piping of embankment material into conduits through joints or cracks, constitutes 10 percent of all failures.

The remaining 6 percent of U.S. dam failures are due to miscellaneous causes. Many dam failures in the United States have been secondary results of other disasters. The prominent causes are earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage. The most likely disaster-related causes of dam failure in Contra Costa County are earthquakes, excessive rainfall, and landslides.

Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable by a program of regular inspections. Terrorism and vandalism are serious concerns that all operators of public facilities must plan for; these threats are under continuous review by public safety agencies.

DEFINITIONS

Dam—Any artificial barrier, together with appurtenant works, that does or may impound or divert water, and that either (a) is 25 feet or more in height from the natural bed of the stream or watercourse at the downstream toe of the barrier (or from the lowest elevation of the outside limit of the barrier if it is not across a stream channel or watercourse) to the maximum possible water storage elevation; or (b) has an impounding capacity of 50 acre-feet or more. (CA Water Code, Division 3.)

Dam Failure—An uncontrolled release of impounded water due to structural deficiencies in dam.

Emergency Action Plan—A document that identifies potential emergency conditions at a dam and specifies actions to be followed to minimize property damage and loss of life. The plan specifies actions the dam owner should take to alleviate problems at a dam. It contains procedures and information to assist the dam owner in issuing early warning and notification messages to responsible downstream emergency management authorities of the emergency situation. It also contains inundation maps to show emergency management authorities the critical areas for action in case of an emergency. (FEMA 64)

High Hazard Dam—Dams where failure or operational error will probably cause loss of human life. (FEMA 333)

Significant Hazard Dam—Dams where failure or operational error will result in no probable loss of human life but can cause economic loss, environmental damage or disruption of lifeline facilities, or can impact other concerns. Significant hazard dams are often located in rural or agricultural areas but could be located in areas with population and significant infrastructure. (FEMA 333)

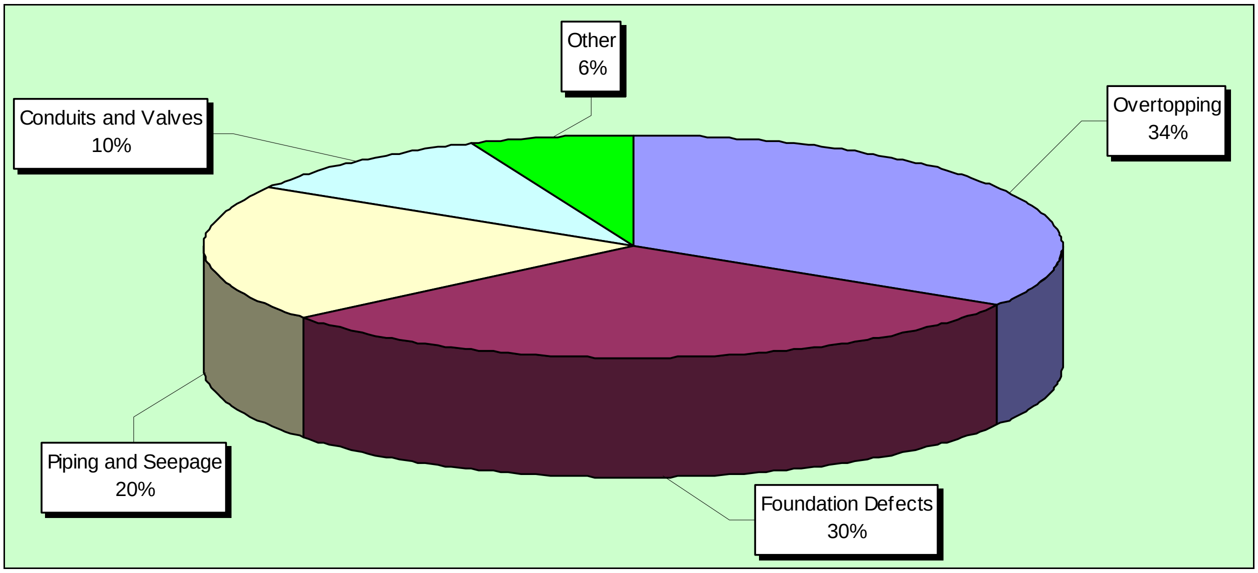


Figure 10-1. Historical Causes of Dam Failure

10.1.2 Regulatory Oversight

The potential for catastrophic flooding due to dam failures led to passage of the National Dam Safety Act (Public Law 92-367). The National Dam Safety Program requires a periodic engineering analysis of every major dam in the country. The goal of this FEMA-monitored effort is to identify and mitigate the risk of dam failure so as to protect the lives and property of the public.

California Division of Safety of Dams

California's Division of Safety of Dams (a division of the Department of Water Resources) monitors the dam safety program at the state level. When a new dam is proposed, Division engineers and geologists inspect the site and the subsurface. Upon submittal of an application, the Division reviews the plans and specifications prepared by the owner to ensure that the dam is designed to meet minimum requirements and that the design is appropriate for the known geologic conditions. After approval of the application, the Division inspects all aspects of the construction to ensure that the work is done in accordance with the approved plans and specifications. After construction, the Division inspects each dam on an annual basis to ensure that it is performing as intended and is not developing problems. Roughly a third of these inspections include in-depth instrumentation reviews. The Division periodically reviews the stability of dams and their major appurtenances in light of improved design approaches and requirements, as well as new findings regarding earthquake hazards and hydrologic estimates in California (DWR Website, 2007).

U.S. Army Corps of Engineers Dam Safety Program

The U.S. Army Corps of Engineers is responsible for safety inspections of some federal and non-federal dams in the United States that meet the size and storage limitations specified in the National Dam Safety Act. The Corps has inventoried dams; surveyed each state and federal agency's capabilities, practices and regulations regarding design, construction, operation and maintenance of the dams; and developed guidelines for inspection and evaluation of dam safety (U.S. Army Corps of Engineers, 1997).

Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) has the largest dam safety program in the United States. The FERC cooperates with a large number of federal and state agencies to ensure and promote dam safety and, more recently, homeland security. There are 3,036 dams that are part of regulated hydroelectric projects are in the FERC program. Two-thirds of these are more than 50 years old. As dams age, concern about their safety and integrity grows, so oversight and regular inspection are important. FERC staff inspects hydroelectric projects on an unscheduled basis to investigate the following:

- Potential dam safety problems
- Complaints about constructing and operating a project
- Safety concerns related to natural disasters
- Issues concerning compliance with the terms and conditions of a license.

Every five years, an independent consulting engineer, approved by the FERC, must inspect and evaluate projects with dams higher than 32.8 feet, or with a total storage capacity of more than 2,000 acre-feet.

FERC staff monitors and evaluates seismic research in geographic areas such as California where there are concerns about seismic activity. This information is applied in investigating and performing structural analyses of hydroelectric projects in these areas. FERC staff also evaluates the effects of potential and actual large floods on the safety of dams. During and following floods, FERC staff visits dams and licensed projects, determines the extent of damage, if any, and directs any necessary studies or remedial measures the licensee must undertake. The FERC publication *Engineering Guidelines for the Evaluation of Hydropower Projects* guides the FERC engineering staff and licensees in evaluating dam safety. The publication is frequently revised to reflect current information and methodologies.

The FERC requires licensees to prepare emergency action plans and conducts training sessions on how to develop and test these plans. The plans outline an early warning system if there is an actual or potential sudden release of water from a dam due to failure. The plans include operational procedures that may be used, such as reducing reservoir levels and reducing downstream flows, as well as procedures for notifying affected residents and agencies responsible for emergency management. These plans are frequently updated and tested to ensure that everyone knows what to do in emergency situations.

10.2 HAZARD PROFILE

10.2.1 Past Events

According to the California State Hazard Mitigation Plan, there have been nine dam failures in the state since 1950, none of them in Contra Costa County. Overtopping caused two of the failures, and the others were caused by seepage or leaks. One failure, the 1963 Baldwin Hills Dam Failure, resulted in three deaths because the leak turned into a washout. The historical record indicates that California has had about 45 failures of non-federal dams. The failures occurred for a variety of reasons, the most common being overtopping. Other reasons include shortcomings in the dams or an inadequate assessment of surrounding geomorphologic characteristics.

California's first notable dam failure was in 1883 in Sierra County, and the most recent failure was in 1965. The most catastrophic event was the failure of William Mulholland's St. Francis Dam, which failed in 1928 and killed an estimated 450 people. San Francisquito Canyon, which was flooded in the event, was home to hundreds of transients who were not accounted for in the death estimate.

10.2.2 Location

According to the California Division of Safety of Dams, there are 24 dams in Contra Costa County, as listed in Table 10-1. Two are operated by federal agencies, and the remainder are under the jurisdiction of the State of California.

**TABLE 10-1.
DAMS IN CONTRA COSTA COUNTY**

Name	National ID #	Water Course	Owner	Year Built	Dam Type	Crest Length (feet)	Height (feet)	Storage Capacity (acre-feet)	Drainage area (sq. mi.)
Martinez	CA10168	Sacramento R. Tributary	US Bureau of Reclamation	1947	Earth	1260	44	268	72
Contra Loma	CA10143	Off-stream	US Bureau of Reclamation	1967	Earth	1050	82	2627	107
Antioch Res	CA00057	San Joaquin Tributary	City of Antioch	1935	Earth	450	30	722	1.68
Argyle #2	CA00186	Off-stream	EBMUD	1970	Reinforced Tank	875	27	22	0
CL Tilden Park	CA00161	Wildcat Ck	EBRPD	1938	Earth	355	88	268	1.56
Clearwell #2	CA01109	Grayson Ck	Contra Costa Sanitation Dist	1977	Earth	2090	30	100	0
Clifton Court Forebay	CA00050	Old River Tributary	CA Dept of Water Res	1970	Earth	39000	34	29000	6
Danville	CA00184	Off-stream	EBMUD	1961	Earth	765	75	45	0
Deer Creek	CA00810	Deer Creek	Contra Costa FCWCD	1963	Earth	900	28	233	4.86
Dry Creek	CA00811	Dry Creek	Contra Costa FCWCD	1963	Earth	470	30	330	2.7
Lafayette	CA00163	Lafayette Creek	EBMUD	1929	Earth	1200	132	4250	1.34
Leland	CA00177	Off-stream	EBMUD	1955	Earth	945	41	60	0
Los Vaqueros	CA01396	Kellogg Creek	Contra Costa Water District	1997	Earth	980	197	10,000	18.38
Mallard	CA00838	Off-stream	Contra Costa Water District	1930	Earth	11,000	30	3113	0
Maloney	CA00180	Off-stream	EBMUD	1960	Earth	620	107	68	0
Marsh Creek	CA00809	Marsh Creek	Contra Costa FCWCD	1963	Earth	1540	59	4425	52.5
Moraga	CA00178	Off-stream	EBMUD	1965	Earth	210	37	36	0
North	CA00183	Off-stream	EBMUD	1961	Earth	1080	82	244	0.09
Orinda Lake	CA00659	Cascade Creek	Orinda Country Club	1936	Earth	360	45	200	0.48
Pine Creek	CA00808	Pine Creek	Contra Costa FCWCD	1956	Earth	320	87	225	4.36
Pine Creek Detention	CA01252	Pine Creek	Contra Costa FCWCD	1981	Gravity	232	30	320	10
San Pablo	CA00166	San Pablo Creek	EBMUD	1920	Earth	1250	170	43,193	32.15
San Pablo Clearwell	CA00185	Off-stream	EBMUD	1922	Earth	627	42	17	0
Sobrante Clearwell	CA00179	Off-stream	EBMUD	1964	Earth	1032	28	25	0

EBMUD = East Bay Municipal Utility District
EBRPD = East Bay Regional Park District

FCWCD = Flood Control and Water Conservation District

10.2.3 Frequency

Dam failure events are infrequent and usually coincide with events that cause them, such as earthquakes, landslides and excessive rainfall and snowmelt. There is a "residual risk" associated with dams. Residual risk is the risk that remains after safeguards have been implemented. For dams, the residual risk is associated with events beyond those that the facility was designed to withstand. However, the probability of any type of dam failure is low in today's regulatory and dam safety oversight environment.

10.2.4 Severity

Dam failure can be catastrophic to all life and property downstream. The U.S. Army Corps of Engineers developed the classification system shown in Table 10-2 for the hazard potential of dam failures.

TABLE 10-2.
HAZARD POTENTIAL CLASSIFICATION

Hazard Category[a]	Direct Loss of Life[b]	Lifeline Losses[c]	Property Losses[d]	Environmental Losses[e]
Low	None (rural location, no permanent structures for human habitation)	No disruption of services (cosmetic or rapidly repairable damage)	Private agricultural lands, equipment, and isolated buildings	Minimal incremental damage
Significant	Rural location, only transient or day-use facilities	Disruption of essential facilities and access	Major public and private facilities	Major mitigation required
High	Certain (one or more) extensive residential, commercial, or industrial development	Disruption of essential facilities and access	Extensive public and private facilities	Extensive mitigation cost or impossible to mitigate

a. Categories are assigned to overall projects, not individual structures at a project.
b. Loss of life potential based on inundation mapping of area downstream of the project. Analyses of loss of life potential should take into account the population at risk, time of flood wave travel, and warning time.
c. Indirect threats to life caused by the interruption of lifeline services due to project failure or operational disruption; for example, loss of critical medical facilities or access to them.
d. Damage to project facilities and downstream property and indirect impact due to loss of project services, such as impact due to loss of a dam and navigation pool, or impact due to loss of water or power supply.
e. Environmental impact downstream caused by the incremental flood wave produced by the project failure, beyond what would normally be expected for the magnitude flood event under which the failure occurs.

Source: U.S. Army Corps of Engineers, 1995

10.2.5 Warning Time

Warning time for dam failure varies depending on the cause of the failure. In events of extreme precipitation or massive snowmelt, evacuations can be planned with sufficient time. In the event of a structural failure due to earthquake, there may be no warning time. A dam's structural type also affects warning time. Earthen dams do not tend to fail completely or instantaneously. Once a breach is initiated, discharging water erodes the breach until either the reservoir water is depleted or the breach resists further erosion. Concrete gravity dams also tend to have a partial breach as one or more monolith sections are forced apart by escaping water. The time of breach formation ranges from a few minutes to a few hours (U.S. Army Corps of Engineers, 1997).

Contra Costa County and its planning partners have established protocols for flood warning and response to imminent dam failure in the flood warning portion of its adopted emergency operations plan. These protocols are tied to the emergency action plans (EAPs) created by the dam owners.

10.3 SECONDARY HAZARDS

Dam failure can cause severe downstream flooding, depending on the magnitude of the failure. Other potential secondary hazards of dam failure are landslides around the reservoir perimeter, bank erosion on the rivers, and destruction of downstream habitat.

10.4 CLIMATE CHANGE IMPACTS

Dams are designed partly based on assumptions about a river's flow behavior, expressed as hydrographs. Changes in weather patterns can have significant effects on the hydrograph used for the design of a dam. If the hygrograph changes, it is conceivable that the dam can lose some or all of its designed margin of safety, also known as freeboard. If freeboard is reduced, dam operators may be forced to release increased volumes earlier in a storm cycle in order to maintain the required margins of safety. Such early releases of increased volumes can increase flood potential downstream. Throughout the west, communities downstream of dams are already increases in stream flows from earlier releases from dams.

Dams are constructed with safety features known as "spillways." Spillways are put in place on dams as a safety measure in the event of the reservoir filling too quickly. Spillway overflow events, often referred to as "design failures," result in increased discharges downstream and increased flooding potential. Although climate change will not increase the probability of catastrophic dam failure, it may increase the probability of design failures.

10.5 EXPOSURE

The flood module of HAZUS-MH was used for a Level 2 assessment of dam failure. HAZUS-MH uses census data at the block level and FEMA floodplain data, which has a level of accuracy acceptable for planning purposes. Where possible, the HAZUS-MH data for this risk assessment was enhanced using GIS data from county, state and federal sources.

10.5.1 Population

All populations in a dam failure inundation zone would be exposed to the risk of a dam failure. The potential for loss of life is affected by the capacity and number of evacuation routes available to populations living in areas of potential inundation. The estimated population living in the mapped inundation areas within the planning area is 138,443 or 13.06 percent of the county's population. Table 10-3 summarizes the at-risk population in the planning area by city.

10.5.2 Property

Based on assessor parcel data, the HAZUS-MH model estimated that there are 46,271 structures within the mapped dam failure inundation areas in the planning area, which is shown in Map 10-1. The value of exposed buildings in the planning area was generated using HAZUS-MH and is summarized in Table 10-4. This methodology estimated $26.27 billion worth of building-and-contents exposure to dam failure inundation, representing 15.09 percent of the total assessed value of the planning area.

10.5.3 Critical Facilities

GIS analysis determined that 513 of the planning area's critical facilities (26.4 percent) are in the mapped inundation areas, as summarized in Tables 10-5 and 10-6.

**TABLE 10-3.
POPULATION AT RISK FROM DAM FAILURE**

City	Affected Population	% of City Population
Antioch	4977	4.93
Brentwood	4877	9.40
Clayton	0	0
Concord	15444	12.4
Danville	1245	2.89
El Cerrito	1185	5.05
Hercules	75	0.31
Lafayette	3052	12.67
Martinez	6	0.02
Moraga	536	3.3
Oakley	0	0
Orinda	30	0.17
Pinole	2370	12.23
Pittsburg	0	0
Pleasant Hill	1705	5.08
Richmond	33752	32.30
San Pablo	17030	53.54
San Ramon	0	0
Walnut Creek	15756	23.92
Unincorporated	36403	21.37
Total[a]	**138,443**	**13.06**

a. Represents the total population in the combined inundation areas all dams.

**TABLE 10-4.
VALUE OF PROPERTY EXPOSED TO DAM FAILURE**

City	Number of Buildings Exposed	Value Exposed			% of Total Assessed Value
		Building	Contents	**Total**	
Antioch	1,663	$249,906,852	$211,519,389	$461,426,241	4.32%
Brentwood	1,630	$343,708,091	$276,361,835	$620,069,926	6.18%
Clayton	0	$0	$0	$0	0.00%
Concord	5,162	$1,378,122,767	$1,262,541,678	$2,640,664,445	19.19%
Danville	416	$168,200,886	$155,523,287	$323,724,173	4.11%
El Cerrito	396	$147,708,624	$138,368,910	$286,077,534	10.87%
Hercules	25	$4,808,182	$3,846,546	$8,654,728	0.23%
Lafayette	1,020	$330,986,378	$288,556,560	$619,542,938	15.10%
Martinez	2	$1,129,708	$1,463,471	$2,593,179	0.04%
Moraga	179	$59,815,148	$50,322,453	$110,137,601	4.16%
Oakley	0	$0	$0	$0	0.00%
Orinda	10	$7,764,120	$7,671,816	$15,435,936	0.40%
Pinole	792	$120,884,874	$102,326,014	$223,210,888	20.19%
Pittsburg	0	$0	$0	$0	0.00%
Pleasant Hill	570	$192,784,356	$171,890,204	$364,674,560	9.01%
Richmond	11,281	$3,861,254,289	$4,744,701,245	$8,605,955,534	55.43%
San Pablo	5,692	$888,356,812	$748,599,682	$1,636,956,494	78.91%
San Ramon	0	$0	$0	$0	0.00%
Walnut Creek	5,266	$1,455,038,925	$1,287,542,814	$2,742,581,739	17.37%
Unincorporated County	12,167	$3,910,067,912	$3,699,762,996	$7,609,830,908	17.34%
Total	**46,271**	**$13,120,537,924**	**$13,150,998,900**	**$26,271,536,824**	**15.09%**

**TABLE 10-5.
CRITICAL FACILITIES IN DAM FAILURE INUNDATION AREAS**

	Medical & Health Services	Government Function	Protective Function	Schools	Hazardous Materials	Other Critical Function	**Total**
Antioch	0	4	0	1	2	4	**11**
Brentwood	0	2	1	1	0	0	**4**
Clayton	0	0	0	0	0	0	**0**
Concord	6	0	8	8	0	0	**22**
Danville	0	0	0	0	0	0	**0**
El Cerrito	0	0	0	0	0	0	**0**
Hercules	0	0	0	0	0	0	**0**
Lafayette	0	0	0	5	0	0	**5**
Martinez	0	0	0	0	2	0	**2**
Moraga	0	0	0	1	0	0	**1**
Oakley	0	0	0	0	0	0	**0**
Orinda	0	0	0	1	0	0	**1**
Pinole	0	0	0	0	0	0	**0**
Pittsburg	0	0	0	0	0	0	**0**
Pleasant Hill	0	0	1	1	0	0	**2**
Richmond	2	0	5	26	51	3	**87**
San Pablo	2	0	4	28	12	0	**46**
San Ramon	0	0	0	0	0	0	**0**
Walnut Creek	0	0	3	5	0	0	**8**
Unincorporated	1	0	4	18	45	0	**68**
Total	**11**	**6**	**26**	**95**	**112**	**7**	**257**

**TABLE 10-6.
CRITICAL INFRASTRUCTURE IN DAM FAILURE INUNDATION AREAS**

	Bridges	Water Supply	Wastewater	Power	Communications	Other Infrastructure	**Total**
Antioch	7	2	0	0	3	0	**12**
Brentwood	8	0	0	0	3	0	**11**
Clayton	0	0	0	0	0	0	**0**
Concord	30	4	0	2	6	9	**51**
Danville	0	0	0	0	1	1	**2**
El Cerrito	0	0	0	0	0	0	**0**
Hercules	0	0	0	0	0	0	**0**
Lafayette	6	2	0	0	1	2	**11**
Martinez	1	1	1	0	0	0	**3**
Moraga	0	0	0	0	0	0	**0**
Oakley	0	0	0	0	0	0	**0**
Orinda	1	2	4	1	0	0	**8**
Pinole	0	0	1	0	0	0	**1**
Pittsburg	0	0	0	0	0	0	**0**
Pleasant Hill	0	0	0	0	0	0	**0**
Richmond	12	0	7	2	0	0	**21**
San Pablo	19	0	0	3	0	0	**22**
San Ramon	0	0	0	0	0	0	**0**
Walnut Creek	17	2	0	2	0	1	**22**
Unincorporated	47	11	16	3	6	9	**92**
Total	**148**	**24**	**29**	**13**	**20**	**22**	**256**

10.5.4 Environment

Reservoirs held behind dams affect many ecological aspects of a river. River topography and dynamics depend on a wide range of flows, but rivers below dams often experience long periods of very stable flow conditions or saw-tooth flow patterns caused by releases followed by no releases. Water releases from dams usually contain very little suspended sediment; this can lead to scouring of river beds and banks.

The environment would be exposed to a number of risks in the event of dam failure. The inundation could introduce many foreign elements into local waterways. This could result in destruction of downstream habitat and could have detrimental effects on many species of animals, especially endangered species such as salmon.

10.6 VULNERABILITY

10.6.1 Population

Vulnerable populations are all populations downstream from dam failures that are incapable of escaping the area within the allowable time frame. This population includes the elderly and young who may be unable to get themselves out of the inundation area. The vulnerable population also includes those who would not have adequate warning from a television or radio emergency warning system.

10.6.2 Property

Vulnerable properties are those closest to the dam inundation area. These properties would experience the largest, most destructive surge of water. Low-lying areas are also vulnerable since they are where the dam waters would collect. Transportation routes are vulnerable to dam inundation and have the potential to be wiped out, creating isolation issues. This includes all roads, railroads and bridges in the path of the dam inundation. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. Utilities such as overhead power lines, cable and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues for the inundation areas.

It is estimated that there could be up to $6.24 billion of loss from a dam failure affecting the planning area. This represents 23.8 percent of the total exposure within the inundation area, or 3.53 percent of the total assessed value of the planning area. Table 10-7 summarizes the loss estimates for dam failure.

TABLE 10-7.
LOSS ESTIMATES FOR DAM FAILURE

	Value Exposed			% of
City	Building Loss	Contents Loss	**Total Loss**	Total Assessed Value
Antioch	$57,244,000	$72,648,000	$129,892,000	1.2%
Brentwood	$67,264,000	$84,037,000	$151,301,000	1.5%
Clayton	$0	$0	$0	0.0%
Concord	$195,374,000	$326,819,000	$522,193,000	3.8%
Danville	$28,111,000	$49,880,000	$77,991,000	1.0%
El Cerrito	$21,511,000	$47,359,000	$68,870,000	2.6%
Hercules	$459,000	$800,000	$1,259,000	0.0%
Lafayette	$88,474,000	$114,465,000	$202,939,000	4.9%
Martinez	$0	$0	$0	0.0%
Moraga	$21,343,000	$36,185,000	$57,528,000	2.2%
Oakley	$0	$0	$0	0.0%
Orinda	$3,446,000	$4,310,000	$7,756,000	0.2%
Pinole	$53,082,000	$67,922,000	$121,004,000	10.9%
Pittsburg	$0	$0	$0	0.0%
Pleasant Hill	$26,692,000	$39,385,000	$66,077,000	1.6%
Richmond	$520,067,000	$1,260,036,000	$1,780,103,000	11.5%
San Pablo	$141,121,000	$214,138,000	$355,259,000	17.1%
San Ramon	$0	$0	$0	0.0%
Walnut Creek	$287,716,000	$466,916,000	$754,632,000	4.8%
Unincorporated County	$756,997,000	$1,099,028,000	$1,856,025,000	4.2%
Total	**$2,268,901,000**	**$3,883,928,000**	**$6,152,829,000**	**3.53%**

10.6.3 Critical Facilities

On average, critical facilities would receive 9.6 percent damage to the structure and 39.25 percent damage to the contents during a dam failure event. The estimated time to restore these facilities to 100 percent of their functionality is 515 days.

10.6.4 Environment

The environment would be vulnerable to a number of risks in the event of dam failure. The inundation could introduce foreign elements into local waterways, resulting in destruction of downstream habitat and detrimental effects on many species of animals, especially endangered species such as coho salmon. The extent of the vulnerability of the environment is the same as the exposure of the environment.

10.8 FUTURE TRENDS IN DEVELOPMENT

Land use in the planning area will be directed by general plans adopted under California’s General Planning Law. The safety elements of the general plans establish standards and plans for the protection of the community from hazards. Dam failure is currently not addressed as a standalone hazard in the safety elements, but flooding is. The municipal planning partners have established comprehensive policies regarding sound land use in identified flood hazard areas. Most of the areas vulnerable to the more severe impacts from dam failure intersect the mapped flood hazard areas. Flood-related policies in the general plans will help to reduce the risk associated with the dam failure hazard for all future development in the planning area.

10.9 SCENARIO

An earthquake within the region could lead to liquefaction of soils around a dam. This could occur without warning during any time of the day. A human-caused failure such as a terrorist attack also could trigger a catastrophic failure of a dam that impacts the planning area. While the probability of dam failure is very low, the probability of flooding associated with changes to dam operational parameters in response to climate change is higher. Dam designs and operations are developed based on hydrographs with historical record. If these hydrographs experience significant changes over time due to the impacts of climate change, the design and operations may no longer be valid for the changed condition. This could have significant impacts on dams that provide flood control. Specified release rates and impound thresholds may have to be changed. This would result in increased discharges downstream of these facilities, thus increasing the probability and severity of flooding.

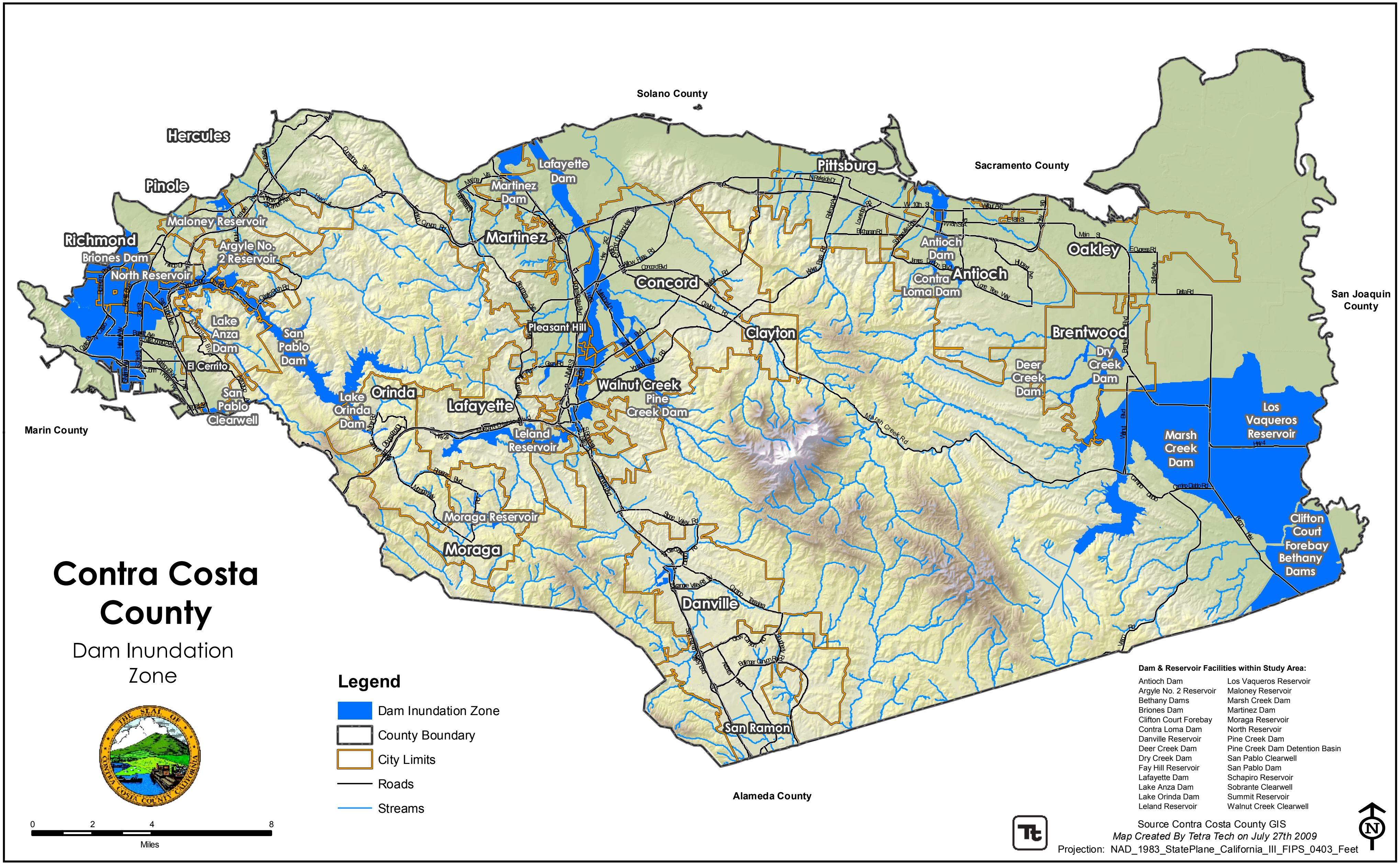
10.10 ISSUES

The most significant issue associated with dam failure involves the properties and populations in the inundation zones. Flooding as a result of a dam failure would significantly impact these areas. There is often limited warning time for dam failure. These events are frequently associated with other natural hazard events such as earthquakes, landslides or severe weather, which limits their predictability and compounds the hazard. Important issues associated with dam failure hazards include the following:

- Federally regulated dams have an adequate level of oversight and sophistication in the development of emergency action plans for public notification in the unlikely event of failure. However, the protocol for notification of downstream citizens of imminent failure needs to be tied to local emergency response planning.
- Mapping for federally regulated dams is already required and available; however, mapping for non-federal-regulated dams that estimates inundation depths is needed to better assess the risk associated with dam failure from these facilities.

- Most dam failure mapping required at federal levels requires determination of the probable maximum flood. While the probable maximum flood represents a worst-case scenario, it is generally the event with the lowest probability of occurrence. For non-federal-regulated dams, mapping of dam failure scenarios that are less extreme than the probable maximum flood but have a higher probability of occurrence can be valuable to emergency managers and community officials downstream of these facilities. This type of mapping can illustrate areas potentially impacted by more frequent events to support emergency response and preparedness.
- The concept of residual risk associated with structural flood control projects should be considered in the design of capital projects and the application of land use regulations.
- Addressing security concerns and the need to inform the public of the risk associated with dam failure is a challenge for public officials.

Map 10-1.



Contra Costa County
Dam Inundation Zone
Solano County
Sacramento County
San Joaquin County
Marin County
Alameda County
Hercules
Pinole
Richmond
Briones Dam
Maloney Reservoir
Argyle No. 2 Reservoir
North Reservoir
Lake Anza Dam
El Cerrito
San Pablo Clearwell
San Pablo Dam
Lake Orinda Dam
Orinda
Lafayette
Leland Reservoir
Moraga Reservoir
Moraga
Martinez Dam
Martinez
Lafayette Dam
Pleasant Hill
Concord
Walnut Creek
Pine Creek Dam
Clayton
Pittsburg
Antioch Dam
Contra Loma Dam
Antioch
Oakley
Brentwood
Deer Creek Dam
Dry Creek Dam
Marsh Creek Dam
Los Vaqueros Reservoir
Clifton Court Forebay Bethany Dams
Danville
San Ramon
Legend
Dam Inundation Zone
County Boundary
City Limits
Roads
Streams
0
2
4
8
Miles
Dam & Reservoir Facilities within Study Area:
Antioch Dam
Argyle No. 2 Reservoir
Bethany Dams
Briones Dam
Clifton Court Forebay
Contra Loma Dam
Danville Reservoir
Deer Creek Dam
Dry Creek Dam
Fay Hill Reservoir
Lafayette Dam
Lake Anza Dam
Lake Orinda Dam
Leland Reservoir
Los Vaqueros Reservoir
Maloney Reservoir
Marsh Creek Dam
Martinez Dam
Moraga Reservoir
North Reservoir
Pine Creek Dam
Pine Creek Dam Detention Basin
San Pablo Clearwell
San Pablo Dam
Schapiro Reservoir
Sobrante Clearwell
Summit Reservoir
Walnut Creek Clearwell
Source Contra Costa County GIS
Map Created By Tetra Tech on July 27th 2009
Projection: NAD_1983_StatePlane_California_III_FIPS_0403_Feet
N

CHAPTER 11.
DROUGHT

11.1 GENERAL BACKGROUND

Most of California's precipitation comes from storms moving across the Pacific Ocean. The path followed by the storms is determined by the position of an atmospheric high pressure belt that normally shifts southward during the winter, allowing low pressure systems to move into the state. On average, 75 percent of California's annual precipitation occurs between November and March, with 50 percent occurring between December and February. If a persistent Pacific high pressure zone takes hold over California mid-winter, there is a tendency for the water year to be dry.

A typical water year produces about 100 inches of rainfall over the North Coast, 50 inches of precipitation (combination of rain and snow) over the Northern Sierra, 18 inches in the Sacramento area, and 15 inches in the Los Angeles area. In extremely dry years, these annual totals can fall to as little as one half, or even one third of these amounts.

> **DEFINITIONS**
>
> **Drought**—The cumulative impacts of several dry years on water users. It can include deficiencies in surface and subsurface water supplies and generally impacts health, well being, and quality of life.
>
> **Hydrological Drought**—Deficiencies in surface and subsurface water supplies.
>
> **Socioeconomic Drought**—Drought impacts on health, well being and quality of life.

Defining when drought begins is a function of the impacts of drought on water users, and includes consideration of the supplies available to local water users as well as the stored water they may have available in surface reservoirs or groundwater basins. Different local water agencies have different criteria for defining drought conditions in their jurisdictions. Some agencies issue drought watch or drought warning announcements to their customers. Determinations of regional or statewide drought conditions are usually based on a combination of hydrologic and water supply factors. The following hydrologic indices define water year types for the Sacramento and San Joaquin River basins, the source of much of California's developed water supplies: critical, dry, below normal, above normal, and wet.

Water year 2006-07 was classified as "Dry" for the Sacramento River and "Critical" for the San Joaquin River. Water year 2007-08 ended with both regions classified as "Critical," and water year 2008-9 ended with both regions classified as "Dry."

11.1.1 Regional Hydrology

The hydrology of Contra Costa County is dominated by its proximity to San Francisco Bay and the San Joaquin-Sacramento River Delta. San Francisco Bay directly or indirectly receives runoff from approximately 40 percent of California, including all of Contra Costa County. Surface waters in the western, urbanized portion of the county discharge into San Pablo Bay or San Francisco Bay. The south-central portion of the County is within the Alameda Creek watershed, and drains south into Alameda County, where runoff discharges into San Francisco Bay at Fremont. The Sacramento and San Joaquin Rivers, which flow along the northern county boundary, provide a substantial portion of freshwater inflow to the bay through the San Joaquin-Sacramento Delta. Surface waters from the northern and eastern portion of the County drain into Suisun Bay and the delta river channels. More than 90 percent of the annual runoff through the delta occurs during the winter and spring, when creeks and rivers swell and are prone to flooding.

11.1.2 Climate

Contra Costa has a moderate climate with an average precipitation of 13 to 23 inches per year; the lower precipitation range is in the eastern portion of the county and the higher average is in the west. The county's climate is strongly influenced by its location and topography; the San Joaquin Valley to the east has hot, dry summers and cool winters, while western Contra Costa adjacent to San Francisco Bay and San Pablo Bay has cool summers and mild winters. In summer, a steady marine wind blows through the Golden Gate and up the Carquinez Strait. This moderating influence is reflected in average July temperatures of 65°F in the western portion of the County (Richmond) and 74°F in the east (Antioch). Marine air results in warmer bayside temperatures in the winter, with average January temperatures of 50°F in Richmond and 46°F in Antioch.

11.1.3 Water Supply Goals

Water supply is one component of the safety element of the Contra Costa County General Plan. The County has a diverse set of water supply options, including surface water and groundwater wells, to ensure that the community has adequate water, even after a period of dry years, through a combination of water supplies and water conservation measures. The Contra Costa County General Plan Update presents four goals related to water supply:

- To ensure a continuous supply of safe water to county residents.
- To protect the quality, quantity, and productivity of water resources as vital resources for maintaining the public, ecological and economic health of the region.
- The safety of valuable underground water supplies for present and future users shall be ensured by preventing contamination.
- All wells and other entrances to aquifers shall be identified and protected

11.1.4 Water Facilities

Any reduction of water supply can have harmful effects on facilities in Contra Costa County that depend on an adequate supply of water. The County is serviced by 11 purveyors of domestic and industrial water. These providers supply water to the entire planning area. The county receives most of its water supply through surface water supplies from the East Bay Municipal Utility District or the Contra Costa Water District. Some small public and private water companies use deeper groundwater supplies, mostly in eastern county communities such as Bethel Island, Knightsen, Byron and Discovery Bay.

11.1.5 Water Supply

Surface Water

Surface waters in the county include freshwater intermittent streams, drainages, canals, and estuarine waters. Contra Costa is bordered by San Pablo Bay, San Francisco Bay and the San Joaquin-Sacramento River Delta. The San Francisco Bay estuary includes deepwater channels, tidelands, and marshlands. The San Francisco Bay Regional Water Quality Control Board's *Water Quality Control Plan* (San Francisco Bay RWQCB, 2007) segments the Bay Area, including western Contra Costa County, into seven watersheds. The county includes portions of the following basins:

- San Pablo Basin encompasses the northwest portion of the county, which drains to San Pablo Bay. Wildcat and San Pablo Creeks are located in the Richmond area. Other freshwater bodies within the San Pablo Basin include San Pablo and Briones Reservoirs, the Pinole River, Rodeo Creek, and Refugio Creek.

- The Suisun Basin encompasses the central portion of the county, which drains to the Carquinez Straight and Suisun Bay. This basin encompasses Walnut Creek and its tributaries, such as Lafayette Reservoir, Las Trampas Creek, and others near Pleasant Hill; Pacheco Creek west of Martinez; Mt. Diablo Creek and its tributaries; Pine Creek, and Mallard Reservoir.
- The Central Basin encompasses central San Francisco Bay and a relatively small area of the county around El Cerrito and southern Richmond. There are several minor streams near El Cerrito in the Central Basin.
- The South Bay Basin includes the south-central portion of the county, which drains south into Alameda Creek. This area encompasses the hills to the north and east of the Livermore Valley, including Arroyo Las Positas and Arroyo Mocho. Other water bodies include Tassajara Creek and Alamo Creek east of San Ramon.

The eastern portion of the county is within the jurisdiction of the Central Valley Regional Water Quality Control Board (RWQCB), whose jurisdiction encompasses Antioch, Brentwood, Oakley, and surrounding areas whose surface water drains northward into the Sacramento-San Joaquin Delta. Drainage flowing from the East Bay Hills includes Marsh Creek Reservoir, numerous unnamed intermittent streams, Marsh Creek, Deer Creek, and several others. The low-lying easternmost portion of Contra Costa is drained by a network of man-made canals, which primarily discharge into Old River. Located on the Contra Costa-San Joaquin County line, Old River empties into the San Joaquin River near Franks Tract.

Groundwater

Shallow groundwater aquifers are closely linked to local surface waters. As surface water runoff flows from the East Bay Hills toward the bays and the San Joaquin-Sacramento River Delta, it percolates through permeable alluvial soils into underlying shallow groundwater systems. Deeper groundwater aquifers are also present, separated in areas from shallow groundwater by low-permeability soil layers. Contra Costa lies over many of the Bay Area’s primary deep groundwater basins, including the Tracy subbasin of San Joaquin Valley (which overlaps into the San Joaquin River Basin), the East Bay Plain, Arroyo Del Hambre Valley, Pittsburg Plain, Clayton Valley, Ygnacio Valley, San Ramon Valley, and Livermore basins (California Department of Water Resources, 2003). All of these basins have existing or potential use as municipal, industrial, or agricultural water sources (San Francisco RWQCB, 2007). In general, shallow groundwater for most of the county is typically saline due to proximity to the Bay. This water is not used for domestic purposes, but serves as a wetland resource in the area.

11.2 HAZARD PROFILE

Droughts originate from a deficiency of precipitation resulting from an unusual weather pattern. If the weather pattern lasts a short time (a few weeks or a couple months), the drought is considered short-term. If the weather pattern becomes entrenched and the precipitation deficits last for several months or years, the drought is considered to be long-term. It is possible for a region to experience a long-term circulation pattern that produces drought, and to have short-term changes in this long-term pattern that result in short-term wet spells. Likewise, it is possible for a long-term wet circulation pattern to be interrupted by short-term weather spells that result in short-term drought.

Droughts typically occur after two or three consecutive years of below-average rainfall for the period from November to March, when about 75 percent of California’s average annual precipitation falls. December, January, and February are when approximately 50 percent of the rainfall occurs in California.

11.2.1 Past Events

The California Department of Water Resources has state hydrologic data back to the early 1900s (watersupplyconditions.water.ca.gov). The hydrologic data show multi-year droughts from 1912 to 1913, 1918 to 1920 and 1922 to 1924. Since then, three prolonged periods of drought occurred in California, all of which impacted Contra Costa County to some degree:

- **1929 to 1934 Drought**—The 1929 to 1934 drought established the criteria for designing many large Northern California reservoirs. The Sacramento Valley runoff was 55 percent of average for the time period from 1901 to 1996, with only 9.8 million acre-feet received.
- **1975 to 1977 Drought**—California had one of its most severe droughts due to lack of rainfall during the winters of 1976 and 1977. 1977 was the driest period on record in California, with the previous winter recorded as the fourth driest in California's hydrological history. The cumulative impact led to widespread water shortages and severe water conservation measures throughout the state. Only 37 percent of the average Sacramento Valley runoff was received, with just 6.6 million acre-feet recorded. Over $2.6 billion in crop damage was recorded in 31 counties. A federal disaster declaration was declared in some counties.
- **1987-1992 Drought**—California received precipitation well below average levels for four consecutive years. While the Central Coast was most affected, the Sierra Nevadas in Northern California and the Central Valley counties were also affected. During this drought, only 56 percent of average runoff for the Sacramento Valley was received, totaling just 10 million acre-feet. By February 1991, all 58 counties in California were suffering from drought conditions, and urban areas as well as rural and agricultural areas were impacted.

11.2.2 Location

The National Oceanic and Atmospheric Administration (NOAA) has developed several indices to measure drought impacts and severity and to map their extent and locations:

- The ***Palmer Crop Moisture Index*** measures short-term drought on a weekly scale and is used to quantify drought's impacts on agriculture during the growing season.
- The ***Palmer Z Index*** measures short-term drought on a monthly scale. Figure 11-1 shows this index for July 2010.
- The ***Palmer Drought Severity Index (PDSI)*** measures the duration and intensity of long-term drought-inducing circulation patterns. Long-term drought is cumulative, so the intensity of drought during a given month is dependent on the current weather patterns plus the cumulative patterns of previous months. Weather patterns can change quickly from a long-term drought pattern to a long-term wet pattern, and the PDSI can respond fairly rapidly. Figure 11-2 shows this index for July 2010.
- The hydrological impacts of drought (e.g., reservoir levels, groundwater levels, etc.) take longer to develop and it takes longer to recover from them. The ***Palmer Hydrological Drought Index (PHDI)***, another long-term index, was developed to quantify hydrological effects. The PHDI responds more slowly to changing conditions than the PDSI. Figure 11-3 shows this index for July 2010.
- While the Palmer indices consider precipitation, evapotranspiration and runoff, the ***Standardized Precipitation Index (SPI)*** considers only precipitation. In the SPI, an index of zero indicates the median precipitation amount; the index is negative for drought and positive for wet conditions. The SPI is computed for time scales ranging from one month to 24 months. Figure 11-4 shows the 24-month SPI map for August 2008 through July 2010.

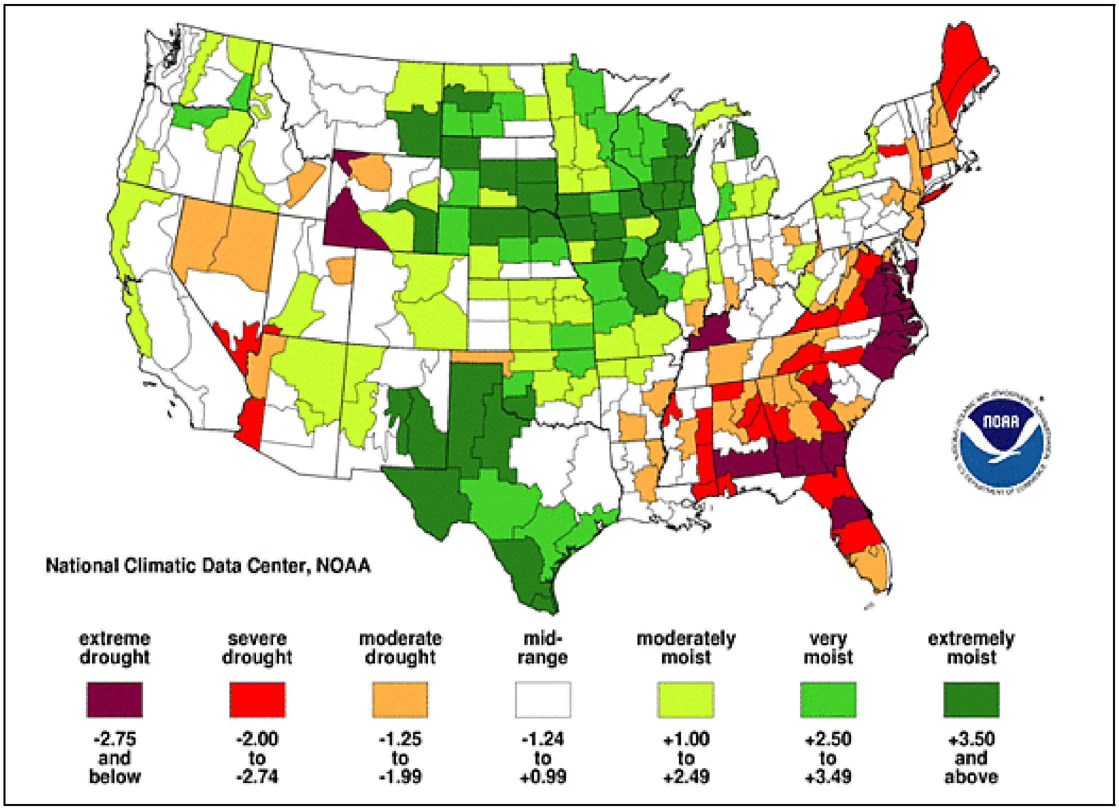


Figure 11-1. Palmer Z Index Short-Term Drought Conditions (July 2010)

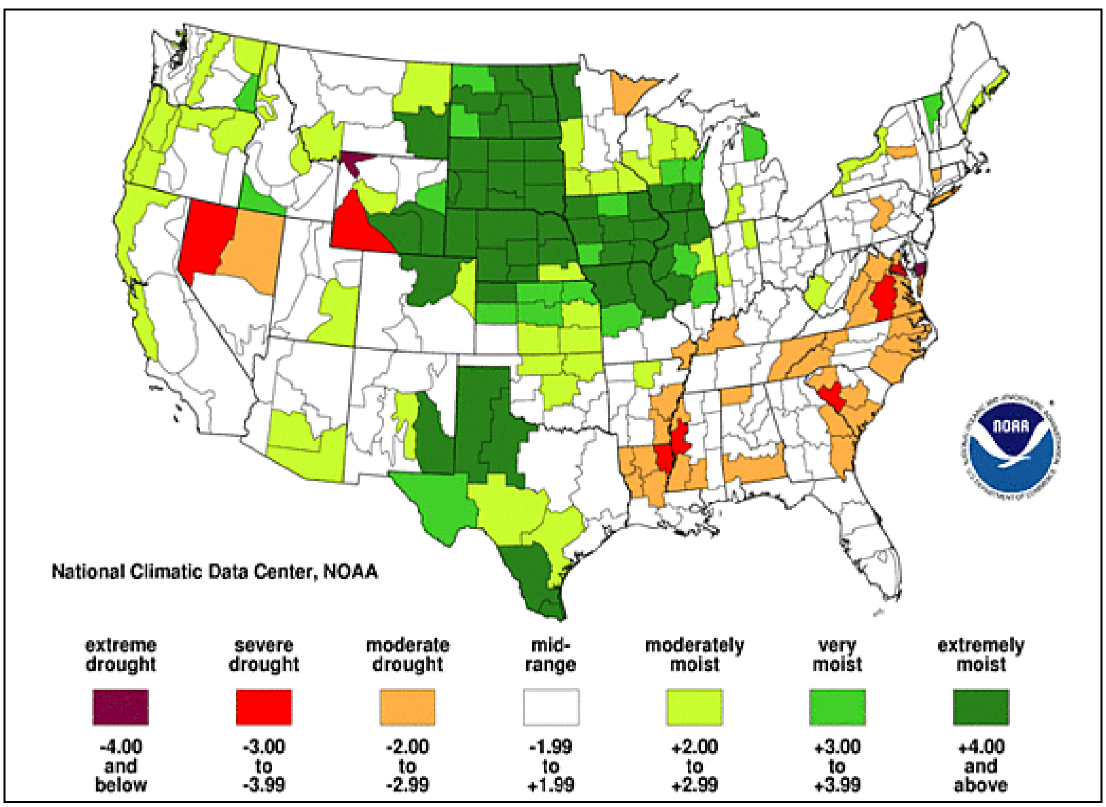


Figure 11-2. Palmer Drought Severity Index Long-Term Drought Conditions (July 2010)

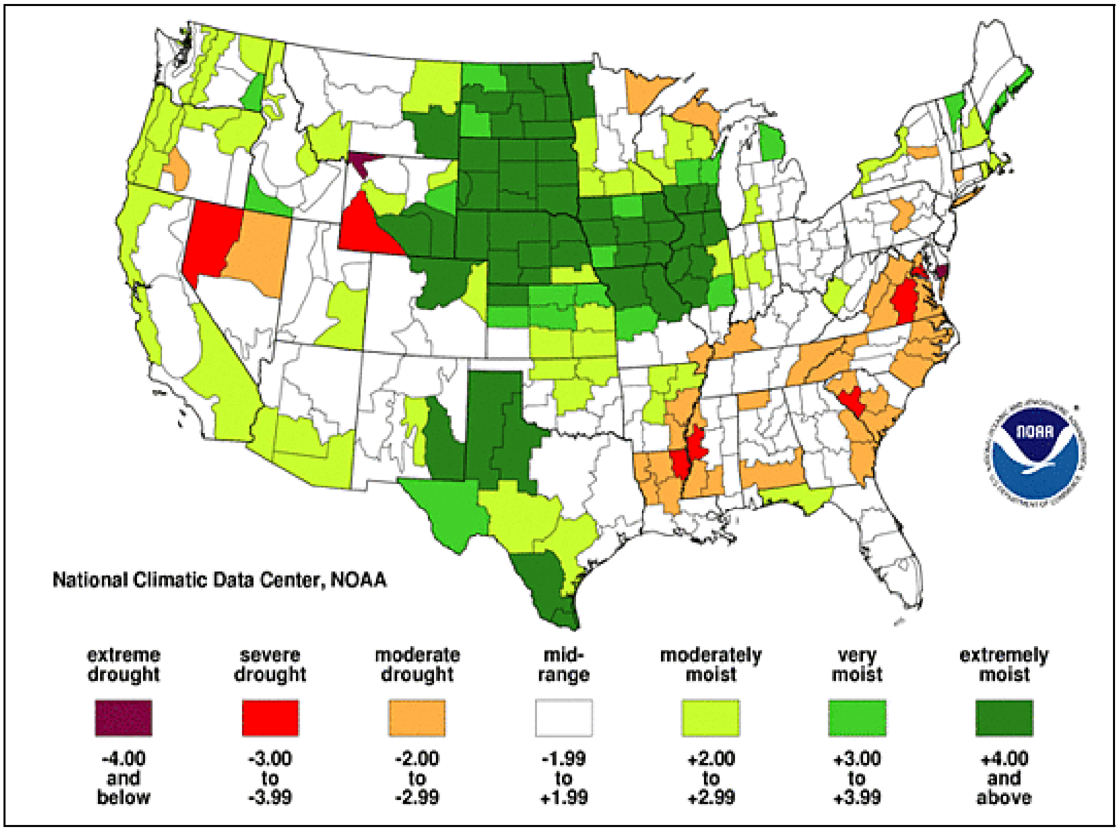


Figure 11-3. Palmer Hydrological Drought Index Long-Term Hydrologic Conditions (July 2010)

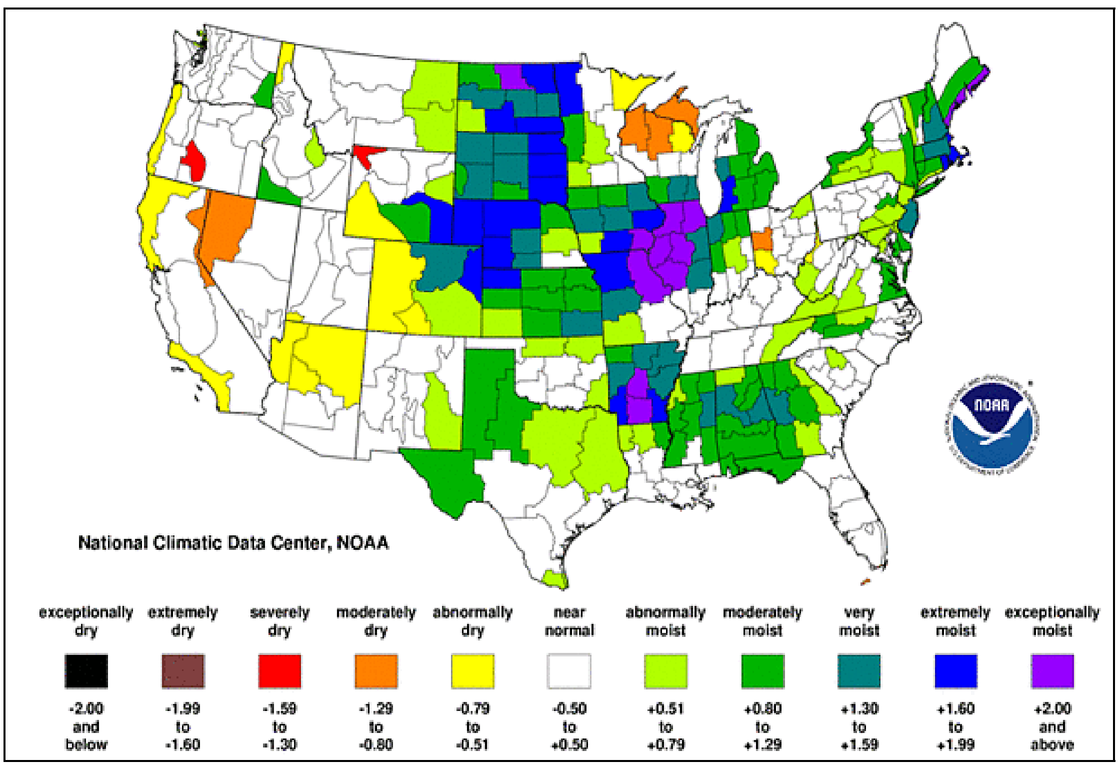


Figure 11-4. 24-Month Standardized Precipitation Index (August 2008—July 2010)

11.2.3 Frequency

Historical drought data for the Contra Costa County region indicate there have been four significant droughts in the last 79 years. This equates to a drought every 19.8 years on average, or a 5.1 percent chance of a drought in any given year.

11.2.4 Severity

The severity of a drought depends on the degree of moisture deficiency, the duration, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts. Droughts are not usually associated with direct impacts on people or property, but they can have significant impacts on agriculture, which can impact people indirectly. When measuring the severity of droughts, analysts typically look at economic impacts on a planning area.

11.2.5 Warning Time

Droughts are climatic patterns that occur over long periods of time. Only generalized warning can take place due to the numerous variables that scientists have not pieced together well enough to make accurate and precise predictions.

11.3 SECONDARY HAZARDS

The secondary hazard most commonly associated with drought is wildfire. A prolonged lack of precipitation dries out vegetation, which becomes increasingly susceptible to ignition as the duration of the drought extends.

11.4 CLIMATE CHANGE IMPACTS

The long-term effects of climate change on regional water resources are unknown, but global water resources are already experiencing the following stresses without climate change:

- Growing populations
- Increased competition for available water
- Poor water quality
- Environmental claims
- Uncertain reserved water rights
- Groundwater overdraft
- Aging urban water infrastructure.

With a warmer climate, droughts could become more frequent, more severe, and longer-lasting. The drought of the late 1980s showed what the impacts might be if climate change leads to increased frequency and intensity of droughts in the United States. From 1987 to 1989, losses from drought in the U.S. totaled $39 billion (OTA, 1993). More frequent extreme events such as droughts could end up being more cause for concern than the long-term change in temperature and precipitation averages.

The best advice to water resource managers regarding climate change is to start addressing current stresses on water supplies and build flexibility and robustness into any system. Flexibility helps to ensure a quick response to changing conditions, and robustness helps people prepare for and survive the worst conditions. With this approach to planning, water system managers will be better able to adapt to the impacts of climate change.

11.5 EXPOSURE

All people, property and environments in the Contra Costa County planning area would be exposed to some degree to the impacts of moderate to extreme drought conditions.

11.6 VULNERABILITY

Drought produces a complex web of impacts that spans many sectors of the economy and reaches well beyond the area experiencing physical drought. This complexity exists because water is integral to the ability to produce goods and provide services. Drought can affect a wide range of economic, environmental and social activities. The vulnerability of an activity to the effects of drought usually depends on its water demand, how the demand is met, and what water supplies are available to meet the demand. California's 2005 Water Plan indicates that water demand in the state will increase through 2030. Although the Department of Water Resources predicts a modest decrease in agricultural water use, the agency anticipates that urban water use will increase by 1.5 to 5.8 million acre-feet per year.

11.6.1 Population

Contra Costa County and all of its planning partners have spent considerable time and effort to protect life, safety and health should several consecutive dry years occur. Steps have been taken to analyze and account for anticipated water shortages. The planning partnership has the ability to minimize any impacts on residents and water consumers in the county. No significant life or health impacts are anticipated as a result of drought within the planning area.

11.6.2 Property

No structures will be directly affected by drought conditions in Contra Costa County, though some structures may become vulnerable to wildfires, which are more likely following years of drought. Droughts can also have significant impacts on landscapes, which could cause a financial burden to property owners. However, these impacts are not considered critical in planning for impacts from the drought hazard.

11.6.3 Critical Facilities

Critical facilities as defined for this plan will continue to be operational during a drought. Critical facility elements such as landscaping may not be maintained due to limited resources, but the risk to the planning area's critical facilities inventory will be largely aesthetic. For example, when water conservation measures are in place, landscaped areas will not be watered and may die. These aesthetic impacts are not considered significant.

11.6.4 Environment

Environmental losses from drought are associated with damage to plants, animals, wildlife habitat, and air and water quality; forest and range fires; degradation of landscape quality; loss of biodiversity; and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent. Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes and vegetation. However, many species will eventually recover from this temporary aberration. The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity. Although environmental losses are difficult to quantify, growing public awareness and concern for environmental quality has forced public officials to focus greater attention and resources on these effects.

11.6.5 Economic Impact

Economic impact will be largely associated with industries that use water or depend on water for their business. For example, landscaping businesses were affected in the droughts of the past as the demand for service significantly declined because landscaping was not watered. Agricultural industries will be impacted if water usage is restricted for irrigation.

11.7 FUTURE TRENDS IN DEVELOPMENT

Land use in the planning area will be directed by general plans adopted under California’s General Planning Law. Each municipal planning partner in this effort has an established General Plan that includes policies directing land use and dealing with issues of water supply and the protection of water resources. These plans provide the capability at the local municipal level to protect future development from the impacts of drought. All planning partners reviewed their general plans under the capability assessments performed for this effort. Deficiencies identified by these reviews can be identified as mitigation actions to increase the capability to deal with future trends in development.

11.9 SCENARIO

An extreme multiyear drought more intense than the 1977 drought could impact the region with little warning. Combinations of low precipitation and unusually high temperatures could occur over several consecutive years. Intensified by such conditions, extreme wildfires could break out throughout Contra Costa County, increasing the need for water. Surrounding communities, also in drought conditions, could increase their demand for water supplies relied upon by the planning partnership, causing social and political conflicts. If such conditions persisted for several years, the economy of Contra Costa County could experience setbacks, especially in water dependent industries.

11.10 ISSUES

The planning team has identified the following drought-related issues:

- Identification and development of alternative water supplies
- Utilization of groundwater recharge techniques to stabilize the groundwater supply
- The probability of increased drought frequencies and durations due to climate change
- The promotion of active water conservation even during non-drought periods.

CHAPTER 12.
EARTHQUAKE

12.1 GENERAL BACKGROUND

12.1.1 How Earthquakes Happen

An earthquake is the vibration of the earth's surface that follows a release of energy in the earth's crust. This energy can be generated by a sudden dislocation of segments of the crust or by a volcanic eruption. Most destructive quakes are caused by dislocations of the crust. The crust may first bend and then, when the stress exceeds the strength of the rocks, break and snap to a new position. In the process of breaking, vibrations called "seismic waves" are generated. These waves travel outward from the source of the earthquake along the surface and through the earth at varying speeds, depending on the material through which they move.

Geologists have found that earthquakes tend to reoccur along faults, which are zones of weakness in the earth's crust. Even if a fault zone has recently experienced an earthquake, there is no guarantee that all the stress has been relieved. Another earthquake could still occur. In fact, relieving stress along one part of a fault may increase stress in another part.

California is seismically active because of movement of the North American Plate, on which Contra Costa County and everything east of the San Andreas Fault sits, and the Pacific Plate, which includes coast communities from Monterey to San Diego. The movement of these tectonic plates creates stress that can be released as earthquakes.

Active faults are those that have experienced displacement during recorded history. However, inactive faults, for which no displacements have been recorded, maintain the potential to reactivate or experience displacement along a branch sometime in the future. Earthquake activity throughout California could cause tectonic movement along currently inactive fault systems. For example, the Foothills Fault Zone was considered inactive when evidence was first found of an earthquake 1.6 million years ago near Spenceville, California. Then, in 1975, an earthquake occurred on another branch of the zone near Oroville, California (now known as the Cleveland Hills Fault).

DEFINITIONS

Earthquake—The shaking of the ground caused by an abrupt shift of rock along a fracture in the earth or a contact zone between tectonic plates. Earthquakes are typically measured in both magnitude and intensity.

Epicenter—The point on the earth's surface directly above the hypocenter of an earthquake. The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth.

Fault—A fracture in the earth's crust along which two blocks of the crust have slipped with respect to each other.

Focal Depth—The depth from the earth's surface to the hypocenter.

Hypocenter—The region underground where an earthquake's energy originates

Liquefaction—Loosely packed, water-logged sediments losing their strength in response to strong shaking, causing major damage during earthquakes.

12.1.2 Earthquake Classifications

Earthquakes are classified according to the amount of energy released as measured by magnitude or intensity scales. Currently the most commonly used scales are the moment magnitude (Mw) scale, and the modified Mercalli intensity scale. Estimates of moment magnitude roughly match the local magnitude scale (ML) commonly called the Richter scale. One advantage of the moment magnitude scale is that, unlike other magnitude scales, it does not saturate at the upper end. That is, there is no value beyond which all large earthquakes have about the same magnitude. For this reason, moment magnitude is now the most often used estimate of large earthquake magnitudes. Table 12-1 presents a classification of earthquakes according to their magnitude. Table 12-2 compares the moment magnitude scale to the modified Mercalli intensity scale.

TABLE 12-1.
EARTHQUAKE MAGNITUDE CLASSES

Magnitude Class	Magnitude Range (M = magnitude)
Great	M > 8
Major	7 <= M < 7.9
Strong	6 <= M < 6.9
Moderate	5 <= M < 5.9
Light	4 <= M < 4.9
Minor	3 <= M < 3.9
Micro	M < 3

12.1.3 Ground Motion

Earthquake hazard assessment is also based on expected ground motion. This involves determining the annual probability that certain ground motion accelerations will be exceeded, then summing the annual probabilities over the time period of interest. The most commonly mapped ground motion parameters are the horizontal and vertical peak ground accelerations (PGA) for a given soil or rock type. Instruments called accelerographs record levels of ground motion due to earthquakes at stations throughout a region. These readings are recorded by state and federal agencies that monitor and predict seismic activity.

Maps of PGA values form the basis of seismic zone maps that are included in building codes such as the International Building Code. Building codes that include seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake. PGA values are directly related to these lateral forces that could damage “short period structures” (e.g. single-family dwellings). Longer period response components determine the lateral forces that damage larger structures with longer natural periods (apartment buildings, factories, high-rises, bridges). Table 12-3 lists damage potential by PGA factors compared to the Mercalli scale.

12.1.5 Effect of Soil Types

The impact of an earthquake on structures and infrastructure is largely a function of ground shaking, distance from the source of the quake, and liquefaction, a secondary effect of an earthquake in which soils lose their shear strength and flow or behave as liquid, thereby damaging structures that derive their support from the soil. Liquefaction generally occurs in soft, unconsolidated sedimentary soils. A program called the National Earthquake Hazard Reduction Program (NEHRP) creates maps based on soil characteristics to help identify locations subject to liquefaction. Table 12-4 summarizes NEHRP soil classifications. NEHRP Soils B and C typically can sustain ground shaking without much effect, dependent on the earthquake magnitude. The areas that are commonly most affected by ground shaking have NEHRP Soils D, E and F. In general, these areas are also most susceptible to liquefaction.

**TABLE 12-2.
EARTHQUAKE MAGNITUDE AND INTENSITY**

Magnitude (Mw)	Intensity (Modified Mercalli)	Description
1.0—3.0	I	I. Not felt except by a very few under especially favorable conditions
3.0—3.9	II—III	II. Felt only by a few persons at rest, especially on upper floors of buildings. III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it is an earthquake. Standing cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
4.0—4.9	IV—V	IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like a heavy truck striking building. Standing cars rocked noticeably.
5.0—5.9	VI—VII	VI. Felt by all; many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight. VII. Damage negligible in buildings of good design and construction; slight in well-built ordinary structures; considerable in poorly built or badly designed structures. Some chimneys broken.
6.0—6.9	VII—IX	VIII. Damage slight in specially designed structures; considerable damage in ordinary buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
7.0 and higher	VIII and higher	X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent. XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly. XII. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

TABLE 12-3.
MERCALLI SCALE AND PEAK GROUND ACCELERATION COMPARISON

Mercalli Scale	Potential Damage	Estimated PGA
I	None	0.017
II-III	None	0.017
IV	None	0.014-0.039
V	Very Light	0.039-0.092
VI	None to Slight; USGS-Light	0.02-0.05
	Unreinforced Masonry-Stair Step Cracks; Damage to Chimneys; Threshold of Damage	0.04-0.08 0.06-0.07 0.06-0.13 0.092-0.18
VII	Slight-Moderate; USGS-Moderate	0.05-0.10
	Unreinforced Masonry-Significant; Cracking of parapets	0.08-0.16 0.10-0.15
	Masonry may fail; Threshold of Structural Damage	0.1 0.18-0.34
VIII	Moderate-Extensive; USGS: Moderate-Heavy	0.10-0.20
	Unreinforced Masonry-Extensive Cracking; fall of parapets and gable ends	0.16-0.32 0.25-0.30 0.13-0.25 0.2 0.35-0.65
IX	Extensive-Complete; USGS-Heavy	0.20-0.50
	Structural collapse of some un-reinforced masonry buildings; walls out of plane. Damage to seismically designed structures	0.32-0.55 0.50-0.55 0.26-0.44 0.3 0.65-1.24
X	Complete ground failures; USGS- Very Heavy (X+); Structural collapse of most un-reinforced masonry buildings; notable damage to seismically designed structures; ground failure	0.50-1.00

TABLE 12-4.
NEHRP SOIL CLASSIFICATION SYSTEM

NEHRP Soil Type	Description	Mean Shear Velocity to 30 m (m/s)
A	Hard Rock	1,500
B	Firm to Hard Rock	760-1,500
C	Dense Soil/Soft Rock	360-760
D	Stiff Soil	180-360
E	Soft Clays	< 180
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays >36 m thick)	

12.2 HAZARD PROFILE

Earthquakes can last from a few seconds to over five minutes; they may also occur as a series of tremors over several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties generally result from falling objects and debris, because the shocks shake, damage or demolish buildings and other structures. Disruption of communications, electrical power supplies and gas, sewer and water lines should be expected. Earthquakes may trigger fires, dam failures, landslides or releases of hazardous material, compounding their disastrous effects.

Earthquakes in the San Francisco Bay region result from strain energy constantly accumulating across the region because of the northwestward motion of the Pacific Plate relative to the North American Plate. Small, local faults produce lower magnitude quakes, but ground shaking can be strong and damage can be significant in areas close to the fault. In contrast, large regional faults can generate earthquakes of great magnitudes but, because of their distance and depth, they may result in only moderate shaking in an area.

12.2.1 Past Events

Table 12-5 lists past seismic events that have impacted the Bay Area. The area experienced large and destructive earthquakes of magnitude 7.0 or greater in 1838, 1868, 1906 and 1989.

TABLE 12-5.
HISTORICAL EARTHQUAKES IMPACTING THE BAY AREA

Year	Magnitude	Fault	Region Impacted
1836	6.8	Undetermined	South San Francisco Bay
1838	7.0	San Andreas	San Francisco Peninsula
1865	6.5	San Andreas	--
1868	7.0	Hayward	Hayward Earthquake
1892	6.5	Undetermined	Vacaville Earthquake
1898	6.5	Rodgers Creek	Mare Island Earthquake
1906	7.8	San Andreas	Great San Francisco Earthquake
1911	6.5	Calaveras	Morgan Hill Earthquake
		68 year quiet period	
1979	6.0	Undetermined	Coyote Lake Earthquake
1980	6.0	Mt. Diablo/Greenville	Livermore Earthquake
1984	6.3	Calaveras	Morgan Hill Earthquake
1989	7.1	San Andreas	Loma Prieta Earthquake
2001	5.1	West Napa	Napa Earthquake
2007	5.6	Calaveras	--

12.2.2 Location

The Bay Area is crossed by many active faults. Figure 12-1 shows that major active faults run through or adjacent to all nine Bay Area counties.

Figure 12-1. Bay Area Faults

Maps of Earthquake Impact in Contra Costa County

Identifying the extent and location of an earthquake is not as simple as it is for other hazards such as flood, landslide or wild fire. The impact of an earthquake is largely a function of the following components:

- Ground shaking (ground motion accelerations)
- Liquefaction (soil instability)
- Distance from the source (both horizontally and vertically).

Mapping that shows the impacts of these components was used to assess the risk of earthquakes within the planning area. While the impacts from each of these components can build upon each other during an earthquake event, the mapping looks at each component individually. The mapping used in this assessment is described below.

Shake Maps

A shake map is a representation of ground shaking produced by an earthquake. The information it presents is different from the earthquake magnitude and epicenter that are released after an earthquake because shake maps focus on the ground shaking resulting from the earthquake, rather than the parameters describing the earthquake source. An earthquake has only one magnitude and one epicenter, but it produces a range of ground shaking at sites throughout the region, depending on the distance from the earthquake, the rock and soil conditions at sites, and variations in the propagation of seismic waves from the earthquake due to complexities in the structure of the earth's crust. A shake map shows the extent and variation of ground shaking in a region immediately following significant earthquakes.

Ground motion and intensity maps are derived from peak ground motion amplitudes recorded on seismic sensors (accelerometers), with interpolation based on estimated amplitudes where data are lacking, and site amplification corrections. Color-coded instrumental intensity maps are derived from empirical relations between peak ground motions and Modified Mercalli intensity. Two types of shake map are typically generated from the data:

- A probabilistic seismic hazard map shows the hazard from earthquakes that geologists and seismologists agree could occur. The maps are expressed in terms of probability of exceeding a certain ground motion, such as the 10-percent probability of exceedance in 50 years. This level of ground shaking has been used for designing buildings in high seismic areas. Maps 12-1 and 12-2 show the estimated ground motion for the 100-year and 500-year probabilistic earthquakes in Contra Costa County.
- Earthquake scenario maps describe the expected ground motions and effects of hypothetical large earthquakes for a region. Maps of these scenarios can be used to support all phases of emergency management. Two scenarios were chosen by the County OES for this plan:
  - Calaveras Fault Scenario—A Magnitude 6.9 event with a shallow depth and epicenter in northern Santa Clara County, 45 miles south of Concord. See Map 12-3.
  - Hayward/Rodgers Creek Fault Scenario—A Magnitude 7.05 event with an epicenter in San Pablo Bay, 30 miles east of Concord. See Map 12-4.

NEHRP Soil Maps

NEHRP soil types define the locations that will be significantly impacted by an earthquake. NEHRP Soils B and C typically can sustain low-magnitude ground shaking without much effect. The areas that are most commonly affected by ground shaking have NEHRP Soils D, E and F. Map 12-5 shows NEHRP soil classifications in the county.

Liquefaction Maps

Soil liquefaction maps are useful tools to assess potential damage from earthquakes. When the ground liquefies, sandy or silty materials saturated with water behave like a liquid, causing pipes to leak, roads and airport runways to buckle, and building foundations to be damaged. In general, areas with NEHRP Soils D, E and F are also susceptible to liquefaction. If there is a dry soil crust, excess water will sometimes come to the surface through cracks in the confining layer, bringing liquefied sand with it, creating sand boils. Map 12-6 shows the liquefaction susceptibility in Contra Costa County.

12.2.3 Frequency

The probability of future large quakes in the Bay Area is 268 percent greater than the overall U.S. average. Since 1836, there have been five earthquakes in the San Francisco Bay Area with a magnitude of 6.75 or higher. If earthquakes struck consistently over time, the region would expect another earthquake of this magnitude in the next 30 years with about a 50-percent probability. But earthquakes do not occur consistently over time. They can be more frequent at some times than others. There were 18 earthquakes of Magnitude 6 or larger in the Bay Area during the 75 years between 1836 and 1911; yet there were no events of this magnitude during the 68 years between 1911 and 1979. Apparently, the earthquake of 1906 was large enough to reduce strain throughout the region, so that only one large earthquake followed it.

Since 1979, however, there have been four earthquakes of Magnitude 6 or greater, leading up to the Magnitude 7.1 Loma Prieta earthquake in 1989. A new era of major earthquake activity may have begun in 1979, similar to the era before 1911. If the level of earthquake activity during the next few decades is similar to activity between 1836 and 1911, then the probability of a Magnitude 7 earthquake in the next 30 years is about 75 percent.

Probabilities for earthquakes occurring on individual faults over the next 30 years have been estimated by USGS, as shown in Table 12-6, which also shows estimates for average long-term movement (“slip rate”) of each fault in millimeters per year (mm/year).

12.2.4 Severity

The severity of an earthquake can be expressed in terms of intensity or magnitude. Intensity represents the observed effects of ground shaking on people, buildings, and natural features. The USGS has created ground motion maps based on current information about several fault zones. These maps show the PGA that has a certain probability (2 percent or 10 percent) of being exceeded in a 50-year period. The PGA is measured in numbers of g’s (the acceleration associated with gravity). Figure 12-2 shows the PGAs with a 2-percent exceedance chance in 50 years for California and Nevada. The Bay Area is a high-risk area, with a PGA for this probability equal to 1.62 g’s.

Magnitude is related to the amount of seismic energy released at the hypocenter of an earthquake. It is determined by the amplitude of the earthquake waves recorded on instruments. Whereas intensity varies depending on location with respect to the earthquake epicenter, magnitude is represented by a single, instrumentally determined value for each earthquake event.

In simplistic terms, the severity of an earthquake event can be measured in the following terms:

- How hard did the ground shake?
- How did the ground move? (Horizontally or vertically)
- How stable was the soil?
- What is the fragility of the built environment in the area of impact?

The Association of Bay Area Governments (ABAG) estimates a potential loss of 159,000 housing units in Bay Area communities after a large earthquake. This would have disastrous effects on local and regional economies. It also means that recovery, repair and rebuilding time for each household would be very lengthy, due to the number of homes that would need repairs or replacement.

12.2.5 Warning Time

There is currently no reliable way to predict the day or month that an earthquake will occur at any given location. Research is being done with warning systems that use the low energy waves that precede major earthquakes. These potential warning systems give approximately 40 seconds notice that a major earthquake is about to occur. The warning time is very short but it could allow for someone to get under a desk, step away from a hazardous material they are working with, or shut down a computer system.

TABLE 12-6.
EARTHQUAKE PROBABILITIES AND SLIP RATES

Segment	Average Long-Term Slip Rate (mm/year)	% Probability of Quake in Next 30 Years: Characteristic Quake 2002-2031	% Probability of Quake in Next 30 Years: Quake ≥6.7, 2007-2036
N. San Andreas			
Santa Cruz Mountains (SAS)	17	2.6	4.0*
Peninsula (SAP)	17	4.4	0.6*
North Bay (SAN)	24	0.9	0.04*
Ocean (north of Bay Area - SAO)	24	0.9	1.9*
South Bay Segments (SAS + SAP)	17	3.5	4.4*
Central Bay Segments (SAP + SAN)	17 - 24	0.0	0.0*
Northern Segments (SAN + SAO)	24	3.4	4.1*
Bay Area Segments (SAS+SAP+SAN)	17 - 24	0.1	0.05*
Central + North (SAP + SAN +SAO)	17 - 24	0.2	0.2*
Entire - Repeat of 1906(SAS + SAP +SAN + SAO)	17 - 24	4.7	3.8*
Floating M6.9	17 - 24	7.1	6.8
Hayward/Rodgers Creek			
Southern (HS)	9	11.3	4.8*
Northern (HN)	9	12.3	1.2*
Entire (HS + HN)	9	8.5	8.8*
Rodgers Creek (RC)	9	15.2	16.3*
HN + RC	9	1.8	2.1*
HS + HN + RC	9	1.0	1.2*
Floating M6.9	9	0.7	0.7
Calaveras			
Southern (Outside Bay Area - CS)	15	21.3	0.0*
Central (CC)	15	13.8	0.0*
CS + CC	15	5.0	0.1*
Northern (CN)	6	12.4	2.4*
CC + CN	6 - 15	0.3	0.3*
CS + CC + CN	6 - 15	2.0	3.6*
Floating M6.2	6 - 15	7.4	0.0
Floating M6.2 on CS + CC	15	7.4	0.0

TABLE 12-6 (continued).
EARTHQUAKE PROBABILITIES AND SLIP RATES

Segment	Average Long-Term Slip Rate (mm/year)	% Probability of Quake in Next 30 Years	
		Characteristic Quake 2002-2031	Quake ≥6.7, 2007-2036
Concord/Green Valley			
Concord (CON)	4	5.0	0.1
Southern Green Valley (GVS)	5	2.3	0.0
CON + GVS	4-5	1.6	0.3
Northern Green Valley (GVN)	5	6.1	0.0
Entire Green Valley (GVS + GVN)	5	3.2	0.4
Entire (CON + GVS + GVN)	4-5	6.0	2.7
Floating M6.2	4-5	6.2	0.0
San Gregorio			
Southern (Outside Bay Area - SGS)	3	2.3	2.1
Northern (SGN)	7	3.9	3.9
SGS + SGN	3-7	2.6	2.6
Floating M6.9	3-7	2.1	2.0
Greenville			
Southern (GS)	2	3.1	0.7
Northern (GN)	2	2.9	1.0
Entire (GS + GN)	2	1.5	1.4
Floating M6.2	2	0.4	0.0
Mt. Diablo Thrust			
Mt. Diablo Thrust (MTD)	2	7.5	0.7*
Maacama - Garberville			
Southern (only part in Bay Area)	9*	Not available	12.6*
Monte Vista - Shannon			
Monte Vista Segment	0.4*	Not available	0.02*
West Napa			
Entire Segment	1*	Not available	0.3*

Based on USGS Working Group on Earthquake Probabilities. 2003 and 2008*

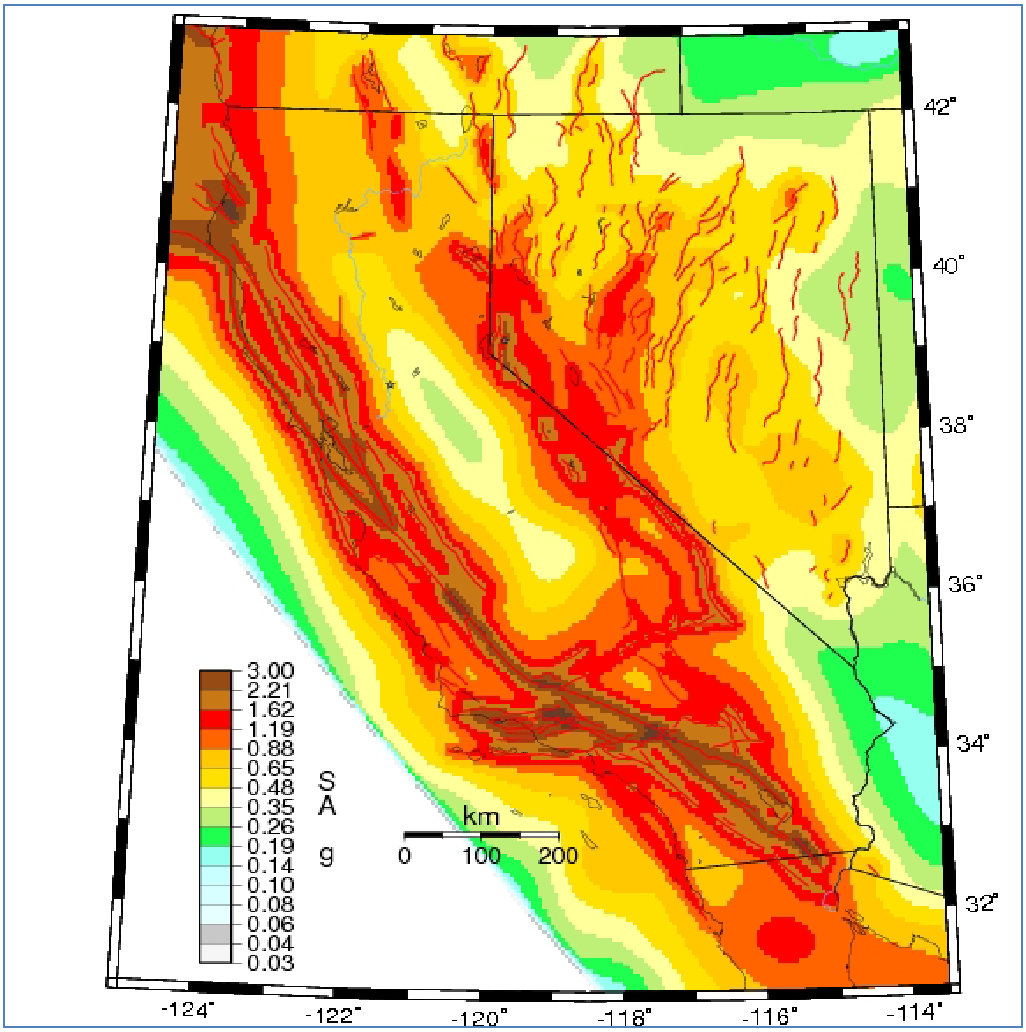


Figure 12-2. PGA with 2-Percent Probability of Exceedance in 50 Years, California and Nevada

12.3 SECONDARY HAZARDS

Earthquakes can cause large and sometimes disastrous landslides and mudslides. River valleys are vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction occurs when water-saturated sands, silts or gravelly soils are shaken so violently that the individual grains lose contact with one another and float freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink into what was previously solid ground. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people. Earthen dams and levees are highly susceptible to seismic events and the impacts of their eventual failures can be considered secondary risks for earthquakes.

12.4 CLIMATE CHANGE IMPACTS

The impacts of global climate change on earthquake probability are unknown. Some scientists say that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the earth’s crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity according to research into prehistoric earthquakes and volcanic activity. NASA and USGS scientists found that retreating glaciers in southern Alaska may be opening the way for future earthquakes (NASA, 2004).

Secondary impacts of earthquakes could be magnified by climate change. Soils saturated by repetitive storms could experience liquefaction during seismic activity due to the increased saturation. Dams storing increased volumes of water due to changes in the hydrograph could fail during seismic events. There are currently no models available to estimate these impacts.

12.5 EXPOSURE

12.5.1 Population

The entire population of Contra Costa County is potentially exposed to direct and indirect impacts from earthquakes. The degree of exposure is dependent on many factors, including the age and construction type of the structures people live in, the soil type their homes are constructed on, their proximity to fault location, etc. Whether directly impacted or indirectly impact, the entire population will have to deal with the consequences of earthquakes to some degree. Business interruption could keep people from working, road closures could isolate populations, and loss of functions of utilities could impact populations that suffered no direct damage from an event itself.

12.5.2 Property

The Contra Costa County Assessor estimates that there are 334,741 buildings in Contra Costa County, with a total assessed value of $174.13 billion. Since all structures in the planning area are susceptible to earthquake impacts to varying degrees, this total represents the county-wide property exposure to seismic events. Most of the buildings (96.6 percent) are residential.

Building Age

The California State Building Code Council identifies significant milestones in building and seismic code requirements that directly affect the structural integrity of development in California. Using these time periods, the planning team used HAZUS to identify the number of structures within the County by date of construction. Table 12-7 shows the results of this analysis.

TABLE 12-7.
AGE OF STRUCTURES IN CONTRA COSTA COUNTY

Time Period	Number of Current County Structures Built in Period	Significance of Time Frame
Pre-1933	11,634	Before 1933, there were no explicit earthquake requirements in building codes. State law did not require local governments to have building officials or issue building permits.
1933-1940	6,667	In 1940, the first strong motion recording was made.
1941-1960	78,101	In 1960, the Structural Engineers Association of California published guidelines on recommended earthquake provisions.
1961-1975	78,287	In 1975, significant improvements were made to lateral force requirements.
1976-1994	99,014	In 1994, the Uniform Building Code was amended to include provisions for seismic safety.
1994 - present	61,038	Seismic code is currently enforced.
Total	**334,741**	

The number of structures does not reflect the number of total housing units, as many multi-family units and attached housing units are reported as one structure. Approximately 18.2 percent of the planning area's structures were constructed after the Uniform Building Code was amended in 1994 to include seismic safety provisions. Approximately 3.5 percent were built before 1933 when there were no building permits, inspections, or seismic standards.

Soft-Story Buildings

A soft-story building is a multi-story building with one or more floors that are "soft" due to structural design. If a building has a floor that is 70-percent less stiff than the floor above it, it is considered a soft-story building. This soft story creates a major weak point in an earthquake. Since soft stories are typically associated with retail spaces and parking garages, they are often on the lower stories of a building. When they collapse, they can take the whole building down with them, causing serious structural damage that may render the structure totally unusable (see Figure 12-3).

Figure 12-3. Soft-Story Damage from 1989 Loma Prieta Earthquake

These floors can be especially dangerous in earthquakes, because they cannot cope with the lateral forces caused by the swaying of the building during a quake. As a result, the soft story may fail, causing what is known as a soft story collapse. Soft-story collapse is one of the leading causes of earthquake damage to private residences.

Exposure associated with soft story construction in the planning area is not currently known. ABAG and other agencies in the Bay Area have programs generating this type of data, but it is not known when such data will be available for Contra Costa County. This type of data will need to be generated to support future risk assessments of the earthquake hazard.

12.5.3 Critical Facilities and Infrastructure

All critical facilities in Contra Costa County are exposed to the earthquake hazard. Tables 8-2 and 8-3 lists the number of each type of facility by jurisdiction. Hazardous materials releases can occur during an earthquake from fixed facilities or transportation-related incidents. Transportation corridors such as Highways 680, 24 and 4 and BART can be disrupted during an earthquake, leading to the release of materials to the surrounding environment. Facilities holding hazardous materials are of particular concern because of possible isolation of neighborhoods surrounding them. During an earthquake, structures storing these materials could rupture and leak into the surrounding area or an adjacent waterway, having a disastrous effect on the environment.

12.5.4 Environment

Secondary hazards associated with earthquakes will likely have some of the most damaging effects on the environment. Earthquake-induced landslides can significantly impact surrounding habitat. It is also possible for streams to be rerouted after an earthquake. This can change the water quality, possibly damaging habitat and feeding areas. There is a possibility of streams fed by groundwater drying up because of changes in underlying geology.

12.6 VULNERABILITY

Earthquake vulnerability data was generated using a Level 2 HAZUS-MH analysis. Once the location and size of a hypothetical earthquake are identified, HAZUS-MH estimates the intensity of the ground shaking, the number of buildings damaged, the number of casualties, the damage to transportation systems and utilities, the number of people displaced from their homes, and the estimated cost of repair and clean up.

12.6.1 Population

Three population groups are particularly vulnerable to earthquake hazards:

- **Linguistically Isolated Populations**——Approximately 180,000 residents in the planning area census blocks on NEHRP D and E soils do not speak English as their native language. This is about 32 percent of all residents in these census blocks. Problems arise when there is an urgent need to inform non-English speaking residents of an earthquake event. They are vulnerable because of difficulties in understanding hazard-related information from predominantly English-speaking media and government agencies.
- **Population Below Poverty Level**—Approximately 31,000 households in the planning area census blocks on NEHRP D and E soils are listed as being below the poverty level. This is about 14 percent of all households in these census blocks. These households may lack the financial resources to improve their homes to prevent or mitigate earthquake damage. Poorer residents are also less likely to have insurance to compensate for losses in earthquakes.
- **Population Over 65 Years Old**—Approximately 65,000 residents in the planning area census blocks on NEHRP D and E soils are over 65 years old. This is about 12 percent of all residents in these census blocks. This population group is vulnerable because they are more likely to need special medical attention, which may not be available due to isolation caused by earthquakes. Elderly residents also have more difficulty leaving their homes during earthquake events and could be stranded in dangerous situations.

Impacts on persons and households in the planning area were estimated for the 100-year and 500-year earthquakes and the two scenario events through the Level 2 HAZUS-MH analysis. Table 12-8 summarizes the results.

TABLE 12-8.
ESTIMATED EARTHQUAKE IMPACT ON PERSON AND HOUSEHOLDS

	Number of Displaced Households	Number of Persons Requiring Short-Term Shelter
100-Year Earthquake	9,791	6,400
500-Year Earthquake	30,314	19,200
Calaveras Earthquake Scenario	1,583	910
Hayward/Rodgers Creek Earthquake Scenario	8,639	5,900

12.6.2 Property

Property losses were estimated through the Level 2 HAZUS-MH analysis for the 100-year and 500-year earthquakes and the two scenario events. Tables 12-9 and 12-10 show the results for two types of property loss:

- Structural loss, representing damage to building structures
- Non-structural loss, representing the value of lost contents and inventory, relocation, income loss, rental loss, and wage loss.

The total of the two types of losses is also shown in the tables. A summary of the property-related loss results is as follows:

- For a 100-year probabilistic earthquake, the estimated damage potential is $10.22 billion, or 5.9 percent of the total assessed value for the planning area.
- For a 500-year earthquake, the estimated damage potential is $24.87 billion, or 14.3 percent of the total assessed value for the planning area.
- For a 6.9-magnitude event on the Calaveras Fault, the estimated damage potential is $2.66 billion, or 1.5 percent of the total assessed value for the planning area.
- For a 7.0-magnitude event on the Hayward/Rodgers Creek Fault, the estimated damage potential is $9.40 billion, or 5.4 percent of the total assessed value for the planning area.

The HAZUS-MH analysis also estimated the amount of earthquake-caused debris in the planning area for the 100-year and 500-year earthquakes and the two scenario events, as summarized in Table 12-11.

12.6.3 Critical Facilities and Infrastructure

Level of Damage

HAZUS-MH classifies the vulnerability of critical facilities to earthquake damage in five categories: no damage, slight damage, moderate damage, extensive damage, or complete damage. The model was used to assign a vulnerability category to each critical facility in the planning area except hazmat facilities and "other infrastructure" facilities, for which there are no established damage functions. The analysis was performed for the 100-year event and the Hayward/Rodgers Creek Fault scenario, which have, respectively, the highest probability of occurrence and the largest potential impact on the planning area. Tables 12-12 and 12-13 summarize the results.

TABLE 12-9.
EARTHQUAKE BUILDING LOSS POTENTIAL—PROBABILISTIC

	Estimated Earthquake Loss Value					
	100- Year Probabilistic Earthquake			500- Year Probabilistic Earthquake		
Jurisdiction	Structural	Non-Structural	**Total**	Structural	Non-Structural	**Total**
Antioch	$243,524,300	$98,382,877	**$341,907,177**	$719,532,185	$251,459,122	**$970,991,306**
Brentwood	$205,049,906	$83,482,973	**$288,532,879**	$633,926,219	$231,542,789	**$865,469,008**
Clayton	$47,992,504	$18,898,736	**$66,891,240**	$142,261,738	$47,846,646	**$190,108,384**
Concord	$736,458,993	$261,154,526	**$997,613,519**	$1,510,815,462	$506,362,734	**$2,017,178,196**
Danville	$331,619,289	$127,614,967	**$459,234,256**	$1,121,466,641	$348,487,719	**$1,469,954,359**
El Cerrito	$125,148,855	$44,083,369	**$169,232,224**	$364,717,717	$115,639,316	**$480,357,033**
Hercules	$127,444,545	$50,087,340	**$177,531,885**	$436,693,340	$148,569,639	**$585,262,979**
Lafayette	$158,382,557	$60,806,485	**$219,189,042**	$413,068,703	$134,530,307	**$547,599,010**
Martinez	$270,940,510	$113,260,699	**$384,201,208**	$652,424,887	$266,319,137	**$918,744,023**
Moraga	$96,319,906	$37,293,623	**$133,613,529**	$252,939,742	$82,287,359	**$335,227,102**
Oakley	$116,640,908	$43,340,470	**$159,981,378**	$335,483,219	$115,398,232	**$450,881,451**
Orinda	$142,563,306	$56,115,343	**$198,678,649**	$451,250,371	$144,097,070	**$595,347,441**
Pinole	$37,438,715	$14,289,387	**$51,728,102**	$131,200,617	$42,479,402	**$173,680,020**
Pittsburg	$293,544,210	$126,649,254	**$420,193,464**	$605,826,500	$229,197,007	**$835,023,507**
Pleasant Hill	$155,193,606	$55,869,667	**$211,063,274**	$358,727,855	$117,539,771	**$476,267,626**
Richmond	$1,119,375,676	$512,337,308	**$1,631,712,984**	$2,113,910,891	$903,617,897	**$3,017,528,788**
San Pablo	$100,790,208	$34,274,249	**$135,064,457**	$267,362,029	$85,217,107	**$352,579,137**
San Ramon	$486,484,553	$181,081,333	**$667,565,886**	$1,504,206,211	$500,966,482	**$2,005,172,693**
Walnut Creek	$797,666,830	$283,447,057	**$1,081,113,887**	$1,812,046,363	$608,682,146	**$2,420,728,510**
Unincorporated	$1,710,287,102	$720,528,121	**$2,430,815,223**	$4,479,665,053	$1,679,789,496	**$6,159,454,549**
Total	**$7,302,866,479**	**$2,922,997,784**	**$10,225,864,263**	**$18,307,525,743**	**$6,560,029,378**	**$24,867,555,122**

**TABLE 12-10.
EARTHQUAKE BUILDING LOSS POTENTIAL—SCENARIO EVENTS**

	Estimated Earthquake Loss Value					
	6.9 M Calaveras Fault			7.0 M Hayward/Rodgers Creek Fault		
Jurisdiction	Structural	Non-Structural	**Total**	Structural	Non-Structural	**Total**
Antioch	$38,920,494	$22,011,295	**$60,931,790**	$76,019,419	$40,067,017	**$116,086,436**
Brentwood	$26,618,094	$16,235,217	**$42,853,312**	$141,117,707	$65,242,881	**$206,360,588**
Clayton	$14,781,831	$7,706,119	**$22,487,950**	$12,999,265	$8,160,495	**$21,159,760**
Concord	$207,980,247	$88,994,065	**$296,974,312**	$330,755,490	$133,997,537	**$464,753,027**
Danville	$214,144,051	$88,855,129	**$302,999,180**	$345,803,820	$139,084,084	**$484,887,904**
El Cerrito	$5,968,805	$3,481,415	**$9,450,220**	$171,841,468	$71,560,205	**$243,401,673**
Hercules	$6,957,762	$3,914,733	**$10,872,495**	$165,457,627	$71,167,472	**$236,625,099**
Lafayette	$40,776,333	$20,450,301	**$61,226,634**	$147,967,059	$64,594,687	**$212,561,745**
Martinez	$39,084,651	$21,079,597	**$60,164,248**	$88,082,888	$43,302,745	**$131,385,634**
Moraga	$36,178,128	$18,555,582	**$54,733,710**	$104,565,260	$45,480,673	**$150,045,933**
Oakley	$12,451,635	$7,054,249	**$19,505,885**	$32,388,399	$15,426,202	**$47,814,601**
Orinda	$24,356,019	$13,312,084	**$37,668,103**	$104,425,343	$52,650,982	**$157,076,325**
Pinole	$2,311,252	$1,219,518	**$3,530,770**	$49,835,102	$20,503,888	**$70,338,989**
Pittsburg	$33,298,624	$18,432,891	**$51,731,515**	$49,785,060	$26,159,882	**$75,944,942**
Pleasant Hill	$29,737,507	$14,887,289	**$44,624,796**	$56,400,837	$27,441,296	**$83,842,133**
Richmond	$35,201,339	$22,046,509	**$57,247,848**	$1,579,703,790	$719,445,317	**$2,299,149,107**
San Pablo	$4,171,554	$2,210,498	**$6,382,052**	$213,870,061	$83,207,649	**$297,077,709**
San Ramon	$412,510,002	$150,540,686	**$563,050,688**	$828,130,764	$299,780,996	**$1,127,911,760**
Walnut Creek	$227,200,634	$105,290,812	**$332,491,447**	$654,779,129	$246,943,173	**$901,722,302**
Unincorporated	$415,625,621	$201,042,171	**$616,667,792**	$1,453,619,570	$619,411,119	**$2,073,030,689**
Total	**$1,828,274,583**	**$827,320,160**	**$2,655,594,747**	**$6,607,548,058**	**$2,793,628,300**	**$9,401,176,356**

**TABLE 12-11.
ESTIMATED EARTHQUAKE-CAUSED DEBRIS**

	Debris to Be Removed (tons)
100-Year Earthquake	2.6 million
500-Year Earthquake	6.07 million
Calaveras Earthquake Scenario	438,160
Hayward/Rodgers Creek Earthquake Scenario	2.53 million

TABLE 12-12.
CRITICAL FACILITY VULNERABILITY TO 100-YEAR EARTHQUAKE EVENT

Category[a]	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical and Health	0	0	10	16	1
Government Functions	0	6	7	2	0
Protective Functions	0	11	46	93	0
Schools	0	9	134	282	0
Other Critical Functions	7	38	1	0	0
Bridges	404	66	7	0	0
Water supply	71	63	30	0	0
Wastewater	15	48	4	0	0
Power	1	51	0	0	0
Communications	5	117	3	0	0
Total	**503**	**404**	**242**	**393**	**1**

a. Vulnerability not estimated for hazmat facilities or for "other infrastructure" facilities due to lack of established damage functions for these type facilities.

TABLE 12-13.
CRITICAL FACILITY VULNERABILITY TO HAYWARD/RODGERS CREEK FAULT SCENARIO

Category[a]	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical and Health	0	19	4	2	2
Government Functions	0	11	2	2	0
Protective Functions	1	66	44	34	5
Schools	1	206	91	89	38
Other Critical Functions	5	40	1	0	0
Bridges	372	102	2	1	0
Water supply	57	64	36	7	0
Wastewater	7	40	10	10	0
Power	12	39	1	0	0
Communications	47	75	3	0	0
Total	**502**	**662**	**194**	**145**	**45**

a. Vulnerability not estimated for hazmat facilities or for "other infrastructure" facilities due to lack of established damage functions for these type facilities.

Transportation Disruption

ABAG has modeled road closures with grants from Caltrans and the U.S. Geological Survey. The models calculate the number of road closures from a variety of sources: fault rupture, liquefaction, earthquake-triggered landslides, shaking damage to bridges and highway structures, and indirect causes such as building damage, hazmat releases, and utility pipeline breaks. They produce estimates by census tract and city, but their accuracy is reduced as modeled area decreases. The models are based on multiple factors:

- Locations of roads and transportation structures
- Shaking exposure
- Hazard maps of faults, slides, and liquefaction
- Locations of buildings that might fall to close roads
- Sources of hazmat releases
- Pipeline locations
- Damage data from past earthquakes.

Table 12-14 summarizes the model results for various earthquake events.

TABLE 12-14.
ESTIMATED ROAD CLOSURES IN CONTRA COSTA COUNTY FOR VARIOUS EARTHQUAKE SCENARIOS

Earthquake Location (Fault)	Estimated Number of Road Closures in Contra Costa County
San Andreas (Santa Cruz Mountains)	10
San Andreas (Entire Bay Area)	30
Hayward Fault (North and South)	268
Rodgers Creek	34
Rodgers Creek/N. Hayward	256
Concord/Green Valley	201
North Calaveras	107
Central Calaveras	10
Mt. Diablo	78

Time to Return to Functionality

HAZUS-MH estimates the time to restore critical facilities to fully functional use. Results are presented as probability of being functional at specified time increments: 1, 3, 7, 14, 30 and 90 days after the event. For example, HAZUS-MH may estimate that a facility has 5 percent chance of being fully functional at Day 3, and a 95-percent chance of being fully functional at Day 90. The analysis of critical facilities in the planning area was performed for the 100-year and Hayward/Rodgers Creek Fault earthquake events. Tables 12-15 and 12-16 summarize the results.

12.6.4 Environment

The environment vulnerable to earthquake hazard is the same as the environment exposed to the hazard.

**TABLE 12-15.
FUNCTIONALITY OF CRITICAL FACILITIES, 100-YEAR EARTHQUAKE**

Planning Unit	# of Critical Facilities	Probability of Being Fully Functional (%) at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical and Health	27	68.3	88.4	92.1	96.6	98.8	99.7
Government Functions	15	1.8	5.6	40.3	48.6	65.9	81.6
Protective Functions	150	55.9	67.5	76.9	78.9	84.0	90.1
Schools	425	0.1	0.3	9.5	9.7	28.5	42.2
Other Critical functions	46	59.7	78.7	89.7	92.2	93.4	97.0
Bridges	477	76.4	79.7	82.4	82.7	85.3	89.7
Water supply	164	41.0	77.9	85.9	87.0	90.0	98.2
Wastewater	67	24.7	55.6	78.9	82.9	84.5	96.6
Power	52	0.0	0.2	6.6	6.8	23.5	37.1
Communications	125	65.5	82.4	87	90.6	94.6	96.4
Total/Average	**1,548**	**39.3**	**53.6**	**64.9**	**67.6**	**74.6**	**82.9**

**TABLE 12-16.
FUNCTIONALITY OF CRITICAL FACILITIES, HAYWARD/RODGERS CREEK FAULT EARTHQUAKE**

Planning Unit	# of Critical Facilities	Probability of Being Fully Functional (%) at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical and Health	27	2.0	2.9	39.5	40.4	68.8	78.7
Government Functions	15	0.8	1.6	33.9	34.8	65.7	76.8
Protective Functions	150	3.0	3.8	40.9	41.8	65.4	74.3
Schools	425	2.1	2.7	29.4	30.0	50.7	60.4
Other Critical functions	46	92.0	96.3	97.8	97.9	98.1	99.2
Bridges	477	93.7	95.6	96.5	96.6	96.8	98.2
Water supply	164	51.7	84.6	90.6	91.4	93.4	98.8
Wastewater	67	38.0	70.3	88.4	91.2	92.1	98.4
Power	52	44.9	76.9	94.7	98.8	99.3	99.9
Communications	125	89.9	97.2	98.2	99.2	99.7	99.9
Total/Average	**1,548**	**41.8**	**53.1**	**70**	**71.2**	**81.3**	**86.4**

12.7 FUTURE TRENDS IN DEVELOPMENT

Land use in the planning area will be directed by general plans adopted under California's General Planning Law. The safety elements of the general plans establish standards and plans for the protection of the community from hazards. The information in this plan provides the participating partners a tool to ensure that there is no increase in exposure in areas of high seismic risk. Development in the planning area will be regulated through building standards and performance measures so that the degree of risk will be reduced. The geologic hazard portions of the planning area are heavily regulated under California's General Planning Law. The International Building Code establishes provisions to address seismic risk.

12.8 SCENARIO

With the abundance of fault exposure in the Bay Area, the potential scenarios for earthquake activity are many. An earthquake does not have to occur within Contra Costa County to have a significant impact on the people, property and economy of the county, as was seen during the 1989 Loma Prieta Earthquake.

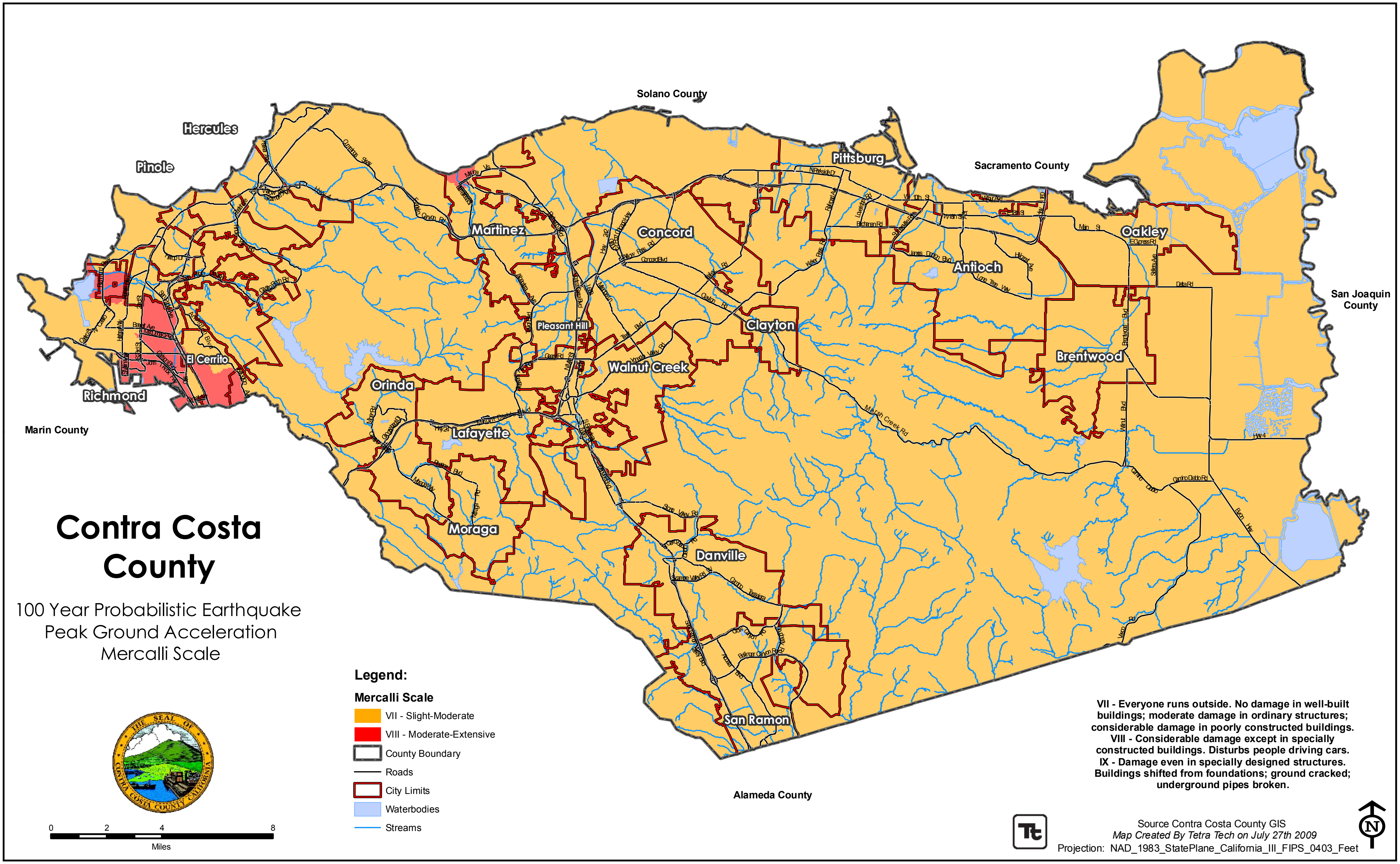
Any seismic activity of 6.0 or greater on faults within the planning area would have significant impacts throughout the county. Potential warning systems could give approximately 40 seconds notice that a major earthquake is about to occur. This would not provide adequate time for preparation. Earthquakes of this magnitude or higher would lead to massive structural failure of property on NEHRP C, D, E, and F soils. Levees and revetments built on these poor soils would likely fail, representing a loss of critical infrastructure. These events could cause secondary hazards, including landslides and mudslides that would further damage structures. River valley hydraulic-fill sediment areas are also vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction would occur in water-saturated sands, silts or gravelly soils.

12.9 ISSUES

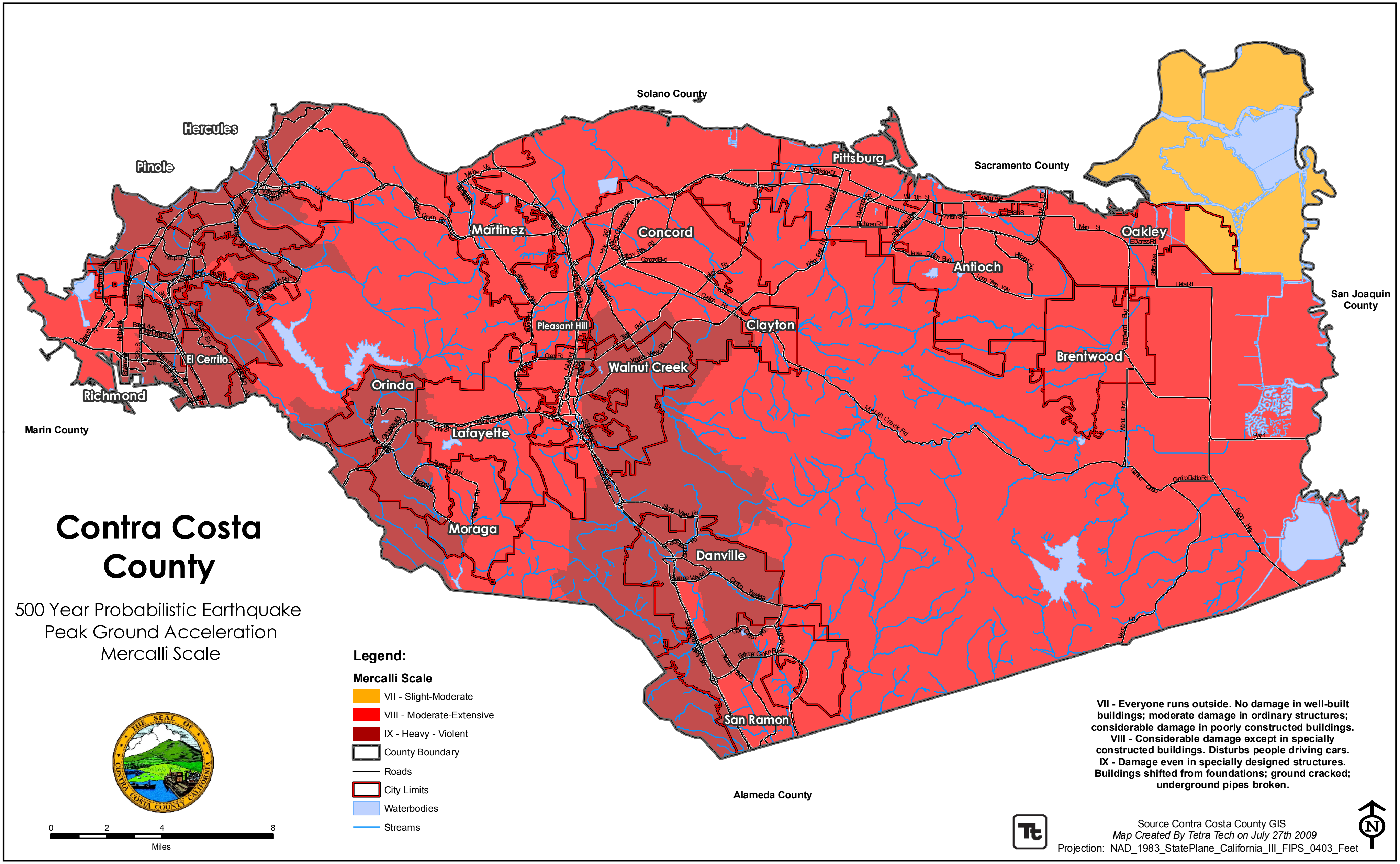
Important issues associated with an earthquake include but are not limited to the following:

- More information is needed on the exposure and performance of soft-story construction within the planning area.
- More than 50 percent of the planning area's building stock was built prior to 1975, when seismic provisions became uniformly applied through building code applications.
- Based on the modeling of critical facility performance performed for this plan, a high number of facilities in the planning area are expected to have complete or extensive damage from scenario events. These facilities are prime targets for structural retrofits.
- Critical facility owner should be encouraged to create or enhance Continuity of Operations Plans using the information on risk and vulnerability contained in this plan.
- Geotechnical standards should be established that take into account the probable impacts from earthquakes in the design and construction of new or enhanced facilities.
- The County has over 156 miles of earthen levees and revetments on soft, unstable soil. These soils are prone to liquefaction, which would severely undermine the integrity of these facilities.
- There are a large number of earthen dams within the planning area. Dam failure warning and evacuation plans and procedures should be reviewed and updated to reflect the dams' risk potential associated with earthquake activity in the region.
- Earthquakes could trigger other natural hazard events such as dam failures and landslides, which could severely impact the county.
- A worst-case scenario would be the occurrence of a large seismic event during a flood or high-water event. Levee failures would happen at multiple locations, increasing the impacts of the individual events.

Map 12-1.

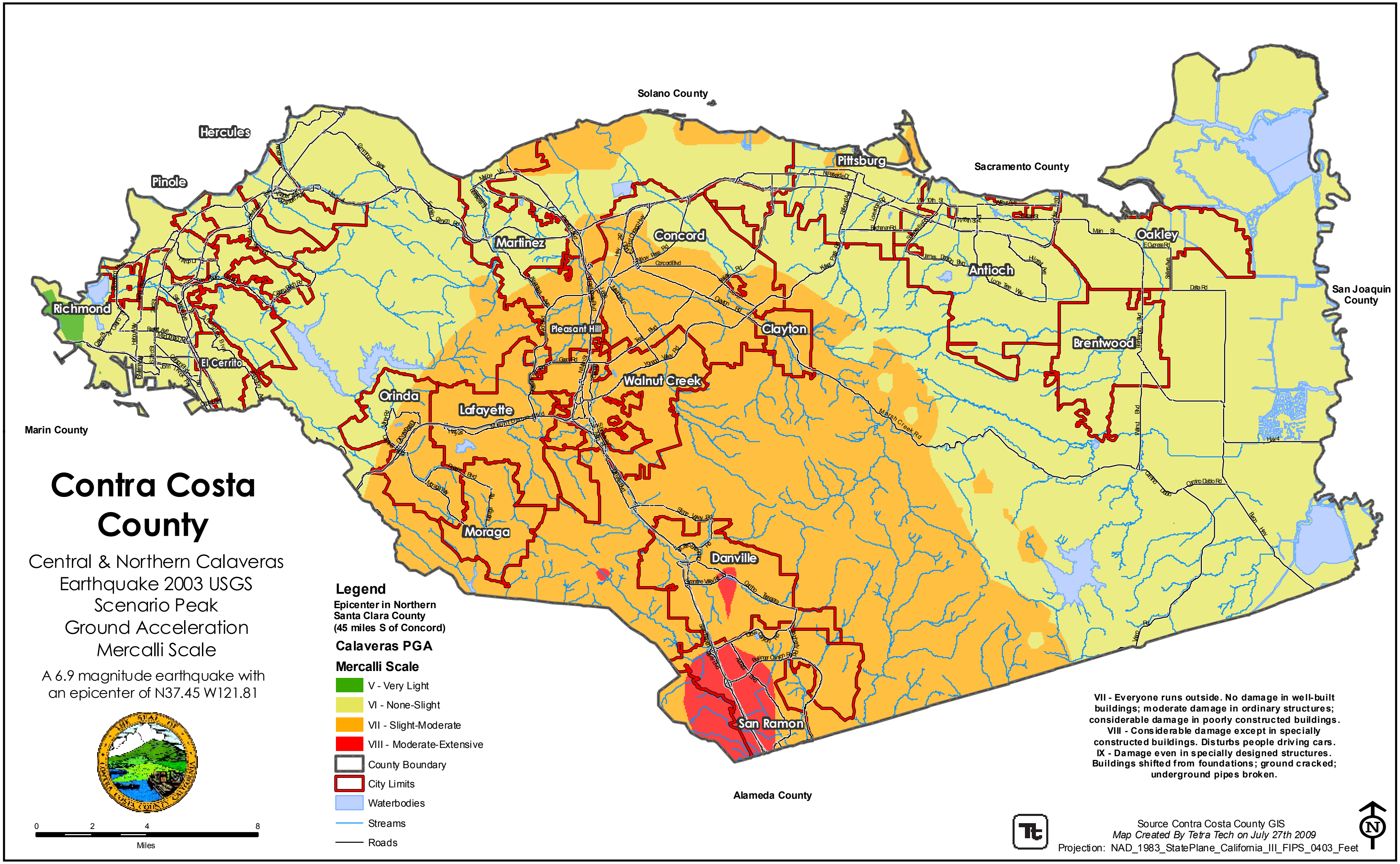

Contra Costa County
100 Year Probabilistic Earthquake Peak Ground Acceleration Mercalli Scale
Solano County
Sacramento County
San Joaquin County
Marin County
Alameda County
Hercules
Pinole
Richmond
El Cerrito
Martinez
Concord
Pittsburg
Antioch
Oakley
Brentwood
Clayton
Pleasant Hill
Walnut Creek
Orinda
Lafayette
Moraga
Danville
San Ramon
Legend:
Mercalli Scale
VII - Slight-Moderate
VIII - Moderate-Extensive
County Boundary
Roads
City Limits
Waterbodies
Streams
VII - Everyone runs outside. No damage in well-built buildings; moderate damage in ordinary structures; considerable damage in poorly constructed buildings.
VIII - Considerable damage except in specially constructed buildings. Disturbs people driving cars.
IX - Damage even in specially designed structures. Buildings shifted from foundations; ground cracked; underground pipes broken.
0
2
4
8
Miles
Source Contra Costa County GIS
Map Created By Tetra Tech on July 27th 2009
Projection: NAD_1983_StatePlane_California_III_FIPS_0403_Feet
N

Map 12-2.

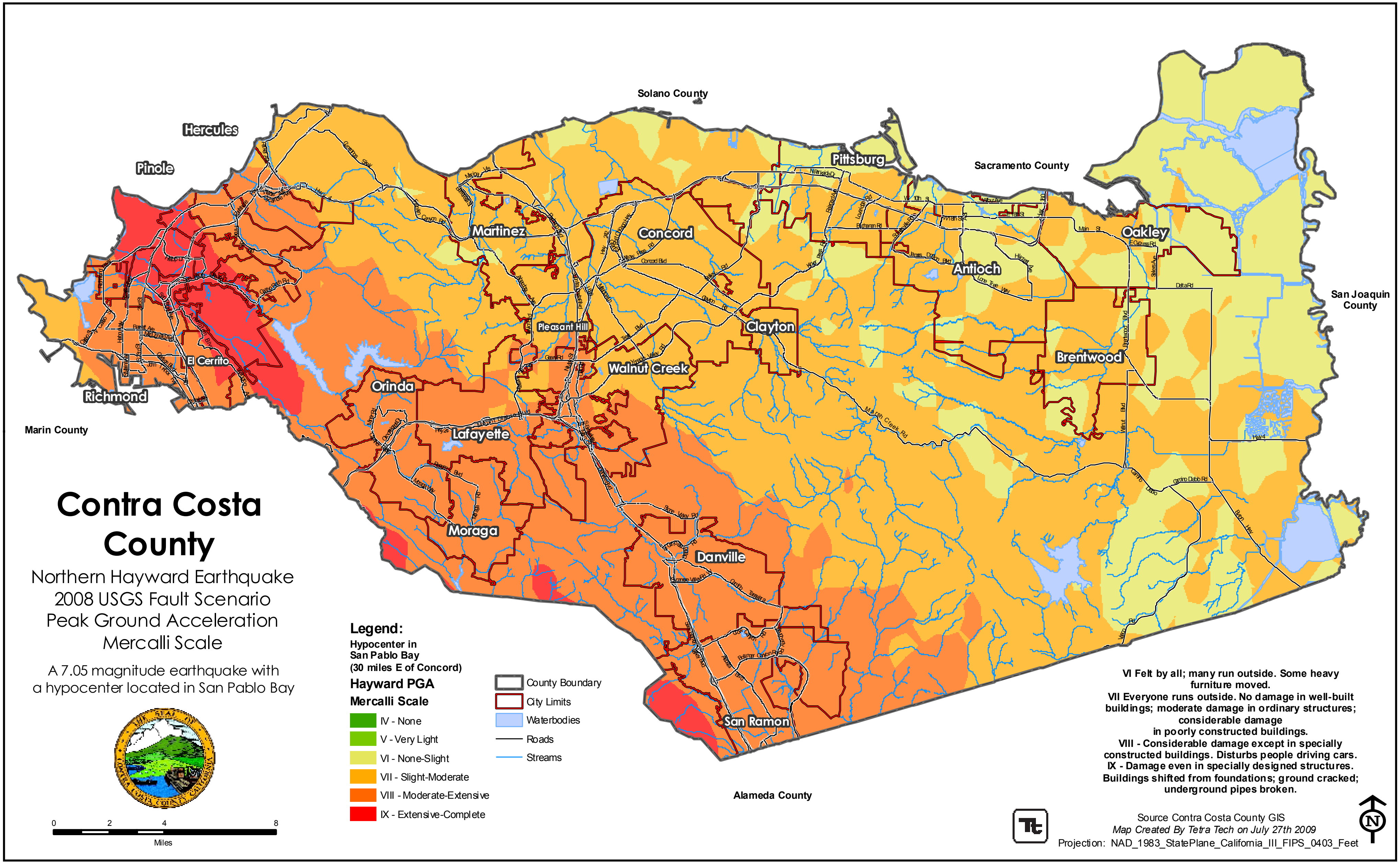


Contra Costa County
500 Year Probabilistic Earthquake Peak Ground Acceleration Mercalli Scale
Solano County
Sacramento County
San Joaquin County
Marin County
Alameda County
Hercules
Pinole
Richmond
El Cerrito
Martinez
Concord
Pittsburg
Antioch
Oakley
Brentwood
Clayton
Pleasant Hill
Walnut Creek
Orinda
Lafayette
Moraga
Danville
San Ramon
Legend:
Mercalli Scale
VII - Slight-Moderate
VIII - Moderate-Extensive
IX - Heavy - Violent
County Boundary
Roads
City Limits
Waterbodies
Streams
VII - Everyone runs outside. No damage in well-built buildings; moderate damage in ordinary structures; considerable damage in poorly constructed buildings.
VIII - Considerable damage except in specially constructed buildings. Disturbs people driving cars.
IX - Damage even in specially designed structures. Buildings shifted from foundations; ground cracked; underground pipes broken.
0 2 4 8
Miles
Source Contra Costa County GIS
Map Created By Tetra Tech on July 27th 2009
Projection: NAD_1983_StatePlane_California_III_FIPS_0403_Feet

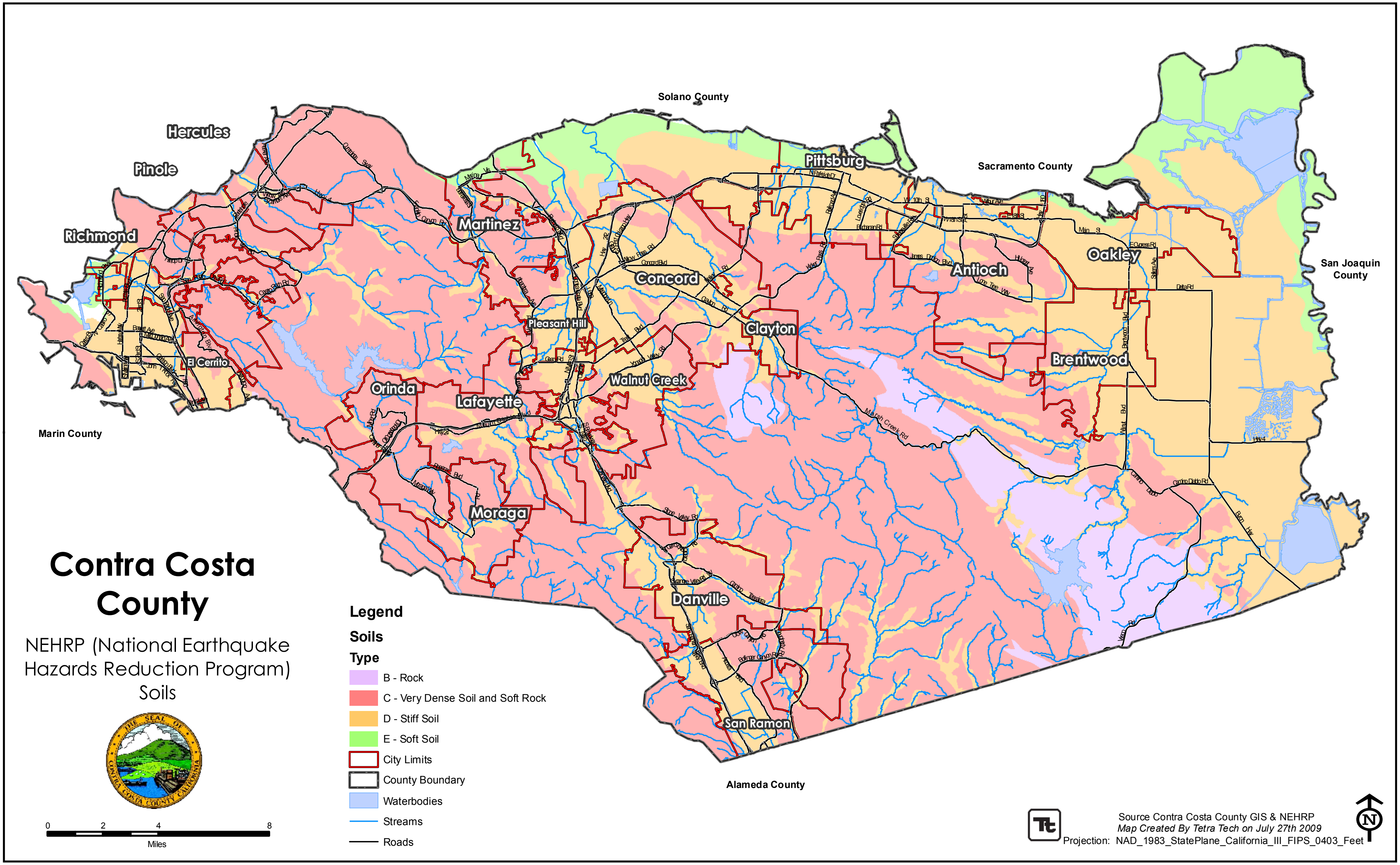
Map 12-3.


Contra Costa County
Central & Northern Calaveras Earthquake 2003 USGS Scenario Peak Ground Acceleration Mercalli Scale
A 6.9 magnitude earthquake with an epicenter of N37.45 W121.81
Solano County
Sacramento County
San Joaquin County
Marin County
Alameda County
Hercules
Pinole
Richmond
El Cerrito
Orinda
Lafayette
Moraga
Martinez
Pleasant Hill
Concord
Walnut Creek
Clayton
Danville
San Ramon
Pittsburg
Antioch
Oakley
Brentwood
Legend
Epicenter in Northern Santa Clara County (45 miles S of Concord)
Calaveras PGA
Mercalli Scale
V - Very Light
VI - None-Slight
VII - Slight-Moderate
VIII - Moderate-Extensive
County Boundary
City Limits
Waterbodies
Streams
Roads
VII - Everyone runs outside. No damage in well-built buildings; moderate damage in ordinary structures; considerable damage in poorly constructed buildings.
VIII - Considerable damage except in specially constructed buildings. Disturbs people driving cars.
IX - Damage even in specially designed structures. Buildings shifted from foundations; ground cracked; underground pipes broken.
0 2 4 8
Miles
Source Contra Costa County GIS
Map Created By Tetra Tech on July 27th 2009
Projection: NAD_1983_StatePlane_California_III_FIPS_0403_Feet
N

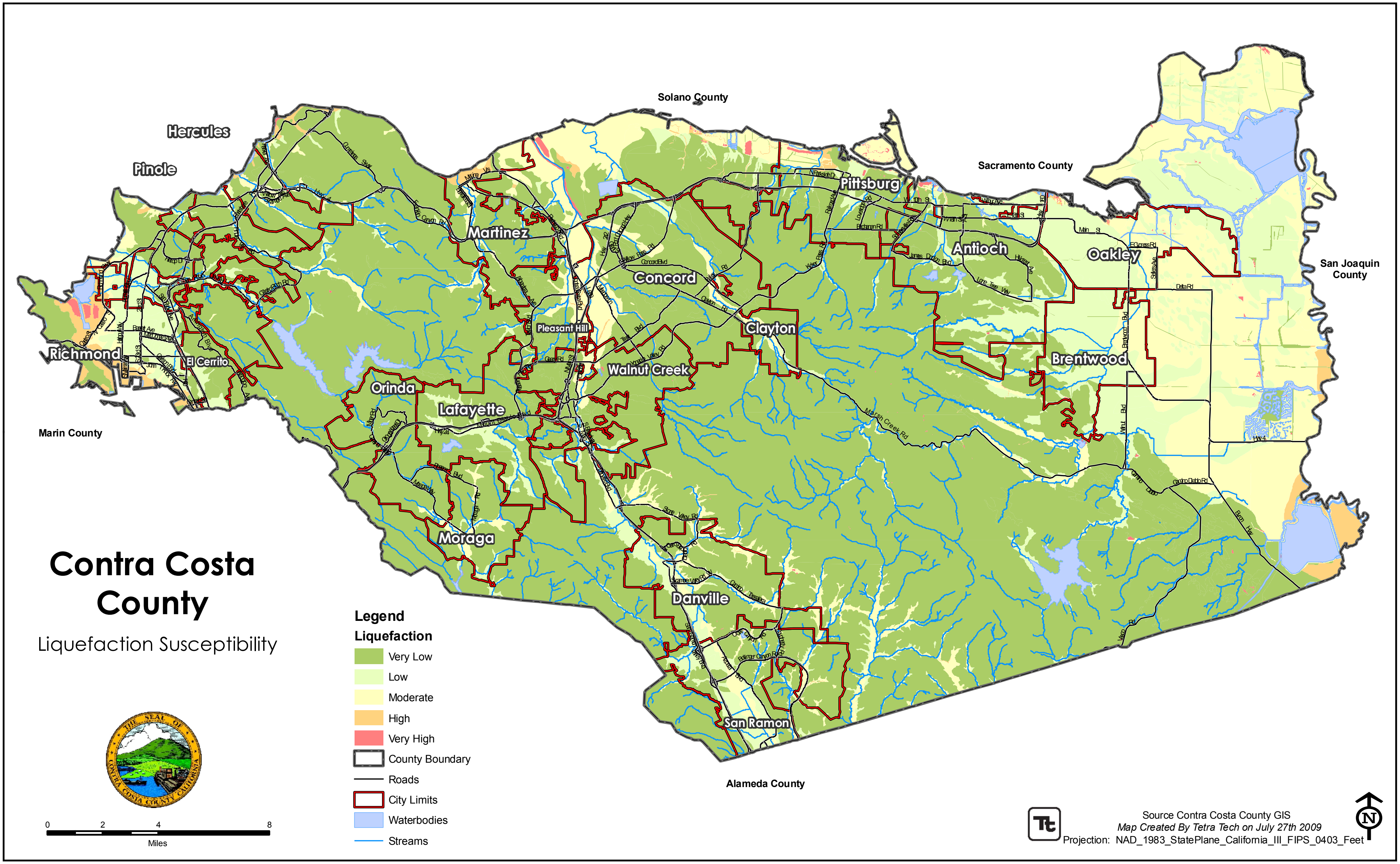
Map 12-4.


Contra Costa County
Northern Hayward Earthquake
2008 USGS Fault Scenario
Peak Ground Acceleration
Mercalli Scale
A 7.05 magnitude earthquake with a hypocenter located in San Pablo Bay
Solano County
Sacramento County
San Joaquin County
Alameda County
Marin County
Hercules
Pinole
Richmond
El Cerrito
Martinez
Concord
Pittsburg
Antioch
Oakley
Brentwood
Clayton
Pleasant Hill
Walnut Creek
Orinda
Lafayette
Moraga
Danville
San Ramon
Legend:
Hypocenter in San Pablo Bay (30 miles E of Concord)
Hayward PGA
Mercalli Scale
IV - None
V - Very Light
VI - None-Slight
VII - Slight-Moderate
VIII - Moderate-Extensive
IX - Extensive-Complete
County Boundary
City Limits
Waterbodies
Roads
Streams
VI Felt by all; many run outside. Some heavy furniture moved.
VII Everyone runs outside. No damage in well-built buildings; moderate damage in ordinary structures; considerable damage in poorly constructed buildings.
VIII - Considerable damage except in specially constructed buildings. Disturbs people driving cars.
IX - Damage even in specially designed structures. Buildings shifted from foundations; ground cracked; underground pipes broken.
0 2 4 8
Miles
Source Contra Costa County GIS
Map Created By Tetra Tech on July 27th 2009
Projection: NAD_1983_StatePlane_California_III_FIPS_0403_Feet

Map 12-5.


Contra Costa County
NEHRP (National Earthquake Hazards Reduction Program) Soils
Solano County
Sacramento County
San Joaquin County
Alameda County
Marin County
Hercules
Pinole
Richmond
El Cerrito
Martinez
Pittsburg
Concord
Antioch
Oakley
Pleasant Hill
Clayton
Brentwood
Walnut Creek
Orinda
Lafayette
Moraga
Danville
San Ramon
Legend
Soils
Type
B - Rock
C - Very Dense Soil and Soft Rock
D - Stiff Soil
E - Soft Soil
City Limits
County Boundary
Waterbodies
Streams
Roads
0
2
4
8
Miles
Source Contra Costa County GIS & NEHRP
Map Created By Tetra Tech on July 27th 2009
Projection: NAD_1983_StatePlane_California_III_FIPS_0403_Feet
N

Map 12-6.


Contra Costa County
Liquefaction Susceptibility
Legend
Liquefaction
Very Low
Low
Moderate
High
Very High
County Boundary
Roads
City Limits
Waterbodies
Streams
0 2 4 8
Miles
Solano County
Sacramento County
San Joaquin County
Alameda County
Marin County
Hercules
Pinole
Richmond
El Cerrito
Martinez
Pleasant Hill
Concord
Pittsburg
Antioch
Oakley
Clayton
Walnut Creek
Brentwood
Orinda
Lafayette
Moraga
Danville
San Ramon
Source Contra Costa County GIS
Map Created By Tetra Tech on July 27th 2009
Projection: NAD_1983_StatePlane_California_III_FIPS_0403_Feet

CHAPTER 13.
FLOOD

13.1 GENERAL BACKGROUND

A floodplain is the area adjacent to a river, creek or lake that becomes inundated during a flood. Floodplains may be broad, as when a river crosses an extensive flat landscape, or narrow, as when a river is confined in a canyon.

When floodwaters recede after a flood event, they leave behind layers of rock and mud. These gradually build up to create a new floor of the floodplain. Floodplains generally contain unconsolidated sediments (accumulations of sand, gravel, loam, silt, and/or clay), often extending below the bed of the stream. These sediments provide a natural filtering system, with water percolating back into the ground and replenishing groundwater. These are often important aquifers, the water drawn from them being filtered compared to the water in the stream. Fertile, flat reclaimed floodplain lands are commonly used for agriculture, commerce and residential development.

DEFINITIONS

Flood—The inundation of normally dry land resulting from the rising and overflowing of a body of water.

Floodplain—The land area along the sides of a river that becomes inundated with water during a flood.

100-Year Floodplain—The area flooded by a flood that has a 1-percent chance of being equaled or exceeded each year. This is a statistical average only; a 100-year flood can occur more than once in a short period of time. The 1-percent annual chance flood is the standard used by most federal and state agencies.

Return Period—The average number of years between occurrences of a hazard (equal to the inverse of the annual likelihood of occurrence).

Riparian Zone—The area along the banks of a natural watercourse.

Connections between a river and its floodplain are most apparent during and after major flood events. These areas form a complex physical and biological system that not only supports a variety of natural resources but also provides natural flood and erosion control. When a river is separated from its floodplain with levees and other flood control facilities, natural, built-in benefits can be lost, altered, or significantly reduced.

13.1.1 Measuring Floods and Floodplains

The frequency and severity of flooding are measured using a discharge probability, which is a statistical tool used to define the probability that a certain river discharge (flow) level will be equaled or exceeded within a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels. The flood frequency equals 100 divided by the discharge probability. For example, the 100-year discharge has a 1-percent chance of being equaled or exceeded in any given year. The “annual flood” is the greatest flood event expected to occur in a typical year. These measurements reflect statistical averages only; it is possible for two or more floods with a 100-year or higher recurrence interval to occur in a short time period. The same flood can have different recurrence intervals at different points on a river.

The extent of flooding associated with a 1-percent annual probability of occurrence (the base flood or 100-year flood) is used as the regulatory boundary by many agencies. Also referred to as the special flood hazard area (SFHA), this boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities. Many communities have maps that show the extent and likely depth of flooding for the base flood. Corresponding water-surface elevations describe the elevation of water that will result from a given discharge level, which is one of the most important factors used in estimating flood damage.

13.1.2 Floodplain Ecosystems

Floodplains can support ecosystems that are rich in quantity and diversity of plant and animal species. A floodplain can contain 100 or even 1000 times as many species as a river. Wetting of the floodplain soil releases an immediate surge of nutrients: those left over from the last flood, and those that result from the rapid decomposition of organic matter that has accumulated since then. Microscopic organisms thrive and larger species enter a rapid breeding cycle. Opportunistic feeders (particularly birds) move in to take advantage. The production of nutrients peaks and falls away quickly; however the surge of new growth endures for some time. This makes floodplains particularly valuable for agriculture. Species growing in floodplains are markedly different from those that grow outside floodplains. For instance, riparian trees (trees that grow in floodplains) tend to be very tolerant of root disturbance and very quick-growing compared to non-riparian trees.

13.1.3 Effects of Human Activities

Because they border water bodies, floodplains have historically been popular sites to establish settlements. Human activities tend to concentrate in floodplains for a number of reasons: water is readily available; land is fertile and suitable for farming; transportation by water is easily accessible; and land is flatter and easier to develop. But human activity in floodplains frequently interferes with the natural function of floodplains. It can affect the distribution and timing of drainage, thereby increasing flood problems. Human development can create local flooding problems by altering or confining drainage channels. This increases flood potential in two ways: it reduces the stream's capacity to contain flows, and it increases flow rates or velocities downstream during all stages of a flood event. Human activities can interface effectively with a floodplain as long as steps are taken to mitigate the activities' adverse impacts on floodplain functions.

13.1.4 Federal Flood Programs

National Flood Insurance Program

The NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in participating communities. For most participating communities, FEMA has prepared a detailed Flood Insurance Study (FIS). The study presents water surface elevations for floods of various magnitudes, including the 1-percent annual chance flood and the 0.2-percent annual chance flood (the 500-year flood). Base flood elevations and the boundaries of the 100- and 500-year floodplains are shown on Flood Insurance Rate Maps (FIRMs), which are the principle tool for identifying the extent and location of the flood hazard. FIRMs are the most detailed and consistent data source available, and for many communities they represent the minimum area of oversight under their floodplain management program.

Participants in the NFIP must, at a minimum, regulate development in floodplain areas in accordance with NFIP criteria. Before issuing a permit to build in a floodplain, participating jurisdictions must ensure that three criteria are met:

- New buildings and those undergoing substantial improvements must, at a minimum, be elevated to protect against damage by the 100-year flood.
- New floodplain development must not aggravate existing flood problems or increase damage to other properties.
- New floodplain development must exercise a reasonable and prudent effort to reduce its adverse impacts on threatened salmonid species.

Contra Costa County entered the NFIP on July 16, 1987. Structures permitted or built in the County before then are called "pre-FIRM" structures, and structures built afterwards are called "post-FIRM." The insurance rate is different for the two types of structures. The effective date for the current countywide FIRM is June 16, 2009. This map is a DFIRM (digital flood insurance rate map).

All 19 incorporated cities in Contra Costa County also participate in the NFIP. The county and cities are currently in good standing with the provisions of the NFIP. Compliance is monitored by FEMA regional staff and by the California Department of Water Resources under a contract with FEMA. Maintaining compliance under the NFIP is an important component of flood risk reduction. All planning partners that participate in the NFIP have identified initiatives to maintain their compliance and good standing.

The Community Rating System

The CRS is a voluntary program within the NFIP that encourages floodplain management activities that exceed the minimum NFIP requirements. Flood insurance premiums are discounted to reflect the reduced flood risk resulting from community actions meeting the following three goals of the CRS:

- Reduce flood losses.
- Facilitate accurate insurance rating.
- Promote awareness of flood insurance.

For participating communities, flood insurance premium rates are discounted in increments of 5 percent. For example, a Class 1 community would receive a 45 percent premium discount, and a Class 9 community would receive a 5 percent discount. (Class 10 communities are those that do not participate in the CRS; they receive no discount.) The CRS classes for local communities are based on 18 creditable activities in the following categories:

- Public information
- Mapping and regulations
- Flood damage reduction
- Flood preparedness.

Figure 13-1 shows the nationwide number of CRS communities by class as of May 1, 2010, when there were 1,138 communities receiving flood insurance premium discounts under the CRS program.

CRS activities can help to save lives and reduce property damage. Communities participating in the CRS represent a significant portion of the nation’s flood risk; over 66 percent of the NFIP’s policy base is located in these communities. Communities receiving premium discounts through the CRS range from small to large and represent a broad mixture of flood risks, including both coastal and riverine flood risks.

Contra Costa County and the cities of Concord, Pleasant Hill, Richmond, San Ramon and Walnut Creek are currently participating in the CRS program. Their CRS status is summarized in Table 13-1. The total annual savings on flood insurance premiums within the planning area is $549,194. Many of the mitigation actions identified in Volume 2 of this plan are creditable activities under the CRS program. Therefore successful implementation of this plan offers the potential for these communities to enhance their CRS classifications and for currently non-participating communities to join the program.

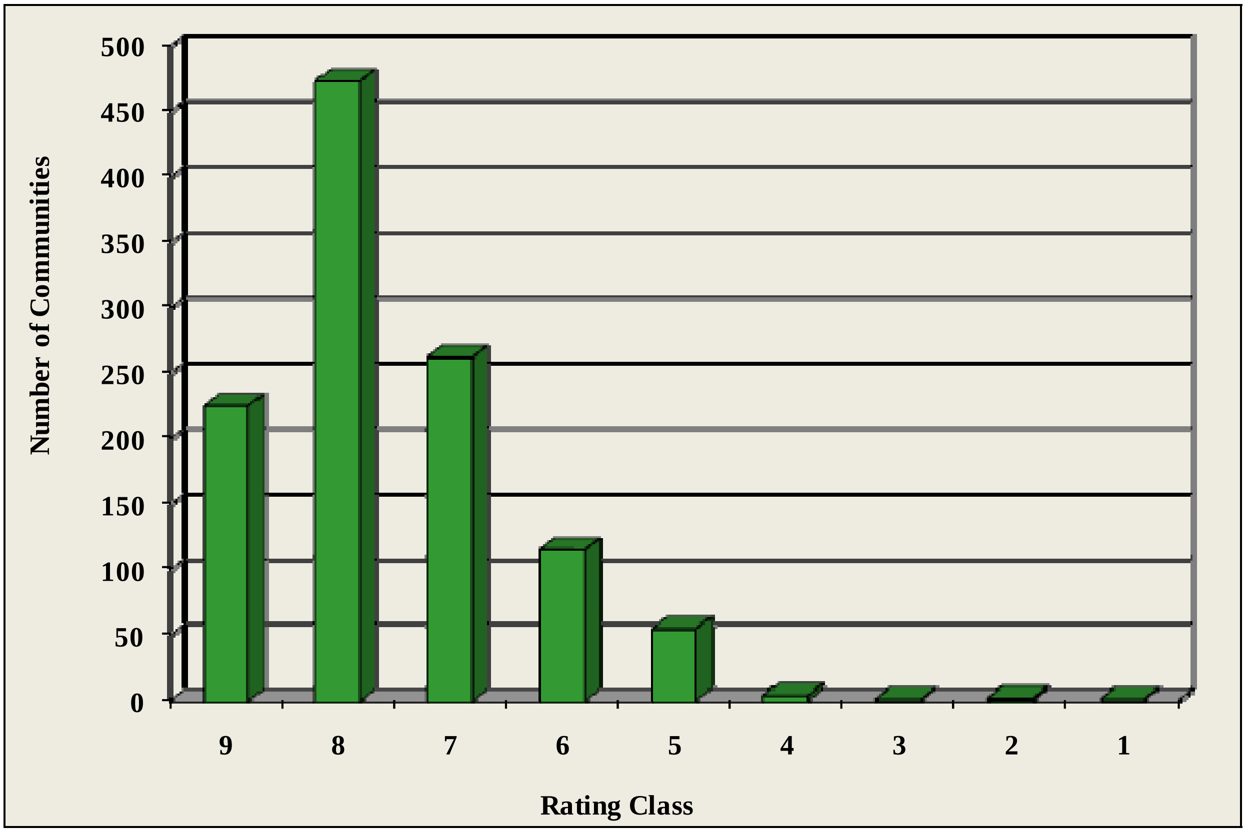


Figure 13-1. CRS Communities by Class as of May 1, 2010

TABLE 13-1.
CRS COMMUNITY STATUS-CONTRA COSTA COUNTY

Community	NFIP Community #	CRS Entry Date	Current CRS Classification	% Premium Discount, SFHA/non-SFHA	Total Premium Savings
Concord	065022	10/1/2008	8	10/5	$54,792
Pleasant Hill	060034	04/02/2002	8	10/5	$44,197
Richmond	060035	12/15/1994	9	5/5	$5,385
San Ramon	060710	12/15/1990	6[a]	20/10	$11,899
Walnut Creek	065070	12/15/1990	8[a]	10/5	$32,116
Contra Costa County	060025	12/15/1990	6	20/10	$400,805
Total					**$549,194**

a. Classification will become effective on 5/1/2011

13.2 HAZARD PROFILE

Flooding in Contra Costa County is typically caused by high-intensity, short-duration (1 to 3 hours) storms concentrated on a stream reach with already saturated soil. Two types of flooding are typical:

- Flash floods that occur suddenly after a brief but intense downpour. They move rapidly, end suddenly, and can occur in areas not generally associated with flooding (such as subdivisions not adjacent to a water body and areas serviced by underground drainage systems). Although the duration of these events is usually brief, the damage they cause can be severe. Flash floods cannot be predicted accurately and can happen whenever there are heavy storms.
- Riverine floods described in terms of their extent (including the horizontal area affected and the vertical depth of floodwater) and the related probability of occurrence (expressed as the percentage chance that a flood of a specific extent will occur in any given year).

Flooding is predominantly confined within traditional riverine valleys. Locally, some natural or manmade levees separate channels from floodplains and cause independent overland flow paths. Occasionally, railroad, highway or canal embankments form barriers, resulting in ponding or diversion of the flow. Some localized flooding not associated with stream overflow can occur where there are no drainage facilities to control flows or when runoff volumes exceed the design capacity of drainage facilities.

13.2.1 Principal Flooding Sources

The San Joaquin-Sacramento River Delta Region

Water that falls in the Central Valley of California and in most of the Sierra Nevada Mountains ultimately flows to the Pacific Ocean through the San Joaquin-Sacramento River Delta and along the shorelines of Contra Costa County.

Much of the delta is tidally influenced, and significant land in it has been reclaimed by about 1,100 miles of levees along natural and manmade waterways that divide it into about 120 tracts that are locally known as islands. The entire region of approximately 700,000 acres is under the influence of the tides, and much of the land is lower than the water on the opposite side of the levees. Many of the islands are 15 to 25 feet below sea level due to the subsidence of the peat land structure. Flooding of the delta islands has usually resulted from structural failure of the levees prior to overtopping. Major levee breaks have created new water bodies such as Franks Tract and Big Break. However, since the construction of many upstream dams, the flood factor has been reduced and now the major cause of flooding is levee instability.

Naturally occurring rich soil deposited in the lowlands by repeated flooding from the delta have attracted agricultural to this region. Flood control infrastructure was constructed to protect farmland, and irrigation canals crisscross the land to channel water through the region. Water for much of the county and the rest of the state is pumped from the delta. Clifton Court Forebay in the Brushy Creek watershed is the primary diversion point.

Baxter, Cerrito and West Richmond Watersheds

This 11,832-acre area is a series of subbasins containing two historically important East Bay waterways:

- Baxter Creek and its tributaries (14.44 miles) originate in underground springs beneath El Cerrito’s Mira Vista Golf Course and flow down from the hills in three branches. After running through a series of neighborhood parks, the creeks join near the Gateway Property at San Pablo and Macdonald Avenues. The creek then flows through Richmond into Stege Marsh and San Francisco Bay.

- Cerrito Creek (5.82 miles) straddles the Contra Costa-Alameda County border, draining the hills of El Cerrito and the unincorporated Community of Kensington before emptying into the Albany Flats and San Francisco Bay, just south of Point Isabel Regional Shoreline.

The headwaters of these creeks are in the northern extent of the East Bay Hills. The Wildcat Creek watershed forms this region's northern boundary. The Contra Costa County line follows Cerrito Creek along the watershed's southern boundary.

Many creeks in the Baxter and Cerrito Creek watersheds were lined or culverted during the first half of the 20th century to accommodate urbanization and prevent flooding in the lower areas. This relatively level area between the Berkeley Hills and Point Richmond is now drained by an extensive municipal stormwater system. The Richmond flatlands were first drained for agricultural use. Later, following the introduction of the railroad, this area became the site of industry in the region.

Wildcat Creek Watershed

The Wildcat Creek watershed drains a 6,848-acre area. The upper watershed is contained in Wildcat Canyon. The lower watershed enters the alluvial plain at Alvarado Park in the City of Richmond. Wildcat Creek then flows through San Pablo and Richmond to the San Francisco Bay.

Complex geologic characteristics affect the 13.43-mile Wildcat Creek. Trending parallel to the Hayward Fault, the creek leaves the Berkeley Hills and enters a massive alluvial fan. Repeated drought and flood events have caused changes in the shape of the fan and the course of the creek.

Rancho San Pablo (18,000-acre land-grant, 1823), one of the East Bay's earliest agricultural areas, included most of the Wildcat Creek watershed. Rich sediments in the alluvial fan supported farming of fruits and vegetables. The middle and upper watershed provided pasture for livestock and horses. After a deep water port was established at Point Richmond, land use in the area changed dramatically. Farms gave way to industry and manufacturing. The endpoint on the Santa Fe Railroad line was established in the region, further encouraging this land use transition. Oil refining was introduced as an industry in 1900, and remains a major industry in the area today.

San Pablo Creek Watershed

The San Pablo Creek watershed is 27,640 acres in the heart of western Contra Costa County. This area also was included in the site of Rancho San Pablo.

The headwaters of San Pablo Creek are in the City of Orinda. The headwaters cross into land administered by the East Bay Municipal Utility District (EBMUD) and flow into the San Pablo Reservoir. From the headwaters, the creek flows approximately 20 miles before reaching the San Francisco Bay. Tributary headwaters to the north enter the Briones Reservoir and are regulated by EBMUD as well. As water leaves the San Pablo Reservoir, it flows through first rural and then heavily urbanized residential and commercial areas before reaching the saltwater marshes adjacent to San Francisco Bay.

San Pablo Creek's flow regime and steep banks have prevented the creek from being diverted through culverts, providing the cities of San Pablo and Richmond, and the community of El Sobrante with a natural reminder of the surrounding watershed.

Rheem and Garrity Creek Watersheds

This 1,790-acre area in western Contra Costa County includes the watersheds of Rheem Creek (3.36 miles) and Garrity Creek (3.67 miles). These watersheds include sections of the Cities of Richmond, Pinole and San Pablo, as well as a small portion of unincorporated County (El Sobrante). Point Pinole Regional Shoreline is at the westernmost tip of the area, providing 632 acres of parkland in the watershed and marking the northernmost boundary of Rancho San Pablo.

The Giant Powder Company, one of the first American Companies to produce dynamite, moved to the area in 1892, making the area a populated, industrial center. Explosives were produced at the factory until 1960. The Carquinez Golf Club leased land just east of the explosive factory in 1934, and presently the Richmond Country Club occupies 180 acres of open space in the region.

The headwaters of Rheem Creek begin just east of Interstate 80 in a residential neighborhood of Richmond. On its route to San Pablo Bay, the creek passes into the City of San Pablo for one mile before entering the City of Richmond again, continuing its course to San Francisco Bay. One third of the creek is culverted under residential areas; the other two-thirds are above ground but contained in concrete and earthen channels. Flowing through a variety of industrial and residential area, it reaches the bay a half mile south of Point Pinole Regional Shoreline.

Pinole Creek Watershed

Pinole Creek is a perennial stream that drains a 9,705-acre watershed in western Contra Costa County. The creek is an important feature of the City of Pinole, and the City government is working with organizations such as the Friends of Pinole Creek, County Flood Control, and the U.S. Army Corps of Engineers to restore the creek through the center of the city. The creek flows northwest for approximately 11 miles from headwaters in the Briones Hills to its outlet at San Pablo Bay.

The Pinole Creek watershed is lightly developed compared to other watersheds in western Contra Costa County. One reason for this is that a drinking water reservoir was at one time planned for construction in the center of the watershed. EBMUD purchased thousands of acres of land in the area to prepare for this possibility. Plans for the new reservoir were ultimately set aside, but the public watershed land remains, and it continues to be managed by EBMUD. General watershed features are as follows:

- The City of Pinole occupies the northern third of the watershed. Pinole was incorporated in 1903 after being the site of Rancho Pinole (land-grant—1823). The city was originally settled in the alluvial floodplain of Pinole Creek, close to transport provided by the railroad and shipping on the bay.
- Interstate 80 forms a man-made margin where Pinole Creek leaves the confines of the East Bay Hills. From this point to the bay, the U.S. Army Corps of Engineers carried out extensive work on the Pinole Creek channel in the 1950s to control flooding in the downtown area.
- In the middle third of the watershed owned and managed by the EBMUD, various restoration projects along the tributaries that feed Pinole Creek (such as the Pavon Creeks restoration project) have provided shade and habitat to areas previously denuded by grazing and erosion. The central reaches of Pinole Creek and its tributaries meander through a broad, open valley and have a relatively intact floodplain, an unusual feature in the western part of County.
- The upper watershed consists of private ranchlands and remains a northern California oak woodlands and grasslands landscape. The very tip of the upper watershed is part of Briones Regional Park and is owned by the East Bay Regional Park District (EBRPD).

Refugio, Rodeo and Carquinez Area Watersheds

Refugio Creek, Rodeo Creek and the drainages at the northwest tip of Contra Costa County that flow into the Carquinez Strait cover 16,348 acres. The watersheds feature diverse land uses, including pristine oak-covered hills, an interstate highway, ranches, heavy industry, towns and new residential development. The City of Hercules and the communities of Rodeo, Crockett and Port Costa are located in the watershed.

Refugio Creek (4.52 miles), Rodeo Creek (8.35 miles), Canada del Cierbo Creek (2.86 miles) and Edwards Creek (2.0 miles) trend northwest and resemble other west county drainages, with a rural upper watershed with an urbanized or industrialized lower watershed. However, these watersheds do not have flatland areas in their lower reaches like the watersheds of Pinole, San Pablo, and Wildcat Creeks.

The upper watershed of Rodeo Creek and its tributaries is on private ranchland and EBRPD property. An industrial area and the community of Rodeo are in the lower watershed. Two smaller drainages to the north of Rodeo, including Canada del Cierbo Creek and an unnamed creed, begin in undeveloped land on the east side of Interstate 80 before being diverted underground through refinery properties.

The shorter, steeper Carquinez drainages flow southeast to northwest. These drainages are mostly unnamed except for Bull Valley Creek (2 miles), which flows north through the town of Port Costa, first filling the reservoir south of the town. The upper watersheds of these drainages also begin in EBRPD land and ranchlands before reaching residential and industrial areas on the shores of the Carquinez Strait.

Alhambra Creek and Peyton Slough Watersheds

The 7.88-mile main stem of Alhambra Creek and its two large tributaries (Franklin Creek and Arroyo Del Hambre) drain a 10,753-acre watershed and flow through the City of Martinez before discharging to the Carquinez Strait. Before the City of Martinez incorporated in 1876, the community was a busy trading post and transportation hub. Prospectors rode a ferry from the Martinez waterfront to cross the delta on their way to the Sierra-Nevada foothills. Tons of sediment, loosened by hydraulic mining practices in the Sierras, washed into the delta and changed the shape of the waterfront, repeatedly forcing the mouth of Alhambra Creek to advance northward.

The upper watershed retains much of its rural character. Alhambra Creek’s headwaters are located in Briones Regional Park. Other tracts of open space and agricultural lands further protect habitat in the watershed. Coastal Oak woodlands dominate the north-facing slopes of the upper and middle watershed.

The lower watershed also retains a rural feeling in higher elevations. Carquinez Strait Regional Shoreline protects the watershed north of Highway 4. Lower elevations, defined by the Alhambra Creek floodplain, were urbanized through the late 1800s. Shell opened its first U.S. refinery in Martinez in 1915.

Peyton Slough watershed (3,914 acres) is east of the Alhambra Creek watershed and has experienced almost 100 years of industrialization and urbanization. Peyton Creek (3.64 miles) is culverted underground through residential and industrial areas for over a third of its length. Over half of the watershed is urbanized, including all of the upper watershed. Early industry in the lower watershed included oil refining, chemical manufacturing and copper smelting.

Water in the predominantly residential upper watershed is controlled by storm drain systems. The lower watershed retains some of the marshland habitat central to the early history of this area. Native Americans lived in and frequented the local marshes for their abundant food sources. MacNabney Marsh, located in the Pacific Flyway, is home to many species of waterfowl and shorebirds.

Walnut Creek Watershed (Grayson-Murderers, Concord, Pine-Galindo, San Ramon and Las Trampas Subbasins)

Walnut Creek watershed encompasses 93,556 acres in central Contra Costa County. Draining the west side of Mount Diablo and the east side of the East Bay Hills, Walnut Creek’s major tributaries include

San Ramon Creek (18.89 miles), Bollinger Creek (6.72 miles), Las Trampas Creek (12.37 miles), Lafayette Creek (3.78 miles), Grayson Creek (8.87 miles), Murderer’s Creek (4.37 miles), Pine Creek (12.65 miles) and Galindo Creek (6.5 miles). Rainfall varies throughout the area in part due to the rain shadow effect of the East Bay Hills and the western slopes of Mount Diablo.

The Cities of Walnut Creek, Lafayette, Pleasant Hill and Danville lie completely within the boundaries of the watershed, and the Cities of Concord, Martinez, and small areas of Moraga and San Ramon are partly within the watershed. Rancho Monte Del Diablo, Rancho Arroyo de las Nueces y Bolbones, Rancho San Ramon, Rancho Las Juntas and Rancho Canada de Hambre all were established in the watershed in the early 1800s when agriculture and livestock played an important role. With the introduction of irrigation technologies, fruit and nut orchards started evolving in the valley. Later housing and commercial ventures along the Walnut Creek corridor resulted in an increased need for flood control. An extensive stormwater drainage system reroutes surface waters that once meandered across the valley.

Mount Diablo Creek Watershed

Mount Diablo Creek flows northwest from the Mount Diablo for 17.24 miles before reaching Suisun Bay. Unincorporated county land accounts for 64 percent of the watershed, which also includes the cities of Clayton and Concord. The lower third of the watershed is owned and managed by the U.S. Navy. Naval Weapons Station Seal Beach (previously the Concord Naval Weapons Station) occupies approximately 13,000 acres of open, relatively unaltered floodplain.

The headwaters of Mount Diablo Creek are in Mount Diablo State Park. Major tributaries—Mitchell Creek, Back Creek and Donner Creek—also originate in the state park. The creek and its tributaries flow relatively unencumbered from the headwaters to its outlet in Suisun Bay. The creek is channeled underground through the few areas that are more developed.

Willow and Kirker Creek Watersheds

The 10,132-acre Kirker Creek watershed reaches from the foothills of Mount Diablo to the Sacramento-San Joaquin Delta. Flowing north from its headwaters, Kirker Creek (9.43 miles) runs through parkland and ranchland in the upper watershed and continues through suburban residential neighborhoods and commercial areas in the lower watershed. Though most of Kirker Creek is open channel, culverts direct the creek underground at road crossings and through some urban areas. Originally, Kirker Creek flowed directly north to the delta. In the 1940s, it was diverted to bypass the U.S. Steel property (now USS-POSCO). Kirker Creek now makes a 90-degree turn and flows into Los Medanos Wasteway. At high flow it also uses Dowest Slough.

The creek flows during the rainy season (November through April) and dries out in the summer. Irrigation and related urban runoff produce some urban dry-weather flow that keeps areas of the creek wet throughout the year, which is characteristic of the entire watershed. Annual rainfall here averages 16.5 inches in the upper reaches.

The Willow Creek watershed encompasses 16,063 acres. Willow Creek (6.16 miles) is located in the middle of the watershed, with approximately 10 miles of unnamed tributaries draining into it in its lower reaches. Most of the lower reaches of these tributaries, including creeks to the east of Willow Creek, are in underground culverts as they flow through the single-family residential neighborhoods of Bay Point and Pittsburg.

East and West Antioch Creek Watersheds

The watersheds of East and West Antioch Creeks are in the northeastern part of Contra Costa County, between the hills south of Antioch and the Sacramento-San Joaquin River Delta.

The main stem of West Antioch Creek flows from headwaters in land managed by EBRPD. The creek flows through a valley that was at one time proposed for a major landfill facility. After a different location was selected for the landfill, the valley was purchased by EBRPD and added to Black Diamond Mine Regional Preserve. West Antioch Creek (6.24 miles) is joined by Markley Canyon Creek (5.3 miles) and a few unnamed tributaries, before passing near the Dow Wetlands Preserve and discharging into the San Joaquin River. The headwaters of Markley Canyon Creek are in the Black Diamond Mine Preserve. The confluence of Markley Canyon Creek and West Antioch is north of Highway 4, where both creeks are channelized. Although channelized in its lower half, the main stem of West Antioch Creek remains above ground for most of its length. Large sections of tributaries, however, are routed underground to provide flood protection and drainage through more developed areas.

East Antioch Creek flows from low-elevation headwaters near Lone Tree Way in Antioch. Various detention basins and levees along the length of the creek prevent stormwater from moving into the Marsh Creek drainage area, which it has done historically during flood events.

Two reservoirs located in these watersheds—Contra Loma Reservoir and the Antioch Municipal Reservoir—provide drinking water storage.

Marsh Creek Watershed

Marsh Creek flows 34.57 miles from headwaters in the foothills and on the eastern flanks of Mount Diablo to the San Joaquin River Delta at Big Break. The second largest watershed in Contra Costa County, it encompasses 60,066 acres in the eastern county. Tributaries in the upper watershed include Curry Canyon Creek (5.8 miles), Sycamore Creek (4 miles) and Briones Creek (13 miles), which flows into the Marsh Creek Reservoir. Tributaries entering the middle portion of the main stem near and in the City of Brentwood include Dry Creek (5.8 miles), Sand Creek (18.74 miles) and Dear Creek (9 miles).

North of the Marsh Creek Reservoir, Marsh Creek runs through urban and agricultural areas in the Cities of Brentwood and Oakley. Much of the undeveloped area north of the Marsh Creek Reservoir is planned for development, as well as area along Sand Creek in the City of Antioch.

Marsh Creek goes through hydrologic, geologic and topographic changes as it leaves its steep, rocky headwaters and enters the alluvial plain north of the Marsh Creek Reservoir. Historically, Marsh Creek meandered through this alluvial area. However, since 1856 and the establishment of Rancho Los Meganos, and more dramatically after the turn of the century, farmers and flood control authorities have altered the channel and the surrounding landscape to protect agricultural resources. The building of levees, detention basins, dams and reservoirs, as well as culverting, straightening and the creation of concrete-lined channels, led to a severe reduction in riparian habitat and vegetation.

Hydrology in the eastern portion of the watershed is complex due to the number of irrigation canals and diversions. The eastern boundary of the Marsh Creek watershed was generated using Contra Costa County Flood Control drainage inventory and topographical information only.

Kellogg and Brushy Creek Watersheds

The Kellogg Creek and Brushy Creek watersheds are in southeastern Contra Costa County, bordering Alameda and San Joaquin Counties. Due to the rain shadow effect of Mount Diablo, average annual rainfall is approximately 20 inches in the upper portions of these watersheds and 10 inches or less in the lower portions. Few areas here are developed, and all land is in unincorporated Contra Costa County.

The 20,863-acre Kellogg Creek watershed includes the Contra Costa Water District's Los Vaqueros Reservoir, which can store up to 100,000 acre-feet of water, pumped to the facility from an intake at Old River near Discovery Bay. Water from Los Vaqueros serves 450,000 customers in Contra Costa County during the summer. The protected open space at Los Vaqueros Reservoir is now home to a variety of animal and bird species. The Contra Costa Water District runs educational programs for school groups from their interpretive center at the reservoir that highlights water issues, plants, wildlife and the history of the area.

Originally known as Arroyo de los Posos, the 25.34-mile Kellogg Creek barely resembles its original course through the area. Both Kellogg and Brushy Creek were diverted and altered by farmers in the north and eastern parts of the watershed, where Marsh, Kellogg and Brushy creeks enter the alluvial plain.

Upper Alameda Creek Watershed (Cayetano, Alamo-Tassajara, and South San Ramon Subbasins)

One of the largest watersheds in the Bay Area, the 405,120-acre Alameda Creek watershed stretches from the Mount Diablo foothills in the north to Mount Hamilton in the south. The 39,142-acre portion of this watershed in southern Contra Costa County is part of the headwaters. Alameda Creek's outlet is in Alameda County in the City of Fremont near the EBRPD's Coyote Hill Regional Park and the San Francisco Bay National Wildlife Refuge.

Other creeks in Contra Costa County portion of this watershed are South San Ramon, Alamo, Tassajara, and Cayetano Creeks. San Ramon and a small area of Danville are in the westernmost part of the area. Most of land to the east in unincorporated. The City of San Ramon's Environmental Affairs Advisory Committee is active on creek and watershed issues in this area.

Upper San Leandro and Moraga Creek Watersheds

The Upper San Leandro and Moraga Creek watersheds include 13,059 acres in Contra Costa County. These creeks flow into the Upper San Leandro Reservoir, managed by the EBMUD. The reservoir spans the county line, and its outlet is in Alameda County. Its discharge flows through Alameda County to the San Francisco Bay.

Creeks in this area include Moraga Creek (4.7 miles), San Leandro Creek (4.76 miles), Laguna Creek (3.2 miles), Redwood Creek (1.8 miles), Indian Creek (1.8 miles), Rimer Creek (3.14 miles), Buckhorn Creek (2.1 miles), and Callahan Creek (1.3 miles). The channels of the creeks in the area are relatively unmodified. Large flood control channels have not been built in this region. Moraga Creek has been routed underground in short reaches to accommodate urbanization and infrastructure development.

The southern extent of Orinda and a major portion of Moraga make up much of these watersheds. The remaining area is unincorporated county lands, including areas managed by EBRPD and EBMUD.

13.2.2 Past Events

Delta flooding has a long history in Contra Costa County and is a continuing problem. Since construction of levees started in the early 1860s, every island in the delta has been flooded at least once due to levee overtopping or failure. Approximately 110 levee failures have occurred since 1900, almost 45 since 1930, approximately 25 since 1950, and about 12 since 1980. Little data is available for specific flood events from 1850 to the early 1900s, but records show that 13 of the many floods that occurred were outstanding events (1850, 1852, 1861-62, 1871, 1875, 1878, 1879, 1881, 1902, 1904, 1906, 1907 and 1909), and the floods of 1878, 1881, 1904, 1907 and 1909 were the most severe. Large portions of the delta area were inundated and there was widespread and extensive damage.

Floods in 1950 and 1955 were outstanding in peak outflows through the delta area, and several islands were flooded. The 1955 flood flow inundated almost 38,000 acres, more than doubling the flooded acreage of 1950 (about 18,000 acres), and caused about $3.3 million in damage (compared to about $1.2 million in 1950). The delta area suffered permanent damage to a sizeable amount of agricultural land. Concurrent strong onshore winds generated high waves that threatened many islands.

Table 13-2 summarizes flood events in the planning area since 1955. Since 1969, 10 presidential-declared flood events in the County have caused in excess of $50 million in property damage.

TABLE 13-2.
CONTRA COSTA COUNTY FLOOD EVENTS

Date	Declaration #	Type of event	Estimated Damage[a]
1/1/2006	DR 1628	Flooding	22,000,000 property/8,710,359 crop
2/14/2000	N/A	Flash flood	$100,000 property
2/9/1998	DR 1203	Severe winter storms and flooding	—
1/1997	DR 1155	Severe storms/flooding	—
3/12/1995	DR 1046	Flooding	$11.2 million
1/10/1995	DR 1044	Severe winter storms, flooding, landslides, mud flows	
1/13/1993	DR 979	Flooding (flash flood)	$5.5 million property/crop
12/11/1992	N/A	Flooding/severe weather	$131,579 property
2/14/1992	N/A	Flooding- severe weather	$20,718 property
5/28/1990	N/A	Flooding (flash flood)	$500,000 property
2/17/1986	DR 758	Flooding (flash flood)	$5,000,000 property
12/9/1983	N/A	Levee failure, high winds, high tides, floods, storm, wind driven water	public-7,240,785; private- 2,669 million; agriculture 1 million
2/9/1983	DR 677	Flood- severe weather	$384,165 property
3/3/1982	N/A	Flooding	$166,667 property
1/3/1982	DR 651	Flood- severe weather	7,142,857 property
1/23/1980	N/A	Delta levee break Holland & Webb levee breaks	Public-11,158,700; private-1,479,500; agriculture-3,887,195; total-17,388,013
1/16/1973	N/A	Flood- severe storm/thunder	$86,206 property
1/18/1969	DR 253	Flood- severe storm/thunder	$862,068 property
1/1978	N/A		—
12/1955	N/A	Severe winter storms, flooding	$22 million

a. Data obtained from Spatial Hazard Events and Losses Database for the United States (SHELDUS)
N/A = Information is not available

The flood of December 1955 had an estimated recurrence interval of 22 years. Flood conditions created by heavy rains were aggravated by high tides. The damage in Contra Costa County was extensive, with an estimated loss to private dwellings of $1.25 million (1955 dollars). Approximately 460 families were evacuated from Byron, Brentwood, Knightsen, Tree Haven, Fair Oaks, Meadow Homes, Sherman Acres, Gregory Gardens (now part of the City of Pleasant Hill), and the City of Walnut Creek.

In December 1964 and January 1965, the coincidental occurrence of very high tides and heavy inflow resulted in unusually high stages on all delta area waterways.

In January and February 1969, high tides and adverse wave action in the delta area combined with large river inflow and rain-soaked levees to cause the flooding of several islands. Approximately 11,400 acres were inundated and flood damage amounted to $9.2 million.

In mid-January 1980, severe rainstorms over central California precipitated high river outflow through the delta area which, coinciding with gale force winds over the delta area and high tides, resulted in the levee failure and flooding of two tracts, placing approximately 9,600 acres under water. Continued high inflow to the delta area and wind-generated waves increased erosion on all delta-area levees, necessitating the temporary curtailment of boat traffic.

13.2.3 Flooding Extent and Location

The major floods in Contra Costa County have resulted from intense weather rainstorms between November and March. The flooding that has occurred in portions of the county has been extensively documented by gage records, high water marks, damage surveys and personal accounts. This documentation was the basis for the June 16, 2009 FIRMs generated by FEMA for Contra Costa County. The 2009 Flood Insurance Study is the sole source of data used in this risk assessment to map the extent and location of the flood hazard, as shown in Map 13-1.

13.2.4 Frequency

Contra Costa County experiences episodes of river flooding almost every winter. Large floods that can cause property damage typically occur every three to seven years. Urban portions of the county annually experience nuisance flooding related to drainage issues.

13.2.5 Severity

The principal factors affecting flood damage are flood depth and velocity. The deeper and faster flood flows become, the more damage they can cause. Shallow flooding with high velocities can cause as much damage as deep flooding with slow velocity. This is especially true when a channel migrates over a broad floodplain, redirecting high velocity flows and transporting debris and sediment. Flood severity is often evaluated by examining peak discharges; Table 13-3 lists peak flows used by FEMA to map the floodplains of Contra Costa County.

13.2.6 Warning Time

Due to the sequential pattern of meteorological conditions needed to cause serious flooding, it is unusual for a flood to occur without warning. Warning times for floods can be between 24 and 48 hours. Flash flooding can be less predictable, but potential hazard areas can be warned in advanced of potential flash flooding danger.

TABLE 13-3.
SUMMARY OF PEAK DISCHARGES WITHIN CONTRA COSTA COUNTY

	Discharge (cubic feet/second)			
Source/Location	10-Year	50-Year	100-Year	500-Year
Arroyo Del Hambre Creek at Jose Lane	2,240	3,290	3,660	4,380
San Ramon Bypass at Junction Of Old Channel	7,820	12,000	13,400	16,300
Wildcat Creek at Church Lane	1,250	1,950	2,300	2,600
West Antioch Creek at Fairgrounds	790	1,580	2,000	2,900
Walnut Creek at Corporate Limits at State Highway 4	9,520	18,000	22,300	31,000
South San Ramon Creek at Alcosta Boulevard	2,650	3,920	4,350	5,300
Mount Diablo Creek Downstream Of Bailey Road	3,670	5,670	6,350	7,760
Pine Creek at Confluence With Walnut Creek	3,200	6,000	7,300	10,000
Pacheco Creek Near Suisun Bay	11,000	20,500	25,000	35,000
Marsh Creek at Union Pacific Railroad	2,100	4,200	5,200	8,300
Moraga Creek at Confluence With Laguna Creek	1,790	3,300	3,800	4,300
Las Trampas Creek at San Ramon Creek	5,410	8,090	9,000	10,800

Flooding is more likely to occur due to a rain storm when the soil is already wet and/or streams are already running high from recent previous rains (conditions already in place when a storm begins are called “antecedent conditions”). Contra Costa County Flood Control District maintains a flood warning system that is tied to monitoring rainfall amounts during storms as well as current antecedent conditions at several rain gauges in Contra Costa County. Critical antecedent conditions for flood warning are defined as follows:

- 7 inches of rain for the season starting on July 1.
- 5 inches of rain in the last 30 days.
- 3 inches of rain in the last 7 days.

If any of these conditions have been met and 2 inches of rainfall is forecast in the next 24 hours, then flooding is likely in the next 24 hours. This information has been provided to the public via the Contra Costa County Flood Control and Water Conservation District’s “7-5-3-2” outreach campaign.

13.3 SECONDARY HAZARDS

The most problematic secondary hazard for flooding in Contra Costa County is bank erosion, which in some cases can be more harmful than actual flooding. This is especially true in the upper courses of rivers with steep gradients, where floodwaters may pass quickly and without much damage, but scour the banks, edging properties closer to the floodplain or causing them to fall in. Flooding is also responsible for hazards such as landslides when high flows over-saturate soils on steep slopes, causing them to fail. Hazardous materials spills are also a secondary hazard of flooding if storage tanks rupture and spill into streams, rivers or storm sewers.

13.4 CLIMATE CHANGE IMPACTS

Global climate change could trigger an increase in flood activity in two ways: flooding associated with sea level rise; and atmospheric changes that alter the frequency, duration and intensity of storms that cause flooding.

13.4.1 Sea Level Rise

As the earth heats up, sea levels may rise as melting glaciers pour more fresh water into the oceans. Rising seas threaten to inundate low-lying areas and islands, threaten dense coastal populations, erode shorelines, damage property and destroy ecosystems that protect coasts against storms.

Sea levels have risen between 4 and 8 inches in the past 100 years. Current projections suggest that sea levels could continue to rise between 4 inches and 36 inches over the next 100 years. Such a sea level rise could displace people in low-lying areas such as portions of Contra Costa County.

13.4.2 Changes to the Hydrograph

Use of historical hydrologic data has long been the standard of practice for designing and operating water supply and flood protection projects. For example historical data are used for flood forecasting models and to forecast snowmelt runoff for water supply. This method of forecasting assumes that the climate of the future will be similar to that of the period of historical record. However, the hydrologic record cannot be used to predict changes in frequency and severity of extreme climate events such as floods. Going forward, model calibration or statistical relation development must happen more frequently, new forecast-based tools must be developed, and a standard of practice that explicitly considers climate change must be adopted. Climate change is already impacting California's water resources, and resource managers have observed the following:

- Historical hydrologic patterns can no longer be solely relied upon to forecast the water future.
- Precipitation and runoff patterns are changing, increasing the uncertainty for water supply and quality, flood management and ecosystem functions.
- Extreme climatic events will become more frequent, necessitating improvement in flood protection, drought preparedness and emergency response.

The amount of snow is critical for water supply and environmental needs, but so is the timing of snowmelt runoff into rivers and streams. Rising snowlines caused by climate change will allow more of the Sierra Nevada watersheds to contribute to peak storm runoff. High frequency flood event s (e.g. 10 -year floods) in particular will likely increase with a changing climate. Along with reductions in the amount of the snowpack and accelerated snowmelt, scientists project greater storm intensity, resulting in more direct runoff and flooding. Changes in watershed vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As stream flows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality. With potential increases in the frequency and intensity of wildfires due to climate change, there is potential for more floods following fire, which increase sediment loads and water quality impacts.

As hydrology changes, what is currently considered a 100 -year flood may strike more often, leaving many communities at greater risk. Planners will need to factor a new level of safety into the design, operation, and regulation of flood protection facilities such as dams, floodways, bypass channels and levees, as well as the design of local sewers and storm drains.

13.5 EXPOSURE

The Level 2 HAZUS-MH protocol was used to assess the risk and vulnerability to flooding in the planning area. The model used census data at the block level and FEMA floodplain data, which has a level of accuracy acceptable for planning purposes. Where possible, the HAZUS-MH default data was enhanced using local GIS data from county, state and federal sources.

13.5.1 Population

Population counts of those living in the floodplain in the planning area were generated by analyzing census blocks that intersect with the 100-year and 500-year floodplains identified on FIRMs. Census blocks do not follow the boundaries of the floodplain. Therefore, the methodology used to generate these estimates counted census block groups whose centers are in the floodplain or where the majority of the population most likely lives in or near the floodplain. HAZUS-MH estimated the number of buildings within the floodplain in each block, and then estimated the total population by multiplying the number of residential structures by the average Contra Costa County household size of 2.72 persons per household.

Using this approach, it was estimated that the exposed population for the entire county is 24,338 within the 100-year floodplain (2.30 percent of the total county population) and 33,766 within the 500-year floodplain (3.18 percent of the total). For the unincorporated portions of the county, it is estimated that the exposed population is 9,210 within the 100-year floodplain (5.41 percent of the total unincorporated county population) and 14,512 within the 500-year floodplain (8.52 percent of the total).

13.5.2 Property

Structures in the Floodplain

Tables 13-4 and 13-5 summarize the total area and number of structures in the floodplain by municipality. The HAZUS-MH model determined that there are 8,948 structures within the 100-year floodplain and 21,362 structures within the 500-year floodplain. In the 100-year floodplain, about 38 percent of these structures are in unincorporated areas. Eighty-eight percent are residential, and 9.7 percent are commercial, industrial or agricultural.

Exposed Value

Tables 13-6 and 13-7 summarize the estimated value of exposed buildings in the planning area. This methodology estimated $6.4 billion worth of building-and-contents exposure to the 100-year flood, representing 3.65 percent of the total assessed value of the planning area, and $13.4 billion worth of building-and-contents exposure to the 500-year flood, representing 7.67 percent of the total.

Land Use in the 100-Year Floodplain

Some land uses are more vulnerable to flooding, such as single-family homes, while others are less vulnerable, such as agricultural land or parks. Table 13-8 shows the existing land use of all parcels in the 100-year and 500-year floodplain, including vacant parcels and those in public/open space uses, broken down for the unincorporated portion of the county. About 79 percent of the parcels in the 100-year floodplain are zoned for agricultural uses. These are favorable, lower-risk uses for the floodplain. The amount of the floodplain that contains vacant, developable land is not known. This would be valuable information for gauging the future development potential of the floodplain.

TABLE 13-4.
AREA AND STRUCTURES WITHIN THE 100-YEAR FLOODPLAIN

	Area (Acres)	Number of Structures							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	**Total**
Antioch	834.25	184	24	6	0	0	17	0	**231**
Brentwood	302.06	197	4	0	1	0	2	1	**205**
Clayton	129.75	85	11	0	0	0	4	1	**101**
Concord	891.53	643	14	19	0	4	8	2	**690**
Danville	239.85	146	8	0	1	1	2	1	**159**
El Cerrito	25.53	152	2	0	0	0	0	0	**154**
Hercules	259.35	71	1	0	0	0	0	0	**72**
Lafayette	280.97	282	36	1	0	0	0	1	**320**
Martinez	1227.14	829	152	7	0	7	19	7	**1021**
Moraga	105.96	68	0	0	0	0	0	0	**68**
Oakley	3967.40	141	14	1	4	0	6	0	**166**
Orinda	139.51	149	25	0	0	0	2	0	**176**
Pinole	103.88	37	1	0	0	0	1	0	**39**
Pittsburg	2150.63	164	3	16	0	1	5	0	**189**
Pleasant Hill	294.79	725	32	0	0	0	2	2	**761**
Richmond	2032.99	83	22	19	0	0	6	0	**130**
San Pablo	173.09	561	16	8	0	5	0	0	**590**
San Ramon	173.46	143	2	0	0	0	1	0	**146**
Walnut Creek	165.72	324	19	0	0	0	1	0	**344**
Unincorporated	59,303.27	2920	237	30	136	12	49	2	**3386**
Total	**72,801.13**	**7904**	**623**	**107**	**142**	**30**	**125**	**17**	**8948**

**TABLE 13-5.
AREA AND STRUCTURES WITHIN THE 500-YEAR FLOODPLAIN**

	Area (Acres)	Number of Structures							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	**Total**
Antioch	1085.45	409	45	6	0	0	19	0	**479**
Brentwood	867.60	1123	17	3	4	0	9	2	**1158**
Clayton	142.81	88	19	0	0	0	4	1	**112**
Concord	1395.02	1585	67	20	0	4	10	7	**1693**
Danville	399.95	445	9	0	1	1	2	2	**460**
El Cerrito	25.55	152	2	0	0	0	0	0	**154**
Hercules	287.70	210	1	0	0	0	0	0	**211**
Lafayette	414.58	474	69	1	0	0	1	3	**548**
Martinez	1381.57	905	169	18	0	8	26	7	**1133**
Moraga	168.50	176	16	0	0	0	0	0	**192**
Oakley	5137.83	1245	14	1	12	0	7	1	**1280**
Orinda	151.33	149	28	0	0	0	2	0	**179**
Pinole	115.27	52	8	0	0	3	4	0	**67**
Pittsburg	2196.37	165	3	18	0	1	5	0	**192**
Pleasant Hill	654.03	1776	97	0	0	1	5	4	**1883**
Richmond	2552.09	726	46	48	0	6	12	1	**839**
San Pablo	309.42	1142	52	9	0	9	5	0	**1217**
San Ramon	200.35	168	3	0	0	0	1	1	**173**
Walnut Creek	326.04	547	172	0	0	0	10	0	**729**
Unincorporated	67,402.41	8046	304	64	160	18	64	7	**8663**
Total	**85,213.87**	**19583**	**1141**	**188**	**177**	**51**	**186**	**36**	**21,362**

TABLE 13-6.
VALUE OF EXPOSED BUILDINGS WITHIN 100-YEAR FLOODPLAIN

	Estimated Flood Exposure			% of Total Assessed Value
	Structure	Contents	**Total**	
Antioch	$48,176,680	$44,489,820	**$92,666,500**	0.87%
Brentwood	$57,060,134	$47,912,827	**$104,972,961**	1.05%
Clayton	$33,477,378	$29,834,764	**$63,312,142**	3.22%
Concord	$172,344,202	$177,324,979	**$349,669,181**	2.54%
Danville	$50,046,456	$41,806,637	**$91,853,093**	1.17%
El Cerrito	$29,829,557	$23,863,914	**$53,693,471**	2.04%
Hercules	$11,506,905	$9,449,076	**$20,955,981**	0.57%
Lafayette	$89,064,735	$76,088,364	**$165,153,099**	4.03%
Martinez	$312,326,254	$344,052,129	**$656,378,383**	9.25%
Moraga	$15,108,131	$12,086,507	**$27,194,638**	1.03%
Oakley	$47,366,489	$41,357,863	**$88,724,352**	1.86%
Orinda	$60,955,757	$54,130,134	**$115,085,891**	3.00%
Pinole	$4,791,819	$3,889,382	**$8,681,201**	0.79%
Pittsburg	$100,555,857	$123,399,191	**$223,955,048**	3.13%
Pleasant Hill	$177,097,733	$156,739,542	**$333,837,275**	8.24%
Richmond	$172,201,101	$220,105,363	**$392,306,464**	2.53%
San Pablo	$82,810,777	$69,530,409	**$152,341,186**	7.34%
San Ramon	$37,197,704	$30,097,475	**$67,295,179**	0.59%
Walnut Creek	$82,913,997	$71,612,289	**$154,526,286**	0.98%
Unincorporated	$1,495,632,613	$1,695,692,279	**$3,191,324,892**	7.27%
Total	**$3,080,464,279**	**$3,273,462,944**	**$6,353,927,223**	**3.65%**

TABLE 13-7.
VALUE OF EXPOSED BUILDINGS WITHIN 500-YEAR FLOODPLAIN

	Estimated Flood Exposure			% of Total Assessed Value
	Structure	Contents	**Total**	
Antioch	$186,408,574	$174,785,633	**$361,194,207**	3.38%
Brentwood	$329,193,095	$274,103,014	**$603,296,109**	6.02%
Clayton	$39,895,538	$35,948,416	**$75,843,954**	3.86%
Concord	$640,409,320	$617,797,825	**$1,258,207,145**	9.14%
Danville	$129,121,497	$105,247,783	**$234,369,280**	2.97%
El Cerrito	$29,829,557	$23,863,914	**$53,693,471**	2.04%
Hercules	$35,812,229	$28,893,337	**$64,705,566**	1.75%
Lafayette	$159,917,207	$138,842,321	**$298,759,528**	7.28%
Martinez	$331,549,355	$362,037,155	**$693,586,510**	9.77%
Moraga	$49,903,035	$42,223,329	**$92,126,364**	3.48%
Oakley	$329,596,551	$267,473,143	**$597,069,694**	12.51%
Orinda	$62,730,186	$55,904,563	**$118,634,749**	3.09%
Pinole	$11,753,926	$10,621,373	**$22,375,299**	2.02%
Pittsburg	$201,348,129	$274,547,111	**$475,895,240**	6.64%
Pleasant Hill	$369,484,620	$320,073,023	**$689,557,643**	17.03%
Richmond	$294,508,347	$340,295,992	**$634,804,339**	4.09%
San Pablo	$203,458,934	$176,004,905	**$379,463,839**	18.29%
San Ramon	$45,791,850	$37,569,995	**$83,361,845**	0.73%
Walnut Creek	$383,710,551	$363,402,030	**$747,112,581**	4.73%
Unincorporated	$2,973,466,906	$2,904,683,735	**$5,878,150,641**	13.40%
Total	**$6,807,889,407**	**$6,554,318,597**	**$13,362,208,004**	**7.67%**

TABLE 13-8.
LAND USE WITHIN THE FLOODPLAIN (UNINCORPORATED COUNTY)

	100-Year Floodplain		500-Year Floodplain	
Land Use	Area (acres)	% of total	Area (acres)	% of total
Agricultural Preserve	7907.52	13.33%	7907.52	11.73%
Controlled Manufacturing	0.43	0.00%	0.43	0.00%
Exclusive Agricultural	2591.70	4.37%	2710.12	4.02%
Forestry Recreational	69.39	0.12%	69.82	0.10%
General Agricultural	25263.92	42.60%	25825.35	38.32%
General Commercial	30.31	0.05%	37.89	0.06%
Heavy Agricultural	11663.37	19.67%	16769.65	24.88%
Heavy Industrial	4171.89	7.03%	4173.89	6.19%
Light Industrial	358.85	0.61%	362.73	0.54%
Limited Office	1.41	0.00%	1.92	0.00%
Mobile Home/Manufactured Home Park	136.25	0.23%	167.37	0.25%
Multiple Family Residential	49.33	0.08%	59.87	0.09%
Neighborhood Business	1.97	0.00%	4.54	0.01%
Planned Unit	2937.83	4.95%	4415.84	6.55%
Retail Business	283.47	0.48%	288.34	0.43%
Single Family Residential	598.58	1.01%	960.96	1.43%
Two Family Residential	5.19	0.01%	8.19	0.01%
Unrestricted	2306.15	3.89%	2543.19	3.77%
Water Recreational	925.71	1.56%	1094.79	1.62
Total	**59303.27**	**100%**	**67402.41**	**100%**

13.5.3 Critical Facilities and Infrastructure

Tables 13-9 through 13-12 summarize the critical facilities and infrastructure in the 100-year and 500-year floodplains of Contra Costa County. Details are provided in the following sections.

Tier II Facilities

Tier II facilities are those that use or store materials that can harm the environment if damaged by a flood. Sixty-one businesses in the 100-year floodplain and 62 businesses in the 500-year floodplain report having Tier II hazardous materials. During a flood event, containers holding these materials can rupture and leak into the surrounding area, having a disastrous effect on the environment as well as residents.

Utilities and Infrastructure

It is important to determine who may be at risk if infrastructure is damaged by flooding. Roads or railroads that are blocked or damaged can isolate residents and can prevent access throughout the county, including for emergency service providers needing to get to vulnerable populations or to make repairs. Bridges washed out or blocked by floods or debris also can cause isolation. Water and sewer systems can be flooded or backed up, causing health problems. Underground utilities can be damaged. Dikes can fail or be overtopped, inundating the land that they protect. The following section describe specific types of critical infrastructure.

**TABLE 13-9.
CRITICAL FACILITIES IN THE 100-YEAR FLOODPLAIN**

Jurisdiction	Medical and Health Services	Government Function	Protective	Hazardous Materials	Schools	Other	**Total**
Antioch	0	0	0	0	0	2	**2**
Brentwood	1	0	0	0	0	0	**1**
Clayton	0	0	0	0	1	0	**1**
Concord	0	0	0	0	2	0	**2**
Danville	0	0	0	0	0	0	**0**
El Cerrito	0	0	0	0	0	0	**0**
Hercules	0	0	0	0	0	0	**0**
Lafayette	0	0	0	0	1	0	**1**
Martinez	1	2	2	2	3	1	**11**
Moraga	0	0	0	0	0	0	**0**
Oakley	0	0	1	0	0	0	**1**
Orinda	0	0	0	0	0	0	**0**
Pinole	0	0	0	0	0	0	**0**
Pittsburg	0	0	0	2	0	1	**3**
Pleasant Hill	0	0	0	0	1	0	**1**
Richmond	0	0	0	1	0	1	**2**
San Pablo	0	0	0	6	0	0	**6**
San Ramon	0	0	1	0	0	0	**1**
Walnut Creek	0	0	1	0	1	0	**2**
Unincorporated	0	0	7	50	5	26	**88**
Total	**2**	**2**	**12**	**61**	**14**	**31**	**122**

**TABLE 13-10.
CRITICAL FACILITIES IN THE 500-YEAR FLOODPLAIN**

Jurisdiction	Medical and Health Services	Government Function	Protective	Hazardous Materials	Schools	Other	**Total**
Antioch	0	0	0	0	0	2	**2**
Brentwood	1	0	0	0	1	0	**2**
Clayton	0	0	0	0	1	0	**1**
Concord	0	0	0	0	5	0	**5**
Danville	0	0	0	0	0	0	**0**
El Cerrito	0	0	0	0	0	0	**0**
Hercules	0	0	0	0	0	0	**0**
Lafayette	0	0	0	0	1	0	**1**
Martinez	1	2	4	2	3	1	**13**
Moraga	0	0	0	0	0	0	**0**
Oakley	0	0	1	0	2	0	**3**
Orinda	0	0	0	0	0	0	**0**
Pinole	0	0	0	0	0	0	**0**
Pittsburg	0	0	0	2	0	1	**3**
Pleasant Hill	0	0	0	0	2	0	**2**
Richmond	0	0	1	2	1	2	**6**
San Pablo	0	0	1	6	2	0	**9**
San Ramon	0	0	1	0	0	0	**1**
Walnut Creek	0	0	3	0	1	0	**4**
Unincorporated	0	0	11	50	9	27	**97**
Total	**2**	**2**	**22**	**62**	**28**	**33**	**149**

TABLE 13-11.
CRITICAL INFRASTRUCTURE IN THE 100-YEAR FLOODPLAIN

Jurisdiction	Bridges	Water Supply	Wastewater	Power	Communications	Other	**Total**
Antioch	1	0	0	0	1	0	**2**
Brentwood	3	0	0	0	0	1	**4**
Clayton	0	0	0	0	0	0	**0**
Concord	12	0	1	2	0	5	**20**
Danville	2	0	0	0	0	13	**15**
El Cerrito	0	0	0	0	0	0	**0**
Hercules	0	0	0	0	0	0	**0**
Lafayette	1	0	0	0	1	3	**5**
Martinez	8	1	0	2	0	4	**15**
Moraga	0	0	0	0	0	0	**0**
Oakley	1	1	0	0	0	1	**3**
Orinda	4	0	2	1	0	0	**7**
Pinole	0	0	1	0	0	0	**1**
Pittsburg	3	0	1	3	0	2	**9**
Pleasant Hill	7	1	0	0	0	1	**9**
Richmond	1	0	0	0	0	0	**1**
San Pablo	3	0	0	0	0	0	**3**
San Ramon	1	0	0	0	0	0	**1**
Walnut Creek	5	0	0	1	0	1	**7**
Unincorporated	35	5	8	2	5	19	**74**
Total	**87**	**8**	**13**	**11**	**7**	**50**	**176**

**TABLE 13-12.
CRITICAL INFRASTRUCTURE IN THE 500-YEAR FLOODPLAIN**

Jurisdiction	Bridges	Water Supply	Wastewater	Power	Communications	Other	**Total**
Antioch	1	1	0	0	1	0	**3**
Brentwood	5	0	0	0	0	1	**6**
Clayton	0	0	0	0	0	0	**0**
Concord	12	0	1	2	0	5	**20**
Danville	4	1	0	0	0	13	**18**
El Cerrito	0	0	0	0	0	0	**0**
Hercules	0	0	0	0	0	0	**0**
Lafayette	3	0	0	0	2	3	**8**
Martinez	10	1	0	2	0	4	**17**
Moraga	0	0	0	0	0	0	**0**
Oakley	1	1	0	0	0	1	**3**
Orinda	4	0	2	1	0	0	**7**
Pinole	0	0	1	0	0	0	**1**
Pittsburg	3	0	1	3	0	2	**9**
Pleasant Hill	9	1	0	0	0	3	**13**
Richmond	3	0	0	0	0	0	**3**
San Pablo	3	0	0	1	0	0	**4**
San Ramon	1	0	0	0	0	0	**1**
Walnut Creek	7	0	0	1	0	1	**9**
Unincorporated	40	6	8	3	7	22	**86**
Total	**106**	**11**	**13**	**13**	**10**	**55**	**208**

Roads

The following major roads in Contra Costa County pass through the 100-year floodplain and thus are exposed to flooding:

- Brentwood Boulevard
- Highway 160
- Interstate 80
- Byron Highway
- Highway 24
- John T Knox Freeway
- East 18th Street
- Highway 242
- Main Street (Walnut Creek)
- East Shore Freeway
- Highway 4
- San Pablo Avenue
- El Portal Drive
- Interstate 680

Some of these roads are built above the flood level, and others function as levees to prevent flooding. Still, in severe flood events these roads can be blocked or damaged, preventing access to some areas.

Bridges

Flooding events can significantly impact road bridges. These are important because often they provide the only ingress and egress to some neighborhoods. An analysis showed that there are 87 bridges that are in or cross over the 100-year floodplain and 106 bridges in the 500-year floodplain.

Water and Sewer Infrastructure

Water and sewer systems can be affected by flooding. Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can be backed up, causing wastewater to spill into homes, neighborhoods, rivers and streams.

Levees

Levees have historically been used to control flooding in potions of Contra Costa County. The county has over 156.44 miles of earthen levees and revetments managed by Contra Costa County Flood Control District as well as the reclamation districts in the county. There are also levees on many smaller rivers, streams and creeks that protect small areas of land. Many of the levees are older and were built under earlier flood management goals. Many of these older levees are exposed to scouring and failure due to old age and construction methods.

Environment

Flooding is a natural event, and floodplains provide many natural and beneficial functions. Nonetheless, with human development factored in, flooding can impact the environment in negative ways. Migrating fish can wash into roads or over dikes into flooded fields, with no possibility of escape. Pollution from roads, such as oil, and hazardous materials can wash into rivers and streams. During floods, these can settle onto normally dry soils, polluting them for agricultural uses. Human development such as bridge abutments and levees, and logjams from timber harvesting can increase stream bank erosion, causing rivers and streams to migrate into non-natural courses.

13.6 VULNERABILITY

Many of the areas exposed to flooding may not experience serious flooding or flood damage. This section describes vulnerabilities in terms of population, property, infrastructure and environment.

13.6.1 Population

A geographic analysis of demographics, using the HAZUS-MH model and data from the U.S. Census Bureau and Dun & Bradstreet, identified populations vulnerable to the flood hazard as follows:

- **Economically Disadvantaged Populations**—It is estimated that 7 percent of the people within the 100-year floodplain are economically disadvantaged, defined as having household incomes of $10,000 or less.
- **Population over 65 Years Old**—It is estimated that 11 percent of the population in the census blocks that intersect the 100-year floodplain are over 65 years old. Approximately 5 percent of the over-65 population in the floodplain also have incomes considered to be economically disadvantaged and are considered to be extremely vulnerable.
- **Population under 16 Years Old**—It is estimated that 20 percent of the population within census blocks located in or near the 100-year floodplain are under 16 years of age.

HAZUS estimated that a 100-year flood could displace up to 36,167 people, with 28,923 of those people needing short-term shelter. For a 500-year event, HAZUS estimated that up to 47,457 people could be displaced, with 39,791 needing short-term shelter.

13.6.2 Property

HAZUS-MH calculates losses to structures from flooding by looking at depth of flooding and type of structure. Using historical flood insurance claim data, HAZUS-MH estimates the percentage of damage to structures and their contents by applying established damage functions to an inventory. For this analysis, local data on facilities was used instead of the default inventory data provided with HAZUS-MH.

The analysis is summarized in Tables 13-13 and 13-14 for the 100-year and 500-year flood events, respectively. It is estimated that there would be up to $832.0 million of flood loss from a 100-year flood event in the planning area. This represents 13.1 percent of the total exposure to the 100-year flood and 0.5 percent of the total assessed value for the county. It is estimated that there would be $1.561 billion of flood loss from a 500-year flood event, representing 11.7 percent of the total exposure to a 500-year flood event and 0.9 percent of the total assessed value.

National Flood Insurance Program

Table 13-15 lists flood insurance statistics that help identify vulnerability in Contra Costa County. Nineteen communities in the planning area participate in the NFIP, with 5,419 flood insurance policies providing $1.31 billion in insurance coverage. According to FEMA statistics, 991 flood insurance claims were paid between January 1, 1978 and December 31, 2010, for a total of $6.8 million, an average of $6,888 per claim.

Properties constructed after a FIRM has been adopted are eligible for reduced flood insurance rates. Such structures are less vulnerable to flooding since they were constructed after regulations and codes were adopted to decrease vulnerability. Properties built before a FIRM is adopted are more vulnerable to flooding because they do not meet code or are located in hazardous areas. The first FIRMs in Contra Costa County were available in 1978.

TABLE 13-13.
ESTIMATED FLOOD LOSS FOR THE 100-YEAR FLOOD EVENT

	Structures Impacted[a]	Estimated Flood Loss			% of Total Assessed Value
		Structural	Contents	**Total**	
Antioch	134	$9,882,000	$14,713,500	**$24,595,500**	0.2%
Brentwood	119	$3,352,000	$5,132,000	**$8,484,000**	0.1%
Clayton	59	$2,757,000	$4,108,500	**$6,865,500**	0.3%
Concord	400	$18,783,000	$31,848,000	**$50,631,000**	0.4%
Danville	92	$12,210,000	$14,118,500	**$26,328,500**	0.3%
El Cerrito	89	$1,361,500	$1,444,500	**$2,806,000**	0.1%
Hercules	42	$2,043,500	$2,341,500	**$4,385,000**	0.1%
Lafayette	186	$8,296,000	$11,878,500	**$20,174,500**	0.5%
Martinez	592	$17,819,500	$38,625,500	**$56,445,000**	0.8%
Moraga	39	$2,518,000	$2,712,500	**$5,230,500**	0.2%
Oakley	96	$1,784,000	$2,277,500	**$4,061,500**	0.1%
Orinda	102	$5,530,500	$8,417,500	**$13,948,000**	0.4%
Pinole	23	$898,000	$1,238,000	**$2,136,000**	0.2%
Pittsburg	110	$10,164,000	$18,663,000	**$28,827,000**	0.4%
Pleasant Hill	441	$8,028,500	$14,408,000	**$22,436,500**	0.6%
Richmond	75	$44,899,000	$124,810,000	**$169,709,000**	1.1%
San Pablo	342	$6,858,500	$8,910,500	**$15,769,000**	0.8%
San Ramon	85	$11,834,500	$14,481,500	**$26,316,000**	0.2%
Walnut Creek	200	$12,677,500	$18,844,500	**$31,522,000**	0.2%
Unincorporated	1964	$111,621,000	$199,984,984	**$311,605,000**	0.7%
Total	**5190**	**$293,318,000**	**$538,958,484**	**$832,275,500**	**0.5%**

a. Impacted structures are those structures with finished floor elevations below the 100-year water surface elevation. These structures are the most likely to receive significant damage in a 100-year flood event

TABLE 13-14.
ESTIMATED FLOOD LOSS FOR THE 500-YEAR FLOOD EVENT

	Structures Impacted[a]	Estimated Flood Loss			% of Total Assessed Value
		Structural	Contents	**Total**	
Antioch	335	$17,082,800	$25,385,500	**$42,468,300**	0.4%
Brentwood	811	$4,780,300	$7,286,300	**$12,066,600**	0.1%
Clayton	78	$7,303,800	$10,118,500	**$17,422,300**	0.9%
Concord	1185	$37,137,100	$59,656,800	**$96,793,900**	0.7%
Danville	322	$19,210,800	$22,653,400	**$41,864,200**	0.5%
El Cerrito	108	$1,895,600	$2,011,800	**$3,907,400**	0.1%
Hercules	148	$12,876,500	$13,716,500	**$26,593,000**	0.7%
Lafayette	384	$21,714,000	$34,782,300	**$56,496,300**	1.4%
Martinez	793	$25,785,900	$54,872,300	**$80,658,200**	1.1%
Moraga	134	$4,127,200	$4,448,500	**$8,575,700**	0.3%
Oakley	896	$2,499,000	$3,187,100	**$5,686,100**	0.1%
Orinda	125	$8,680,700	$13,099,100	**$21,779,800**	0.6%
Pinole	47	$2,344,300	$3,658,200	**$6,002,500**	0.5%
Pittsburg	134	$17,868,900	$30,311,400	**$48,180,300**	0.7%
Pleasant Hill	1318	$48,238,400	$82,847,800	**$131,086,200**	3.2%
Richmond	587	$62,946,800	$174,976,900	**$237,923,700**	1.5%
San Pablo	852	$19,478,200	$26,843,600	**$46,321,800**	2.2%
San Ramon	121	$18,742,500	$23,052,400	**$41,794,900**	0.4%
Walnut Creek	510	$39,079,600	$73,079,300	**$112,158,900**	0.7%
Unincorporated	6,064	$194,514,600	$328,507,900	**$523,022,500**	1.2%
Total	**14,952**	**$566,307,000**	**$994,495,600**	**$1,560,802,600**	**0.9%**

a. Impacted structures are those structures with finished floor elevations below the 100-year water surface elevation. These structures are the most likely to receive significant damage in a 100-year flood event

**TABLE 13-15.
FLOOD INSURANCE STATISTICS FOR CONTRA COSTA COUNTY**

Jurisdiction	Date of Entry Initial FIRM Effective Date	# of Flood Insurance Policies as of 12/31/2010	Insurance In Force	Total Annual Premium	Claims, 11/1978 to 3/31/2010	Value of Claims paid, 11/1978 to 12/31/2010
Antioch	12/02/1980	148	$29,864,800	$122,762	56	$1,253,731
Brentwood	06/16/2009	43	$11,276,800	$21,415	2	$783
Clayton	12/04/1979	59	$15,506,200	$79,179	2	$750
Concord	07/05/1984	520	$127,747,000	$552,355	64	$117,325
Danville	09/27/1985	108	$29,736,200	$95,494	12	$36,119
El Cerrito	06/01/1977	95	$21,136,500	$116,976	19	$78,183
Hercules	09/30/1982	28	$7,560,800	$14,779	0	$0
Lafayette	03/16/1981	163	$44,840,600	$183,895	63	$173,138
Martinez	03/15/1978	611	$136,062,600	$786,040	127	$745,417
Moraga	05/19/1981	34	$9,855,500	$20,554	9	$11,268
Oakley	02/02/2002	67	$18,925,500	$51,199	0	$0
Orinda	01/06/1988	77	$22,268,800	$64,335	45	$240,935
Pinole	08/15/1980	13	$3,522,400	$8,816	4	$12,666
Pittsburg	08/15/1980	203	$66,958,200	$109,551	10	$13,480
Pleasant Hill	09/30/1983	461	$122,906,900	$495,516	41	$426,765
Richmond	03/01/1979	77	$24,241,000	$108,959	50	$337,240
San Pablo	08/01/1977	362	$77,702,000	$423,004	65	$467,122
San Ramon	09/27/1985	69	$16,249,500	$63,218	10	$166,811
Walnut Creek	05/01/1985	304	$75,986,900	$298,993	103	$987,042
Unincorporated	07/16/1987	1,977	$451,496,500	$1,749,434	309	$1,756,932
Total		**5,419**	**$1,313,844,700**	**$5,366,474**	**991**	**$6,825,707**

The following information from flood insurance statistics is relevant to reducing flood risk:

- The use of flood insurance in Contra Costa County is below the national average. Only 38.3 percent of insurable buildings in the county are covered by flood insurance. According to an NFIP study, about 49 percent of single-family homes in special flood hazard areas are covered by flood insurance nationwide.
- The average claim paid in the planning area represents about 2 percent of the 2010 average assessed value of structures in the floodplain.
- The percentage of policies and claims outside a mapped floodplain suggests that not all of the flood risk in the planning area is reflected in current mapping. Based on information from the NFIP, 59.6 percent of policies in the planning area are on structures within an identified SFHA, and 40.4 percent are for structures outside such areas. Of total claims paid, 21.2 percent were for properties outside an identified 100-year floodplain.

Repetitive Loss

A repetitive loss property is defined by FEMA as an NFIP-insured property that has experienced any of the following since 1978, regardless of any changes in ownership:

- Four or more paid losses in excess of $1,000
- Two paid losses in excess of $1,000 within any rolling 10-year period
- Three or more paid losses that equal or exceed the current value of the insured property.

Repetitive loss properties make up only 1 to 2 percent of flood insurance policies in force nationally, yet they account for 40 percent of the nation's flood insurance claim payments. In 1998, FEMA reported that the NFIP's 75,000 repetitive loss structures have already cost $2.8 billion in flood insurance payments and that numerous other flood-prone structures remain in the floodplain at high risk. The government has instituted programs encouraging communities to identify and mitigate the causes of repetitive losses. A recent report on repetitive losses by the National Wildlife Federation found that 20 percent of these properties are outside any mapped 100-year floodplain. The key identifiers for repetitive loss properties are the existence of flood insurance policies and claims paid by the policies.

FEMA-sponsored programs, such as the CRS, require participating communities to identify repetitive loss areas. A repetitive loss area is the portion of a floodplain holding structures that FEMA has identified as meeting the definition of repetitive loss. Identifying repetitive loss areas helps to identify structures that are at risk but are not on FEMA's list of repetitive loss structures because no flood insurance policy was in force at the time of loss. Map 13-2 shows the repetitive loss areas in Contra Costa County. FEMA's list of repetitive loss properties identifies 59 such properties in the Contra Costa County planning area as of February 28, 2011. The breakdown of the properties by jurisdiction is presented in Table 13-16

A review of the repetitive loss list indicated that 18 of the properties are outside the County's special flood hazard area. Ten of these properties are on the outer fringes of the SFHA in the 500-year floodplain, and no localized flooding issues have been identified. They were most likely flooded by flood events typical for the floodplain they are adjacent to. The 8 remaining properties outside of the 100-year floodplain appear to have minor flooding issues associated with localized flooding related to stormwater issues. These appear to be isolated incidents involving no more than the structures listed on the repetitive loss list. The average claim paid for these 8 properties was $12,365, which would appear appropriate for shallow flood damage associated with stormwater issues. Therefore it can be concluded that the overall cause of repetitive flooding is the same as has been identified for the river basins in which each repetitive loss area is found. With the potential for flood events every three to seven years, the County and its planning partners consider all of the mapped floodplain areas as susceptible to repetitive flooding.

TABLE 13-16.
REPETITIVE LOSS PROPERTIES IN CONTRA COSTA COUNTY

Jurisdiction	Repetitive Loss Properties	Properties That Have Been Mitigated	Number of Corrections	Corrected Number of Repetitive Loss Properties
Antioch	11	0	0	11
Lafayette	2	0	0	2
Martinez	13	0	0	13
Orinda	2	0	0	2
Pittsburg	1	0	0	1
Pleasant Hill	3	0	0	3
Richmond	6	0	0	6
San Pablo	6	0	0	6
Walnut Creek	4	0	0	4
Unincorporated	11	0	0	11
Total	**59**	**0**	**0**	**59**

Based on FEMA Report of Repetitive Losses, 2/28/2011

13.6.3 Critical Facilities and Infrastructure

HAZUS-MH was used to estimate the flood loss potential to critical facilities exposed to the flood risk. Using depth/damage function curves to estimate the percent of damage to the building and contents of critical facilities, HAZUS-MH correlates these estimates into an estimate of functional down-time (the estimated time it will take to restore a facility to 100 percent of its functionality). This helps to gauge how long the planning area could have limited usage of facilities deemed critical to flood response and recovery. The HAZUS critical facility results are as follows:

- **100-year flood event**—On average, critical facilities would receive 8.62 percent damage to the structure and 26.13 percent damage to the contents during a 100-year flood event. The estimated time to restore these facilities to 100 percent of their functionality is 470 days.
- **500-year flood event**—A 500-year flood event would damage the structures an average of 9.45 percent and the contents an average 32.3 percent. The estimated time to restore these facilities to 100 percent of their functionality after a 500-year event is 502 days.

13.6.4 Environment

The environment vulnerable to flood hazard is the same as the environment exposed to the hazard. Loss estimation platforms such as HAZUS-MH are not currently equipped to measure environmental impacts of flood hazards. The best gauge of vulnerability of the environment would be a review of damage from past flood events. Loss data that segregates damage to the environment was not available at the time of this plan. Capturing this data from future events could be beneficial in measuring the vulnerability of the environment for future updates.

13.7 FUTURE TRENDS

The county has experienced moderate growth over the past 10 years, averaging a 1.25-percent increase in population every year from 2000 through 2009. However, economic problems in the past three years impacted growth in the County, with some area experiencing negative growth. Contra Costa County and its planning partners are optimistic that marginal, sustained growth will return to the county as the state and national economies strengthen.

The County and its planning partners are equipped to handle future growth within flood hazard areas. All municipal planning partners have general plans that address frequently flooded areas in their safety elements. All partners have committed to linking their general plans to this hazard mitigation plan. This will create an opportunity for wise land use decisions as future growth impacts flood hazard areas.

Additionally, all municipal planning partners are participants in the NFIP and have adopted flood damage prevention ordinances in response to its requirements. With over 30 percent of communities in the county participating in the CRS program, there is incentive to adopt consistent, appropriate, higher regulatory standards in communities with the highest degree of flood risk. All municipal planning partners have committed to maintaining their good standing under the NFIP through initiatives identified in this plan. Communities participating or considering participation in the CRS program will be able to refine this commitment using CRS programs and templates as a guide.

13.8 SCENARIO

The primary water courses in Contra Costa County have the potential to flood at irregular intervals, generally in response to a succession of intense winter rainstorms. Storm patterns of warm, moist air usually occur between early November and late March. A series of such weather events can cause severe flooding in the planning area. The worst-case scenario is a series of storms that flood numerous drainage basins in a short time. This could overwhelm the response and floodplain management capability within the planning area. Major roads could be blocked, preventing critical access for many residents and critical functions. High in-channel flows could cause water courses to scour, possibly washing out roads and creating more isolation problems. In the case of multi-basin flooding, the County would not be able to make repairs quickly enough to restore critical facilities and infrastructure.

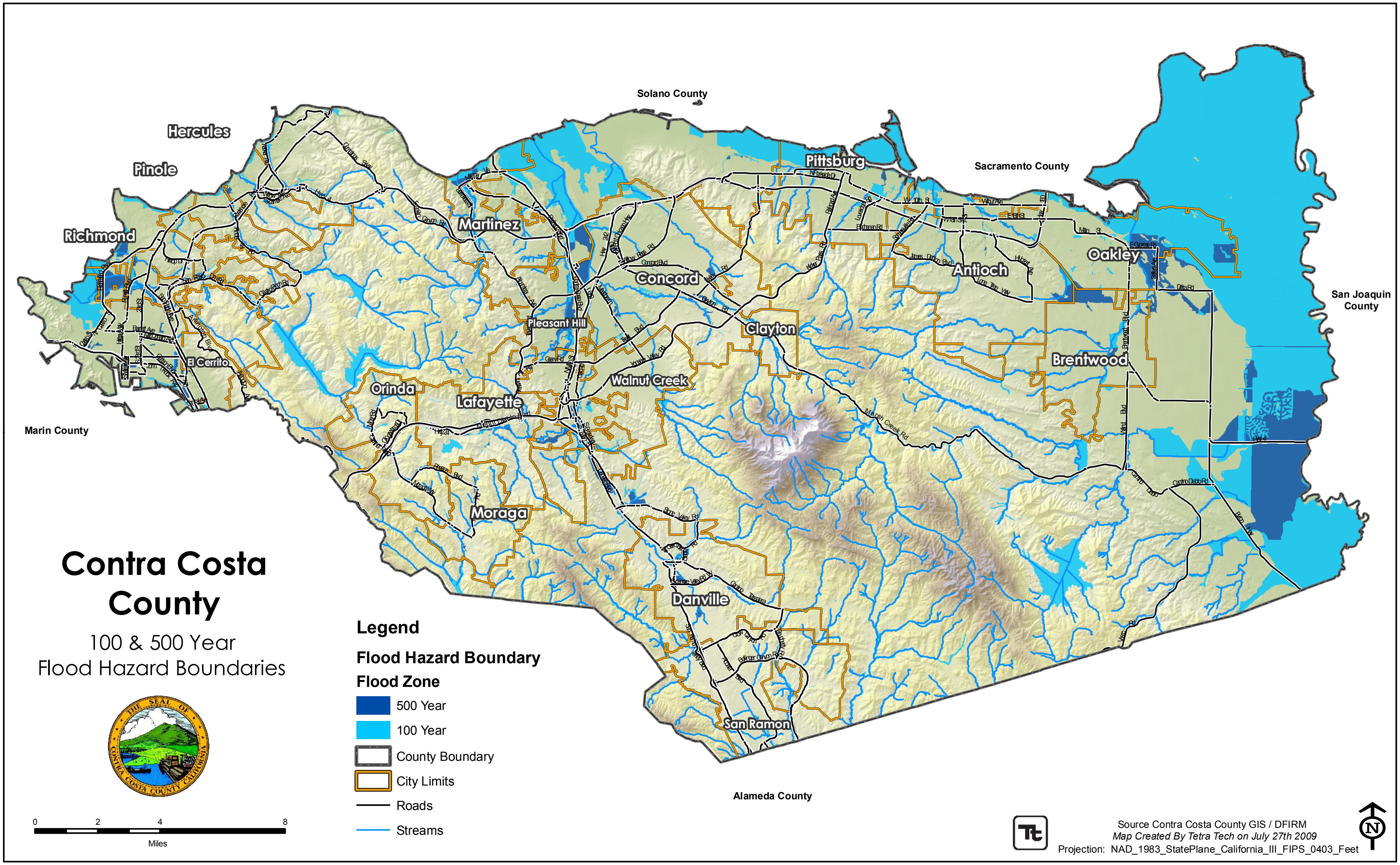
13.9 ISSUES

The planning team has identified the following flood-related issues relevant to the planning area:

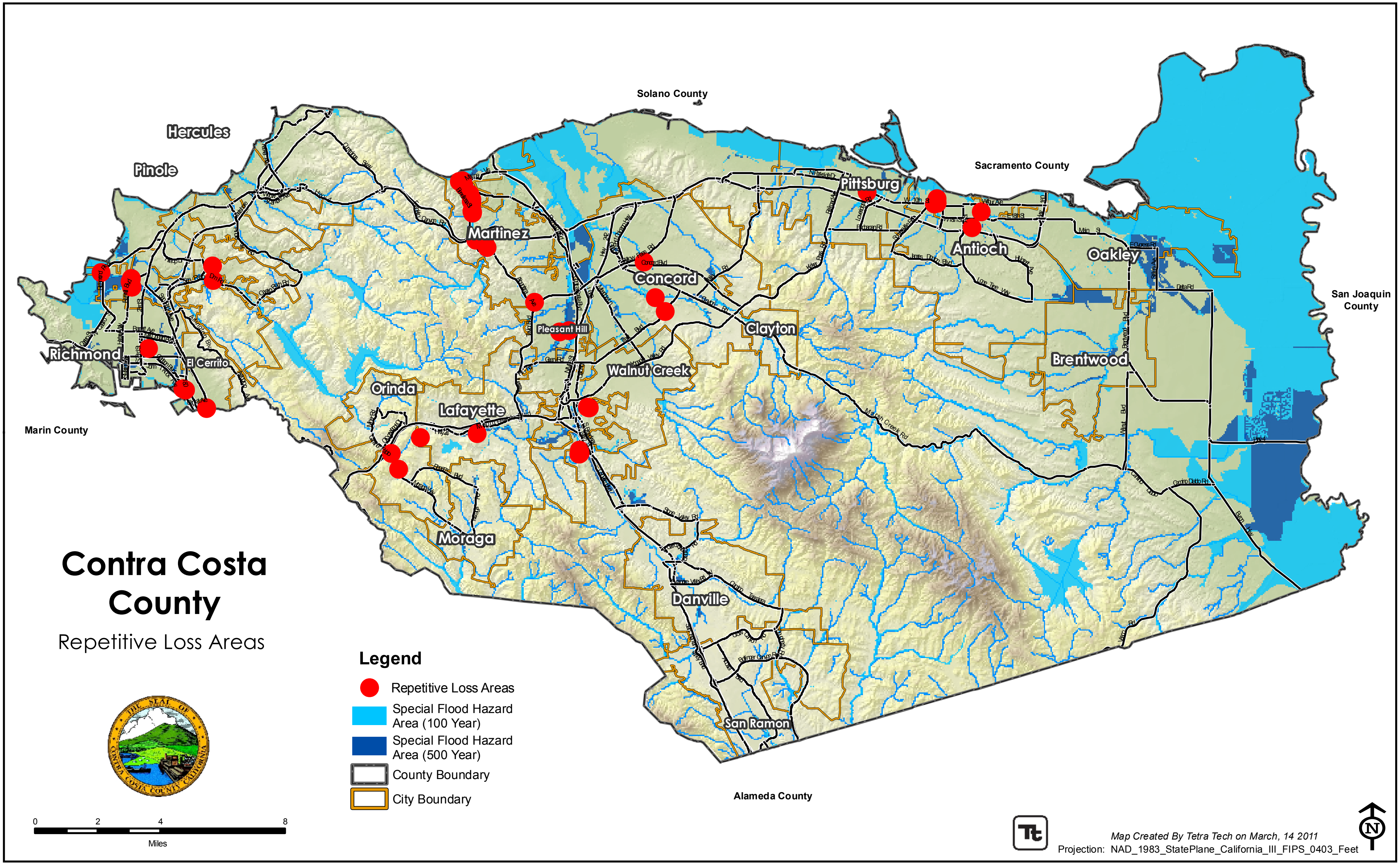
- The accuracy of the existing flood hazard mapping produced by FEMA in reflecting the true flood risk within the planning area is questionable. This is most prevalent in areas protected by levees not accredited by the FEMA mapping process.
- The extent of the flood-protection currently provided by flood control facilities (dams, dikes and levees) is not known due to the lack of an established national policy on flood protection standards.
- Older levees are subject to failure or do not meet current building practices for flood protection.
- The risk associated with the flood hazard overlaps the risk associated with other hazards such as earthquake, landslide and fishing losses. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.
- There is no degree of consistency of land-use practices and regulatory floodplain management scope within the planning area.
- How will potential climate change impact flood conditions in Contra Costa County?
- More information is needed on flood risk to support the concept of risk-based analysis of capital projects.

- There needs to be a sustained effort to gather historical damage data, such as high water marks on structures and damage reports, to measure the cost-effectiveness of future mitigation projects.
- Ongoing flood hazard mitigation will require funding from multiple sources.
- There needs to be a coordinated hazard mitigation effort between jurisdictions affected by flood hazards in the county.
- Floodplain residents need to continue to be educated about flood preparedness and the resources available during and after floods.
- The concept of residual risk should be considered in the design of future capital flood control projects and should be communicated with residents living in the floodplain.
- The promotion of flood insurance as a means of protecting private property owners from the economic impacts of frequent flood events should continue.
- Existing floodplain-compatible uses such as agricultural and open space need to be maintained. There is constant pressure to convert these existing uses to more intense uses within the planning area during times of moderate to high growth.
- The economy affects a jurisdiction’s ability to manage its floodplains. Budget cuts and personnel losses can strain resources needed to support floodplain management.

Map 13-1.


Contra Costa County
100 & 500 Year Flood Hazard Boundaries
Solano County
Sacramento County
San Joaquin County
Alameda County
Marin County
Hercules
Pinole
Richmond
El Cerrito
Martinez
Pittsburg
Concord
Pleasant Hill
Clayton
Antioch
Oakley
Brentwood
Walnut Creek
Orinda
Lafayette
Moraga
Danville
San Ramon
Legend
Flood Hazard Boundary
Flood Zone
500 Year
100 Year
County Boundary
City Limits
Roads
Streams
0
2
4
8
Miles
Source Contra Costa County GIS / DFIRM
Map Created By Tetra Tech on July 27th 2009
Projection: NAD_1983_StatePlane_California_III_FIPS_0403_Feet
N

Map 13-2.



Contra Costa County
Repetitive Loss Areas
Solano County
Sacramento County
San Joaquin County
Marin County
Alameda County
Hercules
Pinole
Richmond
El Cerrito
Martinez
Pittsburg
Antioch
Oakley
Concord
Pleasant Hill
Clayton
Walnut Creek
Brentwood
Orinda
Lafayette
Moraga
Danville
San Ramon
Legend
Repetitive Loss Areas
Special Flood Hazard Area (100 Year)
Special Flood Hazard Area (500 Year)
County Boundary
City Boundary
0
2
4
8
Miles
Map Created By Tetra Tech on March, 14 2011
Projection: NAD_1983_StatePlane_California_III_FIPS_0403_Feet
N

CHAPTER 14.
LANDSLIDES AND OTHER MASS MOVEMENTS

14.1 GENERAL BACKGROUND

A landslide is a mass of rock, earth or debris moving down a slope. Landslides may be minor or very large, and can move at slow to very high speeds. They can be initiated by storms, earthquakes, fires, volcanic eruptions or human modification of the land.

> **DEFINITIONS**
>
> **Landslide**—The sliding movement of masses of loosened rock and soil down a hillside or slope. Such failures occur when the strength of the soils forming the slope is exceeded by the pressure, such as weight or saturation, acting upon them.
>
> **Mass Movement—**A collective term for landslides, debris flows, falls and sinkholes.
>
> **Mudslide (or Mudflow or Debris Flow)—**A river of rock, earth, organic matter and other materials saturated with water.

Mudslides (or mudflows or debris flows) are rivers of rock, earth, organic matter and other soil materials saturated with water. They develop in the soil overlying bedrock on sloping surfaces when water rapidly accumulates in the ground, such as during heavy rainfall or rapid snowmelt. Water pressure in the pore spaces of the material increases to the point that the internal strength of the soil is drastically weakened. The soil's reduced resistance can then easily be overcome by gravity, changing the earth into a flowing river of mud or "slurry." A debris flow or mudflow can move rapidly down slopes or through channels, and can strike with little or no warning at avalanche speeds. The slurry can travel miles from its source, growing as it descends, picking up trees, boulders, cars and anything else in its path. Although these slides behave as fluids, they pack many times the hydraulic force of water due to the mass of material included in them. Locally, they can be some of the most destructive events in nature.

All mass movements are caused by a combination of geological and climate conditions, as well as the encroaching influence of urbanization. Vulnerable natural conditions are affected by human residential, agricultural, commercial and industrial development and the infrastructure that supports it.

14.2 HAZARD PROFILE

Landslides are caused by one or a combination of the following factors: change in slope of the terrain, increased load on the land, shocks and vibrations, change in water content, groundwater movement, frost action, weathering of rocks, and removing or changing the type of vegetation covering slopes. In general, landslide hazard areas are where the land has characteristics that contribute to the risk of the downhill movement of material, such as the following:

- A slope greater than 33 percent
- A history of landslide activity or movement during the last 10,000 years
- Stream or wave activity, which has caused erosion, undercut a bank or cut into a bank to cause the surrounding land to be unstable
- The presence or potential for snow avalanches
- The presence of an alluvial fan, indicating vulnerability to the flow of debris or sediments
- The presence of impermeable soils, such as silt or clay, which are mixed with granular soils such as sand and gravel.

Flows and slides are commonly categorized by the form of initial ground failure. Figures 14-1 through 14-4 show common types of slides in Contra Costa County. The most common is the shallow colluvial slide, occurring particularly in response to intense, short-duration storms. The largest and most destructive are deep-seated slides, although they are less common than other types.

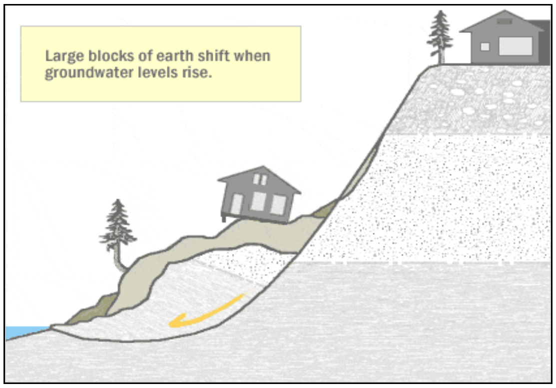


Figure 14-1. Deep Seated Slide

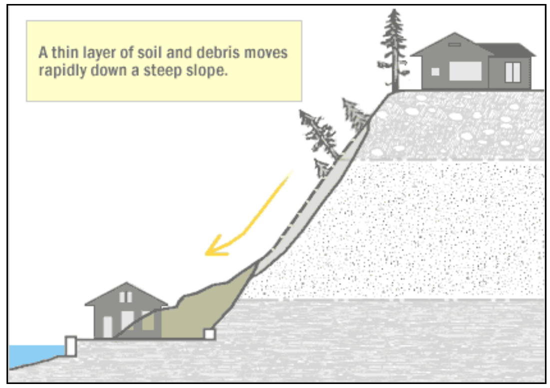


Figure 14-2. Shallow Colluvial Slide

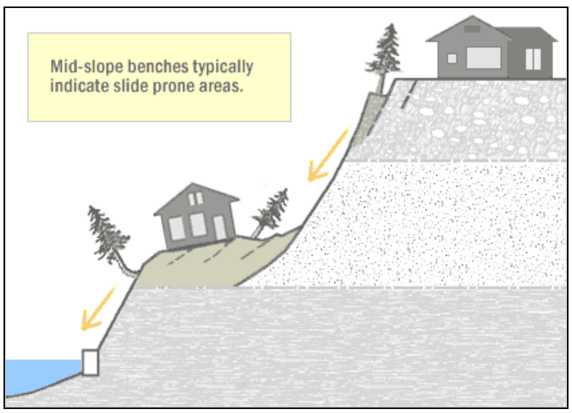


Figure 14-3. Bench Slide

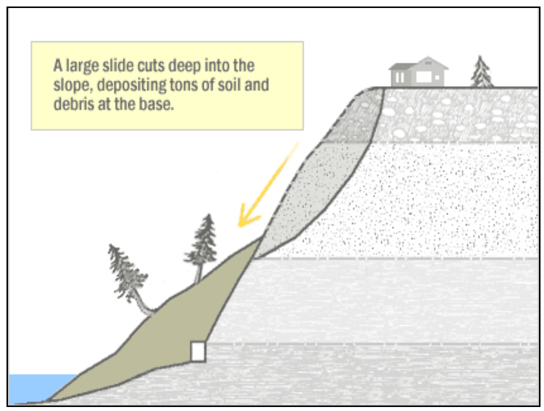


Figure 14-4. Large Slide

Slides and earth flows can pose serious hazard to property in the hillside terrain of Contra Costa County. They tend to move slowly and thus rarely threaten life directly. When they move—in response to such changes as increased water content, earthquake shaking, addition of load, or removal of downslope support—they deform and tilt the ground surface. The result can be destruction of foundations, offset of roads, breaking of underground pipes, or overriding of downslope property and structures.

In general, landslides are most likely during periods of higher than average rainfall. The ground must be saturated prior to the onset of a major storm for significant landsliding to occur. Most local landslides occur in January after the water table has risen during the wet months of November and December. In addition to the coastal bluffs, landsliding is most common in the rolling hills of Contra Costa County that have slopes and soil types that are susceptible to landslides. Water is involved in nearly all cases; and human influence has been identified in more than 80 percent of reported slides.

14.2.1 Past Events

Losses from landslides are typically lower than those from flooding. However, in the El Niño storms of early 1998, the USGS documented $150 million in losses due to approximately 300 landslides in the Bay Area and Santa Cruz County. The slides ranged from a 25-cubic-meter failure of engineered material to reactivation of the 13 million-cubic-meter Mission Peak earth flow complex in Alameda County.

There is little recorded information regarding landslides in Contra Costa County. According to the Spatial Hazard Events and Losses Database for the United States (SHELDUS), there have been two recorded landslide events in Contra Costa County since 1960. These events occurred on April 6, 2006, and on January 1, 1997, and both coincided with presidential disaster declarations for severe storms and flooding. The combined estimated damage for these two events exceeded $20 million. There are no records in the County of fatalities attributed to mass movement. However, deaths have occurred across the west coast as a result of slides and slope collapses.

14.2.2 Location

The best available predictor of where movement of slides and earth flows might occur is the location of past movements. Past landslides can be recognized by their distinctive topographic shapes, which can remain in place for thousands of years. Most landslides recognizable in this fashion range from a few acres to several square miles. Most show no evidence of recent movement and are not currently active. A small proportion of them may become active in any given year, with movements concentrated within all or part of the landslide masses or around their edges.

The recognition of ancient dormant mass movement sites is important in the identification of areas susceptible to flows and slides because they can be reactivated by earthquakes or by exceptionally wet weather. Also, because they consist of broken materials and frequently involve disruption of groundwater flow, these dormant sites are vulnerable to construction-triggered sliding.

The USGS began a program in September 1997 to provide digital data and map files outlining areas of potential landslide activity in the 10-county San Francisco Bay region. Information about catastrophic slope failures in prior winter storms, combined with the availability of digital topographic, geologic, and climatologic data for the entire San Francisco Bay region, provides a basis for identifying areas that are vulnerable to slope failure. The maps provide a summary of the distribution of landslides evident in the landscape of the San Francisco Bay region. Delineation of these landslides required detailed analysis of the topography by geologists, a task generally accomplished through the study of aerial photographs. Map 14-1 shows the landslide hazard areas in Contra Costa County. Two hazard area classifications are used:

- Mostly Landslide—Areas with mapped landslides, intervening areas typically narrower than 1,500 feet, and narrow borders around landslides; defined by drawing envelopes around groups of mapped landslides.
- Few Landslides—Areas with few, if any, large mapped landslides but local scattered small landslides and questionably identified larger landslides; defined by excluding groups of mapped landslides.

14.2.3 Frequency

Landslides are often triggered by other natural hazards such as earthquakes, heavy rain, floods or wildfires, so landslide frequency is often related to the frequency of these other hazards. In Contra Costa County, landslides typically occur during and after major storms, so the potential for landslides largely coincides with the potential for sequential severe storms that saturate steep, vulnerable soils. Landslide events occurred during the winter storms of 2006 and 1997. According to SHELDUS records, the planning area has been impacted by severe storms at least once every other year since 1960. Until better data is generated specifically for landslide hazards, this severe storm frequency is appropriate for the purpose of ranking risk associated with the landslide hazard.

14.2.4 Severity

Landslides destroy property and infrastructure and can take the lives of people. Slope failures in the United States result in an average of 25 lives lost per year and an annual cost to society of about $1.5 billion. According to SHELDUS, the 2006 and 1997 storms caused in excess of $20 million in property damage due to landslides, mudslides and debris flows. This was about half of all damage caused by the storm. The landslides caused by the storm also caused tens of millions of dollars of damage to road infrastructure.

14.2.5 Warning Time

Mass movements can occur suddenly or slowly. The velocity of movement may range from a slow creep of inches per year to many feet per second, depending on slope angle, material and water content. Some methods used to monitor mass movements can provide an idea of the type of movement and the amount of time prior to failure. It is also possible to determine what areas are at risk during general time periods. Assessing the geology, vegetation, and amount of predicted precipitation for an area can help in these predictions. However, there is no practical warning system for individual landslides. The current standard operating procedure is to monitor situations on a case-by-case basis, and respond after the event has occurred. Generally accepted warning signs for landslide activity include:

- Springs, seeps, or saturated ground in areas that have not typically been wet before
- New cracks or unusual bulges in the ground, street pavements or sidewalks
- Soil moving away from foundations
- Ancillary structures such as decks and patios tilting and/or moving relative to the main house
- Tilting or cracking of concrete floors and foundations
- Broken water lines and other underground utilities
- Leaning telephone poles, trees, retaining walls or fences
- Offset fence lines
- Sunken or down-dropped road beds
- Rapid increase in creek water levels, possibly accompanied by increased turbidity (soil content)
- Sudden decrease in creek water levels though rain is still falling or just recently stopped
- Sticking doors and windows, and visible open spaces indicating jambs and frames out of plumb
- A faint rumbling sound that increases in volume as the landslide nears
- Unusual sounds, such as trees cracking or boulders knocking together.

14.3 SECONDARY HAZARDS

Landslides can cause several types of secondary effects, such as blocking access to roads, which can isolate residents and businesses and delay commercial, public and private transportation. This could result in economic losses for businesses. Other potential problems resulting from landslides are power and communication failures. Vegetation or poles on slopes can be knocked over, resulting in possible losses to power and communication lines. Landslides also have the potential of destabilizing the foundation of structures, which may result in monetary loss for residents. They also can damage rivers or streams, potentially harming water quality, fisheries and spawning habitat.

14.4 CLIMATE CHANGE IMPACTS

Climate change may impact storm patterns in California, increasing the probability of more frequent, intense storms with varying duration. Increase in global temperature could affect the snowpack and its ability to hold and store water. Warming temperatures also could increase the occurrence and duration of droughts, which would increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. All of these factors would increase the probability for landslide occurrences.

14.5 EXPOSURE

14.5.1 Population

Population could not be examined by landslide hazard area because census block group areas do not coincide with the hazard areas. A population estimate was made using the structure count of buildings within the landslide hazard areas and applying the census value of 2.72 persons per household for Contra Costa County. Using this approach, the estimated population living in the "few-landslides" risk area is 303,454, and 52,597 live in the "mostly-landslide" area. It should be noted that this approach could understate the exposure by as much as a factor of two, so it is reasonable to assume that the exposed population to the higher risk landslide area may be as high as 105,000, about 10 percent of the total county population.

14.5.2 Property

Tables 14-1 and 14-2 show the number and assessed value of structures exposed to the landslide risk. There are 111,564 structures on parcels in the "few-landslides" risk areas, with an estimated value of $53.4 billion. There are 19,337 structures on parcels in the "mostly-landslide" risk areas, with an estimated value of $11.2 billion. Over 90 percent of the exposed structures are dwellings.

The predominant land uses in cities are single-family, vacant and manufactured homes. Table 14-3 shows the general land use of parcels exposed to landslides in unincorporated portions of the County. Lands zoned for agricultural uses are most vulnerable.

14.5.3 Critical Facilities and Infrastructure

Table 14-4 summarizes the critical facilities exposed to the landslide hazard. No loss estimation of these facilities was performed due to the lack of established damage functions for the landslide hazard. A significant amount of infrastructure can be exposed to mass movements:

- **Roads**—Many of the major roads in Contra Costa County are exposed to mass movement hazards. Access to major roads is crucial to life-safety after a disaster event and to response and recovery operations. Landslides can block egress and ingress on roads, causing isolation for neighborhoods, traffic problems and delays for public and private transportation. This can result in economic losses for businesses.
- **Bridges**—Landslides can significantly impact road bridges. Mass movements can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use.
- **Power Lines**—Power lines are generally elevated above steep slopes; but the towers supporting them can be subject to landslides. A landslide could trigger failure of the soil underneath a tower, causing it to collapse and ripping down the lines. Power and communication failures due to landslides can create problems for vulnerable populations and businesses. Pacific Gas and Electric (PG&E) lines pass through steep slope areas.

TABLE 14-1.
CONTRA COSTA COUNTY STRUCTURES IN “FEW-LANDSLIDES” RISK AREAS

Jurisdiction	Buildings Exposed	Assessed Value Structure	Assessed Value Contents	Assessed Value **Total**	% of AV
Antioch	11,451	$2,852,896,036	$2,328,598,320	**$5,181,494,356**	48.5%
Brentwood	1,704	$639,440,783	$514,518,484	**$1,153,959,267**	11.5%
Clayton	500	$157,519,544	$126,015,635	**$283,535,179**	14.4%
Concord	2,246	$547,841,877	$440,139,427	**$987,981,304**	7.2%
Danville	5,340	$1,790,231,831	$1,448,497,108	**$3,238,728,939**	41.1%
El Cerrito	7,447	$836,124,407	$641,166,687	**$1,477,291,094**	56.1%
Hercules	5,062	$1,274,617,944	$1,100,847,399	**$2,375,465,343**	64.3%
Lafayette	3,143	$1,027,860,202	$841,334,334	**$1,869,194,536**	45.6%
Martinez	9,586	$2,189,668,256	$1,973,049,669	**$4,162,717,925**	58.7%
Moraga	1,634	$410,945,966	$333,539,188	**$744,485,154**	28.1%
Oakley	0	$0	$0	**$0**	0.0%
Orinda	4,066	$1,305,509,995	$1,059,298,892	**$2,364,808,887**	61.6%
Pinole	4,624	$265,202,518	$339,929,871	**$605,132,389**	54.7%
Pittsburg	3,480	$777,662,164	$625,547,473	**$1,403,209,637**	19.6%
Pleasant Hill	3,235	$754,850,498	$618,440,143	**$1,373,290,641**	33.9%
Richmond	9,098	$1,840,482,340	$1,634,036,230	**$3,474,518,570**	22.4%
San Pablo	363	$61,621,239	$51,616,738	**$113,237,977**	5.5%
San Ramon	8,344	$3,203,760,577	$2,613,462,111	**$5,817,222,688**	50.9%
Walnut Creek	8,471	$2,031,038,409	$1,714,500,312	**$3,745,538,721**	23.7%
Unincorporated	21,770	$6,734,623,996	$6,315,110,527	**$13,049,734,523**	29.7%
Total	**111,564**	**$28,701,898,582**	**$24,719,648,548**	**$53,421,547,130**	**30.7%**

TABLE 14-2.
CONTRA COSTA COUNTY STRUCTURES IN "MOSTLY-LANDSLIDE" RISK AREAS

Jurisdiction	Buildings Exposed	Assessed Value Structure	Assessed Value Contents	Assessed Value **Total**	% of AV
Antioch	198	$57,436,302	$45,949,049	**$103,385,351**	1.0%
Brentwood	74	$28,070,773	$22,456,620	**$50,527,393**	0.5%
Clayton	606	$190,088,092	$152,251,624	**$342,339,716**	17.4%
Concord	243	$126,007,547	$100,806,032	**$226,813,579**	1.6%
Danville	1644	$679,372,395	$544,662,626	**$1,224,035,021**	15.5%
El Cerrito	608	$90,251,580	$72,207,616	**$162,459,196**	6.2%
Hercules	1210	$239,101,566	$195,620,777	**$434,722,343**	11.8%
Lafayette	1583	$537,834,827	$430,949,114	**$968,783,941**	23.6%
Martinez	249	$58,935,936	$50,313,246	**$109,249,182**	1.5%
Moraga	1759	$535,973,155	$434,627,591	**$970,600,746**	36.7%
Oakley	0	$0	$0	**$0**	0.0%
Orinda	1922	$636,128,732	$510,045,274	**$1,146,174,006**	29.9%
Pinole	596	$85,263,648	$68,215,672	**$153,479,320**	13.9%
Pittsburg	141	$42,121,541	$33,697,232	**$75,818,773**	1.1%
Pleasant Hill	141	$31,678,372	$25,342,698	**$57,021,070**	1.4%
Richmond	1086	$446,947,343	$376,257,710	**$823,205,053**	5.3%
San Pablo	153	$24,696,531	$18,443,245	**$43,139,776**	2.1%
San Ramon	1488	$585,035,117	$469,129,529	**$1,054,164,646**	9.2%
Walnut Creek	2165	$462,814,624	$374,029,875	**$836,844,499**	5.3%
Unincorporated	3,471	$1,330,062,192	$1,053,836,942	**$2,383,899,134**	5.4
Total	**19,337**	**$6,187,820,273**	**$4,978,842,472**	**$11,166,662,745**	**6.4%**

**TABLE 14-3.
LAND USE IN LANDSLIDE RISK AREAS OF UNINCORPORATED COUNTY**

	"Few Landslide" areas		"Mostly Landslide" areas	
Land Use	Area (acres)	% of total	Area (acres)	% of total
Agricultural Preserve	29,903.56	26.87%	20,327.18	26.98%
Controlled Manufacturing	48.64	0.04%	38.73	0.05%
Exclusive Agricultural	12,389.10	11.13%	16,567.14	21.99%
Forestry Recreational	2,050.03	1.84%	1,494.28	1.98%
General Agricultural	35,269.45	31.69%	29,808.52	39.57%
General Commercial	24.47	0.02%	0	0.00%
Heavy Agricultural	13,748.41	12.35%	2,510.93	3.33%
Heavy Industrial	2,239.50	2.01%	230.04	0.31%
Light Industrial	48.37	0.04%	6.20	0.01%
Limited Office	0.49	0.00%	0.63	0.00%
Mobile Home/Manufactured Home Park	17.66	0.02%	0	0.00%
Multiple Family Residential	87.51	0.08%	22.92	0.03%
Neighborhood Business	9.30	0.01%	0.84	0.00%
Planned Unit	8,291.02	7.45%	3,217.08	4.27%
Retail Business	74.95	0.07%	7.59	0.01%
Single Family Residential	7,072.93	6.35%	1,092.92	1.45%
Two Family Residential	22.61	0.02%	2.59	0.00%
Unrestricted	3.70	0.01	5.06	0.01%
Total	**111,301.7**	**100%**	**75,332.65**	**100%**

**TABLE 14-4.
CRITICAL FACILITIES EXPOSED TO LANDSLIDE HAZARDS**

	Number of Exposed Critical Facilities in Risk Area	
	"Few-Landslides" Risk Areas	"Mostly-Landslide" Risk Areas
Medical and Health Services	4	1
Government Function	2	0
Protective Function	40	4
Schools	100	9
Hazmat	85	0
Other Critical Function	2	0
Bridges	84	8
Water	56	13
Waste Water	17	5
Communications	46	8
Total	**436**	**48**

14.5.4 Environment

Environmental problems as a result of mass movements can be numerous. Landslides that fall into streams may significantly impact fish and wildlife habitat, as well as affecting water quality. Hillsides that provide wildlife habitat can be lost for prolong periods of time due to landslides.

14.6 VULNERABILITY

14.6.1 Population

Due to the nature of census block group data, it is difficult to determine demographics of populations vulnerable to mass movements. In general, all of the estimated 105,000 persons exposed to higher risk landslide areas are considered to be vulnerable. Increasing population and the fact that many homes are built on view property atop or below bluffs and on steep slopes subject to mass movement, increases the number of lives are endangered by this hazard.

14.6.2 Property

Although complete historical documentation of the landslide threat in Contra Costa County is lacking, the landslides of 1997 and 2006 suggest a significant vulnerability to such hazards. The millions of dollars in damage countywide attributable to mass movement during those storms affected private property and public infrastructure and facilities.

Loss estimations for the landslide hazard are not based on modeling utilizing damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the assessed value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Tables 14-5 and 14-6 show the general building stock loss estimates in landslide risk areas.

14.6.3 Critical Facilities and Infrastructure

There are 484 critical facilities exposed to the landslide hazard to some degree. A more in-depth analysis of the mitigation measures taken by these facilities to prevent damage from mass movements should be done to determine if they could withstand impacts of a mass movement.

Several types of infrastructure are exposed to mass movements, including transportation, water and sewer and power infrastructure. Highly susceptible areas of the county include mountain and coastal roads and transportation infrastructure. At this time all infrastructure and transportation corridors identified as exposed to the landslide hazard are considered vulnerable until more information becomes available.

14.6.4 Environment

The environment vulnerable to landslide hazard is the same as the environment exposed to the hazard.

**TABLE 14-5.
ESTIMATED BUILDING LOSSES IN THE "FEW-LANDSLIDES" RISK AREAS**

Jurisdiction	Building Count	Assessed Value	10% Damage	30% Damage	50% Damage
Antioch	11,451	$5,181,494,356	$518,149,436	$1,554,448,307	$2,590,747,178
Brentwood	1,704	$1,153,959,267	$115,395,927	$346,187,780	$576,979,634
Clayton	500	$283,535,179	$28,353,518	$85,060,554	$141,767,590
Concord	2,246	$987,981,304	$98,798,130	$296,394,391	$493,990,652
Danville	5,340	$3,238,728,939	$323,872,894	$971,618,682	$1,619,364,470
El Cerrito	7,447	$1,477,291,094	$147,729,109	$443,187,328	$738,645,547
Hercules	5,062	$2,375,465,343	$237,546,534	$712,639,603	$1,187,732,672
Lafayette	3,143	$1,869,194,536	$186,919,454	$560,758,361	$934,597,268
Martinez	9,586	$4,162,717,925	$416,271,793	$1,248,815,378	$2,081,358,963
Moraga	1,634	$744,485,154	$74,448,515	$223,345,546	$372,242,577
Oakley	0	$0	$0	$0	$0
Orinda	4,066	$2,364,808,887	$236,480,889	$709,442,666	$1,182,404,444
Pinole	4,624	$605,132,389	$60,513,239	$181,539,717	$302,566,195
Pittsburg	3,480	$1,403,209,637	$140,320,964	$420,962,891	$701,604,819
Pleasant Hill	3,235	$1,373,290,641	$137,329,064	$411,987,192	$686,645,321
Richmond	9,098	$3,474,518,570	$347,451,857	$1,042,355,571	$1,737,259,285
San Pablo	363	$113,237,977	$11,323,798	$33,971,393	$56,618,989
San Ramon	8,344	$5,817,222,688	$581,722,269	$1,745,166,806	$2,908,611,344
Walnut Creek	8,471	$3,745,538,721	$374,553,872	$1,123,661,616	$1,872,769,361
Unincorporated	21,770	$13,049,734,523	$1,304,973,452	$3,914,920,357	$6,524,867,262
Total	**111,564**	**$53,421,547,130**	**$5,342,154,714**	**$16,026,464,139**	**$26,710,773,571**

TABLE 14-6.
ESTIMATED BUILDING LOSSES IN THE "MOSTLY-LANDSLIDE" RISK AREAS

Jurisdiction	Building Count	Assessed Value	10% Damage	30% Damage	50% Damage
Antioch	198	$103,385,351	$10,338,535	$31,015,605	$51,692,676
Brentwood	74	$50,527,393	$5,052,739	$15,158,218	$25,263,697
Clayton	606	$342,339,716	$34,233,972	$102,701,915	$171,169,858
Concord	243	$226,813,579	$22,681,358	$68,044,074	$113,406,790
Danville	1644	$1,224,035,021	$122,403,502	$367,210,506	$612,017,511
El Cerrito	608	$162,459,196	$16,245,920	$48,737,759	$81,229,598
Hercules	1210	$434,722,343	$43,472,234	$130,416,703	$217,361,172
Lafayette	1583	$968,783,941	$96,878,394	$290,635,182	$484,391,971
Martinez	249	$109,249,182	$10,924,918	$32,774,755	$54,624,591
Moraga	1759	$970,600,746	$97,060,075	$291,180,224	$485,300,373
Oakley	0	$0	$0	$0	$0
Orinda	1922	$1,146,174,006	$114,617,401	$343,852,202	$573,087,003
Pinole	596	$153,479,320	$15,347,932	$46,043,796	$76,739,660
Pittsburg	141	$75,818,773	$7,581,877	$22,745,632	$37,909,387
Pleasant Hill	141	$57,021,070	$5,702,107	$17,106,321	$28,510,535
Richmond	1086	$823,205,053	$82,320,505	$246,961,516	$411,602,527
San Pablo	153	$43,139,776	$4,313,978	$12,941,933	$21,569,888
San Ramon	1488	$1,054,164,646	$105,416,465	$316,249,394	$527,082,323
Walnut Creek	2165	$836,844,499	$83,684,450	$251,053,350	$418,422,250
Unincorporated	3,471	$2,383,899,134	$238,389,913	$715,169,740	$1,191,949,567
Total	**19,337**	**$11,166,662,745**	**$1,116,666,275**	**$3,349,998,825**	**$5,583,331,377**

14.7 FUTURE TRENDS IN DEVELOPMENT

The county has experienced moderate growth over the past 10 years, averaging a 1.25-percent increase in population every year from 2000 through 2009. However, economic problems in the past three years impacted growth in the County, with some area experiencing negative growth. Contra Costa County and its planning partners are optimistic that marginal, sustained growth will return to the county as the state and national economies strengthen.

The County and its planning partners are equipped to handle future growth within landslide hazard areas. All municipal planning partners have general plans that address landslide risk areas in their safety elements. All partners have committed to linking their general plans to this hazard mitigation plan. This will create an opportunity for wise land use decisions as future growth impacts landslide hazard areas.

Additionally, the State of California has adopted the International Building Code (IBC) by reference in its California Building Standards Code. The IBC includes provisions for geotechnical analyses in steep slope areas that have soil types considered susceptible to landslide hazards. These provisions assure that new construction is built to standards that reduce the vulnerability to landslide risk.

14.8 SCENARIO

Major landslides in Contra Costa County occur as a result of soil conditions that have been affected by severe storms, groundwater or human development. The worst-case scenario for landslide hazards in the planning area would generally correspond to a severe storm that had heavy rain and caused flooding. Landslides are most likely during late winter when the water table is high. After heavy rains from November to December, soils become saturated with water. As water seeps downward through upper soils that may consist of permeable sands and gravels and accumulates on impermeable silt, it will cause weakness and destabilization in the slope. A short intense storm could cause saturated soil to move, resulting in landslides. As rains continue, the groundwater table rises, adding to the weakening of the slope. Gravity, poor drainage, a rising groundwater table and poor soil exacerbate hazardous conditions.

Mass movements are becoming more of a concern as development moves outside of city centers and into areas less developed in terms of infrastructure. Most mass movements would be isolated events affecting specific areas. It is probable that private and public property, including infrastructure, will be affected. Mass movements could affect bridges that pass over landslide prone ravines and knock out rail service through the county. Road obstructions caused by mass movements would create isolation problems for residents and businesses in sparsely developed areas. Property owners exposed to steep slopes may suffer damage to property or structures. Landslides carrying vegetation such as shrubs and trees may cause a break in utility lines, cutting off power and communication access to residents.

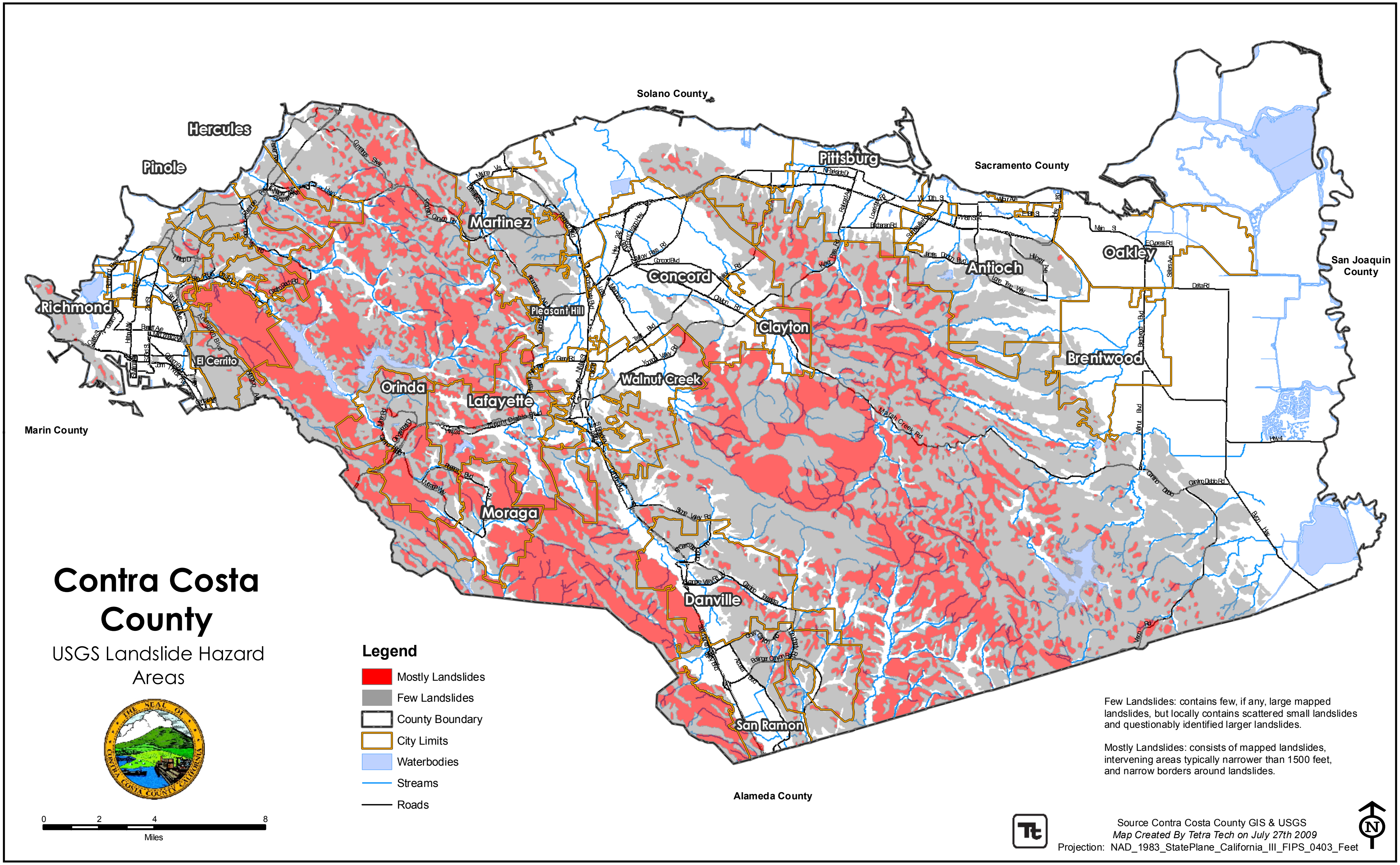
Continued heavy rains and flooding will complicate the problem further. As emergency response resources are applied to problems with flooding, it is possible they will be unavailable to assist with landslides occurring all over Contra Costa County.

14.9 ISSUES

Important issues associated with landslides in Contra Costa County include the following:

- There are existing homes in landslide risk areas throughout the County. The degree of vulnerability of these structures depends on the codes and standards the structures were constructed to. Information to this level of detail is not currently available.
- Future development could lead to more homes in landslide risk areas.
- Mapping and assessment of landslide hazards are constantly evolving. As new data and science become available, assessments of landslide risk should be reevaluated.
- The impact of climate change on landslides is uncertain. If climate change impacts atmospheric conditions, then exposure to landslide risks is likely to increase.
- Landslides may cause negative environmental consequences, including water quality degradation.
- The risk associated with the landslide hazard overlaps the risk associated with other hazards such as earthquake, flood and wildfire. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.

Map 14-1.


Contra Costa County
USGS Landslide Hazard Areas
Solano County
Sacramento County
San Joaquin County
Marin County
Alameda County
Hercules
Pinole
Richmond
El Cerrito
Martinez
Pleasant Hill
Concord
Pittsburg
Antioch
Oakley
Clayton
Brentwood
Walnut Creek
Orinda
Lafayette
Moraga
Danville
San Ramon
Legend
Mostly Landslides
Few Landslides
County Boundary
City Limits
Waterbodies
Streams
Roads
0 2 4 8
Miles
Few Landslides: contains few, if any, large mapped landslides, but locally contains scattered small landslides and questionably identified larger landslides.
Mostly Landslides: consists of mapped landslides, intervening areas typically narrower than 1500 feet, and narrow borders around landslides.
Source Contra Costa County GIS & USGS
Map Created By Tetra Tech on July 27th 2009
Projection: NAD_1983_StatePlane_California_III_FIPS_0403_Feet
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CHAPTER 15.
SEVERE WEATHER

15.1 GENERAL BACKGROUND

Severe weather refers to any dangerous meteorological phenomena with the potential to cause damage, serious social disruption, or loss of human life. It includes thunderstorms, downbursts, tornadoes, waterspouts, snowstorms, ice storms, and dust storms.

Severe weather can be categorized into two groups: those that form over wide geographic areas are classified as general severe weather; those with a more limited geographic area are classified as localized severe weather. Severe weather, technically, is not the same as extreme weather, which refers to unusual weather events are at the extremes of the historical distribution for a given area.

Four types of severe weather events typically impact Contra Costa County: thunderstorms, damaging winds, hail storms and flash flooding. There have been two recorded tornado/funnel cloud events with the County since 1950. However, these were F0-rated events that caused no damages, and tornados are not considered a high risk for the county. Flooding issues associated with severe weather are discussed in Chapter 13. The other three types of severe weather common to Contra Costa County are described in the following sections.

15.1.1 Thunderstorms

A thunderstorm is a rain event that includes thunder and lightning. A thunderstorm is classified as "severe" when it contains one or more of the following: hail with a diameter of three-quarter inch or greater, winds gusting in excess of 50 knots (57.5 mph), or tornado.

Three factors cause thunderstorms to form: moisture, rising unstable air (air that keeps rising when disturbed), and a lifting mechanism to provide the disturbance. The sun heats the surface of the earth, which warms the air above it. If this warm surface air is forced to rise (hills or mountains can cause rising motion, as can the interaction of warm air and cold air or wet air and dry air) it will continue to rise as long as it weighs less and stays warmer than the air around it. As the air rises, it transfers heat from the surface of the earth to the upper levels of the atmosphere (the process of convection). The water vapor it contains begins to cool and

DEFINITIONS

Freezing Rain—The result of rain occurring when the temperature is below the freezing point. The rain freezes on impact, resulting in a layer of glaze ice up to an inch thick. In a severe ice storm, an evergreen tree 60 feet high and 30 feet wide can be burdened with up to six tons of ice, creating a threat to power and telephone lines and transportation routes.

Severe Local Storm—"Microscale" atmospheric systems, including tornadoes, thunderstorms, windstorms, ice storms and snowstorms. These storms may cause a great deal of destruction and even death, but their impact is generally confined to a small area. Typical impacts are on transportation infrastructure and utilities.

Thunderstorm—A storm featuring heavy rains, strong winds, thunder and lightning, typically about 15 miles in diameter and lasting about 30 minutes. Hail and tornadoes are also dangers associated with thunderstorms. Lightning is a serious threat to human life. Heavy rains over a small area in a short time can lead to flash flooding.

Tornado—Funnel clouds that generate winds up to 500 miles per hour. They can affect an area up to three-quarters of a mile wide, with a path of varying length. Tornadoes can come from lines of cumulonimbus clouds or from a single storm cloud. They are measured using the Fujita Scale, ranging from F0 to F5.

Windstorm—A storm featuring violent winds. Southwesterly winds are associated with strong storms moving onto the coast from the Pacific Ocean. Southern winds parallel to the coastal mountains are the strongest and most destructive winds. Windstorms tend to damage ridgelines that face into the winds.

Winter Storm—A storm having significant snowfall, ice, and/or freezing rain; the quantity of precipitation varies by elevation.

it condenses into a cloud. The cloud eventually grows upward into areas where the temperature is below freezing. Some of the water vapor turns to ice and some of it turns into water droplets. Both have electrical charges. Ice particles usually have positive charges, and rain droplets usually have negative charges. When the charges build up enough, they are discharged in a bolt of lightning, which causes the sound waves we hear as thunder. Thunderstorms have three stages (see Figure 15-1):

- The *developing stage* of a thunderstorm is marked by a cumulus cloud that is being pushed upward by a rising column of air (updraft). The cumulus cloud soon looks like a tower (called towering cumulus) as the updraft continues to develop. There is little to no rain during this stage but occasional lightning. The developing stage lasts about 10 minutes.
- The thunderstorm enters the *mature stage* when the updraft continues to feed the storm, but precipitation begins to fall out of the storm, and a downdraft begins (a column of air pushing downward). When the downdraft and rain-cooled air spread out along the ground, they form a gust front, or a line of gusty winds. The mature stage is the most likely time for hail, heavy rain, frequent lightning, strong winds, and tornadoes. The storm occasionally has a black or dark green appearance.
- Eventually, a large amount of precipitation is produced and the updraft is overcome by the downdraft beginning the *dissipating stage*. At the ground, the gust front moves out a long distance from the storm and cuts off the warm moist air that was feeding the thunderstorm. Rainfall decreases in intensity, but lightning remains a danger.

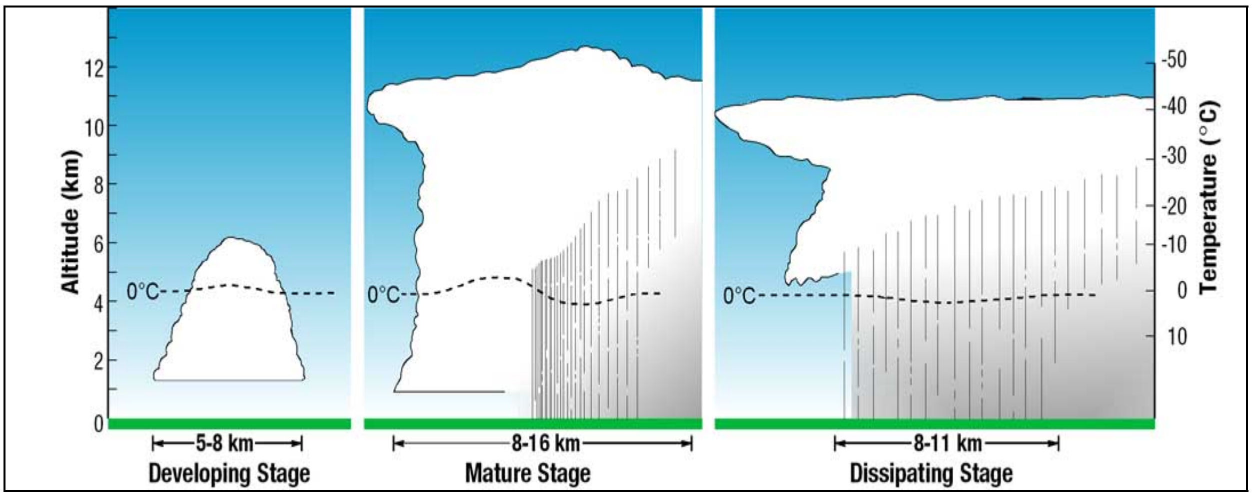


Figure 15-1. The Thunderstorm Life Cycle

There are four types of thunderstorms:

- **Single-Cell Thunderstorms—**Single-cell thunderstorms usually last 20 to 30 minutes. A true single-cell storm is rare, because the gust front of one cell often triggers the growth of another. Most single-cell storms are not usually severe, but a single-cell storm can produce a brief severe weather event. When this happens, it is called a pulse severe storm.
- **Multi-Cell Cluster Storm—**A multi-cell cluster is the most common type of thunderstorm. The multi-cell cluster consists of a group of cells, moving as one unit, with each cell in a different phase of the thunderstorm life cycle. Mature cells are usually found at the center of the cluster and dissipating cells at the downwind edge. Multi-cell cluster storms can produce moderate-size hail, flash floods and weak tornadoes. Each cell in a multi-cell cluster lasts only about 20 minutes; the multi-cell cluster itself may persist for several hours. This type of storm is usually more intense than a single cell storm.

- **Multi-Cell Squall Line—**A multi-cell line storm, or squall line, consists of a long line of storms with a continuous well-developed gust front at the leading edge. The line of storms can be solid, or there can be gaps and breaks in the line. Squall lines can produce hail up to golf-ball size, heavy rainfall, and weak tornadoes, but they are best known as the producers of strong downdrafts. Occasionally, a strong downburst will accelerate a portion of the squall line ahead of the rest of the line. This produces what is called a bow echo. Bow echoes can develop with isolated cells as well as squall lines. Bow echoes are easily detected on radar but are difficult to observe visually.
- **Super-Cell Storm—**A super-cell is a highly organized thunderstorm that poses a high threat to life and property. It is similar to a single-cell storm in that it has one main updraft, but the updraft is extremely strong, reaching speeds of 150 to 175 miles per hour. Super-cells are rare. The main characteristic that sets them apart from other thunderstorms is the presence of rotation. The rotating updraft of a super-cell (called a mesocyclone when visible on radar) helps the super-cell to produce extreme weather events, such as giant hail (more than 2 inches in diameter), strong downbursts of 80 miles an hour or more, and strong to violent tornadoes.

15.1.2 Damaging Winds

Damaging winds are classified as those exceeding 60 mph. Damage from such winds accounts for half of all severe weather reports in the lower 48 states and is more common than damage from tornadoes. Wind speeds can reach up to 100 mph and can produce a damage path extending for hundreds of miles. There are seven types of damaging winds:

- **Straight-line winds**—Any thunderstorm wind that is not associated with rotation; this term is used mainly to differentiate from tornado winds. Most thunderstorms produce some straight-line winds as a result of outflow generated by the thunderstorm downdraft.
- **Downdrafts**—A small-scale column of air that rapidly sinks toward the ground.
- **Downbursts**—A strong downdraft with horizontal dimensions larger than 2.5 miles resulting in an outward burst or damaging winds on or near the ground. Downburst winds may begin as a microburst and spread out over a wider area, sometimes producing damage similar to a strong tornado. Although usually associated with thunderstorms, downbursts can occur with showers too weak to produce thunder.
- **Microbursts**—A small concentrated downburst that produces an outward burst of damaging winds at the surface. Microbursts are generally less than 2.5 miles across and short-lived, lasting only 5 to 10 minutes, with maximum wind speeds up to 168 mph. There are two kinds of microbursts: wet and dry. A wet microburst is accompanied by heavy precipitation at the surface. Dry microbursts, common in places like the high plains and the intermountain west, occur with little or no precipitation reaching the ground.
- **Gust front—**A gust front is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Gust fronts are characterized by a wind shift, temperature drop, and gusty winds out ahead of a thunderstorm. Sometimes the winds push up air above them, forming a shelf cloud or detached roll cloud.
- **Derecho**—A derecho is a widespread thunderstorm wind caused when new thunderstorms form along the leading edge of an outflow boundary (the boundary formed by horizontal spreading of thunderstorm-cooled air). The word "derecho" is of Spanish origin and means "straight ahead." Thunderstorms feed on the boundary and continue to reproduce. Derechos typically occur in summer when complexes of thunderstorms form over plains, producing heavy rain and severe wind. The damaging winds can last a long time and cover a large area.

- **Bow Echo**—A bow echo is a linear wind front bent outward in a bow shape. Damaging straight-line winds often occur near the center of a bow echo. Bow echoes can be 200 miles long, last for several hours, and produce extensive wind damage at the ground.

15.1.3 Hail Storms

Hail occurs when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere where they freeze into ice. Recent studies suggest that super-cooled water may accumulate on frozen particles near the back-side of a storm as they are pushed forward across and above the updraft by the prevailing winds near the top of the storm. Eventually, the hailstones encounter downdraft air and fall to the ground.

Hailstones grow two ways: by wet growth or dry growth. In wet growth, a tiny piece of ice is in an area where the air temperature is below freezing, but not super cold. When the tiny piece of ice collides with a super-cooled drop, the water does not freeze on the ice immediately. Instead, liquid water spreads across tumbling hailstones and slowly freezes. Since the process is slow, air bubbles can escape, resulting in a layer of clear ice. Dry growth hailstones grow when the air temperature is well below freezing and the water droplet freezes immediately as it collides with the ice particle. The air bubbles are “frozen” in place, leaving cloudy ice.

Hailstones can have layers like an onion if they travel up and down in an updraft, or they can have few or no layers if they are “balanced” in an updraft. One can tell how many times a hailstone traveled to the top of the storm by counting its layers. Hailstones can begin to melt and then re-freeze together, forming large and very irregularly shaped hail.

15.2 HAZARD PROFILE

15.2.1 Past Events

Table 15-1 summarizes severe weather events in Contra Costa County since 1970, as recorded by the National Oceanic and Atmospheric Administration (NOAA).

15.2.2 Location

Severe weather events have the potential to happen anywhere in the planning area. Communities in low-lying areas next to streams or lakes are more susceptible to flooding. Wind events are most damaging to areas that are heavily wooded. Maps 15-1, 15-2, 15-3 and 15-4 show the distribution of average weather conditions over Contra Costa County.

15.2.3 Frequency

The severe weather events for Contra Costa County shown in Table 15-1 are often related to high winds associated with winter storms and thunderstorms. The planning area can expect to experience exposure to some type of severe weather event at least annually.

15.2.4 Severity

The most common problems associated with severe storms are immobility and loss of utilities. Fatalities are uncommon, but can occur. Roads may become impassable due to flooding, downed trees, ice or snow, or a landslide. Power lines may be downed due to high winds or ice accumulation, and services such as water or phone may not be able to operate without power. Lightning can cause severe damage and injury.

TABLE 15-1.
SEVERE WEATHER EVENTS IMPACTING CONTRA COSTA COUNTY SINCE 1970

Date	Type	Deaths or Injuries	Property Damage
04/29/1983	Hail	0	0
Description: *Hail up to 0.75" was reported in portions of Contra Costa County.*			
09/18/1989	Tornado	0	0
Description: *An F0 tornado 10 yards wide and 0.20 miles long was reported in Contra Costa County.*			
02/07/1994	Funnel Cloud	0	0
Description: *Severe weather developed in the cold air behind the first of two Pacific storm systems to hit California. The severe thunderstorm produced wind gusts of 64 mph at Travis Air Force base.*			
02/07/1994	Severe Thunderstorm	0	Estimated $50,000
Description: *Severe weather developed in the cold air behind the first of two Pacific storm systems to hit California. The severe thunderstorm produced wind gusts in excess of 60 mph were reported within the County.*			
11/04/1994	Strong Winds	0	0
Description: *South winds 42 mph gusting to 79 mph.*			
03/10/1995	Winter Storm/High Winds	0	0
Description: *Several feet of snow a day fell in the mountains. Winds to 80 mph were reported in mountains. Winds to 55 mph were reported along the coast south of Pt. Reyes. More than 1.5 million people were without power during this period, primarily the San Francisco Bay area. 89 mph winds in Belmont. Roof ripped off the San Ramon Valley High School.*			
12/9/1995	Winter Storm/High Winds	1	$60 million (multiple counties)
Description: *Widespread winds over 40 mph many reported 60 to 80 mph. Max wind 135 mph from PG&E in San Francisco Area. Major damage in the San Francisco Bay area. Power outages to around 1.5 million people resulted from this storm and some power was out for more than a week, causing financial damage and personal hardship, particularly in mountainous areas. The wind strength and area coverage was labeled as the worst in the San Francisco area since 1962-63. 2 to 5 inches of rain fell over a good part of the area with some flash flooding but mainly small stream and local flooding occurred. Many reports of houses and other buildings damaged by falling trees and broken glass due to wind-driven debris. 169 schools closed in the area. 14 inches of rain in a 36-hour period over the Russian River Basin. From some of the damage across the San Francisco area it was determined that a wet downburst mechanism may have contributed to the wind damage.*			
02/19/1998	Tornado	0	$50,000
Description: *Weak tornado (F0) demolished a 120' by 40' shade structure at a nursery as well as a chicken coop and a tool shed.*			
11/29/1998	High Winds	0	$1.8 million (multiple counties)
Description: *Wind gusts up to 75 mph were reported within eight bay area counties.*			
12/5/1998	Tornado	0	$200,000
Description: *An F0 tornado 150 yards wide and 1.5 miles long was reported in Richmond.*			
12/16/1998	High Winds	0	$50,000
Description: *Wind gusts up to 61 mph were reported in Alameda and Contra Costa Counties.*			
02/09/1999	High Winds	0	$1 million (multiple counties)
Description: *Wind gusts up to 60 mph were reported in five bay area counties.*			
12/21/1999	High Winds	0	$125,000
Description: *A strong high pressure inland and a low offshore created strong northeasterly down slope wind in the Oakland and Contra Costa County hills. A strong offshore gradient created high down slope winds in the Oakland hills area. Many trees were downed and power was lost for 10,000 people.*			

TABLE 15-1 (continued).
SEVERE WEATHER EVENTS IMPACTING CONTRA COSTA COUNTY SINCE 1970

Date	Type	Deaths or Injuries	Property Damage
06/14/2000	Excessive Heat	9	0
Description: *This unusual early summer record breaking heat wave was responsible for 10 deaths in the Bay Area and a large number of heat-related injuries. Temperature of 103 degrees in San Francisco tied the record high temperature. High temperature caused overloading of power resources and rolling blackouts were implemented to keep the power system from exceeding capacity, so many people lost power for a period during the heat.*			
12/18/2000	High Winds	0	$1.1 million
Description: *The Oakland Hills section of Alameda county experienced winds gusting as high as 66 mph according to the observation on Mt. Diablo. Gusts to 62 mph were recorded at Oakland South Remote Automated Weather Station (RAWS) and a gust of 71 mph was reported at the Oakland north RAWS in Contra Costa County. A large Monterey Pine tree was blown down onto a house causing extensive damage in the Montclair district. Power to over 2500 customers was lost due to trees blowing into power lines. Three cars were crushed by two trees falling into the road in the Broadway terrace neighborhood. Trees blown down across Highway 13 and the entry ramp to I-580 snarled traffic.*			
01/25/2001	High Wind	0	0
Description: *A strong cold front swept over the area from the northwest. It formed a squall line that produced high winds, small hail and snow as low as 800 feet. A severe thunderstorm watch was issued for only the second time in 25 years for the San Francisco Bay area. No severe thunderstorms were reported, but rotation was noted near Richmond. There was damage from mainly strong gradient winds and lightning strikes. A number of trees were downed causing power outages to the Bay area.*			
11/07/2002	High Wind	0	$1 million (multiple counties)
Description: *One very strong weather system affected central California. For a three-day period starting on November 7, rainfall totaling 2 to 5 inches fell across the North Bay counties, 2 to 4 inches fell across the San Francisco Peninsula, 1 to 3 inches fell across the East Bay, 1 to 4 inches fell across the South Bay and 1 to 2 inches fell across Monterey and San Benito Counties. Since this was the first appreciable rain of the season, no major flooding occurred, with the ground absorbing most of the rain. Only urban and small stream advisories were needed. Strong winds blew the roof off a large aircraft hangar at San Francisco Airport. Many trees and branches were down, blocking roads and interrupting power. Winds also blew down power poles and lines. As many as 1 million homes were without power at one time. A number of trees fell on homes and automobiles. Total damage to the area was estimated at $2.5 million. 96 mph gust at Kregor Peak, Contra Costa County at 8 PM, November 7. Other peak winds of note: Pt. San Pablo, 87 mph; Fort Funston, 77 mph; Mt. Tamalpias, 65 mph; San Francisco International Airport, 64 mph; Richmond, 57 mph; Sonoma (Baylands Raceway), 56 mph; Sunol, 55 mph; Lake Chabot (Castro Valley), 55 mph; Oakland International Airport, 50 mph; San Jose International Airport, 46 mph; San Carlos Airport, 52 mph; Buchanan Field (Concord), 46 mph.*			
12/14/2003	High Wind	0	0
Description: *High winds hit the Bay Area, with winds gusting to 62 mph at Las Trampas in the East Bay Hills - causing thousands of power outages.*			
02/17/2004	High Winds	0	0
Description: *Strong winter storm produced a 74 mph wind gust on Kregor Peak in the East Bay Hills.*			
01/23/2010	Tornado	0	$25,000
Description: *A low topped super cell produced an F0 tornado near Brentwood. The tornado crossed power lines and destroyed a utility pole. An eyewitness described the tornado as high winds from a swirling white cloud. The 40-foot pole was twisted to the ground and the top one-third of it was splintered. Fifty-five customers lost power. Lingering moisture combined with the cold air left behind a front that moved across the San Francisco Bay Area on Friday to produce a damaging thunderstorm on Saturday.*			

Windstorms can be a frequent problem in the planning area and have been known to cause damage to utilities. The predicted wind speed given in wind warnings issued by the National Weather Service is for a one-minute average; gusts may be 25 to 30 percent higher.

Tornadoes are potentially the most dangerous of local storms, but they are not common in the planning area. If a major tornado were to strike within the populated areas of the county, damage could be widespread. Businesses could be forced to close for an extended period or permanently, fatalities could be high, many people could be homeless for an extended period, and routine services such as telephone or power could be disrupted. Buildings may be damaged or destroyed. California ranks 32nd among states for frequency of tornadoes, 44th for the frequency of tornados per square mile, 36th for injuries, and 31st for cost of damage. The state has no reported deaths from tornadoes.

15.2.5 Warning Time

Meteorologists can often predict the likelihood of a severe storm. This can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity of the storm. Some storms may come on more quickly and have only a few hours of warning time.

15.3 SECONDARY HAZARDS

The most significant secondary hazards associated with severe local storms are floods, falling and downed trees, landslides and downed power lines. Rapidly melting snow combined with heavy rain can overwhelm both natural and man-made drainage systems, causing overflow and property destruction. Landslides occur when the soil on slopes becomes oversaturated and fails.

15.4 CLIMATE CHANGE IMPACTS

Climate change presents a significant challenge for risk management associated with severe weather. The frequency of severe weather events has increased steadily over the last century. The number of weather-related disasters during the 1990s was four times that of the 1950s, and cost 14 times as much in economic losses. Historical data shows that the probability for severe weather events increases in a warmer climate (see Figure 15-2). The changing hydrograph caused by climate change could have a significant impact on the intensity, duration and frequency of storm events. All of these impacts could have significant economic consequences.

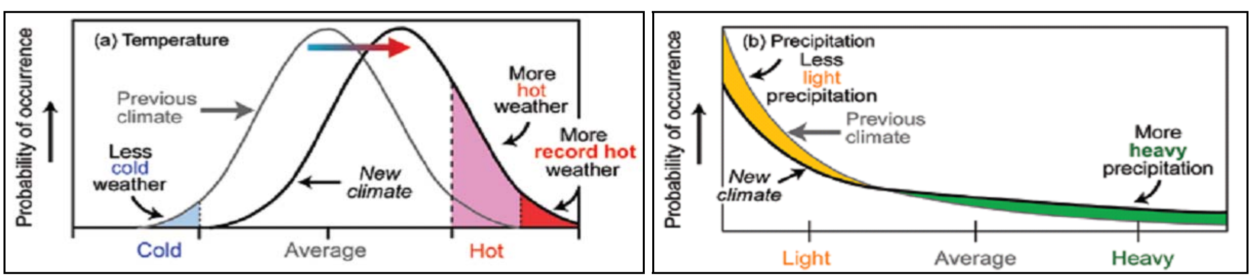


Figure 15-2. Severe Weather Probabilities in Warmer Climates

15.5 EXPOSURE

15.5.1 Population

A lack of data separating severe weather damage from flooding and landslide damage prevented a detailed analysis for exposure and vulnerability. However, it can be assumed that the entire county is exposed to some extent to severe weather events. Certain areas are more exposed due to geographic location and local weather patterns. Populations living at higher elevations with large stands of trees or power lines may be more susceptible to wind damage and black out, while populations in low-lying areas are at risk for possible flooding.

15.5.2 Property

According to the Contra Costa County Assessor, there are 334,741 buildings within the census tracts that define the planning area. Most of these buildings are residential. It is estimated that 20 percent of the residential structures were built without the influence of a structure building code with provisions for wind loads. All of these buildings are considered to be exposed to the severe weather hazard, but structures in poor condition or in particularly vulnerable locations (located on hilltops or exposed open areas) may risk the most damage. The frequency and degree of damage will depend on specific locations.

15.5.3 Critical Facilities and Infrastructure

All critical facilities exposed to flooding (Chapter 13) are also likely exposed to severe weather. Additional facilities on higher ground may also be exposed to wind damage or damage from falling trees. The most common problems associated with severe weather are loss of utilities. Downed power lines can cause blackouts, leaving large areas isolated. Phone, water and sewer systems may not function. Roads may become impassable due to ice or snow or from secondary hazards such as landslides.

15.5.4 Environment

The environment is highly exposed to severe weather events. Natural habitats such as streams and trees are exposed to the elements during a severe storm and risk major damage and destruction. Prolonged rains can saturate soils and lead to slope failure. Flooding events caused by severe weather or snowmelt can produce river channel migration or damage riparian habitat. Storm surges can erode beachfront bluffs and redistribute sediment loads.

15.6 VULNERABILITY

15.6.1 Population

Vulnerable populations are the elderly, low income or linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Power outages can be life threatening to those dependent on electricity for life support. Isolation of these populations is a significant concern. These populations face isolation and exposure during severe weather events and could suffer more secondary effects of the hazard.

15.6.2 Property

All property is vulnerable during severe weather events, but properties in poor condition or in particularly vulnerable locations may risk the most damage. Those in higher elevations and on ridges may be more prone to wind damage. Those that are located under or near overhead lines or near large trees may be vulnerable to falling ice or may be damaged in the event of a collapse.

Loss estimations for the severe weather hazard are not based on damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the assessed value of exposed structures. This allows emergency managers to select a range of potential economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 15-2 lists the loss estimates to the general building stock.

TABLE 15-2.
BUILDINGS VULNERABLE TO SEVERE WEATHER HAZARD

City	Assessed Value	10% Damage	30% Damage	50% Damage
Antioch	$10,690,394,000	$1,069,039,400	$3,207,118,200	$5,345,197,000
Brentwood	$10,026,675,000	$1,002,667,500	$3,008,002,500	$5,013,337,500
Clayton	$1,965,123,000	$196,512,300	$589,536,900	$982,561,500
Concord	$13,763,615,000	$1,376,361,500	$4,129,084,500	$6,881,807,500
Danville	$7,882,344,000	$788,234,400	$2,364,703,200	$3,941,172,000
El Cerrito	$2,632,321,000	$263,232,100	$789,696,300	$1,316,160,500
Hercules	$3,693,555,000	$369,355,500	$1,108,066,500	$1,846,777,500
Lafayette	$4,103,097,000	$410,309,700	$1,230,929,100	$2,051,548,500
Martinez	$7,097,041,000	$709,704,100	$2,129,112,300	$3,548,520,500
Moraga	$2,647,579,000	$264,757,900	$794,273,700	$1,323,789,500
Oakley	$4,771,034,000	$477,103,400	$1,431,310,200	$2,385,517,000
Orinda	$3,839,256,000	$383,925,600	$1,151,776,800	$1,919,628,000
Pinole	$1,105,559,000	$110,555,900	$331,667,700	$552,779,500
Pittsburg	$7,164,745,000	$716,474,500	$2,149,423,500	$3,582,372,500
Pleasant Hill	$4,049,489,000	$404,948,900	$1,214,846,700	$2,024,744,500
Richmond	$15,525,828,000	$1,552,582,800	$4,657,748,400	$7,762,914,000
San Pablo	$2,074,394,000	$207,439,400	$622,318,200	$1,037,197,000
San Ramon	$11,430,496,000	$1,143,049,600	$3,429,148,800	$5,715,248,000
Walnut Creek	$15,788,742,000	$1,578,874,200	$4,736,622,600	$7,894,371,000
Unincorporated	$43,881,618,000	$4,388,161,000	$13,164,485,400	$21,940,809,000
Total	**$174,132,905,000**	**$17,413,289,700**	**$52,239,871,500**	**$87,066,452,500**

15.6.3 Critical Facilities and Infrastructure

Incapacity and loss of roads are the primary transportation failures resulting from severe weather, mostly associated with secondary hazards. Landslides caused by heavy prolonged rains can block roads are. High winds can cause significant damage to trees and power lines, blocking roads with debris, incapacitating transportation, isolating population, and disrupting ingress and egress. Snowstorms in higher elevations can significantly impact the transportation system and the availability of public safety services. Of particular concern are roads providing access to isolated areas and to the elderly.

Prolonged obstruction of major routes due to landslides, snow, debris or floodwaters can disrupt the shipment of goods and other commerce. Large, prolonged storms can have negative economic impacts for an entire region.

Severe windstorms, downed trees, and ice can create serious impacts on power and above-ground communication lines. Freezing of power and communication lines can cause them to break, disrupting electricity and communication. Loss of electricity and phone connection would leave certain populations isolated because residents would be unable to call for assistance.

15.6.4 Environment

The vulnerability of the environment to severe weather is the same as the exposure.

15.7 FUTURE TRENDS IN DEVELOPMENT

All future development will be affected by severe storms. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. The planning partners have adopted the International Building Code in response to California mandates. This code is equipped to deal with the impacts of severe weather events. Land use policies identified in general plans within the planning area also address many of the secondary impacts (flood and landslide) of the severe weather hazard. With these tools, the planning partnership is well equipped to deal with future growth and the associated impacts of severe weather.

15.8 SCENARIO

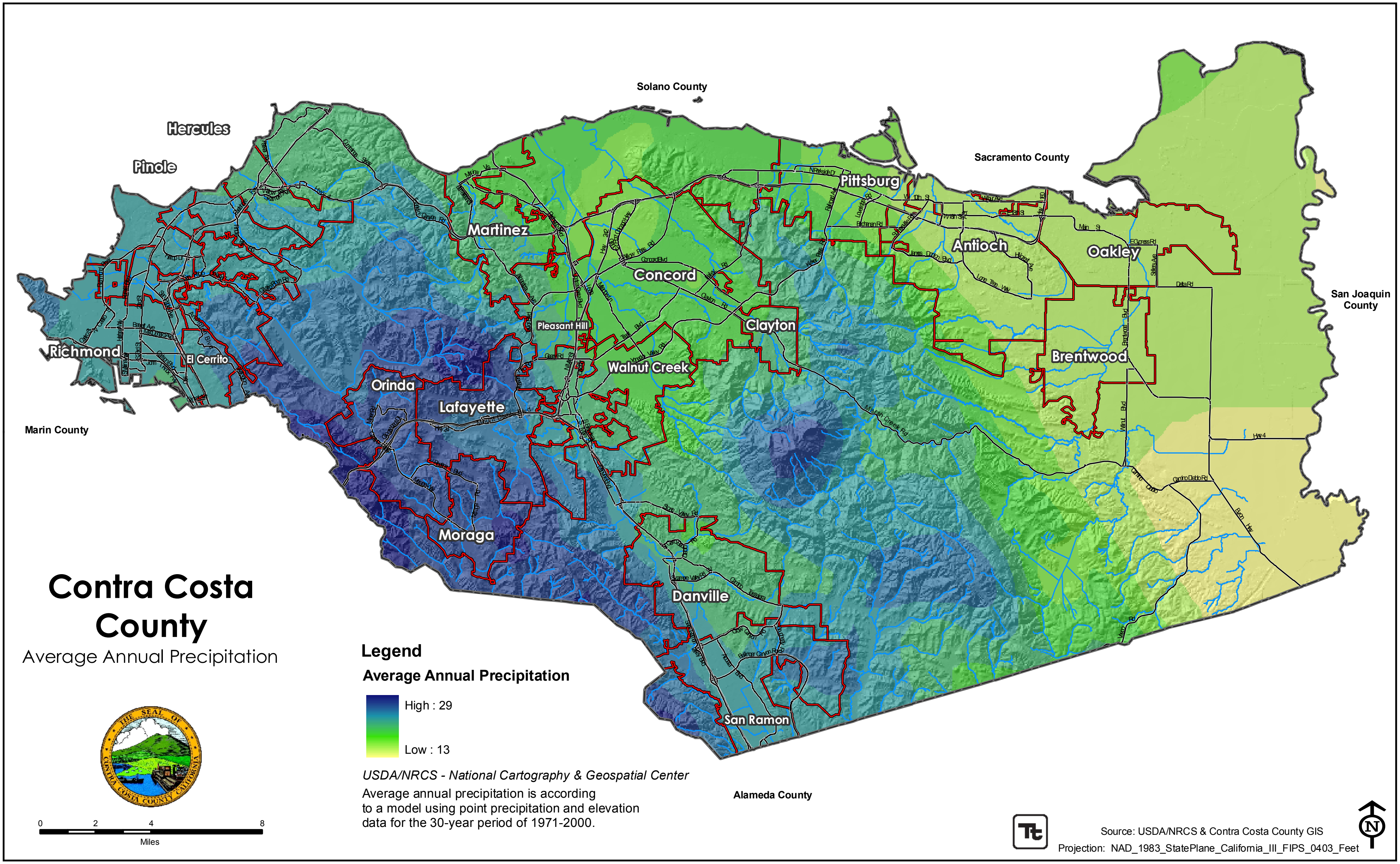
Although severe local storms are infrequent, impacts can be significant, particularly when secondary hazards of flood and landslide occur. A worst-case event would involve prolonged high winds during a winter storm accompanied by thunderstorms. Such an event would have both short-term and longer-term effects. Initially, schools and roads would be closed due to power outages caused by high winds and downed tree obstructions. In more rural areas, some subdivisions could experience limited ingress and egress. Prolonged rain could produce flooding, overtopped culverts with ponded water on roads, and landslides on steep slopes. Flooding and landslides could further obstruct roads and bridges, further isolating residents.

15.9 ISSUES

Important issues associated with a severe weather in the Contra Costa County planning area include the following:

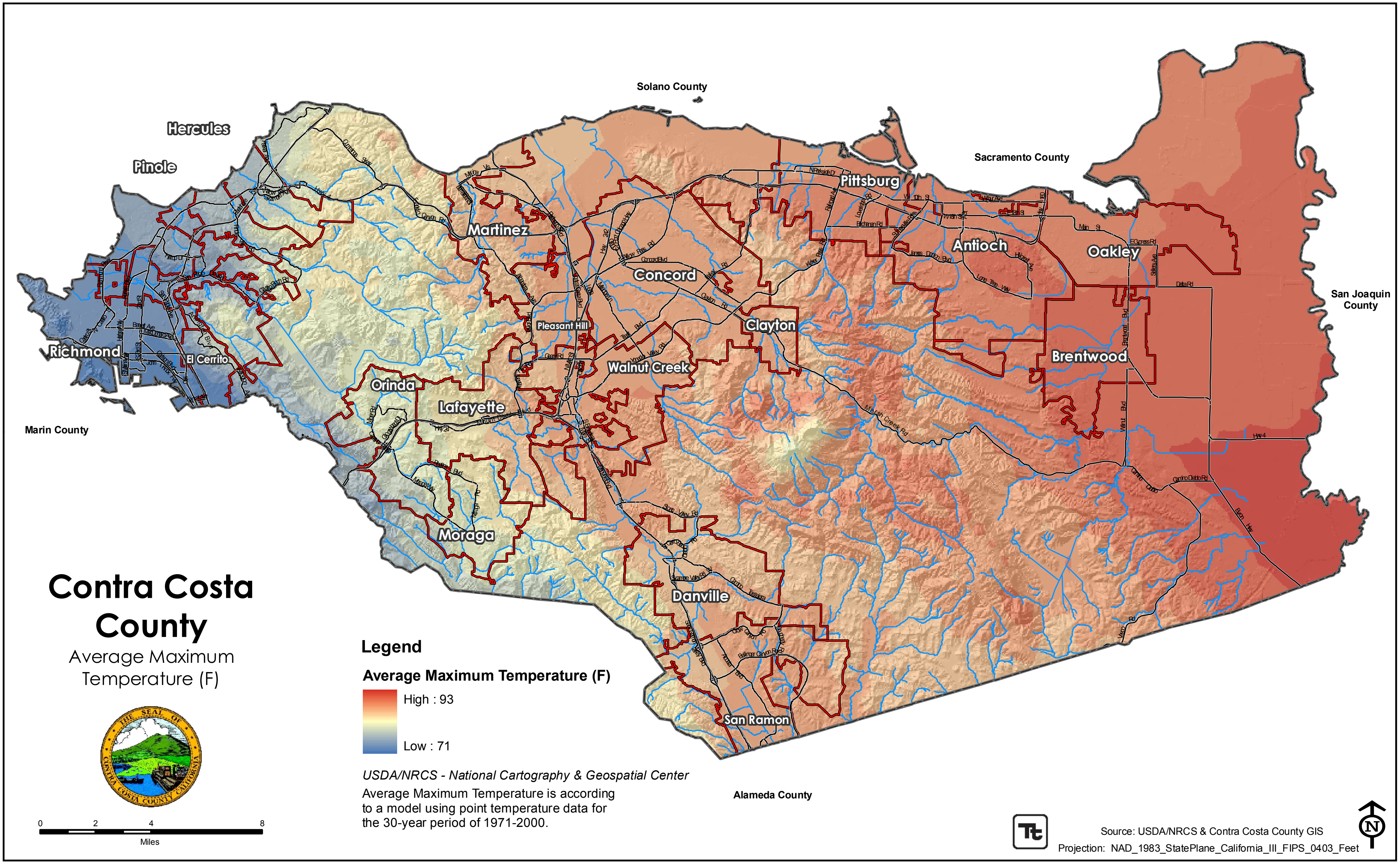
- Older building stock in the planning area is built to low code standards or none at all. These structures could be highly vulnerable to severe weather events such as windstorms.
- Redundancy of power supply must be evaluated.
- The capacity for backup power generation is limited.
- Isolated population centers.

Map 15-1.



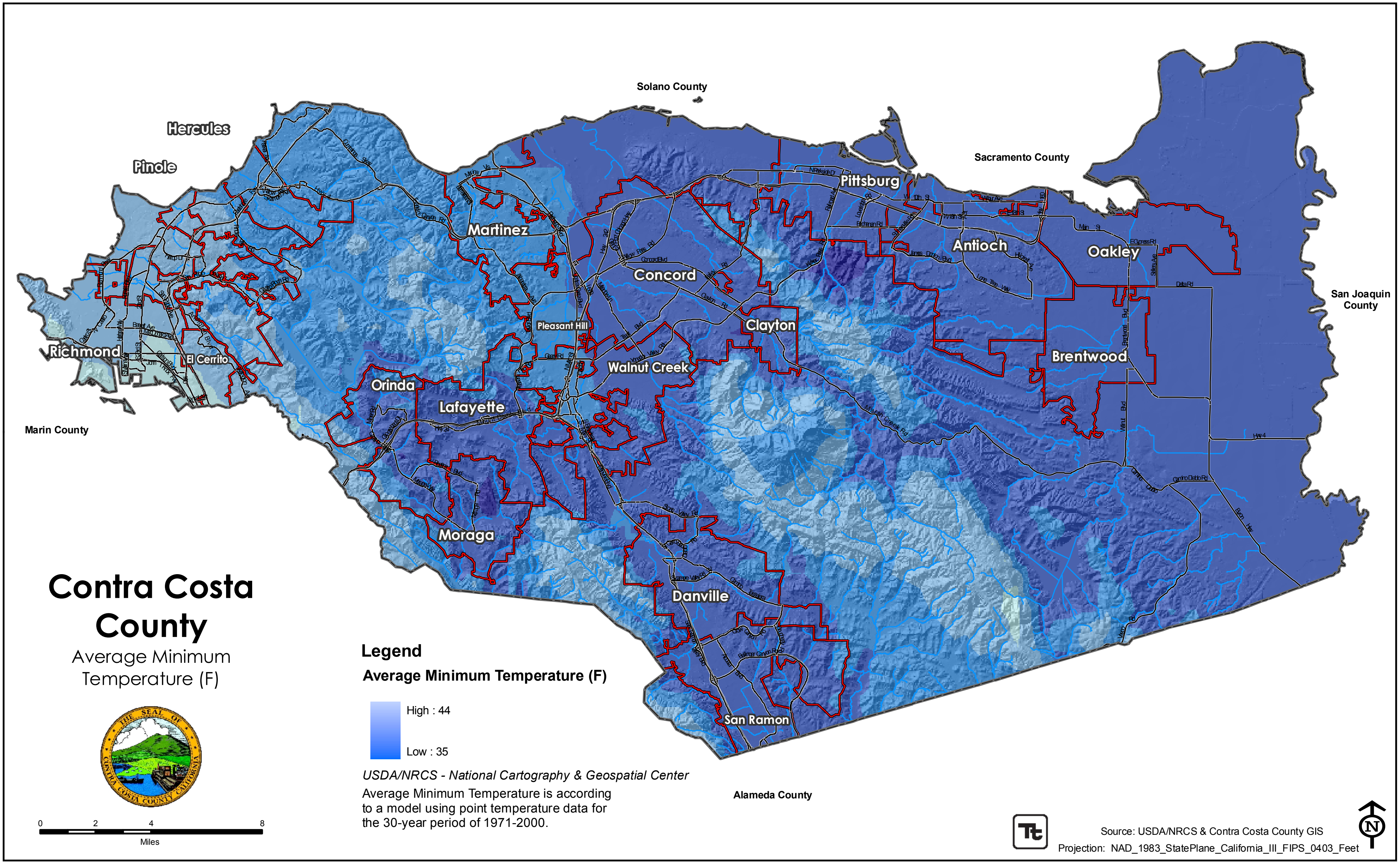
Solano County
Hercules
Pinole
Sacramento County
Pittsburg
Martinez
Antioch
Oakley
Concord
San Joaquin County
Pleasant Hill
Clayton
Richmond
El Cerrito
Walnut Creek
Brentwood
Orinda
Lafayette
Marin County
Moraga
Danville
San Ramon
Alameda County
Contra Costa County
Average Annual Precipitation
Legend
Average Annual Precipitation
High : 29
Low : 13
USDA/NRCS - National Cartography & Geospatial Center
Average annual precipitation is according to a model using point precipitation and elevation data for the 30-year period of 1971-2000.
0 2 4 8
Miles
Source: USDA/NRCS & Contra Costa County GIS
Projection: NAD_1983_StatePlane_California_III_FIPS_0403_Feet

Map 15-2.

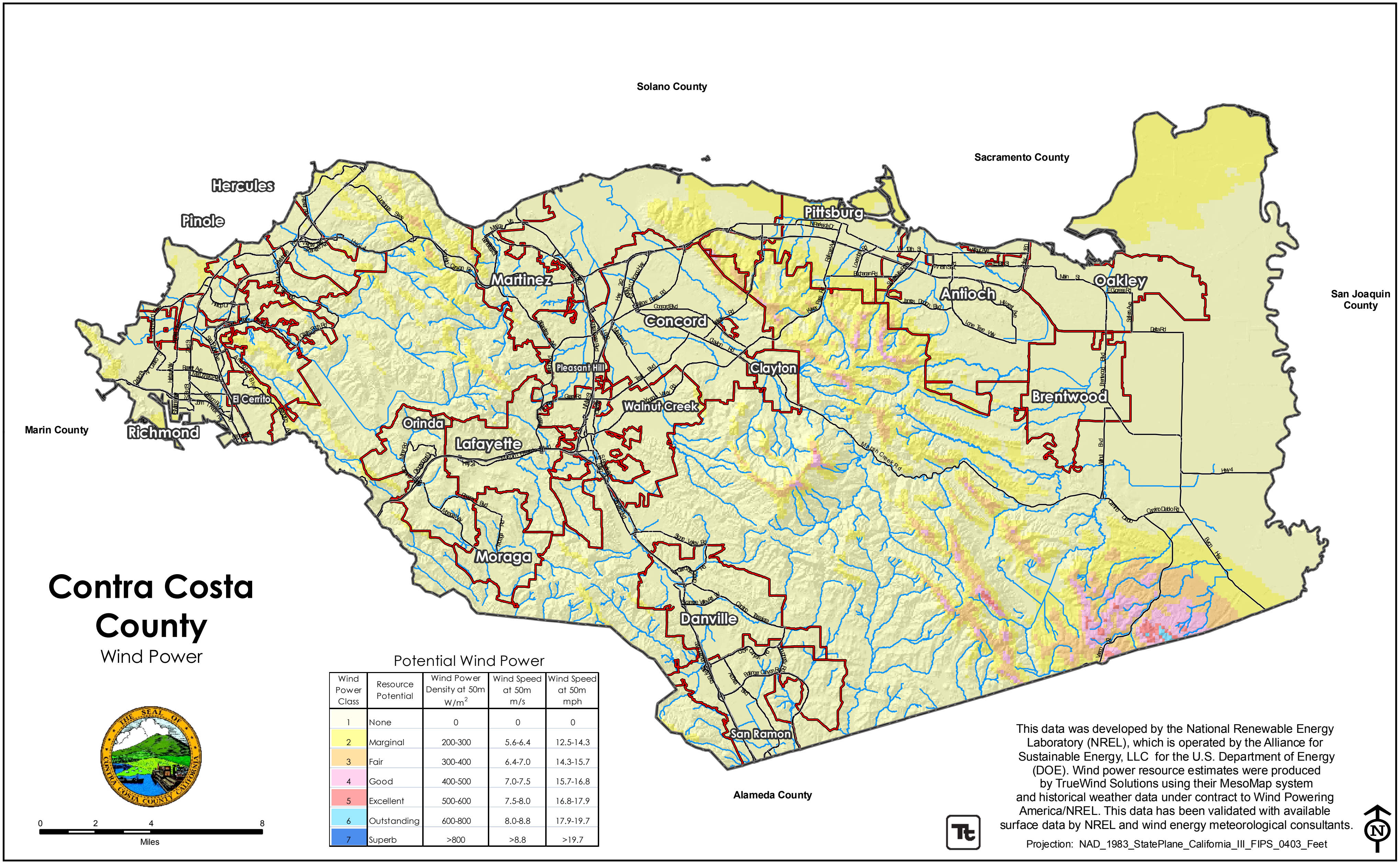


Solano County
Sacramento County
San Joaquin County
Marin County
Alameda County
Hercules
Pinole
Richmond
El Cerrito
Martinez
Pittsburg
Antioch
Oakley
Concord
Pleasant Hill
Clayton
Walnut Creek
Brentwood
Orinda
Lafayette
Moraga
Danville
San Ramon
Contra Costa County
Average Maximum Temperature (F)
Legend
Average Maximum Temperature (F)
High : 93
Low : 71
USDA/NRCS - National Cartography & Geospatial Center
Average Maximum Temperature is according to a model using point temperature data for the 30-year period of 1971-2000.
0
2
4
8
Miles
Source: USDA/NRCS & Contra Costa County GIS
Projection: NAD_1983_StatePlane_California_III_FIPS_0403_Feet
N

Map 15-3.


Contra Costa County
Average Minimum Temperature (F)
Solano County
Sacramento County
San Joaquin County
Marin County
Alameda County
Hercules
Pinole
Richmond
El Cerrito
Martinez
Pittsburg
Antioch
Oakley
Concord
Pleasant Hill
Clayton
Walnut Creek
Orinda
Lafayette
Brentwood
Moraga
Danville
San Ramon
Legend
Average Minimum Temperature (F)
High : 44
Low : 35
USDA/NRCS - National Cartography & Geospatial Center
Average Minimum Temperature is according to a model using point temperature data for the 30-year period of 1971-2000.
0 2 4 8
Miles
Source: USDA/NRCS & Contra Costa County GIS
Projection: NAD_1983_StatePlane_California_III_FIPS_0403_Feet

Map 15-4.



Potential Wind Power

Wind Power Class	Resource Potential	Wind Power Density at 50m W/m^2	Wind Speed at 50m m/s	Wind Speed at 50m mph
1	None	0	0	0
2	Marginal	200-300	5.6-6.4	12.5-14.3
3	Fair	300-400	6.4-7.0	14.3-15.7
4	Good	400-500	7.0-7.5	15.7-16.8
5	Excellent	500-600	7.5-8.0	16.8-17.9
6	Outstanding	600-800	8.0-8.8	17.9-19.7
7	Superb	>800	>8.8	>19.7

This data was developed by the National Renewable Energy Laboratory (NREL), which is operated by the Alliance for Sustainable Energy, LLC for the U.S. Department of Energy (DOE). Wind power resource estimates were produced by TrueWind Solutions using their MesoMap system and historical weather data under contract to Wind Powering America/NREL. This data has been validated with available surface data by NREL and wind energy meteorological consultants.

Projection: NAD_1983_StatePlane_California_III_FIPS_0403_Feet

CHAPTER 16.
WILDFIRE

16.1 GENERAL BACKGROUND

A wildfire is any uncontrolled fire occurring on undeveloped land that requires fire suppression. Wildfires can be ignited by lightning or by human activity such as smoking, campfires, equipment use, and arson.

Fire hazards present a considerable risk to vegetation and wildlife habitats throughout Contra Costa County. Short-term loss caused by a wildfire can include the destruction of timber, wildlife habitat, scenic vistas, and watersheds. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, and destruction of cultural and economic resources and community infrastructure. Vulnerability to flooding increases due to the destruction of watersheds. The potential for significant damage to life and property exists in areas designated as "wildland urban interface (WUI) areas," where development is adjacent to densely vegetated areas.

16.1.1 Local Conditions Related to Wildfire

Because the natural vegetation and dry-farmed grain areas of the county are extremely flammable during late summer and fall, wildfire is a serious hazard in undeveloped areas and on large lot home sites with extensive areas of un-irrigated vegetation.

Grassland fires are easily ignited, particularly in dry seasons. These fires are relatively easily controlled if they can be reached by fire equipment; the burned slopes, however, are highly subject to erosion and gullying.

While brush-lands are naturally adapted to frequent light fires, fire protection in recent decades has resulted in heavy fuel accumulation on the ground. Brush fires, particularly near the end of the dry season, tend to burn fast and very hot, threatening homes and leading to serious destruction of vegetative cover. A brush fire that spreads to a woodland can generate a destructive hot crown fire. No suitable management technique of moderate cost has been devised to reduce the risk of brush fires.

Peat fires represent a special hazard in that once ignited, they are extremely difficult to extinguish. In some instances, islands have been flooded in order to extinguish peat fires. Any area lying landward of the mean high water line may be peaty due to the marshy origin of the soil.

DEFINITIONS

Conflagration—A fire that grows beyond its original source area to engulf adjoining regions. Wind, extremely dry or hazardous weather conditions, excessive fuel buildup and explosions are usually the elements behind a wildfire conflagration.

Firestorm—A fire that expands to cover a large area, often more than a square mile. A firestorm usually occurs when many individual fires grow together into one. The involved area becomes so hot that all combustible materials ignite, even if they are not exposed to direct flame. Temperatures may exceed 1000°C. Superheated air and hot gases of combustion rise over the fire zone, drawing surface winds in from all sides, often at velocities approaching 50 miles per hour. Although firestorms seldom spread because of the inward direction of the winds, once started there is no known way of stopping them. Within the area of the fire, lethal concentrations of carbon monoxide are present; combined with the intense heat, this poses a serious life threat to responding fire forces. In very large events, the rising column of heated air and combustion gases carries enough soot and particulate matter into the upper atmosphere to cause cloud nucleation, creating a locally intense thunderstorm and the hazard of lightning strikes.

Interface Area—An area susceptible to wildfires and where wildland vegetation and urban or suburban development occur together. An example would be smaller urban areas and dispersed rural housing in forested areas.

Wildfire—Fires that result in uncontrolled destruction of forests, brush, field crops, grasslands, and real and personal property in non-urban areas. Because of their distance from firefighting resources, they can be difficult to contain and can cause a great deal of destruction.

16.1.2 Wildfire Protection Responsibility in California

There are hundreds of agencies that have fire protection responsibility for wildland and WUI fires in California. Local, state, tribal, and federal organizations have primary legal (and financial) responsibility for wildfire protection. In many instances, two fire organizations have dual primary responsibility on the same parcel of land —one for wildfire protection and the other for structural or "improvement" fire protection. According to the *2010 California State Hazard Mitigation Plan,* this layering of responsibility and resulting dual policies, rules, practices, and legal ordinances can cause conflict or confusion. To address wildfire jurisdictional responsibilities, the California state legislature in 1981 adopted Public Resource Code Section 4291.5 and Health and Safety Code Section 13108.5 establishing the following responsibility areas:

- **Federal Responsibility Areas (FRAs)—**FRAs are fire-prone wildland areas that are owned or managed by a federal agency such as the U.S. Forest Service, National Park Service, Bureau of Land Management, U.S. Fish and Wildlife Service, or U.S. Department of Defense. Primary financial and rule-making jurisdictional authority rests with the federal land agency. In many instances, FRAs are interspersed with private land ownership or leases. Fire protection for developed private property is usually not the responsibility of the federal land management agency; structural protection responsibility is that of a local government agency.
- **State Responsibility Areas (SRAs)**—SRAs are lands in California where the California Department of Forestry and Fire Protection (CAL FIRE) has legal and financial responsibility for wildfire protection and where CAL FIRE administers fire hazard classifications and building standard regulations. SRAs are defined as lands that meet the following criteria:
  - Are county unincorporated areas
  - Are not federally owned
  - Have wildland vegetation cover rather than agricultural or ornamental plants
  - Have watershed and/or range/forage value
  - Have housing densities not exceeding three units per acre.

  Where SRAs contain built environment or development, the responsibility for fire protection of those improvements (non-wildland) is that of a local government agency.
- **Local Responsibility Areas (LRAs)—**LRAs include land in cities, cultivated agriculture lands and non-flammable areas in unincorporated areas, and lands that do not meet the criteria for SRA or FRA. LRA fire protection is typically provided by city fire departments, fire protection districts, and counties, or by CAL FIRE under contract to local governments. LRAs may include flammable vegetation and WUI areas where the financial and jurisdictional responsibility for improvement and wildfire protection is that of a local government agency.

SRAs were originally mapped in 1985 and have not been updated since, except with respect to changes in boundaries. LRAs were originally mapped in 1996, and also have not been updated since, although many local governments have made similar designations under their own authority.

16.2 HAZARD PROFILE

The *2010 California State Hazard Mitigation Plan* provides the following description of wildfire hazard and risk:

> "The diversity of WUI settings and disagreement about alternative mitigation strategies has led to confusion and different methods of defining and mapping WUI areas. One major

disagreement has been caused by terms such as "hazard" and "risk" being used interchangeably. Hazard is the physical condition that can lead to damage to a particular asset or resource. The term fire hazard is related to those physical conditions related to fire and its ability to cause damage, specifically how often a fire burns a given locale and what the fire is like when it burns (its fire behavior). Thus, fire hazard only refers to the potential characteristics of the fire itself. Risk is the likelihood of a fire occurring at a given site (burn probability) and the associated mechanisms of fire behavior that cause damage to assets and resources (fire behavior). This includes the impact of fire brands (embers) that may be blown some distance igniting fires well away from the main fire."

16.2.1 Past Events

While Contra Costa County has a rich fire history, none of its fires have caused sufficient damage to trigger a state or federal disaster declaration. According to the *2010 California State Hazard Mitigation Plan*, Contra Costa County has received no state or federal disaster declarations since 1950.

The California Fire Alliance maintains a website (http://www.cafirealliance.org/) with interactive maps that detail the fire history in California. Map 16-1 shows the mapped fire history for Contra Costa County. The fire history shows 51 wildfires in the planning area since the 1950s.

16.2.2 Location

CAL FIRE maps areas of significant fire hazards based on factors such as the following:

- **Fuel**—Fuel may include living and dead vegetation on the ground, along the surface as brush and small trees, and above the ground in tree canopies. Lighter fuels such as grasses, leaves and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs and trunks take longer to warm and ignite. Trees killed or defoliated by forest insects and diseases are more susceptible to wildfire.
- **Weather**—Relevant weather conditions include temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount and duration, and the stability of the atmosphere. Of particular importance for wildfire activity are wind and thunderstorms:
  - Strong, dry winds produce extreme fire conditions. Such winds generally reach peak velocities during the night and early morning hours.
  - The thunderstorm season typically begins in June with wet storms, and turns dry with little or no precipitation reaching the ground as the season progresses into July and August.
- **Terrain**—Topography includes slope and elevation. The topography of a region influences the amount and moisture of fuel; the impact of weather conditions such as temperature and wind; potential barriers to fire spread, such as highways and lakes; and elevation and slope of land forms (fire spreads more easily uphill than downhill).

Taking these factors into consideration, a fire hazard severity scale has been devised that characterizes zones by the number of days of moderate, high and extreme fire hazard. These zones, referred to as Fire Hazard Severity Zones (FHSZ), define the application of various mitigation strategies to reduce risk associated with wildfires. Map 16-2 shows the FHSZ map for Contra Costa County. This map is the basis for this wildfire risk assessment.

The FHSZ model is built from existing data and hazard constructs developed by CAL FIRE's Fire and Resource Assessment Program. The model refines the zones to characterize fire exposure mechanisms that cause ignitions to structures. The model characterizes potential fire behavior for vegetation fuels, which are by nature dynamic. Since model results are used to identify permanent engineering mitigations for structures, it is desirable that the model reflect changes in fire behavior over the length of time a structure is likely to be in place. Significant land-use changes need to be accounted for through period maintenance routines.

The model output of fire probability also is based on frequency of fire weather, ignition patterns, expected rate-of spread, and past fire history. It also accounts for flying ember production, and hazards based on the area of influence where embers are likely to land and cause ignitions. This is the principal driver of hazard in densely developed areas. A related concern in built-out areas is the relative density of vegetative fuels that can serve as sites for new spot fires within the urban core and spread to adjacent structures.

In Contra Costa County, 118,509 acres are located in WUI areas and approximately 37,721 acres are in a high, very high or extreme FHSZ. The geography, weather patterns and vegetation in the East Bay area provide ideal conditions for recurring wildfires. Especially vulnerable are the East Bay Hills in Lamorinda (which includes Lafayette, Moraga, and Orinda). Parts of Walnut Creek, including the area surrounding Rossmoor, are vulnerable to WUI fires, as are Clayton, the Danville/San Ramon area, and the San Pablo - El Cerrito, El Sobrante area.

16.2.3 Frequency

The Association of Bay Area Governments (ABAG) has evaluated wildfire frequency in the Bay Area using the California Fire Alliance map of past wildfires and the FHSZ maps. Table 16-1 shows the record of fires over the past 130 years (1878 to 2008). In that time, only 0.24 percent of areas mapped in an extreme FHSZ have burned, 22.8 percent of those mapped as very high, and 18.5 percent of those mapped as high. In addition, 4.5 percent of the WUI areas have burned.

TABLE 16-1.
RECORD OF FIRE AFFECTING BAY AREA OVER PAST 130 YEARS

		Area Burned, 1878 – 2008	
FHSZ Category	Total Area in Zone (acres)	Acres	Percent of Total
Moderate	1,300,662	41,651	3.2%
High	1,183,899	218,947	18.49%
Very High	1,344,664	306,264	22.78
Extreme	2,272	5	0.24%

16.2.4 Severity

Potential losses from wildfire include human life, structures and other improvements, and natural resources. There are no recorded incidents of loss of life from wildfires in Contra Costa County. However, the most destructive WUI fire in the region to date—the October 1991 Oakland/Berkeley Hills "Tunnel Fire"—occurred close to Contra Costa County and resulted in 25 lives lost, including a fire battalion chief and an Oakland police officer, 148 people injured, and 3,500 homes destroyed. The blaze started from a grass fire in the Berkeley Hills and burned 1,600 acres. The estimated private property loss was $1.7 billion at the time, according to the Insurance Information Institute.

Given the immediate response times to reported fires, the likelihood of injuries and casualties is minimal. Smoke and air pollution from wildfires can be a health hazard, especially for sensitive populations including children, the elderly and those with respiratory and cardiovascular diseases. Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke. In addition, wildfire can lead to ancillary impacts such as landslides in steep ravine areas and flooding due to the impacts of silt in local watersheds.

16.2.5 Warning Time

Wildfires are often caused by humans, intentionally or accidentally. There is no way to predict when one might break out. Since fireworks often cause brush fires, extra diligence is warranted around the Fourth of July when the use of fireworks is highest. Dry seasons and droughts are factors that greatly increase fire likelihood. Dry lightning may trigger wildfires. Severe weather can be predicted, so special attention can be paid during weather events that may include lightning. Reliable National Weather Service lightning warnings are available on average 24 to 48 hours prior to a significant electrical storm.

If a fire does break out and spread rapidly, residents may need to evacuate within days or hours. A fire’s peak burning period generally is between 1 p.m. and 6 p.m. Once a fire has started, fire alerting is reasonably rapid in most cases. The rapid spread of cellular and two-way radio communications in recent years has further contributed to a significant improvement in warning time.

16.3 SECONDARY HAZARDS

Wildfires can generate a range of secondary effects, which in some cases may cause more widespread and prolonged damage than the fire itself. Fires can cause direct economic losses in the reduction of harvestable timber and indirect economic losses in reduced tourism. Wildfires cause the contamination of reservoirs, destroy transmission lines and contribute to flooding. They strip slopes of vegetation, exposing them to greater amounts of runoff. This in turn can weaken soils and cause failures on slopes. Major landslides can occur several years after a wildfire. Most wildfires burn hot and for long durations that can bake soils, especially those high in clay content, thus increasing the imperviousness of the ground. This increases the runoff generated by storm events, thus increasing the chance of flooding.

16.4 CLIMATE CHANGE IMPACTS

Fire in western ecosystems is determined by climate variability, local topography, and human intervention. Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. Hot dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation. When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. Climate change also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods.

Historically, drought patterns in the West are related to large-scale climate patterns in the Pacific and Atlantic oceans. The El Niño–Southern Oscillation in the Pacific varies on a 5- to 7-year cycle, the Pacific Decadal Oscillation varies on a 20- to 30-year cycle, and the Atlantic Multidecadal Oscillation varies on a 65- to 80-year cycle. As these large-scale ocean climate patterns vary in relation to each other, drought conditions in the U.S. shift from region to region. El Niño years bring drier conditions to the Pacific Northwest and more fires.

Climate scenarios project summer temperature increases between 2ºC and 5°C and precipitation decreases of up to 15 percent. Such conditions would exacerbate summer drought and further promote high-elevation wildfires, releasing stores of carbon and further contributing to the buildup of greenhouse gases. Forest response to increased atmospheric carbon dioxide—the so-called "fertilization effect"—could also contribute to more tree growth and thus more fuel for fires, but the effects of carbon dioxide on mature forests are still largely unknown. High carbon dioxide levels should enhance tree recovery after fire and young forest regrowth, as long as sufficient nutrients and soil moisture are available, although the latter is in question for many parts of the western United States because of climate change.

16.5 EXPOSURE

16.5.1 Population

Population could not be examined by WUI area because census block group areas do not coincide with the fire risk areas. However, population was estimated using the structure count of buildings in the WUI area and applying the census value of 2.72 persons per household for Contra Costa County. These estimates are shown in Table 16-2.

**TABLE 16-2.
POPULATION ESTIMATES WITHIN FIRE HAZARD SEVERITY ZONES**

	Moderate FHSZ			High FHSZ			Very High FHSZ		
		Population			Population			Population	
	Buildings	Number	% of Total	Buildings	Number	% of Total	Buildings	Number	% of total
Antioch	0	0	0	1	3	<1%	0	0	0
Concord	24	65	<1%	5	15	<1%	0	0	0
Danville	0	0	0	0	0	0	193	525	1.27
El Cerrito	0	0	0	0	0	0	2,789	7586	32.4
Lafayette	0	0	0	0	0	0	2,649	7205	29.9
Martinez	0	0	0	1	3	<1%	938	2551	7.02
Moraga	0	0	0	0	0	0	2	5	<1%
Pinole	0	0	0	0	0	0	31	84	<1%
Richmond	0	0	0	1	3	<1%	539	1466	1.40
San Ramon	2199	5,981	9.47	0	0	0	0	0	0
Unincorporated	1844	5,016	2.95	5,124	13,937	8.18	5,312	14,450	8.48
Total	**4067**	**11,062**	**1.04**	**5,132**	**13,961**	**1.32**	**12,453**	**33,872**	**3.19**

16.5.2 Property

Property damage from wildfires can be severe and can significantly alter entire communities. Tables 16-3, 16-4, and 16-5 display the number of homes in the various wildfire hazard zones within the planning area and their values. The communities not listed in the following tables are considered to have little or no direct exposure to the wildfire hazard. The unincorporated county and the cities of Antioch, Concord, Danville, El Cerrito, Lafayette, Martinez, Moraga, Pinole, Richmond and San Ramon all have exposure to wildfire hazards to some degree. Table 16-6 shows the general land use of parcels exposed to the wildfire hazard in the unincorporated portions of the County.

TABLE 16-3.
CONTRA COSTA COUNTY STRUCTURES EXPOSED TO VERY HIGH WILDFIRE HAZARDS

Jurisdiction	Buildings Exposed	Assessed Value Structure	Assessed Value Contents	Assessed Value Total	% of AV
Danville	193	$115,477,255	$92,381,805	**$207,859,060**	2.6%
El Cerrito	2789	$486,002,718	$394,545,942	**$880,548,660**	33.5%
Lafayette	2649	$1,063,652,122	$856,016,311	**$1,919,668,433**	46.8%
Martinez	938	$186,637,895	$159,121,507	**$345,759,402**	4.9%
Moraga	2	$17,686	$14,149	**$31,835**	>1%
Pinole	31	$9,072,436	$7,304,636	**$16,377,072**	1.5%
Richmond	539	$115,522,233	$92,545,603	**$208,067,836**	1.3%
Unincorporated	5,312	$1,700,985,089	$1,372,200,023	**$3,073,185,112**	7.0%
Total	**12,453**	**$3,677,367,434**	**$2,974,129,976**	**$6,651,497,410**	**3.8**

TABLE 16-4.
CONTRA COSTA COUNTY STRUCTURES EXPOSED TO HIGH WILDFIRE HAZARDS

Jurisdiction	Buildings Exposed	Assessed Value Structure	Assessed Value Contents	Assessed Value Total	% of AV
Antioch	1	$169,793	$169,793	**$339,586**	>1%
Concord	5	$608,334	$486,668	**$1,095,002**	>1%
Martinez	1	$126,906	$126,906	**$253,812**	>1%
Richmond	1	$24,725,606	$24,725,606	**$49,451,212**	>1%
Unincorporated	5,124	$2,497,628,393	$2,011,354,757	**$4,508,983,757**	10.28%
Total	**5,132**	**$2,523,259,032**	**$2,036,863,730**	**$4,560,123,369**	**2.62%**

TABLE 16-5.
CONTRA COSTA COUNTY STRUCTURES EXPOSED TO MODERATE WILDFIRE HAZARDS

Jurisdiction	Buildings Exposed	Assessed Value Structure	Assessed Value Contents	Assessed Value Total	% of AV
Concord	24	$35,241,050	$34,891,077	**$70,132,127**	>1%
San Ramon	2199	$1,078,454,154	$888,263,783	**$1,966,717,937**	17.2%
Unincorporated	1844	$822,965,095	$675,434,075	**$1,498,399,170**	3.4%
Total	**4067**	**$1,936,660,299**	**$1,598,588,935**	**$3,535,249,234**	**2.0%**

TABLE 16-6.
LAND USE WITHIN THE WILDFIRE RISK AREAS (UNINCORPORATED COUNTY)

	Moderate FHSZ		High FHSZ		Very High FHSZ	
Land Use	Area (acres)	% of total	Area (acres)	% of total	Area (acres)	% of total
Agricultural Preserve	11735.97	27.28%	40280.20	30.90%	1911.31	6.75%
Controlled Manufacturing	0	0.00%	29	0.02%	84.6	0.30%
Exclusive Agricultural	7780.39	18.09%	17771.84	13.63%	7480.18	26.40%
Forestry Recreational	203.88	0.47%	1574.94	1.20%	1914.66	6.76%
General Agricultural	8612.93	20.02%	51911.41	39.82%	11819.69	41.72%
General Commercial	0	0.00%	0	0.00%	0	0.00%
Heavy Agricultural	10873.22	25.27%	9031.07	6.93%	301.35	1.06%
Heavy Industrial	687.69	1.60%	1382.96	1.06%	75.19	0.27%
Light Industrial	18.73	0.05%	16.61	0.01%	0	0.00%
Limited Office	0	0.00%	0	0.00%	0.12	0.00%
Mobile Home/Manufactured Home Park	1.6	0.00%	19.55	0.01%	0	0.00%
Multiple Family Residential	0	0.00%	0.12	0.00%	0.42	0.00%
Neighborhood Business	0	0.00%	0	0.00%	0.05	0.00%
Planned Unit	2904.78	6.75%	6457.06	4.95%	2878.57	10.16%
Retail Business	1.19	0.00%	6.92	0.01%	5.14	0.02%
Single Family Residential	162.38	0.38%	1886.09	1.45%	1857.92	6.56%
Two Family Residential	0	0.00%	0	0.00%	0	0.00%
Unrestricted	37.11	0.09%	8.8	0.01%	0.77	0.00%
Water Recreational	0	0%	0	0%	0	0%
Total	**43019.87**	**100%**	**130376.57**	**100%**	**28329.97**	**100%**

16.5.3 Critical Facilities and Infrastructure

Table 16-7 identifies critical facilities exposed to the wildfire hazard in the county. Currently there are two registered Tier II hazardous material containment sites in wildfire risk zones. During a wildfire event, these materials could rupture due to excessive heat and act as fuel for the fire, causing rapid spreading and escalating the fire to unmanageable levels. In addition they could leak into surrounding areas, saturating soils and seeping into surface waters, and have a disastrous effect on the environment.

In the event of wildfire, there would likely be little damage to the majority of infrastructure. Most road and railroads would be without damage except in the worst scenarios. Power lines are the most at risk to wildfire because most are made of wood and susceptible to burning. In the event of a wildfire, pipelines could provide a source of fuel and lead to a catastrophic explosion.

TABLE 16-7.
CRITICAL FACILITIES EXPOSED TO WILDFIRE HAZARDS

	Moderate FHSZ	High FHSZ	Very High FHSZ
Medical and Health Services	0	1	0
Government Function	0	0	2
Protective Function	1	11	9
Schools	5	4	12
Hazmat	0	2	0
Other Critical Function	1	2	0
Bridges	19	20	10
Water	4	13	12
Waste Water	0	1	9
Communications	8	10	3
Total	**38**	**64**	**57**

16.5.4 Environment

Fire is a natural and critical ecosystem process in most of California's diverse terrestrial ecosystems, dictating in part the types, structure, and spatial extent of native vegetation in the state. Many of California's ecosystems are adapted to historical patterns of fire occurrence in a given area. These patterns, called "fire regimes," include temporal attributes (e.g., frequency and seasonality), spatial attributes (e.g., size and spatial complexity), and magnitude attributes (e.g., intensity and severity), each of which have ranges of natural variability.

Ecosystem stability is threatened when any of the attributes for a given fire regime diverge from its range of natural variability. Compared to historical fire regimes, many mixed-conifer forests now experience fires that are more intense and severe, while chaparral brush-lands experience fire at a greater frequency. Both trends have profound impacts on ecosystem stability throughout California.

Wildfires can cause severe environmental impacts:

- Damaged Fisheries—Critical fisheries can suffer from increased water temperatures, sedimentation, and changes in water quality.
- Soil Erosion—The protective covering provided by foliage and dead organic matter is removed, leaving the soil fully exposed to wind and water erosion. Accelerated soil erosion occurs, causing landslides and threatening aquatic habitats.
- Spread of Invasive Plant Species—Non-native woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes, and become difficult and costly to control.
- Disease and Insect Infestations—Unless diseased or insect-infested trees are swiftly removed, infestations and disease can spread to healthy forests and private lands. Timely active management actions are needed to remove diseased or infested trees.
- Destroyed Endangered Species Habitat—Catastrophic fires can have devastating consequences for endangered species.

- Soil Sterilization—Topsoil exposed to extreme heat can become water repellant, and soil nutrients may be lost. It can take decades or even centuries for ecosystems to recover from a fire. Some fires burn so hot that they can sterilize the soil.

16.6 VULNERABILITY

Structures, above-ground infrastructure, critical facilities and natural environments are all vulnerable to the wildfire hazard. There is currently no validated damage function available to support wildfire mitigation planning. Except as discussed in this section, vulnerable populations, property, infrastructure and environment are assumed to be the same as described in the section on exposure.

16.6.1 Population

There are no recorded incidents of loss of life from wildfires within the planning area. Given the immediate response times to reported fires, the likelihood of injuries and casualties is minimal; therefore, injuries and casualties were not estimated for the wildfire hazard.

Smoke and air pollution from wildfires can be a severe health hazard, especially for sensitive populations, including children, the elderly and those with respiratory and cardiovascular diseases. Smoke generated by wildfire consists of visible and invisible emissions that contain particulate matter (soot, tar, water vapor, and minerals), gases (carbon monoxide, carbon dioxide, nitrogen oxides), and toxics (formaldehyde, benzene). Emissions from wildfires depend on the type of fuel, the moisture content of the fuel, the efficiency (or temperature) of combustion, and the weather. Public health impacts associated with wildfire include difficulty in breathing, odor, and reduction in visibility.

Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke.

16.6.2 Property

Loss estimations for the wildfire hazard are not based on damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the assessed value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 16-8 lists the loss estimates for the general building stock for jurisdictions that have an exposure to a fire hazard severity zone.

16.6.3 Critical Facilities and Infrastructure

Critical facilities of wood frame construction are especially vulnerable during wildfire events. In the event of wildfire, there would likely be little damage to most infrastructure. Most roads and railroads would be without damage except in the worst scenarios. Power lines are the most at risk from wildfire because most poles are made of wood and susceptible to burning. Fires can create conditions that block or prevent access and can isolate residents and emergency service providers. Wildfire typically does not have a major direct impact on bridges, but it can create conditions in which bridges are obstructed. Many bridges in areas of high to moderate fire risk are important because they provide the only ingress and egress to large areas and in some cases to isolated neighborhoods.

TABLE 16-8.
BUILDINGS VULNERABLE TO WILDFIRE HAZARD

	Building Count	Assessed Value	10% Damage	30% Damage	50% Damage
Antioch	1	$339,586	$33,959	$101,876	$169,793
Concord	29	$71,227,129	$7,122,713	$21,368,139	$35,613,565
Danville	193	$207,859,060	$20,785,906	$62,357,718	$103,929,530
El Cerrito	2789	$880,548,660	$88,054,866	$264,164,598	$440,274,330
Lafayette	2649	$1,919,668,433	$191,966,843	$575,900,530	$959,834,217
Martinez	939	$346,013,214	$34,601,321	$103,803,964	$173,006,607
Moraga	2	$31,835	$3,184	$9,551	$15,918
Pinole	31	$16,377,072	$1,637,707	$4,913,122	$8,188,536
Richmond	540	$257,519,048	$25,751,905	$77,255,714	$128,759,524
San Ramon	2199	$1,966,717,937	$196,671,794	$590,015,381	$983,358,969
Unincorporated	12,280	$9,080,567,432	$908,056,743	$2,724,170,230	$4,540,283,716
Total	**21,652**	**$14,746,869,406**	**$1,474,686,941**	**$4,424,060,823**	**$7,373,434,705**

6.7 FUTURE TRENDS IN DEVELOPMENT

The county has experienced moderate growth over the past 10 years, averaging a 1.25-percent increase in population every year from 2000 through 2009. However, economic problems in the past three years impacted growth in the County, with some area experiencing negative growth. Contra Costa County and its planning partners are optimistic that marginal, sustained growth will return to the county as the state and national economies strengthen.

The highly urbanized portions of the planning area have little or no wildfire risk exposure. Urbanization tends to alter the natural fire regime, and can create the potential for the expansion of urbanized areas into wildland areas. The expansion of the wildland urban interface can be managed with strong land use and building codes. The planning area is well equipped with these tools and this planning process has asked each planning partner to assess its capabilities with regards to the tools. As Contra Costa County experiences future growth, it is anticipated that the exposure to this hazard will remain as assessed or even decrease over time due to these capabilities.

16.8 SCENARIO

A major conflagration in Contra Costa County might begin with a wet spring, adding to fuels already present on the forest floor. Flashy fuels would build throughout the spring. The summer could see the onset of insect infestation. A dry summer could follow the wet spring, exacerbated by dry hot winds. Carelessness with combustible materials or a tossed lit cigarette, or a sudden lighting storm could trigger a multitude of small isolated fires.

The embers from these smaller fires could be carried miles by hot, dry winds. The deposition zone for these embers would be deep in the forests and interface zones. Fires that start in flat areas move slower, but wind still pushes them. It is not unusual for a wildfire pushed by wind to burn the ground fuel and later climb into the crown and reverse its track. This is one of many ways that fires can escape containment, typically during periods when response capabilities are overwhelmed. These new small fires would most likely merge. Suppression resources would be redirected from protecting the natural resources to saving more remote subdivisions.

The worst-case scenario would include an active fire season throughout the American west, spreading resources thin. Firefighting teams would be exhausted or unavailable. Many federal assets would be responding to other fires that started earlier in the season. While local fire districts would be extremely useful in the urban interface areas, they have limited wildfire capabilities or experience, and they would have a difficult time responding to the ignition zones. Even though the existence and spread of the fire is known, it may not be possible to respond to it adequately, so an initially manageable fire can become out of control before resources are dispatched.

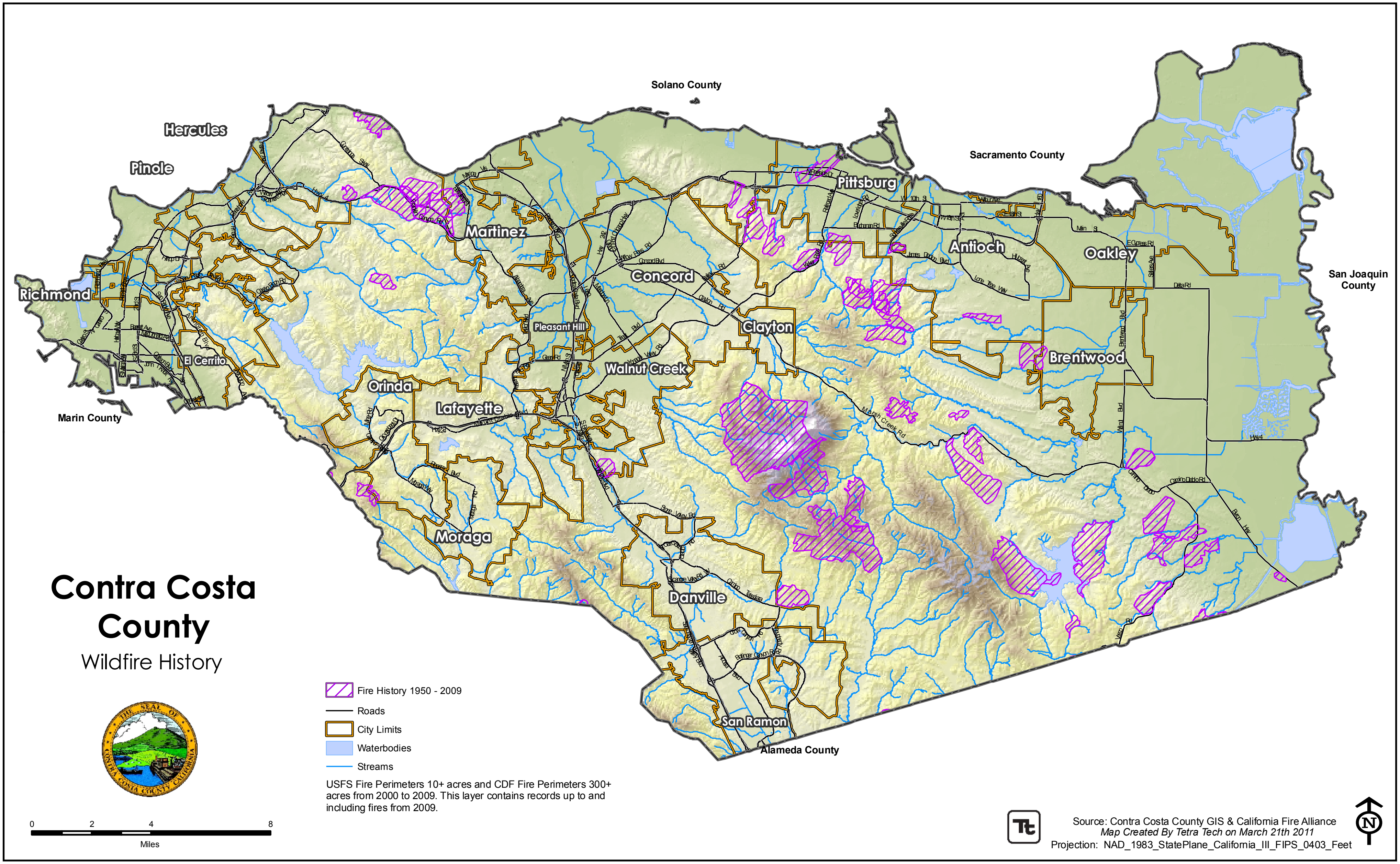
To further complicate the problem, heavy rains could follow, causing flooding and landslides and releasing tons of sediment into rivers, permanently changing floodplains and damaging sensitive habitat and riparian areas. Such a fire followed by rain could release millions of cubic yards of sediment into streams for years, creating new floodplains and changing existing ones. With the forests removed from the watershed, stream flows could easily double. Floods that could be expected every 50 years may occur every couple of years. With the streambeds unable to carry the increased discharge because of increased sediment, the floodplains and floodplain elevations would increase.

16.9 ISSUES

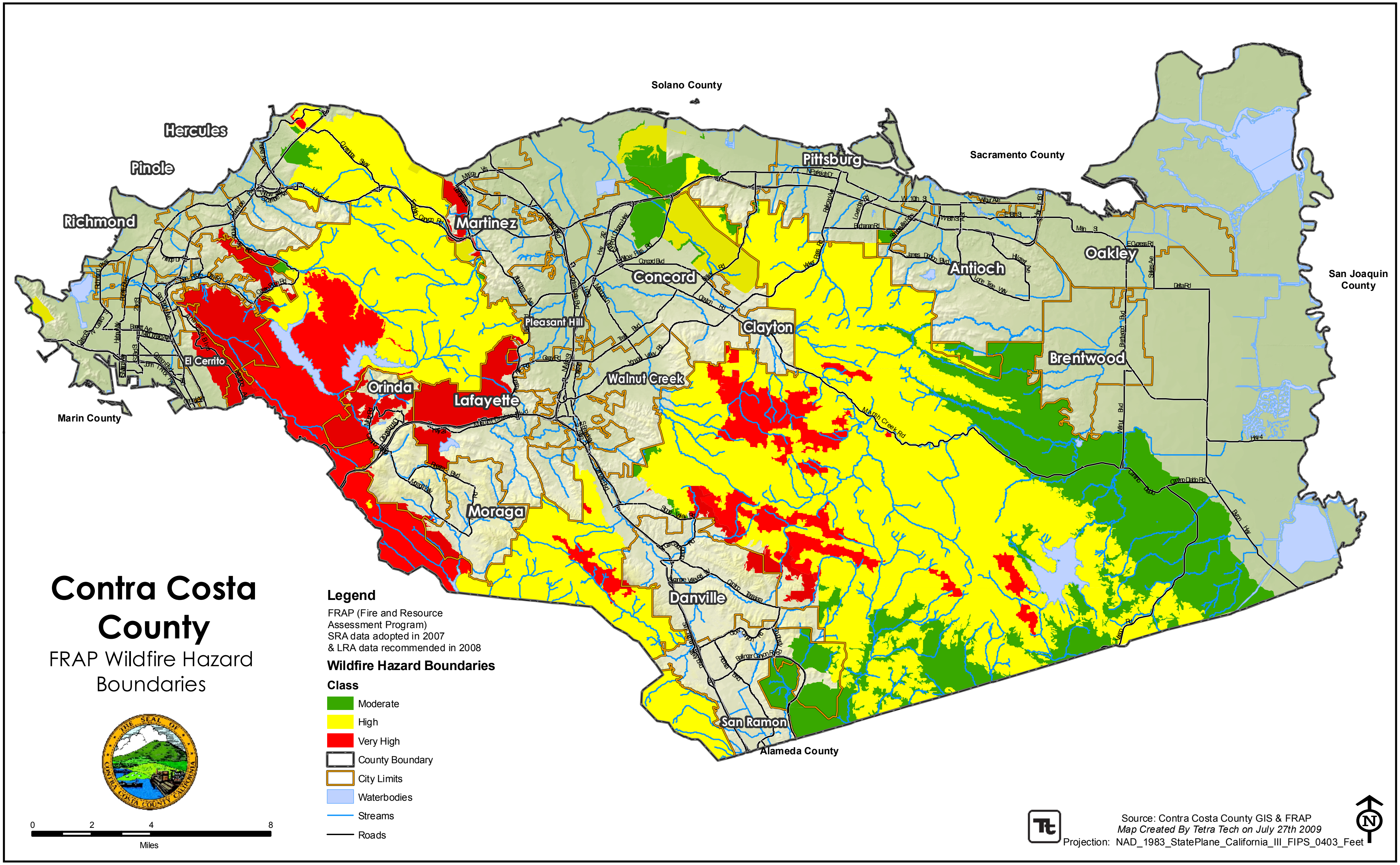
The major issues for wildfire are the following:

- Public education and outreach to people living in or near the fire hazard zones should include information about and assistance with mitigation activities such as defensible space, and advance identification of evacuation routes and safe zones.
- Wildfires could cause landslides as a secondary natural hazard.
- Climate change could affect the wildfire hazard.
- Future growth into interface areas should continue to be managed.
- Area fire districts need to continue to train on wildland-urban interface events.
- Vegetation management activities. This would include enhancement through expansion of the target areas as well as additional resources.
- Regional consistency of higher building code standards such as residential sprinkler requirements and prohibitive combustible roof standards.
- Fire department water supply in high risk wildfire areas.
- Expand certifications and qualifications for fire department personnel. Ensure that all firefighters are trained in basic wildfire behavior, basic fire weather, and that all company officers and chief level officers are trained in the wildland command and strike team leader level.

Map 16-1.


Contra Costa County
Wildfire History
Solano County
Sacramento County
San Joaquin County
Alameda County
Marin County
Hercules
Pinole
Richmond
El Cerrito
Martinez
Pittsburg
Antioch
Oakley
Concord
Pleasant Hill
Clayton
Brentwood
Walnut Creek
Orinda
Lafayette
Moraga
Danville
San Ramon
Fire History 1950 - 2009
Roads
City Limits
Waterbodies
Streams
USFS Fire Perimeters 10+ acres and CDF Fire Perimeters 300+ acres from 2000 to 2009. This layer contains records up to and including fires from 2009.
0
2
4
8
Miles
Source: Contra Costa County GIS & California Fire Alliance
Map Created By Tetra Tech on March 21th 2011
Projection: NAD_1983_StatePlane_California_III_FIPS_0403_Feet

Map 16-2.


Contra Costa County
FRAP Wildfire Hazard Boundaries
Legend
FRAP (Fire and Resource Assessment Program)
SRA data adopted in 2007
& LRA data recommended in 2008
Wildfire Hazard Boundaries
Class
Moderate
High
Very High
County Boundary
City Limits
Waterbodies
Streams
Roads
Solano County
Sacramento County
San Joaquin County
Alameda County
Marin County
Hercules
Pinole
Richmond
El Cerrito
Martinez
Pittsburg
Concord
Antioch
Oakley
Pleasant Hill
Clayton
Brentwood
Walnut Creek
Orinda
Lafayette
Moraga
Danville
San Ramon
Marsh Creek Rd
0
2
4
8
Miles
Source: Contra Costa County GIS & FRAP
Map Created By Tetra Tech on July 27th 2009
Projection: NAD_1983_StatePlane_California_III_FIPS_0403_Feet

CHAPTER 17.
PLANNING AREA RISK RANKING

A risk ranking was performed for the hazards of concern described in this plan. This risk ranking assesses the probability of each hazard's occurrence as well as its likely impact on the people, property, and economy of Contra Costa County. The risk ranking was conducted via facilitated brainstorming sessions with the Steering Committee. Estimates of risk were generated with data from HAZUS-MH using methodologies promoted by FEMA. The results are used in establishing mitigation priorities.

17.1 PROBABILITY OF OCCURRENCE

The probability of occurrence of a hazard is indicated by a probability factor based on likelihood of annual occurrence:

- High—Hazard event is likely to occur within 25 years (Probability Factor = 3)
- Medium—Hazard event is likely to occur within 100 years (Probability Factor =2)
- Low—Hazard event is not likely to occur within 100 years (Probability Factor =1)
- No exposure—There is no probability of occurrence (Probability Factor = 0)

The assessment of hazard frequency is generally based on past hazard events in the area. Table 17-1 summarizes the probability assessment for each hazard of concern for this plan.

TABLE 17-1.
PROBABILITY OF HAZARDS

Hazard Event	Probability (high, medium, low)	Probability Factor
Dam Failure	Low	1
Drought	High	3
Earthquake	High	3
Flood	High	3
Landslide	High	3
Severe Weather	High	3
Wildfire	High	3

17.2 IMPACT

Hazard impacts were assessed in three categories: impacts on people, impacts on property and impacts on the local economy. Numerical impact factors were assigned as follows:

- **People**—Values were assigned based on the percentage of the total ***population exposed*** to the hazard event. The degree of impact on individuals will vary and is not measurable, so the calculation assumes for simplicity and consistency that all people exposed to a hazard because they live in a hazard zone will be equally impacted when a hazard event occurs. It should be noted that planners can use an element of subjectivity when assigning values for impacts on people. Impact factors were assigned as follows:

- High—50 percent or more of the population is exposed to a hazard (Impact Factor = 3)
- Medium—25 percent to 49 percent of the population is exposed to a hazard (Impact Factor = 2)
- Low—25 percent or less of the population is exposed to the hazard (Impact Factor = 1)
- No impact—None of the population is exposed to a hazard (Impact Factor = 0)

- **Property**—Values were assigned based on the percentage of the total ***property value exposed*** to the hazard event:
  - High—30 percent or more of the total assessed property value is exposed to a hazard (Impact Factor = 3)
  - Medium—15 percent to 29 percent of the total assessed property value is exposed to a hazard (Impact Factor = 2)
  - Low—14 percent or less of the total assessed property value is exposed to the hazard (Impact Factor = 1)
  - No impact—None of the total assessed property value is exposed to a hazard (Impact Factor = 0)
- **Economy**—Values were assigned based on the percentage of the total ***property value vulnerable*** to the hazard event. Values represent estimates of the loss from a major event of each hazard in comparison to the total assessed value of the property exposed to the hazard. For some hazards, such as wildfire, landslide and severe weather, vulnerability was considered to be the same as exposure due to the lack of loss estimation tools specific to those hazards. Loss estimates separate from the exposure estimates were generated for the earthquake and flood hazards using HAZUS-MH.
  - High—Estimated loss from the hazard is 20 percent or more of the total assessed property value (Impact Factor = 3)
  - Medium—Estimated loss from the hazard is 10 percent to 19 percent of the total assessed property value (Impact Factor = 2)
  - Low—Estimated loss from the hazard is 9 percent or less of the total assessed property value (Impact Factor = 1)
  - No impact—No loss is estimated from the hazard (Impact Factor = 0)

The impacts of each hazard category were assigned a weighting factor to reflect the significance of the impact. These weighting factors are consistent with those typically used for measuring the benefits of hazard mitigation actions: impact on people was given a weighting factor of 3; impact on property was given a weighting factor of 2; and impact on the operations was given a weighting factor of 1.

Tables 17-2, 17-3 and 17-4 summarize the impacts for each hazard.

TABLE 17-2.
IMPACT ON PEOPLE FROM HAZARDS

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (3)
Dam Failure	Low	1	3
Drought	Low	1	3
Earthquake	High	3	9
Flooding	Low	1	3
Landslide	Medium	2	6
Severe Weather	High	3	9
Wildfire	Low	1	3

TABLE 17-3.
IMPACT ON PROPERTY FROM HAZARDS

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (2)
Dam Failure	Low	1	2
Drought	No Impact	0	0
Earthquake	High	3	6
Flooding	Medium	2	4
Landslide	Medium	2	4
Severe Weather	Medium	2	4
Wildfire	Medium	2	4

TABLE 17-4.
IMPACT ON ECONOMY FROM HAZARDS

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (1)
Dam Failure	High	3	3
Drought	Medium	2	2
Earthquake	High	3	3
Flooding	Medium	2	2
Landslide	Medium	2	2
Severe Weather	Medium	2	2
Wildfire	Low	1	1

17.3 RISK RATING AND RANKING

The risk rating for each hazard was determined by multiplying the probability factor by the sum of the weighted impact factors for people, property and operations, as summarized in Table 17-5.

Based on these ratings, a priority of high, medium or low was assigned to each hazard. The hazards ranked as being of highest concern are earthquake and severe weather. Hazards ranked as being of medium concern are landslide, flood and wildfire. The hazards ranked as being of lowest concern are drought and dam failure. Table 17-6 shows the hazard risk ranking.

**TABLE 17-5.
HAZARD RISK RATING**

Hazard Event	Probability Factor	Sum of Weighted Impact Factors	Total (Probability x Impact)
Dam Failure	1	3+2+3=8	8
Drought	3	3+0+2=5	15
Earthquake	3	9+6+3=18	54
Flooding	3	3+4+2=9	27
Landslide	3	6+4+2=12	36
Severe Weather	3	9+4+2=15	45
Wildfire	3	3+4+1=8	24

**TABLE 17-6.
HAZARD RISK RANKING**

Hazard Ranking	Hazard Event	Category
1	Earthquake	High
2	Severe Weather	High
3	Landslide	Medium
4	Flood	Medium
5	Wildfire	Medium
6	Drought	Low
7	Dam Failure	Low

PART 3—MITIGATION STRATEGY

CHAPTER 18.
MITIGATION ALTERNATIVES

Catalogs of hazard mitigation alternatives were developed that present a broad range of alternatives to be considered for use in Contra Costa County, in compliance with 44CFR (Section 201.6.c.3.ii). One catalog was developed for each hazard of concern evaluated in this plan. The catalogs for each hazard are listed in Tables 18-1 through 18-9. The catalogs present alternatives that are categorized in two ways:

- By what the alternative would do:
  - Manipulate a hazard
  - Reduce exposure to a hazard
  - Reduce vulnerability to a hazard
  - Increase the ability to respond to or be prepared for a hazard
- By who would have responsibility for implementation:
  - Individuals
  - Businesses
  - Government.

Hazard mitigation initiatives recommended in this plan were selected from among the alternatives presented in the catalogs. The catalogs provide a baseline of mitigation alternatives that are backed by a planning process, are consistent with the planning partners' goals and objectives, and are within the capabilities of the partners to implement. However, not all the alternatives meet all the planning partners' selection criteria. All actions recommended in this plan were reviewed against the selection criteria, which are listed in Chapter 19.

**TABLE 18-1.
CATALOG OF MITIGATION ALTERNATIVES—DAM FAILURE**

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
• None	1. Remove dams 2. Remove levees 3. Harden dams	1. Remove dams 2. Remove levees 3. Harden dams
Reduce Exposure		
• Relocate out of dam failure inundation areas.	• Replace earthen dams with hardened structures	1. Replace earthen dams with hardened structures 2. Relocate critical facilities out of dam failure inundation areas. 3. Consider open space land use in designated dam failure inundation areas.
Reduce Vulnerability		
• Elevate home to appropriate levels.	• Flood-proof facilities within dam failure inundation areas	1. Adopt higher regulatory floodplain standards in mapped dam failure inundation areas. 2. Retrofit critical facilities within dam failure inundation areas.
Increase Preparation or Response Capability		
1. Learn about risk reduction for the dam failure hazard. 2. Learn the evacuation routes for a dam failure event. 3. Educate yourself on early warning systems and the dissemination of warnings.	1. Educate employees on the probable impacts of a dam failure. 2. Develop a Continuity of Operations Plan.	1. Map dam failure inundation areas. 2. Enhance emergency operations plan to include a dam failure component. 3. Institute monthly communications checks with dam operators. 4. Inform the public on risk reduction techniques 5. Adopt real-estate disclosure requirements for the re-sale of property located within dam failure inundation areas. 6. Consider the probable impacts of climate in assessing the risk associated with the dam failure hazard. 7. Establish early warning capability downstream of listed high hazard dams. 8. Consider the residual risk associated with protection provided by dams in future land use decisions.

**TABLE 18-2.
CATALOG OF MITIGATION ALTERNATIVES—DROUGHT**

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
None	None	Groundwater recharge through stormwater management
Reduce Exposure		
None	None	Identify and create groundwater backup sources
Reduce Vulnerability		
1. Drought-resistant landscapes 2. Reduce water system losses 3. Modify plumbing systems (through water saving kits)	1. Drought-resistant landscapes 2. Reduce private water system losses	1. Water use conflict regulations 2. Reduce water system losses 3. Distribute water saving kits
Increase Preparation or Response Capability		
• Practice active water conservation	• Practice active water conservation	1. Public education on drought resistance 2. Identify alternative water supplies for times of drought; mutual aid agreements with alternative suppliers 3. Develop drought contingency plan 4. Develop criteria "triggers" for drought-related actions 5. Improve accuracy of water supply forecasts 6. Modify rate structure to influence active water conservation techniques

**TABLE 18-3.
CATALOG OF MITIGATION ALTERNATIVES—EARTHQUAKE**

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
None	None	None
Reduce Exposure		
• Locate outside of hazard area (off soft soils)	• Locate or relocate mission-critical functions outside hazard area where possible	• Locate critical facilities or functions outside hazard area where possible
Reduce Vulnerability		
1. Retrofit structure (anchor house structure to foundation) 2. Secure household items that can cause injury or damage (such as water heaters, bookcases, and other appliances) 3. Build to higher design	1. Build redundancy for critical functions and facilities 2. Retrofit critical buildings and areas housing mission-critical functions	1. Harden infrastructure 2. Provide redundancy for critical functions 3. Adopt higher regulatory standards
Increase Preparation or Response Capability		
1. Practice “drop, cover, and hold” 2. Develop household mitigation plan, such as creating a retrofit savings account, communication capability with outside, 72-hour self-sufficiency during an event 3. Keep cash reserves for reconstruction 4. Become informed on the hazard and risk reduction alternatives available. 5. Develop a post-disaster action plan for your household	1. Adopt higher standard for new construction; consider “performance-based design” when building new structures 2. Keep cash reserves for reconstruction 3. Inform your employees on the possible impacts of earthquake and how to deal with them at your work facility. 4. Develop a Continuity of Operations Plan	1. Provide better hazard maps 2. Provide technical information and guidance 3. Enact tools to help manage development in hazard areas (e.g., tax incentives, information) 4. Include retrofitting and replacement of critical system elements in capital improvement plan 5. Develop strategy to take advantage of post-disaster opportunities 6. Warehouse critical infrastructure components such as pipe, power line, and road repair materials 7. Develop and adopt a Continuity of Operations Plan 8. Initiate triggers guiding improvements (such as <50% substantial damage or improvements) 9. Further enhance seismic risk assessment to target high hazard buildings for mitigation opportunities. 10. Develop a post-disaster action plan that includes grant funding and debris removal components.

**TABLE 18-4.
CATALOG OF MITIGATION ALTERNATIVES—FLOOD**

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
1. Clear stormwater drains and culverts 2. Institute low-impact development techniques on property	1. Clear stormwater drains and culverts 2. Institute low-impact development techniques on property	1. Maintain drainage system 2. Institute low-impact development techniques on property 3. Dredging, levee construction, and providing regional retention areas 4. Structural flood control, levees, channelization, or revetments. 5. Stormwater management regulations and master planning 6. Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff
Reduce Exposure		
1. Locate outside of hazard area 2. Elevate utilities above base flood elevation 3. Institute low impact development techniques on property	1. Locate business critical facilities or functions outside hazard area 2. Institute low impact development techniques on property	1. Locate or relocate critical facilities outside of hazard area 2. Acquire or relocate identified repetitive loss properties 3. Promote open space uses in identified high hazard areas via techniques such as: planned unit developments, easements, setbacks, greenways, sensitive area tracks. 4. Adopt land development criteria such as planned unit developments, density transfers, clustering 5. Institute low impact development techniques on property 6. Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff
Reduce Vulnerability		
1. Retrofit structures (elevate structures above base flood elevation) 2. Elevate items within house above base flood elevation 3. Build new homes above base flood elevation 4. Flood-proof existing structures	1. Build redundancy for critical functions or retrofit critical buildings 2. Provide flood-proofing measures when new critical infrastructure must be located in floodplains	1. Harden infrastructure, bridge replacement program 2. Provide redundancy for critical functions and infrastructure 3 Adopt appropriate regulatory standards, such as: increased freeboard standards, cumulative substantial improvement or damage, lower substantial damage threshold; compensatory storage, non-conversion deed restrictions. 4. Stormwater management regulations and master planning. 5. Adopt “no-adverse impact” floodplain management policies that strive to not increase the flood risk on downstream communities.

TABLE 18-4 (continued).
CATALOG OF MITIGATION ALTERNATIVES—FLOOD

Personal Scale	Corporate Scale	Government Scale
Increase Preparation or Response Capability		
1. Buy flood insurance 2. Develop household mitigation plan, such as retrofit savings, communication capability with outside, 72-hour self-sufficiency during and after an event	1. Keep cash reserves for reconstruction 2. Support and implement hazard disclosure for the sale/re-sale of property in identified risk zones. 3. Solicit cost-sharing through partnerships with other stakeholders on projects with multiple benefits.	1. Produce better hazard maps 2. Provide technical information and guidance 3. Enact tools to help manage development in hazard areas (stronger controls, tax incentives, and information) 4. Incorporate retrofitting or replacement of critical system elements in capital improvement plan 5. Develop strategy to take advantage of post-disaster opportunities 6. Warehouse critical infrastructure components 7. Develop and adopt a Continuity of Operations Plan 8. Consider participation in the Community Rating System 9. Maintain existing data and gather new data needed to define risks and vulnerability 10. Train emergency responders 11. Create a building and elevation inventory of structures in the floodplain 12. Develop and implement a public information strategy 13. Charge a hazard mitigation fee 14. Integrate floodplain management policies into other planning mechanisms within the planning area. 15. Consider the probable impacts of climate change on the risk associated with the flood hazard 16. Consider the residual risk associated with structural flood control in future land use decisions 17. Enforce National Flood Insurance Program 18. Adopt a Stormwater Management Master Plan

**TABLE 18-5.
CATALOG OF MITIGATION ALTERNATIVES—LANDSLIDE**

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
1. Stabilize slope (dewater, armor toe) 2. Reduce weight on top of slope 3. Minimize vegetation removal and the addition of impervious surfaces.	1. Stabilize slope (dewater, armor toe) 2. Reduce weight on top of slope	1. Stabilize slope (dewater, armor toe) 2. Reduce weight on top of slope
Reduce Exposure		
• Locate structures outside of hazard area (off unstable land and away from slide-run out area)	• Locate structures outside of hazard area (off unstable land and away from slide-run out area)	1. Acquire properties in high-risk landslide areas. 2. Adopt land use policies that prohibit the placement of habitable structures in high-risk landslide areas.
Reduce Vulnerability		
• Retrofit home.	• Retrofit at-risk facilities.	1. Adopt higher regulatory standards for new development within unstable slope areas. 2. Armor/retrofit critical infrastructure against the impact of landslides.
Increase Preparation or Response Capability		
1. Institute warning system, and develop evacuation plan 2. Keep cash reserves for reconstruction 3. Educate yourself on risk reduction techniques for landslide hazards.	1. Institute warning system, and develop evacuation plan 2. Keep cash reserves for reconstruction 3. Develop a Continuity of Operations Plan 4. Educate employees on the potential exposure to landslide hazards and emergency response protocol.	1. Produce better hazard maps 2. Provide technical information and guidance 3. Enact tools to help manage development in hazard areas: better land controls, tax incentives, information 4. Develop strategy to take advantage of post-disaster opportunities 5. Warehouse critical infrastructure components 6. Develop and adopt a Continuity of Operations Plan 7. Educate the public on the landslide hazard and appropriate risk reduction alternatives.

**TABLE 18-6.
CATALOG OF MITIGATION ALTERNATIVES—SEVERE WEATHER**

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
None	None	None
Reduce Exposure		
None	None	None
Reduce Vulnerability		
1. Insulate house 2. Provide redundant heat and power 3. Insulate structure 4. Plant appropriate trees near home and power lines ("Right tree, right place" National Arbor Day Foundation Program)	1. Relocate critical infrastructure (such as power lines) underground 2. Reinforce or relocate critical infrastructure such as power lines to meet performance expectations 3. Install tree wire	1. Harden infrastructure such as locating utilities underground 2. Trim trees back from power lines 3. Designate snow routes and strengthen critical road sections and bridges
Increase Preparation or Response Capability		
1. Trim or remove trees that could affect power lines 2. Promote 72-hour self-sufficiency 3. Obtain a NOAA weather radio. 4. Obtain an emergency generator.	1. Trim or remove trees that could affect power lines 2. Create redundancy 3. Equip facilities with a NOAA weather radio 4. Equip vital facilities with emergency power sources.	1. Support programs such as "Tree Watch" that proactively manage problem areas through use of selective removal of hazardous trees, tree replacement, etc. 2. Establish and enforce building codes that require all roofs to withstand snow loads 3. Increase communication alternatives 4. Modify land use and environmental regulations to support vegetation management activities that improve reliability in utility corridors. 5. Modify landscape and other ordinances to encourage appropriate planting near overhead power, cable, and phone lines 6. Provide NOAA weather radios to the public

**TABLE 18-7.
CATALOG OF MITIGATION ALTERNATIVES—WILDFIRE**

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
• Clear potential fuels on property such as dry overgrown underbrush and diseased trees	• Clear potential fuels on property such as dry underbrush and diseased trees	1. Clear potential fuels on property such as dry underbrush and diseased trees 2. Implement best management practices on public lands.
Reduce Exposure		
1. Create and maintain defensible space around structures 2. Locate outside of hazard area 3. Mow regularly	1. Create and maintain defensible space around structures and infrastructure 2. Locate outside of hazard area	1. Create and maintain defensible space around structures and infrastructure 2. Locate outside of hazard area 3. Enhance building code to include use of fire resistant materials in high hazard area.
Reduce Vulnerability		
1. Create and maintain defensible space around structures and provide water on site 2. Use fire-retardant building materials 3. Create defensible spaces around home	1. Create and maintain defensible space around structures and infrastructure and provide water on site 2. Use fire-retardant building materials 3. Use fire-resistant plantings in buffer areas of high wildfire threat.	1. Create and maintain defensible space around structures and infrastructure 2. Use fire-retardant building materials 3. Use fire-resistant plantings in buffer areas of high wildfire threat. 4. Consider higher regulatory standards (such as Class A roofing) 5. Establish biomass reclamation initiatives
Increase Preparation or Response Capability		
1. Employ techniques from the National Fire Protection Association's Firewise Communities program to safeguard home 2. Identify alternative water supplies for fire fighting 3. Install/replace roofing material with non-combustible roofing materials.	1. Support Firewise community initiatives. 2. Create /establish stored water supplies to be utilized for fire fighting.	1. More public outreach and education efforts, including an active Firewise program 2. Possible weapons of mass destruction funds available to enhance fire capability in high-risk areas 3. Identify fire response and alternative evacuation routes 4. Seek alternative water supplies 5. Become a Firewise community 6. Use academia to study impacts/solutions to wildfire risk 7. Establish/maintain mutual aid agreements between fire service agencies. 8. Create/implement fire plans 9. Consider the probable impacts of climate change on the risk associated with the wildfire hazard in future land use decisions

CHAPTER 19.
AREA-WIDE MITIGATION INITIATIVES

19.1 SELECTED COUNTY-WIDE MITIGATION INITIATIVES

The planning partners and the Steering Committee determined that some initiatives from the mitigation catalogs could be implemented to provide hazard mitigation benefits countywide. Table 19-1 lists the recommended countywide initiatives, the lead agency for each, and the proposed timeline. The parameters for the timeline are as follows:

- Short Term = to be completed in 1 to 5 years
- Long Term = to be completed in greater than 5 years
- Ongoing = currently being funded and implemented under existing programs.

19.2 BENEFIT/COST REVIEW

44CFR requires the prioritization of the action plan according to a benefit/cost analysis of the proposed projects and their associated costs (Section 201.6.c.3iii). The benefits of proposed projects were weighed against estimated costs as part of the project prioritization process. The benefit/cost analysis was not of the detailed variety required by FEMA for project grant eligibility under the Hazard Mitigation Grant Program (HMGP) and Pre-Disaster Mitigation (PDM) grant program. A less formal approach was used because some projects may not be implemented for up to 10 years, and associated costs and benefits could change dramatically in that time. Therefore, a review of the apparent benefits versus the apparent cost of each project was performed. Parameters were established for assigning subjective ratings (high, medium, and low) to the costs and benefits of these projects.

Cost ratings were defined as follows:

- **High**—Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).
- **Medium**—The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.
- **Low**—The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.

Benefit ratings were defined as follows:

- **High—**Project will provide an immediate reduction of risk exposure for life and property.
- **Medium—**Project will have a long-term impact on the reduction of risk exposure for life and property, or project will provide an immediate reduction in the risk exposure for property.
- **Low—**Long-term benefits of the project are difficult to quantify in the short term.

Using this approach, projects with positive benefit versus cost ratios (such as high over high, high over medium, medium over low, etc.) are considered cost-beneficial and are prioritized accordingly.

For many of the strategies identified in this action plan, the partners may seek financial assistance under the HMGP or PDM programs, both of which require detailed benefit/cost analyses. These analyses will be performed on projects at the time of application using the FEMA benefit-cost model. For projects not seeking financial assistance from grant programs that require detailed analysis, the partners reserve the right to define "benefits" according to parameters that meet the goals and objectives of this plan.

19.3 COUNTY-WIDE ACTION PLAN PRIORITIZATION

Table 19-2 lists the priority of each countywide initiative, using the same parameters used by each of the planning partners in selecting their initiatives. A qualitative benefit-cost review was performed for each of these initiatives. The priorities are defined as follows:

- **High Priority**—A project that meets multiple objectives (i.e., multiple hazards), has benefits that exceed cost, has funding secured or is an ongoing project and meets eligibility requirements for the HMGP or PDM grant program. High priority projects can be completed in the short term (1 to 5 years).
- **Medium Priority**—A project that meets goals and objectives, that has benefits that exceed costs, and for which funding has not been secured but that is grant eligible under HMGP, PDM or other grant programs. Project can be completed in the short term, once funding is secured. Medium priority projects will become high priority projects once funding is secured.
- **Low Priority**—A project that will mitigate the risk of a hazard, that has benefits that do not exceed the costs or are difficult to quantify, for which funding has not been secured, that is not eligible for HMGP or PDM grant funding, and for which the time line for completion is long term (1 to 10 years). Low priority projects may be eligible for other sources of grant funding from other programs.

**TABLE 19-1.
ACTION PLAN—COUNTYWIDE MITIGATION INITIATIVES**

Hazards Addressed	Lead Agency	Possible Funding Sources or Resources	Time Line[a]	Objectives
CW-1—Continue to maintain a County-wide hazard mitigation website that will house the plan and provide the public an opportunity to monitor plan implementation progress. Each planning partner can support this initiative by including an initiative in its action plan of creating a link to the County Hazard Mitigation webpage.				
All Hazards	OES	OES operational budget	Short term/ongoing	3, 6, 16
CW-2—Leverage public outreach partnering capabilities (such as CERT) within the planning area to promote a uniform and consistent message on the importance of proactive hazard mitigation.				
All Hazards	OES, CERT	OES operational budget	Short term/ ongoing	2, 3, 6 ,16
CW-3—Coordinate mitigation planning and project efforts within the planning area to leverage all resources available to the planning partnership.				
All Hazards	OES, Public Works	FEMA mitigation grant funding will reimburse for grant application preparation. General fund allocations of all planning partners.	Short term	6, 16
CW-4—Where appropriate, support retrofitting, purchase, or relocation of structures located in hazard-prone areas to protect structures from future damage, with repetitive and severe repetitive loss properties as a priority. Seek opportunities to leverage partnerships within the planning area in these pursuits.				
All Hazards	OES, Public Works	FEMA Mitigation Grant funding	Long-term/ depends on funding	7, 15, 16
CW-5—Continue to update hazard mapping with best available data and science as it evolves within the capabilities of the partnership. Support FEMA's Risk MAP Initiative.				
All Hazards	Public Works	FEMA Mitigation Grant Funding, FEMA's CTP program, County CIP funding	Long-term/ depends on funding	3, 6, 16
CW-6—To the extent possible based on available resources, provide coordination and technical assistance in the application for grant funding that includes assistance in cost vs. benefit analysis for grant eligible projects.				
All Hazards	OES, Public Works	FEMA mitigation grant funding will reimburse for grant application preparation. General fund allocations of all planning partners.	Short term	6, 16
CW-7—A steering committee will remain as a viable body over time to monitor progress of the hazard mitigation plan, provide technical assistance to Planning Partners and oversee the update of the plan according to schedule. This body will continue to operate under the ground rules established at its inception.				
All Hazards	OES, Public Works	Public Works and OES operational budgets	Short term/ ongoing	8, 16
CW-8—Amend or enhance the Contra Costa County Hazard Mitigation Plan on an "as needed" basis to seek compliance with state or federal mandates (i.e., CA. Assembly Bill # 2140) as guidance for compliance with these programs become available.				
All Hazards	OES, DCD, Public Works	County General Fund	Short term/ ongoing	5, 6, 14

**TABLE 19-1 (CONTINUED).
ACTION PLAN—COUNTYWIDE MITIGATION INITIATIVES**

Hazards Addressed	Lead Agency	Possible Funding Sources or Resources	Time Line[a]	Objectives
CW-9—Utilize information contained within the Contra Costa County Hazard Mitigation Plan to support updates to other emergency management plans in effect within the planning area.				
All Hazards	OES	Possible DHS funding, General funds of all planning partners	Long term, depends on funding	2, 13, 16
CW-10—Continue to coordinate emergency management and hazard mitigation planning functions with the Association of Bay Area Governments to leverage resources and information on the planning area to support/enhance these activities for the Contra Costa County planning partnership.				
All Hazards	OES	OES operational budget	Short term/ ongoing	2, 13, 16
CW-11—Sponsor the formation and training of Community Emergency Response Team (CERT) training through partnerships with local businesses				
All Hazards	All Municipal Planning Partners, OES	General Funds	Short term/ ongoing	2, 3, 6 ,16

a. Short term = 1 to 5 years; Long Term= 5 years or greater
OES = Sheriff's Office of Emergency Services; DCD = Contra Costa County Department of Conservation and Development

**TABLE 19-2.
PRIORITIZATION OF COUNTYWIDE MITIGATION INITIATIVES**

Initiative #	# of Objectives Met	Benefits	Costs	Do Benefits equal or exceed Costs?	Is project Grant eligible?	Can Project be funded under existing programs/ budgets?	Priority (High, Med., Low)
CW-1	3	Low	Low	Yes	No	Yes	High
CW-2	4	Low	Low	Yes	Yes	Yes	High
CW-3	2	Medium	Low	Yes	Yes	Yes	High
CW-4	3	High	High	Yes	Yes	No	Medium
CW-5	3	Medium	Medium	Yes	Yes	No	Medium
CW-6	2	Medium	Low	Yes	Yes	No	High
CW-7	2	Low	Low	Yes	No	Yes	High
CW-8	3	Medium	Low	Yes	No	Yes	High
CW-9	3	Low	Low	Yes	Yes	Yes	High
CW-10	3	Low	Low	Yes	No	Yes	High
CS-11	4	High	Low	Yes	No	Yes	High

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APPENDIX A. ACRONYMS AND DEFINITIONS

July 2011

APPENDIX A.
ACRONYMS AND DEFINITIONS

ACRONYMS

ABAG—Association of Bay Area Governments

AB—Assembly Bill

Cal EMA—California Emergency Management Agency

CAL FIRE—California Department of Forestry and Fire Protection

CCR—California Code of Regulations

CCTV—Contra Costa Television

CEQA—California Environmental Quality Act

CFR—Code of Federal Regulations

cfs—cubic feet per second

CIP—Capital Improvement Plan

CRS—Community Rating System

DCD—Contra Costa County Department of Conservation and Development

DFIRM—Digital Flood Insurance Rate Maps

DHS—Department of Homeland Security

DMA —Disaster Mitigation Act

DWR—California Department of Water Resources

EAP—Emergency Action Plan

EPA—U.S. Environmental Protection Agency

ESA—Endangered Species Act

FCWCD—Flood Control and Water Conservation District

FEMA—Federal Emergency Management Agency

FERC—Federal Energy Regulatory Commission

FHSZ —Fire Hazard Severity Zone

FIRM—Flood Insurance Rate Map

FIS—Flood Insurance Study

FRA—Federal responsibility area

GIS—Geographic Information System

HAZUS-MH—Hazards, United States-Multi Hazard

HMGP—Hazard Mitigation Grant Program

IBC—International Building Code

IRC—International Residential Code

LRA—Local responsibility area

MCI—Multi-Casualty Incident

MM—Modified Mercalli Scale

NEHRP—National Earthquake Hazards Reduction Program

NFIP—National Flood Insurance Program

NOAA—National Oceanic and Atmospheric Administration

NWS—National Weather Service

OES—Office of Emergency Services

PDM—Pre-Disaster Mitigation Grant Program

PDSI—Palmer Drought Severity Index

PGA—Peak Ground Acceleration

PHDI—Palmer Hydrological Drought Index

RAWS—Remote Automated Weather Station

RWQCB—Regional Water Quality Control Board

SEMS—Standardized Emergency Management System

SFHA—Special Flood Hazard Area

SHELDUS—Special Hazard Events and Losses Database for the US

SPI—Standardized Precipitation Index

SRA—State responsibility area

USGS—U.S. Geological Survey

DEFINITIONS

100-Year Flood: The term "100-year flood" can be misleading. The 100-year flood does not necessarily occur once every 100 years. Rather, it is the flood that has a 1 percent chance of being equaled or exceeded in any given year. Thus, the 100-year flood could occur more than once in a relatively short period of time. The Federal Emergency Management Agency (FEMA) defines it as the 1 percent annual chance flood, which is now the standard definition used by most federal and state agencies and by the National Flood Insurance Program (NFIP).

Acre-Foot: An acre-foot is the amount of water it takes to cover 1 acre to a depth of 1 foot. This measure is used to describe the quantity of storage in a water reservoir. An acre-foot is a unit of volume. One acre foot equals 7,758 barrels; 325,829 gallons; or 43,560 cubic feet. An average household of four will use approximately 1 acre-foot of water per year.

Asset: An asset is any man-made or natural feature that has value, including, but not limited to, people; buildings; infrastructure, such as bridges, roads, sewers, and water systems; lifelines, such as electricity and communication resources; and environmental, cultural, or recreational features such as parks, wetlands, and landmarks.

Base Flood: The flood having a 1% chance of being equaled or exceeded in any given year, also known as the “100-year” or “1% chance” flood. The base flood is a statistical concept used to ensure that all properties subject to the National Flood Insurance Program (NFIP) are protected to the same degree against flooding.

Basin: A basin is the area within which all surface water—whether from rainfall, snowmelt, springs, or other sources—flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains, and ridges. Basins are also referred to as “watersheds” and “drainage basins.”

Benefit: A benefit is a net project outcome and is usually defined in monetary terms. Benefits may include direct and indirect effects. For the purposes of benefit-cost analysis of proposed mitigation measures, benefits are limited to specific, measurable, risk reduction factors, including reduction in expected property losses (buildings, contents, and functions) and protection of human life.

Benefit/Cost Analysis: A benefit/cost analysis is a systematic, quantitative method of comparing projected benefits to projected costs of a project or policy. It is used as a measure of cost effectiveness.

Building: A building is defined as a structure that is walled and roofed, principally aboveground, and permanently fixed to a site. The term includes manufactured homes on permanent foundations on which the wheels and axles carry no weight.

Capability Assessment: A capability assessment provides a description and analysis of a community’s current capacity to address threats associated with hazards. The assessment includes two components: an inventory of an agency’s mission, programs, and policies, and an analysis of its capacity to carry them out. A capability assessment is an integral part of the planning process in which a community’s actions to reduce losses are identified, reviewed, and analyzed, and the framework for implementation is identified. The following capabilities were reviewed under this assessment:

- Legal and regulatory capability
- Administrative and technical capability
- Fiscal capability

Community Rating System (CRS): The CRS is a voluntary program under the NFIP that rewards participating communities (provides incentives) for exceeding the minimum requirements of the NFIP and completing activities that reduce flood hazard risk by providing flood insurance premium discounts.

Critical Area: An area defined by state or local regulations as deserving special protection because of unique natural features or its value as habitat for a wide range of species of flora and fauna. A sensitive/critical area is usually subject to more restrictive development regulations.

Critical Facility: Facilities and infrastructure that are critical to the health and welfare of the population. These become especially important after any hazard event occurs. For the purposes of this plan update, critical facilities include:

- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic and/or water reactive materials;
- Hospitals, nursing homes, and housing likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a hazard event.

- Police stations, fire stations, vehicle and equipment storage facilities, and emergency operations centers that are needed for disaster response before, during, and after hazard events, and
- Public and private utilities, facilities and infrastructure that are vital to maintaining or restoring normal services to areas damaged by hazard events.
- Government facilities.

Cubic Feet per Second (cfs): Discharge or river flow is commonly measured in cfs. One cubic foot is about 7.5 gallons of liquid.

Dam: Any artificial barrier or controlling mechanism that can or does impound 10 acre-feet or more of water.

Dam Failure: Dam failure refers to a partial or complete breach in a dam (or levee) that impacts its integrity. Dam failures occur for a number of reasons, such as flash flooding, inadequate spillway size, mechanical failure of valves or other equipment, freezing and thawing cycles, earthquakes, and intentional destruction.

Debris Avalanche: Volcanoes are prone to debris and mountain rock avalanches that can approach speeds of 100 mph.

Debris Flow: Dense mixtures of water-saturated debris that move down-valley; looking and behaving much like flowing concrete. They form when loose masses of unconsolidated material are saturated, become unstable, and move down slope. The source of water varies but includes rainfall, melting snow or ice, and glacial outburst floods.

Debris Slide: Debris slides consist of unconsolidated rock or soil that has moved rapidly down slope. They occur on slopes greater than 65 percent.

Disaster Mitigation Act of 2000 (DMA); The DMA is Public Law 106-390 and is the latest federal legislation enacted to encourage and promote proactive, pre-disaster planning as a condition of receiving financial assistance under the Robert T. Stafford Act. The DMA emphasizes planning for disasters before they occur. Under the DMA, a pre-disaster hazard mitigation program and new requirements for the national post-disaster hazard mitigation grant program (HMGP) were established.

Drainage Basin: A basin is the area within which all surface water- whether from rainfall, snowmelt, springs or other sources- flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains and ridges. Drainage basins are also referred to as **watersheds** or **basins**.

Drought: Drought is a period of time without substantial rainfall or snowfall from one year to the next. Drought can also be defined as the cumulative impacts of several dry years or a deficiency of precipitation over an extended period of time, which in turn results in water shortages for some activity, group, or environmental function. A hydrological drought is caused by deficiencies in surface and subsurface water supplies. A socioeconomic drought impacts the health, well being, and quality of life or starts to have an adverse impact on a region. Drought is a normal, recurrent feature of climate and occurs almost everywhere.

Earthquake: An earthquake is defined as a sudden slip on a fault, volcanic or magmatic activity, and sudden stress changes in the earth that result in ground shaking and radiated seismic energy. Earthquakes can last from a few seconds to over 5 minutes, and have been known to occur as a series of tremors over a period of several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties may result from falling objects and debris as shocks shake, damage, or demolish buildings and other structures.

Exposure: Exposure is defined as the number and dollar value of assets considered to be at risk during the occurrence of a specific hazard.

Extent: The extent is the size of an area affected by a hazard.

Fire Behavior: Fire behavior refers to the physical characteristics of a fire and is a function of the interaction between the fuel characteristics (such as type of vegetation and structures that could burn), topography, and weather. Variables that affect fire behavior include the rate of spread, intensity, fuel consumption, and fire type (such as underbrush versus crown fire).

Fire Frequency: Fire frequency is the broad measure of the rate of fire occurrence in a particular area. An estimate of the areas most likely to burn is based on past fire history or fire rotation in the area, fuel conditions, weather, ignition sources (such as human or lightning), fire suppression response, and other factors.

Flash Flood: A flash flood occurs with little or no warning when water levels rise at an extremely fast rate

Flood Insurance Rate Map (FIRM): FIRMs are the official maps on which the Federal Emergency Management Agency (FEMA) has delineated the Special Flood Hazard Area (SFHA).

Flood Insurance Study: A report published by the Federal Insurance and Mitigation Administration for a community in conjunction with the community's Flood Insurance rate Map. The study contains such background data as the base flood discharges and water surface elevations that were used to prepare the FIRM. In most cases, a community FIRM with detailed mapping will have a corresponding flood insurance study.

Floodplain: Any land area susceptible to being inundated by flood waters from any source. A flood insurance rate map identifies most, but not necessarily all, of a community's floodplain as the Special Flood Hazard Area (SFHA).

Floodway: Floodways are areas within a floodplain that are reserved for the purpose of conveying flood discharge without increasing the base flood elevation more than 1 foot. Generally speaking, no development is allowed in floodways, as any structures located there would block the flow of floodwaters.

Floodway Fringe: Floodway fringe areas are located in the floodplain but outside of the floodway. Some development is generally allowed in these areas, with a variety of restrictions. On maps that have identified and delineated a floodway, this would be the area beyond the floodway boundary that can be subject to different regulations.

Fog: Fog refers to a cloud (or condensed water droplets) near the ground. Fog forms when air close to the ground can no longer hold all the moisture it contains. Fog occurs either when air is cooled to its dew point or the amount of moisture in the air increases. Heavy fog is particularly hazardous because it can restrict surface visibility. Severe fog incidents can close roads, cause vehicle accidents, cause airport delays, and impair the effectiveness of emergency response. Financial losses associated with transportation delays caused by fog have not been calculated in the United States but are known to be substantial.

Freeboard: Freeboard is the margin of safety added to the base flood elevation.

Frequency: For the purposes of this plan, frequency refers to how often a hazard of specific magnitude, duration, and/or extent is expected to occur on average. Statistically, a hazard with a 100-year frequency is expected to occur about once every 100 years on average and has a 1 percent chance of occurring any given year. Frequency reliability varies depending on the type of hazard considered.

Fujita Scale of Tornado Intensity: Tornado wind speeds are sometimes estimated on the basis of wind speed and damage sustained using the Fujita Scale. The scale rates the intensity or severity of tornado events using numeric values from F0 to F5 based on tornado wind speed and damage. An F0 tornado (wind speed less than 73 miles per hour (mph)) indicates minimal damage (such as broken tree limbs), and an F5 tornado (wind speeds of 261 to 318 mph) indicates severe damage.

General Plan: California state law requires that every county and city prepare and adopt a comprehensive long-range plan to serve as a guide for community development. The plan must consist of an integrated and internally consistent set of goals, policies, and implementation measures. In addition, the plan must focus on issues of the greatest concern to the community and be written in a clear and concise manner.

Goal: A goal is a general guideline that explains what is to be achieved. Goals are usually broad-based, long-term, policy-type statements and represent global visions. Goals help define the benefits that a plan is trying to achieve. The success of a hazard mitigation plan is measured by the degree to which its goals have been met (that is, by the actual benefits in terms of actual hazard mitigation).

Geographic Information System (GIS): GIS is a computer software application that relates data regarding physical and other features on the earth to a database for mapping and analysis.

Hazard: A hazard is a source of potential danger or adverse condition that could harm people and/or cause property damage.

Hazard Mitigation Grant Program (HMGP): Authorized under Section 202 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, the HMGP is administered by FEMA and provides grants to states, tribes, and local governments to implement hazard mitigation actions after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to disasters and to enable mitigation activities to be implemented as a community recovers from a disaster

Hazards U.S. Multi-Hazard (HAZUS-MH) Loss Estimation Program: HAZUS-MH is a GIS-based program used to support the development of risk assessments as required under the DMA. The HAZUS-MH software program assesses risk in a quantitative manner to estimate damages and losses associated with natural hazards. HAZUS-MH is FEMA's nationally applicable, standardized methodology and software program and contains modules for estimating potential losses from earthquakes, floods, and wind hazards. HAZUS-MH has also been used to assess vulnerability (exposure) for other hazards.

Hydraulics: Hydraulics is the branch of science or engineering that addresses fluids (especially water) in motion in rivers or canals, works and machinery for conducting or raising water, the use of water as a prime mover, and other fluid-related areas.

Hydrology: Hydrology is the analysis of waters of the earth. For example, a flood discharge estimate is developed by conducting a hydrologic study.

Intensity: For the purposes of this plan, intensity refers to the measure of the effects of a hazard.

Inventory: The assets identified in a study region comprise an inventory. Inventories include assets that could be lost when a disaster occurs and community resources are at risk. Assets include people, buildings, transportation, and other valued community resources.

Landslide: Landslides can be described as the sliding movement of masses of loosened rock and soil down a hillside or slope. Fundamentally, slope failures occur when the strength of the soils forming the slope exceeds the pressure, such as weight or saturation, acting upon them.

Lightning: Lightning is an electrical discharge resulting from the buildup of positive and negative charges within a thunderstorm. When the buildup becomes strong enough, lightning appears as a "bolt," usually within or between clouds and the ground. A bolt of lightning instantaneously reaches temperatures approaching 50,000ºF. The rapid heating and cooling of air near lightning causes thunder. Lightning is a major threat during thunderstorms. In the United States, 75 to 100 Americans are struck and killed by lightning each year (see http://www.fema.gov/hazard/thunderstorms/thunder.shtm).

Liquefaction: Liquefaction is the complete failure of soils, occurring when soils lose shear strength and flow horizontally. It is most likely to occur in fine grain sands and silts, which behave like viscous fluids when liquefaction occurs. This situation is extremely hazardous to development on the soils that liquefy, and generally results in extreme property damage and threats to life and safety.

Local Government: Any county, municipality, city, town, township, public authority, school district, special district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate government entity, or agency or instrumentality of a local government; any Indian tribe or authorized tribal organization, or Alaska Native village or organization; and any rural community, unincorporated town or village, or other public entity.

Magnitude: Magnitude is the measure of the strength of an earthquake, and is typically measured by the Richter scale. As an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

Mass movement: A collective term for landslides, mudflows, debris flows, sinkholes and lahars.

Mitigation: A preventive action that can be taken in advance of an event that will reduce or eliminate the risk to life or property.

Mitigation Actions: Mitigation actions are specific actions to achieve goals and objectives that minimize the effects from a disaster and reduce the loss of life and property.

Objective: For the purposes of this plan, an objective is defined as a short-term aim that, when combined with other objectives, forms a strategy or course of action to meet a goal. Unlike goals, objectives are specific and measurable.

Peak Ground Acceleration: Peak Ground Acceleration (PGA) is a measure of the highest amplitude of ground shaking that accompanies an earthquake, based on a percentage of the force of gravity.

Preparedness: Preparedness refers to actions that strengthen the capability of government, citizens, and communities to respond to disasters.

Presidential Disaster Declaration: These declarations are typically made for events that cause more damage than state and local governments and resources can handle without federal government assistance. Generally, no specific dollar loss threshold has been established for such declarations. A Presidential Disaster Declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, designed to help disaster victims, businesses, and public entities.

Probability of Occurrence: The probability of occurrence is a statistical measure or estimate of the likelihood that a hazard will occur. This probability is generally based on past hazard events in the area and a forecast of events that could occur in the future. A probability factor based on yearly values of occurrence is used to estimate probability of occurrence.

Repetitive Loss Property: Any NFIP-insured property that, since 1978 and regardless of any changes of ownership during that period, has experienced:

- Four or more paid flood losses in excess of $1000.00; or
- Two paid flood losses in excess of $1000.00 within any 10-year period since 1978 or
- Three or more paid losses that equal or exceed the current value of the insured property.

Return Period (or Mean Return Period): This term refers to the average period of time in years between occurrences of a particular hazard (equal to the inverse of the annual frequency of occurrence).

Riverine: Of or produced by a river. Riverine floodplains have readily identifiable channels. Floodway maps can only be prepared for riverine floodplains.

Risk: Risk is the estimated impact that a hazard would have on people, services, facilities, and structures in a community. Risk measures the likelihood of a hazard occurring and 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 occurrence of a specific type of hazard. Risk also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Risk Assessment: Risk assessment is the process of measuring potential loss of life, personal injury, economic injury, and property damage resulting from hazards. This process assesses the vulnerability of people, buildings, and infrastructure to hazards and focuses on (1) hazard identification; (2) impacts of hazards on physical, social, and economic assets; (3) vulnerability identification; and (4) estimates of the cost of damage or costs that could be avoided through mitigation.

Risk Ranking: This ranking serves two purposes, first to describe the probability that a hazard will occur, and second to describe the impact a hazard will have on people, property, and the economy. Risk estimates for the City are based on the methodology that the City used to prepare the risk assessment for this plan. The following equation shows the risk ranking calculation:

Risk Ranking = Probability + Impact (people + property + economy)

Robert T. Stafford Act: The Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 100-107, was signed into law on November 23, 1988. This law amended the Disaster Relief Act of 1974, Public Law 93-288. The Stafford Act is the statutory authority for most federal disaster response activities, especially as they pertain to FEMA and its programs.

Sinkhole: A collapse depression in the ground with no visible outlet. Its drainage is subterranean. It is commonly vertical-sided or funnel-shaped.

Special Flood Hazard Area: The base floodplain delineated on a Flood Insurance Rate Map. The SFHA is mapped as a Zone A in riverine situations and zone V in coastal situations. The SFHA may or may not encompass all of a community's flood problems

Stakeholder: Business leaders, civic groups, academia, non-profit organizations, major employers, managers of critical facilities, farmers, developers, special purpose districts, and others whose actions could impact hazard mitigation.

Stream Bank Erosion: Stream bank erosion is common along rivers, streams and drains where banks have been eroded, sloughed or undercut. However, it is important to remember that a stream is a dynamic and constantly changing system. It is natural for a stream to want to meander, so not all eroding banks are "bad" and in need of repair. Generally, stream bank erosion becomes a problem where development has limited the meandering nature of streams, where streams have been channelized, or where stream bank structures (like bridges, culverts, etc.) are located in places where they can actually cause damage to downstream areas. Stabilizing these areas can help protect watercourses from continued sedimentation, damage to adjacent land uses, control unwanted meander, and improvement of habitat for fish and wildlife.

Steep Slope: Different communities and agencies define it differently, depending on what it is being applied to, but generally a steep slope is a slope in which the percent slope equals or exceeds 25%. For this study, steep slope is defined as slopes greater than 33%.

Sustainable Hazard Mitigation: This concept includes the sound management of natural resources, local economic and social resiliency, and the recognition that hazards and mitigation must be understood in the largest possible social and economic context.

Thunderstorm: A thunderstorm is a storm with lightning and thunder produced by cumulonimbus clouds. Thunderstorms usually produce gusty winds, heavy rains, and sometimes hail. Thunderstorms are usually short in duration (seldom more than 2 hours). Heavy rains associated with thunderstorms can lead to flash flooding during the wet or dry seasons.

Tornado: A tornado is a violently rotating column of air extending between and in contact with a cloud and the surface of the earth. Tornadoes are often (but not always) visible as funnel clouds. On a local scale, tornadoes are the most intense of all atmospheric circulations, and winds can reach destructive speeds of more than 300 mph. A tornado's vortex is typically a few hundred meters in diameter, and damage paths can be up to 1 mile wide and 50 miles long.

Vulnerability: Vulnerability describes how exposed or susceptible an asset is to damage. 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. Flooding of an electric substation would affect not only the substation itself but businesses as well. Often, indirect effects can be much more widespread and damaging than direct effects.

Watershed: A watershed is an area that drains downgradient from areas of higher land to areas of lower land to the lowest point, a common drainage basin.

Wildfire: These terms refer to any uncontrolled fire occurring on undeveloped land that requires fire suppression. The potential for wildfire is influenced by three factors: the presence of fuel, topography, and air mass. Fuel can include living and dead vegetation on the ground, along the surface as brush and small trees, and in the air such as tree canopies. Topography includes both slope and elevation. Air mass includes temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount, duration, and the stability of the atmosphere at the time of the fire. Wildfires can be ignited by lightning and, most frequently, by human activity including smoking, campfires, equipment use, and arson.

Windstorm: Windstorms are generally short-duration events involving straight-line winds or gusts exceeding 50 mph. These gusts can produce winds of sufficient strength to cause property damage. Windstorms are especially dangerous in areas with significant tree stands, exposed property, poorly constructed buildings, mobile homes (manufactured housing units), major infrastructure, and aboveground utility lines. A windstorm can topple trees and power lines; cause damage to residential, commercial, critical facilities; and leave tons of debris in its wake.

Zoning Ordinance: The zoning ordinance designates allowable land use and intensities for a local jurisdiction. Zoning ordinances consist of two components: a zoning text and a zoning map.

Contra Costa County
Hazard Mitigation Plan Update

APPENDIX B.
PUBLIC OUTREACH

July 2011

PUBLIC MEETINGS OVERVIEW

Meeting #1, July 29, 2009
Central Contra Costa Sanitary District-
5019 Imhoff Place, Martinez, CA 94553
Multi Purpose room

Attendance:

- Planning Team-2
- Steering Committee-5
- Planning Partners-2
- Citizens-8

Total 17

Questionnaires completed= 6
Comments/Questions received: 4
Note: this session was recorded by CCTV and replayed on 8/5 and 8/7

Meeting #2, July 30, 2009
The City of Pinole
Council Chamber/Community Center
880 Tennent Ave., Pinole, CA 94564

Attendance:

- Planning Team-2
- Steering Committee-5
- Planning Partners-4
- Citizens-18

Total 29

Questionnaires completed= 12
Comments/Questions received: 2
Note: this session was recorded by the Pinole cable TV channel for replay and dissemination to others cities within the planning area.

Meeting #3, August 11, 2009
The City of San Ramon
Community Center
12501 Alcosta Blvd.
San Ramon, CA 94598

Attendance:

- Planning Team-2
- Steering Committee-6
- Planning Partners-2
- Citizens-21

Total 31

Questionnaires completed= 15
Comments/Questions received: 5

Meeting #4, August 13, 2009
The City of Antioch
Police Department- Community Room
3000 “L” Street, Antioch, CA 94509

Attendance:

- Planning Team-2
- Steering Committee-5
- Planning Partners-5
- Citizens-22

Total 34

Questionnaires completed= 5
Comments/Questions received: 9

Meeting Totals
Average attendance = 28
Average # 0f Questionnaires received = 9
Average # of comments received = 5

County of Contra Costa

Press Release
For Immediate Release

July 26, 2009

Public Input Needed for Countywide Multi-Hazard Mitigation Plan

A recently approved grant from the Federal Emergency Management Agency (FEMA) will help Contra Costa County and many of the local jurisdictions and special districts develop a Countywide Multi-Hazard Mitigation Plan. The plan will enable the county and the cities to take ongoing action to reduce or eliminate long-term risks to human life, property and the environment from many types of natural hazards, such as earthquakes, flooding, and wildfires.

Funding from this Multi-Hazard Mitigation grant is earmarked to develop a multi-hazard mitigation plan compliant with the Disaster Mitigation Act of 2000, which was established by Congress, and emphasizes the need for States and communities to prepare for possible disasters by developing a multi-hazard mitigation plans for existing and future buildings.

Contra Costa County Office of Emergency Services, 13 cities, and 27 special purpose districts working with Tetra Tech, Inc. (Tetra Tech) are participating in the process of creating a county-wide multi-hazard mitigation plan, or updating their existing multi-hazard mitigation plans. Tetra Tech has with the help of the planning partners, collected and analyzed data to estimate the economic loss and population disruption caused by anticipated disaster events. For example, based on preliminary information, an earthquake measuring 7.1 on the Richter scale on the Hayward-Rodgers Creek fault could cause $3.5 billion in damages to structures and their contents and displace almost 1,300 households in Contra Costa County.

Public input is an important part of the planning process. We have scheduled four public meetings:

-Wednesday, July 29, 2009, 6:00pm - 9:00pm, Central Contra Costa Sanitary District,
5019 Imhoff Place (Multi Purpose room), Martinez, CA 94553
-Thursday, July 30, 2009, 6:00pm - 9:00pm, Council Chamber/Community Center,
880 Tennent Ave., Pinole, CA 94564
-Tuesday, August 11, 2009, 6:00pm to 9:00pm, San Ramon Community Center,
12501 Alcosta Blvd., San Ramon, CA 94598
-Thursday, August 13, 2009, 6:00pm to 9:00pm, Antioch Police Department,
Community Room, 3000 L Street, Antioch, CA 94509

Please refer to the County website, http://www.co.contra-costa.ca.us, for additional information regarding hazard mitigation planning efforts.

Once completed, the plan will go before the Contra Costa County Board of Supervisors, the California Emergency Management Agency and FEMA for approval. Once the county, cities, and the special districts have completed their plans, they'll have access to FEMA funds in case of a disaster. Those entities that have an existing multi-hazard mitigation plan and are in the process of updating their plans currently have access to FEMA funds.

For more information contact:
Susan Roseberry, Emergency Planning Coordinator – Office of Emergency Services, (925) 313-9625
Rich Lierly, Floodplain/Watershed Manager, Senior Civil Engineer, Flood Control District, (925) 313-2348
Rob Flaner, Certified Flood Manager, Tetra Tech, (208) 939-4391

District 2 Highlights

Rossmoor, Saranap, Walnut Creek Edition

Supervisor Gayle B. Uilkema, Contra Costa County Board of Supervisors, District 2
Phone: (925) 335-1046 Fax: (925) 335-1076 Email: gayle@bos.cccounty.us

Fall 2009 Serving Rossmoor, Saranap, Walnut Creek

Your Help Is Needed in Planning for Future Disasters

While Contra Costa County is not prone to the types of disasters that other parts of the country face, such as tornadoes and hurricanes, we do have to be prepared to respond to those potentially life-threatening situations that may occur here. To that end, the County has its County Wide Multi-Hazard Mitigation Plan (HMP). The purpose of the HMP is to prioritize actions to be taken by the County and the participating cities and special districts (school, fire, flood, water, sewer, etc.) to reduce or eliminate long-term risks to human life, property and the environment from seven types of natural hazards: earthquakes, floods (including levee issues), landslides dam failures, severe weather, drought and wildfires.

Contra Costa County recently received a planning grant from the Federal Emergency Management Agency (FEMA) to be used to update its plan. Having a FEMA approved HMP is a necessary prerequisite to applying for FEMA pre-disaster funding grants. These FEMA grants can be used to fund improvements that will help reduce or eliminate the anticipated effects of a natural disaster on the citizens of Contra Costa County. *You, as a resident of the County, will directly benefit from any FEMA grants that the County receives through the improvements that will be funded.*

Contra Costa County, thirteen cities, and twenty-seven special districts and a planning consultant (Tetra Tech, Inc.) are working together to modify the existing HMP by establishing a uniform set of planning criteria and gathering data on the vulnerability of facilities owned by each planning partner. The data they collect will be analyzed with FEMA software to estimate the economic loss and population disruption caused by the anticipated disaster events. For example, based on

Continued on Page 2

Good food and good friends at CCCafe at Rossmoor

Friday Lunch at Rossmoor

The Friday Lunch, also known as CCCafe, held at Hillside Clubhouse always draws a crowd. Over 100 residents regularly show up for these reasons – good food, good friends, and good health!

County Supervisor Gayle Uilkema makes an annual summer visit to see how well the county program is working, to speak with the friends she already knows, and to meet new people. These visits give Gayle an opportunity to hear comments and opinions that the attendees would like to share.

Senior Outreach Services, a department within the Area Agency on Aging, organizes the program that provides the lunches at Rossmoor as well as at numerous senior centers around the county.

Gayle was welcomed by Juliet Lee, a Rossmoor Recreation staff member, and was introduced by Ralph Daniel. Attendees arrived early to enjoy the live piano music as they entered the dining area and chatted with others at their tables while they awaited the lunch served by volunteers.

Continued on Page 2

Disaster – *Continued from Page 1*

preliminary information, an earthquake of Richter magnitude 7.1 on the Hayward-Rodgers Creek fault would cause approximately $3.5 billion in damages to structures and displace almost 1,300 households in Contra Costa County.

The County's plan must be compliant with Federal law in order for the participating agencies to be eligible for the FEMA grants and Federal law requires that the planning team get input from the public – **this means you**! To date, four public meetings have been held in order to present to the public information regarding the plan and the planning process and to receive feed-back from those who attended.

Here are some ways that you can give input into the planning process:

- Information regarding the hazard mitigation planning efforts is available on the County website **www.co.contra-costa.ca.us**. Follow the links to the "**Local Multi-Hazard Mitigation Plan**". Everyone is encouraged to help improve the Local Multi-Hazard Mitigation planning process by completing the Natural Hazards Mitigation Questionnaire available at the bottom of the web page.
- The Multi-Hazard Mitigation Steering Committee meets the fourth Wednesday of every month from 1:00PM to 3:00PM. The meetings are open to the public, and are held at the Public Works Department conference room located at 255 Glacier Drive in Martinez.

Once completed, the HMP will go before the board or council of each planning partner agency, the Contra Costa County Board of Supervisors, the California Emergency Management Agency (formerly known as the California Office of Emergency Services) and FEMA for approval.

For further information, refer to the County website or contact Susan Roseberry, Emergency Planning Coordinator – Office of Emergency Services at **925 313-9625**, Rich Lierly, Floodplain/Watershed Manager Senior Civil Engineer - Flood Control District at **925 313-2348** or Rob Flaner, Certified Flood Manager-Tetra Tech **208 939-4391**.

If you believe that you, or someone you know, are the victim of elder abuse,
Adult Protective Services operates a 24-hour response telephone line.
Call 925-646-2854 or toll free 877-839-4347.

Friday Lunch – *Continued from Page 1*

On this occasion, Gayle gave information on the Fall Prevention Program of Contra Costa County. There was considerable interest in the printed material she provided at an information table. A book titled *Exercise & Physical Activity: Your Everyday Guide from The National Institute on Aging* was on display and is available for free from the National Institutes of Health.

To receive *your* free copy of this excellent guide, call the National Institute on Aging at **800-222-2225** or, for those who are computer savvy, visit their website at **www.nia.nih.gov**. If you need help placing your order, please call Gayle's office at **925-335-1046**.

Where is *Your* Evac Pac?

If you are a Rossmoor resident, can you answer this question, "Where is your Evac Pac?" If you can, then the second and third questions are, 'What is in your Evac Pac?" and, "When did you last update your medical information and your medications?"

These questions were the items of interest to the residents and officials from Rossmoor, the county, and the local ambulance company who met recently to discuss the need to refresh the use of the Evac Pac. The Evac Pac program began as a

Continued on Page 3

Saranap Community Garden Update

From an email sent by Jeanette S. Mone on June 22, 2009

"Happy Summer! I hope you are enjoying the garden!

Supervisor Uilkema surprised the Saranap Community Garden with a $2,000 grant earmarked specifically for community based volunteer projects.

Since 2006 the Supervisor has been instrumental in helping to establish and maintain the pathway garden. From providing grant funding to leveraging her relationships with Public Works and EBMUD, she has always supported our neighborhood.

The $2,000 will be spent in October 2010 on re-mulching the quarter mile garden ($3,000 price tag). While this project is exhausting and not very glamorous, it will serve to keep our neighborhood pathway in tip-top shape.

Thank you, Supervisor Uilkema!"

Prevent Fires and Burns in your Home

Kitchen:

- Keep a fire extinguisher in the kitchen. However, if you are not able to use it safely, get out immediately and call for help from outside.
- Keep baking soda on hand to extinguish stove-top grease fires.
- Turn handles of pots and pans away from the front of the stove.
- Install curtains and towel holders away from burners on the stove.
- Maintain a constant watch when preparing food.

Bedrooms: Turn off electric blankets and other electrical appliances when not in use.

Bathroom: Disconnect appliances such as curling irons and hair dryers when done; store in a safe location when cool.

For more tips and information, call the Contra Costa County Fire District at **925-941-3327**.

Evac Pac – *Continued from Page 2*

pilot program in Rossmoor several years ago when Supervisor Uilkema saw the need for an easy to use and recognizable repository for one's medical information and a 3 day supply of medication.

Inquiries directed to the Contra Costa Fire Department and American Medical Response, the local ambulance company, revealed that a review of the use of the Evac Pac would be most beneficial to both residents and first responders.

Ideas were discussed to heighten the awareness of how to use the Evac Pac and how to communicate to the residents the ways to get the ultimate benefit from the tool they have at their fingertips.

Supervisor Uilkema met with Dennis Bell, Rossmoor Public Safety Coordinator; Pete McCabe, Securitas site manager; Donna Kaufman, Chair of RREPO, Leslie Mueller, General Manager, and Joanne Leibe of AMR; Keith Cormier of CCC Fire District; and resident Fil Fong. The group will have a follow-up meeting in October to discuss how the ideas have been implemented and what yet needs to be done to encourage the proper use of the Evac Pac.

Here are is what *you* need to do immediately:

- Have an Evac Pac.
- Fill out the personal information and keep the prescriptions up to date. Ask your doctor for a copy to place in the Evac Pac.
- Put at least a 3 day supply of medications in the red bag and replace frequently.
- Hang the bag next to the door so that it can be seen by emergency personnel who are exiting through the open door (do not put on the door where it will not be seen when the door is open).
- Be certain that caregivers are instructed to put the bag on the arm of resident who may not have done so independently.
- If you have a caregiver with you, please instruct them to put the bag on your arm if you must leave your home for any emergency.

Evac Pacs were distributed throughout the Rossmoor community a few years ago and are currently given to newcomers in their packets. If you do not have an Evac Pac, you may go to the Administration Office at Gateway Complex and request one.

Board of Supervisors Actions

June '09 – August '09

Conference with Labor Negotiators; Legal Counsel – existing litigation; Real Property Negotiators; Public Employee Appointment Title: Fire Chief, Contra Costa County Fire Protection District; Public Defender.

Report from TWIC on the floodplain impacts on unincorporated County areas resulting from FEMA remapping and levee accreditation efforts; Authorize necessary actions to minimize impacts on the County.

Update on the State and County fiscal problems as discussed at CSAC Annual Conference, 5/27-5/28/09, and impacts on CCC.

Adjourn to the Annual Luncheon with the CCC Superior Court Bench.

Resolution to change from a 27-day work period to a 24-day work period for qualifying fire protection employees in ConFire District, pursuant to the provisions of the Federal Fair Labor Standards Act.

Authorize County Counsel to initiate legal action against specified parties to recover monies owed for outstanding debts and costs of suit.

Authorize realignment of certain impact fees by allowing for deferral of impact fee payments for residential/non-residential projects.

Approve 2-year extension of MOU between ConFire and IAFF, Local 1230.

Approve/Authorize funding from the CA Dept of Aging Federal Nutrition Stimulus Program for senior nutrition programs.

Approve/Authorize contract with CC Senior Legal Services to provide countywide legal services to eligible clients, 60 years and older.

Approve/Authorize contract to provide certification review/probable cause/capacity hearing officer services for patients involuntarily confined.

Approve/Authorize contract for a CCC Earthquake Response Plan.

Approve/Authorize the Librarian to decrease pricing threshold from $50 to $35 as minimum for accounts that will be turned over for recovery/collection.

Accept March '09 update on operations of EHSD, Community Svcs Bureau.

Terminate emergency action taken by BOS 5/12/09 re: H1N1 Flu in CCC.

Continue emergency action taken 11/16/99 re: homelessness in CCC.

Resolution on the spending of federal economic renewal grants to CCC.

Accept Grant Deed of Development Rights, Approve Final Map/Subdivision Agreement for project by KATCAR Properties, LLC, Walnut Creek.

Accept FY 09/10 Annual Report for CSA L-100 (Countywide Street Lighting), declaring intent to levy/collect service charges; fix public hearing for 6/23/09 to authorize charges be placed on FY 09/10 property tax rolls.

Authorize new revenue from donations and grants, and appropriating it for library materials, equipment, and programs.

Adopt "Support" position on HR 1618, which would maintain the current 80,000-pound federal limit on the size of trucks using Interstate Highway System and would extend the weight limit to additional highways; Authorize letters communicating this position to federal legislators.

Resolution regarding economic benefit from providing human services, and the Human Services Funding Deficit.

Approve/Authorize a contract amendment with EDD Workforce Services Division, Workforce Investment Act, for American Recovery and Reinvestment Act funds.

Approve/Authorize contract with the CA Dept of Aging to pay County for Health Insurance Counseling and Advocacy Program services.

Approve/Authorize contract with the CA Department of Aging for the Title III and Title VII of the Older Americans Act.

Approve/Authorize execution of contracts with UC Davis to provide Employment Services Training and Eligibility Training.

Approve/Authorize contract to provide respite services to foster parents and relative caregivers through the Heritage Project.

Recognize the art exhibit "We the People" presented by District II and the Martinez Art Association, by Supervisor Uilkema

Resolution urging the CA Legislature and Governor to reject proposals that would shift billions of dollars of local revenue from counties.

Introduce the 2009-2010 Contra Costa County Grand Jury.

Report from CAO on the impacts of the State Budget on the County.

Consider accepting tabulation of mail-in ballots, confirming the Engineer's Report, authorizing the levy of street light charges for Minor Subdivision 05-0045, as recommended by the Public Works Director, Walnut Creek.

Continued on page 5

County Contacts

Supervisor Gayle B. Uilkema	(925) 335-1046
Abandoned Vehicles	(925) 313-2500
Adult Protective Services	(925) 313-2659
Agricultural Department	(925) 646-5250
Airport, Buchanan Field, Keith Freitas	(925) 646-5722
Animal Services Dept., Martinez – Glenn Howell	(925) 335-8300
Animal Services Dept., Pinole	(510) 374-3966
Area Agency on Aging, John Cottrell	(925) 313-1700
Auditor-Controller, Stephen Ybarra	(925) 646-2181
Building Inspection Division, Jason Crapo	(925) 335-1108
Building Application & Permits	(925) 646-1609
CCTV, Patricia Burke	(925) 313-1180
Children's Services – Adoptions	(925) 313-7770
Children's Protective Services – Central County.	(925) 646-1680
Children's Protective Services - West County.	(510) 374-3324
Clerk-Recorder, Stephen Weir	(925) 335-7899
Code Enforcement, Central County, Tim Honea	(925) 335-1128
West County, Tyrone Ridgle	(925) 335-1147
Lamorinda, Greg Wixom	(925) 299-0116
Community Development Division, Aruna Bhat	(925) 335-1221
Community Services, Pat Stroh	(925) 646-5990
Community Substance Abuse Services	(925) 313-6300
County Employment Information	(925) 335-1701
Contra Costa Health Plan, Milt Camhi	(925) 313-6000
Contra Costa Regional Medical Center	(925) 370-5000
County Administrator, David Twa	(925) 335-1086
County Assessor, Gus Kramer	(925) 313-7400
County Librarian, Ann Cain	(925) 927-3205
Central Library	(925) 646-6434
Library –Crockett Branch	(510) 787-2345
Library –Hercules Branch	(510) 245-2420
Library –Lafayette Branch	(925) 283-3872
Library –Martinez Branch	(925) 646-2898
Library –Moraga Branch	(925) 376-6852
Library –Orinda Branch	(925) 254-2184
Library –Pinole Branch	(510) 758-2741
Library –Rodeo Branch	(510) 799-2606
Library –Walnut Creek Branch	(925) 646-6773
County Road Maintenance, Joe Yee	(925) 313-7000
District Attorney, Robert J. Kochly	(925) 957-2200
Employment & Human Services, Joe Valentine	(925) 313-1500
Environmental Health, Sherm Quinlan	(925) 646-5225
Fire District of Contra Costa, Interim Chief John Ross	(925) 930-5500
Crockett-Carquinez Fire Protection Dist.	(510) 787-2717
Moraga-Orinda Fire Protection Dist.	(925) 258-4599
Rodeo-Hercules Fire Protection Dist.	(510) 799-4561
First Time Home Buyers	(925) 335-7235
Grand Jury.	(925) 646-2345
Hazardous Materials Ombudsman, Michael Kent	(925) 370-5020
Head Start Programs	(925) 646-5540
Health Services, William Walker, MD	(925) 370-5003
Homeless Programs	(800) 808-6444
Household Hazardous Waste	(800) 750-4096
Housing Authority, Joseph Villarreal	(925) 957-8011
In-Home Support Services	(925) 313-1770
Juvenile Hall	(925) 646-4800
LAFCO, Lou Ann Texeira	(925) 646-4090
Law Library	(925) 646-2783
Legal Assistant for the Elderly	(510) 374-3712
Martinez Detention Facility, Inmate Info	(925) 646-4495
Medi-Cal Services Eligibility	(925) 646-2941
Mental Health Services, Donna Wigand	(925) 957-5150
Mosquito Abatement/Vector Control	(925) 685-9301
Office of Emergency Services	(925) 646-4461
Private Industry Council	(925) 646-5239
Probation Department, Lionel Chatman	(925) 313-4023
Public Defender, David Coleman	(925) 335-8000
Public Works, Julie Bueren	(925) 313-2202
Retirement Office	(925) 646-5741
Sheriff-Coroner, Warren Rupf	(925) 335-1500
Superior Court, Clerk of the Court	(925) 646-2951
Superior Court, Jury Services	(925) 646-2002
Superior Court, Richmond	(510) 374-3800
Superior Court, Richmond, Jury Info.	(510) 374-3803
Treasurer-Tax Collector, William Pollacek	(925) 646-4122
Veterans Service Office, Phil Munley	(925) 313-1481
West County Detention Facility, Inmate Info	(510) 262-4200

Additional county departmental information can be found on the county website: **www.co.contra-costa.ca.us/**

Board of Supervisors Actions

Approve proposed fees for the CCC Certified Unified Program Agency.

Status report on the Light Brown Apple Moth Infestation in CCC.

Report on the advisory body review, consider findings and preliminary recommendations, provide additional direction.

Resolution celebrating 25 years of Tobacco Prevention efforts in CCC.

Approve/Authorize annual Drainage Area Benefit Assessments for FY 09/10 for Drainage Areas 67A, 75A, 76A, 520, 910, 1010, 1010A, Walnut Creek.

Resolution against State seizure of local gas tax and redevelopment funds.

Approve/Authorize contract with Maddie's Fund to accept grant funding to support ASD adoption programs for homeless dogs and cats.

Approve/Authorize contract amendment w/CA Dept of Food & Agriculture for increased regulatory work due to expansion of Light Brown Apple Moth infestation in CCC.

Approve/Authorize contract with Community Violence Solutions for Rescue & Restore Victims of Human Trafficking Regional Program.

Approve/Authorize contract with Child Abuse Prevention Council, a Non-Profit Corporation for child abuse prevention program services.

Refer review of the BOS' advisory bodies to the IOC, including the role, mission, operating procedures, and activities, to determine if additional standards would increase efficiency and effectiveness.

Authorize new budget unit/fund to complete merging of the BID and CDD into Dept of Conservation and Development.

Accept audit from Auditor-Controller on activities of the County Treasurer and the Treasury Oversight Committee as required by Govt Code Section 27134.

Authorize participation in '09 CA State Fair with a booth in the County Booth section, Direct the CCC Fair Board and Cooperative Extension to work with the BOS on development of a plan for participation in the '10 CA State Fair.

Accept actuarial valuation of future annual costs of negotiated/proposed changes to OPEB as provided by Buck Consultants in letter of 7/1/09.

EHSD: Authorize new revenue from CDSS, appropriating it for operating expenses in Child Welfare Svcs Promoting Safe & Stable Families programs.

Support AB 1487: would increase from $3 to $6 fee charged for each inmate-initiated medical visit by an inmate confined in a county or city jail, and requires that the $3 fee increase be deposited in the county inmate welfare fund.

Resolution establishing appropriation limits for CCC General, Special Districts, and Service Areas for FY 09/10.

Report on revision of CCC Hazard Mitigation Plan pursuant to the Federal Disaster Mitigation Act of 2000.

Accept written acknowledgment by CAO that he understands current/future costs of health benefits, determined by CCC's actuary in 7/1/09 Report.

Approve MOU w/Public Employees Union, Local One, AFSCME Local 512, SEIU Local 1021, Western Council of Engineers.

Accept report from the CAO regarding recommendations on health care changes for unrepresented employees and appointed and elected officials, Contra Costa County Fire Protection District unrepresented fire safety management employees, IHSS; Resolution regarding compensation and benefits for County Elected and Appointed Department Heads, Management, Exempt, Unrepresented employees, and IHSS, CCC FPD unrepresented fire safety management employees to reflect changes.

Acting in the capacities of the Governing Body of CCC, the CCC FPD, the ECC FPD, and IHSS Public Authority, consider Resolution applying health plan modifications to certain retirees.

Approve Agreed Upon Temporary Absences Implementation Agreement for County Appointed Department Heads, Management Employees, Exempt Employees, and Unrepresented Employees, CCC FPD Unrepresented Fire Safety Management Employees, ECC FPD Unrepresented Fire Safety Management Employees and IHSS Public Authority.

Resolution ending the Tier 2 time County-subsidized Buyback Program.

Resolution to invite Elected Officials to waive salary in conjunction with employees participation in Agreed-Upon Temporary Absences.

Adjourn to the Housing Authority Board of Commissioners meeting.

Recommendation by Planning Comm. to adopt '09 Housing Element Update.

Note: this is a partial list of Board activities. A complete record of Board activities can be found at the County's web page: www.co.contra-costa.ca.us

Volunteer Opportunities

Have you been looking for an opportunity to become more involved in your community? Are you interested in meeting new and interesting people? If you answered yes to either of these questions, then here is your opportunity! Below is a list of available County positions, please take a moment to peruse the list and see if something is of interest to you.

Application forms for **Volunteer Opportunities** are available from Supervisor Gayle B. Uilkema's office at **925-335-1046**, the Clerk of the Board of Supervisors office at **925-335-1900** or can be downloaded from the District 2 website at:
www.co.contra-costa.ca.us/depart/dis2/

Contra Costa County Library Commission

This Commission serves to advise and make recommendations to the Board of Supervisors and the County Librarian as to the needs of the public as well as to develop and recommend proposals for the betterment of the County Library including such efforts as insuring a stable and adequate funding level for the libraries in the County; to provide a link between the community and the Library System; and to establish a forum for the community to express its' views regarding goals and operations of the County Library. The Commission meets the fourth Thursday of each month at 7:00pm.

Contra Costa County Women's Commission

The Commission serves to identify major economic, educational and social concerns of women in Contra Costa County as well as to reach and inform all women on a variety of issues. The commission meets in Concord the third Tuesday of each month at 3:00pm. The term is three years.

CCC FPD's Fire Advisory Commissioners

This Commission serves to review and advise on: annual operations and capital budgets, district expenditures, long-range capital improvement plans, serve as the Appeals Board on weed abatement matters, serve as liaison between the BOS and the community served by each district, as well as other duties and responsibilities as may be assigned and directed by the BOS. Applicants must live within the Contra Costa County Fire Protection District's boundaries.

For more volunteer opportunities, you may go to the Board Advisory page of the Contra Costa County website – or type in this link to your web browser: http://contra.napanet.net/maddybook/

County calls on locals in disaster plan

Mitigation plan could lead to federal funding for work such as retrofitting

By Robert Salonga
rsalonga@bayareanewsgroup.com

MARTINEZ — County emergency planners will hold the first of four public meetings Wednesday as they put together a plan to be ready for the next earthquake, flood or other large-scale natural disaster.

Among the scenarios that will be covered in the plan is a magnitude 7.1 earthquake along the Hayward Fault, which officials estimate could cause $3.5 billion in damage and displace people in about 1,300 Contra Costa households.

Agencies including the county Office of Emergency Services and the county Flood Control District are spearheading the meetings and formation of the Countywide Multi-Hazard Mitigation Plan. Once completed, the plan will identify potential disaster zones and suggest ways to prepare buildings and the people who lived in them.

In advance of the public meetings, the county has produced computer-generated models of fault lines, flood zones and areas prone to wildfires, which will be put on display. But officials hope that people who come to the meetings can offer firsthand knowledge of potential disaster areas that have not been identified by county software.

"There might be an area that isn't on our map, and a person can say, 'We get flooded every year,'" said Rich Lierly, flood plain and watershed manager for the Flood Control District.

If all goes according to plan, the efforts could be backed with federal dollars: Completion of the new mitigation plan would make the county eligible for funding from the Federal Emergency Management Agency for projects like retrofitting buildings or helping defray the cost of flood damage.

Susan Roseberry, emergency planning coordinator for the county OES, said BART's mitigation plans made it eligible for more than $1 million in FEMA funding that the transit agency used to retrofit the Rockridge and Fruitvale stations.

The public meetings and formation of the disaster plan is funded by a FEMA grant and a 20 percent matching contribution from the county, totaling about $250,000.

Reach Robert Salonga at 925-943-8013.

MEETING DATES

Public meetings gathering input for the countywide multi-hazard mitigation plan will be held from 6 p.m. to 9 p.m. at the following dates and locations:

- Wednesday, Central Contra Costa Sanitary District multipurpose room, 5019 Imhoff Place, Martinez
- Thursday, Council Chamber/Community Center, 880 Tennent Ave., Pinole
- Aug. 11, San Ramon Community Center, 12501 Alcosta Blvd., San Ramon
- Aug. 13, Antioch Police Department community room, 300 L St., Antioch

CENTRAL COUNTY
CONTRA COSTA TIMES
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Bureaucratic morass could expand flood plain

Change might force more property owners to purchase insurance

By Matthias Gafni
STAFF WRITER

About 200 homeowners in unincorporated Contra Costa County received courtesy letters last month recommending they buy flood insurance — even though they do not live in a flood plain.

What gives? A federal agency messed up its maps, according to a county report.

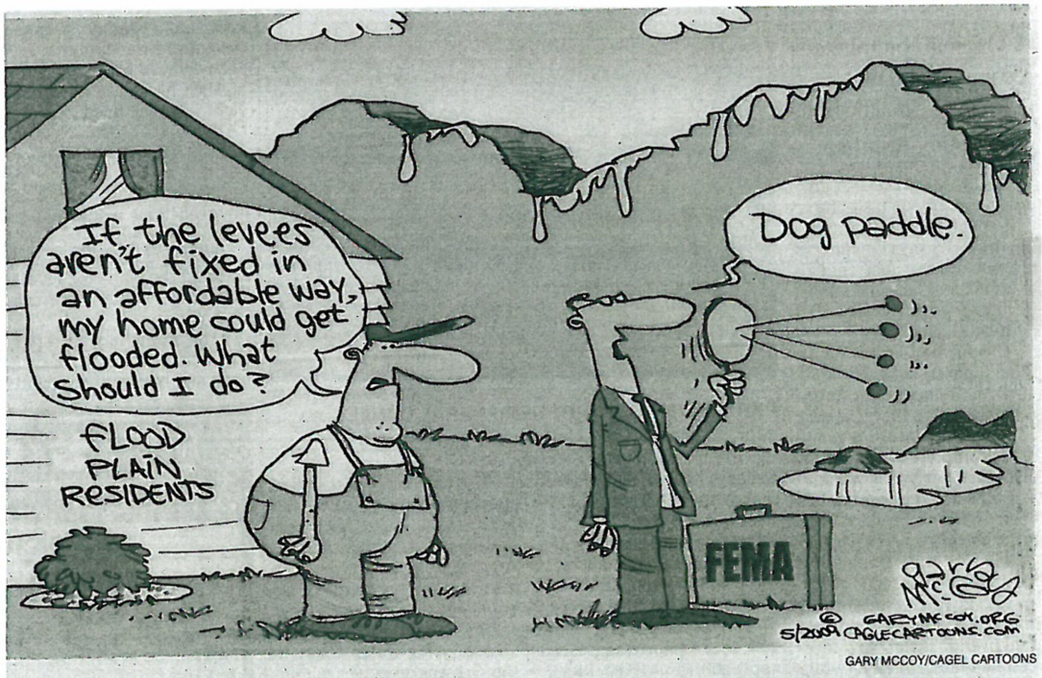
The Federal Emergency Management Agency will also begin enforcing strict levee guidelines that could put all of North Richmond in a federal flood plain, forcing homeowners to buy costly flood insurance.

See FLOODS, Page 4

Broader flood plain?

North Richmond homeowners may need to buy flood insurance as Contra Costa County has concerns that levees near Wildcat and San Pablo creeks will not satisfy FEMA standards.

DAVE JOHNSON/STAFF



GARY MCCOY/CAGEL CARTOONS

Floods

FROM PAGE 3

FEMA's not just for hurricane country, evidently: Nearly four years after Hurricane Katrina, Contra Costa and other local jurisdictions, far from any hurricane eyes, are still dealing with the bureaucratic storm surge.

Two deadlines fast approach:

- On June 16, new digital maps outlining federal flood plains will be finalized.
- On July 24, owners must certify levees on those maps at strict federal standards.

Contra Costa supervisors will hear a report on the implications today. The county is dealing only with unincorporated areas, but all counties and cities nationwide must hit deadlines or face repercussions.

Rich Lierly, Contra Costa's flood plain manager, said he was shocked when reviewing FEMA's recent conversion from paper to digital maps, which show parcel-by-parcel details.

About 1,000 properties — a couple hundred with buildings affected — were added to the flood plain by mistake, with some map boundaries off by 100 feet, Lierly said. In Port Costa, for example, hillside homes were mapped within the flood plain.

"It doesn't take an engineer to see that that's not going to happen," Lierly said. "They are putting a guy in the flood plain who can see his neighbor two feet below him who's out of the flood plain."

By federal law, a homeowner with a federally backed mortgage on a house in a high-risk flood plain must buy flood insurance. The county sent courtesy letters to affected homeowners, recommending they buy flood insurance before the June 16 deadline in order to get coverage at a lower cost, about $400 a year. Wait until after the deadline, Lierly said, and a homeowner may have to pay several thousand dollars.

"Whether you're in a flood plain or not has significant ramifications in your property," including permit costs and lower property values, Lierly said.

Eric Simmons, a senior FEMA engineer, said the deadline is firm, but his agency will work to update the maps.

"I've been working with Contra Costa County and I'm aware of their concerns in some areas, but I'm not in a position to say maps will change when I haven't seen the data yet," he said.

Maps aside, the North Richmond community near Wildcat and San Pablo creeks could become a federal flood plain. In 1993, a flood control project widened creek channels, created levees and restored habitat, prompting FEMA to remove the low-lying community from its flood plain. Now, with levee certification forcing higher standards on those improvements, the area could be redesignated as a federal flood plain.

Timing is one problem. Contra Costa will likely miss the July 24 deadline to certify those levees because the state's budget crisis has frozen a $500,000 grant.

But even if tested, the levees most likely will not meet FEMA regulations, Lierly said. A lack of federal funding for maintenance over time has caused those creeks to lose capacity because of sediment accumulation and additional vegetation.

"(FEMA is) black-and-white with levees. There is no gray," he said. "The writing is kind of on the wall ... Probably all of North Richmond will be added in."

Some East County levees will also probably fail to meet FEMA standards, which were established in 1986, Lierly said, but those protect mostly agricultural areas.

As for funding levee repair and certification, Lierly said he has no answers.

"There's no free lunch," Lierly said. "It's all very expensive stuff."

Lierly is penning a letter to all the county's city managers alerting them of the issues.

"The county has a very active flood plain management program. Some cities do have it and some don't. Many just don't have the staffing," he said.

If the federal mapping and levee certifications were not harrowing enough, Lierly said a federal study on rising sea levels is expected in the next couple years that could completely change all flood protection data and levee requirements.

"Who's to say we're not flushing all this money down the toilet?"

Reach Matthias Gafni at 925-952-5053 or mgafni@bayareanewsgroup.com.

Uploaded: Wednesday, August 5, 2009, 12:55 PM

SAN RAMON express

County wants input on hazard mitigation plan

Public meetings will inform about potential disasters

by Geoff Gillette

Officials from the Contra Costa County Office of Emergency Services will be in San Ramon next week to talk to area residents about a countywide plan designed to deal with potential natural disasters.

"We're going to have earthquake maps so the public can look at the map and see where their home is in proximity to fault lines. Also where they are in proximity to flood zones," said Emergency Planning Coordinator Susan Roseberry.

"We're in the process of updating our current mitigation plan so we're looking at strategies for strengthening the infrastructure."

Roseberry said the countywide effort is designed to provide residents with an awareness of the potential hazards in the area and also to garner input on how the county can best be prepared as well.

"We want to get the public aware of the hazards that surround them here in the county and provide them with methods of strengthening their homes and mitigating some of these hazards," she stated.

The county, 13 cities and 27 special purpose districts are working with a consultant to either create a new mitigation plan or update their current one.

Four public meetings have been set up around the county. Danville residents are encouraged to attend the Aug. 11 meeting in the San Ramon Community Center from 6-9 p.m.

Funding for the plan comes from a grant from the Federal Emergency Management Agency. The grant is designed to help the county develop a multi-hazard mitigation plan. The plan will enable the county and the cities to take steps to help reduce or eliminate long-term risks to life, property and the environment.

Contra Costa County currently has a plan, but in order to get money from Federal Emergency Management Agency, the plan must be updated and the cities and the state must also must have their own mitigation plans as well.

Roseberry said the most recent iteration of the mitigation plan for the county was written in 2007. She added that some aspects of the plan, such as potential flood zones, have changed and that needs to be accounted for in the new plan.

According to the Office of Emergency Services, an earthquake on the Hayward-Rodgers fault measuring 7.1 could cause $3.5 billion in damages to structures and their contents and displace almost 1,300 households in Contra Costa County.

Roseberry said that making people aware of the dangers is one step toward getting residents to take the necessary steps to make their houses safer and more resistant to natural disaster.

"We're trying to make our county more resilient in the case of a natural hazard," she explained. "It's better to mitigate before an event than after."

Once the meetings are completed, the county will continue to work on its plan. Roseberry said the plan must be approved by the Contra Costa County Board of Supervisors, California Emergency Management Agency and FEMA. Once approved, the county, cities and specials districts will have access to FEMA funds in the case of a disaster.

1. Where in Contra Costa County do you live?

	Response Percent	Response Count
Antioch	4.7%	21
Brentwood	4.2%	19
Clayton	4.4%	20
Concord	9.1%	41
Danville	6.2%	28
El Cerrito	2.0%	9
Hercules	0.9%	4
Lafayette	6.4%	29
Martinez	**9.6%**	**43**
Moraga	5.1%	23
Oakley	2.9%	13
Orinda	7.6%	34
Pinole	1.8%	8
Pittsburg	2.9%	13

Pleasant Hill	4.4%	20
Richmond	1.6%	7
San Pablo	0.4%	2
San Ramon	3.1%	14
Walnut Creek	8.9%	40
Unincorporated County	4.9%	22
Other (please specify)	8.9%	40
	answered question	**450**
	skipped question	**0**

2. Do you work in Contra Costa County?

	Response Percent	Response Count
Yes	**67.0%**	**288**
No	33.0%	142
	answered question	**430**
	skipped question	**20**

3. Which of the following natural hazard events have you or has anyone in your household experienced in the past 20 years within Contra Costa County? (Check all that apply)

	Response Percent	Response Count
Dam Failure	0.5%	2
Drought	44.9%	199
Earthquake	**76.3%**	**338**
Flood	12.4%	55
Hazardous Materials	12.4%	55
Household Fire	9.5%	42
Landslide	7.7%	34
Severe Weather (wind, lightning, winter storm, etc.)	34.8%	154
Wildland Fire	12.9%	57
None	11.7%	52
Other (please specify)	2.9%	13
	answered question	**443**
	skipped question	**7**

4. How prepared is your household is to deal with a natural hazard event?

	Not at all prepared	Somewhat prepared	Adequately prepared	Well prepared	Very well prepared	Rating Average	Response Count
Check one:	8.5% (35)	**50.7% (210)**	25.4% (105)	11.8% (49)	3.6% (15)	2.51	414
						answered question	**414**
						skipped question	**36**

5. Which of the following have provided you with useful information to help you be prepared? (Check all that apply)	Response Percent	Response Count
Emergency preparedness information from a government source (e.g., federal, state, or local emergency management)	**65.4%**	**261**
Have experienced one or more natural hazards or disasters	39.8%	159
Locally provided news or other media information	45.9%	183
Schools and other academic institutions	14.3%	57
Attended meetings that have dealt with disaster preparedness	41.4%	165
Community Emergency Response Training (CERT)	40.1%	160
Other (please specify)	12.0%	48
	answered question	**399**
	skipped question	**51**

6. Which of the following steps has your household taken to prepare for a natural hazard event? (Check all that apply)

	Response Percent	Response Count
Received first aid/CPR training	62.2%	255
Made a fire escape plan	43.2%	177
Designated a meeting place	36.8%	151
Identified utility shutoffs	67.6%	277
Prepared a disaster supply kit	48.8%	200
Installed smoke detectors on each level of the house	**86.8%**	**356**
Stored food and water	67.1%	275
Stored flashlights and batteries	76.1%	312
Stored a battery-powered radio	57.8%	237
Stored a fire extinguisher	67.8%	278
Stored medical supplies (first aid kit, medications)	63.7%	261
Other (please specify)	12.9%	53
	answered question	**410**
	skipped question	**40**

7. How concerned are you about the following natural hazards in Contra Costa County? (Check one response for each hazard)

	Not Concerned	Somewhat Concerned	Concerned	Very Concerned	Extremely Concerned	Rating Average	Response Count
Dam Failure	**68.8% (271)**	17.0% (67)	9.9% (39)	3.3% (13)	1.0% (4)	1.51	394
Drought	11.5% (46)	21.3% (85)	**36.0% (144)**	24.5% (98)	6.8% (27)	2.94	400
Earthquake	2.9% (12)	10.9% (45)	27.9% (115)	**31.8% (131)**	26.5% (109)	3.68	412
Flood	**45.0% (177)**	26.5% (104)	19.1% (75)	6.1% (24)	3.3% (13)	1.96	393
Hazardous Materials	19.1% (77)	28.0% (113)	**29.8% (120)**	14.6% (59)	8.4% (34)	2.65	403
Household Fire	14.2% (57)	27.4% (110)	**29.9% (120)**	19.2% (77)	9.5% (38)	2.82	402
Landslide	**46.2% (184)**	27.9% (111)	15.1% (60)	8.5% (34)	2.3% (9)	1.93	398
Severe Weather	26.8% (106)	**33.2% (131)**	27.3% (108)	8.6% (34)	4.1% (16)	2.30	395
Wildland Fire	20.2% (80)	**22.7% (90)**	21.4% (85)	20.7% (82)	15.1% (60)	2.88	397
Other	**46.0% (23)**	6.0% (3)	18.0% (9)	10.0% (5)	20.0% (10)	2.52	50
						(Please specify other natural hazard)	27
						answered question	**414**
						skipped question	**36**

8. Which of the following methods do you think are most effective for providing information on emergency management? (Check all that apply)

	Response Percent	Response Count
Newspaper	50.7%	210
Telephone Book	15.5%	64
Informational Brochures	48.3%	200
City Newsletters	44.0%	182
Public Meetings	34.8%	144
Workshops	37.4%	155
Schools	38.4%	159
TV News	59.9%	248
TV Ads	33.1%	137
Radio News	46.9%	194
Radio Ads	25.8%	107
Internet	**64.0%**	**265**
Outdoor Advertisements	16.9%	70
Fire Department/Rescue	32.6%	135
Church (faith-based institutions)	18.6%	77
CERT Classes	46.6%	193

Public Awareness Campaign (e.g., Flood Awareness Week, Winter Storm Preparedness Month)	52.7%	218
Books	8.9%	37
Chamber of Commerce	8.7%	36
Academic Institutions	9.4%	39
Public Library	23.9%	99
Red Cross Information	33.8%	140
Community Safety Fairs	42.8%	177
Other (please specify)	5.6%	23
	answered question	**414**
	skipped question	**36**

9. Is your property located in or near a FEMA designated floodplain?

	Response Percent	Response Count
Yes	7.2%	30
No	**61.8%**	**256**
Not Sure	30.9%	128
	answered question	**414**
	skipped question	**36**

10. Do you have flood insurance?

	Response Percent	Response Count
Yes	9.9%	41
No	**90.1%**	**373**
	answered question	**414**
	skipped question	**36**

11. Is your property located near an earthquake fault?

	Response Percent	Response Count
Yes	**65.2%**	**270**
No	13.5%	56
Not Sure	21.3%	88
	answered question	**414**
	skipped question	**36**

12. Do you have earthquake insurance?

	Response Percent	Response Count
Yes	26.8%	111
No	**73.2%**	**303**
	answered question	**414**
	skipped question	**36**

13. Is your property located in an area at risk for wild fires?

	Response Percent	Response Count
Yes	32.6%	135
No	**46.9%**	**194**
Not Sure	20.5%	85
	answered question	**414**
	skipped question	**36**

14. Have you ever had problems getting homeowners or renters insurance due to risks from natural hazards?

	Response Percent	Response Count
Yes	6.3%	26
No	**93.7%**	**385**
	If "yes," what natural hazard was the cause of the problem?	18
	answered question	**411**
	skipped question	**39**

15. When you moved into your home, did you consider the impact a natural disaster could have on your home?

	Response Percent	Response Count
Yes	**51.1%**	**207**
No	48.9%	198
	answered question	**405**
	skipped question	**45**

16. Was the presence of a natural hazard risk zone (e.g., dam failure zone, flood zone, landslide hazard area, high fire risk area) disclosed to you by a real estate agent, seller, or landlord before you purchased or moved into your home?

	Response Percent	Response Count
Yes	33.6%	136
No	**66.4%**	**269**
	answered question	**405**
	skipped question	**45**

17. Would the disclosure of this type of information influence your decision to purchase or move into a home?

		Response Percent	Response Count
Yes		**79.8%**	**323**
No		20.2%	82
		answered question	**405**
		skipped question	**45**

18. How much money would you be willing to spend to retrofit your home to reduce risks associated with natural disasters? (for example, by elevating a structure above the flood level, performing seismic upgrades, or replacing a combustible roof with non-combustible roofing)

		Response Percent	Response Count
$10,000 or above		18.0%	73
$5,000 to $9,999		15.3%	62
$1,000 to $4,999		15.8%	64
Less than $1,000		10.6%	43
Nothing		8.1%	33
Don't Know		**32.1%**	**130**
		answered question	**405**
		skipped question	**45**

19. Which of the following incentives would encourage you to spend money to retrofit your home to protect against natural disasters? (Check all that apply)

	Response Percent	Response Count
Building permit fee waiver	52.3%	212
Insurance premium discount	72.1%	292
Mortgage discount	49.4%	200
Property tax break or incentive	**78.0%**	**316**
Low interest rate loan	49.1%	199
Grant funding	59.5%	241
None	5.7%	23
Other (please specify)	7.2%	29
	answered question	**405**
	skipped question	**45**

20. If your property were located in a designated "high hazard" area, or had received repetitive damages from a natural hazard event, would you consider a "buyout" offered by a public agency?

		Response Percent	Response Count
Yes		**76.8%**	**291**
No		23.2%	88
		answered question	**379**
		skipped question	**71**

21. Please indicate how you feel about the following statement: It is the responsibility of government (local, state and federal) to provide education and programs that promote citizen actions that will reduce exposure to the risks associated with natural hazards.

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Rating Average	Response Count
Choose one:	6.7% (27)	10.4% (42)	8.4% (34)	**39.0% (157)**	35.5% (143)	3.86	403
						answered question	**403**
						skipped question	**47**

22. Please indicate your age range:

	Response Percent	Response Count
18 to 30	5.3%	21
31 to 40	14.1%	56
41 to 50	19.8%	79
51 to 60	28.9%	115
61 or older	**31.9%**	**127**
	answered question	**398**
	skipped question	**52**

23. Please indicate the primary language spoken in your household.

	Response Percent	Response Count
English	**98.0%**	**391**
Spanish	1.0%	4
Other Indo-European Language	0.0%	0
Asian and Pacific Island Languages	1.0%	4
Other (please specify)	0.0%	0
	answered question	**399**
	skipped question	**51**

24. Please indicate your gender:

	Response Percent	Response Count
Male	42.6%	169
Female	**57.4%**	**228**
	answered question	**397**
	skipped question	**53**

25. Please indicate your highest level of education.

	Response Percent	Response Count
Grade school/No schooling	0.0%	0
Some high school	0.5%	2
High school graduate/GED	4.3%	17
Some college/Trade school	22.6%	90
College degree	**43.4%**	**173**
Post-graduate degree	28.8%	115
Other (please specify)	0.5%	2
	answered question	**399**
	skipped question	**51**

26. How long have you lived in Contra Costa County?

	Response Percent	Response Count
Less than 1 year	1.0%	4
1 to 5 years	7.1%	28
6 to 10 years	11.6%	46
11 to 20 years	16.9%	67
More than 20 years	**63.4%**	**251**
	answered question	**396**
	skipped question	**54**

27. Do you own or rent your place of residence?

	Response Percent	Response Count
Own	**92.4%**	**366**
Rent	7.6%	30
	answered question	**396**
	skipped question	**54**

28. How much is your gross household income?

	Response Percent	Response Count
$20,000 or less	1.9%	7
$20,001 to $49,999	14.1%	51
$50,000 to $74,999	16.1%	58
$75,000 to $99,999	16.1%	58
$100,000 or More	**51.8%**	**187**
	answered question	**361**
	skipped question	**89**

29. Do you have access to the Internet?

	Response Percent	Response Count
Yes	**96.7%**	**381**
No	3.3%	13
	answered question	**394**
	skipped question	**56**

30. Comments

	Response Count
	75
answered question	**75**
skipped question	**375**

Contra Costa County
Hazard Mitigation Plan Update

APPENDIX C.
EXAMPLE PROGRESS REPORT

July 2011

APPENDIX C.
EXAMPLE PROGRESS REPORT

Contra Costa County
Hazard Mitigation Plan
Annual Progress Report

Reporting Period: *(Insert reporting period)*

Background: Contra Costa County and participating cities and special purpose districts in the county developed a hazard mitigation plan to reduce risk from all hazards by identifying resources, information, and strategies for risk reduction. The federal Disaster Mitigation Act of 2000 requires state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. To prepare the plan, the participating partners organized resources, assessed risks from natural hazards within the county, developed planning goals and objectives, reviewed mitigation alternatives, and developed an action plan to address probable impacts from natural hazards. By completing this process, these jurisdictions maintained compliance with the Disaster Mitigation Act, achieving eligibility for mitigation grant funding opportunities afforded under the Robert T. Stafford Act. The plan can be viewed on-line at:

http://www.co.contra-costa.ca.us/index.aspx?NID=2302

Summary Overview of the Plan's Progress: The performance period for the Hazard Mitigation Plan became effective on ____, 2011, with the final approval of the plan by FEMA. The initial performance period for this plan will be 5 years, with an anticipated update to the plan to occur before ______, 2016. As of this reporting period, the performance period for this plan is considered to be __% complete. The Hazard Mitigation Plan has targeted __ hazard mitigation initiatives to be pursued during the 5-year performance period. As of the reporting period, the following overall progress can be reported:

- __ out of __ initiatives (__%) reported ongoing action toward completion.
- __ out of __ initiatives (__%) were reported as being complete.
- __ out of __ initiatives (___%) reported no action taken.

Purpose: The purpose of this report is to provide an annual update on the implementation of the action plan identified in the Contra Costa County Hazard Mitigation Plan. The objective is to ensure that there is a continuing and responsive planning process that will keep the Hazard Mitigation Plan dynamic and responsive to the needs and capabilities of the partner jurisdictions. This report discusses the following:

- Natural hazard events that have occurred within the last year
- Changes in risk exposure within the planning area (all of Contra Costa County)
- Mitigation success stories
- Review of the action plan
- Changes in capabilities that could impact plan implementation
- Recommendations for changes/enhancement.

The Hazard Mitigation Plan Steering Committee: The Hazard Mitigation Plan Steering Committee, made up of planning partners and stakeholders within the planning area, reviewed and approved this progress report at its annual meeting held on _____, 201_. It was determined through the plan's development process that a steering committee would remain in service to oversee maintenance of the plan. At a minimum, the Steering Committee will provide technical review and oversight on the development of the annual progress report. It is anticipated that there will be turnover in the membership annually, which will be documented in the progress reports. For this reporting period, the Steering Committee membership is as indicated in Table 1.

**TABLE 1.
STEERING COMMITTEE MEMBERS**

Name	Title	Jurisdiction/Agency

Natural Hazard Events within the Planning Area: During the reporting period, there were __ natural hazard events in the planning area that had a measurable impact on people or property. A summary of these events is as follows:

- ____________________________
- ____________________________

Changes in Risk Exposure in the Planning Area: *(Insert brief overview of any natural hazard event in the planning area that changed the probability of occurrence or ranking of risk for the hazards addressed in the hazard mitigation plan)*

Mitigation Success Stories: *(Insert brief overview of mitigation accomplishments during the reporting period)*

Review of the Action Plan: Table 2 reviews the action plan, reporting the status of each initiative. Reviewers of this report should refer to the Hazard Mitigation Plan for more detailed descriptions of each initiative and the prioritization process.

Address the following in the "status" column of the following table:

- *Was any element of the initiative carried out during the reporting period?*
- *If no action was completed, why?*
- *Is the timeline for implementation for the initiative still appropriate?*
- *If the initiative was completed, does it need to be changed or removed from the action plan?*

TABLE 2.
ACTION PLAN MATRIX

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O,✓)
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				

**TABLE 2.
ACTION PLAN MATRIX**

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O,✓)
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
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Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				

Completion status legend:
- ✓= Project Completed
- O = Action ongoing toward completion
- X = No progress at this time

Changes That May Impact Implementation of the Plan: *(Insert brief overview of any significant changes in the planning area that would have a profound impact on the implementation of the plan. Specify any changes in technical, regulatory and financial capabilities identified during the plan's development)*

Recommendations for Changes or Enhancements: Based on the review of this report by the Hazard Mitigation Plan Steering Committee, the following recommendations will be noted for future updates or revisions to the plan:

- ______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________

Public review notice: *The contents of this report are considered to be public knowledge and have been prepared for total public disclosure. Copies of the report have been provided to the governing boards of all planning partners and to local media outlets and the report is posted on the Contra Costa County Hazard Mitigation Plan website. Any questions or comments regarding the contents of this report should be directed to:*

Insert Contact Info Here

APPENDIX D. PLAN ADOPTION RESOLUTIONS FROM PLANNING PARTNERS

July 2011

APPENDIX D.
PLAN ADOPTION RESOLUTIONS FROM PLANNING PARTNERS

To Be Provided With Final Release