TEHAMA COUNTY CALIFORNIA

Hazard Mitigation Plan

Volume 1: Planning-Area-Wide Elements

April 2012

TETRA TECH

Tehama County

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

DRAFT

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Tehama County
Hazard Mitigation Plan;
Volume 1—Planning-Area-Wide Elements

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The Disaster Mitigation Act (DMA) is federal legislation that promotes 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. It established a Pre-Disaster Mitigation Program and new requirements for the national post-disaster Hazard Mitigation Grant Program (HMGP).

The DMA encourages state and local authorities to work together on pre-disaster planning, and it promotes sustainability as a strategy for disaster resistance. Sustainable hazard mitigation 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 government's articulate accurate needs for mitigation, resulting in faster allocation of funding and more cost-effective risk-reduction projects.

A planning partnership made up of Tehama County and local government planning partners worked together to create the Tehama County Hazard Mitigation Plan, fulfilling the DMA requirements for all participating partners. This effort was funded by an HMGP grant from the Federal Emergency Management Agency (FEMA), administered by the California Emergency Management Agency (CalEMA).

PLAN PURPOSE

Several factors initiated this planning effort for Tehama County and its planning partners:

- The Tehama County area has significant exposure to numerous natural hazards that have caused millions of dollars in past damage.
- The partners want to be proactive in preparedness for the probable impacts of natural hazards.
- Limited local resources make it difficult to implement proactive risk-reduction measures. Federal financial assistance is paramount to successful hazard mitigation in the area.

PLAN DEVELOPMENT METHODOLOGY

Tehama County committed to a planning process to comply with multiple program requirements by attaining grant funding, establishing a planning partnership, and securing technical assistance. Development of the Tehama County Hazard Mitigation Plan included seven phases:

- **Phase 1, Organize Resources**—Grant funding was secured to fund the effort, a planning partnership was formed, and a steering committee was assembled to oversee development of the plan. A public involvement strategy was implemented, centered on a hazard preparedness questionnaire and a program website. This phase included coordination with local, state and federal agencies involved in hazard mitigation, and a review of existing programs that support hazard mitigation actions.
- **Phase 2, Hazard Identification and Profiling; Phase 3, Asset Inventory and Vulnerability Analysis (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. Phase 2 occurred simultaneously with Phase 1, with the two efforts using information generated by one another to create the best possible regionally applicable risk assessment.

- **Phase 4, Develop Mitigation Initiatives**—This phase included development of a guiding principle, goals and measurable objectives; review of mitigation alternatives to create a catalog of actions; development of a benefit/cost review methodology to use for prioritizing actions; ranking of risk to support prioritization of actions; review of jurisdiction-specific capabilities; identification of actions; and prioritization of the identified actions.
- **Phase 5, Prepare Draft Plan**—Key information from Phases 1 and 2 was assembled into a document to that meets DMA requirements. The document was produced in two volumes: Volume 1 including all information that applies to the entire planning area; and Volume 2, including jurisdiction-specific information.
- **Phase 6, Plan Review and Revision**—The draft plan was circulated to planning partners, stakeholders, and agencies to solicit comment on the identified actions. The plan was presented to the public for review and comment via the public involvement strategy developed under Phase 1. A pre-adoption review draft of the plan was prepared along with a DMA compliance "crosswalk," which was submitted to CalEMA for review and approval. After determining that the plan is compliant with federal requirements, CalEMA they will forward the plan to FEMA Region IX for approval.
- **Phase 7, Plan Adoption and Submittal**—The final adoption phase begins after pre-adoption approval has been granted by CalEMA and FEMA. Each planning partner will be required to adopt the plan according to its formal adoption protocol. The planning team will provide support in the form of model resolutions and presentation materials

THE PLANNING PARTNERSHIP

A planning partnership was assembled consisting of Tehama County, three incorporated cities and five special purpose districts defined as "local governments" under the DMA. This partnership represents approximately 35 percent of the eligible local governments in the planning area. Of these planning partners, six completed all required phases of the hazard mitigation plan's development. Individual annexes for those six partners are included in Volume 2 of the plan. Jurisdictions not covered can link to this plan at a future date by following procedures identified in Appendix B of Volume 2.

MITIGATION GUIDING PRINCIPLE, GOALS AND OBJECTIVES

The following guided the steering committee and the planning partnership in selecting the initiatives contained in this plan:

- **Guiding Principle—**Through partnerships, reduce the vulnerability to natural hazards in order to protect the health, safety, welfare and economy of the residents and communities within Tehama County.
- **Goals**
  - Protect life, property and the environment.
  - Promote public awareness and education.
  - Build and support local capacity to enable the public to mitigate, prepare for, respond to and recover from the impact of hazards and disasters.
  - Improve cooperation and coordination of all stakeholders.
  - Encourage the development and implementation of long-term, cost-effective, environmentally conscious mitigation practices.

- **Objectives—**Nine objectives were identified to help establish priorities, each addressing multiple goals:
  - 1. Increase resilience of (or protect and maintain) infrastructure and critical facilities.
  - 2. Educate the public on the risk from natural hazards and increase awareness, preparation, mitigation, response and recovery activities.
  - 3. Establish partnerships among government, businesses and communities to improve and implement methods to protect property.
  - 4. Encourage hazard mitigation measures that minimize adverse effect on the natural environment.
  - 5. Maintain and make available maps of identified risk areas.
  - 6. Encourage coordination between participating jurisdictions and adjoining communities.
  - 7. Develop or improve early warning emergency response systems and evacuation procedures.
  - 8. Consider the impacts of natural hazards in all planning mechanisms that address current and future land uses within the planning area.
  - 9. Support and encourage mitigation measures for homeowners in high-risk areas.

MITIGATION INITIATIVES

For the purposes of this document, mitigation initiatives are defined as activities designed to reduce or eliminate losses resulting from natural hazards. The mitigation initiatives are the key element of the hazard mitigation plan. It is through the implementation of these initiatives that the planning partnership can strive to become disaster-resistant.

Although one of the driving influences for preparing this plan was grant funding eligibility, its purpose is more than just access to federal funding. 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—grant eligibility was not the focus of the selection. Rather, the focus was the initiatives' effectiveness in achieving the goals of the plan and whether they are within each jurisdiction's capabilities.

This planning process resulted in the identification of mitigation actions to be targeted for implementation by each planning partner, as presented in Volume 2 of this plan. In addition, seven countywide initiatives were identified. These are initiatives that benefit the whole partnership, to be implemented by pooling resources based on capability. These initiatives are summarized in Table ES-1.

CONCLUSION

Full implementation of the recommendations of this plan will take time and resources. The measure of the plan's success will be the coordination and pooling of resources within the planning partnership. Keeping this coordination and communication intact will be the key to the successful implementation of this plan. Teaming together to seek financial assistance at the state and federal level will be a priority to initiate projects that are dependent on alternative funding sources. This plan was built upon the effective leadership of a multi-disciplined steering committee and a process that relied heavily on public input and support. The plan will succeed for the same reasons.

TABLE ES-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 countywide hazard mitigation plan website to house the plan and plan updates, in order to provide the public an opportunity to monitor plan implementation and progress. Each planning partner may support the initiative by including an initiative in its action plan and creating a web link to the website.				
All Hazards	County Public Works	General Fund	Short term/ongoing	2, 3, 6, 9
CW-2—Leverage public outreach partnering capabilities to inform and educate the public about hazard mitigation and preparedness.				
All Hazards	Sheriff's Office, County Public Works	General Fund	Short term/ongoing	2, 3, 6, 9
CW-3—Coordinate all mitigation planning and project efforts, including grant application support, to maximize all resources available to the planning partnership.				
All Hazards	Sheriff's Office	General Fund, FEMA mitigation grants	Short term/ongoing	1, 2, 3, 4, 5, 6, 7, 8, 9
CW-4—Support the collection of improved data (hydrologic, geologic, topographic, volcanic, historical, etc.) to better assess risks and vulnerabilities.				
All Hazards	Sheriff's Office, County Public Works	General Fund, FEMA mitigation grants	Short term/ongoing	2, 3, 5, 6
CW-5—Provide coordination and technical assistance in grant application preparation that includes assistance in cost vs. benefit analysis for grant-eligible projects.				
All Hazards	Sheriff's Office	General Fund, FEMA mitigation grants	Short term/ongoing	3, 6
CW-6—Where appropriate, support retrofitting, purchase, or relocation of structures or infrastructure located in hazard-prone areas to protect structures/infrastructure from future damage, with repetitive loss and severe repetitive loss properties as priority when applicable.				
All Hazards	County Public Works	FEMA mitigation grants	Long term	1, 3, 4, 6, 9
CW-7— Continue to maintain the steering committee as a viable committee to monitor the progress of the hazard mitigation plan, provide technical assistance to planning partners and oversee the update of the plan as necessary.				
All Hazards	County Public Works	General Fund	Short term/ongoing	3, 6

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 Purposes for Planning

This hazard mitigation plan identifies resources, information, and strategies for reducing risk from natural hazards. Several factors initiated this planning effort by Tehama County and the local jurisdictions that participated as planning partners:

- The Tehama County area has significant exposure to numerous natural hazards that have caused millions of dollars in past damage.
- The partners want to be proactive in preparedness for the probable impacts of natural hazards.
- Limited local resources make it difficult to implement proactive risk-reduction measures. Federal financial assistance is paramount to successful hazard mitigation in the area.

Elements and strategies in the plan were selected because they best meet the needs of the planning partners and their citizens. 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 Tehama 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.
- 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?

A benefit 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. The plan will help guide and coordinate mitigation activities throughout Tehama County.

All citizens and businesses of Tehama 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

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 includes all federally required elements of a hazard mitigation plan 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 1 includes the following appendices:
  - 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
- **Volume 2**—Volume 2 includes all federally required jurisdiction-specific elements, in annexes for each participating jurisdiction. It describes participation requirements established by the steering committee, and includes instructions and templates that the partners used to complete their annexes. Volume 2 presents "linkage" procedures for eligible jurisdictions that did not participate in development of this plan 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.

CHAPTER 2.
PLANNING METHODOLOGY

To develop the Tehama County Hazard Mitigation Plan, 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.

These objectives are discussed in the following sections.

2.1 GRANT FUNDING

This planning effort was supplemented by a Hazard Mitigation Grant Program (HMGP) grant from FEMA. Tehama County was the applicant agent for the grant. The grant was applied for in 2008 and funding was appropriated in 2009. It covered 75 percent of the cost for development of this plan; the County and its planning partners covered the balance through in-kind contributions.

2.2 FORMATION OF THE PLANNING TEAM

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

- Gary Antone, Tehama County Project Manager
- Rob Flaner, Tetra Tech (Lead Project Planner)
- Laura Hendrix, Tetra Tech (Public Policy Lead)
- Ed Whitford, Tetra Tech (GIS/HAZUS lead)
- Dan Portman**,** Tetra Tech (Technical Editor)

2.3 ESTABLISHMENT OF THE PLANNING PARTNERSHIP

Tehama County recognized that disasters are not always contained within jurisdictional boundaries and therefore opened the planning effort to all eligible local governments within the County. The planning team made a presentation at a stakeholder meeting on July 29, 2010 to introduce the mitigation planning process and solicit planning partners. Key meeting objectives were as follows:

- Provide an overview of the Disaster Mitigation Act.

- Describe the reasons for a plan.
- 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. Linkage procedures have been established (see Volume 2 of this plan) for any jurisdiction wishing to link to the Tehama County plan in the future. The planning partners covered under this plan are shown in Table 2-1.

TABLE 2-1.
PLANNING PARTNERS

Jurisdiction	Point of Contact	Title
Tehama County Public Works	Gary Antone	Director of Public Works
City of Corning	Martin Spannaus	Fire Chief
City of Red Bluff	Michael Bachmeyer	Fire Chief
City of Tehama	Carolyn Steffan	City Administrator/City Clerk
Capay Fire Protection District	Ian Turnbull	Fire Chief
Tehama County Department of Education	Amy Schutter	Director of Student Support Services
Corning Union High School District	Amy Schutter	—
Gerber Union School District	Rod Stone	Superintendent/Principal
Red Bluff Joint Union High School District	Joe Kittle	Director of Maintenance, Operations and Transportation
Tehama County Health Services Agency	Valerie Lucero	Public Health Nurse

2.4 DEFINING THE PLANNING AREA

The planning area is contiguous with the Tehama County boundary. All partners to this plan have jurisdictional authority over specific locations within this planning area.

2.5 THE STEERING COMMITTEE

Hazard mitigation planning enhances collaboration and support among diverse parties whose interests can be affected by hazard losses. A steering committee was formed to oversee all phases of the plan. 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 at the kickoff meeting. Leadership roles and ground rules were established during the steering committee's initial meeting on October 21, 2010. Table 2-2 lists the committee members.

**TABLE 2-2.
STEERING COMMITTEE MEMBERS**

Name	Title	Jurisdiction/Agency	Representing
Gary Antone	Director of Public Works	Tehama County Public Works	Planning partner
Martin Spannaus	Fire Chief	City of Corning	Planning partner
Michael Bachmeyer	Fire Chief	City of Red Bluff	Planning partner
Carolyn Steffan	City Administrator/City Clerk	City of Tehama	Planning partner
Dennis Garton	Supervisor	Tehama County Board of Supervisors	Planning partner
Amy Henderson	Director of Student Support Services	Tehama County Department of Education	Planning partner
Mike Paisley	Sergeant	Tehama County Sheriff's Office	Stakeholder
Joe Kittle	Director of Maintenance, Operations and Transportation	Red Bluff Joint Union High School District	Planning partner
Tim Wood	Senior Civil Engineer	Tehama County Public Works	Planning partner
Paul Mitchell	Homeowner	Lake California Property Owners Association	Stakeholder

The steering committee agreed to meet monthly or 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 plan. The steering committee met eight times during the course of the plan's development, from October 2010 through January 2012. All meetings were posted and open to the public. Agendas and meeting notes were posted to the hazard mitigation plan website. Protocols for managing public comments were established in the ground rules. Meeting agendas, notes and attendance logs are available for review upon request.

2.6 COORDINATION WITH OTHER AGENCIES

Opportunities for involvement in the planning process must 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 (Code of Federal Regulations Title 44 (44 CFR), 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.
- **Agency Notification**—The following agencies in addition to the planning partners were invited to participate in the plan development process and were kept informed of plan development milestones:
  - FEMA Region IX
  - California Emergency Management Agency (CalEMA)
  - California Department of Transportation
  - Shasta College
  - Deer Creek Watershed Conservancy

  – Lake California Property Owners' Association

  These agencies received meeting announcements, meeting agendas, and meeting minutes by e-mail throughout the plan development 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, primarily through the hazard mitigation plan website. Each agency was sent an e-mail message informing them that draft portions of the plan were available for review.

2.7 REVIEW OF EXISTING PROGRAMS

Hazard mitigation planning must include review and incorporation, if appropriate, of existing plans, studies, reports and technical information (44 CFR, Section 201.6(b)(3)). Chapter 5 of this plan provides a review of laws and ordinances in effect within the planning area that can affect hazard mitigation initiatives. An assessment of all planning partners' regulatory, technical and financial capabilities to implement hazard mitigation initiatives is presented in the individual jurisdiction-specific annexes in Volume 2. Relevant plans, studies and regulations are cited in the capability assessment. The following programs can affect mitigation within the planning area:

- Tehama County General Plan Update (2009-2029)
- Tehama County Code (Titles 1-17)
- State of California Multi-Hazard Mitigation Plan (2007)
- Tehama West Fire Plan (2005)
- Tehama County Ground Water Management Plan (1996)
- General/Comprehensive Plans for each of the incorporated city planning partners.

2.8 PUBLIC INVOLVEMENT

Public participation in the planning process helps ensure that diverse points of view about the planning area's needs are considered and addressed. The public must have opportunities to comment on hazard mitigation plans during the drafting stages and prior to plan approval (44 CFR, Section 201.6(b)(1)). The Community Rating System offers CRS credits for optional public involvement activities.

2.8.1 Strategy

The strategy for involving the public in this plan emphasized the following elements:

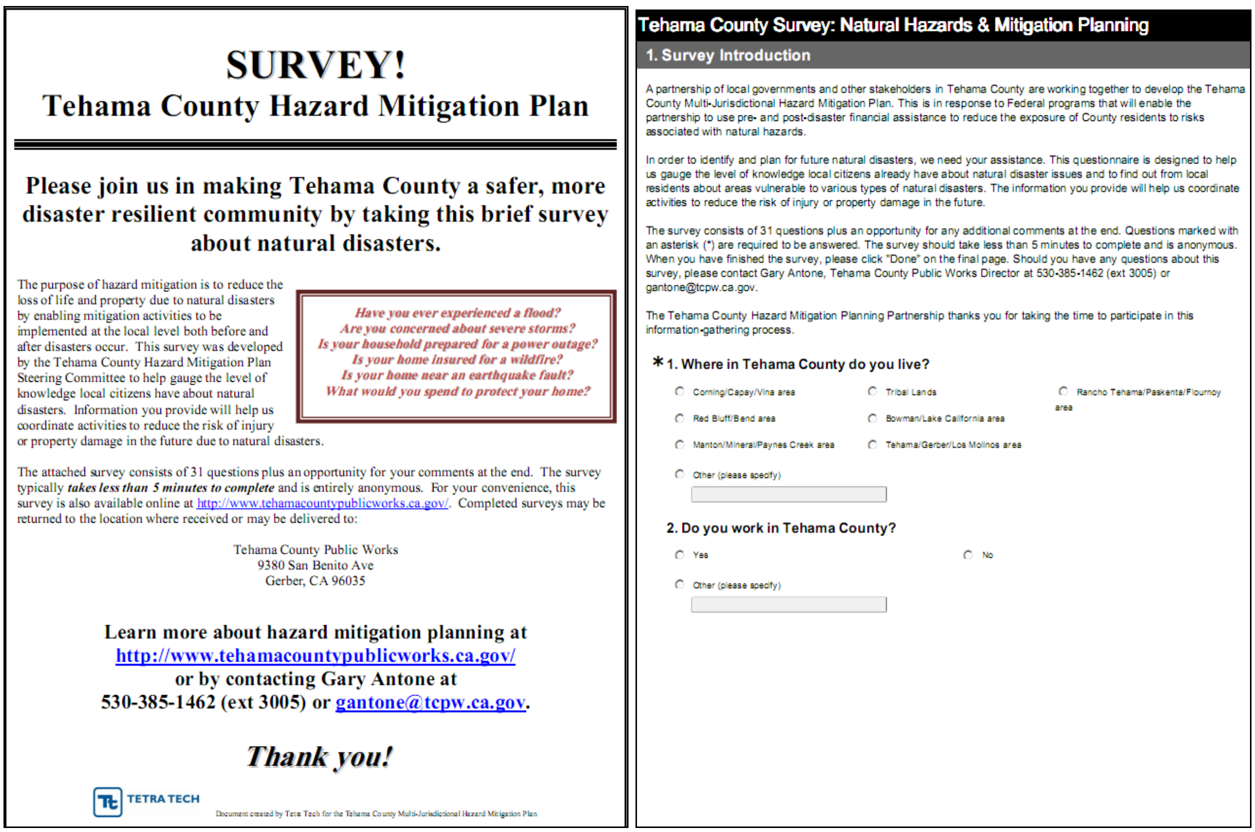
- Include planning area stakeholders and members of the public on the steering committee.
- Use a questionnaire to determine if the public's perception of risk and support of hazard mitigation has changed since the initial planning process.
- Attempt to reach as many planning area citizens as possible using public meetings, outreach to local media organizations, and the internet.

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 Tehama County. Committee members represented government agencies, health services, homeowner associations, and fire and school districts.

Questionnaire

A hazard mitigation plan questionnaire (see Figure 2-1) 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. Responses helped guide the steering committee in selecting goals, objectives and mitigation strategies. Over 300 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.


SURVEY!

Tehama County Hazard Mitigation Plan

Please join us in making Tehama County a safer, more disaster resilient community by taking this brief survey about natural disasters.

The purpose of hazard mitigation is to reduce the loss of life and property due to natural disasters by enabling mitigation activities to be implemented at the local level both before and after disasters occur. This survey was developed by the Tehama County Hazard Mitigation Plan Steering Committee to help gauge the level of knowledge local citizens have about natural disasters. Information you provide will help us coordinate activities to reduce the risk of injury or property damage in the future due to natural disasters.

Have you ever experienced a flood?
Are you concerned about severe storms?
Is your household prepared for a power outage?
Is your home insured for a wildfire?
Is your home near an earthquake fault?
What would you spend to protect your home?

The attached survey consists of 31 questions plus an opportunity for your comments at the end. The survey typically ***takes less than 5 minutes to complete*** and is entirely anonymous. For your convenience, this survey is also available online at http://www.tehamacountypublicworks.ca.gov/. Completed surveys may be returned to the location where received or may be delivered to:

Tehama County Public Works
9380 San Benito Ave
Gerber, CA 96035

Learn more about hazard mitigation planning at http://www.tehamacountypublicworks.ca.gov/ or by contacting Gary Antone at 530-385-1462 (ext 3005) or gantone@tcpw.ca.gov.

Thank you!

TETRA TECH

Document created by Tetra Tech for the Tehama County Multi-Jurisdictional Hazard Mitigation Plan

Tehama County Survey: Natural Hazards & Mitigation Planning

1. Survey Introduction

A partnership of local governments and other stakeholders in Tehama County are working together to develop the Tehama County Multi-Jurisdictional Hazard Mitigation Plan. This is in response to Federal programs that will enable the partnership to use pre- 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 disasters. The information you provide will help us coordinate activities to reduce the risk of injury or property damage in the future.

The survey consists of 31 questions plus an opportunity for any additional comments at the end. Questions marked with an asterisk (*) are required to be answered. The survey should take less than 5 minutes to complete and is anonymous. When you have finished the survey, please click "Done" on the final page. Should you have any questions about this survey, please contact Gary Antone, Tehama County Public Works Director at 530-385-1462 (ext 3005) or gantone@tcpw.ca.gov.

The Tehama County Hazard Mitigation Planning Partnership thanks you for taking the time to participate in this information-gathering process.

*** 1. Where in Tehama County do you live?**

- Corning/Capay/Vina area
- Tribal Lands
- Rancho Tehama/Paskenta/Flournoy area
- Red Bluff/Bend area
- Bowman/Lake California area
- Manton/Mineral/Paynes Creek area
- Tehama/Gerber/Los Molinos area
- Other (please specify)

2. Do you work in Tehama County?

- Yes
- No
- Other (please specify)

Figure 2-1. Sample Pages from Questionnaire Distributed to the Public

Public Meetings

Open-house public meetings were held on May 10, 2011 in Red Bluff, California (see Figure 2-2 through Figure 2-6) The two meetings were from 1:30 to 3 p.m. and from 6 to 8 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.

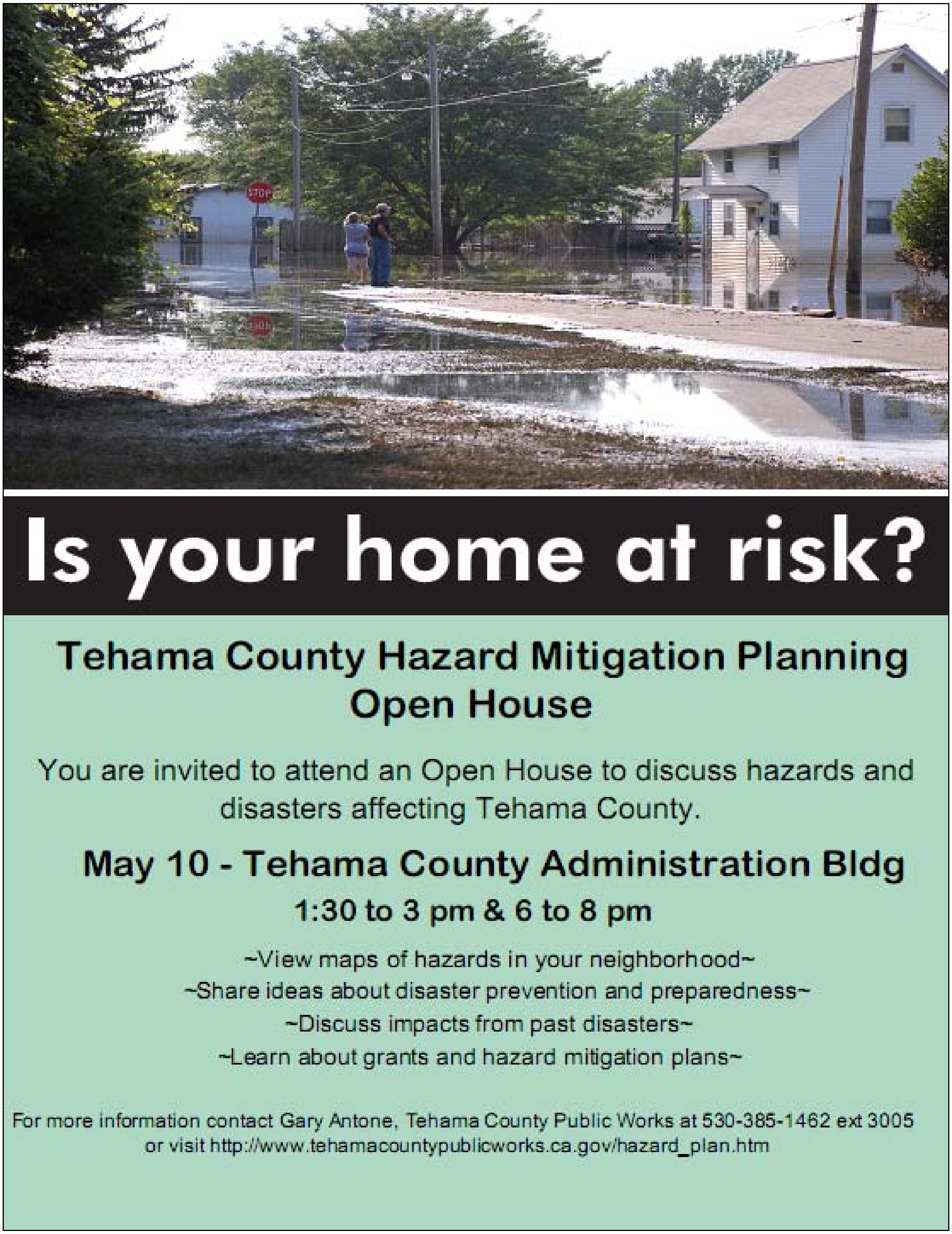


Figure 2-2. Flyer Advertising Public Open House Press Releases

Figure 2-3. Public Open House Location

Figure 2-4. Greeting Attendees at Open House

Figure 2-5. Risk Assessment Maps at Open House

Figure 2-6. Attendees Review Risk Data

A HAZUS-MH workstation set up at the public meetings allowed citizens to see information on their property, including exposure and damage estimates for earthquake and flood 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 at the meetings 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.

Outreach to Local Media

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:

- Article on the planning process in the Corning Observer on April 22, 2011: http://www.corning-observer.com/news/city-9625-hazard-plan.html
- Article on the planning process in the Corning Observer on April 29, 2011: http://www.corning-observer.com/news/plan-9661-hazard-city.html
- Public service announcements advertising the public open houses on KBOF radio, May 2—8
- Article in the Red Bluff/Tehama County Daily News on May 9, 2011 advertising public meetings
- Article in the Red Bluff/Tehama County Daily News on May 12, 2011 (see Figure 2-7).

Mostly sunny 77/51
Weather forecast 8B

RED BLUFF DAILY NEWS TEHAMA COUNTY
DAILY 50¢
THE VOICE OF TEHAMA COUNTY SINCE 1885 A MediaNews Group NEWSPAPER

County seeks input on hazard plan

By ANDREA WAGNER
DN Staff Writer

Natural disasters in Tehama County are the ongoing focus of a response plan that ultimately would ensure federal help should hazards occur.

In a Hazard Mitigation Planning Open House Tuesday, the public was invited to view hazard maps, discuss past local disasters and learn about disaster preparedness.

Avalanches, drought, earthquakes, flood, landslides, severe weather, volcanic eruption, dam failures and wildfires have been picked out as hazards of concern.

The multi-jurisdictional, countywide plan is in the third phase of a seven-step process, said Laura Hendrix, a hazard mitigation specialist from Tetra Tech, Inc.

The hazard mitigation plan will outline the history, vulnerability and future damage potential for each hazard identified. It does not include man-made disasters, such as chemical spills, which are handled by Homeland Security, Hendrix said.

Tetra Tech, Inc., was hired to develop the county's portion of the plan. Hendrix gave an informational presentation to the Board of Supervisors Tuesday afternoon.

Planning partnerships and risk assessment have already been addressed, Hendrix said.

See PLAN, page 7A

Figure 2-7. Red Bluff Daily News Article

Internet

At the beginning of the plan development process, a website was created to keep the public posted on plan development milestones and to solicit relevant input (see Figure 2-8):

http://www.tehamacountypublicworks.ca.gov/hazard_plan.htm

The site's address was publicized in all press releases, mailings, questionnaires and public meetings. Information on the plan development 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 plans.

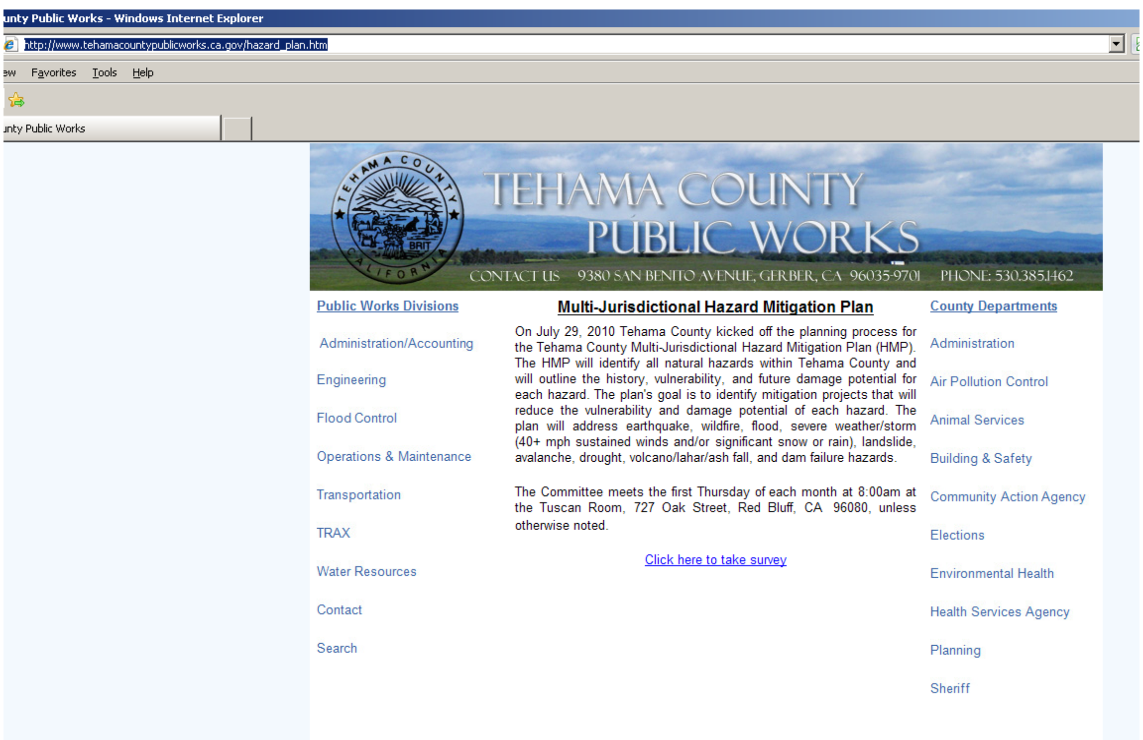


Figure 2-8. Sample Page from Hazard Mitigation Plan Web Site

2.8.2 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. The May 10, 2011 public open house in Red Bluff was attended by 13 citizens, and five questionnaires were received at the event. Over 182 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.

2.9 PLAN DEVELOPMENT CHRONOLOGY/MILESTONES

Table 2-3 summarizes important milestones in the development of the plan.

TABLE 2-3.
PLAN DEVELOPMENT MILESTONES

Date	Event	Description	Attendance
2008			
9/15	County submits grant application	Seek funding for plan development process.	N/A
2009			
2/15	County receives notice of grant award	Funding secured.	N/A
6/3	County initiates contractor procurement	Seek a planning expert to facilitate the process.	N/A
2010			
1/8	County selects Tetra Tech to facilitate plan development	Facilitation contractor secured.	N/A
7/29	Planning team identified	Formation of the planning team.	N/A
7/29	Stakeholder meeting	Presentation on plan process given to potential planning partners.	17
7/29	Planning partner kickoff meeting	Second meeting with potential planning partners. Attendees were advised of planning partner expectations and asked to formally commit to the process. Steering committee volunteers were solicited.	17
10/21	Planning partnership finalized	Deadline for submittal of letters of intent to participate in the planning effort.	N/A
10/21	Steering committee formed	Planning partners nominated potential committee members. Planning partners submitted commitments. Formation of the steering committee was finalized.	N/A
10/21	Steering Committee Meeting #1	• Review purposes for mitigation plan • Organize steering committee • State plan review • Public involvement strategy	10
12/2	Steering Committee Meeting #2	• Review/approve ground rules • Risk assessment update • State plan review observations • Critical facilities definitions • Public outreach—design survey/questionnaire	8

TABLE 2-3.
PLAN DEVELOPMENT MILESTONES

Date	Event	Description	Attendance
2011			
1/6	Steering Committee Meeting #3	• Planning partner status and deadlines • Risk assessment update • Critical facilities decisions • Guiding principle • Public outreach campaign	11
2/3	Steering Committee Meeting #4	• Risk assessments • Establishing critical facilities data deadline • Determining the guiding principle • Defining goals • Public outreach campaigns	8
3/3	Steering Committee Meeting #5	• Risk assessment updates • Hazard maps & critical facilities data discussion • Identifying plan objectives • Public outreach campaign	9
3/4	Public Outreach	A hazard mitigation survey/questionnaire was deployed on-line. Web links and hard copies were distributed to planning partners and steering committee members for dissemination to the public.	N/A
3/4	Public Outreach	Planning Partner Amy Henderson made 300 hard copies of the survey. She forwarded 100 copies to Paul Mitchell for distribution at the Lake California Property Owner's Meeting; the remaining copies were brought to the steering committee meeting for other planning partners to distribute within their own jurisdictions.	N/A
4/7	Steering Committee Meeting #6	• Risk assessment updates • Hazard maps & critical facilities data discussion • Finalizing plan objectives • Public outreach campaign	8
4/14	Public Outreach	Hazard mitigation plan website established on the County's Public Works web page at http://www.tehamacountypublicworks.ca.gov/hazard_plan.htm	N/A
4/19	Public Outreach	Steering Committee Member Paul Mitchell set up a booth at the annual Lake California Property Owner's Meeting to distribute surveys and information about the hazard mitigation plan. An announcement about the upcoming public meetings was made and the information was posted in the Association's monthly newsletter.	N/A
5/2	Public Outreach	County distributed a press release to local media outlets advertising the upcoming open houses. Flyers distributed to stakeholders and planning partners and posted throughout Tehama County.	N/A
5/11	Public Outreach	Two public open houses were held in Red Bluff at the County Administration Building. Following the afternoon presentation, maps and information were on display in the early afternoon and again in the evening.	13
6/2	Steering Committee Meeting #7	• Public meeting follow-up • Risk assessment updates • Session to review mitigation alternatives • Scheduling annex workshops	5

TABLE 2-3.
PLAN DEVELOPMENT MILESTONES

Date	Event	Description	Attendance
7/7	Jurisdictional Annex Workshop	Mandatory session for planning partners. Workshop held in Red Bluff focused on how to complete the jurisdictional annex template.	14
2012			
1/25	Draft Plan	Internal review draft provided by planning team to steering committee	N/A
2/28	Steering Committee Meeting #8	• Provide comments on Draft Plan • Confirm Plan Maintenance strategy • Confirm County-wide initiatives • Determine public comment process	9
4/16	Public Outreach	Press release advertising the public comment period disseminated to all media outlets.	N/A
4/17	Public Outreach	Final public meeting on draft plan	27
4/18	Public Comment Period	Initial public comment period of draft plan opens. Draft plan posted on plan website with press release notifying public of plan availability	N/A
5/18	Public Comment Period	The end of the public comment period.	N/A
5/19	Adoption	Adoption window of final plan opens	N/A
X/X	Plan approval	Final draft plan submitted to CalEMA for review and approval	N/A
X/X	Plan Approval	Final plan approved by FEMA	N/A

CHAPTER 3.
GUIDING PRINCIPLE, GOALS AND OBJECTIVES

Hazard mitigation plans must identify goals for reducing long-term vulnerabilities to identified hazards (44 CFR Section 201.6(c)(3)(i)). The steering committee established a guiding principle, a set of goals and measurable objectives for this plan, based on data from the preliminary risk assessment and the results of the public involvement strategy. The guiding principle, goals, objectives and actions in this plan all support each other. Goals were selected to support the guiding principle. Objectives were selected that met multiple goals. Actions were prioritized based on their ability to achieve multiple objectives.

3.1 GUIDING PRINCIPLE

A guiding principle focuses the range of objectives and actions to be considered. This is not a goal because it does not describe a hazard mitigation outcome, and it is broader than a hazard-specific objective. The guiding principle for the Tehama County Hazard Mitigation Plan is as follows:

> Through partnerships, reduce the vulnerability to natural hazards in order to protect the health, safety, welfare and economy of the residents and communities within Tehama County.

3.2 GOALS

The effectiveness of a mitigation strategy is assessed by determining how well the goals of the strategy are achieved. The following are the goals for this plan:

1. Protect life, property and the environment.
2. Promote public awareness and education.
3. Build and support local capacity to enable the public to mitigate, prepare for, respond to and recover from the impact of hazards and disasters.
4. Improve cooperation and coordination of all stakeholders.
5. Encourage the development and implementation of long-term, cost-effective, environmentally conscious mitigation practices.

3.3 OBJECTIVES

Each selected objective meets multiple goals, serving 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. The objectives are as follows:

1. Increase resilience of (or protect and maintain) infrastructure and critical facilities.
2. Educate the public on the risk from natural hazards and increase awareness, preparation, mitigation, response, and recovery activities.
3. Establish partnerships among government, businesses and communities to improve and implement methods to protect property.
4. Encourage hazard mitigation measures that minimize adverse effect on the natural environment.
5. Maintain and make available maps of identified risk areas.
6. Encourage coordination between participating jurisdictions and adjoining communities.

7. Develop or improve early warning emergency response systems and evacuation procedures.
8. Consider the impacts of natural hazards in all planning mechanisms that address current and future land uses within the planning area.
9. Support and encourage mitigation measures for homeowners in high-risk areas.

PART 2 — RISK ASSESSMENT

CHAPTER 4.
IDENTIFIED HAZARDS AND RISK ASSESSMENT METHODOLOGY

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 Tehama County and meets requirements of the DMA (44 CFR, Section 201.6(c)(2)).

4.1 IDENTIFIED HAZARDS

4.1.1 Hazards of Concern

The steering committee considered all natural hazards that could impact the planning area and then listed hazards that present the greatest concern. A complete risk assessment is provided for each hazard of concern. The identification process incorporated review of state and local hazard planning documents, as well as information on the frequency, magnitude and costs associated with hazards that have impacted or could impact the planning area. Anecdotal information and the perceived vulnerability of planning area assets was also used. Based on the review, the following were identified as hazards of concern:

- Avalanche
- Dam Failure
- Drought
- Earthquake
- Flood
- Landslide
- Severe weather
- Wildfire.

4.1.2 Hazards of Interest

The steering committee also identified hazards that, while not posing enough threat to warrant a complete risk assessment, do have some potential to impact the planning area. These “hazards of interest” were not evaluated with a complete risk assessment for this plan, but a profile of all of them is presented in a single chapter at the end of the risk assessment section of the plan. The hazards of interest are as follows:

- Air quality/smoke pollution
- Energy shortages
- Hazardous materials
- Insects/pests/marine invasive species
- Noxious weeds
- Human-caused hazards (terrorism and technological hazards)
- Volcano.

4.1.3 Climate Change

Climate refers to patterns of temperature, precipitation, humidity, wind and seasons. Climate shapes 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 that climate change will have a measurable impact on the occurrence and severity of natural hazards around the world. Impacts include the following:

- Snow cover losses will continue, and declining snowpack will affect snow-dependent water supplies and stream flow levels around the world.
- Drought and the frequency, intensity, and duration of heat waves are expected to increase.
- More extreme precipitation is likely, increasing the risk of flooding.
- The world’s average temperature is expected to increase.

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; and the spread of existing or new vector-born disease into a community. In many cases, communities are already facing these problems to some degree. Climate change can affect the frequency, intensity, extent and/or magnitude of the problems.

This hazard mitigation plan addresses climate change as a 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 models are currently being developed to assess the potential impacts of climate change, there are currently none available to support hazard mitigation planning. As such models are developed in the future, this risk assessment may be enhanced to better measure these impacts.

4.2 METHODOLOGY

The risk assessments in Chapter 6 through Chapter 13 describe the risks associated with each identified hazard of concern. 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:
  - History of occurrence in the planning area
  - 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 are exposed to each hazard.
- 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 geographic information systems (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.

4.3 RISK ASSESSMENT TOOLS

4.3.1 Earthquake, Flood and Dam Failure—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 hurricanes and floods.

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 MR5, released by FEMA in September 2010.

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 HAZUS-MH defaults for essential facilities, transportation and utilities. Current Tehama County flood mapping data were used to delineate flood hazard areas and estimate potential losses from the 100-year flood event. Using the floodplain boundaries and a countywide 10-meter digital elevation model (DEM), a 100-year flood depth grid was generated and integrated into the model. Flood exposure numbers were generated using County assessor data. Flood hazard vulnerability numbers were generated in HAZUS using the updated census block general building stock.
- **Dam Failure**—Dam failure inundation mapping for the planning area 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 probabilistic data prepared by the U.S. Geological Survey (USGS) was used for the analysis of this hazard. An updated general building stock inventory was developed using replacement cost values and detailed structure information from County assessor data. An updated inventory was used in place of HAZUS-MH defaults for essential facilities, transportation and utilities. A modified version of the California Department of Conservation National Earthquake Hazard Reduction Program (NEHRP) soils inventory was used. The standard HAZUS analysis for the 100- and 500-year probabilistic events were used to assess earthquake risk.

4.3.2 Avalanche, 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 Tehama County GIS database, augmented with state and federal data sets. Additional data sources for specific hazards were as follows:

- **Avalanche**—There are no real assets at risk from the avalanche hazard, and no available mapping identifies areas subject to the hazard. Therefore the avalanche risk assessment is subjective, focusing mainly on social impacts from the hazard.
- **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. Landslide exposure numbers were generated using Tehama County assessor data.

- **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 California Department of Forestry and Fire Protection. Wildfire exposure numbers were generated using Tehama County assessor data.

4.3.3 Drought

The risk assessment methodologies used for this plan focus on damage to structures as well as critical facilities and infrastructure. 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.

4.3.4 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, Tehama County and its planning partners will collect additional data to assist in estimating potential losses associated with other hazards.

CHAPTER 5.
TEHAMA COUNTY PROFILE

Tehama County is located in northern California, about two hours north of Sacramento (see Figure 5-1). Interstate-5, the primary north-south transportation corridor along the West Coast, and the meandering Sacramento River divide the eastern and western portions of the county. The County is bounded to the north by Shasta County, to the east by Butte and Plumas Counties, to the south by Glenn County, and to the west by Mendocino and Trinity Counties.

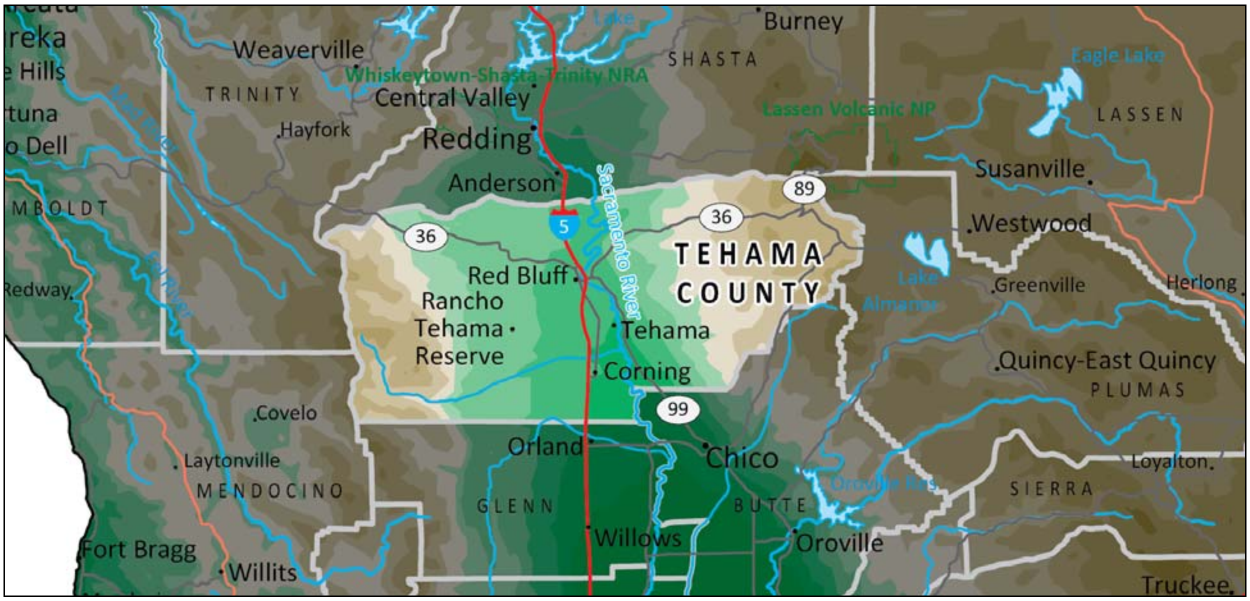


Figure 5-1. Main Features of Tehama County

With its rural setting and sparse population, Tehama County is ranked 41st in population among California's 58 counties. The county's three small incorporated cities are Corning, Red Bluff and Tehama. Red Bluff, in north-central Tehama County, is the county seat and population center. Most of the population is located along the transportation corridors, which are also interspersed with commercial and industrial operations. Located on Interstate 5, Highway 99 and Highway 36, Red Bluff is a hub for area travel. Educational services, health care and social assistance services, retail trade and manufacturing are important base industries.

Much of the land use in the county is resource-based, taking the form of cropland, range and pasture land as well as woodland. The county is home to multiple sheep farms and cattle ranches as well as fruit and nut orchards. About 71 percent of the land area is held in private ownership; the other 24 percent is managed by the federal government.

Much of the land in Tehama County consists of open spaces, providing access to natural resources and recreation. The Sacramento River, one of the largest salmon-spawning rivers in the world, attracts tourists and residents alike, as do miles of trails in the Pacific Coast Range and Sierra Nevada. Black Butte Reservoir offers water-related recreation. Other outdoor activities abound at the Sacramento River Bend Area, Lake Red Bluff, Mendocino National Forest, Shasta-Trinity National Forest and Lassen National Forest. Nearby recreational features also include Lassen Volcanic National Park.

5.1 GEOGRAPHY

Tehama County covers nearly 3,000 square miles and is one of 10 counties in the northern Sacramento Valley. Tehama County's agricultural valley is bounded by the Sierra Nevada Mountains on the east and the Coastal Range on the west. Lassen Peak, the southernmost active volcano in the Cascade Range, is located to the northeast in Shasta County. At over 10,450 feet, it towers over Tehama County and has presented a series of powerful eruptions within the past century.

The Sacramento River winds a meandering path from north to south along the valley floor, dividing the County into two nearly equal parts. Cottonwood and Battle Creeks on the northern county boundary, along with Antelope, Reed's, Red Bank, Payne's, Dibble, Mill, Elder and Thomes Creeks are among the principal tributaries flowing into the Sacramento River.

5.2 HISTORICAL OVERVIEW

Two primary Native American tribes once occupied the region presently recognized as Tehama County. The Yana tribe were hunter-gatherers whose territory covered about 2,400 square miles in the region's mountains, meadows and streams. From Round Mountain and the Pit River in Shasta County to Deer Creek in Tehama County, the Yana people lived on wild game, salmon, berries, acorns and roots. As gold miners and ranchers flocked into their territory, the tribe's food supply suffered and they experienced great losses as they fought with settlers. The Yana are now extinct as a functional tribe, although some individuals still exist.

The Nomlaki (Central Wintun) people occupied the Sacramento River Valley and west toward the coastal range in both Tehama and Glenn Counties. The Nomlaki subsisted by fishing, hunting and gathering. Pre-settlement estimates of tribal population members range from 1,000 to 8,000. Contact with early settlers and a malaria epidemic greatly reduced the tribe's population. The federal government restored the Paskenta Band of Nomlaki Indians to full tribal status in 1994. The tribe was able to acquire enough land to establish the Rolling Hills Casino near Corning.

European-American settlers first settled the area in the mid-1800s as a result of Mexican land grants. As Mexico gained independence from Spain in 1821, the reorganization of held lands soon followed. Four settlers were each given land grants by the government of Mexico in 1844. Robert Hasty Thomes received Rancho Saucos, Albert Gallatin Toomes settled Rancho Rio de los Molinos, William George Chard occupied Rancho Las Flores and Job Francis Dye took possession of Rancho Primer Cañon o Rio de Los Berrendos.

Peter Lassen developed the town site of Benton City, but the Gold Rush of 1848 led most settlers to the hills, undermining the success of the town. The gold rush brought considerable numbers of gold-seekers to Tehama County. Many failed gold-seekers stayed in the region establishing small settlements and boomtowns, along with roads, churches, hotels and schools. The town of Red Bluff was one such settlement, settled in the 1850s under various names.

Tehama County was created April 9, 1856 from three neighboring counties: Shasta, Butte and Colusa. The County was named for the City of Tehama, however the origin of the name is not entirely understood. Some possible roots are the Arabic word *tehama* meaning "hot lowlands" or the Spanish word *tejamanil* which means "roof shingle." It is generally accepted that *tehama* is an old Native American word meaning "high water," "low land" or possibly "salmon" in reference to the abundant salmon in the Sacramento River. In the organization of the county, there was a strong attempt to locate the county seat at the community of Tehama, but Red Bluff was ultimately chosen.

In early days, Tehama County's land was considered worthless for farming, so cattle ranching prevailed. However, in the 1850s settlers along Elder and Thomes Creeks began farming the land. From that time forward, agriculture successfully spread across the County and is presently evolving into fruit farming.

Industry in Tehama County began on the banks of the Sacramento River. The first saw mill was established on the river just above Mill Creek in 1851. Several other mills followed on the Sacramento River and its tributaries. The Sierra Lumber Company began operations in 1875. Today the company owns over 60,000 acres of timberland, operates multiple mills, has several miles of flume and railway and provides local employment opportunities. The wool industry is also important in Tehama County, producing as much if not more than Wyoming, Utah, Montana and other states within that region. The annual exportation is about 2,000,000 pounds.

Primary occupations for the residents of Tehama County are farming and sheep-raising, though fruit-raising is beginning to attract entrepreneurs. The Sierra Lumber Mills at Red Bluff employ about 100 people. The County's grain crops are extensive and produce considerable amount goods, with wheat and barley being the leading products. The floodplains and lowlands adjacent to the Sacramento River are recognized for their fertility and production.

Historically, Red Bluff's location along the Sacramento River enabled it to serve as a transportation hub exporting local agricultural and lumber products by steamship. Corning, the County's second largest city, was incorporated in 1907. It originally served as an agricultural hub, producing olives, plums, almonds, walnuts, and peaches, as well as cattle and sheep. Corning is home to the Lindsey Olive Company and Bell Carter Foods. The City of Tehama, established in 1846, is Tehama's oldest and smallest incorporated city, with an area of less than one square mile. Other central area communities include Dairyville, Proberta, Las Flores, Gerber, El Camino, Los Molinos, Richfield, Vina and Kirkwood. Western communities in Tehama County include Red Bank, Flournoy, Paskenta and the Rancho Tehama Reserve. Eastern unincorporated areas include the towns of Manton, Mill Creek, Paynes Creek, Mineral and Dales.

5.3 MAJOR PAST HAZARD EVENTS

Presidential disaster declarations are typically issued for hazard 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. Tehama County has experienced 12 events since 1964 for which presidential disaster declarations were issued. These events are listed in Table 5-1. 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. Many natural hazard events that do not trigger federal disaster declaration protocols still have significant impacts on their communities. These events are also important to consider in establishing recurrence intervals for hazards of concern.

5.4 PHYSICAL SETTING

5.4.1 Geology

The Northern Sacramento River Valley is characterized by surrounding mountain ranges: the wooded Northern Coast Ranges to the west, the forested Siskiyou Mountains to the north and the snow-capped Sierra Nevada to the east. The broad, flat valley floor sharply contrasts with the rugged mountains and gentle hills that are typical of most of California's terrain. The general terrain consists of a series of northwest-trending mountains and valleys formed by thousands of years of tectonic plate movement.

TABLE 5-1.
PRESIDENTIAL DISASTER DECLARATIONS FOR HAZARD EVENTS IN TEHAMA COUNTY

Year	Date	Incident Description	Disaster Number
1998	02/09	Severe Winter Storms and Flooding	1203
1997	01/04	Severe Storms/Flooding	1155
1995	03/12	Severe Winter Storms, Flooding, Landslides, Mud Flows	1046
1995	01/10	Severe Winter Storms, Flooding, Landslides, Mud Flows	1044
1993	02/03	Severe Storm, Winter Storm, Mud & Landslides, Flooding	979
1991	02/11	Severe Freeze	894
1986	02/21	Severe Storms, Flooding	758
1983	02/09	Coastal Storms, Floods, Slides, Tornadoes	677
1974	01/25	Severe Storms, Flooding	412
1970	02/16	Severe Storms, Flooding	283
1969	01/26	Severe Storms, Flooding	253
1964	12/24	Heavy Rains & Flooding	183

Primarily composed of granite, the Sierra Nevada Range on the east side of Tehama County formed as the oceanic plate began to move under the North American Plate. Magma from the melting oceanic plate rose in plumes to create the Sierra Nevada Batholith, which has since been weathered and worn down to form rolling mountains. River formation and glacial erosion cut deep canyons in the Sierra Nevada Range, exposing metamorphic rock at the top of some peaks.

Geologists theorize that the valley floor originated below sea level as an offshore depression created by movement of the Farrallon Plate into a trench far off the California coast. The Central Valley was later enclosed by the uplift of the Coastal Range to the west. Many faults exist within both the Coastal Range and the Sierra Nevada Range, as the mountains continue building. Erosion of the surrounding mountains over thousands of years has filled the valley with stream-borne sediment creating the broad, flat surface. Prior to construction of California's enormous flood control and canal system, annual snow melt turned much of Tehama County's valley into an inland lake. The Sacramento River cuts through the valley, transporting and re-distributing nutrient-rich sediments throughout the productive floodplain.

The Northern Coastal Range extends from north to south along the eastern boundary of Tehama County. Bedrock of the Coastal Range varies greatly in type and geologic age. Most of the rocks were formed millions of years ago as deposits on the sea bottom. Less-dense deposits moving laterally on the oceanic crust as a result of plate tectonics failed to pass under the North American Plate and instead accumulated on the overriding plate. In some places, lava or igneous rock was forced in molten condition into cracks and crevices in the sedimentary rocks. Erosion of the softer sedimentary rock gives the range much of its present appearance.

Though both mountain ranges paralleling Tehama County have many active faults, seismic activity in the County is relatively low. However, smaller faults in the area are capable of producing numerous lower-magnitude earthquakes.

5.4.2 Soils

No published soil survey for Tehama County is available, so a soil survey from the Shasta County area was used assess the region's soils. General soil types are fairly uniform in the upper Central Valley of California. The U.S. Soil Conservation Service (now known as the Natural Resources Conservation Service or NRCS) published the soil survey for the Shasta County area. Based on the regional geomorphic provinces and physiography, Tehama County's soils may be classified into three general categories:

- **Mountain Soil Associations**—The mountain soils are rugged, steep soils in the Coastal Range, and range from nearly level to steep in the Sierra Nevada landscape. They range from somewhat excessively drained to well-drained cobbles and gravelly loams underlain by various granites, volcanic, sedimentary and metamorphic bedrock. The mountain soils are typically covered by conifer and hardwood forests along with shrubbery. The Cascade Range/Sierra Nevada soils are relatively porous, and much of the subsurface flow returns at lower elevations to form perennial streams. Many soils below the timberline have large amounts of runoff, but erosion is only minimal. Fault lines are noticeable in the Sierra Nevada Range. Coast Range soils experience significant surface runoff; few fault lines are apparent but deeply weathered shale dipping to the east can lead to foundation seepage and slope stability issues.
- **Foothills Soil Associations**—Foothills soils are excessively drained to well-drained on foothills that range from rolling to steep. Topography is much less rugged than in the mountains and vegetation is composed of grasses, grass-oak, brush and conifers. These soils are primarily formed from weathered sedimentary, volcanic and metamorphic rock.
- **Terraces, Valley Bottom and Floodplain Soil Associations**—Soils of the terraces, valley bottoms and floodplains are located on nearly level dissected terraces, along sloping valley walls and in the nearly level valley bottoms and floodplains. These soils are formed from alluvium and contain cobbly alluvial and river wash materials. Soils in this association are typically covered with grasses, brush, oak, Digger Pine, sycamore, cottonwood and other riparian trees. The soils of this association are used for range, pasture, irrigated crops, orchards, wildlife habitat, recreation and urban development. The flooding hazard is severe on much of the cobbly alluvium, so intensive use of these areas is limited.

Topsoil erosion can reduce crop productivity and cause sedimentation in nearby streams. Sedimentation in turn fills in stream beds, therefore diminishing water quality and limiting water transportation; it also may damage sensitive riparian habitats. Soil erosion in Tehama County occurs as a result of intensive land use, wind and water erosion. Erosion may be most severe where urbanization, development, recreational activities 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 drier areas. Agricultural crops are subject to the erosive forces of water. The conversion of agricultural lands to housing and other development may cause exposed soils to become susceptible to erosion. All soil types benefit from conservation management techniques to prevent accelerated erosion. With proper drainage construction and landscaping techniques, altered soils may return to pre-construction stability and condition.

5.4.3 Climate

As Tehama County's landscape varies from valley to surrounding mountains, so does its climate. The valley areas are characterized by hot, dry summers and mild, wet winters. Mountain regions in Tehama County offer warm, dry summer weather, while the higher elevations are considerably colder and snowy during winter.

Due to the inland location, temperatures in Tehama County vary significantly between summer and winter. Valley temperatures in the City of Red Bluff average 81.9ºF during July and 45.3ºF in January. Red Bluff is located about 350 feet above sea level and the mean annual temperature is 62.8ºF. It is not uncommon for temperatures to reach nearly 100 degrees in the valleys during the summer. In the mountain town of Mineral, located at 4,872 feet above sea level, the annual average temperate is 44.8ºF, summer temperatures average 61.5ºF, and winter temperatures are typically around 32ºF. Summer maximum temperatures in the mountains are around 80ºF.

Rain may occur year-round in Tehama County, although most precipitation occurs during the winter. Much of the rainfall is due to storm fronts coming from the west across the Pacific Ocean. Much of the moisture from the Pacific storms falls on the windward (western) side of the Coastal Ranges. The leeward (east) side of the Coastal Range and valley within Tehama County is in a rain shadow and is therefore considerably drier. Annual average precipitation in Red Bluff is 22.4 inches. Areas of the County on the windward side of the Sierra Nevada, east of the valley, see higher precipitation levels. Mineral's mean annual precipitation exceeds 54 inches, its annual average snowfall is about 140 inches.

5.5 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. Through a facilitated exercise, the steering committee crafted the following definition of "critical facilities" for this plan:

> *A critical facility is defined as a local facility or infrastructure in either the public or private sector that provides essential products and services to the general public, such as preserving the quality of life in Tehama County and fulfilling important public safety, emergency response, and disaster recovery functions. Loss of a critical facility would result in a severe economic or catastrophic impact and would affect the County's ability to provide essential services that protect life and property.*

The critical facilities profiled in this plan include but are not limited to the following:

- Government facilities, such as departments, agencies, and administrative offices
- Emergency response facilities, including police, fire, communications and emergency operations centers
- Educational facilities
- Medical and care facilities, such as hospitals, nursing homes, retirement facilities and housing likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a hazard event
- Community gathering places, such as parks, museums, libraries, senior centers, churches and family resource centers
- Public and private utilities and infrastructure vital to maintaining or restoring normal services to areas damaged by hazard events
- Structures or facilities that produce, use, store or transport highly volatile, flammable, explosive, toxic, and/or water-reactive materials.

Map 5-1 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. Table 5-2 and Table 5-3 provide summaries of the general types of critical facilities and infrastructure, respectively, in each municipality and unincorporated county areas. The risk assessment for each hazard qualitatively discusses critical facilities with regard to that hazard.

TABLE 5-2.
TEHAMA COUNTY CRITICAL FACILITIES EXPOSED TO THE EARTHQUAKE HAZARD

City	Medical and Health	Government Functions	Protective Functions	Schools	Hazmat	Other Critical Functions	**Total**
Corning	1	2	2	8	0	1	**14**
Red Bluff	8	9	6	18	0	1	**42**
Tehama	0	0	0	1	0	3	**4**
Unincorporated	0	4	4	30	1	2	**41**
Total	**9**	**15**	**12**	**57**	**1**	**7**	**101**

TABLE 5-3.
TEHAMA COUNTY CRITICAL INFRASTRUCTURE EXPOSED TO THE EARTHQUAKE HAZARD

City	Bridges	Water Supply	Wastewater	Power	Communications	Other	**Total**
Corning	12	8	0	1	0	1	**22**
Red Bluff	21	13	1	2	1	1	**39**
Tehama	2	2	0	0	0	0	**4**
Unincorporated	417	4	3	1	6	14	**445**
Total	**452**	**27**	**4**	**4**	**7**	**16**	**510**

5.6 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.

5.6.1 Tehama County Population Characteristics

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. Knowledge of the composition of the population and how it has changed in the past and how it may change in the future provides information for making informed decisions about the future. A growing population generally indicates a growing economy, while a declining population generally signifies economic decline.

The California Department of Finance estimated Tehama County's population at 62,941 as of July 1, 2009. The population increased an average of 1.32 percent per year between 2000 and 2009 and a total of 11.9 percent (7,010 people) during that period. Of California's 58 counties, Tehama County ranks as the 41st most populous. Between 1990 and 2005, California's total population grew by 22 percent (about 1.4 percent per year) while Tehama County's population increased by 19.53 percent (1.3 percent per year). Figure 5-2 shows the growth rate of Tehama County from 1990 to 2005 compared with the State of California. While California shows stable growth rates (indicative of a growing economy), Tehama County shows unstable, but rebounding, growth rates.

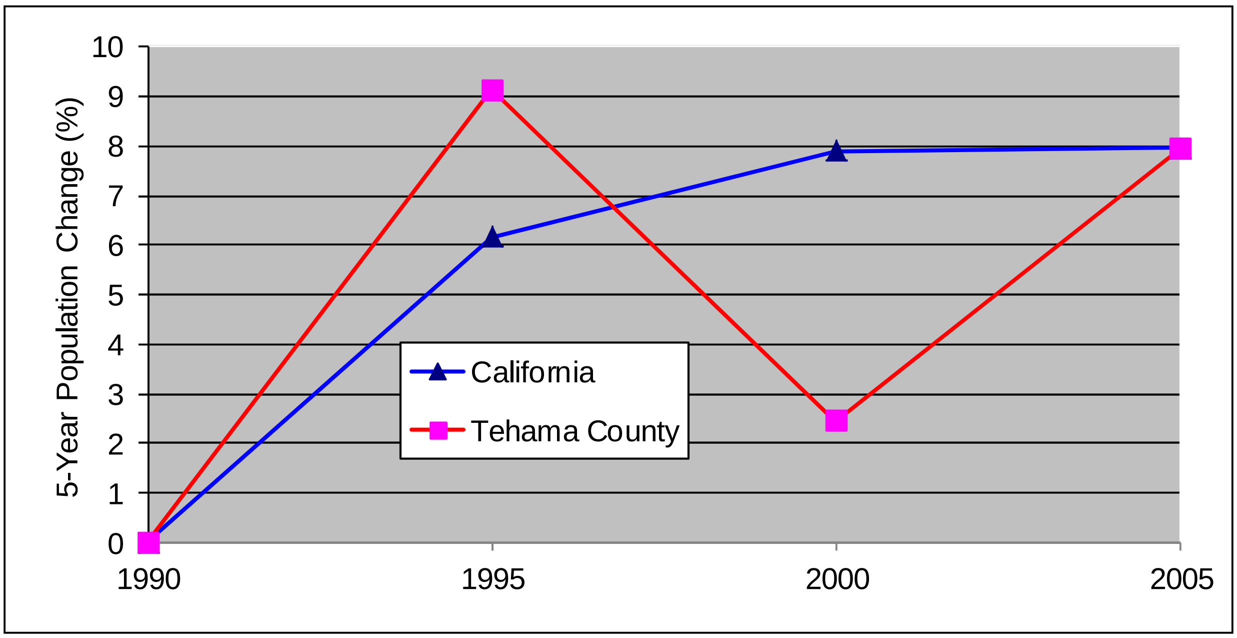


Figure 5-2. Population Growth Rates 1990-2005

According to January 1, 2009 Census population estimates, about 65 percent of Tehama County's residents lived outside of incorporated areas. Overall growth in incorporated areas was approximately 16 percent from 1990 to 2009, while the unincorporated areas of the county grew about 33 percent during the same time frame. Red Bluff is the only incorporated city in Tehama County with a population of over 10,000. Corning is the second largest city, with over 7,300 residents. The city of Tehama hosts a population of just 425. Table 5-4 shows the population of incorporated municipalities and the combined unincorporated areas in Tehama County from 1990 through 2009.

TABLE 5-4.
POPULATION OF CITIES AND UNINCORPORATED COUNTY

	Corning	Red Bluff	Tehama	**Incorporated Total**	Unincorporated	**Tehama County Total**
1990	5,870	12,363	401	**18,634**	30,991	**49,625**
1991	6,036	12,535	397	**18,968**	31,762	**50,730**
1992	6,222	12,727	397	**19,346**	32,838	**52,184**
1993	6,228	12,760	409	**19,397**	33,591	**52,988**
1994	6,305	12,760	416	**19,481**	34,035	**53,516**
1995	6,390	13,152	427	**19,969**	34,230	**54,199**
1996	6,513	13,116	429	**20,058**	34,550	**54,608**
1997	6,560	13,042	426	**20,028**	34,895	**54,923**
1998	6,632	13,056	428	**20,116**	35,169	**55,285**
1999	6,663	13,092	427	**20,182**	35,277	**55,459**
2000	6,741	13,147	432	**20,320**	35,719	**56,039**
2001	6,733	13,157	431	**20,321**	35,910	**56,231**
2002	6,770	13,355	432	**20,557**	36,373	**56,930**
2003	6,849	13,491	435	**20,775**	37,089	**57,864**
2004	6,898	13,576	436	**20,910**	37,924	**58,834**
2005	7,012	13,678	435	**21,125**	38,751	**59,876**
2006	7,154	13,525	434	**21,113**	39,846	**60,959**
2007	7,164	13,671	426	**21,261**	40,365	**61,626**
2008	7,200	13,776	427	**21,403**	40,776	**62,179**
2009	7,396	13,776	425	**21,597**	41,239	**62,836**

5.6.2 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 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 impacted 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 survey estimates for 2005-2009, per capita income in Tehama County was $20,299, and the median household income was $38,179 (in 2009 dollars, adjusted for inflation). It is estimated that there are 1,947 households with less than $10,000 in income per year and 5,852 households with $10,000 to $25,000 in income per year. About 33.3 percent of the households in Tehama 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.

5.6.3 Age Distribution

The vulnerability of elderly citizens can vary significantly based on health, age, and economic security. However, 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.

Based on U.S. Census data estimates for 2010, 15.9 percent of Tehama County's population is 65 or older, higher than the state average of 11.4 percent. According to the 2010 U.S. Census data, 44.8 percent of the County's over-65 population has disabilities of some kind and 9.2 percent have incomes below the poverty line. It is estimated that 19.5 percent of the County's population is 14 or younger, slightly less than the state average of 21.2 percent. Children under 18 account for 27 percent of individuals who are below the poverty line. The overall age distribution for Tehama County is illustrated in Figure 5-3.

5.6.4 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, Tehama County is predominately white, at 81.6 percent of the total population. The largest minority population is American Indian/Alaska Native at 1.7 percent of the total county population; 19.9 percent of the population is of Hispanic or Latino descent. Figure 5-4 shows the racial distribution within Tehama County.

Tehama County has a 7.9 percent foreign-born population, with the majority born in Latin America according to the 2000 U.S. Census. Other than English, the most commonly spoken language is Spanish. Census data show that 9.2 percent of County residents reported speaking English "less than very well."

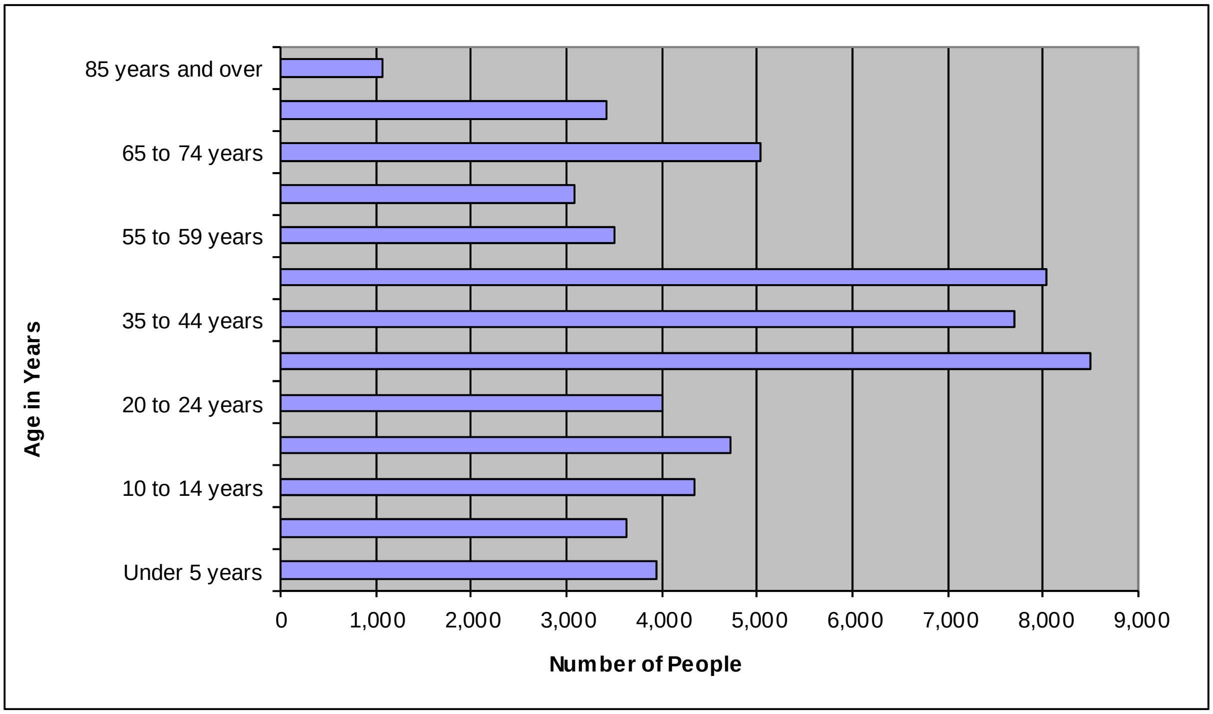


Figure 5-3. Tehama County Age Distribution

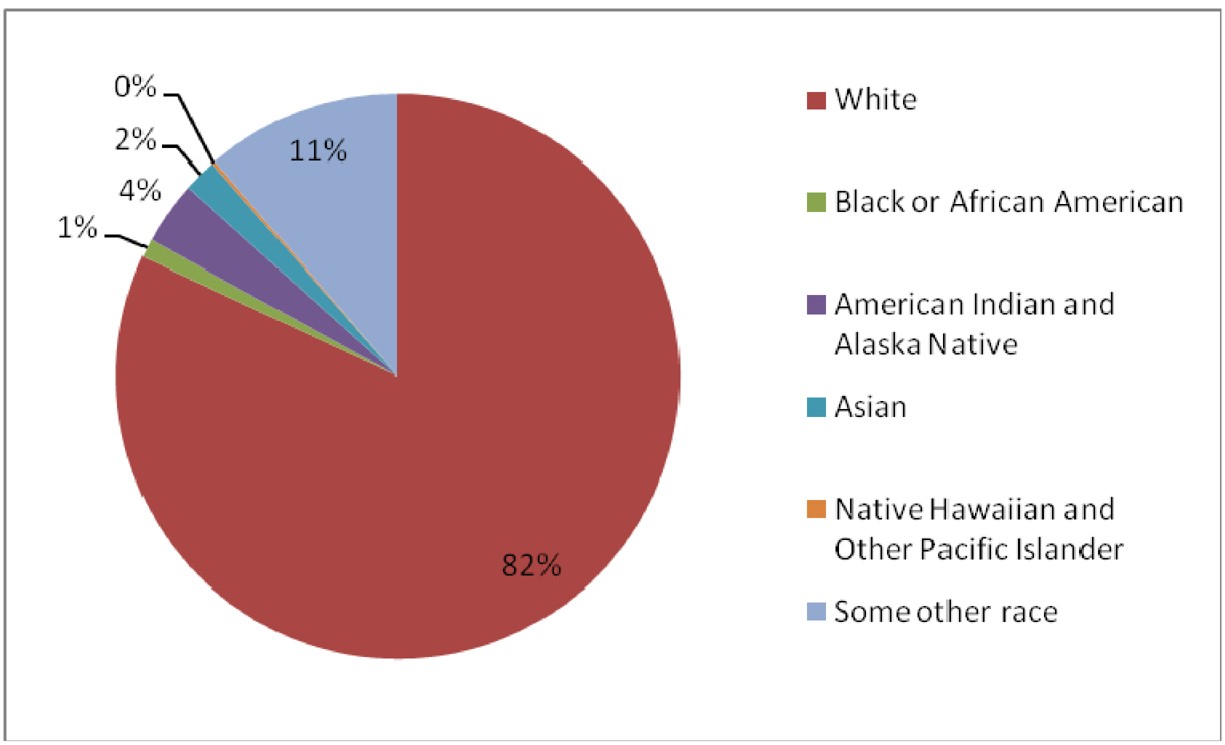


Figure 5-4. Tehama County Race Distribution

5.6.5 Disabled Populations

Because people living with disabilities are significantly more likely to have difficulty responding to a hazard event than the general population, they have a special stake in emergency planning efforts. According to U.S. Census figures, roughly one-fifth of the U.S. population lives with a disability, and the percentage is rising. Furthermore, disabled populations are increasingly integrated into society. This means that a relatively large segment of the population will require assistance during the 72 hours post-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 often 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 in Tehama 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 5-5). According to 2000 U.S. Census data, 23.1 percent of the County's population over the age of 5 has a disability.

TABLE 5-5.
DISABILITY STATUS OF NON-INSTITUTIONALIZED POPULATION

Age	Persons with a Disability	Percent of Age Group
Age 5 to 20 years	1,207	8.8
Age 21 to 64 years	6,842	23.3
Age 65 years and over	3,913	44.8

Detailed spatial analysis to locate areas in which there are higher concentrations of vulnerable community members such as people with low incomes, people who are elderly or with disabilities, and people of minority ethnicity would assist the county in extending focused public outreach and education to these most vulnerable citizens.

5.7 ECONOMY

Tehama County's General Plan indicates economic development as highly importance to the community. Development of new businesses can expand the property tax base and increase sales tax, both directly and indirectly, as can the retention and expansion of existing businesses. Increasing County revenues has become more important in recent years due to declining revenues from the State of California and the decline in natural resource-related industries, including major declines in timber-related industries.

The County and its incorporated cities recognize that economic development is an important planning tool for managing growth to achieve a broad range of community goals and objectives, including economic diversification, entrepreneurial development, human resource development, job retention and growth of the tax base. These communities must coordinate economic development approaches to address logging cutbacks, lumber mill closures and other imminent changes.

In spite of current economic stresses, Tehama County possesses many crucial assets that may contribute to economic revitalization. Corning and Red Bluff are centrally located in Northern California on Interstate 5, the state's major north-south corridor. Tehama County is further advantaged by its proximity to major metropolitan growth centers including Shasta/Redding, Butte/Chico and the Sacramento Metropolitan Area. Many other County assets exist, including a large supply of entry-level labor; reasonably priced business environments; affordable housing; abundant cultural and recreational resources; and broad agricultural opportunities. Resource-based businesses are encouraged within the County by revitalizing traditional timber and agricultural industries. A change in demographics and culture promotes ecotourism, organic food production and lesser impact recreation.

5.7.1 Industry, Businesses and Institutions

Tehama County's economy is strongly based in resource extraction as most of the land is used as cropland, range and pasture land, or woodland. The area's many natural resources support its primary industries of manufacturing, agriculture and trade.

According to the California Department of Finance, there are over 450 service-based establishments in Tehama County, followed by the trade industry (wholesale and retail) and mining/utility construction businesses. According to the 2006-2008 American Community Survey by the U.S. Census, the prevailing industry in Tehama County is educational services, health care and social assistance (20.7 percent). About 17.6 percent of the County's industry is in retail trade. Manufacturing makes up about 9.5 percent of Tehama County's industry, followed by agriculture, forestry, fishing, hunting and mining at 9 percent. Only about 1 percent of the industry in the County is involved with information-based businesses (see Figure 5-5). Diversifying the County's businesses and industries could improve the County's economic base and provide a broad range of employment opportunities for the county's residents.

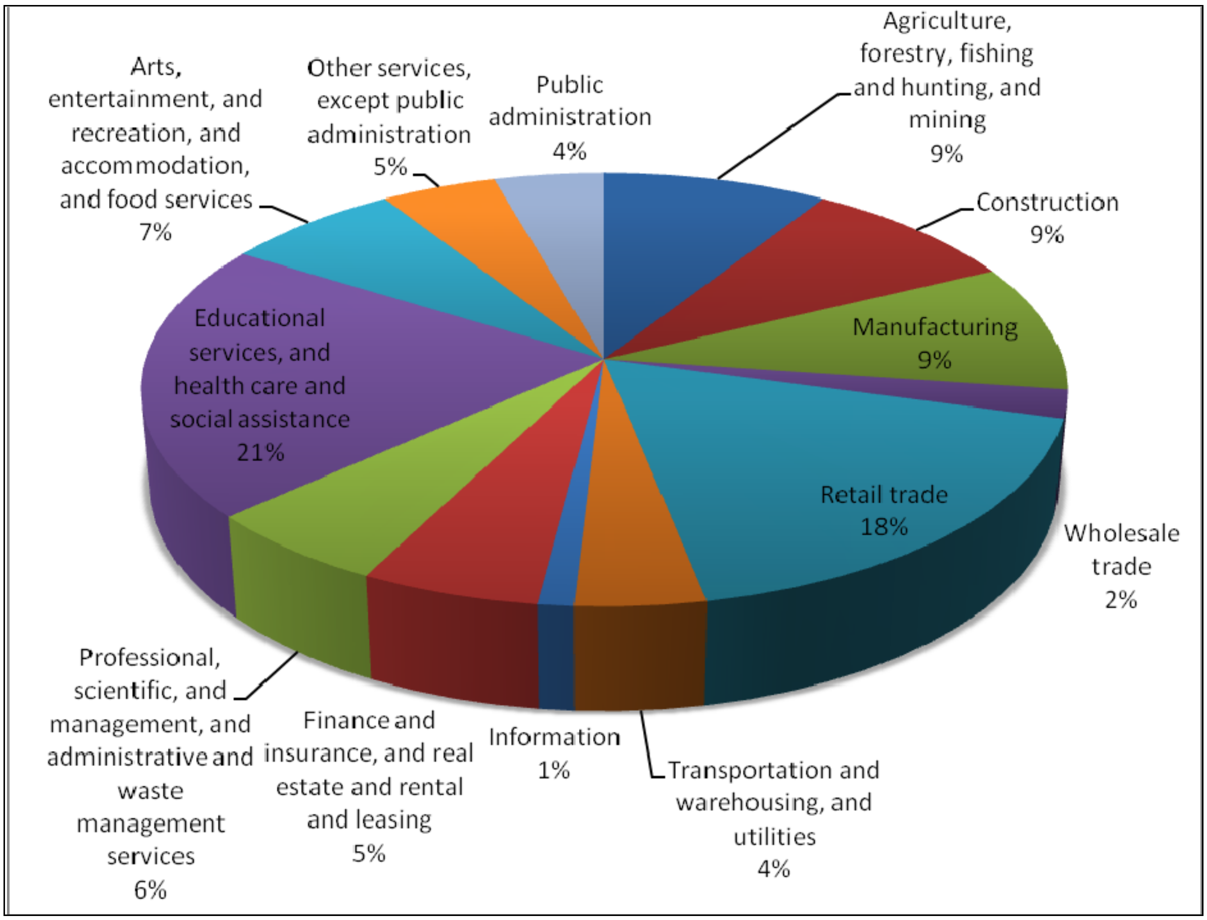


Figure 5-5. Industry in Tehama County

Tehama County hosts a range of major employers including the Tehama County Government, Sierra Pacific Lumber and Millwork Industries, Wal-Mart store and distribution center and the Rolling Hills Casino. The County benefits from a variety of business activity ranging from heavy industrial/manufacturing, to agriculture and to the retail services sectors.

5.7.2 Employment Trends and Occupations

According to the 2006-2008 American Community Survey, about 54 percent of Tehama County's population is in the labor force. This number may be reflective of the number of retired persons in Tehama County, as the fourth largest age group (ages 65 to 74) is not typically in the active work force.

Tehama County's unemployment trends have closely mirrored the state's pattern; though the County's annual average unemployment rates are slightly higher (Figure 5-6). The County's unemployment rates were lowest in 2001 at 6.5 percent. Unemployment rates again dipped to 6.5 percent in 2006, but have since been on an upward trend and are expected to rise. Preliminary labor market data from the California Employment Development Department indicated that Tehama County's unemployment rate rose to 17 percent as of February 2010.

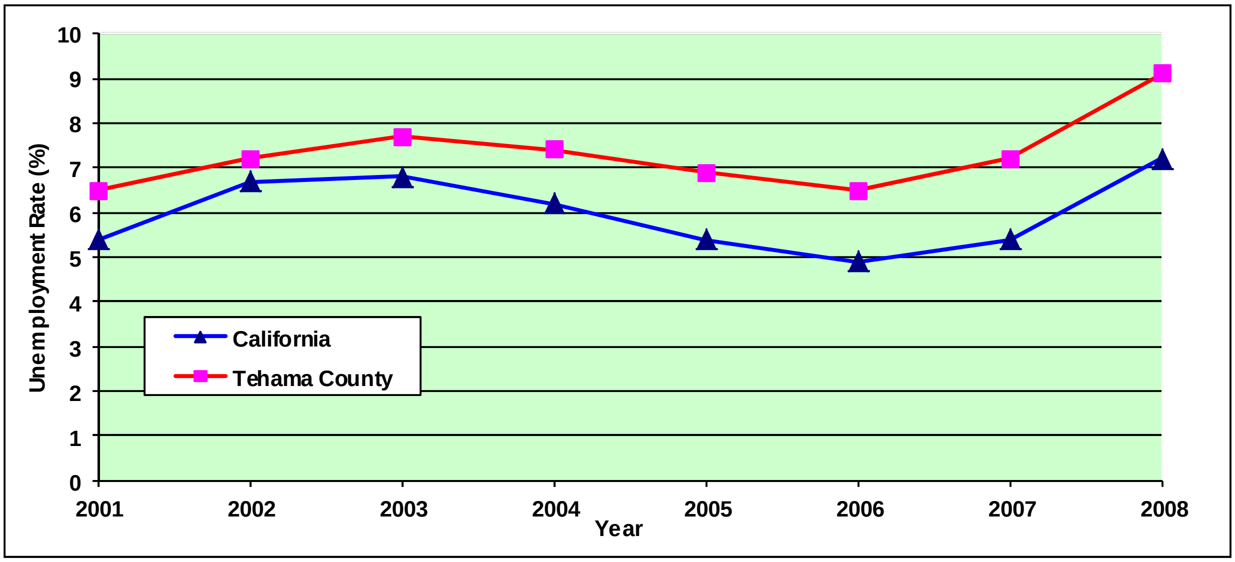


Figure 5-6. California and Tehama County Unemployment Rate

Non-agricultural employment is led by trade, transportation and utilities, followed by employment in state and local government and manufacturing. Management and professional occupations make up 27 percent of the occupations within Tehama County. The largest employers in the County are Sierra Pacific Industries and the Wal-Mart Distribution Center and Retail Store. Government workers (including federal, state and local) make up 15.3 percent of the working population. Other major employment occupations include sales and office at 23 percent and service-related occupations with 20 percent of the working population. Only about 5 percent of the employment in Tehama County is in farming, forestry, and fishing-related occupations (see Figure 5-7). The California Employment Development Department projects that the fastest growing occupations in Tehama County over the next few years will be in health services, service-related fields and educational fields.

The U.S. Census estimates that 77 percent of Tehama County workers commute to work alone (by car, truck or van) and that mean travel time to work is 23.9 minutes (the state average is 27 minutes). This suggests that the work force in Tehama County lives relatively close to the workplace.

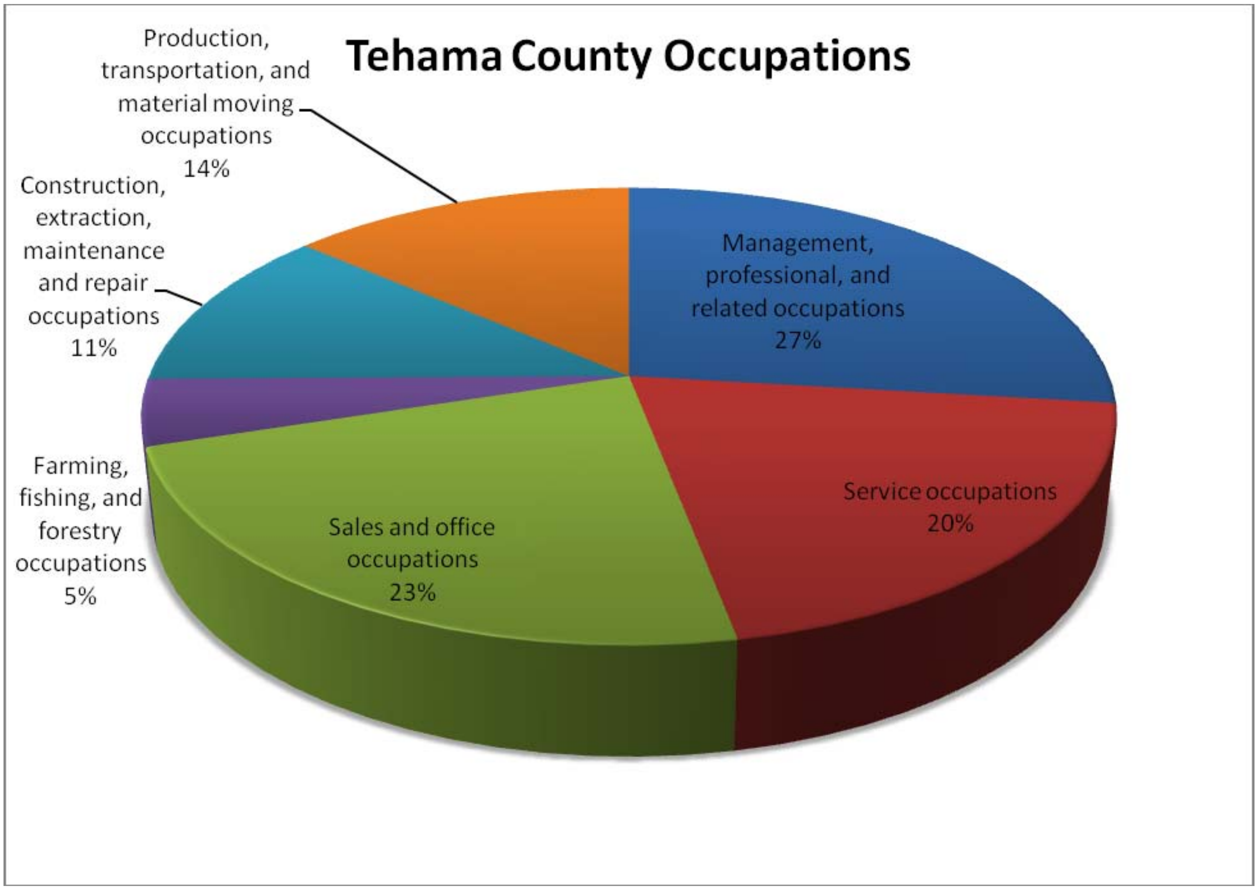


Figure 5-7. Occupations in Tehama County

5.8 FUTURE TRENDS IN DEVELOPMENT

The County and its cities have adopted comprehensive plans that govern land use decision and policy making their jurisdictions. Decisions on land use will be governed by these programs. 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 Tehama County.

All municipal planning partners will incorporate by reference the Tehama County Hazard Mitigation Plan in their comprehensive plans. 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.

5.9 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 to include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information as part of the planning process (44 CFR, 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.

5.9.1 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 plan participate in the NFIP and have adopted regulations that meet the NFIP requirements. At the time of the preparation of this plan, all participating jurisdictions in the partnership were in good standing with NFIP requirements.

5.9.2 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, CalEMA, 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 CalEMA 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.

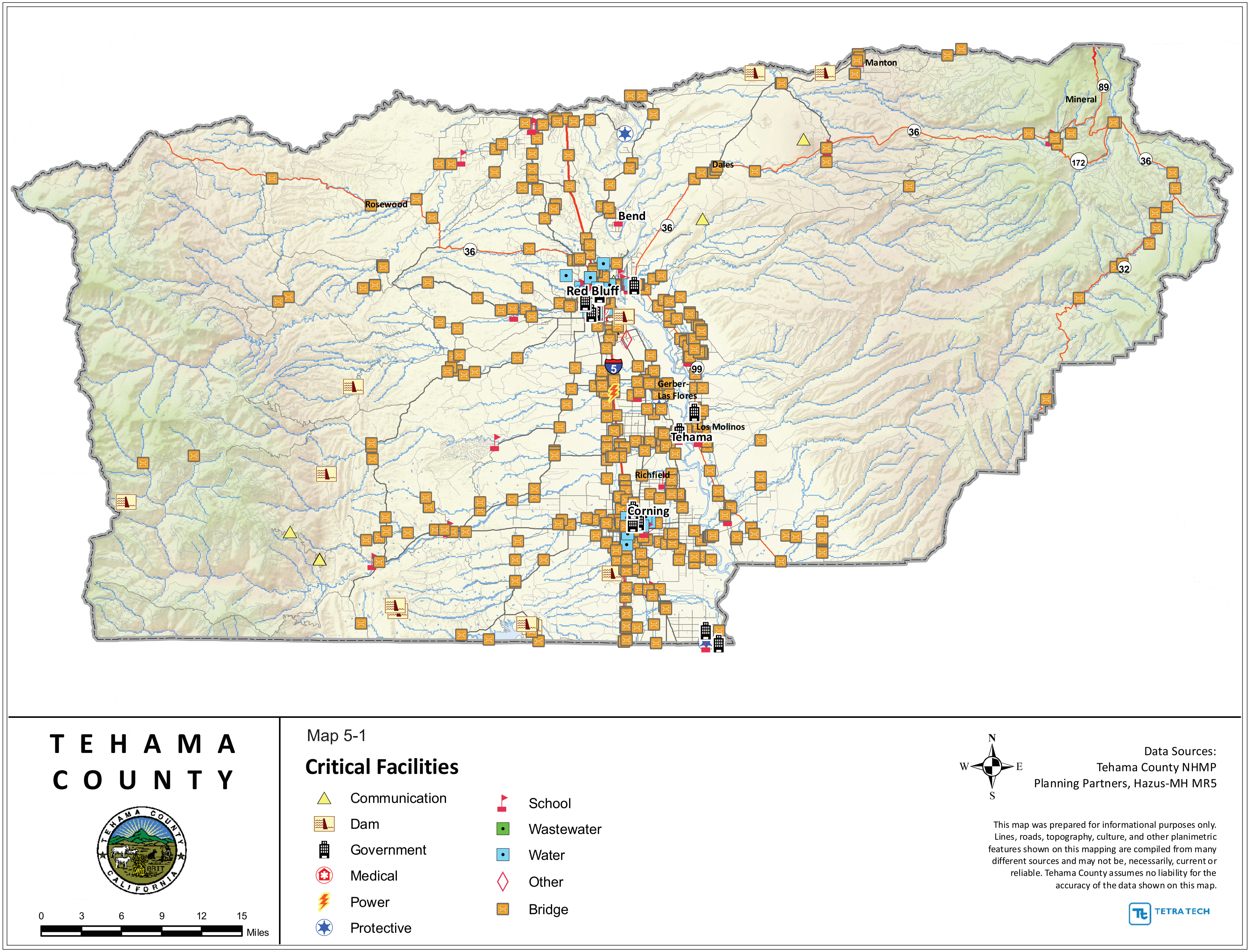
5.9.3 Cities and County

The Tehama County Flood Mitigation Plan

The Tehama County Flood Mitigation Plan (FMP) was prepared in October 2006 on behalf of the Tehama County Flood Control and Water Conservation District. The purpose of the FMP is to identify and characterize hazards and risks associated with flooding in Tehama County and to develop a program of mitigation measures to reduce or eliminate long-term flood risks to people and property. The FMP was prepared to qualify the County for flood mitigation project funding through FEMA and to facilitate preparing the flood hazard element of a hazard mitigation plan. All actions identified in the FMP have been brought over to this hazard mitigation plan. The flood hazard risk assessment of the hazard mitigation plan (Chapter 10) will replace that contained in the FMP. The merger of these documents will enable Tehama County to better implement and maintain a single planning document for flood risk reduction within the planning area.

Planning Partner Jurisdictional Annexes

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.



Manton
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Critical Facilities
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Protective
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Wastewater
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Data Sources:
Tehama County NHMP
Planning Partners, Hazus-MH MR5
This map was prepared for informational purposes only. Lines, roads, topography, culture, and other planimetric features shown on this mapping are compiled from many different sources and may not be, necessarily, current or reliable. Tehama County assumes no liability for the accuracy of the data shown on this map.
TETRA TECH

CHAPTER 6.
AVALANCHE

6.1 GENERAL BACKGROUND

Avalanches involve rapid, down-slope movement of snow, ice and potentially other debris. Avalanches can occur whenever a sufficient depth of snow is deposited on slopes steeper than about 20 degrees, with the most dangerous coming from slopes in the 35- to 40-degree range. Avalanche-prone areas can be identified with some accuracy, since they typically follow the same paths year after year, leaving scarring on the paths. However, unusual weather conditions can produce new paths or cause avalanches to extend beyond their normal paths.

In the spring, warming of the snowpack occurs from below (from the warmer ground) and above (from warm air, rain, etc.). Warming can be enhanced near rocks or trees that transfer heat to the snowpack. The effects of a snowpack becoming weak may be enhanced in steeper terrain where the snowpack is shallow, and over smooth rock faces that may focus meltwater and produce “glide cracks.” Such slopes may fail during conditions that encourage melt.

Wind can affect the transfer of heat into the snowpack and associated melt rates of near-surface snow. During moderate to strong winds, the moistening near-surface air in contact with the snow is constantly mixed with drier air above through turbulence. As a result, the air is continually drying out, which enhances evaporation from the snow surface rather than melt. Heat loss from the snow necessary to drive the evaporation process cools off near-surface snow and results in substantially less melt than otherwise might occur, even if temperatures are well above freezing.

When the snow surface becomes uneven in spring, air flow favors evaporation at the peaks, while calmer air in the valleys favors condensation there. Once the snow surface is wet, its ability to reflect solar energy drops dramatically; this becomes a self-perpetuating process, so that the valleys deepen (favoring calmer air and more heat transfer), while more evaporation occurs near the peaks, increasing the differential between peaks and valleys. However, a warm wet storm can quickly flatten the peaks as their larger surface area exposed to warm air, rain or condensation hastens their melt over the sheltered valleys.

DEFINITIONS

Avalanche—Any mass of loosened snow or ice and/or earth that suddenly and rapidly breaks loose from a snowfield and slides down a mountain slope, often growing and accumulating additional material as it descends.

Slab avalanches—The most dangerous type of avalanche, occurring when a layer of coherent snow ruptures over a large area of a mountainside as a single mass. Like other avalanches, slab avalanches can be triggered by the wind, by vibration, or even by a loud noise, and will pull in surrounding rock, debris and even trees.

Climax avalanches—An avalanche involving multiple layers of snow, usually with the ground as a bed surface.

Loose snow avalanches—An avalanche that occurs when loose, dry snow on a slope becomes unstable and slides. Loose snow avalanches start from a point and gather more snow as they descend, fanning out to fill the topography.

Powder snow avalanches—An avalanche that occurs when sliding snow has been pulverized into powder, either by rapid motion of low-density snow or by vigorous movement over rugged terrain.

Surface avalanches—An avalanche that occurs only in the uppermost snow layers.

Wet snow avalanche—An avalanche in wet snow, also referred to as a wet loose avalanche or a wet slab avalanche. Often the basal shear zone is a water-saturated layer that overlies an ice zone.

6.2 HAZARD PROFILE

6.2.1 Past Events

The California State Hazard Mitigation Plan reports property damage and loss of life caused by avalanches across the state. From 1950 through 1997, 15 deaths were reported as a result of avalanche. Tehama County is not listed among the 16 counties affected by avalanche during that timeframe, but avalanches do occur in the eastern portion of the county. An example of the type of event possible in the planning area is the following report from the Mt. Shasta Avalanche Center (avalanche.org, 2000):

> *On January 30th National Park Service personnel, National Ski Patrol Volunteers and Tehama County Sherriff's Search and Rescue successfully rescued a cross-country skier that had been buried by an avalanche for nearly six hours in approximately five feet of snow…. At 12:15 p.m., the park personnel received notification from an individual that his partner had been buried in an avalanche. The reporting party gave incorrect directions as to where the incident had occurred. The search team did not reach the RP until four hours from the time it was reported which was 12:15 p.m. which was 1620 hours. At 1715 hours a member of the California Rescue Dogs Association, Ms. Claudia Houghton and search dog Nikiya, arrived on scene. The location was a 1 mile north of Diamond Peak. The search team found clues of the buried victim and determined the last seen area. They were able to narrow the search area and started probing. A National Ski Patrol volunteer was spot probing the area and got a hit. They had the dog alerted in that same area after the hit. Searchers dug down and found the avalanche victim five feet under the snow in a sitting position. The victim was given first aid and transported immediately. At the hospital, the victim's body temperature was recorded as 89ºF with no other injuries. The individual was released from the hospital 2-1-00. The avalanche had a crown of 12" and was 200 yards wide and ran less than 50 ft. It was a road cut that slid when crossing underneath it.*

6.2.2 Location

Avalanches can occur on any snow-covered slope, and can cause death, injury and property damage. Avalanche hazard can vary with differences in terrain, weather, and snow-pack. Avalanche science is evolving, and maps of avalanche hazard covering all affected areas of the entire United States are not presently available. Ski areas, highway departments, and forecast centers may produce hazard maps and atlases. Geologic/natural hazard maps may depict avalanche hazard. Local studies of avalanche hazard may be conducted by independent consulting firms in order to meet building or planning requirements.

Some areas of the state such as the Mt. Shasta vicinity have prepared "Potential Avalanche Starting zone" maps that look at slope, exposure and historical accumulated snowfall to identify areas of avalanche risk for advisory purposes. These types of maps do not currently exist for Lassen Peak or the Tehama County planning area. Therefore, mapping the extent and location of this hazard in not possible at this time.

6.2.3 Frequency

Frequency of occurrence of the avalanche hazard is dependent upon several parameters, most notably snow accumulation. In California, periods of high snow accumulations can coincide with the La Niña weather pattern, which is caused by cooler than normal sea-surface temperatures in the central and eastern tropical Pacific Ocean. La Niña conditions recur every few years and can persist for as long as two years

At lower mountain elevations, the avalanche season begins in November and continues until the last remnants of snow have melted in early summer. In high alpine regions, the hazard continues year-round.

6.2.4 Severity

A number of weather and terrain factors determine avalanche severity and danger:

- Weather:
  - Storms—A large percentage of all snow avalanches occur during and shortly after storms.
  - Rate of snowfall—Snow falling at a rate of 1 inch or more per hour rapidly increases avalanche danger.
  - Temperature—Storms starting with low temperatures and dry snow, followed by rising temperatures and wetter snow, are more likely to cause avalanches than storms that start warm and then cool with snowfall.
  - Wet snow—Rainstorms or spring weather with warm, moist winds and cloudy nights can warm the snow cover, resulting in wet snow avalanches. Wet snow avalanches are more likely on sun-exposed terrain (south-facing slopes) and under exposed rocks or cliffs.
- Terrain:
  - Ground cover—Large rocks, trees and heavy shrubs help anchor snow.
  - Slope profile—Dangerous slab avalanches are more likely to occur on convex slopes.
  - Slope aspect—Leeward slopes are dangerous because windblown snow adds depth and creates dense slabs. South-facing slopes are more dangerous in the springtime.
  - Slope steepness—Snow avalanches are most common on slopes of 30 to 45 degrees.

The common factors contributing to the avalanche hazard are old snow depth, old snow surface, new snow depth, new snow type, density, snowfall intensity, precipitation intensity, settlement, wind direction and speed, temperature, and subsurface snow crystal structure.

6.2.5 Warning Time

The time of an avalanche release depends on the condition of the snow pack; which can change rapidly during a day and particularly during rainfall. Research in the Cascade Mountains has shown that most natural avalanches occurred less than 1 hour after the onset of rain; in these cases the snow pack was initially weak (Washington Emergency Management Division, 1996). In cases where the snow pack was stronger, avalanche activity was delayed or did not occur. Nonetheless an avalanche can occur with little or no warning time, which makes them particularly deadly.

6.3 SECONDARY HAZARDS

Avalanches can cause several types of secondary effects, such as blocking 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 avalanches are power and communication failures. Avalanches also can damage rivers or streams, potentially harming water quality, fisheries and spawning habitat.

6.4 CLIMATE CHANGE IMPACTS

Snow avalanches are mainly ruled by temperature fluctuations, heavy precipitation and wind regimes. Climate change is likely to modify the frequency and magnitude of both ordinary and extreme avalanche events. However, these possible changes are not taken into account in current engineering practice:

reference scenarios and return periods for avalanche hazard management are always computed under the assumption of a stationary process. Unlike other phenomena such as tropical storms, snow avalanches are rarely used as indicators of climate change.

6.5 EXPOSURE

There is minimal development in the mountains of Tehama County, so the County’s exposure to the avalanche hazard is small. Most mountainous areas in the County are part of the Lassen National Forest and other protected forests.

6.5.1 Population

There are no major residential populations exposed to avalanches in the County. Most of the avalanche hazard area is uninhabited or has minimal development. Recreational users of the Lassen Volcanic National Park in the winter, such as back country skiers and climbers, could be exposed to the hazard.

6.5.2 Property

There is little or no developed property that is exposed to avalanches. Buildings exposed include National Forest huts and temporary structures belonging to mining and forestry operations.

6.5.3 Critical Facilities and Infrastructure

There are no critical facilities exposed to avalanches. Some infrastructure—mostly roads and bridges—may be exposed to the avalanche hazard. However, without avalanche hazard mapping, it is not possible to identify facilities at risk.

6.5.4 Environment

Avalanches are a natural event, but they can negatively affect the environment. This includes trees located on steep slopes. A large avalanche can knock down many trees and kill the wildlife that lives in them. In spring, this loss of vegetation on the mountains may weaken the soil, causing landslides and mudflows.

6.6 VULNERABILITY

In general, everything that is exposed to an avalanche event is vulnerable. The risk is especially great at times of the year when rapid warming follows heavy, wet snowfall. There may be an impact on Tehama County’s economy as a result of the avalanche hazard. The timber industry, power companies, recreational resorts, homeowners and recreational groups depend on relatively free access to wildland areas that may be restricted during periods of high avalanche threat.

6.7 FUTURE TRENDS IN DEVELOPMENT

Future trends in development cannot be evaluated until avalanche hazard areas are accurately mapped. High-density development in areas susceptible to the avalanche hazard is not anticipated because most of these areas are protected as national parks or forests. However, populations that use these areas for recreational uses can be anticipated to increase, as the population in Tehama County and neighboring areas continues to grow.

6.8 SCENARIO

In a worst-case scenario, an avalanche would occur in the Sierra Nevada Mountains after a series of storms. Storms starting with low temperatures and dry snow, followed by rising temperatures and wetter snow, are most likely to cause avalanches.

6.9 ISSUES

The only issue of concern in the event of an avalanche is the threat to recreational users and property. The U.S. Forest Service, National Park Service, and National Weather Service currently have programs to monitor avalanche zones and forecast avalanche danger. However, there is no effective way to keep the public out of avalanche-prone areas, even during times of highest risk. A coordinated effort is needed among state, county and local law enforcement, fire, emergency management, public works agencies and media to provide winter snow pack and avalanche risk information to the public.

A national program to rate avalanche risk has been developed to standardize terminology and provide a common basis for recognizing and describing hazardous conditions. This United States Avalanche Danger Scale relates degree of avalanche danger (low, moderate, considerable, high, extreme) to descriptors of avalanche probability and triggering mechanism, degree and distribution of avalanche hazard, and recommended action in back country. Figure 6-1 shows key elements of the danger scale.

This information, updated daily, is available during avalanche season from the joint NOAA/U.S. Forest Service Northwest Weather and Avalanche Center and can be obtained from Internet, NOAA weather wire, and Department of Transportation sources. Avalanche danger scale information should be explained to the public and made available through appropriate county and local agencies and the media.

Measures that have been used in other jurisdictions to reduce avalanche threat include monitoring timber harvest practices in slide-prone areas to ensure that snow cover is stabilized as well as possible, and encouraging reforestation in areas near highways, buildings, power lines and other improvements. The development of a standard avalanche report form, and the maintenance of a database of potential avalanche hazards likely to affect proposed developments in mountain wilderness areas, would be of significant value to permitting agencies.

Avalanche Safety Basics

Avalanches don't happen by accident *and most human involvement is a matter of* ***choice*** *not chance. Slab avalanches, which are triggered by the victim or a member of the victim's party, cause most avalanche accidents. However, any avalanche may cause injury or death and even small slides may be dangerous. Hence, always practice safe route finding skills, be aware of changing conditions, and carry avalanche rescue gear. Learn and apply avalanche terrain analysis and snow stability evaluation techniques to help minimize your risk. Remember that avalanche danger rating levels are only general guidelines. Distinctions between geographic areas, elevations, slope aspect and slope angle are approximate, and transition zones between dangers exist. No matter what the current avalanche danger is, there are avalanche-safe areas in the mountains.*

UNITED STATES AVALANCHE DANGER DESCRIPTORS

Danger Level (Color)	Avalanche Probability and Avalanche Trigger	Degree and Distribution of Avalanche Danger	Recommended Action in the Back Country
Low (Green)	Natural Avalanches very unlikely. Human avalanches unlikely.	Generally stable snow. Isolated areas of instability.	Travel is generally safe. Normal caution advised.
Moderate (yellow)	Natural avalanches unlikely. Human triggered avalanches possible.	Unstable slabs possible on steep terrain.	Use caution on steeper terrain on certain aspects
Moderate to High (orange)	Natural avalanches possible. Human triggered avalanches possible.	Unstable slabs possible on steep terrain.	Be increasingly cautious in steep terrain.
High (red)	Natural and human triggered avalanches likely.	Unstable slabs likely on a variety of aspects and slope angles	Travel in avalanche terrain is not recommended. Safest travel on windward ridges of lower angle slopes without steeper terrain above.
Extreme (red with black border)	Widespread natural or human triggered avalanches are certain	Extremely unstable slabs are certain on most aspects and slope angles. Large destructive avalanches possible.	Travel in avalanche terrain should be avoided and travel confined to low angle terrain well away from avalanche path run-outs.

Figure 6-1. United States Avalanche Danger Scale

CHAPTER 7.
DAM FAILURE

7.1 GENERAL BACKGROUND

7.1.1 Causes of Dam Failure

Dam failures in the United States typically occur in one of four ways (see Figure 7-1):

- 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, such as earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage. The most likely disaster-related causes of dam failure in Tehama 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)

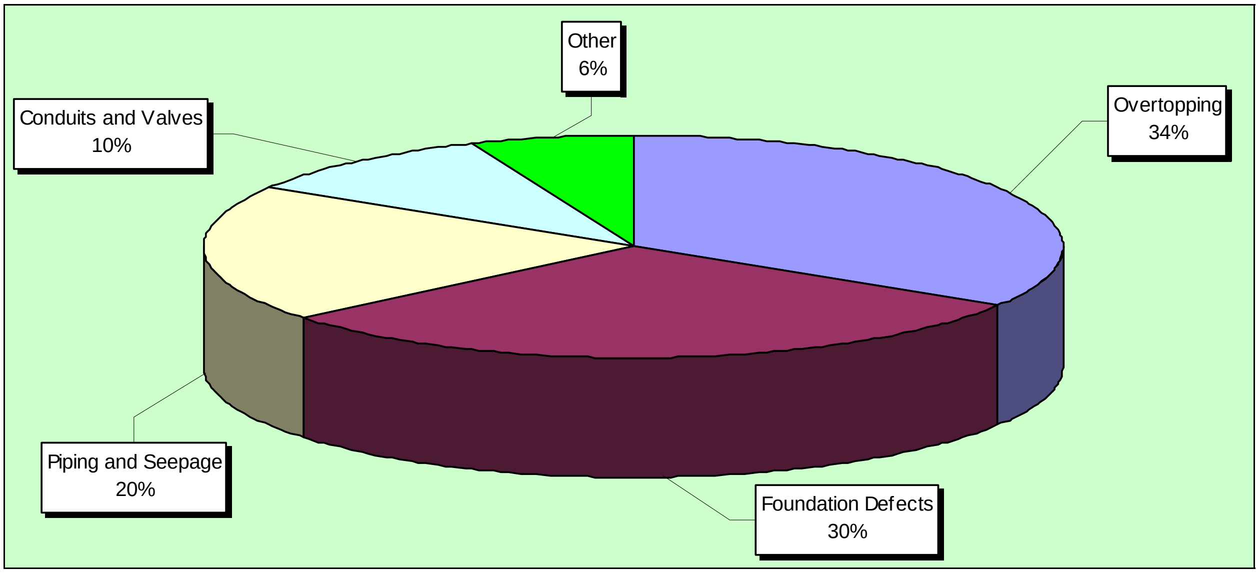


Figure 7-1. Historical Causes of Dam Failure

7.1.2 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 staff inspect the site. When an application is received, the Division reviews the plans to ensure that the dam is designed to meet minimum requirements and that the design is appropriate for known geologic conditions. After approval of the application, the Division inspects the construction to ensure that the work is done in accordance with the approved plans. 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 10 meters (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 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.

7.2 HAZARD PROFILE

7.2.1 Past Events

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 1928 failure of the St. Francis Dam in Los Angeles County, which 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. According to the California State Hazard Mitigation Plan, there have been nine dam failures in the state since 1950, none of them in Tehama 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. California has had about 45 failures of non-federal dams, most of them caused by overtopping. Other reasons include shortcomings in the dams or an inadequate assessment of surrounding geomorphologic characteristics.

7.2.2 Location

According to California Department of Water Resources Dam Safety Program, there are 10 dams in Tehama County and three dams outside the county with inundation areas that reach into Tehama County (Macumber, Shasta and Whiskeytown). Table 7-1 lists these dams. Seven are operated by federal or tribal agencies, and the remainder are under the jurisdiction of the state.

TABLE 7-1.
DAMS IN SISKIYOU COUNTY

Name	National ID #	Water Course	Owner	Year Built	Dam Type	Crest Length (feet)	Height (feet)	Storage Capacity (acre-feet)	Drainage area (sq. mi.)
Black Butte Reregulating	CA01226	Stony Creek	City of Santa Clara	1989	Gravity	1,464	25	9	0.05
Corral	CA00527	Kendrick Creek	TM Cattle Company	1959	Earthen	500	31	51	4
Macumber	CA00393	N. Battle Creek	PG&E	1907	Earth & Rock	2,425	28	425	7.7
S. Log Pond	CA00529	Tr. To Sacramento River	Meyers Motels Ltd	1957	Earthen	540	20	146	17
Sunflower	CA01116	Sunflower Gulch	Newell T & Anne W. Partch	1976	Earthen	720	50	420	21
Top Cat	CA01115	Tr. to Barnin Creek	Paskenta Band of Nomlaki Indians of CA	1976	Earthen	830	26	516	68
Black Butte	CA10102	Stony Creek	Corps of Engineers	1963	Earthen	2,970	156	143,700	741
Finley	CA10309	Oak Creek	US Forest Service	Unknown	Earthen	500	6	70	--
Orwick	CA10355	Unnamed	US Bureau of Land Management	1950	Earthen	421	22	88	12
Red Bluff Div.	CA10181	Sacramento River	US Bureau of Reclamation	1964	Gravity	752	41	3,920	530
Rye	CA00528	Kendrick Creek	TM Cattle Company	1959	Earthen	350	37	3	9
Shasta	CA10186	Sacramento River	US Bureau of Reclamation	1945	Gravity	3,460	521	4,552,000	6,665
Whiskeytown	CA10204	Clear Creek	US Bureau of Reclamation	1963	Earthen	4,000	263	241,100	201

Maps 7-1 through 7-3 show inundation zones for the Macumber, Shasta and Whiskeytown dams, the only dams affecting the planning area for which inundation mapping has been prepared. Areas of the County most threatened by dam inundation are those along the Sacramento River corridor, including the cities of Red Bluff and Tehama.

7.2.3 Frequency

Dams are constructed with safety features known as “spillways” that allow water to overtop the dam if the reservoir fills too quickly. Spillway overflow events, often referred to as “design failures,” result in increased discharges downstream and increased flooding potential. The “residual risk” associated with dams is the risk beyond that for which safeguards have been implemented. However, the probability of any type of dam failure is low in today’s regulatory and dam safety oversight environment. Dam failure events usually coincide with events such as earthquakes, landslides and excessive rainfall and snowmelt.

7.2.4 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 7-2 for the hazard potential of dam failures. The Corps of Engineers hazard rating system is based only on the potential consequences of a dam failure; it does not take into account the probability of such failures.

TABLE 7-2.
CORPS OF ENGINEERS 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	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

7.2.5 Warning Time

Warning time for dam failure depends on the cause of failure. In event 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 instantaneously. Once a breach is initiated, discharging water erodes the breach until the reservoir water is depleted or the breach resists further erosion. Concrete gravity dams also tend to have a partial breach. The time of breach formation ranges from a few minutes to a few hours (U.S. Army Corps of Engineers, 1997). Several planning partners have established protocols for warning and response to imminent dam failure in the flood warning portion of their emergency operations plans. These protocols are tied to emergency action plans created by the dam owner.

7.3 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.

7.4 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. Although climate change will not increase the probability of catastrophic dam failure, it may increase the probability of design failures. If the hygrograph changes, then dam operators may be forced to release increased volumes earlier in a storm cycle to maintain required margins of safety. Such early releases can increase flood potential downstream. Throughout the west, communities downstream of dams are already experiencing increases in stream flows from earlier releases from dams.

7.5 EXPOSURE

The Level 2 HAZUS-MH protocol was used to assess the exposure to dam failure in the planning area. The model used census data at the block level and dam failure inundation data to estimate potential dam failure exposure. The inundation area evaluated represents failure of the Shasta Dam on the Sacramento River. This dam lies outside the planning area, but has significant inundation area within it. The Shasta Dam and the Whiskeytown Dam on Clear Creek are the only high-risk dams for which flood inundation mapping in the planning area is available (the inundation area for the Macumber Dam has been mapped, but there are no structures exposed to this hazard within the planning area). The mapped inundation area for the Whiskeytown Dam is entirely within the inundation area for the Shasta dam, so the exposure analysis focused on the more extensive Shasta Dam inundation area.

Dam failure exposure numbers were generated using Tehama County Assessor and parcel data. County assessor data does not include tax exempt structures, such as federal and local government buildings. Where possible, the HAZUS-MH default data was enhanced using local GIS data from county, state and federal sources. All data sources have a level of accuracy acceptable for planning purposes.

7.5.1 Population

The entire population in a dam failure inundation zone is exposed to the risk of a dam failure. The estimated population living in the inundation area mapped for this risk assessment is 14,191, 22.36 percent of the County's population. Table 7-3 summarizes the at-risk population.

**TABLE 7-3.
POPULATION AT RISK FROM DAM FAILURE**

	Affected Population	% of Total Population in Jurisdiction
Corning	0	0.00%
Red Bluff	2,902	20.62%
Tehama	418	100.00%
Unincorporated	10,850	26.27%
Total	**14,191**	**22.36%**

7.5.2 Property

The analysis estimated 6,475 structures in the mapped dam failure inundation area in the planning area. Table 7-4 summarizes the estimated value of exposed buildings and contents. The estimated $1.51 billion worth of exposed value represents 30 percent of the planning area's total assessed value.

**TABLE 7-4.
VALUE OF PROPERTY EXPOSED TO DAM FAILURE**

	Number of Buildings Exposed	Value Exposed			% of Total Assessed Value in Jurisdiction
		Building	Contents	**Total**	
Corning	0	0	0	**0**	0.00%
Red Bluff	1,362	$189,599,000	$177,843,000	**$367,442,000**	37.54%
Tehama	183	$11,667,000	$9,534,000	**$21,201,000**	100.00%
Unincorporated	4,930	$597,338,000	$524,230,000	**$1,121,568,000**	30.67%
Total	**6,475**	**$798,604,000**	**$711,607,000**	**$1,510,211,000**	**29.74%**

7.5.3 Critical Facilities

GIS analysis determined that 150 of the planning area's critical facilities (25 percent) are in the mapped Shasta Dam inundation area, as summarized in Table 7-5 and Table 7-6.

**TABLE 7-5.
CRITICAL FACILITIES IN DAM FAILURE INUNDATION AREA**

	Medical & Health Services	Government Function	Protective Function	Schools	Hazardous Materials	Other Critical Function	**Total**
Corning	0	0	0	0	0	0	**0**
Red Bluff	3	3	6	2	0	0	**14**
Tehama	0	0	0	1	0	3	**4**
Unincorporated	0	2	1	11	0	0	**14**
Total	**3**	**5**	**7**	**14**	**0**	**3**	**32**

**TABLE 7-6.
CRITICAL INFRASTRUCTURE IN DAM FAILURE INUNDATION AREA**

	Bridges	Water Supply	Wastewater	Power	Communications	Other Infrastructure	**Total**
Corning	0	0	0	0	0	0	**0**
Red Bluff	12	4	1	0	0	0	**17**
Tehama	2	2	0	0	0	0	**4**
Unincorporated	91	2	0	0	1	3	**97**
Total	**105**	**8**	**1**	**0**	**1**	**3**	**118**

7.5.4 Environment

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 destroy downstream habitat and have detrimental effects on many species of animals, especially endangered species such as salmon.

7.6 VULNERABILITY

7.6.1 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. 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.

7.6.2 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.

Inundation mapping indicates that the Shasta and Whiskeytown dam failure events would have significant differences in water depth, leading to different amounts of damage to properties. For this reason, separate loss estimates were made for the two dam failure scenarios, as summarized in Table 7-7 and Table 7-8.

It is estimated that there could be up to $69 million of loss from a Whiskeytown dam failure event. This represents 4.6 percent of the total exposure within the inundation area, or 1.37 percent of the total assessed value of the planning area. The estimated potential loss from a Shasta dam failure event is $122 million. This represents 8.1 percent of the total exposure within the inundation area, or 2.41 percent of the total assessed value of the planning area.

TABLE 7-7.
LOSS ESTIMATES FOR WHISKEYTOWN DAM FAILURE

	Estimated Loss			% of Total Assessed Value in Jurisdiction
	Building Loss	Contents Loss	**Total Loss**	
Corning	$0	$0	**$0**	0.00%
Red Bluff	$10,558,000	$19,603,000	**$30,161,000**	3.08%
Tehama	$755,000	$637,000	**$1,392,000**	6.57%
Unincorporated	$18,996,000	$18,804,000	**$37,800,000**	1.03%
Total	**$30,309,000**	**$39,044,000**	**$69,353,000**	**1.37%**

**TABLE 7-8.
LOSS ESTIMATES FOR SHASTA DAM FAILURE**

	Estimated Loss			% of Total Assessed Value in Jurisdiction
	Building	Contents	**Total**	
Corning	$0	$0	**$0**	0.00%
Red Bluff	$28,024,000	$31,887,000	**$59,911,000**	6.12%
Tehama	$762,000	$616,000	**$1,378,000**	6.50%
Unincorporated	$30,976,000	$30,224,000	**$61,200,000**	1.67%
Total	**$59,762,000**	**$62,727,000**	**$122,489,000**	**2.41%**

7.6.3 Critical Facilities

On average, critical facilities would receive 5.3 percent damage to structures and 22.3 percent damage to contents during a Whiskeytown dam failure event, and 5.7 percent damage to structures and 22.8 percent damage to contents during a Shasta dam failure event. For both scenarios, the estimated time to restore facilities to 100 percent of their functionality is 480 days.

7.6.4 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. The extent of the vulnerability of the environment is the same as the exposure of the environment.

7.7 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. 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.

7.8 SCENARIO

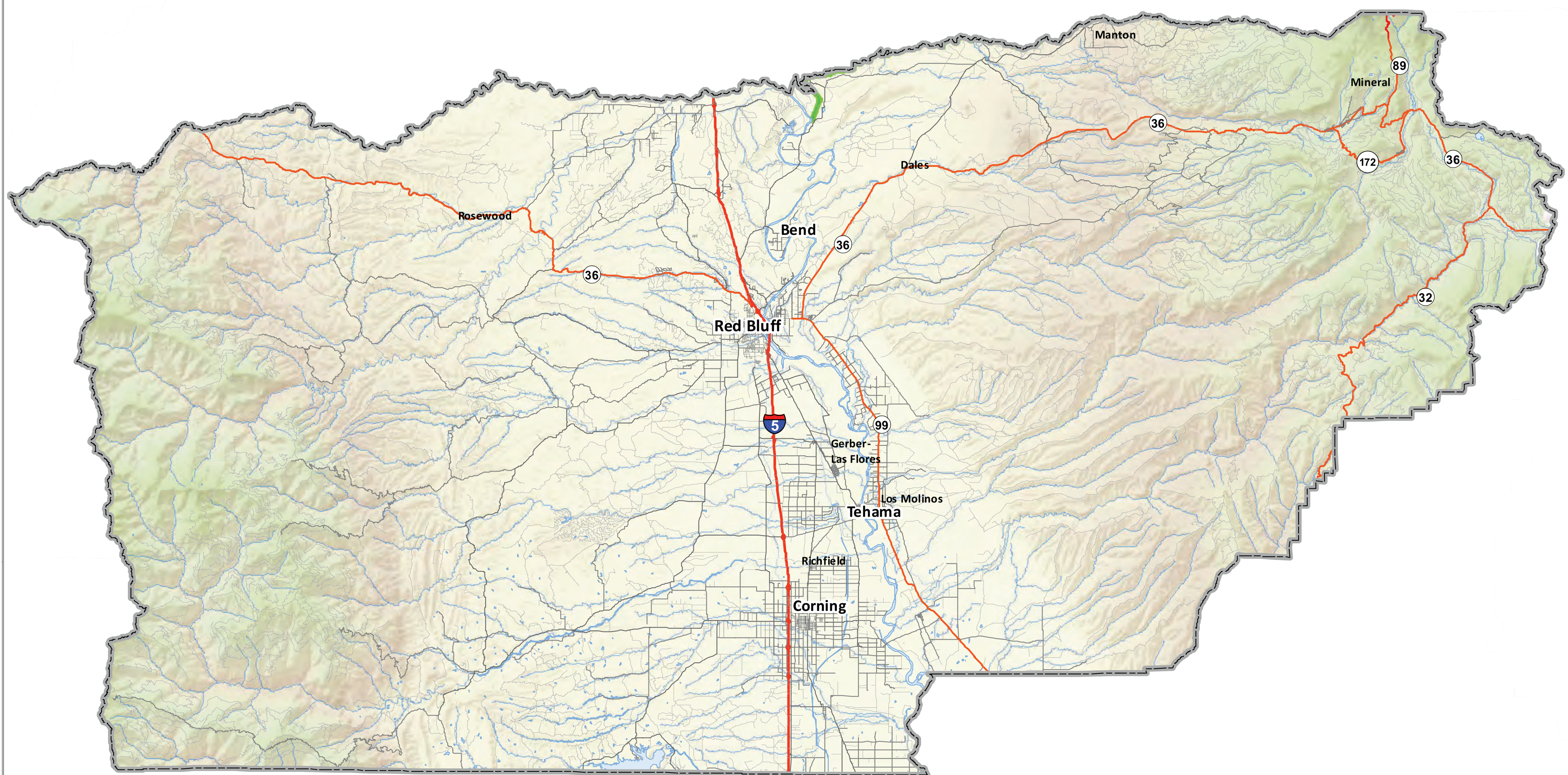
An earthquake can occur without warning at any time of the day, leading to liquefaction of soils around a dam. A human-caused failure such as a terrorist attack also could trigger a catastrophic failure of a dam.

More likely than dam failure is increased flooding due to dam operations being revised in response to climate change. Dam operations are developed using hydrographs based on historical records. If these hydrographs experience significant changes over time due to climate change, then dam operations may no longer be valid. This can 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, increasing the frequency and severity of flooding.

7.9 ISSUES

Important issues associated with the dam failure hazard include the following:

- 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.
- 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 that estimates inundation depths for federally regulated dams is already required and available; however, mapping for non-federal-regulated dams is needed to better assess the risk associated with failure of 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.



TEHAMA COUNTY

0 3 6 9 12 15 Miles

Map 7-1

Macumber Dam Inundation Area

Flood Zone

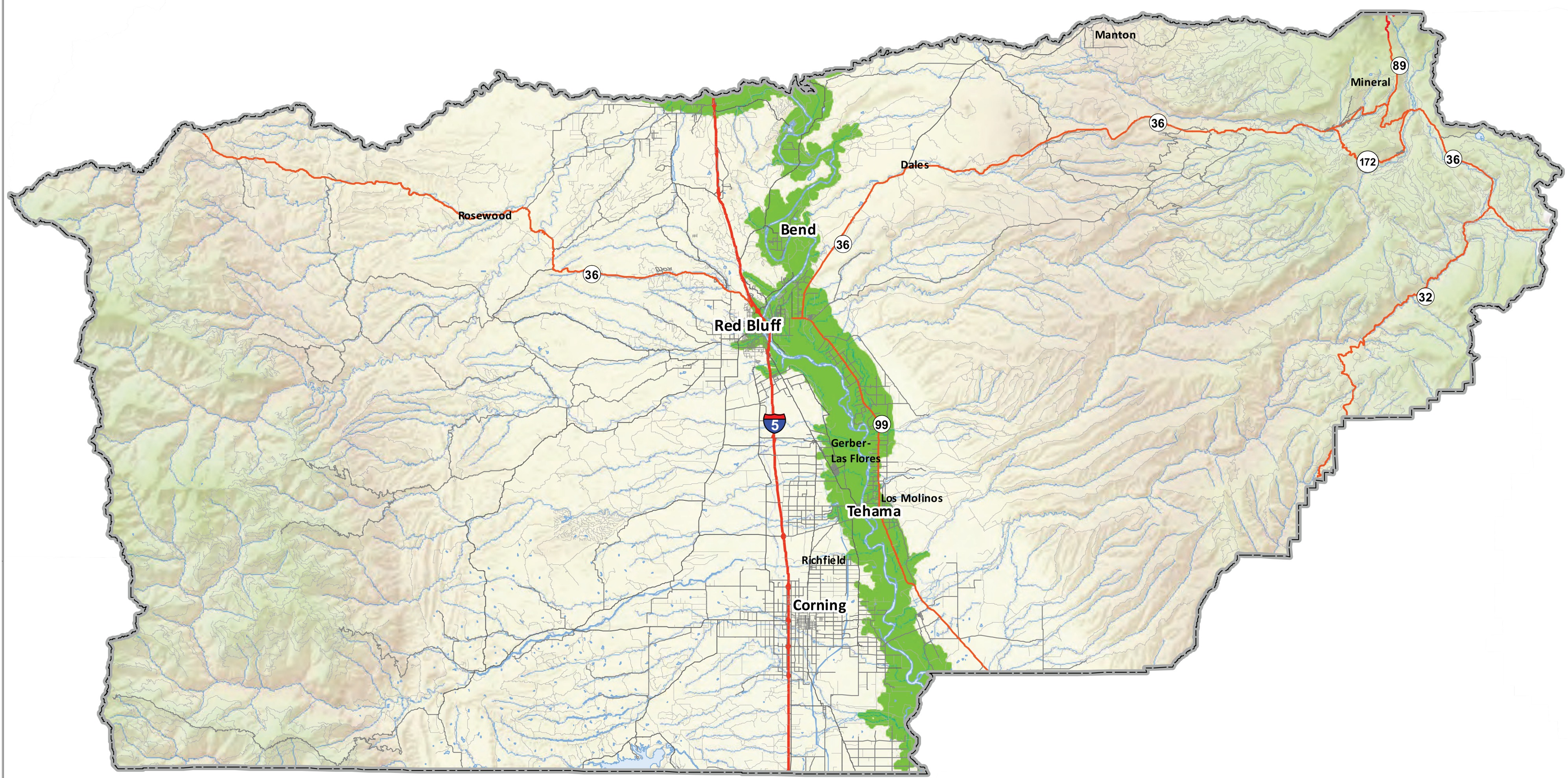
Macumber Dam Inundation Area

N W E S

Data Sources:
Dam Inundation Areas
Pacific Gas and Electric Company

This map was prepared for informational purposes only. Lines, roads, topography, culture, and other planimetric features shown on this mapping are compiled from many different sources and may not be, necessarily, current or reliable. Tehama County assumes no liability for the accuracy of the data shown on this map.

TETRA TECH



T E H A M A
C O U N T Y

0 3 6 9 12 15 Miles

Map 7-2

Shasta Dam Inundation Area

Flood Zone

Shasta Dam Inundation Area

N W E S

Data Sources:
Dam Inundation Areas
California Emergency Management Agency

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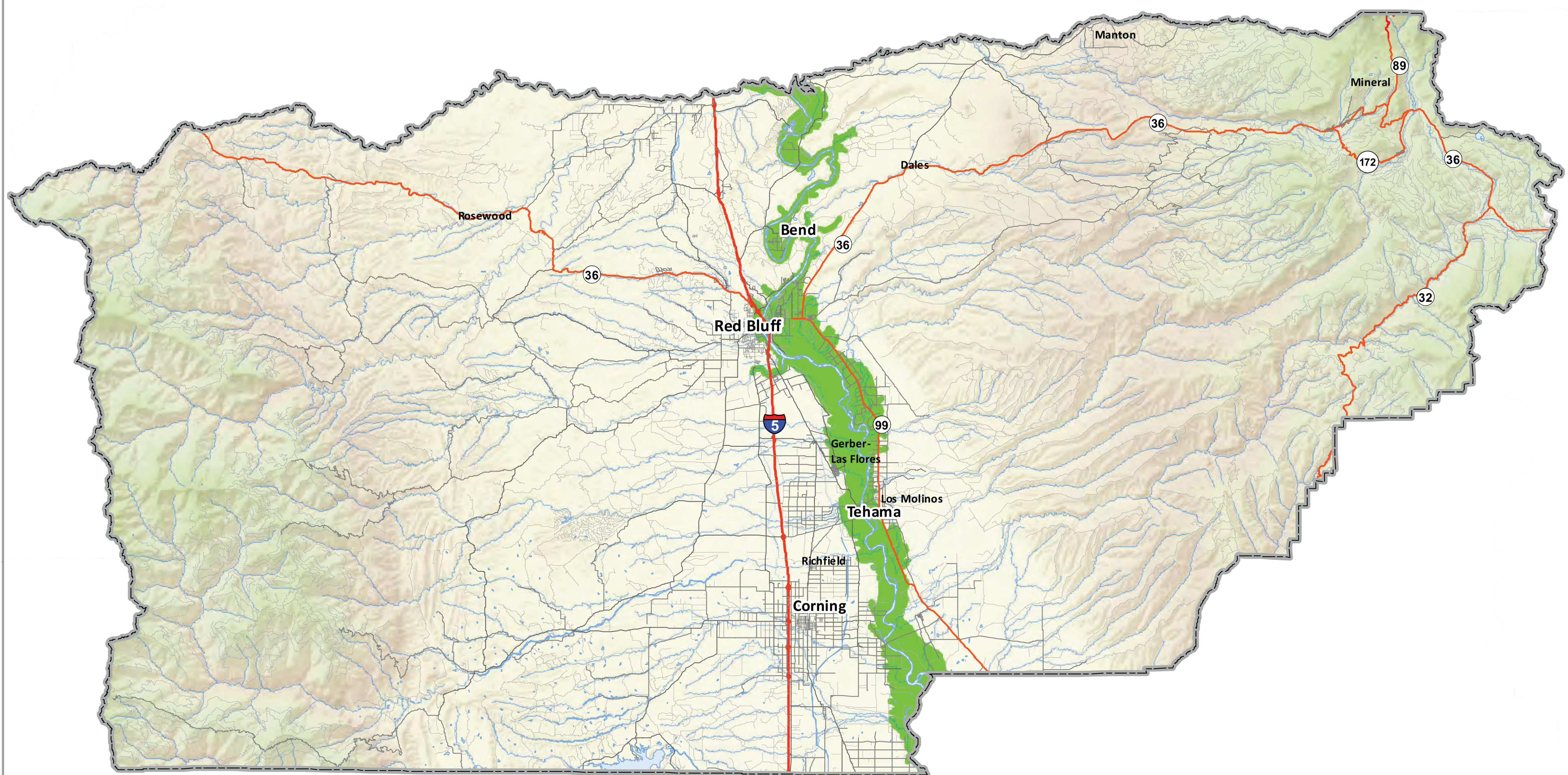
TETRA TECH



TEHAMA
COUNTY

0 3 6 9 12 15 Miles

Map 7-3

Whiskeytown Dam Inundation Area

Flood Zone

Whiskeytown Dam Inundation Area

N W E S

Data Sources:
Dam Inundation Areas
California Emergency Management Agency

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TETRA TECH

CHAPTER 8.
DROUGHT

8.1 GENERAL BACKGROUND

Drought is a prolonged period of dryness severe enough to reduce soil moisture, water and snow levels below the minimum necessary for sustaining plant, animal and economic systems. Droughts are a natural part of the climate cycle, but can have a widespread impact on the environment and the economy, depending upon their severity. Drought typically does not result in loss of life or damage to property, as do other natural disasters. The National Drought Mitigation Center uses three categories to describe likely drought impacts:

- Agricultural—Drought threatens crops that rely on precipitation.
- Water supply—Drought threatens supplies of water for irrigated crops and for communities.
- Fire hazard—Drought increases the threat of wildfires from dry conditions in forest and rangelands.

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.

8.1.1 Drought in California

Drought has impacted almost every county in California at one time or another, causing more than $2.6 million in damage. Droughts exceeding three years are relatively rare in northern California, the source of much of the state's water supply. The 1929-1934 drought established the criteria commonly used in designing storage capacity and yield for large northern California reservoirs. The driest single year in California's measured hydrologic history was 1977.

Past experience shows that drought impacts in California are felt first by those most dependent on annual rainfall: agencies fighting wild fires, ranchers engaged in dryland grazing, rural residents relying on wells in low-yield rock formations, or small water systems lacking a reliable water source. California's last major statewide drought was 1987-92. Southern California experienced dry years in the late 1990s/early 2000s, with water year 2002 setting records for the driest water year in Los Angeles and San Diego.

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.

8.2 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.

8.2.1 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 Tehama 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 Nevada Range 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. The 1987 drought was of enough significance to trigger a federal disaster declaration.

8.2.2 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 8-1 shows this index for March 2011.
- The ***Palmer Drought Index (PDI)*** 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 PDI can respond fairly rapidly. Figure 8-2 shows this index for March 2011.

- 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 PDI. Figure 8-3 shows this index for March 2011.
- 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 8-4 shows the 24-month SPI map for April 2009 through March 2011.

8.2.3 Frequency

Historical data for the Tehama County region indicate numerous period of drought, the most significant being the period from 1987 through 1994. According to the California State Hazard Mitigation Plan, Tehama County was affected by four drought incidents from 1970 to 2002. This equates to a drought every seven years on average, or a 13 percent chance of a drought in any given year.

8.2.4 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.

Unlike most disasters, droughts normally occur slowly but last a long time. On average, the nationwide annual impacts of drought are greater than the impacts of any other natural hazard. They are estimated to be between $6 billion and $8 billion annually in the United States and occur primarily in the agriculture, transportation, recreation and tourism, forestry, and energy sectors. Social and environmental impacts are also significant, although it is difficult to put a precise cost on these impacts.

Drought affects groundwater sources, but generally not as quickly as surface water supplies, although groundwater supplies generally take longer to recover. Reduced precipitation during a drought means that groundwater supplies are not replenished at a normal rate. This can lead to a reduction in groundwater levels and problems such as reduced pumping capacity or wells going dry. Shallow wells are more susceptible than deep wells. Reduced replenishment of groundwater affects streams. Much of the flow in streams comes from groundwater, especially during the summer when there is less precipitation and after snowmelt ends. Reduced groundwater levels mean that even less water will enter streams when steam flows are lowest.

A drought directly or indirectly impacts all people in affected areas. A drought can result in farmers not being able to plant crops or the failure of planted crops. This results in loss of work for farm workers and those in food processing jobs. Other water-dependent industries are commonly forced to shut down all or a portion of their facilities, resulting in further layoffs. A drought can harm recreational companies that use water (e.g., swimming pools, water parks, and river rafting companies) as well as landscape and nursery businesses because people will not invest in new plants if water is not available to sustain them.

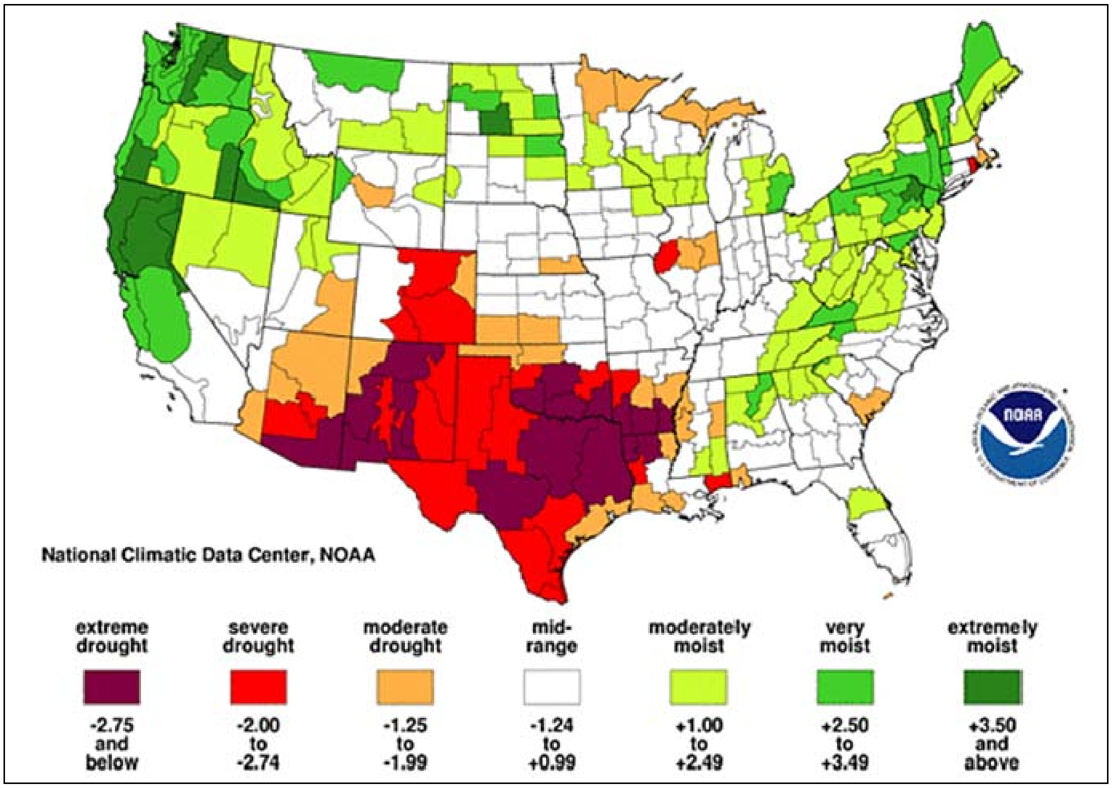


Figure 8-1. Palmer Z Index Short-Term Drought Conditions (March 2011)

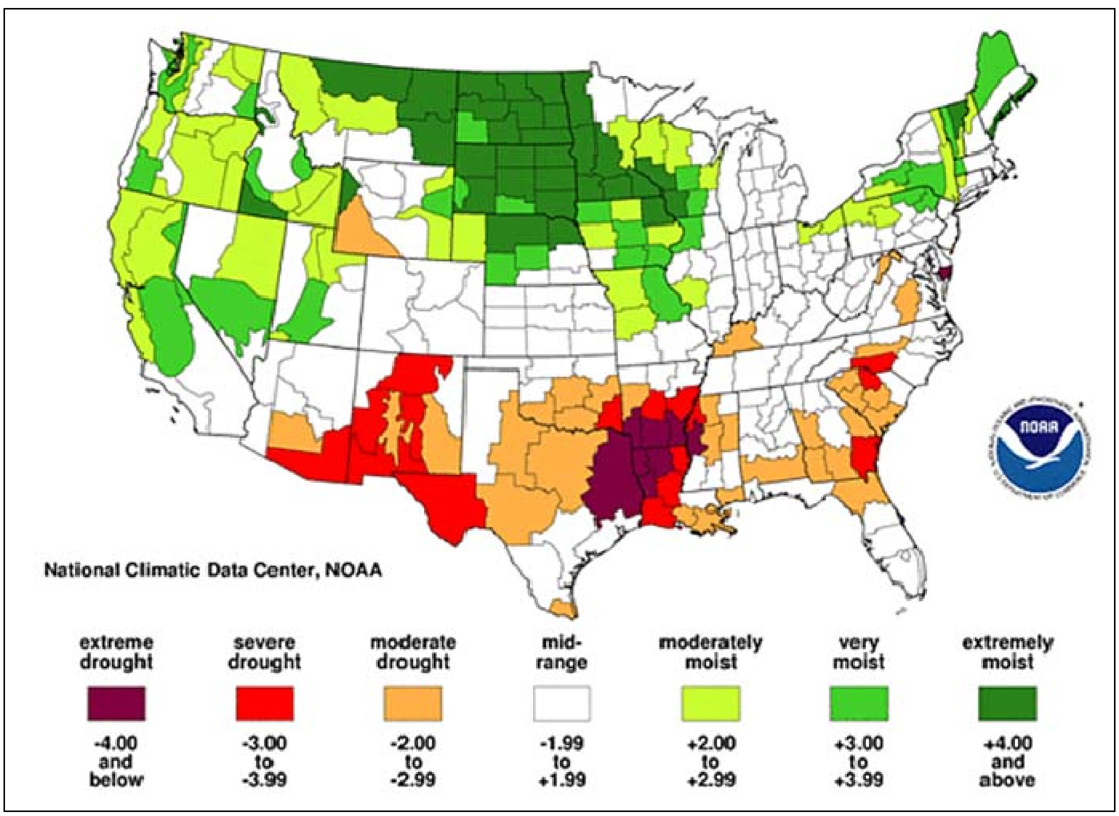


Figure 8-2. Palmer Drought Index Long-Term Drought Conditions (March 2011)

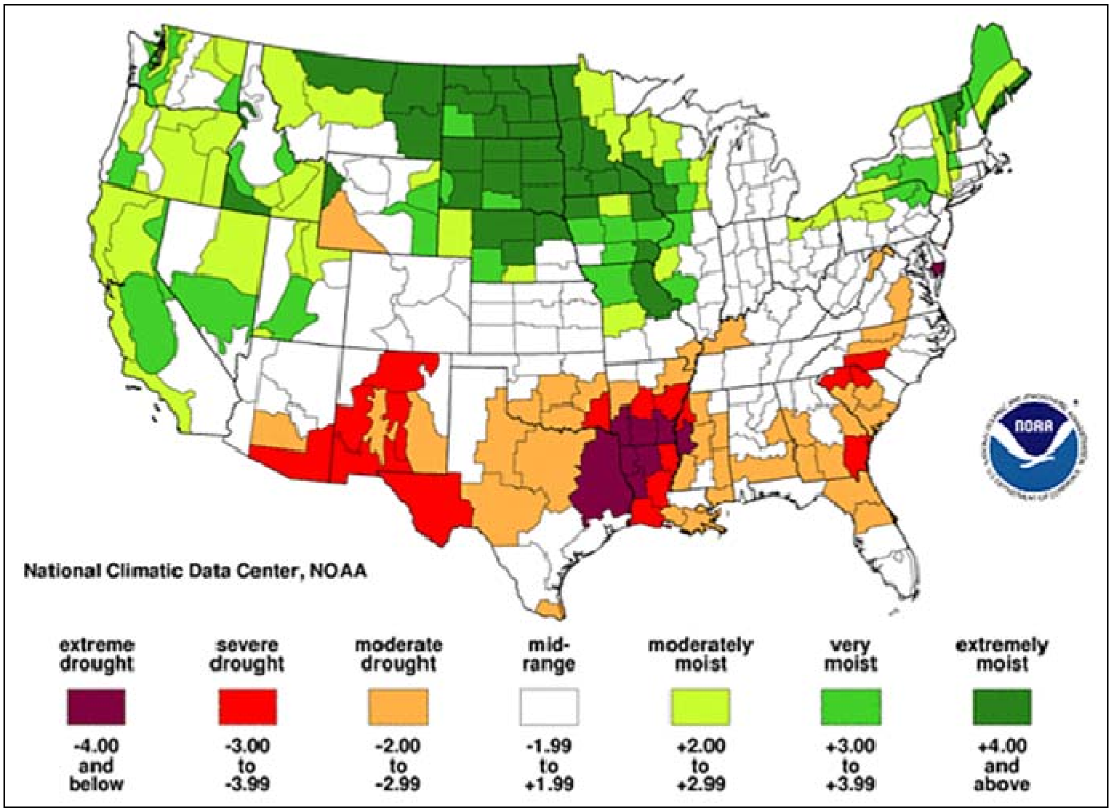


Figure 8-3. Palmer Hydrological Drought Index Long-Term Hydrologic Conditions (March 2011)

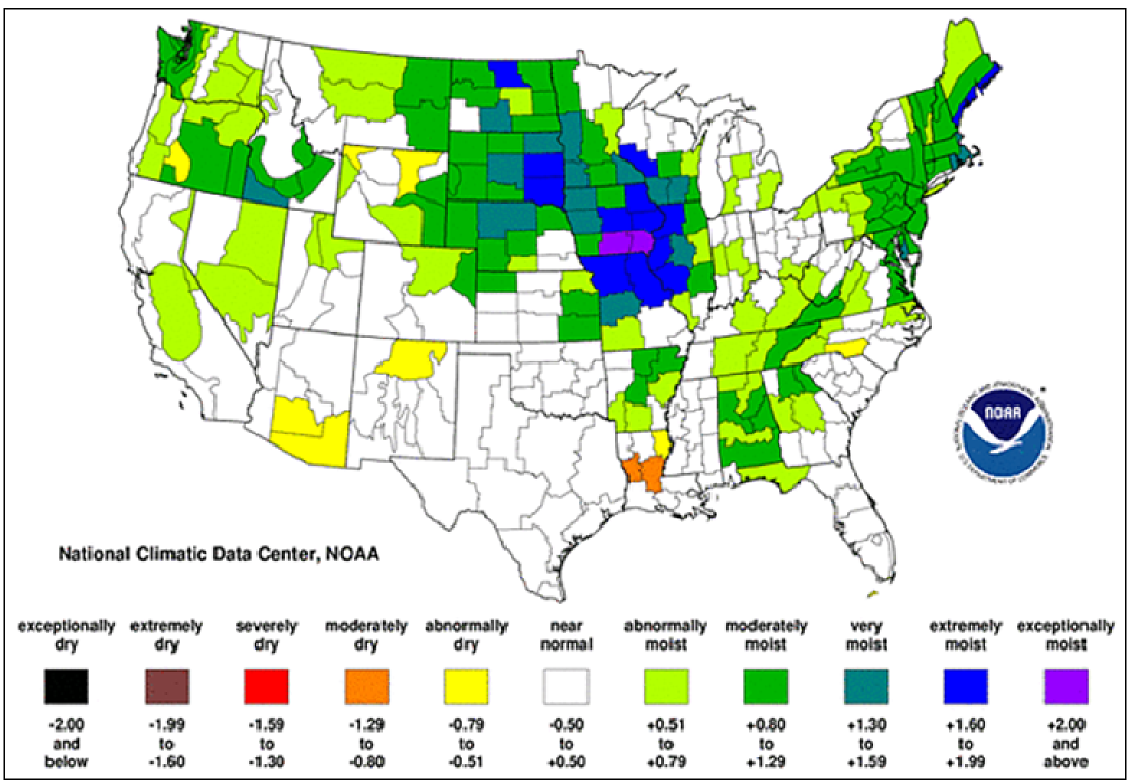


Figure 8-4. 24-Month Standardized Precipitation Index (April 2009—March 2011)

8.2.5 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.

Empirical studies conducted over the past century have shown that meteorological drought is never the result of a single cause. It is the result of many causes, often synergistic in nature; these include global weather patterns that produce persistent, upper-level high-pressure systems along the West Coast with warm, dry air resulting in less precipitation.

Scientists at this time do not know how to predict drought more than a month in advance for most locations. Predicting drought depends on the ability to forecast precipitation and temperature. Anomalies of precipitation and temperature may last from several months to several decades. How long they last depends on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of weather systems on the global scale.

8.3 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.

8.4 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. 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.

8.5 EXPOSURE

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

8.6 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.

8.6.1 Population

The planning partnership has the ability to minimize any impacts on residents and water consumers in the county should several consecutive dry years occur. No significant life or health impacts are anticipated as a result of drought within the planning area.

8.6.2 Property

No structures will be directly affected by drought conditions, 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.

8.6.3 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.

8.6.4 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.

8.6.5 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.

8.7 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.

8.8 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 Tehama 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 Tehama County could experience setbacks, especially in water dependent industries.

8.9 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 9.
EARTHQUAKE

9.1 GENERAL BACKGROUND

9.1.1 How Earthquakes Happen

An earthquake is the vibration of the earth's surface following a release of energy in the earth's crust. This energy can be generated by a sudden dislocation 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 at varying speeds.

California is seismically active because of movement of the North American Plate and the Pacific Plate. The movement of these tectonic plates creates stress that can be released as earthquakes.

Earthquakes tend to reoccur along faults, which are zones of weakness in the 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.

Faults are more likely to have earthquakes on them if they have more rapid rates of movement, have had recent earthquakes along them, experience greater total displacements, and are aligned so that movement can relieve accumulating tectonic stresses. A direct relationship exists between a fault's length and location and its ability to generate damaging ground motion at a given site. In some areas, smaller, local faults produce lower magnitude quakes, but ground shaking can be strong, and damage can be significant as a result of the fault's proximity to the area. In contrast, large regional faults can generate great magnitudes but, because of their distance and depth, may result in only moderate shaking in the area.

Geologists classify faults by their relative hazards. Active faults, which represent the highest hazard, are those that have ruptured to the ground surface during the Holocene period (about the last 11,000 years). Potentially active faults are those that displaced layers of rock from the Quaternary period (the last 1,800,000 years). Determining if a fault is "active" or "potentially active" depends on geologic evidence, which may not be available for every fault. Although there are probably still some unrecognized active faults, nearly all the movement between the two plates, and therefore the majority of the seismic hazards, are on the well-known active faults. 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.

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.

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.

9.1.2 Earthquake Classifications

Earthquakes are typically classified in one of two ways: By the amount of energy released, measured as **magnitude**; or by the impact on people and structures, measured as **intensity**.

Magnitude

Currently the most commonly used magnitude scale is the moment magnitude (M_W) scale, with the follow classifications of magnitude:

- Great—$M_W \geq 8$
- Major—M_W = 7.0 - 7.9
- Strong—M_W = 6.0 - 6.9
- Moderate—M_W = 5.0 - 5.9
- Light—M_W = 4.0 - 4.9
- Minor—M_W = 3.0 - 3.9
- Micro—$M_W < 3$

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.

Intensity

Currently the most commonly used intensity scale is the modified Mercalli intensity scale, with ratings defined as follows (USGS, 1989):

- I. Not felt except by a very few under especially favorable conditions
- 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.
- 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.
- V. Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
- 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.

- 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.
- 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.

9.1.3 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 9-1 lists damage potential and perceived shaking by PGA factors, compared to the Mercalli scale.

**TABLE 9-1.
MERCALLI SCALE AND PEAK GROUND ACCELERATION COMPARISON**

Modified Mercalli Scale	Perceived Shaking	Potential Structure Damage		Estimated PGA[a] (%g)
		Resistant Buildings	Vulnerable Buildings	
I	Not Felt	None	None	<0.17%
II-III	Weak	None	None	0.17% - 1.4%
IV	Light	None	None	1.4% - 3.9%
V	Moderate	Very Light	Light	3.9% - 9.2%
VI	Strong	Light	Moderate	9.2% - 18%
VII	Very Strong	Moderate	Moderate/Heavy	18% - 34%
VIII	Severe	Moderate/Heavy	Heavy	34% - 65%
IX	Violent	Heavy	Very Heavy	65% - 124%
X - XII	Extreme	Very Heavy	Very Heavy	>124%

a. PGA measured in percent of g, where g is the acceleration of gravity
Sources: USGS, 2008; USGS, 2010

9.1.4 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 9-2 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 9-2.
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)	

9.2 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. 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.

9.2.1 Past Events

Tehama County does not have an extensive earthquake history. According to the California State Hazard Mitigation Plan, Tehama County had only one occurrence of earthquake activity that caused any measurable damage from 1800 to 2007. The only known seismic activity in the planning area occurred in concurrence with the volcanic eruption of Lassen Peak in 1914. There has been no declared disaster activity for earthquake within the planning area since 1950.

9.2.2 Location

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 three 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.

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 9-1 and 9-2 show the estimated ground motion for the 100-year and 500-year probabilistic earthquakes in Tehama County.

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 9-3 shows NEHRP soil classifications in the county.

9.2.3 Frequency

According the California State Hazard Mitigation Plan, earthquakes large enough to cause moderate damage to structures—those of Magnitude 5.5 or larger—occur three to four times a year statewide. Strong earthquakes of Magnitude 6 to 6.9 strike on an average of once every two to three years. Major earthquakes (Magnitude 7 to 7.9) occur in California about once every 10 years.

While earthquake activity in California as a whole is frequent, the activity in Tehama County is not. The Northern California Earthquake Data Center identifies no seismic events with a magnitude of 3.0 or higher felt in Tehama County between 1910 and 2003. Northern California, including Tehama County, is in a moderate-risk area, with a majority of the County having a 2-percent probability in a 50-year period of ground shaking from a seismic event exceeding 0.48 percent of gravity (see Figure 9-1).

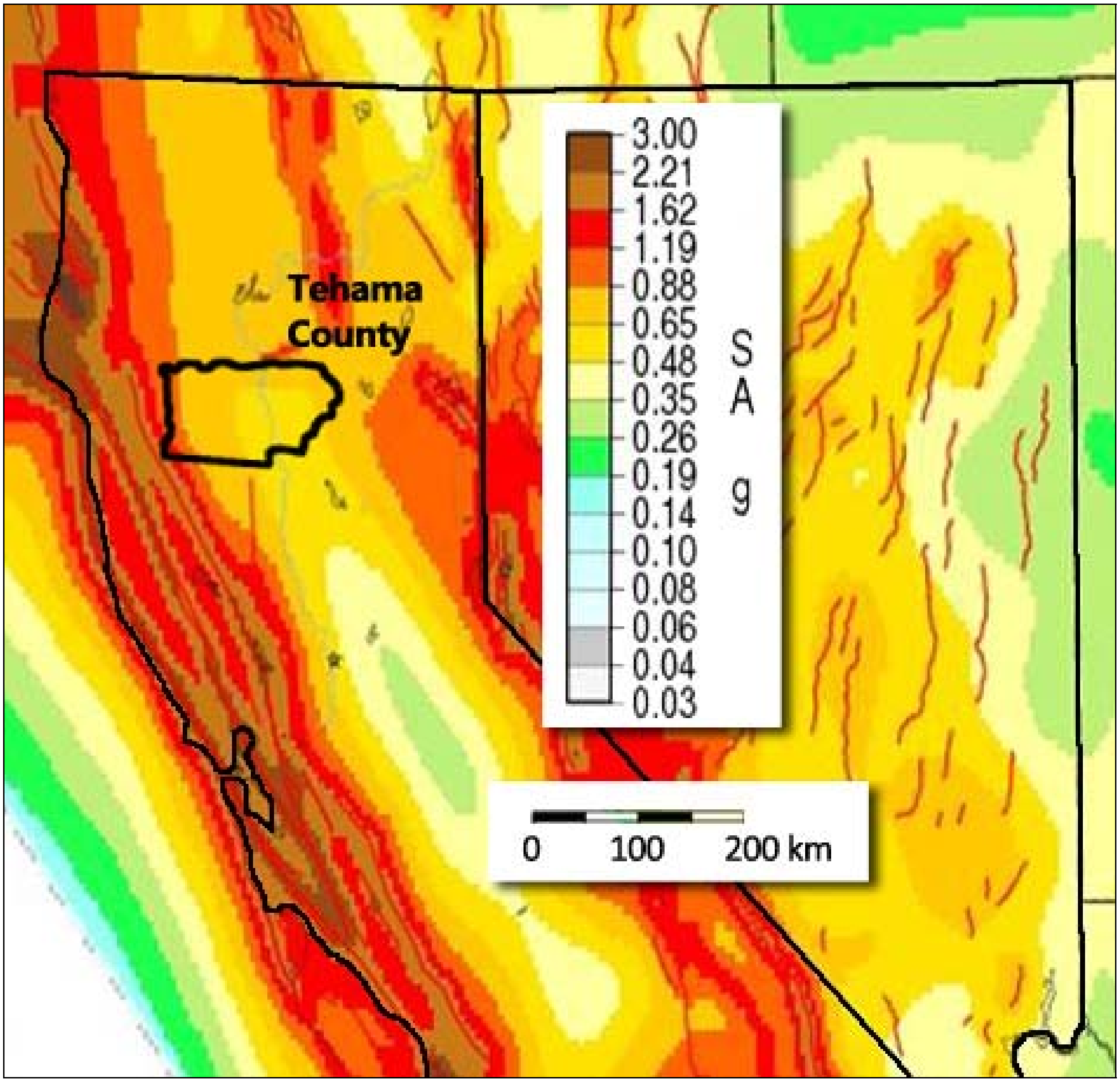


Figure 9-1. PGA with 2-Percent Probability of Exceedance in 50 Years

9.2.4 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 9-1 shows the PGAs with a 2-percent exceedance chance in 50 years in northern California. The region around Tehama County is a medium-risk area.

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?

9.2.5 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.

9.3 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.

9.4 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.

9.5 EXPOSURE

9.5.1 Population

The entire population of Tehama 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.

9.5.2 Property

The Tehama County Assessor estimates that there are 24,376 buildings in Tehama County, with a total assessed value of $5.08 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 (82 percent) are residential.

9.5.3 Critical Facilities and Infrastructure

All critical facilities in Tehama County are exposed to the earthquake hazard. Table 5-2 and Table 5-3 list 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 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.

9.5.4 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.

9.6 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.

9.6.1 Population

Three population groups are particularly vulnerable to earthquake hazards:

- **Linguistically Isolated Populations**——Approximately 5,500 residents in the planning area census blocks on NEHRP D and E soils do not speak English as their native language. This is about 19 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 1,450 households in the planning area census blocks on NEHRP D and E soils are listed as being below the poverty level. This is about 13 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 2,100 residents in the planning area census blocks on NEHRP D and E soils are over 65 years old. This is about 7 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 through a Level 2 HAZUS-MH analysis. Table 9-3 summarizes the results.

TABLE 9-3.
ESTIMATED EARTHQUAKE IMPACT ON PERSON AND HOUSEHOLDS

	Displaced Households	Persons Requiring Short-Term Shelter
100-Year Earthquake	4	3
500-Year Earthquake	64	48

9.6.2 Property

Property losses were estimated through the Level 2 HAZUS-MH analysis for the 100-year and 500-year earthquakes. Table 9-4 shows 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.

TABLE 9-4.
EARTHQUAKE BUILDING LOSS POTENTIAL

	Estimated Earthquake Loss Value					
	100- Year Probabilistic Earthquake			500- Year Probabilistic Earthquake		
Jurisdiction	Structural	Non-Structural	**Total**	Structural	Non-Structural	**Total**
Corning	$507,979	$134,909	**$642,887**	$3,035,744	$812,979	**$3,848,723**
Red Bluff	$6,189,761	$1,671,590	**$7,861,351**	$40,027,090	$11,190,031	**$51,217,121**
Tehama	$185,675	$48,186	**$233,861**	$1,108,684	$281,422	**$1,390,106**
Unincorporated	$8,014,398	$2,067,422	**$10,081,820**	$48,769,650	$13,182,489	**$61,952,139**
Total	**$14,897,813**	**$3,922,107**	**$18,819,919**	**$92,941,168**	**$25,466,921**	**$118,408,089**

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

- For a 100-year probabilistic earthquake, the estimated damage potential is $18.8 million, or 0.37 percent of the total assessed value for the planning area.

- For a 500-year earthquake, the estimated damage potential is $118 million, or 2.3 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 as summarized in Table 9-5.

TABLE 9-5.
ESTIMATED EARTHQUAKE-CAUSED DEBRIS

	Debris to Be Removed (tons)
100-Year Earthquake	6,630
500-Year Earthquake	53,970

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 9-6 shows the results of this analysis.

TABLE 9-6.
AGE OF STRUCTURES IN TEHAMA COUNTY

Time Period	Number of Current County Structures Built in Period	Significance of Time Frame
Pre-1933	2,076	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	954	In 1940, the first strong motion recording was made.
1941-1960	4,136	In 1960, the Structural Engineers Association of California published guidelines on recommended earthquake provisions.
1961-1975	3,687	In 1975, significant improvements were made to lateral force requirements.
1976-1994	7,205	In 1994, the Uniform Building Code was amended to include provisions for seismic safety.
1994 - present	6,318	Seismic code is currently enforced.
Total	**24,376**	

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 26 percent of the planning area's structures were constructed after the Uniform Building Code was amended in 1994 to include seismic safety provisions. Approximately 8.5 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 9-2).

Figure 9-2. 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. The level of vulnerability due to this type of construction within the planning area is not currently known. This type of data will should be generated to support future risk assessments of the earthquake hazard.

9.6.3 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 earthquake event. Table 9-7 summarizes the results.

**TABLE 9-7.
CRITICAL FACILITY VULNERABILITY TO 100-YEAR EARTHQUAKE EVENT**

Category[a]	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical and Health	0	9	0	0	**0**
Government Functions	0	15	0	0	**0**
Protective Functions	0	12	0	0	**0**
Schools	0	57	0	0	**0**
Other Critical Functions	13	0	0	0	**0**
Bridges	452	0	0	0	**0**
Water supply	27	0	0	0	**0**
Wastewater	4	0	0	0	**0**
Total	**496**	**93**	**0**	**0**	**0**

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

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 earthquake event. Table 9-8 summarizes the results.

**TABLE 9-8.
FUNCTIONALITY OF CRITICAL FACILITIES FOR 100-YEAR EVENT**

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	9	27	29	89	91	98	99
Government Functions	15	24	26	87	89	97	99
Protective Functions	12	25	26	88	90	98	99
Schools	57	23	24	87	88	97	98
Other Critical functions	13	95	99	99	100	100	100
Bridges	452	99	100	100	100	100	100
Water supply	27	94	99	100	100	100	100
Wastewater	4	85	97	99	100	100	100
Total/Average	**589**	**59**	**62**	**94**	**95**	**99**	**99**

9.6.4 Environment

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

9.7 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.

9.8 SCENARIO

With the abundance of fault exposure in California, the potential scenarios for earthquake activity are many. An earthquake does not have to occur within Tehama County to have a significant impact on the people, property and economy of the county. Seismic activity on unknown or perceived inactive faults happens all the time.

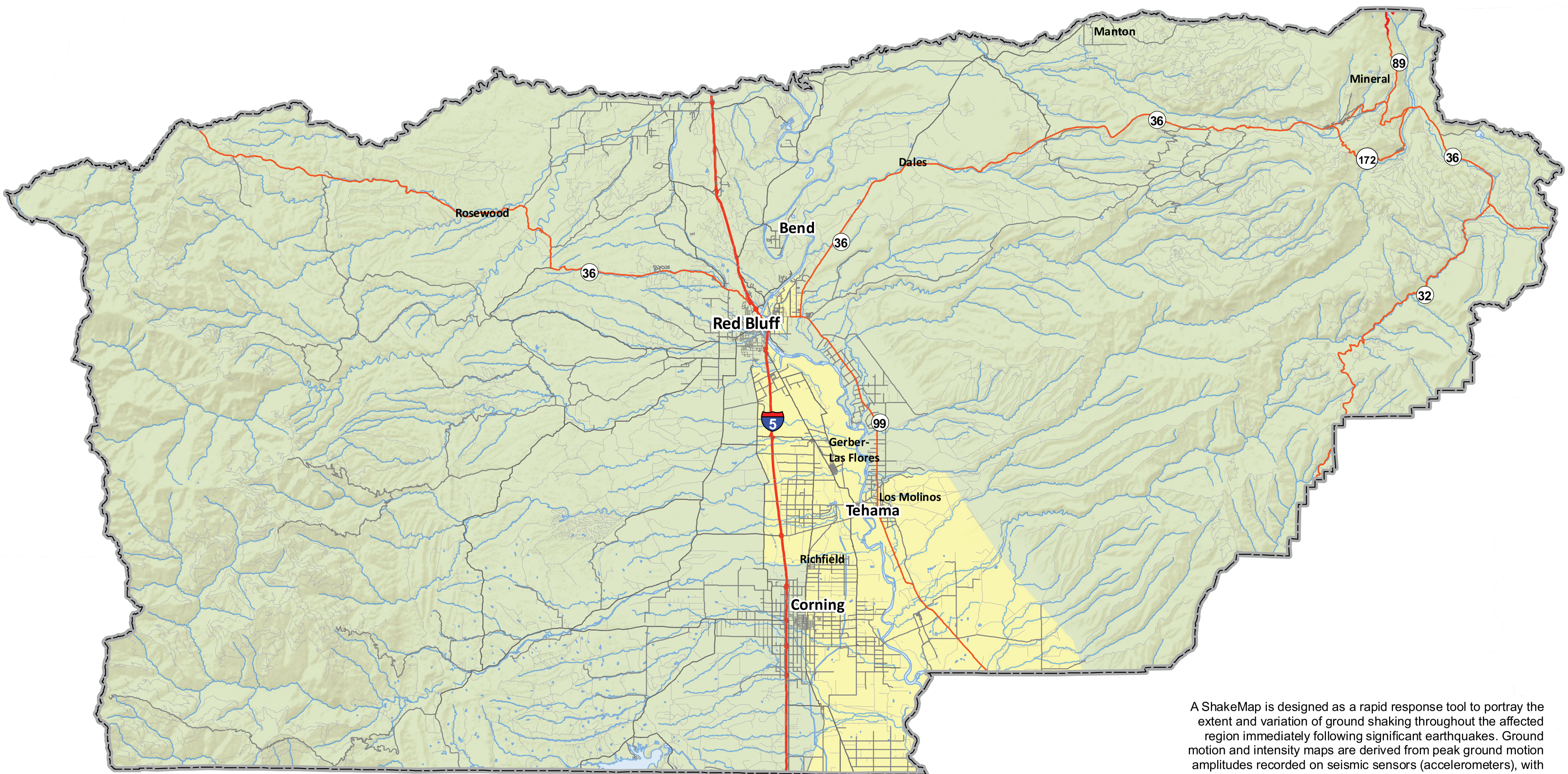
Any seismic activity of 6.0 or greater on faults within the planning area would have significant impacts throughout the county. Potential warning systems could give approximately 40 seconds notice that a major earthquake is about to occur. This would not provide adequate time for preparation. Earthquakes 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.

9.9 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.
- When scenario-based shake maps are developed for the planning area, the seismic risk assessment should be updated to look at those scenarios.
- Mapping of liquefaction potential within the planning area would significantly enhance the seismic risk assessment.
- 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 earthen levees and revetments on soft, unstable soil. These soils are prone to liquefaction, which would severely undermine the integrity of these facilities.
- 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.

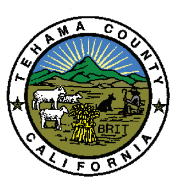
- While the direct risk of earthquakes in Tehama County is considered to be low, the indirect impacts from earthquake activity in areas surrounding Tehama County could be significant. A large earthquake in the Bay Area could have significant economic impacts on Tehama County as a principle source for goods and services. With Interstate 5 as a major state transportation corridor, Tehama County could be impacted by large volumes of evacuated populations following a large event in the Bay Area or Sacramento area.



A ShakeMap is designed as a rapid response tool to portray the extent and variation of ground shaking throughout the affected 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 both 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.

United States Geological Survey (USGS)

T E H A M A
C O U N T Y



0 3 6 9 12 15 Miles

Map 9-1

Peak Ground Acceleration
USGS 100 Year Probabilistic Event

Mercalli Scale, Potential Damage

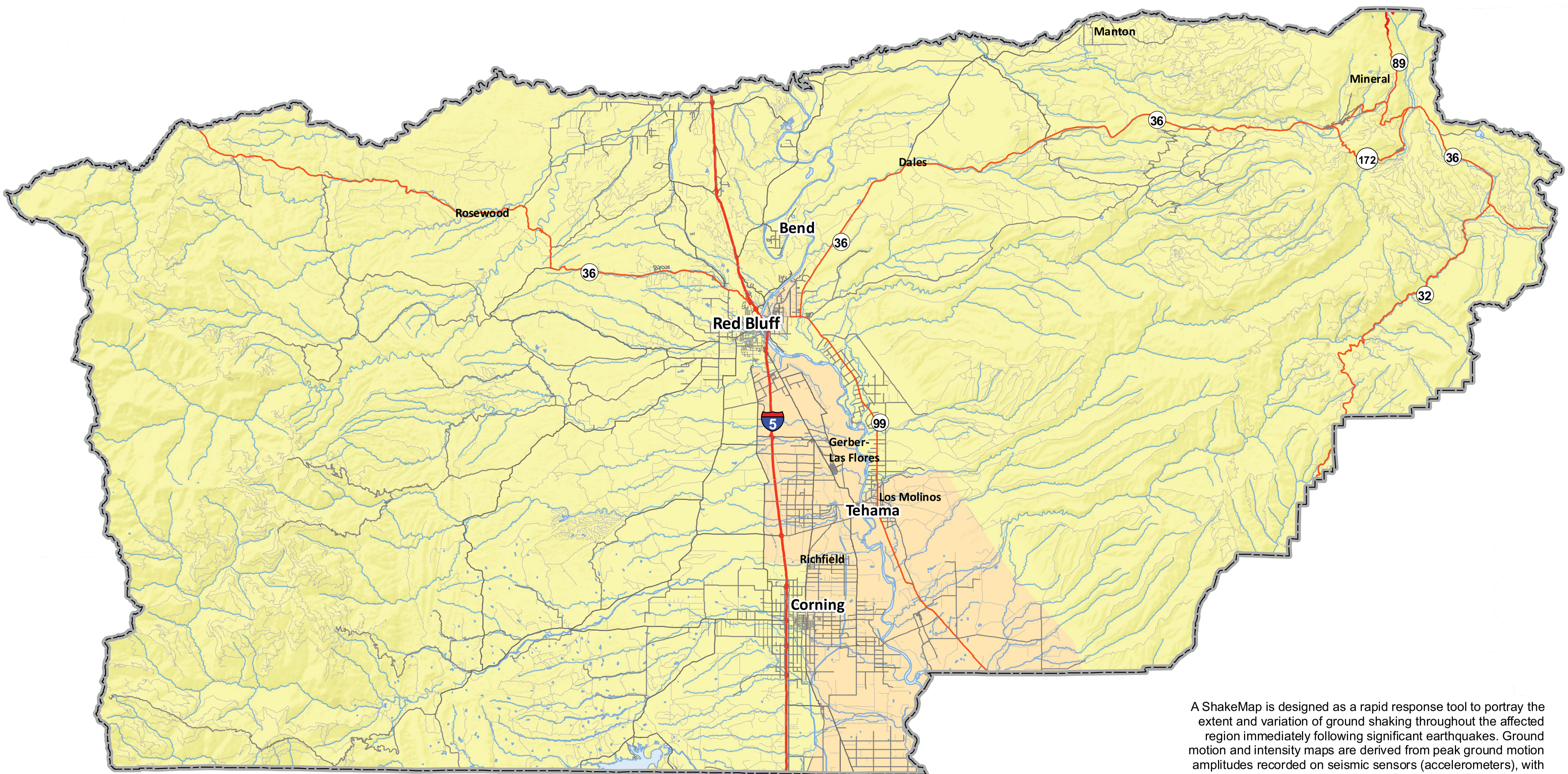
- IV, None
- V, Very Light
- VI, Light
- VII, Moderate
- VIII, Moderate to Heavy

N W E S

Data Sources:
HAZUS-MH MR4 Output
US Geological Survey

This map was prepared for informational purposes only. Lines, roads, topography, culture, and other planimetric features shown on this mapping are compiled from many different sources and may not be, necessarily, current or reliable. Tehama County assumes no liability for the accuracy of the data shown on this map.

TETRA TECH



A ShakeMap is designed as a rapid response tool to portray the extent and variation of ground shaking throughout the affected 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 both 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.

United States Geological Survey (USGS)

T E H A M A
C O U N T Y

0 3 6 9 12 15 Miles

Map 9-2

Peak Ground Acceleration
USGS 500 Year Probabilistic Event

Mercalli Scale, Potential Damage

- IV, None
- V, Very Light
- VI, Light
- VII, Moderate
- VIII, Moderate to Heavy

N W E S

Data Sources:
HAZUS-MH MR4 Output
US Geological Survey

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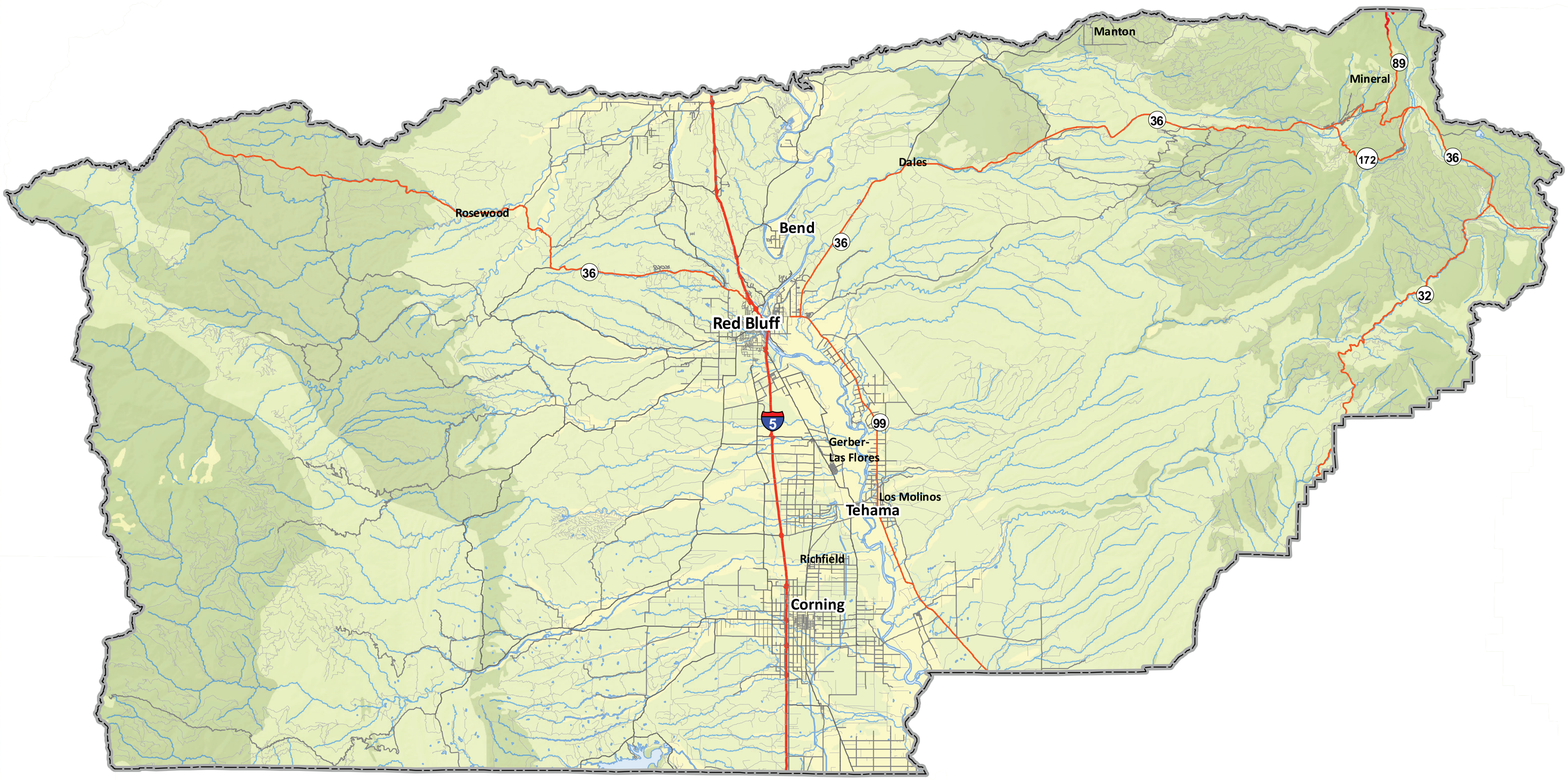
TETRA TECH



TEHAMA COUNTY

0 3 6 9 12 15 Miles

Map 9-3

National Earthquake Hazard Reduction Program (NEHRP) Soil Site Classes

- Site Class E - Soft Soil
- Site Class D - Stiff Soil
- Site Class C - Very Dense Soil and Soft Rock
- Site Class B - Rock

N W E S

Data Sources:
NEHRP Soil Data
California Department of Conservation

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TETRA TECH

CHAPTER 10.
FLOOD

10.1 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.

10.1.1 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.

10.1.2 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.

10.1.3 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.

10.1.4 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.

Tehama County entered the NFIP on June 1, 1982. 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 August 29, 2011. This map is a digital flood insurance rate map (DFIRM).

All three incorporated cities in Tehama 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 10-1 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.

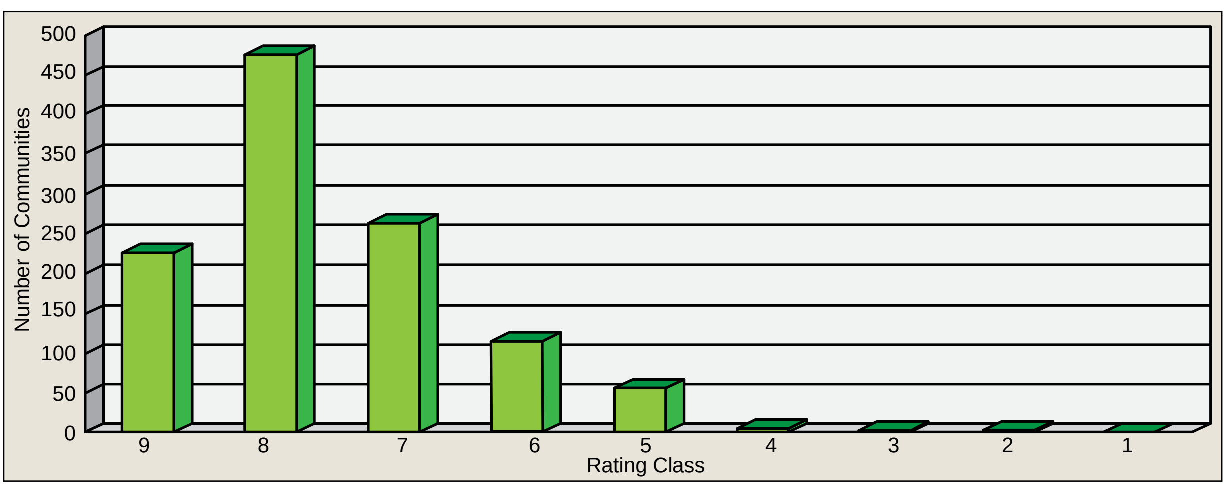


Figure 10-1. CRS Communities by Class Nationwide as of May 1, 2010

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.

The City of Tehama is currently participating in the CRS program. The city's CRS status is as follows:

- NFIP Community #: 060400
- CRS Entry Date: 10/1/2003
- Current CRS Classification: 6
- Premium Discount, SFHA/non-SFHA: 20% / 10%
- Total Premium Savings: $59,039 ($155 per policy)

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 the City of Tehama to enhance its CRS classifications and for currently non-participating communities to join the program.

10.2 HAZARD PROFILE

Flooding in Tehama 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 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 can be a major problem in almost any part of the County. Large portions of Tehama County are within a 100-year floodplain. Most of the floodplains in the County are along the Sacramento River corridor, including the Cities of Red Bluff and Tehama, or along the corridors of its associated tributaries.

10.2.1 Principal Flooding Sources

Except for small areas that drain to Black Butte Reservoir and Stony Creek on the west side and Pine Creek on the east side, all water originating in Tehama County drains to the Sacramento River within the county or on the county's boundary. Cottonwood Creek and Battle Creek form the boundary between Tehama and Shasta Counties. The Sacramento River at the Red Bluff Diversion Dam drains 9,150 square miles. Shasta Dam, an important flood control structure on the Sacramento River, is 69 miles upstream of Red Bluff and controls runoff from approximately 6,670 square miles, or 73 percent of the Sacramento River watershed upstream of Red Bluff.

Table 10-1 lists the principal tributaries to the Sacramento River from the west and from the east. Several smaller tributaries enter the Sacramento River in between the principal watersheds listed. Generally, the tributaries whose watersheds originate in the higher elevations are perennial; those originating at lower elevations are generally seasonal.

**TABLE 10-1.
SACRAMENTO RIVER TRIBUTARIES**

West Side Tributaries		Eastside Tributaries	
Cottonwood Creek (P)[a]	McClure Creek	Battle Creek (P)[a]	Dye Creek
Reeds Creek	Thomes Creek (P)	Salt Creek	Mill Creek (P)[a]
Red Bank Creek (P)	Jewett Creek	Antelope Creek (P)	Dry Creek
Oat Creek	Burch Creek	Craig Creek	Deer Creek (P)[a]
Elder Creek (P)	Hall Creek	Butler Slough	Pine Creek[b]

(P) = Perennial Creek
a. Creeks for which a Watershed Conservancy has been formed.
b. Pine Creek discharges into the Sacramento River in Butte County.

Runoff from watersheds on the west side is mostly influenced by precipitation as rain and, as a consequence, tends to be more “flashy” than runoff from streams on the east side, which are influenced to a greater extent by snowmelt. Storm runoff frequently exceeds the capacity of the stream channels. The result is widespread overland/sheet flow that floods roads and mobile home parks, requiring the evacuation of people and moving mobile homes. The flooding resulting from high tributary flow is exacerbated when it is coincident with high stages in the Sacramento River.

10.2.2 Past Events

Since 1950, the State of California has proclaimed nine states of emergencies due to flooding that included Tehama County. Major floods occurred in December 1937, December 1955, December 1963, February 1986, January 1995 and January 1997, ranging from a 20-year flood to more than a 100-year event causing millions of dollars in property damage. Numerous road closures occur during these events, isolating people and restricting access by emergency vehicles. Table 10-2 summarizes flood events in the planning area since 1964. In that timeframe, 11 presidential-declared flood events in the County have caused in excess of $25.6 million in property damage.

10.2.3 Location

The major floods in Tehama County have resulted from intense weather rainstorms between December and March. The flooding has been documented by gage records, high water marks, damage surveys and personal accounts. This documentation was the basis for the August 29, 2011 FIRM generated by FEMA for Tehama County. The 2011 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 10-1.

10.2.4 Frequency

Tehama 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.

TABLE 10-2.
TEHAMA COUNTY FLOOD EVENTS

Date	Declaration #	Type of event	Estimated Damage
02/09/98	1203	Severe Winter Storms and Flooding	$2,971,428[a] ($669,963[b])
01/04/97	1155	Severe Storms/Flooding	$1,238,671[b]
03/12/95	1046	Severe Winter Storms, Flooding, Landslides, Mud Flows	$871,254[b]
01/10/95	1044	Severe Winter Storms, Flooding, Landslides, Mud Flows	$11,241,379[a, c]
02/03/93	979	Severe Storm, Winter Storm, Mud & Landslides, Flooding	$40,108[b]
02/14/92	—	Flooding-Winter weather	$20,717[a]
02/21/86	758	Severe storms, flooding	$5,000,000[a]
02/09/83	677	Coastal storms, floods, slides, tornadoes	$1,791,666[a]
01/25/74	412	Severe storms, flooding	
01/16/73	—	Flooding - Severe Storm/Thunder Storm	$86,207[a]
02/16/70	283	Severe storms, flooding	$10,416[a]
01/26/69	253	Severe storms, flooding	
12/24/64	183	Heavy Rains & Flooding	$1,785,174[a]

a. Data obtained from Spatial Hazard Events and Losses Database for the United States (SHELDUS)
b. Information taken from the Tehama County Flood Mitigation Plan, October 2006
c. Crop damage loss only

10.2.5 Severity

The main factors affecting flood damage are water depth and velocity. Deeper and faster flood flows can cause more damage. 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 10-3 lists peak flows used by FEMA to map the floodplains of Tehama County.

10.2.6 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. While many streams in the planning area have gauges to monitor flows in real time, the County has no real-time flood warning protocol, with the exception of the Sacramento River, which has flows controlled by Shasta Dam. A real-time, phased warning protocol is needed to significantly enhance flood warning in the planning area.

10.3 SECONDARY HAZARDS

The most problematic secondary hazard for flooding 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 a secondary hazard of flooding if storage tanks rupture and spill into streams or storm sewers.

TABLE 10-3.
SUMMARY OF PEAK DISCHARGES IN TEHAMA COUNTY

Source/Location	Drainage Area	Discharge (cubic feet/second) 10-Year	50-Year	100-Year	500-Year
Brewery Creek, at the mouth	2.3	290	720	1,020	1,800
Brewery Creek Tributary, at the mouth	0.5	—	—	230	—
Brickyard Creek, at the mouth	7.0	840	1,750	2,340	3,610
Cottonwood Creek					
At US Highway 99	917	54,153	—	102,750	—
Upstream of confluence with Hooker Creek	878	—	—	98,500	—
Upstream of confluence with SF Cottonwood Creek	475	—	—	54,280	—
Dibble Creek					
At mouth	31.1	2,580	5,440	6,700	9,860
At McCoy Bridge	13.5	1,310	—	3,325	—
~ 3.25 miles upstream of McCoy Rd. Bridge	7.1	—	—	2,030	—
East Sand Slough, at divergence from Sacramento River	—	35,300	55,500	65,000	*a*
Grasshopper Creek, at the mouth	4.8	410	980	1,330	2,310
HWY 99 overflow, at confluence of Red Bank Creek	—	—	—	130	1,280
Hooker Creek, at confluence with cottonwood Creek	26.5	2,830	—	4,050	—
Jewett Creek					
At Interstate 5	8.1	800	1,200	2,300	3,350
Downstream of State HWY 99 (Edith Ave)	—	—	—	2,500	—
Downstream of Toomes Ave	—	—	—	2,100	—
Payne Creek Slough, at divergence from Sacramento River	—	11,400	24,500	31,000	*a*
Reeds Creek					
At the mouth	74.7	4,950	9,500	13,500	17,650
Upstream of confluence with Brickyard Creek	67.7	—	—	12,000	—
Sacramento River, near the City of Tehama	10,000	155,000	220,000	245,000	580,000
Sacramento River, near the city of Red Bluff					
At Red Bluff Diversion Dam	9,150	141,000	194,000	220,000	546,000
Downstream of confluence with Reeds Creek	8,900	140,000	192,000	217,500	541,000
Sacramento River, near Lake California, below confluence with Battle Creek	8,800	133,000	183,000	205,000	525,000
Samson Slough, at divergence from Paynes Creek Slough	—	3,300	8,000	11,750	*a*
South Fork Cottonwood Creek, at confluence with Cottonwood Creek	395	23,560	—	45,390	—
Spyglass Dr. overflow, at convergence with Grasshopper Creek	—	—	—	200	890

a. Controlling Discharge from Sacramento River

10.4 CLIMATE CHANGE IMPACTS

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 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 mountain area 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.

10.5 EXPOSURE

The Level 2 HAZUS-MH protocol was used to assess the exposure to flooding in the planning area. The model used census data at the block level and FEMA floodplain data, to estimate potential flooding impacts. Where possible, the HAZUS-MH default data was enhanced using County assessor and parcel data and GIS data from county, state and federal sources. All data sources have a level of accuracy acceptable for planning purposes

10.5.1 Population

Population counts of those living in the floodplain were generated by analyzing County assessor and parcel data that intersect with the 100-year and 500-year floodplains identified on FIRMs. Using GIS, residential structures on parcels that intersect the floodplain were identified, and an estimate of population was calculated by multiplying the residential structures by the average Tehama County household size of 2.6 persons per household.

Using this approach, it was estimated that the total exposed population is 6,248 within the 100-year floodplain (10 percent of the total county population) and 8,845 within the 500-year floodplain (14 percent of the total). For unincorporated portions of the county, it is estimated that the exposed population is 4,787 within the 100-year floodplain (8 percent of the total unincorporated county population) and 7,056 within the 500-year floodplain (11 percent of the total).

10.5.2 Property

Structures in the Floodplain

Table 10-4 and Table 10-5 summarize the total area and number of structures in the floodplain by municipality. The HAZUS-MH model determined that there are 2,936 structures within the 100-year floodplain and 4,002 structures within the 500-year floodplain. In the 100-year floodplain, 79 percent of these structures are in unincorporated areas; 82 percent are residential.

TABLE 10-4.
AREA AND STRUCTURES WITHIN THE 100-YEAR FLOODPLAIN

	Area in Floodplain (Acres)	Number of Structures in Floodplain							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	**Total**
Corning	34	140	19	2	2	0	0	0	**163**
Red Bluff	55	253	21	1	0	1	0	0	**276**
Tehama	44	169	3	1	7	2	1	0	**183**
Unincorporated	7,865	1,841	78	21	362	5	6	1	**2,314**
Total	**7,998**	**2,403**	**121**	**25**	**371**	**8**	**7**	**1**	**2,936**

TABLE 10-5.
AREA AND STRUCTURES WITHIN THE 500-YEAR FLOODPLAIN

	Area in Floodplain (Acres)	Number of Structures in Floodplain							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	**Total**
Corning	36	154	21	3	2	0	0	0	**180**
Red Bluff	69	365	27	1	0	1	0	0	**394**
Tehama	44	169	3	1	7	2	1	0	**183**
Unincorporated	8,101	2,714	114	24	376	8	8	1	**3,245**
Total	**8,250**	**3,402**	**165**	**29**	**385**	**11**	**9**	**1**	**4,002**

Exposed Value

Table 10-6 and Table 10-7 summarize the estimated value of exposed buildings in the planning area. This methodology estimated $742 million worth of building-and-contents exposure to the 100-year flood, representing 14.6 percent of the total assessed value of the planning area, and $978 million worth of building-and-contents exposure to the 500-year flood, representing 19.3 percent of the total.

TABLE 10-6.
VALUE OF EXPOSED BUILDINGS WITHIN 100-YEAR FLOODPLAIN

	Estimated Flood Exposure			% of Total Assessed Value in Jurisdiction
	Structure	Contents	**Total**	
Corning	$35,964,000	$32,825,000	**$68,789,000**	16.33%
Red Bluff	$43,373,000	$38,011,000	**$81,384,000**	8.31%
Tehama	$11,667,000	$9,534,000	**$21,201,000**	100%
Unincorporated	$302,458,000	$267,940,000	**$570,398,000**	15.6%
Total	**$393,462,000**	**$348,310,000**	**$741,772,000**	**14.61%**

TABLE 10-7.
VALUE OF EXPOSED BUILDINGS WITHIN 500-YEAR FLOODPLAIN

	Estimated Flood Exposure			% of Total Assessed Value in Jurisdiction
	Structure	Contents	**Total**	
Corning	$38,090,000	$35,510,000	**$73,600,000**	17.47%
Red Bluff	$52,535,000	$45,606,000	**$98,141,000**	10.03%
Tehama	$11,667,000	$9,534,000	**$21,201,000**	100%
Unincorporated	$420,235,000	$365,010,000	**$785,245,000**	21.47%
Total	**$522,527,000**	**$455,660,000**	**$978,187,000**	**19.26%**

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 10-8 shows the land use dictated by general zoning classifications 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 70 percent of the area in the 100-year floodplain is 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.

10.5.3 Critical Facilities and Infrastructure

Table 10-9 through Table 10-12 summarize the critical facilities and infrastructure in the 100-year and 500-year floodplains of Tehama 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. 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. No tier II facilities were identified within the floodplain.

TABLE 10-8.
LAND USE WITHIN THE FLOODPLAIN (UNINCORPORATED COUNTY)

	100-Year Floodplain		500-Year Floodplain	
Land Use	Area (acres)	% of total	Area (acres)	% of total
Agriculture	59943.36	70.76%	61014.12	69.92%
Commercial	205.99	0.24%	238.62	0.27%
Floodplain	15889.38	18.76%	15955.64	18.28%
Government	2780.02	3.28%	2860.72	3.28%
Industrial	341.97	0.40%	350.79	0.40%
Natural Resource	735.58	0.87%	938.83	1.08%
Planned Development	325.21	0.38%	338.11	0.39%
Recreation	15.66	0.02%	15.71	0.02%
Total	**80237.17**	**100%**	**81712.54**	**100%**

TABLE 10-9.
CRITICAL FACILITIES IN THE 100-YEAR FLOODPLAIN

Jurisdiction	Medical and Health Services	Government Function	Protective	Hazardous Materials	Schools	Other	**Total**
Corning	0	0	0	0	0	0	**0**
Red Bluff	0	0	0	0	0	0	**0**
Tehama	0	0	0	0	1	3	**4**
Unincorporated	0	2	1	0	0	2	**5**
Total	**0**	**2**	**1**	**0**	**1**	**5**	**9**

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

Jurisdiction	Medical and Health Services	Government Function	Protective	Hazardous Materials	Schools	Other	**Total**
Corning	0	0	0	0	0	0	**0**
Red Bluff	0	0	0	0	0	0	**0**
Tehama	0	0	0	0	1	3	**4**
Unincorporated	0	2	1	0	4	0	**7**
Total	**0**	**2**	**1**	**0**	**5**	**3**	**11**

**TABLE 10-11.
CRITICAL INFRASTRUCTURE IN THE 100-YEAR FLOODPLAIN**

Jurisdiction	Bridges	Water Supply	Wastewater	Power	Communications	Other	**Total**
Corning	5	2	0	0	0	0	**7**
Red Bluff	12	0	0	0	0	0	**12**
Tehama	2	2	0	0	0	0	**4**
Unincorporated	125	2	0	0	1	4	**132**
Total	**144**	**6**	**0**	**0**	**1**	**4**	**155**

**TABLE 10-12.
CRITICAL INFRASTRUCTURE IN THE 500-YEAR FLOODPLAIN**

Jurisdiction	Bridges	Water Supply	Wastewater	Power	Communications	Other	**Total**
Corning	5	2	0	0	0	0	**7**
Red Bluff	13	3	1	0	0	0	**17**
Tehama	2	2	0	0	0	0	**4**
Unincorporated	128	2	0	0	1	4	**135**
Total	**148**	**9**	**1**	**0**	**1**	**4**	**163**

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 sections describe specific types of critical infrastructure.

Roads

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

- Interstate 5
- Route 99
- Route 36
- Antelope Boulevard
- San Benito Avenue
- Adobe Road
- South Avenue
- Edith Avenue

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 144 bridges that are in or cross over the 100-year floodplain and 148 bridges in or crossing 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 are used to control flooding in parts of the County. The county has over 13.64 miles of earthen levees and revetments managed by Tehama 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.

10.6 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.

10.6.1 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 11 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 9 percent of the population in the census blocks that intersect the 100-year floodplain are over 65 years old. Approximately 10 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 12 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 7,819 people, with 5,515 of those people needing short-term shelter.

10.6.2 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 Table 10-13 for the 100-year flood event. It is estimated that there would be up to $69 million of flood loss from a 100-year flood event in the planning area. This represents 9.3 percent of the total value exposed to the 100-year flood and 1.3 percent of the total assessed value for the county.

TABLE 10-13.
ESTIMATED FLOOD LOSS FOR THE 100-YEAR FLOOD EVENT

	Structures Impacted[a]	Estimated Flood Loss			% of Total Assessed Value in Jurisdiction
		Structural	Contents	**Total**	
Corning	130	$867,000	$1,091,000	**$1,958,000**	0.46%
Red Bluff	220	$7,807,000	$9,911,000	**$17,718,000**	1.81%
Tehama	146	$1,598,000	$1,137,000	**$2,735,000**	12.90%
Unincorporated	1,851	$22,863,000	$23,426,000	**$46,289,000**	1.27%
Total	**2,347**	**$33,135,000**	**$35,565,000**	**$68,700,000**	**1.35%**

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

National Flood Insurance Program

Table 10-14 lists flood insurance statistics for the four communities in the planning area participating in the NFIP. The statistics show 317 flood insurance claims paid between January 1, 1978 and September 30, 2011, for a total of $1.956 million, an average of $6,172 per claim.

TABLE 10-14.
FLOOD INSURANCE STATISTICS FOR TEHAMA COUNTY

Jurisdiction	Date of Entry (Initial FIRM Effective Date)	No. of Flood Insurance Policies as of 09/30/2011	Insurance In Force	Total Annual Premium	Claims, 11/1978 to 9/30/2011	Value of Claims paid, 11/1978 to 9/30/2011
Corning (060398)	8/16/1982	52	$13,671,300	$69,799	21	$92,234
Red Bluff (065053)	02/04/1987	178	$36,973,000	$177,914	59	$214,150
Tehama (060400)	09/17/1980	95	$16,611,900	$59,039	43	$386,813
Unincorporated (065064)	06/01/1982	793	$162,742,900	$609,911	194	$1,263,478
Total		**1118**	**$229,999,100**	**$916,663**	**317**	**$1,956,675**

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 Tehama County were published in the 1980s. They were converted into a countywide digital FIRM (DFIRM) on August 29, 2011.

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

- The use of flood insurance in Tehama County is below the national average. Only 38 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 2.44 percent of the 2011 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, 67.5 percent of policies in the planning area are on structures within an identified SFHA, and 32.5 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 10-2 shows the repetitive loss areas in Tehama County. FEMA’s list of repetitive loss properties identifies 24 such properties in the Tehama County planning area as of November 30, 2011. The breakdown of the properties by jurisdiction is presented in Table 10-15.

TABLE 10-15.
REPETITIVE LOSS PROPERTIES IN TEHAMA COUNTY

Jurisdiction	Repetitive Loss Properties	Properties That Have Been Mitigated	Number of Corrections	Corrected Number of Repetitive Loss Properties
Corning	2	0	0	2
Red Bluff	9	0	0	9
Tehama	7	0	0	7
Unincorporated	6	0	0	6
Total	**24**	**0**	**0**	**24**

Based on FEMA Report of Repetitive Losses, 11/30/2011

A review of the repetitive loss list indicated that 14 of the properties are outside the County's special flood hazard area. All 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 average claim paid for these 14 properties was $21,497, which is comparable to the average claim of $23,743 paid on properties within a mapped floodplain. 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.

10.6.3 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.

HAZUS indicates that, on average, critical facilities would receive 3.19 percent damage to the structure and 11.41 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 480 days.

10.6.4 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.

10.7 FUTURE TRENDS

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.

Based on information presented in the Tehama County Draft Housing Element, most of the population growth in the county through 2020 is anticipated to occur in unincorporated areas. The total County population is projected to grow 17 percent, from 58,175 in 2004 to 68,323 in 2020. The unincorporated area population is projected to grow about 25 percent, from 37,865 in 2004 to 47,298 in 2020. Using the historical figure of 2.3 people per housing unit, an additional 4,000 housing units would be needed in the unincorporated area by 2020. This represents a 25 percent increase in the number of residential units and does not reflect new commercial buildings that would undoubtedly accompany the population growth. These growth forecasts could be altered substantially by the proposed Del Webb Sun City Tehama and Morgan Ranch developments.

The Bowman area in the north part of the county and the Antelope area east of Red Bluff are the most populous areas. The Bowman area, along with the Gerber and Los Molinos areas, represent the fastest growing areas in the county.

All municipal planning partners are participants in the NFIP and have adopted flood damage prevention ordinances in response to its requirements. With the City of Tehama 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.

10.8 SCENARIO

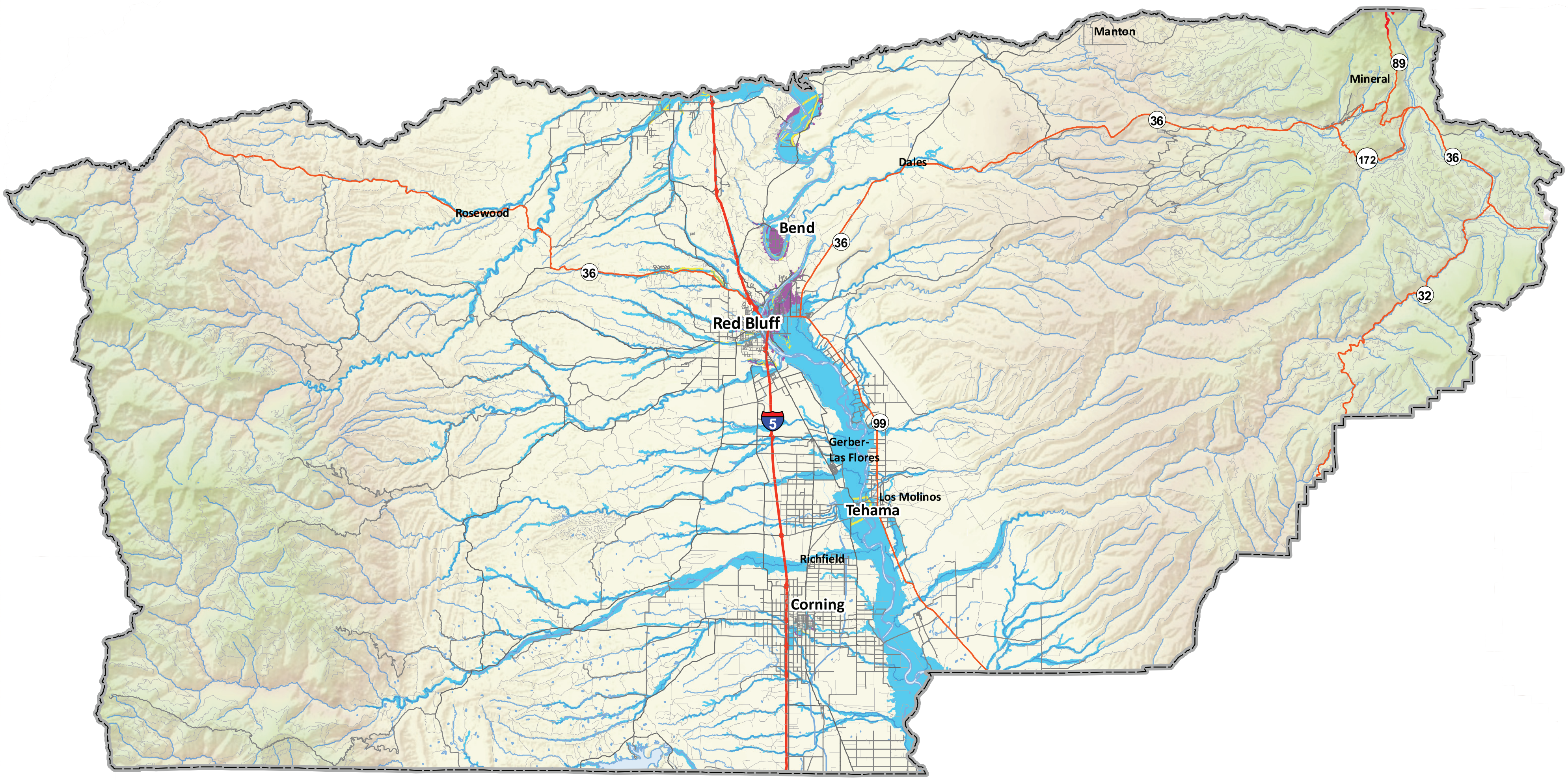
The primary water courses in Tehama County have the potential to flood at irregular intervals, generally in response to a succession of intense winter rainstorms. Storm patterns of warm, moist air usually occur between early November and late March. A series of such weather events can cause severe flooding 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. Overland and sheet flooding could be widespread, causing flood damage in areas that are not currently mapped as floodplains. Road flooding and closures would be widespread as well. Road closure would prevent 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.

10.9 ISSUES

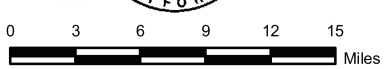
The planning team has identified the following flood-related issues relevant to the planning area:

- 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 dam failure, earthquake, landslide and wildfire. 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 Tehama 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.



TEHAMA COUNTY



Map 10-1

Special Flood Hazard Areas

Flood Zone

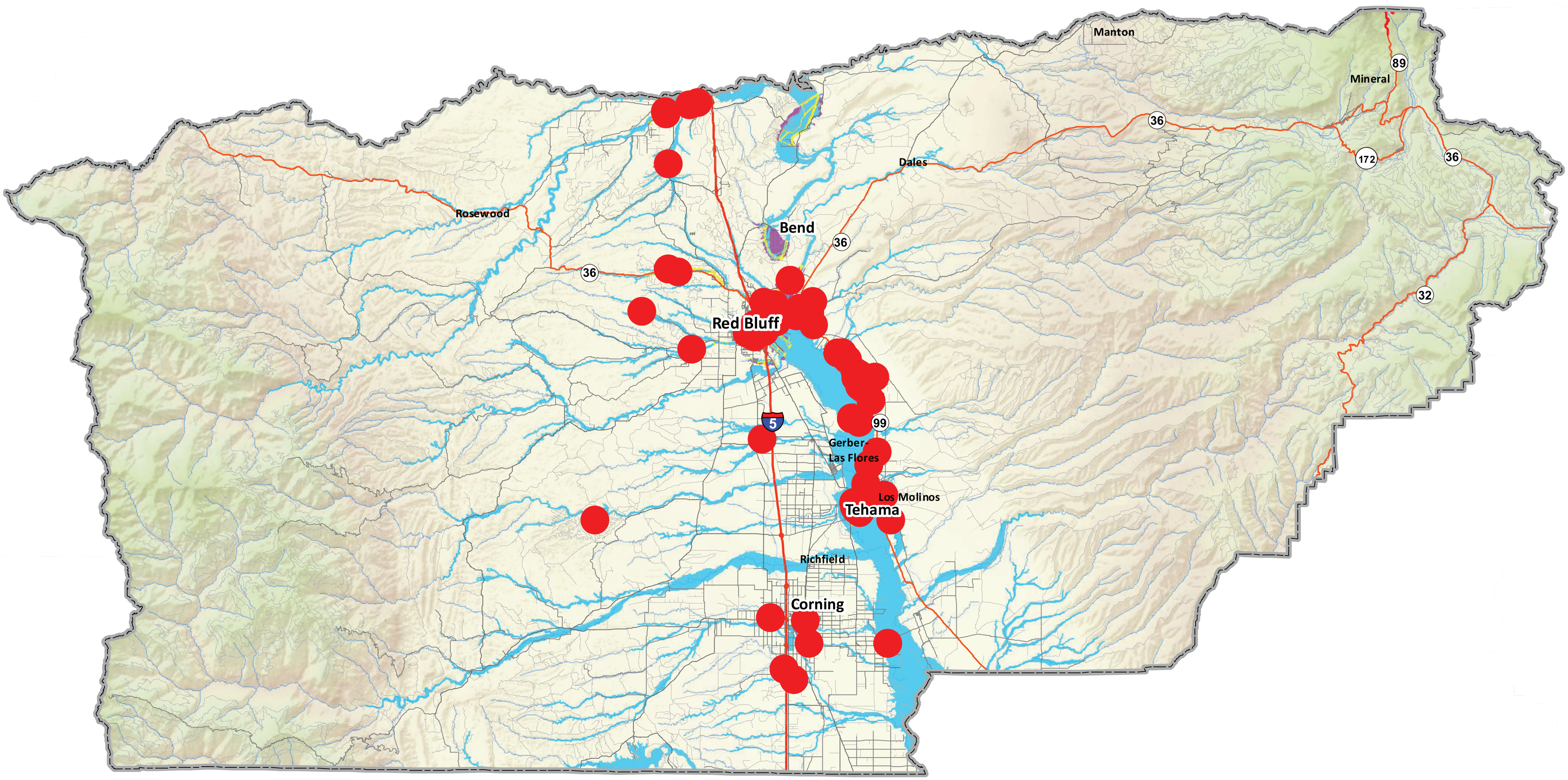
- Floodway
- 1 Percent Annual Chance Special Flood Hazard Area (100 Year)
- 0.2 Percent Annual Chance Special Flood Hazard Area (500 Year)

N W E S

Data Sources:
Flood Hazard Areas
FEMA Preliminary DFIRM

This map was prepared for informational purposes only. Lines, roads, topography, culture, and other planimetric features shown on this mapping are compiled from many different sources and may not be, necessarily, current or reliable. Tehama County assumes no liability for the accuracy of the data shown on this map.

TETRA TECH



T E H A M A
C O U N T Y

0 3 6 9 12 15 Miles

Map 10-2

Repetitive Loss Areas

Repetitive Loss Areas

Flood Zone

Floodway

1 Percent Annual Chance Special Flood Hazard Area (100 Year)

0.2 Percent Annual Chance Special Flood Hazard Area (500 Year)

N W E S

Data Sources:
FEMA DFIRM Database
FEMA Region 9

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TETRA TECH

CHAPTER 11.
LANDSLIDE

11.1 GENERAL BACKGROUND

> **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.

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.

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.

11.2 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. Figure 11-1 through Figure 11-4 show common types of slides. 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.

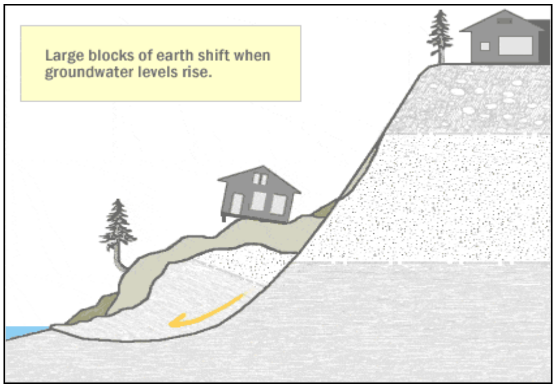


Figure 11-1. Deep Seated Slide

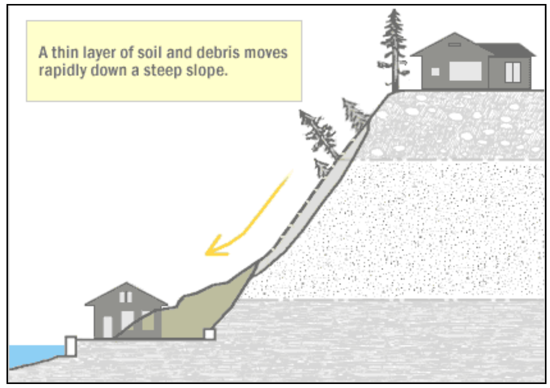


Figure 11-2. Shallow Colluvial Slide

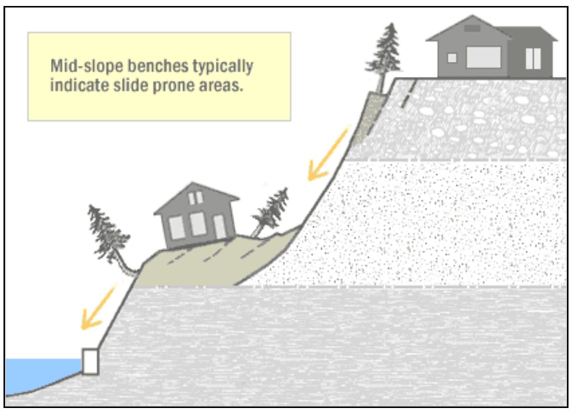


Figure 11-3. Bench Slide

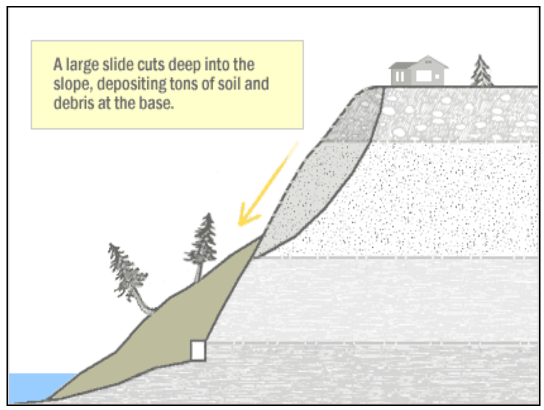


Figure 11-4. Large Slide

Slides and earth flows can pose serious hazard to property in hillside terrain. 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.

11.2.1 Past Events

There is little recorded information regarding landslides in Tehama County. According to the Spatial Hazard Events and Losses Database for the United States (SHELDUS), there have been no recorded landslide events in Tehama County since 1960. 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.

11.2.2 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.

Map 11-1 shows relative slope stability throughout Tehama County, indicating areas of the County that are more susceptible to landslides based on their soils and the steepness of slope. This map should be used with caution, as site-specific conditions can make some locations in low to moderate instability areas highly unstable and some locations in high instability areas less unstable.

11.2.3 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 Tehama 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. 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. Water is involved in nearly all cases; and human influence has been identified in more than 80 percent of reported slides.

11.2.4 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 FEMA, the December 2005 to January 2006 storm in Northern California caused in excess of $35 million in property damage across multiple counties 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.

11.2.5 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.

11.3 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.

11.4 CLIMATE CHANGE IMPACTS

Climate change may impact storm patterns, 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.

11.5 EXPOSURE

11.5.1 Population

Population could not be examined by landslide hazard area because census block group areas do not coincide with the hazard areas. Population was estimated using the structure count of residential buildings within the steep slope risk area and applying the census value of 2.6 persons per household for Tehama County. Using this approach, the estimated population living in steep-slope areas is 205. This approach can greatly understate the exposure, and it is reasonable to assume that the population exposed to the landslide risk may be as high as 1,000.

11.5.2 Property

Table 11-1 shows the number and assessed value of structures in the steep-slope risk areas. There are 115 structures on properties with slopes greater than 14 percent, with an estimated value of $14,917,000. Over 65 percent of the exposed structures are residential dwellings. The predominant zoning classes in cities are single-family, vacant and manufactured homes. Table 11-2 shows the general zoning classes of property exposed to steep slopes in unincorporated portions of the County.

TABLE 11-1.
TEHAMA COUNTY STRUCTURES IN STEEP-SLOPE RISK AREAS

Jurisdiction	Buildings Exposed	Assessed Value			% of Total Assessed Value in Jurisdiction
		Structure	Contents	**Total**	
Corning	0	$0	$0	**$0**	0.00%
Red Bluff	0	$0	$0	**$0**	0.00%
Tehama	0	$0	$0	**$0**	0.00%
Unincorporated	115	$8,105,000	$6,812,000	**$14,917,000**	0.41%
Total	**115**	**$8,105,000**	**$6,812,000**	**$14,917,000**	**0.29%**

TABLE 11-2.
LAND USE IN STEEP-SLOPE RISK AREAS OF UNINCORPORATED COUNTY

Land Use	"Steep Slope" areas	
	Area (acres)	% of total
Agriculture	62,229.81	28.27%
Floodplain	58.76	0.03%
Government	115,360.84	52.40%
Industrial	0.01	0.00%
Natural Resource	3,061.80	1.39%
Planned Development	20.96	0.01%
Recreation	0.06	0.00%
Residential	551.08	0.25%
Timber Production	38,857.06	17.65%
Total	**220,140.38**	**100%**

11.5.3 Critical Facilities and Infrastructure

Table 11-3 summarizes the critical facilities exposed to the landslide hazard.

**TABLE 11-3.
CRITICAL FACILITIES EXPOSED TO LANDSLIDE HAZARDS**

	Number of Critical Facilities Exposed to Landslide Risk
Medical and Health Services	0
Government Function	0
Protective Function	0
Schools	0
Hazmat	0
Other Critical Function	3
Bridges	3
Water	0
Waste Water	0
Communications	0
Total	**6**

A significant amount of infrastructure can be exposed to mass movements:

- **Roads**—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.

11.5.4 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.

11.6 VULNERABILITY

11.6.1 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 persons exposed to landslide risk areas are considered to be vulnerable. Increasing population and new development on property atop or below bluffs and on steep slopes subject to mass movement increase the number of lives endangered by this hazard.

11.6.2 Property

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. Table 11-4 shows the general building stock loss potential.

TABLE 11-4.
POTENTIAL BUILDING LOSSES FROM LANDSLIDE HAZARD

	Buildings in Steep Slope Areas		Loss Potential		
	Count	Assessed Value	10% Damage	30% Damage	50% Damage
Corning	0	$0	$0	$0	$0
Red Bluff	0	$0	$0	$0	$0
Tehama	0	$0	$0	$0	$0
Unincorporated	115	$8,105,000	$810,500	$2,431,500	$4,052,500
Total	**115**	**$8,105,000**	**$810,500**	**$2,431,500**	**$4,052,500**

11.6.3 Critical Facilities and Infrastructure

Six critical facilities were identified as being exposed to the landslide hazard to some degree. A more in-depth analysis of 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.

11.6.4 Environment

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

11.7 FUTURE TRENDS IN DEVELOPMENT

The county has experienced moderate growth over the past 10 years, averaging a 1.23-percent annual increase in population from 2000 through 2010. Tehama 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.

11.8 SCENARIO

Major landslides in Tehama 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.

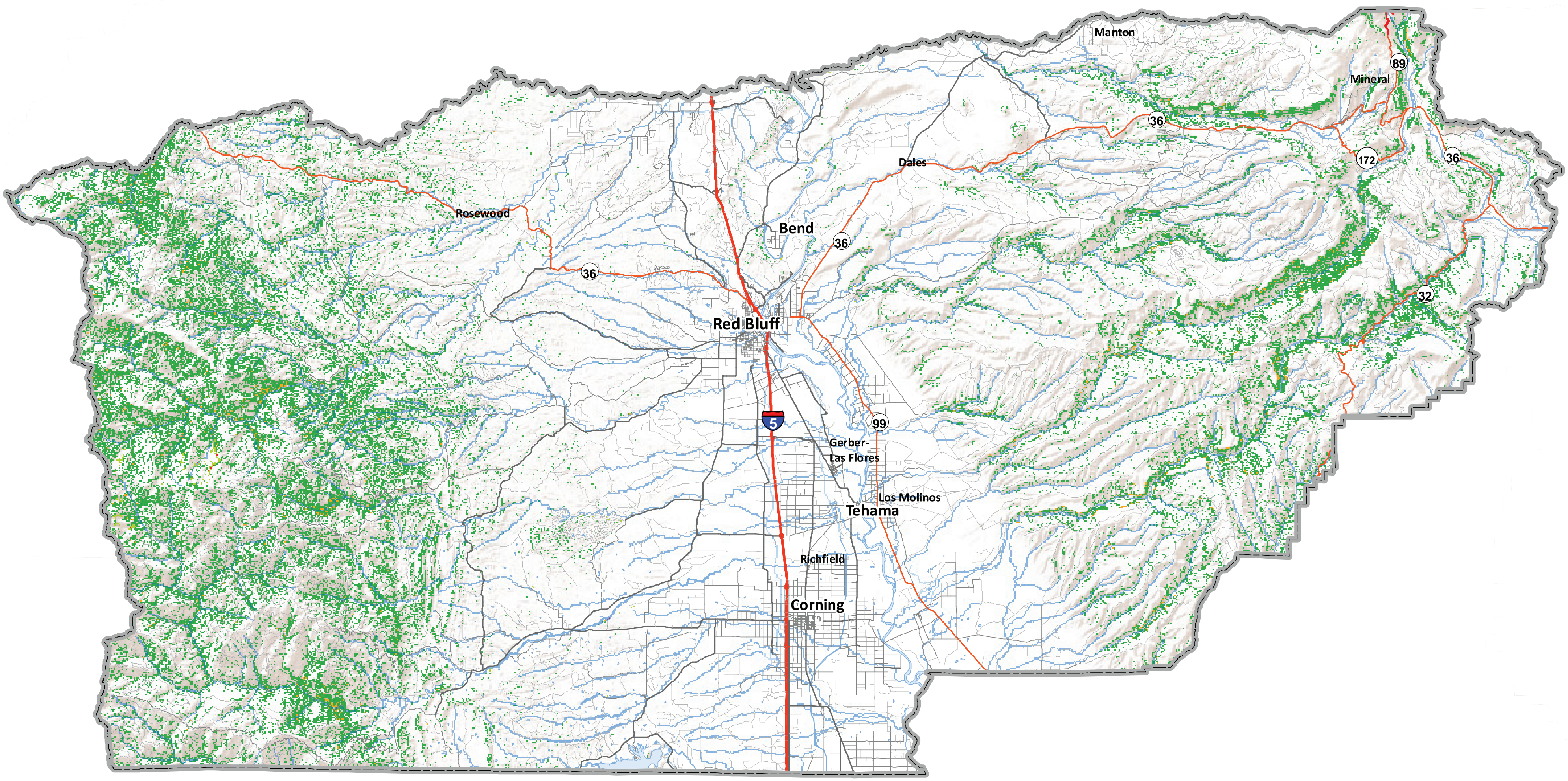
Mass movements are becoming more of a concern as development moves outside of city centers and into areas less developed in terms of infrastructure. Most mass movements would be isolated events affecting specific areas. It is probable that private and public property, including infrastructure, will be 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 Tehama County.

11.9 ISSUES

Important issues associated with landslides in Tehama 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.



T E H A M A
C O U N T Y

Map 11-1

Steep Slopes, Soils

- 15%-30% Slope, Intersecting B&C Soils
- 15%-30% Slope, Intersecting D Soils
- Greater than 30% Slope, Intersecting B&C Soils
- Greater than 30% Slope, Intersecting D Soils

Data Sources:
Ten Meter Digital Elevation Model,
National Earthquake Hazards Reduction Program Soils

This map was prepared for informational purposes only. Lines, roads, topography, culture, and other planimetric features shown on this mapping are compiled from many different sources and may not be, necessarily, current or reliable. Tehama County assumes no liability for the accuracy of the data shown on this map.

TETRA TECH

CHAPTER 12.
SEVERE WEATHER

12.1 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.

Three types of severe weather events typically impact Tehama County: thunderstorms, damaging winds and hail storms. These types of severe weather are described in the following sections. 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 10.

12.1.1 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

<u>DEFINITIONS</u>

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 12-1):

- 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.

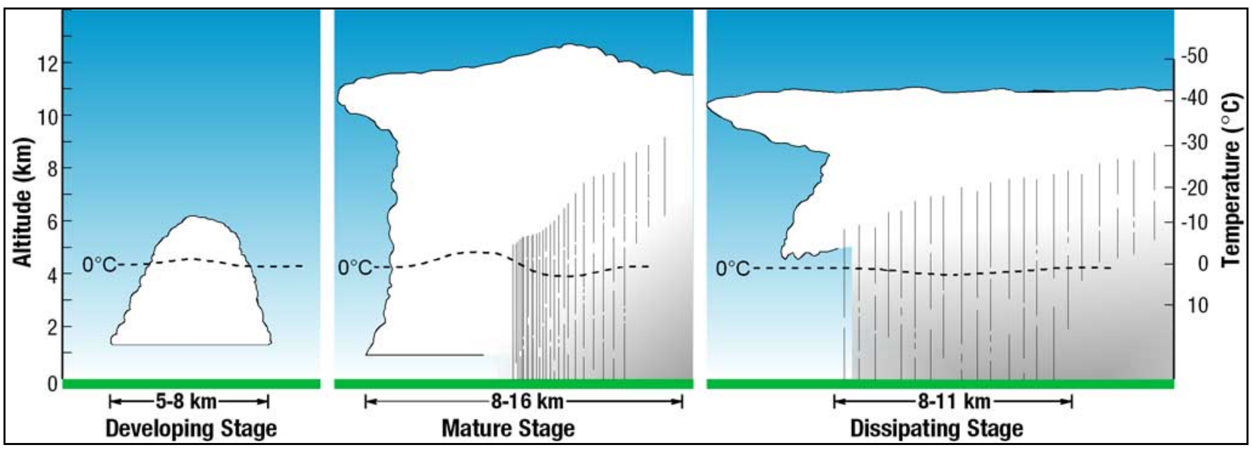


Figure 12-1. The Thunderstorm Life Cycle

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. Squall lines can produce large hail, heavy rainfall, weak tornadoes, and 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.
- **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.

12.1.2 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.

12.1.3 Hail Storms

Hail occurs when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere where they freeze into ice. 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.

12.2 HAZARD PROFILE

12.2.1 Past Events

Table 12-1 summarizes severe weather events in Tehama County since 1970, as recorded by the National Oceanic and Atmospheric Administration (NOAA).

12.2.2 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 12-1, 12-2, 12-3 and 12-4 show the distribution of average weather conditions over Tehama County.

12.2.3 Frequency

The severe weather events for Tehama County shown in Table 12-1 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.

12.2.4 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.

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.

TABLE 12-1.
SEVERE WEATHER EVENTS IMPACTING PLANNING AREA SINCE 1970

Date	Type	Deaths or Injuries	Property Damage
3/5/1978	Tornado	0	$2,500
Description: *An F-0 tornado touched down in Tehama County.*			
5/9/1980	Tornado	0	$25,000
Description: *An F-2 tornado touched down in Tehama County.*			
9/24/1986	Tornado	1 injury	$2,500,000
Description: *An F-2 tornado touched down in Tehama County.*			
3/14/1987	Tornado	0	$50,000
Description: *An F-0 tornado touched down in Tehama County.*			
9/20/1987	Lightning	0	$3,571,428
Description: *Widespread lightning caused by thunderstorm activity.*			
6/23/1992	Severe Storm/Thunder Storm	0	$16,675
Description: *None reported*			
7/4/2000	Hail	0	None reported
Description: *A line of thunderstorms developed rapidly off the Trinity Mountains and moved across northern Tehama and southern Shasta counties. Reports were received of widespread large hail and several minor car accidents were reported on I-5 and local highways. Localized street flooding was reported in the town of Cottonwood.*			
2/22/2001	Hail	0	None reported
Description: *One inch hail was reported in Red Bluff.*			
3/23/2005	Hail	0	$8,000
Description: *Several minor accidents occurred due to slick roadways. Minor damage reported to vehicles.*			
6/22/2007	Thunderstorm Wind	0	$6,000
Description: *Downdraft winds from a diminishing thunderstorm caused damage to a neighborhood of mobile homes. Damage included torn roofing and skirting material and loss of some small backyard items.*			
10/3/2008	Flash Flood	0	None reported
Description: *Heavy rain from a Pacific storm brought rock and mud down onto highways adjacent to areas that burned the previous summer. Total rainfall in the mountains exceeded 3 inches at some locations and several daily rainfall records were set in the Central Valley on October 4. Slippery roads from this first major rain of the season led to numerous car accidents.*			
6/11/2009	Hail	0	None reported
Description: *Thunderstorms with 1 inch hail, locally strong winds, and heavy rain.*			
10/13/2009	Heavy Rain/Thunderstorm	0	None reported
Description: *The remnants of Super Typhoon Melor from the western Pacific Ocean combined with a Canadian upper level low pressure system to form a strong storm over Northern California. Numerous trees and large branches were knocked down, causing damage to cars, homes, and power lines, with loss of power to thousands of customers. Heavy rain caused minor flooding on roads and in small streams. Red Bluff Airport recorded 1.95 inches of rainfall on October 13. Strong, gusty winds peaking at 53 mph brought down numerous trees, large branches, and power lines*			

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.

12.2.5 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.

12.3 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.

12.4 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 12-2). 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.

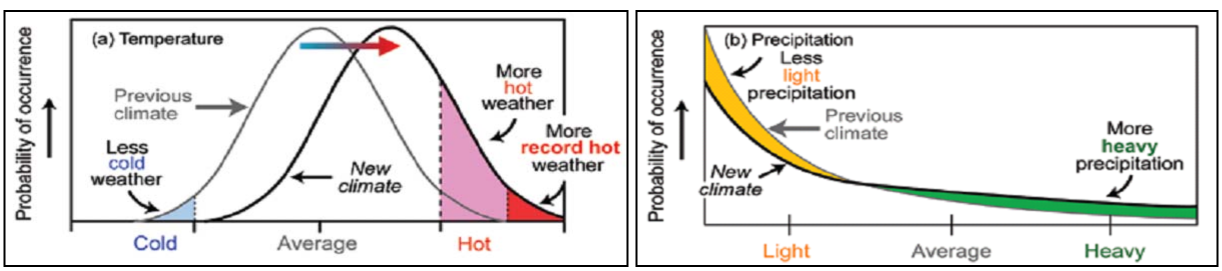


Figure 12-2. Severe Weather Probabilities in Warmer Climates

12.5 EXPOSURE

12.5.1 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 planning area 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.

12.5.2 Property

According to the Tehama County Assessor, there are 24,376 buildings within the census tracts that define the planning area. Most of these buildings are residential. It is estimated that 29 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.

12.5.3 Critical Facilities and Infrastructure

All critical facilities exposed to flooding (Chapter 10) 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.

12.5.4 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.

12.6 VULNERABILITY

12.6.1 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.

12.6.2 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 12-2 lists the loss estimates to the general building stock.

TABLE 12-2.
POTENTIAL BUILDING LOSS FROM SEVERE WEATHER HAZARD

	Assessed Value of Exposed Buildings	Potential Loss		
		10% Damage	30% Damage	50% Damage
Corning	$421,187,000	$42,118,700	$126,356,100	$210,593,500
Red Bluff	$978,885,000	$97,888,500	$293,665,500	$489,442,500
Tehama	$21,201,000	$2,120,100	$6,360,300	$10,600,500
Unincorporated	$3,657,427,000	$365,742,700	$1,097,228,100	$1,828,713,500
Total	**$5,078,700,000**	**$507,870,000**	**$1,523,610,000**	**$2,539,350,000**

12.6.3 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.

12.6.4 Environment

The vulnerability of the environment to severe weather is the same as the exposure.

12.7 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.

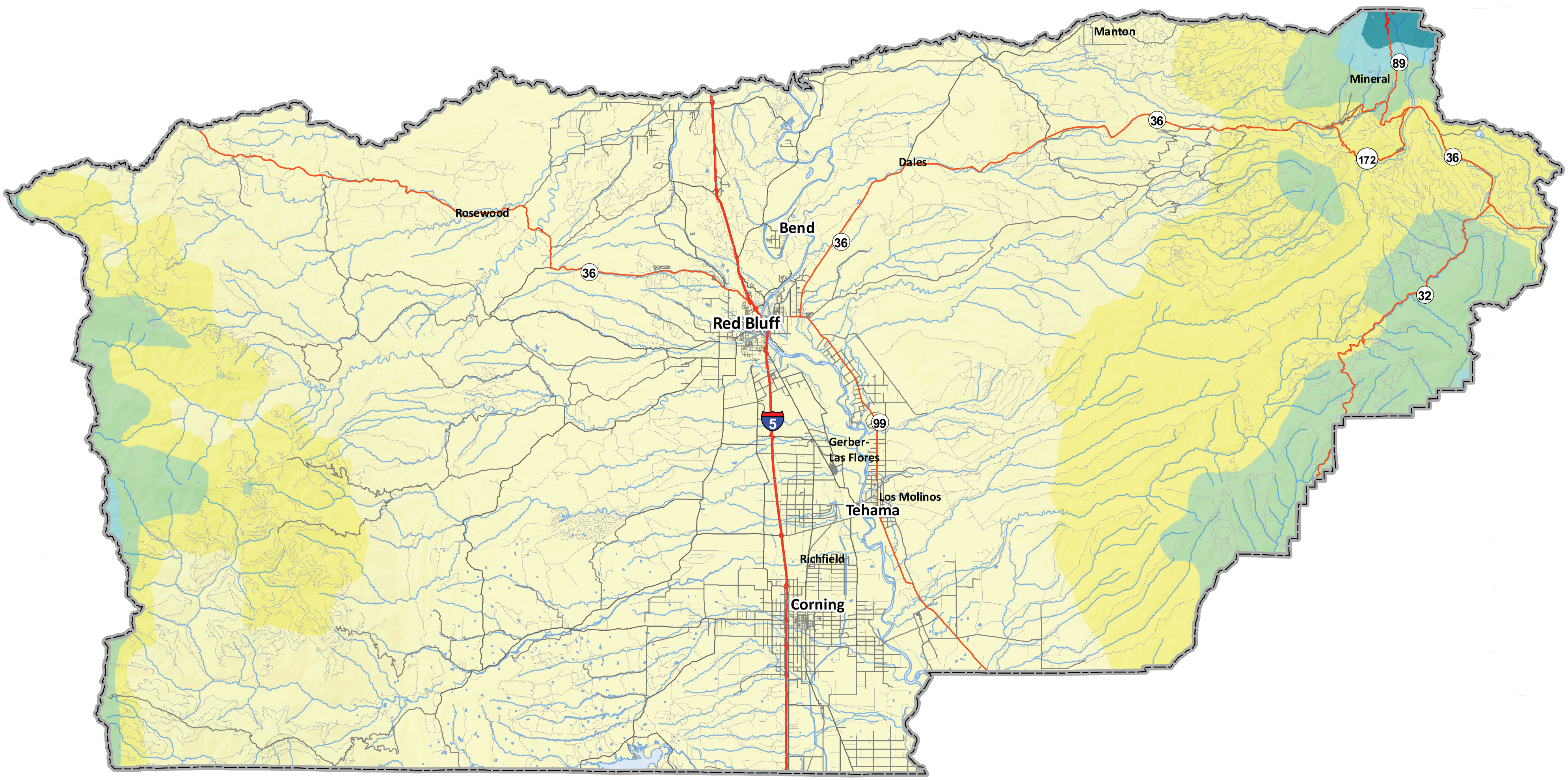
12.8 SCENARIO

Severe local storms can and do occur frequently in the planning area. The impacts of these events 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.

12.9 ISSUES

Important issues associated with a severe weather in the Tehama 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.
- Road closures (both rural roads to isolated communities and Interstate-5).



T E H A M A
C O U N T Y

0 3 6 9 12 15
Miles

Map 12-1

Average Annual Precipitation

Average Annual Precipitation (Inches)

- 21 - 40
- 41 - 60
- 61 - 80
- 81 - 100
- 101 - 119

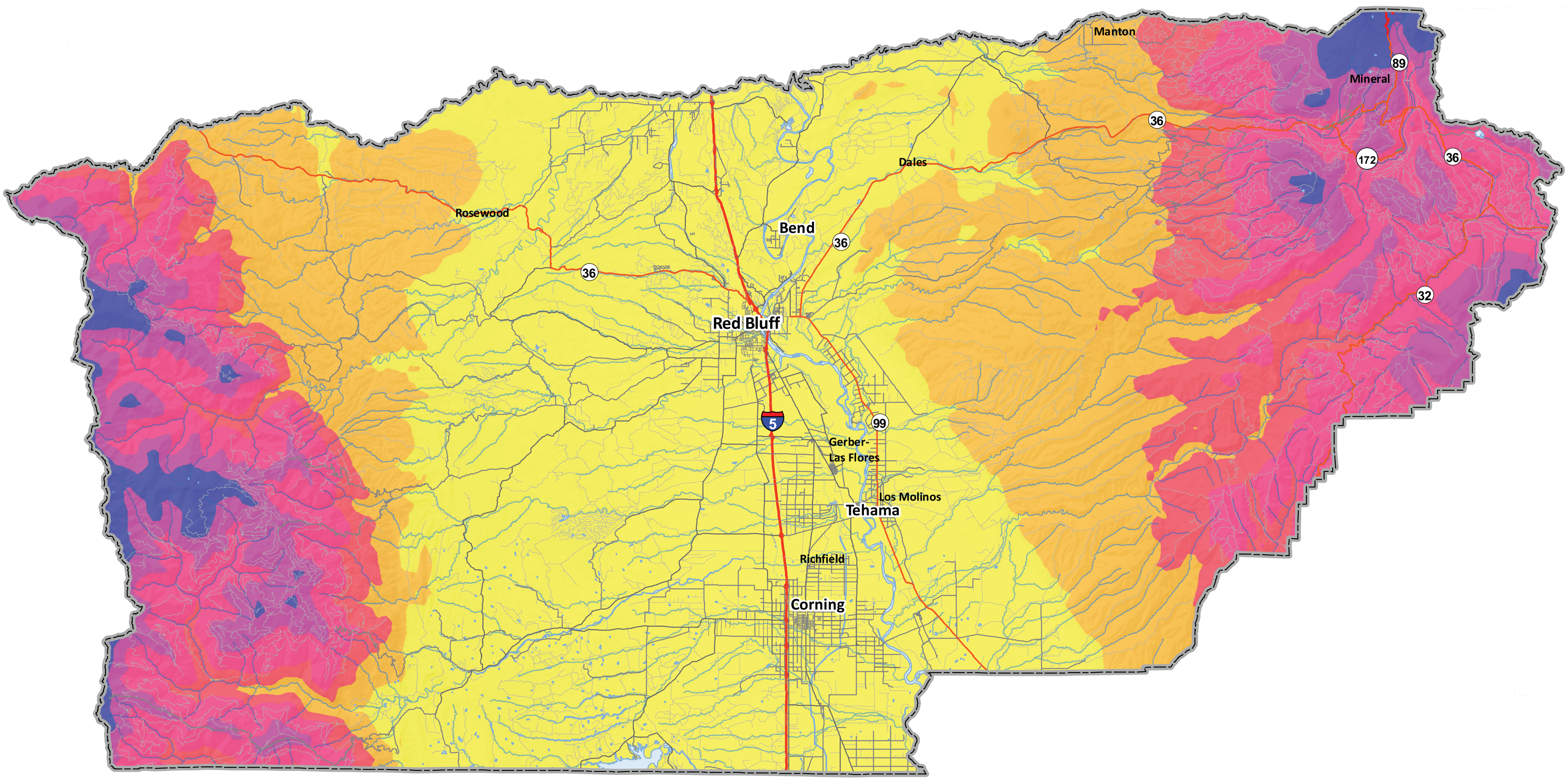
Average precipitation is according to a model using point data for the 30-year period of 1971-2000.

N W E S

Data Sources:
Climate Data
USDA/NRCS
National Cartography &
Geospatial Center

This map was prepared for informational purposes only. Lines, roads, topography, culture, and other planimetric features shown on this mapping are compiled from many different sources and may not be, necessarily, current or reliable. Tehama County assumes no liability for the accuracy of the data shown on this map.

TETRA TECH



TEHAMA COUNTY

0 3 6 9 12 15 Miles

Map 12-2

Average Annual Maximum Temperature

Average Annual Maximum Temperature (F)

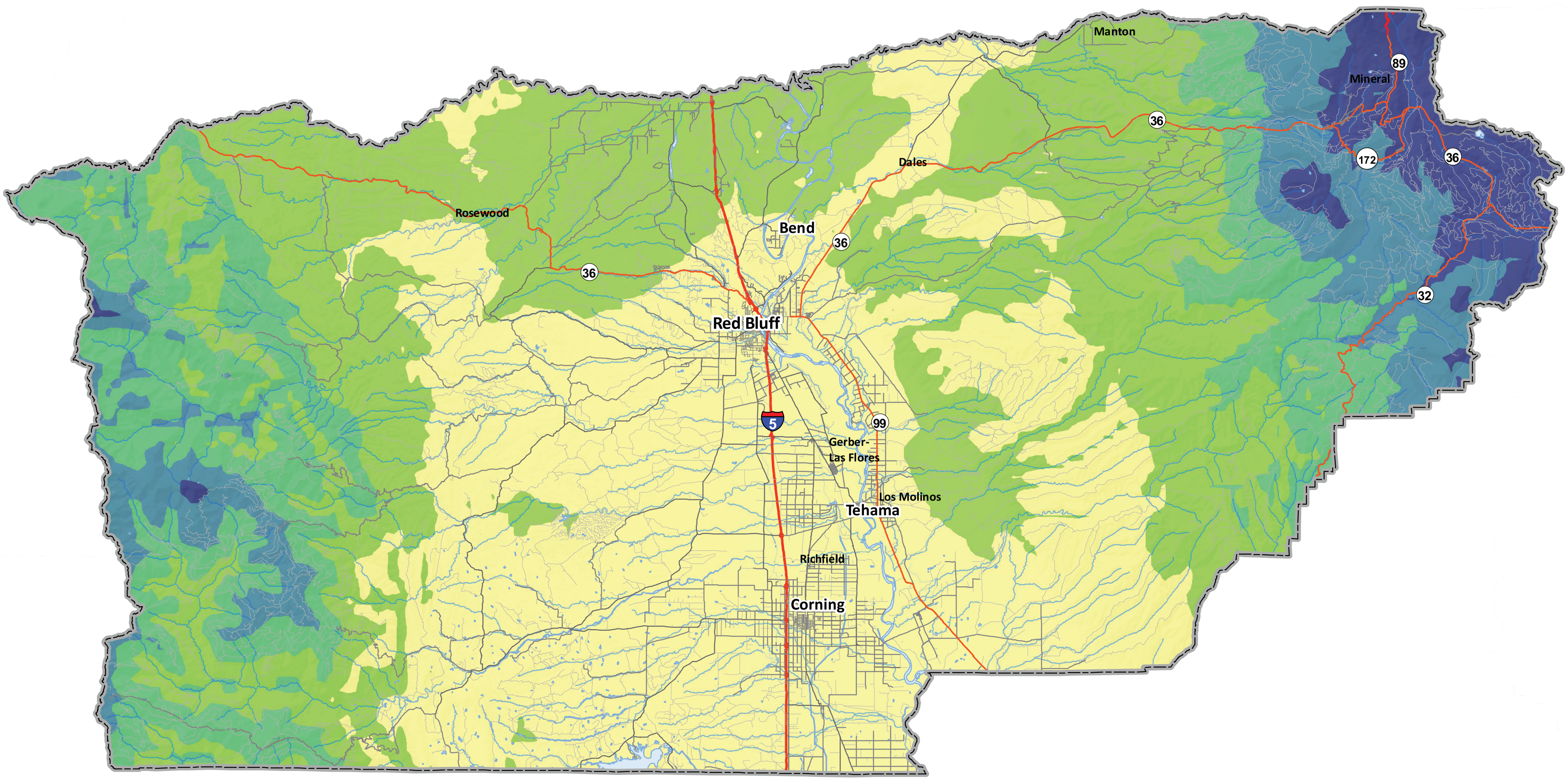
- 69 - 75
- 76 - 80
- 81 - 85
- 86 - 90
- 91 - 95
- 96 - 99

Average maximum temperature is according to a model using point temperature data for the 30-year period of 1971-2000.

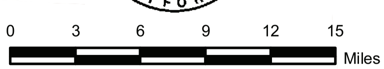
N W E S

Data Sources:
Climate Data
USDA/NRCS
National Cartography & Geospatial Center

TETRA TECH



TEHAMA COUNTY



Map 12-3

Average Annual Minimum Temperature

Average Annual Minimum Temperature (F)

- 19 - 23
- 24 - 27
- 28 - 31
- 32 - 35
- 36 - 41

Average minimum temperature is according to a model using point temperature data for the 30-year period of 1971-2000.

Data Sources:
Climate Data
USDA/NRCS
National Cartography &
Geospatial Center

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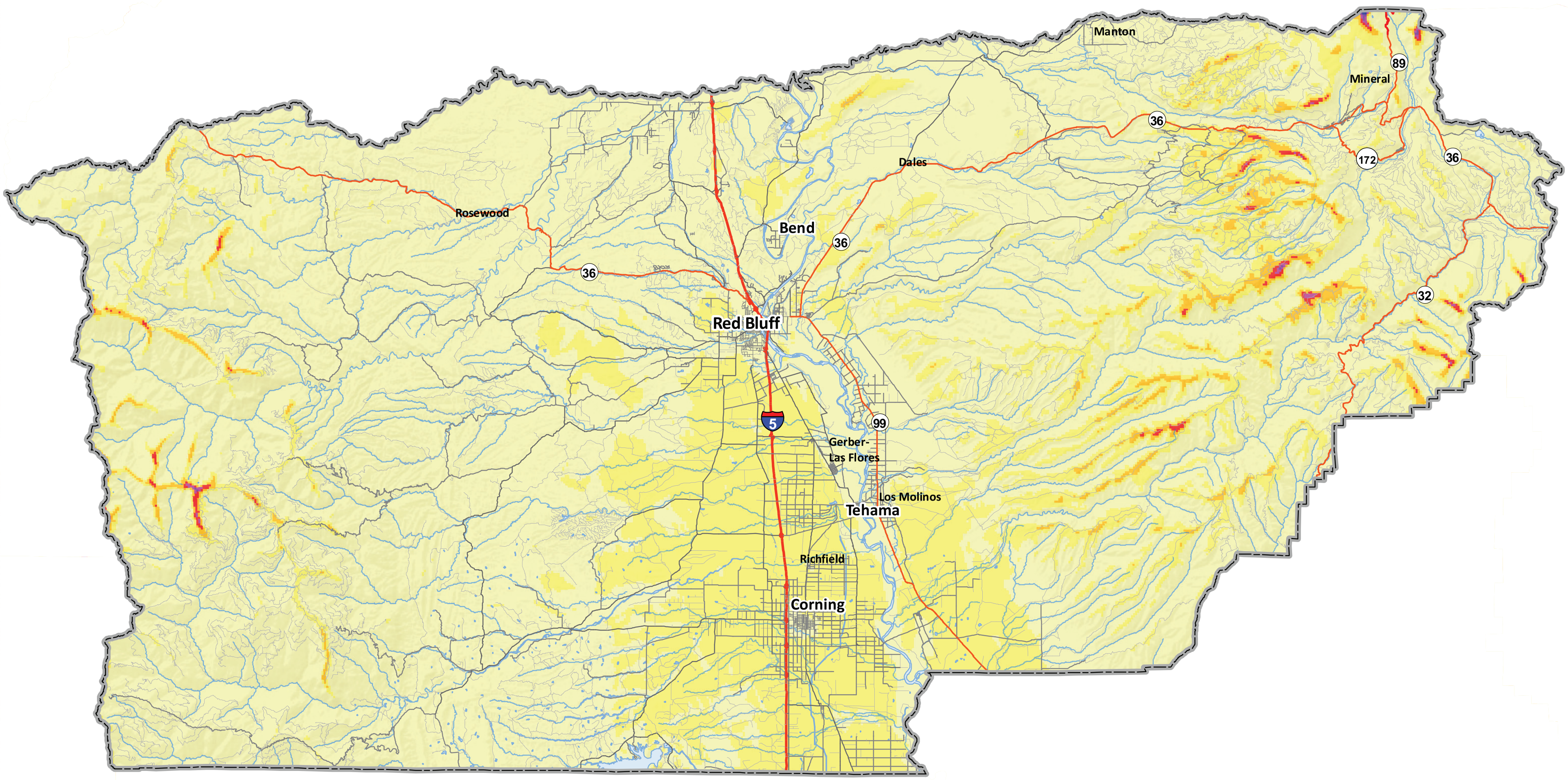
TETRA TECH



TEHAMA COUNTY

0 3 6 9 12 15 Miles

Map 12-4

Wind Power

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.

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

N W E S

Data Sources:
Wind Data
US Dept of Energy
National Renewable
Energy Laboratory

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TETRA TECH

CHAPTER 13.
WILDFIRE

13.1 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.

Wildfires are costly, compromising watersheds, open space, timber, range, recreational opportunities, wildlife habitats, endangered species, historic and cultural assets, wild and scenic rivers, other scenic assets and local economies, as well as putting lives and property at risk.

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.

On average, 10,000 wildfires burn half a million acres in California annually. While the number of acres burned fluctuates from year to year, a trend that has remained constant is the rise in wildfire-related losses. The challenge is to reduce wildfire losses within a framework of California's diverse ecosystems.

13.1.1 Local Conditions Related to Wildfire

How a fire behaves primarily depends on the following:

- **Fuel Type**—Fuel refers to all combustible material available to burn in a given land area. Fuel types in Tehama County include timber, timber with grass understory (see Figure 13-1), grass, brush, oak woodland and desert sage and juniper stands. Each fuel has its own burning characteristics based on moisture content, volume, live-to-dead vegetation ratio, size, arrangement and genetic makeup.

  Grass burns rapidly, with a short period of intense, maximum heat output. Brush has a long sustained high heat output, making it more difficult to control. Non-compacted fine fuel such as grass spreads fire rapidly since more of its surface can be heated at one time. Compacted fuel such as pine litter burns more slowly because heat and air only reach the top of the fuel.

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. Hot gases of combustion rise over the fire zone, drawing surface winds in from all sides, often at velocities approaching 50 miles per hour. Firestorms seldom spread because of the inward direction of the winds, but there is no known way of stopping them. Lethal concentrations of carbon monoxide are present in the area of the fire, posing a 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. For example, 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.

Figure 13-1. Wildfire-Prone Landscapes in Tehama County

- **Fuel Loading**—Fuel loading is measured in tons per acre. Grass is considered a light fuel with approximately three-quarters of a ton per acre. Thick brush, a heavy fuel, can have a density of over 21 tons per acre.
- **Fuel Arrangement**—Fuel arrangement is linked to how readily fuel burns and a fire spreads. Fine fuels that have not been compacted, such as grass, spread fire rapidly since more of the fuel's surface can be heated at one time. Compacted fuels, such as pine litter, burn more slowly because heat and air only reach the top of the fuel. Vertical arrangement refers to the continuity of fuel from the forest floor to the tree canopy. Fire burning in grass or pine needles near the ground may spread to brush, snags and low tree branches, and from there to the crowns of trees. Continuous burnable fuel from the ground to the crown is called "ladder fuel." Crown or canopy closure refers to the density of a forest created by treetops. It is important in the lateral progression of fire from tree to tree through the forest canopy.
- **Weather**—Weather conditions that influence fire behavior include temperature, humidity, wind, precipitation, and atmospheric stability. When the temperature is high, humidity is low, wind is increasing and from the east, and there has been little or no precipitation so vegetation is dry, conditions are favorable for severe wildfires. These conditions occur more frequently inland where temperatures are higher and fog is less prevalent. During summer, Tehama County's abundant vegetation dries out and becomes hazardous fuel. That fuel combined with a Chinook wind—hot and dry from the Great Basin—can produce extreme fire danger.

  Precipitation in Northern California is usually at its lowest from July to September. Thunderstorm activity, which typically begins in June with wet storms, turns dry with little or no precipitation reaching the ground as the season progresses into July and August. Thunderstorms with dry lightning are more prevalent in the eastern portion of the county. July and August are when local winds (slope winds) predominate, with the Pacific jet stream weak and well to the north. By mid or late September, north to northeast winds return to the north half of the planning area, bringing in moist ocean air.

- **Terrain**—Terrain includes slope and elevation. The terrain 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).
- **Time of Day**—A fire's peak burning period generally is between 1 p.m. and 6 p.m.

13.1.2 Wildfire Protection Responsibility in California

Local, state, tribal, and federal organizations all have 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 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.

13.1.3 Tehama County Fire Management Planning Zones

The 2005 Tehama-Glenn Unit Fire Management Plan documents the current and historical assessments of the fire situation within the Unit's area of responsibility, and efforts taken to protect it. The document identifies strategic areas for pre-fire planning and fuels treatment as defined by the people who live and work with the local fire issues. The plan established 13 zones for fire management planning: 10 SRAs (Zones 1-10), two FRAs (FRA-East and FRA-West), and one LRA. Nine of the SRAs are in the Tehama County planning area:

- **Zone 1, Paskenta, Red Bank, R-Ranch—**Zone 1 encompasses much of western Tehama County and includes the communities of Paskenta and R-Ranch. Besides communities, fires in this zone threaten timber stands, rural ranches and agricultural land. Grassy fuels at lower elevations present the primary fire threat in Zone 1, as they ignite easily and carry fire rapidly. These fuels are often located where the threat of human-caused ignition is greatest. The predominant vegetation types affecting fire danger include blue oak, live oak-woodland, and mixed chaparral brush. The leading causes of fires in Zone 1 from 1994 to 2004 were by vehicle use and equipment use. Zone 1 is particularly affected by severe weather because high winds carry fire quickly through the predominantly grass- and brush-covered land. Much of the area is difficult to access by fire equipment.
- **Zone 2, Bowman, Dibble Creek, Lake California, and Wilcox—**Zone 2 encompasses the northern valley floor of Tehama County and includes the Lake California development and the rural communities of Bowman, Wilcox and Dibble Creek. Most undeveloped land is used for livestock grazing. Three vegetation types are present in the zone, including grassland, chaparral, and oak woodland. Grasses are the major fire risk. Expanding human population in this zone is accompanied by an increasing threat of fires along the wildland urban interface. Activity along roads (e.g. equipment use, vehicle exhaust, smoking) has been the leading cause of vegetation fires from 1994 to 2004. Fires in grasslands may spread quickly into inaccessible areas.
- **Zone 3, Bend, Dales, Hog Lake—**Zone 3 is in northern Tehama County. Communities in the zone—Dales and Bend—are rural and sparsely populated. Most of the zone is grassland and grass-dominated oak-woodland. Grasses are the major carrier of fire in this area. Grassland fires accompanied by high winds are likely to spread rapidly and damage large areas. Rangeland, structures and occupants are the major assets at risk in Zone 3. Another issue is the lack of dependable year-round water sources. Most fires in Zone 3 have been caused by human activity, including equipment use and vehicle exhaust.
- **Zone 4, Manton, Sky Ranch—**Zone 4 is in northeastern Tehama County and includes the rural communities of Manton and Ponderosa Sky Ranch. Chaparral and oak-woodland are the dominant vegetation types. Grasses are often a major carrier of fire. Multiple large wildland fires have threatened the structures, occupants and rangeland in Zone 4. The WUI area is the most at risk. The Battle Creek watershed is also at risk. Water supply is adequate in the zone, but access is limited. Causes of fire in this area have primarily been lightning and human activities, including equipment use, vehicle exhaust and debris burns.
- **Zone 5, Mill Creek, Mineral—**Zone 5 is in northeastern Tehama County. Most people in the zone live in the communities of Mineral and Mill Creek. The vegetation is primarily mixed conifer timberland. Although generally a poor carrier of fire, timberland can support large, intense fires when associated with high wind, especially when trees become dry in late summer. The communities and timberland are the primary assets in Zone 5. Lightning caused almost half the fires in the zone over the past decade, but most lightning fires were small. The other half of the fires were caused by equipment use. Fires causing significant losses such as the 1992 Fountain Fire in Shasta County were due to high winds and dry weather.

- **Zone 6, Live Oak, West Red Bluff—**Zone 6 is in central Tehama County. Human population is concentrated in the eastern part of the zone in Red Bluff. There are many rural ranch houses in the area. The ranch houses and their rangelands as well as the communities are considered the primary assets at risk of fire. Arson and other human activities are a significant cause of fire in the zone. Equipment use, arson, controlled/debris burn escapes and other undetermined human activities caused over half the fires in the past decade.
- **Zone 7, Vina Plains—**Zone 7 is on the valley floor from central to southern Tehama County. There are no communities in the zone. Vegetation is primarily grassland and grass-dominated oak-woodland. Grass is the major carrier of fire and has the potential to carry fires from the populated western portion of the zone into the foothills on the eastern side of the valley. Rangeland and prime fisheries are the main assets at risk from fire. Most fires in Zone 7 are due to human activities at the western edge in the WUI area. Equipment use and debris burning are the most common causes of fire.
- **Zone 8, Ishi, Paynes Creek—**Zone 8 is in the eastern foothills of Tehama County and contains the rural community of Paynes Creek. Oak-woodland and chaparral are the predominant vegetation types in the zone; grasses are often the major carrier of fire. Fast-spreading grass/chaparral fires pose the greatest threat in the low elevations of Zone 8, while high-intensity fires of woodlands present the most significant threat in high elevations. Protection from fires in the zone is most needed for the watersheds of Antelope, Dye, Mill and Deer Creeks and rangeland used for livestock grazing. Lightning and power lines have caused several large fires. Most smaller fires are due to equipment use, arson, and vehicle exhaust.
- **Zone 9, Flournoy, Rancho Tehama—**Zone 9 encompasses much of the southern portion of Tehama County and includes the primarily residential communities of Flournoy and Rancho Tehama. Vegetation is a mixture of grassland, chaparral and oak-woodland. Grasses are the major carrier of fire. Zone 9 had the second highest occurrence of fires during the period from 1990 to 2001. High winds in the zone threaten to spread fires rapidly. Approximately one-third of the fires were caused by equipment use. Arson, vehicle exhaust and smoking were also significant fire causes.

13.2 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)."*

Risk refers to the likelihood of a hazard and the scale of damage it is expected to produce. There are different risks for various assets/resources subjected to the same hazard. For instance, a wildfire may cause damage to soils but not cause damage to a large tree. Consequently risk assessments include hazard, but must also include characterization of the assets/resources.

13.2.1 Past Events

Tehama County has an extensive fire history due to the abundance of fuel sources combined with the climate and topography of the planning area. According to CAL FIRE, there have been over 650 fires within Tehama County that burned over 23,000 acres and causing over $8.9 million in property damage since 2005. Table 13-1 lists the number and types of fires from 2005 to 2010.

TABLE 13-1.
FIRES BY CAUSE—TEHAMA-GLENN UNIT, 2005-2010

	2010	2009	2008	2007	2006	2005	**Total**
Arson	0	2	1	4	4	9	**20**
Campfire	0	1	0	6	1	2	**10**
Debris Burning	6	5	5	25	5	14	**60**
Equipment Use	15	5	13	40	25	54	**152**
Lightning	0	6	13	0	2	1	**22**
Miscellaneous	17	14	40	70	5	13	**159**
Power line	3	1	0	2	1	3	**10**
Smoking	2	1	2	6	5	6	**22**
Undetermined	17	13	20	47	19	14	**130**
Vehicle	3	1	1	0	8	54	**67**
Total	**63**	**49**	**95**	**200**	**75**	**170**	**652**

13.2.2 Location

CAL FIRE maps areas of significant fire hazards based on factors such as fuel, weather and terrain. 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.

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 Tehama County, approximately 959,000 acres are in a high or very high FHSZ. This represents over 50 percent of the area of the County. The geography, weather patterns and vegetation in the planning area provide ideal conditions for recurring wildfires. Map 13-1 shows the FHSZ map for Tehama County. This map is the basis for this wildfire risk assessment.

13.2.3 Frequency

Over the past 130 years (1878 to 2008), 44.16 percent of the areas mapped as very high, and 73.75 percent of those mapped as high have burned. Table 13-2 summarizes area burned within the planning area during that period.

TABLE 13-2.
RECORD OF FIRE AFFECTING PLANNING AREA

		Area Burned, 1878—2008	
FHSZ Category	Total Area in Zone (acres)	Acres	Percent of Total
Moderate	810,075	229,568	28.34%
High	194,533	143,466	73.75%
Very High	765,060	337,830	44.16%
Extreme	0	0	0.00%

13.2.4 Severity

Tehama County has an extensive history of large and damaging fires, mostly in WUI areas, resulting in losses of property and life. Given the immediate response times to reported fires, the likelihood of injuries and casualties is minimal, but the area burned can be significant. 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.

13.2.5 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.

13.3 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.

13.4 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.

13.5 EXPOSURE

13.5.1 Population

Population was estimated using the structure count of residential buildings within each Fire Hazard Severity Zone and applying the census value of 2.6 persons per household for Tehama County. These estimates are shown in Table 13-3.

13.5.2 Property

Property damage from wildfires can be severe and can significantly alter entire communities. Table 13-4 through Table 13-6 display the number of homes in the very high, high and moderate wildfire hazard zones within the planning area and their values. The unincorporated county and the cities of Corning, Red Bluff, and Tehama all have exposure to wildfire hazards to some degree. Table 13-7 shows the general zoning of parcels exposed to the wildfire hazard in the unincorporated portions of the County.

**TABLE 13-3.
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
Corning	203	528	6.89%	0	0	0.00%	0	0	0.00%
Red Bluff	596	1550	11.01%	0	0	0.00%	0	0	0.00%
Tehama	5	13	3.11%	0	0	0.00%	0	0	0.00%
Unincorporated	8,441	21,947	53.13	151	393	0.95%	183	476	1.15%
Total	**9,245**	**24,038**	**37.87**	**151**	**393**	**0.01%**	**183**	**476**	**0.01%**

**TABLE 13-4.
PLANNING AREA STRUCTURES EXPOSED TO VERY HIGH WILDFIRE HAZARDS**

	Buildings Exposed	Assessed Value			% of Total Assessed Value in Jurisdiction
		Structure	Contents	**Total**	
Corning	0	0	0	**0**	0.00%
Red Bluff	0	0	0	**0**	0.00%
Tehama	0	0	0	**0**	0.00%
Unincorporated	719	$48,102,000	$50,169,000	**$98,271,000**	2.69%
Total	**719**	**$48,102,000**	**$50,169,000**	**$98,271,000**	**1.93%**

**TABLE 13-5.
PLANNING AREA STRUCTURES EXPOSED TO HIGH WILDFIRE HAZARDS**

	Buildings Exposed	Assessed Value			% of Total Assessed
		Structure	Contents	**Total**	
Corning	0	0	0	**0**	0.00%
Red Bluff	0	0	0	**0**	0.00%
Tehama	0	0	0	**0**	0.00%
Unincorporated	315	$21,793,000	$19,889,000	**$41,682,000**	1.14%
Total	**315**	**$21,793,000**	**$19,889,000**	**$41,682,000**	**0.82%**

**TABLE 13-6.
PLANNING AREA STRUCTURES EXPOSED TO MODERATE WILDFIRE HAZARDS**

	Buildings Exposed	Assessed Value			% of Total Assessed Value in Jurisdiction
		Structure	Contents	**Total**	
Corning	207	$16,349,000	$13,418,000	**29,767,000**	7.07%
Red Bluff	647	$80,141,000	$68,637,000	**148,778,000**	15.20%
Tehama	6	$352,000	$300,000	**652,000**	3.08%
Unincorporated	9,692	$1,065,430,000	$897,179,000	**$1,962,609,000**	53.66%
Total	**10,552**	**$1,162,272,000**	**$979,534,000**	**$2,141,806,000**	**42.17%**

**TABLE 13-7.
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
Agriculture	725497	89.90%	120149	61.84%	118468	15.58%
Commercial	416	0.05%	3	0.00%	15	0.00%
Floodplain	5446	0.67%	117	0.06%	0	0.00%
Government	18902	2.34%	67029	34.50%	383506	50.43%
Industrial	1750	0.22%	0	0.00%	0	0.00%
Natural Resource	2938	0.36%	4146	2.13%	11838	1.56%
Planned Development	5659	0.70%	47	0.02%	27	0.00%
Recreation	176	0.02%	0	0.00%	29	0.00%
Residential	45419	5.63%	526	0.27%	2677	0.35%
Timber Production	840	0.10%	2289	1.18%	243,845	32.07%
Total	**807043**	**100%**	**194306**	**100%**	**760,405**	**100%**

13.5.3 Critical Facilities and Infrastructure

Table 13-8 identifies critical facilities exposed to the wildfire hazard in the county. Currently there are no 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 roads and railroads would be without damage except in the worst scenarios. Power lines are the most at risk to wildfire because most support poles 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 13-8.
CRITICAL FACILITIES EXPOSED TO WILDFIRE HAZARDS

	Moderate FHSZ	High FHSZ	Very High FHSZ
Medical and Health Services	0	0	0
Government Function	0	0	0
Protective Function	3	0	0
Schools	17	1	1
Hazmat	0	0	0
Other Critical Function	6	2	1
Bridges	229	5	17
Water	11	0	0
Waste Water	1	0	0
Communications	1	2	3
Total	**268**	**10**	**22**

13.5.4 Environment

Fire is a natural and critical ecosystem process in most terrestrial ecosystems, dictating in part the types, structure, and spatial extent of native vegetation. However, 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.

Many ecosystems are adapted to historical patterns of fire occurrence. 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.

13.6 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.

13.6.1 Population

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.

13.6.2 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 13-9 lists the loss estimates for the general building stock for jurisdictions that have an exposure to a fire hazard severity zone.

**TABLE 13-9.
POTENTIAL BUILDING LOSSES FROM WILDFIRE HAZARD**

	Buildings in Fire Hazard Zones		Potential Loss		
	Building Count	Assessed Value	10% Damage	30% Damage	50% Damage
Corning	207	$16,349,000	$1,634,900	$4,904,700	$8,174,500
Red Bluff	647	$80,141,000	$8,014,100	$24,042,300	$40,070,500
Tehama	6	$352,000	$35,200	$105,600	$176,000
Unincorporated	10,726	$1,135,325,000	$113,532,500	$340,597,500	$567,662,500
Total	**11,586**	**$1,232,167,000**	**$123,216,700**	**$369,650,100**	**$616,083,500**

13.6.3 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.

13.7 FUTURE TRENDS IN DEVELOPMENT

California has over 600 recognized ecotypes. Human impact on the land has forever changed many of these ecotypes, and as greater numbers of people come into contact with the land, the changes become more profound. The full spectrum of fire management issues are represented in the Tehama County planning area: WUI issues, mechanical thinning treatments, wildfire response and fire suppression, and prescribed fire as a land management tool. Human intervention is neither wholly the problem nor wholly the solution to the fire situation. Fire hazard planning is complicated by the fire environment of each ecosystem, the complexities brought by people, and the need for sufficient resources to address fire issues specific to each ecosystem. Despite the best efforts of fire service professionals, resource managers and other stakeholders, large, damaging, costly fires will continue.

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 Tehama 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.

13.8 SCENARIO

A major conflagration in Tehama 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.

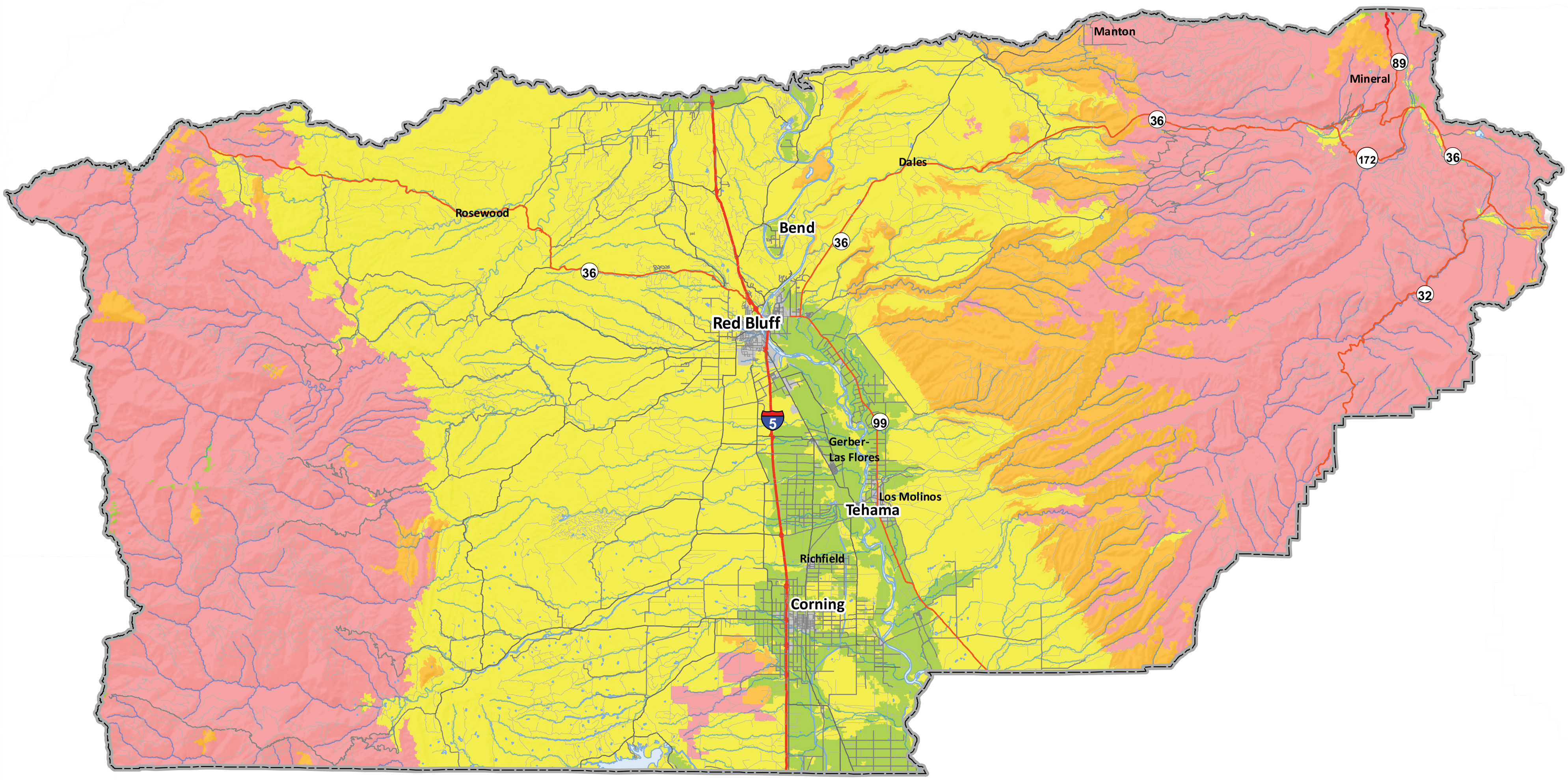
The worst-case scenario would include an active fire season throughout the American west, spreading resources thin. Firefighting teams would be exhausted or unavailable. Many federal assets would be responding to other fires that started earlier in the season. While local fire districts would be extremely 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.

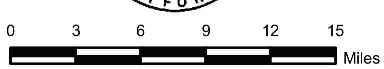
13.9 ISSUES

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.
- Most fuel reduction projects are complex because they involve conflicting land use interests and political factors. Any project likely to have a long-term impact on fuels and fire hazard will have to deal with the following:
  - Accommodation of property owner land-use
  - Active landowner participation
  - Planning for re-growth and long-term maintenance
  - Overlapping jurisdictions
  - Long-term funding needs
  - Environmental clearance under CEQA and the National Environmental Protection Act.
- Funding for wildfire management initiatives and programs.



TEHAMA COUNTY



Map 13-1

Wildfire Hazard Areas

Fire Hazard Severity

- Very High
- High
- Moderate
- Non-Wildland/Non-Urban
- Urban Unzoned

Data Sources:
Fire Hazard Areas
California Department of
Forestry and Fire Protection

This map was prepared for informational purposes only. Lines, roads, topography, culture, and other planimetric features shown on this mapping are compiled from many different sources and may not be, necessarily, current or reliable. Tehama County assumes no liability for the accuracy of the data shown on this map.

TETRA TECH

CHAPTER 14.
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 the planning area. 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.

14.1 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 14-1 summarizes the probability assessment for each hazard of concern for this plan.

**TABLE 14-1.
PROBABILITY OF HAZARDS**

Hazard Event	Probability (high, medium, low)	Probability Factor
Avalanche	Medium	2
Dam Failure	Low	1
Drought	High	3
Earthquake	Medium	2
Flood	High	3
Landslide	Medium	2
Severe Weather	High	3
Wildfire	High	3

14.2 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.

Table 14-2, Table 14-3 and Table 14-4 summarize the impacts for each hazard.

TABLE 14-2.
IMPACT ON PEOPLE FROM HAZARDS

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (3)
Avalanche	Low	1	(3x1) = 3
Dam Failure	Medium	2	(3x2) = 6
Drought	No Impact	0	(3x0) = 0
Earthquake	Medium	2	(3x2) = 6
Flood	Medium	2	(3x2) = 6
Landslide	Low	1	(3x1) = 3
Severe Weather	High	3	(3x3) = 9
Wildfire	Medium	2	(3x2) = 6

TABLE 14-3.
IMPACT ON PROPERTY FROM HAZARDS

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (2)
Avalanche	Low	1	(2x1) = 2
Dam Failure	Medium	2	(2x2) = 4
Drought	No Impact	0	(2x0) = 0
Earthquake	Medium	2	(2x2) = 4
Flood	Medium	2	(2x2) = 4
Landslide	Low	1	(2x1) = 2
Severe Weather	High	3	(2x3) = 6
Wildfire	Medium	2	(2x2) = 4

TABLE 14-4.
IMPACT ON ECONOMY FROM HAZARDS

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (1)
Avalanche	Low	1	(1x1) = 1
Dam Failure	High	3	(3x1) = 3
Drought	High	3	(3x1) = 3
Earthquake	Low	1	(1x1) = 1
Flood	Low	1	(1x1) = 1
Landslide	Low	1	(1x1) = 1
Severe Weather	High	3	(1x3) = 3
Wildfire	Medium	2	(1x2) = 2

14.3 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 14-5.

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 14-6 shows the hazard risk ranking.

**TABLE 14-5.
HAZARD RISK RATING**

Hazard Event	Probability Factor	Sum of Weighted Impact Factors	Total (Probability x Impact)
Avalanche	2	(3+2+1) = 6	(2x6) = 12
Dam Failure	1	(6+4+3) = 13	(1x13) = 13
Drought	3	(0+0+3) = 3	(3x3) = 9
Earthquake	2	(6+4+1) = 11	(2x11) = 22
Flood	3	(6+4+1) = 11	(3x11) = 33
Landslide	2	(3+2+1) = 6	(2x6) = 12
Severe Weather	3	(9+6+3) = 18	(3x18) = 54
Wildfire	3	(6+4+2) = 12	(3x12) = 36

**TABLE 14-6.
HAZARD RISK RANKING**

Hazard Ranking	Hazard Event	Category
1	Severe Weather	High
2	Wildfire	High
3	Flood	High
4	Earthquake	Medium
5	Dam Failure	Low
6	Avalanche	Low
6	Landslide	Low
7	Drought	Low

CHAPTER 15.
OTHER HAZARDS OF INTEREST

The hazards that are assessed in Chapter 6 through Chapter 13 and rated and ranked in Chapter 14 are those that present significant risks within the Tehama County planning area. Additional hazards, both natural and human-caused, were identified by the steering committee as having some potential to impact the planning area, but at a much lower risk level than the hazards of concern. These other hazards are identified as hazards of interest. A short profile of each hazard of interest, including a qualitative discussion of its potential to impact Tehama County, is included in the sections below. No formal risk assessment of these hazards was performed, and no mitigation initiatives have been developed to address them. However, all planning partners for this plan should be aware of these hazards and should take steps to reduce the risks they present whenever it is practical to do so.

15.1 AIR QUALITY/SMOKE POLLUTION

While an individual air quality or smoke pollution incident is not as significant as a flood or earthquake, cumulatively, air quality degradation is likely more hazardous to the health of vulnerable populations. Pollutants include smog, soot, particulate matter and toxic air contaminants. Air pollution is a continuous problem, particularly within densely populated basins. Smoke pollution from wildfires can be a problem in almost any region. Dense smoky air tends to settle in the mountainous valleys of Tehama County, making breathing and visibility challenging, especially for those who work outdoors or have respiratory issues. Whatever is in the air will eventually make its way to the ground to contaminate water and soil. With increasing regulation, toxic emissions are declining throughout the state; however, the reduction in smoke pollution rests with improved wildfire mitigation techniques.

Health hazards due to air pollution can have far-reaching effects. Some effects are immediate, such as acid rain deposition, causing plant damage and lake acidification. Other effects, such as non-point source pollution, are more complex, causing health hazards far from the source of the pollution.

15.2 ENERGY SHORTAGES

The 2000-2001 California electricity crisis brought to light issues about the state's dependency on out-of-state energy resources and in-state transmission challenges. Since then, the state has taken steps to lessen market manipulation, construct additional transmission systems and implement energy conservation programs. Still, California continues to be challenged with population growth and demand for additional power, along with severe weather events that necessitate considerable energy supplies.

The impacts of energy shortages are felt most severely by vulnerable populations. Those who rely on electrical power for life-sustaining medical equipment and the young or elderly subject to extreme heat or severe cold are most vulnerable to the loss of power.

Tehama County and its planning partners can increase their ability to cope with energy shortages and power disruptions. Some mitigation actions include strengthening minimum building code standards and requiring backup generators, modifying zoning ordinances for electrical power requirements and improving growth and development trends to better understand future energy demand. The state has developed an online toolkit (CalEMA, 2003) to help local governments address electric power disruption. This document identifies potential disruptions, types of customers affected and the types of facilities and populations with critical electrical needs.

15.3 HAZARDOUS MATERIALS

According to the California State Hazard Mitigation Plan, hazardous materials are substances that are flammable, combustible, explosive, toxic, noxious, corrosive, an oxidizer, an irritant, or radioactive. Hazardous material spills or releases can pose a risk to life, health and property. An incident may result in the evacuation of a facility or an entire neighborhood. In addition to the immediate risk from hazardous materials releases to life, public health, air quality, water quality and the environment, long-term public health and environmental impacts may result from sustained use or exposure to certain substances.

Federal laws that regulate hazardous materials include the Superfund Amendments and Reauthorization Act of 1986, the Resource Conservation and Recovery Act of 1976, the October 2007 Hazardous Materials Transportation Act, the Occupational Safety and Health Act, the Toxic Substances Control Act, and the Clean Air Act. California law established the Unified Program, which consolidates, coordinates, and makes consistent the administrative requirements, permits, inspections and enforcement activities of six environmental and emergency response programs. The programs are regulated and overseen by Cal EPA, however local governments are responsible for implementing and enforcing the standards.

Hazardous materials in Tehama County and are likely accidently released or spilled numerous times each day. Eliminating these widespread substances throughout the county would be nearly impossible, but the threats of an accidental release or spill may be reduced by mitigation. The following required mitigation efforts pertaining to hazardous substances are implemented through state and federal regulation:

- Fixed Facilities:
  - Process hazard analysis through the California Division of Occupational Safety and Health
  - Policies and procedures, hazard communication, and training
  - Placarding and labeling of containers
  - Hazard assessment
  - Security
  - Process and equipment maintenance
  - Mitigating techniques (flares, showers, mists, containment vessels, failsafe devices)
  - Use of inherently safer alternative products
  - Emergency plans and coordination
  - Response procedures
- Transported:
  - Placards and labeling of containers
  - Proper container established for material type
  - Random inspections of transporters
  - Safe handling policies and procedures
  - Hazard communications
  - Training for handlers
  - Permitting
  - Transportation flow studies, e.g., restricting HAZMAT transportation over certain routes.

15.4 INSECTS-BORNE DISEASE

15.4.1 Mosquito-Borne Disease

Many of the 48 species of mosquitoes in California can carry disease. The easiest and best way to avoid mosquito-borne illnesses is to prevent mosquito bites. Three mosquito-transmitted illnesses most affecting the human population are encephalitis, malaria and the West Nile Virus.

Encephalitis

There are four main viral agents of encephalitis in the United States: Eastern Equine, Western Equine, St. Louis and La Crosse. All four can be transmitted by mosquitoes. The most common types of mosquito-borne encephalitis in California are Western Equine and St. Louis. Most human infections have no effect or result in a nonspecific flu-like syndrome. Onset may be gradual or sudden, with fever, headache, muscle pain, malaise and occasionally prostration. Only a small portion of infected persons progress to encephalitis, which may have a fatal outcome or cause permanent neurologic damage.

Because encephalitis is a viral disease, antibiotics are not effective for treatment and no effective antiviral drugs have yet been discovered. Treatment attempts to deal with problems such as swelling of the brain, loss of automatic breathing activity, bacterial pneumonia, and other treatable complications.

Malaria

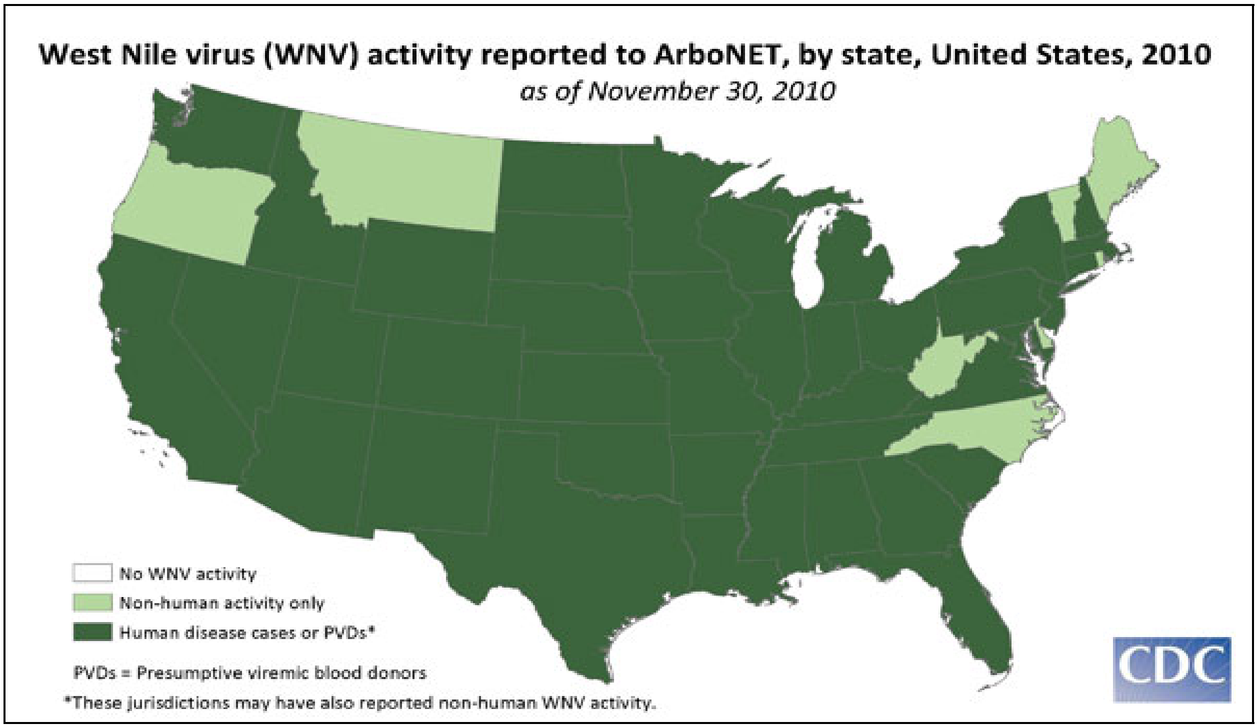
Malaria is a sometimes fatal disease caused by a parasite that commonly infects the *Anopheles* mosquito, which feeds on humans. People who contract malaria are typically very sick with high fevers, chills, and flu-like illness. Although malaria can be fatal, illness and death can usually be prevented.

On average 1,500 cases of malaria are diagnosed in the United States each year. The vast majority are in travelers and immigrants returning from countries where malaria transmission occurs, many from sub-Saharan Africa and South Asia. Although rare, cases of malaria have been reported in California. In many temperate areas, such as western Europe and the United States, economic development and public health measures have succeeded in eliminating malaria. However, most of these areas have *Anopheles* mosquitoes that can transmit malaria, and reintroduction of the disease is a constant risk.

West Nile Virus

West Nile virus is a potentially serious illness that is established as a seasonal epidemic in North America that flares up in the summer and continues into the fall. West Nile virus is a recent disease to affect California. Mosquitoes transmit the virus to birds, livestock and humans. Figure 15-1 shows recent distribution of the disease in the U.S.

About 80 percent of people infected with West Nile virus show no symptoms. Up to 20 percent have symptoms such as fever, headache, body aches, nausea, vomiting, and sometimes swollen lymph glands or a skin rash on the chest, stomach and back. Symptoms can last for as short as a few days, though even healthy people have become sick for several weeks. About 1 percent of people infected with West Nile virus develop severe illness, with symptoms that can include high fever, headache, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, vision loss, numbness and paralysis. These symptoms may last several weeks, and neurological effects may become permanent. There is no specific treatment for West Nile virus infection. In severe cases, people may need to go to the hospital where they can receive supportive treatment including intravenous fluids, help with breathing and nursing care.



Source: Centers for Disease Control

Figure 15-1. Distribution of West Nile Virus by State, 2010

15.4.2 Lyme Disease

Lyme disease is caused by the bacterium *Borrelia burgdorferi* which normally lives in mice, squirrels and other small animals. It is transmitted among these animals—and to humans—through the bites of certain species of ticks. In the northeastern and north-central United States, the black-legged tick (or deer tick, *Ixodes scapularis*) transmits Lyme disease. In the Pacific coastal United States, the disease is spread by the western black-legged tick (*Ixodes pacificus*). Other major tick species found in the United States have not been shown to transmit *Borrelia burgdorferi*.

Typical symptoms include fever, headache, fatigue, and a characteristic skin rash. If left untreated, infection can spread to joints, the heart, and the nervous system. Lyme disease is diagnosed based on symptoms, physical findings (e.g., rash), and the possibility of exposure to infected ticks. Laboratory testing is helpful in the later stages of disease. Most cases of Lyme disease can be treated successfully with a few weeks of antibiotics. Steps to prevent Lyme disease include using insect repellent, removing ticks promptly, landscaping, and integrated pest management. The ticks that transmit Lyme disease can occasionally transmit other tick-borne diseases as well.

15.5 MARINE INVASIVE SPECIES

As humans travel, they transport, intentionally or unintentionally, plants and animals, introducing non-indigenous species. Twentieth-century ships are painted with anti-fouling paints to prevent the settlement of fouling organisms, but the ships use water as ballast. Millions of gallons of water, along with the small organisms living in it, are taken up into the ship at one port and released in another. Millions of planktonic organisms including larvae can be contained in the ballast water. When the water is taken up, sediment is drawn into the ballast tanks as well, hosting benthic communities that can be transported around the world. Some fouling organisms still hitchhike around the world attached to nooks and crannies of ships.

15.6 NOXIOUS WEEDS

Some non-native plant species introduced into California spread aggressively and may be able to disrupt agricultural production and ecological systems. They may lower agricultural productivity, alter ecosystem functions (e.g., nutrient cycles, hydrology and wildfire frequency), outcompete and exclude native plants and animals, and add to maintenance costs of roads, parks and waterways. Noxious and invasive weeds infest millions of acres in the state and result in hundreds of millions of dollars in control costs and lost productivity. The California Department of Food and Agriculture Plant Health Division is responsible for protecting California's plant and flood supply by keeping invasive species out of the state. The Integrated Pest Control Branch conducts a wide range of pest management and eradication projects. Eradicating weeds at the earliest stages of invasion is more cost-effective and efficient than the long-term commitment of resources to ongoing containment or eliminating established weeds.

The Tehama County Resource Conservation District is a non-regulatory public agency whose mission is "to assist citizens with managing, conserving, and improving the natural resources of Tehama County." The district's vision is for a balanced use of the county's natural resources, where all land use decisions are socially acceptable, environmentally sound, and economically feasible. The District service area includes all of Tehama County with the exception of the cities of Tehama, Corning and Red Bluff. The District's services include the following:

- Funding cost-share projects for landowners and agricultural producers
- Financial management and oversight of projects related to natural resource conservation, protection, and improvement
- Noxious weed mapping and eradication projects
- Resource surveys and analysis
- Wildfire plans, conservation plans, and resource assessments
- Technical assistance to landowners and agricultural producers for evaluating irrigation systems through the Mobile Irrigation Lab Program
- Educational services, materials, and workshops for students, teachers, and adults.

15.7 HUMAN-CAUSED HAZARDS

Human-caused hazards fall into the following categories:

- Acts of terrorism are intentional, criminal, malicious acts. Key elements to defining a terrorist event are as follows:
  - Activities involve the use of illegal force.
  - Actions are intended to intimidate or coerce.
  - Actions are committed in support of political or social objectives.
- Technological hazards are incidents that arise from human activities such as the manufacture, transportation, storage and use of hazardous materials. These incidents are assumed to be accidental.

15.7.1 Terrorism

The Federal Bureau of Investigation (FBI) categorizes two types of terrorism in the United States:

- Domestic terrorism involves groups or individuals whose terrorist activities are directed at elements of our government or population without foreign direction. The bombing of the Alfred P. Murrah federal building in Oklahoma City is an example of domestic terrorism. The FBI is the primary response agency for domestic terrorism. The FBI coordinates domestic preparedness programs and activities of the United States to limit acts posed by terrorists, including the use of weapons of mass destruction.
- International terrorism involves groups or individuals whose terrorist activities are foreign-based and/or directed by countries or groups outside the United States, or whose activities transcend national boundaries. Examples include the 1993 bombing of the World Trade Center, the U.S. Capitol, and Mobil Oil's corporate headquarters and the attacks of September 11, 2001 at the World Trade Center and the Pentagon.

Most terrorist events in the United States have been bombing attacks, involving detonated and undetonated explosive devices, tear gas, pipe bombs, and firebombs. The effects of terrorism can vary from loss of life and injuries to property damage and disruptions in services such as electricity, water supplies, transportation, or communications. The event may have an immediate effect or a delayed effect. Terrorists often choose targets that offer limited danger to themselves and areas with relatively easy public access. Foreign terrorists look for visible targets where they can avoid detection before and after an attack such as international airports, large cities, major special events, and high-profile landmarks.

Three considerations distinguish terrorism hazards from other types of hazards:

- In the case of chemical, biological, and radioactive agents, their presence may not be immediately obvious, making it difficult to determine when and where they may have been released, who has been exposed, and what danger is present for first responders and emergency medical technicians.
- There is limited scientific understanding of how these agents affect the population at large.
- Terrorism evokes strong emotional reactions, ranging from anxiety, to fear, to anger, to despair, to depression.

While education, heightened awareness, and early warning of unusual circumstances may deter crime and terrorism, intentional acts that harm people and property are possible at any time. Public safety entities would then react to the threat, locating, isolating, and neutralizing further damage and investigating potential scenes and suspects to bring criminals to justice.

Those involved with terrorism response, including public health and public information staff, are trained to deal swiftly with the public's emotional reaction. The area of the event must be clearly identified in all emergency alert messages to prevent those not affected by the incident from overwhelming local emergency rooms and response resources, which would reduce service to those actually affected. The public will be informed clearly and frequently about what government agencies are doing to mitigate the impacts of the event. The public will also be given clear directions on how to protect the health of individuals and families.

In dealing terrorism, the unpredictability of human beings must be considered. People with a desire to perform criminal acts may seek out targets of opportunity that may not fall into established lists of critical areas or facilities. First responders train not only to respond to organized terrorism events, but also to respond to random acts by individuals who, for a variety of reasons ranging from fear to emotional trauma to mental instability, may choose to harm others and destroy property.

Table 15-1 provides a hazard profile summary for terrorism-related events. For each type of event, the following factors are addressed:

- **Application Mode**—Application mode describes the human acts necessary to cause the event to occur.
- **Duration**—Duration is the length of time the hazard is present. For example, a chemical warfare agent such as mustard gas, if un-remediated, can persist for hours or weeks under the right conditions.
- **Dynamic or Static Characteristics**—These characteristics describe an event's tendency to expand, contract, or remain confined in time, magnitude, and space. For example, a cloud of chlorine gas leaking from a storage tank can change location by drifting with the wind and can diminish in danger by dissipating over time.
- **Mitigation and Exacerbating Conditions**—Mitigating conditions are characteristics of the target and its physical environment that can reduce the effects of a hazard. For example, earthen berms can provide protection from bombs; exposure to sunlight can render some biological agents ineffective; and effective perimeter lighting and surveillance can minimize the likelihood of someone approaching a target unseen. In contrast, exacerbating conditions are characteristics that can enhance or magnify the effects of a hazard. For example, depressions or low areas in terrain can trap heavy vapors, and a proliferation of street furniture (trash receptacles, newspaper vending machines, mail boxes, etc.) can provide hiding places for explosive devices.

15.7.2 Technological Hazards

Technological hazards can be categorized as follows:

- Hazardous materials incidents
- Utility losses
- Data and telecommunications disruptions
- Water/wastewater disruption
- Air and transportation accidents
- Infrastructure threats.

Hazardous materials are present in nearly every city and county in the United States in facilities that produce, store or use them. For example, water treatment plants use chlorine on-site to eliminate bacterial contaminants. Hazardous materials are transported along interstate highways and railways daily. Even the natural gas used in every home and business is a dangerous substance when a leak occurs. Except for severe weather and flooding, hazardous materials incidents are the hazards most likely to Tehama County.

Title 49 of the CFR lists thousands of hazardous materials, including gasoline, insecticides, household cleaning products, and radioactive materials. State regulated substances that have the greatest probability of adversely impacting the community are listed in the CCR, Title 19.

**TABLE 15-1.
EVENT PROFILES FOR TERRORISM**

Hazard	Application Mode	Hazard Duration	Static/Dynamic Characteristics	Mitigating and Exacerbating Conditions
Conventional Bomb	Detonation of explosive device on or near target; delivery via person, vehicle, or projectile.	Instantaneous; additional secondary devices, and/or diversionary activities may be used, lengthening the time duration of the hazard until the attack site is determined to be clear.	Extent of damage is determined by type and quantity of explosive. Effects generally static other than cascading consequences, incremental structural failure, etc.	Blast force is inversely proportional to the cube of the distance from the blast; thus, each additional increment of distance provides progressively more protection. Terrain, forestation, structures, etc. can provide shielding by absorbing and/or deflecting energy and debris. Exacerbating conditions include ease of access to target; lack of barriers and shielding; poor construction; and ease of concealment of device.
Chemical Agent	Liquid/aerosol contaminants can be dispersed using sprayers or other aerosol generators; liquids vaporizing from puddles/ containers; or munitions.	Chemical agents may pose viable threats for hours to weeks depending on the agent and the conditions in which it exists.	Contamination can be carried out of the initial target area by persons, vehicles, water, and wind. Chemicals may be corrosive or otherwise damaging over time if not remediated.	Air temperature can affect evaporation of aerosols. Ground temperature affects evaporation of liquids. Humidity can enlarge aerosol particles, reducing inhalation hazard. Precipitation can dilute and disperse agents but can spread contamination. Wind can disperse vapors but also cause target area to be dynamic. The micro-meteorological effects of buildings and terrain can alter travel and duration of agents. Shielding in the form of sheltering in place can protect people and property from harmful effects.
Arson/ Incendiary Attack	Initiation of fire or explosion on or near target via direct contact or remotely via projectile.	Generally minutes to hours.	Extent of damage is determined by type and quantity of device, accelerant, and materials present at or near target. Effects generally static other than cascading consequences, incremental structural failure, etc.	Mitigation factors include built-in fire detection and protection systems and fire-resistive construction techniques. Inadequate security can allow easy access to target, easy concealment of an incendiary device, and undetected initiation of a fire. Non-compliance with fire and building codes, as well as failure to maintain existing fire protection systems, can substantially increase the effectiveness of a fire weapon.
Armed Attack	Tactical assault or sniping from remote location, or random attack based on fear, emotion, or mental instability.	Generally minutes to days.	Varies based on the perpetrators' intent and capabilities.	Inadequate security can allow easy access to target, easy concealment of weapons, and undetected initiation of an attack.
Biological Agent	Liquid or solid contaminants can be dispersed using sprayers/aerosol generators or by point or line sources such as munitions, covert deposits, and moving sprayers.	Biological agents may pose viable threats for hours to years depending on the agent and the conditions in which it exists.	Depending on the agent used and the effectiveness with which it is deployed, contamination can be spread via wind and water. Infection can spread via human or animal vectors.	Altitude of release above ground can affect dispersion; sunlight is destructive to many bacteria and viruses; light to moderate wind will disperse agents but higher winds can break up aerosol clouds; the micro-meteorological effects of buildings and terrain can influence aerosolization and travel of agents.

**TABLE 15-1.
EVENT PROFILES FOR TERRORISM**

Hazard	Application Mode	Hazard Duration	Static/Dynamic Characteristics	Mitigating and Exacerbating Conditions
Cyber-terrorism	Electronic attack using one computer system against another.	Minutes to days.	Generally no direct effects on built environment.	Inadequate security can facilitate access to critical computer systems, allowing them to be used to conduct attacks.
Agro-terrorism	Direct, generally covert contamination of food supplies or introduction of pests and/or disease agents to crops and livestock.	Days to months.	Varies by type of incident. Food contamination events may be limited to specific distribution sites, whereas pests and diseases may spread widely. Generally no effects on built environment.	Inadequate security can facilitate adulteration of food and introduction of pests and disease agents to crops and livestock.
Radiological Agent	Radioactive contaminants can be dispersed using sprayers/ aerosol generators, or by point or line sources such as munitions.	Contaminants may remain hazardous for seconds to years depending on material used.	Initial effects will be localized to site of attack; depending on meteorological conditions, subsequent behavior of radioactive contaminants may be dynamic.	Duration of exposure, distance from source of radiation, and the amount of shielding between source and target determine exposure to radiation.
Nuclear Bomb	Detonation of nuclear device underground, at the surface, in the air, or at high altitude.	Light/heat flash and blast/shock wave last for seconds; nuclear radiation and fallout hazards can persist for years. Electromagnetic pulse from a high-altitude detonation lasts for seconds and affects only unprotected electronic systems.	Initial light, heat, and blast effects of a subsurface, ground, or air burst are static and determined by the device's characteristics and employment; fallout of radioactive contaminants may be dynamic, depending on meteorological conditions.	Harmful effects of radiation can be reduced by minimizing the time of exposure. Light, heat, and blast energy decrease logarithmically as a function of distance from seat of blast. Terrain, forestation, structures, etc. can provide shielding by absorbing and/or deflecting radiation and radioactive contaminants.
Intentional Hazardous Material Release (fixed facility or transportation)	Solid, liquid, and/or gaseous contaminants may be released from fixed or mobile containers	Hours to days.	Chemicals may be corrosive or otherwise damaging over time. Explosion and/or fire may be subsequent. Contamination may be carried out of the incident area by persons, vehicles, water, and wind.	As with chemical weapons, weather conditions directly affect how the hazard develops. The micro-meteorological effects of buildings and terrain can alter travel and duration of agents. Shielding in the form of sheltering in place can protect people and property from harmful effects. Non-compliance with fire and building codes, as well as failure to maintain existing fire protection and containment features, can substantially increase the damage from a hazardous materials release.

Source: FEMA 386-7

The following are the most common type of hazardous material incidents:

- **Fixed-Facility Hazardous Materials Incident**—This is the uncontrolled release of materials from a fixed site capable of posing a risk to health, safety and property as determined by the Resource and Conservation Act. It is possible to identify and prepare for a fixed-site incident because federal and state laws require those facilities to notify state and local authorities about what is being used or produced at the site.
- **Hazardous Materials Transportation Incident**—A hazardous materials transportation incident is any event resulting in uncontrolled release of materials during transport that can pose a risk to health, safety and property as defined by Department of Transportation Materials Transport regulations. Transportation incidents are difficult to prepare for because there is little if any notice about what materials could be involved should an accident happen. Hazardous materials transportation incidents can occur at any place within the country, although most occur on interstate highways, other major federal or state highways, or major rail lines.

  In addition to materials such as chlorine that are shipped throughout the country by rail, thousands of shipments of radiological materials, mostly medical materials and low-level radioactive waste, take place via ground transportation across the United States. Many incidents occur in sparsely populated areas and affect very few people. There are occasions, however, when materials are involved in accidents in areas with much higher population densities, such as the January 6, 2005 train accident in Graniteville, South Carolina that released chlorine gas killing nine, injuring 500, and causing the evacuation of 5,400 residents. Fortunately, such events are rare.
- **Interstate Pipeline Hazardous Materials Incident**—There are a significant number of interstate natural gas, heating oil, and petroleum pipelines running through the State of California. These are used to provide natural gas to the utilities in California and to transport these materials from production facilities to end-users.

15.8 VOLCANO

A volcano is a vent in the earth’s crust through which magma, rock fragments, gases and ash are ejected from the earth’s interior. Over time, accumulation of these erupted products on the earth’s surface creates a volcanic mountain. A wide variety of hazards are related to volcanoes. The hazards are distinguished by the different ways in which volcanic materials and other debris flow from the volcano. The molten rock that erupts from a volcano (lava) forms a hill or mountain around the vent. The lava may flow out as a viscous liquid, or it may explode from the vent as solid or liquid particles. Ash and fragmented rock material can become airborne and travel far from the erupting volcano to affect distant areas.

Volcanoes can lie dormant for centuries between eruptions. When they erupt, high-speed avalanches of hot ash and rock (called pyroclastic flows), lava flows, and landslides can devastate areas 10 or more miles away. Huge mudflows of volcanic ash and debris called lahars can inundate valleys more than 50 miles downstream. Ash from explosive eruptions, called tephra, can disrupt human activities hundreds of miles downwind, and drifting clouds of fine ash can cause severe damage to the engines of jet aircraft hundreds or thousands of miles away.

Lassen Peak (Figure 15-2) is the southernmost active volcano in the Cascade Range, located in northern California halfway between Lake Tahoe and the Oregon border. Prior to Mount Saint Helens in 1980, Lassen Peak was the last volcano in the continental U.S. to erupt, with a major series of eruptions starting in 1914 and continuing sporadically until 1921 (Figure 15-3).

Figure 15-2. Lassen Peak

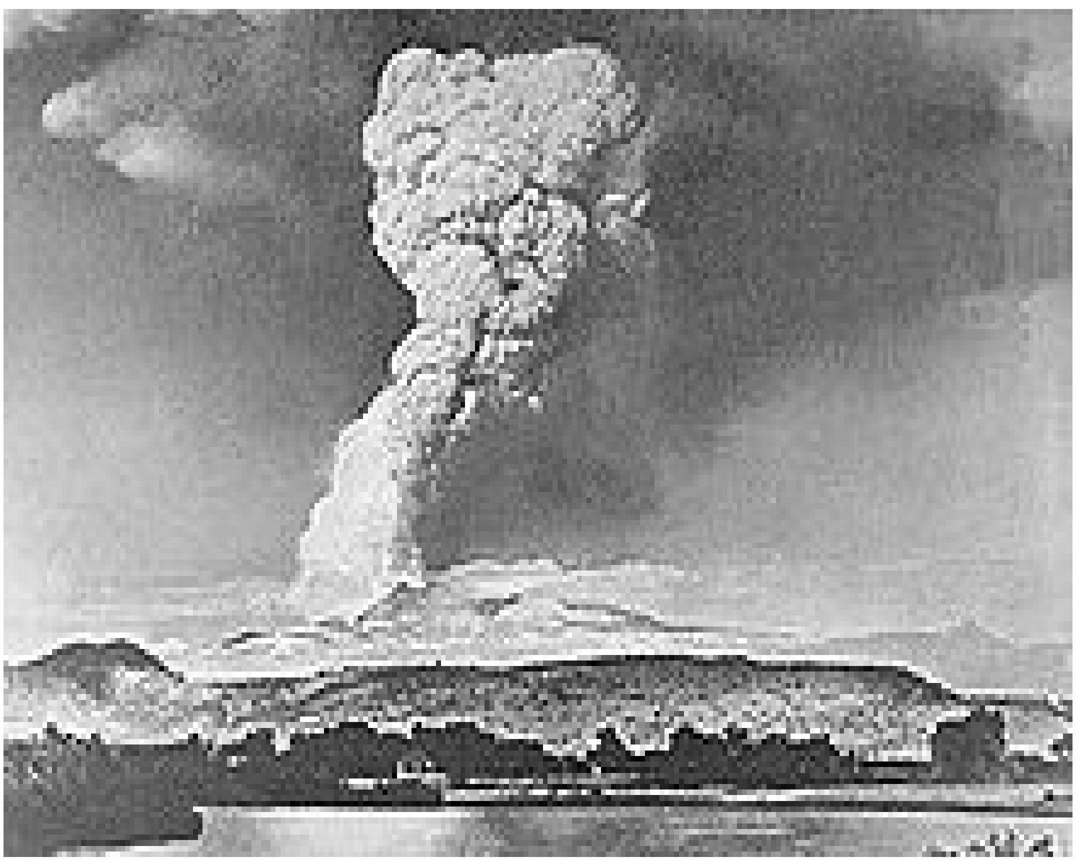


Figure 15-3. Lassen Peak 1914 volcanic eruption

Lassen Peak is one of the largest plug domes in the world, a massive block of dacite lava extruded up from the shattered remains of the collapsed Mount Tehama stratovolcano. Brokeoff Mountain and Mount Diller are the highest remnants of this former progenitor volcano, the bulk of which was eroded away by repeated glaciations during the past several hundred-thousand years. Active hydrothermal features of provide evidence that magma still underlies this area.

Lassen Volcanic National Park receives some of the heaviest snowfalls in California during the winter and spring, with the snowpack often 20 to 25 feet deep near Lake Helen, just south of Lassen Peak. Despite this, Lassen Peak's southern latitude and modest elevation prevent the formation of glaciers, with only a few small permanent snowfields lasting through the hot summers. However, the Lassen Park Road allows easy access to a variety of ski routes throughout winter, spring, and into early summer. The road is easily skied in winter, and as plowing of the road progresses in spring, the distance to the summit shortens significantly.

PART 3 —
MITIGATION STRATEGY

CHAPTER 16.
MITIGATION ALTERNATIVES

Catalogs of hazard mitigation alternatives were developed that present a broad range of alternatives to be considered for use in the planning area, in compliance with 44 CFR (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 Table 16-1 through Table 16-7. 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.

No actions were reviewed for the avalanche hazard other that public education actions, since there is very little development exposed to this hazard within the planning area.

TABLE 16-1.
CATALOG OF RISK REDUCTION MEASURES—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 16-2.
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 16-3.
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 16-4.
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 16-4.
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 16-5.
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 16-6.
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 16-7.
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 firefighting.	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 17.
AREA-WIDE MITIGATION INITIATIVES

17.1 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 17-1 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.

17.2 BENEFIT/COST REVIEW

The action plan must be prioritized according to a benefit/cost analysis of the proposed projects and their associated costs (44 CFR, Section 201.6(c)(3)(iii)). 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.

TABLE 17-1.
ACTION PLAN—COUNTYWIDE MITIGATION INITIATIVES

Hazards Addressed	Lead Agency	Possible Funding Sources or Resources	Time Line[a]	Objectives
CW-1—Continue to maintain a countywide hazard mitigation plan website to house the plan and plan updates, in order to provide the public an opportunity to monitor plan implementation and progress. Each planning partner may support the initiative by including an initiative in its action plan and creating a web link to the website.				
All Hazards	County Public Works	General Fund	Short term/ongoing	2, 3, 6, 9
CW-2—Leverage public outreach partnering capabilities to inform and educate the public about hazard mitigation and preparedness.				
All Hazards	Sheriff's Office, County Public Works	General Fund	Short term/ongoing	2, 3, 6, 9
CW-3—Coordinate all mitigation planning and project efforts, including grant application support, to maximize all resources available to the planning partnership.				
All Hazards	Sheriff's Office	General Fund, FEMA mitigation grants	Short term/ongoing	1, 2, 3, 4, 5, 6, 7, 8, 9
CW-4—Support the collection of improved data (hydrologic, geologic, topographic, volcanic, historical, etc.) to better assess risks and vulnerabilities.				
All Hazards	Sheriff's Office, County Public Works	General Fund, FEMA mitigation grants	Short term/ongoing	2, 3, 5, 6
CW-5—Provide coordination and technical assistance in grant application preparation that includes assistance in cost vs. benefit analysis for grant-eligible projects.				
All Hazards	Sheriff's Office	General Fund, FEMA mitigation grants	Short term/ongoing	3, 6
CW-6—Where appropriate, support retrofitting, purchase, or relocation of structures or infrastructure located in hazard-prone areas to protect structures/infrastructure from future damage, with repetitive loss and severe repetitive loss properties as priority when applicable.				
All Hazards	County Public Works	FEMA mitigation grants	Long term	1, 3, 4, 6, 9
CW-7— Continue to maintain the steering committee as a viable committee to monitor the progress of the hazard mitigation plan, provide technical assistance to planning partners and oversee the update of the plan as necessary.				
All Hazards	County Public Works	General Fund	Short term/ongoing	3, 6

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.

17.3 COUNTY-WIDE ACTION PLAN PRIORITIZATION

Table 17-2 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.

**TABLE 17-2.
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	4	High	Low	Yes	No	Yes	High
CW-2	4	Low	Low	Yes	No	Yes	Med
CW-3	9	Med	Low	Yes	Yes	Yes	High
CW-4	4	High	High	Yes	Yes	No	High
CW-5	2	Med	Low	Yes	Yes	No	High
CW-6	5	High	High	Yes	Yes	No	High
CW-7	2	Low	Low	Yes	No	Yes	High

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.

17.4 PLAN ADOPTION

A hazard mitigation plan must document that it has been formally adopted by the governing body of the jurisdiction requesting federal approval of the plan (44 CFR Section 201.6(c)(5)). 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 CalEMA and FEMA prior to adoption. Once pre-adoption approval has been provided, all planning partners will formally adopt the plan. 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.

17.5 PLAN MAINTENANCE STRATEGY

A hazard mitigation plan must present a plan maintenance process that includes the following (44 CFR 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 section details the formal process that will ensure that the Tehama 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 section also describes how public participation will be integrated throughout the plan maintenance and implementation process, and how the mitigation strategies outlined in this plan will be incorporated into existing planning mechanisms and programs. 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.

17.5.1 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 Tehama County Department of Public Works and the Tehama County Sheriff's Office 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).

17.5.2 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.

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 the Sheriff's Office on possible enhancements to be considered at the next update. Future plans will be overseen by a steering committee similar to the one that participated in this plan development process, so keeping an interim 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 plans.

17.5.3 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.

Tehama County Department of Public Works will assume the responsibility of initiating the annual progress reporting process. A template to guide the planning partners in preparing a progress report has been created as part of this planning process (see Appendix C). At Public Work's discretion, a committee may be convened to provide feedback to the planning partners on items included in the template. Public Works will then prepare a formal annual report on the progress of the plan. This report should be used as follows:

- Posted on the Department of Public works website page dedicated to the hazard mitigation plan: http://www.tehamacountypublicworks.ca.gov/hazard_plan.htm
- 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 44 CFR. 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.

17.5.4 Plan Updates

Local hazard mitigation plans be reviewed, revised if appropriate, and resubmitted for approval in order to remain eligible for benefits under the DMA (44 CFR, Section 201.6(d)(3)). The Tehama 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 comprehensive 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 comprehensive 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.

17.5.5 Continuing Public Involvement

The public will continue to be apprised of the plan's progress through the hazard mitigation plan 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. The Department of Public Works 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 Tehama 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.

17.5.6 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 plan was prepared. The Tehama 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 development 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 Tehama County. An update to a comprehensive plan may trigger an update to the hazard mitigation plan.

All municipal planning partners are committed to creating a linkage between the hazard mitigation plan and their individual comprehensive 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.

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APPENDIX A.
ACRONYMS AND DEFINITIONS

April 2012

APPENDIX A.
ACRONYMS AND DEFINITIONS

ACRONYMS

CalEMA—California Emergency Management Agency

CCR—California Code of Regulations

CEQA—California Environmental Quality Act

CFR—Code of Federal Regulations

CRS—Community Rating System

DFIRM—Digital Flood Insurance Rate Maps

DMA —Disaster Mitigation Act

DWR—California Department of Water Resources

EPA—U.S. Environmental Protection Agency

ESA—Endangered Species Act

FEMA—Federal Emergency Management Agency

FERC—Federal Energy Regulatory Commission

FHSZ—Fire Hazard Severity Zone

FIRM—Flood Insurance Rate Map

FIS—Flood Insurance Study

FMP—Tehama County Flood Mitigation Plan

FRA—Federal Responsibility Area

GIS—Geographic Information System

HAZUS-MH—Hazards, United States-Multi Hazard

HMGP—Hazard Mitigation Grant Program

IBC—International Building Code

LRA—Local Responsibility Area

NEHRP—National Earthquake Hazards Reduction Program

NFIP—National Flood Insurance Program

NOAA—National Oceanic and Atmospheric Administration

NRCS—Natural Resources Conservation Service

NWS—National Weather Service

PDM—Pre-Disaster Mitigation Grant Program

PDI—Palmer Drought Index

PGA—Peak Ground Acceleration

PHDI—Palmer Hydrological Drought Index

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

WUI—Wildland urban interface

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).

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 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, 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.

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 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.

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.

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.

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.

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; or
- Two paid flood losses in excess of $1,000 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.

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.

APPENDIX B.
PUBLIC OUTREACH

April 2012

Tehama County Survey: Natural Hazards & Mitigation Planning

1. Where in Tehama County do you live?

	Response Percent	Response Count
Corning/Capay/Vina area	3.9%	8
Red Bluff/Bend area	**51.9%**	**107**
Manton/Mineral/Paynes Creek area	2.4%	5
Tribal Lands	0.5%	1
Bowman/Lake California area	17.0%	35
Tehama/Gerber/Los Molinos area	16.5%	34
Rancho Tehama/Paskenta/Flournoy area	1.5%	3
Other (please specify)	6.3%	13
	answered question	**206**
	skipped question	**0**

2. Do you work in Tehama County?

	Response Percent	Response Count
Yes	**64.2%**	**129**
No	28.4%	57
Other (please specify)	7.5%	15
	answered question	**201**
	skipped question	**5**

3. Which of the following natural hazard events have you or has anyone in your household experienced in the past 20 years within Tehama County? (Check all that apply)

	Response Percent	Response Count
Avalanche	4.0%	8
Dam/Levee Failure	5.0%	10
Drought	25.0%	50
Earthquake	23.5%	47
Flood	24.5%	49
Hazardous Materials	11.0%	22
Household Fire	13.5%	27
Landslide	6.0%	12
Severe Weather (wind, lightning, winter storm, etc.)	**57.0%**	**114**
Volcanic Eruption (lahar, ash fall)	5.0%	10
Wildland Fire	21.5%	43
None	28.0%	56
Other (please specify)	4.5%	9
	answered question	**200**
	skipped question	**6**

4. How prepared is your household 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:	14.8% (22)	**51.0% (76)**	20.1% (30)	6.0% (9)	8.1% (12)	2.42	149
						answered question	**149**
						skipped question	**57**

5. Which of the following have provided you with useful information to help you be prepared for a natural hazard event? (Check all that apply)

	Response Percent	Response Count
Emergency preparedness information from a government source (e.g., federal, state, or local emergency management)	31.1%	46
Personal experience with one or more natural hazards/disasters	43.2%	64
Locally provided news or other media information	**46.6%**	**69**
Schools and other academic institutions	21.6%	32
Attended meetings that have dealt with disaster preparedness	16.9%	25
Community Emergency Response Training (CERT)	6.1%	9
None	13.5%	20
Other (please specify)	9.5%	14
	answered question	**148**
	skipped question	**58**

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	52.4%	76
Made a fire escape plan	35.2%	51
Designated a meeting place	38.6%	56
Identified utility shutoffs	49.0%	71
Sand bags	6.9%	10
Prepared a disaster supply kit	25.5%	37
Installed smoke detectors on each level of the house	**80.0%**	**116**
Stored food and water	51.7%	75
Stored flashlights and batteries	69.0%	100
Stored a battery-powered radio	36.6%	53
Stored a fire extinguisher	56.6%	82
Stored medical supplies (first aid kit, medications)	58.6%	85
Natural hazard insurance (Flood, Earthquake, Wildfire)	33.8%	49
None	6.9%	10

Other (please specify)		3.4%	5
		answered question	**145**
		skipped question	**61**

7. How concerned are you about the following natural hazards in Tehama County? (Check one response for each hazard)

	Not Concerned	Somewhat Concerned	Concerned	Very Concerned	Extremely Concerned	Rating Average	Response Count
Avalanche	**94.3% (133)**	2.8% (4)	0.0% (0)	0.0% (0)	2.8% (4)	1.14	141
Climate Change	**39.6% (55)**	28.8% (40)	20.9% (29)	5.0% (7)	5.8% (8)	2.09	139
Dam/Levee Failure	**35.2% (50)**	31.7% (45)	21.8% (31)	6.3% (9)	4.9% (7)	2.14	142
Drought	17.4% (24)	**37.7% (52)**	23.2% (32)	15.2% (21)	6.5% (9)	2.56	138
Earthquake	26.1% (37)	**38.7% (55)**	22.5% (32)	7.7% (11)	4.9% (7)	2.27	142
Flood	24.1% (35)	**31.0% (45)**	27.6% (40)	11.0% (16)	6.2% (9)	2.44	145
Hazardous Materials	**34.8% (48)**	32.6% (45)	16.7% (23)	6.5% (9)	9.4% (13)	2.23	138
Household Fire	21.3% (30)	**37.6% (53)**	26.2% (37)	6.4% (9)	8.5% (12)	2.43	141
Landslide	**75.7% (106)**	15.0% (21)	5.7% (8)	0.0% (0)	3.6% (5)	1.41	140
Severe Weather	16.1% (23)	**37.1% (53)**	28.7% (41)	11.2% (16)	7.0% (10)	2.56	143
Volcanic Eruption	**51.1% (71)**	30.9% (43)	10.1% (14)	2.9% (4)	5.0% (7)	1.80	139
Wildland Fire	22.0% (31)	**27.7% (39)**	22.7% (32)	15.6% (22)	12.1% (17)	2.68	141
Other	**66.7% (24)**	8.3% (3)	2.8% (1)	5.6% (2)	16.7% (6)	1.97	36

(Please specify other natural hazard)		6
answered question		**149**
skipped question		**57**

8. Which of the following methods do you think are most effective for providing hazard and disaster information? (Check all that apply)

	Response Percent	Response Count
Newspaper	55.7%	83
Telephone Book	12.8%	19
Informational Brochures	26.8%	40
City Newsletters	17.4%	26
Public Meetings	21.5%	32
Workshops	18.8%	28
Schools	38.3%	57
TV News	**72.5%**	**108**
TV Ads	32.9%	49
Radio News	63.1%	94
Radio Ads	34.9%	52

Internet	68.5%	102
Outdoor Advertisements	14.8%	22
Fire Department/Rescue	32.2%	48
Church (faith-based institutions)	15.4%	23
CERT Classes (Community Emergency Response Training)	17.4%	26
Books	8.1%	12
Chamber of Commerce	12.1%	18
Academic Institutions	14.1%	21
Public Library	15.4%	23
Red Cross Information	32.2%	48
Community Safety Events	30.2%	45
Fair Booths	26.8%	40
Word of Mouth	36.2%	54
Post Office	19.5%	29
Local Businesses	14.8%	22
Family Resource Centers	20.1%	30
Public Awareness Campaign (e.g., Flood Awareness Week, Winter Storm Preparedness Month)	32.2%	48
Other (please specify)	2.7%	4

	answered question	**149**
	skipped question	**57**

9. Is your property located in or near a FEMA designated floodplain?

	Response Percent	Response Count
Yes	34.9%	52
No	**39.6%**	**59**
Not Sure	25.5%	38
	answered question	**149**
	skipped question	**57**

10. Do you have flood insurance?

	Response Percent	Response Count
Yes	27.5%	41
No	**62.4%**	**93**
Not Sure	10.1%	15
	answered question	**149**
	skipped question	**57**

11. Is your property located near an earthquake fault?

	Response Percent	Response Count
Yes	9.4%	14
No	**52.3%**	**78**
Not Sure	38.3%	57
	answered question	**149**
	skipped question	**57**

12. Do you have earthquake insurance?

	Response Percent	Response Count
Yes	10.7%	16
No	**75.2%**	**112**
Not Sure	14.1%	21
	answered question	**149**
	skipped question	**57**

13. Is your property located in an area at risk for wild fires?

	Response Percent	Response Count
Yes	40.3%	60
No	**45.0%**	**67**
Not Sure	14.8%	22
answered question		**149**
skipped question		**57**

14. Have you ever had problems getting homeowners or renters insurance due to risks from natural hazards?

	Response Percent	Response Count
Yes	10.7%	16
No	**79.9%**	**119**
Not Sure	9.4%	14
If "yes," which natural hazard was involved?		13
answered question		**149**
skipped question		**57**

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	43.9%	61
No	**51.8%**	**72**
Not Sure	4.3%	6
answered question		**139**
skipped question		**67**

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	30.2%	42
No	**55.4%**	**77**
Not Sure	14.4%	20
answered question		**139**
skipped question		**67**

17. Would the disclosure of this type of natural hazard risk information influence your decision to buy or rent a home?

	Response Percent	Response Count
Yes	**55.4%**	**77**
No	30.2%	42
Not Sure	14.4%	20
	answered question	**139**
	skipped question	**67**

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 home above the flood level, performing seismic upgrades, or replacing a combustible roof with non-combustible roofing)

	Response Percent	Response Count
$10,000 or above	10.8%	15
$5,000 to $9,999	7.9%	11
$1,000 to $4,999	10.1%	14
Less than $1,000	11.5%	16
Nothing	20.9%	29
Not Sure	**38.8%**	**54**
	answered question	**139**
	skipped question	**67**

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	46.8%	65
Insurance premium discount	59.0%	82
Mortgage discount	36.7%	51
Property tax break or incentive	**66.2%**	**92**
Low interest rate loan	38.8%	54
Grant funding	55.4%	77
None	17.3%	24
Other (please specify)	3.6%	5
	answered question	**139**
	skipped question	**67**

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	**46.7%**	**64**
No	19.7%	27
Not Sure	33.6%	46
answered question		**137**
skipped question		**69**

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:	13.4% (18)	10.4% (14)	20.9% (28)	**31.3% (42)**	23.9% (32)	3.42	134
answered question							**134**
skipped question							**72**

22. Please indicate how you feel about the following statement: It is my responsibility to educate myself and take actions that will reduce my 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:	6.6% (9)	4.4% (6)	11.0% (15)	26.5% (36)	**51.5% (70)**	4.12	136
						answered question	**136**
						skipped question	**70**

23. Please indicate how you feel about the following statement: Information about the risks associated with natural hazards is readily available and easy to locate.

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Rating Average	Response Count
Choose one:	11.8% (16)	24.3% (33)	23.5% (32)	**30.1% (41)**	10.3% (14)	3.03	136
						answered question	**136**
						skipped question	**70**

24. Please indicate your age range:

	Response Percent	Response Count
Under 18	8.9%	12
18 to 30	5.2%	7
31 to 40	17.0%	23
41 to 50	21.5%	29
51 to 60	19.3%	26
61 or older	**28.1%**	**38**
	answered question	**135**
	skipped question	**71**

25. Please indicate the primary language spoken in your household.

	Response Percent	Response Count
English	**94.8%**	**127**
Spanish	2.2%	3
Other Indo-European Languages	0.7%	1
Asian and Pacific Island Languages	1.5%	2
Other (please specify)	0.7%	1
	answered question	**134**
	skipped question	**72**

26. Please indicate your gender:

	Response Percent	Response Count
Male	33.6%	45
Female	**66.4%**	**89**
	answered question	**134**
	skipped question	**72**

27. Please indicate your highest level of education.

	Response Percent	Response Count
Grade school/No schooling	0.0%	0
Some high school	5.1%	7
High school graduate/GED	11.8%	16
Some college/Trade school	24.3%	33
College degree	**34.6%**	**47**
Graduate degree	21.3%	29
Other (please specify)	2.9%	4
	answered question	**136**
	skipped question	**70**

28. How long have you lived in Tehama County?

	Response Percent	Response Count
Less than 1 year	0.8%	1
1 to 5 years	12.1%	16
6 to 10 years	18.9%	25
11 to 20 years	23.5%	31
More than 20 years	**44.7%**	**59**
	answered question	**132**
	skipped question	**74**

29. Do you own or rent your place of residence?

	Response Percent	Response Count
Own	**85.2%**	**115**
Rent	14.8%	20
	answered question	**135**
	skipped question	**71**

30. How much is your gross household income?

	Response Percent	Response Count
$20,000 or less	9.6%	12
$20,001 to $49,999	**31.2%**	**39**
$50,000 to $74,999	28.0%	35
$75,000 to $99,999	11.2%	14
$100,000 or more	20.0%	25
	answered question	**125**
	skipped question	**81**

31. Do you have regular access to the Internet?

	Response Percent	Response Count
Yes	**84.8%**	**112**
No	12.1%	16
Not Sure	3.0%	4
	answered question	**132**
	skipped question	**74**

32. Comments

	Response Count
	17
answered question	**17**
skipped question	**189**

APPENDIX C.
EXAMPLE PROGRESS REPORT

April 2012

APPENDIX C. EXAMPLE PROGRESS REPORT

Tehama County Hazard Mitigation Plan Annual Progress Report

Reporting Period: *(Insert reporting period)*

Background: Tehama 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:

INSERT LINK

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 Tehama 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 Tehama 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]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
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 Tehama 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

April 2012

APPENDIX D.
PLAN ADOPTION RESOLUTIONS FROM PLANNING PARTNERS

To Be Provided With Final Release