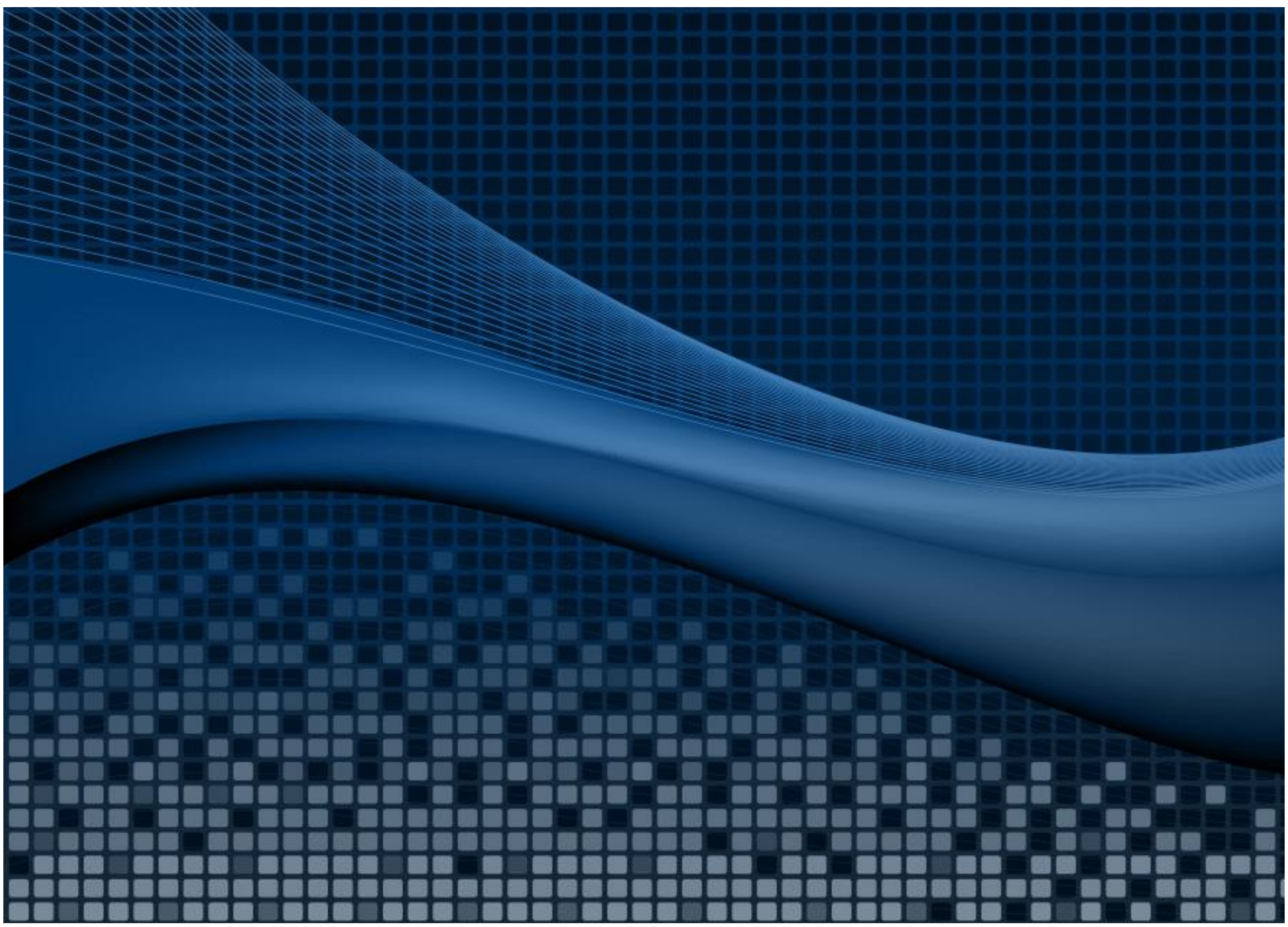
Humboldt County Operational Area Hazard Mitigation Plan 2019

Volume 1—Area-Wide Elements



TETRA TECH

January 2020

Humboldt County Operational Area Hazard Mitigation Plan 2019

Volume 1—Area-Wide Elements

January 2020

PREPARED FOR

Humboldt County Office of Emergency Services
826 Fourth Street
Eureka, CA 95501

PREPARED BY

Tetra Tech
1999 Harrison Street
Suite 500
Oakland, CA 94612
Phone: 510.302.6300
Fax: 510.433.0830
www.tetratech.com

Tetra Tech Project #103S5974
HumboldtCountyHMP_Vol1_Final_2020-01-17.docx

CONTENTS

Appendices

Tables

Figures

ACKNOWLEDGMENTS

Humboldt County

- Dorie Lanni, Emergency Services Manager, Office of Emergency Services
- Cybelle Immitt, Senior Planner, Humboldt County Department of Public Works
- John Miller, Senior Planner, Humboldt County Planning and Building Department

Consultants

- Rob Flaner, CFM, Tetra Tech, Inc., Project Manager
- Bart Spencer, Tetra Tech, Inc., Project Lead Planner
- Carol Baumann, GISP, Tetra Tech, Inc., Risk Assessment Lead
- Dan Portman, Tetra Tech, Inc., Technical Editor
- Melissa Schloss, Tetra Tech, Inc., Planner

Stakeholders

- Jay Parrish, City Manager, City of Ferndale
- Justin Robbins, General Manager, Shelter Cove Resort Improvement District
- Brian Issa, Deputy Public Works Director, City of Eureka
- Guy Vitello, Engineering Manager, Southern Humboldt Community Healthcare District
- Jan Marnell, Emergency Services Coordinator, California Office of Emergency Services
- Merritt Perry, City Manager, City of Fortuna
- Ryan Aylward, Warning Coordination Meteorologist, National Weather Service
- Mickey Hulstrom, Community Services Manager, Humboldt Community Services District
- Victoria LaMar-Haas, Governor's Office of Emergency Services
- Justin McDonald, Humboldt County Fire Chief's Association
- Aldaron Laird, Environmental Planner, Trinity Associates

Special Acknowledgments

The development of this plan would not have been possible without the dedication and commitment to this process by the Hazard Mitigation Plan Steering Committee. The dedication of the volunteers on this committee to allocate their time to this process is greatly appreciated. Also, the citizens of Humboldt County are commended for their participation in the plan outreach activities. Their involvement sets the course for successful implementation of this plan.

EXECUTIVE SUMMARY

HAZARD MITIGATION OVERVIEW

Hazard mitigation is the use of long-term and short-term policies, programs, projects, and other activities to alleviate the death, injury, and property damage that can result from a disaster. Humboldt County and a partnership of local governments within the operational area have developed a hazard mitigation plan to reduce risks from natural disasters in the Humboldt County Operational Area—defined as the unincorporated county, incorporated cities, and special purpose districts planning partners authorized to govern, develop, or regulate. The plan complies with federal and state hazard mitigation planning requirements to establish eligibility for funding under Federal Emergency Management Agency (FEMA) grant programs for all planning partners.

UPDATING THE HUMBOLDT COUNTY PLAN

This plan is a comprehensive update of the *2014 Humboldt Operational Area Hazard Mitigation Plan*, which covered the unincorporated county, the Cities of Arcata, Blue Lake, Eureka, Ferndale, Fortuna, Rio Dell and Trinidad, and 23 special-purpose districts within the county. FEMA approved the 2014 plan on March 20, 2014, and it expired on March 20, 2019. This update reestablishes FEMA hazard mitigation grant assistance eligibility for participating planning partners. All but one of the original planning partners have participated in the update and four new planning partners were added, as listed in Table ES-1.

PLAN DEVELOPMENT APPROACH

Organization

A core planning team consisting of a contract consultant and Humboldt County staff was assembled to facilitate this plan update. A planning partnership was formed by engaging eligible local governments within the Operational Area and making sure they understood their expectations for compliance under the updated plan. A steering committee was assembled to oversee the plan update, consisting of both governmental and non-governmental stakeholders within the Operational Area. Coordination with other county, state, and federal agencies involved in hazard mitigation occurred throughout the plan update process. Organization efforts included a review of the *2014 Humboldt Operational Area Hazard Mitigation Plan*, the California statewide hazard mitigation plan, and existing programs that may support hazard mitigation actions.

Public Outreach

The planning team implemented a multi-media public involvement strategy utilizing the outreach capabilities of the planning partnership that was approved by the Steering Committee. The strategy included public meetings, a hazard mitigation survey, an information booth at the Veteran’s day parade, a project website, the use of social media and multiple media releases.

Table ES-1. Planning Partners

Jurisdiction	Point of Contact	Title
Humboldt County	Dorie Lanni	Emergency Services Manager
City of Arcata	Mike Clinton	Environmental Services Deputy Director
City of Blue Lake	Amanda Mager	City Manager
City of Eureka	Brian Gerving	Public Works Director
City of Ferndale	Jay Parrish	City Manager
City of Fortuna	Kevin Carter	Public Works Deputy Director
City of Rio Dell	Kyle Knopp	City Manager
City of Trinidad	Bryan Buckman	Public Works Director
Fieldbrook Glendale Community Services District	Richard Hanger	General Manager
Humboldt Community Services District	David Hull	General Manager
Manila Community Services District	Christopher Drop	General Manager
McKinleyville Community Services District	Gregory Orsini	General Manager
Redway Community Services District	Terrence Williams	General Manager
Westhaven Community Services District	Paul Rosenblatt	General Manager
Willow Creek Community Services District	Susan O'Gorman	General Manager
Arcata Fire District	Justin McDonald	Fire Chief
Fortuna Fire Protection District	Rus Brown	Division Chief
Humboldt Bay Fire District	William M. Reynolds	Deputy Chief
Samoa Peninsula Fire Protection District	Dale Unea	Fire Chief
Humboldt Bay Municipal Water District	John Friedenbach	General Manager
Humboldt Bay Harbor, Recreation, and Conservation District	Larry Oetker	General Manager
Shelter Cove Resort Improvement District	Justin Robbins	General Manager
Southern Humboldt Community Healthcare District	Guy Vitello	Engineering Manager

Plan Document Development

The planning team and Steering Committee assembled a document to meet federal hazard mitigation planning requirements for all partners. The updated plan contains two volumes. Volume 1 contains components that apply to all partners and the broader Operational Area. Volume 2 contains all components that are jurisdiction-specific. Each planning partner has a dedicated annex in Volume 2.

Adoption

Once pre-adoption approval has been granted by the California Office of Emergency Services and FEMA Region IX, the final adoption phase will begin. Each planning partner will individually adopt the updated plan.

RISK ASSESSMENT

Risk assessment is the process of measuring the potential loss of life resulting from natural hazards, as well as personal injury, economic injury and property damage, in order to determine the vulnerability of people, buildings, and infrastructure to natural hazards. For this update, risk assessment models were enhanced with new data and technologies that have become available since 2010. The Steering Committee used the risk assessment to rank risk and to gauge the potential impacts of each hazard of concern in the Operational Area. The risk assessment included the following:

- Hazard identification and profiling
- Assessment of the impact of hazards on physical, social, and economic assets

- Identification of particular areas of vulnerability
- Estimates of the cost of potential damage.

Based on the risk assessment, hazards were ranked for the risk they pose to the overall Operational Area, as shown in Table ES-2. Each planning partner also ranked hazards for its own area. Table ES-3 summarizes the categories of high, medium and low (relative to other rankings) based on the numerical ratings that each jurisdiction assigned each hazard.

Table ES-2. Hazard Risk Ranking

Hazard Ranking	Hazard Event	Category[a]
1	Earthquake	High
2	Wildfire	High
3	Severe weather	High
4	Landslide	Medium
4	Seal Level Rise	Medium
5	Flooding	Medium
5	Tsunami	Medium
6	Drought	Low
7	Dam Failure	Low

a. Scores of 30 or greater are rated as "high," scores of 15 to 29 are "medium," and scores of less than 15 are "low

Table ES-3. Summary of Hazard Ranking Results

	Number of Jurisdictions Assigning Ranking to Hazard			
	High	Medium	Low	Not Ranked
Dam Failure	0	6	10	7
Drought	3	1	17	2
Earthquake	23	0	0	0
Flooding	4	12	7	0
Landslide	13	7	1	2
Sea Level Rise	3	7	2	11
Severe Weather	21	2	0	0
Tsunami	1	9	5	8
Wildfire	10	10	3	0

The results indicate the following general patterns:

- Almost all planning partner ranked earthquake as high and more than half ranked wildfire as high.
- The flooding and severe weather hazards were most commonly ranked as medium.
- The drought hazard was most commonly ranked as low.
- Exposure and vulnerability to the hazards differ significantly among the planning partners.

MITIGATION GOALS AND OBJECTIVES

The Steering Committee reviewed and made minor updates to the guiding principle, goals, and objectives from the *2014 Humboldt Operational Area Hazard Mitigation Plan*. The following guiding principle guided the Steering Committee and planning partners in selecting actions contained in this plan update:

> *Through partnerships and careful planning, identify and reduce the vulnerability to hazards in order to protect the health, safety, quality of life, environment, and economy of the communities within the Humboldt Operational Area.*

Goals

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

1. Protect Health and Safety
2. Protect Property
3. Protect the Economy
4. Protect Quality of Life
5. Protect Environment
6. Promote Partnerships in Planning

The effectiveness of a mitigation strategy is assessed by determining how well these goals are achieved.

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. Minimize disruption of local government operations caused by hazards.
2. Increase resilience of (or protect and maintain) infrastructure and critical facilities.
3. Reduce hazard-related risks and vulnerability of the populations in Humboldt County.
4. Sustain reliable local emergency operations and facilities during and after a disaster.
5. Enhance emergency response capabilities and participation within the planning area.
6. Enhance understanding of hazards and the risk they pose through public education that emphasizes awareness, preparation, mitigation, response and recovery alternatives.
7. Continually improve understanding of the location and potential impacts of hazards that impact the planning area utilizing the best available data and science as it becomes available, and share this information with all stakeholders.
8. Establish a partnership among all levels of government and the business community to improve and implement methods to protect property.
9. Develop and implement hazard mitigation strategies that reduce losses to wildlife habitat and protect water supply and quality, while also reducing damage to development.
10. Integrate hazard identification information and mitigation policies into other planning-based processes that direct or impact land uses in the planning area.
11. Enhance building codes and their proper implementations so that new construction can withstand the impacts of hazards and lessen the impact of that development on the environment’s ability to absorb the impact of hazards.
12. Seek to integrate and coordinate all phases of emergency management within the planning area.

MITIGATION ACTION PLAN

The planning partners selected mitigation actions to work toward achieving the goals set forth in this plan update. Mitigation actions presented in this update are activities designed to reduce or eliminate losses resulting from natural hazards. The update process resulted in the identification of 309 mitigation actions for implementation by individual planning partners, as presented in Volume 2 of this plan. In addition, the Steering Committee and planning partners identified countywide actions benefiting the whole partnership, as listed in Table ES-4.

IMPLEMENTATION

The Steering Committee developed a plan implementation and maintenance strategy that includes grant monitoring and coordination, a strategy for continued public involvement, a commitment to plan integration with other relevant plans and programs, and a recommitment from the planning partnership to actively monitoring and evaluating the plan over the five-year performance period.

Full implementation of the recommendations of this plan will require time and resources. The measure of the plan's success will be its ability to adapt to changing conditions. The County of Del Norte and its planning partners will assume responsibility for adopting the recommendations of this plan and committing resources toward implementation. The framework established by this plan commits all planning partners to pursue actions when the benefits of a project exceed its costs. The planning partnership developed this plan with extensive public input, and public support of the actions identified in this plan will help ensure the plan's success.

Table ES-4. Area-Wide Hazard Mitigation Actions

Action Number and Description	Implementation Priority
CW-1—Continue to participate in the planning partnership and, to the extent possible based on available resources, provide coordination and technical assistance in applications for grant funding that include assistance in cost vs. benefit analysis.	High
CW-2—Encourage the development and implementation of an operational area-wide hazard mitigation public-information strategy that meets the needs of all planning partners.	High
CW-3—Coordinate updates to land use and building regulations as they pertain to reducing the impacts of natural hazards, to seek a regulatory cohesiveness within the planning area. This can be accomplished via a commitment from all planning partners to involve each other in their adoption processes, by seeking input and comment during the course of regulatory updates or general planning.	High
CW-4—Sponsor and maintain a natural hazards informational website to include the following types of information: • Hazard-specific information such as GIS layers, private property mitigation alternatives, important facts on risk and vulnerability • Pre- and post-disaster information such as notices of grant funding availability • Links to Planning Partners' pages, FEMA, Red Cross, NOAA, USGS and the National Weather Service. • Hazard mitigation plan information such as progress reports, mitigation success stories, update strategies, Steering Committee meetings.	Medium
CW-5—Maintain the Hazard Mitigation Plan Steering Committee as a viable body over time to monitor progress of the plan, provide technical assistance to Planning Partners and oversee the update of the plan according to schedule. This body will continue to operate under the ground rules established at its inception.	High
CW-6—Amend or enhance the Humboldt County Operational Area Hazard Mitigation Plan as well as the general Plans for each municipality as needed to comply with state or federal mandates (i.e., CA. Assembly Bill # 2140) as guidance for compliance with these programs become available.	High
CW-7—Work with the Humboldt County Assessor to begin the capture of general building stock information such as area, date of construction and foundation type, to better support future risk assessments.	Medium

Humboldt County Operational Area Hazard Mitigation Plan 2019

PART 1—PLANNING PROCESS AND COMMUNITY PROFILE

1. INTRODUCTION TO HAZARD MITIGATION PLANNING

1.1 WHY PREPARE THIS PLAN?

1.1.1 The Big Picture

Hazard mitigation is defined as any action taken to reduce or alleviate the loss of life, personal injury, and property damage that can result from a disaster. It involves long- and short-term actions implemented before, during and after disasters. Hazard mitigation activities include planning efforts, policy changes, programs, studies, improvement projects, and other steps to reduce the impacts of hazards.

For many years, federal disaster funding focused on relief and recovery after disasters occurred, with limited funding for hazard mitigation planning in advance. The Disaster Mitigation Act (DMA), passed in 2000, shifted the federal emphasis toward planning for disasters before they occur. The DMA requires state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. Regulations developed to fulfill the DMA's requirements are included in Title 44 of the Code of Federal Regulations (44 CFR).

The responsibility for hazard mitigation lies with many, including private property owners, commercial interests, and local, state and federal governments. The DMA encourages cooperation among state and local authorities in pre-disaster planning. The enhanced planning network called for by the DMA helps local governments to articulate accurate needs for mitigation, resulting in faster allocation of funding and more cost-effective risk-reduction projects.

The DMA also promotes sustainability in hazard mitigation. To be sustainable, hazard mitigation needs to incorporate sound management of natural resources and address hazards and mitigation in the largest possible social and economic context.

1.1.2 Purposes for Planning

Humboldt County prepared a hazard mitigation plan in compliance with the DMA in 2007. Cities and special purpose districts with jurisdiction inside the county participated as planning partners in the plan. That initial plan identified resources, information, and strategies for reducing risk from natural hazards. It called for ongoing updates and was last updated in 2014. This *Humboldt County Operational Area Hazard Mitigation Plan 2019* fulfills the ongoing update requirement.

In preparing this update, Humboldt County has again partnered with local communities and special-purpose districts. One of the benefits of such 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. Elements and strategies in the plan were selected because they meet a program requirement and because they best meet the needs of all the planning partners and their citizens.

The *Humboldt County Operational Area Hazard Mitigation Plan 2019* will help guide and coordinate mitigation activities throughout the planning area. It 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 of local hazards of concern.
- Meet the planning requirements of FEMA's Community Rating System (CRS), allowing eligible planning partners to consider participation in the CRS program.
- Coordinate existing plans and programs so that high-priority projects to mitigate possible disaster impacts are funded and implemented.

1.2 WHO WILL BENEFIT FROM THIS PLAN?

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

1.3 CONTENTS OF 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 disaster mitigation plan that apply to the entire planning area. This includes the description of the planning process, public involvement strategy, goals and objectives, planning area hazard risk assessment, planning area mitigation actions, and a plan maintenance strategy.
- Volume 2—Volume 2 includes all federally required jurisdiction-specific elements, in annexes for each participating jurisdiction. It includes a description of the participation requirements established by the Steering Committee, as well as instructions and templates that the partners used to complete their annexes. Volume 2 also includes "linkage" procedures for eligible jurisdictions that did not participate in development of this plan but wish to adopt it in the future.

Both volumes include elements required under federal guidelines. DMA compliance requirements are cited at the beginning of subsections as appropriate to indicate compliance.

The following appendices provided at the end of Volume 1 include information or explanations to support the main content of the plan:

- Appendix A—Public involvement information used in preparation of this update
- Appendix B—A summary of federal and state programs and regulations relevant to hazard mitigation.
- Appendix C—Quantitative results from risk assessment modeling.
- Appendix D— Plan adoption resolutions from planning partners.

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.

2. PLAN UPDATE—WHAT HAS CHANGED

2.1 THE PREVIOUS PLAN

The *2014 Humboldt Operational Area Hazard Mitigation Plan* was prepared for a planning partnership that consisted of Humboldt County, the Cities of Arcata, Blue Lake, Eureka, Ferndale, Fortuna, Rio Dell and Trinidad, and 23 special-purpose districts within the county. This approach addressed several meaningful considerations:

- Multi-jurisdictional planning allows participating partners to pool resources toward collaborative activities within a planning area that has uniform risk exposure and vulnerabilities.
- The County provides many services on a countywide basis that influence or directly impact all phases of emergency management.
- Due to limited financial resources at the municipal level, the ability of each city and district to prepare a DMA-compliant plan was uncertain.
- There is a natural planning area boundary that coincides with the jurisdictional boundaries of the County's emergency management function.
- FEMA promotes multi-jurisdictional planning, so a multi-jurisdictional partnership was more likely to receive grant funding for the planning effort.
- The State of California's Standardized Emergency Management System encourages multi-jurisdictional efforts for emergency planning and establishes the "***Operational area***"—consisting of a county and all political subdivisions within it—as one of the five state-defined levels for use in all emergencies and disasters involving multiple agencies or multiple jurisdictions.

The 2014 plan recommended seven countywide mitigation actions and nearly 400 actions specific to individual planning partners. The actions address the following identified hazards of concern:

- Dam failure
- Earthquake
- Flood
- Landslide
- Severe weather
- Tsunami
- Wildfire.

Participating planning partners completed individual annexes to the plan, thereby achieving DMA compliance through the plan. FEMA issued approval of the plan on March 20, 2014.

2.2 WHY UPDATE?

2.2.1 Federal Eligibility

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

2.2.2 Changes in Development

Hazard mitigation plan updates must be revised to reflect changes in development within the planning area during the previous performance period of the plan (44 CFR Section 201.6(d)(3)). The plan must describe changes in development in hazard-prone areas that increased or decreased vulnerability for each jurisdiction since the last plan was approved. If no changes in development impacted the jurisdiction's overall vulnerability, plan updates may validate the information in the previously approved plan. The intent of this requirement is to ensure that the mitigation strategy continues to address the risk and vulnerability of existing and potential development and takes into consideration possible future conditions that could impact vulnerability.

The planning area experienced a 7.49-percent increase in population between 2000 and 2018, an average annual growth rate of 1.06 percent per year. Humboldt County and its incorporated cities have general plans that govern land-use decisions and policy-making, as well as building codes and specialty ordinances based on state and federal mandates. This plan update assumes that some new development triggered by increased population occurred in hazard areas. Because all such new development would have been regulated pursuant to local programs and codes, it is assumed that vulnerability did not increase even if exposure did. More detailed information on the types and location of new construction over the last five years is available in the city and county annexes in Volume 2 of this plan.

The following are significant demographic changes in the Humboldt County operational area since the previous hazard mitigation plan update (statistics for population provided by California Office of Financial Management and statistics for general building stock provided by the Humboldt County Assessor):

- The net increase in population from January 1, 2013 to January 1, 2018 was 793, or 0.58 percent
- The general building stock for the operational area decreased by 2,576 structures, or 5.1 percent
- The valuation of the general building stock increased by $19.774 billion, or 127 percent

2.2.3 New Analysis Capabilities

The risk assessment for the 2019 plan used both quantitative and qualitative analyses. Building count data and annualized average loss estimates were provided for some, but not all, hazards of concern. These estimates were predominantly reported at the countywide scale. The updated risk assessment provides more detailed information on exposed population and building counts for each hazard of concern. This update also expands the level of detail in multiple-scenario loss estimation modeling for earthquake, flood, landslide, wildfire, and sea level rise. Exposure and vulnerability estimates are presented at the jurisdictional level. This enhanced risk assessment allows for a more detailed understanding of the ways risk in the planning area is changing over time.

The changes in risk assessment results since the previous plan are significant. The 2014 plan used U.S. Census data at the census-block level, which can underestimate exposure to hazards. The 2019 update used point-based data correlated to County assessor data, which provides extra detail and a more accurate estimate of exposure. Therefore, increased estimates of hazard exposure in this plan are not fully attributable to new development in the operational area since the last plan; much of it is also attributable to the new analysis methodology.

2.3 THE UPDATED PLAN—WHAT IS DIFFERENT?

The updated plan differs from the initial plan in a variety of ways. Table 2-1 indicates the major changes between the two plans as they relate to 44 CFR planning requirements.

Table 2-1. Plan Changes Crosswalk

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(b): In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: *(1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;* *(2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and* *(3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.*	The 2014 plan followed an outreach strategy utilizing multiple media developed and approved by the Steering Committee. This strategy involved: • Public participation on an oversight Steering Committee. • Establishment of a plan informational website. • Press releases. • Use of a public information survey Stakeholders were identified and coordinated with throughout the process. A comprehensive review of relevant plans and programs was performed by the planning team.	Building upon the approach from the 2014 plan, the 2018-2019 planning effort deployed the same public engagement methodology. Enhancements included: • Utilization of social media • Web-deployed survey • Enhanced press coverage As with the 2014 plan, the 2018-2019 planning process identified key stakeholders and coordinated with them throughout the process. A comprehensive review of relevant plans and programs was performed by the planning team.
§201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.	Part 2 of Volume 1 presents a comprehensive risk assessment for the planning area that looks at eight hazards of concern: dam failure, drought, earthquake, flood, landslide, severe weather, tsunami and wildfire. This section also includes an aggregate profile of other hazards of concern that have a potential impact on the planning area but do not warrant a full risk assessment: fish losses, marine invasive species, oil spills, human-caused hazards and volcanoes.	The same methodology, using new, updated data, was deployed for the 2018-2019 plan update. The risk assessment now includes a detailed profile of potential impacts of climate change on the assessed hazards of concern. A qualitative profile of non-natural hazards was included. These hazards were profiled only and not fully assessed or ranked as with the natural hazards.
§201.6(c)(2)(i): [The risk assessment shall include a] description of the … location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.	Volume 1 presents a comprehensive risk assessment of each hazard of concern in Chapter 8 through Chapter 15. Each chapter describes the following: • Hazard profile, including maps of extent and location, historical occurrences, frequency, severity and warning time • Secondary hazards • Climate change impacts • Exposure of people, property, critical facilities and environment • Vulnerability of people, property, critical facilities and environment • Future trends in development • Scenarios • Issues	The same format, using updated data, was deployed for the 2018-2019 plan update. Climate change was addressed as a stand-alone chapter.

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(c)(2)(ii): [The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i). This description shall include an overall summary of each hazard and its impact on the community	Vulnerability was assessed for all hazards of concern. The HAZUS computer model (version MR-3) was used for the dam failure, earthquake, flood and tsunami hazards. These were abbreviated Level 2 analyses using planning partner and County data. Site-specific data on County-identified critical facilities was entered into the HAZUS model. HAZUS outputs were generated for other hazards by applying an estimated damage function to affected assets. The asset inventory was extracted from the HAZUS model. Best available data was used for all analyses.	The same methodology was deployed for the 2018 plan update, using updated data. Hazus version 4.0 was utilized for all analyses.
§201.6(c)(2)(ii): [The risk assessment] must also address National Flood Insurance Program insured structures that have been repetitively damaged floods	The repetitive loss section was provided to meet DMA and CRS planning requirements. The update includes a comprehensive analysis of repetitive loss areas that includes an inventory of the number and types of structures in the repetitive loss area. Repetitive loss areas were delineated, causes of repetitive flooding were cited, and these areas were reflected on maps.	The 2018/2019 plan included a CRS level-of-detail repetitive loss area analysis based on 2016 repetitive loss data and the 2017 CRS Coordinators Manual.
§201.6(c)(2)(ii)(A): The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.	A complete inventory of the numbers and types of buildings exposed was generated for each hazard of concern at the census block/tract level. This data was updated with relevant current assessor's data where available. The Steering Committee retained the critical facility definition from the initial planning effort, with the addition of levees as critical facilities. Each hazard chapter provides a discussion on future development trends as they pertain to each hazard.	The same methodology was deployed for the 2018/2019 plan update, using updated data that is cited in Section 6.4.4 of this volume.
§201.6(c)(2)(ii)(B): [The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) and a description of the methodology used to prepare the estimate.	Estimates of dollar loss were generated for all hazards of concern. These were generated by HAZUS for the dam failure, earthquake, flood and tsunami hazards. For the other hazards, loss estimates were generated by applying a regionally relevant damage function to the exposed inventory. In all cases, a damage function was applied to an asset inventory. The asset inventory was the same for all hazards and was generated in the HAZUS model.	The same methodology was deployed for the 2018/2019 plan update, using updated data.
§201.6(c)(2)(ii)(C): [The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.	A qualitative analysis of future trends in development was applied to all hazards of concern.	The same methodology was deployed for the 2018/2019 plan update, using updated data. In addition, a look at the change in risk due to new development over the performance period of the plan was performed for each hazard of concern.

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(c)(3): The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.	The update includes both countywide initiatives and jurisdiction-specific initiatives. A crosswalk is provided in the plan update to identify the status of actions identified in the initial plan.	The same methodology for setting goals, objectives and actions was applied to the 2018/2019 plan update. The Steering Committee reviewed and reconfirmed the guiding principle, goals and objectives for the plan. Each planning partner used the progress reporting from the plan maintenance and evaluated the status of actions identified in the 2014 plan. Actions that were completed or no longer considered to be feasible were removed. The rest of the actions were carried over to the 2017 plan and in some cases, new actions were added to the action plan.
§201.6(c)(3)(i): [The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.	The Steering Committee identified a guiding principal, 6 goals and 12 objectives.	The Steering Committee affirmed the guiding principle and objectives of the 2014 Plan update and continued to use them in the 2018/2019 update. These planning components can be viewed in Chapter 18 of this volume.
§201.6(c)(3)(ii): [The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.	An enhanced mitigation catalog supported each planning partner. The mitigation catalog is included in the body of the report of the update. An analysis in each jurisdictional annex identifies which of six mitigation categories each initiative meets. This helps to illustrate the comprehensive range of actions identified.	The mitigation catalog was reviewed and updated by the Steering Committee for the 2018/2019 update. As with the 2014 plan, the catalog is included in the 2018 plan to represent the comprehensive range of alternatives considered by each planning partner. The analysis of mitigation action was again used in jurisdictional annexes to the plan.
§201.6(c)(3)(ii): [The mitigation strategy] must also address the jurisdiction's participation in the National Flood Insurance Program, and continued compliance with the program's requirements, as appropriate.	All municipal planning partners that participate in the National Flood Insurance Program (NFIP) identified an action stating their commitment to maintain compliance and good standing under the NFIP. An assessment of program capabilities under the NFIP was included in the capability assessment of each municipal planning partner.	The same methodology was deployed for the 2018/2019 plan update, using updated data.
§201.6(c)(3)(iii): [The mitigation strategy shall describe] how the actions identified in Section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.	Each recommended initiative is prioritized using a qualitative methodology that looked at the objectives the project will meet, the timeline for completion, how the project will be funded, the impact of the project, the benefits of the project and the costs of the project. This prioritization scheme is detailed in Chapter 1 of Volume 2 of the plan.	The same methodology was deployed for the 2018 plan update, using updated data.
§201.6(c)(4)(i): [The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.	The plan maintenance strategy was revised to change progress reporting from an annual approach to a plan performance period approach (5 years). All other components of the strategy were maintained. The strategy is presented in Chapter 19.	The same plan maintenance strategy was carried over for the 2018/2019 plan update process.

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(c)(4)(ii): [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.	Chapter 19 details recommendations for incorporating the plan into other planning components such as: • Partnership emergency response plans • Capital improvement programs • Municipal codes • Community design guidelines • Water-efficient landscape design guidelines • Stormwater management programs • Water system vulnerability assessments • Humboldt County Master Fire Protection Plan.	This component of the plan maintenance strategy from the 2014 plan was carried over to the 2018/2019 plan update. The maintenance strategy for this plan can be viewed in Section 21.2 of this volume.
§201.6(c)(4)(iii): [The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.	Chapter 19 details a strategy for continuing public involvement such as: • Website • Libraries • Publication of a progress report	This component of the plan maintenance strategy from the 2014 plan was carried over to the 2018/2019 plan update. The maintenance strategy for this plan can be viewed in Section 21.2 of this volume.
§201.6(c)(5): [The local hazard mitigation plan shall include] documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County Commission, Tribal Council).	All planning partners that fully met their participation requirements as defined by the planning process formally adopted the plan. Appendix D presents the resolutions of all planning partners that adopted this plan	All planning partners that fully met their participation requirements as defined by the planning process formally adopted the plan. Appendix D presents the resolutions of all planning partners that adopted this plan

3. PLAN UPDATE APPROACH

The process followed to develop the *Humboldt County Operational Area Hazard Mitigation Plan 2019* 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.

3.1 GRANT FUNDING

This planning effort was supplemented by a FEMA Hazard Mitigation Assistance grant (Hazard Mitigation Grant Program for DR 4301 in fiscal year 2017. The Humboldt County Office of Emergency Services (OES) was the applicant agent for the grant. It covered 75 percent of the cost for development of this plan; the planning partners covered the balance through in-kind match funding.

3.2 DEFINING STAKEHOLDERS

At the beginning of the planning process, the planning team identified a list of stakeholders to engage during the update of the Hazard Mitigation Plan. For this planning process, “stakeholder” was defined as any person or public or private entity that owns or operates facilities that would benefit from the mitigation actions of this plan, and/or has an authority or capability to support mitigation actions identified by this plan. Stakeholders were separated into two categories:

- **Participatory Stakeholders**—Stakeholders that actively participated in the planning process as planning partners or members of the Steering Committee.
- **Coordinating Stakeholders**—Stakeholders that were not able to commit to actively participating in the process as a participatory stakeholder but were kept apprised of plan development milestones or were able to provide data that was used in the plan development.

3.3 FORMATION OF THE CORE PLANNING TEAM

Humboldt County OES contracted with Tetra Tech, Inc. to assist with development, update, and implementation of the plan. The Tetra Tech project manager managed the overall plan development; Tetra Tech’s lead planner was tasked with interacting with the Humboldt County OES project manager. A core planning team was formed to lead the planning effort, made up of the following members:

- Dorie Lanni, Emergency Services Manager, Humboldt County Office of Emergency Services
- Rob Flaner, Tetra Tech, Project Manager
- Bart Spencer, Tetra Tech, Project Lead Planner
- Carol Baumann, Tetra Tech, Risk Assessment Lead

3.4 ESTABLISHMENT OF THE PLANNING PARTNERSHIP

Humboldt County opened this planning effort to all eligible local governments within the planning area. The planning team made a presentation at a stakeholder kickoff meeting on August 30, 2018, 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 hazard mitigation plan update- 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 *Humboldt County Operational Area Hazard Mitigation Plan 2019* in the future. The planning partners covered under this plan are shown in Table 3-1.

Table 3-1. Hazard Mitigation Planning Partners

Jurisdiction	Point of Contact	Title
Humboldt County	Dorie Lanni	Emergency Services Manager
City of Arcata	Mike Clinton	Environmental Services Deputy Director
City of Blue Lake	Amanda Mager	City Manager
City of Eureka	Brian Gerving	Public Works Director
City of Ferndale	Jay Parrish	City Manager
City of Fortuna	Kevin Carter	Public Works Deputy Director
City of Rio Dell	Kyle Knopp	City Manager
City of Trinidad	Bryan Buckman	Public Works Director
Fieldbrook Glendale Community Services District	Richard Hanger	General Manager
Humboldt Community Services District	David Hull	General Manager
Manila Community Services District	Christopher Drop	General Manager
McKinleyville Community Services District	Gregory Orsini	General Manager
Redway Community Services District	Terrence Williams	General Manager
Westhaven Community Services District	Paul Rosenblatt	General Manager
Willow Creek Community Services District	Susan O'Gorman	General Manager
Arcata Fire District	Justin McDonald	Fire Chief
Fortuna Fire Protection District	Rus Brown	Division Chief
Humboldt Bay Fire District	William M. Reynolds	Deputy Chief
Samoa Peninsula Fire Protection District	Dale Unea	Fire Chief
Humboldt Bay Municipal Water District	John Friedenbach	General Manager
Humboldt Bay Harbor, Recreation, and Conservation District	Larry Oetker	General Manager
Shelter Cove Resort Improvement District	Justin Robbins	General Manager
Southern Humboldt Community Healthcare District	Guy Vitello	Engineering Manager

3.5 DEFINING THE PLANNING AREA

The planning area was defined to consist of the unincorporated county, incorporated cities, and special purpose districts within the geographical boundary of Humboldt County. All partners to this plan have jurisdictional authority within this planning area. A map showing the geographic boundary of the defined planning area for this plan update is provided in Chapter 4, along with a description of planning area characteristics.

3.6 THE STEERING COMMITTEE

Hazard mitigation planning enhances collaboration among diverse parties who can be affected by hazard losses. A key element of the public engagement strategy for this plan update was the formation of a stakeholder steering committee to oversee all phases of the update. The members of this committee included planning partner representatives, 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 planning partners confirmed a committee at the kickoff meeting. Table 3-2 lists the Steering Committee members and their designated alternates.

Table 3-2. Steering Committee Members

Name	Title	Jurisdiction/Agency
PRIMARY MEMBERS		
Jay Parrish[a]	City Manager	City of Ferndale
John Miller[b]	Senior Planner	Humboldt County
Justin Robbins	General Manager	Shelter Cove Resort Improvement District
Dorie Lanni	Emergency Services Manager	Humboldt County
Brian Issa	Deputy Public Works Director	City of Eureka
Cybelle Immitt	Natural Resources Planning Manager	Humboldt County
Guy Vitello	Engineering Manager	Southern Humboldt Community Healthcare District
Jan Marnell	Emergency Services Coordinator	California Office of Emergency Services
Aldaron Laird	Environmental Planner	Trinity Associates
Merritt Perry	City Manager	City of Fortuna
Ryan Aylward	Warning Coordination Meteorologist	National Weather Service
Mickey Hulstrom	Community Services Manager	Humboldt Community Services District
DESIGNATED ALTERNATES		
Chris Harris	Business Manager	Humboldt County Municipal Water District
David Hull	General Manager	Humboldt Community Services District
Danielle Allred	Administrative Assistant	City of Arcata
Delo Freitas	Contract Planner	City of Ferndale
Bernadette Clueit	Harbor Specialist III	Humboldt Bay Harbor, Recreation, and Conservation District
Merritt Perry	City Manager	City of Fortuna
Larry Oetker	Executive Director	Humboldt Bay Harbor, Recreation, and Conservation District

a. Chairman
b. Vice-Chairperson

Leadership roles and ground rules were established during the Steering Committee's first meeting, on October 9, 2018. The Steering Committee then met about every other month 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 an established work plan. The Steering Committee met four times from October 2018 through January 2019. Meeting summaries and attendance logs are provided in Appendix A to this volume. All Steering

Committee meetings were open to the public and were advertised as such on the hazard mitigation plan website. Agendas were posted to the website prior to each scheduled Steering Committee meeting, and meeting summaries were posted to the hazard mitigation plan website following their approval by the Steering Committee.

3.7 COORDINATION WITH STAKEHOLDERS AND 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 (44 CFR, Section 201.6(b)(2)). Agency coordination for this plan was accomplished as follows:

- **Steering Committee Involvement**—Agency representatives were invited to participate on the Steering Committee.
- **Agency Notification**—The following agencies were invited to participate in the plan development process from the beginning and were kept apprised of plan development milestones:

  - American Red Cross-Northern California Coastal Region
  - California Department of Water Resources, California State National Flood Insurance Program Coordinator
  - California Office of Emergency Services, Emergency Services Coordinator
  - FEMA Region IX, Lead Community Planner
  - U.S. Geological Survey, Science Advisor
  - California Department of Transportation, Director-District 1
  - Bureau of Land Management, Tribal Relations
  - California Department of Forestry and Fire Protection, Resource Management Division
  - The Wiyot Tribe

  These agencies received meeting announcements, meeting agendas, and meeting minutes by e-mail throughout the plan development process and were provided the option to attend meetings. Some 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 (see Section 3.9). All were sent an e-mail message informing them that draft portions of the plan were available for review. Upon completion of a public comment period, a complete draft plan was sent to the California Office of Emergency Services for a pre-adoption review to ensure program compliance.

Special assistance with the planning process was provided by the following federal and state agencies:

- FEMA Region IX provided updated planning guidance, provided summary and detailed data for the planning area from the National Flood Insurance Program (NFIP) (including repetitive loss information), and conducted plan review.
- The U.S. Geological Survey (USGS) provided maps to support the earthquake risk assessment.
- The California Governor’s Office of Emergency Services (Cal OES) facilitated FEMA review, provided updated planning guidance, and reviewed the draft and final versions of the plan prior to FEMA review.
- The California Department of Forestry and Fire Protection (CAL FIRE) provided fire severity mapping to support the wildfire risk assessment.
- The California Department of Water Resources (DWR) provided information on NFIP compliance for local cities.
- The California Department of Conservation provided the tsunami hazard mapping

- the National Oceanic and Atmospheric Administration (NOAA) Office for Coastal Management provided sea-level-rise data
- The California Department of Transportation (Caltrans) provided information on state and local bridges and other transportation infrastructure.

3.8 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 actions. In addition, the following programs can affect mitigation within the planning area:

- California Fire Code
- California Fire Alliance
- 2016 California Building Code
- California State Hazard Mitigation Forum
- Local capital improvement programs
- Local emergency operations plans
- Local general plans
- Local tribal hazard mitigation plans
- Housing elements of general plans
- Safety elements of general plans
- Local zoning ordinances
- Local coastal program policies.
- Humboldt Operational Area Emergency Operations Plan (2017)—This is an emergency support function-based plan that directs emergency response actions in the planning area
- Humboldt County General Plan: Comprehensive update, March 19, 2012—This plan directs land use policy in Humboldt County
- Repower Humboldt; A Strategic Plan for Renewable Energy Security and Prosperity (2013)
- Humboldt Bay Shoreline Inventory, Mapping and Sea Level Rise Vulnerability Assessment (January 2013)
- Humboldt Bay Region Sea Level Rise Data Synthesis, Humboldt County, California; Executive Summary
- Humboldt County Community Wildfire Protection Plan (2018)

Assessments of all planning partners' regulatory, technical and financial capabilities to implement hazard mitigation actions are presented in the individual jurisdiction-specific annexes in Volume 2. Many of these relevant plans, studies and regulations are cited in the capability assessments.

3.9 PUBLIC INVOLVEMENT

Broad public participation in the planning process helps ensure that diverse points of view about local needs are considered and addressed. The public must have opportunities to comment on disaster mitigation plans during the drafting stages and prior to plan approval (44 CFR, Section 201.6(b)(1). The Community Rating System expands on these requirements by making CRS credits available for optional public involvement activities. For this plan update, "public" has been defined as the general public within the Humboldt County planning area. This includes, but is not limited to:

- Residents
- Tribal members

- Tourists
- Employers within the operational area
- Employees within the operational area
- Students (primary and secondary education levels).

3.9.1 Strategy

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

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

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 all planning partners. The effort to include stakeholders in this process included stakeholder participation on the Steering Committee. The planning team invited all the following potential stakeholders to actively participate in the plan update process:

- **Federal Agencies**—FEMA Region IX provided updated planning guidance and data from the National Flood Insurance Program (including repetitive loss information) and conducted plan review.
- **State Agencies**—Cal OES facilitated FEMA review, provided updated planning guidance, and reviewed the draft and final versions of the plan prior to FEMA review.
- **Regional and Local Stakeholders**—The following organizations received information about the planning process and invitations to provide input, and elected to participate in the planning process as members or subject matter advisors to the Steering Committee:
  - All participating planning partner jurisdictions
  - Briceland Community Services District
  - Orick Community Services District
  - Orleans Community Services District
  - Weott Community Services District
  - Briceland Fire Protection District
  - Loleta Fire Protection District
  - Petrolia Fire Protection District
  - Rio Dell Fire Protection District
  - Willow Creek Fire Protection District
  - Garberville Sanitary District
  - Reclamation District #768
  - Blue Lake Rancheria
  - The Hoopa Valley Tribe
  - The Karuk Tribe
  - The Bear River Band of the Rohnerville Rancheria
  - The Table Bluff Rancheria
  - The Cher-Ae Heights Indian Community of the Trinidad Rancheria
  - The Yurok Tribe

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 (https://humboldtgov.org/506/Local-Hazard-Mitigation ; see Figure 3-1). The site's address was publicized in all press releases, mailings, surveys and public meetings. Each planning partner established a link to this site on its own agency website. Information on the plan development process, the Steering Committee, a plan survey, and drafts of the plan was made available to the public on the site throughout the process. Humboldt County intends to keep a website active after the plan's completion to keep the public informed about successful mitigation projects and future plan updates.

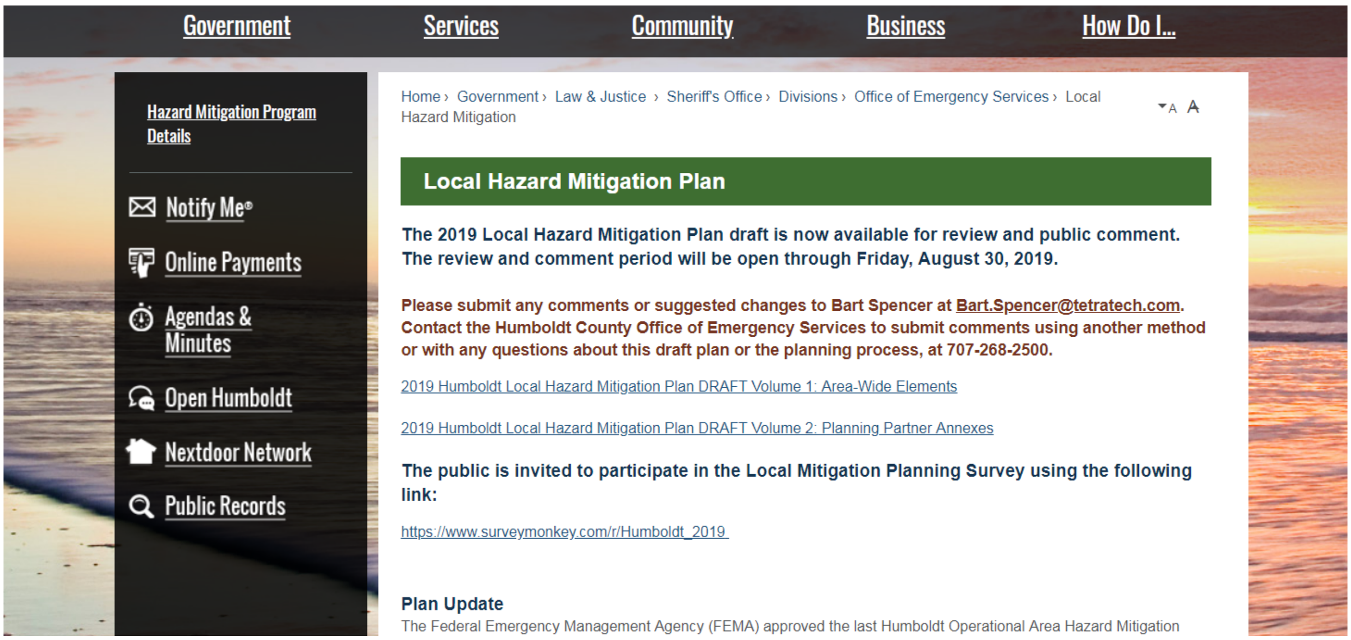


Figure 3-1. Sample Page from Hazard Mitigation Plan Web Site

Survey

A hazard mitigation plan survey (see Figure 3-2) was developed by the planning team with guidance from the Steering Committee. The survey 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 survey was designed to help identify areas vulnerable to one or more natural hazards. The answers to its 42 questions helped guide the Steering Committee in selecting goals, objectives and mitigation strategies. The survey was made available on the hazard mitigation plan website and advertised throughout the course of the planning process. During the course of this planning process, 211 completed surveys were submitted. The complete survey and a summary of its findings can be found in Appendix A of this volume.

Public Outreach

The public outreach process for this plan update consisted of general outreach information during various partner meetings and events.

The draft plan was made available to the public for comment during a noticed, 2-week public comment that ran from Monday, August 19 to Monday, August 2, 2019. A public meeting with a presentation was held during the scheduled Fire Safe Council meeting on Thursday, August 15, 2019. This presentation outlined the update process, changes since the 2014 plan update, and announcement of the public comment period. This meeting was noticed via the County website and provided an opportunity for the public to comment.

2019, Humboldt County Survey: Hazard Mitigation Planning

1. Survey Introduction

1 / 5

A partnership of local governments and other stakeholders in Humboldt County is working together to update the Humboldt County Operational Area Hazard Mitigation Plan. This plan was initially created in 2007, and updated in 2012 in response to Federal programs that 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 with an emphasis on identifying projects that will reduce/avoid future loss, 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 and identify projects to reduce the risk of injury or damage to property from future hazard events.

The survey consists of 39 questions plus an opportunity for any additional comments at the end. The survey should take less than 10 minutes to complete and is anonymous. When you have finished the survey, please click "Done" on the final page.

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

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

- ALDERPOINT/BLOCKSBURG
- ARCATA
- AVENUE OF THE GIANTS (FRUITLAND RIDGE, HOLMES, MIRANDA, MYERS FLAT, PEPPERWOOD, PHILLIPSVILLE, REDCREST, SHIVELY, WEOTT)
- BAYSIDE
- BIG LAGOON
- BLUE LAKE
- BRICELAND
- BRIDGEVILLE/DINSMORE
- CARLOTTA/HYDESVILLE/ALTON/RO HNERVILLE
- CUTTEN
- EUREKA
- FORT SEWARD/MCCANN/EEL ROCK
- FERNBRIDGE
- FERNDALE
- FIELDBROOK/GLENDALE
- FIELDS LANDING/KING SALMON
- FORTUNA
- FRESHWATER
- GARBERVILLE/REDWAY/BENBOW
- HARRIS/PALO VERDE
- KNEELAND
- KORBEL
- LOLETA/TABLE BLUFF
- MANILA/SAMOA/FAIRHAVEN
- MAPLE CREEK
- MCKINLEYVILLE
- ORICK
- ORLEANS
- PETROLIA/HONEYDEW
- RIO DELL
- SCOTIA/STAFFORD
- SHELTER COVE
- TRINIDAD
- WEITCHPEC
- WESTHAVEN
- WHITETHORN/ETTERSBURG
- WILLOW CREEK
- HOOPA RESERVATION
- YUROK RESERVATION
- Other (please specify)

Figure 3-2. Sample Page from Survey Distributed to the Public

The public comment period gave the public an opportunity to comment on the draft plan update prior to its submittal to Cal OES and FEMA. The principle avenue for public comment on the draft plan was the website established for this plan update (see Figure 3-1). Seven sets of written comments were received via e-mail during the public comment period. Comments received on the draft plan are available upon request. All comments were reviewed by the planning team and incorporated into the draft plan as appropriate.

3.9.2 Public Involvement Results

Survey

Detailed analysis of the survey findings is presented in Appendix A; a summary is as follows:

- 211 surveys were completed.
- Surveys were received from each planning partner.
- Survey respondents ranked the earthquake hazard of greatest concern, followed by wildfire, severe weather climate change, tsunami, flood, sea-level rise and drought.
- 84 percent of respondents reported having experienced earthquake, and more than half reported having experienced severe weather events.
- Most respondents (75 percent) felt that the internet was the most effective way to provide hazard and disaster information to the public, followed by the “Humboldt Alert” emergency notification system and social media.
- 48 percent of respondents stated that they felt “somewhat prepared” to deal with a natural hazard event. The remainder were about evenly divided between those who feel “very prepared” and those who feel “not at all prepared.”

Survey results were provided to the Steering Committee for use in support of confirming the guiding principle, goals, objectives and county-wide actions for this plan update. Additionally, the survey results were included in the toolkit provided to each planning partner through the jurisdictional annex process described in Volume 2. Each planning partner was able to use the survey results to help identify actions as follows:

- Gauge the public’s perception of risk and identify what citizens are concerned about.
- Identify the best ways to communicate with the public.
- Determine the level of public support for different mitigation strategies.
- Understand the public’s willingness to invest in hazard mitigation.

Public Outreach Events

The public involvement strategy used for this plan update introduced the concept of mitigation to the public and provided the Steering Committee with feedback to use in developing the plan. All citizens of the planning area were provided ample opportunities to provide comment during all phases of this plan update process. Details of attendance and comments received from the public outreach events are summarized in Table 3-3.

Table 3-3. Summary of Public Outreach Events

Date	Location	Number of Citizens in Attendance	Number of Comments Received
8/15/2019	Humboldt County Fire Safe Council Meeting, 1106 Second Street, Eureka	25	2
8/19 to 9/2	Open Public Comment Period	N/A	7
Total		**25**	**9**

3.10 PLAN DEVELOPMENT CHRONOLOGY/MILESTONES

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

Table 3-4. Plan Development Chronology/Milestones

Date	Event	Description	Attendance
2018			
2/6	Organize Resources	County releases request for proposals for a technical support contractor to facilitate the update to the hazard mitigation plan.	N/A
2/28	Organize Resources	Proposals from interested vendors due to be submitted to the County	N/A
3/16	Organize Resources	County OES staff hold a project kickoff meeting with potential planning partners to advise of the County's selection process of a support contractor and the next steps for the plan update process.	35
3/29	Organize Resources	County selects Tetra Tech as its technical assistance contractor to facilitate the plan update process.	N/A
7/31	Organize Resources	Humboldt County Board of Commissioners approves contract with Tetra Tech and authorizes the notice to proceed on work for the update.	N/A
8/6	1st Core Planning Team Call	• Discuss content for kickoff meeting • Steering Committee organization • Project timeline	3
8/30	Project Kickoff Meeting	• Review work plan • Discuss planning partner expectations • Organize Steering Committee • Risk assessment data needs • Discuss public involvement strategy • Homework: review prior plan and state plan	27
9/24	2nd Core Planning Team Call	• Finalize planning partnership roster • Discuss risk assessment data needs • Finalize agenda for Steering Committee meeting #1	4
10/5	Public Outreach	• Hazard mitigation plan website adapted for information on 2018/2019 plan update process.	
10/9	Steering Committee Meeting #1	• Homework report out: Changes to the plan update • Deploy Phase 1 of the jurisdictional annex process • Risk assessment data identification/confirmation • Confirm hazards of concern • Confirm guiding principle, goals and objectives for the plan • Define critical facilities/infrastructure	15
10/12	Planning Process	Phase 1 annexes and instructions distributed to all planning partners by the core planning team	N/A
10/24	Steering Committee Meeting #2	• Confirm critical facility definition • Phase 1, jurisdictional annex status report • Risk assessment status report • Public outreach strategy: website and survey	15
11/8	3rd Core Planning Team Call	• Phase 1 jurisdictional annex status report • Review website content • Discuss Phase 2, jurisdictional annex process	2
11/28	4th Core Planning Team Call	• Discuss risk assessment data needs • Discuss Phase 1 and 2 jurisdictional annex technical assistance needs • Discuss survey content	3

Date	Event	Description	Attendance
12/3	5th Core Planning Team Call	• Finalize Steering Committee meeting #3 agenda • Jurisdictional annex technical assistance needs	3
12/5	Steering Committee Meeting #3	• Phase 1 jurisdictional annex status • Discuss/deploy Phase 2 of the jurisdictional annex process • Prior action status review/discussion	15
12/7	Planning Process	Phase 2 templates and instructions distributed to all planning partners by the core planning team	N/A
2019			
1/9	Planning Process	Workshop for planning partners to work together to complete Phase 2 of the jurisdictional annex process. Remote technical support provided by Tetra tech	8
1/14	6th Core Planning Team Call	• Follow-up discussion from Phase 2 workshop • Critical facilities inventory discussion • Survey content • Steering committee meeting content discussion	3
1/16	Steering Committee Meeting # 4	• Phase 2 jurisdictional annex status report • Risk assessment status report • Confirm plan maintenance strategy • Confirm countywide initiatives	10
1/28	7th Core Planning Team Call	• Phase 2 jurisdictional annex process status • Critical facility inventory • Survey content	2
2/11	8th Core Planning Team Call	• Overall plan status discussion	3
3/11	9th Core Planning team Call	• Finalize survey content and deployment plan • Overall plan status discussion • Phase 3 workshop logistics • Preliminary risk assessment results	3
3/21	Planning Process	Workshop for planning partners to work together to complete Phase 3 of the jurisdictional annex process. Remote technical support provided by Tetra tech	26
4/5	Planning Process	Workshop for planning partners to work together to complete Phase 3 of the jurisdictional annex process. Remote technical support provided by Tetra tech	24
4/8	Public Outreach	Hazard mitigation survey launched by the core planning team. Survey link posted on County hazard mitigation plan website and deployed via social media and e-mail by the core planning team	N/A
4/9	10th Core Planning Team Call	• Confirmation of survey deployment • Overall plan status discussion	2
5/6	11th Core Planning Team Call	• Survey status report • Phase 3 jurisdictional annex process status discussion • Overall plan status discussion	2
8/15	Public Outreach	Presentation on the planning process, draft plan and announcement of a 2-week public comment period provided at the Fire Safe County meeting in Eureka	25
8/19	Public Outreach	Final, 2-week public comment period initiated for the draft plan	N/A
9/2	Public Outreach	Closure of the 2-week public comment period	N/A
TBD	Plan Submittal	Pre-adoption review draft of the plan submitted to Cal OES.	XX
TBD	APA	Approval Pending Adoption (APA) provided by FEMA	XX
TBD	Adoption	Adoption Window opens for planning partnership	XX
TBD	Approval	Final Plan approval issued by FEMA region IX	XX

4. HUMBOLDT COUNTY PROFILE

4.1 GEOGRAPHIC OVERVIEW

Humboldt County is located on California's northern coast, bordered by Del Norte County on the north, Siskiyou County on the north and east, Trinity County on the east, and Mendocino County on the south (see Figure 4-1). It is the 35th most populous county in the state.

The major population centers in Humboldt County are the incorporated cities of Eureka, Arcata and Fortuna and the unincorporated McKinleyville community. Other incorporated cities are Rio Dell, Ferndale, Blue Lake and Trinidad. Eureka, along the coast in the center of the county, is the county seat. It lies at the north end of Humboldt Bay, which is the focal point of the County. The bay serves as the primary port and center of commerce, as well as a significant natural resource area, including the Humboldt Bay National Wildlife Area.

Humboldt County covers 2.3 million acres, 80 percent of which is forestlands, protected redwoods and recreation areas. The natural resources and scenic beauty of Humboldt County make it a popular tourist destination and attract permanent residents as well. The Coast Range dominates the landscape of much of the County, and includes the Eel, Van Duzen, Mattole, and Mad River drainages in the central and southern areas, and the Redwood Creek drainage in the northwest. In the northeast, the higher, steeper terrain of the Klamath Mountains province is drained by the Klamath and Trinity Rivers.

Thirty percent of Humboldt County is state or federal public lands, with major land holdings including Redwood National and State Parks in the north, Six Rivers National Forest in the east, King Range National Conservation Area along the south coast, and Humboldt Redwoods State Park along the Avenue of the Giants in the south-central area.

Humboldt County typically leads the state in timber production. Agriculture and fishing are other important base industries. The extensive bottom-land floodplains of Humboldt Bay and the Eel River delta support the County's dairy industry. Humboldt Bay provides most of California's oyster production. Offshore of Cape Mendocino is an area of intensive ocean upwelling and rich marine productivity.

The southern border of the County is 225 miles north of San Francisco, the closest major metropolitan city. The County is linked by U.S. Coastal Highway 101 to the rest of California to the south and the Oregon Coast to the north. State Highway 299 links the County to Interstate 5 to the east. The County's Arcata/Eureka airport in McKinleyville has daily flights to San Francisco, Sacramento, Portland and Seattle. Fog along the coastline for much of the year often delays passenger flights at the airport.

Figure 4-1. Humboldt County Planning Area

4.2 HISTORICAL OVERVIEW

Native Americans were the first residents of the Humboldt area. Multiple tribes occupied specific territories—the Wiyot, Yurok, Hupa, Karuk, Chilula, Whilkut, and the southern Athabascans, including the Mattole and Nongatl. These tribes spoke languages of several different stocks and had similar but distinct social and cultural structures. Today, the indigenous tribal entities and lands in Humboldt are sovereign nations, with protected cultural and environmental assets and infrastructure at risk within and beyond the county. Tribes in the planning area maintain tribal hazard mitigation plans and emergency management personnel.

The first record of European explorers in the Humboldt area was by the Spanish at Trinidad in 1775. The first entrance to Humboldt Bay was made by an American in 1806. The Gregg-Wood Party entered the region by land in December 1849. In 1850, ships entered Humboldt and Trinidad bays bringing explorers, generally from the United States, on their way to gold mining districts on the Klamath, Salmon and Trinity rivers. Eureka, Union (Arcata), and Trinidad were first settled as points of arrival and as supply centers for these interior mines. Douglas Ottinger and Hans Buhne named the bay Humboldt in honor of a naturalist and explorer. Humboldt County was established on May 12, 1853. The County seat, Eureka, was created on that same date. When the rush for gold subsided, the economy shifted to the region's premiere resources: trees, salmon and land.

The area's multi-cultural makeup was further established with the arrival of new groups from different cultures. The Chinese came to mine on the Klamath and Salmon rivers, work in the fish canneries on lower Eel River, and build railroads. They were forcibly expelled in 1885. Later, Italians fished commercially on lower Eel River, acting as buyers for San Francisco firms. Canadians, particularly from Nova Scotia and New Brunswick, came to work in Humboldt's woods. William Carson developed logging and milling operations and recruited workers. People of Slavic origins came at the turn-of-the-century to work in Humboldt County's woods and mills. The French made homes in Blue Lake and Arcata, published newspapers, developed town sites, and opened restaurants. The interior prairies of the Bald Hills, Kneeland, Showers Pass, Bridgeville and the headwaters of the Van Duzen, Mad and North Fork Eel rivers were settled by Americans who ran cattle and sheep operations.

Through the Second World War, this demographic and occupational structure prevailed; and the population and work remained fairly stable. The natural resources of the North Coast continued to provide livelihoods for most of Humboldt County's people. Large timber companies, such as Hammond, Northern Redwood Lumber Co., Pacific Lumber Company, and Dolbeer and Carson kept people employed. After the war, a new Douglas fir/plywood industry brought woods and mill workers from Oregon and Washington. Workers from Arkansas and Oklahoma found ready work. The town of Manila became a settlement of the new arrivals, many of whom brought home scrap wood from the mill at Samoa to build their houses. In 1947, Arcata was a lumber boom town with 30 mills in operation and more to come. Railroad shipments of lumber broke records year after year.

Timber dominated in the county well into the 1970s. By then, college students, back-to-the-land refugees, and environmentalists brought a new perspective to resource use. What had once been a totally resource-extractive economy became a more diverse economy that included education, health and social services, resource protection and restoration, and government.

4.3 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 makes federal recovery programs available to help public entities, businesses, and individuals. Some disaster assistance programs are partially matched by state programs. Review of presidential disaster declarations helps establish the probability of reoccurrence for each hazard and identify targets for risk reduction. Table 4-1 shows the declared disasters that have affected Humboldt County through 2019 (records date back to 1954).

Table 4-1. Historical Humboldt County Natural Hazard Events

Type of Event	Disaster Declaration #	Declaration Date
Flood & Erosion[a]	15	2/5/1954
Flood[a]	47	12/23/1955
Forest Fire[a]	65	12/29/1956
Heavy Rainstorms & Flood[a]	82	4/4/1958
Fire [a]	119	11/16/1961
Severe Storms & Flooding[a]	138	10/24/1962
Severe Storms, Heavy Rains & Flooding[a]	145	2/25/1963
Flood Due to Broken Dam[a]	161	12/21/1963
Seismic Sea Wave[a]	169	4/1/1964
Heavy Rains & Flooding	183	12/24/1964
Severe Storms & Flooding	212	1/22/1966
Severe Storms & Flooding	253	1/26/1969
Severe Storms & Flooding	329	4/5/1972
Severe Storms & Flooding	412	1/25/1974
Severe Storms, Flood, Mudslides & High Tide	651	12/19/1981
Coastal Storms, Floods, Slides & Tornadoes	677	1/21/1983
Severe Storms & Flooding	758	2/12/1986
Earthquake & Aftershocks	943	4/25/1992
Severe Winter Storm, Mud & Land Slides, & Flooding	979	1/5/1993
The El Nino (The Salmon Industry)	1038	5/1/1994
Severe Winter Storms, Flooding, Landslides, Mud Flows	1044	1/3/1995
Severe Winter Storms, Flooding Landslides, Mud Flow	1046	2/13/1995
Severe Storms, Flooding, Mud and Landslides	1155	12/28/1996
Severe Winter Storms, and Flooding	1203	2/2/1998
Severe Storms, Flooding, Mudslides, and Landslides	1628	2/3/2006
Hurricane Katrina Evacuation	3248	9/13/2005
Wildfires	3287	6/20/2008
Karuk Tribe Wildfire	4142	8/29/2013
Severe Winter Storms, Flooding and Mudslides	4301	2/14/2017
Hoopa Valley Tribe Severe Winter Storm	4302	2/14/2017
Severe Winter Storms, Flooding, Mudslides	4308	5/18/2017
Severe Winter Storms, Flooding, Landslides and Mudslides	4434	5/18/2019

a. Declarations prior to 1964 are California-statewide, not Humboldt County specific; FEMA did not begin distinguishing declarations by county until 1964.

Source: www.fema.gov/disaster

4.4 PHYSICAL SETTING

4.4.1 Geology

The bedrock geology of the County is divided generally into two provinces: the Klamath Mountains province in the northeast and the Coast Ranges province in the central and southwest portion of the County. The dividing line between the two provinces is the South Fork Mountain Ridge, which separates the Trinity River basin from the Mad River and Redwood Creek drainages.

The bedrock geology is poorly mapped in much of the county, particularly the inland areas. Lack of detailed mapping in most cases precludes determining specific site stability without a site investigation. However, it may be valid to conclude varying degrees of relative risk based on general mapping of rock units when averaged over time.

Coast Ranges

The Coast Ranges province is the dominant geologic province in the county, trending northwest and drained by the Mad, Eel, and Mattole River drainages. The Franciscan and Yager complexes dominate inland, with sand and other alluvial deposits dominating in the lower reaches of the river basins and the area surrounding Humboldt Bay:

- The Franciscan complex can be divided into two units:
  - Franciscan sandstone consists mainly of sandstone and siltstone. Although this sandstone unit is frequently sheared, there is little evidence of massive rock deformation. Slopes are fairly stable, but subject to debris sliding along steep river banks and in steep headwater drainages.
  - Franciscan mélange consists of a rubble of sheared sandstone and siltstone with blocks of volcanic rock, chert, and schist. Mélange terrain is generally unstable and characterized by rolling hummocky slopes that are highly susceptible to mass movement.
- The Yager formation is predominantly shale and sandstone. Local shearing occurs, but in general the formation is much less deformed and more stable than the Franciscan. However, it is subject to debris slides on steep slopes and river banks.
- In the lower reaches of the river basins and in the area surrounding Humboldt Bay, alluvial sediments dominate. These unconsolidated-to-partially-consolidated sediments have been mildly folded and faulted, but when forested or gently sloped, are generally stable.

Klamath Mountains

The Klamath Mountains province is an area of high alpine peaks, some attaining elevations of 8,000 feet and more, east of the Humboldt County line. The province is drained by the Klamath and Trinity Rivers and farther north by the Smith River. Rocks in the Klamath Mountains province are generally older than those in the Coast Ranges. Rocks of sedimentary origin such as sandstone, chert, slate and schist occur abundantly, with occasional granite intrusions.

4.4.2 Soils

Agricultural Soils

Some of the more abundant agricultural and lowland soils in Humboldt County are the Ferndale series, a deep, well-drained soil formed on recent floodplains; the Bayside and the Loleta series, both deep, poorly drained soils found in depressed areas or on nearly level alluvial fans; and the Rohnerville, Carlotta and Hookton soils series, all moderately well-drained soils. Rohnerville soils are found on relatively flat, high marine terraces. The Hookton soils are on sloping, dissected marine terraces and the Carlotta soils are found on flat, low-lying terraces. Most of these agricultural soils are rated 80 to 100 in the Storie Index of Agricultural Productivity (good to excellent productivity), except the Bayside soils where drainage problems may reduce agricultural potential.

Forest Soils

The forest soils of the County are, in general, medium textured, acidic, and generally increasing in acidity with depth. They are permeable and well drained. In the lowlands they are formed on alluvial floodplains or low-lying terraces. Here they are either unclassified or of the Carlotta and Ferndale groups. The most superlative old growth redwood groves are found on these soils.

Grassland Soils

The general characteristics of grassland soils range from shallow loamy soils to deep clay soils. Their permeability ranges from moderate to slow. The general nutrient level of these grassland soils is higher than that of the adjacent forest soils. The major portion of these soils is intermingled with other soils in the Douglas fir zone beyond the fog belt. Some of these soils are formed on Franciscan parent material. Many of these are found in the shear zone or fault gouge material or on the mélange material of the Franciscan. This parent material weathers rapidly, forming a grey-blue clay subsoil (commonly called "blue goo") that tends to slip when wet. Thus, because of the parent material, these soils are found in landslide topography.

Woodland Soils

Most of the woodland soils are inland beyond the cool, foggy belt. They are intermingled with the conifer forest soils of the Douglas fir belt and the adjacent grassland soils. These are shallow soils, usually well drained, but permeability may be slow in some locations. The natural nutrient level of these soils tends to be somewhat higher than for the neighboring forest soils. Because the parent material is predominantly Franciscan mélange, one should expect these soils to be relatively unstable.

4.4.3 Climate

The location of Humboldt County is such that climatic elements produce a marine-type climate on the coast, while inland the climate has both continental and marine characteristics. The coastal area has a cool, stable temperature regime. With distance from the ocean, the marine influence becomes less pronounced, and inland areas experience wider variations of temperature. Two factors affect the climate:

- **Mountain ranges**—The coastal mountains affect rainfall. The first major release of rain occurs along the coast, and the second is along the west slopes of the Klamath Mountains.
- **Location and intensity of semi-permanent pressure areas over the Pacific Ocean**—During summer and fall, circulation of air around a high-pressure area over the North Pacific brings a prevailing flow of comparatively dry, cool and stable air into the Pacific Northwest. As the air moves inland, it becomes warmer and drier, resulting in a dry season. In winter and spring, the high pressure is further south and low pressure prevails in the Northeast Pacific. Circulation of air around both pressure centers brings a prevailing flow of mild, moist air into the Pacific Northwest. Condensation occurs as the air moves inland over the cooler land and rises on the slopes of the mountains. This results in a wet season beginning in late October or November, reaching a peak in winter, and gradually decreasing by late spring.

On the coast, summers are cool and relatively dry while winters are mild, wet and generally cloudy. About 90 percent of the total rain falls from October through April. During the wet season, rainfall is usually of light to moderate intensity and continuous over a long period rather than occurring in heavy downpours for brief periods; heavier intensities occur along the windward slopes of the mountains. Because of the moisture and moderate temperature, the average relative humidity is high. Fog is also present along the coastline for much of the year.

Measurable rainfall occurs on 118 days each year at Humboldt Bay and on 190 days in the mountains. Thunderstorms occur up to 10 days each year over the lower elevations and up to 15 days in the mountainous regions. Damaging hailstorms rarely occur in Northern California. During July and August, the driest months, two to four weeks can pass with only a few showers; however, in December and January, the wettest months, precipitation is frequently recorded on 20 to 25 days or more each month. The range in annual precipitation is from about 38 inches along Humboldt Bay to 100 inches along the southern Humboldt Coast. The mountainous interior of Humboldt County averages close to 90 inches of rain per year. Snowfall is light in the lower elevations and heavier in the mountains.

Temperatures along the coast vary only 10º from summer to winter, although a greater range is found over inland areas. Temperatures of 32ºF or lower are experienced nearly every winter throughout the area, and colder temperatures are common in the interior. Maximum readings for the year often do not exceed 80ºF on the coast, while readings over 100ºF occur frequently in the mountain valleys. July mean maximum readings are in the 60s in the area 15 to 30 miles wide along the coast.

The strongest winds are generally from the south or southwest and occur during the winter and spring. In interior valleys, wind velocities reach 40 to 50 mph each winter, and 75 to 90 mph a few times every 50 years. The highest summer and lowest winter temperatures generally occur during periods of easterly winds. During most of the year, the prevailing wind is from the southwest or west. The frequency of northeasterly winds is greatest in the fall and winter. Wind velocities ranging from five to 10 knots can be expected 60 to 80 percent of the time; 10 to 15 knots, 30 to 45 percent of the time; and 20 knots or higher, two to 15 percent of the time. The highest wind velocities are from the southwest or west and are frequently associated with rapidly moving weather systems. Extreme sustained wind velocities on the coast generally reach 50 mph at least once in two years; 60 to 70 mph once in 50 years; and 80 mph once in 100 years. The highest wind gust recorded in Eureka was 69 mph on Jan 31, 1981.

4.5 CULTURAL RESOURCES

4.5.1 Culturally Sensitive Resources

The Humboldt County General Plan Cultural Resources subsection provides the following overview of culturally sensitive resources in the county (Humboldt County, October 2017):

> *Cultural resources are elements of cultural heritage. From a land use perspective, important cultural resources include archaeological sites, historic architecture, industrial relics, artifacts, cultural landscapes, spiritual places, and historic districts. These elements provide traces of Humboldt County's rich history and add to the unique character and identity of the county. The importance of history to local residents can be seen in the many celebrations and expressions of Native American cultural heritage, the architectural preservation efforts of numerous local home and business owners, and the high level of support for local museums and historical societies. The educational, social, and economic benefits of historic preservation to the county are tremendous; protecting outstanding cultural resources and the legacy they represent is a priority of the Humboldt County General Plan.*
>
> *Over one thousand sites of cultural significance have been surveyed and officially designated as cultural resources in Humboldt County. The participation of state and federal historic registration programs includes 13 sites as California Historical Landmarks, 16 sites included on the National Register of Historic Places, 58 sites as California Historical Resources, and nearly 700 sites as historical and prehistoric archeological sites. Many of these sites, as well as numerous unlisted sites, are of cultural and religious significance for Native American populations. Any scientific archeological interest in such sites must be respectful of the cultural and religious significance they may hold.*

Culturally sensitive areas exist on both public and private lands. While some locations are publicly identified, others are held as confidential information by tribal organizations. The Northwest Information Center at Sonoma

State University maintains records of cultural resource sites, including cemeteries, villages, and lithic scatters (surface-visible concentrations of stone chips, flakes, and tools). Three-quarters of these resources are located along rivers and major tributaries; the remainder are in flat mountainous areas or prairies. High-density sites (villages, cemeteries, and ceremonial and gathering areas) are concentrated in the Hoopa and Yurok reservations, Karuk tribal lands and riverine areas. Ridgelines along rivers and creeks, where traveling between villages likely occurred, and lithic scatters around Trinidad, Humboldt Bay, the Eel delta, and Shelter Cove are considered medium-density resource sites. In addition to these resources, the County is home to a World Heritage Site designated by the United Nations (the World's Tallest Tree at Redwood National Park), 48 structures or locations listed on the National Register of Historic Places, and 13 California Historic Landmarks.

4.5.2 Scenic Resources

Humboldt County features a broad range of scenic resources, including the coastline and Pacific Ocean, mountains, hills, ridgelines, inland water features, forests, agricultural features, and distinctive rural communities. A discussion of Humboldt County's scenic resources, viewshed evaluation and policy discussion is contained in the *Natural Resources and Hazards Discussion Paper* prepared for the General Plan Update (Dyett and Bhatia, 2002).

Coastal Views

Humboldt County's varied and extensive coastline allows for a wide range of scenic vistas from U.S. 101 and from beaches, state parks and coastal access points. The County's Local Coastal Program includes a technical study on visual resources. The study includes a detailed inventory of local visual resources along the coastline and identifies areas as "highly scenic" or "visually degraded areas" (Humboldt County, 1979). A recent discussion of Humboldt County's scenic resources, viewshed evaluation and policy discussion is contained in the *Natural Resources and Hazards Discussion Paper* prepared for the General Plan Update (Dyett and Bhatia, 2002).

Forests

Forestlands define much of the visual landscape of Humboldt County. Redwood National Park, Six Rivers National Forest, Redwoods State Park, and King Range National Conservation Area are all significant protected forests in the county. Forestland is abundant well beyond these protected areas. The scenic value of these natural resources, viewed from within or from outside, is of great importance.

Scenic Highways

Several highways in Humboldt County have unique scenic qualities because of their natural setting. A scenic road is defined as a roadway that, in addition to its transportation function, provides opportunities for the enjoyment of natural and scenic resources. Scenic roads direct views to areas of exceptional beauty, natural resources or landmarks, or historic and cultural interest. Although no highways in Humboldt County are officially designated as California State scenic highways, several state highways are eligible for such designation:

- State Highway 36 from U.S. 101 near Fortuna to Trinity County
- State Highway 96 from State Highway 299 at Willow Creek north to Siskiyou County
- U.S. 101 for its entire length in Humboldt County
- State Highway 299 from Arcata to Willow Creek.

Local Humboldt County roadways also have significant scenic view values (Dyett and Bhatia, 2002).

4.6 DEVELOPMENT PROFILE

4.6.1 Current Land Ownership and Use

Land use in the planning area is dictated by the Humboldt County General Plan (dated October 23, 2017). Figure 4-2 presents the chief characteristics of the land area in Humboldt County. Eighty percent of the County's 2.3-million-acre area is forested. Of the forested area, 50 percent is private commercial timberland, and 35 percent is state or federal public land, including Redwood National and State Parks, Six Rivers National Forest, the King Range National Conservation Area, and Humboldt Redwoods State Park (Humboldt County General Plan, October 2017).

Source: Humboldt County General Plan, October 2017

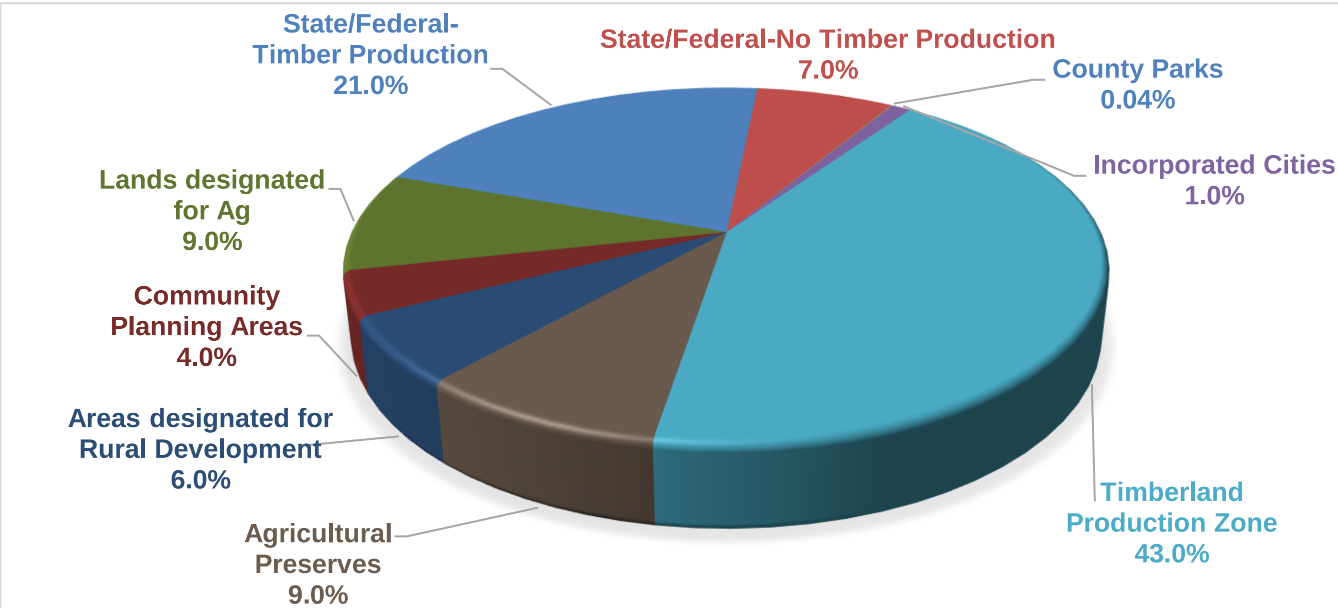


Figure 4-2. Chief Characteristics of Land within Humboldt County

4.6.2 Building Count, Occupancy Class and Estimated Replacement Value

Table 4-2 presents planning area building counts by building occupancy class. Table 4-3 summarizes estimated replacement value for building structures and contents combined.

Table 4-2. Planning Area Building Counts by Occupancy Class

	Number of Buildings						
	Residential	Commercial	Industrial	Agricultural	Government	Education	Total
Arcata	4,583	198	92	2	58	7	4,940
Blue Lake	443	15	11	1	13	1	484
Eureka	8,732	497	97	0	113	7	9,446
Ferndale	605	24	2	0	14	2	647
Fortuna	3,945	143	11	6	32	3	4,140
Rio Dell	1,149	30	3	4	11	1	1,198
Trinidad	186	10	1	0	7	2	206
Unincorporated County	26,285	608	112	1,682	776	37	29,500
Total	**45,928**	**1525**	**329**	**1,695**	**1024**	**60**	**50,561**

Table 4-3. Estimated Replacement Value of Planning Area Buildings

Jurisdiction	Estimated Total Replacement Value (Structure and Contents)[a]
Arcata	$3,860,000,000
Blue Lake	$304,000,000
Eureka	$7,463,000,000
Ferndale	$507,000,000
Fortuna	$2,816,000,000
Rio Dell	$593,000,000
Trinidad	$130,000,000
Unincorporated County	$19,623,000,000
Total	**$35,296,000,000**

a. Values based on Humboldt County tax parcel data as of February 2019.

4.6.3 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 any hazard event. 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. For this hazard mitigation plan update, the Steering Committee defined critical facilities and infrastructure as infrastructure or facilities that are critical to the health and welfare of the population. These become especially important after any hazard/natural disaster event occurs.

The following categories of critical facilities and infrastructure were established for this hazard mitigation plan:

- Essential Facilities:
    - **Medical and Shelter Facilities and Vulnerable Populations**—Facilities likely to be used as a sheltering or community assembly location, and structures likely to contain occupants who may not be sufficiently mobile to avoid death or injury during and after a natural disaster event, including but not limited to hospitals, schools, skilled nursing facilities, board and care homes, pharmacies, clinics, fairgrounds, community centers, ambulance services, and veterinary hospitals.
    - **Emergency Response**—Facilities and emergency operations centers that are needed for response and recovery activities before, during, and after a natural disaster event, including but not limited to police stations, fire stations, local, state and federal vehicle and equipment storage facilities, and emergency response staging sites.
    - **Utility Services**—Public and private utility facilities that are vital to maintaining or restoring normal services to impacted areas before, during, and after a natural disaster event, including but not limited to primary and secondary transportation infrastructure, municipal water pumps and wells, water treatment plants, water storage, sewage treatment facilities, lift stations, water and sewer mainlines, substations, electric power generating infrastructure, gas transmission infrastructure, telecommunications, repeater stations, radio stations and towers, fuel storage facilities, aviation control towers, standby power-generating equipment, and grocery stores.
    - **Levees**—Soil embankments along the bank or shoreline of a river, creek, slough, or bay to prevent or limit flooding impacts on the adjacent floodplain. Levees may be engineered structures or un-engineered fills. The level of flood protection varies with capacity, quality of design and construction, age and deterioration, history of flood damage, and level of maintenance. A levee failure can cause sudden, unpredictable distribution of water or debris to the land and structures behind the levee.

- Hazardous Facilities:
  - **Major Dams**—Failure of upriver dams located in other counties could significantly impact Humboldt County.
  - **Risk Management Plan Hazardous Material Sites**—These sites include but are not limited to facilities that use or store acutely hazardous materials as defined by California Code of Regulations Title 19, Division 2, Chapter 4.5, Section 2770.5.
  - **Additional Hazardous Material Sites**—Additional hazmat sites may include nuclear material storage sites, retail and wholesale fuel facilities, hazardous materials yards, and pulp mills.

These categories were used to identify critical facilities and infrastructure in the planning area. In order to perform a risk assessment of critical facilities, the identified facilities and infrastructure were reassigned to categories as defined in the risk assessment software that was used (FEMA's Hazus software). The identified facilities, grouped by Hazus category, are mapped on Figure 4-3 and Figure 4-4 and listed in Table 4-4 and Table 4-5. This information is based upon the best data available on critical facilities and infrastructure at the time of this plan update. The County and its planning partners consider this information to be subject to change as new information about critical facilities and infrastructure become available during the performance period for this plan.

Table 4-4. Planning Area Critical Facilities

	Number of Facilities						
	Medical & Health Services	Government Function [a]	Protective Function [b]	Schools	Hazardous Materials	Other Critical Function [c]	Total
Arcata	6	1	4	12	4	0	**27**
Blue Lake	0	1	2	1	0	0	**4**
Eureka	9	9	9	12	3	0	**42**
Ferndale	1	1	2	2	0	0	**6**
Fortuna	7	1	5	8	1	0	**22**
Rio Dell	0	1	2	3	1	0	**7**
Trinidad	0	1	2	1	0	0	**4**
Unincorporated County	17	1	75	58	24	2	**177**
Total	40	16	101	97	33	2	**289**

a. Government functions are those associated with continuity of operations at the federal, state or local level.
b. Protective functions are those associated with protecting the public and include police, fire and ambulance.
c. Other critical functions include all facilities that have been identified to provide critical functions but do not fit into another assigned category. These include parks, campgrounds, fairgrounds, etc.

Table 4-5. Planning Area Critical Infrastructure

	Number of Facilities					
	Water Supply	Wastewater	Power	Communication	Transportation	Total
Arcata	26	16	0	0	18	**60**
Blue Lake	1	2	0	0	0	**3**
Eureka	6	23	0	1	16	**46**
Ferndale	0	0	0	1	0	**1**
Fortuna	4	16	0	0	9	**29**
Rio Dell	6	3	0	0	7	**16**
Trinidad	3	0	0	0	1	**4**
Unincorporated County	163	77	1	6	365	**612**
Total	**209**	**137**	**1**	**8**	**416**	**771**

Insert Map

Figure 4-3. Critical Facilities

Insert Map

Figure 4-4. Critical Infrastructure

4.6.4 Future Trends in Development

The County's 2017 General Plan designates Community Planning Areas in various parts of the County to allow for more precise mapping and application of General Plan policies. These areas include most of the County's population and urban infrastructure, so they will continue to be the focus of development activity. Defining these areas also allows for more direct citizen involvement in the planning of their communities, as well as increased opportunities for infrastructure planning.

The 2017 General Plan promotes existing focused community development patterns referred to as "phased urban development." Land use designations contained in the Land Use Element and Land Use Map promote efficient use of public infrastructure and provide higher development potential in urban areas with access to public sewer and water. The General Plan also establishes a framework for the phased expansion of urban areas. This is intended to create housing opportunities, ensure the continued fiscal viability of infrastructure and urban services, and safeguard the continued profitability of resource production in rural lands.

The development timing measures for phased urban development primarily consist of designating areas where near-term availability of services is feasible and designating outlying areas as the next logical areas for development. The outlying areas are reserved until the primary areas are nearing capacity. These measures require coordination between the County, the Local Agency Formation Commission, cities, special districts and community members. Issues to be addressed by this partnership include the following:

- Timing growth to be consistent with public service capacity.
- Arranging urban land uses to the benefit of the community, while giving due consideration to individual property rights.
- Estimating the amount of development that can be absorbed and its relationship to the environment.

The development timing measures focus and facilitate growth in the urban development areas. Basically, this system sets the framework for designating regions for urban development and expansion based on the availability and capacity of urban services.

The municipal planning partners have adopted general plans that govern land use decision and policy making for 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 the planning area. All municipal planning partners will incorporate this hazard mitigation plan update in their general plans by reference. This will ensure that future development trends can be established with the benefits of the information on risk and vulnerability to natural hazards identified in this plan.

4.7 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, women, children, ethnic minorities, renters, individuals with disabilities, and others with access and functional needs, all experience 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 help to extend focused public outreach and education to these most vulnerable citizens.

4.7.1 Population Estimates

Current Population

Knowledge of the composition of the population and how it has changed in the past and how it may change in the future is needed for making informed decisions about the future. Information about population is a critical part of planning because it directly relates to land needs such as housing, industry, stores, public facilities and services, and transportation. Humboldt County is the 35th largest of California's 58 counties. The California Department of Finance estimated the county's population at 136,373 as of July 2018 (California Department of Finance, 2018a).

Historical Population Trends

Population changes are useful socio-economic indicators. A growing population can indicate a growing economy, and a decreasing population may signify economic decline. Figure 4-5 shows the population growth trends in Humboldt County from 1900 to 2020 compared to that of the State of California (California Department of Finance, 2018b). The state and county both experienced 10-year growth rates of about 50 percent in the 1940s and 1950s. Since then, the County has seen much lower growth rates, of less than 10 percent per decade (including a 5-percent decline from 1960 to 1970), and the state growth rate has gradually declined to about 10 percent over the 10-year period from 2000 to 2010.

Source: California Department of Finance

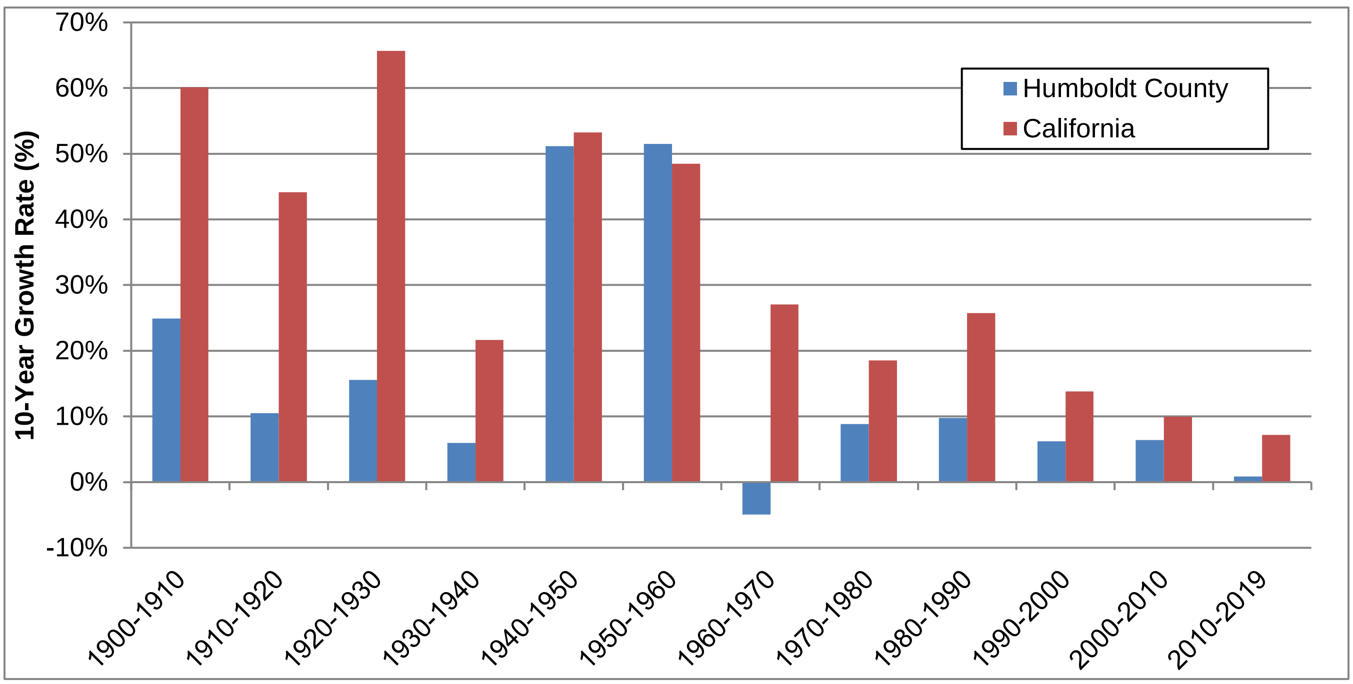


Figure 4-5. California and Humboldt County Historical Population Growth Rates

Table 4-6 shows the population of incorporated municipalities and the combined unincorporated areas in Humboldt County from 2000 to 2018. The portion of the planning area's residents living outside incorporated areas has been relatively constant over that period, changing from 53 percent in 2000 to 53 percent in 2018. Overall growth in both incorporated and unincorporated areas from 2000 to 2018was approximately 7 percent.

Table 4-6. Population Growth Data

	Population					
	April 1, 2000	April 1, 2010	January 1, 2015	January 1, 2016	January 1, 2017	January 1, 2018
Arcata	16,651	17,231	17,860	17,952	18,118	18,084
Blue Lake	1135	1253	1262	1271	1276	1253
Eureka	26,128	27,191	27,178	27,170	27,301	27,195
Ferndale	1382	1371	1364	1360	1366	1344
Fortuna	10,497	11,926	12,020	12,042	12,092	12,144
Rio Dell	3174	3368	3341	3344	3365	3351
Trinidad	311	367	359	359	362	363
Unincorporated	67,240	71,916	72,051	72,168	72,682	72,380
Total	**126,518**	**134,623**	**135,435**	**135,666**	**136,562**	**136,084**

Source: California Department of Finance

Projected Future Population

According to population projections by the California Department of Finance, Humboldt County's population should increase to 140,243 by 2040. This represents a 3.63 percent increase from the 2018 population. According the County's 2017 General Plan, a 0.23 percent average annual growth rate is projected for Humboldt County through 2025, compared to the 0.94 percent growth rate in the 1990s. Humboldt County's population is projected to decline after 2028 from 141,441 in 2028 to 138,307 in 2040. There are expected to be 6,325 more persons in 2028 than in 2016, and only 3,134 more persons in 2040 than in 2016. The General Plan includes a policy to review these trends every five years and make adjustments as necessary.

4.7.2 Age Distribution

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

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

The overall age distribution for the planning area is illustrated in Figure 4-6. Based on U.S. Census data, 16.1 percent of the planning area's population is 65 years or older, and 23 percent of the population is 19 years or younger. According to U.S. Census data, 8 percent of the over-65 years population have incomes below the poverty level. Of children under 18 years, 22.5 percent live below the poverty level.

Source: American Fact Finder, American Community Survey

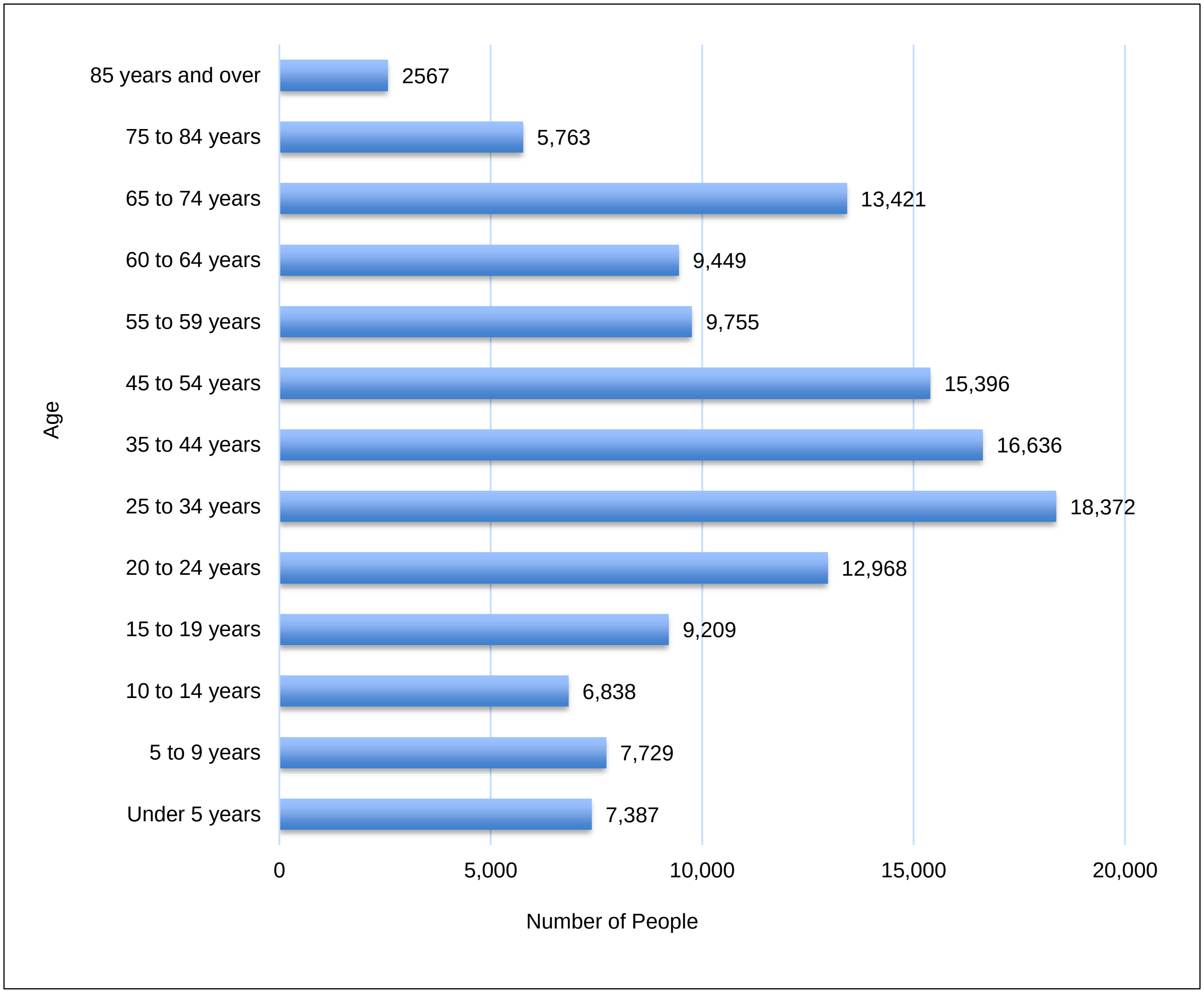


Figure 4-6. Planning Area Age Distribution

4.7.3 Race, Ethnicity and Language

Research shows that minorities are less likely to be involved in pre-disaster planning and experience higher mortality rates during a disaster event. Post-disaster recovery can be ineffective and is often characterized by cultural insensitivity. Since higher proportions of ethnic minorities live below the poverty line than the majority white population, poverty can compound vulnerability. According to the U.S. Census, the racial composition of the planning area is predominantly white, at about 82 percent. The largest minority populations are multi-racial at 6 percent and American Indian and Alaskan Native 7 percent. While not considered a separate race, the planning area has 6 percent Hispanic or Latino population. Figure 4-7 shows the racial distribution in the planning area.

The planning area has a 5.3 percent foreign-born population. Other than English, the most commonly spoken language in the planning area is Spanish. The census estimates 4.3 percent of the residents speak English “less than very well.”

Source: State of California Department of Finance.

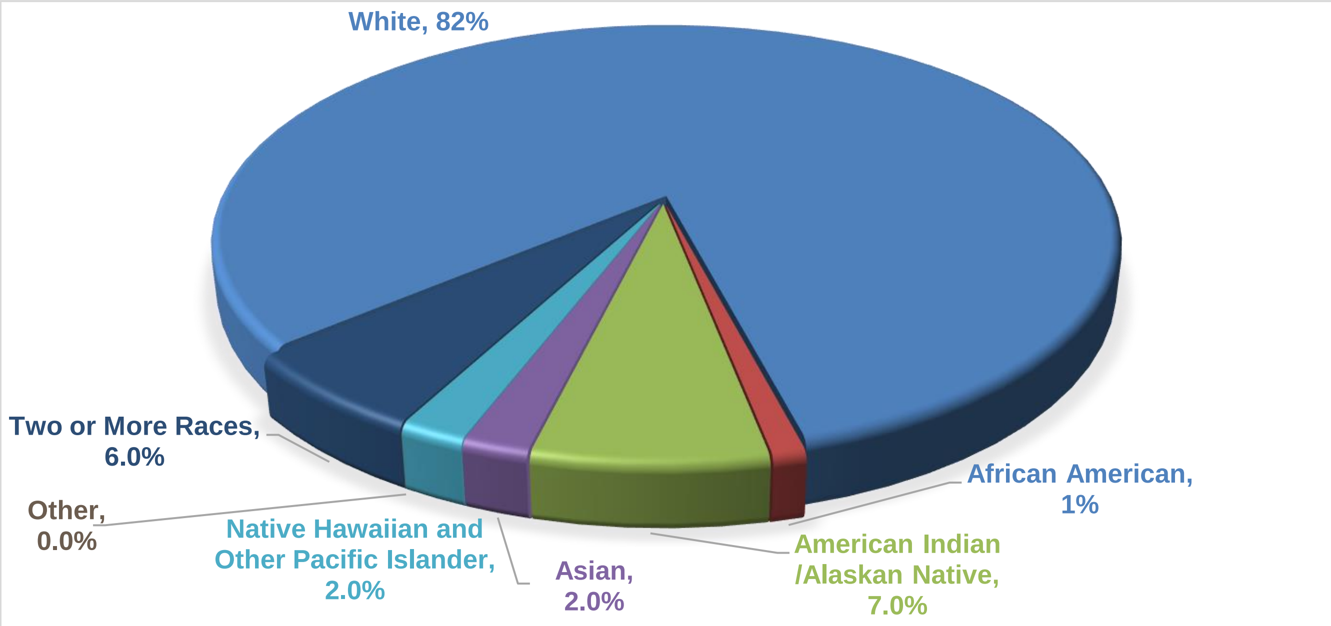


Figure 4-7. Planning Area Race Distribution

4.7.4 Individuals with Disabilities or with Access and Functional Needs

The 2010 U.S. Census estimates that 54 million non-institutionalized Americans with disabilities live in the U.S. This equates to about one-in-five persons. Individuals with disabilities are more likely to have difficulty responding to a hazard event than the general population. Local government is the first level of response to assist these individuals, and coordination of efforts to meet their access and functional needs is paramount to life safety efforts. It is important for emergency managers to distinguish between functional and medical needs in order to plan for incidents that require evacuation and sheltering. Knowing the percentage of population with a disability will allow emergency management personnel and first responders to have personnel available who can provide services needed by those with access and functional needs. According to U.S. Census data, 50.2 percent of the over-65 population in the planning area has disabilities of some kind, as well as 16.7 percent of those under 65.

4.8 ECONOMY

Humboldt County's economy is resource-extraction oriented. The area's many natural resources support its primary industries of timber, fisheries, agriculture and recreation-tourism. The County's economy experiences the problems typical of primary production economics, such as cyclical and seasonal instability, high unemployment rates and slow growth rates. Historically, cyclical instability has been a function of changes in the national demand for lumber, which has caused timber production in Humboldt County to fluctuate accordingly.

4.8.1 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 impact people's decisions on evacuation. Individuals who cannot afford gas for their cars will likely decide not to evacuate.

Based on U.S. Census Bureau estimates, per capita income in the planning area in 2017 was $25,208, and the median household income was $60,394. It is estimated that 9.0 percent of households receive an income between $100,000 and $149,999 per year and 5.8 percent of household incomes are above $150,000 annually. The Census estimates that 10.7 percent of all families in the planning area have incomes below the poverty level.

4.8.2 Industry, Businesses and Institutions

The top employers in the planning area shown in Table 4-7. Figure 4-8 shows the breakdown of employment by industry type in the planning area, according to U.S. Census data.

Table 4-7. Top Employers for the Planning Area

Employer	Employer Size Class (# of Employees)
Bettendorf Trucking	250-499
Blue Lake Casino & Hotel	250-499
Costco Warehouse	100-249
City of Eureka	250-499
Green Diamond Resource Company	250-499
Humboldt County	500-999
Mad River Community Hospital	250-499
Newmarket International Inc	250-499
Pacific Seafood Company	100-249
Redwood Memorial Hospital	100-249
Schmidbauer Lumber Inc	100-249
St. Joseph Hospital	1000-4,999
Sun Valley Group	500-999
Target	100-249
Trinidad Rancheria	250-499
Umpqua Bank	250-499
U.S. Post Office	100-249
Walmart	100-249
Winco Foods	100-249

4.8.3 Employment Trends and Occupations

The U.S. Census estimates a labor force of 64,000 in Humboldt County, of which 61,200 are employed with a 4.3 percent unemployment rate. According to the American Community Survey, about 43.8 percent of the planning area's working-age population (16 and over) is in the labor force—41.7 percent of working-age men and 48.2 percent of working-age women.

Figure 4-9 compares California's and Humboldt County's unemployment trends from 2010 through 2018. The county's rate is very close to the statewide average, but both followed a similar trend of rising for few years after the 2008-2009 recession and then falling steadily to the present.

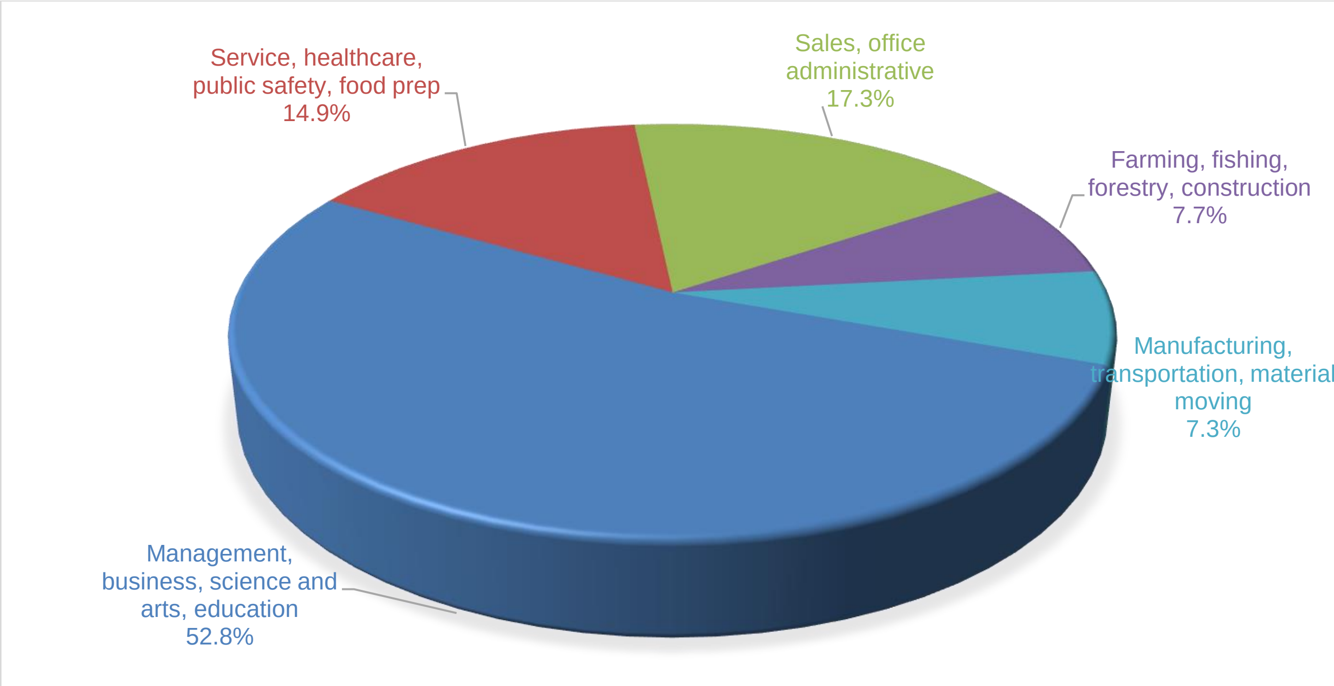


Figure 4-8. Industry in the Planning Area

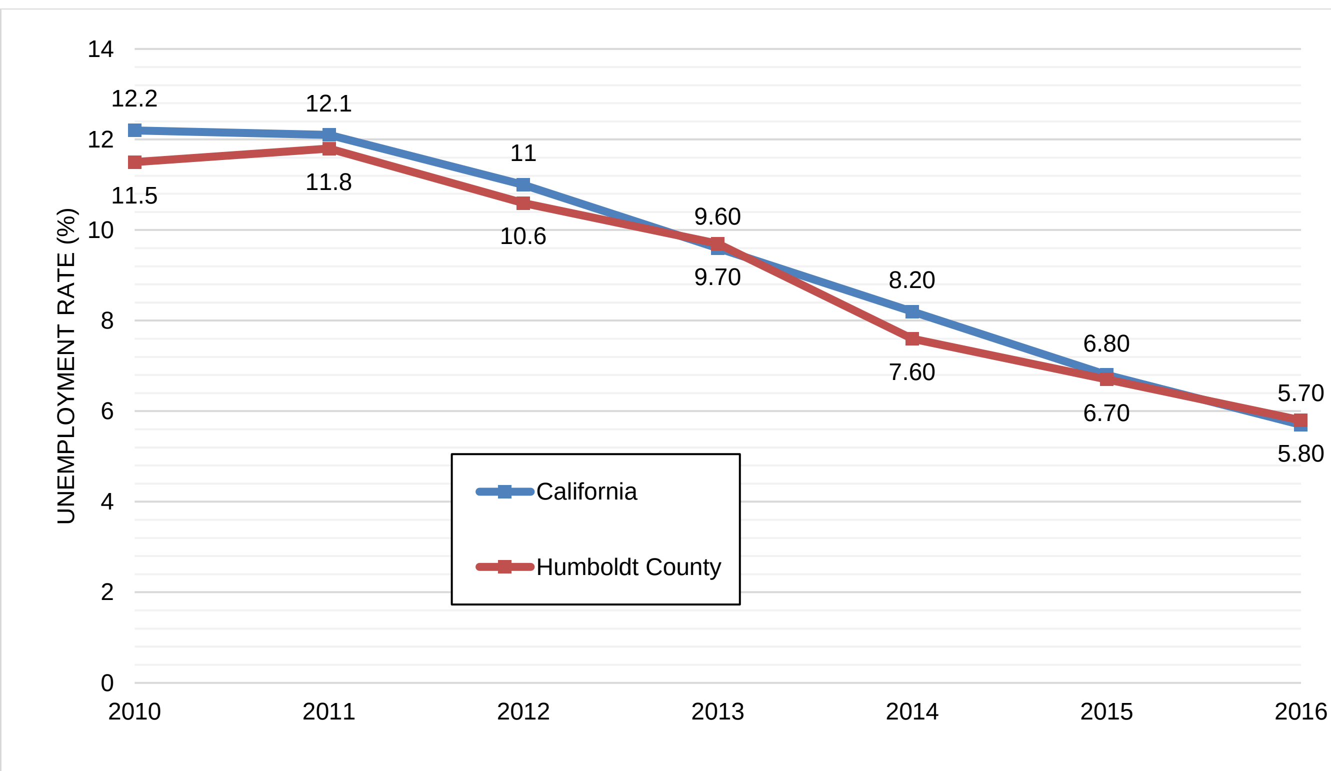


Figure 4-9. California and Humboldt County Unemployment Rate

5. REGULATIONS AND PROGRAMS

Existing regulations, agencies and programs at the federal, state and local level can support or impact hazard mitigation actions 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)). Information presented in this section can be used to review local capabilities to implement the action plan this hazard mitigation plan presents. Individual review by each planning partner of existing local plans, studies, reports, and technical information is presented in the annexes in Volume 2.

5.1 RELEVANT FEDERAL AND STATE AGENCIES, PROGRAMS AND REGULATIONS

State and federal regulations and programs that need to be considered in hazard mitigation are constantly evolving. For this plan, a review was performed to determined which regulations and programs are currently most relevant to hazard mitigation planning. The findings are summarized in Table 5-1 and Table 5-2. Short descriptions of each program are provided in Appendix B.

Table 5-1. Summary of Relevant Federal Agencies, Programs and Regulations

Agency, Program or Regulation	Hazard Mitigation Area Affected	Relevance
A Collaborative Approach for Reducing Wildfire Risks to Communities and the Environment	Wildfire Hazard	This strategy implementation plan prepared by federal and Western state agencies outlines measures to restore fire-adapted ecosystems and reduce hazardous fuels.
Americans with Disabilities Act	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.
Bureau of Indian Affairs	Wildfire Hazard	The Bureau's Fire and Aviation Management National Interagency Fire Center provides wildfire protection, fire use and hazardous fuels management, and emergency rehabilitation on Indian forest and rangelands.
Bureau of Land Management	Wildfire Hazard	The Bureau funds and coordinates wildfire management programs and structural fire management and prevention on BLM lands.
Civil Rights Act of 1964	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.
Clean Water Act	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.
Community Development Block Grant Disaster Resilience Program	Action Plan Funding	This is a potential alternative source of funding for actions identified in this plan.
Community Rating System	Flood Hazard	This voluntary program encourages floodplain management activities that exceed the minimum National Flood Insurance Program requirements.
Disaster Mitigation Act	Hazard Mitigation Planning	This is the current federal legislation addressing hazard mitigation planning.

Agency, Program or Regulation	Hazard Mitigation Area Affected	Relevance
Emergency Relief for Federally Owned Roads Program	Action Plan Funding	This is a possible funding source for actions identified in this plan.
Emergency Watershed Program	Action Plan Funding	This is a possible funding source for actions identified in this plan.
Endangered Species Act	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.
Federal Energy Regulatory Commission Dam Safety Program	Dam Failure Hazard	This program cooperates with a large number of federal and state agencies to ensure and promote dam safety.
National Environmental Policy Act	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.
Federal Wildfire Management Policy and Healthy Forests Restoration Act	Wildfire Hazard	These documents mandate community-based collaboration to reduce risks from wildfire.
National Dam Safety Act	Dam Failure Hazard	This act requires a periodic engineering analysis of most dams in the country
National Fire Plan (2001)	Wildfire Hazard	This plan calls for joint risk reduction planning and implementation by federal, state and local agencies.
National Flood Insurance Program	Flood Hazard	This program makes federally backed flood insurance available to homeowners, renters, and business owners in exchange for communities enacting floodplain regulations
National Incident Management System	Action Plan Development	Adoption of this system for government, nongovernmental organizations, and the private sector to work together to manage incidents involving hazards is a prerequisite for federal preparedness grants and awards
National Park Service, Redwood National Park	Wildfire Hazard	Park staff provide wildland and structure fire protection and conduct wildfire management within the park.
Presidential Executive Order 11988 (Floodplain Management)	Flood Hazard	This order requires federal agencies to avoid long and short-term adverse impacts associated with modification of floodplains
Presidential Executive Order 11990 (Protection of Wetlands)	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable presidential executive orders.
U.S. Army Corps of Engineers Dam Safety Program	Dam Failure Hazard	This program is responsible for safety inspections of dams that meet size and storage limitations specified in the National Dam Safety Act.
U.S. Army Corps of Engineers Flood Hazard Management	Flood Hazard, Action Plan Implementation, Action Plan Funding	The Corps of Engineers offers multiple funding and technical assistance programs available for flood hazard mitigation actions
U.S. Fire Administration	Wildfire Hazard	This agency provides leadership, advocacy, coordination, and support for fire agencies and organizations.
U.S. Fish and Wildlife Service	Wildfire Hazard	This service's fire management strategy employs prescribed fire throughout the National Wildlife Refuge System to maintain ecological communities.
U.S. Forest Service Six Rivers National Forest	Wildfire Hazard	Staff provide wildfire management primarily on National Forest lands.

Table 5-2. Summary of Relevant State Agencies, Programs and Regulations

Agency, Program or Regulation	Hazard Mitigation Area Affected	Relevance
AB 32: The California Global Warming Solutions Act	Action Plan Development	This act establishes a state goal of reducing greenhouse gas emissions to 1990 levels by 2020
AB 70: Flood Liability	Flood Hazard	A city or county may be required to partially compensate for property damage caused by a flood if it unreasonably approves new development in areas protected by a state flood control project
AB 162: Flood Planning	Flood Hazard	Cities and counties must address flood-related matters in the land use, conservation, and safety and housing elements of their general plans.
AB 747: General Plans—Safety Element	Hazard Mitigation Planning	The safety elements of cities' and counties' general plans must address evacuation routes and include any new information on flood and fire hazards and climate adaptation and resiliency strategies.
AB 2140: General Plans—Safety Element	Hazard Mitigation Planning	This bill enables state and federal disaster assistance and mitigation funding to communities with compliant hazard mitigation plans.
AB 2800: Climate Change—Infrastructure Planning	Action Plan Development	This act requires state agencies to take into account the impacts of climate change when developing state infrastructure.
Alquist-Priolo Earthquake Fault Zoning Act	Earthquake Hazard	This act restricts construction of buildings used for human occupancy on the surface trace of active faults.
California Coastal Management Program	Flood, Landslide, Tsunami and Wildfire Hazards	This program requires coastal communities to prepare coastal plans and requires that new development minimize risks to life and property in areas of high geologic, flood, and fire hazard.
California Department of Forestry and Fire Protection (CAL FIRE)	Wildfire Hazard	CAL FIRE has responsibility for wildfires in areas that are not under the jurisdiction of the Forest Service or a local fire organization.
California Department of Parks and Recreation	Wildfire Hazard	State Parks Resources Management Division has wildfire protection resources available to suppress fires on State Park lands.
California Department Water Resources	Flood Hazard	This state department is the state coordinating agency for floodplain management.
California Division of Safety of Dams	Dam Failure Hazard	This division monitors the dam safety program at the state level and maintains a working list of dams in the state.
California Environmental Quality Act	Action Plan Implementation	This act establishes a protocol of analysis and public disclosure of the potential environmental impacts of development projects. Any project action identified in this plan will seek full California Environmental Quality Act compliance upon implementation.
California Fire Alliance	Wildfire Hazard	The alliance works with communities at risk from wildfires to facilitate the development of community fire loss mitigation plans.
California Fire Plan	Wildfire Hazard	This plan's goal is to reduce costs and losses from wildfire through pre-fire management and through successful initial response.
California Fire Safe Council	Wildfire Hazard	This council facilitates the distribution of National Fire Plan grants for wildfire risk reduction and education.
California Fire Service and Rescue Emergency Mutual Aid Plan	Wildfire Hazard	This plan provides guidance and procedures for agencies developing emergency operations plans, as well as training and technical support.
California General Planning Law	Hazard Mitigation Planning	This law requires every county and city to adopt a comprehensive long-range plan for community development, and related laws call for integration of hazard mitigation plans with general plans.

Agency, Program or Regulation	Hazard Mitigation Area Affected	Relevance
California Multi-Hazard Mitigation Plan	Hazard Mitigation Planning	Local hazard mitigation plans must be consistent with their state's hazard mitigation plan.
California Residential Mitigation Program	Earthquake Hazard	This program helps homeowners with seismic retrofits to lessen the potential for damage to their houses during an earthquake.
California State Building Code	Action Plan Implementation	Local communities must adopt and enforce building codes, which include measures to improve buildings' ability to withstand hazard events.
Disadvantaged and Low-Income Communities Investments	Action Plan Funding	This is a potential source of funding for actions located in disadvantaged or low-income communities.
Division of the State Architect's AB 300 List of Seismically At-Risk Schools	Earthquake Hazard, Action Plan Development	The Division of the State Architect recommends that local school districts conduct detailed seismic evaluations of seismically at-risk schools identified in the inventory that was required by AB 300.
Governor's Executive Order S-13-08 (Climate Impacts)	Action Plan Implementation	This order includes guidance on planning for sea level rise in designated coastal and floodplain areas for new projects.
Office of the State Fire Marshal	Wildfire Hazard	This office has a wide variety of fire safety and training responsibilities.
Senate Bill 97: Guidelines for Greenhouse Gas Emissions	Action Plan Implementation	This bill establishes that greenhouse gas emissions and the effects of greenhouse gas emissions are appropriate subjects for California Environmental Quality Act analysis.
Senate Bill 379: General Plans: Safety Element—Climate Adaptation	Action Plan Implementation	This bill requires cities and counties to include climate adaptation and resiliency strategies in the safety element of their general plans.
Senate Bill 1000: General Plan Amendments—Safety and Environmental Justice Elements	Action Plan Implementation	Under this bill, review and revision of general plan safety elements are required to address only flooding and fires (not climate adaptation and resilience), and environmental justice is required to be included in general plans.
Senate Bill 1241: General Plans: Safety Element—Fire Hazard Impacts	Wildfire Hazard	This bill requires cities and counties to make findings regarding available fire protection and suppression services before approving a tentative map or parcel map.
Standardized Emergency Management System	Action Plan Implementation	Local governments must use this system to be eligible for state funding of response-related personnel costs.

5.2 LOCAL PLANS, REPORTS AND CODES

Plans, reports and other technical information were identified and provided directly by participating jurisdictions and stakeholders or were identified through independent research by the planning consultant. These documents were reviewed to identify the following:

- Existing jurisdictional capabilities.
- Needs and opportunities to develop or enhance capabilities, which may be identified within the local mitigation strategies.
- Mitigation-related goals or objectives considered during the development of the overall goals and objectives.
- Proposed, in-progress, or potential mitigation projects, actions and initiatives to be incorporated into the updated jurisdictional mitigation strategies.

The following local regulations, codes, ordinances and plans were reviewed in order to develop complementary and mutually supportive goals, objectives, and mitigation strategies that are consistent across local and regional planning and regulatory mechanisms:

- General plans (land use, housing, safety, and open space elements)
- Building codes
- Zoning and subdivision ordinances
- NFIP flood damage prevention ordinances
- Stormwater management plans
- Emergency management and response plans
- Land use and open space plans
- Climate action plans.
- Community wildfire protection plans
- Tribal hazard mitigation plans.

5.3 LOCAL CAPABILITY ASSESSMENT

All participating jurisdictions compiled an inventory and analysis of existing authorities and capabilities called a “capability assessment.” A capability assessment creates an inventory of a jurisdiction’s mission, programs and policies, and evaluates its capacity to carry them out. This assessment identifies potential gaps in the jurisdiction’s capabilities.

The planning partnership views all core jurisdictional capabilities as fully adaptable to meet a jurisdiction’s needs. Every code can be amended, and every plan can be updated. Such adaptability is itself considered to be an overarching capability. If the capability assessment identified an opportunity to add a missing core capability or expand an existing one, then doing so has been selected as an action in the jurisdiction’s action plan, which is included in the individual annexes presented in Volume 2 of this plan.

Capability assessments for each planning partner are presented in the jurisdictional annexes in Volume 2. The sections below describe the specific capabilities evaluated under the assessment.

5.3.1 Legal and Regulatory Capabilities

Jurisdictions have the ability to develop policies and programs and to implement rules and regulations to protect and serve residents. Local policies are typically identified in a variety of community plans, implemented via a local ordinance, and enforced through a governmental body.

Jurisdictions regulate land use through the adoption and enforcement of zoning, subdivision and land development ordinances, building codes, building permit ordinances, floodplain, and stormwater management ordinances. When effectively prepared and administered, these regulations can lead to hazard mitigation.

5.3.2 Fiscal Capabilities

Assessing a jurisdiction’s fiscal capability provides an understanding of the ability to fulfill the financial needs associated with hazard mitigation projects. This assessment identifies both outside resources, such as grant-funding eligibility, and local jurisdictional authority to generate internal financial capability, such as through impact fees.

5.3.3 Administrative and Technical Capabilities

Legal, regulatory, and fiscal capabilities provide the backbone for successfully developing a mitigation strategy; however, without appropriate personnel, the strategy may not be implemented. Administrative and technical capabilities focus on the availability of personnel resources responsible for implementing all the facets of hazard mitigation. These resources include technical experts, such as engineers and scientists, as well as personnel with capabilities that may be found in multiple departments, such as grant writers.

5.3.4 NFIP Compliance

Flooding is the costliest natural hazard in the United States and, with the promulgation of recent federal regulation, homeowners throughout the country are experiencing increasingly high flood insurance premiums. Community participation in the NFIP opens up opportunity for additional grant funding associated specifically with flooding issues. Assessment of the jurisdiction’s current NFIP status and compliance provides planners with a greater understanding of the local flood management program, opportunities for improvement, and available grant funding opportunities.

5.3.5 Public Outreach Capability

Regular engagement with the public on issues regarding hazard mitigation provides an opportunity to directly interface with community members. Assessing this outreach and education capability illustrates the connection between the government and community members, which opens a two-way dialogue that can result in a more resilient community based on education and public engagement.

5.3.6 Participation in Other Programs

Other programs, such as the Community Rating System, Storm/Tsunami Ready, and Firewise USA, can enhance a jurisdiction’s ability to mitigate, prepare for, and respond to natural hazards. These programs indicate a jurisdiction’s desire to go beyond minimum requirements set forth by local, state and federal regulations in order to create a more resilient community. These programs complement each other by focusing on communication, mitigation, and community preparedness to save lives and minimize the impact of natural hazards on a community.

5.3.7 Development and Permitting Capability

Identifying previous and future development trends is achieved through a comprehensive review of permitting since completion of the previous plan and in anticipation of future development. Tracking previous and future growth in potential hazard areas provides an overview of increased exposure to a hazard within a community.

5.3.8 Adaptive Capacity

An adaptive capacity assessment evaluates a jurisdiction’s ability to anticipate impacts from future conditions. By looking at public support, technical adaptive capacity, and other factors, jurisdictions identify their core capability for resilience against issues such as sea level rise. The adaptive capacity assessment provides jurisdictions with an opportunity to identify areas for improvement by ranking their capacity high, medium or low.

5.3.9 Integration Opportunity

The assessment looked for opportunities to integrate this mitigation plan with the legal/regulatory capabilities identified. Capabilities were identified as integration opportunities if they can support or enhance the actions identified in this plan or be supported or enhanced by components of this plan. Planning partners considered actions to implement this integration as described in their jurisdictional annexes.

Humboldt County Operational Area Hazard Mitigation Plan 2019

PART 2—RISK ASSESSMENT

6. IDENTIFIED HAZARDS OF CONCERN AND RISK ASSESSMENT METHODOLOGY

Risk assessment is the process of estimating the potential loss of life, personal injury, economic injury, and property damage resulting from identified hazards. The process focuses on the following elements:

- **Hazard identification**—Use all available information to determine what types of hazards may affect a jurisdiction, how often they can occur, and their potential severity.
- **Exposure identification—**Estimate the total number of people and properties in the jurisdiction that are likely to experience a hazard event if it occurs.
- **Vulnerability identification and loss estimation**—Assess the impact of hazard events on the people, property, environment, economy and lands of the region, including estimates of 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 the planning area and meets requirements of the Disaster Mitigation Act (44 CFR, Section 201.6(c)(2)). To protect individual privacy and the security of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual personal or public properties.

6.1 IDENTIFIED HAZARDS OF CONCERN

The Steering Committee considered the full range of natural hazards that could affect the planning area and then listed hazards that present the greatest concern. The process incorporated a review of state and local hazard planning documents as well as information on the frequency of, magnitude of, and costs associated with hazards that have struck the planning area or could do so. Anecdotal information regarding natural hazards and the perceived vulnerability of the planning area's assets to them was also used. Based on the review, this plan addresses the following hazards of concern (presented in alphabetical order; the order of listing does not indicate the hazards' relative severity):

- Climate change
- Dam failure
- Drought
- Earthquake
- Flooding
- Landslide
- Severe weather
- Tsunami
- Wildfire

An additional chapter provides a profile of other hazards of concern, calling attention to hazards that may impact the planning area but whose risk is difficult to quantify due to a lack of data or well-established assessment parameters. This chapter provides a profile of these hazards but does not assess them to the same level of detail as the primary hazards of concern. These "other" hazards are not included in the risk ranking for this plan update.

6.2 RISK ASSESSMENT TOOLS

6.2.1 Mapping

National, state, and county databases were reviewed to locate available spatially based data relevant to this planning effort. Maps were produced using geographic information system (GIS) software to show the spatial extent of hazards when such datasets were available. These maps are included in the hazard profile chapters of this document and the jurisdiction-specific annexes in Volume 2.

6.2.2 Modeling

Overview

In 1997, FEMA developed the standardized Hazards U.S. (Hazus) computer simulation 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 with additional capabilities to estimate potential losses from hurricanes and floods.

Hazus is a GIS-based software program that provides a wide range of inventory data, such as demographics, building stock, critical facilities, transportation elements, and utilities. 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 they can readily be updated as population, inventory, and other factors change and as mitigation planning efforts evolve.
- Facilitates 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.

Levels of Detail for Evaluation

Hazus provides default data for inventory, vulnerability, and hazards; these 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 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. These data are derived from national databases and describe 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.

6.3 RISK ASSESSMENT APPROACH

The risk assessments in this plan describe the risks associated with each identified hazard of concern. The following steps were used to assess the risk of each hazard:

- **Identify and profile each hazard**—The following information is given for each hazard:
    - A summary of past events that have impacted the planning area
    - Geographic areas most affected by the hazard
    - Event frequency estimates
    - Severity descriptions
    - Warning time likely to be available for response.
- **Determine exposure to each hazard**—Exposure was assessed by overlaying hazard maps with an inventory of structures, facilities, and systems to decide which of them would be exposed to each hazard.
- **Assess the vulnerability of exposed facilities**—Vulnerability of exposed structures and infrastructure was evaluated by interpreting the probability of occurrence of each event and assessing structures, facilities, and systems that are exposed to each hazard. Tools such as GIS and Hazus were used for this assessment for the flood, earthquake, and tsunami hazards. Outputs similar to those from Hazus were generated for other hazards, using data generated through GIS.

6.3.1 Hazard Profile Development

Hazard profiles were developed through web-based research and review of previously developed reports and plans, including community general plans and state and local hazard mitigation plans. Frequency and severity indicators include past events and the expert opinions of geologists, emergency management specialists, and others.

6.3.2 Exposure and Vulnerability

Earthquake, Flood and Tsunami

Community exposure and vulnerability to the following hazards were evaluated using Hazus:

- **Flood**—A Level 2 user-defined analysis was performed for general building stock in flood zones and for critical facilities and infrastructure. Current flood mapping for the planning area was used to delineate flood hazard areas and estimate potential losses from the 1-percent-annual-chance and 0.2-percent-annual-chance flood events. To estimate damage that would result from a flood, Hazus uses pre-defined relationships between flood depth at a structure and resulting damage, with damage given as a percent of total replacement value. Curves defining these relationships have been developed for damage to structures and for damage to typical contents within a structure. By inputting flood depth data and known property replacement cost values, dollar-value estimates of damage were generated.
- **Dam Failure**—A Level 2 analysis was run using the flood methodology described above.
- **Tsunami**—A modified Level 2 analysis was run using the flood methodology described above with tsunami inundation mapping produced by the California Office of Emergency Services, California Geological Survey, and University of Southern California Tsunami Research Center.
- **Earthquake**—A Level 2 analysis was performed to assess earthquake vulnerability for five scenario events:
    - Big Lagoon-Bald Mountain M7.9 scenario.
    - Cascadia Megathrust M9.3 scenario.

- Little Salmon Onshore M7.1 scenario.
- Mad River Trinidad Alt 2 M7.5 scenario.
- Russ M7.4 scenario.

All Other Assessed Hazards

Historical datasets were not adequate to model future losses for most of the hazards of concern. However, areas and inventory susceptible to some of the hazards of concern were mapped by other means and exposure was evaluated. A qualitative analysis was conducted using the best available data and professional judgment. The risk assessment for drought was more limited and qualitative than the assessment for the other hazards of concern because drought does not affect structures.

6.4 SOURCES OF DATA USED

6.4.1 Building and Cost Data

Replacement cost values and structure information derived from parcel and tax assessor data provided by Humboldt County were loaded into Hazus. When available, an updated inventory was used in place of the Hazus defaults for critical facilities and infrastructure.

Replacement cost is the cost to replace the entire structure with one of equal quality and utility. Replacement cost is based on industry-standard cost-estimation models published in *RS Means Square Foot Costs* (RS Means, 2019). It is calculated for each structure by multiplying the structure's footprint area by the RS Means cost per square foot for structures with the identified Hazus occupancy class (i.e. multi-family residential or commercial retail trade).

6.4.2 Hazus Data Inputs

The following hazard datasets were used for the Hazus Level 2 analysis conducted for the risk assessment:

- **Flood**—The effective Digital Flood Insurance Rate Map (DFIRM) for the planning area was used to delineate flood hazard areas and estimate potential losses from the 1-percent-annual-chance and 0.2-percent-annual-chance flood events. The DFIRM is effective as of June 21, 2017. Using the DFIRM floodplain boundaries and the U.S. Geological Survey's 10-meter digital elevation model, flood depth grids were generated and integrated into the Hazus model.
- **Dam Failure**—Dam inundation area data for Copco No. 1, Iron Gate, Trinity, Matthews and Scott dams provided by the County for its 2014 Hazard Mitigation Plan and the USGS 10-meter digital elevation model were used to develop depth grids that were integrated into the Hazus model.
- **Tsunami**—Tsunami inundation zone data from the California Department of Conservation was used in combination with the USGS 10-meter digital elevation model to develop a tsunami depth grid that was integrated into the Hazus model.
- **Earthquake**—Earthquake ShakeMap data prepared by the USGS were used for the analysis of the earthquake hazard. A National Earthquake Hazard Reduction Program (NEHRP) soils map from the California Department of Conservation was also integrated into the Hazus model.

6.4.3 Other Local Hazard Data

Locally relevant information on hazards was gathered from a variety of sources. Data sources for specific hazards were as follows:

- **Climate Change**—Sea level rise data were provided by NOAA, and Humboldt Bay sea level rise inundation mapping was provided by the Coastal Ecosystems Institute of Northern California. From the

NOAA data, sea level rises of 3 feet and 8 feet above current mean higher high water were used for the exposure analysis. From the Humboldt Bay data, the mean monthly maximum water scenario of sea level rise of 200 cm above Year 2000 was used.

- **Landslide**— Data on susceptibility to deep-seated landslides was provided by the California Geological Survey.
- **Severe Weather**—No GIS-format severe weather datasets were identified for Humboldt County.
- **Wildfire**—Fire severity data was acquired from California Department of Forestry and Fire Protection.

6.4.4 Data Source Summary

Table 6-1 summarizes the data sources used for the risk assessment for this plan.

Table 6-1. Hazus Model Data Documentation

Data	Source	Date	Format
Property parcel data	Humboldt County	2019	Digital (GIS) format
Land information system (tax assessor) data	Humboldt County	2019	Digital (tabular) format
Open Street Map building footprints	Microsoft	2018	Digital (GIS) format
Building replacement cost	RS Means	2019	Paper format Updated RS Means
Population data	FEMA Hazus version 4.2 SP01	2010	Digital (GIS and tabular) format
Effective DFIRM	FEMA	2017	Digital (GIS) format
Dam failure inundation areas	Humboldt County (provided for 2014 hazard mitigation plan)	Unknown	Digital (GIS) format
Tsunami inundation map for emergency planning	CA Department of Conservation website (produced by CA Emergency Management Agency, CA Geological Survey, and University of Southern California Tsunami Research Center)	2009	Digital (GIS) format
ShakeMaps	USGS Earthquake Hazards Program	2017	Digital (GIS) format
NEHRP soils	CA Department of Conservation	2008	Digital (GIS) format
Susceptibility to deep-seated landslides in California	CA Geological Survey	2011	Digital (GIS) format
California fire hazard severity zone maps for local responsibility areas	CAL FIRE	2007	Digital (GIS) format
Sea level rise data: 1- to 10-foot sea level rise inundation extent	NOAA Office for Coastal Management	2017	Digital (GIS) format
Humboldt Bay sea level rise inundation mapping	Coastal Ecosystems Institute of Northern California	2014	Digital (GIS) format
10-meter digital elevation model	U.S. Geological Survey	2016	Digital (GIS) format
2014 Humboldt County Hazard Mitigation Plan critical facilities geodatabase	Humboldt County/Tetra Tech Inc.	2014	Digital (GIS) format
Updates to 2014 hazard mitigation plan critical facilities geodatabase	Humboldt County	2019	Digital (tabular) format
Local and state bridges	CA Department of Transportation	2015	Digital (GIS) format

6.5 LIMITATIONS

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

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

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate and should be used only to understand relative risk. Over the long term, Humboldt County will collect additional data to assist in estimating potential losses associated with other hazards.

7. DAM FAILURE

7.1 GENERAL BACKGROUND

7.1.1 Definition and Classification of Dams

A dam is an artificial barrier that has the ability to store water, wastewater, or liquid-borne materials for many reasons—flood control, human water supply, irrigation, livestock water supply, energy generation, containment of mine tailings, recreation, or pollution control. Many dams fulfill a combination of these functions. They are an important resource in the United States (ASDSO, 2013). In California, dams are regulated by the State of California Division of Safety of Dams. Additional regulatory oversight of dams is cited in Chapter 5 and described in Appendix B.

The California Water Code (Division 3) defines a dam as any artificial barrier, together with appurtenant works, that does or may impound or divert water, and that either:

- 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
- Has an impounding capacity of 50 acre-feet or more.

Dams can be classified according to their purpose, the construction material or methods used, their slope or cross-section, the way they resist the force of the water pressure, or the means used for controlling seepage. Materials used to construct dams include earth, rock, tailings from mining or milling, concrete, masonry, steel, timber, plastic, rubber, and combinations of these.

7.1.2 Causes of Dam Failure

Dam failures in the United States typically occur in one of four ways:

- 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 are secondary results of other disasters. The prominent causes are earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage (ASDSO, 2016).

7.1.3 Planning Requirements

All dams whose inundation areas may impact the planning area have emergency action plans (EAPs) on file. The State of California updated its requirements regarding EAPs via Senate Bill 92, which became effective in June 2017. High-hazard dam owners must submit EAPs to Cal OES for approval by January 1, 2019. The EAPs must include the following (California Government Code Section 8589.5; Cal OES, 2018):

- Emergency notification flow charts
- Information on a four-step response process
- Description of agencies' roles and actions in response to an emergency incident
- Description of actions to be taken in advance of an emergency
- Inundation maps
- Additional information such as revision records and distribution lists.

After approval by Cal OES, dam owners must send the approved EAP to relevant stakeholders. Local public agencies may then adopt emergency procedures that incorporate the information in the EAP in a manner that conforms to local needs and includes methods and procedures for alerting and warning the public and other response and preparedness related items (State of California, 2018). These updates to emergency procedures have been made in Humboldt County.

Dams that fall under the jurisdiction of the Federal Energy Regulatory Commission (FERC) also have specified planning requirements. FERC has the largest dam safety program in the United States. It cooperates with a large number of federal and state agencies to ensure and promote dam safety and, more recently, homeland security. FERC requires licensees to prepare emergency action plans and conducts training sessions on how to develop and test these plans. The plans are designed to serve as an early warning system if there is a potential for, or a sudden release of water from, a dam failure or accident to the dam. The plans include operational procedures that may be used, such as reducing reservoir levels and reducing downstream flows and procedures for notifying affected residents and agencies responsible for emergency management. These plans are frequently updated and tested to ensure that in emergency situations everyone knows what to do, thus saving lives and minimizing property damage.

7.1.4 Dam Removal

The largest dam removal project in U.S. history is set to begin in 2020 on the Klamath River in Siskiyou County. The Klamath River Renewal Corporation plans to begin site work during the performance period of this plan, to remove four dams on the Klamath River. Dam deconstruction will begin in 2021, according to the *Definite Plan for the Lower Klamath Project*. Under the proposal submitted to FERC, the corporation plans to remove four dams: J.C. Boyle, Copco No. 1, Copco No. 2 and Iron Gate. Three are in Siskiyou County and one, the J.C. Boyle Dam, is in Southern Oregon. The scope and scale of this project when completed will impact the Humboldt County planning area within the Klamath River watershed.

The Definite Plan describes the proposed project as "full removal." Full removal involves the complete removal of dams, power generation facilities, water intake structures, canals, pipelines, and ancillary buildings, of the Lower Klamath Project. The Definite Plan also describes a "partial removal" alternative for purposes of environmental review. Under the partial removal alternative, portions of each dam could remain in place, along with ancillary buildings and structures such as powerhouses, foundations, tunnels, and pipes, while still achieving the project purpose to achieve a free-flowing condition and volitional fish passage.

According to the corporation, removing the dams will improve water quality, revive fisheries in the river, create local jobs, and boost tourism and recreation. The dam removal will cost just under $400 million.

7.2 HAZARD PROFILE

7.2.1 Past Events

No known failures have occurred on dams that impact Humboldt County. However, according to the 2013 *State of California Multi-Hazard Mitigation Plan*, there have been nine failures of federally regulated dams elsewhere in the state since 1950. Overtopping caused two of the nine dam failures in the state, and the others were caused by seepage or leaks. The most catastrophic event was the failure of the St. Francis Dam in Los Angeles County, which failed in 1928 and killed an estimated 450 people.

The state's most recent dam emergency occurred in February 2017 when the Oroville Dam in Butte County was on the verge of overflow. The dam's concrete spillway was damaged by erosion and a massive hole developed. The auxiliary spillway was used to prevent overtopping of the dam, and it experienced erosion problems also. Evacuation orders were issued in advance of a potential large uncontrolled release of water from Lake Oroville, but such a release did not occur. After this incident, state officials ordered that flood-control spillways be re-inspected on 93 California dams with potential geologic, structural or performance issues that could jeopardize their ability to safely pass a flood event. The dams to be re-inspected include the Iron Gate Dam, whose failure would impact Humboldt County (California Division of Safety of Dams, 2018). At the time of this plan update, the status of this re-inspection is unknown; however, many dam owners responded to the order immediately.

7.2.2 Location

According to California's Division of Safety of Dams, there are 15 dams within the planning area or with inundation areas that extend into the planning area, as listed in Table 7-1. Three are owned by the U.S. Bureau of Reclamation, and the remainder are under the jurisdiction of the state.

Dams on the Klamath, Trinity, Mad, and Eel Rivers pose the major threats to people or property in Humboldt County because they hold the most water and would inundate the widest area. The Scotia Log Pond, which impounds up to 210 acre-feet of water on a tributary to the Eel River, poses the most immediate threat to life. A total failure of this dam would inundate some or all of the 49 homes immediately downstream within 60 feet to 400 feet of the dam. At this proximity, inundation would occur without warning.

The total potential dam failure inundation area is 22,769 acres for the Klamath/Trinity Rivers, 8,074 acres for the Mad River, and 16,673 acres for the Eel River. Combined, this accounts for just over 2 percent of the total area of Humboldt County. However, streamside and riverfront properties are often more heavily populated and more highly valued than other areas. Therefore, the potential impact of dam failures on human life and property in the County is considerable. In addition, there could be a significant cultural impact on Tribal lands in dam failure inundation areas.

7.2.3 Frequency

Dam failure events are infrequent and usually coincide with or follow events such as earthquakes, landslides and excessive rainfall and snowmelt. Although the recent Oroville event raised public concern about dam failure, the probability of such failures remains low in today's regulatory environment. No recorded failures have occurred on dams that impact the planning area, so no estimate of frequency or probability of future occurrence can be developed based on the historical record.

Table 7-1. Dams in the Planning Area or with Inundation Areas that Extend into the Planning Area

Name	County	Water Course	Owner	Year Built	Crest Elevation (feet)	Dam Type	Crest Length (feet)	Height (feet)	Storage Capacity (acre-feet)	Use[a]
Trinity	Trinity	Trinity River	U.S. Bureau of Reclamation	1962	2,395.0	Earth	2,450	458	2,447,650	MULTI, IRR, REC, POW
Link River Diversion Dam	Klamath, Oregon	Klamath/ Link River	U.S. Bureau of Reclamation	1928	4,145.0		435	22	735,000	DIV
Copco No. 1	Siskiyou	Klamath River	PacifiCorp	1922	2,613.0	Gravity	415	132	77,000	STO, DIV, POW
Scott	Lake	Eel River	Pacific Gas and Electric	1921	1924.6	Gravity	815	138	73,000	STO, POW
Robert W Matthews	Trinity	Mad River	Humboldt Bay Municipal Water District	1962	2,686.0	Earth	630	150	61,000	STO, POW, MUN, REC
Iron Gate	Siskiyou	Klamath River	PacifiCorp	1962	2,343.0	Earth and Rock	745	188	58,000	STO, REG, POW
Lewiston	Trinity		U.S. Bureau of Reclamation	1963	1,910.0	Earth	745	73	14,660	MULTI
JC Boyle	Klamath, Oregon	Klamath River	PacifiCorp	1958	3,800.0	Earth	693	68	3,495	POW,
Benbow	Humboldt	S. Fork Eel River	CA Dept. of Parks and Recreation	1932	374.0	Slab and Buttress	283	16	1,060	STO, REC
Big Lagoon	Humboldt	Big Lagoon	Green Diamond Resource Company	1947	17.2	Earth	3,700	16	780	STO, IND
Van Arsdale	Mendocino	South Eel River	Pacific Gas and Electric	1907	1,519.0	Gravity	515	96	700	STO, DIV, POW
Scotia Log Pond	Humboldt	Tributary Eel River	Humboldt Redwood Company	1910	135.0	Earth	3,700	24	210	STO, IND
Jones Ranch	Trinity	Tributary Trinity River	Eleanor Jones	1980	1,905.5	Earth	350	36	58	STO, REC
Copco No. 2	Siskiyou	Klamath River	PacifiCorp	1925	2,484.0	Gravity	148	37	55	DIV, POW
Arcata	Humboldt	Jolly Giant Creek	City Of Arcata	1937	455.0	Earth	160	50	46	STO, DOM, MUN

a. Use codes: DIV = Diversion; DOM = Domestic; IND = Industrial; IRR = Irrigation; MULTI = Multi-purpose; MUN = Municipal; POW = Power Generation; REC = Recreation; REG = Regulation; STO = Storage

Source: U.S. Army Corps of Engineers, National Inventory of Dams, 2018

All dams face a "residual risk" of failure, which represents the risk that conditions may exceed those for which the dam was designed. For example, dams may be designed to withstand a probable maximum precipitation, defined as "theoretically, the greatest depth of precipitation for a given duration that is physically possible over a given storm area at a particular geographical location at a certain time of the year" (Taylor, 2006). The chance of occurrence of a precipitation event of a greater magnitude than that represents residual risk for such dams. This in turn represents a theoretical probability of future occurrence for a dam failure event, though the probability of an event exceeding the assumed maximum is not generally calculated as part of dam design.

7.2.4 Severity

Dam failure can be catastrophic to all life and property downstream. California's Division of Safety of Dams has developed a hazard potential classification system for state-jurisdiction dams, as shown on Table 7-2. This system is modified from federal guidelines, which recommend three-tier classification.

Table 7-2. State of California Downstream Hazard Potential Classification

Hazard Category	Direct Loss of Life	Economic, Environmental, and Lifeline Losses
Low	None expected	Low and principally limited to dam owner's property
Significant	None expected	Yes
High	Probable (one or more expected)	Yes, but not necessary for this classification
Extremely High	Considerable	Yes, major impacts to critical infrastructure or property

Source: California Division of Safety of Dams, 2017a

The California system adds a fourth hazard classification of "extremely high." Dams classified as extremely high hazard may impact highly populated areas or critical infrastructure or have short evacuation warning times (California Division of Safety of Dams, 2017). All dams listed in Table 7-1 are classified as high hazard in this system.

7.2.5 Warning Time

Advance Warning of Failure

Warning time for dam failure varies depending on the cause of the failure. Events of extreme precipitation or massive snowmelt can be predicted in advance, so evacuations can be planned with sufficient time. In the event of a structural failure due to earthquake, there may be no or limited warning time. The USGS Earthquake Hazards Program has several dam-safety related earthquake programs, including dam-specific earthquake monitoring programs in California to help monitor safety concerns following seismic events.

Time for Failure to Occur

The process of the dam failure affects warning time. Earthen dams do not tend to fail completely or instantaneously. Once a breach is initiated, discharging water erodes the breach until either the reservoir water is depleted or the breach resists further erosion. Concrete gravity dams also tend to have a partial breach as one or more monolith sections are forced apart by escaping water. The time of breach formation ranges from a few minutes to a few hours.

Time After Failure Before Downstream Areas Are Affected

The leading edge of a total breach at Matthews Dam would reach Humboldt in approximately 3 hours. The arrival time would be about 6 hours on the Eel River and 7 hours on the Trinity River. The number of people to be alerted and evacuated can vary widely. There may be few people along the river in winter, when only permanent residents are apt to be present; but there may be many people in summer, when seasonal cabins are occupied and there are fishermen and campers along all the rivers.

Another factor that must be considered is the initial flow in the river when the failure occurs. The initial flow is normally very low on all the rivers from May through October. During the winter, the initial flow is much higher and at times may even be equal to or greater than flood stage. This wide variation in initial flow has a significant impact on the areas that must be evacuated.

7.3 SECONDARY HAZARDS

Dam failure can cause secondary hazards of landslides, bank erosion, and destruction of downstream habitat.

7.4 EXPOSURE

A quantitative assessment of exposure to the dam failure hazard was conducted using inundation mapping and the asset inventory developed for this plan (see Section 6.3). Detailed results are provided in Appendix C and summarized below.

7.4.1 Population

The population within the inundation areas of the Klamath, Trinity, Mad, and Eel Rivers is 12,872, or 9.5 percent of the total County population. Figure 7-1 summarizes the at-risk population in the planning area by river system.

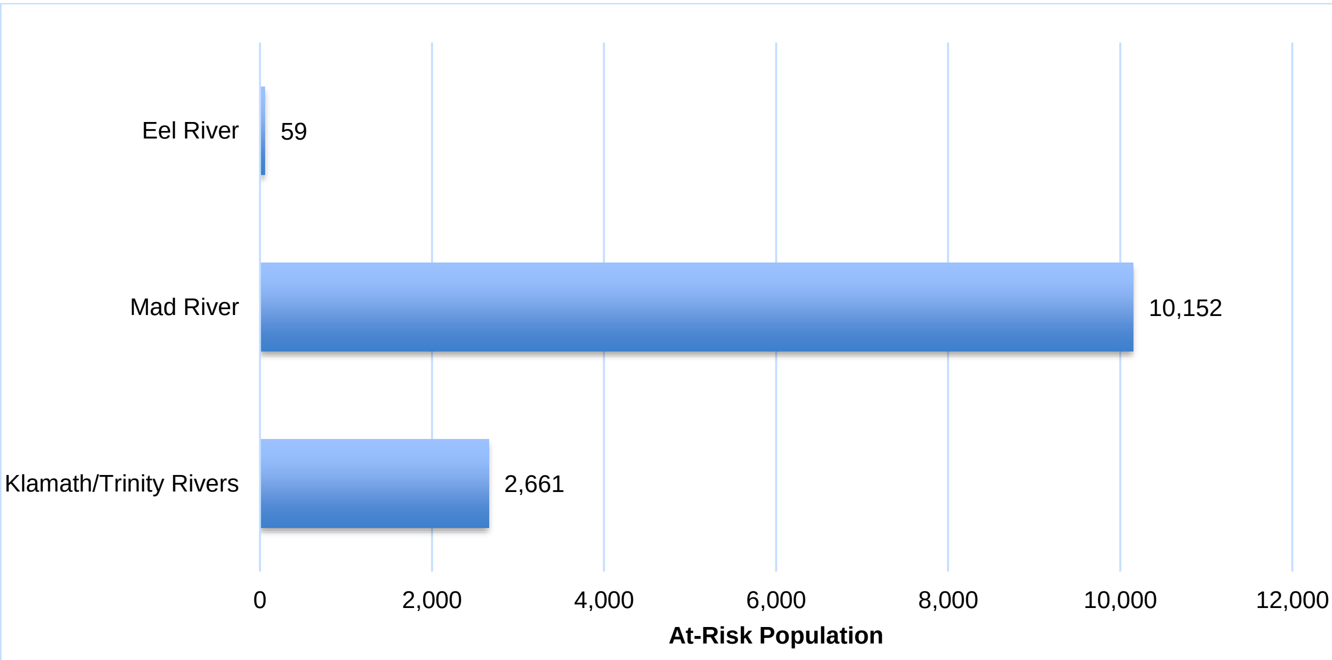


Figure 7-1. Population Within Dam Failure Inundation Areas

7.4.2 Property

Based on assessor parcel data, the Hazus model estimated that there are 4,386 structures, 8.6 percent of the County total within the mapped dam failure inundation areas modeled in the planning area. The value of exposed buildings in the planning area was generated using Hazus and is summarized in Table 7-3. This methodology estimated $4.4 billion worth of building-and-contents exposure to dam failure inundation, representing 12.6 percent of the total replacement value of the planning area.

Table 7-3. Exposure and Value of Structures in Dam Failure Inundation Areas

	Buildings Exposed		Value	
River System	Number	% of County Total	Exposed	% of County Total Replacement Value
Klamath/Trinity	1,300	2.6%	$ 939,727,732	2.7%
Mad	3,057	6%	$3,465,884,494	9.8%
Eel	29	0.06%	$38,513,469	0.1%
Total	**4,386**	**8.67%**	**$4,444,125,695**	**12.60%**

GIS analysis was used to determine the land use types of parcels within the mapped inundation areas. The estimated 9,765 parcels that face the possibility of inundation in the event of dam failure range from just downstream of the dams to coastal riverfront areas. Nearly half of the exposed parcels are zoned residential: about 30 percent occupied rural residential and 16 percent unoccupied rural residential. Figure 7-2 shows the distribution of general land use types in the dam inundation areas.

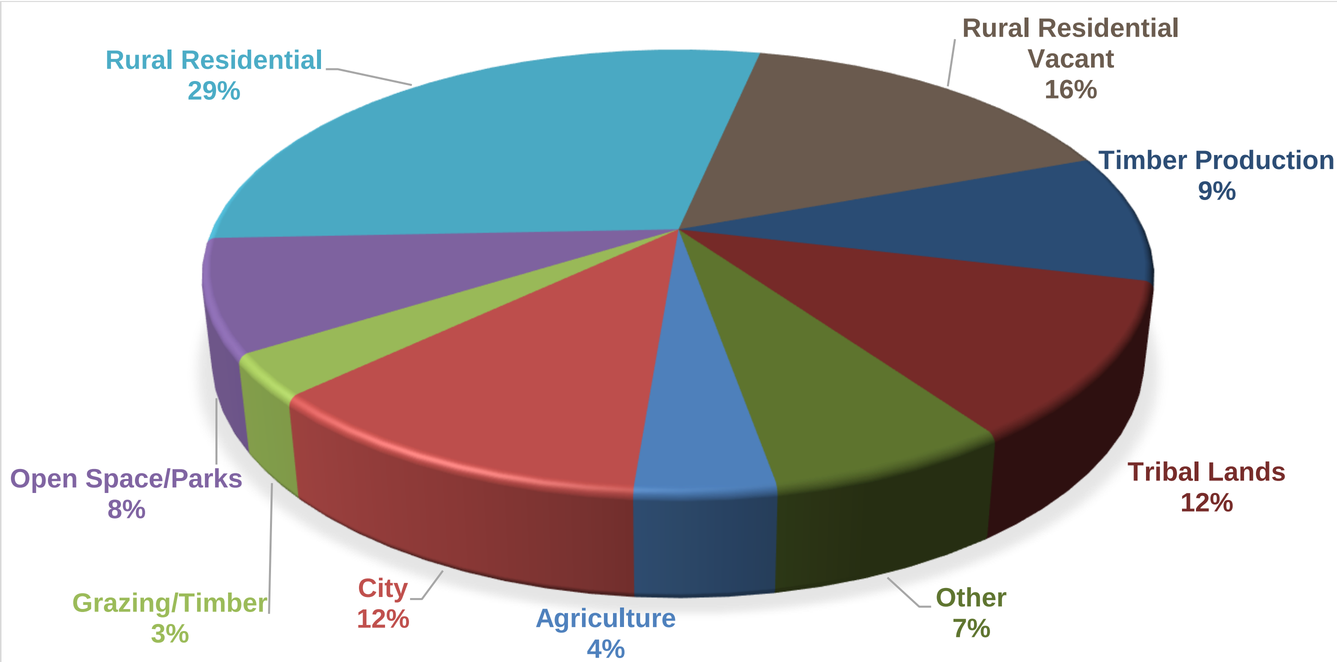


Figure 7-2. Land Use Types in Dam Inundation Areas

7.4.3 Critical Facilities

Figure 7-3 shows critical facilities located in the dam inundation zone by facility type and river system. The total count of critical facilities and infrastructure in the dam failure inundation zone (213) represents 20 percent of the planning area total of 1,092.

7.4.4 Environment

All natural features and wildlife in the dam inundation zone are at risk from the dam failure hazard. The dam inundation zone may include critical habitat for two endangered species: the marbled murrelet and the northern spotted owl (U.S. Fish and Wildlife Service, 2018).

7.5 VULNERABILITY

7.5.1 Population

Vulnerable populations are all populations downstream from dam failures that are incapable of escaping the area before floodwaters arrive. 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, radio emergency warning system, siren, or cell phone alert.

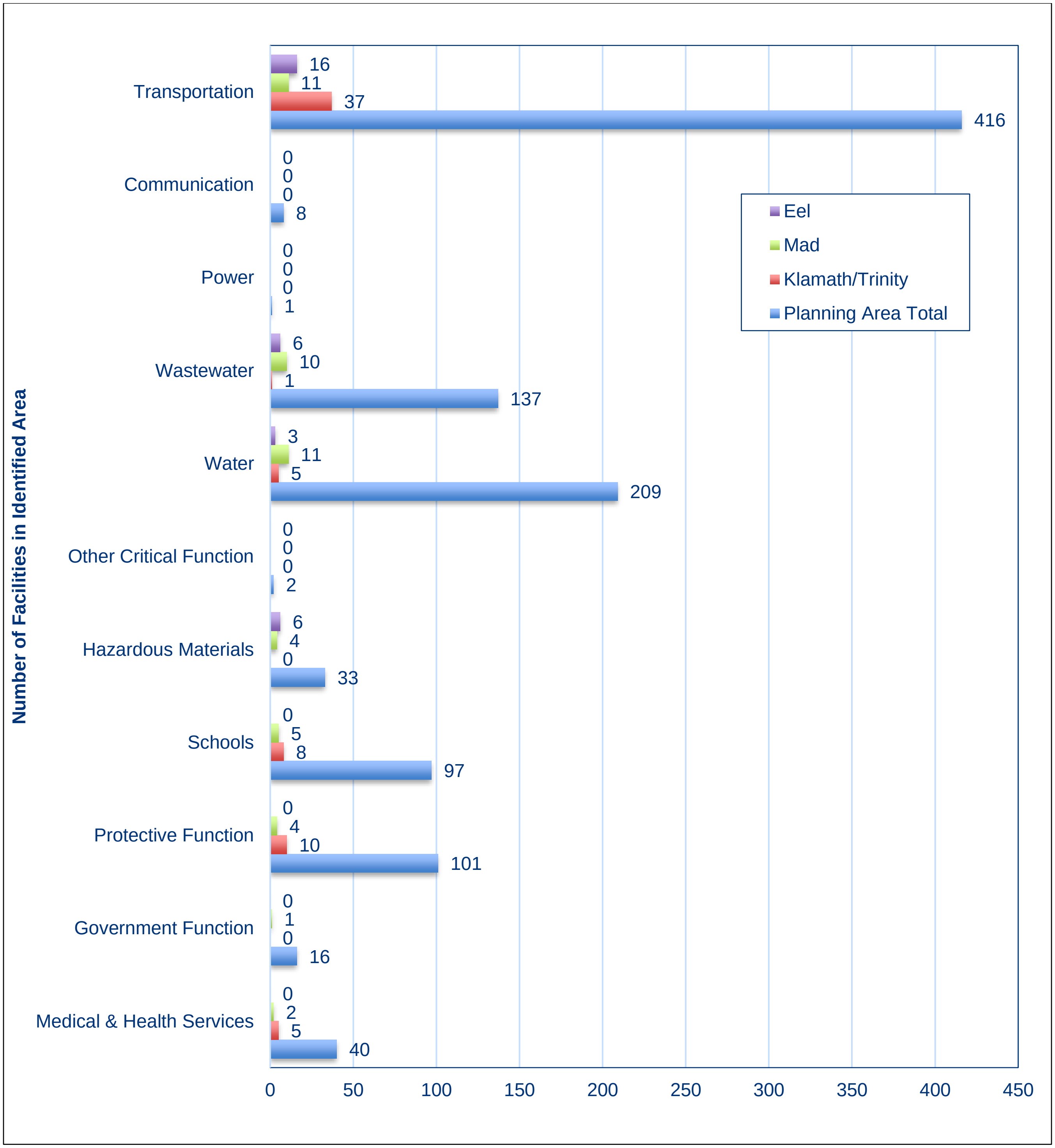


Figure 7-3. Critical Facilities and Infrastructure in Dam Failure Inundation Zones and Countywide

7.5.2 Property

Vulnerable properties are those closest to the dam inundation zone. 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. Properties in the dam inundation zone that are built to National Flood Insurance Program (NFIP) minimum construction standards may have some level of protection against dam inundation, depending on the velocity and elevation of the inundation waters. These properties also are more likely to have flood insurance.

The total loss estimated by Hazus due to property damage in the combined dam failure inundation area is $1.45 billion. This represents 32.8 percent of the total structure exposure in the inundation area, and 4.2 percent of the estimated replacement value of the entire planning area. Table 7-4 summarizes the loss estimates for dam failure.

Table 7-4. Loss Estimates for Dam Failure

Jurisdiction	Estimated Loss Associated with Dam Failure			Estimated Loss as % of Total Planning Area Replacement Value
	Structure	Contents	Total	
Klamath/Trinity	$518,790,346	$420,937,386	$939,727,732	2.7%
Mad	$245,746,634	$268,174,273	$513,920,907	1.5%
Eel	$2,819,361	$2,315,675	$5,135,036	0.01%
Total	**$767,356,341.00**	**$691,427,334.00**	**$1,458,783,675.00**	4.21%

7.5.3 Critical Facilities

Transportation routes are vulnerable to dam inundation and have the potential to be wiped out, creating isolation issues and significant disruption to travel along the Pacific coast, including all roads 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 in the inundation zone could also be vulnerable. If phone lines were lost, significant communication issues may occur in the planning area due to limited cell phone reception in many areas. In addition, emergency response would be hindered due to the loss of transportation routes as well as some protective-function facilities located in the inundation zone. Recovery time to restore many critical functions after an event may be lengthy, as wastewater, potable water, and other community facilities are located in the dam inundation zone.

A failure of Matthews Dam would have a significant impact on Humboldt County critical infrastructure, as this system provides drinking water to residents in the most populated areas of the county, distributed to CSDs in the Humboldt Bay area by Humboldt Bay Municipal Water District.

Hazus was used to estimate the loss potential to critical facilities identified as exposed to dam failure inundation. Using depth/damage function curves to estimate the percent of damage to the building and the building contents, Hazus correlates these estimates to an estimate of functional downtime (the estimated time it will take to restore a facility to 100 percent of its functionality):

- On average, critical facilities would receive 2.3 percent damage to the structure and 42.9 percent damage to the contents during a dam failure event.
- The estimated average time to restore damaged facilities to full functionality is 534 days.

7.5.4 Environment

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

7.6 FUTURE TRENDS IN DEVELOPMENT

Land use in the planning area will be directed by general plans adopted under state 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 stand-alone hazard in the safety elements, but flooding is. Municipalities participating in this plan 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. However, there are structures on the perimeter of the dam failure inundation outside of the regulated floodplain that were not subject to floodplain management codes and standards. These structures would be considered to be more vulnerable than those constructed with floodplain codes and standards. 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.

7.7 SCENARIO

In a worst-case scenario, an earthquake could lead to liquefaction of the ground soils where the dams that impact the planning area are located, causing the dams to fail. This could occur without warning in the middle of the night when residents and campers along the river are asleep and unprepared to evacuate. A human-caused failure such as a terrorist attack also could trigger a catastrophic failure of one of the dams.

7.8 ISSUES

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

- Inundation mapping in a digital format was not available for all high-hazard dams within the planning area to support the risk assessment.
- There may be dams located in the planning area that do not meet regulatory thresholds for jurisdiction under State of California or federal programs.
- Dam infrastructure may require repair and improvement to withstand climate change impacts, such as changing in the timing and intensity of rain events.
- It is unknown if any issues were identified for the spillway of the Iron Gate dam as a result of inspection orders issued after the Oroville Dam event in 2017.
- A significant number of the structures located in the dam inundation zone are located outside of special flood hazard areas, meaning that they are not constructed to withstand floodwaters and are less likely to be covered by flood insurance. Even structures that have been designed with flood hazards in mind may not be able to withstand the height and velocity of flow from a dam failure event.
- California law requires that a property’s location in a dam inundation be disclosed to a seller if the seller or the seller’s agent has knowledge of the property’s location within the hazard area or if the local jurisdiction has compiled a list of parcels that are in the inundation area and has posted at the offices of the county recorder, county assessor, and county planning agency a notice that identifies the location of the list. It is unknown if this list has been compiled for the planning area.
- In the event of a dam failure that interrupted land line phone service, significant issues with communication could occur.
- 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.
- Federally regulated dams have an adequate level of oversight and sophistication in the development of emergency action plans for public notification in the unlikely event of failure. However, the protocol for notification of downstream citizens of imminent failure needs to be tied to local emergency response planning.
- Mapping for federally regulated dams is already required and available; however, mapping for non-federal-regulated dams that estimates inundation depths is needed to better assess the risk associated with dam failure from these facilities.

8. DROUGHT

8.1 GENERAL BACKGROUND

Drought is a significant decrease in water supply relative to what is typical in a given location. It is a normal phase in the climate cycle of most regions, originating from a deficiency of precipitation over an extended period of time, usually a season or more. This leads to a water shortage for some activity, group or environmental sector.

Droughts are climatic patterns that occur over long periods of time as the result of many causes. Global weather patterns that produce persistent, upper-level high-pressure systems along the West Coast result in warm, dry air and reduced precipitation. Anomalies of precipitation and temperature may last from several months to several decades. How long they last depend on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of global weather systems.

Humboldt County was impacted by a statewide drought in recent years and maintained a Local Emergency Proclamation and a Drought Task Force from 2014 to 2016. Impacts included dry residential wells, wildlife habitats endangered by dry creeks and streams and high-water temperatures, compromised river intake and infiltration infrastructure for drinking water systems, proliferation of harmful algae, and increased wildfire risk.

8.1.1 Monitoring and Categorizing Drought

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 to quantify impacts on agriculture.
- The ***Palmer Z Index*** measures short-term drought on a monthly scale.
- The ***Palmer Drought Index*** measures the duration and intensity of long-term weather patterns. The intensity of drought in a given month is dependent on current weather plus the cumulative patterns of previous months. Weather patterns can change quickly, and the Palmer Drought Severity Index can respond fairly rapidly.
- The ***Palmer Hydrological Drought Index*** quantifies hydrological effects (reservoir levels, groundwater levels, etc.), which take longer to develop and last longer. This index responds more slowly to changing conditions than the Palmer Drought Index.
- The ***Standardized Precipitation Index*** considers only precipitation. In the Standardized Precipitation Index, an index of zero indicates the median precipitation amount; the index is negative for drought and positive for wet conditions. The Standardized Precipitation Index is computed for time scales ranging from one month to 24 months.

Maps of these indices show drought conditions nationwide at a given point in time. They are not necessarily indicators of any given area’s long-term susceptibility to drought. The most current versions of the maps at the time of this plan’s preparation are shown on Figure 8-1 through Figure 8-5.

Source: National Weather Service,, 2019

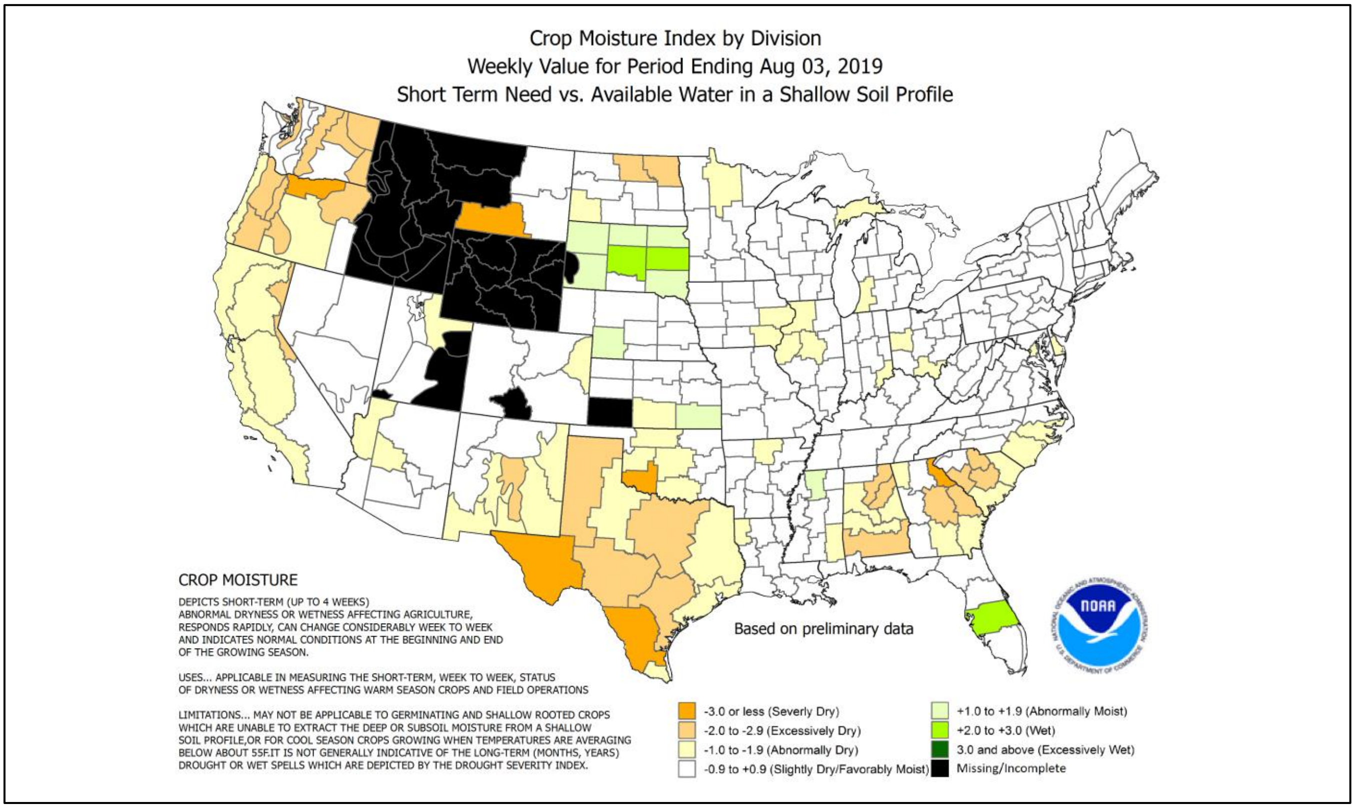


Figure 8-1. Palmer Crop Moisture Index (Week Ending August 3, 2019)

Source: National Centers for Environmental Information, 2019

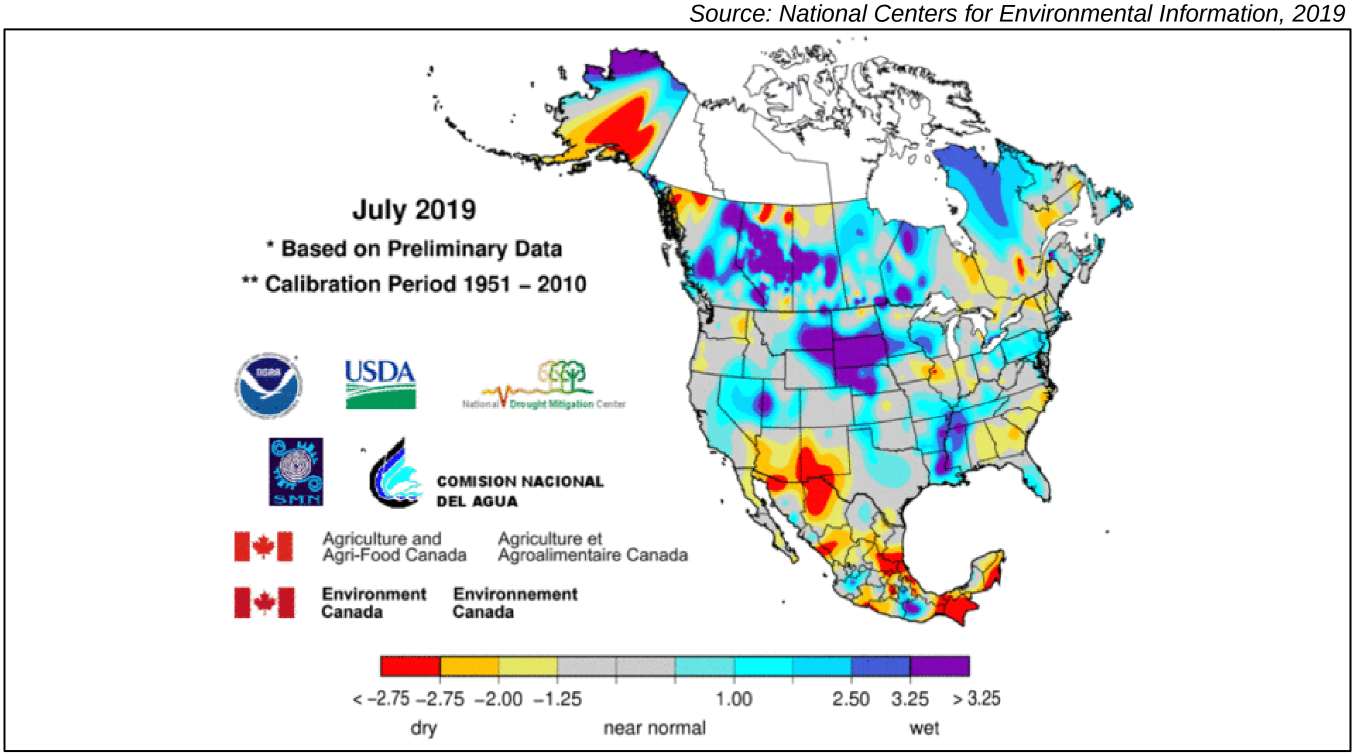


Figure 8-2. Palmer Z Index Short-Term Drought Conditions (July 2019)

Source: National Centers for Environmental Information, 2019

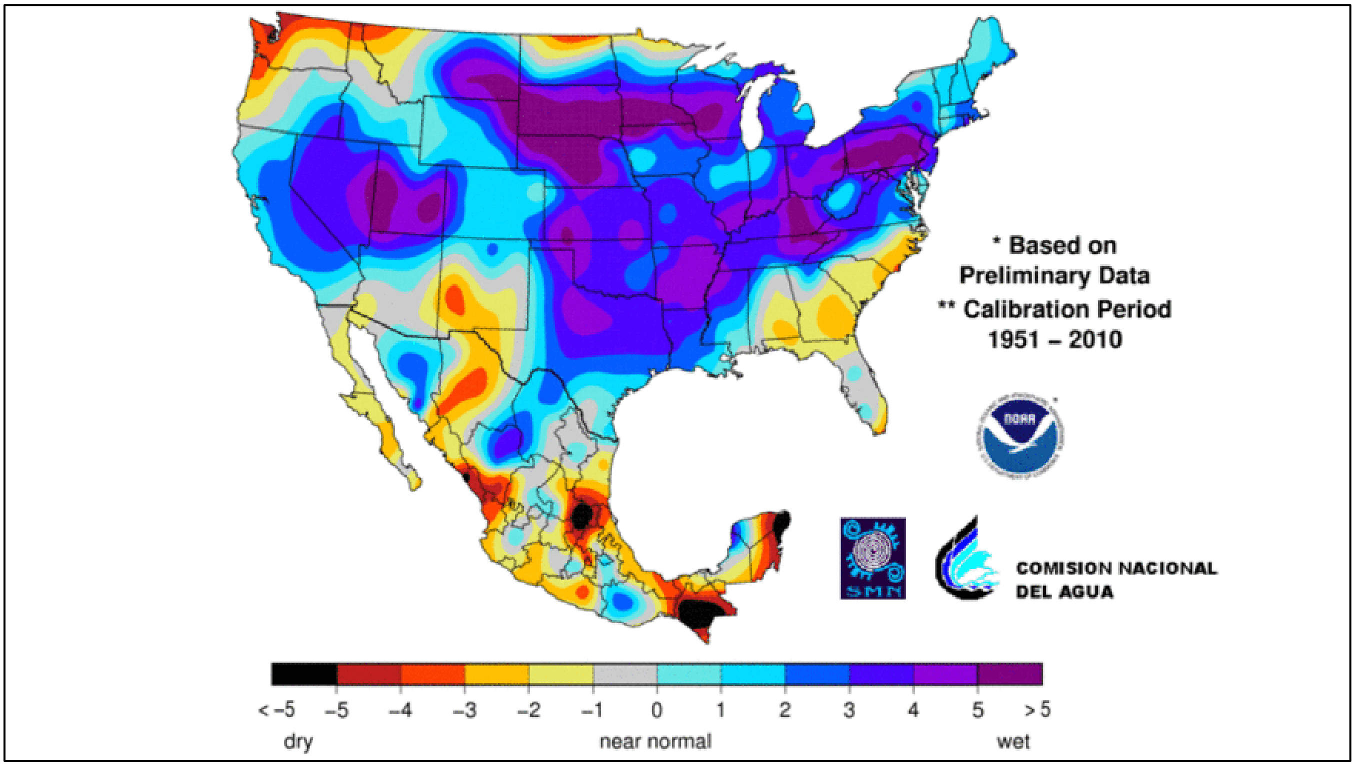


Figure 8-3. Palmer Drought Index (July 2019)

Source: National Centers for Environmental Information, 2019

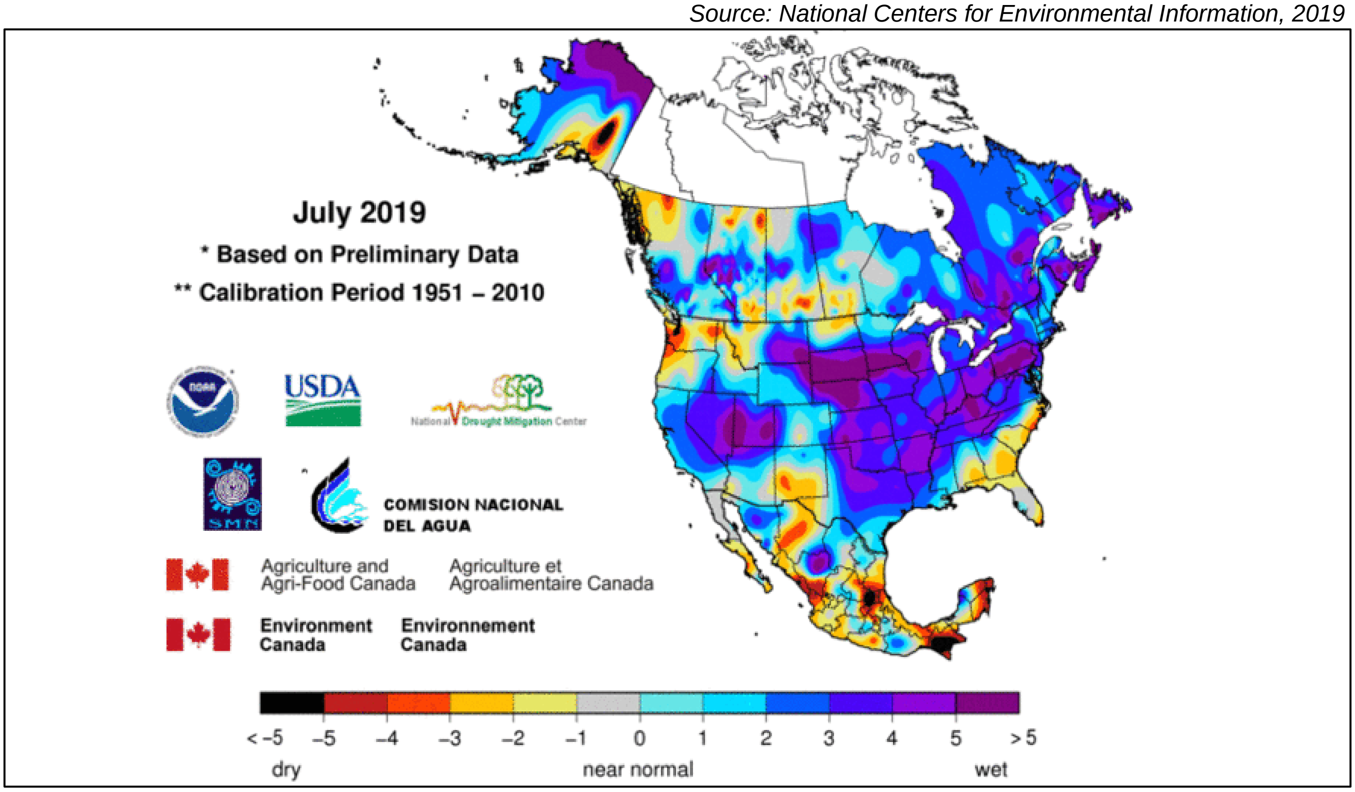


Figure 8-4. Palmer Hydrological Drought Index (July 2019)

Source: National Centers for Environmental Information, 2019

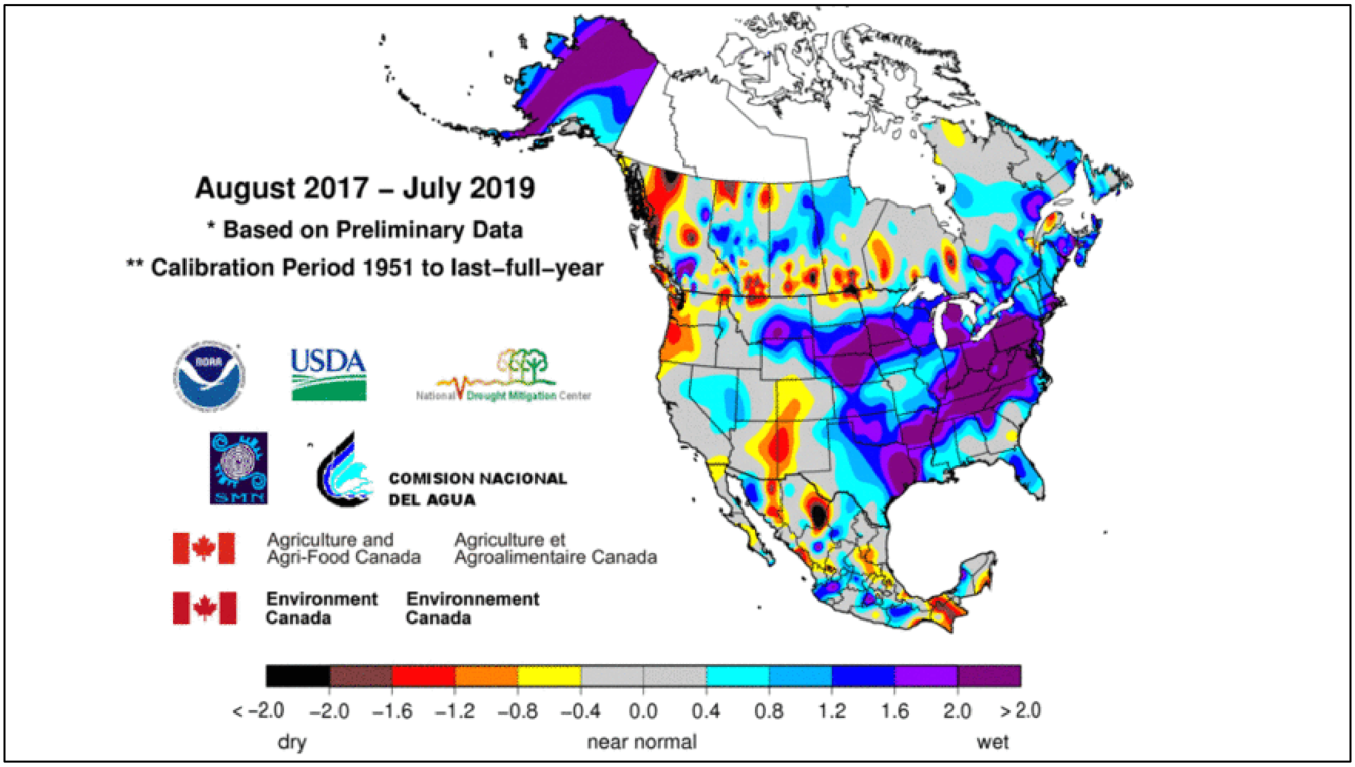


Figure 8-5. 24-Month Standardized Precipitation Index Ending July 2019

The U.S. Drought Monitor categorizes droughts by impact type and intensity. Impact type indicates whether a drought in a given area is short-term or long-term. Short-term is generally less than six months and impacts are expected on agriculture and grasslands. Long-term drought is typically longer than 6 months and impacts are seen on hydrology and ecology in the area impacted. The intensity of a drought is categorized on a scale of 0 to 4, where 0 is abnormally dry and 4 is exceptional drought.

8.1.2 Local Water Supply

Although Humboldt County has abundant water resources as groundwater and surface water supplied by high levels of rainfall with several major rivers, the County faces water-related challenges that impact water supply and demand, cultural values, and economic, social and environmental conditions. California's North Coast region contributes 26 percent of California's water supply (Guivetchi, 2001). The largest portions of the Klamath and Eel Rivers, California's second and third largest rivers, flow through Humboldt County. Both have major diversion projects outside the county, and have economic, social, cultural and ecological impacts affecting the state as a whole.

Humboldt County has large rural, agricultural, timber, cultural, sand and gravel extraction, and fisheries interests that all rely on the abundant water supply. Humboldt County's urban area is concentrated around Humboldt Bay. Lack of sufficient water supply would affect not only residents and businesses that rely on water for their daily household, employee, and industrial needs, but also an economy and culture that rely on the replenishment of rivers, creeks, and groundwater to grow trees and grass/grain for livestock and to support healthy fish populations.

According the County's General Plan, the major purveyor of domestic and industrial water in Humboldt County is the Humboldt Bay Municipal Water District. This district supplies water to the cities of Eureka, Arcata and Blue Lake, and to the community of Fairhaven and various special districts in the Humboldt Bay area. The County's inland and southern special districts, with few exceptions, have sufficient water supply to meet present needs. The districts in Willow Creek, Jacoby Creek, Hydesville, Miranda, Redway, Orick, Alderpoint, and Orleans appear to have adequate water supply and capacity. Water supply or capacity is questionable in Weott and Shelter Cove.

Surface Water Supply

Surface water in Humboldt County varies with the time of year and the amount of rainfall. Insufficient summer flows are experienced in many areas of the county due to the hot dry conditions typically seen in the County just 5 miles inland of the coastal fog belt and because of the seasonal disparity of rainfall and flow conditions. The hydraulic basins in Humboldt County provide very large surface water volumes. Mean annual runoff in Humboldt County from the major rivers and streams is approximately 23 million acre-feet. In comparison, total groundwater yield of the entire County is approximately 100,000 acre-feet. The largest drainage area of the County is that of the Eel River and its tributaries. The contributory surface area is over 763,000 acres, more than a third of the surface area of the County.

The total average annual runoff of the rivers running through the County reflects almost 30 percent of the total runoff of the State of California, but there is an extreme variation in river flows. The Mattole River has a maximum recorded winter discharge in excess of 90,000 cubic feet per second and a minimum summer flow of under 20 cubic feet per second, highlighting the seasonal extremes. The majority of water usage in the County is needed during the lowest flow regimes, further reinforcing the need for drought preparedness and planning. Insufficient summer flows could create problems in the future. The flows of all of the rivers in the County except the Trinity and Klamath Rivers are directly related to rainfall in the County, and over 80 percent of the flows of these streams occur from November through March.

Over 70 percent of the Trinity River is dammed and diverted for Central Valley agricultural projects. Flows from the Klamath River are also diverted for agricultural uses. Significant percentages of the Eel River are diverted to the three moderately drought-stricken and rapidly developing counties to the south (Mendocino, Sonoma, Marin) serving over 350,000 people plus agricultural interest.

The drinking water for most of the Humboldt Bay area is supplied by Ranney Collectors located within the Mad River; other coastal streams provide drinking water for other communities. The Mad River is continuously supplied with water via releases from the Ruth Reservoir (with 48,030-acre-foot storage capacity), although these supplies are dependent on adequate precipitation and flows through the season.

Groundwater Supply

Humboldt County has four principle groundwater basins in the North Coast Hydrologic Area: Hoopa Valley, Mad River Valley, Eureka Plain, and Eel River Valley. All but the Hoopa Valley are a part of the Coastal Basins. Groundwater development in the rural area of Humboldt County has generally been directed to individual domestic requirements or to the irrigation demands of the more extensively farmed areas of the Eel River delta and Mad River delta areas. The prime source of groundwater, by quantity, is in the Eel River and Van Duzen delta. Though the storage capacity is about 136,000 acre-feet, the usable yield of this groundwater storage is estimated to be 40,000 to 60,000 acre-feet annually. A little more than 10,000 acre-feet of groundwater is currently being pumped from the basin for agricultural uses (Winzler and Kelly, 1970). The Mad River basin has been reported to have a yield of about 45,000 acre-feet annually (Baruth and Yoder, 1971). Other groundwater basin areas include Hoopa Valley, Prairie Creek, Big Lagoon, Mattole River Valley, Honeydew, Pepperwood, Weott, Garberville, Larabee Valley and Dinsmore.

More wells are being drilled each year to serve new development, yet little is known about the location or capacity of the groundwater aquifers. Better estimates of groundwater availability is needed so that development will not surpass the capacity and for planning and modeling of potential drought conditions.

8.1.3 California Drought Response

During critically dry years, the California State Water Resources Control Board can mandate conservation by water users and agencies to address statewide water shortages. Table 8-1 lists State Drought Management Program stages mandated to water right holders.

Table 8-1. State Drought Management Program

Drought Stage	State Mandated Customer Demand Reduction	Rate Impacts
Stage 0 or 1	<10%	Normal rates
Stage 2	10 to 15%	Normal rates; Drought surcharge
Stage 3	15 to 20%	Normal rates; Drought surcharge
Stage 4	>20%	Normal rates, Drought surcharge

8.2 HAZARD PROFILE

8.2.1 Past Events

Periods of Drought in California

California Department of Water Resources hydrologic data from the early 1900s shows multi-year droughts from 1912 to 1913, 1918 to 1920, 1922 to 1924, and 1928 to 1934 (CA DWR, 2017). Subsequent prolonged droughts in California have all impacted the planning area to some degree:

- **2012 to 2017 Drought**—California's last drought set several records for the state. The period from 2012 to 2014 ranked as the driest three consecutive years for statewide precipitation. Calendar year 2014 set new records for statewide average temperatures and for record-low water allocations from the State Water Project and the federal Central Valley Project. Calendar year 2013 set minimum annual precipitation records for many communities. Detailed executive orders and regulations addressed water conservation and management. The statewide drought emergency was lifted in April 2017.
- **2007 to 2009 Drought**—The state proclaimed a statewide drought emergency on June 4, 2008 after spring 2008 was the driest spring on record, with low snowmelt runoff. On February 27, 2009, the state proclaimed a state of emergency for the entire state as severe drought continued. The largest court-ordered water restriction in state history (at the time) was imposed.
- **1987 to 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. In 1991, the State Water Project sharply decreased deliveries to water suppliers. By February 1991, all 58 counties in California were experiencing drought. Urban areas as well as agricultural areas were impacted.
- **1976 to 1977 Drought**—California had a severe drought due to lack of rainfall during the winters of 1976 and 1977. 1977 was the driest period on record in California at that time, with the previous winter recorded as the fourth driest in California's hydrological history at that time. The cumulative impact led to widespread water shortages and severe water conservation measures statewide. Only 37 percent of the average Sacramento Valley runoff was received. Over $2.6 billion in crop damage was recorded in 31 counties. FEMA declared a drought emergency (Declaration 3023-EM) on January 20, 1977 for 58 California counties.
- **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.

Agriculture-Related Drought Disasters

The U.S. Department of Agriculture (USDA) Farm Service Agency provides assistance for agriculture-related losses resulting from drought, flood, fire, freeze, tornadoes, pest infestation, and other natural disasters. The U.S. Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to them. Between 2012 and 2017, the period for which data is available, Humboldt County was included in drought-related USDA declarations in 2012, 2013, 2015, and 2016 (USDA Farm Services Agency, 2019).

8.2.2 Location

Drought is a regional phenomenon that has the potential to impact the entire planning area. A drought affects all aspects of the environment and the community simultaneously and has the potential to directly or indirectly impact every person in the planning area as well as adversely affect the local economy.

8.2.3 Frequency

Historical drought data for the planning area indicate there have been four significant multi-year droughts in the last 40 years (1976 to 2017), amounting to a severe drought every 10 to 11 years on average. The planning area has also been included in USDA drought disaster declarations in four of the past seven years. Drought has a high probability of occurrence in the planning area.

8.2.4 Severity

Drought can have a widespread impact on the environment and the economy, although it typically does not result in loss of life or damage to structures, as do other natural disasters. 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. Vulnerability of an activity to drought depends on its water demand and the water supplies available to meet the demand.

National Drought Mitigation Center Impact Categories

The National Drought Mitigation Center uses three categories to describe likely drought impacts:

- **Economic Impacts**—These impacts of drought cost people (or businesses) money. Farmers' crops are destroyed; low water supply necessitates spending on irrigation or drilling of new wells; water-related businesses (such as sales of boats and fishing equipment) may experience reduced revenue.
- **Environmental Impacts**—Plants and animals depend on water. When a drought occurs, their food supply can shrink, and their habitat can be damaged.
- **Social Impacts**—Social impacts include public safety, health, conflicts between people when there is not enough water to go around, and changes in lifestyle.

Drought Impact Reporter

The National Drought Mitigation Center developed the Drought Impact Reporter in response to the need for a national drought impact database for the United States. Information comes from a variety of sources: on-line, drought-related news stories and scientific publications, members of the public who visit the website and submit a drought-related impact for their region, members of the media, and staff of government agencies. The database is being populated beginning with the most recent impacts and working backward in time.

The Drought Impact Reporter indicates 92 impacts from drought that specifically affected Humboldt County from 2010 through January 2019 (Drought Impact Reporter, 2019). Most (85 percent) are based on media reports. The following are the reported numbers of impacts by category (some incidents are assigned to more than one impact category):

- Agriculture—27
- Business and Industry—6
- Energy—5
- Fire—12
- Plants and Wildlife—28
- Relief, Response, and Restrictions—49
- Society and Public Health—28
- Tourism and Recreation—7
- Water Supply and Quality—50

8.2.5 Warning Time

Predicting drought depends on the ability to forecast precipitation and temperature. Scientists at this time do not know how to predict drought more than a month in advance for most locations. 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.

Determination of when drought begins is based on impacts on water users and assessments of available water supply, including water stored in reservoirs or groundwater basins. Different water agencies have different criteria for defining drought. Some issue drought watch or drought warning announcements.

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. In addition, lack of sufficient water resources can stress trees and other vegetation, making them more vulnerable to infestation from pests, which in turn, can make them more vulnerable to ignition. Millions of board feet of timber have been lost, and in many cases erosion occurred, which caused serious damage to aquatic life, irrigation, and power production by heavy silting of streams, reservoirs, and rivers.

8.4 EXPOSURE

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

8.5 VULNERABILITY

8.5.1 Population

The entire population of Humboldt County is vulnerable to drought events. Drought can affect people's health and safety, including health problems related to low water flows, poor water quality, or dust. Droughts can also lead to loss of human life (National Drought Mitigation Center, 2018). Other possible impacts include recreational risks; effects on air quality; diminished living conditions related to energy, air quality, and hygiene; compromised food and nutrition; and increased incidence of illness and disease (Centers for Disease Control and Prevention, 2012).

8.5.2 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 have significant impacts on other types of property such as landscaped areas and economically important natural resources. Drought causes the most significant economic impacts on industries that use water or depend on water for their business, most notably agriculture and related sectors (forestry, fisheries, and waterborne activities), power plants, and oil refineries. In addition to losses in yields in crop and livestock production, drought is associated with increased insect infestations, plant diseases, and wind erosion. Drought can lead to other losses because so many sectors are affected—losses that include reduced income for farmers and reduced business for retailers and others who provide goods and services to farmers. This leads to unemployment, increased credit risk for financial institutions, capital shortfalls, and loss of tax revenue. Prices for food, energy, and other products may also increase as supplies decrease.

8.5.3 Critical Facilities

Critical facilities as defined for this plan will continue to be operational during a drought. Critical facility features such as landscaping may not be maintained due to limited water resources, but the risk to critical facility core functions is low.

8.5.4 Environment

Groundwater and Streams

Drought generally does not affect groundwater sources as quickly as surface water supplies, but 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 stream flows are lowest. Where stream flows are reduced, development that relies on surface water may seek to establish new groundwater wells, which could further increase groundwater depletion.

Other Potential Losses

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. 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. The following are potential impacts of drought:

- Wildlife habitat may be degraded through the loss of wetlands, lakes and vegetation. The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity.
- Drought conditions greatly increase the likelihood of wildfires, the major threat to timber resources.
- Water shortages and severe drought conditions would have a significant impact on Native American tribes’ way of life in fishing and farming subsistence.
- Scenic resources in Humboldt County are vulnerable to the increased likelihood of wildfires associated with droughts.

- Drying up or dying off of forests could reduce ecological and eco-tourist values.
- Any shortage of water supply can have significant economic impacts.

8.6 FUTURE TRENDS IN DEVELOPMENT

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. In addition, water providers in the planning area have plans and programs in place to balance competing needs for water resources within the planning area.

8.7 SCENARIO

A multi-year drought that impacts the entire west or the State of California, similar to the 2012 to 2017 drought, is the worst-case scenario for the planning area. The 2012-2017 drought and the wildfires and floods that followed it caused extensive damage to natural systems. If another severe drought occurs before these systems have a chance to recover, it could exacerbate the stress already placed on existing planning area water resources.

8.8 ISSUES

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

- The probability of drought frequencies and durations may increase due to climate change.
- The promotion of active water conservation even during non-drought periods should be encouraged.
- The planning area should plan for frequent droughts or multi-year droughts that can limit the ability to successfully recover from one drought and prepare for the next—particularly considering the longevity of the 2012 to 2017 drought.
- Surface water resources in the North Coast region are already overallocated and are causing stress between competing users such as agricultural uses and the ecosystem needs, particular for threatened or endangered species in the planning area.
- If tension increases over surface water, additional drawn-downs to groundwater supplies may occur.
- There are existing residences in drought-prone areas in south and east Humboldt County that normally experience water shortages.
- Drought in the county could increase and expand fire-prone areas and adversely affect the timber economy.
- Planning must address the degree of future development in drought-prone areas.
- Counties to the south and east are in a persistent drought and are, at differing levels, dependent on Humboldt County water. The future water demand for those counties if the drought intensifies is presently unknown.
- The diverse fisheries stock is dependent on abundant water availability. Any drop in fisheries productivity due to drought conditions would have immediate and long-term consequences for the economy, culture and ecological structure.
- More studies need to be done regarding overall county water usage and how it relates to the economy to prepare for a worst-case scenario drought.
- With the possibility of climate change, drought may become a larger issue due to warming trends and wider fluctuations in rainfall patterns.

- Alternative water supplies need to be identified and developed, as well as alternative strategies to allocate and distribute existing water sources.
- Groundwater recharge techniques can be used to stabilize the groundwater supply.

9. EARTHQUAKE

9.1 GENERAL BACKGROUND

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.

Geologists have found that earthquakes reoccur along faults, which are zones of weakness in the earth's crust. When a fault experiences an earthquake, there is no guarantee that all the stress has been relieved. Another earthquake can still occur. In fact, relieving stress along one part of a fault may increase it in another part.

California is seismically active because of movement of the North American Plate, east of the San Andreas Fault, and the Pacific Plate to the west, which includes the state's coastal communities. Movement of the tectonic plates against one another creates stresses that build as the rocks are gradually deformed. The rock deformation, or strain, is stored in the rocks as elastic strain energy. When the strength of the rock is exceeded, rupture occurs along a fault. The rocks on opposite sides of the fault slide past each other as they spring back into a relaxed position. The strain energy is released partly as heat and partly as elastic waves called seismic waves. The passage of these seismic waves produces the ground shaking in earthquakes.

Subduction zone earthquakes occur at the interface between tectonic plates. A subduction zone earthquake affecting the Humboldt County Operational Area would be centered in the Cascadia Subduction zone off the coast of Washington or Oregon. Such earthquakes typically have a minute or more of strong ground shaking, and are quickly followed by damaging tsunamis and numerous large aftershocks. The potential exists for large earthquakes along the Cascadia Subduction zone, with a magnitude of 9 or more (CREW, 2009). This could produce a tsunami all along the fault line from British Columbia to Mendocino, California. Such an earthquake would produce catastrophic damage in the region.

For Northern California, the Mendocino Triple Junction is the point where the Gorda plate, the North American plate, and the Pacific plate meet, in the Pacific Ocean near Cape Mendocino. This triple junction is the location of a change in the broad plate motions that dominate the west coast of North America, linking convergence of the northern Cascadia subduction zone and translation of the southern San Andreas Fault system. The Gorda plate is subducting under the North American plate at 2.5 to 3 centimeters per year and is simultaneously converging obliquely against the Pacific plate at a rate of 5 centimeters per year (Oppenheimer 2013).

Faults are more likely to have future 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 the accumulating tectonic stresses. 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) (California Department of Conservation, 2003).

Determining if a fault is "active" or "potentially active" depends on geologic evidence, which may not be available for every fault. 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, where no displacements have been recorded, also have the potential to reactivate or experience displacement along a branch sometime in the future. An example of a fault zone that has been reactivated is the Foothills Fault Zone. The zone was considered inactive until evidence of an earthquake (approximately 1.6 million years ago) was found near Spenceville, California. Then, in 1975, an earthquake occurred on another branch of the zone near Oroville, California (now known as the Cleveland Hills Fault). The State Division of Mines and Geology indicates that increased earthquake activity throughout California may cause tectonic movement along currently inactive fault systems.

9.1.1 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

An earthquake's magnitude is a measure of the energy released at the source of the earthquake. Magnitude is commonly expressed by ratings on the moment magnitude scale (M_W), the most common scale used today (USGS, 2017a). This scale is based on the total moment release of the earthquake (the product of the distance a fault moved and the force required to move it). The scale is as follows:

- Great—Mw > 8
- Major—Mw = 7.0 – 7.9
- Strong—Mw = 6.0 – 6.9
- Moderate—Mw = 5.0 – 5.9
- Light—Mw = 4.0 – 4.9
- Minor—Mw = 3.0 – 3.9
- Micro—Mw < 3

Intensity

The most commonly used intensity scale is the modified Mercalli intensity scale. Ratings of the scale as well as the perceived shaking and damage potential for structures are shown in Table 9-1. The modified Mercalli intensity scale is generally represented visually using shake maps, which show the expected ground shaking at any given location produced by an earthquake with a specified magnitude and epicenter. 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 variation of ground shaking in a region immediately following significant earthquakes (for technical information about shake maps see USGS, 2018).

9.1.2 Ground Shaking

The ground experiences acceleration as it shakes during an earthquake. The peak ground acceleration (PGA) is the largest acceleration recorded by a monitoring station during an earthquake. PGA is a measure of how hard the earth shakes in a given geographic area. It is expressed as a percentage of the acceleration due to gravity (%g). Horizontal and vertical PGA varies with soil or rock type. Earthquake hazard assessment involves estimating the annual probability that certain ground accelerations will be exceeded, and then summing the annual probabilities over a time period of interest.

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 = peak ground acceleration. Measured in percent of g, where g is the acceleration of gravity
Sources: USGS, 2008; USGS, 2010

National maps of earthquake shaking hazards provide information for creating and updating seismic design requirements for building codes, insurance rate structures, earthquake loss studies, retrofit priorities and land use planning. After thorough review of the studies, professional organizations of engineers update the seismic-risk maps and seismic design requirements contained in building codes (Brown et al., 2001). The USGS updated the National Seismic Hazard Maps in 2014. New seismic, geologic, and geodetic information on earthquake rates and associated ground shaking were incorporated into these revised maps. The 2014 map, shown in Figure 9-1, represents the best available data as determined by the USGS.

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. The determination of how great a force a structure should be able to withstand is based on probabilistic seismic mapping of the area. Such mapping identifies the probability of a given magnitude of ground shaking occurring over a specified time period. A common probabilistic rating used for building design is the level of ground shaking that has a 10 percent probability of being equaled or exceeded in a 50-year period.

Buildings, bridges, highways and utilities built to meet modern seismic design requirements are typically able to withstand earthquakes better, with less damage and disruption. 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.

9.1.3 Liquefaction and Soil Types

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. 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 (see SCEC, 2018 for general information on NEHRP soils data). In general, these areas are also most susceptible to liquefaction.

Source: USGS, 2014

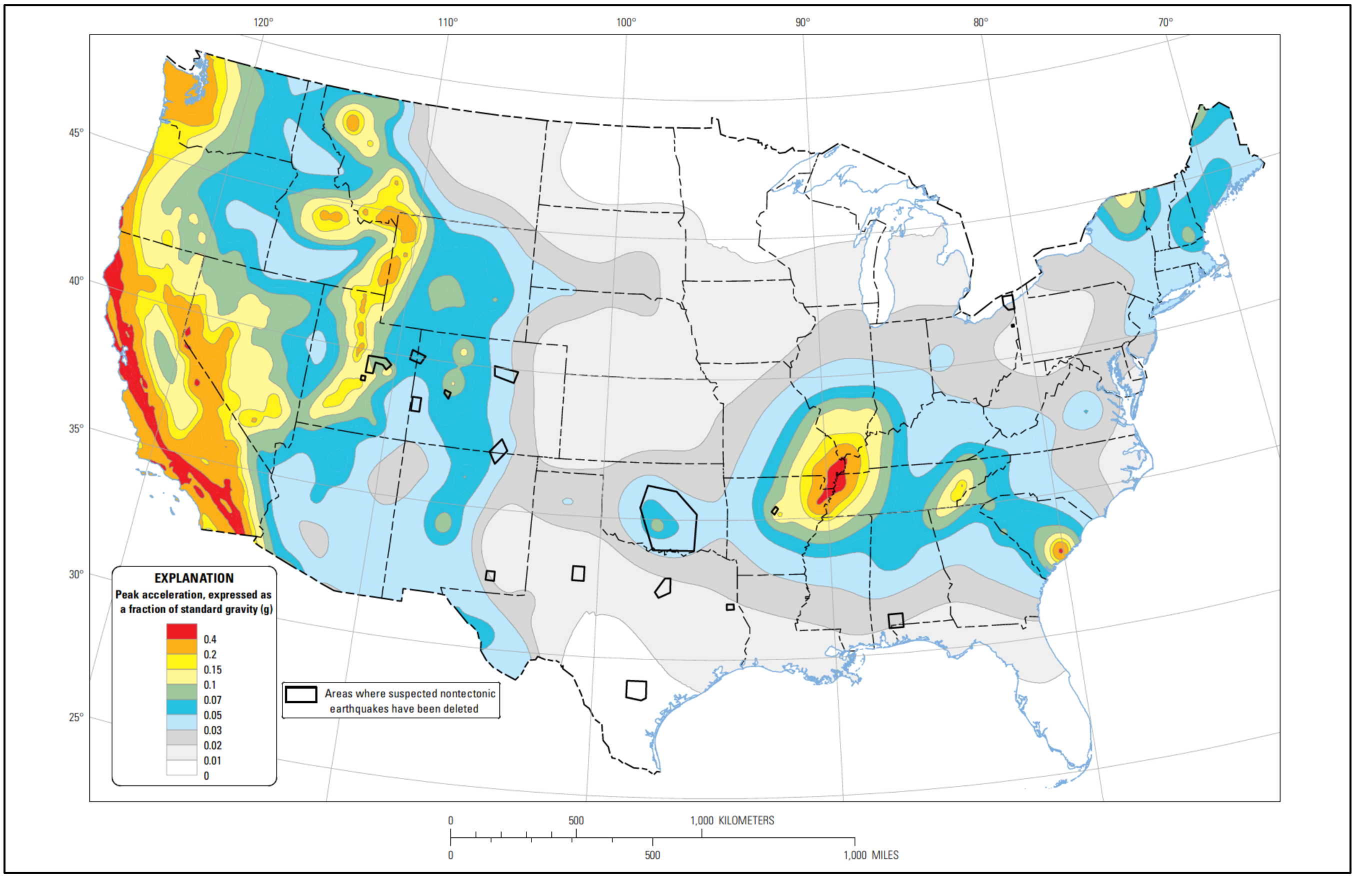


Figure 9-1. Peak Acceleration (%g) with 10% Probability of Exceedance in 50 Years

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

9.2.1 Past Events

According to the California State Hazard Mitigation Plan, two earthquakes between 1950 and 2003 caused sufficient damage in Humboldt County for the State to proclaim a state of emergency. The Cape Mendocino Earthquake on April 25, 1992 caused enough damage in Humboldt County and the region to warrant a presidential disaster declaration (DR-943). Table 9-3 lists seismic events with a magnitude of 5.0 or larger that were felt within the planning area since 2000.

Table 9-3. Recent Earthquakes Magnitude 5.0 or Larger Felt in Humboldt County

Date	Magnitude	Epicenter Location		
		Distance	Direction	Nearest City
July 29, 2017	5.1	84 miles	SW	Ferndale, CA
March 10, 2014	6.8	80 miles	NW	Ferndale, CA
February 13, 2012	5.6	47 miles	SSE	Weitchpec, CA
January 1, 2010	6.5	80 miles	SSW	Ferndale, CA (offshore)
February 26, 2007	5.4	32 miles	W	Ferndale, CA
July 16, 2006	5.0	4 miles	WNW	Punta Gorda, CA
March 25, 2006	5.0	2 miles	WNW	Punta Gorda, CA
June 14, 2005	7.2	97 miles	W	Trinidad, CA
August 15, 2003	5.3	75 miles	WNW	Ferndale, CA
June 17, 2002	5.27	23 miles	W	Eureka, CA
September 20, 2001	5.10	50 miles	WNW	Punta Gorda, CA
January 13, 2001	5.19	57 miles	WNW	Ferndale, CA
March 16, 2000	5.59	N/A	N/A	Offshore Punta Gorda, Point Mendocino

Source: Earthquake Catalogs, Northern California Earthquake Data Center, 2018

9.2.2 Location

Humboldt County is located within the two highest of five seismic risk zones specified by the Uniform Building Code, and offshore Cape Mendocino has the highest concentration of earthquake events anywhere in the continental United States. The area near Cape Mendocino is a complex, seismically active region, where three crustal plates, the Pacific Plate, the Gorda Plate, and North American Plate intersect to form the Mendocino triple junction.

Fault Locations

The USGS maintains a map of information on faults that show evidence of seismic activity with the past 1.6 million years (the Quaternary period), as well as a database of faults that is searchable by location. Figure 9-2 shows the known fault complexes within the Humboldt Operational Area. The USGS database shows two Class A faults within the planning area: Bald Mountain-Big Lagoon and Lost Man. Class A faults are those where "Geologic evidence demonstrates the existence of a Quaternary fault of tectonic origin, whether the fault is exposed for mapping or inferred from liquefaction or other deformational features (USGS, 2018b)."

Faults outside the planning area also can impact its people, property, and economy. A rupture in the Cascadia subduction zone, for example, would have considerable impacts on the planning area (Pacific Northwest Seismic Network, 2018). This is the 600-mile-long offshore zone, from northern Vancouver Island to Cape Mendocino, where the Juan de Fuca plate is being subducted below the North American plate. The Cascadia Subduction zone is at its closest distance to the west coast of the United States in the proximity of Humboldt County.

NEHRP Soil Type Mapping

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. Figure 9-3 shows NEHRP soil classifications in the planning area. Liquefaction mapping with levels of susceptibility suitable for modeling within the Hazus risk assessment platform is currently not available for the planning area.

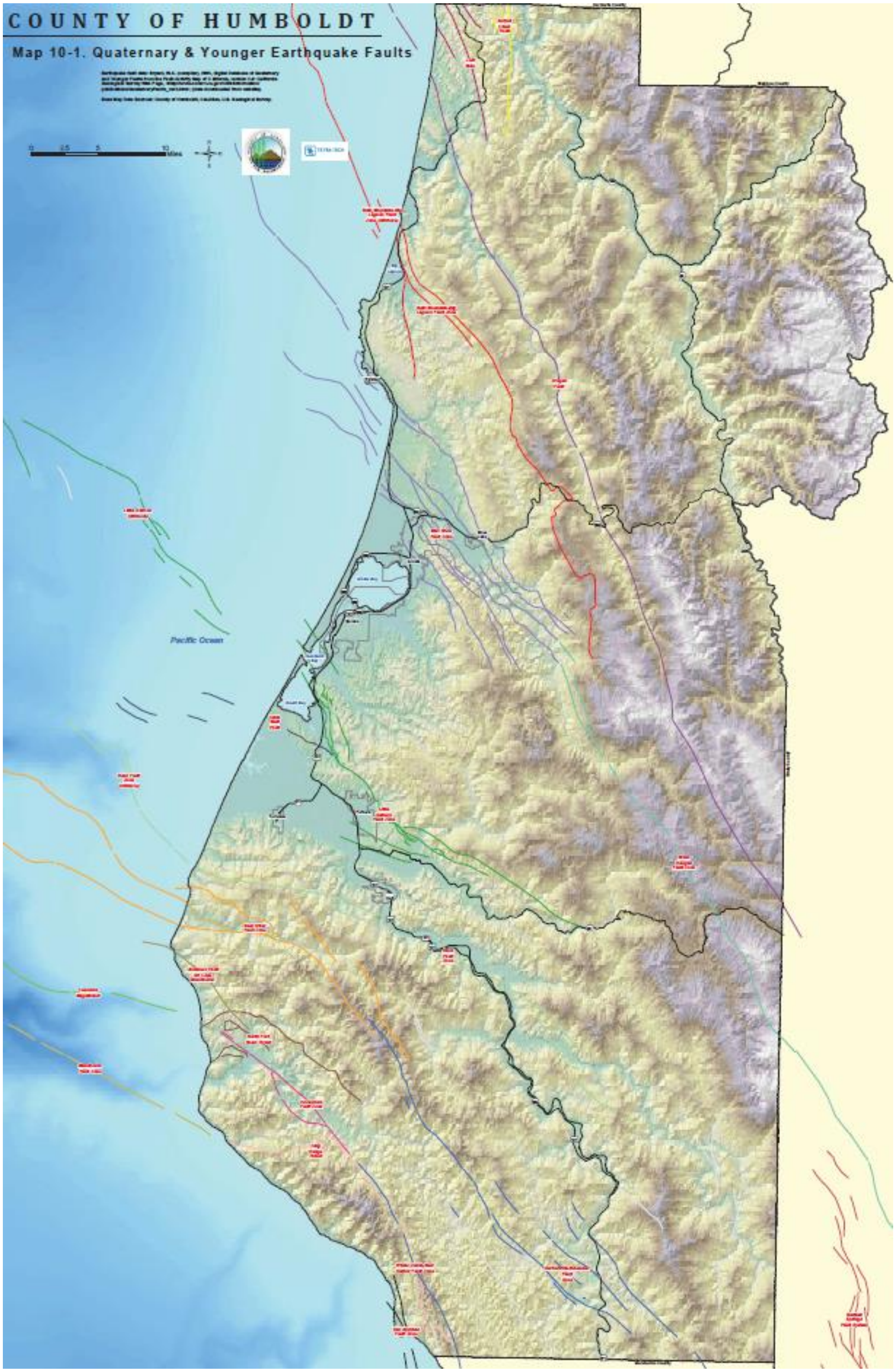


Figure 9-2. Mapped Faults in Humboldt County

Figure Placeholder

Figure 9-3. NEHRP Soil Class

9.2.3 Frequency

California experiences hundreds of earthquakes each year, most which are not felt and do not result in damage, with magnitudes below 3.0. Generally, only two or three events large enough to cause minor to moderate damage (magnitude 5.5 or higher) occur each year. Humboldt County is susceptible to regular earthquake activity, as evidenced by 11 seismic events with a magnitude of 5.0 or higher from 2000 through 2017 (see Table 9-3).

Scientists have developed earthquake forecast models that estimate the magnitude, location and likelihood of earthquake fault ruptures throughout the state. The USGS estimates that there is up to a 5.5-percent probability that an earthquake with a magnitude of 7.5 or greater could occur within 50 kilometers of the planning area within the next 5 years (Figure 9-4).

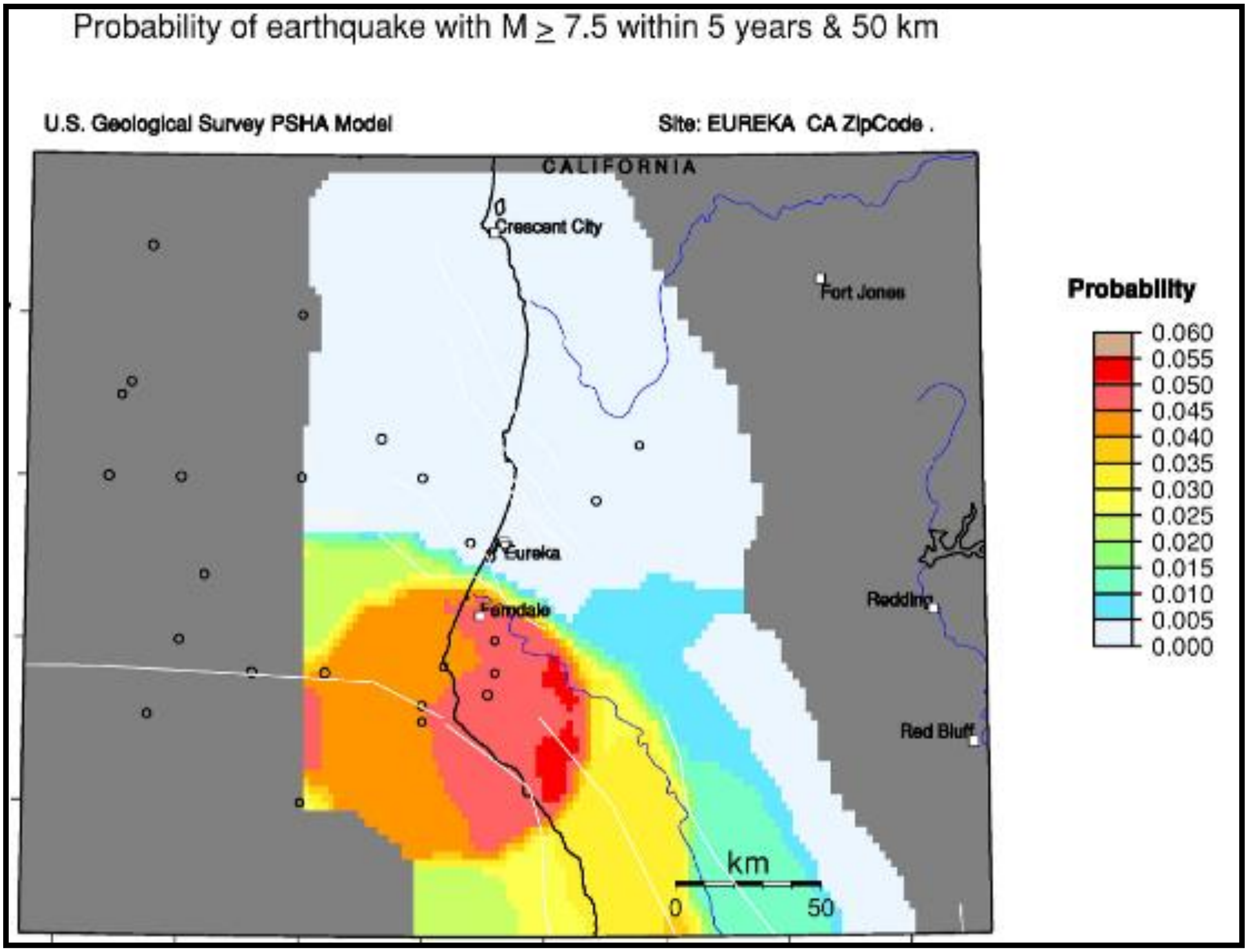


Figure 9-4. Earthquake Recurrence Probability Map for Humboldt County

The Uniform California Earthquake Rupture Forecast estimates events and repeat times for regions in California (Field et al., 2015). Table 9-4 shows the estimates for the Northern California region. Locally, the probability of a magnitude-7.5 or greater event over a 30-year time is 0.11 percent for Subsection 3 of the Trinidad fault zone and 0.69 percent for Subsection 8 of the Big Lagoon-Bald Mountain fault zone.

Table 9-4. Earthquake Forecast for Northern California

Magnitude (Greater than or equal to)	Average Repeat Time (years)	30-Year Likelihood of One or More Events	Readiness[a]
5	0.24	100%	1.0
6	2.4	100%	1.0
6.7	12	95%	1.0
7	25	76%	1.1
7.5	92	28%	1.0
8	645	5%	1.1

a. Readiness indicates that factor by which likelihoods are currently elevated, or lower, because of the length of time since the most recent large earthquake.

Source: Field et al., 2015

The Uniform California Earthquake Rupture Forecast estimates do not account for an earthquake on the Cascadia subduction zone that would impact the planning area. The recurrence interval for a megathrust event on the Cascadia subduction zone is 400 to 600 years on average, although recurrences appear to be irregular. The probability of a magnitude-9.0 earthquake in the subduction zone over the next 50 years is estimated to be about 10 percent (Cascadia Region Earthquake Workgroup, 2013).

9.2.4 Severity

The severity of an earthquake can be expressed in terms of intensity or magnitude (see Section 9.1.1). The State of California Department of Conservation probabilistic ground shaking maps, based on current information about fault zones, show the PGA that has a certain probability of being exceeded in a 50-year period. Humboldt County is in a high-risk area, with a 10-percent probability in a 50-year period of ground shaking from a seismic event exceeding 80 percent of gravity in some parts of the County. Figure 9-5 shows the expected peak horizontal ground accelerations for this probability.

9.2.5 Warning Time

There is no current 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 detect the lower energy compressional waves (P waves) that precede the secondary waves (S waves) experienced as an earthquake. Earthquake early warning systems may provide a few seconds' or a few minutes' 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, pause hazardous or high-risk work, or initiate protective automated systems in structures or critical infrastructure.

9.3 SECONDARY HAZARDS

Earthquakes can cause disastrous landslides. River valleys are vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Earthen dams and levees are highly susceptible to seismic events, and the impacts of their eventual failures can be considered secondary risk exposure to earthquakes. Depending on the location, earthquakes can also trigger tsunamis. Additionally, fires can result from gas lines or power lines that are broken or downed during the earthquake. It may be difficult to control a fire, particularly if the water lines feeding fire hydrants are also broken.

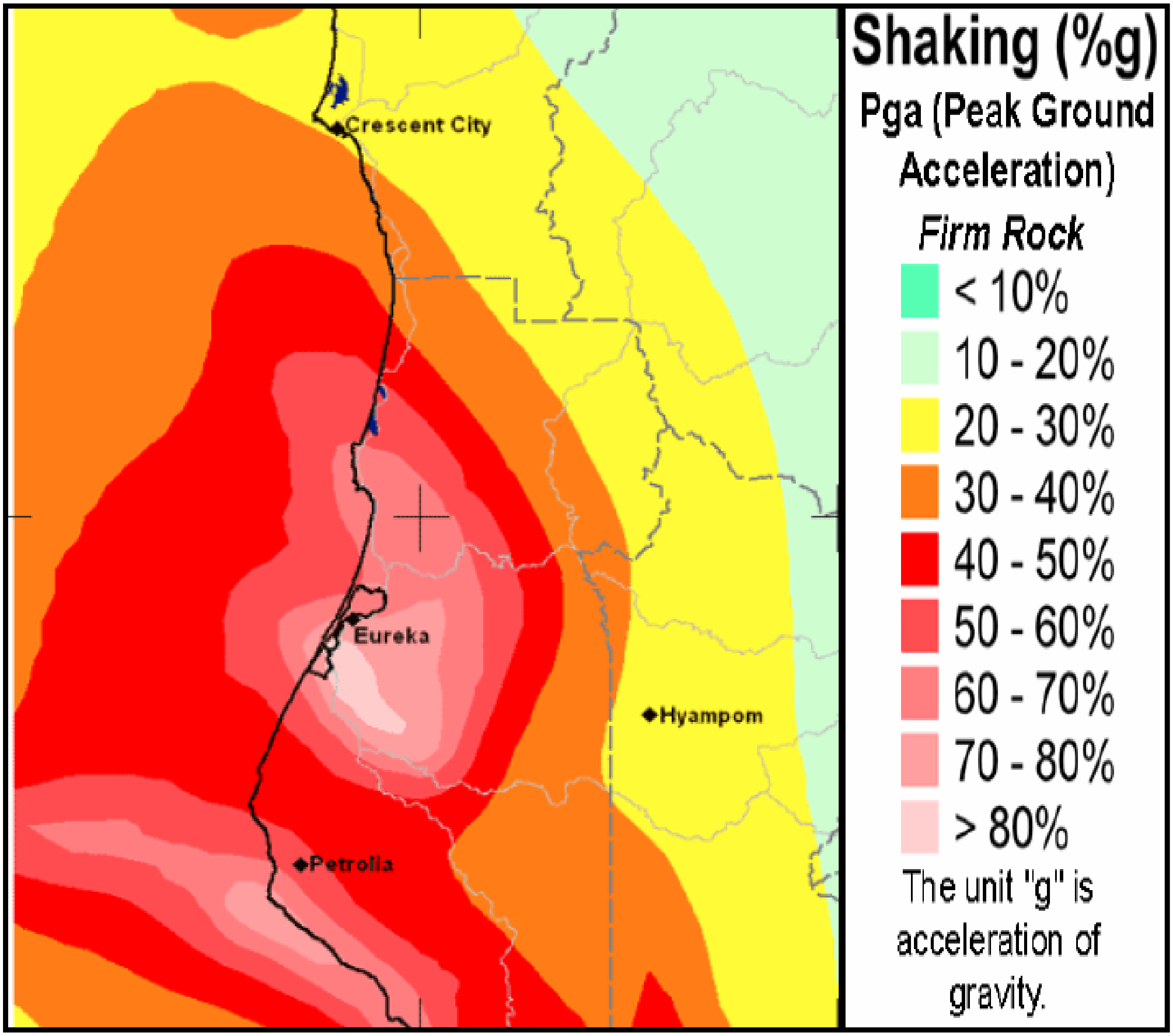


Figure 9-5. Peak Horizontal Acceleration with 10% Probability of Exceedance in 50 Years

9.4 EXPOSURE

9.4.1 Population

The entire population of the planning area is potentially exposed to direct damage from earthquakes or indirect impacts such as business interruption, road closures, and loss of function of utilities.

9.4.2 Property

According to County Assessor records, there are 50,561 buildings in the planning area. Most of the buildings (90.8 percent) are residential. All buildings are considered to be exposed to the earthquake hazard.

9.4.3 Critical Facilities and Infrastructure

Since the entire planning area has exposure to the earthquake hazard, all critical facilities and infrastructure components are considered to be exposed. The breakdown of the numbers and types of facilities is presented in Table 4-4 and Table 4-5.

9.4.4 Environment

The entire planning area is exposed to the earthquake hazard, including all natural resources, habitat and wildlife.

9.5 VULNERABILITY

Earthquake vulnerability data was generated using a Hazus analysis. The following USGS event scenarios were modeled:

- Cascadia Subduction zone Megathrust Scenario—A Magnitude 9.3 event with an epicenter 295 miles north of Eureka (see Figure 9-6)
- Big Lagoon/Bald Mountain Scenario—A Magnitude 7.9 event with an epicenter 55 mile north of Eureka (see Figure 9-7)
- Little Salmon Onshore Scenario—A Magnitude 7.1 event with an epicenter 10 miles southeast of Eureka (see Figure 9-8)
- Mad River Trinidad (Alt 2) Scenario—A Magnitude 7.5 event with an epicenter 3.5 miles north northeast of Trinidad (see Figure 9-9)
- Russ Scenario—A Magnitude 7.4 event with and epicenter with an epicenter 1.5 miles northwest of Rio Dell (see Figure 9-10)

The analysis results are summarized in the sections below, and more detailed information, broken down by municipality, can be found in Appendix C. The results of this analysis are likely to significantly underestimate risk, due to limitations in the modeling parameters:

- There is no available liquefaction data with level of susceptibility resolution to support vulnerability modeling for the planning area, so damage estimates do not consider potential structural issues pertaining to liquefiable soils.
- All critical facilities are assumed to have been built to high code standards. This may not be the case, especially for older facilities.
- The Hazus model does not take into account the extreme duration of shaking expected during a Cascadia Subduction zone event. Some models estimate that ground shaking will occur for up to five minutes.

9.5.1 Population

Residents of High-Risk Areas

The degree of vulnerability 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. There are estimated to be 84,143 people in over 34,690 households living on NEHRP D soils in the planning area. This is about 63 percent of the total population.

Figure Placeholder

Figure 9-6. Cascadia Subduction zone Fault Scenario

Figure Placeholder

Figure 9-7. Big Lagoon/Bald Mountain Fault Scenario

Figure Placeholder

Figure 9-8. Little Salmon Onshore Fault Scenario

Figure Placeholder

Figure 9-9. Mad River Trinidad Fault Scenario

Figure Placeholder

Figure 9-10. Russ Fault Scenario

Susceptible Population Groups

Two groups are particularly vulnerable to earthquake hazards:

- **Population Below Poverty Level**—An estimated 20,278 households in NEHRP D soils areas have household incomes less than $50,000 per year. This is about 58 percent of all households located on NEHRP D soils. These households may lack the financial resources to improve their homes to prevent or mitigate earthquake damage. Economically disadvantaged residents are also less likely to have insurance to compensate for losses incurred during earthquakes.
- **Population Over 65 Years Old**—An estimated 10,833 residents in areas of NEHRP D soils are over 65 years old. This is about 13 percent of all residents in these areas of NEHRP D soils. 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.

Estimated Impacts on Persons and Households

Hazus estimated impacts on persons and households in the planning area for the four selected earthquake scenarios as summarized in Table 9-5.

Table 9-5. Estimated Earthquake Impact on Persons

Scenario	Displaced Households		Persons Requiring Short-Term Shelter	
	Number	% of Total	Number	% of Total
Cascadia Subduction zone Megathrust Scenario	835	0.61	543	0.40
Big Lagoon/Bald Mountain Scenario	59	0.43	38	0.03
Little Salmon Onshore Scenario	493	0.36	327	0.24
Mad River Trinidad Scenario	401	0.29	255	0.19
Russ Scenario	31	0.02	20	0.01

9.5.2 Property

Liquefaction Potential

Damage to structures based on their susceptibility to liquefiable soils could not be modeled due to the lack of available liquefaction data with susceptibility resolution sufficient for risk assessment modeling.

Building Age

Table 9-6 identifies significant milestones in building and seismic code requirements that directly affect the structural integrity of development. Using U.S. Census estimates of housing stock age, estimates were developed of the number of housing units constructed before each of these dates. Nineteen percent of the planning area's housing units were constructed after the Uniform Building Code was amended in 1994 to include seismic safety provisions. Housing units built before 1933 when there were no building permits, inspections, or seismic standards, account for 4 percent. Many of the housing units in the planning area are detached, single-family residences of wood construction, which generally perform well during earthquake events.

Table 9-6. Age of Housing Units in Planning Area

Time Period	Number of Current Planning Area Housing Units Built in Period	% of Total Housing Units	Significance of Time Frame
Pre-1933	2,022	4%	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	5,056	10%	In 1940, the first strong motion recording was made.
1941-1960	11,629	23%	In 1960, the Structural Engineers Association of California published guidelines on recommended earthquake provisions.
1961-1975	14,157	28%	In 1975, significant improvements were made to lateral force requirements.
1976-1994	8,090	16%	In 1994, the Uniform Building Code was amended to include provisions for seismic safety.
1994 – present	9,607	19%	Seismic code is currently enforced.
Total	**50,561**	**100%**	

Note: Number and percent estimates are approximation as housing unit age information does not correspond directly with the time periods indicated. In addition, there are significant margins of error associated with the Census estimates.
Source: 2018 American Community Survey, Humboldt County, California

Unreinforced Masonry Buildings

Unreinforced masonry buildings are constructed from materials such as adobe, brick, hollow clay tiles, or other masonry materials and do not contain an internal reinforcing structure, such as rebar in concrete or steel bracing for brick. Unreinforced masonry poses a significant danger during an earthquake because the mortar holding masonry together is typically not strong enough to withstand significant earthquakes. The brittle composition of these buildings can break apart and fall away or buckle, potentially causing a complete collapse of the building. The number of unreinforced masonry structure in the planning area is unknown.

Loss Potential

Table 9-7 summarizes Hazus estimates of earthquake damage in the planning area for the four scenarios. The debris estimate includes only structural debris; it does not include additional debris that may accumulate, such as from trees. In addition, these estimates do not include losses that would occur from any local tsunamis or fires stemming from an earthquake.

Table 9-7. Estimated Impact of Earthquake Scenario Events in the Planning Area

	Structure Debris		Structure + Contents Damage	
Earthquake Scenario Event	Tons	Truckloads	Value	% of Total Value
Cascadia Subduction zone Megathrust Scenario	1,344,210	53,768	$9,059,029,011	25.7
Big Lagoon/Bald Mountain Scenario	43,380	1,735	$3,496,131,610	9.9
Little Salmon Onshore Scenario	864,510	34,580	$6,551,823,866	18.6
Mad River Trinidad (Alt 2) Scenario	702,210	28,088	$5,172,974,830	14.7
Russ Scenario	178,800	7,152	$2,779,939,387	7.9

9.5.3 Critical Facilities and Infrastructure

A Hazus analysis was conducted on critical facilities and infrastructure in the planning area for the two scenarios likely to cause the most damage: the Cascadia Subduction zone Megathrust scenario and the Little Salmon Onshore scenario.

Level of Damage

Hazus 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 probability of each damage state to every critical facility in the planning area. The results for the Cascadia and Little Salmon scenarios are summarized in Table 9-8 and Table 9-9.

Table 9-8. Estimated Damage to Critical Facilities from Cascadia Subduction Zone Scenario

Category	# of Critical Facilities	Number of Facilities with 50% or Greater Probability of Achieving Damage Level				
		None	Slight	Moderate	Extensive	Complete
Critical Facilities						
Government Functions	16	0	0	2	5	9
Hazardous Materials Facilities	33	0	5	15	5	8
Medical & Health Services	40	0	0	8	17	15
Other Critical Functions	2	0	0	0	1	1
Protective Functions	101	0	5	13	42	41
School Facilities	97	0	8	41	33	9
Critical Infrastructure						
Transportation	416	108	274	14	20	0
Communication	8	0	4	4	0	0
Power	1	0	0	1	0	0
Wastewater	137	0	51	35	51	0
Water Supply	209	47	92	70	0	0

Note: the results of this assessment are likely to significantly underestimate risk due to the limitation in modeling discussed in Section 9.5

Table 9-9. Estimated Damage to Critical Facilities from the Little Salmon Onshore Scenario

Category	# of Critical Facilities	Number of Facilities with 50% or Greater Probability of Achieving Damage Level				
		None	Slight	Moderate	Extensive	Complete
Critical Facilities						
Government Functions	16	2	0	14	0	0
Hazardous Materials Facilities	33	3	23	7	0	0
Medical & Health Services	40	2	1	37	0	0
Other Critical Functions	2	0	1	1	0	0
Protective Functions	101	15	10	75	1	0
School Facilities	97	10	7	79	1	0
Critical Infrastructure						
Transportation	416	392	24	0	0	0
Communication	8	5	3	0	0	0
Power	1	0	1	0	0	0
Wastewater	137	130	7	0	0	0
Water Supply	209	188	21	0	0	0

Note: the results of this assessment are likely to significantly underestimate risk due to the limitation in modeling discussed in Section 9.5

Hazardous Materials

Hazardous material releases from fixed facilities and transportation-related releases can occur during an earthquake event. Vital transit corridors such as U.S. Highways 101 and 199 can be disrupted during an earthquake, which can result in the release of hazardous materials that are being transported along these corridors to the surrounding environment. Facilities holding hazardous materials are of particular concern because of possible isolation of populations surrounding them. There are 33 known facilities in the planning area that handle materials considered to be hazardous. During an earthquake event, structures storing these materials could rupture and leak into the surrounding area, or river, having a disastrous effect on the environment.

Roads

There are many roads that cross earthquake-prone soils in the planning area. These soils have the potential to be significantly damaged during an earthquake event. Access to major roads is crucial to life and safety after a disaster event as well as to response and recovery operations. The following major roads in the planning area pass through NEHRP D soils areas:

- State Highway 36
- State Highway 299
- State Highway 254
- State Highway 255
- U.S. Highway 101
- State Highway 211

Bridges

Earthquake events can significantly impact bridges, isolating many Humboldt communities after a major earthquake. Bridges often follow floodplain boundaries, which typically have soft soils, and thus, are considered vulnerable to earthquakes. A key factor in the degree of vulnerability is the age of the facility and the type of construction, which help indicate the standards to which the facility was built. The Hazus analysis indicated that more than 139 bridges in the planning area would experience slight damage following a Cascadia subduction zone event. Slight damage for bridges is considered to be damage that requires only cosmetic repair. It is likely that many bridges in the planning area would experience severe damage and would not be passable until repairs could be conducted.

Water and Sewer Infrastructure

Water and sewer infrastructure would likely suffer considerable damage in the event of an earthquake. This is hard to analyze due to the amount of infrastructure and the fact that water and sewer infrastructure are usually linear easements, which are not modeled in Hazus. Without further analysis of individual components of the system, it should be assumed that these systems are exposed to potential breakage and failure.

9.5.4 Environment

Environmental problems as a result of an earthquake can be numerous. Secondary hazards will likely have some of the most damaging effects on the environment. Earthquake-induced landslides can significantly damage surrounding habitat. It is also possible for streams to be rerouted after an earthquake. Rerouting can change the water quality, possibly damaging habitat and feeding areas. Streams fed by groundwater wells can dry up because of changes in underlying geology.

9.6 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, including seismic hazards. The information in this plan provides 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.

9.7 SCENARIO

Based on history and geology, the Humboldt County planning area will be frequently impacted by earthquakes. The worst-case scenario is a higher-magnitude event (7.5 or higher) with an epicenter within 50 miles of the county. Earthquakes of this magnitude or higher could lead to massive structural failure of property on soils prone to liquefaction. Building and road foundations would lose load-bearing strength. Injuries could occur from debris, such as parapets and chimneys that could topple or be shaken loose and fall on those walking or driving below. Levees and revetments built on these poor soils would likely fail, representing a loss of critical infrastructure. An earthquake event of this magnitude located off the coast could cause a significant local tsunami that would further damage structures and jeopardize lives. An earthquake may also cause minor landslides along unstable slopes, which put at risk major roads and highways that act as sole evacuation routes. This would be even more likely if the earthquake occurred during the winter or early spring.

9.8 ISSUES

Important issues associated with an earthquake include the following:

- A large percentage of the planning area is located on NEHRP D soils, which is prone to liquefaction. Structures on these soils may experience significant structural damage; however, this threat is unknown as liquefaction susceptibility maps have not been developed.
- It is estimated that 65 percent of the planning area's building stock was built prior to 1975, when seismic provisions became uniformly applied through building code applications. Many structures may need seismic retrofits in order to withstand a moderate earthquake. Residential retrofit programs, such as Earthquake Brace+Bolt, may be able to assist in the costs of these efforts.
- The number and location of unreinforced masonry buildings in the planning area is unknown.
- Significant but infrequent earthquake events, such as an event on the Little Salmon Offshore Fault or the Cascadia Subduction zone, could cause significant property damage in the planning area and generate large amounts of debris that would need to be hauled away.
- Liquefaction mapping with sufficient level of susceptibility resolution would enhance future seismic vulnerability modeling results using the Hazus-MH risk assessment platform.
- Due to limitations in current modeling abilities, the risk to critical facilities and infrastructure in the planning area from the earthquake hazard is likely understated. A more thorough review of the age of critical facilities, codes they were built to, and location on liquefiable soils should be conducted.
- Damage to road systems in the planning area after an earthquake has the potential to significantly disrupt response and recovery efforts and lead to isolation of populations.
- Earthquakes can cause fires in wooden homes and collapse of essential buildings such as fire stations.
- Landslides and tsunamis are major secondary hazards that could have a widespread effect on the county.
- Citizens are expected to be self-sufficient up to two weeks after a major earthquake without government response agencies, utilities, private-sector services, and infrastructure components. Education programs are currently in place to facilitate development of individual, family, neighborhood, and business earthquake preparedness. It takes individuals, families, and communities working in concert with one another to be prepared for disaster.
- After a major seismic event, the planning area is likely to experience disruptions in the flow of goods and services resulting from the destruction of major transportation infrastructure across the broader region.

10. FLOODING

10.1 GENERAL BACKGROUND

10.1.1 Types of Floodplains in the Planning Area

A floodplain is the area adjacent to a river, creek, lake or the ocean that becomes inundated during a flood. In general, there are two types of floodplains in Humboldt County: riverine and coastal.

Riverine Floodplains

Riverine 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.

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.

Coastal Floodplains

Coastal floodplains are adjacent to the ocean and other tidally influenced areas. Like riverine floodplains, coastal floodplains may be broad or narrow, depending on local topography and natural flood defenses such as dune systems or tidal wetlands. Coastal floods are usually caused by coastal storms that, when combined with normal tides, push water toward the shore. This is commonly referred to as storm surge. The result can be waves that extend further inland, causing damage to development that would not normally be subject to wave action.

10.1.2 Measuring Floods and Floodplains

The frequency and severity of flooding are measured using a discharge probability for river systems and wave heights for coastal systems. The discharge probability is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Storm surge levels are determined by modeling water depth, wind speed, vegetative cover and other factors to determine the "wave runup," how far inland waves will reach, and "wave setup" the height, speed, and slope of waves and how they differ from the still-water elevation (see Figure 10-1).

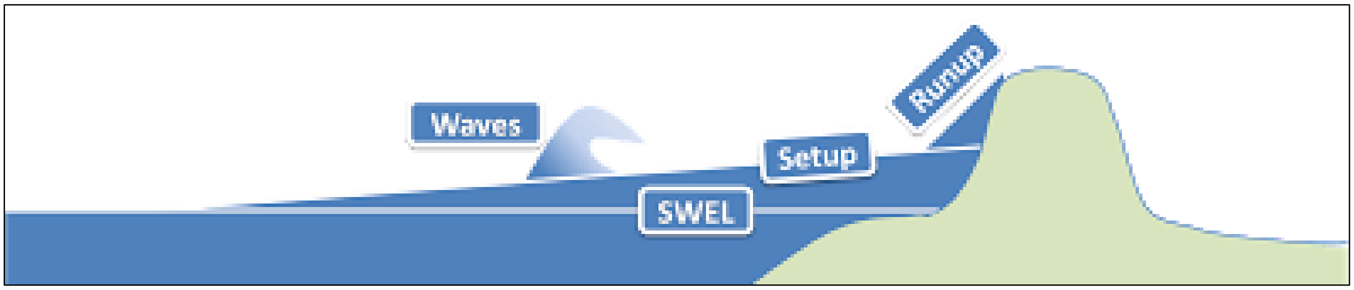


Figure 10-1. Storm Surge Stillwater Elevation and Added Effects of Wave Setup and Runup

Flood studies use historical records to determine the probability of occurrence for different discharge levels and storm surge levels. These measurements reflect statistical averages only; it is possible for multiple floods with a low probability of occurrence (such as a 1-percent-annual-chance flood) to occur in a short time period. For riverine flooding, the same flood event can have flows at different points on a river that correspond to different probabilities of occurrence.

The extent of flooding associated with a 1-percent annual probability of occurrence (also called the base flood) is used as the regulatory boundary by many agencies. Also referred to as the special flood hazard area, 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.

10.1.3 Floodplain Ecosystems and Beneficial Functions

Floodplains can support ecosystems that are rich in plant and animal species. A floodplain can contain 100 or even 1,000 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, but the surge of new growth endures for some time. This makes floodplains 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.

Floodplains have many natural and beneficial functions, and disruption of natural systems can have long-term consequences for entire regions. Some well-known, water-related functions of floodplains (noted by FEMA) include:

- Natural flood and erosion control
- Provide flood storage and conveyance
- Reduce flood velocities
- Reduce flood peaks
- Reduce sedimentation
- Surface water quality maintenance
- Filter nutrients and impurities from runoff
- Process organic wastes
- Moderate temperatures of water
- Provide groundwater recharge
- Promote infiltration and aquifer recharge
- Reduce frequency and duration of low surface flows.

Areas in the floodplain that typically provide these natural functions are wetlands, riparian areas, sensitive areas, and habitats for rare and endangered species.

10.1.4 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; riverine floodplain land is fertile and suitable for farming; transportation by water is easily accessible; land is flatter and easier to develop; and there is value placed in ocean views. 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 or causing erosion of natural flood protection systems such as dunes. Flood potential can be increased in several ways: reducing a stream's capacity to contain flows; increasing flow rates or velocities downstream; and allowing waves to extend further inland. Human activities can interface effectively with a floodplain as long as steps are taken to mitigate the activities' adverse impacts on floodplain functions.

10.1.5 FEMA Regulatory Flood Zones

FEMA defines flood hazard areas as areas expected to be inundated by a flood of a given magnitude. These areas are determined via statistical analyses of records of river flow, storm tides, and rainfall; information obtained through consultation with the community; floodplain topographic surveys; and hydrologic and hydraulic analyses. Flood hazard areas are delineated on DFIRMs (Digital Flood Insurance Rate Maps), which provide the following information:

- Locations of specific properties in relation to special flood hazard areas
- Base flood elevations (1-percent-annual-chance) at specific sites
- Magnitudes of flood in specific areas
- Undeveloped coastal barriers where flood insurance is not available
- Regulatory floodways and floodplain boundaries (1-percent and 0.2-percent-annual-chance floodplains).

Land covered by floodwaters of the base flood is the special flood hazard area on a DFIRM—an area where NFIP floodplain management regulations must be enforced, and where mandatory purchase of flood insurance applies. This regulatory boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities, because many communities have maps showing the extent of the base flood and likely depths that will occur.

The base flood elevation (the water elevation of a flood that has a 1-percent chance of occurring in any given year) is one of the most important factors in estimating potential damage from flooding. A structure within a 1-percent-annual-chance floodplain has a 26-percent chance of undergoing flood damage during the term of a 30-year mortgage. The 1-percent-annual-chance flood is used by the NFIP as the basis for insurance requirements nationwide. DFIRMs also depict 0.2-percent-annual-chance flood designations.

10.2 HAZARD PROFILE

There are six types of flood events that can impact the planning area: coastal flooding, riverine flooding, urban flooding, tsunami flooding, and flooding from sea level rise or a dam failure. This hazard profile focuses on the coastal, riverine and urban flood hazards. Floods resulting from a dam failure are discussed in Chapter 7. Tsunami flooding is discussed in Chapter 13. Floods from sea level rise are discussed in Chapter 15

10.2.1 Flooding Sources

Coastal Flooding

Coastal flooding occurs when intense, offshore low-pressure systems drive ocean water inland. The water pushed ashore is called storm surge. Flooding along the Pacific coast near Humboldt Bay is often associated with the simultaneous occurrence of very high tides, large waves, and storm swells during the winter. Storm centers from the southwest produce the type of storm pattern most commonly responsible for most of the serious coastal flooding. The strong winds and high tides that accompany these storms can create storm surges in excess of 10 feet above mean high tide. Portions of Humboldt County are subject to flooding from storm surge. The highest tidal surge in Humboldt Bay was measured at 6.5 feet, on February 4, 1958.

The configuration of Humboldt Bay protects the coastal communities of Humboldt County from direct exposure to coastal storm flooding. The Samoa Peninsula and South Spit block the effects of normal storm waves and sea swells. A single channel, defined by jetties and seawalls, provides passage for water into and out of Humboldt Bay. The unincorporated community of King Salmon is located on an artificially constructed peninsula along the eastern margin of Humboldt Bay. Old channel dredgings were stockpiled on the site until 1948, when residential development in the area began. The elevation of the King Salmon vicinity is a few inches higher than the normal maximum high tide. Flooding can occur in this area during unusually high tides accompanied by storm surges.

Extreme storm events overtopped the Samoa Peninsula and South Spit during the winters of 1978 and 1983. The winter of 1983 brought an extremely unusual series of high tides, storm surges, and storm waves. Virtually all of the U.S. Coast Guard mooring docks were destroyed. In King Salmon, homes were flooded with 6 to 12 inches of water.

According to FEMA, the coastal high hazard area (or “V zone,” where V stands for velocity wave action) is the most hazardous part of the coastal floodplain, due to its exposure to wave effects. The V zone has an increased degree of flood risk compared to coastal flood areas not within the coastal high hazard area (A zones), and is subject to more stringent regulatory requirements. Figure 10-2 is a typical transect illustrating the coastal V and A zones and the effects of energy dissipation and regeneration of a wave as it moves inland. Wave elevations are decreased by obstructions such as buildings, vegetation and rising ground surface.

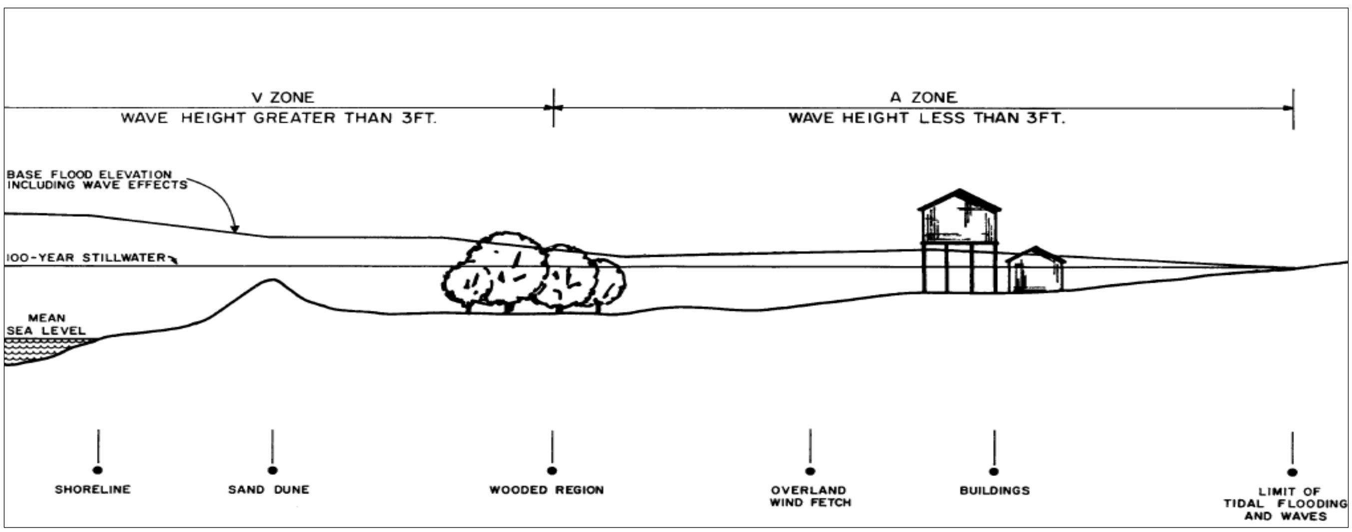


Figure 10-2. Typical Transect Schematic

River Systems

The principal sources of riverine flooding in Humboldt County are as follows:

- **Eel River Basin—**This 3,260-square-mile basin drains a predominantly mountainous area in the southern parat of the county. The Eel River flows through a narrow canyon from its junction with the Middle Fork downstream to its confluence with the Van Duzen River. Downstream of that confluence, the Eel River meanders through a wide coastal plain between the City of Fortuna and the Pacific Ocean. The second largest tributary in this basin is the South Fork Eel River. The South Fork joins the Eel River at Dryerville and flows through steep-walled canyons for most of its length. The Van Duzen River drains an area of approximately 430 square miles to its confluence with the Eel River. The Van Duzen floodplain is narrow for most of its length, widening only in its downstream portions near Cummings Creek Camp. The average annual precipitation in this basin ranges from 59 to 70 inches, depending on the location in the basin. The duration of floods in this basin is relatively short. Stages can rise from normal flow to extreme peaks in 16 to 44 hours. Flooding generally has a duration of 50 to 55 hours.

- **Mad River Basin—**The Mad River drains about 500 square miles at its outlet to the Pacific Ocean. The river flows through narrow canyons for most of its 100-mile length. It enters a wide coastal floodplain just north of Arcata, which continues to its confluence with the Pacific Ocean. The average annual precipitation for this basin is 64 inches upstream of the gauge located at the mouth of the Mad River.
- **Freshwater Creek Basin—**Freshwater Creek drains a small coastal basin of 34 square miles before it enters Ryan Slough. Ryan Slough flows into Eureka Slough, a brackish stream, which in turn empties into Arcata Bay north of Eureka. The floodplain in this basin is moderately wide and situated between a narrow stream in the mountains, widening as it enters the coastal plain. The average annual precipitation for this basin in 54 inches upstream of the gauge located at the confluence with Jacoby Creek.
- **Jacoby Creek Basin—**Jacoby Creek is a coastal stream just north of Freshwater Creek. Its headwaters are in the Coast range, and it flows west from there into Arcata Bay. The creek drains an area of 16 square miles at its mouth. The majority of this stream meanders through the Arcata Bay coastal plain. The average annual precipitation for this basin is 54 inches upstream of the gauge located at the confluence with Freshwater Creek.
- **Trinity River Basin—**As the largest tributary to the Klamath River, the Trinity River drains a total area of 2,969 square miles, most of which is in Trinity County. The river flows through a mountainous, heavily forested area in the eastern portion of Trinity County. Detailed flood insurance studies have been generated for the mountain valley downstream of the confluence with the South Fork Trinity River in the northeastern portion of Humboldt County. The average annual precipitation for this basin is 55 inches upstream of the gauge located at the mouth of the Trinity River.
- **Klamath River Basin—**The largest river in the region is the Klamath River, which originates in Oregon and drains 12,120 square miles. A 50-mile stretch runs through the mountainous, forested northern part of Humboldt County. It drains to the Pacific Ocean in Del Norte County to the north. Detailed flood insurance studies have not been undertaken for the Humboldt portion of the Klamath.
- **Elk River Basin—**The 52-square-mile Elk River watershed flows into Humboldt Bay just southwest of Eureka, California. It can conceptually be divided into a steep, forested upper watershed that makes up the majority of the basin (43 square miles) and a more developed lower watershed with a wide, low-gradient alluvial valley bottom and floodplain. Designated beneficial uses of particular concern include municipal and agricultural water supply, endangered cold-water fisheries habitat, and water contact recreation. Downstream flooding and high turbidity are critical concerns for the residents and are believed by many of the residents to have been greatly aggravated by upstream forest management activities.

Urban Flooding

Like many areas in northern California, Humboldt County has experienced rapid change due to urban development in once rural areas. The drainage facilities in these recently urbanized areas are often a patchwork of pipes, roadside ditches, and channels rather than a coordinated system as found in a mature utility. The two key factors that contribute to urban flooding are rainfall intensity and duration. Topography, soil conditions, urbanization and groundcover also play an important role. Urban flooding occurs when available conveyance systems lack the capacity to convey rainfall runoff to nearby creeks, streams and rivers. As drainage facilities are overwhelmed, roads and transportation corridors become conveyance facilities.

Urban floods can be a great disturbance of daily life in urban areas. Roads can be blocked and people may be unable to go to work or school. Economic damage can be high but the number of casualties is usually limited, because of the nature of the flood. When the city is on flat terrain, the flow speed is low and people can still drive through it. The water rises relatively slowly and usually does not reach life endangering depths.

10.2.2 Flood Control Structures in the Planning Area

The County maintains levees on the Mad River near the City of Blue Lake, the Eel River near the City of Fortuna and on Redwood Creek near Orick. The Mad River levee was built by the Corps of Engineers in 1955 and the Eel River levee was built by the Corps of Engineers in 1958-1959. Congress authorized construction of the Redwood Creek flood control project with the Flood Control Act of 1962, and construction was completed in 1968. In addition, the county as a whole contains nearly 100 non-federal levees.

10.2.3 Past Events

Seventy percent of precipitation in Humboldt County occurs from November to March; major floods have resulted from successions of intense storms during these months. Table 10-1 summarizes the 15 federally declared disasters in Humboldt County related to flooding between 1955 and 2019. The two worst flood events in Humboldt County occurred in December 1955 and December 1964. These events caused tens of millions of dollars in damage and numerous fatalities. The following sections summarize available information on the most significant Humboldt County flood events.

December 1955 Flood Event

The December 1955 flood occurred following weeks of above-normal precipitation in the county, with rainfall measurements reaching as high as 24 inches over three days in Cummings. Damage in the Eel River Basin exceeded $22 million, with one reported fatality and 43,000 acres flooded. Heavy debris carried by high velocity river flows caused the majority of the damage.

December 1964 Flood Event

Heavy rains accompanied by runoff from an unusually large snowpack led to flooding of the Mad and Eel Rivers in December 1964. Total damage reached $100 million, with entire communities being destroyed (including Pepperwood, the site of the 1955 fatality) and 19 fatalities reported. Millions of board feet of lumber, thousands of acres of farmland, and 4,000 head of livestock were lost, causing a tremendous economic impact on the county.

January 1995 Flood Event

Flooding caused one death and over $15 million in damage. Flood damage was reported throughout much of the county, but the most severely impacted area was the Eel River Valley. The county received both a governor’s proclamation and a presidential disaster declaration.

March 1995 Flood Event

Continued winter storms and flooding in the months following the January 1995 event caused an additional $2 million in damage throughout the county. The county received a second presidential declaration in March 1995.

January 1997 Flood Event

The January 1997 flood was the fifth largest flood on record in Humboldt County. The U.S. Forest Service reported that the storms of December and January produced two to three times the monthly average precipitation on the Klamath National Forest. Most the reported damage was from landslides and road failures. The estimated damage to road facilities exceeded $35 million within the Klamath National Forest.

Table 10-1. Sample of Flood Events

Date	Declaration #	Type of event	Assistance Type[b]	Estimated Damage
May 18, 2019	4434	Severe winter storms, flooding, landslides and mudslides	IA. PA, HMGP	N/A
May 18, 2017	4308	Severe winter storms, flooding, mudslides	IA, PA, HMGP	N/A
February 14, 2017	4301	Severe winter storms, flooding and mudslides	IA, PA, HMGP	N/A
February 14, 2017	4302	Hoopa Valley Tribe severe winter storm	PA, HMGP	N/A
February 3, 2006	1628	Flooding, severe winter storms, landslides	PA	$20.3 million[a]
February 9, 1998	1203	Severe winter storms, flooding	PA	$7.75 million
January 4, 1997	1155	Severe winter storms, flooding	IA, PA	$35 million
March 12, 1995	1046	Severe winter storms, flooding		$1.3 million[a]
January 9, 1995	1044	Winter storms, flooding, landslides, mud flows	IA, PA	$15 million
February 25, 1992	935	Flooding	N/A	N/A
February 21, 1986	758	Flooding	N/A	$5.0 million[a]
January 25, 1983	677	Coastal storms, floods, slides, tornados	N/A	$3.84 million[a]
February 8, 1973	364	Severe storms, high tides, flooding	N/A	N/A
December, 1964	N/A	Severe winter storms, flooding	N/A	$100 million
December 1955	N/A	Severe winter storms, flooding	N/A	$22 million

a. Data obtained from Spatial Hazard Events and Losses Database for the United States
b. IA = Individual Assistance; PA = Public Assistance; HMGP = Hazard Mitigation Grant Program; N/A = Information not available or applicable

10.2.4 Location

Figure 10-3 shows the extent of the flood hazard in Humboldt County based on the currently effective FIRMs (Flood Insurance Rate Maps) generated by FEMA under the National Flood Insurance Program. The FIRMs are the principle tool used to identify the extent and location of the flood hazard. FEMA and the floodplain management community acknowledge that FIRMs are not a total depiction of an area's flood risk. The FIRMs represent the best data source available, but the level of risk they indicate may be understated or overstated compared to current conditions. The following limitations to the accuracy of these maps need to be recognized:

- FIRMs are based on hydrologic conditions at the time they are prepared. FIRMs are not set up to account for changes in hydrology over time. The age of the FIRMs used for this assessment range from 10 years to 25 years. Therefore, these maps do not reflect the conditions of the watershed as they exist today.
- FIRMs do not account for the flood protection benefits of levees unless the levees are certified as providing 100-year flood protection (according to criteria specified in Section 65.10 of 44 CFR). The national levee policy is in a state of flux in light of the impacts of Hurricane Katrina in 2005. Some levees in Humboldt County are recognized as 100-year levees on the FIRM, others are not. The age of the maps draws into question the level of protection provided by the levees today. The potential for levees to be certifiable in their current condition requires costly, detailed risk-based analyses.

10.2.5 Frequency

Assigning recurrence intervals to the discharges of historical floods on different rivers can help indicate the intensity of a storm over a large area. For example, the 1964 flood event was determined to have a 290-year recurrence interval on the Eel River, while the recurrence interval for the Mad River was determined to be a 50-year event.

Insert Map

Figure 10-3. FEMA DFIRM Flood Hazard Areas

The planning area can expect an average of one episode of minor river flooding each winter. Winter floods inundate most of the county's 1-percent-annual-chance floodplain at intervals of 3 to 10 years. Large, damaging floods typically occur every 10 years. The frequency of flooding in smaller streams and basins can be expected to increase somewhat as a result of increased development, increasing the amount of impervious surface.

10.2.6 Severity

The principal factors affecting flood damage are flood depth and velocity. The deeper and faster flood flows become, the more damage they can cause. Shallow flooding with high velocities can cause as much damage as deep flooding with slow velocity. Wave action has significant velocity, and waves as small as 1.5 feet can cause substantial damage to structures and other development.

Flood severity for riverine flooding is often evaluated by examining peak discharges; Table 10-2 lists peak flows used by FEMA to map the floodplains of the planning area. Peak discharge is generally described using the measurement cubic feet per second. A discharge rate of 20,000 cubic feet per second would fill an Olympic size swimming pool in about 4 seconds.

Table 10-2. Summary of Peak Discharges in the Planning Area

	Discharge (cubic feet/second)			
Source/Location	10-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance	0.2-Percent Annual Chance
Dave's Creek				
Downstream of Tributary near Hatchery Road	580	890	1,000	1,260
Upstream of Tributary near Hatchery Road	520	800	900	1,130
Eastside Channel				
Upstream of Van Ness Avenue	*	*	140	*
Eel River				
Eel River, at the Mouth	390,000	601,000	695,000	924,000
Eel River, at Scotia	331,000	521,000	680,000	820,000
Van Duzen River				
at the Mouth	60,000	84,000	94,000	117,000
at confluence with Yaeger Creek	39,000	54,000	60,000	75,000
Francis Creek				
Grizzly Bluff Road to confluence with Salt River	*	*	831	*
Freshwater Creek				
At Myrtle Avenue downstream of confluence of Little Freshwater Creek	54,00	8,600	10,000	14,200
Upstream of confluence of Little Freshwater Creek	4,050	64,00	7,400	10,700
Hillside Creek				
At confluence with Rohner Creek	-	-	249	-
Jacoby Creek				
At Myrtle Avenue	3,110	4,560	5,070	6,290
Janes Creek				
At upper limit of detailed study	520	800	900	1,120
At Q Street	610	920	1,030	1,290
Jolly Giant Creek				
At Alliance Road	180	270	310	380
At 11th Street	200	300	340	420

Source/Location	Discharge (cubic feet/second) 10-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance	0.2-Percent Annual Chance
Mad River				
At USGS Gaging Station near Arcata (No. 11481000)	58'360	81,270	90,960	113,480
Downstream of confluence with North Fork Mad River	53,790	74,910	83,840	104,600
Below confluence of North Fork Mad River	47,500	66,900	74,700	92,100
Above confluence of North Fork Mad River	42,900	60,500	67,600	83,300
North Fork Mad River				
Above confluence with Mad River	12,700	18,300	20,500	26,000
Redwood Creek				
At Orick, CA	39,000	52,600	57,700	68,000
At USGS Gaging Station at Orick (No. 11482500)	40,563	54,044	58,868	68,395
Rohner Creek				
Upstream of Strongs Creek	760	1,150	1,290	1,620
Upstream of Hillside Creek	640	980	1,100	1,380
At Corporate Limits	550	840	940	1,180
South Fork Eel River				
At Redway	104,000	159,000	166,000	213,000
Strongs Creek				
At Southern Pacific Railroad	1,990	3,000	3,350	4,210
Upstream of Mill Creek	1,660	,2510	2,810	3,520
Downstream of Jameson Creek	1,620	2,440	2,730	3,430
Upstream of Jameson Creek	1,350	2,050	2,290	2,880
Downstream of Loop Road Drainage	1,280	1,940	2,170	2,720
Upstream of Loop Road Drainage	1,260	1,910	2,140	2,690
Trinity River				
downstream of confluence with Kirkham Creek	98,800	158,000	184,000	250,000
Williams Creek				
At Grizzly Bluff Road, at confluence with Salt River	*	*	1,985	*

* Data not available
Source: FEMA Flood Insurance Study Number 06023CV001B, Humboldt County, California and Incorporated Areas, August 31, 2018

Table 10-3 summarizes the still-water elevations along the Humboldt Bay coastline, representing the steady state water depth not accounting for breaking waves. These are the projected elevations of floodwaters in the absence of waves resulting from wind or seismic effects. In coastal areas, still-water elevations are determined when modeling coastal storm surge; the results of overland wave modeling are used in conjunction with the still-water elevations to develop the coastal base flood elevations.

Flood severity from coastal flooding is determined by wave runup and setup. Table 10-4 shows the storm surge water levels used for mapping the coastal floodplains in the planning area. Base flood elevations that include wave height range from 18 to 55 feet for a 1-percent-annual-chance event in the planning area.

Table 10-3. Summary of Still-Water Elevations Along Humboldt Bay

Flooding Source/Location	Still-Water Elevation[a] (feet) 10-Year	50-Year	100-Year	500-Year
Humboldt Bay at Eureka (southwestern corporate limits)	8.87	9.27	9.37	9.67
Humboldt Bay at King Salmon	8.87	9.27	9.37	9.67

a. Elevation in 1988 North American Vertical Datum
Source: FEMA Flood Insurance Study Number 06023CV001B, Humboldt County, California and Incorporated Areas, August 31, 2018

Table 10-4. Regional Storm Surge Water Elevations

	Regional Storm Surge Water Elevations (feet, North American Vertical Datum)	
	Humboldt Bay, North Spit	Shelter Cove
50-percent	8.5	7.8
20-percent	8.9	8.2
10-percent	9.2	8.4
4-percent	9.6	8.8
2-percent	9.96	9.0
1-percent	10.2	9.3
0.2 percent	11.0	10.1

Source: FEMA Flood Insurance Study Number 06023CV001B, Humboldt County, California and Incorporated Areas, August 31, 2018

10.2.7 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. Flash flooding is infrequent in the planning area.

As major storm systems approach, the National Weather Service, in coordination with the California Department of Water Resources, monitors weather conditions and real-time precipitation and river stage data; forecasts the amount and timing of expected precipitation; and issues official river forecasts and hydrologic statements. Updated a minimum of twice daily, these river forecasts are available as both text products and as graphical river guidance plots, which provide river stage information for each official forecast point for the next five days following the forecast issuance. As storm events continue with streams and rivers rising to threatening levels, these forecasts may be updated more frequently if needed. Graphical river guidance plots can be accessed at these websites:

- http://www.cnrfc.noaa.gov
- http://cdec.water.ca.gov/guidance_plots/

The *Humboldt County Emergency Operations Plan and Flood Response Plan* guides the overall actions of emergency responders, including the following flood-related measures:

- **Pre-Flooding Readiness**—Potential actions when flooding has not occurred but prevailing conditions and forecasts indicate possible flooding within a specified time period:
  - Close monitoring of weather forecasts and water levels within rivers and levees
  - Dissemination of flood awareness and preparedness information to the public
  - Mobilization of response resources

- ➢ Possible activation of the Emergency Operations Center in preparation for potential flooding

- **Flood Emergency Response**—Actions when flooding is occurring or has occurred and immediate mitigation and emergency response measures are required:
  - ➢ Emergency Operations Center activation (Partial Activation)—Partial activation means command staff, section chiefs, and other branches, units and agency representatives are activated as appropriate for the situation
  - ➢ Deployment of flood fighting and public safety resources throughout impacted areas
  - ➢ Rescue of persons imperiled or trapped by flood conditions
  - ➢ Appropriate public information broadcasts
  - ➢ Initiation of preparatory and emergency evacuation of threatened populations
  - ➢ Protection of essential services and critical infrastructure.

10.3 SECONDARY HAZARDS

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

10.4 EXPOSURE

A quantitative assessment of exposure to the dam failure hazard was conducted using the flood mapping shown in Figure 10-3 and the asset inventory developed for this plan (See Section 6.3). Detailed results are provided in Appendix C and summarized below.

10.4.1 Population

Population was estimated using the residential building count in the flood hazard areas and multiplying by the 2018 estimated average population per household from the California Department of Finance. Using this approach, the estimated population residing in the 1-percent-annual-chance flood hazard area is 4.3 percent of the planning area population (5,834 people). The population residing in the 0.2-percent-annual-chance flood hazard area is also about 5 percent of the planning area population (6,824 people). Of these exposed populations, 71.5 percent live in the unincorporated county.

10.4.2 Property

An estimated 8.7 percent (more than $3 billion) of the total replacement value of the planning area is located in the 1-percent-annual-chance flood hazard area and 10.6 percent (more than $3.7 billion) is located in the 0.2-percent-annual-chance flood hazard area. Figure 10-4 and Figure 10-5 show the percentage and count, by land use type, of exposed planning area structures. Over half of the exposed structures are in the unincorporated county.

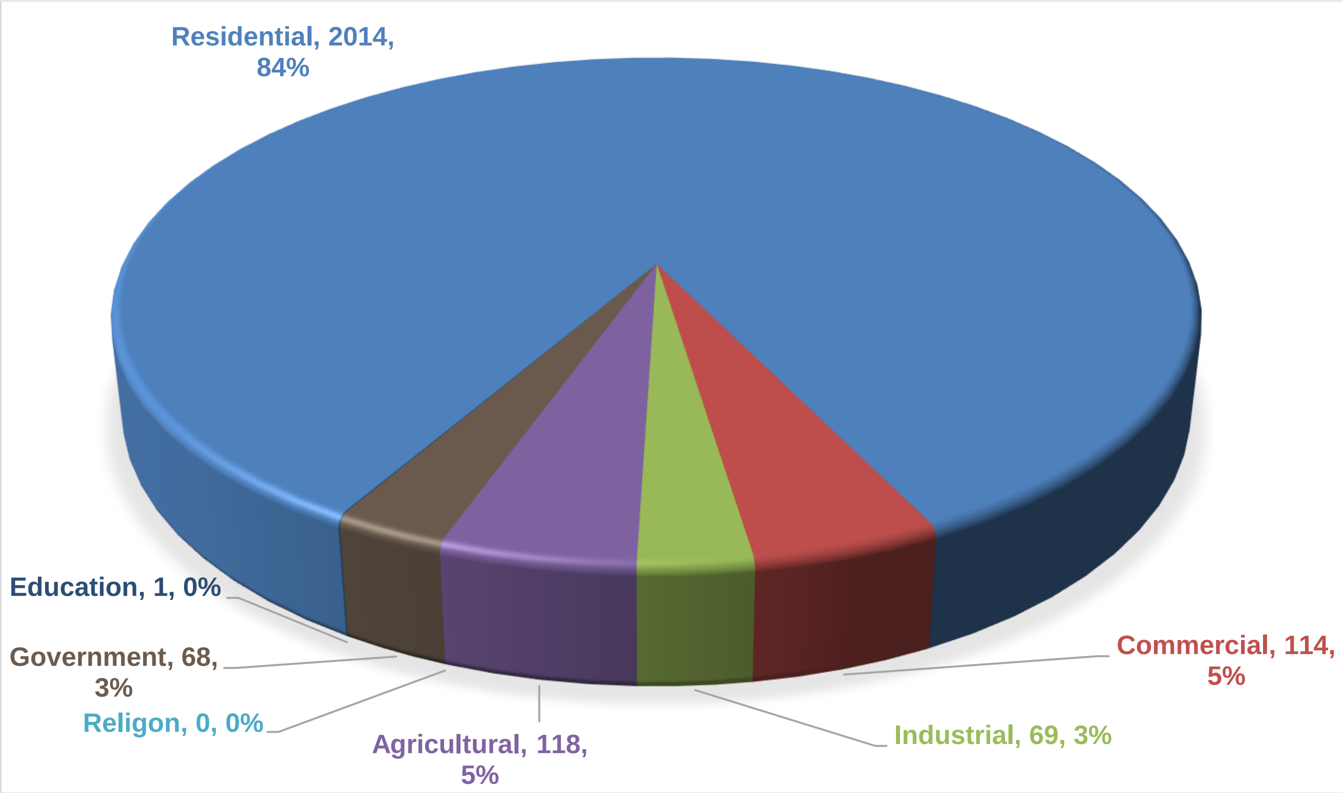


Figure 10-4. Structures in the 1-percent-annual-chance Flood Hazard Area, by Land Use

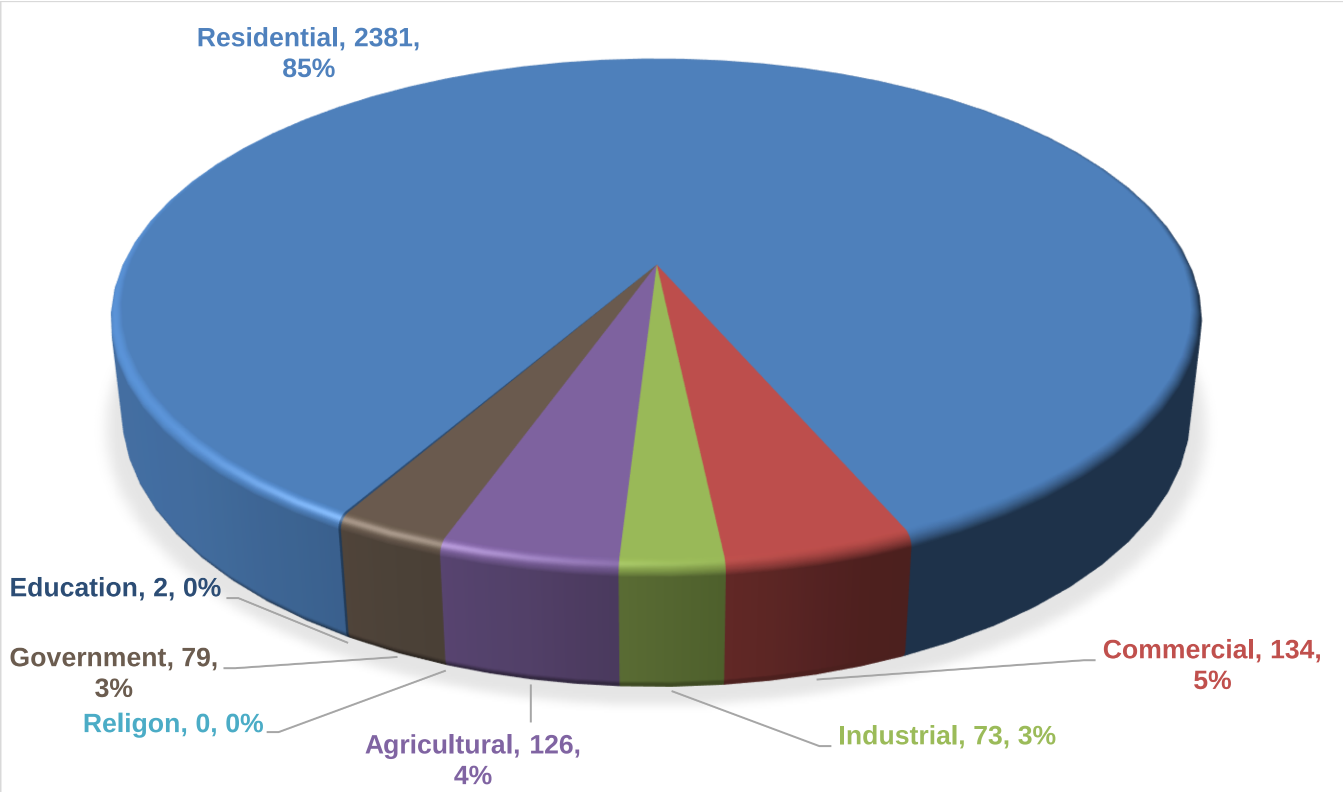


Figure 10-5. Structures in the 0.2-percent-annual-chance Flood Hazard Area, by Land Use

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 10-5 shows the existing land use of all parcels in the 1 percent-annual-chance floodplain. For parcels in cities, residential, commercial and public/open space are the dominant land uses. In unincorporated areas, residential and timber/forest are the dominant land uses. This assessment found that 24 percent of the parcels within the 1 percent-annual-chance floodplain are vacant or undeveloped. Combining the vacant lands with open space or low-density land uses, 57 percent of the parcels in the 1 percent-annual-chance floodplain have existing uses considered to be lower-risk uses for the floodplain.

Table 10-5. General Land Use of Parcels in 1 Percent-Annual-Chance Floodplain

Land Use	Parcels in 1 Percent-Annual-Chance Floodplain								
	Arcata	Blue Lake	Eureka	Ferndale	Fortuna	Rio Dell	Trinidad	Unincorporated County	Total
Residential	277	1	44	74	162	70	4	2969	3601
Commercial	17	3	24	11	57	3	0	81	196
Light Industrial	14	1	22	0	5	0	0	28	70
Heavy Industrial	1	0	4	0	2	0	0	24	31
Agricultural	1	0	0	0	0	0	0	94	95
Timber/Forest	0	0	0	0	0	0	0	1474	1474
Public Lands	59	10	146	9	23	12	0	1229	**1488**
Vacant lands	62	2	64	17	50	17	3	1929	2144
Total	**431**	17	**304**	**111**	**299**	**102**	**7**	**7828**	**9099**

10.4.3 Critical Facilities and Infrastructure

Critical facilities and infrastructure exposed to the flood hazard represent 23.5 percent (257 facilities) of the total critical infrastructure and facilities in the planning area for the 1-percent-annual-chance flood hazard and 24 percent (260 facilities) for the 0.2-percent-annual-chance flood hazard. The breakdown of exposure by facility type is shown in Figure 10-6. Linear infrastructure is also exposed, including utility lines and roads.

Major Roads and Bridges

The following major roads in Humboldt County pass through the 1-percent-annual-chance flood hazard area and thus are exposed to flooding:

- U.S. 101
- Highway 211
- Highway 255
- Highway 254
- Highway 96
- Highway 1
- Highway 36
- Highway 299
- King Salmon Avenue

Some of these roads are built above the flood level and some function as levees to prevent flooding. Still, in certain events these roads may be blocked or damaged by flooding, preventing access to many areas. An analysis showed that there are 128 bridges that are in or cross over the 1 percent-annual-chance floodplain.

Levees

The County maintains levees on the Mad River near the City of Blue Lake, on the Eel River near the City of Fortuna and on Redwood Creek near Orick. The Corps of Engineers built the Mad River levee in 1955, the Eel River levee in 1958-1959, and the Redwood Creek flood control project in 1968. The county also has nearly 100 non-federal levees.

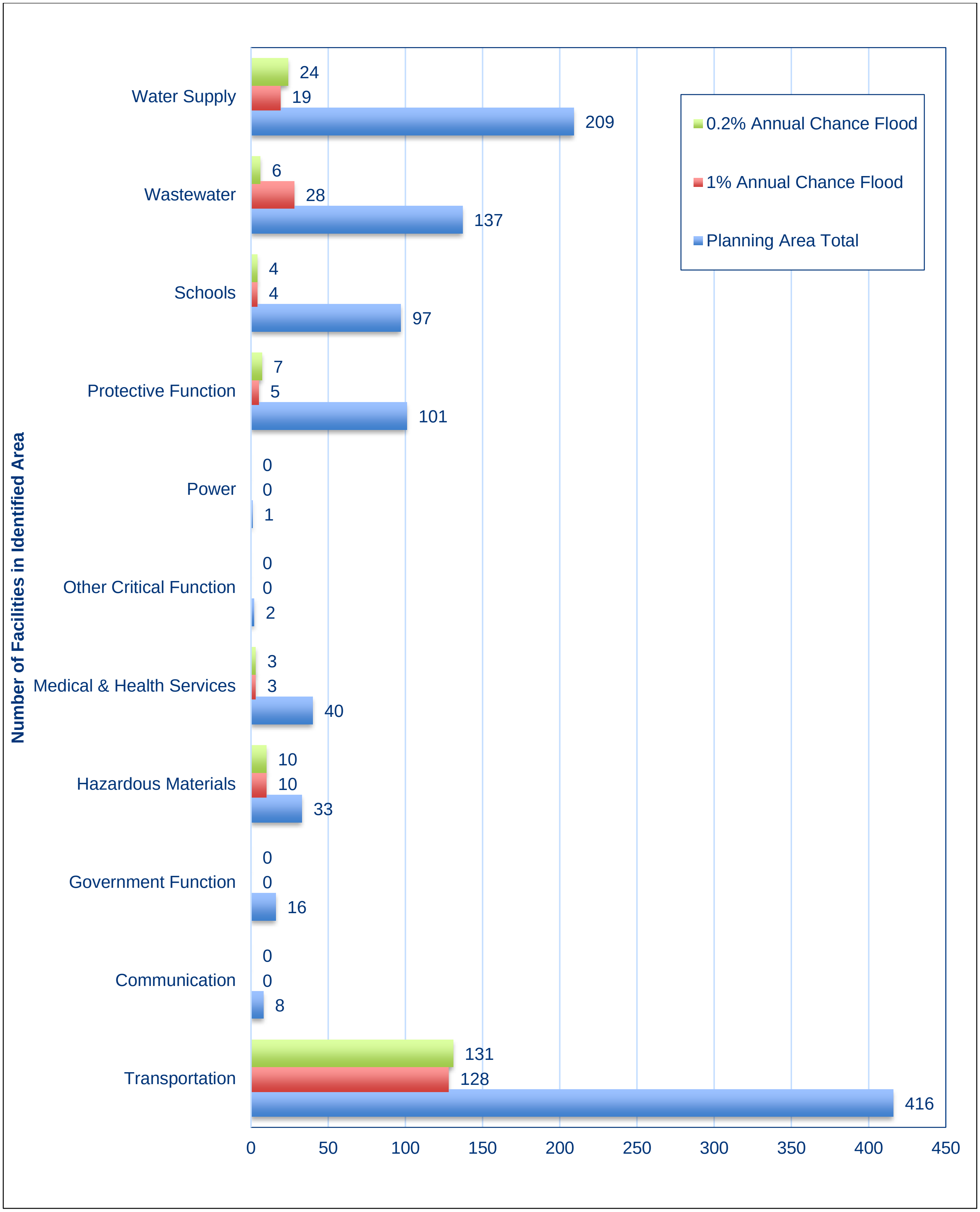


Figure 10-6. Critical Facilities and Infrastructure in Mapped Flood Hazard Areas and Countywide

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.

10.4.4 Environment

Flooding is a natural event, and floodplains provide many natural and beneficial functions. Nonetheless, 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.

10.5 VULNERABILITY

The results of the vulnerability assessment indicate estimated damage for the 1-percent and 0.2-percent-annual-chance flood hazards. It is rare that floodplains throughout the entire planning area would experience a flood of these magnitudes simultaneously.

10.5.1 Population

Displaced Persons and Vulnerable Populations

The Hazus analysis of impacts on persons and households in the planning area estimated that 1,382 people and 1,704 people could be displaced by the 1- and 0.2-percent-annual-chance events, respectively. Hazus estimated that 67 people and 83 people would need short term sheltering following the 1- and 0.2-percent-annual-chance events, respectively. Those who have trouble evacuating, especially if waters rise suddenly without much warning, are most vulnerable. This includes those with access and functional needs, the elderly, and the very young. In addition, economically disadvantaged populations whose houses are impacted by flood events may not have the means to make repairs, especially if they do not have flood insurance. A geographic analysis of demographics using the Hazus model identified populations vulnerable to the flood hazard as follows:

- **Economically Disadvantaged Populations**—Recent catastrophic events on a national scale have shown that economically disadvantaged populations tend to make decisions on their risk exposure based on the net economic impact on their families. It costs money for people to evacuate their homes. If the level of risk is not perceived as high, people often choose to “ride out” the impacts of flood events. For the purposes of this risk assessment, the planning team and the Steering Committee defined “economically disadvantaged” as households with a net annual income of $20,000 or less, based on county demographic data and national standards established for this type of analysis. Based on these parameters, 12.5 percent of the people in the 1 percent-annual-chance floodplain are economically disadvantaged.
- **Population over 65 Years Old**—It is estimated that 12 percent of the population in the census blocks that intersect the floodplain and floodway in the planning area are over 65 years old. This group makes up about 1.0 percent of the total population for the planning area. This population group is vulnerable because they are more likely to need special medical attention. During flood events, this may not be available due to isolation caused by flooding. Furthermore, elderly residents have more difficulty leaving their homes during flood events and could be stranded in dangerous situations. Approximately 5 percent of the over-65 population also have incomes considered to be economically disadvantaged and would be considered to be extremely vulnerable.

- **Population under 16 Years Old**—It is estimated that 21 percent of the population within census blocks located in or near the 1 percent-annual-chance floodplain are under 16 years of age. This represents 1.8 percent of the total population for the planning area. This population is vulnerable because of their young age and dependence on others for basic necessities such as food, water and clothing. Very young children are also vulnerable to injury or sickness; this vulnerability can be worsened during a flood because they may not understand the measures that need to be taken to protect themselves from hazards.

10.5.2 Property

Property Impacted and Flood Insurance Statistics

The most vulnerable structures in the planning area are those that are not constructed to standards to withstand the impacts of a flood. Such structures may have been built before flood damage prevention regulations were in effect or may not be subject to flood-related building codes because they are outside mapped flood hazard areas.

Table 10-6 summarizes planning area participation in the NFIP. The average flood insurance claim paid out in the planning area since participation in NFIP began is $11,973, indicating that many of these claims were likely for slight to moderate damage. The number of flood insurance policies in force in the planning area has decreased by 24 percent since the last hazard mitigations plan was developed in 2014; the biggest decrease was in unincorporated portions of the County. The decrease in policies occurred even though the County’s special flood hazard area increased by over 12,300 acres due to new FEMA mapping. Increases in mapped floodplain usually trigger increases in insurance policy base.

Table 10-6. Flood Insurance Statistics

Jurisdiction	Date of Entry Initial FIRM Effective Date	# of Flood Insurance Policies as of 9/30/2018	% Change from 2014 Plan	Insurance In Force	Total Annual Premium	Claims, 11/1978 to 09/30/2018	Value of Claims paid, 11/1978 to 09/30/2018
Arcata	05/02/1983	94	-55%	$21,474,800	$114,085	18	$186,652.55
Blue Lake	09/30/1982	13	+8%	$2,988,500	$9,168	2	$7,851.86
Eureka	06/01/1982	22	-15%	$5,797,000	$21,005	4	$30,889.91
Ferndale	12/01/1993	16	-15.8%	$4,055,600	$8,299	3	$19,741.49
Fortuna	05/03/1982	76	+22.5	$19,567,400	$62,012	4	$5,968.84
Rio Dell	05/03/1982	4	+50%	$554,100	$4,713	5	30,939.89
Unincorporated	07/19/1982	580	-26.7%	$118,041,700	$614,484	160	$2,064,622.64
Total		805	**-24.4%**	**$**172,479,100	**$**833,766	**196**	**$**2,346,667

There are few flood insurance policies in effect in the planning area outside of the special flood hazard area. If all of the current policies are for structures in the special flood hazard area, then 66 percent of exposed structures still lack flood insurance.

Repetitive Loss Properties

A repetitive loss property is any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling ten-year period, since 1978. FEMA’s list of repetitive loss properties identifies 10 such properties in the Humboldt County planning area, as of May 1, 2012, as summarized in Table 10-7. None of these properties are outside an identified floodplain. They likely were flooded by flood events typical for the floodplain reflected in the current mapping. Note that the special purpose district planning partners to this plan have no identified repetitive loss properties because districts are not eligible participants in the NFIP.

Table 10-7. Repetitive Loss Properties in Humboldt County

Jurisdiction	Repetitive Loss Properties	Properties That Have Been Mitigated	Number of Corrections	Corrected Number of Repetitive Loss Properties
Arcata	1	0	0	1
Unincorporated County	9	2	2[a]	5
Totals	**10**	**2**	**2**	**6**

a. Information provided not sufficient to locate property
Source: January 31, 2019, FEMA Report of Repetitive Losses

The dates of loss coincide with major flood events in the planning area. 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. It can also be concluded that the entire mapped floodplain within Humboldt County can be and is subject to repetitive flooding. Therefore, the Planning Team has defined the Repetitive Loss Area to be contiguous with the currently mapped and regulated 1 percent-annual-chance floodplain.

The County's repetitive loss list has not changed for two planning cycles. The most recent claim paid on any repetitive loss property in the planning area was in 2002—it has been over 17 years since claims have been filed that would trigger an increase in repetitive losses within the planning area. The risk of chronic repetitive loss in the Humboldt County planning area has been reduced in large part due to land use mitigation measures. Flood events are occurring in the planning area, but these events do not seem to be triggering flood insurance claims, likely due to rising costs and the observed decline in flood insurance coverage within the planning area.

Damage Estimates

Table 10-8 summarizes Hazus estimates of flood damage in the planning area. The debris estimate includes only structural debris and building finishes; it does not include additional debris that may result from a flood event, such as from trees, sediment, building contents, bridges or utility lines.

Table 10-8. Estimated Impact of a Flood Event in the Planning Area

Damage Type	1%-Annual-Chance Event	0.2%-Annual-Chance Event
Structure Debris (Tons)	100,806	116,627
Buildings Impacted	1,606	1,888
Total Value (Structure + Contents) Damaged	$664.5 million	$994.6 million
Damage as % of Total Value	1.9%	2.8%

10.5.3 Critical Facilities and Infrastructure

Hazus 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 correlates these estimates into an estimate of functional downtime (the estimated time it will take to restore a facility to 100 percent of its functionality). This helps to gauge how long the planning area could have limited usage of facilities deemed critical to flood response and recovery. The results are as follows:

- **1 percent-annual-chance flood event**—On average, critical facilities would receive 11.7 percent damage to the structure and 33.8 percent damage to the contents during a 1 percent-annual-chance flood event. The estimated time to restore these facilities to 100 percent of their functionality is 510 days.
- **0.2 percent-annual-chance flood event**—A 0.2 percent-annual-chance flood would damage structures an average of 11.7 percent and the contents an average 40.6 percent. The estimated time to restore these facilities to 100 percent of their functionality after a 0.2 percent-annual-chance event is 529 days.

Hazardous Materials

According to the Cal OES Hazardous Materials Spills Reporting Database, there were 88 reported spills in Humboldt County in 2018, none of which caused any fatalities or injuries (Cal OES, 2019). It is not known if any of these events occurred in an identified floodplain. However, if any of these events were triggered by a flood, these facilities could release chemicals that cause cancer or other human health effects, significant adverse acute human health effects, or significant adverse environmental effects. Thirty-four of the reported 88 spill events resulted in hazardous material exposure to waterways and receiving water bodies in the planning area in 2018. During a flood event, containers holding these materials can rupture and leak into the surrounding area, disastrously affecting the environment and residents.

Utilities and Infrastructure

Roads that are blocked or damaged can isolate residents and can prevent access throughout the planning area, 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. Underground utilities can be damaged. Levees can fail or be overtopped, inundating the land that they protect. 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.

10.5.4 Environment

The environment vulnerable to flood hazard is the same as the environment exposed to the hazard. Loss estimation platforms such as Hazus 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.

10.6 FUTURE TRENDS IN DEVELOPMENT

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 update. This will create an opportunity for wise land use decisions as future growth impacts flood hazard areas. In addition, partners who are participating in good standing in the NFIP have agreed to regulate new development in the mapped floodplain according to standards that equal or exceed those specified under 44 CFR Section 60.3. This will ensure that any development allowed in the floodplain will be constructed such that the flood risk exposure is eliminated or significantly reduced.

10.7 SCENARIO

The major river systems in Humboldt County flood at irregular intervals, but 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 storms can cause severe flooding in Humboldt County. The worst-case scenario is a series of storms that flood numerous drainage basins in a short time. This would overwhelm city and county response and floodplain management departments. Major roads would be blocked, preventing access for many residents and critical functions. High river flows could cause rivers 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.

10.8 ISSUES

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

- It is estimated that a number of structures in the planning area were built before any regulations existed on floodplain development. These structures may be particularly vulnerable to the flood hazard.
- No critical facilities in the planning area are expected to be substantially damaged by a 1-percent-annual-chance flood.
- 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 Redwood Creek levee system was not designed to account for the major sediment loading coming from the upper watershed, associated with historical logging and road-building. The capacity of the system is reduced every year by the deposition of thousands of cubic yards of sediment. The County annually excavates accumulated sediment to the extent feasible, but environmental laws prevent the level of removal needed to restore the design capacity. The County has been working with the National Park Service, the Redwood Creek Watershed Group, and others to request Congressional funding for a reconnaissance study by the Corps of Engineers. The reconnaissance study would provide a vehicle for local, state, and federal stakeholders to identify opportunities for long-term flood control for the community and enhancement of the lower Redwood Creek and estuary, which were severely impacted by construction of the levees. The reconnaissance study would be a Section 905(b) analysis authorized under Section 216 of the River and Harbors Flood Control Act of 1970 (33 USC 426 et. seq.) as amended. Setback levees in some form could help ensure continued flood protection, provide environmental restoration, and allow continued agricultural use of adjacent lands.
- The risk associated with the flood hazard overlaps the risk associated with other hazards such as earthquake, landslide and fish losses. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.
- There is no degree of consistency in land-use practices and regulatory floodplain management scope within the planning area.
- Climate change has the potential to impact flood conditions in the planning area
- Climate change may cause more extensive flood problems due to possible sea level rise and more severe weather patterns. Consequently, the 0.2 percent-annual-chance floodplain inundation area may become a higher probability risk. Coastal flood hazard ratings may also need to be reviewed.
- 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.
- Coordinated hazard mitigation efforts among jurisdictions affected by flood hazards in the county are recommended.
- Floodplain residents should 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.

- The economy affects a jurisdiction’s ability to manage its floodplains. Budget cuts and personnel losses can strain resources needed to support floodplain management.
- The planning area experienced a significant decrease in flood insurance coverage during the 2014 plan performance period. This could be attributed to the increasing cost of flood insurance and other hazard-specific additional coverage.

11. LANDSLIDE

11.1 GENERAL BACKGROUND

11.1.1 Landslide Types

Landslides are commonly categorized by the type of initial ground failure. Common types of slides are shown on Figure 11-1 through Figure 11-4. 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, which are less common than other types.

Source: Washington Department of Ecology, 2014

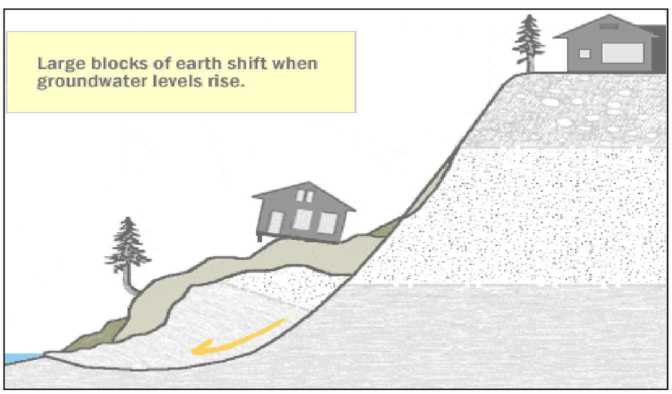


Figure 11-1. Deep Seated Slide

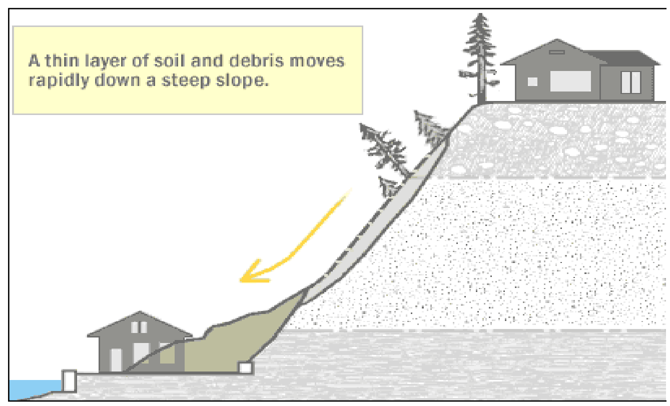


Figure 11-2. Shallow Colluvial Slide

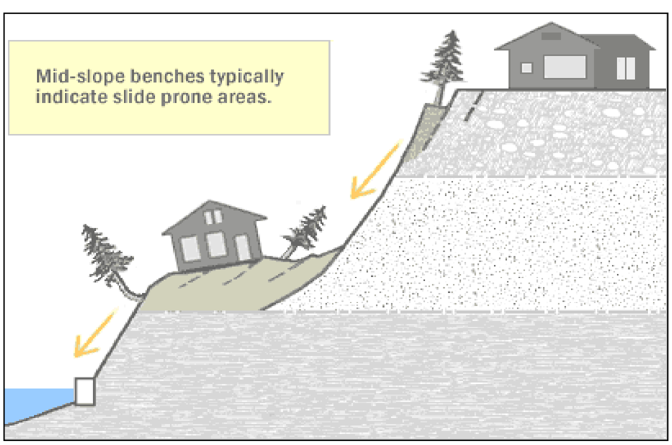


Figure 11-3. Bench Slide

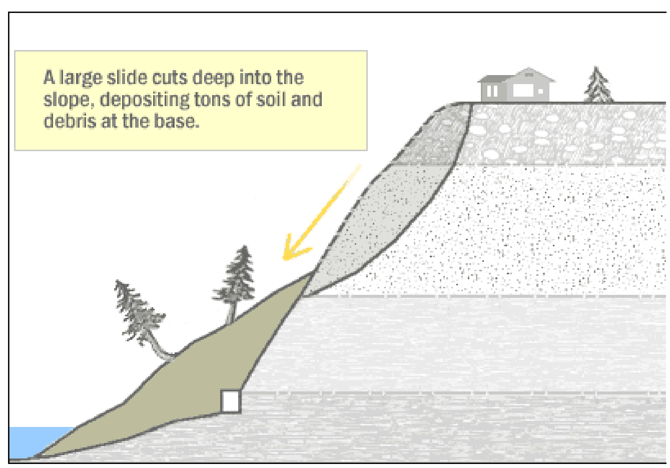


Figure 11-4. Large Slide

Other landslide types also include the following:

- **Block slides**—Blocks of rock that slide along a slip plane as a unit down a slope.
- **Creep**—A slow-moving landslide often only noticed through crooked trees and disturbed structures.
- **Debris avalanche**—A debris flow that travels faster than about 10 miles per hour (mph). Speeds in excess of 20 mph are not uncommon, and speeds in excess of 100 mph, although rare, can occur. The slurry can travel miles from its source, growing as it descends, picking up trees, boulders, cars, and anything else in its path (Figure 11-5).
- **Earth flows**—Fine-grained sediments that flow downhill and typically form a fan structure.
- **Mudslides or Debris Flows**—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.
- **Rock falls**—Blocks of rock that fall away from a bedrock unit without a rotational component.
- **Rock topples**—Blocks of rock that fall away from a bedrock unit with a rotational component.
- **Rotational slumps**—Blocks of fine-grained sediment that rotate and move down slope.
- **Transitional slides**—Sediments that move along a flat surface without a rotational component.

Source: California Department of Conservation, 2017c

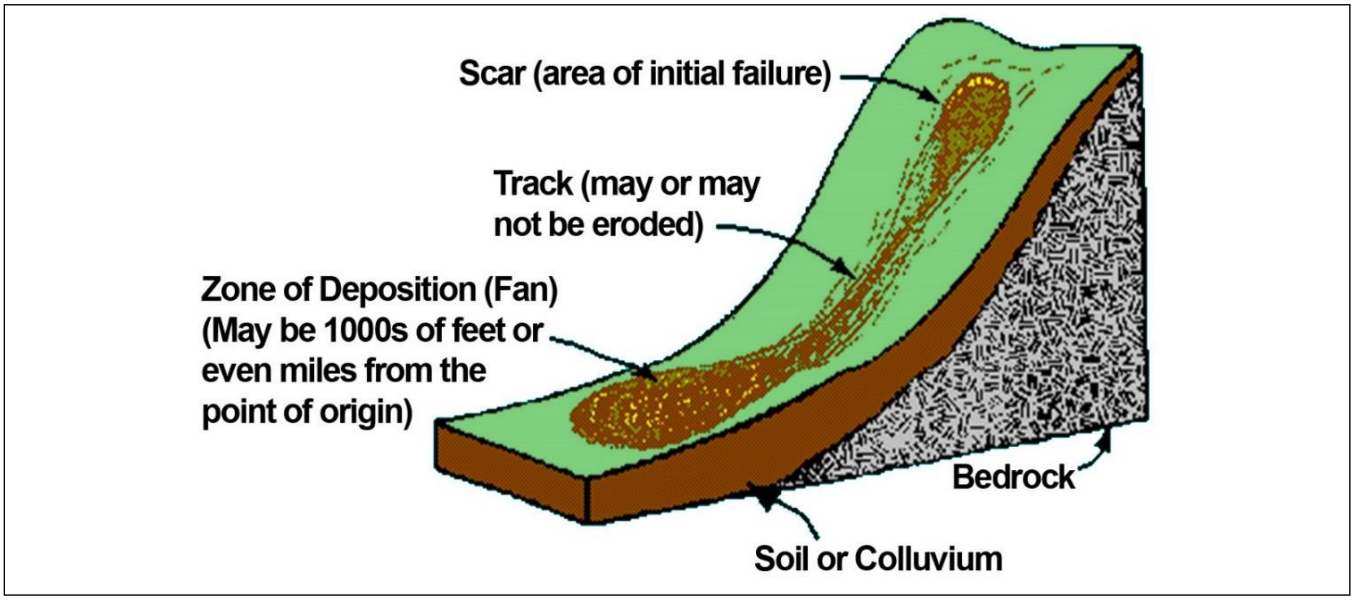


Figure 11-5. Typical Debris Avalanche Scar and Track

11.1.2 Factors Causing Landslides

Landslides are caused by a combination of geological and climate conditions, as well as encroaching urbanization. Vulnerable areas are affected by residential, agricultural, commercial, and industrial development and the infrastructure that supports it. Factors causing landslides fall into two categories:

- Factors that increase driving forces:
  - Steepening the slope
  - Adding weight to (loading) the slope, especially the upper parts
  - Increasing the height of a slope (either by human or natural downcutting)
  - Seismic shaking

- Factors that reduce resisting forces:
  - Adding water to the slope, which causes increased pore pressure, which reduces frictional strength
  - Steepening the slope, which reduces normal stress, and thus reduces internal friction
  - Bedding, jointing, or foliation parallel to slope or dipping out of slope—these discontinuities are low-strength zones along which the rock can fail and slide out of the slope
  - Intrinsically weak materials (e.g., deeply weathered, sheared, unconsolidated, or clay-rich materials)
  - Undercutting the slope, which reduces support
  - Removing vegetation, especially trees, which reduces root strength and leads to increased water in soil due to reduced evaporation losses
  - Seismic shaking
  - Coastal bluff erosion caused by wave action

11.2 HAZARD PROFILE

11.2.1 Past Events

Landside activity is frequent in Humboldt County, with the severity ranging from minor to severe. Table 11-1 lists the known damage-causing landslides that have occurred in the County.

Table 11-1. Landslide Events in Humboldt

Dates of Event	Primary Event Type	FEMA Disaster #	Losses/Impacts
5/18/2019	Severe Winter Storms	DR-4434	Flooding, landslides and mudslides
5/18/2017	Severe Winter Storms	DR-4308	Flooding, mudslides
2/14/2017	Severe Winter Storms	DR-4301	Flooding, mudslides
1/9/2017	Heavy Rain	N/A	Multiple sinks in the roadway and a landslide along Highway 101 from milepost 28 to milepost 32.
12/14/2016	Heavy Rain	N/A	A landslide caused by heavy rain resulted in damage of Shelter Cove Road, the primary route from Shelter Cove at the coast to interior areas of Humboldt County.
April, 2011	Severe Winter Storms	N/A	Slide occurred between Blocksburg and Alderpoint in a rural area of southern Humboldt County. The hillside began breaking apart under heavy rain and dammed up Dobbyn Creek with mud, trees and rocks. The creek rerouted itself around the slide and threatened private property and Alder Point Road. Officials closed Casterlin Elementary
12/17/2005 – 1/3/2006	Severe Storm	DR-1628	Flooding, mudslides, and landslides
12/28/1996 – 4/1/1997	Severe Storm	DR-1155	Flooding, mud and landslides
2/13/1995	Severe Winter Storm	DR-1046	Flooding Landslides, Mud Flow
1/3/1995 – 2/10/1995	Severe Storm	DR-1044	Flooding, landslides, mud flows
1/5/1993 – 3/20/1993	Flood	DR-979	Mud & landslides, and flooding
12/19/1981	Severe Storm	DR-651	Flood, mudslides & high tide

Sources: FEMA 2019; 2014 Humboldt County operational Area Hazard Mitigation Plan, National Climatic Data Center Website, Accessed June 2019

The most recent landslide activity in the planning area occurred in February 2019. Damage from this event was enough to meet the threshold for a presidential disaster declaration. Tons of debris tumbled and slid onto Highway 101 about 5 miles north of Garberville, causing the road to buckle under the weight. California Department of Transportation estimated the slide was about 600 feet wide and about 1,500 feet up the side of the slope.

Widespread landslide damage in Humboldt county occurred during the winter storm of 2005-06. Humboldt County was a designated county included in FEMA's "California Severe Storms, Flooding, Mudslides, and Landslides" declaration after this event. Record high rains and winds of the 2005-06 winter storms resulted in thousands of large- and small-scale landslides along every major transportation corridor in the county (U.S. Highways 101, 299, 96 and 36). The result was millions of dollars in damage and much of the county being cut off from the outside world. Drainage systems and catchment basins could not handle the volume of runoff, focusing the water's energy against vulnerable slopes and manmade structures. In some cases, saturated soils became overloaded with the weight of rainwater and collapsed. Private homeowners, particularly in areas where the natural drainage has been paved or otherwise modified, also reported significant damage.

The landslide and mudslide/debris flow activity during the winter storms of 2005-06 caused widespread disruption of surface transportation. The closing of roads in places for almost a week resulted in widespread goods shortages to Eureka and the Humboldt Bay area, where the majority of the county's population resides. Slides cut off not only road transport of goods, but also services and utilities. Wind gusts up to 100 mph blew over tens of thousands of trees, which in turn knocked out power lines. Power could not be serviced until roads were cleared of trees and landslides. Many people were without power for a week or more. Given the shipping volume by road through Humboldt County, some of it involving hazardous materials, it was fortunate that no serious chemical spills occurred.

U.S. Highway 101, the main transportation corridor in northern coastal California and Humboldt County, traverses a landslide-prone area. Landslides along this corridor, especially at Confusion Hill in Mendocino County to the south (Figure 11-6 and Figure 11-7), have been an ongoing problem for decades and regularly shut down the highway. The associated costs are estimated to be over a quarter million dollars per day in travel delay and added vehicle operating costs. Over $14 million in emergency work was conducted in the area to keep the highway open in 2007, and $33 million in the last 10 years.

11.2.2 Location

Dormant Sites of Previous Landslides

One of the best predictors of where landslides might occur is the location of past landslides, which can be recognized by distinctive topographic shapes that can remain in place for thousands of years. Such sites range from a few acres to several square miles. Many show no evidence of recent movement and are not currently active. A few may become active in any given year. The recognition of ancient dormant landslide sites is important in the identification of areas susceptible to landslides because they can be reactivated by earthquakes or by exceptionally wet weather. These dormant sites are also vulnerable to construction-triggered sliding. The shoreline contains many large, deep-seated dormant landslides.

Landslide Susceptibility Mapping

In 2011, the California Geological Survey conducted a statewide analysis using a combination of regional rock strength and slope data to create classes of susceptibility to deep-seated landslides. The analysis assumed, in general, that susceptibility to deep-seated landslides is low on very low slopes in all rock materials and increases with slope and in weak rocks. The analysis also factored in locations of past landslides. Figure 11-8 shows deep-seated landslide susceptibility classes (none, low, moderate, high, and very high).

Figure 11-6. Confusion Hill Slide, April 2017

Figure 11-7. Confusion Hill Slide, View Looking South on U.S. Highway 101, Winter 2005-06

Insert Map

Figure 11-8. Susceptibility to Deep-Seated Landslides

11.2.3 Frequency

Landslides are often triggered by other natural hazards such as earthquakes, heavy rain, floods or wildfires, so their frequency is often related to the frequency of the precipitating hazards. In Humboldt County, landslides typically occur during and after severe storms, so the potential for landslides largely coincides with the potential for sequential severe storms that saturate steep, vulnerable soils. Most weather-induced landslides in the county occur in the winter after the water table has risen. Landslides that result from earthquakes can occur at any time.

Since 1993, there have been seven disaster declarations where landslide impacts were known to occur, an average of about one such event every four years. Many smaller-scale landslides occur in the planning area every year. The probability of a landslide event occurring in the County in any given year is high.

11.2.4 Severity

Landslides destroy property and infrastructure and can claim human lives. They have the potential of destabilizing the foundation of structures, which may result in monetary loss for residents. Slope failures in the United States result in an average of 25 to 50 lives lost per year and an annual cost to society of about $1.5 billion (FEMA, n.d.). Landslides can pose a serious hazard to properties on or below hillsides. They can cause block access to roads, which can isolate residents and businesses and delay commercial, public and private transportation. This can result in economic losses for businesses. Vegetation or poles on slopes can be knocked over, resulting in possible losses to power and communication lines. Landslides also can damage rivers or streams, potentially harming water quality, fisheries and spawning habitat.

The 2005-06 storms in Humboldt County caused millions of dollars in damage due to falls, slides, and mud 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

The velocity of landslides ranges 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 landslides 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 the following:

- 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 are not generally known to result in secondary hazards. However, they themselves are often secondary hazards of other event types, such as earthquakes, severe weather or wildfires. For example, severe thunderstorms over steep slopes denatured by wildfire can be susceptible to landslides.

11.4 EXPOSURE

A quantitative assessment of exposure to the landslide hazard was conducted using the susceptibility class mapping shown in Figure 11-8 and the asset inventory developed for this plan (See Section 6.3). Detailed results are provided in Appendix C and summarized below.

11.4.1 Population

Population was estimated using the residential building count in each mapped hazard area and multiplying by the 2018 estimated average population per household. Using this approach, the estimated population living in mapped landslide hazard areas is 34 percent of the total planning area population (46,381 people). Population exposure estimates by susceptibility class are shown in Table 11-2.

Table 11-2. Humboldt County Population Exposure to Landslide Hazard

Susceptibility Class	Population Exposed	% of Total Population
Moderate (susceptibility categories V and VI)	9,583	7.05
High (susceptibility categories VII, VIII and IX)	34,463	25.34
Very High (Susceptibility Category X-Includes existing landslides)	2,335	1.72
Total	**46,381**	**34.1**

11.4.2 Property

Figure 11-9 shows the percentage and count, by land use type, of planning area structures in the very high and high susceptibility classes. An estimated 89 percent of these (12,493 structures) are residential. Almost all of the structures in the very high susceptibility class are residential (778 structures), and the vast majority of them (64 percent) are in the unincorporated County.

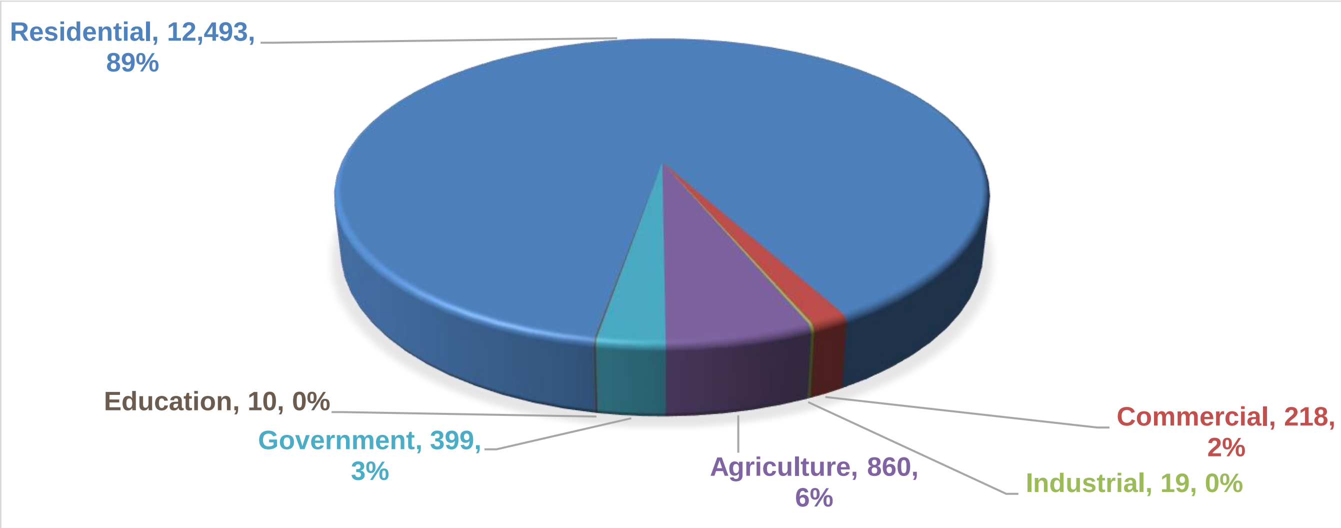


Figure 11-9. Structures in the High or Very High Landslide Susceptibility Classes, by Land Use Type

The total replacement value of property in the landslide hazard area is more than $10.5 billion—29.8 percent of the planning area total:

- Moderate susceptibility class: $2.42 billion (6.86 percent)
- High susceptibility class: $7.7 billion (21.71 percent)
- Very high susceptibility class: $439.5 million (1.25 percent)

11.4.3 Critical Facilities and Infrastructure

It is estimated that 282 critical facilities and pieces of critical infrastructure—25.8 percent of the total critical infrastructure and facilities in the planning area—are exposed to the landslide hazard to some degree. Linear infrastructure is also exposed to damage from landslides, including roads, power and phone lines. The breakdown of exposure by susceptibility class and facility type is shown in Figure 11-10.

11.4.4 Environment

Natural Resources

Landslides can destroy natural assets that are highly valued by the community. All natural resources and habitats in the mapped landslide susceptibility class areas are exposed to the landslide hazard.

Agricultural and Timber Resources

Agricultural resources include rangelands, timberlands, cultivated farmlands and dairy lands. Landslides can have major consequences to such resources, primarily timberland, due to the large percentage of such land in remote locations on steep slopes. Roads accessing timberlands are often susceptible to slides and frequently are contributing factors to landslides. Landslide activity on these roads can remove them from production.

Cultural Resources

Many cultural sites are at risk from landslides, which can destroy artifacts and structures.

Scenic Resources

Humboldt County features a broad range of scenic resources, including the coastline and Pacific Ocean, mountains, hills, ridgelines, inland water features, forests, agricultural features, and distinctive rural communities. Many of these resources or access routes to them are exposed and vulnerable to landslides.

- **Coastal Views—**Humboldt County's varied and extensive coastline allows for a wide range of scenic vistas from U.S. 101 and from beaches, state parks and coastal access points. Landslides could visually impact these views or prevent access to views.
- **Forests—**Forestlands define much of the visual landscape of Humboldt County. The scenic value of these natural resources, viewed from within or from outside, is of great importance. Landslides are a natural part of forest lands and can have an impact.
- **Scenic Highways—**Several highways in Humboldt County have unique scenic qualities because of their natural setting. Because these routes are frequently located in less developed areas, they are frequently susceptible to landslides.

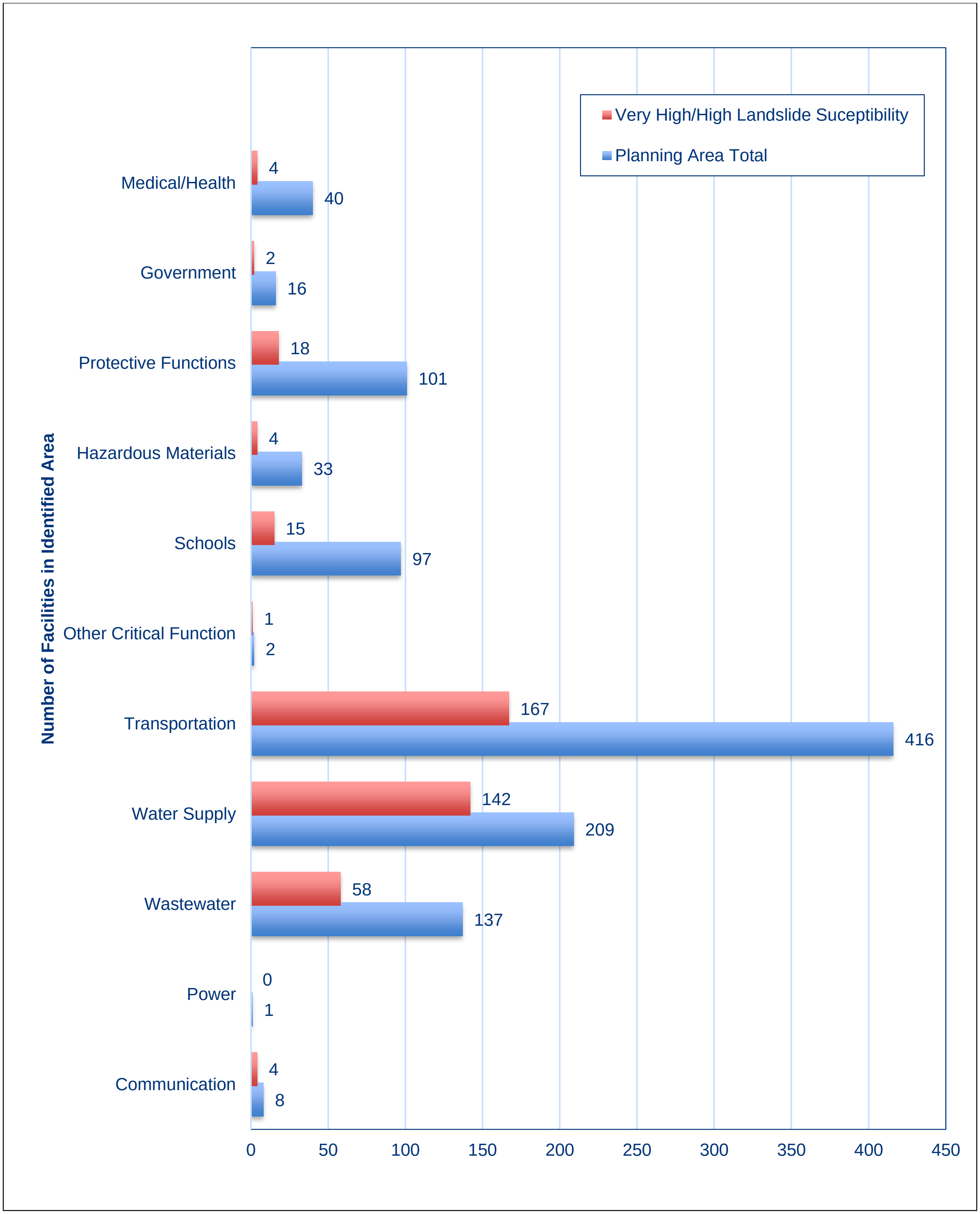


Figure 11-10. Critical Facilities and Infrastructure in Mapped Landslide Susceptibility Classes and Countywide

11.5 VULNERABILITY

Vulnerability estimates for the landslide hazard are described qualitatively. No loss estimation of these facilities was performed because damage functions have not been established for the landslide hazard. Modeling based on identified landslide hazard areas would overestimate potential losses because it is unlikely that all areas susceptible to landslides would experience landslides at the same time.

11.5.1 Population

All people exposed the landslide hazard are potentially vulnerable to landslide impacts. Populations with access and functional needs as well as elderly populations and the very young are more vulnerable to the landslide hazards as they may not be able to evacuate quickly enough to avoid the impacts of a landslide.

11.5.2 Property

All property exposed to the landslide hazard is vulnerable. Property located in very high landslide susceptibility classes is most vulnerable, especially structures that were built before modern building codes were adopted. Estimates were developed to indicate the loss that would occur if landslide damage were equal to 10, 30 or 50 percent of the exposed property value, as summarized in Table 11-3. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure.

Table 11-3. Loss Potential in the Landslide Hazard Areas

		Damage = 10% of Exposed Value		Damage = 30% of Exposed Value		Damage = 50% of Exposed Value	
Susceptibility Class	Exposed Value	Loss	% of Total Replacement Value	Loss	% of Total Replacement Value	Loss	% of Total Replacement Value
Moderate	$2.42 Billion	$242.1 million	0.69%	$726.3 million	2.06%	$1.2 billion	3.43%
High	$7.7 billion	$766.4 million	2.17%	$2.3 billion	6.51%	$3.8 billion	10.86%
Very High	$439.5 Million	$43.95 million	0.12%	$131.9million	0.37%	$219.8 million	0.62%
Total	**$10.5 billion**	**$1.05 billion**	**3%**	**$3.2 billion**	**8.9%**	**$5.3 billion**	**14.9%**

11.5.3 Critical Facilities and 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. A more in-depth analysis of the mitigation measures taken by landslide-exposed critical facilities to prevent damage from landslides should be done to determine if they could withstand impacts of a mass movement.

11.5.4 Environment

Landslides can serve beneficial functions to the natural environment, supplying sediment and large wood to stream channel networks and contributing to complexity and dynamic channel behavior critical for aquatic and riparian ecological diversity. However, landslides also can cause numerous problems for the environment:

- 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 due to landslides.
- Endangered species and their critical habitat in the planning area may be located in landslide hazard areas.

- Landslides can have major consequences for timberland due to the large portion of it on steep slopes in remote locations. Roads accessing timberlands are often susceptible to slides and erosional events and frequently are contributing factors to landslides. Landslide activity on these roads can remove them from production.
- Landslides can visually impact coastal views or prevent access to views.
- Scenic roads are frequently located in less developed areas and are therefore susceptible to landslides.

11.6 FUTURE TRENDS IN DEVELOPMENT

As the population continues to grow, more people are building and living on or otherwise modifying areas with marginal stability. Humboldt County's steep coastal bluffs and riverfront and stream-front properties are the sites of debris flows and other types of landslides, but many landslides there cannot be seen from aerial reconnaissance. These failures are only clearly visible from close quarters on the ground. These are areas of intense development pressure. An accurate picture of where landslides were triggered during previous storms is vital for making intelligent land use planning decisions. Consideration of existing landslide susceptibilities and potential hazards will reduce the risk to people and property both now and with future development. In the past, many landslide losses may have gone unrecorded because insurance companies do not cover such damages. Transportation network damage has often been repaired under the general category of maintenance.

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 update. This will create an opportunity for wise land use decisions as future growth impacts landslide hazard areas.

The California Building Standards Code has adopted the International Building Code (IBC) by reference. 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. The Humboldt County General Plan (2017) contains policies relating to managing risk to development in landslide hazard areas.

11.7 SCENARIO

Major landslides in Humboldt County occur as a result of soil conditions that have been affected by severe storms, groundwater or human development. Landslides are most likely during late winter when the water table is high. After heavy rains, 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. The worst-case scenario for landslide hazards in the planning area would generally correspond to a severe storm with heavy rain and flooding and/or high ocean waves, followed by a damaging earthquake. An earthquake that occurs when water tables are high and soils are saturated has the potential to trigger a significant number of landslides in the planning area.

11.8 ISSUES

Important issues associated with landslides in the planning area include the following:

- An accurate picture of where landslides occurred during previous storms is vital in making intelligent land use planning and mitigation decisions. In the past, many landslide losses may have gone unrecorded because insurance companies do not cover such damage. Transportation network damage has often been repaired under the general category of "maintenance." Many of the landslides on Humboldt County's steep coastal bluffs and river and stream front properties cannot be seen from aerial reconnaissance; they are only clearly visible from close quarters on the ground.

- Landslides may result in isolation of the entire county (worst case) or neighborhoods and communities, due to the fact that large portions of the transportation infrastructure are in areas of high and moderate slope instability. Isolation may result in food shortages, loss of power, and severely reduced economic productivity.
- There are critical facilities in areas of unstable slopes that could result in interruption to utility services, particularly water and power. This creates a need for mitigation and for continuity of operations planning to develop procedures for providing services without access to essential facilities.
- Landslides may result in loss of water quality to the environment and for drinking purposes, due to increased sediment delivery into surface waterways.
- There are existing homes in landslide hazard areas throughout the planning area. 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.
- The impact of climate change on landslides is uncertain. If climate change impacts the timing and intensity of rain event, then the frequency of landslide events may increase.
- 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.
- California’s Disclosures in Real Property Transactions law requires disclosure if a property is in a landslide hazard area. Such disclosure is dependent upon knowledge by the seller or the seller’s real estate agent or the posting of a landslide hazard map at the offices of the county recorder, county assessor, and county planning agency and a notice identifying the location of the map and any changes to it.
- More detailed property information is needed from the County Assessor to properly assess the risk from the landslide hazard.
- 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.
- Coastal bluff erosion is particularly susceptible to ocean wave height and the direction of wave approach. El Niño conditions often result in substantial increases in the of coastal bluff retreat. Roads and residential developments are most exposed to these hazards.

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. The most common severe weather events to impact the planning area are thunderstorms, damaging winds and winter weather. For this risk assessment, the term “severe weather” refers to these three event types in aggregate. They are assessed as a single hazard for the following reasons:

- Records indicate that each of these weather event types has impacted the planning area to some degree, and all have similar frequencies of occurrence.
- None of these weather event types have a clearly defined extent or location. Therefore, no quantitative, geospatial analysis is available to support exposure or vulnerability analysis; the analyses for this hazard are qualitative.

12.1.1 Thunderstorms, Lightning and Hail

NOAA classifies a thunderstorm as a storm with lightning and thunder produced by cumulonimbus clouds, usually producing gusty winds, heavy rain, and sometimes hail. Thunderstorms are usually short in duration (seldom more than two hours), but they may deliver enough rainfall to cause urban or flash flooding. Flooding is addressed in Chapter 10. The risk assessment for severe weather focuses on the thunderstorm hazards of lightning and hail.

Lightning is an electrical discharge that results from the buildup of positive and negative charges within a thunderstorm. When the buildup becomes strong enough, lightning appears as a “bolt.” This flash of light usually occurs within the clouds or between the clouds and the ground. A bolt of lightning instantaneously reaches temperatures approaching 50,000ºF. The rapid heating and cooling of air near the lightning causes thunder.

Hail occurs when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere where they freeze into ice. Eventually, the hailstones encounter downdraft air and fall to the ground. Hailstones can begin to melt and then re-freeze together, forming large and very irregularly shaped hail.

12.1.2 Damaging Winds

Straight-Line Winds

Straight-line wind is a general term used to describe damaging winds that are not tornadoes. They are many different types of straight-line winds. Most damaging straight-line winds are generated by thunderstorm systems, although some result from other types of weather phenomena (National Severe Storms Laboratory, 2018).

Tornado

A tornado is a violently rotating column of air with circulation reaching the ground. It almost always starts as a funnel cloud and may be accompanied by a loud roaring noise. Tornadoes are extremely destructive on a local scale (NOAA, NWS, 2018).A tornado is the smallest and potentially most dangerous of local storms, though extremely uncommon in Humboldt County. A tornado is formed by the turbulent mixing of layers of air with contrasting temperature, moisture, density and wind flow. The mixing layers of air account for most of the tornadoes occurring in April, May and June, when cold, dry air meets warm, moister air moving up from the south.

12.1.3 Winter Weather

Severe winter storms occur when there is significant precipitation and the temperature is low enough that the precipitation completely or partially freezes. Figure 12-1 shows the general circumstances that result in different winter precipitation events. The type of precipitation experienced during a winter storm can depend on location. Winter precipitation may fall as snow at higher altitudes but rain at lower elevations, with freezing rain or sleet at elevations in between.

Source: NOAA, NWS, 2018b

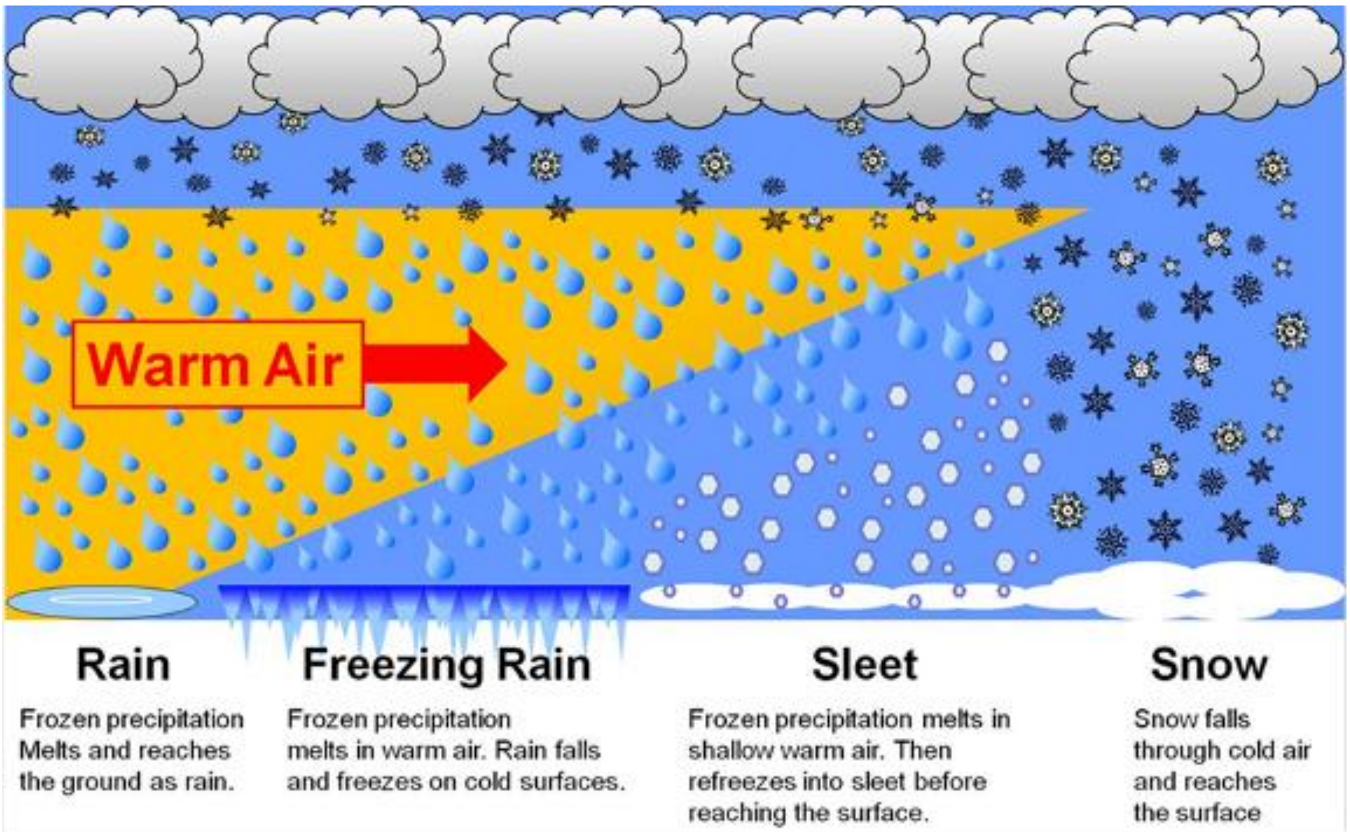


Figure 12-1. Effects of Air Temperature on Winter Precipitation Events

12.2 HAZARD PROFILE

12.2.1 Past Events

Table 12-1 summarizes some past severe weather events in the planning area.

Table 12-1. Sample of Past Severe Weather Events in the Planning Area

Date	Event Type	Deaths or Injuries	Property Damage
2/18/2018	Hail	16	None reported
Description: *Hail covered road led to a 19-vehicle accident at the intersection of Highway 101 and Highway 255. 16 injuries were reported.*			
1/25/2018	Tornado	0	None reported
Description: *A waterspout over Humboldt Bay moved inland across Woodley Island. A wind speed of 54 mph was recorded. A fiber glass case snapped on a dock. The path length was estimated to be 200 feet, and the width was approximately 30 yards.*			
12/31/2017	Dense Fog	1	None reported
Description: *Dense fog on December 31st reduced visibility for drivers in Humboldt County. The reduction in visibility resulted in an indirect fatality when a car struck a pedestrian near Eureka, CA.*			
3/5/2017	Hail	0	None Reported
Description: *A winter storm brought widespread snow to interior portions of Northwest California while convective showers produced numerous swaths of small hail near the coast. Some of the hail showers resulted in travel difficulties including minor car accidents in the Humboldt Bay area.*			
12/11/2014	High Winds	0	None reported
Description: *A strong storm system brought high winds to parts of Northwest California. This resulted in numerous power outages and trees blown down. Remote weather stations on the highest mountain peaks reported gusts over 70 mph.*			
03/31/2012	Thunderstorm Wind	0	None reported
Description: *Thunderstorms with gusty winds caused a tree to fall onto Highway 36. A car drove into the fallen tree resulting in one fatality. The wind was preceded by heavy rain that saturated soils, making trees more vulnerable to wind damage.*			
12/31/2005	High Winds	0	$3.2 million
Description: *Costs refer to all of North Coast, including Del Norte, Humboldt, and Trinity County*			
11/28/2005	High Winds	0	$10,000
Description: *High winds downed trees and power poles*			
2/25/2004	Thunderstorm Wind	0	None reported
Description: *Severe thunderstorms activity near Patrick's Point State park. Wind gusts up to 75 knots reported near Orick.*			
12/07/2003	Funnel Cloud	0	None reported
Description: *Funnel cloud spotted in Orick*			
08/04/2003	Hail	0	None reported
Description: *Hail up to 1 inch in diameter reported.*			
12/30/2002	Thunderstorm Wind	0	None reported
Description: *Thunderstorm embedded in a strong cold front. Wind speeds in excess of 60 knots reported.*			
11/30/1999	Thunderstorm Wind	0	None Reported
Description: *Thunderstorm activity produced wind gusts up to 57 knots.*			
02/03/1998	Lightning	0	$10,000
Description: *Three cows struck and killed by lightning.*			
01/29/1998	Hail	0	None reported
Description: *0.75-inch hail reported in Humboldt County.*			
4/23/1997	Waterspout	0	None reported
Description: *A waterspout was sighted by the public over the southern part of Humboldt Bay near the College of the Redwoods. It was reported to be picking up water and mud.*			
3/30/1997	Funnel Cloud	0	None Reported
Description: *Funnel cloud was seen by off-duty National Weather Service employee off the coast near Trinidad.*			
10/25/1996	High Wind	0	None reported
Description: *Two trees were downed, several artichoke plants were ripped out of the ground and a willow tree was damaged by a convective wind gust. Unconfirmed report of a funnel cloud, possible cold air funnel.*			
3/4/1996	Hail	0	None reported
Description: *Widespread convection producing hail, mostly pea-sized.*			

Source: NOAA Storm Events Database, 2019

12.2.2 Location

Severe weather events have the potential to happen anywhere in the planning area. Mountainous regions experience heavier snowfall and a greater risk of road closures. Wind events are most damaging to areas that are heavily wooded. Under most conditions, the planning area's highest winds come from the southwest.

12.2.3 Frequency

According to the NOAA Storm Events Database, there have been 212 severe weather events over 123 days that affected the planning area since 1996. During this time frame, eight types of severe weather event occurred, causing two deaths; seven events caused reported property damage. This amounts to 4.7 damaging severe weather events every year on average. Severe winter storm events have occurred 72 times, with an average recurrence rate of 2.76 events per year. Damaging winds events have occurred over 100 times, with an average recurrence rate of 4.3 events year. In the planning area, there are an average of five thunderstorm days per year (NOAA, NWS 2018a). The probability of a severe weather event impacting the planning area is high.

12.2.4 Severity

Thunderstorms, Lightning and Hail

The National Weather Service classifies a thunderstorm as "severe" if it produces a tornado, has winds of at least 58 mph, or has hail at least 1 inch in diameter (NOAA, NWS, 2018c). The effects on Humboldt County of a strong thunderstorm can include fallen trees, downed power lines and interruption of transportation lifelines, damaged homes and public buildings. Fatalities are uncommon, but they can occur. Lightning can cause severe damage and can be deadly.

Damaging Winds

Damaging winds are those that exceed 50 to 60 mph. The Beaufort Wind Chart (Table 12-2) provides terminology and a description of potential impacts at different levels (National Severe Storms Laboratory, 2018). Tornado severity classified on the Fujita Tornado Damage Scale is shown in Table 12-3.

Table 12-2. Beaufort Wind Chart

Beaufort Number	Range (mph)	Terminology	Description
0	0	Calm	Calm. Smoke rises vertically.
1	1-3	Light air	Wind motion visible in smoke.
2	4-7	Light breeze	Wind felt on exposed skin. Leaves rustle.
3	8-12	Gentle breeze	Leaves and smaller twigs in constant motion.
4	13-18	Moderate breeze	Dust and loose paper is raised. Small branches begin to move.
5	19-24	Fresh breeze	Smaller trees sway
6	25-31	Strong breeze	Large branches in motion. Whistling heard in overhead wires. Umbrella use is difficult.
7	32-38	Near gale	Whole trees in motion. Some difficulty when walking into the wind.
8	39-46	Gale	Twigs broken from trees. Cars veer on road.
9	47-54	Sever gale	Light structure damage.
10	55-63	Storm	Trees uprooted. Considerable structural damage.
11	64-73	Violent storm	Widespread structural damage.
12	74-95	Hurricane	Considerable and widespread damage to structures.

Source: Lewis, 2018

Table 12-3. Operational Enhanced Fujita Scale

Enhanced Fujita Number	3-Second Gust (mph)
0	65-85
1	86-110
2	111-135
3	136-165
4	166-200
5	Over 200

Source: NOAA, 2018a

Windstorms are a frequent problem in Humboldt County and have been known to cause substantial damage. In the case of extremely high winds, some buildings may be damaged or destroyed. If a major tornado were to strike a populated area, 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. Due to the often short warning period, livestock are commonly the victims of a tornado.

Winter Weather

Winter storms are generally categorized by the amount of precipitation, degree of cold or wind chill, and strength of winds. A blizzard occurs when a winter storm has sustained or frequent wind gusts of 30 mph or greater and considerable falling and/or blowing snow that reduces visibility to less than a quarter mile. Generally, blizzards last for a period of three hours or longer (NOAA, NWS, 2009). Snowfall is generally considered heavy when 4 or more inches accumulates in 12 hours or less, or 6 or more inches accumulates in 24 hours or less. In the planning area, severe winter storms generally consist of rain and wind events, rarely snow and ice.

The effects of an ice storm or snowstorm are downed power lines and trees and a large increase in traffic accidents. These storms can cause death by exposure, heart failure due to strenuous snow removal activity, traffic accidents (over 85 percent of ice storm deaths are caused by traffic accidents), and carbon monoxide poisoning. These storms also have the potential to cause large losses of livestock, primarily due to dehydration. Two major concerns for snowfall are dangerous roadway conditions and collapse of structures due to heavy snow load on roofs. In addition, ice can create dangerous situations on roadways as well as freeze pipes.

12.2.5 Warning Time

Meteorologists can often predict the likelihood of a severe weather event. This can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity of a storm. Some storms may come on quickly, with only a few hours of warning time.

12.3 SECONDARY HAZARDS

Major flooding can occur if heavy rain falls on snow, resulting in rapid snow melt, or if rain is heavy enough that local streams and rivers reach flood stage (see Chapter 10 for more information on flooding). Localized flooding can occur when heavy rain overwhelms local drainage systems or pools in low-lying areas. Rain falling on saturated soils on slopes or on areas recently burned by wildfire may lead to landslides (see Chapter 11 for more information on landslides). Lightning during thunderstorms presents a risk of starting a wildfire (see Chapter 14 for more information on wildfires).

12.4 EXPOSURE

All people and property and the entire environment of the planning area is exposed to some degree to the severe weather hazard.

12.5 VULNERABILITY

12.5.1 Population

The most common problems associated with severe weather events are immobility and loss of utilities. Although all populations in the planning area are exposed to severe weather events, some populations are more vulnerable. 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. 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. In general, populations who lack adequate shelter during severe weather events, those who are reliant on sustained sources of power in order to survive, and those who live in isolated areas with limited ingress and egress options are the most vulnerable. The most common impacts of specific weather event types on people are as follows:

- **Thunderstorms, Lightning and Hail**—California and the planning area are not particularly prone to thunderstorm events and there are no recorded fatalities from lightning within the planning area. Thunderstorm-related deaths and injuries in the planning area are most likely to result from accompanying wind and flood events.
- **Damaging Winds**—Damaging winds can cause injuries and fatalities in a number of ways. Downed trees may fall on homes or cars, killing or injuring those inside. Objects that are not secured can be picked up in wind events and become projectiles. Structures that collapse or blow over during damaging wind events, especially tornadoes, may kill or injure those inside.
- **Winter Weather**—Deaths and injuries from severe winter storms are generally the result of traffic accidents, heart attacks from shoveling snow, and frostbite or hypothermia from prolonged exposure to the cold. About 70 percent of snow and ice-related injuries occur in automobiles, and 25 percent result from exposure. Of those killed or injured, 50 percent are people over the age of 60; more than 75 percent are male (National Severe Storms Laboratory, 2018).

12.5.2 Property

All property is vulnerable during severe weather events, but properties in poor condition or in particularly vulnerable locations may risk the most damage. The most common impacts of specific weather event types on property are as follows:

- **Thunderstorms, Lightning and Hail**—Damage from thunderstorms in the planning area is most likely to be related to secondary hazards accompanying the event, such as flooding, landslides or damaging winds. If lightning directly strikes a building, it may cause substantial damage and may even set the structure on fire.
- **Damaging Winds**—Mobile homes can be seriously damaged by wind gusts over 80 mph, even if they are anchored (National Severe Storms Laboratory, 2018). Properties at higher elevations or on ridges may be more prone to wind damage. Falling trees can result in significant damage to structures. A major tornado could cause widespread damage to property in the planning area, but such an event is unlikely.

- **Winter Weather**—Damage from severe winter storms in the planning area is most likely to be related to secondary hazards, such as major or localized flooding or landslides. If extreme cold events accompany a severe winter storm, pipes may freeze, resulting in property damage.

No modeling is available for quantitative loss estimations for the severe weather hazard. Instead, loss estimates were developed representing 1 percent, 3 percent and 5 percent of the replacement value of exposed structures:

- Loss of 1 percent of planning area replacement value—$353 million
- Loss of 3 percent of planning area replacement value—$1.06 billion
- Loss of 5 percent of planning area replacement value—$1.76 billion

12.5.3 Critical Facilities

All critical facilities are vulnerable during severe weather events, especially those that lack backup power generation capabilities. When facilities supplying power to planning area land line telephone systems are frequently disrupted, significant issues arise with communication in the planning area. In addition, some facilities are particularly vulnerable to specific types of severe weather events:

- **Winter Weather and Thunderstorms**—Facilities located in areas prone to localized or major flooding are vulnerable. Transportation systems are vulnerable to disruption from flooding, snow and ice, or secondary hazard such as landslides.
- **Damaging Winds**—Critical facilities in the direct path of a tornado would be particularly vulnerable. Facilities located near trees or power lines that are likely to fall are also vulnerable. Roads and other transportation infrastructure could be blocked by downed trees or other debris.

Electric power losses due to severe weather can be estimated using standard values for loss of service for utilities published in FEMA's *2009 Benefit Cost Analysis Reference Guide*. The values associated with the loss of power are based on the affected population. Table 12-4 presents estimates for power failure associated with severe weather in the event of 10, 30 or 50 percent of the total planning area population losing power simultaneously. These results do not account for physical damage to utility equipment and infrastructure.

Table 12-4. Loss of Use Estimates for Power Failure for the Planning Area

Affected Planning Area Population	Number of People Affected	Estimated Electric Loss of Use[a]
10%	2,776	$349,816
30%	8,329	$1,049,447
50%	13,882	$1,749,078

a. $126 per person per day; based on FEMA's 2009 Benefit Cost Analysis Reference Guide

12.5.4 Environment

The environment is highly vulnerable to severe weather events. Natural habitats such as streams and trees exposed to the elements during a severe storm risk major damage. Prolonged rains can saturate soils and lead to slope failure. Flood 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 FUTURE TRENDS

All future development will be affected by severe weather events. 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 partners are well equipped to deal with future growth and the associated impacts of severe weather.

12.7 SCENARIO

A worst-case severe-weather event would involve prolonged high winds during a winter storm with large amounts of precipitation after soils are already saturated. Such an event would have both short-term and long-term effects. Initially, schools and roads would be closed due to power outages caused by high winds and downed tree obstructions. Some areas of the county could experience limited ingress and egress. Prolonged rain could produce flooding, overtopped culverts with ponded water on roads, mud over roadways, and landslides on steep slopes. Floods and landslides could further obstruct roads and bridges, further isolating residents. If major landslides impact the two major highways in the planning area, significant transportation disruption could result.

12.8 ISSUES

Important issues associated with severe weather in the planning area include the following:

- The most common direct impact from severe weather events is loss of power.
- 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 damaging winds.
- Redundancy of power supply must be evaluated, especially for critical facilities.
- Major transportation routes in the planning area are limited. If severe weather results in road closures, there could be cascading impacts on the county-wide transportation system, resulting in delays in response and recovery.
- Dead or dying trees as a result of drought are more susceptible to falling during severe storm events.
- Power outages that disrupt land line service could cause significant communication disruption.
- Severe local storms will have significant impacts as Humboldt County continues to experience residential growth. In general, every household and resident in the County is likely to be exposed to severe weather, but some are more likely than others to experience isolation as a result. Those residing in higher elevations with limited transportation routes may have the greatest vulnerability to isolation from storms. Another group at risk is the 10 percent of the County population that is over the age of 65.
- Climate change may cause more severe weather patterns that could impact vulnerable populations within the planning area. Increased frequency and intensity of storms may result in greater damage.
- Detailed spatial analysis is needed to locate the most vulnerable populations, followed by focused public education and outreach mitigation activities for these populations.
- The risk associated with the severe weather hazard overlaps the risk associated with other hazards such as earthquake, landslide and flood. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.
- Isolated population centers are most vulnerable to the severe weather hazard. Rural areas frequently experience extended power outages, loss of communications, and damage to roads due to severe weather.

13. TSUNAMI

13.1 GENERAL BACKGROUND

A tsunami is a series of high-energy waves that radiate outward like pond ripples from an area where a generating event occurs, arriving at shorelines over an extended period. Tsunamis can be induced by earthquakes, landslides and submarine volcanic explosions (see Figure 13-1). Tsunamis are typically classified as local or distant, depending on the location of their source in comparison to where waves occur:

- The waves nearest to the generating source represent a local tsunami. Such events have minimal warning time, leaving few options except to run to high ground after a strong, prolonged local earthquake. Damage from the tsunami adds to damage from the triggering earthquake due to ground shaking, surface faulting, liquefaction, and landslides.
- The waves far from the generating source represent a distant tsunami. Distant tsunamis may travel for hours before striking a coastline, giving a community a chance to implement evacuation plans if a warning is received.

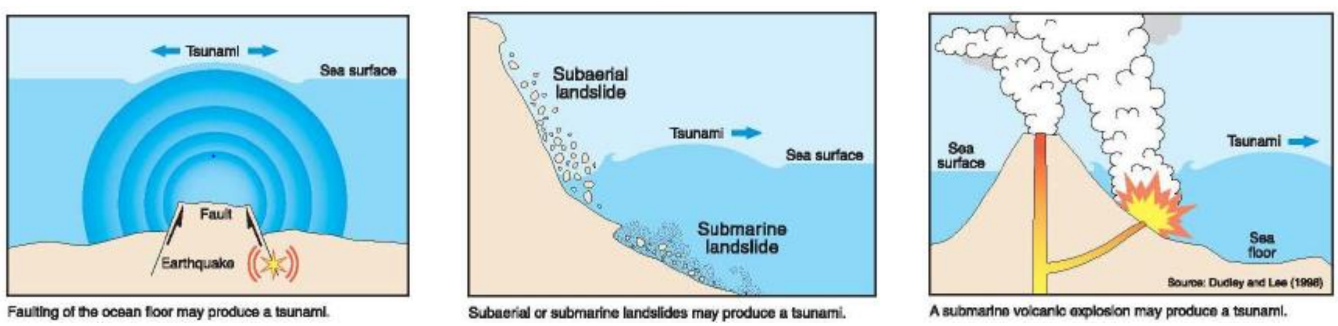


Figure 13-1. Common Sources of Tsunamis

In the open ocean, a tsunami may be only a few inches or feet high, but it can travel with speeds approaching 600 miles per hour. As a tsunami enters the shoaling waters near a coastline, its speed diminishes, its wavelength decreases, and its height increases greatly. At the shoreline, tsunamis may take the form of a fast-rising tide, a cresting wave, or a bore (a large, turbulent wall-like wave). The bore phenomenon resembles a step-like change in the water level that advances rapidly (from 10 to 60 miles per hour). The first wave is usually followed by several larger and more destructive waves.

The configuration of the coastline, the shape of the ocean floor, and the characteristics of advancing waves play important roles in the destructiveness of the waves. Bays, sounds, inlets, rivers, streams, offshore canyons, islands, and flood control channels may cause various effects that alter the level of damage. Offshore canyons can focus tsunami wave energy, and islands can filter the energy. It has been estimated that a tsunami wave entering a flood control channel could reach a mile or more inland, especially if it enters at high tide. The orientation of the coastline determines whether the waves strike head-on or are refracted from other parts of the coastline. A wave may be small at one point on a coast and much larger at other points. The inundation area for a tsunami event is often described as runup as illustrated in Figure 13-2.

Source: UNESCO, Retrieved from Different Directions: Tsunami, n.d.

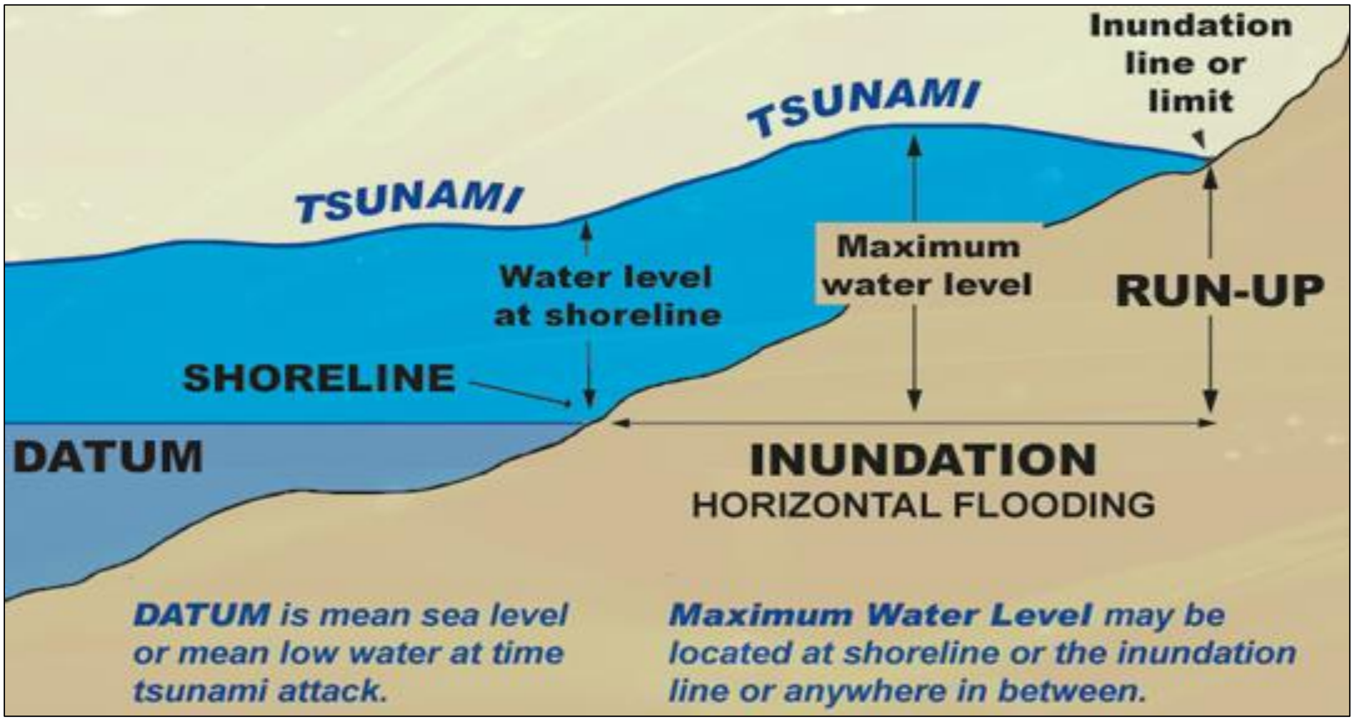


Figure 13-2. Runup Distance and Height in Relation to the Datum and Shoreline

13.2 HAZARD PROFILE

13.2.1 Past Events

California is at risk from both local and distant tsunamis. Eighty-two possible or confirmed tsunamis in California have been observed or recorded. Most recently, the March 11, 2011 tsunami caused by an earthquake near Japan resulted in nearly $100 million in damage to the California maritime community. The February 27, 2010 earthquake near Chile also resulted in minor recorded tsunami inundation in California.

Table 13-1 summarizes the recorded tsunami events in Humboldt County. Most of these events were small and only detected by tide gages. Additional events have been recorded in Del Norte County immediately north of Humboldt County, including two that caused major damage on the California coast:

- The 1960 Chilean earthquake produced a tsunami that impacted the entire Pacific basin. Damage was reported in California ports and harbors from San Diego to Crescent City and losses exceeded $1 million.
- The 1964 tsunami generated by the Magnitude-9.2 Alaska earthquake (see Figure 13-3) killed 12 in Northern California and caused over $15 million in damage. The peak wave height was 21 feet in Crescent City and 29 city blocks were inundated. Wave oscillations in San Francisco Bay lasted more than 12 hours, causing nearly $200,000 in damage to boats and harbor structures.

In addition to these recorded events, a major tsunami impacted the area on January 26, 1700 after a major earthquake on the Cascadia Subduction zone (see Figure 13-4). The tsunami that left markers in the geologic record from Humboldt County to Vancouver Island in Canada and is noted in written records in Japan.

Table 13-1. Example Tsunamis That Have Affected North Coast California

Source Event		Runup			
Date	Description	Location	Distance from Source (miles)	Travel Time from Source	Water Height (feet)
3/20/1855	M 6.0 Earthquake, California	Humboldt Bay	2		0.0
11/24/1885	Meteorological Event	Eureka	0		0.0
4/1/1946	M 8.6 Earthquake, Unimak Island, AK	Humboldt Bay	1,985		0.0
3/28/1964	M 9.2 Earthquake, Prince William Sound, AK	Trinidad	1,697		8.9
		King Salmon Slough, Humboldt Bay	1,714		4.5
		Humboldt Bay	1,712		6.2
		North Spit, Humboldt Bay	1,712		3.1
		Municipal Marina, Eureka	1,711		5.1
		Pacific Gas & Elec., Humboldt Bay	1,714		3.8
4/25/1992	M 7.2 Earthquake, Cape Mendocino, N. CA	Trinidad	49		3.0
		North Spit, Humboldt Bay	28	26 minutes	0.7
		Clam Beach	43		0.0
11/17/2003	M 7.8 Earthquake, Rat Islands, AK	North Spit, Humboldt Bay	2,763	6 hours 17 minutes	0.2
6/15/2005	M 7.2 Earthquake, N. California	North Spit, Humboldt Bay	99		0.1

a. Source includes combination of earthquake and landslide.
Source: Global Historical Tsunami Database, National Center for Environmental Information, 2019

Source: National Centers for Environmental Information, 2018b

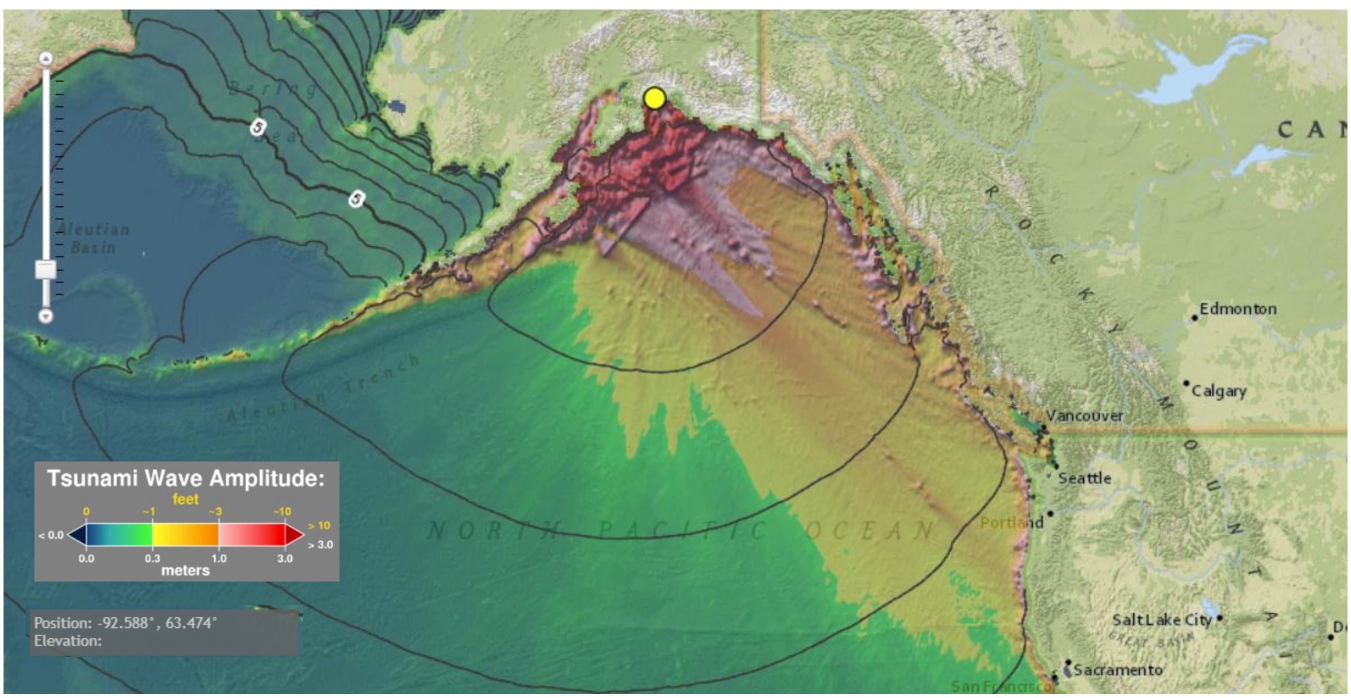


Figure 13-3. 1964 Alaska Earthquake Tsunami Event

Source: National Centers for Environmental Information, 2018b

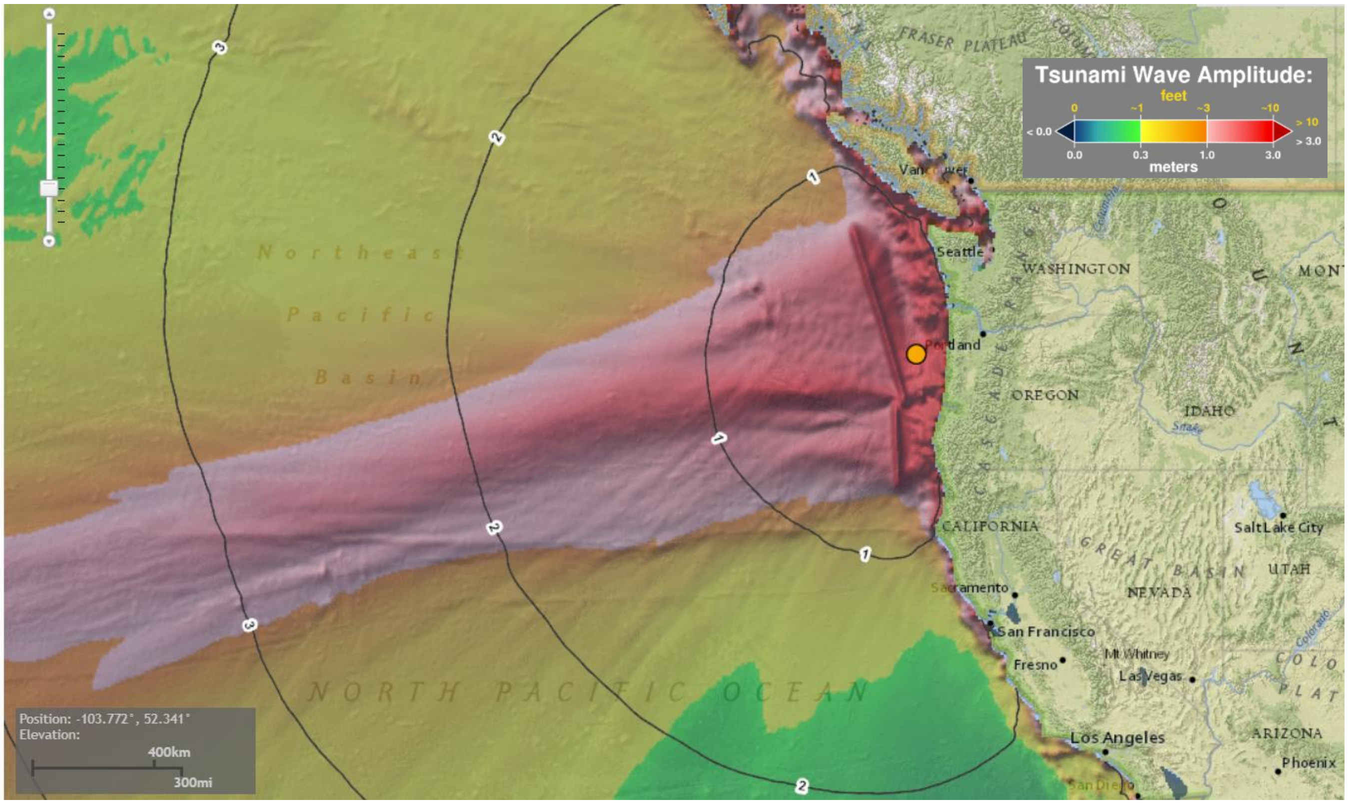


Figure 13-4. 1700 Cascadia Subduction zone Earthquake Tsunami Event

13.2.2 Location

Figure 13-5 shows the extent and the location of the tsunami inundation areas for the Humboldt County planning area. This map does not represent risk from a single event but shows a composite area of risk that combines the inundation areas from a number of local and distant potential sources, including the Cascadia subduction zone, the Central Aleutians Island subduction zone, historical earthquake events, and other sources (California Department of Conservation, 2017). The inundation areas represent the maximum considered tsunami runup from a number of extreme, yet realistic, tsunami sources. The tsunami hazard zone is mostly influenced by a local source Cascadia event; however, distant sources can result in notable wave run ups. Additional tsunami mapping information is available from the California Department of Conservation (California Department of Conservation, 2017a and 2017b) and the Redwood Coast Tsunami Work Group.

13.2.3 Frequency

There have been 39 tsunami events known to impact the planning area in 80 years. This amounts to a tsunami event in the planning area every 2 years on average. Most of these events are minor. Only three recorded major events (defined for these purposes as 1 meter or more of runup) have impacted the planning area, amounting to a major event occurring every 27 years on average. The National Tsunami Hazard Mitigation Program rates the risk to the U.S. west coast from the tsunami hazard as high to very high (Dunbar and Weaver, 2015).

Insert Map

Figure 13-5. Tsunami Inundation Zones

13.2.4 Severity

According to the National Tsunami Hazard Mitigation Program, tsunami events with runups of more than 1 meter are the most likely to be dangerous to people and property. The tsunami's size and speed, as well as the coastal area's form and depth, affect the impact of a tsunami. At some locations, the advancing turbulent wave front will be the most destructive part of the tsunami wave. In other situations, the greatest damage will be caused by the outflow of water back to the sea between crests, sweeping away items on the surface and undermining roads, buildings, bulkheads, and other structures. This outflow action can carry enormous amounts of highly damaging debris, resulting in further destruction. Ships and boats, unless moved away from shore, may be forced against breakwaters, wharves, and other craft, or be washed ashore and left grounded after the withdrawal of the seawater (National Tsunami Hazard Mitigation Program, 2001). A local tsunami resulting from an earthquake event on the Cascadia Subduction zone presents the most severe risk to the planning area.

13.2.5 Warning Time

Visible Indications

Tsunamis are difficult to detect in the open ocean; with waves generally less than 3 feet high. The first visible indication of an approaching tsunami may be either a rise or drop in water surface levels (National Tsunami Hazard Mitigation Program, 2001):

- A drop in water level (draw down) can be caused by the trough preceding the advancing, large inbound wave crest. Rapid draw down can create strong currents in harbor inlets and channels that can severely damage coastal structures due to erosive scour around piers and pilings. As the water's surface drops, piers can be damaged by boats or ships straining at or breaking their mooring lines. The vessels can overturn or sink due to strong currents, collisions with other objects, or impact with the harbor bottom.
- The advancing tsunami may initially arrive as a strong surge increasing the sea level. This can be similar to the rising tide, but the tsunami surge rises faster and does not stop at the shoreline. Even if the wave height appears to be small, 3 to 6 feet for example, the strength of the accompanying surge can be deadly. Waist-high surges can cause strong currents that float cars, small structures, other debris, and hazardous materials. Boats and debris are often carried inland by the surge and left stranded when the water recedes.

Warning System

Tsunami Warning System for the Pacific Ocean

The tsunami warning system for the Pacific Ocean evolved from a program initiated in 1946. It is a cooperative effort involving 26 countries along with numerous seismic stations, water level stations and information distribution centers. The National Weather Service operates two regional information distribution centers: The Pacific Tsunami Warning Center in Ewa Beach, Hawaii; and the National Tsunami Warning Center covering the California coast in Palmer, Alaska. The warning centers issue tsunami watches, warnings, and advisories. A watch is issued when a large earthquake has occurred far away from the region and the threat is still being determined. A warning is issued when damaging tsunami waves inundating dry land are expected. An advisory is issued when tsunami waves less than 1 meter high and dangerous strong currents will occur in harbors. The warning system is activated when a Pacific basin earthquake of magnitude 6.5 occurs or an earthquake is widely felt along the North American coast. When this occurs, the following sequence of actions occurs:

- Data is interpolated to determine epicenter and magnitude of the event.
- If the earthquake is of the right type, depth, magnitude, and is far away from California coast, a TSUNAMI WATCH is typically issued for the California coastline.

- A TSUNAMI WATCH is upgraded to a TSUNAMI WARNING if tsunami wave heights are forecast to be 1 meter or larger. A TSUNAMI ADVISORY is issued if tsunami wave heights are forecast to be 0.3 meters to less than 1 meter.
- Tsunami travel times are calculated, and the warning is transmitted to disseminating agencies who relay it to the public.
- The National Tsunami Warning Center will cancel/expire watches, warnings, or advisories if tide gauges and buoys indicate no significant tsunami was generated or if tsunami waves no longer meet the criteria for at least 3 hours.

This system is not considered to be effective for communities close to the tsunami source, because the first wave would arrive before the data can be processed and analyzed, and communications systems may be impacted by the precipitating event. In this case, strong ground shaking would provide the first warning of a potential tsunami and evacuations should begin immediately.

Local Warning Systems

The National Oceanic and Atmospheric Administration (NOAA), California Governor's Office of Emergency Services (Cal OES), and local emergency managers coordinate tsunami warning communications for the planning area. This emergency notification system is routinely tested and includes broadcasts on NOAA Weather Radio All Hazards, social media, local television and radio stations, sirens, and aircraft public address system. Humboldt Alert and the Wireless Emergency Alert System will also be activated during a real event. In Humboldt County, the tsunami sirens and public address system are still in use and notification may be supplemented by assistance from the local Civil Air Patrol flying along the coast with an audible message. Tsunami sirens in the planning area are former Civil Defense sirens, in poor repair and in need of replacement.

Estimated Travel Times

The NOAA National Center for Environmental Information website provides maps that show estimated travel times to coastal locations for various tsunami-generating events. Figure 13-6 shows one example of the travel time for a tsunami generated in Aburatsu, Japan to reach the planning area—approximately 11 hours.

13.3 SECONDARY HAZARDS

Aside from the tremendous hydraulic force of the tsunami waves themselves, floating debris carried by a tsunami can endanger human lives, batter inland structures, carry hazardous and flammable materials, and rupture gas lines. Flooding can cause contamination of drinking water and can result in the spread of disease.

13.4 EXPOSURE

The exposure estimates for the tsunami hazard are based on a composite area of risk. Not all areas exposed would be impacted by any single event.

13.4.1 Population

Population was estimated using the residential building count in the tsunami inundation area and multiplying by the 2018 estimated average population per household. Using this approach, it is estimated that exposed population is 4,556 people (3.4 percent of the county total). Most of these (1,727 people) reside in in the unincorporated County.

Source: National Centers for Environmental Information, 2018c

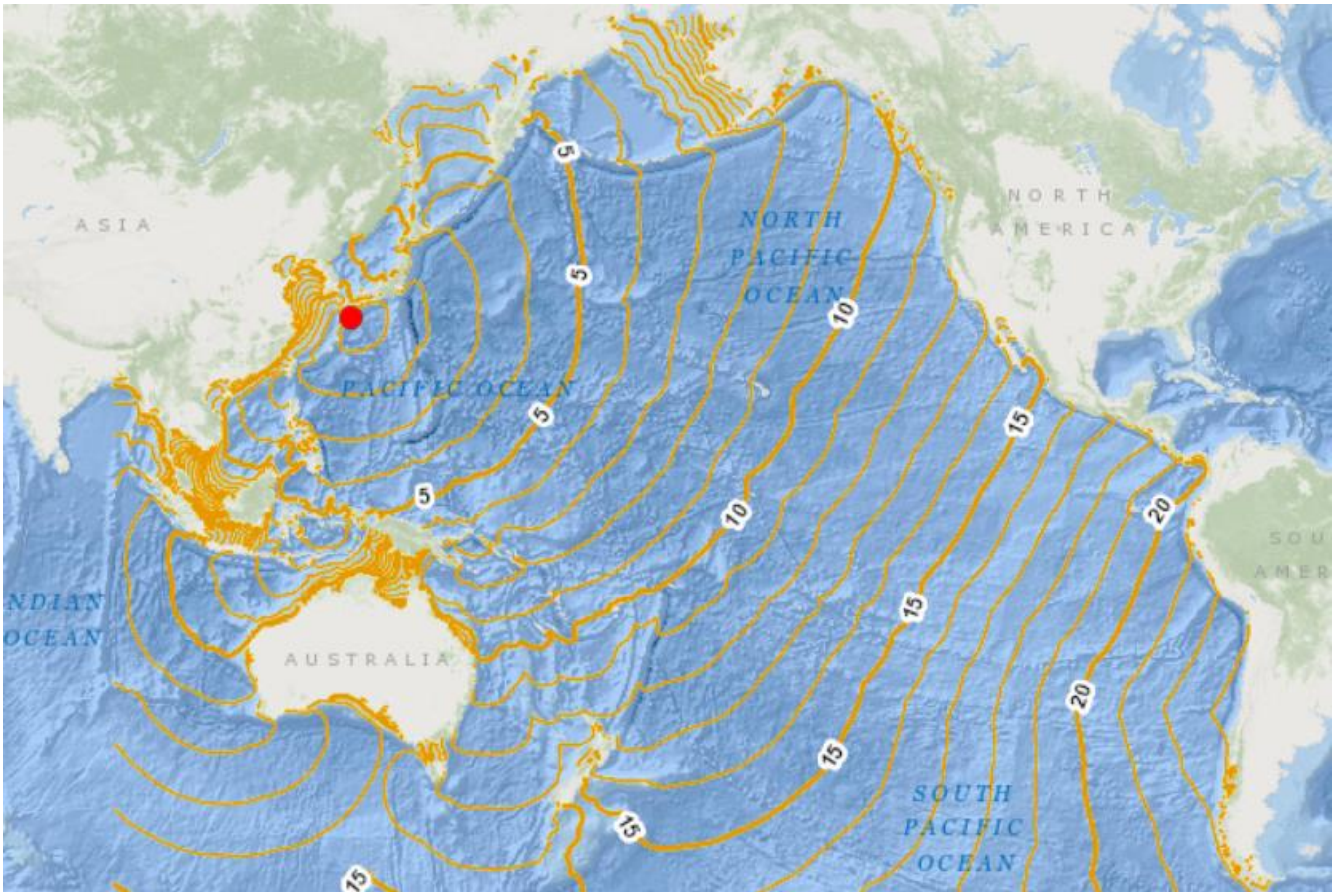


Figure 13-6. Potential Tsunami Travel Times in the Pacific Ocean, in Hours

13.4.2 Property

An estimated 9.9 percent (more than $3.4 billion) of the total replacement value of the planning area is located in tsunami inundation areas. Figure 13-7 shows the percentage and count, by land use type, of exposed planning area structures. Most these (53 percent) are in the unincorporated County. Residential structures make up 76 percent of the exposed total (1,549 structures).

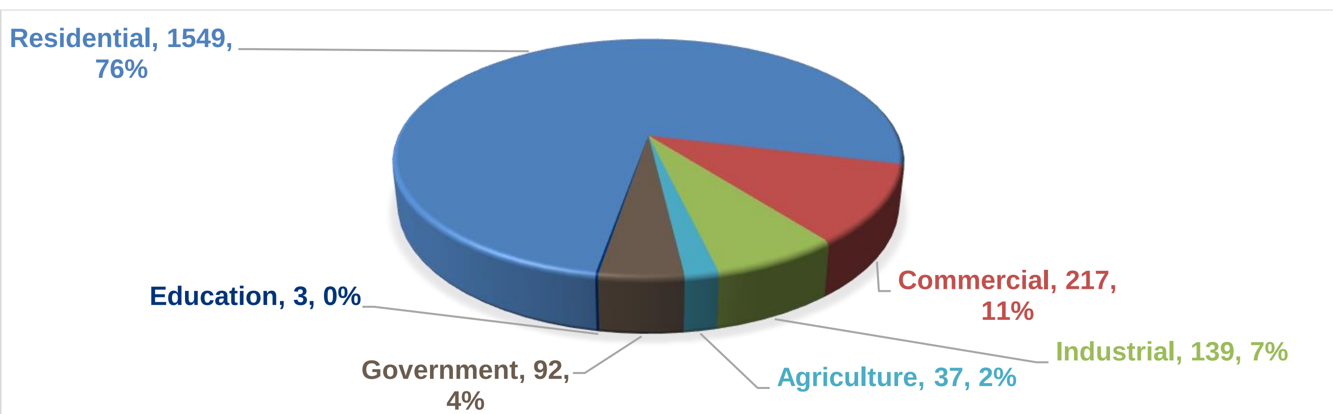


Figure 13-7. Structures in the Tsunami Inundation Zone, by Land Use Type

13.4.3 Critical Facilities and Infrastructure

Critical facilities and infrastructure exposed to the tsunami hazard represent 17 percent (45 facilities) of the total critical infrastructure and facilities in the planning area. Linear infrastructure is also exposed, including utility lines and roads. Using Hazus, the planning team identified the following major roads that may be impacted by tsunami events by analyzing the bridge inventory exposed to the tsunami hazard areas:

- U.S. Highway 101
- Highway 255
- Highway 211
- Highway 299
- Highway 1
- King Salmon Avenue.

The breakdown of exposure by facility type is shown in Figure 13-8.

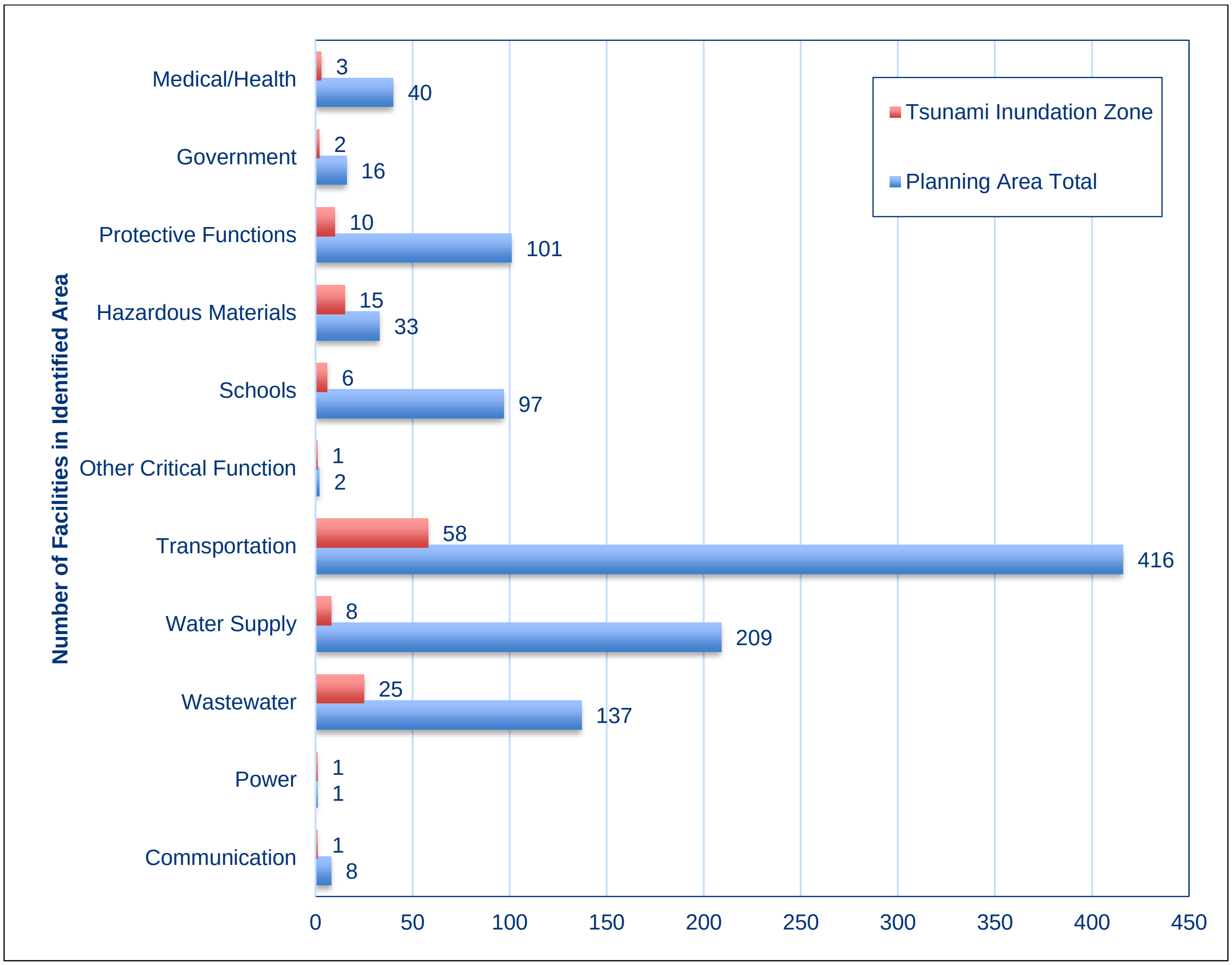


Figure 13-8. Critical Facilities and Infrastructure in Mapped Tsunami Inundation Zone and Countywide

13.4.4 Environment

All waterways and beaches would be exposed to the effects of a tsunami; inundation of water and introduction of foreign debris could be hazardous to the environment. All wildlife inhabiting the area also is exposed.

13.5 VULNERABILITY

The vulnerability estimates for the tsunami hazard are based on a composite area of risk. Not all areas exposed would be impacted by any single event; therefore, vulnerability estimates are overstated.

13.5.1 Population

The populations most vulnerable to the tsunami hazard are the elderly, disabled and very young who reside near beaches, low-lying coastal areas, tidal flats and river deltas that empty into ocean going waters. In the event of a local tsunami generated in or near the planning area, there would be little warning time, so more of the population would be vulnerable. Hazus analysis of the tsunami inundation area indicates that a tsunami event could displace 1,441 people in the planning area, with up to 96 people needing short-term shelter assistance.

13.5.2 Property

Property Impacted

The impact of tsunami waves and the scouring associated with debris that may be carried in the water could be damaging to all structures along beaches, low-lying coastal areas, tidal flats and river deltas. The most vulnerable are those in the front line of tsunami impact and those that are structurally unsound. The Hazus analysis indicated that 49 percent of the exposed structures (997 structures) would be impacted by the modeled scenario event.

Damage Estimates

Table 13-2 summarizes Hazus estimates of tsunami damage in the planning area. The estimated damage value is associated with the tsunami wave only; it does not include additional damage that may occur as a result of debris battering structures as the tsunami wave rushes in and out of the inundation area or fires caused by an earthquake and tsunami event. The debris estimate includes only structural debris and building finishes; it does not include additional debris that may result from a tsunami event, such as from boats, trees, sediment, building contents, bridges or utility lines.

Table 13-2. Estimated Impact of a Tsunami Event in the Planning Area

Structure Debris (tons)	475
Buildings Impacted	997
Total Value (Structure + Contents) Damaged	$447.8 million
Damage as % of Total Value	1.3%

Structures that were built to current floodplain regulations in the tsunami inundation area may have some level of protection, particularly if they were built to withstand wave action. In the unincorporated County, an estimated 63 percent of the housing units were built before the County entered the National Flood Insurance Program in 1982 and began enforcing floodplain regulations (U.S. Census, 2018). It is unknown how many of these structures are located in tsunami inundation areas. In addition to structure damage, ships moored at piers and in harbors often are swamped and sunk or are left battered and stranded high on the shore.

13.5.3 Critical Facilities and Infrastructure

Table 13-3 summarizes the Hazus estimates of damage to critical facilities and infrastructure in the planning area. An estimated 37 percent of the exposed facilities show damage to some extent in the tsunami scenario analyzed; none are likely to be substantially damaged. The following infrastructure is also vulnerable to damage:

- **Water Proximate Infrastructure**—Breakwaters and piers collapse, sometimes because of scouring actions that sweep away their foundation material and sometimes because of the sheer impact of the tsunami waves.
- **Flood Control Systems**—Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by debris from tsunami events, also causing localized urban flooding.
- **Utility Systems—**Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can be backed up, causing waste to spill into homes, neighborhoods, rivers and streams. Tsunami waves can knock down power lines and radio/cellular communication towers. Power generation facilities can be severely impacted by wave action and by inundation from floodwater.
- **Fuels—**The Chevron terminal is located in the tsunami inundation zone on Humboldt Bay and receives most of the vehicle fuel for the planning area by barge.

Table 13-3. Damage Estimates to Critical Facilities in the Tsunami Hazard Area

Facility Type	Number of Facilities Exposed	Damage Level[a]			
		None	Slight	Moderate	Substantial
Other Infrastructure	11	12	1	0	0
Communication	1	0	1	0	0
Power	1	0	0	1	0
Wastewater	25	10	0	15	0
Water Supply	8	2	4	2	0
Transportation	58	31	18	9	0
Other Critical Functions	1	0	0	1	0
Schools	6	2	2	2	0
Hazardous Materials	15	15	0	0	0
Protective Functions	10	4	3	3	0
Government	2	1	0	1	0
Medical/ Health	3	0	3	0	0
Total/Average	**141**	**77**	**32**	**34**	**0**

a. None = No damage to structure or contents; Slight = 0-10% damage to structure; Moderate = 11-49% damage to structure; Substantial = 50-100% damage to structure

13.5.4 Environment

Environmental impacts on local waterways and wildlife would be most significant in areas closest to the point of impact. Areas near gas stations, industrial areas and facilities storing hazardous materials are vulnerable. The vulnerability of aquatic habit and associated ecosystems in low-lying areas close to the coastline is high. Tsunami waves can carry destructive debris and pollutants that can have devastating impacts on all facets of the environment. Millions of dollars spent on habitat restoration and conservation in the planning area could be wiped out by one significant tsunami.

13.6 FUTURE TRENDS IN DEVELOPMENT

According to population projections by the California Department of Finance, Humboldt County's population should increase 3.63 percent by 2040. The County is subject to state general planning laws and the California Coastal Act. The County and its cities have adopted critical areas and resources lands regulations pursuant to these laws. It has been Humboldt County's policy in the past to not allow for an increase in exposure within its floodplains. The information in this plan provides Humboldt County and its planning partners a tool to ensure that there is no increase in exposure within the mapped tsunami inundation area of the planning area.

13.7 SCENARIO

The worst-case scenario for the planning area is a local tsunami triggered by a seismic event along the Cascadia subduction zone. Historical records suggest that tsunami wave heights on the order of 15 to 60 feet could be generated by a Cascadia subduction event. The most destructive tsunami will be associated with a local source Cascadia event and will be preceded by strong ground shaking. Significant damage will result from the ground shaking, tsunami wave forces, and impacts associated with debris. A major tsunami event in the region would have devastating impacts on the people, property and economy of the planning area.

13.8 ISSUES

Important issues associated with a tsunami in the planning area include the following:

- A local source tsunami presents the highest risk to the planning area, as there will not be time to initiate evacuation with the first surge arriving in as few as 10 minutes. Strong ground shaking preceding the tsunami would damage buildings, communications and electric utility infrastructure, roads, and bridges.
- Risk from tsunami inundation is not subject to the State of California real estate disclosure law at this time.
- There are estimated to be 1,549 residential structures in the planning area located in tsunami inundation areas. Some of these structures have flood protection measures in place that may offer a degree of protection from tsunami risk; however, a large number of structures in the planning area were built before the cities and County entered the NFIP. Structures not designed to resist tsunami forces and built to have habitable areas above runup levels should not be assumed to provide protection.
- It is estimated that more than 1,441 people would be displaced as a result of the modeled tsunami event, which does not include populations likely to be displaced by the earthquake that caused the tsunami.
- Significant debris would be produced as a result of a major tsunami impacting the planning area and could be exacerbated by damage caused by the earthquake that preceded it.
- More than 1 percent of the total replacement value of the planning area could be lost as a result of a tsunami event. This would have significant implications for the local economy and local taxes.
- There are 115 critical facilities and infrastructure in the planning area that are located in tsunami risk areas.
- The loss of harbor and dock facilities and impacts on fisheries after a tsunami would have significant impacts on the local economy and the ability to receive recovery resources by sea if roads are severely damaged.
- To effectively measure and evaluate the probable impacts of tsunamis on planning, new hazard mapping based on probabilistic scenarios likely to occur for Humboldt County is in process. The science and technology in this field are emerging. For tsunami hazard mitigation programs to be effective, probabilistic tsunami mapping will be a key component. It is anticipated that this level of detail will be available to support the next update to this plan.

- Present building codes and guidelines do not adequately address the impacts of tsunamis on structures, and current tsunami hazard mapping is not appropriate for code enforcement. It is anticipated that future updates to the California Building Code will include amendments that address these issues.
- The Redwood Coast Tsunami Work Group and its geologists have done extensive work in implementing and supporting public information and awareness programs. These programs need to be continued, supported and enhanced to promote the concepts of mitigation and preparedness for the impacts of tsunamis and all hazards addressed by this plan.
- As tsunami warning technologies evolve, the tsunami warning capability within the planning area will need to be enhanced to provide the highest degree of warning to planning partners with tsunami risk exposure.
- With the future impacts from climate change, the issue of sea level rise may become an important consideration as probable tsunami inundation areas are identified through future studies. Humboldt County is in the process of updating the Humboldt Bay Area Plan of the Humboldt County Local Coastal Program to include updated tsunami hazard policies, based on probabilistic modeling by the California Geologic Survey. Policies will include considerations of the impact of projected sea level rise on tsunami hazards.
- Special attention will be focused on the vulnerable communities and tourists in the tsunami zone and on hazard mitigation through public education and outreach.

14. WILDFIRE

The *Humboldt County Community Wildfire Protection Plan (CWPP) Update*, approved by the County Board of Supervisors in 2019, is effectively the wildfire hazard mitigation plan for the Humboldt Operational Area. The CWPP is hereby linked to this hazard mitigation plan by reference, and key components of it are referenced in this chapter, which provides an overview of the wildfire hazard. The complete document can be viewed online at: https://humboldtgov.org/2431/CWPP-2019

14.1 GENERAL BACKGROUND

A wildfire is any uncontrolled fire on undeveloped land that requires fire suppression. Wildfires can occur naturally and are important to many ecosystem processes, but most are started by people. CAL FIRE has modeled and mapped wildfire hazard zones using a computer model that designates moderate, high or very high fire hazard severity zones (FHSZ). FHSZ ratings are derived from a combination of fire frequency (how often an area burns) and expected fire behavior under severe weather conditions. CAL FIRE's model derives fire frequency from 50 years of fire history data. Fire behavior is based on factors such as the following (CAL FIRE, 2017a):

Fire Hazard Severity as Determined by CAL FIRE

- The classification of a zone as Moderate, High, or Very High fire hazard is based on a combination of how a fire will behave and the probability of flames and embers threatening buildings.
- Zone boundaries and hazard levels are determined based on vegetation. For wildland areas, the current FHSZ model uses burn probability and expected fire behavior based on weather, fuel, and terrain conditions. For urban areas, zone boundaries and hazard levels are based on vegetation density, adjacent wildland FHSZ scores, and distance from wildlands.
- Each area of the map gets a score for flame length, embers, and the likelihood of the area burning. Scores are then averaged over the zone areas.

- **Fuel**—Fuel may include living and dead vegetation on the ground, along the surface as brush and small trees, and above the ground in tree canopies. Lighter fuels such as grasses, leaves and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs and trunks take longer to warm and ignite. Trees killed or defoliated by forest insects and diseases are more susceptible to wildfire.
- **Weather**—Relevant weather conditions include temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount and duration, and the stability of the atmosphere. When the temperature is high, relative humidity is low, wind speed is increasing and coming from the east (offshore flow), and there has been little or no precipitation so vegetation is dry, conditions are very favorable for extensive and severe wildfires. These conditions occur more frequently inland where temperatures are higher and fog is less prevalent.
- **Terrain**—Topography includes slope and elevation. The topography of a region influences the amount and moisture of fuel; the impact of weather conditions such as temperature and wind; potential barriers to fire spread, such as highways and lakes; and elevation and slope of land forms (fire spreads more easily uphill than downhill).

The model also is based on frequency of fire weather, ignition patterns, and expected rate-of-spread. It accounts for flying ember production, which is the principal driver of the wildfire 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. The model refines the zones to characterize fire exposure mechanisms that cause ignitions to structures. Significant land-use changes need to be accounted for through periodic model updates. Detailed discussions of the zones and how they are developed are available on the CAL FIRE website (CAL FIRE, 2012 and 2012a).

14.2 HAZARD PROFILE

14.2.1 Wildfire Factors for the Planning area

Topography

Humboldt County has a mixture of rugged mountains, rolling hills, and broad valleys. Elevations range from the coastal community of Manila, just 13 feet above sea level, to Salmon Mountain, the county's highest peak at 6,962 feet (in the Trinity Alps Wilderness of Six Rivers National Forest). The drier, more fire-prone areas of the county are also the steepest and most rugged. These steep drainages can act as chimneys, which can move wind and fire very quickly up a slope. Due to the remoteness and steepness of slopes within the county, fire equipment and personnel can be limited in their access to wildfires. This adds significant fire risk to Humboldt County communities.

Weather

Inland thunderstorm activity in Humboldt County typically begins in June with wet storms. These storms often turn dry and are accompanied by lightning as the season progresses into July and August. The combination of dry thunderstorms and a lack of marine influence increases the potential for summer fires in the eastern portion of the county. Prevailing winds during the fire season (generally June through October) are out of the northwest. In July and August, local winds (slope winds and sea breezes) predominate, with the Pacific jet stream weak and well to the north. By September, weak to moderate north-to-northeast winds can become more prevalent. These winds are more critical for bringing in moist ocean air than in the late spring. The more easterly flows in particular are problematic, being significantly drier. Fires during foehn events—or subsiding winds— usually result in extreme fire behavior as the winds are particularly strong and dry, reducing fuel moistures. This leads to easier ignitions and increased fire intensity and rate of spread. Foehn winds can also cause extreme fire behavior at night when fires normally die down.

Vegetation and Fuels

Nearly every major fuel type in California exists in Humboldt County: grasslands, oak woodlands, brushlands, hardwood forests, mixed conifer forests, and conifer forests, including the redwood groves. Because of this ecosystem diversity, Humboldt County can experience virtually any type of wildfire that can occur in California, from fast spreading grass fires to long-duration forest fires.

The virtual exclusion of widespread low- to moderate-severity fire has affected the structure and composition of vegetation types. Conifer stands are generally denser, mainly in small- and medium-size classes of shade tolerant and fire-sensitive tree species like Douglas fir and tanoak. Fuels have become more vertically continuous, contributing to more spatially homogeneous forests. Selective cutting of large overstory trees, intense fire suppression, and the relatively warm, moist climate during much of the twentieth century likely enhanced conifer seedling establishment and hardwood sprouting.

14.2.2 Past Events

Fire has been a significant factor in Humboldt County's history. Evidence of this can be seen in the fire scars on ancient redwoods, some dating back more than a thousand years. Despite the generally damp climate prevailing in these forests, studies have suggested an historical fire return interval of 50 to 100 years in the northern part of the county and 12 to 50 years in the south. Several of the more destructive historical fires occurred on the coast around the Trinidad area, including the 7,432-acre Luffenholz Fire of 1908, the 17,527-acre A-Line Fire of 1936, and a 15,000-acre unnamed fire near Patrick's Point in 1945.

According to current CAL FIRE data, 634 wildfires burned in Humboldt County between 1910 and 2017, as shown in the Figure 14-1. The decade with the highest number of large fires was the 1950s, followed by the decades at the beginning of the 20th century. This data is generated by CAL FIRE from a multi-agency map of fire history. CAL FIRE includes timber fires 10 acres or greater, brush fires 30 acres and greater, and grass fires 300 acres or greater. For fires recorded by the U.S. Forest Service, there has been a 10-acre minimum for fires since 1950.

Source: 2019 Humboldt County CWPP

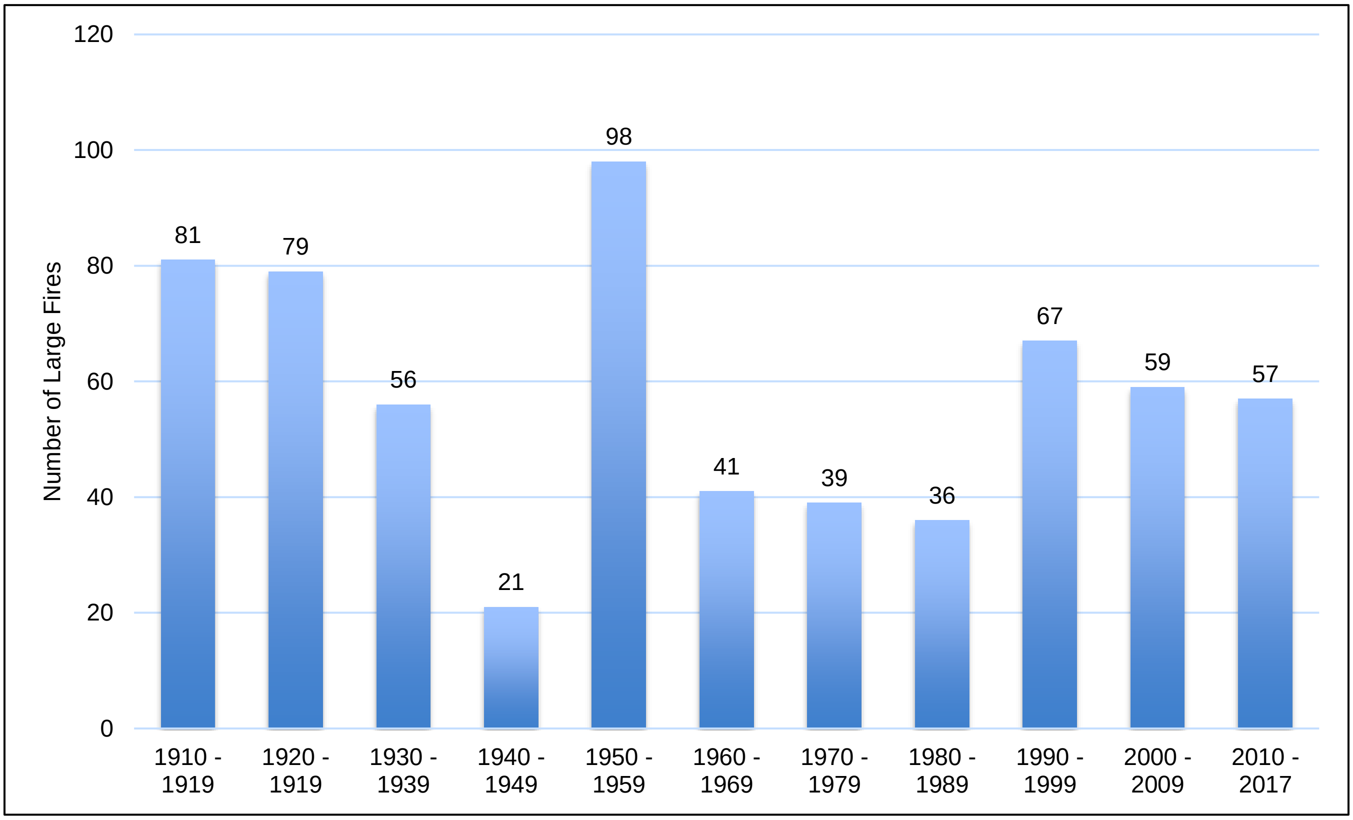


Figure 14-1. Humboldt County, Large Fires by Decade, 1910–2017

Figure 14-2 shows the total number of fires by size between 1908 and 2017. As expected, most fires (259 or 40 percent) are small, in this case less than 25 acres. Beyond these small fires, the largest number of fires (135 fires or 21 percent of all fires in Humboldt County between 1908 and 2017) were between 100 and 500 acres. There have been only 22 fires over 5,000 acres since 1908, 3 percent of the total. Of the 22 large fires, seven occurred since 1999.

Source: 2019 Humboldt County CWPP

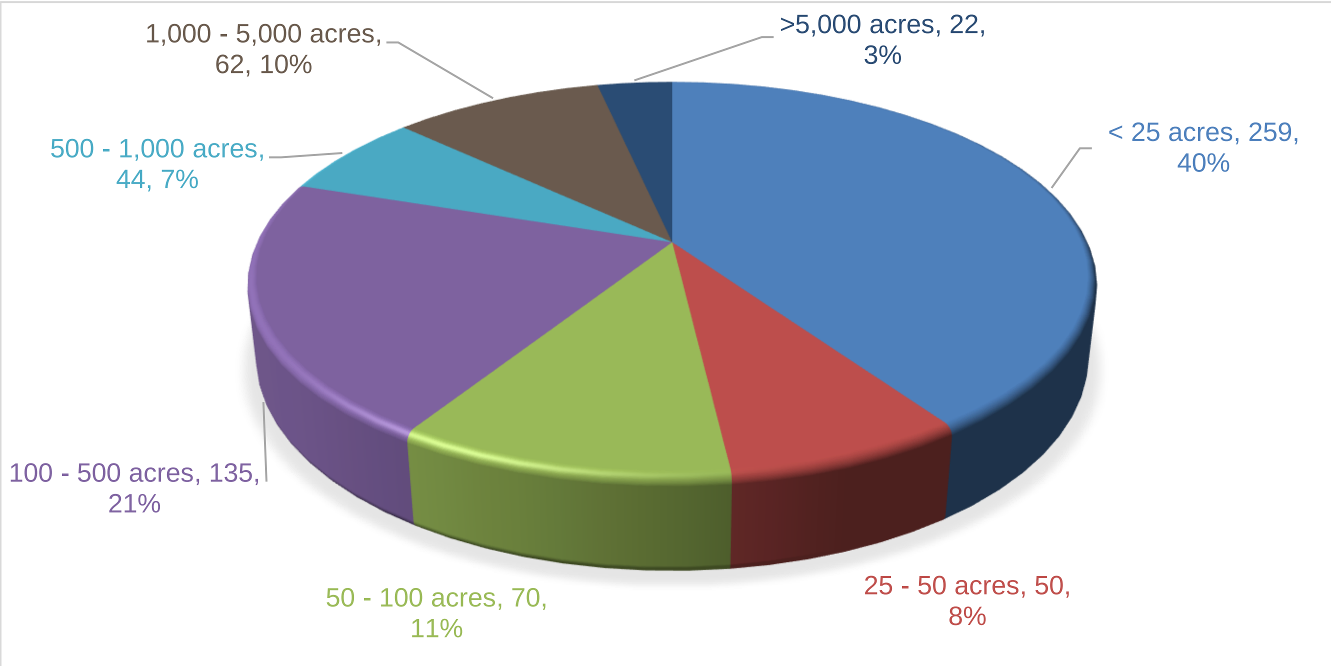


Figure 14-2. Humboldt County, Total Number of Fires by Size, 1908–2017

14.2.3 Location

Figure 14-3 shows the FHSZ mapping for the planning area. Humboldt County exhibits the complete range of severity classification from Moderate to Very High. In State Responsibility Area (SRA) lands, the map generally reflects a High rating in the western portions of Humboldt County, where the fuel potential is high, but the climate is damp. Humboldt's Very High ratings are generally in the drier, eastern portions of the county, or in very steep terrain, such as found along the Lost Coast. Moderate ratings are in valley bottom areas, which are generally urban or agricultural. Areas with lower fire risk are concentrated in coastal and estuary lands. There are no Very High classifications in the local responsibility area in Humboldt County. In Humboldt County, 2.13 million acres are in a high, or very high FHSZ. This represents over 82 percent of the area of the County.

14.2.4 Frequency

The overall probability of some wildfire event impacting the planning area is high. Figure 14-4 charts the major fires in the county each year from 1908 to 2017. The average is 2 fires per year, and the range is from 0 to 17 fires per year. The wildfire probability varies with time of year and size of fire, as described in the following sections.

Frequency by Month

The wildfire season in Humboldt County historically began in June and ended in mid-October; however, today's fire season is longer. Changing climate conditions are beginning to change the local fire season, especially in terms of earlier snowmelt and increased night-time temperatures. Drought, light snow pack, and local weather conditions can expand or shorten the length of fire season. In most parts of the state, the fire season is now considered to be year-round.

Insert Figure

Figure 14-3. Fire Hazard Severity Zones

Source: 2019 Humboldt County CWPP

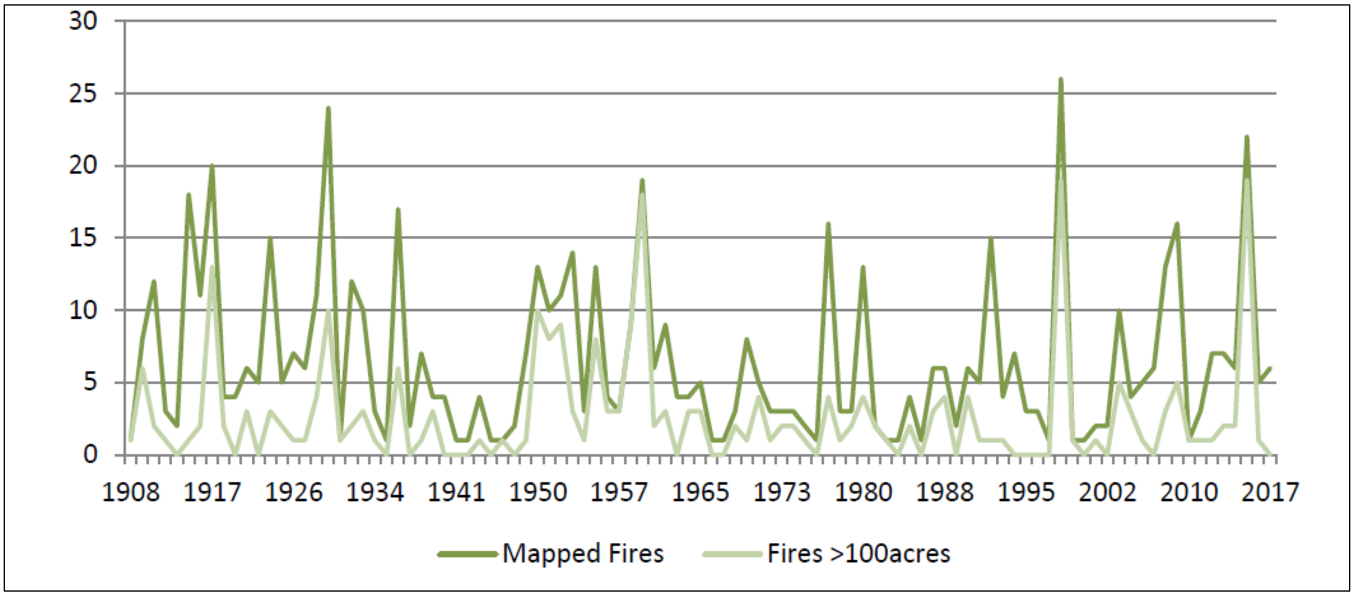


Figure 14-4. Humboldt County, Number of Fires per Year, 1908–2017

Figure 14-5 shows the number of fire ignitions by month in Humboldt County, from 1974 through 2017. The greatest potential for ignitions occurs between June and October. Figure 14-6 shows the average number of acres burned by month for the same years. The greatest potential for fires to grow to a large size happens in September. This is likely due to weather and fuel conditions, which could be exacerbated by the possibility that fire suppression resources could be stretched throughout the state in the fall.

Source: 2019 Humboldt County CWPP

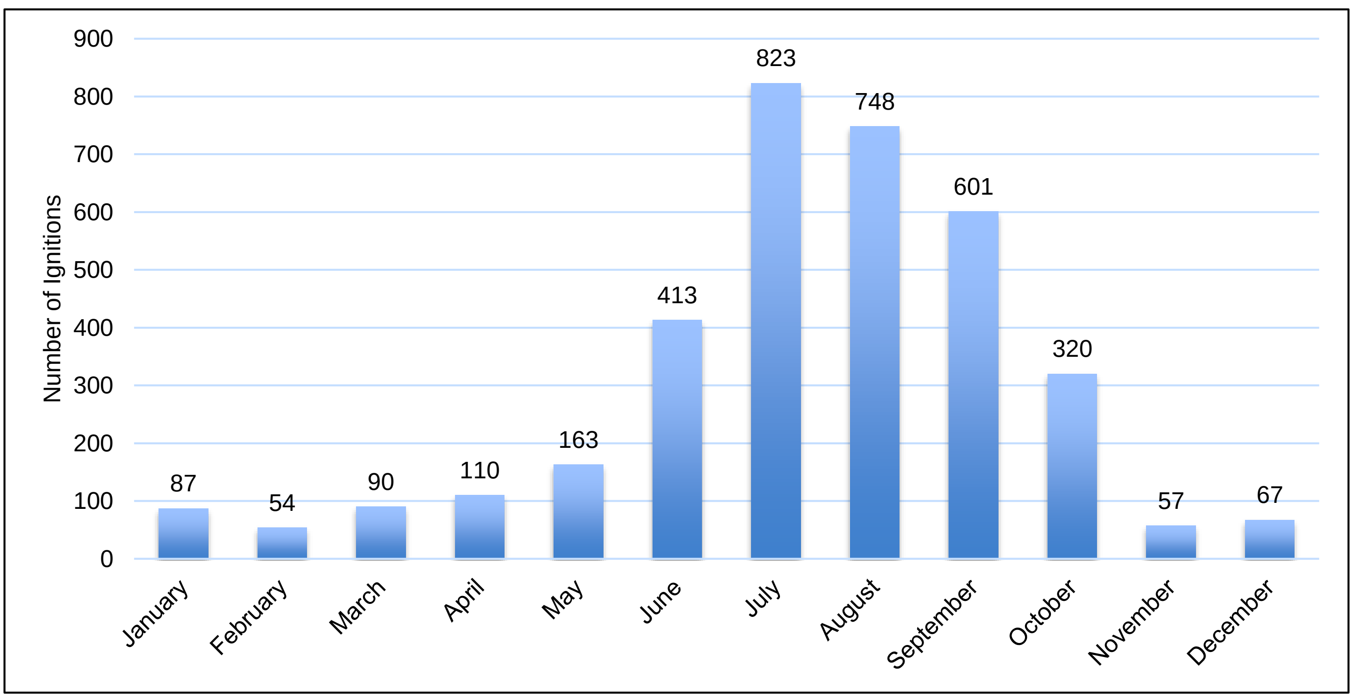


Figure 14-5. Humboldt County, Number of Ignitions by Month, 1974-2017

Source: 2019 Humboldt County CWPP

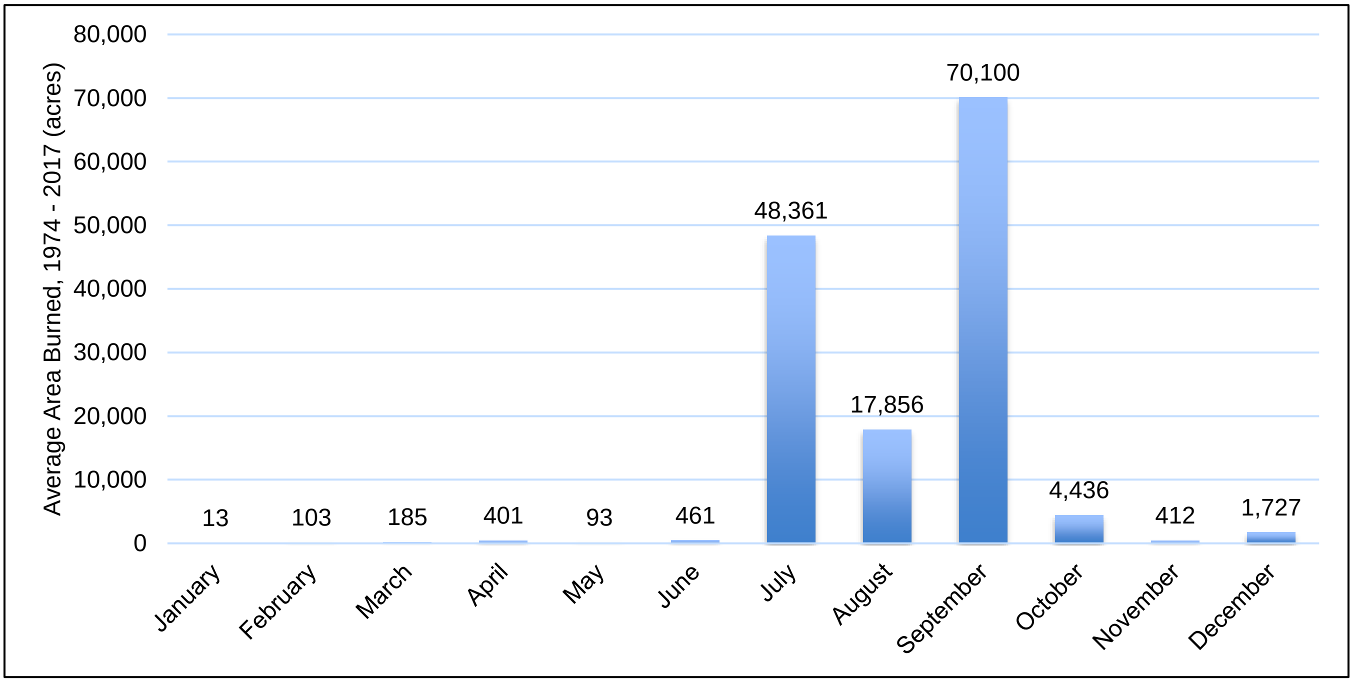


Figure 14-6. Humboldt County, Average Number of Acres Burned by Month, 1974-2017

Fire Regimes

Fire regime is a description of fire's historical natural occurrence, variability, and influence on vegetation dynamics in the landscape. Fire regimes can provide information for fire planning, as they describe the frequency of fire and the effects a fire is expected to have on a particular area's vegetation. Generally based on fire history reconstructions, fire regime descriptions include the season, frequency, severity, size, and spatial distribution of fires. There is a wide variability in intervals, severities and seasons, but some generalities have been made. Over the years, foresters and plant ecologists have come to use a small number of standardized fire regime classes to make general comparisons about the fire ecology of ecosystems and regions. Five historical fire regimes are defined, based on the average number of years between fires (fire frequency) and fire severity (amount of consumption of the dominant overstory vegetation):

- I: 0 to 35-year frequency and low (surface fires most common) to mixed severity (less than 75 percent of the dominant overstory vegetation replaced)
- II: 0 to 35-year frequency and high (stand replacement) severity (greater than 75 percent of the dominant overstory vegetation replaced)
- III: 35- to 100+-year frequency and mixed severity
- IV: 35- to 100+-year frequency and high severity
- V: 200+-year frequency and high severity.

According to CAL FIRE, Humboldt County primarily has Fire Regime I, which means a natural fire-return interval between 0 and 35 years of low severity fire. There are also scattered areas of Fire Regime III, with a mixed severity fire frequency from 35 to over 100 years, generally found on ridgetops, and more often in the eastern parts of the county. All three condition classes (1, 2, and 3) exist in Humboldt County. Condition class is generally within or near fires' historical range for the western and lower elevation/riparian areas of the county. As elevation increases, condition class changes from moderately altered to severely altered from historical range.

14.2.5 Severity

Potential losses from wildfire include human life, structures and other improvements, and natural resources. Given the immediate response times to reported fires and the proximity to firefighting resources, the likelihood of injuries and casualties is minimal. However, under the right conditions, fire can move quickly and overwhelm an initial response. 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.

Air Quality Impact

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. The North Coast Unified Air Quality Management District monitors smoke impacts from active wildfires and issues wildfire smoke air quality notifications ranging from “good” to “hazardous” (North Coast Unified Air Quality Management District, 2018).

The planning area is prone to temperature inversions, which occur when a layer of warm air traps cool air near the surface and creates a lid that inhibits the vertical dispersion of smoke and other pollutants. The Megram Fire (Big Bar Complex Fire) burned 135,000 acres between late August and early November 1999 in eastern Humboldt and Trinity Counties, and resulted in the first air quality related state of emergency in California history. Smoke from the fire was trapped by an inversion layer between late September and early October, causing officials to close schools and encourage residents to leave the area. Those who remained in the affected area were encouraged to remain indoors.

14.2.6 Warning Time

Wildfires are mostly 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; however, the lack of reliable cell service in many parts of Humboldt County means that providing warning to those in the path of a fire may still be difficult, particularly if individuals are not in areas with land lines.

14.3 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. These secondary impacts of wildfire can also affect the quantity and quality of water, which can pose a significant challenge to drinking water utilities (US EPA August 2019).

14.4 EXPOSURE

A quantitative assessment of exposure to the wildfire hazard was conducted using the fire hazard severity zone mapping shown in Figure 14-3 and the asset inventory developed for this plan (See Section 6.3). Detailed results are provided in Appendix C and summarized below.

14.4.1 Population

Population was estimated using the residential building count in each mapped hazard area and multiplying by the 2018 estimated average population per household (US Census American Community Survey, 2018). Using this approach, the estimated population living in mapped wildfire risk areas is 55.9 percent of the planning area population (76,012 people). The population exposure estimates by risk area are shown in Table 14-1. In addition to populations who reside in risk areas where fires may occur, hikers and campers in the mountains may be exposed to wildfires and the entire population of the planning area has the potential to be exposed to smoke from nearby wildfires.

Table 14-1. Humboldt County Population Exposure to the Wildfire Hazard

Fire Hazard Severity Zone	Population Exposed	% of Total Population
Moderate	42,597	31.3%
High	27,896	20.5%
Very High	5,519	4.1%
Total	**76,012**	**55.90%**

14.4.2 Property

Figure 14-7 shows the percentage and count, by land use type, of planning area structures in very high and high severity zones. An estimated 83 percent of these structures (11,862 structures) are residential.

The total replacement value of property in the wildfire hazard area is about $18.6 billion—52.7 percent of the planning area total:

- Moderate fire hazard severity: $10.4 billion
- High fire hazard severity: $6.7 billion
- Very high fire hazard severity: $1.6 billion

14.4.3 Critical Facilities and Infrastructure

Critical facilities and infrastructure exposed to the wildfire hazard represent 35 percent of the total critical infrastructure and facilities in the planning area. The breakdown of exposure by severity zone and facility type is shown in Figure 14-8. Linear, above-ground infrastructure, such as power lines, is also exposed to damage from wildfire, but is not included in this quantitative analysis.

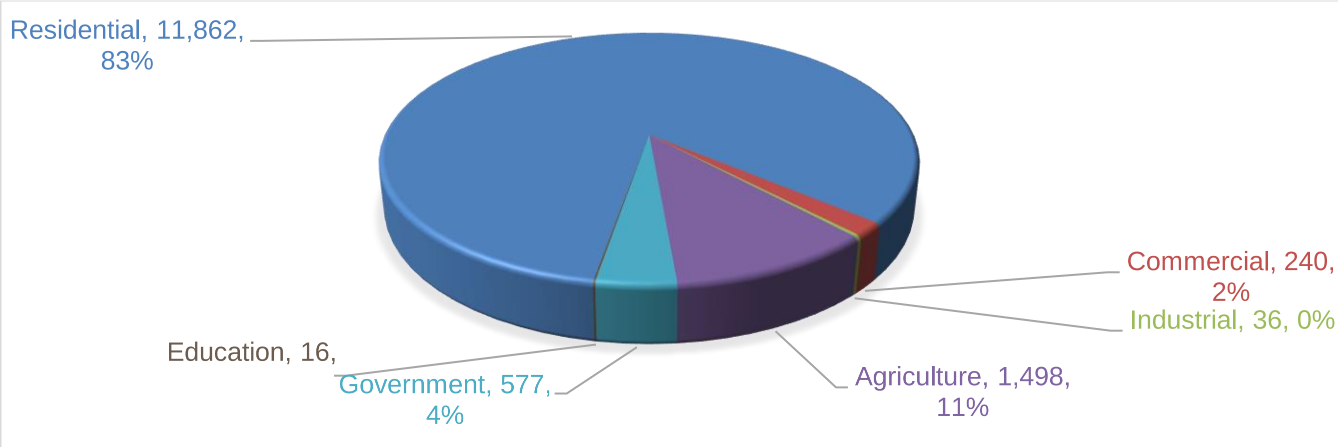


Figure 14-7. Structures in the High or Very High Fire Hazard Severity Zones, by Land Use Type

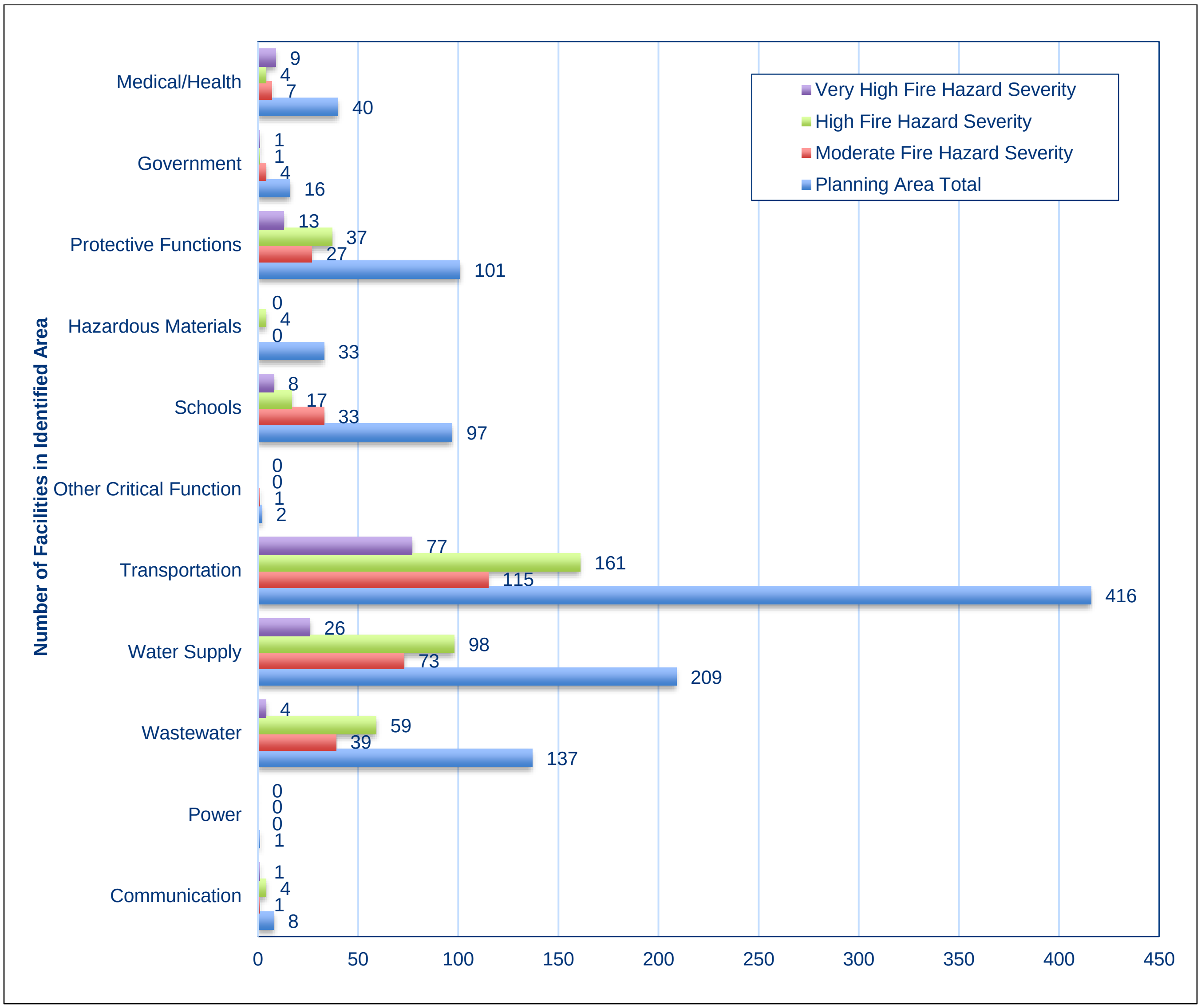


Figure 14-8. Critical Facilities and Infrastructure in Mapped Fire Hazard Severity Zones and Countywide

14.4.4 Environment

All natural resources and habitats in mapped fire hazard severity zones are exposed to the risk of wildfire.

14.5 VULNERABILITY

Vulnerability estimates for the wildfire hazard are described qualitatively. No loss estimation of these facilities was performed because damage functions have not been established for the wildfire hazard. Modeling based on identified fire hazard areas would overestimate potential losses because it is unlikely that all areas susceptible to wildfire would experience a fire at the same time.

14.5.1 Population

All people exposed to the wildfire hazard are potentially vulnerable to wildfire impacts. Humboldt County is very large, and fires can occur almost anywhere. The resident population is widely distributed. Response times can be very long and the weight of response (number of firefighters and engines) can be limited. Humboldt County has many areas where the roads accessing communities and residential clusters do not meet emergency access standards for road width (to allow residential population evacuation and incoming emergency apparatus) and where alternative access routes are not available. 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. In addition, wildfire may threaten the health and safety of those fighting the fires. First responders are exposed to dangers from the initial incident and after-effects from smoke inhalation and heat stroke. Persons with access and functional needs, the elderly and very young may be especially vulnerable to a wildfire if there is not adequate warning time before evacuation is needed.

14.5.2 Property

All property exposed to the wildfire hazard is vulnerable. Structures that were not constructed to standards designed to protect a building from a wildfire may be especially vulnerable. As of 2008, California State Building code requires minimum standards be met for new buildings in fire hazard severity zones. Most housing in the planning area—84 percent—was built prior to this code requirement (U.S. Census, 2018). It is unknown how many of these structures are in fire hazard zones.

Estimates were developed to indicate the loss that would occur if wildfire damage were equal to 10, 30 or 50 percent of the exposed property value, as summarized in Table 14-2. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure.

Table 14-2. Loss Estimates for Fire Hazard Severity Zones

Fire Hazard Severity Zone	Exposed Value	Damage = 10% of Exposed Value		Damage = 30% of Exposed Value		Damage = 50% of Exposed Value	
		Loss	% of Total Replacement Value	Loss	% of Total Replacement Value	Loss	% of Total Replacement Value
Moderate	$10.4 billion	$ 1.04 billion	2.94%	$ 3.1 billion	8.82%	$ 5.2 billion	29.4%
High	$6.7 billion	$669.6 million	1.9%	$2 billion	5.69%	$3.3 billion	9.49%
Very High	$1.6 billion	$160.4 million	0.45%	$ 481.1 million	1.36%	$ 801.9 million	2.27%
Total	**$18.7 billion**	**$1.8 billion**	**5.29%**	**$5.6 billion**	**15.87%**	**$9.34 billion**	**26.45%**

14.5.3 Critical Facilities and Infrastructure

Critical facilities not built to fire protection standards, utility poles and lines, and facilities containing hazardous materials are most vulnerable to the wildfire hazard. Most roads would not be damaged except in the worst scenarios, although roads and bridges can be blocked by debris or other wildfire-related conditions and become impassable. The following critical facilities are located in very high and high severity zones and their vulnerability could complicate response and recovery efforts during and following an event:

- **Hazardous Materials and Fuel Storage**—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.
- **Communication Facilities**—If these facilities are damaged and become inoperable, it would exacerbate already difficult communication in the planning area.
- **Protective Function Facilities (Police and Fire)**—Approximately 50 percent of these types of facilities are within the high-severity wildfire zone.

14.5.4 Environment

Fire is a natural and critical ecosystem process in most terrestrial ecosystems, affecting the types, structure, and spatial extent of native vegetation. However, under a specific set of circumstances, it can also cause severe environmental impacts, such as the following:

- **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—**Wildfire can have negative consequences for endangered species by degrading their habitat.
- **Soil Sterilization**—Some wildfires burn so hot that they can sterilize the soil. Topsoil exposed to extreme heat can become water repellant, and soil nutrients may be lost.
- **Reduced Timber Harvesting**—Timber can be destroyed and lead to smaller available timber harvests.
- **Reduced Agricultural Resources—**Wildfire can have disastrous consequences on agricultural resources, removing them from production and necessitating lengthy restoration programs.
- **Damaged Cultural and Historical Resources**—The destruction of cultural and historic resources may occur, scenic vistas can be damaged, and access to recreational areas can be reduced.

14.6 FUTURE TRENDS IN DEVELOPMENT

The urbanized portions of the planning area, while having, in many cases, relatively hazardous wildfire conditions (high fuels and rugged topography), also have a low likelihood or risk of wildfire. 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 development toward wildfire hazard areas can be managed with strong land use and building codes.

The California Building Code includes minimum standards related to the design and construction of buildings in fire hazard zones. Any newly permitted buildings within the SRA in Humboldt County must conform to standards that manage flammable materials from around the building (defensible space laws) and construct buildings from fire resistant material (Chapter 7A or the Building Code). New residential construction permitted in Humboldt County's State Responsibility Areas have been built according to the standards of the 2007 California Building Code Chapter 7A, "Materials and Construction Methods for Exterior Wildfire Exposure" (effective January 1, 2008). In addition, the Humboldt County General Plan and those for each municipal planning partner include policies that address managing development in fire hazard severity zones. 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 the planning area experiences future growth and if the recommendations of this plan are implemented, it is anticipated that the exposure to this hazard will remain as assessed or even decrease over time due to these capabilities.

State and local policies and regulations require landowners to carry out activities such as maintaining defensible space and reducing vulnerability to damage or loss from wildfire. The most important policies and regulations related to residential wildfire safety in Humboldt County are as follows:

- **General Plan Safety Element Review: Government Code 65302.5**—The Board of Forestry and Fire Protection (BOF) must provide recommendations to a local jurisdiction's General Plan Safety Element at the time that the General Plan is being amended. BOF recommendations include goals and policies that provide for contemporary fire-prevention standards for the jurisdiction. This is not a direct and binding fire-prevention requirement for individuals.
- **Sprinkler Systems: California Residential Code, Chapter 3, Section R313—**All new dwellings, dwelling units, and one- and two-family townhomes must be equipped with an automatic fire-sprinkler system that can protect the entirety of the dwelling. Dwellings and homes constructed prior to January 1, 2011, that do not have a sprinkler system may be retrofitted, but it is not required. This code is locally enforced by the Humboldt County Planning and Building Department.
- **Fire Safety Standards: California Public Resources Code 4290 and 14 California Code of Regulations (CCR) 1270—**These regulations govern roads, driveway width, clearance, turnarounds, signing, and water related to fire safety throughout California. Public Resources Code 4290 is typically enacted through regulation at the county level, as described below.
- **SRA Fire Safe Regulations: Humboldt County Code Title III, Div. 11—**These standards to reduce the risk of fire apply to proposed development within the State Responsibility Area (SRA). They are a locally adopted equivalent to the state's SRA Fire Safe Regulations and have been approved by the BOF as meeting or exceeding state regulation. The Humboldt County Planning and Building Department, with CAL FIRE, oversees the development permitting process to ensure that these standards are met. County Building Division staff inspect vegetation clearance and other improvements at the time of construction.
- **Wildland-Urban Interface Building Standards: California Government Code 51189**—The Office of the State Fire Marshal is required to create building standards for wildfire resistance. Construction of buildings in the wildland-urban interface must use fire-resistant materials to save life and property. As of 2011, the standards relevant to fire-safe construction for all new structures in the SRA are the California Building Code, Chapter 7A (for commercial construction) and the California Residential Code, Chapter 3, Section R327 (for residential construction). Humboldt County has adopted these codes.
- **State Responsibility Area: Public Resources Code 4102, 4125-4229 and 14 CCR 1220**—These statutes and regulations establish the locations where CAL FIRE has the financial responsibility for preventing and suppressing fires. These designations define financial arrangements for fire protection services and establish the locations where fire safe and defensible space laws or regulations apply.
- **Hazardous Fire Areas: Public Resources Code 4251-4255 and 14 CCR 1200—**These laws and regulations allow petitioners to the BOF or CAL FIRE to establish hazardous fire areas, providing for area closures and other restrictions for fire prevention.

- **Defensible Vegetation Clearing Around Structures: Public Resources Code 4291/14 CCR 1299**—Public Resources Code 4291 regulates fuel management around a property. It states that a person who owns or controls a building or structure in or adjoining to forest, brush, or grass covered lands shall follow certain guidelines outlined in the code. At least 100 feet of defensible space is required. The owner of the property is liable for making these changes to protect habitable structures. The 100 feet is separated into two zones, with the closer zone, 30 feet out from the structure, being managed more intensively.

14.7 SCENARIO

A major wildfire in the planning area 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 lightning 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 could be deep in forested areas. 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.

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.

14.8 ISSUES

The major issues for wildfire are the following:

- According to the Humboldt County CWPP, of all the wildfires from 1974 to 2017 with known ignition sources, 60 percent were started by people, including 35 percent as arson; 12 percent were caused by lightning. The remaining 28 percent were of unknown origin.
- More than 50 percent of the planning area population lives in wildfire risk areas, including 4.1 percent in very high fire hazard severity zones.
- Much of the planning area’s building stock is of wood-frame construction built before 2008 when California building codes began requiring minimum standards for buildings in fire hazard severity zones. Large clusters of structures are wood-frame structures in high and very high severity zones.
- An estimated 35 percent of the critical facilities and infrastructure in the planning area are located in wildfire risk areas. A large number of the facilities are believed to be wood-frame structures. These facilities could have a significant amount of functional downtime after a wildfire. This creates not only a need for mitigation but also a need for continuity of operations planning to develop procedures for providing services without access to critical facilities.

- There are vulnerable and isolated populations in areas of high and very high risk for wildfire.
- Public education and outreach to people living in 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.
- Analyses based on the degree of wildfire risk should be updated to match new calculations.
- Regional consistency, application and enforcement of higher building code standards such as residential sprinkler requirements and prohibitive combustible roof standards.
- Fire departments require reliable water supply in high risk wildfire areas.
- Certifications and qualifications should be expanded for fire department personnel. All firefighters should be trained in basic wildfire behavior and basic fire weather, and all company officers and chief level officers should be trained at the wildland command and strike team leader level.

15. CLIMATE CHANGE

15.1 GENERAL BACKGROUND

15.1.1 What is Climate Change?

Climate, consisting of patterns of temperature, precipitation, humidity, wind and seasons, plays a fundamental role in shaping natural ecosystems and the human economies and cultures that depend on them. "Climate change" refers to changes over a long period of time. Worldwide, average temperatures have increased 1.8ºF since 1880 (NASA, 2018). Although this change may seem small, it can lead to large changes in climate and weather.

The warming trend and its related impacts are caused by increasing concentrations of carbon dioxide and other greenhouse gases in the earth's atmosphere. Greenhouse gases are gases that trap heat in the atmosphere, resulting in a warming effect. Carbon dioxide is the most commonly known greenhouse gas; however, methane, nitrous oxide and fluorinated gases also contribute to warming. Emissions of these gases come from a variety of sources, such as the combustion of fossil fuels, agricultural production, changes in land use and volcanic eruptions. Carbon dioxide concentrations measured about 280 parts per million before the industrial era began in the late 1700s and are now recorded at more than 407 parts per million (EPA, 2016 and NASA, 2018) (see Figure 15-1).

Source: EPA, 2016

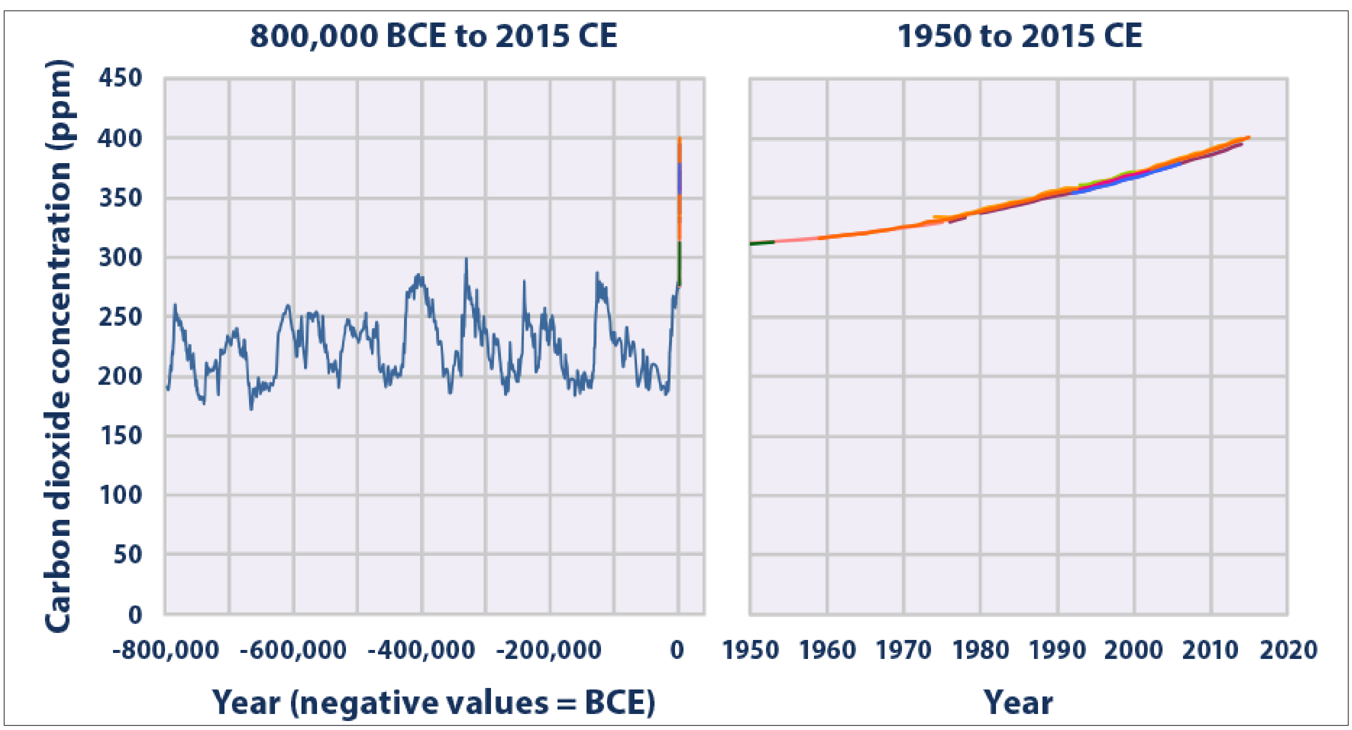


Figure 15-1. Global Carbon Dioxide Concentrations Over Time

In addition, the concentration of methane has almost doubled and nitrous oxide was being measured at a record high of 328 parts per billion as of 2015 (EPA, 2016a). In the United States, electricity generation is the largest source of these emissions, followed by transportation (EPA, 2016b).

Scientists are able to place this rise in carbon dioxide in a longer historical context through the measurement of carbon dioxide in ice cores. According to these records, carbon dioxide concentrations in the atmosphere are the highest that they have been in 650,000 years (NASA, 2016). According to NASA, most of this trend is very likely human-induced and it is proceeding at an unprecedented rate (NASA, 2016). There is broad scientific consensus (97 percent of scientists) that climate-warming trends are extremely likely due to human activities (NASA, 2018). Unless emissions of greenhouse gases are substantially reduced, this warming trend is expected to continue.

Climate change will affect the people, property, economy and ecosystems of the planning area in a variety of ways. Climate change impacts are most frequently associated with negative consequences, such as increased flood vulnerability or increased heat-related illnesses/public health concerns; however, other changes may present opportunities. The most important effect for the development of this plan is that climate change will have a measurable impact on the occurrence and severity of natural hazards.

15.1.2 How Climate Change Affects Hazard Mitigation

An essential aspect of hazard mitigation is predicting the likelihood of hazard events. Typically, predictions are based on statistical projections from records of past events. This approach assumes that the likelihood of hazard events remains essentially unchanged over time. Thus, averages based on the past frequencies of, for example, floods are used to estimate future frequencies: if a river has flooded an average of once every 5 years for the past 100 years, then it can be expected to continue to flood an average of once every 5 years.

For hazards that are affected by climate conditions, the assumption that future behavior will be equivalent to past behavior is not valid if climate conditions are changing. As flooding is generally associated with precipitation frequency and quantity, for example, the frequency of flooding will not remain constant if broad precipitation patterns change over time. Floods currently considered to be 1-percent-annual-chance events might strike more often, leaving many communities at greater risk. The risks of landslide, severe storms, extreme heat and wildfire are all affected by climate patterns as well. For this reason, an understanding of climate change is pertinent to efforts to mitigate natural hazards. Information about how climate patterns are changing provides insight on the reliability of future hazard projections used in mitigation analysis. This chapter summarizes current understandings about climate change in order to provide a context for the recommendation and implementation of hazard mitigation measures.

15.1.3 Current Indicators of Climate Change

The major scientific agencies of the United States and the world—including NASA, NOAA and the Intergovernmental Panel on Climate Change (IPCC)—agree that climate change is occurring. Multiple temperature records from all over the world have shown a warming trend. The IPCC has stated that the warming of the climate system is unequivocal (IPCC, 2014). Seventeen of the 18 warmest years on record occurred since 2001, and 2016 was the warmest year on record (NASA, 2017).

Rising global temperatures have been accompanied by other changes in weather and climate. Many places have experienced changes in rainfall resulting in more intense rain, as well as more frequent and severe heat waves (IPCC, 2014a). The planet's oceans and glaciers have also experienced changes: oceans are warming and becoming more acidic, ice caps are melting, and sea levels are rising. Global sea level has risen approximately 6.7 inches, on average, in the last 100 years (NASA, 2018). This has already put some coastal homes, beaches, roads, bridges, and wildlife at risk (USGCRP, 2009). At the time of the development of this plan, NASA reports the following trends (NASA, 2017):

- Carbon Dioxide—Increasing trend, currently at 407.61 parts per million
- Global Temperature—Increasing trend, increase of 1.8ºF since 1880
- Arctic Ice Minimum—Decreasing trend, 13.2 percent per decade
- Land Ice—Decreasing trend, 286.0 gigatonnes per year
- Sea Level—Increasing trend, 3.2 millimeters (0.13 inches) per year.

15.1.4 Projected Future Impacts

Qualitative Impacts

The *Third National Climate Assessment Report for the United States* indicates that impacts resulting from climate change will continue through the 21st century and beyond. Although not all changes are understood at this time and the impacts of those changes will depend on global emissions of greenhouse gases and sensitivity in human and natural systems, the following impacts are expected in the United States (NASA, 2014):

- Temperatures will continue to rise.
- Growing seasons will lengthen.
- Precipitation patterns will change.
- Droughts and heat waves will increase.
- Hurricanes will become stronger and more intense.
- Sea level will rise 1 to 4 feet by 2100.
- The Arctic may become ice free.

The *California Climate Adaptation Planning Guide* outlines the following climate change impact concerns for North Coast communities (Cal EMA et al., 2012):

- Reduced snowpack
- Increased wildfires
- Sea level rise and inland flooding
- Threats to sensitive species
- Loss in agricultural productivity
- Public health and safety.

Some of these changes are direct or primary climatic changes, such as increased temperature, while others are indirect climatic changes or secondary impacts resulting from these direct changes, such as heat and air pollution. Some direct changes may interact with one another to create unique secondary impacts. These primary and secondary impacts may then result in impacts on human and natural systems. The primary and secondary impacts likely to affect the planning area are summarized in Table 15-1.

Modeled Climate Changes

Climate change projections contain inherent uncertainty, largely derived from the fact that they depend on future greenhouse gas emission scenarios. Generally, the uncertainty in greenhouse gas emissions is addressed by the presentation of differing scenarios: low-emissions or high-emissions scenarios. In low-emissions scenarios, greenhouse gas emissions are reduced substantially from current levels. In high-emissions scenarios, greenhouse gas emissions generally increase or continue at current levels. Uncertainty in outcomes is generally addressed by averaging a variety of model outcomes.

Table 15-1. Summary of Primary and Secondary Impacts

Primary Impact	Secondary Impact	Example Human and Natural System Impacts
Increased temperature	Heat wave	• Increased frequency of illness and death • Increased stress on mechanical systems, such as HVAC systems
Increased temperature and changes in precipitation	Changed seasonal patterns	• Reduced agricultural productivity • Reduced tourism
	Intense rainstorms	• Increased frequency of flood or flash flood events • Reduction in water quality
Increased temperature and/or reduced precipitation	Drought	• Reduced agricultural productivity • Decreased water supply
	Reduced Snowpack	• Decreased water supply • Reduced tourism
	Wildfire	• Increased incidence of landslide or mudslide • Reduced tourism • Increase in air pollution and related health impacts
Sea level rise	Permanent inundation of previously dry land	• Loss of assets and tax base • Loss of coastal habitat
	Larger area impacted by extreme high tide	• More people and structures impacted by storms • Increased incidence of loss of utilities and lifeline systems
	Increased coastal erosion	• Loss of assets and tax base
	Saltwater intrusion into freshwater systems	• Decreased water supply • Ecosystem disruption
Changes in wind patterns	Increased extreme events, including severe storms and fires	• More frequent disruption to systems resulting from severe storms
Ocean acidification		• Decreased biodiversity in marine ecosystems

Source: Adapted and expanded from California Adaptation Planning Guide: Planning for Adaptive Communities

Despite this uncertainty, climate change projections present valuable information to help guide decision-making for possible future conditions. The following sections summarize information developed for the planning area by Cal-Adapt, a resource for public information on how climate change might impact local communities, based on the most current data available. The projections are averaged across the county-wide planning area and include information from two emissions scenarios, which were developed by the IPCC. Historical (1950-1990) observed climate information for the planning area, as well as projected impacts for 2050 and 2099, are summarized in Table 15-2. By the end of the century under a high-emissions scenario, the following changes are projected:

- Average maximum temperatures and minimum temperatures would rise by almost 9°F.
- There would be more than 10 times as many extreme heat days per year on average.
- Average annual precipitation would increase by almost 4 percent to more than 103 inches.
- Snow water equivalent held in snowpack would decrease by 91 percent.
- Wildfire hectares burned annually would increase by 58 percent.

Sea Level Rise

Sea levels have been rising over the past several decades and are expected to continue to rise. Sea level rise is mostly attributed to two factors: the expansion of water as it warms (thermal expansion) and the melting of ice sheets and glaciers. As average ocean temperatures continue to increase, thermal expansion will continue and can be projected with some degree of certainty. Less certain is how quickly ice sheets will melt, accounting for most of the uncertainty in projections.

Table 15-2. Historical and Future Projections for Climate Information in Humboldt County

Climate Parameter	Historic Average (1950-2005)	Low Emissions Scenario[e]				High Emissions Scenario[f]			
		Projection		Difference from Historical Average		Projection		Difference from Historical Average	
		2006-2050	2050-2099	2006-2050	2050-2099	2006-2050	2050-2099	2006-2050	2050-2099
Maximum Average Temperature (°F)	54.8	60.6	62.1	+3.1	+4.6	60.9	66.1	+3.4	+8.6
Minimum Average Temperature (°F)	37.1	41.0	42.3	+3.1	+4.4	41.4	46.8	+3.5	+8.9
Extreme Heat Days[a]	4.2	8	17	+3.8	+12.8	8	42	+3.8	+37.8
Precipitation (inches)[b]	70.6	101.1	102.2	+1.3	+2.4	101.1	103.4	+1.3	+3.6
Snow Water Equivalent in Snowpack (inches)[c]	4.5	1.7	0.8	-2.8	-3.7	1.6	0.4	-2.9	-4.1
Wildfire (hectares)[d]	1,309	2,491	3,554	+1,182	+2,245	3,065	3,568	+1,756	+2,259

a. Extreme heat day threshold for the planning area is 76.8°F
b. On average, total annual precipitation in the state is not projected to change substantially; however, modeled projections do not show a consistent trend. In general, most precipitation is expected to continue to fall during the winter. Small changes in precipitation patterns in the state will have the potential to cause significant disruption to build and natural systems.
c. Measured in April
d. Assumes central population projection trends.
e. Emissions peak around 2040 and then decline (this was designated Scenario B1 in older IPCC analyses and Scenario RCP 4.5 under more recent IPCC analyses)
f. Emissions rise strongly through 2050 and plateau around 2100 (this was designated Scenario A2 in older IPCC analyses and Scenario RCP 8.5 under more recent IPCC analyses).

Source: Cal-Adapt

Sea level rise will cause currently dry areas to be permanently or chronically inundated. Temporary inundation from extreme tide events and storm surge also will change. Unlike many other impacts resulting from climate change, sea level rise will have a defined extent and location. This allows for a more-detailed risk assessment to be conducted for this climate change impact (see Section 15.3). Although the extent and timing of sea level rise is still uncertain, assessing potential areas at risk provides information appropriate for planning purposes.

15.1.5 Responses to Climate Change

Communities and governments worldwide are working to address, evaluate and prepare for climate changes that are likely to impact communities in coming decades. Generally, climate change discussions encompass two separate but inter-related considerations: mitigation and adaptation. The term “mitigation” can be confusing, because its meaning changes across disciplines:

- Mitigation in restoration ecology and related fields generally refers to policies, programs or actions that are intended to reduce or to offset the negative impacts of human activities on natural systems. Generally, mitigation can be understood as avoiding, minimizing, rectifying, reducing or eliminating, or compensating for known impacts.
- Mitigation in climate change discussions is defined as “a human intervention to reduce the impact on the climate system.” It includes strategies to reduce greenhouse gas sources and emissions and enhance greenhouse gas sinks.
- Mitigation in emergency management is typically defined as the effort to reduce loss of life and property by lessening the impact of disasters.

In this chapter, mitigation is used as defined by the climate change community. In the other chapters of this plan, mitigation is primarily used in an emergency management context.

The IPCC defines adaptation as “the process of adjustment to actual or expected climate and its effects.” Mitigation and adaptation are related, as the world’s ability to reduce greenhouse gas emissions will affect the degree of adaptation that will be necessary. Some actions can both reduce greenhouse gas emissions and support adaptation to likely future conditions. Some adaptation actions also help communities reach other community goals (often referred to as co-benefits). The ability to adapt to changing conditions is often referred to as adaptive capacity, which is “the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences” (IPCC, 2014a).

Societies across the world are facing the need to adapt to changing conditions and to identify ways to increase their adaptive capacity. Some efforts are already underway. Farmers are altering crops and agricultural methods to deal with changing rainfall and rising temperature; architects and engineers are redesigning buildings; planners are looking at managing water supplies to deal with droughts or flooding.

Adaptive capacity goes beyond human systems, as some ecosystems are able to adapt to change and to buffer surrounding areas from the impacts of change. Forests can bind soils and hold large volumes of water during times of plenty, releasing it through the year; floodplains can absorb vast volumes of water during peak flows; coastal ecosystems can hold out against storms, attenuating waves and reducing erosion. Other ecosystem services—such as food provision, timber, materials, medicines and recreation—can provide a buffer to societies in the face of changing conditions. Ecosystem-based adaptation is the use of biodiversity and ecosystem services as part of an overall strategy to help people adapt to the adverse effects of climate change. This includes the sustainable management, conservation and restoration of specific ecosystems that provide key services.

Assessment of the current efforts and adaptive capacity of the planning partners participating in this hazard mitigation plan are included in the jurisdiction-specific annexes in Volume 2.

The State Coastal Conservancy is funding a two-phase sea-level rise project on Humboldt Bay. The first phase, completed in January 2013, was the Humboldt Bay Shoreline Inventory, Mapping and Sea Level Rise Vulnerability Project. The second phase, currently underway, is the Humboldt Bay Sea Level Rise Adaptation Planning Project. The second phase consists of inundation modeling and mapping, along with adaptation planning. The Humboldt Bay Harbor, Recreation and Conservation District and Humboldt County Public Works formed the Adaptation Planning Working Group. Adaptation planning will encourage a consistent regional strategy to address impacts associated with sea level rise in the Humboldt Bay region. Sea level rise adaptation planning begins with understanding existing conditions, assessing what areas are vulnerable and what assets are at risk, and developing bay-wide strategies to deal with flooding (Humboldt Bay HRCD, 2013).

15.2 VULNERABILITY ASSESSMENT— HAZARDS OF CONCERN

The following sections provide information on how each identified hazard of concern for this planning process may be impacted by climate change and how these impacts may alter current exposure and vulnerability to these hazards for the people, property, critical facilities and the environment in the planning area.

15.2.1 Dam Failure

Climate Change Impacts on the Hazard

On average, changes in California’s annual precipitation levels are not expected to be dramatic; however, small changes may have significant impacts for water resource systems, including dams. Dams are designed partly based on assumptions about a river’s flow behavior, expressed as hydrographs. Changes in weather patterns can have significant effects on the hydrograph used for the design of a dam. If the hygrograph changes, it is conceivable that the dam can lose some or all of its designed margin of safety, also known as freeboard.

If freeboard is reduced, dam operators may be forced to release increased volumes earlier in a storm cycle in order to maintain the required margins of safety. Such early releases of increased volumes can increase flood potential downstream. According to the California Department of Water Resources, flood flows on many California rivers have been record-setting since the 1950s. This means that water infrastructure, such as dams, have been forced to manage flows for which they were not designed. The California Division of Dam Safety has indicated that climate change may result in the need for increased safety precautions to address higher winter runoff, frequent fluctuations of water levels, and increased potential for sedimentation and debris accumulation from changing erosion patterns and increases in wildfires. According to the Division, climate change also will impact the ability of dam operators to estimate extreme flood events (DWR, 2008).

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

Exposure, Sensitivity and Vulnerability

The following summarizes changes in exposure and vulnerability to the dam failure hazard resulting from climate change:

- **Population**—Population exposure and vulnerability to the dam failure hazard are unlikely to change as a result of climate change.
- **Property**—Property exposure and vulnerability to the dam failure hazard are unlikely to change as a result of climate change.
- **Critical facilities**—The exposure and vulnerability of critical facilities are unlikely to change as result of climate change. Dam owners and operators are sensitive to the risk and may need to alter maintenance and operations to account for changes in the hydrograph and increased sedimentation. Critical facility owners and operators in levee failure inundation areas should always be aware of residual risk from flood events that may overtop the levee system.
- **Environment**—The exposure and vulnerability of the environment to dam and levee failure are unlikely to change as a result of climate change. Ecosystem services may be used to mitigate some factors that could increase the risk of design failures, such as increasing the natural water storage capacity in watersheds above dams.
- **Economy**—Changes in the dam failure hazard related to climate change are unlikely to affect the local economy. Economic impacts may result from changes to the levee failure hazard if accreditation is lost.

15.2.2 Drought

Climate Change Impacts on the Hazard

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. According to the National Climate Assessment, "higher surface temperatures brought about by global warming increase the potential for drought. Evaporation and the higher rate at which plants lose moisture through their leaves both increase with temperature. Unless higher evapotranspiration rates are matched by increases in precipitation, environments will tend to dry, promoting drought conditions" (U.S. Climate Resilience Toolkit, 2018).

Because changes in precipitation patterns are still uncertain, the potential impacts and likelihood of drought are uncertain. DWR has noted impacts of climate change on statewide water resources by charting changes in snowpack, sea level, and river flow. As temperatures rise and more precipitation comes in the form of rain instead of snow, these changes will likely continue or grow even more significant. DWR estimates that the Sierra Nevada snowpack, which provides a large amount of the water supply for other parts of the state, will experience a 48- to 65-percent loss by the end of the century compared to historical averages (DWR, 2016b). Projections for the planning area show a significant decline in projected snow water equivalent in April snowpack. Increasing temperatures may also increase net evaporation from reservoirs by 15 to 37 percent (DWR, 2013).

Exposure, Sensitivity and Vulnerability

The following summarizes changes in exposure and vulnerability to the drought hazard resulting from climate change:

- **Population**—Population exposure and vulnerability to drought are unlikely to increase as a result of climate change. While greater numbers of people may need to engage in behavior change, such as water saving efforts, significant life or health impacts are unlikely.
- **Property**—Property exposure and vulnerability may increase as a result of increased drought resulting from climate change, although this would most likely occur in non-structural property such as crops and landscaping. It is unlikely that structure exposure and vulnerability would increase as a direct result of drought, although secondary impacts of drought, such as wildfire, may increase and threaten structures.
- **Critical facilities**—Critical facility exposure and vulnerability are unlikely to increase as a result of increased drought resulting from climate change; however, critical facility operators may be sensitive to changes and need to alter standard management practices and actively manage resources, particularly in water-related service sectors
- **Environment**—The vulnerability of the environment may increase as a result of increased drought resulting from climate change. Prolonged or more frequent drought resulting from climate change may stress ecosystems in the region, which include many special-status species.
- **Economy**—Increased incidence of drought could increase the potential for impacts on the local economy. Drought may reduce timber production and increase the number of acres of timber lost to wildfire.

15.2.3 Earthquake

Climate Change Impacts on the Hazard

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 or heavy precipitation could experience liquefaction or an increased propensity for slides 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.

Exposure, Sensitivity and Vulnerability

Because impacts on the earthquake hazard are not well understood, increases in exposure and vulnerability of local resources are not able to be determined.

15.2.4 Flood

Climate Change Impacts on the Hazard

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. Scientists project greater storm intensity with climate change, resulting in more direct runoff and flooding. High frequency flood events in particular will likely increase with a changing climate. What is currently considered a 1-percent-annual-chance also may strike more often, leaving many communities at greater risk. Going forward, model calibration 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 areas to contribute to peak storm runoff. 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.

Exposure, Sensitivity and Vulnerability

The following summarizes changes in exposure and vulnerability to the flood hazard resulting from climate change:

- **Population and Property**—Population and property exposure and vulnerability may increase as a result of climate change impacts on the flood hazard. Runoff patterns may change, resulting in flooding in areas where it has not previously occurred.
- **Critical facilities**—Critical facility exposure and vulnerability may increase as a result of climate change impacts on the flood hazard. Runoff patterns may change, resulting in risk to facilities that have not historically been at risk from flooding. Changes in the management and design of flood protection critical facilities may be needed as additional stress is placed on these systems. Planners will need to factor a new

level of safety into the design, operation, and regulation of flood protection facilities such as dams, bypass channels and levees, as well as the design of local sewers and storm drains.
- **Environment—**The exposure and vulnerability of the environment may increase as a result of climate change impacts on the flood hazard. Changes in the timing and frequency of flood events may have broader ecosystem impacts that alter the ability of already stressed species to survive.
- **Economy**—If flooding becomes more frequent, there may be impacts on the local economy. More resources may need to be directed to response and recovery efforts, and businesses may need to close more frequently due to loss of service or access during flood events.

15.2.5 Landslide

Climate Change Impacts on the Hazard

Climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Increase in global temperature is likely to 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.

Exposure, Sensitivity and Vulnerability

The following summarizes changes in exposure and vulnerability to the landslide hazard resulting from climate change:

- **Population and Property**—Population and property exposure and vulnerability would be unlikely to increase as a result of climate change impacts on the landslide hazard. Landslide events may occur more frequently, but the extent and location should be contained within mapped hazard areas or recently burned areas.
- **Critical facilities**—Critical facility exposure and vulnerability would be unlikely to increase as a result of climate change impacts on the landslide hazard; however, critical facility owners and operators may experience more frequent disruption to service provision as a result of landslide hazards. For example, transportation systems may experience more frequent delays if slides blocking these systems occur more frequently. In addition, increased sedimentation resulting from landslides may negatively impact flood control facilities, such as dams.
- **Environment—**Exposure and vulnerability of the environment would be unlikely to increase as a result of climate change, but more frequent slides in river systems may impact water quality and have negative impacts on stressed species.
- **Economy**—Changes to the landslide hazard resulting from climate change are unlikely to result in impacts on the local economy; but impacts may be felt if the limited major highways in the planning area are repeatedly impacted.

15.2.6 Severe Weather

Climate Change Impacts on the Hazard

Climate change presents a challenge for risk management associated with severe weather. The number of weather-related disasters during the 1990s was four times that of the 1950s and led to 14 times as much in economic losses. The science for linking the severity of specific severe weather events to climate change is still evolving; however, a number or trends provide some indication of how climate change may be impacting these events. According to the *U.S. National Climate Change Assessment* (2014), there were more than twice as many high temperature records as low temperature records broken between 2001 and 2012, and heavy rainfall events are becoming more frequent and more severe.

The increase in average surface temperatures can also lead to more intense heat waves. Evidence suggests that heat waves are already increasing, especially in western states. Extreme heat days in the planning area are likely to increase.

Climate change impacts on other severe weather events such as thunderstorms and high winds are still not well understood.

Exposure, Sensitivity and Vulnerability

The following summarizes changes in exposure and vulnerability to the severe weather hazard resulting from climate change:

- **Population and Property**—Population and property exposure and vulnerability would be unlikely to increase as a direct result of climate change impacts on the severe weather hazard. Severe weather events may occur more frequently, but exposure and vulnerability will remain the same. Secondary impacts, such as the extent of localized flooding, may increase, impacting greater numbers of people and structures.
- **Critical facilities**—Critical facility exposure and vulnerability would be unlikely to increase as a result of climate change impacts on the severe weather hazard; however, critical facility owners and operators may experience more frequent disruption to service provision. For example, more frequent and intense storms may cause more frequent disruptions in power service.
- **Environment**—Exposure and vulnerability of the environment would be unlikely to increase; however, more frequent storms and heat events and more intense rainfall may place additional stress on already stressed systems.
- **Economy**—Climate change impacts on the severe weather hazard may impact the local economy through more frequent disruption to services, such as power outages.

15.2.7 Tsunami

Climate Change Impacts on the Hazard

The impacts of global climate change on tsunami probability are unknown. Some scientists say that melting glaciers could induce tectonic activity, inducing earthquakes. Other scientists have indicated that underwater avalanches (also caused by melting glaciers), may also result in tsunamis. Even if climate change does not increase the frequency with which tsunamis occur, it may result in more destructive waves. As sea levels continue to rise, tsunami inundation areas would likely reach further into communities than current mapping indicates.

Exposure, Sensitivity and Vulnerability

As land area likely to be inundated by tsunami waves increases, exposure and vulnerability to the tsunami hazard may increase for population, property, critical facilities and the environment. Changes to the tsunami hazard from climate change may result in more direct economic impacts on a greater number of businesses and economic centers, as well as the infrastructure systems that support those businesses.

15.2.8 Wildfire

Climate Change Impacts on the Hazard

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.

Changes in climate patterns may impact the distribution and perseverance of insect outbreaks that create dead trees (increase fuel). 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.

Exposure, Sensitivity and Vulnerability

The following summarizes changes in exposure and vulnerability to the wildfire hazard resulting from climate change:

- **Population**—*California's Fourth Climate Change Assessment - North Coast Regional Report* states that "wildfires will continue to be a major disturbance in the region. Future wildfire projections suggest a longer fire season, an increase in wildfire frequency, and an expansion of the area susceptible to fire."
- **Property and Critical facilities**—The exposure and vulnerability of property and critical facilities would be the same.
- **Environment**— It is possible that the exposure and vulnerability of the environment will be impacted by changes in wildfire risk due to climate change. Natural fire regimes may change, resulting in more or less frequent or higher intensity burns. These impacts may alter the composition of the ecosystems in areas in and surrounding planning area. If more acres are burned every year, wildlife may be more stressed as the suitable habitat is lost.
- **Economy**—If more acres of timber burn every year, the local economy may be impacted.

15.3 VULNERABILITY ASSESSMENT—SEA LEVEL RISE

15.3.1 Overview

Based on current science, California Emergency Management Agency and the California Natural Resources Agency have estimated that the sea level rise for the North Coast region of California may reach 55 inches by 2100. This will pose threats to many areas in the region, particularly in bays and estuaries. The increase in acreage vulnerable to 100 year floods due to sea level rise in the region will be 18 percent in Humboldt County.

Sea level rise's primary impact on Humboldt Bay will be flooding. Salt water intrusion will also be a concern. Maximum high tides of the year, called king tides, average 8.78 feet at the North Spit tide gage. In some years, king tides have reached as high as 9.5 feet, and dikes have been overtopped or breached. Much of the area's critical infrastructure is at risk from tidal flooding because it was constructed on vulnerable former tidelands. For example, Highway 101, the Eureka and Arcata wastewater treatment plants, and miles of water, gas and electrical transmission lines are located behind earthen dikes or railroad grade on former tidelands. Some public facilities, businesses, residential communities, and agricultural areas also are at risk from tidal flooding (Humboldt Bay HRCD, 2013).

NOAA Coastal Services Center Sea Level Rise Data

The NOAA Coastal Services Center has developed a dataset to show potential sea level rise inundation ranging from 1 to 6 feet above current levels. The dataset provides a preliminary look at sea level rise and coastal flooding impacts. According to NOAA, the data illustrate the scale of potential flooding, not the exact location, and do not account for erosion, subsidence, or future construction. Water levels are shown as they would appear during the highest high tides, excluding wind driven tides (NOAA, 2015).

An exposure analysis was performed using the 3-foot and 8-foot sea level rise data to estimate the potential chronic flooding impacts in the planning area. This assessment assumes that these impacts occur in present-day Humboldt County, rather than gradually over years or decades. The dataset is not associated with any specific time horizons, but the 1-foot rise data can be understood to indicate near-term sea level rise (within the next 30 years), while the 8-foot analysis more closely aligns with projections for the mid- to end of the century. Figure 15-2 shows the inundation areas for the 3-foot and 8-foot sea level rise scenarios.

Humboldt Bay Sea Level Rise Vulnerability and Adaptation Planning project

The Humboldt Bay region is expected to experience the highest rate of sea-level rise within California due to land subsidence from relatively large tectonic vertical land motions associated with the Cascadia subduction zone. The *Humboldt Bay Sea Level Rise Vulnerability and Adaptation Planning* project is identifying sea-level rise vulnerabilities to support decision-making and encourage a unified, consistent regional adaptation approach among the jurisdictions around the bay. This project builds on previous work (Phase I) completed in January 2013. The project, funded by the State Coastal Conservancy, is a partnership of Coastal Ecosystems Institute of Northern California; Humboldt Bay Harbor, Recreation and Conservation District; Trinity Associates; Northern Hydrology and Engineering; and County of Humboldt.

Data in this report is based on a seamless topographic/bathymetric digital elevation model of Humboldt Bay. The model was developed using the 2009-2011 California Coastal Conservancy LiDAR project hydro-flattened bare earth digital elevation model and various subtidal bathymetric data sets. The Scenario modeled for this assessment was the 2-meter scenario which correlates to estimates projected for the end of this century. Figure 15-2 shows the inundation areas for the 2M, Humboldt Bay scenario.

15.3.2 Population

Population was estimated using the residential building count in the flood hazard areas and multiplying by the 2016 estimated average population per household. Using this approach, the estimated population residing in the 3-foot and 4-foot sea level rise exposure areas is less than 2 percent of the total population of the planning area: 620 and 2,589 people, respectively. For the Humboldt Bay scenario, 2,686 people (1.97 percent of the total county population) are estimated to be impacted.

15.3.3 Property

There are 290 structures in the 3-foot sea level rise exposure area and 1,166 in the 8-foot sea level rise exposure area. This amounts to $396.1 million and $2.3 billion of exposure, respectively, which is less than 7 percent of the total replacement value of the planning area. There are 1,184 structures with a total replacement value of $2.32 billion exposed to the inundation area from the Humboldt Bay scenario. All structures in the sea level rise flood zones are residential structures. They are distributed as shown in Figure 15-3.

Insert Map

Figure 15-2. Sea Level Rise Projections

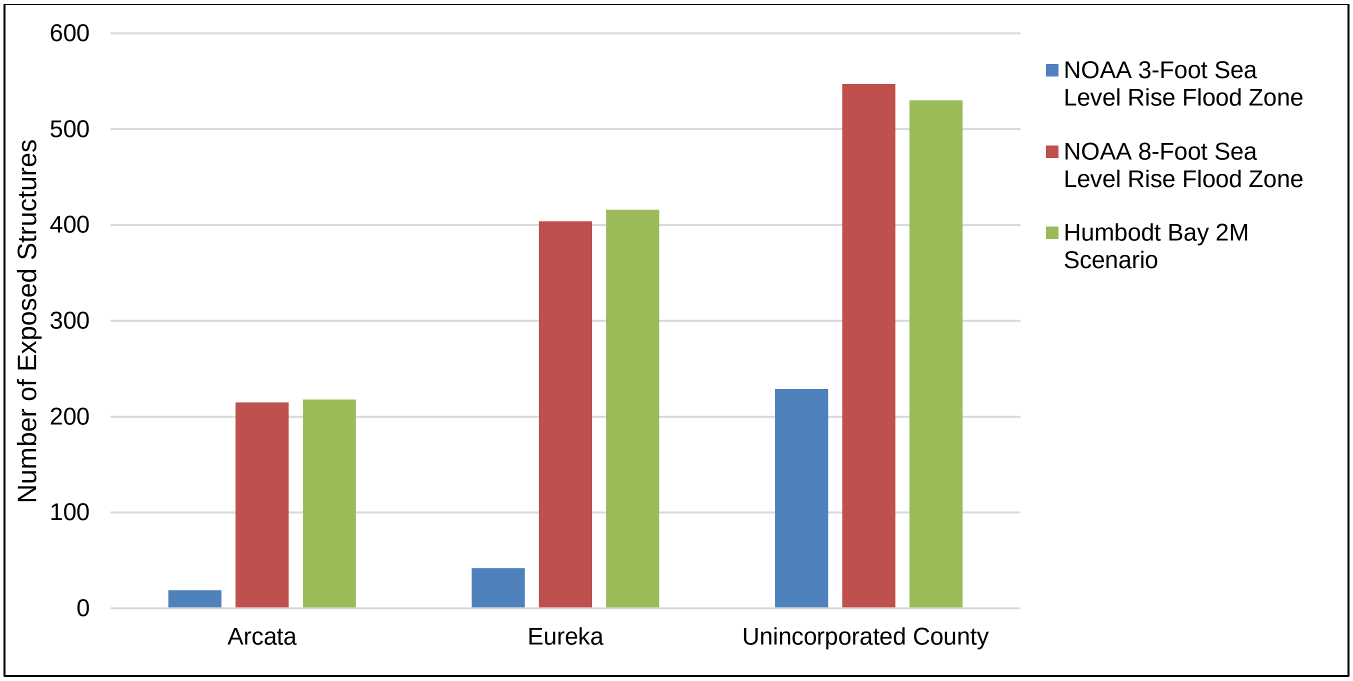


Figure 15-3. Distribution of Structures in the Sea Level Rise Flood Zones

15.3.4 Critical Facilities and Roads

The breakdown of exposure by sea level rise inundation zone and facility type is shown in Figure 15-4. Both "other critical function" facilities are water-dependent uses. In addition to these facilities, storm drainage systems may experience backups as a result of higher level of daily tidal flooding, especially if outfalls are located within sea level rise inundation areas.

15.3.5 Environment

All sea level rise inundation areas are exposed and vulnerable to impacts. Important coastal habitat may be lost as sea level rise permanently inundates areas, or it may be damaged due to extreme tide and storm surge events. Saltwater intrusion into freshwater resources may occur, further altering habitat and ecosystems. Protective ecosystem services may be lost as land area and wetlands are permanently inundated.

15.3.6 Economy

Sea level rise may impact the local economy; however, there are only limited critical facilities and no commercial facilities located in sea level rise inundation areas, so impacts are not likely to be extensive.

15.3.7 Future Development

The land area of Humboldt County will be reduced as sea level rise permanently inundates areas. This will have significant impacts on land use and planning in local communities. The Local general plans as well as Climate Action/Adaptation plans in the planning area will guide this future development.

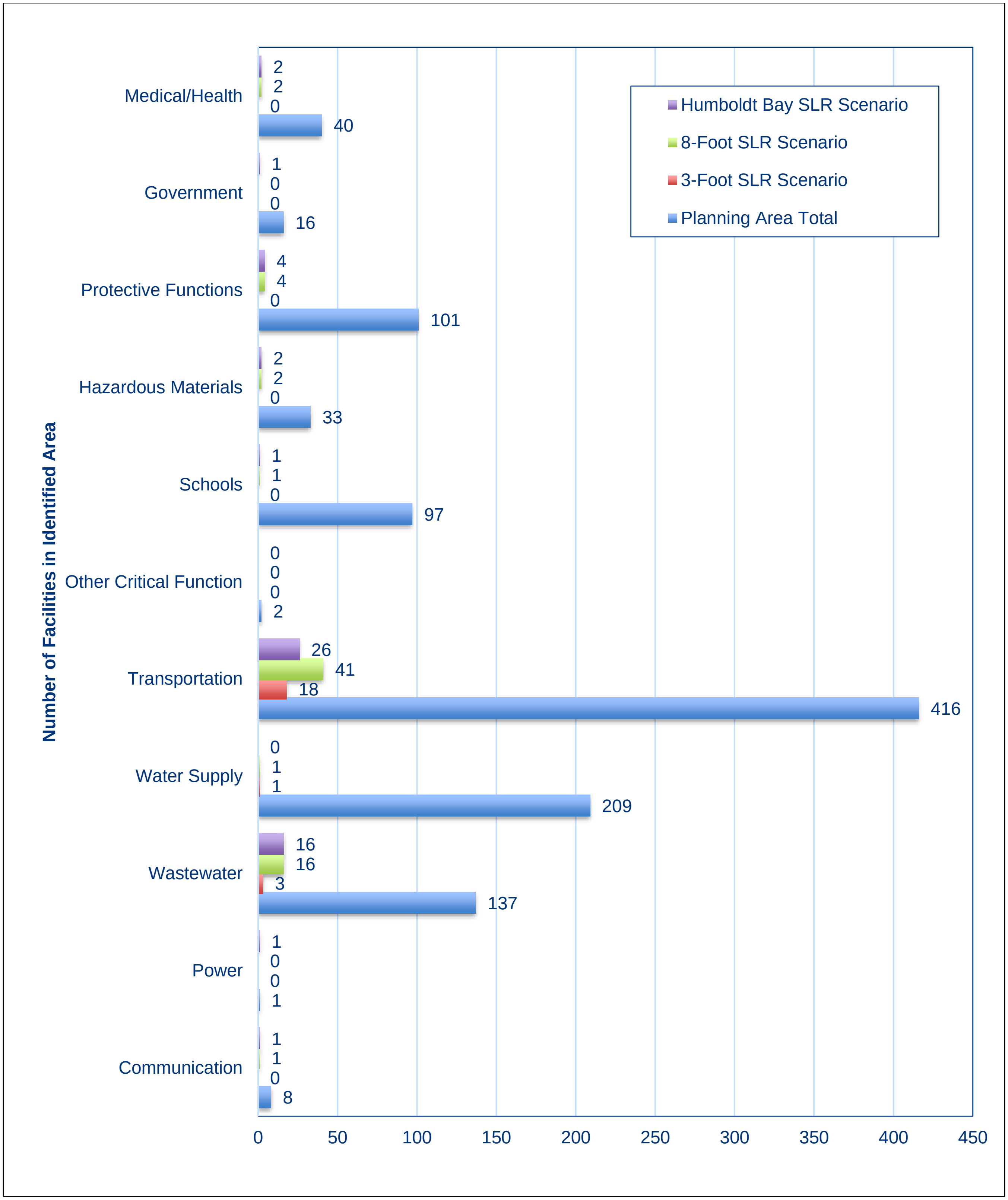


Figure 15-4. Critical Facilities and Infrastructure in Sea-Level Rise Inundation Areas

15.4 ISSUES

The major issues for climate change are the following:

- Planning for climate change related impacts can be difficult due to inherent uncertainties in projection methodologies.
- Average temperatures are expected to continue to increase in the planning area, which may lead to a host of primary and secondary impacts, such as an increased incidence of heat waves.
- Expected changes in precipitation patterns are still poorly understood and could have significant impacts on the water supply and flooding in the planning area.
- Some impacts of climate change are poorly understood such as potential impacts on the frequency and severity of earthquakes, thunderstorms and tsunamis.
- Heavy rain events may result in inland stormwater flooding after stormwater management systems are overwhelmed.
- Permanent and temporary inundation resulting from sea level rise has the potential to impact portions of the population and assets in the planning area.
- There are still many unknowns to living with wildfire within a changing climate. Continued research and modeling are necessary to better understand the impacts of climate change on the fire environment throughout the planning area and to inform adaptation strategies
- Climate change has the potential to impact the following:
  - The vulnerability of municipal and on-site water supplies;
  - The severity of wildfires and acres burned
  - The adequacy of access and evacuation routes
  - Long response times for limited fire suppression resources
  - Heat wave duration coupled with wildfire smoke, especially as they affect disadvantaged populations unlikely to have air conditioning.

16. HAZARDS OF INTEREST

The hazards of concern assessed in Chapters 7 through 15 and rated and ranked in Chapter 17 are those that present significant risks in the Humboldt Operational 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.

The sections below provide short profiles of each hazard of interest, including qualitative discussion of their potential to impact Humboldt County. 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.

16.1 FISH LOSS

Humboldt County's wild rivers, Humboldt Bay, and the ocean all support fisheries. Coastal and inland areas are rich in sport and commercial fish. Bays, estuaries and other tidal inlets provide a variety of habitats supporting many species of anadromous and ocean fish. Humboldt Bay is second only to San Francisco Bay in size among California's coastal estuaries. It is an important habitat for many invertebrates, fish, birds and mammals, and is one of the largest producers of commercial oysters in the state. The inland area of the county is home to a wealth of fish due to relatively undeveloped watersheds, ample rainfall and the mild, consistent climate of the region. Nearly 400,000 acres of the County's inland and coastline are in state and national park systems, leaving large tracts of existing habitat undeveloped and relatively pristine.

In the 1970s, more than half the fish produced and consumed in California were landed in the Humboldt Bay Area (Humboldt County, 1979). The bay provides critical habitat to over 100 fish species. The five major fisheries based in Humboldt Bay are ground fish, salmon, shrimp, crab, and albacore. Inland, sport fishing in Humboldt's many wild rivers should be rich and plentiful, but each year fewer and fewer adult fish return from the sea to spawn as a result of habitat damage from logging, water diversions, road building, grazing, and mining, over-fishing, and well-intended but flawed hatcheries.

The fishing communities of the North Coast once represented some of the most productive salmon rivers in the United States, generating more than $1.25 billion for the regional economy. But declining fish numbers and poor water conditions along many of these rivers have forced the federal government to all but shut down commercial fishing along California's north coast. This closure has cost coastal communities nearly 80 percent of the region's job base, or over 7,000 family wage jobs.

In recent years, fishermen, resource agencies and the state legislature implemented programs to reduce the number of vessels participating in each coastal fishery. Harvest limits and other regulations have been put in place to protect sensitive species. In many cases, these strategies have aided in population recovery. Some species, however have not shown any population recovery.

The decline in the population of several species of salmon and trout has resulted in them being listed as threatened or endangered under the Endangered Species Act. The following are the federal and state listed species in Humboldt County:

- Tidewater Goby (*Eucyclogobius newberryi*)
- Coho Salmon (*Oncorhynchus kisutch*)
- Northern California Steelhead Trout (*Oncorhynchus mykiss*)
- Chinook Salmon (Oncorhynchus tshawytscha)
- Green Sturgeon (*Acipenser medirostris*).

A fishing disaster in Humboldt County has the potential to occur in almost any waterway in the county. Most of the rivers and streams in the county contain fish that are economically and socially important to Humboldt County communities. In 2002 the Klamath fish kill was a tribal and state declared disaster due to its impacts on the cultural and economic viability of the tribes inhabiting the Lower Klamath and its tributaries. The 2002 Klamath Fish kill contributed to the closing of the commercial salmon season in 2006 along the entire northern California coast, which had effects from Del Norte to Santa Cruz County.

The frequency with which fish disasters have occurred is difficult to measure, but with the current decline in all commercial fisheries, an increase in fish related disasters can be expected. A fish related disaster has been declared in Humboldt County in the following years: 1994, 1995, 2000, 2002, and 2006. Changing climate conditions and increased pressure on marine fisheries will lead to further declines in marine fishery production and a greater vulnerability to fluctuations in marine fishery populations.

For coastal communities, a fish disaster can have devastating consequences. The shutdown of the 2006 salmon season resulted in an $80 million dollar aid package for Central and Northern California and affected approximately 8,000 fishermen. Almost $2.5 million in funds were allocated for relief following the declared disaster for the 2000 ground fish season. With so much of the north coast fishery dependent on the productivity of the Dungeness crab season, a collapse of the crab fishery would have a crippling effect on the north coast fishing industry.

The amount of warning time possible to Humboldt County fishermen depends largely on the fishery in question. Crab, salmon, and ground fish all have different seasons and are monitored by different agencies.

16.2 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 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 travel around the world attached to nooks and crannies of ships.

One marine invasive species impacting Humboldt County is the New Zealand mud snail. This 1/8-inch, brownish black snail reproduces asexually and in vast numbers, reaching densities anywhere from 300,000-800,000 snails per square meter. In such vast numbers, the New Zealand mud snail can out-compete native snails and aquatic insects for food and cause fish populations, which feed on these native snails and insects, to suffer. In 2011, the New Zealand mud snail had been identified in Freshwater Lagoon, Big Lagoon, and the Redwood Creek estuary. Many invasive species negatively impact ecosystems by outcompeting and replacing native species. The Humboldt Bay National Wildlife Refuge has identified several invasive plant species, including European beach grass (*ammophila arenaria)* and dense-flowered cordgrass (*Spartina densiflora)* impacting coastal and estuarial ecosystems in this way.

16.3 OIL SPILLS

An oil spill is a release of liquid petroleum into the environment that results in pollution of land, water and air, due to human activity or through oil seeps on land or under water. Oil spills can result from the release of crude oil from offshore oil platforms, drilling rigs, wells, pipelines, tank trucks and marine tank vessels. Refined petroleum products such as gasoline, diesel and bunker fuel used by cargo ships are also sources of potential oil spills.

Depending on the origin, size, and duration of the release, an oil spill can have serious impacts on air and water quality, public health, plant and animal habitat, and biological resources. Spill clean-up and remediation activities may cost millions of dollars and impacts can last for years. The environmental impacts contribute to short- and long-term impacts on economic activities in areas affected by oil spills. Moratoriums may be temporarily imposed on fisheries, and tourism may decline in beach communities, resulting in economic hardship on people dependent on those industries for their livelihood and on the economic health of the community as well.

As an area that is dependent upon maritime industries, Humboldt county is susceptible to impacts from oil spills from a variety of sources. The following historical events exemplify the potential impacts of oil spills on the planning area:

- On November 5, 1997, the M/V Kure punctured a fuel tank and spilled approximately 4,500 gallons of fuel oil while docked in Humboldt Bay. Studies after the event identified the following injuries to natural resources and recreational services from the spill:
  - Marbled murrelets: 130 estimated dead
  - Common murres, other alcids (the bird family that includes auks, murres and puffins), and procellariidae (the seabird family that includes petrels, prions and shearwaters): 910 estimated dead
  - Pelicans, cormorants, and gulls: 220 estimated dead (including 31 brown pelicans)
  - Loons and grebes: 243 estimated dead
  - Waterfowl: 414 estimated dead
  - Shorebirds: 2,033 estimated dead
  - Shoreline habitat: 6,200 acres of mudflat, wetland, beach and riprap habitat exposed to oil
  - Recreational services—767 estimated lost user days of surfing, camping, and sea kayaking activity
- On September 6, 1999, the dredge M/V Stuyvesant spilled at least 2,100 gallons of fuel oil into the Pacific Ocean near the mouth of Humboldt Bay. Studies after the event identified the following injuries to natural resources and recreational services from the spill:
  - Marbled murrelets: 135 estimated dead
  - Common murres: 1,600 estimated dead
  - Other birds: 670 estimated dead
  - Fish and shrimp: 3,282 kg of shrimp and over 6,000 fish estimated dead
  - Sandy beach habitat: 3,054 acres lightly, moderately or heavily oiled
  - Rocky intertidal habitat: 162 acres lightly, moderately or heavily oiled
  - Recreational services: 9,415 estimated lost user-days, 197 diminished user-days

16.4 VOLCANO (ASH FALL)

California has two major volcanoes in the Cascade Range: Mount Shasta and Lassen Peak. Lassen Peak is the southernmost active volcano in the Cascade Range, located 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. These volcanoes can lie dormant for centuries between eruptions. Hazards related to volcanic eruptions are distinguished by the different ways in which materials are emitted from the volcano:

- High-speed avalanches of hot ash and rock called pyroclastic flows, lava flows, and landslides can devastate areas up to 10 miles away. Lava may flow out as a viscous liquid, or it may explode from the vent as solid or liquid particles.
- Huge mudflows of volcanic ash and debris called lahars can inundate valleys more than 50 miles downstream.
- Falling 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.

Humboldt County could be susceptible to ash fall accumulation from any volcanic activity in the Cascade range, depending on jet stream conditions at the time of eruption. Communities several hundred miles away were impacted by ash accumulation following the 1980 eruption of Mt. St. Helens. Volcanic ash can have significant impacts on machinery and equipment, and can lead to structural roof collapse depending on the amount of accumulations. When tephra gets wet, it can dry like cement, and become very heavy. Considering that volcanic activity can trigger thunderstorm activity, the likely hood of tephra accumulations becoming saturated is high.

16.5 HAZARDOUS MATERIALS

Hazardous materials are present in facilities that produce, store or use them in nearly every city in the United States, and they are transported daily along interstate highways and railways. 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. California regulated substances that have the greatest probability of adversely impacting the community are listed in the CCR Title 19. Federal law (49 CFR) lists thousands of hazardous materials, including gasoline, insecticides, household cleaning products and radioactive materials. Even the natural gas used in homes and businesses is a dangerous substance when a leak occurs.

Hazardous material releases can pose a risk to life, public health, air quality, water quality and the environment. They may result in the evacuation of a facility or an entire neighborhood. In addition to the immediate risk, long-term public health and environmental impacts may result from sustained exposure to certain substances. The following are the most common types of hazardous material incidents:

- **Fixed-Facility Hazardous Materials Incident**—This is the uncontrolled release from a fixed site of materials that pose a risk to health, safety and property. It is possible to identify and prepare for fixed-site incidents because federal and state laws require those facilities to notify state and local authorities about materials being used or produced at the site.
- **Hazardous Materials Transportation Incident**—A hazardous materials transportation incident is any event during transport resulting in uncontrolled release of materials that can pose a risk to health, safety and property. Transportation incidents are difficult to prepare for because there is little if any notice about what materials could be involved should an accident happen. Transported hazardous wastes include thousands of shipments of radiological materials moved across the United States by ground transportation, mostly medical materials and low-level radioactive waste. Hazardous materials

transportation incidents can occur on any transportation corridor, although most occur on interstate highways, other major federal or state highways, or major rail lines. Many incidents occur in sparsely populated areas and affect very few people. Others are 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.

- **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 utilities and to transport these materials from production facilities to end-users.

Hazardous materials are likely accidently released or spilled numerous times each day. Eliminating these widespread substances throughout the county would be nearly impossible, but the threat of accidental releases or spills 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 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.

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 the California Environmental Protection Agency, however local governments are responsible for implementing and enforcing the standards.

Highway 101 serves as the primary transportation route in the county; it borders Humboldt Bay and the coastline with a north-to-south orientation and intersects the most populous communities. It is a major, interstate transportation corridor that traverses California from Los Angeles in the southern end of the state, up to the Oregon border in the north, where it continues to parallel the coastline through Oregon and Washington, all the way to Port Angeles. Hundreds of trucks transport an array of cargo across the winding corridors of Highway 101 each day, creating the potential for hazardous materials spills that can threaten the safety of people, wildlife, and waterways. Other hazardous materials threats in Humboldt County come from facilities, such as wastewater treatment plants, that store hazardous materials and have not been retrofitted to withstand seismic activity, flood, or other potentially damaging hazard events.

Humboldt communities are served by the Humboldt/Del Norte Hazardous Materials Response Team (HMRT), a multi-agency Joint Powers Authority staffed by personnel from Humboldt Bay Fire and other local fire districts, County Environmental Health, Humboldt Waste Management, and other agencies. HMRT activities include response, training and coordination. HMRT achieved a California Emergency Management Agency Type II rating in 2010.

16.5.1 Definition

A hazardous material is a substance or combination of substances that, because of quantity, concentration, or physical, chemical, or infectious characteristics, may cause or contribute to an increase in mortality or an increase in serious illness, or otherwise pose a hazard to human life, property, or the environment. Hazardous materials are present in nearly every city and county in the United States in facilities that produce, store, or use them:

- Water treatment plants use chlorine to eliminate bacterial contaminants.
- Hazardous materials are transported along interstate highways and railways daily.
- The natural gas used in homes and businesses is a dangerous substance when a leak occurs.
- Many businesses, through intentional action, lack of awareness or accidental occurrences, have contamination in and around their property.

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 communities are listed in the CCR, Title 19.

16.5.2 Types of Incidents

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. It is possible to identify and prepare for a fixed-site incident because laws require 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. 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 anywhere, although most occur on interstate highways or major federal or state highways, or on 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.
- **Interstate Pipeline Hazardous Materials Incident**—A significant number of interstate natural gas, heating oil, and petroleum pipelines run through California. These are used to provide natural gas to utilities in California and to transport these materials from production facilities to end-users. There are no major natural gas pipelines that pass through the planning area.

16.5.3 Oversight

Hazardous materials management is regulated by federal and state codes. The state fire marshal and the Pipeline and Hazardous Materials Safety Administration enforce oil and gas pipeline safety regulations. The federal government enforces hazardous material transport pursuant to its interstate commerce regulation authority.

The Department of Toxic Substances Control, a Division of the California Environmental Protection Agency, acts to protect California from exposure to hazardous wastes by cleaning up existing contamination and looking for ways to reduce the hazardous waste produced in the state. The Department of Toxic Substances Control regulates hazardous waste in California primarily under the authority of the federal Resource Conservation and Recovery Act, and the California Health and Safety Code. Other laws that affect hazardous waste are specific to handling, storage, transportation, disposal, treatment, reduction, cleanup, and emergency planning. Any release or possible release of hazardous material must be reported to the Cal OES Warning Center.

The State Water Resources Control Board oversees hazardous materials that are stored in underground storage tanks. The board addresses how those hazardous materials are stored and handled, as well as clean-up of any contamination created by leaking underground storage tanks. The Office of the State Fire Marshal oversees petroleum products that are stored in aboveground storage tanks.

The California Environmental Protection Agency certifies 81 local Certified Unified Program Agencies statewide to oversee the following hazardous materials programs:

- Aboveground Petroleum Storage Act Program
- Area Plans for Hazardous Materials Emergencies
- California Accidental Release Prevention Program
- Hazardous Materials Release Response Plans and Inventories
- Hazardous Material Management Plan and Hazardous Material Inventory Statements
- Hazardous Waste Generator and Onsite Hazardous Waste Treatment Programs
- Underground Storage Tank Program

The Certified Unified Program Agency in Humboldt County is the County's Environmental Health Division. This agency helps businesses meet state requirements for reporting hazardous materials and waste above certain designated quantities that they use, store, or handle at their facility. The California Environmental Reporting System is the statewide web-based system that supports the electronic exchange of required information among businesses, local governments and the U.S. EPA.

Businesses must prepare chemical inventory and business emergency plans, review the plans regularly, and perform annual training. Businesses using any of a list of about 260 flammable or toxic regulated chemicals must develop a risk management plan. The risk management plan includes analysis of operations on-site, and projection of off-site consequences with accompanying mitigation plans.

16.6 TERRORISM

Acts of terrorism are intentional, criminal, malicious acts with the following characteristics:

- They involve the use of illegal force.
- They are intended to intimidate or coerce.
- They are committed in support of political or social objectives.

Table 16-1 provides a hazard profile summary for terrorism-related events.

Table 16-1. Event Profiles for Terrorism

Hazard	Application Mode[a]	Hazard Duration[b]	Static/Dynamic Characteristics[c]	Mitigating and Exacerbating Conditions[d]
Conventional Bomb	Detonation of explosive device on or near target; delivery via person, vehicle, or projectile.	Instantaneous; additional secondary devices, or diversionary activities may be used, lengthening the 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.
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.

Hazard	Application Mode[a]	Hazard Duration[b]	Static/Dynamic Characteristics[c]	Mitigating and Exacerbating Conditions[d]
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

a. **Application Mode**—The human acts necessary to cause the event to occur.

b. **Hazard Duration**—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.

c. **Dynamic or Static Characteristics**—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.

d. **Mitigation and Exacerbating Conditions:**
Mitigation Conditions—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.
Exacerbating conditions—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.

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 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 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 or undetonated explosive devices, tear gas, pipe bombs, or 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 factors 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 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 must 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 with 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.

17. RISK RANKING

FEMA requires all hazard mitigation planning partners to have jurisdiction-specific mitigation actions based on local risk, vulnerability and community priorities (FEMA, 2011). This plan included a risk ranking protocol for each planning partner, in which "risk" was calculated by multiplying probability by impact on people, property and the economy. The risk estimates were generated using methodologies promoted by FEMA. The Steering Committee reviewed, discussed and approved the methodology and results. All planning partners ranked risk for their own jurisdictions following the same methodology.

Numerical ratings of probability and impact were based on the hazard profiles and exposure and vulnerability evaluations presented in Chapters 7 through 15. Using that data, each planning partner ranked the risk of all the natural hazards of concern described in this plan. When available, estimates of risk were generated with data from Hazus or GIS. For hazards of concern with less specific data available, qualitative assessments were used. As appropriate, results were adjusted based on local knowledge and other information not captured in the quantitative assessments. The hazards of interest described in Chapter 16 were not ranked for the following reasons:

- A key component of risk as defined for the planning effort is probability of occurrence. While it is possible to assign a recurrence interval for natural hazards because of historical occurrence, it is not feasible to assign recurrence intervals for the other hazards of interest, which lack such historical precedent.
- Federal hazard mitigation planning regulations do not require the assessment of non-natural hazards (44 CFR, 201.6). It is FEMA's position that this is a local decision.

Risk ranking results are used to help establish mitigation priorities. Each partner used its risk ranking to inform the development of its action plan. Planning partners were directed to identify mitigation actions, at a minimum, to address each hazard with a "high" or "medium" risk ranking. Actions that address hazards with a low or no hazard ranking are optional.

Volume 2 presents the risk rankings for each planning partner. The following planning-area-wide risk ranking was prepared by the planning team.

17.1 PROBABILITY OF OCCURRENCE

The probability of occurrence of a hazard is indicated by a probability factor based on likelihood of annual occurrence:

- High—Hazard event is likely to occur within 25 years (Probability Factor = 3)
- Medium—Hazard event is likely to occur within 100 years (Probability Factor =2)
- Low—Hazard event is not likely to occur within 100 years (Probability Factor =1)
- No exposure—There is no probability of occurrence (Probability Factor = 0)

The assessment of hazard frequency is based on past hazard events in the area and the potential for changes in the frequency of these events resulting from climate change. Table 17-1 summarizes the probability assessment for each natural hazard of concern for this plan.

Table 17-1. Probability of Hazards

Hazard Event	Probability (high, medium, low)	Probability Factor
Dam Failure	Low	1
Drought	High	3
Earthquake	High	3
Flooding	High	3
Landslide	High	3
Sea Level Rise	High	3
Severe Weather	High	3
Tsunami	High	3
Wildfire	High	3

NOTES:

- Climate change risk rating based on 4 feet of sea level rise
- Dam failure risk rating based on the combined dam inundation areas of 6 dams.
- Drought is assessed more qualitatively than other hazards. Generally, drought does not cause injury or death to people or result in property damage. Assumptions for risk ranking include high probability, no impact on people, low impact on property and medium impact on economy.
- Earthquake risk rating based on the Cascadia Megathrust M9.3 earthquake scenario. Although this scenario would almost certainly induce a tsunami, the tsunami impacts are ranked separately from the earthquake scenario.
- Flood risk rating based on 1-percent-annual-chance flood zone (also known as the special flood hazard area)
- Landslide risk rating based on "Very High" and "High" landslide susceptibility zones
- Severe weather is assessed more qualitatively than other hazards. Assumptions for risk ranking include high probability, medium impact on people, low impact on property and low impact on economy.
- Tsunami risk rating based on composite possible tsunami events
- Wildfire risk rating based on "Very High" and "High" fire hazard severity zones.

17.2 IMPACT

Hazard impacts were assessed in three categories: impacts on people, impacts on property and impacts on the local economy. Numerical impact factors were assigned as follows:

- **People**—Values were assigned based on the percentage of the total ***population exposed*** to the hazard event. The degree of impact on individuals will vary and is not measurable, so the calculation assumes for simplicity and consistency that all people exposed to a hazard because they live in a hazard zone will be equally impacted when a hazard event occurs. It should be noted that planners can use an element of subjectivity when assigning values for impacts on people. Impact factors were assigned as follows:
  - High—25 percent or more of the population is exposed to a hazard (Impact Factor = 3)
  - Medium—10 percent to 25 percent of the population is exposed to a hazard (Impact Factor = 2)
  - Low—10 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—25 percent or more of the total assessed property value is exposed to a hazard (Impact Factor = 3)
  - Medium—10 percent to 25 percent of the total assessed property value is exposed to a hazard (Impact Factor = 2)
  - Low—10 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 replacement value of the property exposed to the hazard. Loss estimates separate from the exposure estimates were generated for the earthquake, flooding, and tsunami hazards using Hazus. For other hazards, such as dam failure, landslide and wildfire, vulnerability was estimated as a percentage of exposure, due to the lack of loss estimation tools specific to those hazards.
  - High—Estimated loss from the hazard is 10 percent or more of the total exposed property value (Impact Factor = 3)
  - Medium—Estimated loss from the hazard is 5 percent to 10 percent of the total exposed property value (Impact Factor = 2)
  - Low—Estimated loss from the hazard is 5 percent or less of the total exposed 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 economy was given a weighting factor of 1. Table 17-2, Table 17-3 and Table 17-4 summarize the impacts for each hazard.

17.3 RISK RATING AND RANKING

The risk rating for each hazard was determined by multiplying the probability factor by the sum of the weighted impact factors, as summarized in Table 17-5. Based on these ratings, a priority of high, medium or low was assigned to each hazard. The hazards of highest concern are earthquake and tsunami. Hazards ranked as being of medium concern are severe weather, wildfire, flooding, and landslide. The hazards ranked as being of lowest concern are drought, sea level rise, and dam failure. Table 17-6 shows the hazard risk ranking for the planning area. Hazard risk ranking for each participating planning partner can be found in Volume 2 of this plan.

Table 17-2. Impact on People from Hazards

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (3)
Dam Failure	Low	1	3x1=3
Drought[a]	None	0	3x0=0
Earthquake	High	3	3x3=9
Flooding	Low	1	3x1=3
Landslide[b]	Low	1	3x1=3
Sea Level Rise	Low	1	3x1=3
Severe Weather	Medium	2	3x2=6
Tsunami[c]	Low	1	3x1=3
Wildfire[d]	Medium	2	3x2=6

a. Drought generally does not directly cause death or injury to people.
b. Landslide risk ranking impacts are based on very high and high landslide susceptibility zones.
c. Tsunami impacts do not include estimated damage cause by an earthquake that was likely the cause of the tsunami. Earthquake damage is estimated separately.
d. Wildfire risk ranking impacts are based on very high and high fire severity zones.

Table 17-3. Impact on Property from Hazards

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (2)
Dam Failure	Low	1	2x1=2
Drought[a]	Low	1	2x1=2
Earthquake	High	3	2x3=6
Flooding	Low	1	2x1=2
Landslide	Low	1	2x1=2
Sea Level Rise	Low	1	2x1=2
Severe Weather	Medium	2	2x2=4
Tsunami	Low	1	2x1=2
Wildfire	Medium	2	2x2=4

a. Although all property is exposed to drought, direct impacts on property are limited.

Table 17-4. Impact on Economy from Hazards

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (1)
Dam Failure	Medium	2	1x2=2
Drought[a]	Medium	2	1x2=2
Earthquake	High	3	1x3=3
Flooding	Low	1	1x1=1
Landslide[b]	Medium	2	1x2=2
Sea Level Rise[c]	Medium	2	1x2=2
Severe Weather	Medium	2	1x2=2
Tsunami	Low	1	1x1=1
Wildfire[b]	Medium	2	1x2=2

a. Drought may have economic impacts on water using industries
b. Impacts on economy were assumed to be half of exposure for landslide and wildfire
c. Impacts on economy were assumed to be equal to exposure for sea level rise.

Table 17-5. Hazard Risk Rating

Hazard Event	Probability Factor	Sum of Weighted Impact Factors	Total (Probability x Impact)
Dam Failure	1	(3 + 2 + 2) = 7	(1 x 7) = 7
Drought	3	(0 + 2 + 2) = 4	(3 x 4) = 12
Earthquake	3	(9 + 6 + 3) = 18	(3 x 18) = 54
Flooding	3	(3 + 2 + 1) = 6	(3 x 6) = 18
Landslide	3	(3 + 2 + 2) = 7	(3 x 7) = 21
Sea Level Rise	3	(3 + 2 + 2) = 7	(3x7) = 21
Severe Weather	3	(6 + 4 + 2) = 12	(3 x 12) = 36
Tsunami	3	(3 + 2 +1) = 6	(3 x 6) = 18
Wildfire	3	(6 + 4 + 2) = 12	(3 x 12) = 36

Table 17-6. Hazard Risk Ranking

Hazard Ranking	Hazard Event	Category[a]
1	Earthquake	High
2	Wildfire	High
3	Severe weather	High
4	Landslide	Medium
4	Seal Level Rise	Medium
5	Flooding	Medium
5	Tsunami	Medium
6	Drought	Low
7	Dam Failure	Low

a. Scores of 30 or greater are rated as “high,” scores of 15 to 29 are “medium,” and scores of less than 15 are “low

Humboldt County Operational Area Hazard Mitigation Plan 2019

PART 3—MITIGATION STRATEGY

18. 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 reviewed the guiding principle, goals and objectives from the 2010 Hazard Mitigation Plan. It was determined that the 2010 plan's guiding principle, goals, and objectives still reflect community priorities and the results of the risk assessment. Therefore, only minor changes were made, to clarify intent and meaning. 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 (presented in Chapter 19) were prioritized based on their ability to meet multiple objectives.

18.1 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 this hazard mitigation plan is as follows:

> *Through partnerships and careful planning, identify and reduce the vulnerability to hazards in order to protect the health, safety, quality of life, environment, and economy of the communities within the Humboldt Operational Area.*

18.2 GOALS

The following are the mitigation goals for this plan:

1. Protect Health and Safety
2. Protect Property
3. Protect the Economy
4. Protect Quality of Life
5. Protect Environment
6. Promote Partnerships in Planning

The effectiveness of a mitigation strategy is assessed by determining how well these goals are achieved.

18.3 OBJECTIVES

The selected objectives meet multiple goals, as listed in Table 18-1. Therefore, the objectives serve as a stand-alone measurement of the effectiveness of a mitigation action, rather than as a subset of a goal. The objectives also are used to help establish priorities.

Table 18-1. Objectives for the Hazard Mitigation Plan

Objective Number	Objective Statement	Goals for Which It Can Be Applied
O-1	Minimize disruption of local government operations caused by hazards.	3
O-2	Increase resilience of (or protect and maintain) infrastructure and critical facilities.	1, 2, 3
O-3	Reduce hazard-related risks and vulnerability of the populations in Humboldt County.	1, 2, 3, 4, 5
O-4	Sustain reliable local emergency operations and facilities during and after a disaster.	1, 2, 3
O-5	Enhance emergency response capabilities and participation within the planning area.	1, 2, 5, 6
O-6	Enhance understanding of hazards and the risk they pose through public education that emphasizes awareness, preparation, mitigation, response and recovery alternatives.	1, 2, 3, 4, 5, 6
O-7	Continually improve understanding of the location and potential impacts of hazards that impact the planning area utilizing the best available data and science as it becomes available, and share this information with all stakeholders.	1, 2, 3, 4, 5, 6
O-8	Establish a partnership among all levels of government and the business community to improve and implement methods to protect property.	2, 6
O-9	Develop and implement hazard mitigation strategies that reduce losses to wildlife habitat and protect water supply and quality, while also reducing damage to development.	2, 4, 5
O-10	Integrate hazard identification information and mitigation policies into other planning-based processes that direct or impact land uses in the planning area.	1, 5
O-11	Enhance building codes and their proper implementations so that new construction can withstand the impacts of hazards and lessen the impact of that development on the environment's ability to absorb the impact of hazards.	2, 5
O-12	Seek to integrate and coordinate all phases of emergency management within the planning area.	1, 2, 3, 4, 5, 6

19. MITIGATION BEST PRACTICES AND ADAPTIVE CAPACITY

19.1 MITIGATION BEST PRACTICES

Catalogs of hazard mitigation best practices were developed that present a broad range of alternatives to be considered for use in Humboldt County, 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 present alternatives that are categorized in two ways:

- By who would have responsibility for implementation:
  - Individuals (personal scale)
  - Businesses (corporate scale)
  - Government (government scale).
- By what the alternative would do:
  - Manipulate the hazard
  - Reduce exposure to the hazard
  - Reduce vulnerability to the hazard
  - Build local capacity to respond to or prepare for the hazard.

The alternatives presented include actions that will mitigate current risk from hazards and actions that will help reduce risk from changes in the impacts of these hazards resulting from climate change. Hazard mitigation actions recommended in this plan were selected from an analysis of 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 established goals and objectives, and are generally within the capabilities of the planning partners to implement. Some of these actions may not be feasible based on the selection criteria identified for this plan. The purpose of the catalogs was to provide a list of what could be considered to reduce risk from natural hazards within the planning area. Actions selected out of the catalogs were based on an analysis of the planning partner's ability to implement the action and general feasibility. Actions in the catalog that are not included for the partnership's action plan were not selected for one or more of the following reasons:

- The action is not feasible.
- The action is already being implemented.
- The planning partner does not have the capability to implement the action.
- There is an apparently more cost-effective alternative.
- The action does not have public or political support.

The catalogs for each hazard are presented in Table 19-1 through Table-19-8.

Table 19-1. Alternatives to Mitigate the Dam Failure Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Relocate out of dam failure inundation areas • **Reduce vulnerability to the hazard:** ❖ Elevate home to appropriate levels • **Build local capacity to respond to or prepare for the hazard:** ❖ Learn about risk reduction for the dam failure hazard ❖ Learn the evacuation routes for a dam failure event ❖ Educate yourself on early warning systems and the dissemination of warnings	• **Manipulate the hazard:** ❖ Remove dams ❖ Harden dams • **Reduce exposure to the hazard:** ❖ Replace earthen dams with hardened structures • **Reduce vulnerability to the hazard:** ❖ Flood-proof facilities within dam failure inundation areas • **Build local capacity to respond to or prepare for the hazard:** ❖ Educate employees on the probable impacts of a dam failure ❖ Develop a continuity of operations plan	• **Manipulate the hazard:** ❖ Remove dams ❖ Harden dams • **Reduce exposure to the hazard:** ❖ Replace earthen dams with hardened structures ❖ Relocate critical facilities out of dam failure inundation areas ❖ Consider open space land use in designated dam failure inundation areas • **Reduce vulnerability to the hazard:** ❖ Adopt higher floodplain standards in mapped dam failure inundation areas ❖ Retrofit critical facilities within dam failure inundation areas • **Build local capacity to respond to or prepare for the hazard:** ❖ Map dam failure inundation areas ❖ Enhance emergency operations plan to include a dam failure component ❖ Institute monthly communications checks with dam operators ❖ Inform the public on risk reduction techniques ❖ Adopt real-estate disclosure requirements for the re-sale of property located within dam failure inundation areas ❖ Consider the probable impacts of climate change in assessing the risk associated with the dam failure hazard ❖ Establish early warning capability downstream of listed high hazard dams ❖ Consider the residual risk associated with protection provided by dams in future land use decisions

Table-19-2. Alternatives to Mitigate the Drought Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ None • **Reduce vulnerability to the hazard:** ❖ Drought-resistant landscapes ❖ Reduce water system losses ❖ Modify plumbing systems (through water saving kits) ❖ For homes with on-site water systems: increase storage, utilize rainwater catchment • **Build local capacity to respond to or prepare for the hazard:** ❖ Practice active water conservation	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ None • **Reduce vulnerability to the hazard:** ❖ Drought-resistant landscapes ❖ Reduce private water system losses ❖ Support alternative irrigation techniques to reduce water use and encourage use of climate-sensitive water supplies ❖ For businesses with on-site water systems: increase storage, utilize rainwater catchment • **Build local capacity to respond to or prepare for the hazard:** ❖ Practice active water conservation	• **Manipulate the hazard:** ❖ Groundwater recharge through stormwater management ❖ Develop a water recycling program ❖ Increase "above-the-dam" regional natural water storage systems • **Reduce exposure to the hazard:** ❖ Identify and create groundwater backup sources • **Reduce vulnerability to the hazard:** ❖ Water use conflict regulations ❖ Reduce water system losses ❖ Distribute water saving kits ❖ increase conventional storage that is filled during high-flow periods • **Build local capacity to respond to or prepare for the hazard:** ❖ Public education on drought resistance ❖ Identify alternative water supplies for times of drought; mutual aid agreements with alternative suppliers ❖ Develop drought contingency plan ❖ Develop criteria "triggers" for drought-related actions ❖ Improve accuracy of water supply forecasts ❖ Modify rate structure to influence active water conservation techniques ❖ Consider the probable impacts of climate change on the risk associated with the drought hazard

Table-19-3. Alternatives to Mitigate the Earthquake Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate outside of hazard area (off soft soils) • **Reduce vulnerability to the hazard:** ❖ Retrofit structure (anchor house structure to foundation) ❖ Secure household items that can cause injury or damage (such as water heaters, bookcases, and other appliances) ❖ Build to higher design • **Build local capacity to respond to or prepare for the hazard:** ❖ Practice “drop, cover, and hold” ❖ Develop household mitigation plan, such as creating a retrofit savings account, communication capability with outside, 72-hour self-sufficiency during an event ❖ Keep cash reserves for reconstruction ❖ Become informed on the hazard and risk reduction alternatives available. ❖ Develop a post-disaster action plan for your household	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate or relocate mission-critical functions outside hazard area where possible • **Reduce vulnerability to the hazard:** ❖ Build redundancy for critical functions and facilities ❖ Retrofit critical buildings and areas housing mission-critical functions • **Build local capacity to respond to or prepare for the hazard:** ❖ Adopt higher standard for new construction; consider “performance-based design” when building new structures ❖ Keep cash reserves for reconstruction ❖ Inform your employees on the possible impacts of earthquake and how to deal with them at your work facility. ❖ Develop a continuity of operations plan	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate critical facilities or functions outside hazard area where possible • **Reduce vulnerability to the hazard:** ❖ Harden infrastructure ❖ Provide redundancy for critical functions ❖ Adopt higher regulatory standards • **Build local capacity to respond to or prepare for the hazard:** ❖ Provide better hazard maps ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas (e.g., tax incentives, information) ❖ Include retrofitting and replacement of critical system elements in capital improvement plan ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components such as pipe, power line, and road repair materials ❖ Develop and adopt a continuity of operations plan ❖ Initiate triggers guiding improvements (such as <50% substantial damage or improvements) ❖ Further enhance seismic risk assessment to target high hazard buildings for mitigation opportunities. ❖ Develop a post-disaster action plan that includes grant funding and debris removal components.

Table-19-4. Alternatives to Mitigate the Flooding Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ Clear storm drains and culverts ❖ Use low-impact development techniques • **Reduce exposure to the hazard:** ❖ Locate outside of hazard area ❖ Elevate utilities above base flood elevation ❖ Use low-impact development techniques • **Reduce vulnerability to the hazard:** ❖ Raise structures above base flood elevation ❖ Elevate items within house above base flood elevation ❖ Build new homes above base flood elevation ❖ Flood-proof structures • **Build local capacity to respond to or prepare for the hazard:** ❖ Buy flood insurance ❖ Develop household plan, such as retrofit savings, communication with outside, 72-hour self-sufficiency during and after an event	• **Manipulate the hazard:** ❖ Clear storm drains and culverts ❖ Use low-impact development techniques • **Reduce exposure to the hazard:** ❖ Locate critical facilities or functions outside hazard area ❖ Use low-impact development techniques • **Reduce vulnerability to the hazard:** ❖ Build redundancy for critical functions or retrofit critical buildings ❖ Provide flood-proofing when new critical infrastructure must be located in floodplains • **Build local capacity to respond to or prepare for the hazard:** ❖ Keep cash reserves for reconstruction ❖ Support and implement hazard disclosure for sale of property in risk zones. ❖ Solicit cost-sharing through partnerships with others on projects with multiple benefits.	• **Manipulate the hazard:** ❖ Maintain drainage system ❖ Institute low-impact development techniques on property ❖ Dredging, levee construction, and providing regional retention areas ❖ Structural flood control, levees, channelization, or revetments. ❖ Stormwater management regulations and master planning ❖ Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff • **Reduce exposure to the hazard:** ❖ Locate or relocate critical facilities outside of hazard area ❖ Acquire or relocate identified repetitive loss properties ❖ Promote open space uses in identified high hazard areas via techniques such as: planned unit developments, easements, setbacks, greenways, sensitive area tracks. ❖ Adopt land development criteria such as planned unit developments, density transfers, clustering ❖ Institute low impact development techniques on property ❖ Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff ❖ Preserve undeveloped and vulnerable shoreline ❖ Restore existing flood control and riparian corridors • **Reduce vulnerability to the hazard:** ❖ Harden infrastructure, bridge replacement program ❖ Provide redundancy for critical functions and infrastructure ❖ Adopt regulatory standards such as freeboard standards, cumulative substantial improvement or damage, lower substantial damage threshold; compensatory storage, non-conversion deed restrictions. ❖ Stormwater management regulations and master planning. ❖ Adopt "no-adverse impact" floodplain management policies that strive to not increase the flood risk on downstream communities ❖ Facilitate managed retreat from, or upgrade of, the most at-risk areas ❖ Require accounting of sea level rise in all applications for new development in shoreline areas ❖ Implement Assembly Bill 162 (2007) requiring flood hazard information in local general plans • **Build local capacity to respond to or prepare for the hazard:** ❖ Produce better hazard maps ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas (stronger controls, tax incentives, and information) ❖ Incorporate retrofitting or replacement of critical system elements in capital improvement plan ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components ❖ Develop and adopt a continuity of operations plan ❖ Consider participation in the Community Rating System ❖ Maintain and collect data to define risks and vulnerability ❖ Train emergency responders ❖ Create an elevation inventory of structures in the floodplain ❖ Develop and implement a public information strategy ❖ Charge a hazard mitigation fee ❖ Integrate floodplain management policies into other planning mechanisms within the planning area. ❖ Consider the probable impacts of climate change on the risk associated with the flood hazard ❖ Consider the residual risk associated with structural flood control in future land use decisions ❖ Enforce National Flood Insurance Program requirements ❖ Adopt a Stormwater Management Master Plan ❖ Develop an adaptive management plan to address the long-term impacts of sea level rise

Table-19-5. Alternatives to Mitigate the Landslide Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope ❖ Minimize vegetation removal and the addition of impervious surfaces. • **Reduce exposure to the hazard:** ❖ Locate structures outside of hazard area (off unstable land and away from slide-run out area) • **Reduce vulnerability to the hazard:** ❖ Retrofit home • **Build local capacity to respond to or prepare for the hazard:** ❖ Institute warning system, and develop evacuation plan ❖ Keep cash reserves for reconstruction ❖ Educate yourself on risk reduction techniques for landslide hazards	• **Manipulate the hazard:** ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope • **Reduce exposure to the hazard:** ❖ Locate structures outside of hazard area (off unstable land and away from slide-run out area) • **Reduce vulnerability to the hazard:** ❖ Retrofit at-risk facilities • **Build local capacity to respond to or prepare for the hazard:** ❖ Institute warning system, and develop evacuation plan ❖ Keep cash reserves for reconstruction ❖ Develop a continuity of operations plan ❖ Educate employees on the potential exposure to landslide hazards and emergency response protocol.	• **Manipulate the hazard:** ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope • **Reduce exposure to the hazard:** ❖ Acquire properties in high-risk landslide areas. ❖ Adopt land use policies that prohibit the placement of habitable structures in high-risk landslide areas. • **Reduce vulnerability to the hazard:** ❖ Adopt higher regulatory standards for new development within unstable slope areas. ❖ Armor/retrofit critical infrastructure against the impact of landslides. • **Build local capacity to respond to or prepare for the hazard:** ❖ Produce better hazard maps ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas: better land controls, tax incentives, information ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components ❖ Develop and adopt a continuity of operations plan ❖ Educate the public on the landslide hazard and appropriate risk reduction alternatives. ❖ Consider the probable impacts of climate change on the risk associated with the landslide hazard

Table-19-6. Alternatives to Mitigate the Severe Weather Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ None • **Reduce vulnerability to the hazard:** ❖ Insulate house ❖ Provide redundant heat and power ❖ Insulate structure ❖ Plant appropriate trees near home and power lines ("Right tree, right place" National Arbor Day Foundation Program) • **Build local capacity to respond to or prepare for the hazard:** ❖ Trim or remove trees that could affect power lines ❖ Promote 72-hour self-sufficiency ❖ Obtain a NOAA weather radio. ❖ Obtain an emergency generator.	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ None • **Reduce vulnerability to the hazard:** ❖ Relocate critical infrastructure (such as power lines) underground ❖ Reinforce or relocate critical infrastructure such as power lines to meet performance expectations ❖ Install tree wire • **Build local capacity to respond to or prepare for the hazard:** ❖ Trim or remove trees that could affect power lines ❖ Create redundancy ❖ Equip facilities with a NOAA weather radio ❖ Equip vital facilities with emergency power sources.	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Develop an urban heat island reduction program that includes an urban forest program or plan • **Reduce vulnerability to the hazard:** ❖ Harden infrastructure such as locating utilities underground ❖ Trim trees back from power lines ❖ Designate snow routes and strengthen critical road sections and bridges • **Build local capacity to respond to or prepare for the hazard:** ❖ Support programs such as "Tree Watch" that proactively manage problem areas through use of selective removal of hazardous trees, tree replacement, etc. ❖ Establish and enforce building codes that require all roofs to withstand snow loads ❖ Increase communication alternatives ❖ Modify land use and environmental regulations to support vegetation management activities that improve reliability in utility corridors. ❖ Modify landscape and other ordinances to encourage appropriate planting near overhead power, cable, and phone lines ❖ Provide NOAA weather radios to the public ❖ Consider the probable impacts of climate change on the risk associated with the severe weather hazard ❖ Review and update heat response plan in light of climate change (heat events) projections

Table 19-7. Alternatives to Mitigate the Tsunami Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate outside of hazard area • **Reduce vulnerability to the hazard:** ❖ Apply personal property mitigation techniques to your home such as anchoring your foundation and foundation openings to allow flow though. • **Build local capacity to respond to or prepare for the hazard:** ❖ Develop and practice a household evacuation plan ❖ Educate yourself on the risk exposure from the tsunami hazard and ways to minimize that risk ❖ Understand tsunami warning signs and signals	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate structure or mission critical functions outside of hazard area whenever possible • **Reduce vulnerability to the hazard:** ❖ Mitigate personal property for the impacts of tsunami • **Build local capacity to respond to or prepare for the hazard:** ❖ Develop and practice a corporate evacuation plan ❖ Educate employees on the risk exposure from the tsunami hazard and ways to minimize that risk	• **Manipulate the hazard:** ❖ Build wave abatement structures (e.g. the "Jacks" looking structure designed by the Japanese) • **Reduce exposure to the hazard:** ❖ Locate structure or functions outside of hazard area whenever possible ❖ Harden infrastructure for tsunami impacts ❖ Relocate identified critical facilities located in tsunami high hazard areas • **Reduce vulnerability to the hazard:** ❖ Adopt higher regulatory standards that will provide higher levels of protection to structures built in a tsunami inundation area ❖ Utilize tsunami mapping to guide development away from high risk areas through land use planning • **Build local capacity to respond to or prepare for the hazard:** ❖ Use probabilistic tsunami mapping and land use guidance from the state when published ❖ Provide incentives to guide development away from hazard areas ❖ Improve the tsunami warning and response system ❖ Provide residents with tsunami inundation maps ❖ Join NOAA's Tsunami Ready program ❖ Develop and communicate evacuation routes ❖ Enhance the public information program to include risk reduction options for the tsunami hazard

Table-19-8. Alternatives to Mitigate the Wildfire Hazard

<table>
<tr><th>Personal-Scale</th><th>Corporate-Scale</th><th>Government-Scale</th></tr>
<tr>
<td>
• Manipulate the hazard:
❖ Clear potential fuels on property such as dry overgrown underbrush and diseased trees
• Reduce exposure to the hazard:
❖ Create and maintain defensible space around structures
❖ Locate outside of hazard area
❖ Mow regularly
• Reduce vulnerability to the hazard:
❖ Create and maintain defensible space around structures and provide water on site
❖ Use fire-resistant building materials
❖ Create defensible spaces around home
• Build local capacity to respond to or prepare for the hazard:
❖ Employ techniques from the National Fire Protection Association's Firewise USA program to safeguard home
❖ Identify alternative water supplies for fire fighting
❖ Install/replace roofing material with non-combustible roofing materials and implement other strategies to harden homes from embers and flame impingement
</td>
<td>
• Manipulate the hazard:
❖ Clear potential fuels on property such as dry underbrush and diseased trees
• Reduce exposure to the hazard:
❖ Create and maintain defensible space around structures and infrastructure
❖ Locate outside of hazard area
• Reduce vulnerability to the hazard:
❖ Create and maintain defensible space around structures and infrastructure and provide water on site
❖ Use fire-resistant building materials
❖ Use fire-resistant plantings in buffer areas of high wildfire threat.
• Build local capacity to respond to or prepare for the hazard:
❖ Support Firewise USA community initiatives.
❖ Create /establish stored water supplies to be utilized for firefighting.
</td>
<td>
• Manipulate the hazard:
❖ Clear potential fuels on property such as dry underbrush and diseased trees
❖ Implement best management practices on public lands
• Reduce exposure to the hazard:
❖ Create and maintain defensible space around structures and infrastructure
❖ Locate outside of hazard area
❖ Enhance building code to include use of fire resistant materials in high hazard area.
• Reduce vulnerability to the hazard:
❖ Create and maintain defensible space around structures and infrastructure
❖ Use fire-resistant building materials
❖ Use fire-resistant plantings in buffer areas of high wildfire threat.
❖ Consider higher regulatory standards (such as Class A roofing)
❖ Establish biomass reclamation initiatives
❖ Reintroduce fire (controlled or prescribed burns) to fire-prone ecosystems
❖ Manage fuel load through thinning and brush removal
❖ Establish integrated performance standards for new development to harden homes.
• Build local capacity to respond to or prepare for the hazard:
❖ More public outreach and education efforts, including an active Firewise USA program
❖ Possible weapons of mass destruction funds available to enhance fire capability in high-risk areas
❖ Identify fire response and alternative evacuation routes and establish where needed
❖ Seek alternative water supplies
❖ Become a Firewise USA community
❖ Use academia to study impacts/solutions to wildfire risk
❖ Establish/maintain mutual aid agreements between fire service agencies
❖ Develop, adopt, and implement integrated plans for mitigating wildfire impacts in wildland areas bordering on development
❖ Consider the probable impacts of climate change on the risk associated with the wildfire hazard in future land use decisions
❖ Establish a management program to track forest and rangeland health
❖ Provide incentives to for existing structures to be hardened against wildfire.
</td>
</tr>
</table>

19.2 ADAPTIVE CAPACITY

Adaptive capacity is defined as "the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences" (IPCC, 2014b). This term is typically used while discussing climate change adaptation; however, it is similar to the alternatives presented in the tables for building local capacity. In addition to hazard-specific capacity building, the following list provides general alternatives that planning partners considered to build capacity for adapting to both current and future risks (Cal EMA, et al., 2012a and 2012b):

- Incorporate climate change adaptation into relevant local and regional plans and projects.
- Establish a climate change adaptation and hazard mitigation public outreach and education program.
- Build collaborative relationships between regional entities and neighboring communities to promote complementary adaptation and mitigation strategy development and regional approaches.
- Establish an ongoing monitoring program to track local and regional climate impacts and adaptation strategy effectiveness.
- Increase participation of low-income, immigrant, non-English-speaking, racially and ethnically diverse, and special-needs residents in planning and implementation.
- Ask local employers and business associations to participate in local efforts to address climate change and natural hazard risk reduction.
- Conduct a communitywide assessment and develop a program to address health, socioeconomic, and equity vulnerabilities.
- Focus planning and intervention programs on neighborhoods that currently experience social or environmental injustice or bear a disproportionate burden of potential public health impacts.
- Use performance metrics and data to evaluate and monitor the impacts of climate change and natural hazard risk reduction strategies on public health and social equity.
- Develop coordinated plans for mitigating future flood, landslide, and related impacts through concurrent adoption of updated general plan safety elements and local hazard mitigation plans.
- Update safety elements to reflect existing hazards and projected climate change impacts on hazards.
- Implement general plan safety elements through zoning and subdivision practices that restrict development in floodplains, landslide, and other natural hazard areas.
- Identify and protect locations where native species may shift or lose habitat due to climate change impacts (sea level rise, loss of wetlands, warmer temperatures, drought).
- Collaborate with agencies managing public lands to identify, develop, or maintain corridors and linkages between undeveloped areas.
- Promote economic diversity.
- Incorporate consideration of climate change impacts as part of infrastructure planning and operations.
- Conduct a climate impact assessment on community infrastructure.
- Identify gaps in legal and regulatory capabilities and develop ordinances or guidelines to address those gaps.
- Identify and pursue new sources of funding for mitigation and adaptation activities.
- Hire new staff or provide training to current staff to ensure an adequate level of administrative and technical capability to pursue mitigation and adaptation activities.

20. AREA-WIDE ACTION PLAN

20.1 RECOMMENDED MITIGATION ACTIONS

The Steering Committee reviewed the catalogs of hazard mitigation alternatives and selected area-wide actions to be included in a hazard mitigation action plan. The selection of area-wide actions was based on the risk assessment of identified hazards of concern and the defined hazard mitigation goals and objectives. Table-20-1 lists the recommended hazard mitigation actions that make up the action plan. The timeframe indicated in the table is defined 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.

20.2 BENEFIT-COST REVIEW

The action plan must be prioritized according to a benefit/cost analysis of the proposed actions (44 CFR, Section 201.6(c)(3)(iii)). The benefits of proposed actions were weighed against estimated costs as part of the action 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 actions 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 action was performed. Parameters were established for assigning subjective ratings (high, medium, and low) to the costs and benefits of these actions.

Cost ratings were defined as follows:

- **High**—Existing funding will not cover the cost of the action; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).
- **Medium**—The action could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the action would have to be spread over multiple years.
- **Low**—The action could be funded under the existing budget. The action is part of or can be part of an ongoing existing program.

Benefit ratings were defined as follows:

- **High—**Action will provide an immediate reduction of risk exposure for life and property.
- **Medium—**Action will have a long-term impact on the reduction of risk exposure for life and property, or action will provide an immediate reduction in the risk exposure for property.
- **Low—**Long-term benefits of the action are difficult to quantify in the short term.

Using this approach, actions 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-20-1. Action Plan—Countywide Mitigation Initiatives

Hazards Addressed	Lead Agency	Possible Funding Sources or Resources	Time Line[a]	Objectives
CW-1—Continue to participate in the planning partnership and, to the extent possible based on available resources, provide coordination and technical assistance in applications for grant funding that include assistance in cost vs. benefit analysis.				
All Hazards	Planning Partners	Grant Funding	Short term, Ongoing	6, 8, 12
CW-2—Encourage the development and implementation of an operational area-wide hazard mitigation public-information strategy that meets the needs of all planning partners.				
All Hazards	Humboldt County, Planning Partners	Cost sharing from the Partnership General fund allocations Cost sharing with stakeholders	Short term, Ongoing	6, 7, 8, 12
CW-3—Coordinate updates to land use and building regulations as they pertain to reducing the impacts of natural hazards, to seek a regulatory cohesiveness within the planning area. This can be accomplished via a commitment from all planning partners to involve each other in their adoption processes, by seeking input and comment during the course of regulatory updates or general planning.				
All Hazards	Governing body of each eligible planning partner.	General funds	Short term, Ongoing	1, 3, 11, 12
CW-4—Sponsor and maintain a natural hazards informational website to include the following types of information: • Hazard-specific information such as GIS layers, private property mitigation alternatives, important facts on risk and vulnerability • Pre- and post-disaster information such as notices of grant funding availability • Links to Planning Partners' pages, FEMA, Red Cross, NOAA, USGS and the National Weather Service. • Hazard mitigation plan information such as progress reports, mitigation success stories, update strategies, Steering Committee meetings.				
All Hazards	Humboldt County	General fund	Short term, Ongoing	6, 7, 8, 12
CW-5—Maintain the Hazard Mitigation Plan Steering Committee as a viable body over time to monitor progress of the plan, provide technical assistance to Planning Partners and oversee the update of the plan according to schedule. This body will continue to operate under the ground rules established at its inception.				
All Hazards	Humboldt County	Existing, ongoing programs	Short term, Ongoing	All
CW-6—Amend or enhance the Humboldt County Operational Area Hazard Mitigation Plan as well as the general Plans for each municipality as needed to comply with state or federal mandates (i.e., CA. Assembly Bill # 2140) as guidance for compliance with these programs become available.				
All Hazards	Humboldt County, each municipal planning partner	General funds	Short term, Ongoing	All
CW-7—Work with the Humboldt County Assessor to begin the capture of general building stock information such as area, date of construction and foundation type, to better support future risk assessments.				
All Hazards	Humboldt County	General fund	Long term, depending on funding	6, 7, 8

For many of the strategies identified in this action plan, financial assistance may be available through 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 actions not seeking financial assistance from grant programs that require detailed analysis, "benefits" can be defined according to parameters that meet the goals and objectives of this plan.

20.3 ACTION PLAN PRIORITIZATION

Table 20-2 lists the priority of each area-wide action. A qualitative benefit-cost review was performed for each of these actions. The priorities are defined as follows:

- **Implementation Priority**
  - **High Priority**—An action that meets multiple objectives, has benefits that exceed costs, and has a secured source of funding. Action can be completed in the short term (1 to 5 years).
  - **Medium Priority**—An action that meets multiple objectives, has benefits that exceed costs, and is eligible for funding though no funding has yet been secured for it. Action can be completed in the short term (1 to 5 years), once funding is secured. Medium-priority actions become high-priority actions once funding is secured.
  - **Low Priority**—An action that will mitigate the risk of a hazard, has benefits that do not exceed the costs or are difficult to quantify, has no secured source of funding, and is not eligible for any known grant funding. Action can be completed in the long term (1 to 10 years). Low-priority actions are generally "wish-list" actions. They may be eligible for grant funding from programs that have not yet been identified.

- **Grant Pursuit Priority**
  - **High Priority**—An action that meets identified grant eligibility requirements, has high benefits, and is listed as high or medium implementation priority; local funding options are unavailable or available local funds could be used instead for actions that are not eligible for grant funding.
  - **Medium Priority**—An action that meets identified grant eligibility requirements, has medium or low benefits, and is listed as medium or low implementation priority; local funding options are unavailable.
  - **Low Priority**—An action that has not been identified as meeting any grant eligibility requirements.

Table 20-2. Prioritization of Area-Wide Mitigation Actions

Action #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Action Grant Eligible?	Can Action be Funded under Existing Programs/ Budgets?	Implementation Priority	Grant Pursuit Priority
CW-1	3	Medium	Low	Yes	Yes	Yes	High	Low
CW-2	4	Low	Low	Yes	Yes	Yes	High	Low
CW-3	4	Low	Low	Yes	No	Yes	High	Low
CW-4	4	Medium	Medium	Yes	Yes	No	Medium	Medium
CW-5	12	Low	Low	Yes	No	Yes	High	Low
CW-6	12	Low	Low	Yes	No	Yes	High	Low
CW-7	3	Medium	Low	Yes	Yes	No	Medium	Medium

20.4 CLASSIFICATION OF MITIGATION ACTIONS

Each recommended action was classified based on the hazard it addresses and the type of mitigation it involves. Table 20-3 shows these classifications.

Table 20-3. Analysis of Mitigation Actions

Hazard	Actions That Address the Hazard, by Mitigation Type[a]							
	Prevention	Property Protection	Public Education and Awareness	Natural Resource Protection	Emergency Services	Structural Projects	Climate Resiliency	Community Capacity Building
Dam Failure	CW-1, CW-3, CW-6, CW-7		CW-2, CW-4				CW-6	CW-3, CW-5
Drought	CW-1, CW-3, CW-6, CW-7		CW-2, CW-4				CW-6	CW-3, CW-5
Earthquake	CW-1, CW-3, CW-6, CW-7		CW-2, CW-4				CW-6	CW-3, CW-5
Flooding	CW-1, CW-3, CW-6, CW-7		CW-2, CW-4				CW-6	CW-3, CW-5
Landslide	CW-1, CW-3, CW-6, CW-7		CW-2, CW-4				CW-6	CW-3, CW-5
Severe Weather	CW-1, CW-3, CW-6, CW-7		CW-2, CW-4				CW-6	CW-3, CW-5
Tsunami	CW-1, CW-3, CW-6, CW-7		CW-2, CW-4				CW-6	CW-3, CW-5
Wildfire	CW-1, CW-3, CW-6, CW-7		CW-2, CW-4				CW-6	CW-3, CW-5

a. See Section 20.4 for description of mitigation types

Mitigation types used for this categorization are as follows:

- **Prevention**—Government, administrative or regulatory actions that influence the way land and buildings are developed to reduce hazard losses. Includes planning and zoning, floodplain laws, capital improvement programs, open space preservation, and stormwater management regulations.
- **Property Protection**—Modification of buildings or structures to protect them from a hazard or removal of structures from a hazard area. Includes acquisition, elevation, relocation, structural retrofit, storm shutters, and shatter-resistant glass.
- **Public Education and Awareness**—Actions to inform residents and elected officials about hazards and ways to mitigate them. Includes outreach projects, real estate disclosure, hazard information centers, and school-age and adult education.
- **Natural Resource Protection**—Actions that minimize hazard loss and preserve or restore the functions of natural systems. Includes sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, wetland restoration and preservation, and green infrastructure.
- **Emergency Services**—Actions that protect people and property during and immediately after a hazard event. Includes warning systems, emergency response services, and the protection of essential facilities.
- **Structural Projects**—Actions that involve the construction of structures to reduce the impact of a hazard. Includes dams, setback levees, floodwalls, retaining walls, and safe rooms.
- **Climate Resiliency**—Actions that incorporate methods to mitigate and/or adapt to the impacts of climate change. Includes aquifer storage and recovery activities, incorporating future conditions projections in project design or planning, or actions that specifically address jurisdiction-specific climate change risks, such as sea level rise or urban heat island effect.
- **Community Capacity Building**—Actions that increase or enhance local capabilities to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. Includes staff training, memorandums of understanding, development of plans and studies, and monitoring programs.

20.5 ACTION PLAN IMPLEMENTATION

The area-wide action plan here and jurisdiction-specific action plans in Volume 2 present a range of action items for reducing loss from hazard events. The planning partners have prioritized actions and can begin to implement the highest-priority actions over the next five years. The effectiveness of the hazard mitigation plan depends on its effective implementation and incorporation of the outlined action items into all partners' existing plans, policies, and programs. Some action items do not need to be implemented through regulation but can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation.

Humboldt County will have lead responsibility for overseeing the plan implementation and maintenance strategy. Plan implementation will be a shared responsibility among all planning partnership members and agencies identified as lead agencies in the area-wide and jurisdiction-specific action plans.

20.6 INTEGRATION INTO OTHER PLANNING MECHANISMS

Integrating relevant information from this hazard mitigation plan into other plans and programs where opportunities arise will be the ongoing responsibility of the governing bodies for all planning partners covered by this plan. By adopting general plans and zoning ordinances, the planning partners have planned for the impact of natural hazards, and these documents are integral parts of this hazard mitigation plan. The hazard mitigation planning process provided the partners with an opportunity to review and expand on policies contained within these documents, based on the best science and technology available at the time this plan was prepared. The partners should use their general plans and the hazard mitigation plan as complementary documents to achieve the ultimate goal of reducing risk exposure to citizens of the planning area. A comprehensive update to a general plan may trigger an update to the hazard mitigation plan.

All municipal planning partners have committed to creating a linkage between the hazard mitigation plan and their individual general plans or similar plans identified in the core capability assessment. Each municipal jurisdiction-specific action plan includes a high-priority mitigation action to create such a linkage.

Other planning processes and programs to be coordinated with the recommendations of the hazard mitigation plan may include the following:

- Emergency response plans
- Capital improvement programs
- Municipal codes
- Community design guidelines
- Water-efficient landscape design guidelines
- Stormwater management programs
- Water system vulnerability assessments.
- Climate action/adaptation plans
- Debris Management plans
- Post disaster action/Recovery plans

All planning partners have identified opportunities and strategies for integration in their annexes in Volume 2 of this plan.

21. PLAN ADOPTION AND MAINTENANCE

21.1 PLAN ADOPTION

A hazard mitigation plan must document that it has been formally adopted by the governing bodies of the jurisdictions 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 Cal OES and FEMA Region IX prior to adoption. Once pre-adoption approval has been provided, all planning partners will formally adopt the plan. 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.

21.2 PLAN MAINTENANCE STRATEGY

Plan maintenance is the formal process for achieving the following:

- Ensuring that the hazard mitigation plan remains an active and relevant document and that the planning partnership maintains its eligibility for applicable funding sources
- Monitoring and evaluating the plan annually and producing an updated plan every five years
- Integrating public participation throughout the plan maintenance and implementation process
- Incorporating the mitigation strategies outlined in this plan into existing planning mechanisms and programs, such as any relevant comprehensive land-use planning process, capital improvement planning process, and building code enforcement and implementation.

To achieve these ends, a hazard mitigation plan must present a plan maintenance process that includes the following (44 CFR Section 201.6(c)(4)):

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

Table 21-1 summarizes the plan maintenance strategy. The sections below further describe each element (except “integration into other planning mechanisms,” which is discussed in Section 20.6).

21.2.1 Plan Monitoring

Humboldt County Office of Emergency Services will be the lead agency responsible for monitoring the plan, and each partner will have monitor plan implementation by tracking the status of all recommended mitigation actions in its action plan. Staff or departments with primary responsibility are identified in each jurisdictional annex (see Volume 2) and summarized in Table 21-1.

Table 21-1. Plan Maintenance Matrix

Approach	Timeline	Lead Responsibility[a]
Integration into Other Planning Mechanisms		
Create a linkage between the hazard mitigation plan and individual jurisdictions' general plans or similar plans identified in the core capability assessments	Continuous over the 5-year performance period of the plan	Humboldt County, City of Arcata, City of Blue Lake, City of Eureka, City of Ferndale, City of Fortuna, City of Rio Dell, City of Trinidad, Humboldt Bay Harbor, Recreation and Conservation District, Southern Humboldt Community Healthcare District, Shelter Cove Resort Improvement District, Humboldt Bay Municipal Water District, Fieldbrook Glendale Community Services District, Humboldt Community Services District, Manila Community Services District, McKinleyville Community Services District, Redway Community Services District, Westhaven Community Services District, Willow Creek Community Services District, Arcata Fire Protection District, Fortuna Fire Protection District, Humboldt Bay Fire Protection District, Samoa Peninsula Fire Protection District.
Plan Monitoring[b]		
Track the implementation of actions over the performance period of the plan	Continuous over the 5-year performance period of the plan	Humboldt County OES will be the lead agency responsible for the plan, all planning partners will monitor themselves and report to Humboldt OES. All monitoring contacts will be as designated at the primary point of contacts in their jurisdictional annexes
Plan Evaluation		
Review the status of previous actions; assess changes in risk; evaluate success of integration	Upon initiation of hazard mitigation plan update, comprehensive general plan update, or major disaster	Humboldt County, City of Arcata, City of Blue Lake, City of Eureka, City of Ferndale, City of Fortuna, City of Rio Dell, City of Trinidad, Humboldt Bay Harbor, Recreation and Conservation District, Southern Humboldt Community Healthcare District, Shelter Cove Resort Improvement District, Humboldt Bay Municipal Water District, Fieldbrook Glendale Community Services District, Humboldt Community Services District, Manila Community Services District, McKinleyville Community Services District, Redway Community Services District, Westhaven Community Services District, Willow Creek Community Services District, Arcata Fire Protection District, Fortuna Fire Protection District, Humboldt Bay Fire Protection District, Samoa Peninsula Fire Protection District.
Incorporation into Other Planning Mechanisms		
Create a linkage between the hazard mitigation plan and individual jurisdictions' general plans or similar plans identified in the core capability assessments	Ongoing during the performance period of this plan as opportunities for integration become available, or according to timelines identified in the action plans for each planning partner	Jurisdictional points of contact identified in Volume 2 annexes
Grant Monitoring and Coordination		
As grant opportunities present themselves, the planning partners will consider options to pursue grants to fund actions identified in this plan	As grants become available	Humboldt County OES provides notification to planning partners and convenes grant funding meeting as needed.
Plan Update		
The planning partnership will reconvene, at a minimum, every 5 years to guide a comprehensive update of the plan.	Every 5 years or upon comprehensive update to General Plan or major disaster; funding and organizing for plan update will begin in FY 2021/2022	The governing bodies for all planning partners covered by this plan.

Approach	Timeline	Lead Responsibility[a]
Continuing Public Participation		
Humboldt OES will keep the website maintained, bring the plan to the Board of Supervisors meeting for review once a year (these meetings are also televised and on public notices in community newspaper), and receive comments through the website. The website and comments will be maintained over the course of the plan.	Continuous over the 5-year performance period of the plan	Humboldt OES will be the lead agency responsible. Other jurisdictional point of contacts identified in volume 2 annexes will help support.

a. Responsible lead party may designate an alternate. Jurisdictional points of contact identified in Volume 2 annexes have support responsibility.
b. For the monitoring task, agencies identified as lead agencies in each jurisdictions' action plan will report status as requested to the agency charged with lead responsibility for plan monitoring

21.2.2 Plan Evaluation

The plan will be evaluated by how successfully the implementation of identified actions has helped to achieve the goals and objectives identified in this plan. This will be assessed by a review of the changes in risk that occur over the performance period and by the degree to which mitigation goals and objectives are incorporated into existing plans, policies and programs. Plan evaluation will be a shared responsibility among all planning partnership members and agencies identified as lead agencies in the area-wide and jurisdiction-specific action plans.

21.2.3 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 general plans of the planning partners are considered to be integral parts of this plan. The planning partners, through adoption of general plans and zoning ordinances, have planned for the impact of natural hazards. The hazard mitigation plan development process provided them with an 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 planning area. An update to a general 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 general plans by identifying a mitigation action to do so and giving that action a high priority. Other planning processes and programs to be coordinated with the recommendations of the hazard mitigation plan include the following:

- Emergency response plans
- Training and exercise of emergency response plans
- Debris management plans
- Recovery plans
- Capital improvement programs
- Municipal codes
- Community design guidelines
- Water-efficient landscape design guidelines
- Stormwater management programs
- Water system vulnerability assessments
- Community wildfire protection plans
- Comprehensive flood hazard management plans

- Resiliency plans
- Community Development Block Grant-Disaster Recovery action plans
- Public information/education 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.

For the special purpose district planning partners to this plan, identified planning capabilities include: capital facility plans, emergency operations plan, continuity of operations plans and community wildfire protection plans. Special purpose districts do not have land use authority, so integration with land use plans is not a capability for districts. However, for the planning capabilities that the districts do possess, they will integrate where appropriate relevant sections of this plan when those plans are scheduled for updates. This has already occurred for most of the district planning partners as indicated in Volume 2 of this plan.

21.2.4 Grant Monitoring and Coordination

Humboldt County OES will identify grant funding opportunities and send notifications to participating partner jurisdictions. Once these opportunities are identified, planning partners interested in pursuing a grant opportunity will convene in a short meeting to review the hazard mitigation plan and pursue a strategy to capture that grant funding. Humboldt County OES will assume lead responsibility for planning and facilitating grant opportunity meetings. Review of the hazard mitigation plan at these meetings can include the following:

- Discussion of any hazard events that occurred during the prior year and their impact on the planning area
- Impact of potential grant opportunities on the implementation of mitigation actions
- Re-evaluation of the action plans to determine if the timeline for identified actions need to be amended (such as changing a long-term action to a short-term action because of funding availability)
- Recommendations for new actions
- Impact of any other planning programs or initiatives that involve hazard mitigation.

If multiple planning partners decide to pursue the same grant funding opportunity, partnerships can be formed to utilize the hazard mitigation plan in the grant application.

21.2.5 Plan Update

Federal regulations require that local hazard mitigation plans be reviewed, revised if appropriate, and resubmitted for approval in order to remain eligible for benefits awarded under the Disaster Mitigation Act (44 CFR Section 201.6.d(3)). This plan's format allows the planning partnership to review and update sections when new data become available. New data can be easily incorporated, resulting in a plan that will remain current and relevant. The planning partnership intends to update the plan on a five-year cycle from the date of plan approval. 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 20-year plan update of a participating jurisdiction's general plan

It will not be the intent of the update process to develop a complete new hazard mitigation plan. Based on needs identified by the planning team, the update will, at a minimum, include the following elements:

- The update process will be convened through a new steering committee.

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

Because plan updates can require a year or more to complete, the Humboldt County OES will initiate efforts to update the plan before it expires. Humboldt County OES will consider applying for funding to update the plan in the Fiscal Year 2022/2023 grant cycle or will identify an alternate source of funding for the plan update in order to begin the update process in the spring of 2023.

21.2.6 Continuing Public Participation

The public outreach strategy used during development of the current update will provide a framework for public engagement through the plan maintenance process. It can be adapted for ongoing public outreach as determined to be feasible by the planning partnership. A steering committee similar to the one involved in developing this hazard mitigation plan update will be put in place to provide stakeholder input on plan maintenance activities.

The public will continue to be apprised of hazard mitigation activities through the website and reports on successful hazard mitigation actions provided to the media. Humboldt OES will keep the website maintained, including monitoring the email address where members of the public can submit comments to the steering committee. This site will house the final plan and will be a one-stop shop for information regarding the plan, the partnership and plan implementation. Copies of the plan also will be distributed to the Humboldt County Library System.

Once a year, Humboldt OES will bring the plan to a Board of Supervisors meeting for review. These meetings are also televised and on public notices in community newspaper.

Upon initiation of the next plan update process, a new public involvement strategy will be initiated, with guidance from the 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, it will include the use of local media outlets.

REFERENCES

Association of State Dam Safety Officials (ASDSO). 2013. “Introduction to Dams.” Dam Safety 101. Accessed 2017. http://www.damsafety.org/news/?p=e4cda171-b510-4a91-aa30-067140346bb2.

Association of State Dam Safety Officials (ASDSO). 2016. Dam Failures and Incidents. The website of the ASDSO, accessed January 2016, http://www.damsafety.org/news/?p=412f29c8-3fd8-4529-b5c9-8d47364c1f3e

Association of State Dam Safety Officials. 2000. Summary of State Dam Regulations Compiled by the Association of State Dam Safety Officials, July 2000. Accessed online September 16, 2013 at http://www.damsafety.org/media/Documents/PDF/CA.pdf

Baruth and Yoder. 1971. Mid-Humboldt County Urban Planning Program: Wastewater Collection, Treatment and Disposal. Prepared for the Humboldt County Board of Supervisors by Baruth and Yoder.

Brown, W. et al. 2001. U.S. Geological Survey (USGS). “Hazard Maps Help Save Lives and Property.” 2001. Accessed 2017. http://pubs.usgs.gov/fs/1996/fs183-96/fs183-96.pdf.

Cal FIRE. 2009. “FRAP Projects.” The website of Cal FIRE. Accessed 2018. http://frap.fire.ca.gov/projects/fire_data/fire_perimeters_index

Cal FIRE. 2012. “Fire Hazard Severity Zone Re-Mapping Project.” The website of Cal FIRE. Accessed 2018. http://frap.fire.ca.gov/projects/hazard/fhz

Cal FIRE. 2012a. “Fire Hazard Severity Zone Development.” The website of Cal FIRE. Accessed 2018. http://www.fire.ca.gov/fire_prevention/fire_prevention_wildland_zones_development

Cal FIRE 2013. http://frap.cdf.ca.gov/.California Department of Forestry and Fire Prevention. 2013. Fire and Resource Assessment Program. Website mapping and data. 2013.

California Department of Conservation. 2003. “Faults and Earthquakes in California; Note 31.” Accessed online: http://www.conservation.ca.gov/cgs/Documents/Note_31.pdf

California Department of Conservation. 2017a. “Official Tsunami Inundation Maps. Accessed 2018. http://www.conservation.ca.gov/cgs/geologic_hazards/Tsunami/Inundation_Maps/Pages/index.aspx#DownloadData

California Department of Conservation. 2017b. *New Maximum Tsunami Inundation Maps for Use by Local Emergency Planners in the State of California.* Accessed 2018. http://www.conservation.ca.gov/cgs/geologic_hazards/Tsunami/Inundation_Maps/Pages/index.aspx#DownloadData

California Department of Conservation. 2017c. “Hazards from ‘Mudslides’…Debris Avalanches and Debris Flows in Hillside and Wildfire Areas.” The website of the State of California Department of Conservation. Accessed 2018. http://www.conservation.ca.gov/cgs/Pages/Note_33.aspx

California Department of Finance. 2012a. State of California, Department of Finance. E-2. California County Population Estimates and Components of Change by Year — July 1, 2010–2012. December 2012.

California Department of Finance. 2012b. State of California, Department of Finance. Historical Census Populations of California, Counties, and Incorporated Cities, 1850 – 2010. June 4, 2012.

California Department of Finance. 2012c. State of California, Department of Finance. E-1. City/County Population Estimates with Annual Percent Change, January 1, 2011 and 2012. April 20, 2012.

California Department of Finance. 2018. "E-4 Population Estimates for Cities, Counties, and the States, 2001-2010, with 2000 and 2010 Census Counts." Website of the State of California Department of Finance. Accessed 2018. http://www.dof.ca.gov/Forecasting/Demographics/Estimates/E-4/2001-10/

California Department of Finance. 2018a. 'E-4 Population Estimates for Cities, Counties, and the State, 2011-2017 with 2010 Census Benchmark." Website of the State of California Department of Finance. Accessed 2018. http://www.dof.ca.gov/Forecasting/Demographics/Estimates/E-4/2010-17/

California Department of Transportation. 2011. "California Scenic Highway Mapping System." The website of California Department of Transportation. Accessed 2018. http://www.dot.ca.gov/hq/LandArch/16_livability/scenic_highways/index.htm

California Department of Transportation. 2017. "Long-Term Socio-Economic Forecasts by County." Website of the California Department of Transportation. Accessed 2018. http://www.dot.ca.gov/hq/tpp/offices/eab/socio_economic.html

California Department of Transportation. 2018. Record of Meeting, Last Chance Grade Partnering Meeting, March 8, 2018. Accessed 2018. http://www.lastchancegrade.com/files/managed/Document/291/LCG_Partnering_Meeting_Minutes_2018-3-8.pdf

California Department of Water Resources (DWR). 2008. *Managing and Uncertain Future: Climate Change Adaptation for California's Water.* Accessed 2018. https://www.water.ca.gov/LegacyFiles/climatechange/docs/ClimateChangeWhitePaper.pdf

California Department of Water Resources (DWR). 2017. "State Hydrologic Data." Accessed March 2017. http://www.watersupplyconditions.water.ca.gov.

California Department of Water Resources. 2008. Managing for an Uncertain Future, Climate Change Adaptation Strategies.

California Division of Oil, Gas & Geothermal Resources. 2013. Website: Online Production and Injection Query. http://opi.consrv.ca.gov/opi/opi.dll

California Division of Safety of Dams. 2013. California Department of Water Resources Division of Safety of Dams "Frequently Asked Questions" Web address: damsafety.water.ca.gov/FAQanswers.cfm#safety.

California Division of Safety of Dams. 2013. Hydrologic Analysis Within California's Dam Safety Program. Paper prepared by Emil R. Calzascia and James A. Fitzpatrick. Accessed online September 16, 2013 at http://www.water.ca.gov/damsafety/docs/fitz-paper.pdf

California Division of Safety of Dams. 2017. *Dams within Jurisdiction of the State of California*. Accessed 2018. https://www.water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/All-Programs/Division-of-safety-of-dams/Files/Publications/Dams-Within-Jurisdiction-of-the-State-of-California-Alphabetically-by-County.pdf

California Division of Safety of Dams. 2017a. Criteria for DSOD's Downstream Hazard Potential Classification. Accessed 2018. https://www.water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/All-Programs/Division-of-safety-of-dams/Emergency-Action-Planning/Files/Publications/Criteria-for-DSODs-Downstream-Hazard-Potential-Classification.pdf

California Division of Safety of Dams. 2018. Jurisdictional Dams. Accessed 2018. https://www.water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/All-Programs/Division-of-safety-of-dams/Files/Publications/Jurisdictional-Dams-Receiving-Additional-Spillway-Re-evaluation.pdf

California Emergency Management Agency (Cal EMA) et al. 2012. "California Adaptation Planning Guide." Accessed 2017. http://resources.ca.gov/docs/climate/APG_Understanding_Regional_Characteristics.pdf.

California Emergency Management Agency. 2010, State of California Multi-hazard mitigation Plan. October 2010

California Emergency Management Agency. 2012a. California Adaptation Planning Guide, Defining Local and Regional Impacts. July 2012

California Emergency Management Agency. 2012b. California Adaptation Planning Guide, Understanding Regional Characteristics. July 2012

California Employment Development Department. 2013. Major Employers in Humboldt County. Website accessed September 24, 2013 at http://www.labormarketinfo.edd.ca.gov/majorer/countymajorer.asp?CountyCode=000023

California Energy Commission. 2013a. Website: Annual Generation – County. http://www.energyalmanac.ca.gov/electricity/web_qfer/Annual_Generation-County.php

California Energy Commission. 2013b. Website: Annual Reporting Results -=- California Retail Fuel Outlet Annual Report (A15). http://energyalmanac.ca.gov/gasoline/piira_retail_survey.html

California Energy Commission. 2013c. Website: California Power Plants. http://www.energyalmanac.ca.gov/powerplants/index.html

California Energy Commission. 2013d. Website: Electricity Consumption by County. http://www.ecdms.energy.ca.gov/elecbycounty.aspx

California Energy Commission. 2013e. Website: Gas Consumption by County. http://www.ecdms.energy.ca.gov/gasbycounty.aspx

California Energy Commission. 2013f. Website: Propane or Liquefied Petroleum Gas (LPG) http://energyalmanac.ca.gov/propane/index.html#california

California Energy Commission. 2013g. Website: Retail Gasoline Sales by County. http://energyalmanac.ca.gov/gasoline/retail_fuel_outlet_survey/retail_gasoline_sales_by_county.html

California Energy Commission. 2013h. Local Energy Assurance Planning website: www.CaLEAP.org , accessed 2013

California Gas and Electric Utilities. 2011. California Gas Report. Supplement. http://www.pge.com/pipeline/library/regulatory/downloads/cgr11.pdf

California Geologic Survey. No date. *Landslides in the Highway 101 Corridor*. Accessed 2018. http://www.conservation.ca.gov/cgs/rghm/landslides/sr_184/Documents/ct101dn%20plate%202.pdf

California Geological Survey. 2002. California Geomorphic Provinces, Note 36. http://www.consrv.ca.gov/cgs/information/publications/cgs_notes/note_36/Documents/note_36.pdf

California Geological Survey. 2013. http://www.conservation.ca.gov/cgs/Pages/Index.aspx Website accessed 2013.

California Governor's Office of Emergency Services (Cal OES). 2018. "Dam Emergency Action Planning." Website of Cal OES. Accessed 2018. http://www.caloes.ca.gov/for-individuals-families/hazard-mitigation-planning/dam-emergency-action-planning

California Governor's Office of Emergency Services (Cal OES). 2019. "Spill Release Reporting" web page of the Cal OES Special Operations & Hazardous Materials Section. Accessed online at https://www.caloes.ca.gov/cal-oes-divisions/fire-rescue/hazardous-materials/spill-release-reporting

Caltrans. 2016. *Project Study Report Permanent Restoration, Last Chance Grade.* Accessed 2018. http://www.lastchancegrade.com/files/managed/Document/208/lcg_psr_final_s.pdf

Caltrans. 2016a. "Process and Schedule." The website of Caltrans, Last Chance Grade. Accessed 2018. http://www.lastchancegrade.com/app_pages/view/13

Cascadia Region Earthquake Workgroup. 2013. Cascadia Subduction zone Earthquakes: A Magnitude 9.0 Earthquake Scenario. Available online at http://file.dnr.wa.gov/publications/ger_ic116_csz_scenario_update.pdf

Centers for Disease Control and Prevention (CDC). 2012. "Drought and Health." Accessed February 2017. http://www.cdc.gov/nceh/drought/.

Drought Impact Reporter. 2018. The website of the National Drought Mitigation Center. Accessed 2018. http://drought.unl.edu/monitoringtools/droughtimpactreporter.aspx

Dunbar, Paula K. and Craig S. Weaver. 2015. *United States and Territories National Tsunami Hazard Assessment: Historical record and Sources for Waves-Update.* http://www.nws.noaa.gov/om/hazstats/resources/weather_fatalities.pdf

Dyett & Bhatia. 2002. Natural Resources and Hazards Volume II: Detailed Watershed Characteristics and Regulatory Framework Analysis, Humboldt County Community Development Services and Dyett & Bhatia September 2002.

Federal Emergency Management Agency (FEMA). No date. *Geological Hazards: Subpart B.* Accessed 2018. https://www.fema.gov/media-library-data/20130726-1545-20490-9696/mhira_n2.pdf

Federal Emergency Management Agency (FEMA). 1999. National Flood Insurance Program. Flood Insurance Study for Humboldt County

Federal Emergency Management Agency (FEMA). 2001. Understanding Your Risks; Identifying Hazards and Determining your Risks. FEMA (386-2). August 2001

Federal Emergency Management Agency (FEMA). 2002. Getting Started; Building support for Mitigation Planning; FEMA (386-1). September 2002

Federal Emergency Management Agency (FEMA). 2003. Developing the Mitigation Plan; Identifying Mitigation Actions and Implementing Strategies. FEMA (386-3). April 2003

Federal Emergency Management Agency (FEMA). 2004. Using HAZUS-MH for Risk Assessment, How to Guide, FEMA (433). August 2004

Federal Emergency Management Agency (FEMA). 2007. FEMA, National Flood Insurance Program, Community Rating System; CRS Coordinator's Manual FIA-15/2007 OMB No. 1660-0022

Federal Emergency Management Agency (FEMA). 2012. FEMA Disaster Declaration Summary – Open Government Dataset. Spreadsheet Data Accessed December 10, 2012 from Federal Emergency Management Agency Website: http://www.fema.gov/library/viewRecord.do?id=6292

Field, Edward H., and members of the 2014 Working Group on California Earthquake Probabilities. 2015. *UCERF3 [Uniform California Earthquake Rupture Forecast]: A New Earthquake Forecast for California's Complex Fault System*. The website of USGS. Accessed 2018. https://dx.doi.org/10.3133/fs20153009.

Guivetchi, Kamyar. 2001. California Department of Water Resources, Transcript Siting Committee Workshop before the California Energy Resources Conservation and Development Commission. February 8.

Humboldt Bay Harbor, Recreation & Conservation District (HRCD). 2013. Humboldt Bay Sea Level Rise Adaptation Planning Project website. Accessed 11/18/2013 at: http://humboldtbay.org/humboldt-bay-sea-level-rise-adaptation-planning-project#overlay-context=humboldt-bay-sea-level-rise-adaptation-planning-project

Humboldt County. 2013. Humboldt County General Plan Update. Accessed online at https://co.humboldt.ca.us/gpu/

Humboldt County. 2014. Humboldt Operational Area Hazard Mitigation Plan Update. Prepared for County of Humboldt Department of Public Works by Tetra Tech, Inc. San Diego, California. February 2014.

Intergovernmental Panel on Climate Change (IPCC). 2014. "Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Parts A, B and Annexes." Accessed January 2017. http://www.ipcc.ch/report/ar5/wg2/.

Intergovernmental Panel on Climate Change (IPCC). 2014a. "Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Parts A, B and Annexes." Accessed January 2017. http://www.ipcc.ch/report/ar5/wg2/.

International Strategy for Disaster Reduction. 2008. Disaster Risk Reduction Strategies and Risk Management Practices: Critical Elements for Adaptation to Climate Change. 11/11/2008.

Lewis, Michael S. No date. "Beaufort Wind Chart – Estimating Winds Speeds." The website of NOAA. Accessed 2018. http://www.crh.noaa.gov/Image/iwx/publications/Beaufort_Wind_Chart.pdf

Lund, J.R. 2013. Table of Dam Failures. On website of Jay R. Lund, Department of Civil and Environmental Engineering, University of California, Davis. Accessed September 16, 2013 at http://cee.engr.ucdavis.edu/faculty/lund/dams/Dam_History_Page/Failures.htm

McKinley, Jesse. 2011. "Sleepy California Town, and a Tsunami Magnet." Crescent City Journal and the New York Times. Accessed 2018. http://www.nws.noaa.gov/om/hazstats/resources/weather_fatalities.pdf

NASA, 2004. http://earthobservatory.nasa.gov/Newsroom/view.php?id=25145 NASA Earth Observatory News Web Site Item, dated August 2, 2004.

National Aeronautics and Space Administration (NASA). 2016. "NASA, NOAA Data Show 2016 Warmest Year on Record Globally." Accessed February 2017. https://www.nasa.gov/press-release/nasa-noaa-data-show-2016-warmest-year-on-record-globally.

National Aeronautics and Space Administration (NASA). 2017. "NASA, NOAA Data Show 2016 Warmest Year on Record Globally" Accessed May 2017. https://www.nasa.gov/press-release/nasa-noaa-data-show-2016-warmest-year-on-record-globally.

National Aeronautics and Space Administration (NASA). 2018. "Global Climate Change: Vital Signs of the Planet." Accessed April 2018. http://climate.nasa.gov/vital-signs

National Center for Environmental Information. 2018c. Tsunami Travel Times to Coastal Locations viewer. Accessed 2018. https://maps.ngdc.noaa.gov/viewers/ttt_coastal_locations/

National Centers for Environmental Information. 2018b. "NGDC/WDS Global Historical Tsunami Database." Accessed 2018. https://www.ngdc.noaa.gov/hazard/tsu_db.shtml

National Centers for Environmental Information. 2019. North American Drought Monitor; Drought Indices and Data. The website of NOAA. Accessed August 8, 2019. https://www.ncdc.noaa.gov/temp-and-precip/drought/nadm/indices

National Drought Mitigation Center. 2017. "Drought Affecting People." Accessed February 2017. http://drought.unl.edu/droughtbasics/ensoandforecasting.aspx.

National Oceanic and Atmospheric Administration (NOAA). 2010. http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms. NOAA, National Climatic Data Center website, accessed 2010

National Oceanic and Atmospheric Administration (NOAA). 2018. "Sea Level Rise Viewer." Accessed at https://coast.noaa.gov/digitalcoast/tools/slr.html.

National Oceanic and Atmospheric Administration (NOAA). 2018a. "Enhanced F Scale for Tornado Damage." The website of NOAA. Accessed 2018. http://www.spc.noaa.gov/faq/tornado/ef-scale.html

National Oceanic and Atmospheric Administration and National Weather Service (NOAA and NWS). 2009. "National Weather Service Glossary." Accessed 2018. http://w1.weather.gov/glossary/.

National Oceanic and Atmospheric Administration and National Weather Service (NOAA and NWS). 2018. "Drought Monitoring." The website of NOAA. Last updated 2015. http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml

National Oceanic and Atmospheric Administration and National Weather Service (NOAA and NWS). 2018a. "Introduction to Thunderstorms." The website of the NWS. Accessed 2018. https://www.weather.gov/jetstream/tstorms_intro

National Oceanic and Atmospheric Administration and National Weather Service (NOAA and NWS). 2018b. "Freezing Rain and Sleet." The website of the NWS. Accessed 2018. https://www.weather.gov/rnk/Measure_Icing

National Oceanic and Atmospheric Administration and National Weather Service (NOAA and NWS). 2018c. "Severe Weather Definitions." The website of the NWS. Accessed 2018. https://www.weather.gov/bgm/severedefinitions

National Oceanic and Atmospheric Administration and National Weather Service (NOAA and NWS). 2018d. "Weather Fatalities." The website of NWS. Accessed 2018. http://www.nws.noaa.gov/om/hazstats/resources/weather_fatalities.pdf

National Severe Storms Laboratory. 2018. "Severe Weather 101." The website of the National Severe Storms Laboratory. Accessed 2018. https://www.nssl.noaa.gov/education/svrwx101/wind/types/

National Tsunami Hazard Mitigation Program. 2001. *Designing for Tsunamis: Seven Principles for Planning and Designing for Tsunami Hazards.* Accessed 2018. https://nws.weather.gov/nthmp/documents/designingfortsunamis.pdf

National Weather Service. 2019. National Weather Service Climate Prediction Center Drought Monitoring web page. Accessed August 8, 2019. https://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml

North Coast Resource Partnership. 2014. *North Coast Integrated Regional Water Management Plan*. Accessed 2018. http://www.northcoastresourcepartnership.org/files/managed/Document/8214/NCIRWMP_PhaseIII_Aug14_final_w_appendix.pdf

North Coast Unified Air Quality Management District. 2018. District web site: http://www.ncuaqmd.org/index.php

OTA (Congressional Office of Technology Assessment). 1993. Preparing for an Uncertain Climate, Vol. I. OTA–O–567. U.S. Government Printing Office, Washington, D.C.

Pacific Northwest Seismic Network. 2018. "Cascadia Subduction zone." Website accessed 2018. https://pnsn.org/outreach/earthquakesources/csz

Pacific Watershed Associates. 2012. Humboldt Bay Region, Sea Level Rise Data Synthesis, Humboldt County, California: Executive Summary. May 2012

Redwood Coast Energy Authority. 2013a. Redwood Neighborhood Energy Challenge. Website. http://challenge.redwoodenergy.org/

Redwood Coast Energy Authority. 2013b. Website: Energy Upgrade California. http://www.redwoodenergy.org/programs/energy-upgrade

Schatz Energy Research Center. 2005. Humboldt County General Plan Energy Element Appendices: Technical Report. Prepared by Humboldt State University Schatz Energy Research Center.

Schatz Energy Research Center. 2013. RePower Humboldt: A Strategic Plan for Renewable Energy Security and Prosperity. Prepared for the Redwood Coast Energy Authority by Humboldt State University Schatz Energy Research Center. March 2013. Accessed online at http://www.redwoodenergy.org/images/RESCO/RePower_Humboldt_Strategic_Plan_FINAL_2013-04-17.pdf

Southern California Earthquake Center (SCEC). 2018. "A Site Conditions Map for California Based on Geology and Hear Wave Velocity." The website of SCEC. Accessed 2018. http://scecinfo.usc.edu/phase3/wills.html

State of California. 2018. California Legislative Information website. Accessed 2018. https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?lawCode=GOV&sectionNum=8589.5.

U.S. Army Corps of Engineers. 2018. National Inventory of Dams. Accessed March 2018. https://catalog.data.gov/dataset/national-inventory-of-dams.

U.S. Census Bureau. 2000. Data from 2000 U.S. Census. U.S. Census Bureau.

U.S. Census Bureau. 2018. 2012-2016 American Community Survey. Accessed 2018. https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml#

U.S. Climate Resilience Toolkit. 2018. U.S. Climate Resilience Toolkit web page on drought: https://toolkit.climate.gov/topics/water/drought

U.S. Department of Agriculture (USDA), Farm Service Agency, 2018. "Disaster Designation Information. Accessed 2018. https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/disaster-designation-information/index

U.S. Drought Portal. 2018. National Integrated Drought Information System. Accessed 2018. https://www.drought.gov/drought/data-gallery/crop-moisture-index

U.S. Environmental Protection Agency (EPA). 2016. "Climate Change Indicators in the United States." 2016. https://www.epa.gov/climate-indicators/climate-change-indicators-atmospheric-concentrations-greenhouse-gases.

U.S. Environmental Protection Agency (EPA). 2016a. "Toxics Release Inventory (TRI) Program." https://www.epa.gov/toxics-release-inventory-tri-program/learn-about-toxics-release-inventory.

U.S. Environmental Protection Agency (EPA). 2016b. "Climate Change Indicators in the United States." 2016. EPA 430-R-16-004. www.epa.gov/climate-indicators.

U.S. Fish and Wildlife Service. 2018. Information for Planning and Consultation viewer. Accessed 2018. https://ecos.fws.gov/ipac/location/index

U.S. Geological Survey (USGS). 1989. The Severity of an Earthquake. U.S. Government Printing Office: 1989-288-913. Accessed online at: http://pubs.usgs.gov/gip/earthq4/severity_text.html

U.S. Geological Survey (USGS). 2008. An Atlas of ShakeMaps for Selected Global Earthquakes. U.S. Geological Survey Open-File Report 2008-1236. Prepared by Allen, T.I., Wald, D.J., Hotovec, A.J., Lin, K., Earle, P.S. and Marano, K.D.

U.S. Geological Survey (USGS). 2010. PAGER—Rapid Assessment of an Earthquake's Impact. U.S. Geological Survey Fact Sheet 2010-3036. September 2010.

U.S. Geological Survey (USGS). 2014. "Global Seismographic Network." Earthquake Hazards Program. Accessed February 2017. http://earthquake.usgs.gov/monitoring/gsn/.

U.S. Geological Survey (USGS). 2017a. "Measuring Earthquakes FAQs." Accessed February 2017. https://www2.usgs.gov/faq/categories/9828/3357.

U.S. Geological Survey (USGS). 2018. "3.3 ShakeMap Archives." The website of USGS. Accessed 2018. http://usgs.github.io/shakemap/manual3_5/shakemap_archives.html#generating-earthquake-scenarios

U.S. Geological Survey (USGS). 2018a. "Search Earthquake Catalog." The website of USGS. Accessed 2018. https://earthquake.usgs.gov/earthquakes/search/

U.S. Geological Survey (USGS). 2018b. "Quaternary Fault and Fold Database Background." The website of USGS. Accessed 2018. https://earthquake.usgs.gov/hazards/qfaults/background.php

U.S. Global Change Research Program (USGCRP). 2009. “Global Climate Change Impacts in the United States.” Thomas R. Karl, Jerry M. Melillo and Thomas C. Peterson, (eds.). Cambridge University Press. Accessed 2016. https://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

Washington Department of Ecology. 2014. Puget Sound Landslides Website. Accessed in 2014. http://www.ecy.wa.gov/programs/sea/landslides/about/about.html

Wilson, R., Davenport, C., and Jaffe, B., 2012b, Sediment scour and deposition within harbors in California (USA), caused by the March 11, 2011 Tohoku-oki Tsunami: Sedimentary Geology, doi:10.1016/j.sedgeo.2012.06.001.

Wilson, R.I., Admire, A.R., Borrero, J.C., Dengler, L.A., Legg, M.R., Lynett, P., Miller, K.M., Ritchie, A., Sterling, K., McCrink, T.P., Whitmore, P.M., 2012a, Observations and impacts from the 2010 Chilean and 2011 Japanese tsunami in California (USA): Pure and Applied Geophysics. http://dx.doi.org/10.1007/s00024-012-0527-z.

Winzler and Kelly. 1970. Humboldt County Water Requirements and Water Resources: Mad River, Trinity River, Klamath River, Redwood Creek and Mattole River-Bear River Hydrographic Units. Phase II. Prepared for the Humboldt County Board of Supervisors by Winzler and Kelly Consulting Engineers.

LIST OF ACRONYMS

AB—Assembly Bill
ADA—American with Disabilities Act
ASDSO—Association of State Dam Safety Officials
BIA—Bureau of Indian Affairs
BLM—Bureau of Land Management
BOF—Board of Forestry and Fire Protection
Cal EMA—California Emergency Management Agency
CAL FIRE—California Department of Forestry and Fire Protection
Cal OES—California Office of Emergency Services
Caltrans—California Department of Transportation
CCR—California Code of Regulations
CDBG-DR—Community Development Block Grant Disaster Recovery
CEQA—California Environmental Quality Act
CFA—California Fire Alliance
CFR—Code of Federal Regulations
CIP—Capital Improvement Plan
CRS—Community Rating System
CWA—Clean Water Act
CWPP—Community Wildfire Protection Plan
DFIRM—Digital Flood Insurance Rate Maps
DHS—Department of Homeland Security
DMA —Disaster Mitigation Act
DWR—Department of Water Resources (California)
EAP—Emergency Action Plan
EMA—Emergency Management Agency (California state)
EPA—U.S. Environmental Protection Agency
ESA—Endangered Species Act
EWP—Emergency Watershed Protection
FEMA—Federal Emergency Management Agency
FERC—Federal Energy Regulatory Commission
FHSZ—Fire hazard severity zones

FIRM—Flood Insurance Rate Map

FRAP—Fire and Resources Assessment Program

GBS—General Building Stock

GIS—Geographic Information System

GWh—Gigawatt-hour

Hazus—Hazards, United States

HMGP—Hazard Mitigation Grant Program

HMRT—Hazardous Materials Response Team

IA—Individual Assistance

IBC—International Building Code

IPCC—Intergovernmental Panel on Climate Change

IRC—International Residential Code

MM—Modified Mercalli Scale

mph—Miles per hour

MWh—Megawatt-hour

Mw—Moment Magnitude Scale

NASA—National Aeronautics and Space Administration

NEHRP—National Earthquake Hazards Reduction Program

NFIP—National Flood Insurance Program

NIMS—National Incident Management System

NOAA—National Oceanic and Atmospheric Administration

NPS—National Park Service

NRCS—Natural Resources Conservation Service

NWS—National Weather Service

OES—Office of Emergency Services (Humboldt County)

PA—Public Assistance

PDM—Pre-Disaster Mitigation Grant Program

PGA—Peak Ground Acceleration

SEMS—Standardized Emergency Management Systems

SPI—Standardized Precipitation Index

USDA—U.S. Department of Agriculture

USGCRP—U.S. Global Change Research Program

USGS—U.S. Geological Survey

Humboldt County Operational Area Hazard Mitigation Plan 2019

Appendix A. Public Involvement Materials

A. PUBLIC INVOLVEMENT MATERIALS

STEERING COMMITTEE MEETING SUMMARIES

SURVEY RESULTS

Humboldt County Operational Area Hazard Mitigation Plan 2019

Appendix B. Summary of Federal and State Agencies, Programs and Regulations

B. SUMMARY OF FEDERAL AND STATE AGENCIES, PROGRAMS AND REGULATIONS

Existing laws, ordinances, plans and programs at the federal and state level can support or impact hazard mitigation actions 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)). The following federal and state programs have been identified as programs that may interface with the actions identified in this plan. Each program enhances capabilities to implement mitigation actions or has a nexus with a mitigation action in this plan. Information presented in this section can be used to review local capabilities to implement the actions found in the jurisdictional annexes of Volume 2. Each planning partner has individually reviewed existing local plans, studies, reports, and technical information in its jurisdictional annex, presented in Volume 2.

FEDERAL

Americans with Disabilities Act

The Americans with Disabilities Act (ADA) seeks to prevent discrimination against people with disabilities in employment, transportation, public accommodation, communications, and government activities. Title II of the ADA deals with compliance with the Act in emergency management and disaster-related programs, services, and activities. It applies to state and local governments as well as third parties, including religious entities and private nonprofit organizations.

The ADA has implications for sheltering requirements and public notifications. During an emergency alert, officials must use a combination of warning methods to ensure that all residents have all necessary information. Those with hearing impairments may not hear radio, television, sirens, or other audible alerts, while those with visual impairments may not see flashing lights or other visual alerts. Two technical documents for shelter operators address physical accessibility needs of people with disabilities, as well as medical needs and service animals.

The ADA intersects with disaster preparedness programs in regards to transportation, social services, temporary housing, and rebuilding. Persons with disabilities may require additional assistance in evacuation and transit (e.g., vehicles with wheelchair lifts or paratransit buses). Evacuation and other response plans should address the unique needs of residents. Local governments may be interested in implementing a special-needs registry to identify the home addresses, contact information, and needs for residents who may require more assistance.

FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

Bureau of Indian Affairs

The U.S. Bureau of Indian Affairs' (BIA's) Fire and Aviation Management National Interagency Fire Center provides wildfire protection, fire use and hazardous fuels management, and emergency rehabilitation on Indian forest and rangelands held in trust by the United States, based on fire management plans approved by the appropriate Indian Tribe.

Bureau of Land Management

The U.S. Bureau of Land Management (BLM) funds and coordinates wildfire management programs and structural fire management and prevention on BLM lands. BLM works closely with the Forest Service and state and local governments to coordinate fire safety activities. The Interagency Fire Coordination Center in Boise, Idaho serves as the center for this effort.

Civil Rights Act of 1964

The Civil Rights Act of 1964 prohibits discrimination based on race, color, religion, sex or nation origin and requires equal access to public places and employment. The Act is relevant to emergency management and hazard mitigation in that it prohibits local governments from favoring the needs of one population group over another. Local government and emergency response must ensure the continued safety and well-being of all residents equally, to the extent possible. FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

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, and 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. Numerous 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.

The CWA is important to hazard mitigation in several ways. There are often permitting requirements for any construction within 200 feet of water of the United States, which may have implications for mitigation projects identified by a local jurisdiction. Additionally, CWA requirements apply to wetlands, which serve important functions related to preserving and protecting the natural and beneficial functions of floodplains and are linked with a community’s floodplain management program. Finally, the National Pollutant Discharge Elimination System is part of the CWA and addresses local stormwater management programs. Stormwater management plays a critical role in hazard mitigation by addressing urban drainage or localized flooding issues within jurisdictions.

FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

Community Development Block Grant Disaster Resilience Program

In response to disasters, Congress may appropriate additional funding for the U.S. Department of Housing and Urban Development Community Development Block Grant programs to be distributed as Disaster Recovery grants (CDBG-DR). These grants can be used to rebuild affected areas and provide seed money to start the recovery process. CDBG-DR assistance may fund a broad range of recovery activities, helping communities and neighborhoods that otherwise might not recover due to limited resources. CDBG-DR grants often supplement disaster programs of FEMA, the Small Business Administration, and the U.S. Army Corps of Engineers. Housing and Urban Development generally awards noncompetitive, nonrecurring CDBG-DR grants by a formula that considers disaster recovery needs unmet by other federal disaster assistance programs. To be eligible for CDBG-DR funds, projects must meet the following criteria:

- Address a disaster-related impact (direct or indirect) in a presidentially declared county for the covered disaster
- Be a CDBG-eligible activity (according to regulations and waivers)
- Meet a national objective.

Incorporating preparedness and mitigation into these actions is encouraged, as the goal is to rebuild in ways that are safer and stronger. CDBG-DR funding is a potential alternative source of funding for actions identified in this plan.

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 discount partially depends on location of the property. Properties outside the special flood hazard area receive smaller discounts: a 10-percent discount if the community is at Class 1 to 6 and a 5-percent discount if the community is at Class 7 to 9. 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.

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.

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 Assistance grant funds are available to communities. This plan is designed to meet the requirements of DMA, improving eligibility for future hazard mitigation funds.

Emergency Relief for Federally Owned Roads Program

The U.S. Forest Service's Emergency Relief for Federally Owned Roads Program was established to assist federal agencies with repair or reconstruction of tribal transportation facilities, federal lands transportation facilities, and other federally owned roads that are open to public travel and have suffered serious damage by a natural disaster over a wide area or by a catastrophic failure. The program funds both emergency and permanent repairs (Office of Federal Lands Highway, 2016). Eligible activities under this program meet some of the goals and objectives for this plan and the program is a possible funding source for actions identified in this plan.

Emergency Watershed Program

The USDA Natural Resources Conservation Service (NRCS) administers the Emergency Watershed Protection (EWP) Program, which responds to emergencies created by natural disasters. Eligibility for assistance is not dependent on a national emergency declaration. The program is designed to help people and conserve natural resources by relieving imminent hazards to life and property caused by floods, fires, windstorms, and other natural occurrences. EWP is an emergency recovery program. Financial and technical assistance are available for the following activities (Natural Resources Conservation Service, 2016):

- Remove debris from stream channels, road culverts, and bridges
- Reshape and protect eroded banks
- Correct damaged drainage facilities
- Establish cover on critically eroding lands
- Repair levees and structures
- Repair conservation practices.

This federal program could be a possible funding source for actions identified in this plan.

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.

FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) cooperates with a large number of federal and state agencies to ensure and promote dam safety. More than 3,000 dams are part of regulated hydroelectric projects 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 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 engineer approved by the FERC must inspect and evaluate projects with dams higher than 32.8 feet (10 meters), or with a total storage capacity of more than 2,000 acre-feet.

FERC monitors seismic research and applies it in performing structural analyses of hydroelectric projects. FERC also evaluates the effects of potential and actual large floods on the safety of dams. During and following floods, FERC 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.

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.

National Environmental Policy Act

The National Environmental Policy Act requires federal agencies to consider the environmental impacts of proposed actions and reasonable alternatives to those actions, alongside technical and economic considerations. The National Environmental Policy Act established the Council on Environmental Quality, whose regulations (40 CFR Parts 1500-1508) set standards for compliance. Consideration and decision-making regarding environmental impacts must be documented in an environmental impact statement or environmental assessment. Environmental impact assessment requires the evaluation of reasonable alternatives to a proposed action, solicitation of input from organizations and individuals that could be affected, and an unbiased presentation of direct, indirect, and cumulative environmental impacts. FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

Federal Wildfire Management Policy and Healthy Forests Restoration Act

Federal Wildfire Management Policy and Healthy Forests Restoration Act (2003). These documents call for a single comprehensive federal fire policy for the Interior and Agriculture Departments (the agencies using federal fire management resources). They mandate community-based collaboration to reduce risks from wildfire.

National Dam Safety Act

Potential for catastrophic flooding due to dam failures led to passage of the National Dam Inspection Act in 1972, creation of the National Dam Safety Program in 1996, and reauthorization of the program through the Dam Safety Act in 2006. National Dam Safety Program, administered by FEMA requires a periodic engineering analysis of the majority of dams in the country; exceptions include the following:

- Dams under jurisdiction of the Bureau of Reclamation, Tennessee Valley Authority, or International Boundary and Water Commission
- Dams constructed pursuant to licenses issued under the Federal Power Act
- Dams that the Secretary of the Army determines do not pose any threat to human life or property.

The goal of this FEMA-monitored effort is to identify and mitigate the risk of dam failure so as to protect lives and property of the public. The National Dam Safety Program is a partnership among the states, federal agencies, and other stakeholders that encourages individual and community responsibility for dam safety. Under FEMA's leadership, state assistance funds have allowed all participating states to improve their programs through increased inspections, emergency action planning, and purchases of needed equipment. FEMA has also expanded existing and initiated new training programs. Grant assistance from FEMA provides support for improvement of dam safety programs that regulate most of the dams in the United States.

National Fire Plan (2001)

The 2001 National Fire Plan was developed based on the National Fire Policy. A major aspect of the National Fire Plan is joint risk reduction planning and implementation carried out by federal, state and local agencies and communities. The National Fire Plan presented a comprehensive strategy in five key initiatives:

- Firefighting—Be adequately prepared to fight fires each fire season.
- Rehabilitation and Restoration—Restore landscapes and rebuild communities damaged by wildfires.
- Hazardous Fuel Reduction—Invest in projects to reduce fire risk.
- Community Assistance—Work directly with communities to ensure adequate protection.
- Accountability—Be accountable and establish adequate oversight, coordination, program development, and monitoring for performance.

National Flood Insurance Program

The National Flood Insurance Program (NFIP) makes federally backed flood insurance available to homeowners, renters, and business owners in participating communities that enact floodplain regulations. Participation and good standing under NFIP are prerequisites to grant funding eligibility under the Robert T. Stafford Act.

For most participating communities, FEMA has prepared a detailed Flood Insurance Study. 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. Base flood elevations and the boundaries of the flood hazard areas are shown on Flood Insurance Rate Maps, which are the principle tool for identifying the extent and location of the flood hazard. Flood Insurance Rate Maps are the most detailed and consistent data source available, and for many communities they represent the minimum area of oversight under the local floodplain management program. In recent years, Flood Insurance Rate Maps have been digitized as Digital Flood Insurance Rate Maps, which are more accessible to residents, local governments and stakeholders.

NFIP participants 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 1-percent-annual-chance 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.

Humboldt County, City of Arcata, City of Blue Lake, City of Eureka, City of Ferndale, City of Fortuna, and City of Rio Dell all participate in the NFIP and have adopted and enforced floodplain management regulations that meet or exceed the requirements of the NFIP. At the time of the preparation of this plan, these jurisdictions were in good standing with NFIP requirements (FEMA Community Status Book Report accessed 06/28/2019). Full compliance and good standing under the NFIP are application prerequisites for all FEMA grant programs for which participating jurisdictions are eligible under this plan.

NFIP participation is limited to local governments that possess permit authority and have the ability to adopt and enforce regulations that govern land use. This does not typically apply to special purpose districts. None of the special purpose district planning partners covered by this plan are eligible to participate in the NFIP, so their action plans do not address NFIP participation.

National Incident Management System

The National Incident Management System (NIMS) is a systematic approach for government, nongovernmental organizations, and the private sector to work together to manage incidents involving hazards. The NIMS provides a flexible but standardized set of incident management practices. Incidents typically begin and end locally, and they are managed at the lowest possible geographical, organizational, and jurisdictional level. In some cases, success depends on the involvement of multiple jurisdictions, levels of government, functional agencies, and emergency responder disciplines. These cases necessitate coordination across a spectrum of organizations. Communities using NIMS follow a comprehensive national approach that improves the effectiveness of emergency management and response personnel across the full spectrum of potential hazards (including natural hazards, technological hazards, and human-caused hazards) regardless of size or complexity.

Although participation is voluntary, federal departments and agencies are required to make adoption of NIMS by local and state jurisdictions a condition to receive federal preparedness grants and awards. The content of this plan is considered to be a viable support tool for any phase of emergency management. The NIMS program is considered as a response function, and information in this hazard mitigation plan can support the implementation and update of all NIMS-compliant plans within the planning area.

National Park Service, Redwood National Park

The National Park Service (NPS) provides wildland and structure fire protection, and conducts wildfire management within its units. These activities are guided by the National Park Service Fire Management Plan.

Presidential Executive Order 11988, Floodplain Management

Executive Order 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. It requires federal agencies to provide leadership and take action to reduce the risk of flood loss, minimize the impact of floods on human safety, health, and welfare, and restore and preserve the natural and beneficial values of floodplains. The requirements apply to the following activities (FEMA, 2015a):

- Acquiring, managing, and disposing of federal lands and facilities
- Providing federally undertaken, financed, or assisted construction and improvements
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing.

Presidential Executive Order 11990, Protection of Wetlands

Executive Order 11990 requires federal agencies to provide leadership and take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands. The requirements apply to the following activities (National Archives, 2016):

- Acquiring, managing, and disposing of federal lands and facilities
- Providing federally undertaken, financed, or assisted construction and improvements
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing.

All actions identified in this plan will seek full compliance with all applicable presidential executive orders.

U.S. Army Corps of Engineers Dam Safety Program

The U.S. Army Corps of Engineers operates and maintains approximately 700 dams nationwide. It is also 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. The Corps maintains the National Inventory of Dams, which contains information about a dam's location, size, purpose, type, last inspection and regulatory status (U.S. Army Corps of Engineers, 2017).

U.S. Army Corps of Engineers Flood Hazard Management

The following U.S. Army Corps of Engineers authorities and programs related to flood hazard management:

- The Floodplain Management Services program offers 100-percent federally funded technical services such as development and interpretation of site-specific data related to the extent, duration and frequency of flooding. Special studies may be conducted to help a community understand and respond to flood risk. These may include flood hazard evaluation, flood warning and preparedness, or flood modeling.
- For more extensive studies, the Corps of Engineers offers a cost-shared program called Planning Assistance to States and Tribes. Studies under this program generally range from $25,000 to $100,000 with the local jurisdiction providing 50 percent of the cost.
- The Corps of Engineers has several cost-shared programs (typically 65 percent federal and 35 percent non-federal) aimed at developing, evaluating and implementing structural and non-structural capital projects to address flood risks at specific locations or within a specific watershed:
  - The Continuing Authorities Program for smaller-scale projects includes Section 205 for Flood Control, with a $7 million federal limit and Section 14 for Emergency Streambank Protection with a $1.5 million federal limit. These can be implemented without specific authorization from Congress.
  - Larger scale studies, referred to as General Investigations, and projects for flood risk management, for ecosystem restoration or to address other water resource issues, can be pursued through a specific authorization from Congress and are cost-shared, typically at 65 percent federal and 35 percent non-federal.
  - Watershed management planning studies can be specifically authorized and are cost-shared at 50 percent federal and 50 percent non-federal.
- The Corps of Engineers provides emergency response assistance during and following natural disasters. Public Law 84-99 enables the Corps to assist state and local authorities in flood fight activities and cost share in the repair of flood protective structures. Assistance is provided in the flowing categories:
  - Preparedness—The Flood Control and Coastal Emergency Act establishes an emergency fund for preparedness for emergency response to natural disasters; for flood fighting and rescue operations; for rehabilitation of flood control and hurricane protection structures. Funding for Corps of Engineers emergency response under this authority is provided by Congress through the annual Energy and Water Development Appropriation Act. Disaster preparedness activities include coordination, planning, training and conduct of response exercises with local, state and federal agencies.
  - Response Activities—Public Law 84-99 allows the Corps of Engineers to supplement state and local entities in flood fighting urban and other non-agricultural areas under certain conditions (Engineering Regulation 500-1-1 provides specific details). All flood fight efforts require a project cooperation agreement signed by the public sponsor and the sponsor must remove all flood fight material after the flood has receded. Public Law 84-99 also authorizes emergency water support and drought assistance in certain situations and allows for "advance measures" assistance to prevent or reduce flood damage conditions of imminent threat of unusual flooding.
  - Rehabilitation—Under Public Law 84-99, an eligible flood protection system can be rehabilitated if damaged by a flood event. The flood system would be restored to its pre-disaster status at no cost to the federal system owner, and at 20-percent cost to the eligible non-federal system owner. All systems considered eligible for Public Law 84-99 rehabilitation assistance have to be in the Rehabilitation and Inspection Program prior to the flood event. Acceptable operation and maintenance by the public levee sponsor are verified by levee inspections conducted by the Corps on a regular basis. The Corps has the responsibility to coordinate levee repair issues with interested federal, state, and local agencies following natural disaster events where flood control works are damaged.

These authorities and programs are all available to the planning partners to support any related mitigation actions.

U.S. Fire Administration

There are federal agencies that provide technical support to fire agencies/organizations. For example, the U.S. Fire Administration, which is a part of FEMA, provides leadership, advocacy, coordination, and support for fire agencies and organizations.

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service fire management strategy uses prescribed fire to maintain early successional fire-adapted grasslands and other ecological communities throughout the National Wildlife Refuge system.

U.S. Forest Service Six Rivers National Forest

The U.S. Forest Service role in wildfire management is focused on National Forest lands. However, Forest Service personnel will respond to wildland and structural fires on adjacent lands through mutual aid agreements when crews and equipment are available. Forest Service fire stations are not staffed outside of fire season.

STATE

AB 32: The California Global Warming Solutions Act

This bill identifies the following potential adverse impacts of global warming:

> "… the exacerbation of air quality problems, a reduction in the quality and supply of water to the state from the Sierra snowpack, a rise in sea levels resulting in the displacement of thousands of coastal businesses and residences, damage to marine ecosystems and the natural environment, and an increase in the incidences of infectious diseases, asthma, and other human health-related problems."

AB 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 has 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.

AB 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.

AB 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 state Department of Water Resources (DWR). During the next revision of the housing element on or after January 1, 2009, the conservation element of the general plan must identify rivers, creeks, streams, flood corridors, riparian habitat, and land that may accommodate floodwater for the purpose 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, and the Governor's Office of Emergency Services (Cal OES)
- Historical data on flooding
- Existing and planned development in flood hazard zones.

The general plan must establish goals, policies and objectives related to 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.

AB 162 establishes goals, policies and objectives related to flooding risks. It establishes procedures for the determination of available land suitable for urban development, which may exclude lands where FEMA or DWR has concluded that the flood management infrastructure is not adequate to avoid the risk of flooding.

AB 747: Required Information for General Plan Safety Elements

This bill requires California communities with general plans to address evacuation routes in the safety element of the general plan. Information on the evacuation routes and their capacity, safety and viability under a range of emergency scenarios must be provided. For communities that have not adopted a local hazard mitigation plan, the safety element must be updated with this information by January 1, 2022. For those with a local hazard mitigation plan, the requirement applies upon the next revision of the hazard mitigation plan on or after January 1, 2022. Communities that have adopted a local hazard mitigation plan, emergency operations plan, or other document that fulfills the goals and objectives of this law may comply with this requirement by summarizing and incorporating by reference the other plan or document in the safety element.

In subsequent revisions to the safety element, communities also will be required to identify new information relating to flood and fire hazards and climate adaptation and resiliency strategies applicable to the city or county that was not available during the previous revision of the safety element. These subsequent updates must occur upon each revision of the general plan housing element or local hazard mitigation plan and not less than once every eight years.

AB 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 this legislation. In addition, this bill requires Cal OES to give preference for federal mitigation funding to cities and counties that have adopted local hazard mitigation plans. The intent of the bill is to encourage cities and counties to create and adopt hazard mitigation plans.

AB 2800: Climate Change—Infrastructure Planning

This California State Assembly bill passed in 2016 and until July 1, 2020, requires state agencies to take into account the current and future impacts of climate change when planning, designing, building, operating, maintaining, and investing in state infrastructure. The bill, by July 1, 2017, and until July 1, 2020, requires an agency to establish a Climate-Safe Infrastructure Working Group to examine how to integrate scientific data concerning projected climate change impacts into state infrastructure engineering.

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was enacted in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. The Alquist-Priolo Earthquake Fault Zoning Act's main purpose is to prevent construction of buildings used for human occupancy on the surface trace of active faults. Before a new project is permitted, cities and counties require a geologic investigation to demonstrate that proposed buildings will not be constructed on active faults. The act addresses only the hazard of surface fault rupture and is not directed toward other earthquake hazards, such as liquefaction or seismically induced landslides. The law requires the State of California Geologist to establish regulatory zones around the surface traces of active faults and to issue appropriate maps. The maps are distributed to all affected cities, counties, and state agencies for their use in planning and controlling new or renewed construction. Local agencies must regulate most development projects within the zones. Projects include all land divisions and most structures for human occupancy. All seismic hazard mitigation actions identified in this plan will seek full compliance with the Alquist-Priolo Earthquake Fault Zoning Act.

California Coastal Management Program

The California Coastal Management Program under the California Coastal Act requires each city or county lying wholly or partly within the coastal zone to prepare a local coastal plan. The specific contents of such plans are not specified by state law, but they must be certified by the Coastal Commission as consistent with policies of the Coastal Act (Public Resources Code, Division 20). The Coastal Act has provisions relating to geologic hazards, but does not mention tsunamis specifically. Section 30253(1) of the Coastal Act states that new development shall minimize risks to life and property in areas of high geologic, flood, and fire hazard. Development should be prevented or limited in high hazard areas whenever possible. However, where development cannot be prevented or limited, land use density, building value, and occupancy should be kept at a minimum. Any mitigation project identified in this plan that intersects the mapped coastal zone will be consistent with the recommendations of the local coastal plan.

California Department of Forestry and Fire Protection

CAL FIRE has responsibility for wildfires in areas of the county that are not under the jurisdiction of the Forest Service or a local fire organization, including lands designated as State Responsibility Areas. CAL FIRE also has fire protection responsibilities by contract and mutual aid agreements. For example, CAL FIRE provides year-round fire protection under Amador Plan agreements with certain local government agencies (Public Resources Code §4144). Through these agreements, CAL FIRE provides local structural and wildfire protection or dispatch services to a community and maintains a staffing level that otherwise would be available only during the fire season. The local entity pays the additional cost of the service.

California Department of Parks and Recreation (State Parks)

State Parks manages portions of the California coastline including coastal wetlands, estuaries, beaches, and dune systems. The State Parks Resources Management Division has limited wildfire protection resources available to suppress fires on State Park lands. State Parks does not operate a fire station in Humboldt County and relies on CAL FIRE as the primary wildfire protection resource for the lands under its management. State Parks cooperates with CAL FIRE and Redwood National Park on prescribed burns, and can provide limited mutual aid.

California Department Water Resources

In California, the DWR is the coordinating agency for floodplain management. The DWR works with FEMA and local governments by providing grants and technical assistance, evaluating community floodplain management programs, reviewing local floodplain ordinances, participating in statewide flood hazard mitigation planning, and facilitating annual statewide workshops. Compliance is monitored by FEMA regional staff and by the DWR.

California Division of Safety of Dams

California's Division of Safety of Dams (a division of the DWR) monitors the dam safety program at the state level and maintains a working list of dams in the state. When a new dam is proposed, Division engineers and geologists inspect the site and the subsurface. Upon submittal of an application, the Division reviews the plans and specifications prepared by the owner to ensure that the dam is designed to meet minimum requirements and that the design is appropriate for the known geologic conditions. After approval of the application, the Division inspects all aspects of the construction to ensure that the work is done in accordance with the approved plans and specifications. After construction, the Division inspects each dam to ensure that it is performing as intended and is not developing problems. 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. Over 1,200 dams are inspected by Division engineers on a yearly schedule to ensure performance and maintenance of dams (California Division of Safety of Dams, 2017).

California Environmental Quality Act

The California Environmental Quality Act (CEQA) was passed in 1970, shortly after the federal government enacted the National Environmental Policy Act, 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.

CEQA establishes a statewide environmental policy and mandates actions all state and local agencies must take to advance the policy. Jurisdictions conduct analysis of the project to determine if there are potentially significant environmental impacts, identify mitigation measures, and possible project alternatives by preparing environmental reports for projects that requires CEQA review. This environmental review is required before an agency takes action on any policy, program, or project. Any project action identified in this plan will seek full CEQA compliance upon implementation.

California Fire Alliance

The California Fire Alliance (CFA) was established in response to directives from the 2001 National Fire Plan. The CFA pursues four strategies to deal with the National Fire Plan's community assistance initiative:

- Work with communities at risk from wildfires to develop community-based planning leadership and facilitate the development of community fire loss mitigation plans, which transcend jurisdiction and ownership boundaries.

- Assist communities in development of fire loss mitigation planning, education and projects to reduce the threat of wildfire losses on public and private lands.
- Develop an information and education outreach plan to increase awareness of wildfire protection program opportunities available to communities at risk.
- Work collaboratively to develop, modify and maintain a comprehensive list of communities at risk.

California Fire Plan

The State Board of Forestry and CAL FIRE have prepared a comprehensive update of the California Fire Plan for wildfire protection. The planning process included defining a level of service measurement; considering assets at risk; incorporating the cooperative interdependent relationships of wildfire protection providers; providing for public stakeholder involvement; and creating a fiscal framework for policy analysis. The California Fire Plan's overall goal is to reduce costs and losses from wildfire in the state by protecting assets at risk through pre-fire management and by reducing the spread of fire through more successful initial response.

California Fire Safe Council

In 1993, the statewide Fire Safe Council, consisting of private and public membership, was formed to educate and encourage Californians to plan and prepare for wildfires by reducing the risk of fire to property, communities, and natural/structural resources. In 2002, this group created a nonprofit organization and board of directors, called the California Fire Safe Council. The Council works with the California Fire Alliance to facilitate the distribution of National Fire Plan grants for wildfire risk reduction and education (www.grants.firesafecouncil.org). The Council also provides assistance to local Fire Safe Councils through its website (www.firesafecouncil.org), the distribution of educational materials, and technical assistance, primarily through regional representatives. More than 130 local Fire Safe Councils have formed in California to plan, coordinate, and implement fire prevention activities.

California Fire Service and Rescue Emergency Mutual Aid Plan

The Governor's Office of Emergency Services Fire and Rescue Branch administers the California Fire Service and Rescue Emergency Mutual Aid Plan. The agency provides guidance and procedures for agencies developing emergency operations plans, as well as training and technical support, primarily to overall emergency service organizations and urban search and rescue teams.

California General Planning Law

California state law requires that every county and city prepare and adopt a comprehensive long-range plan to serve as a guide for community development. The general plan expresses the community's goals, visions, and policies relative to future land uses, both public and private. The general plan is mandated and prescribed by state law (Cal. Gov. Code §65300 et seq.), and forms the basis for most local government land use decision-making.

The plan must consist of an integrated, internally consistent set of goals, policies, and implementation measures. In addition, the plan must focus on issues of the greatest concern to the community and be written in a clear and concise manner. City and county actions, such as those relating to land use allocations, annexations, zoning, subdivision and design review, redevelopment, and capital improvements, must be consistent with the plan.

California Multi-Hazard Mitigation Plan

Under the DMA, California must adopt a federally approved state multi-hazard mitigation plan to be eligible for certain disaster assistance and mitigation funding. The intent of the State of California Multi-Hazard Mitigation Plan is to reduce or prevent injury and damage from hazards in the state 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 mitigation strategies for the future. It also establishes hazard mitigation goals and objectives. The plan will be reviewed and updated annually to reflect changing conditions and new information, especially information on local planning activities.

Under 44 CFR Section 201.6, local hazard mitigation plans must be consistent with their state's hazard mitigation plan. In updating this plan, the Steering Committee reviewed the California State Hazard Mitigation Plan to identify key relevant state plan elements (see Section 3.7).

California Residential Mitigation Program

The California Residential Mitigation Program was established in 2011 to help Californians strengthen their homes against damage from earthquakes. The program is a joint powers authority created by Cal OES and the California Earthquake Authority, which is a not-for-profit, publicly managed, privately funded provider of home earthquake insurance to California homeowners and renters.

Earthquake Brace + Bolt was developed to help homeowners lessen the potential for damage to their houses during an earthquake. A residential seismic retrofit strengthens an existing older house, making it more resistant to earthquake activity such as ground shaking and soil failure. The seismic retrofitting involves bolting the house to its foundation and adding bracing around the perimeter of the crawl space. Most homeowners hire a contractor to do the retrofit work, and owners of houses in ZIP Codes with house characteristics suitable for this type of retrofit are eligible for up to $3,000 toward the cost. A typical retrofit by a contractor may cost between $3,000 and $7,000, depending on the location and size of the house, contractor fees, and the amount of materials and work involved. If the homeowner is an experienced do-it-yourselfer, a retrofit can cost less than $3,000.

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 the 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.

On January 1, 2014, California Building Code Accessibility Standards found in Chapter 11B incorporated the 2010 Americans with Disabilities Act (ADA) Standards as the model accessibility code for California. The purpose was to ensure consistency with federal guidelines. As a result of this incorporation, the California standards will fully implement and include 2010 ADA Standards within the California Building Code while maintaining enhanced levels of accessibility already provided by existing California accessibility regulations. All planning partners that have building code and permit authority have adopted building codes that are in full compliance with the California State Building Code.

Disadvantaged and Low-income Communities Investments

Senate Bill (SB) 535 directs state and local agencies to make investments that benefit California's disadvantaged communities. It also directs the California Environmental Protection Agency to identify disadvantaged communities for the purposes of these investments based on geographic, socio-economic, public health, and environmental hazard criteria. Assembly Bill (AB) 1550 increased the percent of funds for projects located in disadvantaged communities from 10 to 25 percent and added a focus on investments in low-income communities and households. This program is a potential alternative source of funding for actions identified in this plan.

Division of the State Architect's AB 300 List of Seismically At-Risk Schools

In 2002, California's Division of the State Architect completed an inventory of public school buildings built before 1978 that identifies buildings with characteristics that might make them unsafe in future earthquakes. This inventory provides a list of potentially at-risk schools known as the AB 300 list (the inventory was authorized by Assembly Bill 300 in 1999). Using available information on school buildings' dates of construction, seismic retrofits, and structural systems (wood-frame, concrete shear wall, or steel moment frame, etc.), the inventory categorized California public school buildings into one of two categories: those expected to perform well in future earthquakes; and those that are not expected to perform well and require more detailed seismic evaluation.

The Division of the State Architect recommends that public schools on this list undergo detailed seismic evaluations to determine if they pose life safety risks, but the state has neither required nor funded school districts to do this.

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. 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.

Office of the State Fire Marshal

The Office of the State Fire Marshal is a division of CAL FIRE that has a wide variety of fire safety and training responsibilities and provides technical support to fire agencies/organizations.

Senate Bill 97: Guidelines for Greenhouse Gas Emissions

Senate Bill 97, enacted in 2007, amends CEQA to clearly establish that greenhouse gas emissions and the effects of greenhouse gas emissions 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 by July 1, 2009 and directs the California Natural Resources Agency to certify and adopt the CEQA Guidelines by January 1, 2010.

Senate Bill 379: General Plans: Safety Element—Climate Adaptation

Senate Bill 379 builds upon the flood planning inclusions into the safety and housing elements and the hazard mitigation planning safety element inclusions in general plans outlined in AB 162 and AB 2140, respectively. SB 379 focuses on a new requirement that cities and counties include climate adaptation and resiliency strategies in the safety element of their general plans beginning January 1, 2017. In addition, this bill requires general plans to include a set of goals, policies and objectives, and specified implementation measures based on the conclusions drawn from climate adaptation research and recommendations.

Senate Bill 1000: General Plan Amendments—Safety and Environmental Justice Elements

In 2016, Senate Bill 1000 amended California's Planning and Zoning Law in two ways:

- The original law established requirements for initial revisions of general plan safety elements to address flooding, fire, and climate adaptation and resilience. It also required subsequent review and revision as necessary based on new information. Senate Bill 1000 specifies that the subsequent reviews and revision based on new information are required to address only flooding and fires (not climate adaptation and resilience).
- Senate Bill 1000 adds a requirement that, upon adoption or revision of any two other general plan elements on or after January 1, 2018, an environmental justice element be adopted for the general plan or environmental justice goals, policies and objectives be incorporated into other elements of the plan.

Senate Bill 1241: General Plans: Safety Element—Fire Hazard Impacts

In 2012, Senate Bill 1241 passed requiring that the safety elements of all future general plans address fire risk in state responsibility areas and very high fire hazard severity zones. The bill requires cities and counties to make findings regarding available fire protection and suppression services before approving a tentative map or parcel map.

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 by December 1, 1996, to be eligible for state funding of response-related personnel costs under CCR Title 19 (Sections 2920, 2925 and 2930). The roles and responsibilities of Individual agencies contained in existing laws or the state emergency plan are not superseded by these regulations. This hazard mitigation plan is considered to be a support document for all phases of emergency management, including those associated with SEMS.

Western Governors Association Ten-Year Comprehensive Strategy

The Western Governors Association Ten-Year Comprehensive Strategy: A Collaborative Approach for Reducing Wildfire Risks to Communities and the Environment (August 2001),

Humboldt County Operational Area Hazard Mitigation Plan 2019

Appendix C. Risk Assessment Results

C. Risk Assessment Results

Insert PDF

Appendix D. Plan Adoption Resolutions from Planning Partners

D. PLAN ADOPTION RESOLUTIONS FROM PLANNING PARTNERS

To Be Provided With Final Draft