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COUNTY OF CHELAN

Multi-Jurisdiction Natural Hazard Mitigation Plan

Volume 1: Planning-Area-Wide Elements

2019 Plan Update
Public Review Draft, June 2019

TETRA TECH

Chelan County Multi-Jurisdiction Natural Hazard Mitigation Plan

Volume 1—Area-Wide Elements

June 2019

PREPARED FOR

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This document should be cited as:

Chelan County. 2018. *Chelan County Multi-Jurisdiction Natural Hazard Mitigation Plan; 2018 Plan Update.* Chelan County Natural Resources Department. Wenatchee, Washington.

Tetra Tech Project #103S5825

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ACKNOWLEDGMENTS

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- To be completed

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- Mike Cushman—Cascadia Conservation District
- Lilith Vespier—City of Leavenworth
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Special Acknowledgments

The development of this plan would not have been possible without the dedication and commitment to the process by the Stakeholder Steering Committee. The dedication of the steering committee volunteers who graciously allocated their time to this process is greatly appreciated. In addition to the Stakeholders Steering Committee's effort, the Chelan County Hazard Mitigation Plan would not be possible without the citizens of Chelan County.

EXECUTIVE SUMMARY

To Be Completed

Part 1. BACKGROUND AND METHODS

1. INTRODUCTION TO HAZARD MITIGATION PLANNING

1.1 ABOUT HAZARD MITIGATION

1.1.1 What Is It?

As the cost of disasters continues to rise, communities must find ways to reduce hazard risks. The term “hazard mitigation” refers to actions that reduce or eliminate long-term risks caused by hazards such as earthquakes, floods, storms, and wildfires. It involves strategies such as planning, policy changes, programs, projects, and other activities that can mitigate the impacts of hazards. Without an investment in hazard mitigation, repeated disasters result in repeated damage and rebuilding. This recurrent reconstruction becomes more expensive as the years go by. Hazard mitigation breaks this costly cycle of damage and reconstruction by taking a long-term view of rebuilding and recovering from disasters.

1.1.2 When Does It Apply?

The federal Disaster Mitigation Act (DMA) of 2000 requires state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. The DMA emphasizes planning for disasters before they occur. However, hazard mitigation is also essential to post-disaster recovery. After disasters, repairs and reconstruction often just restore damaged property to pre-disaster conditions. The implementation of additional hazard mitigation actions leads to building smarter, safer, and more resilient communities that are better able to reduce future injuries and damage.

1.1.3 Who Is Responsible?

The responsibility for hazard mitigation lies with private property owners; business and industry; and local, state and federal governments. The Federal Emergency Management Agency (FEMA) encourages multi-jurisdictional planning under its guidance for the DMA, urging state and local authorities to work together on pre-disaster planning. The enhanced planning network called for by the DMA helps local governments articulate accurate needs for mitigation, resulting in faster allocation of funding and more cost-effective risk reduction projects. One of the benefits of multi-jurisdictional planning is the ability to pool resources and eliminate redundant activities within a planning area that has uniform risk exposure and vulnerabilities.

1.1.4 How Is It Developed and Implemented?

The DMA promotes sustainability for disaster resistance. “Sustainable hazard mitigation” includes the sound management of natural resources and the recognition that hazards, and mitigation must be understood in the largest possible social and economic context. Efforts to reduce risks should be compatible with other community goals, which may be related to economic development, sustainability, public and environmental health, or other issues. As communities plan for new development and improvements to existing infrastructure, mitigation should be an important consideration.

1.2 HAZARD MITIGATION FOR CHELAN COUNTY

The Chelan County Emergency Management Council (EMC) led the development of the initial Chelan County Natural Hazard Mitigation Plan in 2004 and again led the development of an update in 2011. The EMC consists of the Chelan County Commissioners, Chelan County Sheriff, and mayors from incorporated cities in the county. The Chelan County Natural Hazards Mitigation Plan is multi-jurisdictional and satisfies the DMA’s natural hazard mitigation planning requirements for Chelan County its partner cities. The natural hazard mitigation strategies contained within the initial plan and previous update are the result of a planning process involving local jurisdictions, special purpose districts, and a cross-section of the business community and citizens.

The 2018 update to the *Chelan County Multi-Jurisdiction Natural Hazard Mitigation Plan* updates the identification of resources and strategies for reducing risk from natural hazards. Strategies were selected because they meet a program requirement and the needs of the planning partners and their residents. The plan will help guide and coordinate mitigation activities throughout the planning area. The main purpose of the plan is to identify risks posed by hazards and to present strategies to reduce the impact of hazard events. The plan also meets the following objectives:

- Meet or exceed requirements of the DMA.
- Enable all planning partners to use federal grant funding to reduce risk through mitigation.
- Meet the needs of each planning partner.
- Create a risk assessment that focuses on Chelan County hazards of concern.
- Create a single planning document that integrates all planning partners into a framework that supports partnerships within the county and puts all partners on the same planning cycle for future updates.
- Coordinate existing plans and programs so that high-priority actions and projects to mitigate possible disaster impacts are funded and implemented.

1.3 WHO WILL BENEFIT FROM THIS PLAN?

Effective hazard mitigation can provide the following benefits:

- Reduce the loss of life, property, essential services, critical facilities, and economic hardship
- Reduce short-term and long-term recovery and reconstruction costs
- Increase cooperation and communication within the community through the planning process
- Increase potential for state and federal funding for pre- and post-disaster projects.

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

1.4 HOW TO USE THIS PLAN

In order to fulfill the requirements of the DMA and be eligible for federal disaster funding grant programs, a local hazard mitigation plan must contain a set of information as outlined in the Code of Federal Regulations (see box at right). The *Chelan County Multi-Jurisdiction Natural Hazard Mitigation Plan* has been organized to provide all the required information. Notations are provided throughout the plan indicating specific requirements being addressed.

REQUIRED CONTENT FOR LOCAL HAZARD MITIGATION PLANS (44 CFR 201.6(c))

1. Documentation of the process used to develop the plan, including who was involved and how the public was involved.

2. A risk assessment that provides the following information:

- A description of the type, location, and extent of all natural hazards that can affect the jurisdiction, previous occurrences of hazard events, and the probability of future hazard events.
- A description of the jurisdiction's vulnerability to the hazards in terms of:
  - □ Buildings, infrastructure and critical facilities located in hazard areas
  - □ Potential dollar losses
  - □ Development trends and the ability to consider mitigation in land use decisions.
- Assessment of each participating jurisdiction's risks where they vary from those of the entire planning area.

3. A mitigation strategy for reducing potential losses identified in the risk assessment:

- A description of mitigation goals.
- A range of mitigation actions and projects to consider.
- An action plan for each participating jurisdiction recommending and prioritizing specific mitigation actions.

4. A plan maintenance process that includes:

- A schedule for monitoring, evaluating, and updating the mitigation plan.
- A process for incorporating the requirements of the mitigation plan into other local planning mechanisms.
- A plan for ongoing public participation.

5. Documentation that the plan has been formally adopted by the governing body of each jurisdiction requesting approval of the 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, countywide hazard risk assessment, countywide mitigation actions, and a plan maintenance strategy. The following appendices at the end of Volume 1 include supporting information:
  - ➢ Appendix A—Public involvement materials
  - ➢ Appendix B—Summary of federal and state programs and laws
  - ➢ Appendix C—Concepts and methods used for hazard mapping
  - ➢ Appendix D—Detailed risk assessment results
  - ➢ Appendix E—Plan adoption resolutions from Planning Partners
- **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 that each jurisdiction agreed to, 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.

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

In order to integrate various hazard planning activities, the Chelan County EMC chose to lead the development of the initial *Chelan County Multi-Jurisdiction Natural Hazard Mitigation Plan* in 2004 and the update in 2011. The update followed guidelines provided by *FEMA 386-8: Multijurisdictional Mitigation Planning* (August 2006), FEMA's *Local Multi-Hazard Mitigation Planning Guidance* (July 2008), and other FEMA guidance.

The 2011 update was written using the best available information obtained from a wide variety of sources, including the Chelan County Comprehensive Plan, the Chelan County Hazard Inventory and Vulnerability Assessment, the City of Wenatchee Hazard Inventory and Vulnerability Assessment, the Washington State Hazard Risk Assessment (Draft), professional judgment from a wide array of qualified contributors, and local officials and their representatives. Throughout the update process, a concerted effort was made by the planning committee to gather information from participating agencies, stakeholders, business and industry, and the citizens of Chelan County, especially those with specific knowledge of natural hazards and past historical events, as well as planning and zoning codes and ordinances and recent planning decisions.

The mission statement of the initial and updated plans was as follows:

> To promote sound public policy designed to protect citizens, critical facilities, infrastructure, private property and the environment from natural hazards by increasing public awareness, documenting the resources for risk reduction and loss-prevention, and identifying activities to guide Chelan County towards building a safer, more sustainable community.

The 2011 update found that communities in Chelan County are subject to flooding, earthquake, severe storms, landslide, drought, wildfire, seiche, and avalanche. Wildfire, flooding, severe storms, drought, and earthquake were identified as the predominant hazard risks.

The mitigation strategy outlined actions to address natural hazard disasters. From developing disaster response plans to encouraging landowners through incentive programs to avoid disaster areas, the plan covers a breadth of activities that would mitigate the effects of natural disasters. The update made minor adjustments to the initial plan's mitigation strategy to more accurately reflect current approaches to address natural hazard disasters.

Updated jurisdiction-specific sub-plans provided a focused and strategic approach to addressing natural hazard risks in the cities of Cashmere, Chelan, Entiat, Leavenworth, and Wenatchee and the unincorporated areas of Chelan County. These sub-plans provide a close look at the demographics, critical facilities, development trends, and vulnerabilities of the cities in Chelan County. The unincorporated areas sub-plan documents extensively the community assets in rural Chelan County and relies on the larger mitigation strategy for mitigation actions.

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 7.7-percent increase in population between 2008 and 2018, an average annual growth rate of 0.81 percent per year during that time frame. The County and cities within Chelan County have comprehensive 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 County and city annexes in Volume 2 of this plan.

Please note that the changes in risk assessment results between the 2010 plan and the 2018 plan are significant. The Planning Team believe that 2010 plan was an overestimation and 2018 plan is an underestimation and this results from the differing methodologies the availability of better data to support the risk assessment. Therefore, performing a comparative analysis between the two risk assessments would result in a false reading in change of risk due to new developments.

2.2.3 New Analysis Capabilities

The risk assessment for the 2010 plan was based solely on qualitative analyses. No building count data or loss estimates were provided the identified hazards of concern. 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, and wildfire. 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.

2.3 THE UPDATED PLAN—WHAT IS DIFFERENT?

The updated plan differs from the initial plan in a variety of ways:

- The planning partnership was expanded to include cities and special purpose districts.
- The hazards of concern focus on natural hazards and were expanded to include drought, seiche, dam failure, and climate change.

- A Level-2 Hazus analysis forms the basis of risk assessment for the flood, wildfire, earthquake and dam failure hazards.
- A critical facilities and infrastructure database were developed and used in the risk assessment.
- The goals were reviewed and updated.
- Each participating jurisdiction developed an annex to the plan with jurisdiction-specific information including hazard risk ranking and mitigation actions.

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 2010 planning process engaged the public through a series of Public Workshops. The plan did not include any real dialogue on that process, but it did provide copies of workshop notices in Appendix A of the Plan.	The plan development process deployed for this update differed significantly from that of the 2010 planning effort. A public engagement strategy was identified by the Steering Committee that included the following outreach efforts: • Press releases on the planning process, public meetings and final public comment period • A hazard mitigation survey • 2 rounds of public meeting. The 1st round was early in the process to gauge the public's perception of risks and the 2nd round was to present the draft plan.
§201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.	The 2010 plan provides a characteristic assessment of eight identified hazards of concern. The risk assessment provided the following information for each hazard: • Definition and types • Occurrence • Vulnerability • Probability of recurrence	The updated plan includes a comprehensive risk assessment eight hazards of concern. Risk has been defined as (probability x impact), where impact is the impact on people, property and economy of the planning area. All planning partners ranked risk as it pertains to their jurisdiction. The potential impacts of climate change are discussed for each hazard.
§201.6(c)(2)(i): [The risk assessment shall include a] description of the … location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.	The characteristic assessment of the 8 hazards of concern in the 2010 plan did discuss the extent and location of each hazard qualitatively. No maps were included in the plan. Previous occurrences were also included for each hazard.	Volume 1 Part 2 presents a risk assessment of each hazard of concern. Each hazard chapter includes the following components: • Hazard profile, including maps of extent and location, historical occurrences, frequency, severity, and warning time • Secondary hazards • Climate change impacts • Exposure of people, property, critical facilities and environment • Vulnerability of people, property, critical facilities and environment • Future trends in development • Scenarios • Issues

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 subjectively assessed and described for all hazards of concern.	Vulnerability was assessed for all hazards of concern. The Hazus computer model was used for the dam failure, earthquake, and flood hazards, incorporating local data sets. Site-specific data on Steering Committee-identified critical facilities were entered into the Hazus model. Vulnerability was assessed for other hazards by applying varying damage percentages to an asset inventory extracted from Hazus.
§201.6(c)(2)(ii): [The risk assessment] must also address National Flood Insurance Program insured structures that have been repetitively damaged floods	The 2010 plan does not include repetitive damage information as the County had no repetitive loss properties identified by FEMA.	A qualifying repetitive loss section has been added to the 2019 plan update as the planning area has 6 repetitive loss properties.
§201.6(c)(2)(ii)(A): The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.	The 2010 plan does not include specific vulnerability information.	A complete inventory of the numbers and types of buildings exposed was generated for each hazard of concern. The Steering Committee defined and identified "critical facilities" for the planning area, and these facilities were inventoried by exposure. Each hazard chapter provides a discussion on future development trends.
§201.6(c)(2)(ii)(B): [The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) and a description of the methodology used to prepare the estimate.	The 2010 plan does not include loss estimation values.	Loss estimates were generated for all hazards of concern. These were generated by Hazus for the dam failure, earthquake, wildfire, and flood hazards. For the other hazards, loss estimates were generated by applying a regionally relevant damage function to the exposed inventory. In all cases, a damage function was applied to an asset inventory. The asset inventory was the same for all hazards and was generated in Hazus.
§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.	There is some discussion of future development trends as they pertain to each hazard of concern.	There is a discussion on future development trends as they pertain to each hazard of concern. This discussion looks predominantly at the existing land use and the current regulatory environment that dictates this land use.
§201.6(c)(3): The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.	The 2010 plan includes a mitigation strategy that applies to Chelan County and the cities of Cashmere, Chelan, Entiat, Leavenworth, and Wenatchee and provides the overall framework for mitigation actions within the County. In addition to the Mitigation Strategy, the cities have developed individual sub-plans that more specifically address their local concerns.	The plan contains a guiding principal, goals, objectives and actions. The guiding principal, goals and objectives are regional and cover all planning partners. Each planning partner identified actions that can be implemented within their capabilities. The actions are jurisdiction-specific and strive to meet multiple objectives. All objectives meet multiple goals and stand alone as components of the plan. Each planning partner completed an assessment of its regulatory, technical and financial capabilities.
§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 2010 plan identified 7 goals that were listed in priority order, 1 to 7.	The Steering Committee developed a new overall guiding principle for the plan and developed six (6) goals and eleven (11) objectives, as described in Chapter 20. The goals and objectives are specifically for this hazard mitigation plan and are completely new. They were identified based upon the capabilities of the Planning Partnership.

44 CFR Requirement	Previous Plan	Updated Plan
§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.	In the 2010 plan, the development of the mitigation strategy began with a review of FEMA mitigation goals and how they fit the goals specific to Chelan County. The Planning Team reviewed the risk assessment and policy and program analysis and identified mitigation actions which met the needs of the County.	Volume I, Part 3 includes a hazard mitigation catalog that was developed through a facilitated process. This catalog identifies actions that manipulate the hazard, reduce exposure to the hazard, reduce vulnerability, and increase mitigation capability. The catalog further segregates actions by scale of implementation. A table in the action plan chapter analyzes each action by mitigation type to illustrate the range of actions selected.
§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 identified an action to adopt the State's Model Floodplain Ordinance to prohibit/regulate future development in the floodplain.	All municipal planning partners that participate in the National Flood Insurance Program have identified an action stating their commitment to maintain compliance and good standing under the program.
§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 action was prioritized using a points system based on the objectives the project will meet.	Each of the recommended actions 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 21. The prioritization concept is entirely different from what was applied in the 2010 planning effort. Since each planning partner was asked to review all risks and prior actions, any action that was carried over to this plan from the prior plan had the opportunity to have its priority reviewed and if necessary, changed. Therefore, every risk and action in this plan, whether new or carried over from the prior plan, was prioritized as described in the introduction section of Volume 2.
§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 2010 plan details a plan maintenance strategy that involved a protocol for annual progress reporting by the Natural Hazards Mitigation Planning Committee and public outreach. The strategy identifies triggers for plan updates, integration with other plans and programs and identifies protocol for continuing public involvement.	The 2010 plan maintenance strategy was revised for this plan update. The planning partnership will be preparing bi-annual progress in years 2 and 4.
§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.	The 2010 plan details recommendations for incorporating the plan into other planning mechanisms such as: • Comprehensive Plan • Capital Improvement Programs • Municipal Code • County Emergency Operations Plan	Volume I, Part 3 details recommendations for incorporating the plan into other planning mechanisms, such as: • General plans • Emergency response plans • Capital improvement programs • Municipal codes Specific current and future, plan and program integration activities are detailed in each participating jurisdiction's annex in Volume 2.

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(c)(4)(iii): [The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.	The 2010 plan details a strategy for continuing public involvement. The strategy includes annual public meetings and plans kept for public review at various advertised locations.	Volume I, Part 3 details a comprehensive strategy for continuing public involvement.
§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).	Section I if the 2010 plan includes a section s for documentation of adoption of the plan.	All planning partners that fully met their “participation” requirements as defined by the planning process formally adopted the plan. Appendix E presents the resolutions of all planning partners that adopted this plan

3. PLAN UPDATE APPROACH

The approach to developing the *Chelan County Multi-Jurisdictional Natural Hazard Mitigation Plan* encouraged broad participation from many stakeholders. This chapter describes the activities carried out involved (as required by 44 CFR Section 201.6(c)(1)).

Plan preparation was largely funded by grants from FEMA's Pre-Disaster Mitigation (PDM) program and Hazard Mitigation Grant Program (HMGP). Chelan County Natural Resources Department applied for the grants in 2016 and 2017 and funding was appropriated in 2018. The grants covered 75 percent of the cost for developing the plan; the rest was funded by Chelan County and its planning partners.

GROUPS INVOLVED IN DEVELOPING THE HAZARD MITIGATION PLAN

Core Planning Team—The Tetra Tech consultant team and Chelan County Natural Resources Department staff responsible for the facilitation of the planning process and the development of the plan document.

Steering Committee—Representative members from the planning partnership that serve as the oversight body. They are responsible for many of the planning milestones and decisions prescribed for this process to help reduce the burden of time required by each planning partner.

Planning Partners—Municipalities or special purpose districts that are developing an annex to the multi-jurisdictional plan.

3.1 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.

3.2 FORMATION OF THE CORE PLANNING TEAM

Chelan County Natural Resources Department hired Tetra Tech, Inc. to assist with development and implementation of the plan and to provide subject-matter expertise to the overall planning process. A planning team formed to lead the planning effort included the following Chelan County and Tetra Tech staff:

- Hillary Heard, Chelan County Natural Resources Department Project Manager
- Mike Kaputa, Chelan County Natural Resources Department
- Rob Flaner, Tetra Tech, Project Manager
- Christina Wollman, Perteet, Lead Project Planner
- Carol Baumann, Tetra Tech, GIS Analyst and Risk Assessment Lead.

The Core Planning Team coordinated regularly throughout the course of the planning process to track plan development milestones and to develop the content for Steering Committee meetings. The team was principally responsible for the writing and formatting of this 2019 plan update

3.3 ESTABLISHMENT OF THE PLANNING PARTNERSHIP

Chelan County Natural Resources Department encouraged all eligible local governments to participate in this hazard mitigation planning process. The planning team invited all local governments to a planning partner kickoff meeting on June 12, 2018. This meeting was held to introduce the planning team, provide an overview of the mitigation planning process and solicit planning partners. Key objectives were as follows:

- Provide an overview of the Disaster Mitigation Act.
- Describe the reasons for a plan.
- Introduce the planning team.
- Outline the work plan.
- Outline planning partner expectations.
- Seek commitment to the planning partnership.
- Seek volunteers for the Steering Committee.
- Explain the role of Chelan County Natural Resources Department in maintaining the plan and the partnership.

Each jurisdiction wishing to join the planning partnership was asked to provide a “letter of intent to participate” that designated a primary and secondary 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 Chelan County plan 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
Chelan County	Kent Sisson	Emergency Manager
City of Wenatchee	John Ricardi	Utilities Manager
City of Leavenworth	Lilith Vespier	Development Services Manager
City of Chelan	Craig Gildroy	Planning Director
City of Entiat	Jim Brooks	
City of Cashmere	Steve Croci	Director of Operations
Fire District #1	Brian Brett	Fire Chief
Fire District #3	Dave Nalle	Deputy Fire Chief
Fire District #5	Arnold Baker	Fire Chief
Fire District #6	Phil Mosher	Fire Chief
Fire District #8	Mike Asher	Fire Chief
Fire District #9 (Lake Wenatchee Fire & Rescue)	Mick Lamar	Fire Chief
Chelan County Flood Control Zone District	Eric Pierson	Flood Control Zone District Administrator
Cascadia Conservation District	Mike Cushman	Program Manager
Lake Chelan Reclamation District	Rod Anderson	Manager

3.4 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 Chelan 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.

3.5 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 of 10 members 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		
Brian Brett [a]	Fire Chief	Fire District #1
John Ricardi [b]	Utilities Manager	City of Wenatchee
Jim Brooks		City of Entiat
Steve Croci	Director of Operations	City of Cashmere
Mike Cushman	Program Manager	Cascadia Conservation District
Lilith Vespier [c]	Development Services Manager	City of Leavenworth
Craig Gildroy	Planning Director	City of Chelan
Kent Sisson	Emergency Manager	Chelan County EM
Jason Detamore	Environmental Manager	Chelan County Flood Control Zone District
Mike Kaputa	Director	Chelan County Natural Resources Department
Designated Alternates		
John Riley		Fire District #1
Cliff Burdick		City of Wenatchee
Jim Fletcher	Mayor	City of Cashmere
Patrick Haggerty		Cascadia Conservation District
Herb Amick	Public Works Director	City of Leavenworth
John Alt		City of Entiat
Luis Gonzalez		City of Chelan
Stan Smoke		Chelan County EM
Eric Pierson	Public Works Director	Chelan County Flood Control Zone District
Hillary Heard		Chelan County Natural Resources Department

a. Chairperson
b. Vice-Chairperson.
c. Joel Walinski, City Administrator, transferred responsibilities to Lilith Vespier.

Leadership roles and ground rules were established during the Steering Committee's first meeting, on July 19, 2018. The Steering Committee then met on the third Thursday of every 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 seven (7) times from July 2018 through March 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.

3.6 COORDINATION WITH OTHER AGENCIES

Opportunities for involvement in the hazard mitigation 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)). This task was accomplished by the planning team as follows:

- **Planning Partnership Formation**—Eligible local jurisdictions in the planning area were invited to participate in the planning partnership. This included approximately 20 municipalities and special purpose districts, of which 15 submitted letters of intent to participate in the planning partnership.
- **Steering Committee Involvement**—Agency representatives were invited to participate on the Steering Committee. In addition to the agencies that ultimately agreed to serve on the committee, the following agencies and organizations were contacted regarding their participation, but were unable to participate:
    - Washington Emergency Management Division
    - Washington Department of Ecology
    - Washington Department of Natural Resources
    - FEMA Region X
- **Data Provision**—The following agencies were contacted during the course of the planning process to provide data or technical input:
    - Chelan County Flood Control Zone District
    - Washington Department of Natural Resources.
    - Washington Department of Ecology
- **Agency Notification**—The following agencies were kept apprised of planning milestones and invited to participate in the plan development through steering committee meeting reminders and monthly updates:
    - Washington Emergency Management Division
    - Washington Department of Ecology
    - Washington Department of Fish and Wildlife
    - Washington Department of Natural Resources
    - FEMA Region X
    - U.S. Forest Service
    - Washington Department of Transportation
    - National Weather Service
    - Cascadia Conservation District
    - Chelan-Douglas Land Trust

  These agencies received notices that included meeting announcements and meeting agenda. Many of these agencies supported the effort by attending meetings or by sending comments on the draft plan.
- **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 0). Each agency was sent an e-mail message informing them that draft portions of the plan were available for review.

Distribution lists for agency coordination are available upon request.

3.7 REVIEW OF EXISTING PROGRAMS

Hazard mitigation planning must include review and incorporation, if appropriate, of existing plans, studies, reports and technical information (44 CFR, Section 201.6(b)(3)). Chapter 5 of this plan provides a review of laws and ordinances in effect within the planning area that can affect hazard mitigation actions. In addition, the following programs can affect mitigation within the planning area:

- 2018, Washington State Hazard Mitigation Plan
- 2017, Chelan County Comprehensive Flood Hazard Management Plan
- Local capital improvement programs
- Local emergency operations plans
- Local comprehensive plans
- Housing elements of comprehensive plans
- Local zoning ordinances.

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.

3.8 PUBLIC INVOLVEMENT

Broad public participation in the planning process helps ensure that diverse points of view about the planning area's needs are considered and addressed. 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 strategy for involving the public in this plan update emphasized the following elements:

- Include members of the public on the Steering Committee.
- Use a questionnaire to determine if the public's perception of risk and support of hazard mitigation has changed since the initial planning process.
- Utilize/leverage existing public outreach efforts implemented by Chelan County
- Attempt to reach as many planning area citizens as possible using multiple media, including social media.
- Identify and involve planning area stakeholders.

3.8.1 Stakeholders and the Steering Committee

Stakeholders are the individuals, agencies and jurisdictions that have a vested interest in the recommendations of the hazard mitigation plan, including planning partners. All planning partners are stakeholders in the process. The diversity brought to the table by special purpose districts and private non-profit entities creates an opportunity to leverage partnerships between entities that typically do not work together in the field of hazard mitigation.

The effort to include stakeholders in this process included stakeholder participation on the Steering Committee. All members of the Steering Committee live or work in the planning area. Four members represented Chelan County Cities, and the balance represented State, federal or local sector interests. The Steering Committee met throughout the course of the plan's development, and all meetings were open to the public. Protocols for handling public comments were established in the ground rules developed by the Steering Committee.

3.8.2 Hazard Mitigation Plan Website

At the beginning of the plan development process, a website was created to keep the public posted on plan development milestones and to solicit relevant input (see Figure 3-1). The site's address (https://www.co.chelan.wa.us/natural-resources/pages/natural-hazard-mitigation-plan) 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. Chelan 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.

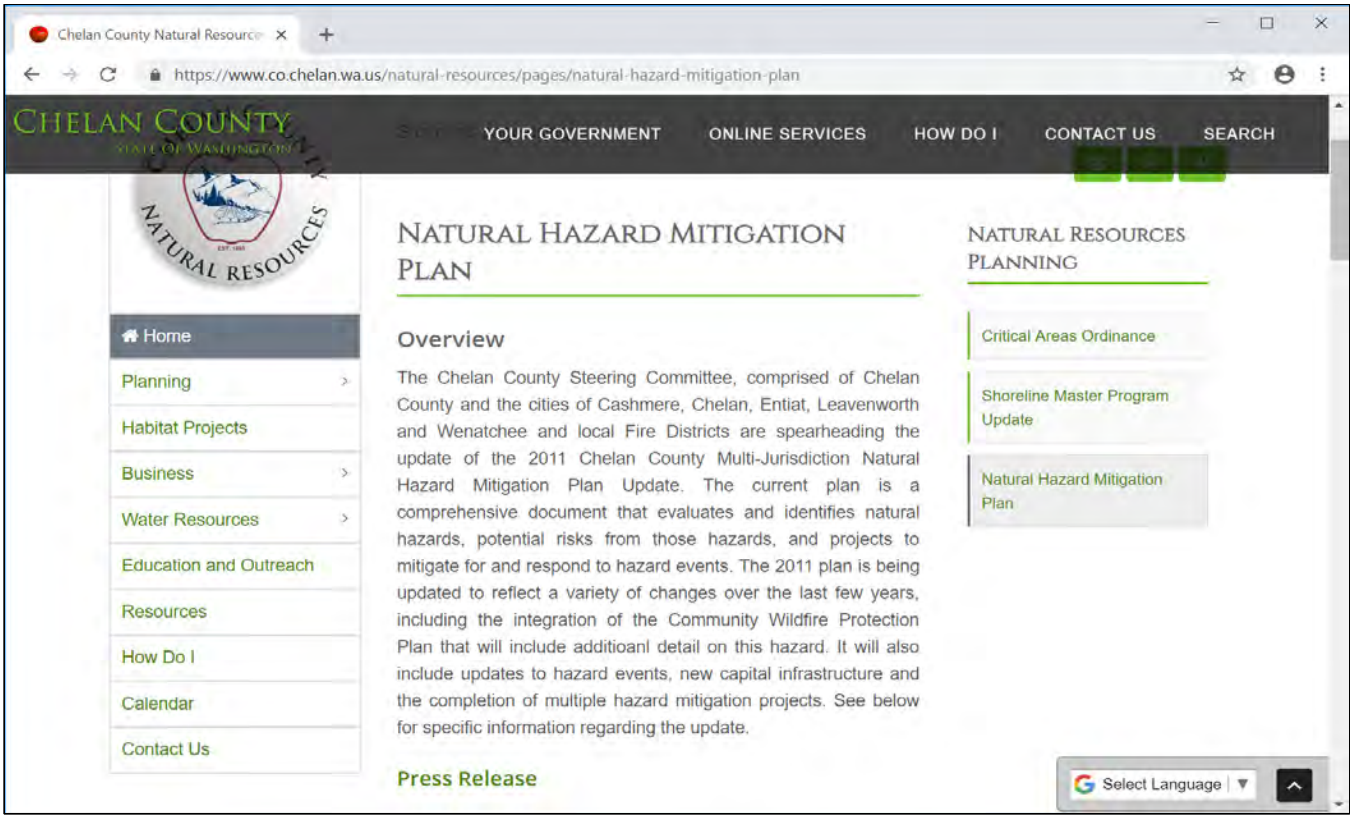


Figure 3-1. Sample Page from Hazard Mitigation Plan Web Site

3.8.3 Hazard Mitigation 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 41 questions helped guide the Steering Committee in selecting goals, objectives and mitigation strategies. The survey was made available in both English and Spanish on the hazard mitigation plan website and advertised throughout the course of the planning process. The results of the survey were provided to each of the planning partners in toolkits used to support the jurisdictional annex process (as described in the introduction to Volume 2 of this plan). 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.
- Enhanced focus on wildfire risk to support integration of the County Community Wildfire Protection Plan (CWPP)

During the course of this planning process, 90 completed surveys were submitted. The complete survey and a summary of its findings can be found in Appendix A of this volume.

Chelan County Hazard Mitigation Plan and Community Wildfire Protection Plan Survey

3. Wildfire Hazard

15. Is your property located in an area at risk for wildfires?

- Yes
- No
- Not Sure

16. What type of roof does your home have?

- Composite (most common roofing material)
- Wood Shake/Shingles
- Ceramic Tiles
- Aluminum, Tin or Other Metal
- Other

17. Do you have a defensible space surrounding your home?

- Yes
- No

18. Do livestock (cattle, horses, sheep) graze the grasses and shrubs around your home?

- Yes
- No

19. Do you conduct periodic fuels reduction activities near your home site such as:

- Clearing and removing brush
- Clearing and removing downed tree limbs on your property
- Trimming tree branches away from your home
- Removing trees that are dead or infested that pose a risk to your home

20. If the primary access to your home were cut off because of wildfire or other hazard, would you have an alternate escape route?

- Yes
- No

6

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

3.8.4 Public Outreach

The public outreach process for this plan update consisted of two phases. Phase 1 took place early in the process to share information with the public from the risk assessment and gauge perception of risk within the planning area. The second phase was conducted at the end of the process during a formal public comment period to provide the public an opportunity to review and comment on the draft plan.

Phase 1

The Phase 1 public outreach was held during October 2018. Planning team members held three open houses, one each in Wenatchee, Leavenworth, and Chelan (see Figure 3-3 and Figure 3-4). The open houses were jointly planned with the Community Wildfire Protection Plan to provide information on both plans. There were maps on site showing the extent and location of the hazards of concern addressed by both plans as well as copies of the survey links to the website.

Figure 3-3. Phase 1 Public meeting in Wenatchee

Figure 3-4. Phase 1 Public meeting in Wenatchee

Phase 2

Phase 2 of the public outreach was the two-week final public comment period, May 8 – 22, 2018, following release of the draft hazard mitigation plan. Three public meetings were held:

- May 7 at the City of Wenatchee City Council meeting
- May 8 at the Chelan County Board of Commissioners meeting
- May 21 at the City of Chelan City Council meeting

These meetings, advertised via a press release, presented a short overview of the final plan and provided an opportunity for the public to comment.

The public comment period gave the public an opportunity to comment on the draft plan update prior to its submittal to Washington State Emergency Management Division. The principle avenue for public comment on the draft plan was the website established for this plan update. 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.

3.8.5 Public Involvement Results

Survey

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

- Number of surveys completed via the internet—89
- Total surveys analyzed—89
- Surveys were received from each planning partner
- The hazard most experienced by respondents was wildfire, followed by severe weather, ice storm and flood.
- Survey respondents ranked wildfire as the hazard of greatest concern, followed by severe weather, urban fire, climate changes and ice storm.
- Most respondents (75 percent) felt the most effective form of communication to receive information on immediate threats caused by hazards is the internet, social media followed by public safety officials and TV or radio news. More than half would expect to be notified through a public notification system or social media.
- 48 percent of respondents stated that they felt "somewhat prepared" to deal with the impacts from a hazard event.
- Over 61% of the respondents stated that they did consider the impact a natural disaster could have on their home before purchasing that property.
- The largest incentive respondents would consider for retrofitting their home was grant funding
- Over 75% of the respondents support the regulation (restriction) of land uses within known high hazard areas.

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 instructed to use the survey results to help frame mitigation actions and public outreach strategies to include in their action plans.

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
10/9/2018	Wenatchee	7	0
10/10/2018	Leavenworth	3	0
10/11/2018	Chelan	2	0
TBD	Chelan County Board of Commissioners	0	0
TBD	City Council	0	0
Total		12	0

3.9 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			
2/22	Organize Resources	County releases request for proposals for a technical support contractor to facilitate the update to the hazard mitigation plan.	N/A
5/1	Organize Resources	County selects Tetra Tech as its technical assistance contractor to facilitate the plan update process.	N/A
6/12	Project Kickoff Meeting	• All potential planning partners were invited to learn about the plan and meet the consultant team.	14
7/19	Steering Committee Meeting #1	• Review work plan • Organize Steering Committee • Discuss mission/vision statement • Discuss current plan goals/objectives • Initiate Washington State plan review • Discuss options for public involvement strategy	16
8/21	Steering Committee Meeting #2	• Confirm steering committee charter • Review hazards of concern • Discuss mission/vision/guiding principle statement • Discuss current plan goals and objectives	14
9/20	Steering Committee Meeting #3	• Introduce jurisdiction annex development process • Discuss hazards of concern • Confirm guiding principle statement • Confirm plan goals • Discuss critical facility definition and inventory • Discuss public survey	12
10/10	Public Outreach	• Web-based public outreach survey deployed via Survey Monkey with web-links distributed via the hazard mitigation website and social media.	N/A
10/9 10/10 10/11	Public Outreach	• Open house meetings held in Wenatchee, Leavenworth, and Chelan in coordination with the Community Wildfire Protection Plan Update process	12
10/18	Steering Committee Meeting #4	• Initiate Phase 1 of jurisdiction annex process • Confirm hazards of concern • Confirm objectives • Update on other aspects of public involvement strategy	15
11/12	Steering Committee Meeting #5	• Update on jurisdiction annex development process • Risk assessment update • Review of plan maintenance strategy • Discuss mitigation alternatives catalog • Initiate Phase 2 jurisdiction annex development • Update on results of public involvement strategy and future outreach	14

Date	Event	Description	Attendance
2019			
1/10	Steering Committee Meeting #6 / Planning Partnership Workshop	• Review project timeline • Discuss jurisdiction annex status and questions • Initiate Phase 3 of jurisdiction annex development • Review and discuss preliminary risk assessment results • Update on results of the public involvement strategy	20
2/14	Steering Committee Meeting #7	• Discuss county-wide actions • Discuss public comment period and future public outreach • Update on annex Phase 3 process • Discussion of public comment period	20
TBD	Begin Comment Period	Initiate public comment period	N/A
TBD	Phase 2 public meeting	TBD	
TBD	Phase 2 public meeting	Public meeting held at Chelan County Board of Commissioners to present draft plan and provide opportunity for the public to provide comment.	
TBD	End Comment Period	Public comment period is closed	N/A
TBD	Plan submittal	Pre-adoption review draft of the plan submitted to Washington State Emergency Management Division.	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 X	XX

4. CHELAN COUNTY PROFILE

Chelan County is located in Central Washington on the east side of the Cascade Mountains, west of the Columbia River (see Figure 4-1). With an area of 2,994 square miles, it is the third largest of Washington's 39 counties. There are five incorporated municipalities in the county: Cashmere, Chelan, Entiat, Leavenworth and Wenatchee. Wenatchee is the largest city in the County and the county seat. Large areas of the county are national forest land.

4.1 HISTORICAL OVERVIEW

Prior to European settlement of what is now Chelan County, the Wenatchee tribe lived along the Wenatchee River and the Chelan tribe lived along the south end of Lake Chelan. The culture and economy of the tribes centered on fishing, but members also gathered roots and berries and hunted game. In 1855, the Wenatchee and 13 other Native American tribes signed the Yakama Treaty, forfeiting title to 10.8 million acres of north central Washington in exchange for a smaller reservation, cash, and other incentives. Soon afterward, many tribes repudiated the agreements and war broke out. Eventually, only a few small allotments near Lake Chelan remained in Native American hands (Wilma, 2006).

Trappers visited the Chelan and Wenatchee valleys from the 1810s through the 1840s in search of beaver pelts. Placer miners came from California in the 1860s and established a village on the Columbia opposite the mouth of the Chelan. Two traders set up a commercial operation in 1872 at the future site of Wenatchee. That same year, a missionary built a small log church, and the town that was established nearby eventually became Cashmere. For a short time in 1880, the U.S. Army maintained Camp Chelan at the south end of Lake Chelan. The town of Wenatchee was founded in 1888. In July 1889, the town of Chelan was laid out where the Chelan River left the lake. The Wenatchee Development Company platted a town site a mile south of the original town in May 1892, and residents of the original town moved to the new community. The residents of Wenatchee voted for incorporation in December 1892 (Wilma, 2006).

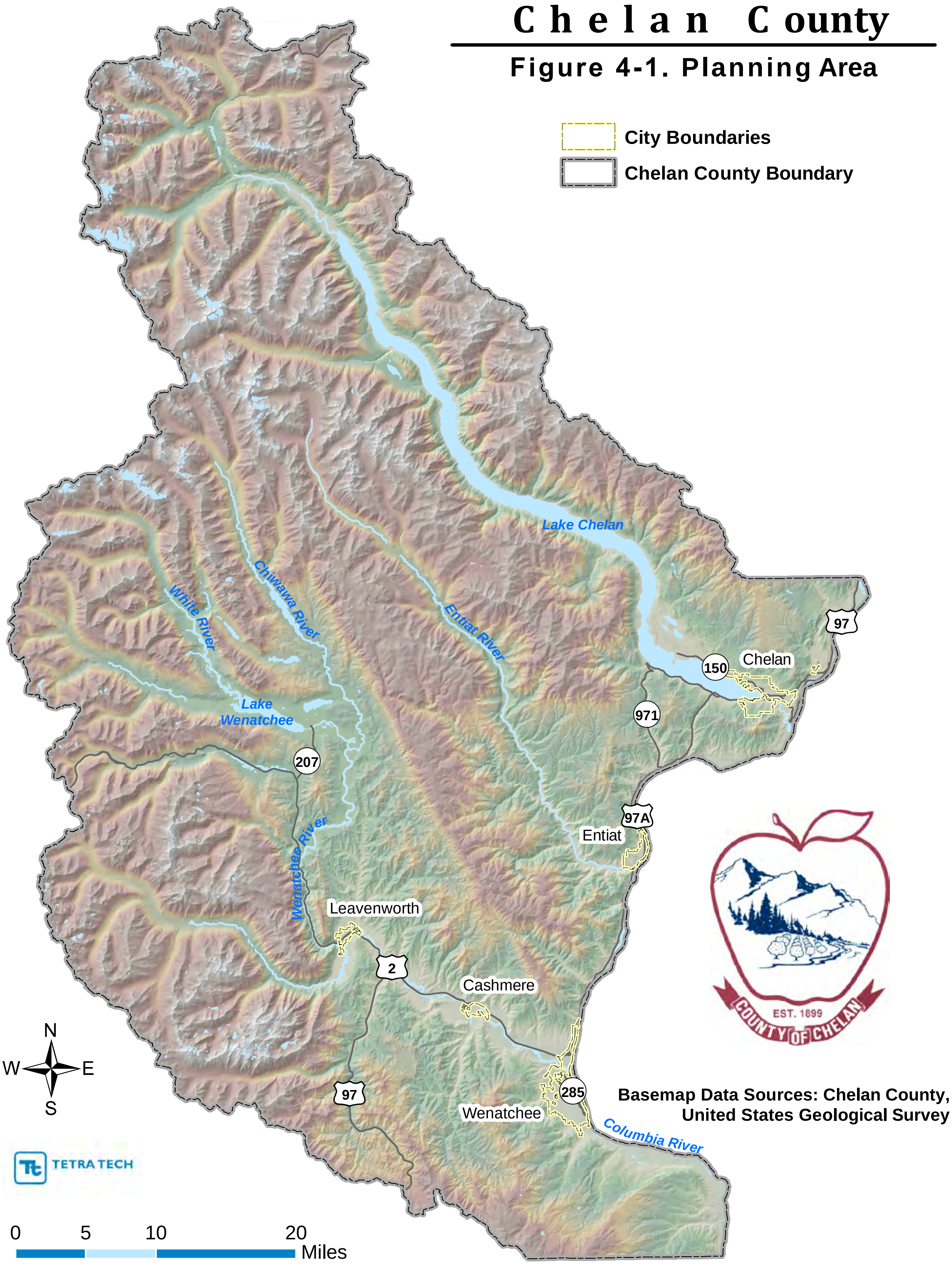
After 1888, the Chelan Valley was part of Okanogan County to the north and the Wenatchee Valley was part of Kittitas County to the south. In 1899, the State Legislature created Chelan County out of the two other counties with Wenatchee as the county seat (Wilma, 2006).

Starting in 1901, businessmen and landowners raised money for the Wenatchee Canal Company and the Highline Canal, running 14 miles from Dryden to Wenatchee. This later became the Wenatchee Reclamation District. The federal Reclamation Act of 1902 provided for the organization and funding of irrigation districts that had the authority of government in acquiring land and issuing bonds. This made possible the construction of reservoirs and canals and the dramatic growth of the fruit industry. In the 1930s, the U.S. government began constructing irrigation and flood control dams on the Columbia (Wilma, 2006).

The Wenatchee Canal Company used the flow from the Highline Canal for power. A number of small power companies later sprung up using the hydraulic potential of the area's rivers. These firms eventually combined under the Puget Sound Power & Light Co. Congress created the Bonneville Power Administration in 1937 to distribute the electricity from Columbia River dams to publicly owned utilities.

Chelan County

Figure 4-1. Planning Area



Basemap Data Sources: Chelan County, United States Geological Survey

Voters approved the Chelan County Public Utility District in 1937, which acquired the properties of Puget Sound Power & Light in 1948, the assets of the Washington Water Power Co. in 1955, and Rock Island Dam on the Columbia in 1956. The Aluminum Company of America (Alcoa) built its plant at Malaga in 1952 to take advantage of the cheap and plentiful power (Wilma, 2006).

Today, Chelan County's Board of County Commissioners is responsible for overall administration of Chelan County government. The Board consists of three officials elected from designated Commissioner districts. Its duties include adopting and enacting ordinances and resolutions, levying taxes, establishing County policies, and conducting general County administration. The Board is responsible for adoption of the annual budget, provision and maintenance of public facilities, construction and maintenance of County roads, development and implementation of planning and zoning policies, and appointments to advisory committees and boards.

4.2 MAJOR PAST HAZARD EVENTS

Presidential disaster declarations are typically issued for hazard events that cause more damage than state and local governments can handle without assistance from the federal government, although no specific dollar loss threshold has been established for these declarations. A presidential disaster declaration puts federal recovery programs into motion to help disaster victims, businesses and public entities. Some of the programs are matched by state programs. 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 Chelan County through 2019 (records date back to 1972).

Table 4-1. Historical Chelan County Natural Hazard Events

Event	State or Federal Disaster #	Date
Severe Storms & Flooding	334	6/10/1972
Drought	3037	3/31/1977
Volcanic Eruption, Mt. St. Helens	623	5/21/1980
Severe Storms & Flooding	883	11/9/1990
Severe Storms, High Wind, And Flooding	1079	11/7/1995
Severe Winter Storms, Land & Muds Slides, Flooding	1159	12/26/1996
Earthquake	1361	2/28/2001
Union Valley Fire	2368	7/28/2001
Icicle Fire Complex	2374	8/14/2001
Rex Creek Fire Complex	2379	8/13/2001
Deer Point Fire	2449	7/20/2002
Severe Storms And Flooding	1499	10/15/2003
Deep Harbor Fire	2537	7/30/2004
Fischer Wildfire	2543	8/11/2004
Dirty Face Fire	2572	7/31/2005
Hurricane Katrina Evacuation	3227	8/29/2005
Severe Storms, Flooding, Landslides, and Mudslides	1671	11/2/2006
Severe Winter Storm, Landslides, and Mudslides	1682	12/14/2006
Easy Street Fire	2711	7/8/2007
Severe Winter Storm, Landslides, Mudslides, and Flooding	1817	1/6/2009
Severe Winter Storm And Record and Near Record Snow	1825	12/12/2008
Union Valley Fire	2823	7/28/2009
Wildfires	3371	7/9/2014
Wildfires	3372	8/13/2015
Wildfires And Mudslides Severe Storms, Straight-Line	4243	8/9/2015
Winds, Flooding, Landslides, and Mudslides	4249	11/12/2015

4.3 PHYSICAL SETTING

4.3.1 Geology

Chelan County sits between the Cascade Mountains to the west and the Columbia Plateau to the east; a significant portion of the County is within the Cascade Mountain Range. The topography of the county ranges from mountainous, with cirques, moraines, spurs and other glacial features, to lower, milder terrain consisting of soils formed of alluvial deposits and glacial drift. The Cascade Mountains are primarily metamorphosed sedimentary, volcanic and granite rock in large outcropping with shallow soils. The Columbia Plateau is mainly thick layers of basaltic bedrock, with outwash deposits of silty sands to sandy gravel at tributary mouths. Elevations range from 700 feet above sea level at the Columbia River to more than 9,000 feet at the highest point of the Cascades.

The Chelan Mountains stretch south to the Columbia River between the Entiat River and the Chelan River. The northern end the Chelan Range merges with the northern end of the Entiat Mountains. Most of the range is within Wenatchee National Forest. The northern end is part of the Glacier Peak Wilderness.

Lake Chelan was formed by the confluence of two glaciers 18,000 years ago: the Chelan Glacier, which originated in the Cascades and advanced down toward the Columbia; and the Cordilleran ice sheet, advancing south from Canada across the Columbia Plateau. The Chelan Glacier extended to somewhere near The Narrows, carving the deep steep walled valley of Lake Chelan's upper Lucerne basin. The continental glacier extended or overrode the basin to at least Wapato Point, creating a small lake between the 2 ice masses. As the glaciers retreated, the outlet of the valley remained filled by the vast quantities of the material deposited by the glaciers, impounding the present-day Lake Chelan. As a result of this history, the lake above The Narrows is quite deep.

4.3.2 Watersheds

The Washington Department of Ecology has divided Washington into Water Resource Inventory Areas (WRIAs) to delineate the state's major watersheds. The following WRIAs make up Chelan County:

- **WRIA 45, Wenatchee River Watershed**—The Wenatchee Watershed (WRIA 45) is approximately 1,370 square miles, including some areas that drain directly into the Columbia River. This area includes 230 miles of major streams and rivers. The headwaters are the Little Wenatchee and White Rivers in the Cascade Mountain range. These rivers flow into Lake Wenatchee, the source of the Wenatchee River. The Wenatchee River discharges into the Columbia River in the City of Wenatchee.
- **WRIA 46, Entiat River Watershed—**The Entiat River is the major surface water source in this 418-square-mile watershed. Dozens of small creeks and streams are tributary to the river.
- **WRIA 47, Lake Chelan Watershed—**The main surface water feature of this 1,047-square-mile watershed is Lake Chelan, the largest and deepest lake in Washington.
- **WRIA 40, Alkali-Squilchuck (Malaga-Stemilt-Squilchuck Area)—**A small portion of WRIA 40 (Alkali-Squilchuck) extends into the southeastern corner of Chelan County around Malaga. The portion of WRIA 40 in Chelan County includes the Squilchuck Creek, Stemilt Creek and Cummings Canyon Creek watersheds. The rest of the watershed extends into Kittitas, Yakima and Benton Counties, and includes other small creeks primarily draining directly to the Columbia River.

4.3.3 Climate

The climate of Chelan County possesses both continental and marine characteristics, with the Cascades serving as a topographic and climatic barrier. Air warms and dries as it descends the eastern slopes of the Cascades, resulting in shrub-steppe conditions in the lower elevations of Chelan County. Table 4-2 summarizes annual temperature and precipitation data for three weather stations around Chelan County: Wenatchee, Plain and Stehekin. Monthly averages are shown on Figure 4-2 and Figure 4-3.

Table 4-2. Annual Average Chelan County Climate Data

	Wenatchee	Plain	Stehekin
Annual Average Daily High Temperature (ºF)	62.5	57.2	58.2
Annual Average Daily Low Temperature (ºF)	42.1	34.0	38.7
Annual Average Total Precipitation (inches)	9.08	27.39	36.12
Annual Average Total Snowfall (inches)	15.7	119.8	124.3

Source: NOAA, 2015

Source: NOAA, 2015

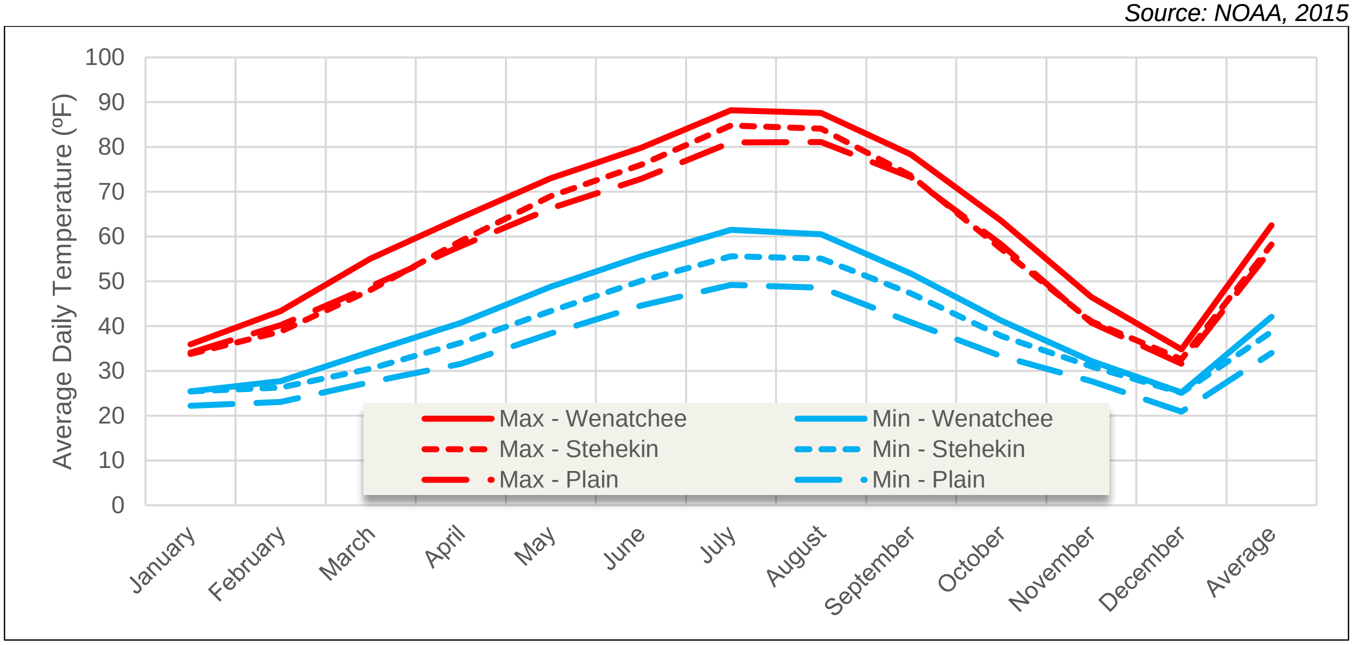


Figure 4-2. Average Daily Temperatures

Source: NOAA, 2015

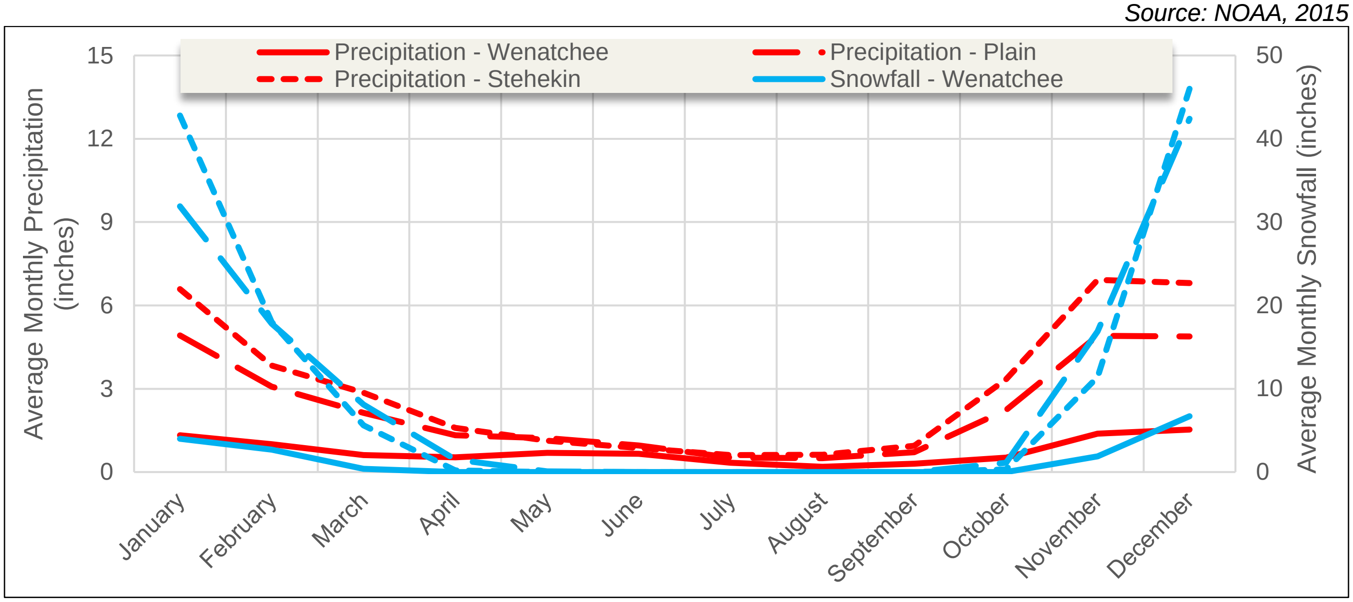


Figure 4-3. Monthly Average Precipitation and Snowfall

Rainfall occurs about 70 days each year in the lowland and about 120 days in the higher elevations. During July and August four to eight weeks can pass with only a few scattered showers. Thunderstorms, most as isolated cells, occur on one to three days each month from April through September. A few damaging hailstorms are reported each summer. Severe local storms occur when the interior of British Columbia is under the influence of high barometric pressure and a deep low-pressure center from over the Pacific approaches the Washington coast. Severe storms normally approach Chelan County from the south or southeast.

Extremes in summer and winter temperatures generally occur when air from the continent influences the inland basin. During the coldest months, freezing drizzle occasionally occurs, as does a Chinook wind that produces a rapid rise in temperature. During most of the year, the prevailing wind is from the southwest or west. The frequency of northeasterly winds is greatest in fall and winter. Wind velocities ranging from 4 to 12 mph can be expected 60 to 70 percent of the time; 13 to 24 mph, 15 to 24 percent of the time; and 25 mph or higher, 1 to 2 percent of the time. The highest wind velocities are from the southwest or west and are frequently associated with rapidly moving weather systems. Extreme wind velocities can be expected to reach 50 mph at least once in two years; 60 to 70 mph once in 50 years; and 80 mph once in 100 years.

4.4 DEVELOPMENT PROFILE

4.4.1 Land Use

Wenatchee River Watershed

The Wenatchee River watershed includes the cities of Wenatchee, Cashmere and Leavenworth and communities of Monitor, Sunnyslope, Plain, Peshastin and Dryden. The primary land uses are forestry, wilderness areas, agriculture, range, residential, and recreation. Much of the area is mountainous forest land designated as National Forest. The largest landowner is the U.S. Forest Service, with approximately 395,000 acres of forest land covering about 45 percent of the total watershed area. Most of the private land in the area is concentrated along the major water bodies and transportation routes. Irrigated farmland acreage within the Wenatchee River valley and its tributaries is estimated to be about 12,500 acres. In the upper watershed, much of the area is not suitable for development due to steep unstable slopes, floodways, wetlands and other critical areas. Development is also constrained by designated resource lands. Current development has occurred on limited areas around the river edges, Lake Wenatchee and Fish Lake. (Washington Department of Ecology, 1995a; Chelan County, 2011).

The rural environment of the lower watershed is characterized by orchards in the valley and on the lower elevations of the rolling hills. Orchards are located throughout much of the valley between Dryden and Sunnyslope. Major crops include apples, pears and cherries. Service industries are found primarily in the incorporated City of Cashmere and the unincorporated community of Sunnyslope. In 2008, a portion of Sunnyslope was included in the City of Wenatchee Urban Growth Area. Several communities along the Wenatchee River and the highway provide small town residential and work opportunities. These areas also contain agricultural processing facilities (Chelan County, 2011).

Most of the Upper Wenatchee River Valley contains evergreen mountains with residential development along the rivers and lakes. The development areas are pockets of higher densities surrounded by natural lands. Land to the west of Leavenworth is extremely limited by mountains and steep slopes. Small parcel sizes are common due to the building area and ownership patterns (Chelan County, 2011).

Most of the Plain-Lake Wenatchee area contains residential homes among the evergreen mountains, with denser populations along the lakes and rivers. This is consistent with the rural recreation opportunities of the area. Plain provides a community area with commercial services and a public post office and school. Development is limited by ownership and parks (Chelan County, 2011).

Entiat River Watershed

The Entiat watershed is 87 percent forested, and timber is the largest land use. Agricultural uses are the second biggest land uses. Most of the irrigated agricultural use is along the Entiat River and downstream from the town of Ardenvoir. There are also 9,000 acres of range land, mostly in the lower part of the watershed near Entiat. Residences and businesses are mostly in the southeastern portion of the watershed near Ardenvoir and Entiat. Development is limited by public access up the valley. The City of Entiat and its urban growth area are at the base of the Entiat River along the Columbia. The area provides for pockets of residential development and rural businesses. Virtually all existing structural and orchard development has occurred on lands below 2,000 feet in elevation and on less than a 20-percent slope (Washington Department of Ecology, 1995b; Chelan County, 2011).

Lake Chelan Watershed

Over 3 percent of the Chelan watershed is in agricultural use, primarily orchards, and less than 1 percent is developed into roads, houses, and commercial areas. Approximately 6 percent of the watershed consists of Lake Chelan and other water bodies, and about 90 percent of the watershed is forest land managed by the U.S. Forest Service, the National Park Service, and private owners. Virtually all existing structural and orchard development has occurred on lands below 2,000 feet in elevation and on less than a 20-percent slope. Most development is concentrated around the lower end of Lake Chelan, where private land dominates. The upper portion of the basin lies within the North Cascades National Park and the Lake Chelan National Recreation Area, while the area between is in the Wenatchee National Forest, a portion of which is in the Glacier Peak Wilderness Area (Washington Department of Ecology, 1995c; Chelan County, 2011).

The Chelan and Manson communities provide urban services. The rest of the region is characterized by a variety of parcel sizes and a mix of orchards, vineyards, wineries, estate homes, golf courses, ranchettes, open space, and pasture land. To the west, access roads are primitive, private or forest service, which greatly reduces the number and types of land uses. Higher levels of development, primarily residential uses, are common along the lakes.

Most of the Stehekin area is undeveloped federal land. The area is influenced by the National Park Service 1995 General Management Plan for the Lake Chelan National Recreation Area. The Park Service manages the majority of federal property in the area. There are about 820 acres of private land, classified as single-family, intermingled with federal land administered by the National Park Service and commercial forest lands. A small community along the northern shore of Lake Chelan continues to develop and grow as a recreation tourist service center. The area is spotted with remote cabins and is not expected to develop (Chelan County, 2011).

Malaga-Stemilt-Squilchuck Area

The town site of Malaga was platted in 1903. Chelan County’s first irrigation ditch was built in Malaga to serve orchards and vineyards. Development of the Alcoa plant in the early 1950s stimulated residential development in the area. Most recent development has been southwest of the original town site, especially around Cortez Lake, which is part of the Three Lakes residential area. The Wenatchee Heights area is a large plateau overlooking the Wenatchee Valley that contains several large orchard tracts. Residences are scattered throughout the area. The Stemilt Hill is another large agricultural area, with residential development scattered throughout the orchards. South of Malaga, the rural character is defined by industrial uses, primarily the Alcoa plant. Colockum Creek, Jumpoff Ridge, Stemilt Basin, Mission Ridge are mainly undeveloped open spaces varying from grassland to forest. Primary land uses in those areas include rangeland, timber production and recreation. Recreation, industrial development, and agriculture are the most significant contributors to the economic base (Chelan County, 2011).

4.4.2 Critical Facilities and Infrastructure

Critical facilities and infrastructure are those that are essential to the health and welfare of the population. These become especially important after a hazard event. Critical facilities typically include police and fire stations, schools and emergency operations centers. Critical infrastructure can include the roads and bridges that provide ingress and egress and allow emergency vehicles access to those in need, and the utilities that provide water, electricity and communication services to the community. Also included are facilities that hold or carry significant amounts of hazardous materials with a potential to impact public health and welfare in a hazard event. Through a facilitated process, the Steering Committee established a definition of critical facilities for this hazard mitigation plan that includes but is not limited to the following:

> A critical facility is defined as a local (not state or federal) facility or infrastructure in either the public or private sector that provides essential products and services to the general public, such as preserving the quality of life in Chelan County and fulfilling important public safety, emergency response, and disaster recovery functions. Loss of a critical facility would result in a severe economic or catastrophic impact and would affect the County's ability to provide essential services that protect life and property. The critical facilities profiled in this plan include but are not limited the following:

- Government facilities, such as departments, agencies, and administrative offices
- Emergency response facilities, including police, fire, and emergency operations centers
- Educational facilities, including K-12
- Medical and care facilities, such as hospitals, nursing homes, continuing care retirement facilities and housing likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a hazard event
- Community gathering places, such as parks, museums, libraries, and senior centers
- Public and private utilities and infrastructure vital to maintaining or restoring normal services to areas damaged by hazard events. These facilities include but are not limited to:
    - Public and private water supply infrastructure, water and wastewater treatment facilities and infrastructure, potable water pumping, flow regulation, distribution and storage facilities and infrastructure
    - Public and private power generation (electrical and non-electrical), regulation and distribution facilities and infrastructure
    - Data and server communication facilities
    - Structures that manage or limit the impacts of natural hazards such as regional flood conveyance systems, potable water truck, main interconnect systems and redundant pipes crossing fault lines and reservoirs
    - Major road and rail systems including bridges, airports and marine terminal facilities
- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic, and/or water-reactive materials.

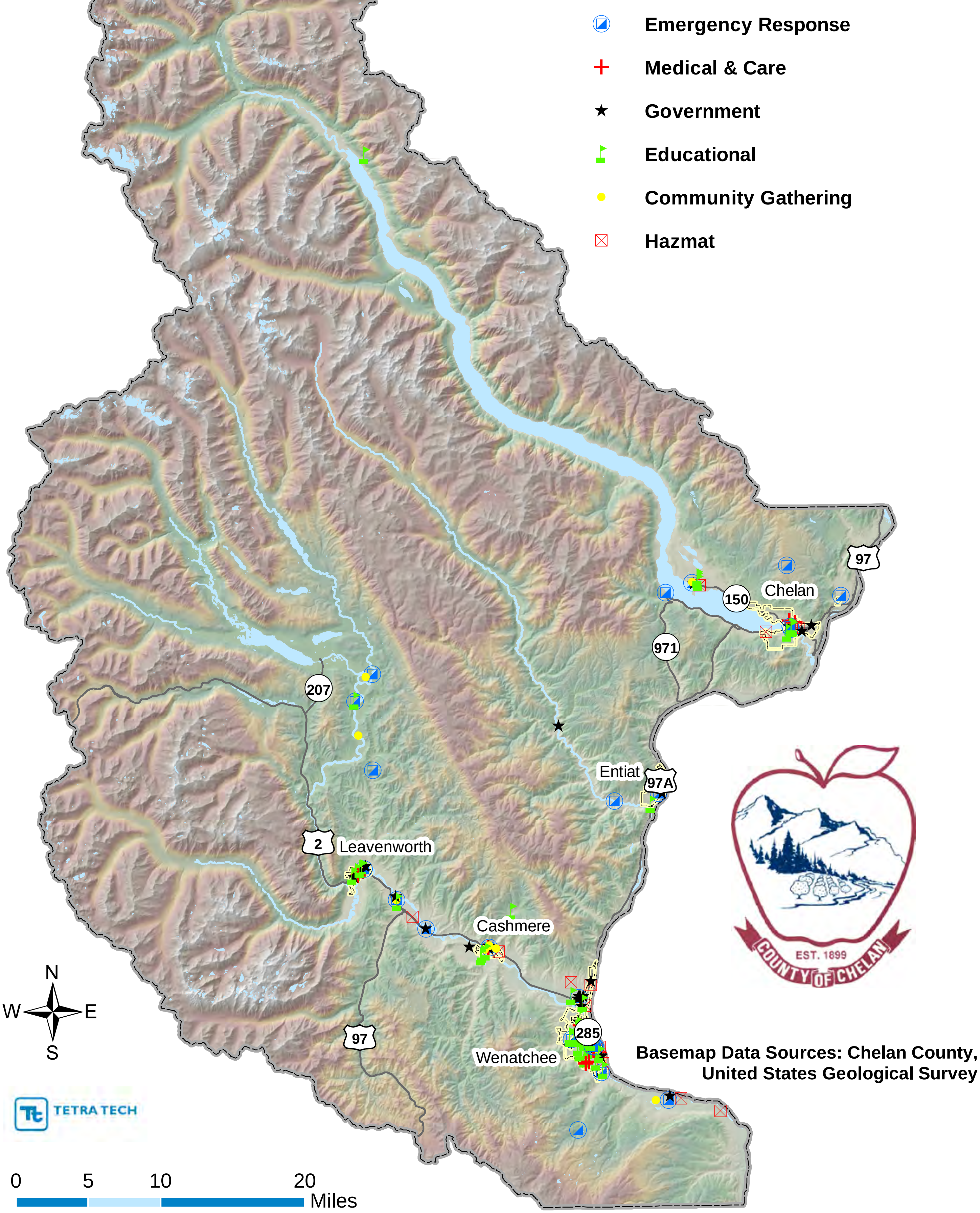
An inventory of facilities that meet this definition was created and input to the computer model used to assess risk for this hazard mitigation plan (FEMA's Hazus model). Two principle sources of information were used for this inventory:

- The Hazus default entries contained in the Comprehensive Data Management System (Hazus version 4.2)
- The inventory of critical facilities and infrastructure maintained by Chelan County Emergency Management to support the Critical Infrastructure/Key Resource initiative.

Figure 4-4 shows the location of critical facilities in the planning area and Figure 4-5 shows the location of critical infrastructure. Due to the sensitivity of this information, a detailed list of facilities is not provided. The list is on file with Chelan County. Table 4-3 and Table 4-4 provide summaries of the general types of critical facilities and infrastructure in the planning area. All critical facilities and infrastructure were analyzed to help identify the flood risk and mitigation actions. Chapter 7 assesses facilities that are exposed and vulnerable to the flood hazard.

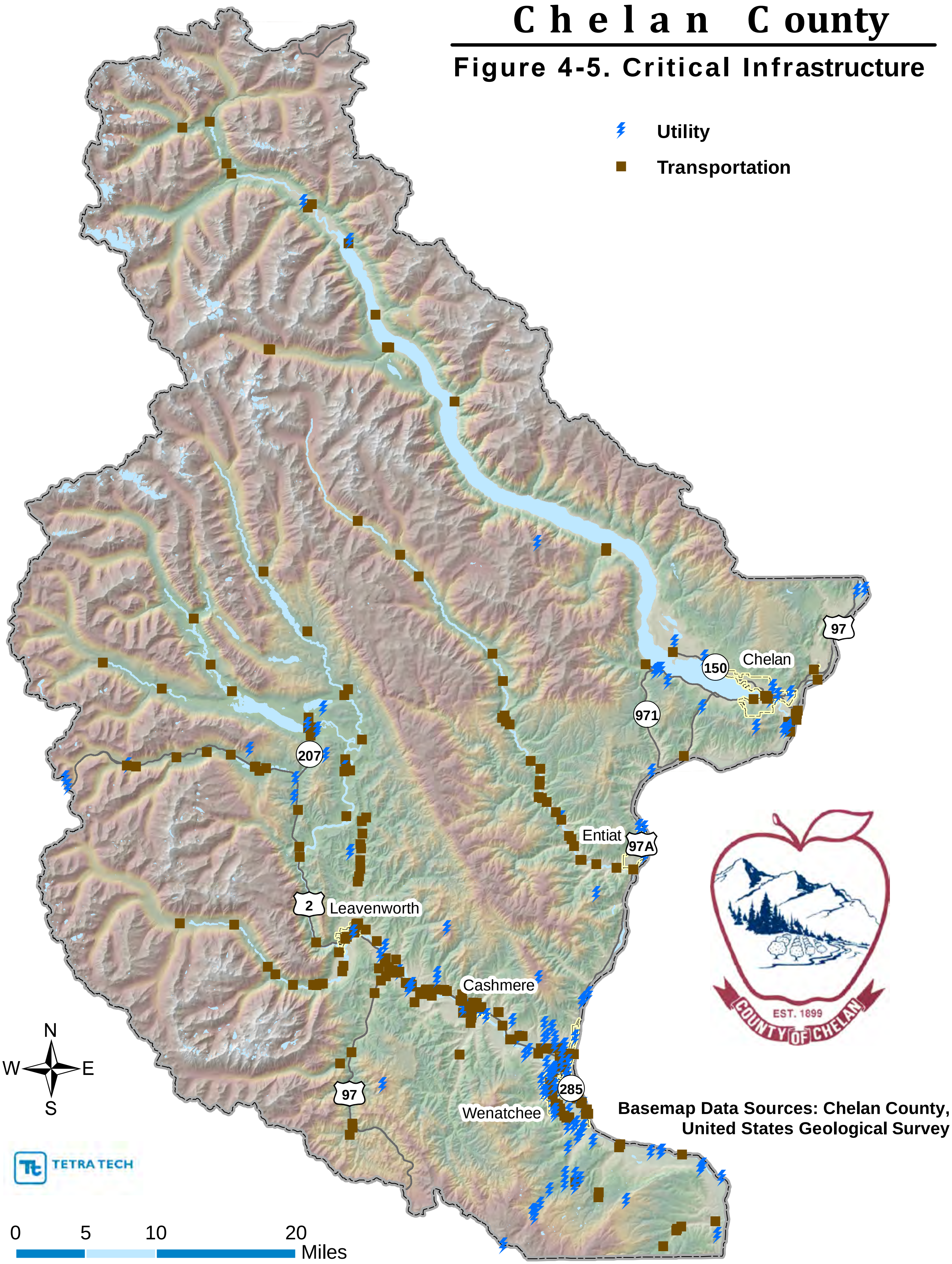
Chelan County

Figure 4-4. Critical Facilities



Chelan County

Figure 4-5. Critical Infrastructure



Basemap Data Sources: Chelan County, United States Geological Survey

Table 4-3. Chelan County Critical Facilities

City	Police & Fire Stations	Emergency Operations Centers	Medical Care	Schools & Educational Facilities	Hazardous Materials Facilities	Dams	Other Essential Facilities	Total
Cashmere	2	0	1	3	1	0	7	14
Chelan	2	0	1	7	5	1	7	23
Entiat	1	0	0	1	0	0	1	3
Leavenworth	1	0	1	5	1	0	4	12
Wenatchee	4	1	2	19	5	0	18	49
Unincorporated	14	0	0	10	7	3	20	54
Total	24	1	5	45	19	4	57	155

Table 4-4. Chelan County Critical Infrastructure

City	Transportation Systems	Communications Facilities	Natural Gas Facilities	Electric Facilities	Potable Water Facilities	Wastewater Facilities	Total
Cashmere	5	0	0	4	1	1	11
Chelan	3	1	0	2	0	0	6
Entiat	0	0	0	1	0	1	2
Leavenworth	4	0	0	2	0	1	7
Wenatchee	20	0	0	11	10	1	42
Unincorporated	208	19	4	31	46	5	313
Total	240	20	4	51	57	9	381

4.4.3 Future Trends in Development

While Chelan County appears to be a large county, with approximately 1.9 million acres or 2, 920 square miles, the majority of land, approximately 1.5 million acres, is in federal and state ownership. The major geographic features include: Cascade Mountains, Chiwaukum mountains, Stuart Range, The Enchantments, Bonanza Peak, and the Chelan, Wenatchee and Columbia rivers. Most of the County is nationally protected lands: Lake Chelan National Recreation Area, North Cascades National Park (part) and the Wenatchee National Forest (part). Most of these lands are not expected to be developed within the next 20 years. Should any development occur it is expected to be only on leased land providing small scale residential or recreation uses.

The County and its cities have adopted comprehensive plans that govern land use decision and policy making their jurisdictions and well as building codes and specialty ordinances based on state and federal mandates. Decisions on land use area 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 Chelan County. Any large-scale development should occur concurrent with a Comprehensive Plan review or amendment to analysis potential Countywide impacts.

As noted in the 2017-2037 Chelan County Comprehensive Plan, there is enough land in the County to satisfy future housing needs; however, the overall number of residential building permits exceeds the creation of new lots (subdivisions). This may impact housing costs, affordability and availability as demand continues to grow. Land available for development, about 436 square miles, is generally found along the valleys and rolling hills associated with Chelan Lake, the Entiat River, the Wenatchee River and the Columbia River, as shown in orange below. The largest populated area is located at the southeast corner of the County, in the City of Wenatchee.

The County anticipates growth to occur in a manner consistent with the land use designations planned for by the zoning map and regulations. is Growth is expected to occur in areas identified as vacant and underutilized by the County Assessor's primary land use classification code. However, there is less land available for development within the Rural Residential/Resource 2.5 and LAMIRD (limited area of more intense rural development) designations. Therefore, the percentage of growth in these areas may be less than other residentially designated lands. As noted in the 2017-2037 Comprehensive Plan, the County has adequate land to meet the projected population growth over the next 20 years.

All municipal planning partners will seek to incorporate this hazard mitigation plan by reference into their comprehensive plans. This will assure that all future trends in development can be established with the benefits of the information on risk and vulnerability to natural hazards identified in this plan.

4.5 DEMOGRAPHICS

Some populations are at greater risk from hazard events because of decreased resources or physical abilities. Elderly people, for example, may be more likely to require additional assistance. Research has shown that people living near or below the poverty line, the elderly (especially older single men), the disabled, women, children, ethnic minorities and renters all experience, to some degree, more severe effects from disasters than the general population (Rufat et al., 2015). 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.

4.5.1 Population Characteristics

Knowledge of the composition of the population and how it has changed in the past and how it may change in the future is needed for making informed decisions about the future. Information about population is a critical part of planning because it directly relates to land needs such as housing, industry, stores, public facilities and services, and transportation. The Washington State Office of Financial Management estimated Chelan County's population at 77,800 as of 2018, making it the 17th largest county by population in the state (OFM, 2019).

Population changes are useful socio-economic indicators. A growing population generally indicates a growing economy, while a decreasing population signifies economic decline. Figure 4-6 shows the Chelan County population change from 1995 to 2018 compared to that of the State of Washington (Washington ESD, 2019). The County grew faster than the statewide average through the early 1990s but has since had a growth rate somewhat below that of the state. Table 4-5 shows the county population from 2005 to 2018.

The Washington Office of Financial Management developed forecasts of future population as shown in Table 4-6. The projections estimate a population of 89,113 in Chelan County by 2040, a 12.7-percent increase from 2018.

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

Source: Washington ESD, 2019

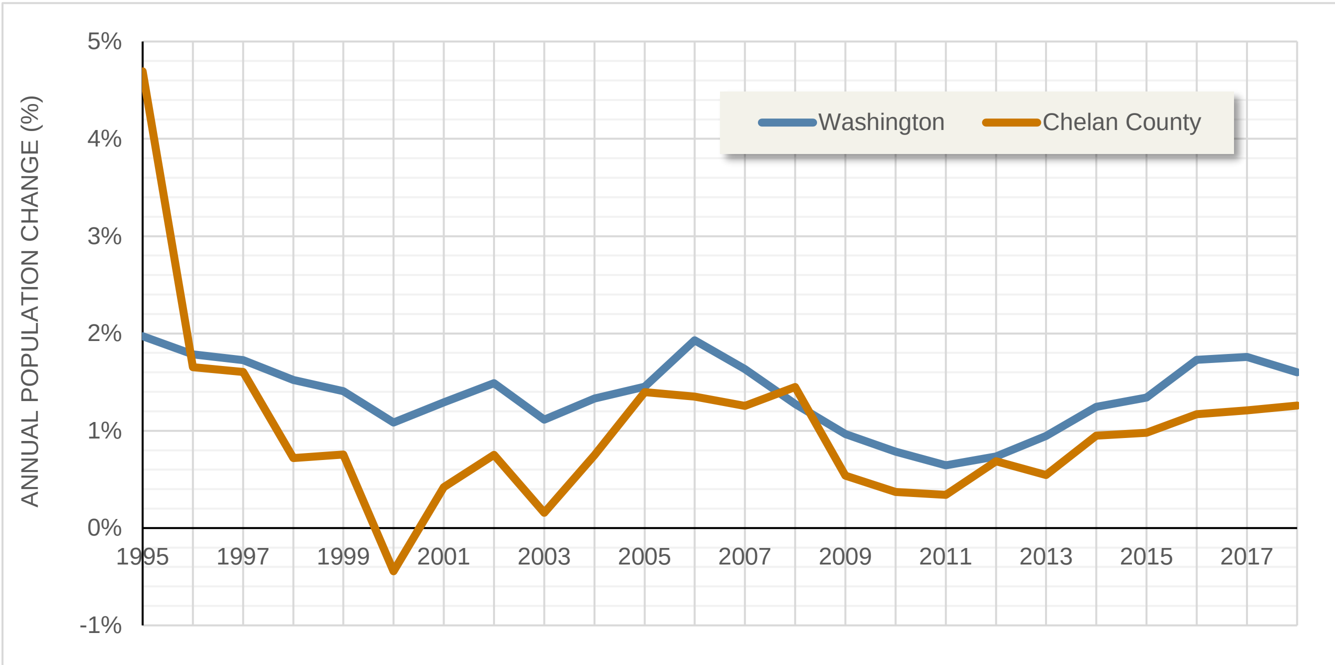


Figure 4-6. Washington and Chelan County Population Growth

Table 4-5. Recent County Population Growth

Year	Chelan County Population	Year	Chelan County Population	Year	Chelan County Population
2005	68,963	2010	72,453	2015	75,030
2006	69,895	2011	72,700	2016	75,910
2007	70,773	2012	73,200	2017	76,830
2008	71,799	2013	73,600	2018	77,800
2009	72,185	2014	74,300		

Source: Washington ESD, 2019

Table 4-6. Projected Future County Population

	Chelan County Population
2015	75,068
2020	78,469
2025	81,763
2030	84,652
2035	87,038
2040	89,113

Source: Washington ESD, 2014

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 the flood hazard.

The overall age distribution for the planning area is illustrated in Figure 4-7. Based on the most recent 3-year estimates (2014 – 2017) from the U.S. Census Bureau's American Community Survey, 19.96 percent of the planning area's population is 65 or older, compared to the state average of 13.2 percent. According to U.S. Census data, 30.0 percent of the over-65 population has disabilities of some kind and 9.6 percent have incomes below the poverty line. The Census estimates that 22.5 percent of children under 18 live below the poverty line. The county's population includes 20.1 percent who are 14 or younger, compared to the state percentage of 19.2 percent (U.S. Census, 2013).

Source: U.S. Census, 2019

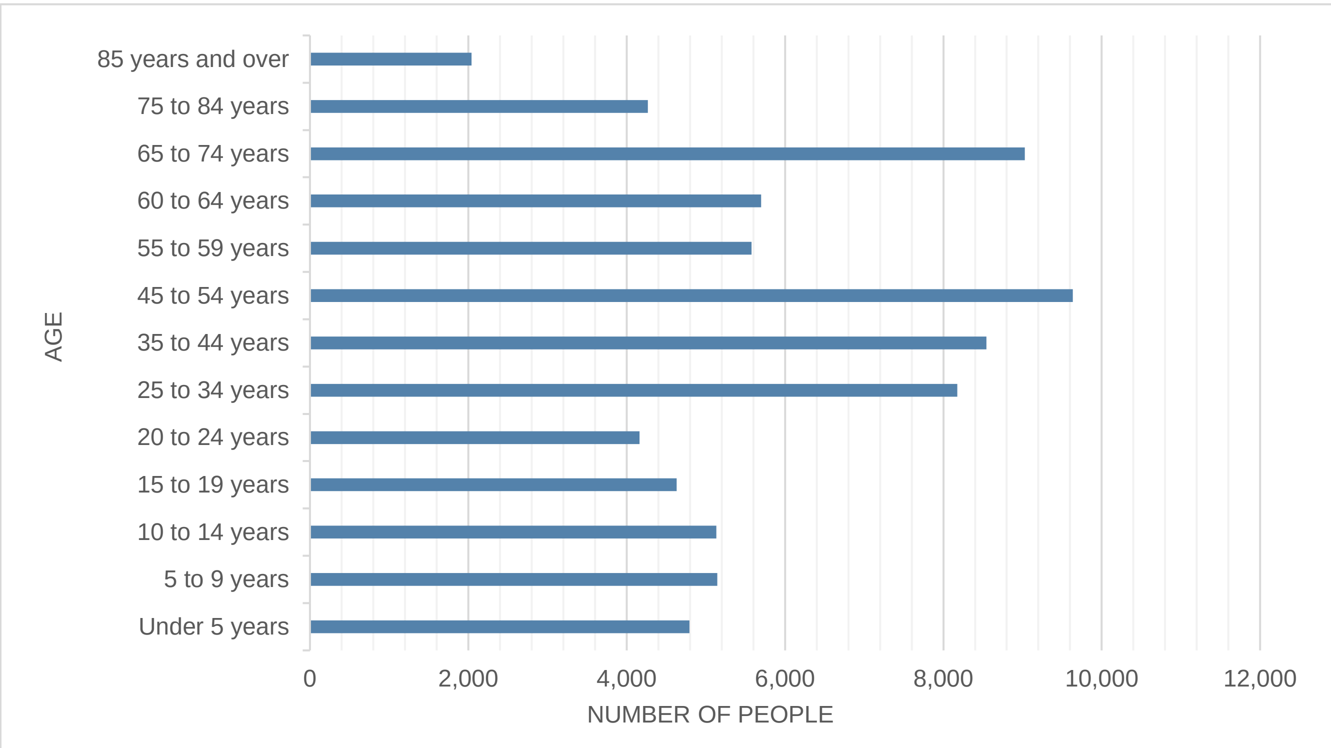


Figure 4-7. Planning Area Age Distribution

4.5.3 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 (Gibbs and Montagnino, 2006). 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 most recent 3-year estimates (2014 – 2017) from the U.S. Census Bureau's American Community Survey, the racial composition of the planning area is predominantly white, at 88.7 percent. The largest non-white populations are those identifying as "some other race" at 6.6 percent and those identifying as two or more races at 2.0 percent. Figure 4-8 shows the racial distribution in the planning area (U.S. Census, 2012). Those identifying as Hispanic or Latino, of any race, make up 26.9 percent of the population.

Source: U.S. Census, 2019

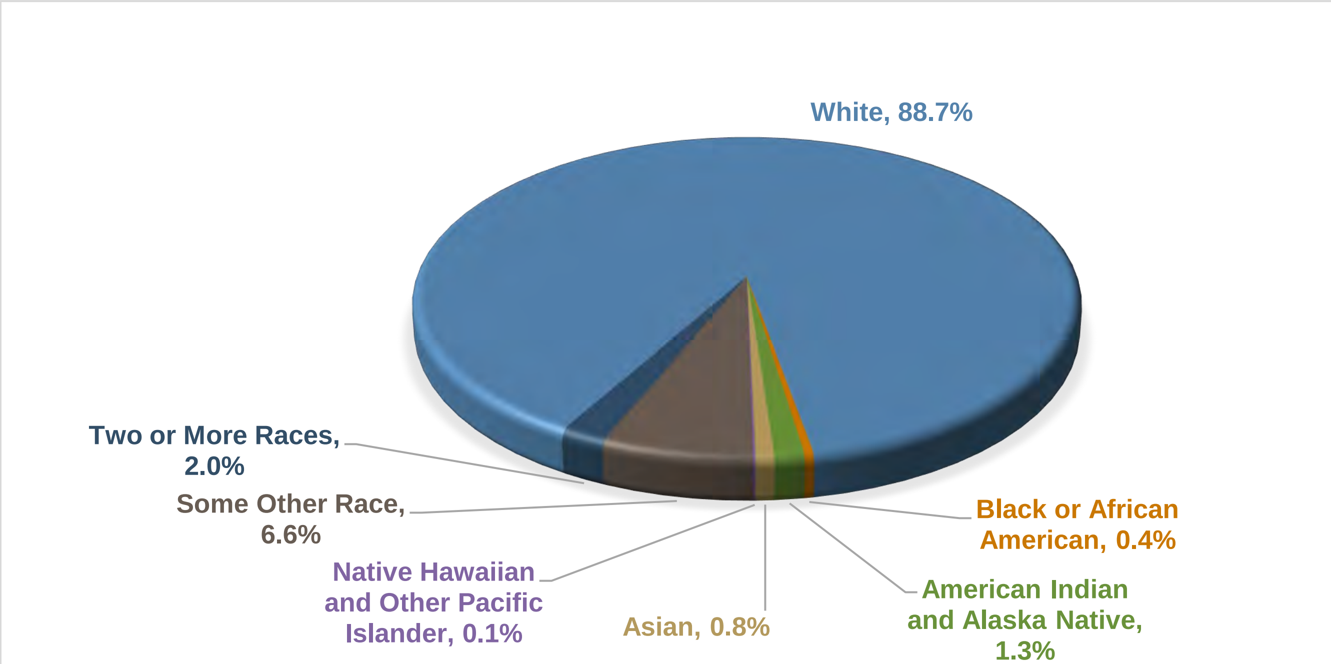


Figure 4-8. Planning Area Race Distribution

The planning area has a 12.9-percent foreign-born population. Other than English, the most commonly spoken language in the planning area is Spanish, with 23.3 percent of the population speaking Spanish at home. The census estimates that 10.3 percent of the residents speak English “less than very well.” (U.S. Census, 2019).

4.5.4 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. People 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 the 2014-2017 3-year Census estimates, there are more than 8,000 individuals with some form of disability in the county, representing 11 percent of the total population (U.S. Census, 2019)

4.6 ECONOMY

4.6.1 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 disadvantaged when confronting hazards such as flooding. Additionally, the poor typically occupy more poorly built and inadequately maintained housing. Mobile or modular homes, for example, are more susceptible to damage in floods than other types of housing. 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 the most recent 3-year estimates (2014 – 2017) from the U.S. Census Bureau's American Community Survey, per capita income per person in Chelan County was $47,428 which ranked 8th is the state. It is estimated that about 11.3 percent of households receive an income between $100,000 and $149,999 per year and 6.5 percent of household incomes are above $150,000 annually. The Census Bureau estimates that 15.4 percent of the population in the planning area lives below the poverty level (U.S. Census, 2019).

4.6.2 Industry, Businesses and Institutions

The planning area's economy is strongly based in the education/health care/social service industry (20 percent of employment), followed by agriculture/forestry/fishing/hunting/mining (13 percent) and retail trade (12 percent). Information (2 percent), public administration (3 percent) and other service industries (3 percent) make up the smallest source of the local economy. Figure 4-9 shows the breakdown of industry types in the planning area. (U.S. Census, 2013)

Source: U.S. Census, 2013

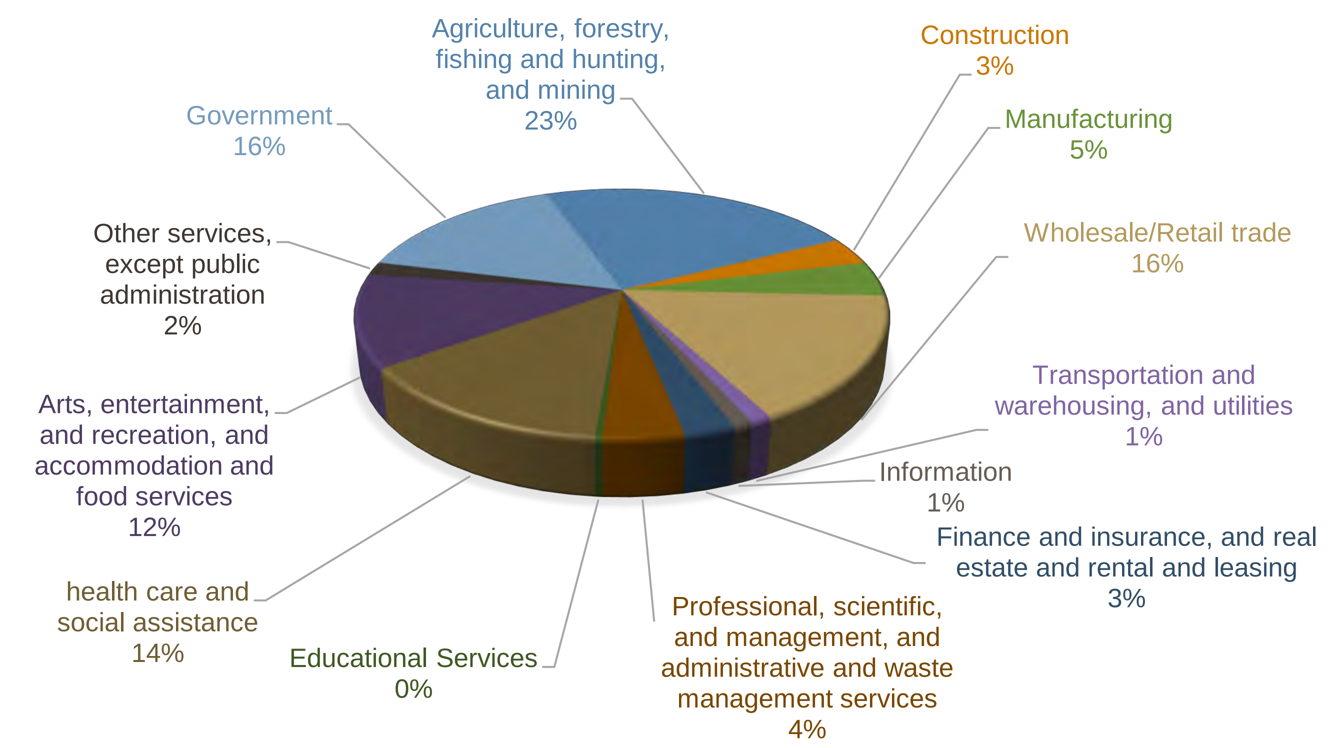


Figure 4-9. Industry in the Planning Area

The Port of Chelan County updates demographics for the Chelan-Douglas County area, including a list of large employers, showing the number of employees for each employer (Port of Chelan County, 2015):

- Confluence Health is the two-county area's largest full-time employer, with 3,527 full-time employees.
- Stemilt Growers, LLC, with 2,000 full-time employees and 4,000 seasonal employees, has the greatest total number of employees in the two-county area.

- The third greatest number of full-time employees in the two-county area is at apple-slicing company Crunch Pak, which has 900 full-time employees, as well as 99 part-time employees.
- The Wenatchee School District employs 581 people full-time and 446 part-time.
- Other companies in the area with 500 or more total employees are as follows:
  - Agricultural company McDougall & Sons, Inc., with 604 full-time and 296 part-time
  - Chelan County PUD No. 1, with 641 full-time, 21 part-time and 72 seasonal
  - Eastmont School District #206, with 651 full-time and 41 part-time
  - Chelan County, with 443 full-time and 68 part-time

4.6.3 Employment Trends and Occupations

According to the 2014-2017 3-year American Community Survey, 62.6 percent of the planning area's population 16 years old or older is in the labor force, including 55 percent of women in that age range and 70 percent of men (U.S. Census, 2013).

Figure 4-10 compares unemployment trends from 1990 through 2014 for the United States, Washington and Chelan County, based on data from the state Employment Security Department (Washington ESD, 2012). Chelan County's unemployment rate was lowest in 2008 at 5.8 percent. The rate peaked at 8.4 percent in 2011, but has declined steadily since then.

Source: Washington Employment Security Department

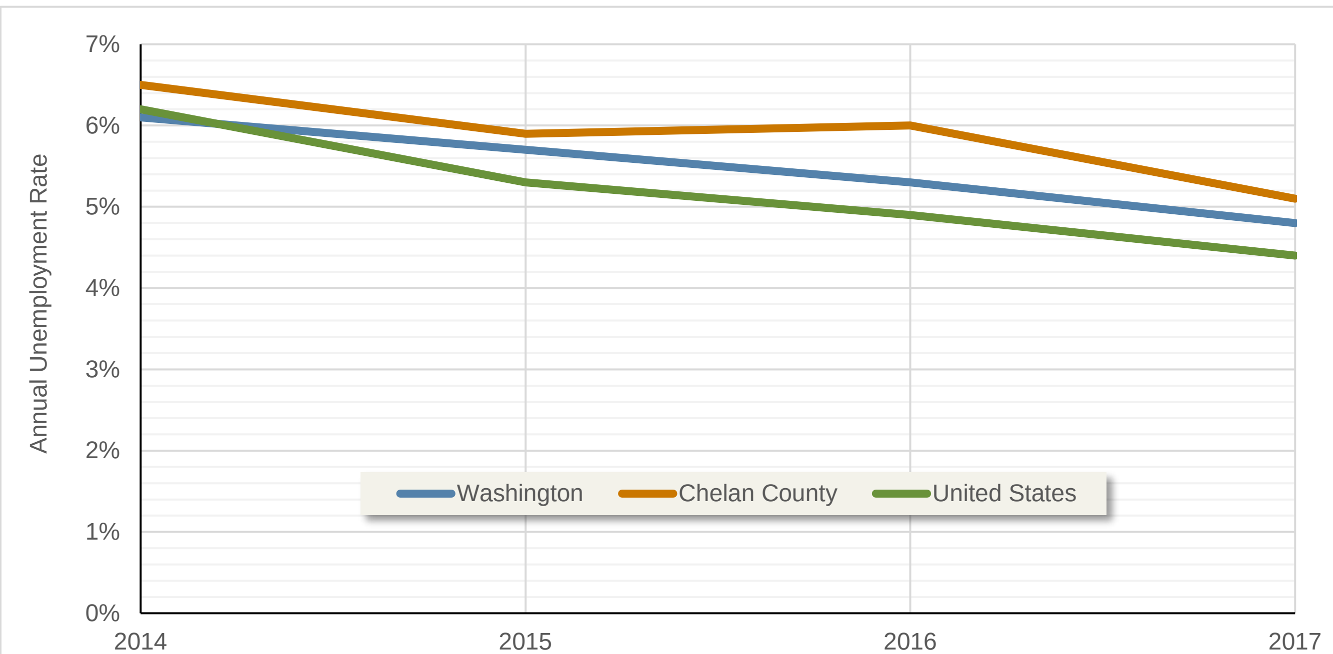


Figure 4-10. U.S., Washington and Chelan County Unemployment Rate

Figure 4-11 shows U.S. Census estimates of employment distribution by occupation category (U.S. Census, 2013). Management, business, science and arts occupations make up 29 percent of the jobs in the planning area. Sales and office occupations make up 20 percent.

The U.S. Census estimates that 77 percent of workers in the planning area commute alone (by car, truck or van) to work (U.S. Census, 2013).

2013 U.S. Census

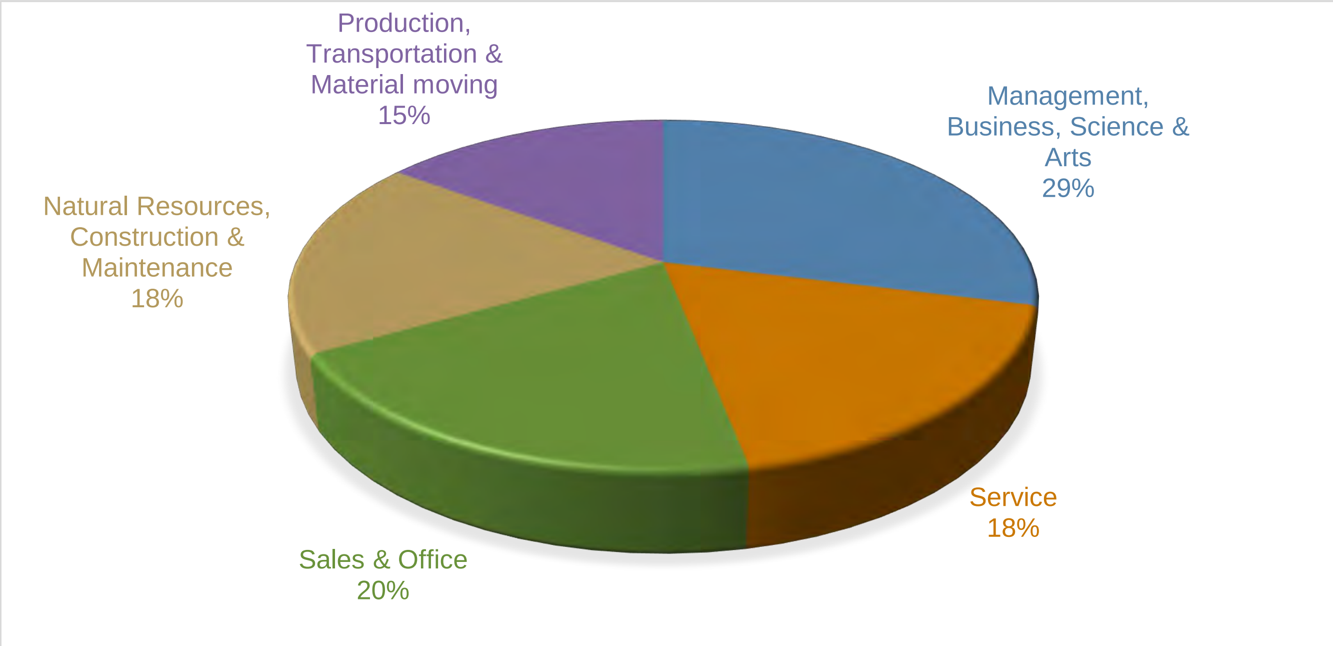


Figure 4-11. Occupations in the Planning Area

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 determine 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.
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 Environmental Policy Act	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.
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
Building Code	Action Plan Implementation	The adoption and enforcement of appropriate building codes is a significant component for hazard mitigation loss avoidance. Using the most up to date and relevant codes reduces risk and increases capability.
Comprehensive Emergency Management Planning	Hazard Mitigation Planning	Emergency management functions of the state and its political subdivisions must be coordinated with comparable functions of the federal government, agencies of other states and localities, and private agencies.
Dam Safety Program	Dam Failure	This program requires regular inspection of state-regulated dams.
Department of Ecology Grants	Action Plan Implementation; Flood Hazard	Flood Control Maintenance Program provides grant funding to local governments for flood hazard management planning and implementation
Enhanced Mitigation Plan	Hazard Mitigation Planning	Local hazard mitigation plans must be consistent with their state's hazard mitigation plan. The Chelan County plan must, at a minimum, address those hazards identified in the state plan as impacting Chelan County.
Environmental Policy 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 Environmental Policy Act compliance upon implementation.
Floodplain Management Law	Flood Hazard	Identifies prevention of flood damage as a matter of statewide public concern and authorizes county governments to levy taxes, condemn properties and undertake flood control activities
Growth Management Act	Hazard Mitigation Planning	Regulates development in critical areas, and therefore has the potential to affect hazard vulnerability and exposure at the local level
Hydraulic Code	Action Plan Implementation	Will require state permit for mitigation projects that will use, divert, obstruct, or change the natural flow or bed of any salt or freshwaters of the state.
Land and Water Conservation Fund	Action Plan Implementation	May provide funding for mitigation projects that include land acquisition and development or renovation, such as natural areas and open space.
Salmon Recovery Fund	Action Plan Implementation	May provide funding for mitigation projects that protect existing, high quality habitat for salmon or that restore degraded habitat to increase overall habitat health and biological productivity
Shoreline Management Act	Hazard Mitigation Planning	Shoreline management programs are local capabilities relevant to mitigation activities.
Silver Jackets	Flood Hazard	The team's projects address state needs and improve flood risk management throughout the full flood life cycle.
Washington Administrative Code 118-30-060(1)	Hazard Mitigation Planning	Requires each political subdivision to base its comprehensive emergency management plan on a hazard analysis and provides a standardized definition of "hazard."
Watershed Management Act	Hazard Mitigation Planning	Encourages local communities to develop plans for protecting local water resources and habitat.

5.2 LOCAL AGENCIES, PLANS 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.

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:

- Comprehensive plans (housing elements, safety 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.

The following sections describe countywide agencies, plans and codes relevant to the hazard mitigation planning process. Additional local information is provided in the partner annexes in Volume 2 of this plan.

5.2.1 Flood Control Zone District

The Chelan County Flood Control Zone District was initiated by the Board of Chelan County Commissioners in June 2014 (Resolution 2014-59). RCW 86.15 enables the creation of such districts for the purpose of undertaking, operating or maintaining flood control projects. Activities of the Flood Control Zone District may include the following:

- Flood warning and emergency response
- Flood-proofing and elevation of structures
- Property acquisition
- Implementation of consistent development regulations that recognize the impacts of flooding
- Basin-wide flood planning
- Flood facility maintenance
- Public education and outreach
- Mapping and technical studies
- Mechanisms for citizen inquiry and public assistance
- Identification, engineering and construction of capital projects to mitigate flood problems.

The Chelan County Flood Control Zone District was established in response to the growing frequency and severity of flash and stage flooding in greater Chelan County. The Interim Operating Guidelines for the Flood

Control Zone District identified the following primary purposes of the District, the spirit of which will continue to be implemented throughout the life of this Plan (Chelan County Flood Control Zone District, 2014):

- To safeguard human life, health, and safety by protecting public infrastructure from flooding and channel migration
- To identify and implement flood hazard management activities in a cost-effective and environmentally sensitive manner
- To identify flood-prone and repetitive loss areas involving public infrastructure within Chelan County and identify solutions for flood control mitigation in those areas
- To prioritize capital projects to mitigate damage from flash and stage flooding in flood-prone and repetitive loss areas
- To lead and coordinate recovery efforts for significant flooding events within Chelan County with local, state, and federal agencies
- To increase awareness and provide education to the public and other local agencies on flood hazards and effective mitigation measures
- To update, manage, and administer flood zone mapping, local flood zone regulations, and flood hazard assessments within greater Chelan County for consistency with the NFIP.

The Chelan County Flood Control Zone District is funded by an annual property tax of $0.07 per $1,000 assessed value. Twenty counties in Washington have some type of flood control district, including seven with county-wide flood control zone districts. Examples of 2016 levy rates in these districts include $0.12980 per $1,000 in King County, $0.1344 per $1,000 in Whatcom County, $0.070054 per $1,000 in Kittitas County, $0.10 per $1,000 in Pierce County and $0.08975 per $1,000 in Yakima County.

Completion of the 2017 Comprehensive Flood Hazard Management Plan was one of the principle goals identified under the interim operating guidelines. The adopted Flood Plan directs future operations of the Flood Control Zone District.

5.2.2 Comprehensive Plan

Chelan County's first Comprehensive Plan, adopted in 1958, provided guidance about what residents hoped to see in their community. Washington's 1990 Growth Management Act established specific goals and requirements for local comprehensive plans and development regulations. Chelan County adopted a Comprehensive Plan in 2000 to comply with the Washington Growth Management Act (GMA). The last mandated review and update to the Comprehensive Plan was completed in 2017 (Resolution 2017-119)), with additional updates occurring annually.

5.2.3 Emergency Management Plan

The 2016 Comprehensive Emergency Management Plan is Chelan County's framework for response to a disaster or emergency. Several emergency support function documents provided as functional annexes to the basic plan outline general guidelines by which County organizations will carry out the responsibilities assigned in the plan. These emergency support function documents are consistent with FEMA's 2008 *National Response Framework*.

The Comprehensive Emergency Management Plan details the authorities, functions, and responsibilities of local, state, and federal agencies in the event of emergency. It describes the processes of crisis and consequence management and how the integrated actions of local, state, and federal agencies establish a mutually cooperative environment for preparedness, prevention, response, and recovery activities.

5.2.4 Critical Areas Ordinance

Washington's GMA requires cities and counties to adopt policies and development regulations based on the best available science to protect critical areas. Chelan County updated its Critical Areas Ordinance to comply with the GMA in 2007 and is currently undergoing another update to the ordinance. Title 11 of the Zoning Code describes, and defines setback requirements for, the following critical areas:

- Fish and wildlife habitat conservation areas
- Wetland areas
- Aquifer recharge areas
- Frequently flooded areas
- Geologically hazardous areas.

5.2.5 Shoreline Master Program

Chelan County's Shoreline Master Program is a planning and regulatory document that contains policies, goals and land-use regulations for shorelines. The current Shoreline Master Program was adopted by the Chelan County Regional Planning Council and the Washington Department of Ecology in 1975 and was revised in 1979. Primary responsibility for administering this regulatory program is assigned to the County's Community Development Department, which has jurisdiction for permitting development on the state's shoreline within the County.

The Chelan County Community Development Department updated the Shoreline Master Program in December 2017 (Resolution 2017-120) . The Cities of Cashmere, Chelan, Entiat, Leavenworth and Wenatchee also participated in the Shoreline Master Program update. Each city and the county adopted Shoreline Master Programs in the mid-1970s to comply with the state's Shoreline Management Act.

5.2.6 WRIA Planning

Although Washington's Watershed Management Act does not require planning, Chelan County and local governments have undertaken WRIA-related planning activities. The Washington Department of Ecology is providing technical and financial support for the effort. Chelan County has participated in watershed planning for four WRIAs (see descriptions in Section 4.3.2):

- Wenatchee Watershed (WRIA 45)
- Entiat Watershed (WRIA 46)
- Chelan Watershed (WRIA 47)
- Alkali-Squilchuck Watershed (WRIA 40).

5.2.7 Chelan County Natural Resources Department

The County's Natural Resource Department addresses federal, state, and local natural resource mandates and issues. Areas of focus include water resources and timber, fish, wildlife, and agricultural activities within Chelan County and north-central Washington. The Department addresses the impacts of local, state, federal, tribal, and other initiatives, both regulatory and non-regulatory, on natural resource and the economic base of Chelan County. It responds to the general policy direction of the Board of County Commissioners and integrates other County departments' activities into its work products.

5.2.8 Voluntary Stewardship Program

The Voluntary Stewardship Program is an optional, incentive-based approach to protecting critical areas while promoting agriculture. The program is allowed under the Growth Management Act as an alternative to traditional approaches to critical areas protection, such as “no touch” buffers. Chelan County is one of 28 counties that has opted in to the Voluntary Stewardship Program and completed a work plan in 2017.

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, StormReady, and Firewise USA, 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 changing conditions. 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.

6. HAZARDS OF CONCERN FOR RISK ASSESSMENT

Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from natural hazards. The DMA requires hazard mitigation planning to include risk assessment (44 CFR, Section 201.6(c)(2)). The risk assessment for the *Chelan County Multi-Jurisdiction Natural Hazard Mitigation Plan* evaluates all natural hazards that are prevalent in the defined planning area. The first step in the process was to identify which hazards to include in the assessment. This chapter describes the process of identifying these hazards of concern.

6.1 FOCUS ON NATURAL HAZARDS

Natural hazards are naturally occurring severe events that have the potential to result in the loss of life and property. Technological or human-caused hazards also have the potential to result in the loss of life and property but originate from human activities. Federal hazard mitigation planning guidelines require risk assessment for all natural hazards of concern; risk assessment of non-natural hazards (technological and/or human-caused) is optional. The Steering Committee decided that this plan will focus on natural hazards of concern, based on several factors:

- The federal funding streams for which this plan creates eligibility are focused on natural hazards of concern.
- The expertise needed to identify and implement appropriate mitigation actions for non-natural hazards of concern differs from the expertise needed for assessing natural hazards. The Steering Committee was formed with an emphasis on knowledge of and experience with natural hazards.
- It is difficult to develop a relative ranking of the risk of natural and non-natural hazards because of differences between the two types of hazard in probabilities, consequences and spatial extent.

The Steering Committee discussed cyber-related threats, specifically crypto currency mining, but decided not to include this hazard in the plan at this time. This hazard will be monitored and included in the next update if warranted.

6.2 IDENTIFIED HAZARDS OF CONCERN

The Steering Committee considered the full range of natural hazards that could impact the planning area and selected those that present the greatest concern for evaluation in this hazard mitigation plan. The process incorporated review of state and local hazard planning documents, as well as information on the frequency, magnitude and costs associated with hazards that have impacted or could impact the planning area. Anecdotal information regarding the perceived vulnerability of planning area assets to natural hazards was used as appropriate. Table 6-1 summarizes the review of hazards and selection of hazards of concern for this plan.

The Steering Committee also recognized the importance in Chelan County of impacts from various hazards on agriculture. Because of this, a stand-alone chapter is provided in the risk assessment for this plan summarizing the impact of all hazards on local agriculture.

Table 6-1. Assessment of Hazards for this Hazard Mitigation Plan

Hazard	Included in 2010 Chelan County Plan	Noted as Local Hazard in State Plan	Consideration	Included in Current Update
Avalanche	Yes	Yes	Winter snow accumulations, temperature variations (freeze-thaw cycle), and steep slopes result in occasional avalanches in the area, although development is typically not located in these areas.	Yes
Climate change	No	No	Steering Committee identified this as a current local hazard	Yes
Cyber threats	No	No	Not a natural hazard; may be included in future updates	No
Dam failure	No	No	Steering Committee identified this as a current local hazard	Yes
Drought	Yes	Yes	Extreme summer heat and markedly low precipitation in the lowlands, where most of the agricultural and residential development occur, result in occasional drought conditions and declarations.	Yes
Earthquake	Yes	Yes	The mountainous terrain and geologic instability of the region result in frequent minor earthquakes and occasional events that cause property damage.	Yes
Flood	Yes	Yes	Chelan County is distinguished by mountainous terrain and narrow river valley bottoms that contain much of the developable land base.	Yes
Landslide	Yes	Yes	A combination of severe storms, steep slopes and unstable geography results in occasional landslides.	Yes
Seiche	No	No	Steering Committee identified this as a current local hazard	Yes
Severe weather	Yes	Yes	The area is marked by four traditional seasons, with summer and winter weather exhibiting sometimes extreme conditions. Long periods of cold weather and snow in the winter and extended periods of 100 degrees + in summer are not uncommon.	Yes
Wildfire	Yes	Yes	Extreme summer conditions combined with historic and present timber management practices have resulted in large-scale wildfires, including areas at the urban wildland interface	Yes
Volcano	Yes	No	State plan does not recognize this as a hazard for Chelan County	No

7. RISK ASSESSMENT METHODOLOGY

7.1 OVERALL RISK ASSESSMENT APPROACH

The risk assessments in Chapter 8 through Chapter 15 describe the risks associated with each identified hazard of concern. Each chapter describes the hazard, the planning area's exposure and vulnerability, and probable event scenarios. The planning team reviewed existing studies, reports and technical information to determine the best available data to utilize in the risk assessment (44 CFR, Section 201.6(b)(3)). Information from these sources was incorporated into the hazard profiles and forms the basis of the exposure and vulnerability assessment (see Section 7.5). The following steps were used to define the risk of each hazard:

- Profile each hazard—The following information is given for each hazard:
  - Summary of past events
  - Geographic area most affected by the hazard
  - Event frequency estimates
  - Severity estimates
  - Warning time likely to be available for response
  - Secondary hazards associated with or resulting from the hazard of concern
  - Future trends that may impact risk, including future development and climate trends
  - Worst-case event scenario
  - Key issues related to mitigation of the hazard in the planning area.
- Determine exposure to each hazard—Exposure was determined by overlaying hazard maps with demographic information and an inventory of structures, facilities and systems to determine which of them would be exposed to each hazard. For each hazard of concern, the best available existing data was used to delineate the hazard area, based on scale, age and source. Data available in a GIS-compatible format with coverage of the full extent of the planning area was preferred when available.
- Assess the vulnerability of exposed facilities—Vulnerability of exposed structures and infrastructure was determined by interpreting the probability of occurrence of each event and assessing structures, facilities, and systems that are exposed to each hazard. FEMA's hazard-modeling program, Hazus was used to perform this assessment for some hazards; GIS-based spatial analysis or qualitative assessments were used for others.

7.2 MAPPING

National, state and county databases were reviewed to locate spatially based data relevant to this planning effort. Maps were produced using GIS software to show the spatial extent and location of identified hazards when such data was available. These maps are included in the hazard profile chapters of this document. Additionally, municipal planning partners have jurisdiction-scale maps included in their annexes in Volume 2 of this plan. Information on the data sources and methodologies used for hazard mapping is provided in Appendix C.

7.3 DAM FAILURE, EARTHQUAKE AND FLOOD

7.3.1 Overview of FEMA's Hazus Software

FEMA developed the Hazards U.S., or Hazus, model in 1997 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 new models for estimating potential losses from hurricanes and floods. The use of Hazus for hazard mitigation planning offers numerous advantages:

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

Hazus is a GIS-based software program used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data, such as demographics, building stock, critical facilities, transportation and utility lifeline, and multiple models to estimate potential losses from natural disasters. The program can be used to map hazard data and the results of damage and economic loss estimates for buildings and infrastructure.

7.3.2 Levels of Detail for Evaluation

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

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

7.3.3 Application for This Plan

The Hazus model was used as follows for the hazards evaluated in this plan:

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.

- **Earthquake**—A Level 2 analysis was performed to assess earthquake exposure and vulnerability for two scenario events and one probabilistic events:
  - A Magnitude-7.2 event on the Chelan Fault with an epicenter approximately 5.6 miles east-southeast of the City of Chelan.
  - A Magnitude-9.0 event on the Cascadia Fault with an epicenter approximately 250 miles southwest of Wenatchee.
  - The standard Hazus 100-year probabilistic event.

7.4 DROUGHT

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

7.5 SOURCES OF DATA USED IN RISK ASSESSMENT

7.5.1 Building Count and Replacement Cost Value

Replacement cost values and detailed structure information from the Chelan County Risk Assessment Database user-defined facilities provided by the Washington State Department of Natural Resources (WDNR) 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, 2018). It is calculated using the RS Means square foot cost for a structure, which is based on the Hazus occupancy class (i.e., multi-family residential or commercial retail trade), multiplied by the square footage of the structure from the tax assessor data. The construction class and number of stories for single-family residential structures also factor into determining the square foot costs.

7.5.2 Hazus Data Inputs

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

- **Flood**—The 2017 Chelan County Floodplain Management Plan (FMP) flood data and Wenatchee Watershed Mass Zone A data provided by WDNR were used to estimate the potential losses from the 1-percent-annual-chance and 0.2-percent-annual-chance flood events. Using the Mass Zone A flood boundaries and a combined digital elevation model (DEM), created from 1-meter and 10-meter DEM datasets, a Mass Zone A flood depth grid was generated. The Mass Zone A depth grid was combined with the FMP depth grids, and integrated into the Hazus model.
- **Earthquake**—Earthquake ShakeMaps and probabilistic data prepared by the U.S. Geological Survey (USGS) were used for the analysis of this hazard. National Earthquake Hazard Reduction Program (NEHRP) soils and liquefaction susceptibility information contained in the Chelan County Risk Assessment Database user-defined facilities were utilized in the Hazus model.

7.5.3 Other Local Hazard Data

Locally relevant information on hazards was gathered from a variety of sources. Frequency and severity indicators include past events and the expert opinions of geologists, emergency management specialists, and others. Data sources for specific hazards were as follows:

- **Avalanche**—No GIS format avalanche area datasets were identified for Chelan County.
- **Dam or Levee Failure**—Overtopping breach inundation area data for Eight Mile Lake Dam were provided by Anchor QEA through the Washington State Department of Ecology (WA Ecology).
- **Landslide**—Deep-seated and shallow landslide hazard area datasets were provided by WDNR. Both datasets have landslide areas categorized into nine susceptibility levels—1 through 9. For the exposure analysis, these levels were grouped into three categories: low (levels 1 – 3), moderate (levels 4 – 6) and high (levels 7 – 9). Separate exposure analyses were conducted for deep-seated and shallow landslide areas.
- **Seiche**—No GIS format seiche area datasets were identified for Chelan County.
- **Severe Storm**—No GIS format severe storm area datasets were identified for Chelan County.
- **Wildfire**—Wildland urban interface areas data was acquired from the Chelan County Natural Resources Department. The interface area categories—interface high structure density, interface medium structure density, interface low structure density, interface very low structure density, intermix medium structure density, intermix low structure density, and intermix very low structure density—were used for the exposure analysis.

7.5.4 Data Used for Spatial Analysis

Table 7-1 describes the data used for spatially based exposure and vulnerability assessments. If no database was available, it was noted as a gap.

7.6 LIMITATIONS

7.6.1 General Limitations

Loss estimates, exposure assessments and hazard-specific vulnerability evaluations rely on the best available data and methodologies. However, results are subject to uncertainties associated with the following factors:

- Incomplete scientific knowledge about natural hazards and their effects on the built environment
- 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.

Hazus currently represents the industry best management practice for assessing risk in support of hazard mitigation planning. However, Hazus and other models used for this risk assessment are limited by the availability of data to support their working components. Such models must assumptions where firm data are not available. Assumptions are used, for example, to estimate ground deformation caused by liquefaction. These model limitations can lead to an understatement or overstatement of risk.

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

Table 7-1. Summary of Data Used for Spatial Analysis

Data	Source	Date	Format
Chelan County Risk Assessment Database user-defined facilities	WDNR	2017	Digital (GIS) format
Building replacement cost	RS Means	2018	Paper format. Updated RS Means values
Population data	FEMA Hazus version 4.2 SP01	2010	Digital (GIS and tabular) format
Chelan County Floodplain Management Plan flood areas & flood depth grids	Tetra Tech	2017	Digital (GIS) format
Wenatchee Watershed Mass Zone A	STARR; provided by WDNR	2016	Digital (GIS) format
1-meter LiDAR DEM	Oregon Department of Geology & Mineral Industries	2015	Digital (GIS) format
1-meter DEM	USGS	Downloaded 2018	Digital (GIS) format
10-meter DEM	USGS	Downloaded 2018	Digital (GIS) format
Cascadia M9.0 ShakeMap	USGS Earthquake Hazards Program website	2016	Digital (GIS) format
Chelan M7.2 ShakeMap	WDNR	2009	Digital (GIS) format
Eight Mile Lake Dam Overtopping Breach Inundation Area	Anchor QEA; provided by WA Ecology	Unknown	Digital (GIS) format
Deep-seated Landslide Hazard Areas	WDNR	Unknown	Digital (GIS) format
Shallow Landslide Hazard Areas	WDNR	Unknown	Digital (GIS) format
Wildland Urban Interface Areas (from Community Wildfire Protection Plan)	Chelan County Natural Resources Dept.	2018	Digital (GIS) format
Digital Elevation Model	San Mateo County	2006	Digital (GIS) format
Critical Facilities and Assets			
Chelan County Floodplain Management Plan Critical Facilities Database	Tetra Tech	2017	Digital (GIS) format
Earthquake Performance Analysis Tool School Building Analysis for Chelan County	WDNR	2017	Digital (spreadsheet) format

Note: Additional information on hazard data can be found in Appendix C.

7.6.2 Specific Limitations Noted During the Planning Process

The following are limitations specific to the datasets used in this planning process:

- Chelan County assessor data lacked detailed information on building and foundation type (e.g. masonry construction and slab-on-grade, respectively). Default information was used, which impacts the accuracy of vulnerability estimates because building and foundation type play a major role in how structures will behave during hazard events.
- Model data input requirements necessitate the conversion of building footprints into single point features. Building locations are represented by single points located in the centroid of the building footprint.
- Data used in the wildfire assessment is dated and does not cover the entire planning area.
- Not all critical facility data was available in a digital format. Best available datasets were used.

Part 2. Risk Assessment

8. AVALANCHE

8.1 GENERAL BACKGROUND

8.1.1 Causes

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

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

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

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

8.1.2 Types

Avalanches are basically of two types:

- **Loose snow avalanches** start at a point or over a small area. Slab avalanches, on the other hand, start when a large area of snow begins to slide at the same time. Snow avalanches grow in size and the quantity of snow involved increases as they descend. Steep slopes, usually from 30 to 50 degrees, and snow, are the only requirement for avalanches. The forces generated by moderate or large avalanches can damage or destroy most man-made structures. Loose avalanches occur when grains of snow cannot hold onto a slope and begin sliding downhill, picking up more snow and fanning out in an inverted V. Slab avalanches occur when a cohesive mass of snow breaks away from the slope all at once.

- **Dry slab avalanches** occur when the stresses on a slab overcome the internal strength of the slab and its attachment to surrounding snow. A decrease in strength caused by warming, melting snow, or rain, or an increase in stress produced by the weight of additional snowfall, a skier or a snowmobile cause this type of avalanche. Dry slab avalanches can travel 60 to 80 miles per hour, reaching these speeds within five seconds after the fracture; they account for most avalanche fatalities. Wet slab avalanches occur when water percolating through the top slab weakens it and dissolves its bond with a lower layer, decreasing the ability of the weaker, lower layer to hold on to the top slab, as well as decreasing the slab's strength.

8.1.3 Zones

Avalanches can reach speeds of up to 200 miles an hour and can exert forces great enough to destroy structures and uproot or snap off large trees. Avalanche paths consist of three zones:

- Starting Zone—A zone near the top of a ridge, bowl or canyon, with steep slopes of 25 to 50 degrees.
- Track Zone—A reach with mild slopes of 15 to 30 degrees and the area where the avalanche will achieve maximum velocity and considerable mass.
- Run-Out Zone—An area of gentler slopes (5 to 15 degrees) at the base of the path, where the avalanche decelerates, and massive snow and debris deposition occurs.

8.2 HAZARD PROFILE

8.2.1 Past Events

Avalanches occasionally occur along state transportation routes at Blewett Pass, Stevens Pass, and Tumwater Canyon, although these events are usually cleared within a few hours. Backcountry avalanches have also occurred, including some at Mission Ridge Ski Resort in southern Chelan County. There have been some fatalities in Chelan County as a result of avalanches. On March 1, 1910 the Wellington disaster occurred just west of the County line, on Stevens Pass. Two stranded passenger trains were swept away and buried by an avalanche. 96 people lost their lives in this disaster. Table 8-1 summarizes other avalanche fatalities in Chelan County.

Table 8-1. Avalanche Fatalities

Year	Location	Fatalities
1962	Stevens Pass	2
1971	Stevens Pass/Yodelin	4
1978	Mission Ridge	1
1994	Mission Ridge	1
2012	Tunnel Creek	3

8.2.2 Location

Much of Chelan County is located in the Cascade Mountains, which receive extensive precipitation due to their size and orientation to the flow of Pacific marine air. The winter snowpack is among the deepest recorded in the United States. There are primarily two areas where avalanches occur that affect the citizens and infrastructure of Chelan County—transportation routes and recreation areas. Stevens Pass and Tumwater Canyon along U.S. Highway 2 and Blewett Pass along U.S. Highway 97 are located in avalanche-prone areas. Additionally, avalanches threaten backcountry recreation areas. With better equipment allowing more people to explore further into the wilderness, areas threatened by avalanche are those accessible by skiers, snowshoers, snowboarders, climbers, and snowmobilers outside developed ski resorts in the mountains of Washington. Figure 8-1 shows avalanche hazard areas in Washington.

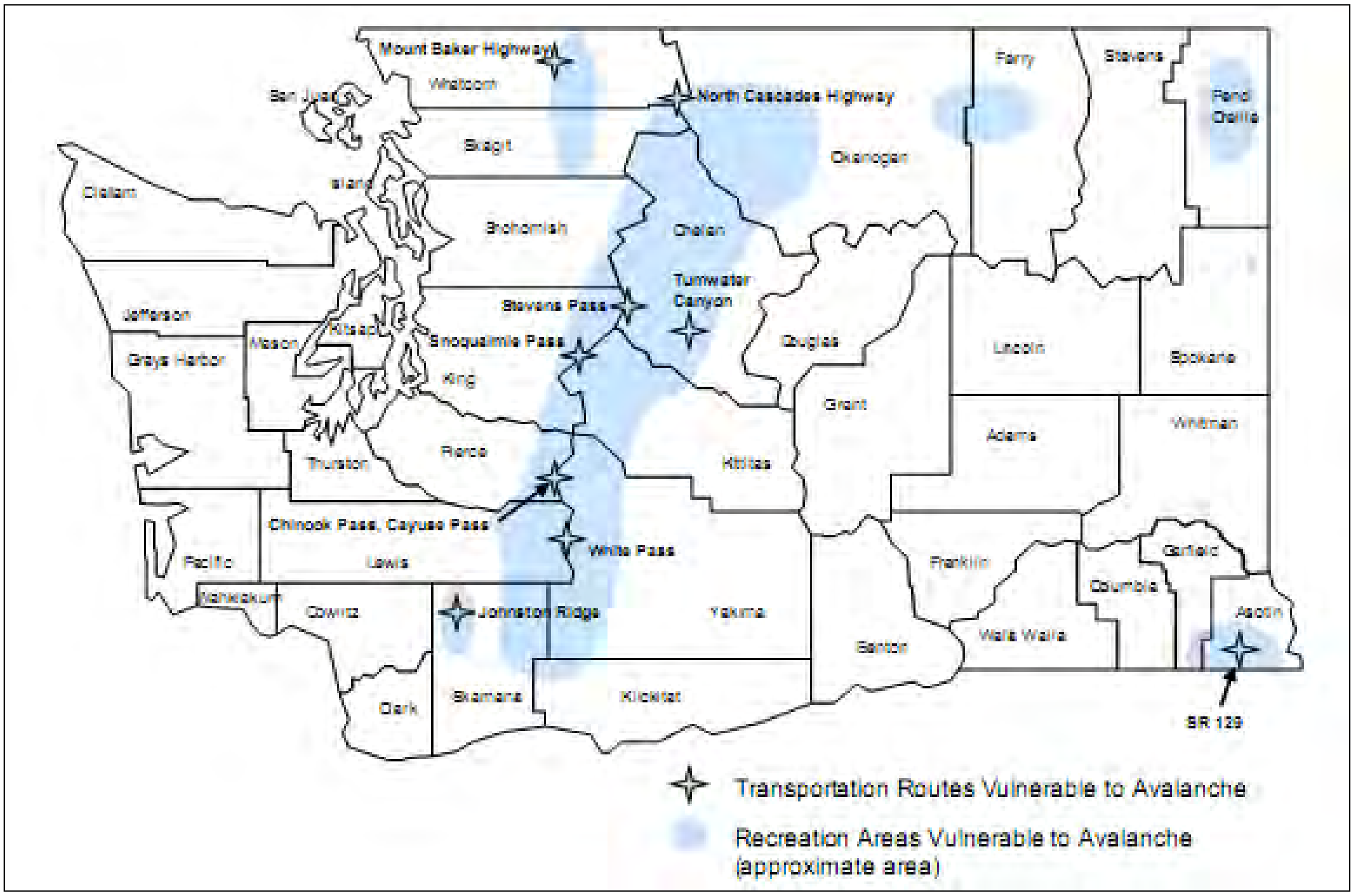


Figure 8-1. Areas Vulnerable to Avalanche

8.2.3 Frequency

Avalanche season in Chelan County can extend from November to early summer. In higher alpine areas, the season continues year-round. At lower elevations of the Cascades, the avalanche season begins in November and continues until the last remnants of snow have melted in early summer. In the high alpine regions, the hazard continues year-round. Hundreds of thousands of avalanches are thought to occur each year in the Cascades.

8.2.4 Severity

Large external lateral loads can cause significant damage to structures and fatalities. Table 8-2 indicates the estimated potential damage for a given range of impact pressures.

Table 8-2. Impact Pressures Related to Damage

Impact Pressure (pounds per square foot)	Potential Damage
40-80	Break windows
60-100	Push in doors, damage walls, roofs
200	Severely damage wood frame structures
400-600	Destroy wood-frame structures, break trees
1,000-2,000	Destroy mature forests
>6,000	Move large boulders

Source: www.avalanche.org

The BNSF Railway follows essentially the same east-west route as SR-2. The potential for rail service interruption, or for damage to a train carrying hazardous cargo in populated or environmentally sensitive areas, is of concern.

The following weather and terrain factors affect avalanche severity and danger:

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

8.2.5 Warning Time

The Northwest Weather and Avalanche Center provides daily forecasts as well as information regarding significantly increased avalanche danger that may serve as advanced warning for individuals participating in activities where avalanches may occur. These warning are generalized and simply alert exposed individuals to an increased risk of occurrence.

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

8.3 SECONDARY HAZARDS

Avalanches can cause blocked roads, which can isolate residents and businesses and delay commercial, public and private transportation. This could result in economic losses for businesses. Other potential problems resulting from avalanches are power and communication failures. Avalanches also can damage rivers or streams, potentially harming water quality, fisheries and spawning habitat.

8.4 EXPOSURE

8.4.1 Population

Due to the presence of key transportation routes and recreation areas in the Cascades, Chelan County is one of the most vulnerable counties in the state to avalanche disasters; however, avalanches in Chelan County do not typically adversely affect significant populations or infrastructure. Most avalanche victims are participating in recreational activities in the backcountry where there is no avalanche control. Only one-tenth of 1 percent of avalanche fatalities occurs on open runs at ski areas or on highways. Because of increased winter recreational use in the Wenatchee National Forest and other adjacent lands in Chelan County, a larger amount of people are becoming exposed to avalanche risks.

8.4.2 Property

There is little property exposed to avalanches. Property and buildings exposed include National Forest huts and temporary structures belonging to mining and forestry operations.

8.4.3 Critical Facilities and Infrastructure

There are no critical facilities exposed to avalanches. There is a small amount of infrastructure that could be blocked by avalanches, including hiking trails, fire roads and logging roads.

8.4.4 Environment

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

8.5 VULNERABILITY

In general, everything that is exposed to an avalanche event is vulnerable. More and more people are working and building in or using the high mountain areas of the Cascades in potential avalanche areas. These individuals often have little experience with, caution regarding, or preparation for, avalanche conditions. The increasing development of recreational sites in the mountains brings added exposure to the people using these sites and the access routes to them. The risk to human life is especially great at times of the year when rapid warming follows heavy, wet snowfall.

8.6 FUTURE TRENDS IN DEVELOPMENT

Future trends in development cannot be determined until the avalanche hazard areas are accurately mapped. However, it is likely that future development will be predominantly concentrated in incorporated areas of the county that have limited exposure to the avalanche hazard. Any future development in more remote and mountainous areas of the County, such as in scenic or resource/recreation designations, may result in a limited increase in exposure.

8.7 SCENARIO

In a worst-case scenario, an avalanche would occur in the Cascade Mountains after a series of storms. Storms starting with low temperatures and dry snow, followed by rising temperatures and wetter snow, are more likely to cause avalanches than storms that start warm and then cool with snowfall.

8.8 ISSUES

Avalanches pose a threat to recreational users and property and can disrupt the east-west transportation network. Specially trained Washington Department of Transportation avalanche-control teams use active and passive means to reduce the avalanche hazard near Snoqualmie and Stevens Pass each year. Their efforts limit the number and duration of highway closures. The state posts warning signs in key locations warning recreation users of avalanche dangers, although these signs are commonly ignored. There is no effective way to keep the public out of avalanche-prone recreational areas, even during times of highest risk. A coordinated effort is needed among state, county and local law enforcement, fire, emergency management and public works agencies and media to provide better avalanche risk information.

A national program to rate avalanche risk has been developed to standardize terminology and provide a common basis for recognizing and describing hazardous conditions. This United States Avalanche Danger Scale relates degree of avalanche danger (low, moderate, considerable, high, extreme) to descriptors of avalanche probability and triggering mechanism, degree and distribution of avalanche hazard, and recommended action in back country. Figure 8-2 shows key elements of the danger scale. This information, updated daily, is available during avalanche season from the joint NOAA/U.S. Forest Service Northwest Weather and Avalanche Center and can be obtained from Internet, NOAA weather wire, and Department of Transportation sources. Avalanche danger scale information should be explained to the public and made available through appropriate county and local agencies and the media.

The state maintains over 50 years of detailed records to help technicians forecast how snow might behave; however, climate change will likely alter the frequency and magnitude of avalanche events in the planning area. Methods will need to be developed to integrate forward-looking standards and best practices for avalanche management techniques.

The Northwest Weather and Avalanche Center provides a source of information to recreational users regarding current conditions and danger levels as well as incident summaries by date and location and additional resources. Measures that have been used in other jurisdictions to reduce avalanche threat include monitoring timber harvest practices in slide-prone areas to ensure that snow cover is stabilized as well as possible, and encouraging reforestation in areas near highways, buildings, power lines and other improvements. The development of a standard avalanche report form, and the maintenance of a database of potential avalanche hazards likely to affect proposed developments in mountain wilderness areas, would be of significant value to permitting agencies.

Avalanche Safety Basics

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

UNITED STATES AVALANCHE DANGER DESCRIPTORS

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

Figure 8-2. United States Avalanche Danger Scale

9. DAM OR LEVEE FAILURE

9.1 GENERAL BACKGROUND

9.1.1 Dams

Dam failures can be caused by natural events, such as flooding or an earthquake, but they are predominantly caused by human error such as poor construction, operation, maintenance or repair. The effects of a dam failure are highly variable, depending on the dam, the amount of water stored behind the dam, the current stream flow, and the size and proximity of the downstream population. There are many effects of a major dam failure: loss of life, destruction of homes and property, damage to roads, bridges, power lines and other infrastructure, loss of power generation and flood control capabilities, disruption of fish stock and spawning beds, and the erosion of stream and river banks.

9.1.2 Levees

Levees are a basic means of providing flood protection along waterways in regions where development exists or is planned, and in agricultural areas. Levees typically confine floodwaters to the main river channel. Failure of a levee can lead to inundation of surrounding areas. The causes of levee failures are structural failures, foundation failures of underlying soils, and overtopping by flood flows and waves. Contributing factors include poor construction materials, erosion by current and wave action, seepage through or under the levee, burrowing rodents, and improper repairs. Lack of adequate and regular maintenance to correct these problems also contributes to levee failure, including vegetation. Most failures are composites of several of these factors.

FEMA accredits levees as providing adequate risk reduction if levee certification and an adopted operation and maintenance plan are adequate. The criteria for which a levee can be accredited are specified in 44 CFR Section 65. Section 65.10 provides the minimum design, operation and maintenance standards levee systems must meet in order to be recognized as providing protection from the base flood on a Flood Insurance Rate Map. In order for a levee to be accredited, the owner must provide data and documentation to demonstrate that the levee complies with these requirements.

An area impacted by an accredited levee is shown as a moderate-risk area and labeled Zone X on a Flood Insurance Rate Map (FIRM). This accreditation affects insurance and building requirements. The NFIP does not require flood insurance for areas protected by accredited levees, although FEMA recommends the purchase of flood insurance in these areas due to the residual risk of flooding from levee failure or overtopping. If a levee is not accredited, the area it protects will still be mapped as a high-flood-risk area, and the federal mandatory purchase of flood insurance will apply (FEMA, 2012).

Even with levee certification and FEMA accreditation, there is a flood risk associated with levees. While levees are designed to reduce risk, even properly maintained levees can fail or be overtopped by large flood events. Levees reduce risk, they do not eliminate it.

9.2 HAZARD PROFILE

9.2.1 Past Events

Many dam failures have occurred in Washington State over the last 40 years, but none have been in or affected Chelan County. In 2018, there was an eminent threat of a potential dam failure on 8-mile lake as the severely burnt watershed surrounding the lake filled the lake with sediment and increased runoff taxing the storage capacity of the lake. Federal, state and local flood fighting efforts helped to avert a potential disaster downstream of the dam.

9.2.2 Location

Dams

Washington State's Downstream Hazard Classification system for dams assigns a hazard rating of "Low," "Significant" or "High" for areas at risk of economic loss and environmental damage should a dam fail. For high hazard dams, inundation mapping is included in their emergency action plans. However, this data is not readily available to local governments for public access in a format that can support planning due to security concerns. Emergency management agencies typically have this data to support emergency response functions, however there can be limitations on the use and distribution of this data due to security concerns.

According to the Washington Department of Ecology's inventory of dams, there are 42 dams in or adjacent to Chelan County. Many of them serve more than one purpose, such as hydroelectric power generation, irrigation and recreation. Of the 42 state inventoried dams within Chelan County, 25 are rated high (see Table 9-1). Failure of any of these dams could affect a population of 300 or more, inundate major transportation routes and industries, and have long-term effects on water quality and wildlife.

The only Dam Failure Inundation Mapping available in a spatial format to support this risk assessment was mapping provided by the WA Department of Ecology for the 8-Mile Lake dam. This mapping was the sole basis for the quantitative analysis performed for this assessment. The extent and location mapping for this dam is not being provided in this plan for security purposes.

Levees

In Chelan County, there are three levee segments that provide protection against floods of 25-year or more frequent recurrence intervals. These levee segments are all located within the City of Cashmere along the Wenatchee River. Information on these levee segments has been provided in Table 9-2. None of these levee segments are accredited by FEMA or fully accepted under the U.S. Army Corps of Engineers PL 84-99 Program.

9.2.3 Frequency

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

Table 9-1. Significant Dams in Chelan County

Name[a]	Water Course	Owner	Year Built	Crest Length (feet)	Height (feet)	Storage Capacity (acre-feet)	Drainage area (sq. mi.)
3 Amigos Reservoir	Stemilt Creek, off stream	Kyle Mathison Orchards, Inc.	2003	2300	23	124	0.00
Antilon Lake Dam	Tributary, Johnson Creek	Lake Chelan Reclamation District	1913	300	65	2900	2.54
Asamaera-Cannon Mine Tailings Dam	Dry Gulch	ConocoPhillips	1986	1050	350	3300	45
Beehive Dam	Tributary, Squilchuck Creek	Beehive Irrigation District	1953	380	10	130	0.11
Chelan Dam[b]	Chelan River	Chelan Co. PUD. #1	1928	490	30[c]	677,400	95.2
Clear Lake dam	Tributary, Stemilt Creek to Columbia River	Stemilt Irrigation District	1888	240	8	60	17
Clear Lake Saddle Dam	Tributary, Stemilt Creek to Columbia River	Stemilt Irrigation District	1888	300	13	48	0.03
Eight-mile Lake Outlet dam	Eight-mile Creek	Icicle & Peshastin Irrigation District	1933	200	22	1610	5.85
Great Depression Dam	Squilchuck Creek, off stream	Camp David Enterprises LLC	1997	210	22	37	0.06
Lilly Lake Dam	Tributary, Stemilt Creek to Columbia River	Stemilt Irrigation District	1892	500	14	420	0.43
Meadow Lake Dam	Tributary, Columbia River	Galler Ditch Co.	1920	350	18	600	5.00
Nada Lake Dam	Snow Creek, off stream	USFS	1940	23	9	150	0.00
Rock Island Dam[b]	Columbia River	Chelan Co. PUD #1	1933	3580	80[d]	113,700	94,900
Rocky Reach[b]	Columbia River	Chelan Co. PUD #1	1962	3820	135[e]	390,000	94,100
Spring Hill Dam	Tributary, Stemilt Creek, off stream	Wenatchee Heights Reclamation District	1918	800	30	520	0.43
Spring Hill Saddle Dam	Tributary, Stemilt Creek, off stream	Wenatchee Heights Reclamation District	1918	250	12	340	0.43
Stemilt Equalizing Reservoir	Tributary, Stemilt Creek, off stream	Stemilt Irrigation District	1985	440	24	43	0.04
Stemilt Main Dam	Orr Creek, off stream	Stemilt Project Inc.	1962	1000	65	580	0.28
Stemilt Saddle Dam	Orr Creek, off stream	Stemilt Project Inc.	1962	200	9	200	0.28
Tumwater Canyon Dam[b]	Wenatchee River	Chelan Co. PUD # 1	1909	400	20	10	686
Upper Loop Reservoir	Tributary, Stemilt Creek, off stream	Kyle Mathison Orchards	--	--	--	115	--
Upper Wheeler Dam	Orr Creek	Wenatchee Heights Reclamation District	1922	900	65	795	2.3
Upper Wheeler Saddle Dam	Orr Creek	Wenatchee Heights Reclamation District	1992	920	15	495	2.24
Wapato Lake Dam	Tributary, Lake Chelan	Lake Chelan Reclamation District	1912	540	40	3500	15.3
Wells Dam	Columbia River	Douglas County T & LS	1967	4105	196	500,000	85,300

a. Dams listed are those with downstream Hazard Class 1 (> 300 lives at risk). This refers to the potential effect in the case of a dam failure. It does not indicate a high probability of such failure.
b. According to Chelan County PUD dam break studies, in an event of a dam-break at these dams, the water surface/flood wave will be maintained within the PUD's project boundaries, so the potential loss of life is near zero.
c. Height measured from deck (1,109) to riverbed (apron at 1,079)
d. Height measured from deck (616) to foundation of north abutment wall (536)
e. Height measured from parapet wall (720) to foundation (585)

Source: Ecology, 2018.

Table 9-2. Levee Profiles

Levee Segment Name	Length (feet)	Top Width (feet)	Level of Protection (% chance of exceedance)	PL 84-99 Rating
Cashmere Segment 1 (partially in unincorporated county)	675	12-50	20	Minimally Acceptable
Cashmere Segment 2	1,450	10-20	10	Minimally Acceptable
Cashmere Segment Sewage Treatment Plant	3,400	10	10	Unacceptable

9.2.4 Severity

The DSO classifies regulated dams in Washington by hazard class, based on the at-risk population living in the area that could be inundated if the dam fails. The hazard class definitions and number of Chelan County dams in each class are as follows (Washington Department of Ecology, 2019a):

- 4 Hazard Class 1A (High—a downstream at-risk population of more than 300)
- 10 Hazard Class 1B (High—a downstream at-risk population of 31 to 300)
- 10 Hazard Class 1C (High—a downstream at-risk population of 7 to 30)
- 7 Hazard Class 2 (Significant—a downstream at-risk population of 1 to 6)
- 13 Hazard Class 3 (Low—no downstream at-risk population).

The U.S. Army Corps of Engineers developed the classification system shown in Table 9-3 for the hazard potential of dam failures. The DSO and Corps of Engineers hazard rating systems are based only on the potential consequences of a dam failure; they do not take into account the probability of such failures.

Table 9-3. Corps of Engineers Hazard Potential Classification

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

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

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

9.2.5 Warning Time

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

9.3 SECONDARY HAZARDS

Dam failure can cause severe downstream flooding, depending on the magnitude of the failure. Other potential secondary hazards of dam failure are landslides around the reservoir perimeter, bank erosion on the downstream watercourse, and destruction of downstream habitat. Hazardous materials spills are also a potential secondary hazard of dam failure if storage tanks rupture and spill.

9.4 EXPOSURE

A quantitative assessment of exposure to the dam failure hazard was conducted using the best available data provided by local, state or federal sources. The flood module of Hazus was used for a Level 2 assessment of dam failure. Where possible, the Hazus data was enhanced using GIS data from county, state and federal sources. Please note that all quantitative analyses are limited to those dams which spatial extent and location mapping was available in a GIS format.

9.4.1 Population

All populations in the dam failure inundation zone would be exposed to the risk of a dam failure. The potential for loss of life is affected by the capacity and number of evacuation routes available to populations living in areas of potential inundation. The estimated population living in the mapped inundation area within the planning area is 97 or 0.12 percent of the county's population. Table 9-4 summarizes the at-risk population in the planning area by jurisdiction.

Table 9-4. Population at Risk from Dam Failure (8-Mile Lake Outlet Dam)

	Affected Population	% of City Population
Cashmere	0	0
Chelan	0	0
Entiat	0	0
Leavenworth	0	0
Wenatchee	0	0
Unincorporated	97	0.29
Total	97	0.12

9.4.2 Property

Based on assessor parcel data, the Hazus model estimated that there are 43 structures in the mapped dam failure inundation area for 8-Mile Lake Outlet Dam. The value of exposed buildings in that inundation area was generated using Hazus and is summarized in Table 9-5. This methodology estimated $13.3 million worth of building-and-contents exposure to dam failure inundation, representing 0.09 percent of the total assessed value of the planning area.

Table 9-5. Value of Property Exposed to Dam Failure

	Number of Buildings Exposed	Value Exposed			% of Total Assessed Value
		Building	Contents	Total	
Cashmere	0	$0	$0	$0	0
Chelan	0	$0	$0	$0	0
Entiat	0	$0	$0	$0	0
Leavenworth	0	$0	$0	$0	0
Wenatchee	0	$0	$0	$0	0
Unincorporated	43	$8,786,245	$4,558,210	$13,344,454	0.23
Total	43	$8,786,245.00	$4,558,210.00	$13,344,454.00	0.09

9.4.3 Critical Facilities

Critical facilities within the dam inundation area could receive significant damage from an event. This could result in significant down-time of identified critical facilities and infrastructure. Damage to roads and bridges could isolate populations. The exposure analysis performed for 8-Mile Lake Outlet Dam identified no critical facilities and 11 bridges within the inundation area for that facility.

9.4.4 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).

9.5 VULNERABILITY

9.5.1 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.

9.5.2 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. In the 8-Mile Lake Outlet Dam Inundation area, there are estimated to be 43 structures that are in the dam inundation zone but outside of special flood hazard areas where NFIP minimum construction standards apply.

9.5.3 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, including all roads, railroads and bridges in the path of the dam inundation. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. Utilities such as overhead power lines, cable and phone lines 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.

9.5.4 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.

9.6 FUTURE TRENDS IN DEVELOPMENT

Land use in the planning area will be directed by local comprehensive plans adopted under state law. The planning partners have established comprehensive policies regarding sound land use in identified flood hazard areas. While some of the areas vulnerable to the more severe impacts from dam failure intersect the mapped flood hazard areas, the inundation areas from a dam failure cover a much larger portion of the planning area. Flood-related policies in these comprehensive plans and in the local municipal code will help to reduce the risk associated with the dam failure hazard for development in the planning area but will be unlikely to help reduce risk to all structures within the dam inundation area.

9.7 SCENARIO

An earthquake in the region could lead to liquefaction of soils around a dam. This could occur without warning during any time of the day. A human-caused failure such as a terrorist attack also could trigger a catastrophic failure of a dam.

While the probability of dam failure is very low, the probability of flooding associated with changes to dam operational parameters in response to climate change is higher. Dam designs and operations are developed based on hydrographs from historical records. If these hydrographs experience significant changes over time due to the impacts of climate change, dam design and operations may no longer be valid for the changed condition. This could have significant impacts on dams that provide flood control. Specified release rates and impound thresholds may have to be changed. This would result in increased discharges downstream of these facilities, increasing the probability and severity of flooding.

9.8 ISSUES

In the late 1980s, the Department of Ecology DSO was reorganized to better use its resources to minimize public safety problems. The DSO has recognized the key role of other government agencies in carrying out its public safety charge. For example, the dam approval process now requires that dams located above populated areas develop emergency action plans in conjunction with local and county emergency management agencies.

The most significant issue associated with dam failure involves properties and populations in the inundation zones. Flooding as a result of a dam failure would significantly impact these areas. In certain scenarios there would be little or no warning time. Dam failure events are frequently associated with other natural hazard events such as earthquakes, landslides or severe weather, which limits their predictability and compounds the hazard. Important issues associated with dam failure hazards include the following:

- The lack of readily available, dam failure inundation mapping in a geospatial format has made it very difficult to fully assess the impacts of this hazards. The County and its planning partners should seek to work with dam owner/operators moving forward so that this data could be acquired to support future updates to this risk assessment.

- A buildable-lands analysis that looks at vacant lands and their designated land use within dam failure inundation areas would be a valuable tool in helping decision-makers make wise decisions about future development.
- 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.
- It is unclear whether dam failure warning and notification strategies will be viable if dam failure occurs as a result of a significant earthquake that interrupts communication systems.
- Changes in hydrographs in the region as a result of climate change are likely to include more instances of winter flooding. This could alter dam operations and increase the potential for design failures.
- Downstream populations are often not aware that they are located in a dam failure inundation area and do not know the risks associated with probable dam failure.
- Balancing the need to address security concerns and the need to inform the public of the risk associated with dam failure is a challenge for public officials.
- Dam failure inundation areas are often located outside of special flood hazard areas under the National Flood Insurance Program, so flood insurance coverage in these areas is not common.
- 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 show areas potentially impacted by more frequent events, to be used in support of emergency response and preparedness measures.
- Limited financial resources for dam maintenance during economic downturns result in decreased attention to dam structure operational integrity, because available funding is often directed to more urgent needs. This could increase the potential for maintenance failures.
- Unpermitted dams may exist within the planning area. These dams may present risks to people and property. In 2008 Washington DOE inspected 95 unpermitted dams, 30 of which were classified as high hazard. Eleven of these high hazard dams (36.6 percent) were determined to need immediate repairs (Washington Department of Ecology, 2016).

10. DROUGHT

10.1 GENERAL BACKGROUND

Drought is a normal phase in the climatic cycle of most geographical regions. Drought originates from a deficiency of precipitation over an extended period of time, usually a season or more, and results in a water shortage for some activity, group or environmental sector. Unlike most disasters, droughts normally occur slowly but last a long time.

Droughts originate from a deficiency of precipitation resulting from an unusual weather pattern. If the weather pattern lasts a short time (a few weeks or months), the drought is considered short-term. If the weather pattern becomes entrenched and the precipitation deficits last for several months or years, the drought is considered to be long-term. It is possible for a region to experience a long-term circulation pattern that produces drought, and to have short-term changes in this long-term pattern that result in short-term wet spells. Likewise, it is possible for a long-term wet circulation pattern to be interrupted by short-term weather spells that result in short-term drought. According to the Washington State Emergency Management Division, drought in Washington usually results from low snow accumulation (from low precipitation or warm winter temperatures) or early melt of the snowpack due to warm weather in late winter or early spring (Washington Emergency Management Division, 2014).

Defining when drought begins is a function of the impacts of drought on water users and includes consideration of the supplies available to local water users as well as the stored water they may have available in surface reservoirs or groundwater basins. Different local water agencies have different criteria for defining drought conditions in their jurisdictions. Some agencies issue drought watch or drought warning announcements to their customers. Determinations of regional or statewide drought conditions are usually based on a combination of hydrologic and water supply factors. Washington has a statutory definition of drought (RCW 43.83B.400), defining an area as being in a drought condition when the water supply for the area is below 75 percent of normal and water uses and users in the area are likely to incur undue hardships because of the water shortage.

10.1.1 Types

There are four generally accepted operational definitions of drought (National Drought Mitigation Center, 2006):

- **Meteorological drought** is an expression of precipitation's departure from normal over some period of time. Meteorological measurements are the first indicators of drought. Definitions are usually region-specific and based on an understanding of regional climatology. A definition of drought developed in one part of the world may not apply to another, given the wide range of meteorological definitions.
- **Agricultural drought** occurs when there is not enough soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought happens after meteorological drought but before hydrological drought. Agriculture is usually the first economic sector to be affected by drought.
- **Hydrological drought** refers to deficiencies in water supplies, measured as stream flow and as lake, reservoir and groundwater levels. There is a time lag between lack of rain and water reduction in streams, rivers, lakes and reservoirs. This shortage is seen after precipitation has been reduced over an extended period. Water supply is controlled not only by precipitation, but also by other factors, including evaporation, transpiration (the use of water by plants), and human use.
- **Socioeconomic drought** occurs when a water shortage starts to affect people. Most socioeconomic definitions of drought associate it with the supply and demand of an economic good.

10.1.2 Impacts

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. 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.

10.1.3 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 Severity 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 10-1 through Figure 10-5.

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.

Source: U.S. Drought Portal, 2018

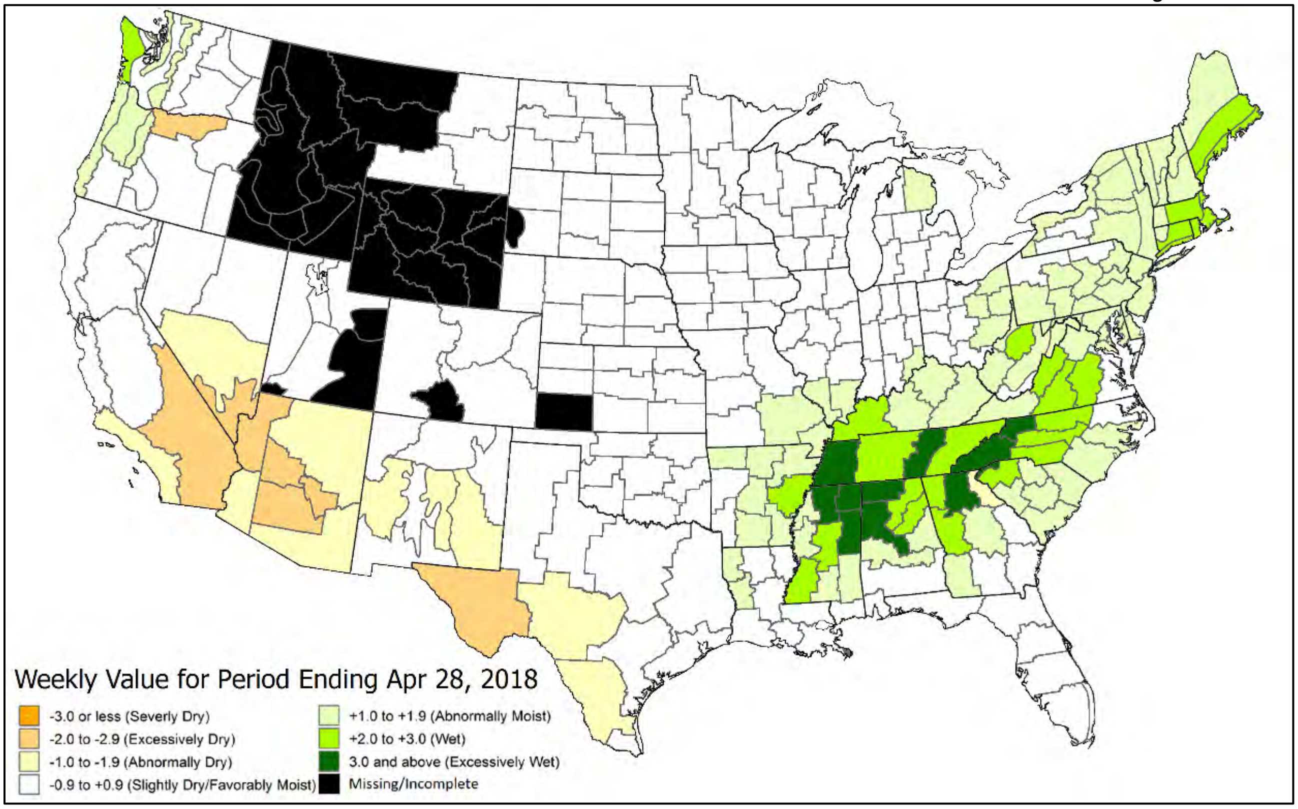


Figure 10-1. Palmer Crop Moisture Index for Week Ending April 28, 2018

Source: National Center for Environmental Information, 2018

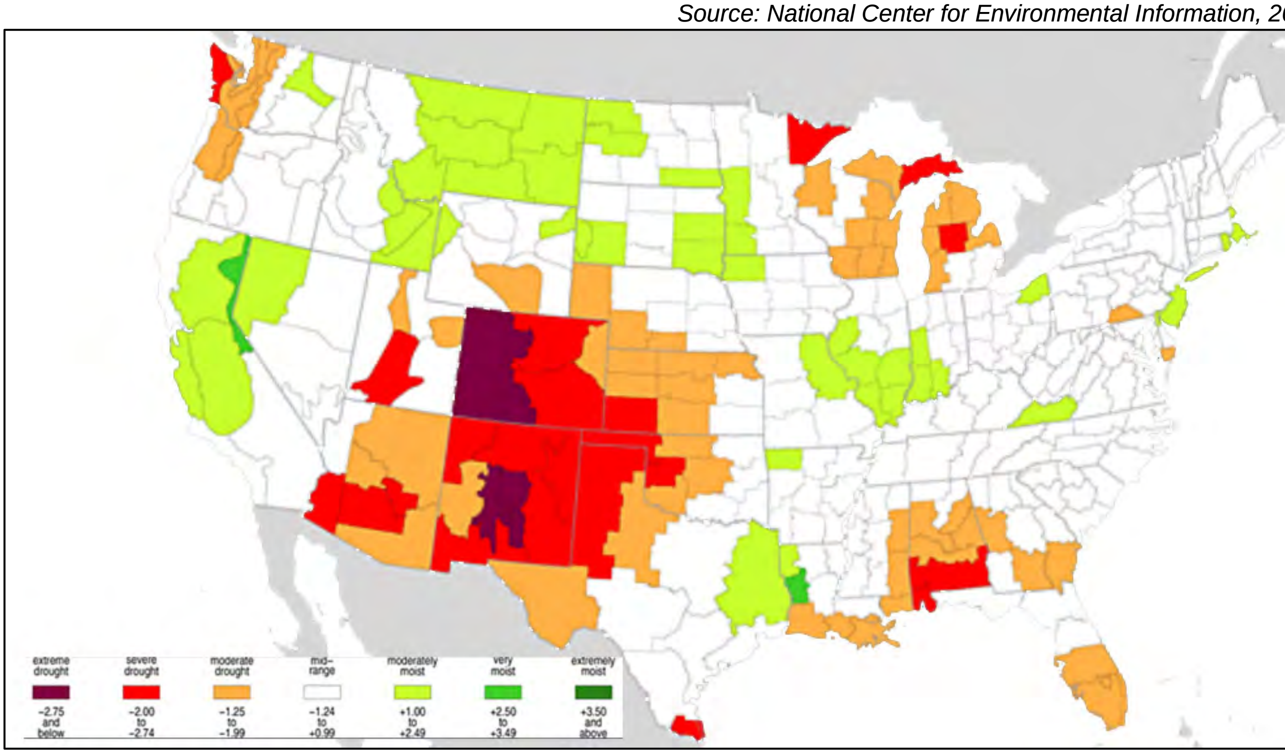


Figure 10-2. Palmer Z Index Short-Term Drought Conditions (March 2018)

Source: NOAA, NWS. 2018

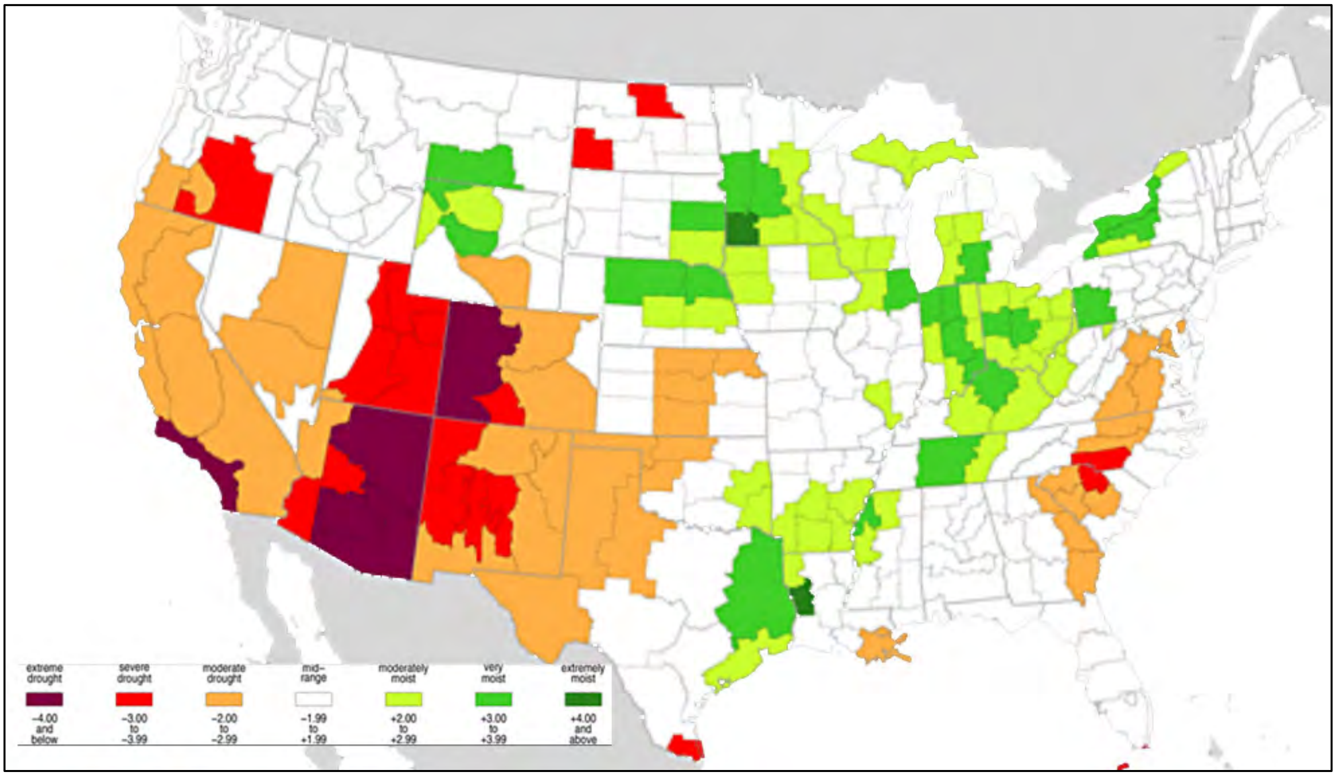


Figure 10-3. Palmer Drought Severity Index (March 2018)

Source: NOAA, NWS. 2018

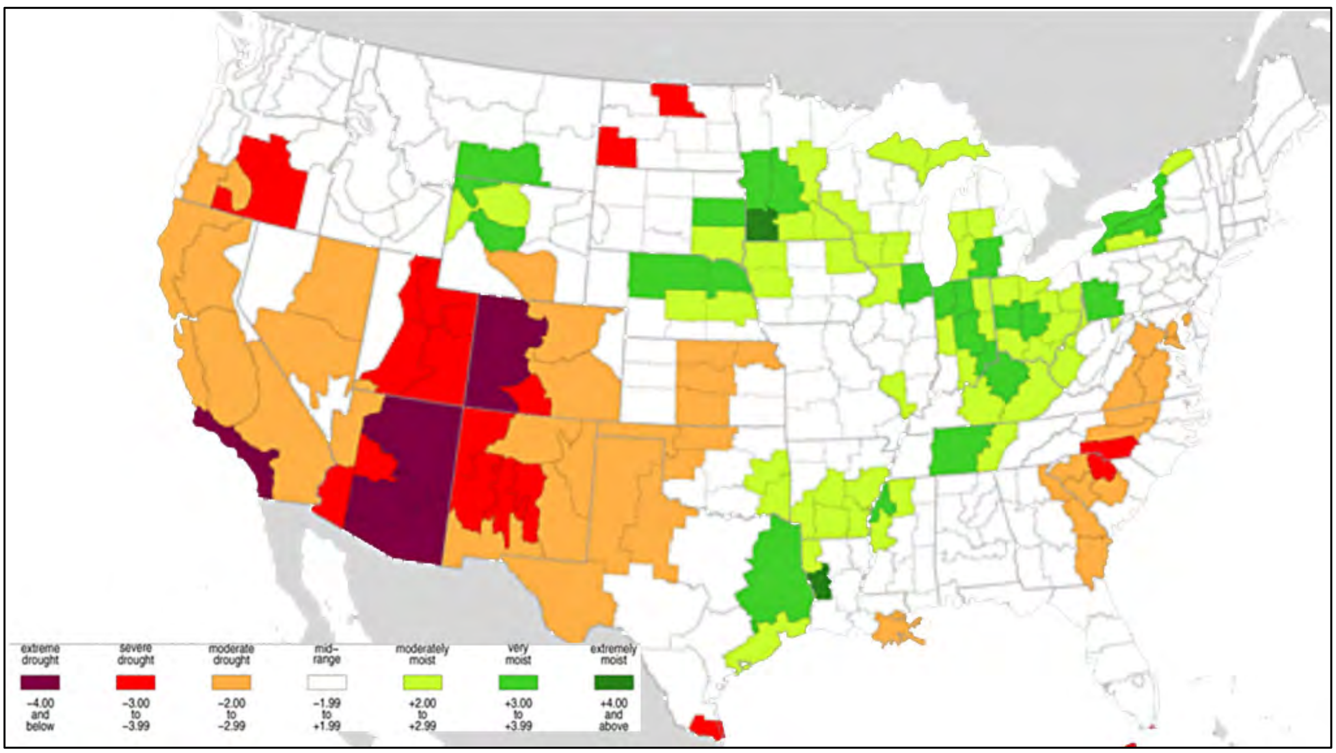


Figure 10-4. Palmer Hydrological Drought Index (March 2018)

Source: National Center for Environmental Information, 2018a

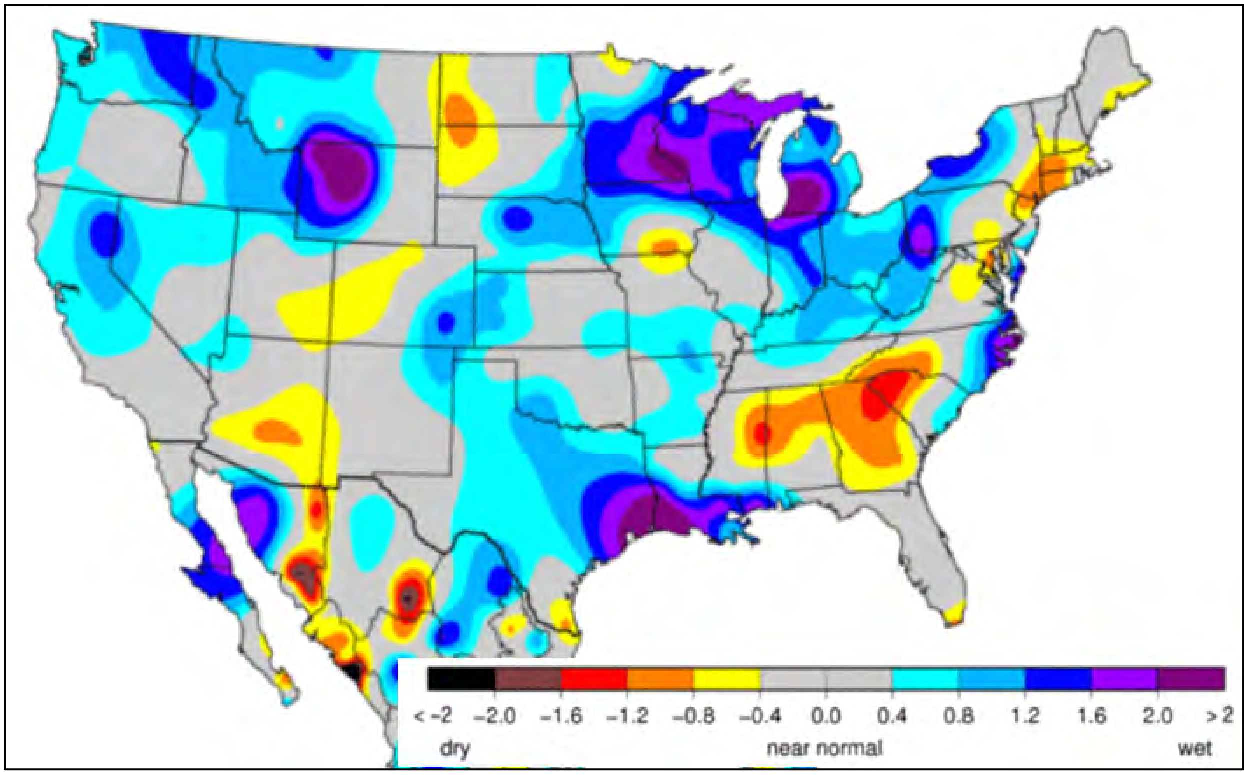


Figure 10-5. 24-Month Standardized Precipitation Index Ending March 2018

10.2 HAZARD PROFILE

10.2.1 Past Events

In the State of Washington there have been 19 drought occurrences since 1901. These dry spells have typically lasted for a period of 1 to 2 months to a period of 2 years. Droughts that lasted for more than a single season occurred in 1928 to 1932, 1992 to 1994, and 1996 to 1997. The most recent droughts in the state were in 2005 and 2015 (Washington Emergency Management Division, 2014; Washington Department of Ecology, 2015b).

Between 1954 and 2015, Washington experienced one FEMA-declared drought-related emergency (EM-3037). This was the 1977 event, which has been identified as the worst drought in state history. Chelan County was included in the declaration (FEMA, 2019c).

The U.S. Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans to agricultural producers suffering losses due to drought. Between 2012 and 2015, Washington has been included in 186 USDA drought declarations. Chelan County has been included in four of these declarations, all of them in 2015—July 28, 2015; July 28, 2015 (second declaration); August 11, 2015; and July 7, 2015 (USDA, 2019a).

Although not subject to severe annual precipitation deficiencies, periodically Chelan County experiences seasonal dry spells lasting two to three months; however, since the early 1920s there have been approximately 13 droughts statewide which have particularly impacted Chelan County. The 2001 drought was the second worst drought on record. While no official drought declarations were issued, low-water conditions existed, at times, during 2004-2010.

10.2.2 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.

10.2.3 Frequency

According to the National Drought Mitigation Center, the Pacific Northwest region (Columbia, Willamette, and Snake River basins of Idaho, Oregon, and Washington, and portions of Montana and Wyoming) experiences drought more frequently than most other regions of the nation. From 1895 to 1995, much of the state was in severe or extreme drought at least 5 percent of the time. The east slopes of the Cascades and much of Western Washington were in severe or extreme drought from 5 to 10 percent of the time.

Chelan County has experienced drought conditions 10-15% from 1895 to 1995, more than 30% from 1985 to 1995, and 30-40% from 1976 to 1977.

10.2.4 Severity

General Impacts

Locally, droughts have left a major impact on individuals and the agriculture, timber and hydroelectric industries. Lack of snowpack has forced ski resorts and other recreation-based companies into bankruptcy. The primary effects of drought in Chelan County include loss of fruit and dryland crops, loss of range and domestic animals, wildlife and wildlife habitat, and extreme increase in the danger for wildfires. Secondary effects involve social and economic hardships due to crop losses, energy curtailment, temporary unemployment, domestic and municipal water shortages and increased number of major wildfires.

Because of the increased fire danger, forested and grassland areas of Chelan County can become extremely hazardous areas during prolonged drought situations. Populated areas in the county, including cities can be directly affected by low stream flows. Hazardous conditions, including domestic and municipal water shortages, affect the ability of local government to effectively fight fires or provide sufficient water and sewage services.

During low-water years, agriculture, forestry and hydroelectric interests have been impacted, particularly non-irrigated farm, range and forest land uses. Drought conditions can affect hydropower production capacity, and significant hydropower facilities exist in Chelan County, notably Rocky Reach and Rock Island Dams owned by the Chelan County Public Utility District #1.

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 34 impacts from drought that specifically affected Chelan County from April 2009 through April 2018 (Drought Impact Reporter, 2019). Most (58 percent) are based on reports from the Community Collaborative Rain, Hail and Snow Network.

The following are the reported numbers of impacts by category (some incidents are assigned to more than one impact category):

- Agriculture—10
- Business and Industry—3
- Energy—1
- Fire—14
- General Awareness- 13
- Plants and Wildlife—7
- Relief, Response, and Restrictions—8
- Society and Public Health—3
- Tourism and Recreation—9
- Water Supply and Quality—5

10.2.5 Warning Time

Droughts are climatic patterns that occur over long periods of time. Predicting drought depends on the ability to forecast precipitation and temperature. Anomalies of precipitation and temperature may last from several months to several decades. How long they last depends on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of weather systems on the global scale.

Because drought conditions in Washington State are often related to deficiencies in snowpack accumulation, some warning is available through monitoring snowpack accumulation through the winter. The U.S. Natural Resources Conservation Service's snow survey and water supply forecasting program conducts snow surveys to develop accurate and reliable water supply forecasts (USDA, 2014). The system, called SNOTEL (short for Snow Telemetry) provides information for local governments, water consumers and providers and the general public on snowpack conditions that may impact water resources in future months. When snowpack levels are below average, communities may make changes to their water management programs and practices to reduce impacts from a possible future drought.

NOAA's National Integrated Drought Information System launched a Drought Early Warning System for the Pacific Northwest in February 2016. The early warning system draws upon new and existing federal, tribal, state, local and academic partner networks to make climate and drought science readily available, easily understandable and usable for decision makers. The system improves stakeholders' abilities to monitor, forecast, plan for and cope with the impacts of drought (NIDIS, 2016).

10.3 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.

10.4 EXPOSURE

All people, property, and environmental features in the planning area are exposed to drought hazard. Drought can affect a wide range of economic, environmental, and social activities. Its impacts can span many sectors of the economy because water is integral to the ability to produce goods and provide services. The impacts can reach well beyond the area undergoing physical drought.

10.5 VULNERABILITY

Drought produces a complex web of impacts that spans many sectors of the economy and reaches well beyond the area experiencing physical drought. This complexity exists because water is integral to the ability to produce goods and provide services. Drought can affect a wide range of economic, environmental and social activities. The vulnerability of an activity to the effects of drought usually depends on its water demand, how the demand is met, and what water supplies are available to meet the demand.

The 2018 Washington State Hazard Mitigation Plan utilized a drought risk index defined as the average of the standardized rank of hazard exposure assessment for county area, population and vulnerable populations. The individual exposure assessment values were categorized into five classes (1: Low, 2: Medium-Low, 3: Medium, 4: Medium-High, and 5: High) using z-score transformation (standard deviations from the mean). The drought risk index is the mean of these individual exposure rankings. Seven counties including Chelan, were ranked high for drought risk

10.5.1 Population

The entire population of Chelan 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, 2017). 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).

10.5.2 Property

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

10.5.3 Critical Facilities and Infrastructure

Critical facilities as defined for this plan will continue to be operational during a drought. Local water providers have plans in place including alternate water sources and memorandums of agreement to ensure operations continue during severe drought conditions. The risk to critical facilities will be largely aesthetic. For example, when water conservation measures are in place, landscaped areas will not be watered and may die. These aesthetic impacts are not considered significant.

10.5.4 Environment

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.

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

10.5.5 Economic Impact

The economic impact of drought is largely associated with industries that use water or depend on water for their business. For example, landscaping businesses are affected as the demand for their service significantly declines because landscaping is not being watered. Livestock owners experience increased expenses for watering their herds. Agricultural industries are impacted if water usage is restricted for irrigation. Drought can lead to a reduction in power-generating capacity in hydroelectric-dominated systems, such as those found in Washington. Reductions in capacity can lead to interruptions in the power supply that may have economic impacts in the region.

10.6 FUTURE TRENDS IN DEVELOPMENT

The U.S. Geological Survey's water use figures for Washington State show that public supply—domestic, commercial, industrial, and thermoelectric generation—uses about one gallon of every eight. Growing counties will find their rate of water use grow as their population grows. Chelan County's average annual growth rate of 0.89 percent between 2010 and 2018 was below the state average of 1.31 percent for that time frame. This rate of growth is not anticipated to significantly increase during the performance period of this plan update.

Each municipal planning partner in this effort has an established comprehensive 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.

10.7 SCENARIO

The worst-case scenario is an extreme multiyear drought impacting the region. Combinations of low summer precipitation and low winter snowpack accumulation could stretch water resources, resulting in increased pressures to meet all users' needs. Intensified by such conditions, wildfires could threaten the planning area, increasing the need for water. Surrounding communities, also in drought conditions, could increase their demand for water supplies relied upon by Chelan County, causing social and political conflicts. If such conditions persist for several years, the local economy could experience setbacks, especially in water-dependent industries and on local farms.

10.8 ISSUES

The planning team identified the following drought-related issues:

- If tension increases over surface water, additional drawn-downs to groundwater supplies may occur.
- Predicting droughts can be challenging, although warning systems are currently under development.
- Recent droughts have resulted in the need to stop pumping from some water courses due to limited stream flow.
- 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.
- Drought frequencies and durations may increase due to climate change. Changes in the timing, frequency and duration of precipitation events may present challenges for current water storage and management practices in the region.
- The promotion of active water conservation even during non-drought periods should be encouraged.
- Water resource management strategies have changed significantly over the last several decades. Managers must now consider the needs of communities, industries, power-generating facilities and the environment. Issues associated with meeting the needs of these competing demands with limited resources will likely increase as population growth continues and the impacts of climate change intensify.

11. EARTHQUAKE

11.1 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.

Earthquakes tend to reoccur along faults, which are zones of weakness in the crust. Even if a fault zone has recently experienced an earthquake, there is no guarantee that all the stress has been relieved. Another earthquake could still occur.

11.1.1 Types of Earthquakes

The earth's crust is divided into eight major plates and many minor plates. In Washington, the primary plates of interest are the Juan De Fuca and North American plates. The Juan De Fuca plate moves northeastward with respect to the North America plate at a rate of about 3 to 4 centimeters per year. The boundary where these two plates converge, the Cascadia Subduction Zone, lies approximately 50 miles offshore and extends from the middle of Vancouver Island in British Columbia to northern California. As it collides with North America, the Juan De Fuca plate slides beneath the continent and sinks into the earth's mantle. The collision of the Juan De Fuca and North America plates produces three types of earthquakes, as shown on Figure 11-1 and described below.

Subduction Zone Earthquakes

Subduction Zone earthquakes occur at the interface between tectonic plates. A subduction zone earthquake affecting Chelan County 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 numerous large aftershocks. The potential exists for large earthquakes along the Cascadia Subduction Zone, up to an earthquake measuring 9 or more on the Richter scale. Such an earthquake would last several minutes and produce catastrophic damage in the region.

Benioff Zone (Deep) Earthquakes

Benioff Zone earthquakes occur within the Juan De Fuca plate as it sinks into the Earth's mantle. These are deep earthquakes, usually 15 to 60 miles deep. Due to their depth, aftershocks are typically not felt in association with these earthquakes. These earthquakes are caused by mineral changes as the plate moves deeper into the mantle. Minerals that make up the plates are altered to denser, more stable forms as temperature and pressure increase. This results in a decrease in the size of the plate, and stresses build up that pull the plate apart (Washington Department of Natural Resources, 2014). Deep earthquakes generally last 20 to 30 seconds and have the potential of reaching 7.5 on the Richter scale. Geologists have concluded that Benioff earthquakes are a phenomenon centered in the Puget Sound basin and as such their epicenters are at a considerable distance from Chelan County.

Source: USGS

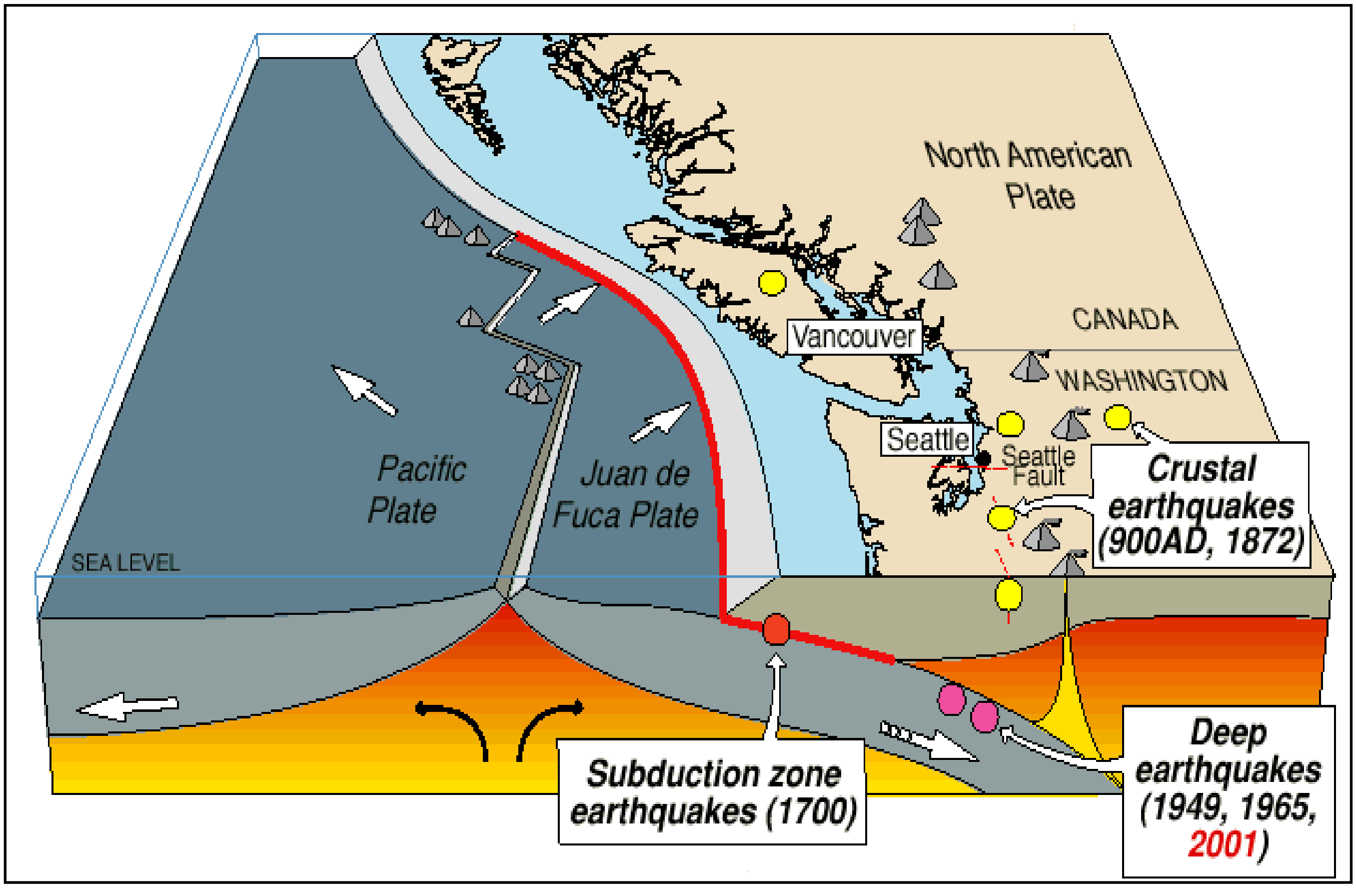


Figure 11-1. Earthquake Types in the Pacific Northwest

Shallow Crustal Earthquakes

Shallow crustal earthquakes occur within the North America plate at depths of 30 kilometers or less. Shallow earthquakes within the North America plate account for most of the earthquakes in the region around Chelan County. Most are relatively small, but the potential exists for major shallow earthquakes as well. Generally, these earthquakes are expected to have magnitudes less than 8 and last from 20 to 60 seconds. Of the three types of earthquake, crustal events are the least understood.

11.1.2 Faults

Geologists classify faults by their relative hazards. Active faults, which represent the highest hazard, are those that have ruptured to the ground surface within the last 11,000 years. Potentially active faults are those that displaced layers of rock within the last 1,800,000 years. Determining if a fault is "active" or "potentially active" depends on geologic evidence, which may not be available for every fault. Additionally, earthquakes may occur on faults that have not been mapped and identified.

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

11.1.3 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 describes the size at the focus of an earthquake and intensity describes the overall felt severity of shaking during the event.

Magnitude

An earthquake's magnitude is a measure of the energy released at the source of the earthquake. It is expressed by ratings on the Richter scale or the moment magnitude scale. Currently the most commonly used magnitude scale is the moment magnitude (M_W) scale, with the follow classifications of magnitude:

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

Estimates of moment magnitude roughly match the local magnitude scale (ML) commonly called the Richter scale. One advantage of the moment magnitude scale is that, unlike other magnitude scales, it does not saturate at the upper end. That is, there is no value beyond which all large earthquakes have about the same magnitude. For this reason, moment magnitude is now the most often used estimate of large earthquake magnitudes.

Intensity

The intensity of an earthquake is based on the observed effects of ground shaking on people, buildings and natural features. Intensity of a given earthquake varies with location. The Modified Mercalli (MMI) scale expresses intensity of an earthquake and describes how strong a shock was felt at a particular location. Table 11-1 summarizes earthquake intensity as expressed by the Modified Mercalli scale.

Table 11-1. Mercalli Scale and Peak Ground Acceleration Comparison

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

a. PGA measured in percent of g, where g is the acceleration of gravity

Sources: USGS, 2008; USGS, 2010

11.1.4 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). PGA varies with soil or rock type. Earthquake risk assessment estimates the annual probability that a certain ground accelerations will be exceeded, and then summing the annual probabilities over a time period of interest.

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.

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 standards typically can withstand earthquakes with less damage and disruption. PGA values are directly related to lateral forces that can damage “short period structures” (e.g. single-family dwellings). Longer-period components determine the lateral forces that damage larger structures with longer natural periods (apartment buildings, factories, high-rises, bridges). Table 11-1 lists damage potential and perceived shaking by PGA factors, compared to the Mercalli scale.

11.1.5 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 11-2 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.

Table 11-2. 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)	

11.2 HAZARD PROFILE

11.2.1 Past Events

Historical Summary

From the early 1900s to the present, over 130 earthquakes have been recorded in North Central Washington. A majority of the seismic activity in Chelan County has been recorded at earthquake epicenters near Lake Chelan, Chelan Falls, Entiat and Wenatchee. Magnitudes of these earthquakes have ranged in intensity from 3 to 6 on the Richter Scale. Damage by earthquakes has been low in the County. Figure 11-2 is a Washington State map of historical earthquakes in the state. Table 11-3 lists seismic events with a magnitude of 4.0 or larger that were felt within the planning area since 1973.

Source: Washington Emergency Management Division, 2013

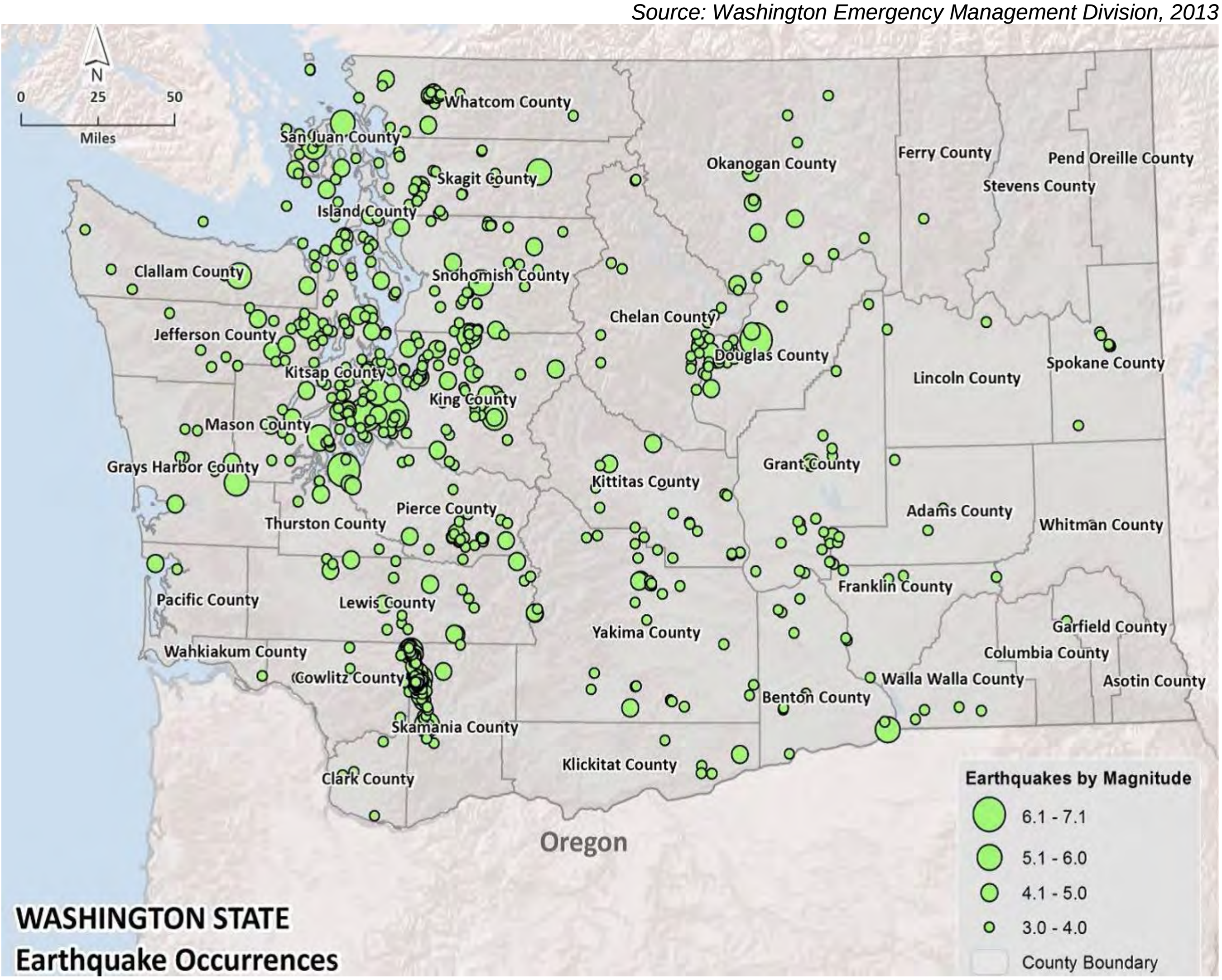


Figure 11-2. Historic Earthquakes in Washington State

Table 11-3. Recent Earthquakes Magnitude 4.0 or Larger felt within Chelan County

Date	Magnitude	Epicenter Location		
		Latitude	Longitude	Nearest City
12/20/1973	4.4	46.8671667	-119.3565	8.9 miles south of Othello, WA
2/18/1981	4.2	47.1973333	-120.8925	2.1 miles SE of Cle Elum, WA
4/11/1984	4.3	47.535	-120.1855	9.5 miles NE of East Wenatchee, EA
12/2/1987	4.2	46.6748333	-120.6838333	2. 6 miles N. of Eschbach, WA
12/2/1987	4.3	46.6791667	-120.6731667	2.2 miles SW of Eschbach, WA
5/9/1989	4.5	48.2305	-119.8538333	15.1 miles S of Twisp, WA
6/24/1997	4.6	48.3635	-119.8881667	13.7 miles SW of Okanogan, WA
11/11/2001	4.0	47.6883333	-117.4001667	Spokane, WA
11/18/2011	4.6	48.4693333	-119.6075	7.9 miles NE of Okanogan, WA
6/27/2013	4.27	47.8241667	-120.6891667	4.1 miles NE of Lake Wenatchee
2/18/2015	4.2	47.2491667	-120.7526667	7.0 miles NE of Tenaway, WA
9/1/2015	4.15	48.3073333	-119.0193333	10.3 miles N of Nespelem, WA

Source: Earthquake Catalog, USGS, 2019a

1872 Event

What may have been the largest earthquake in the history of the Pacific Northwest occurred on December 14, 1872 in Chelan County. Due to poor record keeping in a predominately frontier area, scientists have been unable to determine an exact intensity for that incident. However, general consensus indicates a range of 7 to 8 on the Richter Scale was not unlikely. Most scientists agree that the epicenter of this earthquake was located in the Northern Cascades, Okanogan area within a zone extending from Lake Chelan in the south to Southern British Columbia in the north (Coombs, 1979). This earthquake was felt from British Columbia to Oregon and from the Pacific Ocean to Montana. It occurred in a wilderness area, which in 1872 had only a few inhabitants—local Indian tribes, trappers, traders, and military men. Because there were few man-made structures in the epicenter area near Lake Chelan, most of the information available is about ground effects, including huge landslides, massive fissures in the ground, and a 27-foot high geyser.

Extensive landslides occurred in the slide-prone shorelines of the Columbia River. One massive slide, at Ribbon Cliff between Entiat and Winesap, blocked the Columbia River for several hours. A field reconnaissance to the Ribbon Cliff landslide area in August 1976 showed remnants of a large landslide mass along the west edge of Lake Entiat (Columbia River Reservoir), below Ribbon Cliffs and about 3 kilometers north of Entiat. Although the most spectacular landslides occurred in the Chelan-Wenatchee area, slides occurred throughout the Cascade Mountains.

Most of the ground fissures occurred in the following areas: at the east end of Lake Chelan in the area of the Indian camp; in the Chelan Landing-Chelan Falls area; on a mountain about 12 miles west of the Indian camp area; on the east side of the Columbia River (where three springs formed); and near the top of a ridge on a hogback on the east side of the Columbia River. These fissures formed in several locations. Slope failure, settlements, or slumping in water-saturated soils may have produced the fissures in areas on steep slopes or near bodies of water. Sulfurous water was emitted from the large fissures that formed in the Indian camp area. At Chelan Falls, “a great hole opened in the earth” from which water spouted as much as 27 feet in the air. The geyser activity continued for several days, and, after diminishing, left permanent springs.

In the area of the epicenter, the quake damaged one log building near the mouth of the Wenatchee River. Ground shaking threw people to the floor, waves observed in the ground, and loud detonations heard. About two miles above the Ribbon Cliff slide area, the logs on another cabin caved in.

11.2.2 Location

Earthquakes can occur anywhere, at any time and without warning. Because a majority of earthquakes are not associated with known faults, they are also very unpredictable. Past geological studies indicate areas prone to earthquakes may experience long periods of inactivity. These areas may be building tension which can lead to a major earthquake. Due to the unpredictability of earthquakes, forecasting when or where the next one will occur in Chelan County is impossible.

Historical Epicenter Locations

Although earthquakes are unpredictable and can occur anywhere at any time, historical and scientific data suggest there are some areas within Chelan County with a higher risk potential for future seismic activity. These higher risk areas include Lake Chelan and vicinity and the Entiat area. Historically, the Lake Chelan area is the most active earthquake area in Chelan County. Since 1900, over 23 earthquakes have occurred in the Lake Chelan area and 17 earthquakes have occurred in the Entiat area. Earthquakes have occurred sporadically throughout the rest of Chelan County, the latest occurring north of the Entiat area in 1995.

Fault Locations

In October 1979, the Washington Public Power Supply System (WPPSS) completed an earthquake study prior to construction of Washington nuclear power plants 1 and 4. Parts of this study focused on identifying geologic faults found in the portion of the Cascades within Chelan County. Although presumed inactive, major faults were located at Leavenworth and Entiat Valley areas. Somewhat more active and shorter fault zones of approximately 30 km long merge into these larger faults. They are the Chumstick fault and Eagle Creek fault. An additional major fault is located in the upper Naneum Creek. However, the study concludes recent seismic activity in Chelan County has not been associated with these major faults.

In 1993, the U.S. Geological Survey began developing a database of Quaternary faults and folds in the United States. The database includes information on geographic, geologic, and seismic parameters for making assessments of seismic hazards. Figure 11-3 shows the identified faults in and near the planning area.

Lake Chelan Compression Area

Seismic activity in the Lake Chelan area is related to the compression of the land mass by the weight of the water in the lake. The WPPSS study found this type of stress has a greater risk for earthquake potential than the inactive fault zones found in other areas of the County.

NEHRP Soil Maps

NEHRP soil types define 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 area’s most commonly affected by ground shaking have NEHRP Soils D, E and F. Figure 11-4 shows NEHRP soil classifications in Chelan County.

Liquefaction Maps

Soil liquefaction maps are useful tools to assess potential damage from earthquakes. When the ground liquefies, sandy or silty materials saturated with water behave like a liquid, causing pipes to leak, roads and airport runways to buckle, and building foundations to be damaged. In general, areas with NEHRP Soils D, E and F are also susceptible to liquefaction. If there is a dry soil crust, excess water will sometimes come to the surface through cracks in the confining layer, bringing liquefied sand with it, creating sand boils. Figure 11-5 shows the liquefaction susceptibility in the planning area.

Source: http://earthquake.usgs.gov/hazards/qfaults/map/

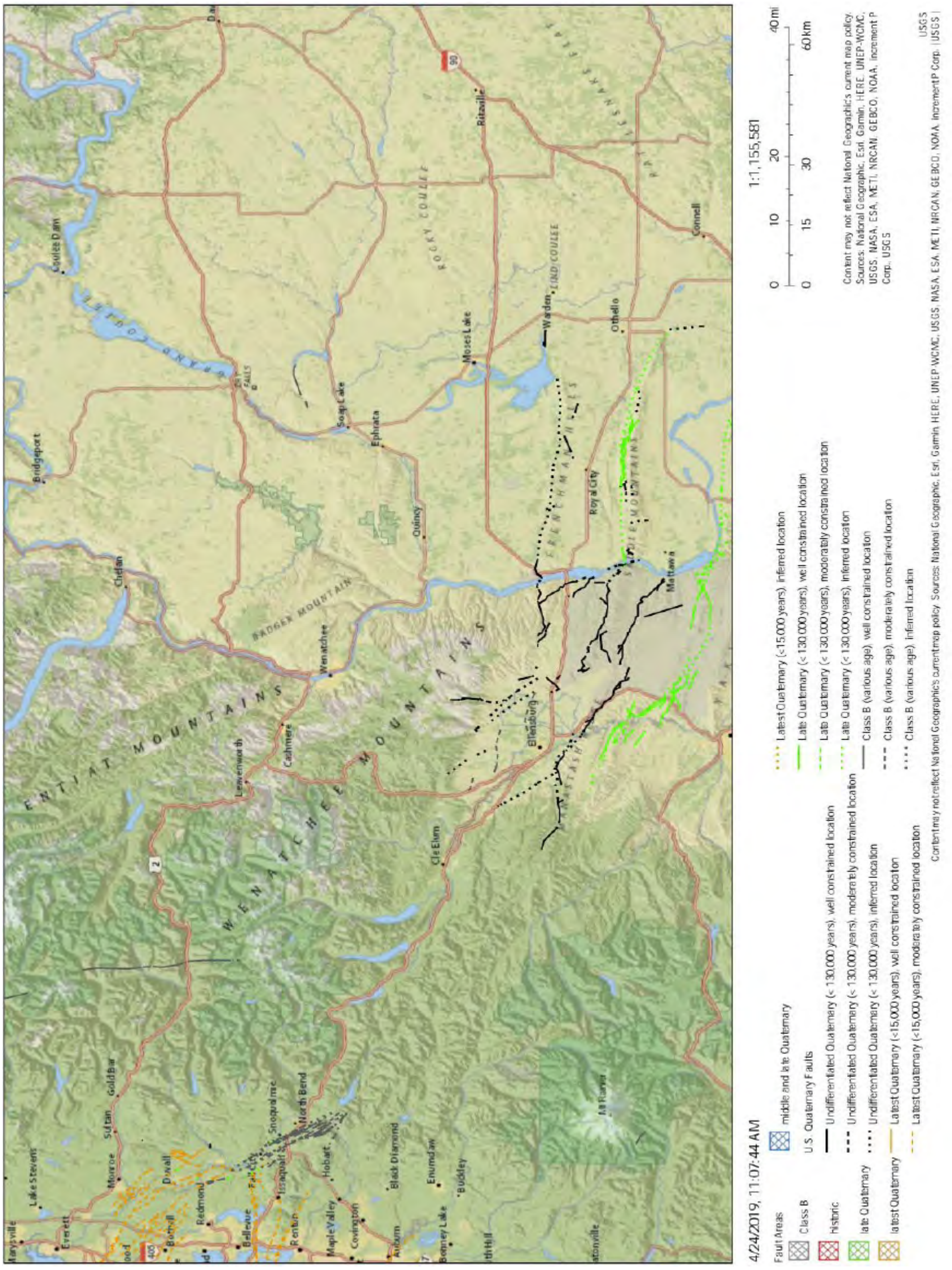
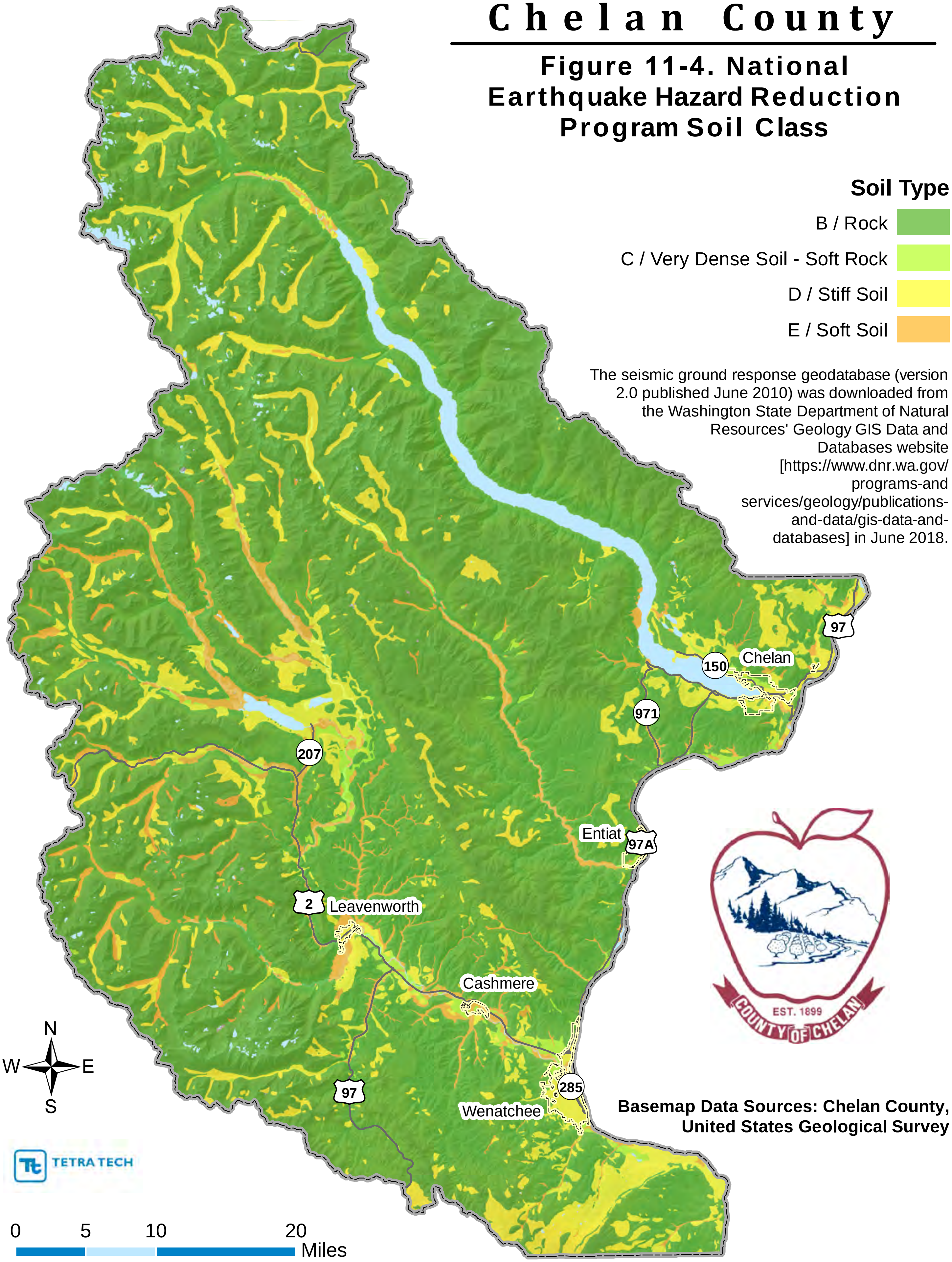


Figure 11-3. Planning Area Active Faults and Folds

Chelan County

Figure 11-4. National Earthquake Hazard Reduction Program Soil Class



The seismic ground response geodatabase (version 2.0 published June 2010) was downloaded from the Washington State Department of Natural Resources' Geology GIS Data and Databases website [https://www.dnr.wa.gov/programs-and services/geology/publications-and-data/gis-data-and-databases] in June 2018.

Basemap Data Sources: Chelan County, United States Geological Survey

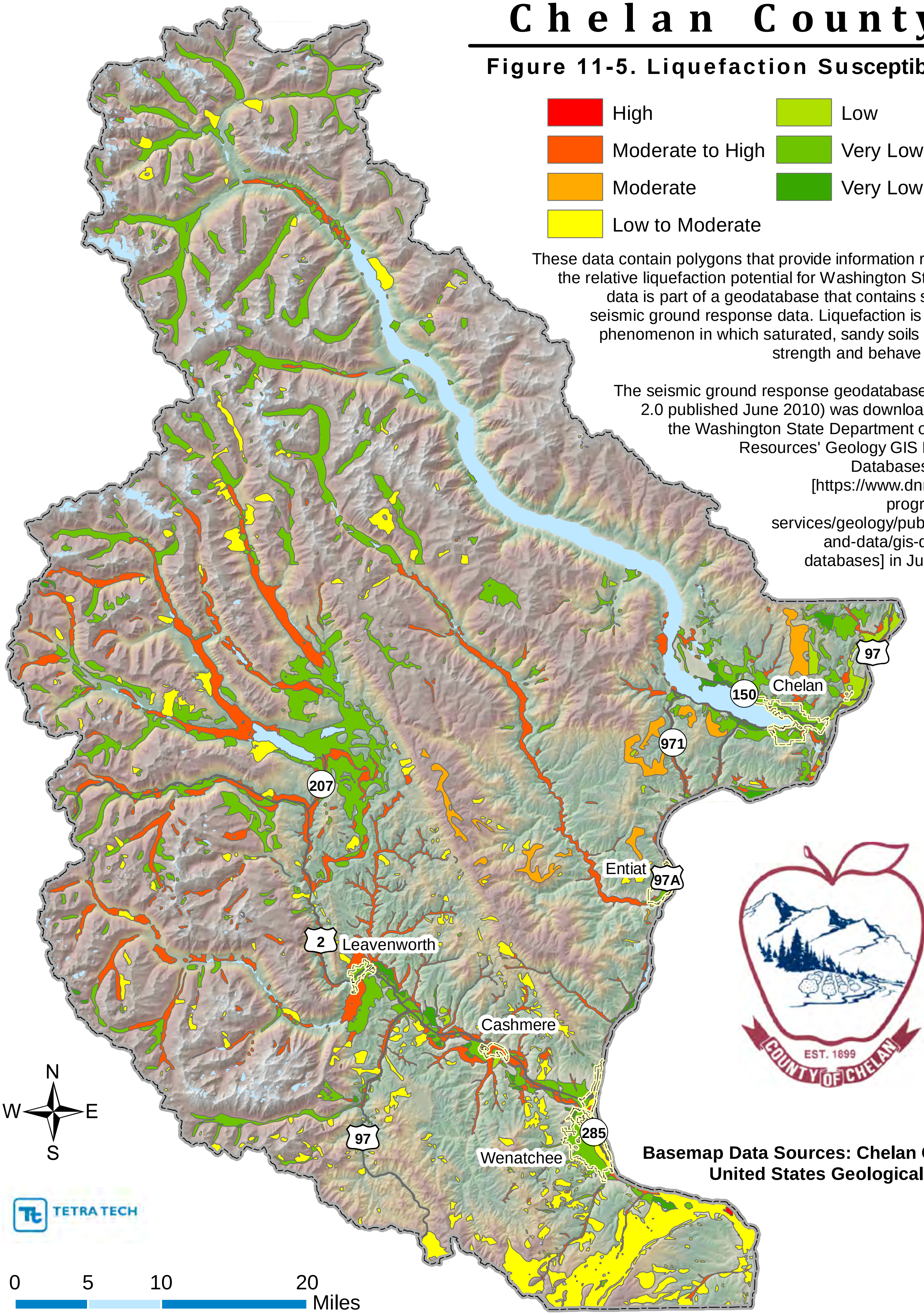
Chelan County

Figure 11-5. Liquefaction Susceptibility

- High
- Moderate to High
- Moderate
- Low to Moderate
- Low
- Very Low to Low
- Very Low

These data contain polygons that provide information regarding the relative liquefaction potential for Washington State. This data is part of a geodatabase that contains statewide seismic ground response data. Liquefaction is a natural phenomenon in which saturated, sandy soils lose their strength and behave as liquid.

The seismic ground response geodatabase (version 2.0 published June 2010) was downloaded from the Washington State Department of Natural Resources' Geology GIS Data and Databases website [https://www.dnr.wa.gov/programs-and services/geology/publications-and-data/gis-data-and-databases] in June 2018.



Basemap Data Sources: Chelan County, United States Geological Survey

11.2.3 Frequency

Earthquakes along the Cascadia Subduction Zone occur on average every 500 to 600 years, although the frequency appears to be irregular. The intervals between earthquakes in this subduction zone have ranged from 200 years to more than 1,000 years. The probability of a magnitude 9.0 earthquake occurring along the subduction zone is estimated to be about 10 percent in the next 50 years (Cascadia Region Earthquake Workgroup, 2013).

For the North Central Washington area, stress profiles obtained for a 1979 WPPSS earthquake study based on regional gravity data identify the Chelan area as a high potential earthquake epicenter zone. The probability that an earthquake will occur in Chelan County is high.

11.2.4 Severity

Earthquakes in Eastern Washington have been generally small in magnitude, but much shallower in depth. These shallow, moderate magnitude earthquakes often cause considerable damage in the immediate vicinity of the earthquake (Noson, 1985). Chelan County is in the "Back Arc" region, where earthquakes have a shallower epicenter than on the west side of the Cascades. Seismic activity in Eastern Washington typically occur at depths less than 8 km. The shallow depths produce more aftershocks than deeper quakes. Although past earthquakes have been in the form of milder tremors, the potential for a major earthquake cannot be ruled out.

USGS 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. The Central Washington area, including Chelan County, is in a moderate-risk area, with a 10-percent probability in a 50-year period of ground shaking from a seismic event exceeding 10 to 15 percent of gravity in some part of the County. Figure 11-6 shows the expected peak horizontal ground accelerations for this probability.

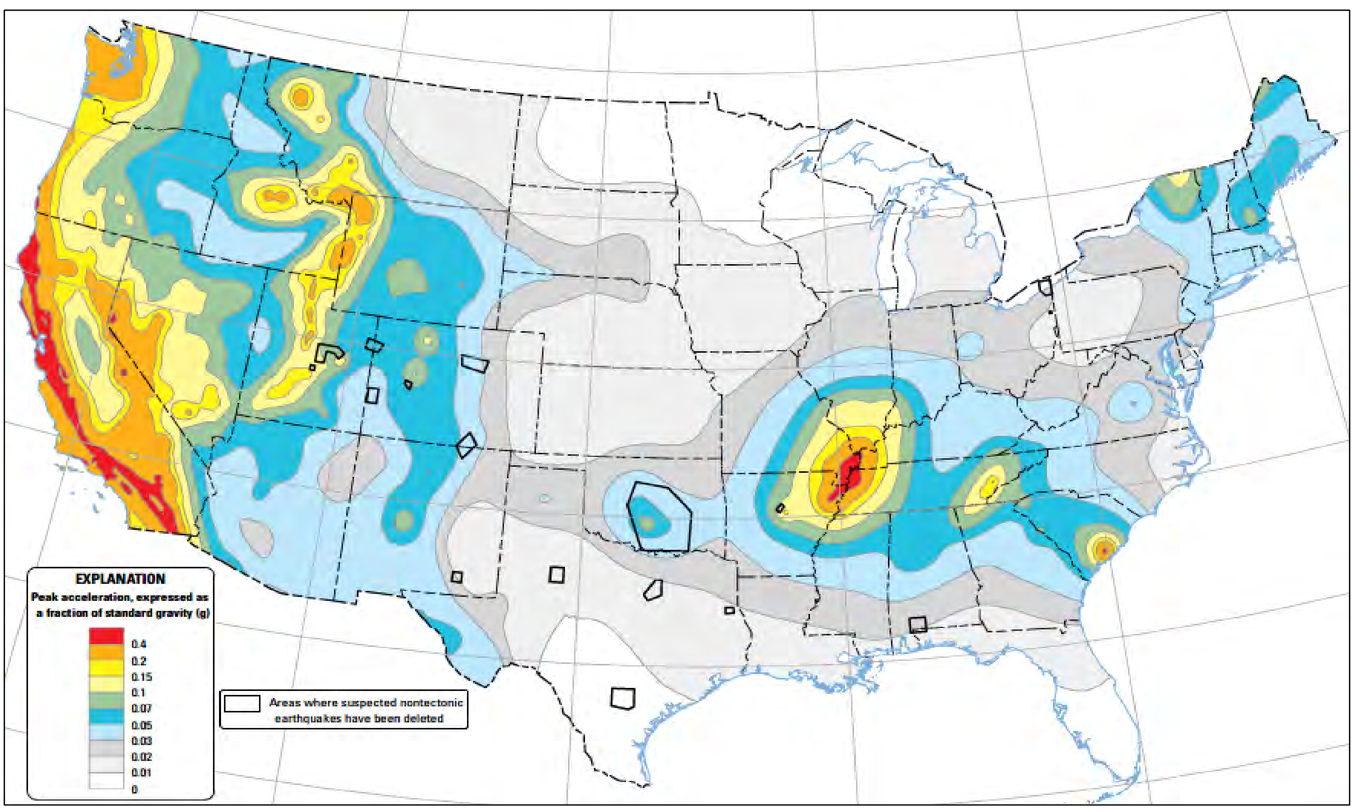


Figure 11-6. Peak Horizontal Acceleration with 10% Probability of Exceedance in 50 Years

11.2.5 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 use the low energy waves that precede major earthquakes. These potential warning systems give approximately 40 seconds notice that a major earthquake is about to occur. The warning time is very short, but it could allow for someone to get under a desk, step away from a hazardous material they are working with, or shut down a computer system.

11.3 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. 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.

11.3.1 Seiche

A seiche is a standing wave in an enclosed or partly enclosed body of water, normally caused by earthquake activity, though also possibly caused by other factors such as wind. The effect is caused by resonances in a body of water that has been disturbed. Vertical harmonic motion results, producing an impulse that travels the length of the basin at a velocity that depends on the depth of the water. The impulse is reflected back from the end of the basin, generating interference. Repeated reflections produce standing waves with one or more nodes, or points, that experience no vertical motion.

The waves in a seiche are stationary in the horizontal plane; they move up and down, but not forward like wind waves at sea. That is why these waves are called standing waves. The frequency of the oscillation is determined by the size of the basin, its depth and contours, and the water temperature.

Seiches can occur in harbors, bays, lakes, rivers and canals. They are often imperceptible to the naked eye, and observers in boats on the surface may not notice that a seiche is occurring due to the extremely long wavelengths. These events usually do not occur near the epicenter of a quake, but often hundreds of miles away. This is due to the fact that earthquake shock waves close to the epicenter consist of high-frequency vibrations, while those at much greater distances are of lower frequency, which can enhance the rhythmic movement in a body of water. The biggest seiches develop when the period of the ground shaking matches the frequency of oscillation of the water body.

Researchers believe local amplification of seismic waves could make other urban areas above sedimentary basins in the region particularly vulnerable to seiches or water waves during large earthquakes on the Seattle Fault or the Cascadia Subduction Zone. With Lake Chelan, other reservoirs and the Columbia River a risk of seismic events within the planning area, there is potential for seiches to occur in Chelan County. The degree of vulnerability to this hazard is difficult to gage without hazard mapping that illustrates extent, location and potential severity of probabilistic events.

11.4 EXPOSURE

11.4.1 Population

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

11.4.2 Property

There are estimated to be 31,485 buildings in the planning area. The majority of these buildings (91 percent) are residential use. All buildings are considered to be exposed to the earthquake hazard.

11.4.3 Critical Facilities and Infrastructure

Since the entire planning area has exposure to the earthquake hazard, all 536 inventoried critical facilities and infrastructure components are considered to be exposed. The breakdown of the numbers and types of facilities is presented in Table 4-3 and Table 4-4.

11.4.4 Environment

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

11.5 VULNERABILITY

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

- A Magnitude-7.2 event on the Chelan Fault with an epicenter approximately 5.6 miles east-southeast of the City of Chelan (see Figure 11-7)
- A Magnitude-9.0 event on the Cascadia Fault with an epicenter approximately 250 miles southwest of Wenatchee (See Figure 11-8).

In addition, standard Hazus 100-year probabilistic mapping for the planning area was assessed (see Figure 11-9). Probabilistic maps show the ground acceleration at each point that has a given chance of being exceeded in any given year, regardless of the earthquake source. The 100-year probabilistic earthquake map shows the acceleration with a 1-percent chance of being exceeded in a given year.

The analysis results are summarized in the sections below. Appendix D presents results for each jurisdiction. The results of this analysis are likely to underestimate risk, due to limitations in the modeling parameters:

- 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.

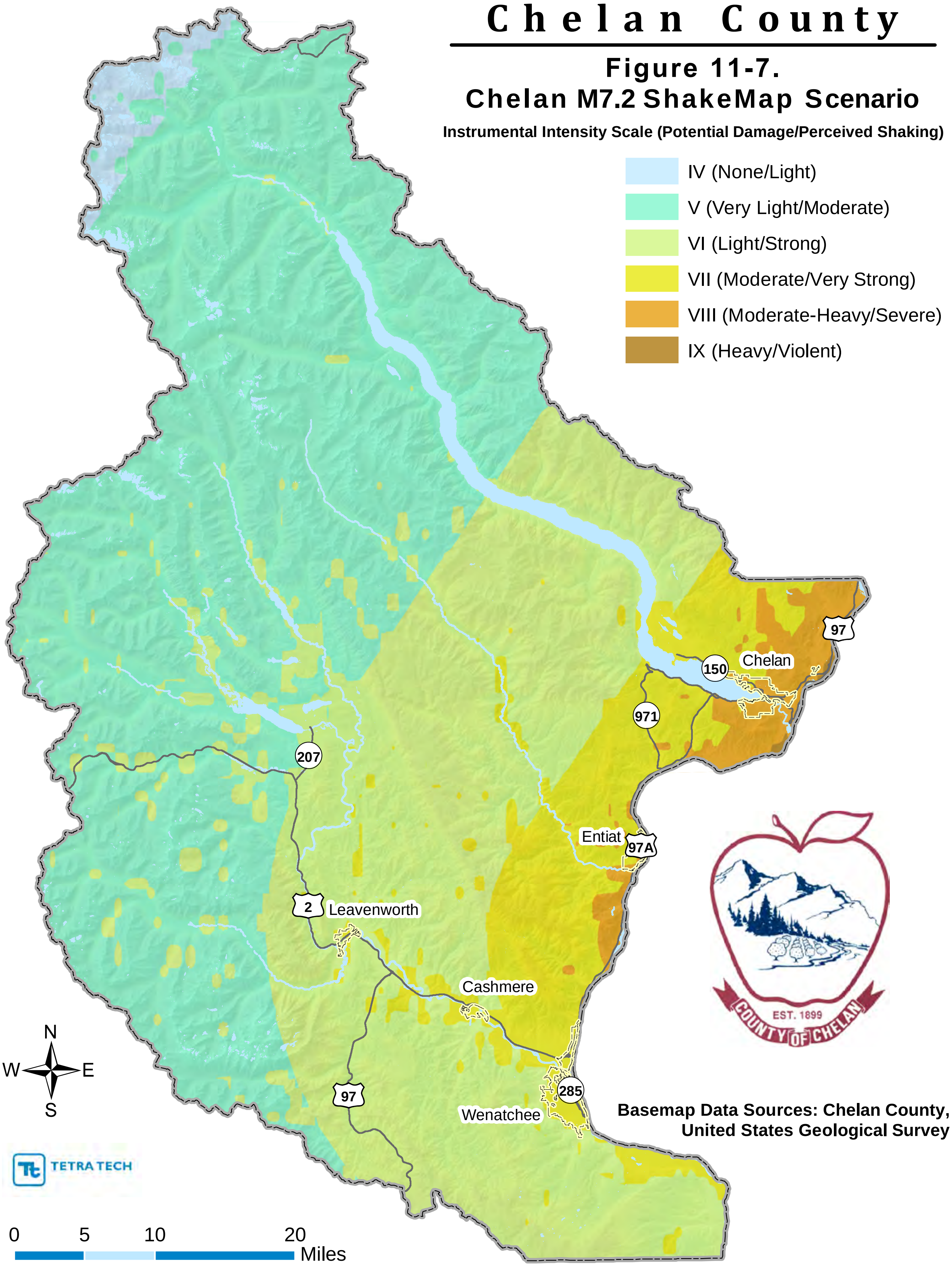
11.5.1 Population

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 58,874 people in over 21,800 households living on NEHRP D soils in the planning area. This is about 75 percent of the total population.

Chelan County

Figure 11-7.
Chelan M7.2 ShakeMap Scenario

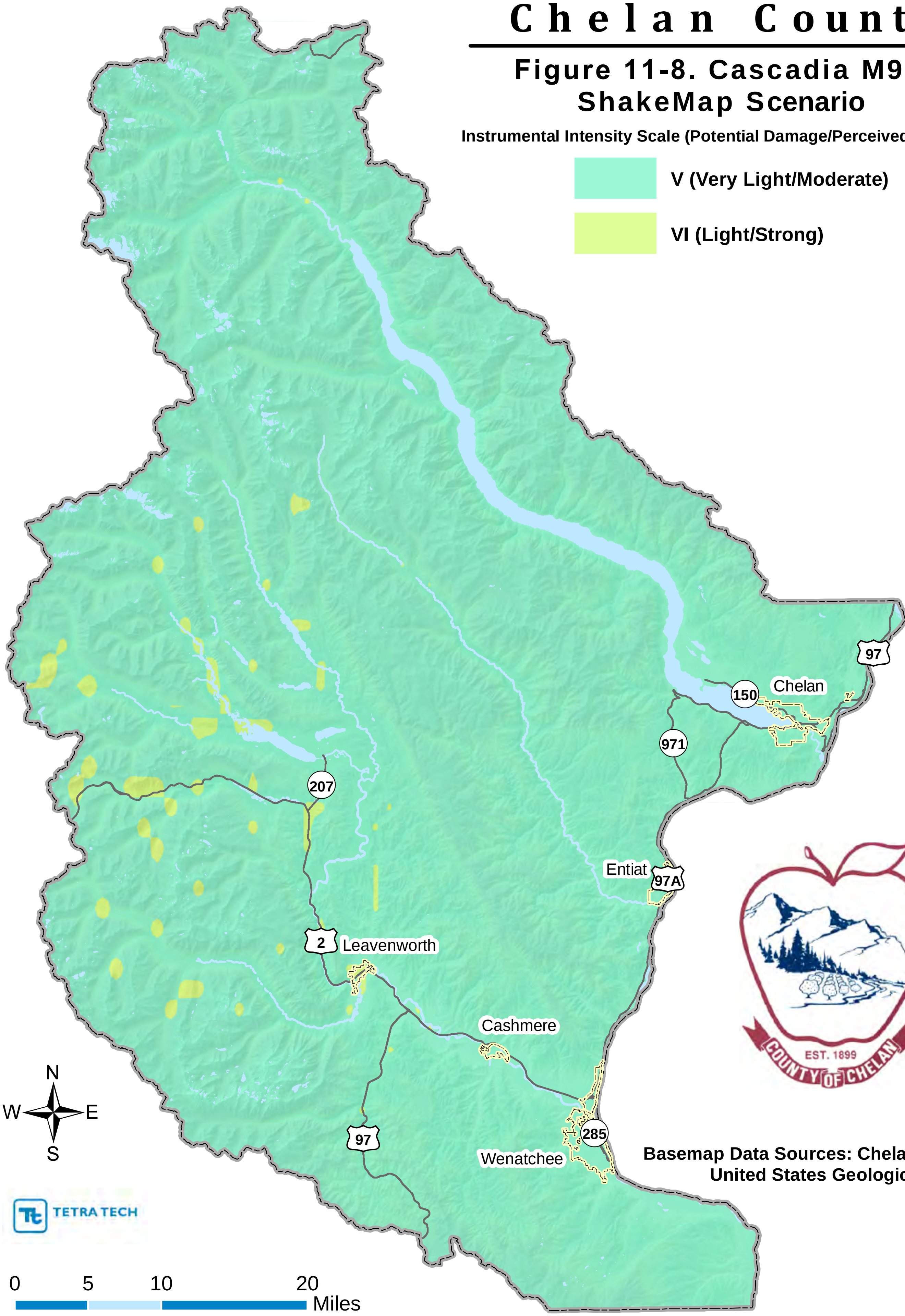


Chelan County

Figure 11-8. Cascadia M9.0 ShakeMap Scenario

Instrumental Intensity Scale (Potential Damage/Perceived Shaking)

- V (Very Light/Moderate)
- VI (Light/Strong)



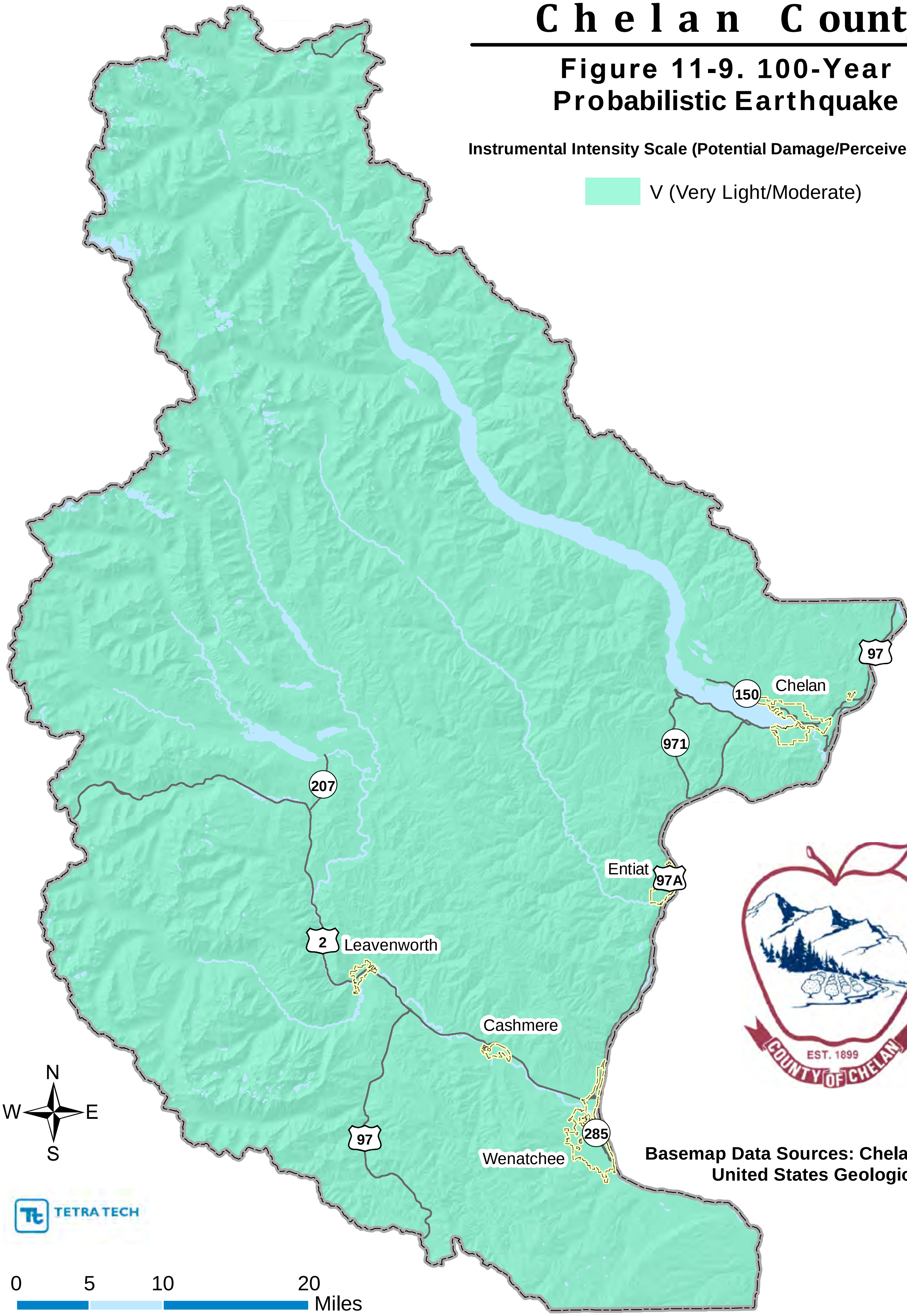
EST. 1899
COUNTY OF CHELAN

Basemap Data Sources: Chelan County, United States Geological Survey

TETRA TECH

Chelan County

Figure 11-9. 100-Year Probabilistic Earthquake



Basemap Data Sources: Chelan County, United States Geological Survey

TETRA TECH

Susceptible Population Groups

Two groups are particularly vulnerable to earthquake hazards:

- **Population Below Poverty Level**—An estimated 13,049 households in NEHRP D and E soils areas have household incomes less than $50,000 per year. This is about 52 percent of all households located on NEHRP D and E 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 9,986 residents in areas of NEHRP D and E soils are over 65 years old. This is about 15 percent of all residents in these areas of NEHRP D and E 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 three (3) selected earthquake scenarios as summarized in Table 11-4.

Table 11-4. Estimated Earthquake Impact on Persons

Scenario	Displaced Households		Persons Requiring Short-Term Shelter	
	Number	% of Total	Number	% of Total
100 Year Probabilistic	3	Less than 0.1%	2	Less than 0.1%
Chelan M7.2	4	Les than 0.1%	3	Less than 0.1%
Cascadia M9.0	None	N/A	None	N/A

11.5.2 Property

Building Age

Table 11-5 identifies significant milestones in building and seismic code requirements that directly affect the structural integrity of development. Using these time periods, the planning team used Chelan County assessor's data to identify the number of structures in the planning area by date of construction. The number of structures does not reflect the number of total housing units, as many multi-family units and attached housing units are reported as one structure. Approximately 41.5 percent of the planning area's structures were constructed before there were state minimums regarding residential seismic construction standards. Approximately 16 percent were built after seismic Zone 3 standards were required.

Liquefaction Potential

Table 11-6 shows the estimated number of structures located on moderate to high potential liquefaction areas or peat soils. There are estimated to be 13,053 such structures in the planning area that were built before 1972 (41.5 percent). An estimated 600 structures on liquefiable soils have been built since 2007 (10.8 percent).

Loss Potential and Estimated Debris

Table 11-7 summarizes Hazus estimates of earthquake damage in the planning area for the three (3) 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 fires stemming from an earthquake.

Table 11-5. Age of Structures in Planning Area

	Number of Current Structures Built in Period[a]	Significance of Time Frame
Pre-1972	13,053	Adoption of building codes was at the discretion of individual cities and counties. There were no state minimums regarding residential construction, although newly constructed schools, hospitals and places of assembly were required to withstand a lateral force of 5 percent of the building weight.
1972-1993	8,715	Houses built after 1972 are in compliance with the 1970 Uniform Building Code, which required that all structures be constructed to Zone 2 seismic standards.
1994-2003	4,676	Zone 3 standards of the Uniform Building Code went into effect in western Washington in 1994, requiring all new construction to be capable of withstanding the effects of 0.3 times the force of gravity.
2004-2006	1,612	Adoption of new codes that became effective in July of 2004 brought Washington State's building codes to the highest level nationwide addressing the state's seismic hazard.
2007-present	3,429	Amendments to the International Building Code that took effect in July of 2007 included provisions for structural design for earthquake loads and flood hazards. The code applies to all building permits in the state of Washington. The codes are driven in part by soil and liquefaction maps prepared.
Total	31,485	

a. Year built information was collected from Chelan County tax assessor data. When year-built information was unavailable, it was estimated based on census block or county-wide average year-built dates.

Source: Western States Seismic Policy Council, 2016

Table 11-6. Structures Located on Moderate to High Liquefaction Potential

Jurisdiction	Structures on Liquefiable Soils	Total Structures	Percent of Total Structures
Cashmere	714	1,034	69.1%
Chelan	414	2,706	15.3%
Entiat	78	503	15.5%
Leavenworth	157	1,281	12.3%
Wenatchee	19	10,972	0.17%
Unincorporated	3,795	14,989	25.3%
Total	5,177	31,485	16.4%

Table 11-7. Estimated Impact of Earthquake Scenario Events in the Planning Area

	Structure Debris		Damage	
Earthquake Scenario Event	Tons	Truckloads	Structure + Contents Damage	% of Total Value
100-year probabilistic	34,198	1,248	$118.2 Million	0.8%
Chelan M7.2	74,160	2,966	$1.325 billion	9.2%
Cascadia Subduction Zone M9.0	2,010	80	$51.7 Million	0.4%

11.5.3 Critical Facilities and Infrastructure

A Hazus analysis was conducted on critical facilities and infrastructure in the planning area for the two most likely scenarios: the 100-year probabilistic scenario and the M9.0 Cascadia Subduction Zone 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 100-year probabilistic event and the Cascadia Subduction Zone events indicated that no damage was expected to any critical facilities or infrastructure. The results for the Chelan Fault scenario event are summarized in Table 11-8.

Table 11-8. Estimated Damage to Critical Facilities from M7.2 Chelan fault Zone Scenario

Category	# of Critical Facilities	Number of Buildings with 50% or Greater Probability of Achieving Damage Level				
		None	Slight	Moderate	Extensive	Complete
Emergency Response Facilities	24	5	12	4	3	0
Medical and Care Facilities	8	2	5	0	1	0
Educational Facilities	45	34	4	7	0	0
Transportation Infrastructure	240	237	1	2	0	0
Utility Infrastructure	139	65	50	12	12	0
Hazardous Material Facilities	19	11	3	4	1	0
Community Gathering Facilities	17	13	1	3	0	0
Government Facilities	36	16	15	5	0	0
Overall	528	383	91	37	17	0

Hazardous Materials

Hazardous material releases from fixed facilities and transportation-related releases can occur during an earthquake event. Vital transit corridors such as WA State Highways 2, 97, 150, 207, 285 and 971 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 at least 19 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 2
- State Highway 97
- State Highway 285
- State Highway 150
- State Highway 207
- State Highway 971

Bridges

Earthquake events can significantly impact bridges. These are important because they often provide the only access to some neighborhoods. 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 at least 3 bridges in the planning area would experience slight damage following a M7.2 event on the Chelan Fault. Slight damage for bridges is considered to be damage that requires only cosmetic repair. Due to the limitations of the analysis however, it is likely that at least some bridges in the planning area would experience more 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.

11.5.4 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.

11.6 FUTURE TRENDS IN DEVELOPMENT

Land use in the planning area will be directed by comprehensive plans adopted under Washington’s Growth Management Act. The information in this plan provides the participating partners a tool to ensure that there is no increase in exposure in areas of high seismic risk. Development in the planning area will be regulated through building standards and performance measures so that the degree of risk will be reduced. The geologic hazard portions of the planning area are regulated under each jurisdiction’s critical areas ordinances. The most recently adopted building codes take liquefaction and soil mapping into account in their standards.

Areas targeted for future growth and development have been identified across the County. It is anticipated that the human exposure and vulnerability to earthquake impacts in newly developed areas will be similar to those that currently exist within the County. New development in areas with softer NEHRP soil classes, liquefaction and landslide-susceptible areas may be more vulnerable to the earthquake hazard.

11.7 SCENARIO

Any seismic activity of 6.0 or greater on faults within the planning area’s general region would have significant impacts throughout the planning area. An earthquake on the Chelan Fault could have disastrous consequences for the entire state and the region. Potential warning systems could give a few seconds’ notice that a major earthquake is about to occur. This would not provide adequate time for preparation.

Large magnitude earthquakes in the region could lead to massive structural failure of property on liquefiable soils. Structural failure may be intensified if the earthquake occurs during winter when soils are saturated. Heavy damage would also occur in areas with poor site conditions, older construction, or construction especially vulnerable to long duration, long period ground motions. Dams, levees and revetments built on poor soils would likely fail, representing a loss of critical infrastructure. Access to and from the County would be challenging, given the likelihood that bridges and major transportation routes may be impassable. These events could cause secondary hazards, including landslides and mudslides that would further damage structures.

11.8 ISSUES

Important issues associated with an earthquake include the following:

- It is estimated that 75 percent of the total population in the planning area resides on soils with moderate to high liquefaction potential or peat soils.
- After a major seismic event, Chelan County would likely experience disruptions in the flow of goods and services due to the destruction of major transportation infrastructure across the broader region.
- Approximately 15 percent of the population living in moderate to high liquefaction potential areas are 65 years or older and may require special medical attention or be unable to evacuate without assistance.
- Approximately 17 percent of households living in moderate to high liquefaction potential areas have household incomes less than $20,000 per year.
- Critical facility owners should be encouraged to create or enhance continuity of operations plans using the information on risk and vulnerability contained in this plan.
- 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.
- 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.
- Earthquakes can cause conflagration of wooden homes and collapse of essential buildings such as fire stations.
- Earthquakes could trigger other natural hazard events such as dam failures, levee failures and landslides, which could severely impact the planning area or regional critical facilities.
- Geotechnical standards should be established that take into account the probable impacts from earthquakes in the design and construction of new or enhanced facilities.
- Major arterials in the planning area cross liquefiable soils and could be impassable after an event.
- Model estimates indicate that debris removal from earthquake events would require approximately 80 to almost 3,000 truckloads, depending on the event scenario.
- Natural hazards have a devastating impact on businesses. Of all businesses that close following a disaster, more than 43 percent never reopen, and an additional 29 percent close for good within the next two years. The Institute of Business and Home Safety has developed “Open for Business,” which is a disaster planning toolkit to help guide businesses in preparing for and dealing with the adverse effects of natural hazards. The kit integrates protection from natural disasters into companies’ risk reduction measures to safeguard employees, customers, and the investment itself. The guide helps businesses secure human and physical resources during disasters and helps to develop strategies to maintain business continuity before, during, and after a disaster occurs.
- Over 69 percent of the planning area’s building stock was built prior to 1994, when Zone 3 seismic standards were incorporated into the building code.
- Residents are expected to be self-sufficient up to three days following a major earthquake without government response agencies, utilities, private sector services and infrastructure components. Education programs are currently in place to facilitate the development of individual, family, neighborhood and business earthquake preparedness. Government alone can never make this region fully prepared. It takes individuals, families, and communities working in concert with one another to truly be prepared for disaster.
- There are likely additional faults in or around Chelan County that have not yet been discovered.

12. FLOOD

12.1 GENERAL BACKGROUND

Flooding is defined as a significant rise in water level due to increased surface water run-off or groundwater saturation that results in an increase in surface water levels beyond what is typically expected and that can cause damage to man-made structures.

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

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

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 altered or significantly reduced.

12.1.1 Measuring Floods and Floodplains

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

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

12.1.2 Floodplain Ecosystems

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. 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.

12.1.3 Effects of Human Activities

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

12.1.4 Types of Floodplains in the Planning Area

Stage, flash and post-fire flooding are three types of flooding common in Chelan County. Stage flooding occurs during periods of heavy rains, especially falling on existing snowpack during early winter and late spring. Stage flooding can last several days after the storm. Flash floods are most likely to occur during the summer thunderstorm season and are usually associated with cloudburst-type rainstorms. Winter flash flooding events, when they occur, are typically caused by ice or debris dams. Due to the County's topography and climate, stage and flash flooding are a continuing threat in most parts of the county (Chelan County, 2013). After a significant wildfire, vegetation is lost and soils can harden to repel rather than absorb water. This can result in mud/silt or debris flows that impact public and private property (county roads, private homes/cabins, etc.). It also reduces flow conveyance, increasing the potential for flood damage.

12.1.5 Stage Flooding

Stage floods occur because of prolonged heavy rainfall, a rapidly melting snow pack or a combination of these. Stage flooding problem areas can occur countywide; some of the most susceptible areas are the area where Icicle Creek and the Wenatchee River meet in Leavenworth, the Wenatchee River between Cashmere and Wenatchee, the headwaters of the Wenatchee River, and the confluence area of the Wenatchee and Columbia Rivers. The following sections describe the watersheds in the planning area that are sources of stage flooding

12.1.6 Flash Flooding

Flash flooding is flooding characterized by a quick rise and fall of water level. Flash floods generally result from intense storms dropping large amounts of rain within a short period of time onto watersheds that cannot absorb or slow the flow.

Historically, Chelan County has had regular occurrences of flash flooding. Present problem areas for flash flooding include Slide Ridge in the Chelan area and No. 1 and No. 2 Canyons and Dry Gulch in the Wenatchee area. The primary cause of flash flooding, which can occur in any county drainage area, is high-intensity rainfall.

Depending upon the characteristics of a particular watershed, peak flows may be reached from less than one hour to several hours after rain begins. The debris dams and mudslides accompanying rapid runoff conditions make narrow canyons and alluvial fans at the mouth of the canyons extremely hazardous areas (Chelan County, 2011).

12.1.7 Post-Fire Flooding

Wildfires dramatically change landscape and ground conditions, which can lead to increased risk of flooding due to heavy rains, flash flooding, and mudflows. The threat of flash flooding is increased in an area that has suffered from a major wildfire. Not only is there a greater amount of loose debris, but most of the ground cover also has been burnt away. Without ground cover, more soil and debris can flow, increasing the chance of debris dams. When rain falls on unprotected earth, as in a burn area, soils on moderate to steep slopes can become unstable. The heavily saturated earth can liquefy and flow down a hillside into populated areas. This can cause devastating floods and mudflows.

Post-fire flooding is a concern in Chelan County. Since 2010, over 600 square miles in the county have been burned by wildfires. Much of this area has been in steep canyons or areas that contribute to drainage area that feed the floodplains of Chelan County. Post-fire flooding can be the worst type of flooding in that there is usually large sediment loads associated with these types events. This sediment transport can lead to channel deposition and migration, which can lead to public safety issues, lack of early warning, and costly cleanup for public agencies and private residents.

The 1972 flood was an area-wide event resulting from a large frontal storm combined with the late melt of a record snow pack. The Preston Creek debris torrent that occurred during this event originated from lands burned in 1970. The Crum/Ringsted/Byrd Canyon floods of 1977, the Dinkelman/Mills/Roaring flood of 1989, and the Potato Creek and Oklahoma Gulch floods of 1997 were all post-fire responses triggered by short duration, high intensity convective storms (Chelan County Conservation District, 2004).

12.2 NFIP AND CRS PARTICIPATION

The cities of Cashmere, Chelan, Leavenworth, Wenatchee and Entiat also participate in the NFIP. All have adopted regulations that meet the NFIP requirements. Table 12-1 summarizes participation dates for these communities. Chelan County is in the process of joining the CRS program, but none of the cities in Chelan County participate in CRS; only 31 of the 293 NFIP communities in Washington participate in CRS.

Table 12-1. NFIP Participation by Chelan County and Municipalities

ID	Community Name	Initial Flood Hazard Boundary Map	Initial Flood Insurance Rate Map	Current Effective Map Date	Program Entry Date
530016	City of Cashmere	04/05/74	12/1/77	09/30/04	12/1/77
530015	Chelan County	01/12/73	02/04/81	09/30/04	02/04/81
530017	City of Chelan	06/25/76	01/05/78	01/05/78	01/05/78
530019	City of Leavenworth	05/24/74	01/05/78	07/02/02	01/05/78
530020	City of Wenatchee	02/01/74	11/2/77	01/06/94	02/04/81
530018	City of Entiat	11/01/74	N/A	NSFHA[a]	08/03/84

a. NSFHA = Non-Special Flood Hazard Area. This indicates an area that is in a moderate- to low-risk flood zone. An NSFHA is not in any immediate danger from flooding caused by overflowing rivers or hard rains, although structures are still at risk. In fact, more than 20 percent of all flood insurance claims come from outside mapped high-risk flood areas.

Source: FEMA, 2018a

Chelan County established eligibility in the NFIP's Emergency Program on October 30, 1974 after receiving its Flood Hazard Boundary Map on February 1, 1974. The County's first Flood Insurance Rate Maps were issued on February 4, 1981, which is also the date the County was converted to the NFIP's Regular Program. FIRMs were updated on June 5, 1989, July 2, 2002 and September 30, 2004. No Digital FIRMs have yet been prepared for Chelan County.

Chelan County's Flood Chapter 3.20 is fully compliant with NFIP and State floodplain management regulations. This chapter exceeds the FEMA and state requirements in the following ways:

- New residences in the floodplain must be elevated 3 feet above the base flood elevation; nonresidential buildings must be one foot above the base flood elevation.
- No fill, grading or excavation that unduly affects the efficiency or capacity of the channel or floodway, or decreases flood storage, is permitted. Fills must be protected against erosion.
- Critical facilities must be located outside the floodplain to the extent possible, or must be elevated at least three feet above the base flood elevation.
- Where base flood elevation data has not been provided by FEMA, applicants must develop such data for subdivision proposals and other proposed developments (exceeds FEMA's 50 lot-5 acre criteria).

Currently the County is in good standing with the NFIP. There are no outstanding compliance issues; a Community Assistance Visit (CAV) was recently completed in August 2018. All the others panning partners NFIP status is discussed in further detail in volume 2 of this plan.

12.2.1 Insurance Summary

Table 12-2 lists flood insurance statistics that help identify vulnerability in the planning area. Six planning area communities participate in the NFIP, with 735 flood insurance policies providing $185.3 million in coverage. According to FEMA statistics, 147 flood insurance claims were paid between January 1, 1978 and September 30,2018, for a total of $1.1 million, an average of $7,540 per claim. Not all structures within the special flood hazard area are covered by flood insurance; according to FEMA, fewer than 25 percent of structures at risk nationally are covered by flood insurance.

Table 12-2. Flood Insurance Statistics for Chelan County

Jurisdiction	Date of Entry Initial FIRM Effective Date	# of Flood Insurance Policies as of 9/30/2018	Insurance In Force	Total Annual Premium	Claims, 11/1978 to 9/30/2018	Value of Claims paid, 11/1978 to 9/30/2018[a]
Cashmere	12/1/1977	24	$5,770,400	$16,743	7	$7,976
City of Chelan	01/05/1978	6	$1,523,400	$10,792	0	0
Chelan County	02/04/1981	418	$109,312,800	$255,673	105	$985,010
Entiat	08/03/1984	0	$0	$0	0	0
Leavenworth	01/05/1978	8	$2,009,100	$3,318	5	$87,000
Wenatchee	11/2/1977	279	$66,686,900	$188,384	30	$28,358
Total		735	$185,302,600	$474,910	147	$1,108,344.00

a. Values reflected have not been converted to current dollar values. Amounts reflect damages covered under the standard flood insurance policy and do not reflect exclusions such as basement flooding or non-structural damages.

Source: FEMA, 2018c

Properties constructed after a FIRM has been adopted are eligible for reduced flood insurance rates. Such structures are less vulnerable to flooding because they were constructed after regulations and codes were adopted to decrease vulnerability. Structures built before a FIRM is adopted are more vulnerable to flooding because they do not meet current codes or are located in hazardous areas. The first FIRMs in the planning area were available in 1977.

The following information related to flood insurance statistics is relevant for understanding and reducing flood risk in the planning area:

- The uptake of flood insurance in the planning area is below the national average. Only 23 percent of insurable buildings in the planning area are covered by flood insurance. According to an NFIP study, about 49 percent of single-family homes in special flood hazard areas are covered by flood insurance nationwide (Congressional Record, V. 152, Pt. 9, June 16, 2006 to June 27, 2006)
- The amount of insurance coverage in force represents approximately 18.3 percent of the total value of the assets exposed within the SFHA.
- The average claim paid in the planning area represents about 2.5 percent of the 2012 average assessed value of structures in the floodplain. This correlates to a flood depth of less than 1 foot for a one story structure with no basement using the U.S. Army Corps of Engineers generic flood-depth/damage curves.
- The percentage of policies and claims outside a mapped floodplain suggests that not all of the flood risk in the planning area is reflected in current mapping. Based on information from the NFIP, 82 percent of policies in the planning area are on structures within an identified SFHA, and 18 percent are for structures outside such areas. It may be that a high number of these policies are in the 500-year floodplain (Shaded X zones), which are not impacted by the mandatory purchase requirement of the NFIP.

12.2.2 Staff Resources

Chelan County's Building Official, a position within the Department of Community Development, serves as the Floodplain Manager. Duties related to floodplain development and NFIP compliance is auxiliary to the main responsibilities as Building Official. The County does not have a Certified Floodplain Manager on staff. NFIP administration services performed by the Building Official include permit review and inspections. Engineering capability and flood elevation certifications are performed by outside surveyors and contractors. There are no barriers within the County to running an effective NFIP program.

12.3 HAZARD PROFILE

12.3.1 Watersheds

The Washington Department of Ecology has divided Washington into Water Resource Inventory Areas to delineate the state's major watersheds. The following sections describe the WRIAs that make up Chelan County.

WRIA 45, Wenatchee River Watershed

Surface Waters

The Wenatchee Watershed (WRIA 45) is approximately 1,370 square miles, including some areas that drain directly into the Columbia River. This area includes 230 miles of major streams and rivers and associated aquatic habitat. The headwaters of WRIA 45 are the Little Wenatchee and White Rivers in the Cascade Mountain range. These rivers flow into Lake Wenatchee, the source of the Wenatchee River. The Wenatchee River discharges into the Columbia River in the City of Wenatchee. The following tributaries enter the Wenatchee River downstream of the lake, adding significant volume to the river.

- Nason Creek—Confluence at Wenatchee River Mile (RM) 53.6
- Chiwawa River—Confluence at RM 48.6
- Chiwaukum Creek—Confluence at RM 35.6

- Icicle Creek—Confluence at RM 25.6
- Chumstick Creek—Confluence at RM 23.5
- Peshastin Creek—Confluence at RM 17.9
- Mission Creek—Confluence at RM 10.4.

The Chiwawa, White and Little Wenatchee Rivers, and Nason and Icicle Creeks are the source of over 90 percent of the surface water in the watershed (Wenatchee River Watershed Steering Committee, 1996).

Climate and Stream Flows

The Wenatchee Watershed extends from snowfields, glaciers and steep, forested Cascade Mountains in the northwest, through orchards in the Wenatchee River Valley, to the shrub-steppe of the eastern watershed at the confluence of the Wenatchee and Columbia Rivers. Average annual precipitation over this drainage area varies from over 150 inches at the Cascade Crest to 8 inches in Wenatchee. The climate in the watershed is hot and dry in the summer, especially in the lower elevations. The higher elevations receive, on average, between 10 and 20 feet of snow in the winter (Wenatchee River Watershed Steering Committee, 1998). Snowmelt is a primary source of late summer and fall stream flow. Variability in winter precipitation results in highly variable stream flow, especially in the more arid lower watershed. The different climatic zones within the watershed are important because the largest irrigation and domestic water demands occur in the drier, lower valley near Wenatchee, where stream flow can be limited some years.

Topography and Soils

The main topographic features of the Wenatchee River watershed are as follows (Chelan County, 2011):

- All or part of the Wenatchee River, Chumstick Creek, Peshastin Creek and Icicle Creek Valleys
- Ollala, Hay, Nahahum, Warner, Warm Springs, Brender, Brisky, Tripp, Yaksum and Fairview Canyons

The topography of the west and north is a direct result of large mountain glaciers that formed in the Icicle, Tumwater, and Chumstick Canyons. Glacial action was responsible for deepening and smoothing the valley floors. These glaciers probably terminated along the Mountain Home Road, to the southeast of Leavenworth, where there is evidence of a terminal moraine (Chelan County, 2011).

Throughout much of the area, the soil is underlain with alluvial deposits and glacial drift. Volcanic pumice and ash from the Glacier Peak region have added substantially to the depth and character of the soil in many areas. The mountainous terrain, with characteristically steep slopes and high elevations, consists largely of rock outcroppings and shallow soils (Chelan County, 2011).

Fish

The Wenatchee River and its tributaries have some of the healthiest anadromous fish runs in the Columbia River drainage and contain salmonid habitat that is important to the entire Columbia River region. However, spring Chinook in the Wenatchee Watershed have been federally listed as endangered and bull trout and steelhead have been listed as threatened under the Endangered Species Act (ESA) (listings occurred in 1998, 1999 and 2006, respectively). Core populations of sockeye salmon, steelhead, bull trout, and spring and summer Chinook salmon in the upper Wenatchee are relatively strong compared to other populations in the Columbia River basin. Anadromous salmonid populations in the Wenatchee watershed must negotiate a 468-mile journey from the mouth of the Wenatchee River to the Pacific Ocean, once as smolts and again as adults. Within the watershed, human alterations are reducing habitat quality and quantity (Andonaegui, 2001).

WRIA 46, Entiat River Watershed

Surface Waters

The Entiat River is the major surface water source in this 418-square-mile watershed. Dozens of small creeks and streams are tributary to the river. The higher elevations in the northwest portion of the watershed receive about 100 inches of precipitation annually, most of which occurs as snow. The lowest elevations, near the town of Entiat, receive about 10 inches of precipitation. Meltwater from the snowpack supplies most of the stream flow in spring and early summer. Nearly all of the precipitation runoff and snowmelt occurs from April through July (Washington Department of Ecology, 1995b).

The watershed is shaped like a triangle with the Columbia River at the base and the valley rising between the Chelan and Entiat Mountains. The Entiat River begins at the terminus of the Entiat Glacier on Mt. Maude and flows approximately 50 miles into the Columbia River at the south end of the City of Entiat. The drainage is generally long and narrow, with numerous small tributaries flowing into the main river. The north fork of the Entiat River and the Mad River are the largest tributaries. These bodies of water and their tributaries provide the main source of drinking water for the area and are also important for irrigation and recreation (Chelan County, 2011).

There are no reservoirs in the Entiat watershed, although the lowest 0.5 miles of the Entiat River and floodplain is influenced by backwater effects from Lake Entiat, which is the pool for the Rocky Reach Dam Hydroelectric Facility on the Columbia River. No artificial ponds have been identified (Andonaegui 1999).

Climate and Stream Flow

Mean annual precipitation varies from 90 inches in the headwater areas near the Cascade crest to less than 10 inches along the Columbia River. Approximately 75 percent of the mean annual precipitation falls from October March. Most winter precipitation falls as snow; however, rain is not unusual at some mid- and lower elevations. Cumulative snow depths range from less than 24 inches in lower elevations to nearly 400 inches in the mountains. Precipitation in July and August, the two driest months, is 5 to 10 percent of the annual mean. Local climate station records from 1949 to 1992 show no definitive increasing or decreasing trend in annual precipitation (Kirk et al. 1995). High flows in the Entiat watershed commonly result from rapid spring snowmelt, large storms (including warm rain-on-snow events), or high-intensity convective storms. High-intensity, short-duration thunderstorms in summer can result in brief but heavy downpours that occasionally produce flash floods.

Topography and Soils

Elevations in the Entiat River watershed range from just over 700 feet above sea level along the Columbia River to 9,249 feet at the summit of Mt. Fernow. Many of the soils in the area become unstable or erosive as slopes increase. Throughout much of the area, the soil is underlain with alluvial deposits and glacial drift. The geology of the Entiat area is igneous bedrock with granite and diorite predominating (Chelan County, 2011).

Most of the large-scale topographic features are the result of alpine glaciation, which significantly affected the upper half of the watershed. During the neo-glaciation period, a valley glacier nearly 25 miles long extended from its source at the headwall of the Entiat watershed to just below Potato Creek, which is marked by a terminal moraine indicating the furthest downstream influence of the glacier on channel geomorphology and bed material. Above the terminal moraine, the Entiat valley has a characteristic U-shaped appearance and is covered with glacial till. Glaciation resulted in hanging valleys and a moderately broad floodplain in the mid Entiat River that contains water-stratified silt, sand, gravel and cobbles. (Chelan County Conservation District, 2004).

WRIA 47, Lake Chelan Watershed

Surface Waters

The main surface water feature of this 1,047-square-mile watershed is Lake Chelan, the largest and deepest lake in Washington. The lake consists of two basins: the Wapato basin at the lower end of the lake is about 12 miles long and has a maximum depth of about 400 feet; the upper Lucerne basin is 38 miles long and has a maximum depth of nearly 1,500 feet. A shallow sill, about 130 feet deep, separates the two basins at a restriction of the lake known as The Narrows. The lake's average width is about 1.5 miles (Kendra and Singleton, 1987). Lake Chelan and the Columbia River provide the main source of drinking water for the area. They are also important for irrigation and recreation (Washington Department of Ecology, 1995c; Chelan County, 2011).

Roughly 75 percent of the inflow to Lake Chelan comes from the Stehekin River and Railroad Creek. Smaller tributaries to the lake include Fish, Prince, Gold, First, Safety Harbor, and Twenty-Five Mile Creeks. The lake discharges to the Chelan River, which in turn discharges to the Columbia River. The outfall is controlled through a hydroelectric dam and a penstock system to the Columbia River.

There are two reservoirs in WRIA 47 with volumes of 10 acre-feet or greater. Wapato Lake, at 2,000 acre-feet, and Antilon Lake, at 1,920 acre-feet, were constructed in natural, in-channel basins enlarged to enhance irrigation storage. These reservoirs cover 338 acres.

About 10 percent of WRIA 47 consists of sub-basins that drain directly to the Columbia River; less than 5 percent of total WRIA 47 stream flow discharges from these sub-basins. Approximately 2 percent of WRIA 47 lies within Okanogan County,

Average annual precipitation in the Chelan watershed ranges from 150 inches per year at the crest of the Cascade Mountains to 11 inches per year in the city of Chelan. Most of the annual precipitation falls in winter as snow. As the snowpack melts in spring and early summer, it supplies most of the stream flow. In addition, some melting snow infiltrates into the soil to become groundwater, which then slowly discharges to rivers and tributary streams, providing a relatively low but constant flow the rest of the year. Precipitation that is not lost to evapotranspiration runs off steep slopes into stream channels and minor tributaries of the Stehekin River and Railroad Creek, and into minor tributaries of Lake Chelan, where they ultimately discharge out of Lake Chelan into Chelan River and finally the Columbia River.

Topography and Soils

Elevations in the Lake Chelan Watershed range from just over 700 feet above sea level along the Columbia River to 9,511 feet at the summit of Bonanza Peak, the highest point in Chelan County. Approximately 70 percent of WRIA 47 is above an elevation of 3,000 feet, and 47 percent is above 5,000 feet. The mountainous terrain, with characteristically steep slopes and high elevations, consists largely of rock outcroppings and shallow soils. The geology is characterized by underlying rock formations covered by a shallow mantle of soils in the valleys (Chelan County, 2011).

The Soil Conservation Service has classified 84 percent of the Lake Chelan watershed ground cover as forest. Lands below the forest level consist of grasses, sagebrush and shrubs, with the more level areas developed as crop land (Chelan County, 2011).

Many of the soils in the area become unstable or erosive as slopes increase. Throughout much of the area, the soil is underlain with alluvial deposits and glacial drift. Volcanic pumice and ash from the Glacier Peak region have added substantially to the depth and character of the soil in many areas (Chelan County, 2011).

Landforms consist of the classic U-shaped glacially-carved valleys of Lake Chelan, the Stehekin River and smaller tributaries in the higher elevation sub-basins, which are surrounded by high ridges and steep cliffs. The Stehekin Valley is a U-shaped, glacially-carved canyon above Lake Chelan that is nearly 6,000 feet deep, and a mile or less wide as it extends 25 miles from Lake Chelan to the Cascade Crest. Lower elevation sub-basins are narrower incised valleys that are tributaries to Lake Chelan and the Columbia River, bounded by rolling hills near the lake's terminus at the City of Chelan, and gravel terraces along the Columbia River.

WRIA 40, Alkali-Squilchuck (Malaga-Stemilt-Squilchuck Area)

Surface Waters

In addition to the three primary watersheds making up Chelan County, a small portion of WRIA 40 (Alkali-Squilchuck) extends into the southeastern corner of the county around Malaga. The portion of WRIA 40 in Chelan County includes the Squilchuck Creek, Stemilt Creek and Cummings Canyon Creek watersheds. The rest of the watershed extends into Kittitas, Yakima and Benton Counties, and includes other small creeks primarily draining directly to the Columbia River.

Squilchuck and Stemilt Creeks are tributaries to the Columbia River. The Squilchuck/Stemilt Watershed (WRIA 40A) covers 76.6 square miles, bounded by the Columbia River to the north, sub-basins of the Wenatchee and Columbia Rivers to the west, Naneum Ridge to the south, and Jump-off Ridge to the east. About 8 percent of WRIA 40A is in Kittitas County and the remainder is in Chelan County. This area consists of four sub-basins: Stemilt (21,430 acres); Squilchuck (17,600 acres); Malaga (8,490 acres); and Wenatchee Heights (2,200 acres).

Squilchuck Creek is 10.6 miles long with three perennial tributaries: Miners Run Creek, Lake Creek and Upper Squilchuck Creek. Numerous intermittent tributaries flow during periods of snowmelt and during high-intensity thunderstorms (USFS, 1998). About 27 percent of the Squilchuck Creek watershed is in public ownership (RH2, 2007).

Stemilt Creek is 12.4 miles long with four perennial tributaries: Orr Creek (also called Westerly Northwest Branch); Middle Creek (also called Easterly Northwest Branch); Little Stemilt Creek (also called Southeast Branch); and Big Stemilt Creek (also called Easterly Southeast Branch). A few springs discharge into lower Stemilt Creek. About 58 percent of the Stemilt Creek watershed is in public ownership (RH2, 2007).

There are approximately 35 reservoirs in WRIA 40A with volumes of 10 acre-feet or greater. They cover 195 acres and provide storage of approximately 3,500 acre-feet. Eight are inactive, and all but one were constructed in natural, off-channel basins enlarged to enhance irrigation storage. Water levels in these reservoirs are largely sustained by diversions from Squilchuck and Stemilt Creeks.

Climate and Stream Flow

Average annual precipitation in WRIA 40A—ranging from 8 inches in the lower elevations to 32 inches in the highest elevations—promotes shrub-steppe and sub-alpine forest vegetation, respectively. Winters are moderately cold, with snow at all elevations. Most precipitation above 3,000 feet is from snow (USFS, 1998). Summers are hot and dry. Approximately 65 percent of annual water flow in Squilchuck and Stemilt Creeks derives from snowmelt during April to July. Springs in the upper reaches support base flow in the creeks (RH2, 2007).

Topography and Soils

The southeast corner of Chelan County includes Pitcher Canyon, Halverson Canyon, Mission Peak, Wenatchee Heights, Jumpoff Ridge, the Malaga and Three Lakes Communities, Rock Island Dam and vicinity, and the drainage basins of Squilchuck Creek, Stemilt Creek, and Colockum Creek. The area is bordered by the Columbia River to the north and east, and by the Kittitas County boundary to the south (Chelan County, 2011).

Elevation in WRIA 40A ranges from 605 feet at the Columbia River to 6,887 feet at Mission Peak. Dominant landforms consist of high ridges and steep slopes that surround large basins, knobs and depressions, deeply incised channels, gravel terraces and the Wenatchee Heights mesa.

12.3.2 Past Events

Presidential disaster declarations are typically issued for hazard events that cause more damage than state and local governments can handle without assistance from the federal government, although no specific dollar loss threshold has been established for these declarations. A presidential disaster declaration puts federal recovery programs into motion to help disaster victims, businesses and public entities. Some of the programs are matched by state programs. Chelan County has experienced 7 flood events and 22 fire events since 1972 for which presidential disaster declarations were issued, as summarized in Table 12-3. The fire events are relevant to flood history in relation to post-fire flooding, as described in Section 12.1.7.

Table 12-3. History of Chelan County Flood and Fire Events with Presidential Disaster Declarations

Disaster #	Event Dates	Declaration Date	Description
DR-4249	11/12/2015 – 11/21/2015	1/15/2016	Severe Storms, Straight-line Winds, Flooding, Landslides, Mudslides
FM-5270	8/10/ 2018 – 8/27/ 2018	8/11/2018	Washington Cougar Creek Fire
FM-5087	6/28/2015	6/29/2015	Sleepy Hollow Fire
FM-5100	8/13/2015 – 9/10/2015	8/14/2015	Chelan Fire Complex
DR-4243	8/13/2015 – 9/10/2015	10/20/2015	Washington Wildfires and Mudslides
FM-5048	8/20/2013 – 8/28/2013	8/21/2013	Eagle Fire ($2.23 million in public assistance grants)
FM-5042	8/10/2013-8/14/2013	8/10/2013	Milepost 10 Fire ($908,893 in public assistance grants)
FM-5038	7/27/2013 -8/14/2013	7/30/2013	Colockum Tarps Fire ($6.8 million in public assistance grants)
FM-5020	9/19/2012	9/20/2012	Table Mountain Fire ($3.03 million in public assistance grants)
FM-5018	9/12/2012	9/13/2012	Peavine Fire ($285,252 in public assistance grants)
FM-5017	9/12/2012-10/31/2012	9/12/2012	Poison Fire ($684,418 in public assistance grants)
FM-5015	9/10/2012-9/19/2012	9/10/2012	Byrd Canyon Fire ($219,571 in public assistance grants)
FM-5012	9/9/2012 – 9/19/2012	9/9/2012	1st Canyon Fire ($528,668 in public assistance grants)
FM-2823	7/28/2009 – 8/2/2009	7/29/2009	Union Valley Fire ($640,028 in public assistance grants)
DR-1817	1/6/2009 – 1/16/2009	1/30/2009	Severe winter storm, landslides, mudslides, and flooding
FM-2711	7/8/2007 – 7/10/2007	7/8/2007	Easy Street Fire ($1.104 million in public assistance grants)
DR-1671	11/2/2006 – 11/11/2006	12/12/2006	Severe storms, flooding, landslides, and mudslides
FM-2674	9/9/2006 -9/16/2016	9/11/2006	Flick Creek Fire ($80,510 in public assistance grants)
FM-2572	7/31/2005 – 8/18/2005	8/1/2005	Dirty Face Fire ($1.061 million in public assistance grants)
FM-2543	8/11/2004 – 8/26/2004	8/11/2004	Fischer Fire ($3.033 million in public assistance grants)
FM-2537	7/30/2004 – 8/5/2004	7/30/2004	Deep Harbor Fire ($47,180 in public assistance grants)
DR-1499	10/15/2003 – 10/23/2003	11/7/2003	Severe storms and flooding
FM-2449	7/20/2002 – 7/27/2002	7/20/2002	Deer Point Fire ($2.573 in public assistance grants)
FM-2379	8/13/2001 – 8/31/2001	8/17/2001	Rex Creek Fire Complex ($1.008 million in PA grants)
DR-1159	12/26/1996 – 2/10/1997	1/17/1997	Severe winter storms, land & muds slides, flooding
DR-1079	11/7/1995 – 12/18/1995	1/3/1996	Severe storms, high wind, and flooding
DR-883	11/9/1990 – 12/20/1990	11/26/1990	Severe storms & flooding
DR-334	6/10/1972	6/10/1972	Severe storms & flooding

Source: FEMA, 2015b

Review of these events helps identify targets for risk reduction and ways to increase a community's capability to avoid large-scale future events. Still, many flood events do not trigger federal disaster declarations, but have significant impacts on the communities impacted. These events are also important to consider in establishing recurrence intervals for flooding. The following sections provide an overview of some of the more significant floods in the county.

Historical Stage Flooding Events

Stage flooding events have been the most common type of recorded flood events to occur within the County in the past 25 years. Episodes in 1990 and 1995 far exceeded the predicted 100-year flood events. These floods have caused extensive damage along the Wenatchee River and Icicle Creek drainages; however, no fatalities have been recorded as a result of stage flooding in Chelan County. In October 2003, substantial flooding occurred in the Stehekin River, destroying public and private property and infrastructure. The following are notable stage flooding events in Chelan County (Chelan County, 2011):

- May/June 1948—Snowmelt flooding broke lake and river records countywide.
- May/June 1972—Snowmelt flooding combined with heavy rains affected rivers countywide, particularly the Entiat River.
- November 1990—Severe storms and flooding occurred during Veteran's Day and Thanksgiving weekend countywide, particularly along the Wenatchee River.
- November/December 1995—Extensive rains caused record-setting flood stages countywide, particularly in the Wenatchee River.
- December 1996/January 1997—Saturated ground combined with snow, freezing rain, rain, rapid warming and high winds within a five-day period combined to cause flooding.
- October 2003—A rain-on-snow event in the upper Cascades caused a flood-of-record in the Stehekin River.
- May 2006—Rapid spring thaw caused flooding in the Entiat River, Chatter Creek and Icicle Creek.
- November 2006—A rain-on-snow event caused extensive flooding in the Stehekin River and limited flooding in Icicle Creek.
- January 2009—A rain-on-snow event caused limited flooding in the Mad River, Mill Creek and Icicle Creek, particularly in the Leavenworth area.

Historical Flash Flooding Events

The following flash flood events in Chelan County have resulted in fatalities:

- 1925, Squilchuck Creek—14 fatalities
- 1942, Tenas Gorge—8 fatalities
- 1972, Preston Creek/Entiat River—4 fatalities.

12.3.3 Location

Chelan County has significant floodplains along the Columbia, Wenatchee, White, Entiat, Chiwawa, and Stehekin Rivers, and Nason, Chumstick, Icicle, Peshastin, Mission and Squilchuck Creeks. There are other unmapped flood hazard areas throughout the County. The hazard areas range from urban settings around the cities of Wenatchee, Cashmere and Leavenworth to rural areas along the White River and smaller streams (Chelan County, 2013).

No. 1 Canyon, No. 2 Canyon and Dry Gulch are each located on the western edge of the City of Wenatchee. The upper basins of these drainages are largely undeveloped and remain vegetated with native plant species. Development has occurred along the eastern fringes where the canyons discharge runoff into the City. These interface zones have experienced flash flooding problems in recent years due to a variety of issues, such as lack of appropriately sized drainage channels, the alteration of drainage channels, development adjacent to the channels, and wildfires. As drainage flows from the county through the city and ultimately is discharged into the Columbia River, new channels can be cut by the flows when current conveyance capacities are exceeded. Outside of those areas immediately adjacent to the city, conveyance systems within the county predominantly consist of open ditches and culverts (Chelan County, 2011).

Flooding in portions of the planning area has been extensively documented by gage records, high water marks, damage surveys and personal accounts. This documentation was the basis for the September 30, 2004 FIRMs generated by FEMA for the planning area. To map the extent and location of the flood hazard for this plan, two sources of data were used (see Figure 12-1):

- The 2004 Flood Insurance Study (special flood hazard areas)
- Hazus-MH version 3.1 (No. 1 Canyon, No. 2 Canyon and Dry Gulch)

Flooding is one of the most common natural hazards in Chelan County. Steep drainage areas and populated low-lying areas typical of the County present a geography that will continually be subject to flooding problems. Historically, Chelan County has had regular occurrences of flash flooding. Due to the County’s topography and climate, stage and flash flooding will continue to be a threat in most parts of the county.

The Columbia River, Wenatchee River, Entiat River, Stehekin River and other perennial streams in Chelan County follow an annual cycle with peak streamflow in April and May and low streamflow in August and September. Normally, streamflow in many of the smaller drainages are intermittent seasonally, while drainages in lower elevations are often dry. Hazardous areas found along stream courses for most types of residential or recreational development include those areas within the floodplain (100-year flood event) and floodway (10-year flood event) boundaries. Present problem areas for flash flooding include Slide Ridge in the Chelan area and No. 1 and No. 2 Canyons in the Wenatchee area. Stage flooding problem areas are in the area where the Icicle and Wenatchee Rivers meet in Leavenworth, the head waters of the Wenatchee River and the confluence area of the Wenatchee River.

The threat of flash flooding is increased in an area that has suffered from a major wildfire. Not only is there a greater amount of loose debris, most of the ground cover has been burnt away. Without ground cover more soil and debris will be allowed to flow, increasing the chance of debris dams. Major wildfires have occurred recently in Chelan County, and flash floods and mud flows have occurred following these events.

12.3.4 Frequency

Floods are commonly described as having a 10-, 50-, 100-, and 500-year recurrence interval, meaning that floods of these magnitudes have (respectively) a 10-, 2-, 1-, or 0.2-percent chance of occurring in any given year. These measurements reflect statistical averages only; it is possible for two or more rare floods (with a 100-year or higher recurrence interval) to occur within a short time period. Assigning recurrence intervals to historical floods on different rivers can help indicate the intensity of an event over a large area.

The Columbia River, Wenatchee River, Entiat River, Stehekin River and other perennial streams in Chelan County follow an annual cycle, with peak flow in April and May and low flow in August and September. Normally, flow in many of the smaller drainages is seasonally intermittent, with drainages in lower elevations often dry. Primary flood seasons in Chelan County are during the spring snowmelt (March to June) and from November to February, when rain-on-snow events have produced historic floods (Chelan County, 2011). Flash flooding can also occur in summer following severe thunder storms.

Chelan County

Figure 12-1. Flood Boundaries

FEMA Flood Boundaries

100-Year Flood Boundary

500-Year Flood Boundary

Mass Zone A Boundaries

100-Year Flood Boundary

Hazus Modeled Flood Boundaries

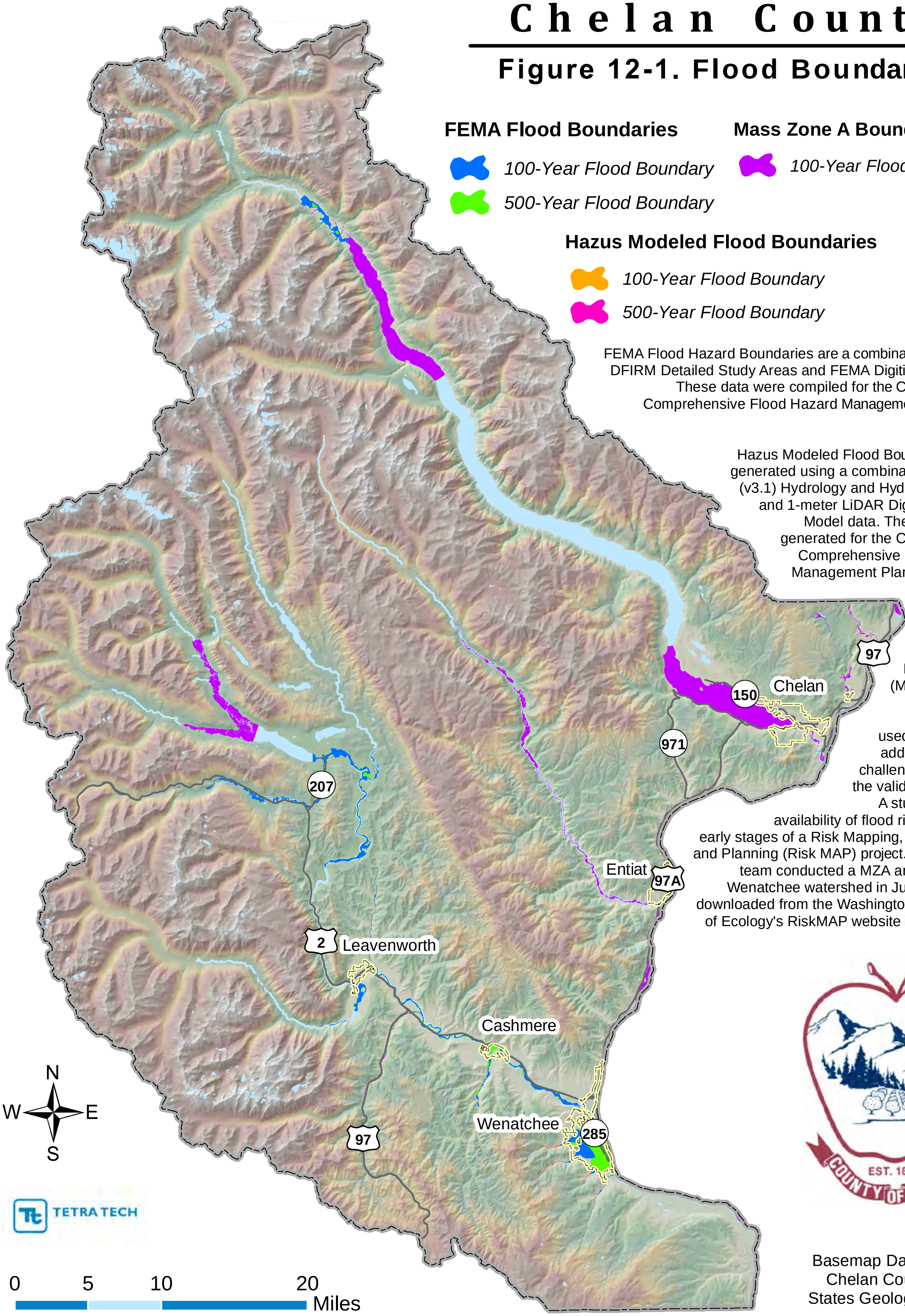
100-Year Flood Boundary

500-Year Flood Boundary

FEMA Flood Hazard Boundaries are a combination of FEMA DFIRM Detailed Study Areas and FEMA Digitized Q3 Data. These data were compiled for the Chelan County Comprehensive Flood Hazard Management Plan (July 2017).

Hazus Modeled Flood Boundaries were generated using a combination of Hazus (v3.1) Hydrology and Hydraulics output and 1-meter LiDAR Digital Elevation Model data. These data were generated for the Chelan County Comprehensive Flood Hazard Management Plan (July 2017).

Mass Zone A (MZA), or basic approximate, analyses are used by FEMA to address program challenges including the validation of Zone A studies and the availability of flood risk data in the early stages of a Risk Mapping, Assessment, and Planning (Risk MAP) project. The STARR team conducted a MZA analysis for the Wenatchee watershed in July 2016. Data downloaded from the Washington Department of Ecology's RiskMAP website in June 2018.



Basemap Data Sources: Chelan County, United States Geological Survey

Recent history has shown that Chelan County can expect an average of one episode of minor river flooding each winter. Large, damaging floods typically occur every two to five years. Urban portions of the county annually experience nuisance flooding related to drainage issues.

Primary flood season in Chelan County occurs during the spring snowmelt (March to June) and again November to February when rain-on-snow events have produced historic floods. Windstorm season is typically October through March, and snow season runs October through March, although higher elevations will see snow ten months of the year.

The primary cause of flash flooding which can occur in any drainage area in the county is high intensity rainfall. Although infrequent, and usually of short duration, high intensity rain fall has been seen in all seasons in the past and particularly in July and August.

12.3.5 Severity

The principal factors affecting flood damage are flood depth and velocity. The deeper and faster flood flows become, the more damage they cause. Shallow flooding with high velocities can cause as much damage as deep flooding with slow velocity. This is especially true when a channel migrates over a broad floodplain, redirecting high velocity flows and transporting debris and sediment. Flood severity is often evaluated by examining peak discharges; Table 12-4 lists peak flows used by FEMA to map the floodplains of the planning area.

Flash flooding has caused deaths in the area and is a threat to populated areas. For example, the City of Wenatchee, with a population nearing 30,000, is located on an alluvial fan below the mouths of three canyons (No. 1 Canyon, No. 2 Canyon and Dry Gulch). A severe thunderstorm or rapid snowmelt can quickly lead to extensive damage and possible fatalities.

Table 12-4. Summary of Peak Discharges Within the Planning Area

Source/Location	Drainage Area (sq. mi.)	Discharge (cubic feet/second)			
		10-Year	50-Year	100-Year	500-Year
Wenatchee River					
At Monitor Gage	1,301	26,500	38,500	48,700	82,000
At Dryden Gage	1,155	25,700	36,863	46,372	78,289
At Peshastin Gage	1,000	24,300	34,000	42,300	71,800
At South Line S34, T26N, R17E	606	17,600	21,500	23,000	26,000
At Plain Gage	591	17,500	26,500	34,100	62,800
At lake Gage	273	10,000	12,100	13,000	14,800
Mission Creek					
At southern city limits of Cashmere	82	660	1,780	2,600	5,700
Peshastin Creek					
At Mouth	143	1,980	3,210	3,790	5,130
Icicle Creek					
At mouth	213	7,930	11,000	12,360	15,650
Chumstick Creek					
At mouth	82	900	1,430	1,720	2,810
At Eagle Creek Road	50	560	900	1,200	1,820
At Cross Section AP	41	470	760	930	1,520
At Sunistich Canyon Rd.	30	400	640	770	1,250
Chiwawa River					
At mouth	190	4,900	6,500	7,200	8,800

Source/Location	Drainage Area (sq. mi.)	Discharge (cubic feet/second) 10-Year	50-Year	100-Year	500-Year
Nason Creek					
At Kahler Creek Bridge	98.6	4,270	5,860	6,590	8,250
Above Kahler Creek confluence	91.2	3,990	5,490	6,170	7,720
Below Butcher Creek confluence	87.5	3,850	5,290	5,960	7,460
Below Roaring Creek confluence	76.3	3,430	4,720	5,320	6,670
Above Gill Creek confluence	70.8	3,220	4,440	5,000	6,260
At Merritt	67.5	3,090	4,270	4,810	6,020
At Burlington Northern Railroad bridge	64.2	2,960	4,090	4,610	5,780
Entiat River					
At mouth	419	6,000	8,000	8,900	11,000
At Fish Hatcher Road	343	5,600	7,500	8,300	10,500
At Mad River Road	251	5,100	6,700	7,400	9,200
At cross section CJ	203	4,700	6,200	6,900	8,400
Mad River					
At mouth	92	1,200	1,750	2,000	2,500
Stehekin River					
At mouth	344	14,400	17,900	19,200	22,100
At Cross section J	308	13,200	16,500	17,700	20,300
At Cross Section U	277	12,200	15,200	16,300	18,800
Squilchuck Creek					
At Mouth	28	400	950	1,300	2,500
At Cross Section Y	15	300	750	1,000	1,900
No. 1 Canyon					
At Mouth	8	254	942	1,490	3,810
No. 2 Canyon					
At Mouth	10	300	1,100	1,700	4,300
Dry Gulch					
At Mouth	1.3	76	270	428	1,090

Data Source: FEMA Flood Insurance Study for Chelan County, WA; September 30, 2004

12.3.6 Warning Time

Flood Timing With Rainfall Events

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.

A hydrograph, which is a graph or chart illustrating stream flow in relation to time (see Figure 12-2), is a useful tool for examining a stream's response to rainfall. Once rain starts falling over a watershed, runoff begins and the stream begins to rise. Water depth in the stream (stage of flow) will continue to rise in response to runoff even after rainfall ends. Eventually, the runoff will reach a peak and the stage of flow will crest. The stream stage will remain the most stable at this point, exhibiting little change over time until it begins to fall and eventually subsides to a level below flooding stage.

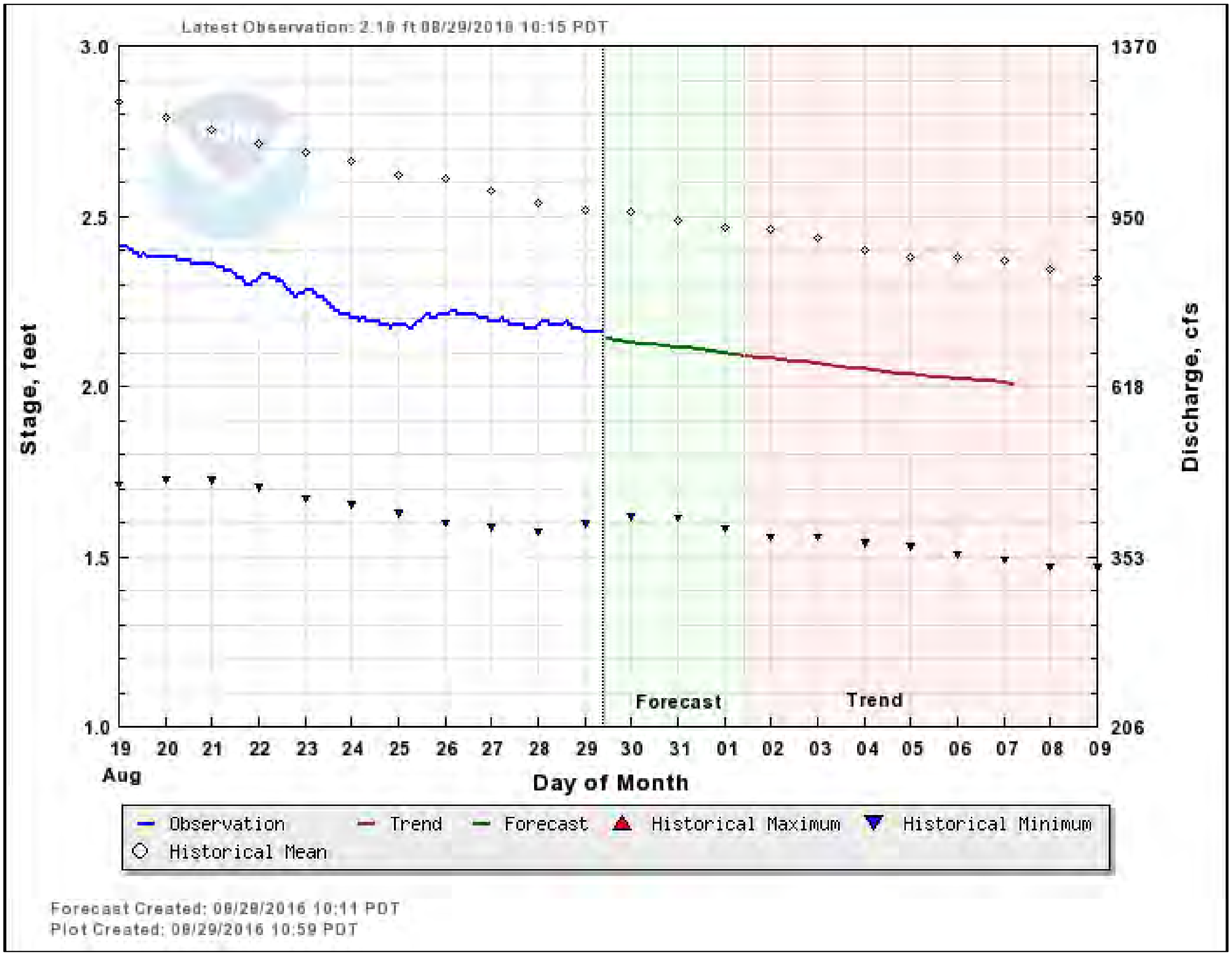


Figure 12-2. Wenatchee River Hydrograph at Peshastin

The potential warning time a community has to respond to a flooding threat is a function of the time between the first measurable rainfall and the first occurrence of flooding. The time it takes to recognize a flooding threat reduces the potential warning time to the time that a community has to take actions to protect lives and property. Another element that characterizes a community’s flood threat is the length of time floodwaters remain above flood stage.

Flood Threat Recognition Systems

The Chelan County flood threat recognition system consists, in part, of precipitation and U.S. Geological Survey stream gages at strategic locations in the county that constantly monitor and report rainfall and stream levels. To assess the flood threat along the major rivers in the county, the stream gage information is fed into a National Weather Service (NWS) river forecasting program. This program creates a forecast of the amount of flow expected in the stream for the next 10 days (measured in cubic feet per second), which can then be compared to the flood stages at those locations. For locations that do not have stream gages or river forecasts, the NWS also provides Doppler radar data and weather/flood forecast information that can determine other types of flood risk across the county, such as flash flooding, small stream flooding, etc. All of this information is analyzed to evaluate the flood threat and possible evacuation needs.

Flood Watches and Warnings

The NWS issues flood watches and warnings when forecasts indicate rivers may approach bank-full levels or when other types of localized flooding are possible. When a flood watch is issued, the public should prepare for the possibility of a flood. When a flood warning is issued, the public is advised to stay tuned to a local radio station for further information and be prepared to take quick action if needed. A flood warning means a flood is imminent, generally within 12 hours, or is occurring. Local media typically broadcast NWS watches and warnings; they can also be found online. If a flash flood warning is issued, which indicates that sudden or violent flooding is imminent or occurring, the Emergency Alert Service will alarm on NOAA weather radios and cut into local media broadcasts. Flash flood warnings will also trigger wireless emergency alerts on smart phones. Official thresholds for flood warnings have been established on the major rivers within Chelan County as follows:

- Wenatchee River—Action phase at 12 feet, flood stage at 13 feet at Peshastin.
- Entiat River—Action phase at 6 feet, flood Stage at 7.5 feet at Ardenvoir.
- Stehekin River— Action Phase at 22 feet, flood stage at 23 feet at Stehekin.

There are several more stream gages across the county for areas that do not currently have river forecasts or predetermined flood stages. These gages are monitored for situational awareness during flood events.

Rain Gages

Chelan County Public Works Department has purchased and installed a series of rain gages, in cooperation with the county’s Natural Resource Department, the U.S. Forest Service, the U.S. Geologic Service, the Natural Resource Conservation Service and the Cascadia Conservation District. These rain gages collect and measure precipitation to provide an early alert system to the community when a potentially high-intensity storm is in the area. Selection of rain gage locations was based upon factors such as historical flooding, high-burn-severity areas and population centers. Seven rain gages are located along ridgelines throughout Chelan County in order to transmit precipitation data to the NWS between from April through November. When a gage receives heavy rainfall over a 10-minute period, the NWS begins to monitor the gage. If warranted, the NWS will issue a watch or warning based on the precipitation information received.

Doppler Radar Gap

The NWS uses five active Doppler radars (Spokane, Pendleton, Langley Hill (Grays Harbor), Camano Island (Seattle), and Portland) to monitor real-time weather conditions in Washington, identify hazardous weather conditions, and predict weather. None of the five radars have coverage of weather conditions below 10,000 feet on the northeastern slopes of the Cascades, leaving a gap in coverage along the eastern slopes of the Cascades and part of the Columbia Basin from the Canadian border in Okanogan County to around Yakima (see Figure 12-3). This gap in coverage creates a less reliable weather prediction system for the area, thus creating a vulnerability or uncertainty for local residents, businesses, and industries.

12.4 SECONDARY HAZARDS

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

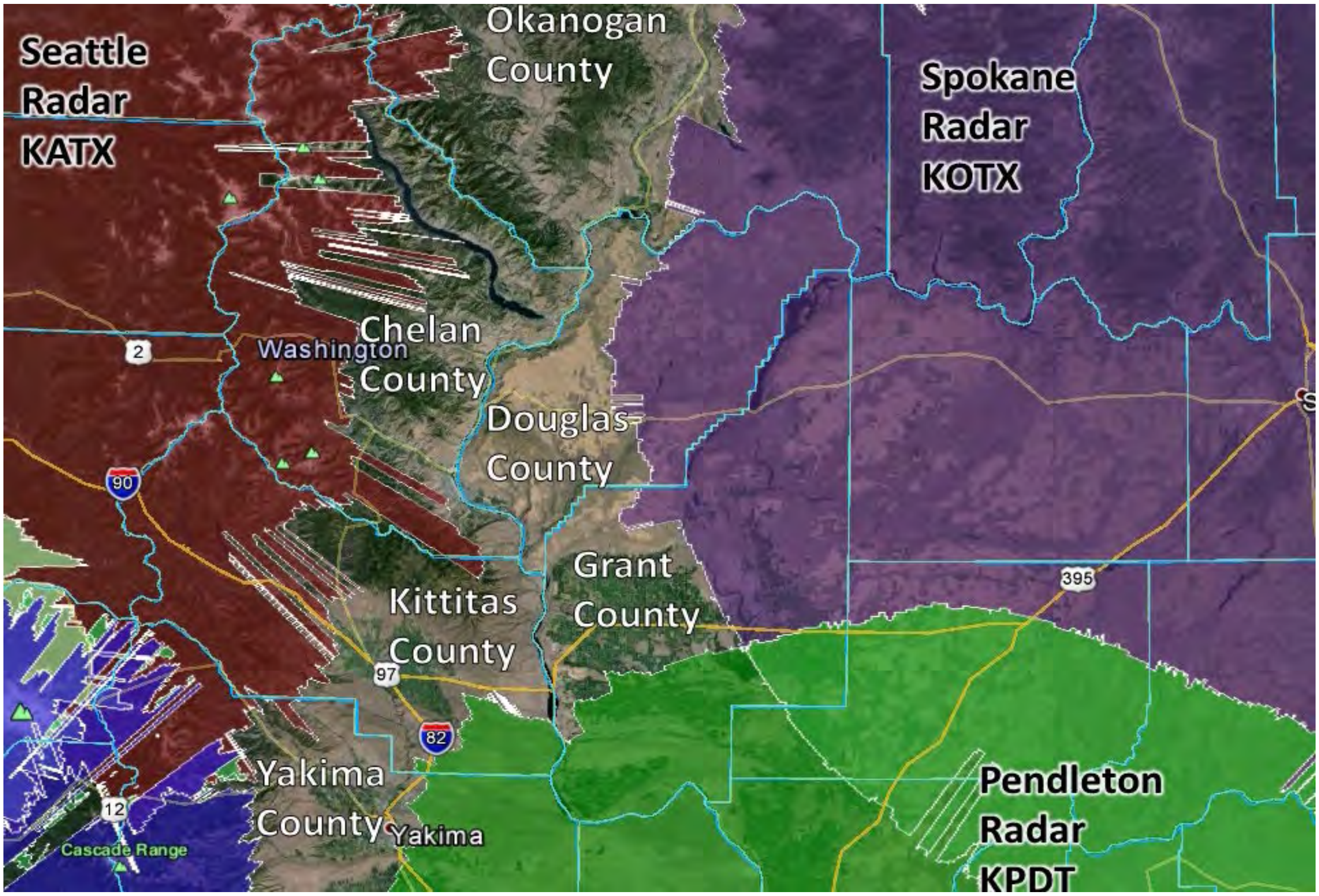


Figure 12-3. Doppler Radar Gap for East Cascades

Within the planning area, the potential for erosion is most concerning following wildfires. Runoff from steep slopes that have been baked and denatured by wildfires increases velocities in channels. This accelerates erosion rates and results in large volumes of sediment being carried downstream. As stream velocities deaccelerate, the sediments fall out and decrease the carrying capacities of the channel, which causes overbank flows and can lead to channel migration. Channel migration is especially a concern for the numerous, developed alluvial fans within the planning area. Additionally, this sediment can be conveyed over land and deposited on developed lands such as roads and public/private property.

12.5 EXPOSURE

The Level 2 (user-defined) Hazus protocol was used to assess exposure to flooding in the planning area. The model used census data at the block level, FEMA floodplain data and hydrologic and hydraulic data developed for this assessment. The 100-year and 500-year floodplain areas used for the risk assessment were expanded to include both FEMA-mapped floodplains and the floodplains developed in No. 1 and No. 2 Canyons and Dry Gulch. Detailed results are provided in Appendix D and summarized below.

12.5.1 Population

Population counts of those living in the 100- and 500-year floodplains were generated by analyzing structures in the floodplain. The total planning area population from the 2010 Census was multiplied by the ratio of the number of residential structures in each floodplain to the total number of residential structures.

Using this approach, the populations in each floodplain were estimated as follows:

- 100-year floodplain—12,780 (16.4 percent of the planning area population)
- 500-year floodplain—33,236 (42.7 percent of the planning area population).

12.5.2 Property

An estimated 6.4 percent (more than $1.12 billion) of the total replacement value of the planning area is located in the 100-year floodplain and 37.9 percent (more than $6.66 billion) is located in the 500-year floodplain. Figure 12-4 and Figure 12-5 show the percentage and count, by land use type, of exposed planning area structures. Over 80 percent of the exposed structures are in Wenatchee. The distribution of land area in the floodplains by land use category is shown in Figure 12-6

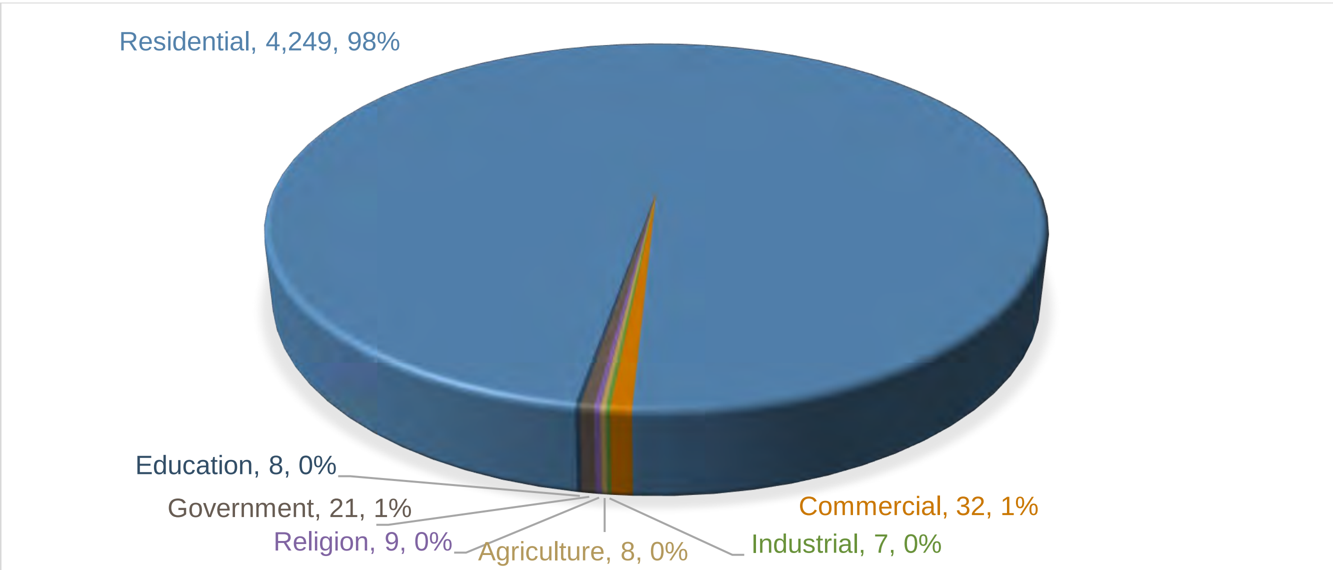


Figure 12-4. Structures in the 100-Year Floodplain, by Land Use Type

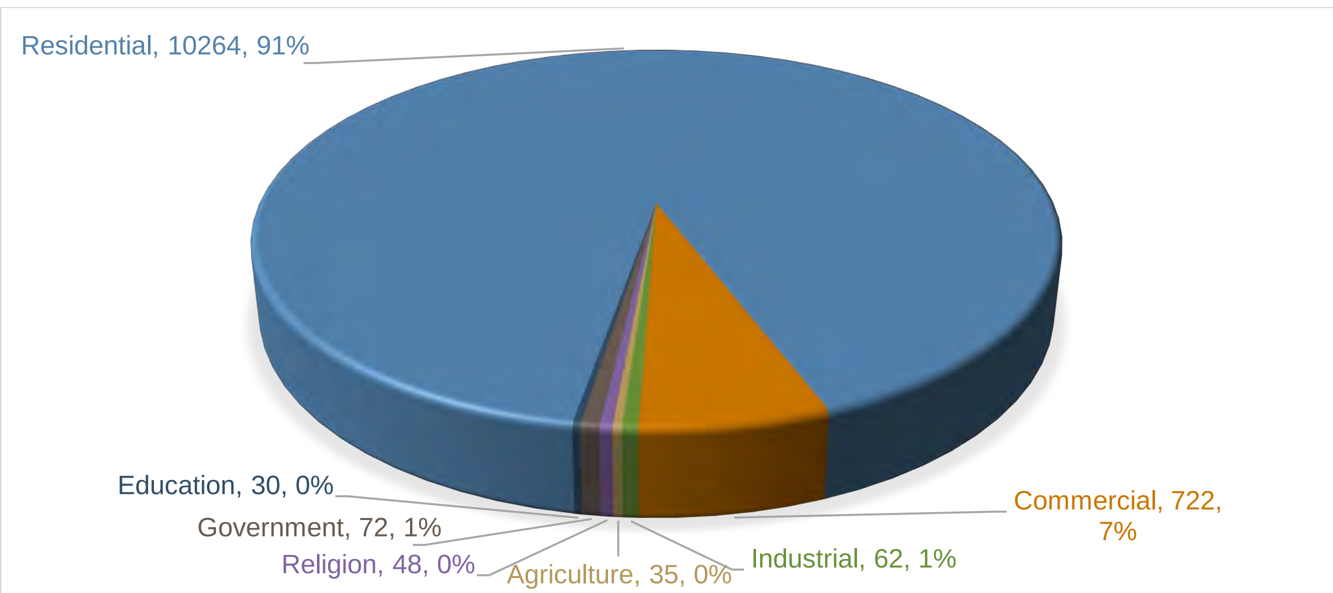


Figure 12-5. Structures in the 500-Year Floodplain, by Land Use Type

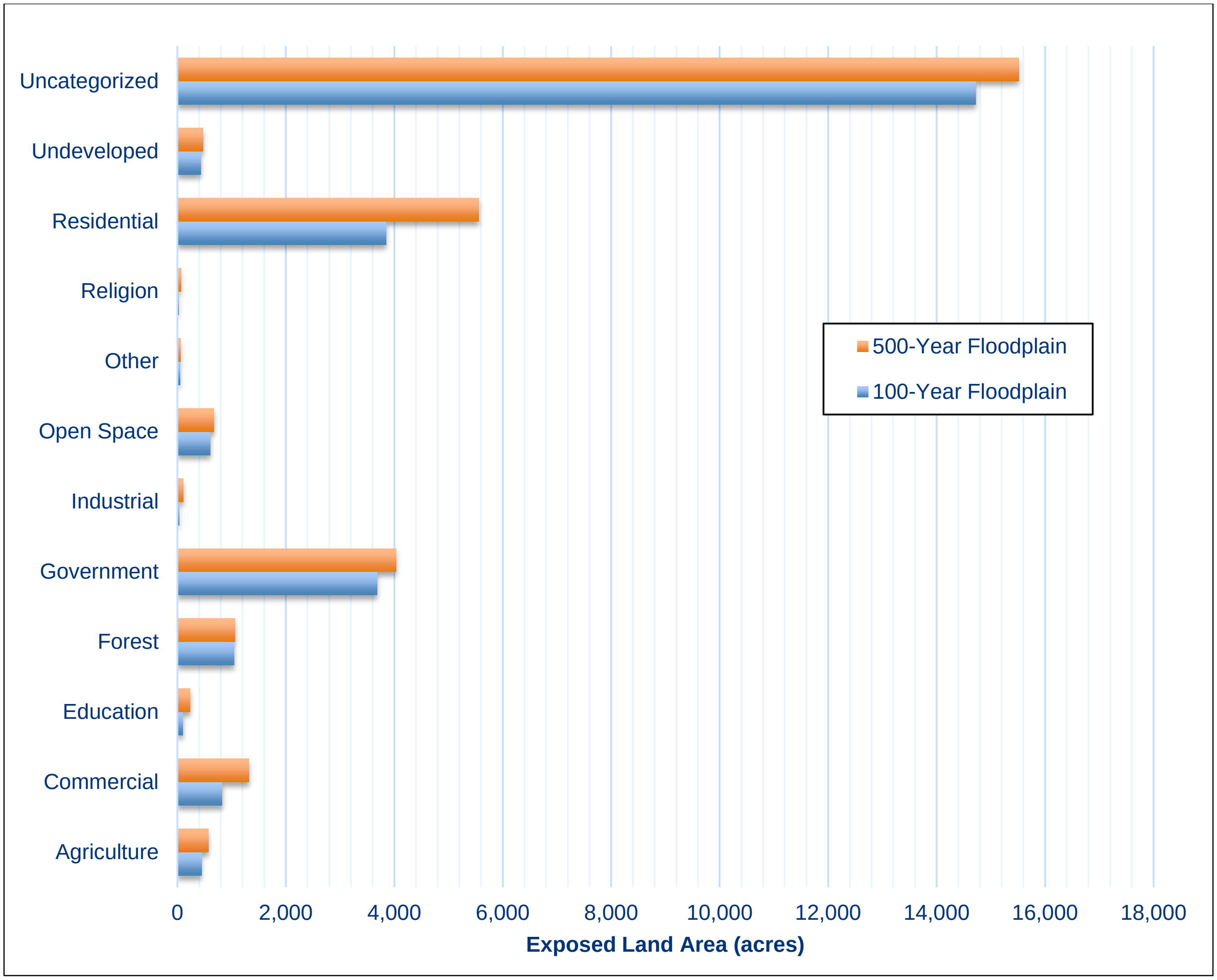


Figure 12-6. Land Area in the 100- and 500-Year Floodplains, by Land Use Category

12.5.3 Critical Facilities and Infrastructure

Critical facilities and infrastructure exposed to the flood hazard represent 17 percent (94 facilities) of the total critical infrastructure and facilities in the planning area for the 100-year floodplain and 33 percent (176 facilities) for the 500-year floodplain. The breakdown of exposure by facility type is shown in Figure 12-7.

Hazardous Material Facilities

Hazardous material facilities are those that use or store materials that can harm the environment if damaged by a flood. For this assessment, such facilities were identified through the EPA's Toxic Release Inventory (TRI) and other facilities identified by the planning team. Five businesses in the 500-year floodplain have been identified as TRI reporting facilities or other known hazardous material containing facilities. During a flood event, containers holding these materials can rupture and leak into the surrounding area, having a disastrous effect on the environment as well as residents.

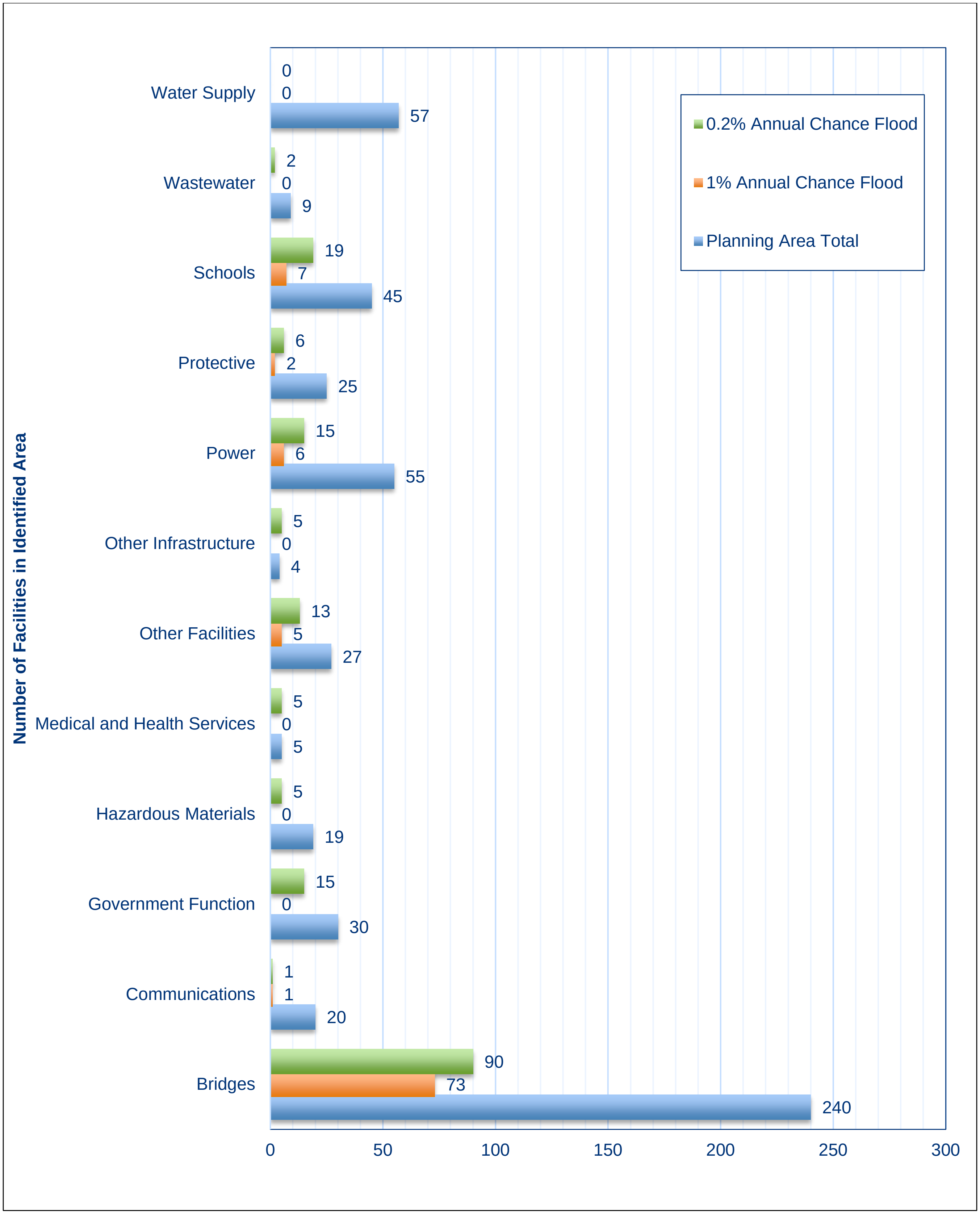


Figure 12-7. Critical Facilities and Infrastructure in Mapped Flood Hazard Areas and Countywide

Utilities and Infrastructure

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

Roads

The following major roads in the planning area pass through the 100-year and/or 500-year floodplain and thus are exposed to flooding. Some of these roads are built above the flood level, and others function as levees to prevent flooding. Still, in severe flood events these roads can be blocked or damaged, preventing access to some areas:

- U.S. Highway 2
- U.S. Highway 97
- U.S. Highway 97 Alternate
- State Route 150
- State Route 207
- State Route 285
- State Route 971

Bridges

Flooding events can significantly impact bridges, which provide the only ingress and egress to some neighborhoods. There are 73 bridges that are in or cross over the 100-year floodplain and 90 bridges that are in or cross over the 500-year floodplain in the planning area.

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.

12.5.4 Environment

Flooding is a natural event and floodplains provide natural and beneficial functions. Still, flooding can impact the environment in negative ways, especially when compounded with impacts from human development. Migrating fish can wash into roads or into flooded fields. Pollution from roads, such as oil, and hazardous materials can wash into rivers and streams. During floods these pollutants 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.

Many species of mammals, birds, reptiles, amphibians and fish live in Chelan County in ecosystems that are dependent upon streams, wetlands and floodplains. Changes in hydrologic conditions can result in a change in the biodiversity of the ecosystem. Wildlife and fish are impacted when plant communities are eliminated or fundamentally altered to reduce suitable habitat. Wildlife populations are limited by shelter, space, food and water. Since water supply is a major limiting factor for many animals, riparian communities are of special importance. Riparian areas are the zones along the edge of a river or stream that are influenced by or are an influence upon the water body. Human disturbance to riparian areas can limit wildlife's access to water, remove breeding or nesting sites, and eliminate suitable areas for rearing young. Wildlife rely on riparian areas and are associated with the flood hazard in the following ways:

- Mammals depend upon a supply of water for their existence. Riparian communities have a greater diversity and structure of vegetation than other upland areas. Beavers and muskrats are now recolonizing streams, wetlands and fallow farm fields, which are converted wetlands. As residences are built in rural areas, there is an increasing concern of beaver dams causing flooding of low-lying areas and abandoned farm ditches being filled leading to localized flooding.
- A great number of birds are associated with riparian areas. They swim, dive, feed along the shoreline, or snatch food from above. Chelan County rivers, lakes and wetlands are important feeding and resting areas for migratory and resident waterfowl. Other threatened or endangered species (such as the bald eagle or the peregrine falcon) eat prey from these riparian areas.
- Fish habitat throughout the county varies widely based on natural conditions and human influence. Many ditches were dug throughout the county to make low, wet ground better for farming. As the water drained away and the wetlands were converted to farm fields, natural stream conditions were altered throughout the county. Agriculture along many rivers extends to the water's edge and smaller side channels have been tiled to drain better. Within developing areas, small streams were placed in pipes and wetland filled in to support urban development.

Protection of these biological resources within the floodplains of the planning area is very important to Chelan County. Equipped with planning tools such as WRIA planning, comprehensive planning, critical areas ordinances, and open space planning, Chelan County has been able to establish a diverse inventory of preserve areas that maintain the natural and beneficial functions of the floodplain. This has resulted in flood hazard areas that are developed as shown in Figure 12-6. Habitat complexity project areas that promote the natural and beneficial functions of floodplains include the following:

- The Peshastin Fishway (Chelan County Natural Resources Department, 2019a)
- Cashmere Pond (Chelan County Natural Resources Department, 2019b)
- The Nason Creek Oxbow (Chelan County Natural Resources Department, 2019c)
- The Wenatchee River Irwin property (Chelan County Natural Resources Department, 2019d)
- The Entiat National Fish hatchery
- Icicle Creek (Chelan County Natural Resources Department, 2019e)

12.6 VULNERABILITY

Many areas exposed to flooding may not experience serious flooding or flood damage. Vulnerability can be defined as: the extent of harm, which can be expected under certain conditions of exposure, susceptibility and resilience (UNESCO-IHE, 2016). Defining vulnerability can help flood hazard managers understand the best ways to reduce it. The main objective in assessing vulnerability is to inform decision-makers or specific stakeholders about options for adapting to the impact of flooding hazards. This section summarizes vulnerabilities in terms of population, property, critical facilities infrastructure and environment. Detailed risk assessment results are provided in Appendix D.

12.6.1 Population

Displaced Persons and Vulnerable Populations

The Hazus analysis of impacts on persons and households in the planning area estimated that 6,947 people and 27,800 people could be displaced by the 100-year and 500-year flood 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**—An estimated 16.3 percent of the people within the households in the census blocks that intersect the 100-year floodplain are economically disadvantaged, defined as having annual household incomes of $20,000 or less.
- **Population over 65 Years of Age**—An estimated 20.5 percent of the population in the census blocks that intersect the 100-year floodplain are over 65 years of age. Approximately 28 percent of the over-65 population in the floodplain also have incomes considered to be economically disadvantaged and are considered to be extremely vulnerable.
- **Population under 16 Years of Age**—An estimated 23.1 percent of the population within census blocks that intersect the 100-year floodplain are under 16 years of age.

In addition, persons with disabilities or others with access and functional needs are more likely to have difficulty responding to a flood or other hazard event than the general population. Local government is the first level of response to assist these individuals. 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 allows emergency management personnel and first responders to have personnel available who can provide services needed by those with access and functional needs. According to the U.S. Census Bureau 2015 American Community Survey estimates, there are 10,164 individuals in Chelan County with some form of disability, representing 13.6 percent of the county population. Approximately 62 percent (6,290 individuals) are under the age of 65 (U.S. Census, 2015).

Public Health and Safety

Floods present threats to public health and safety. Floodwater is frequently contaminated by pollutants such as sewage, human and animal feces, pesticides and insecticides, fertilizers, oil, asbestos, and rusting building materials. The following health and safety risks are commonly associated with flood events:

- **Unsafe food—**Floodwaters contain disease-causing bacteria, dirt, oil, human and animal waste, and farm and industrial chemicals. Their contact with food items, including food crops in agricultural lands, can make that food unsafe to eat. Refrigerated and frozen foods are affected during power outages caused by flooding. Foods in cardboard, plastic bags, jars, bottles, and paper packaging may be unhygienic with mold contamination.
- **Contaminated drinking and washing water and poor sanitation—**Flooding impairs clean water sources with pollutants. The pollutants also saturate into the groundwater. Flooded wastewater treatment plants can be overloaded, resulting in backflows of raw sewage. Private wells can be contaminated by floodwaters. Private sewage disposal systems can become a cause of infection if they or overflow.
- **Mosquitoes and animals—**Floods provide new breeding grounds for mosquitoes in wet areas and stagnant pools. The public should dispose of dead animals that can carry viruses and diseases only in accordance with guidelines issued by local animal control authorities. Leptospirosis—a bacterial disease associated predominantly with rats—often accompanies floods in developing countries, although the risk is low in industrialized regions unless cuts or wounds have direct contact with disease-contaminated floodwaters or animals.
- **Mold and mildew—**Excessive exposure to mold and mildew can cause flood victims—especially those with allergies and asthma—to contract upper respiratory diseases, triggering cold-like symptoms. Molds grow in as short a period as 24 to 48 hours in wet and damp areas of buildings and homes that have not been cleaned after flooding, such as water-infiltrated walls, floors, carpets, toilets and bathrooms. Very

small mold spores can be easily inhaled by human bodies and, in large enough quantities, cause allergic reactions, asthma episodes, and other respiratory problems. Infants, children, elderly people and pregnant women are considered most vulnerable to mold-induced health problems.

- **Carbon monoxide poisoning—**In the event of power outages following floods, some people use alternative fuels for heating or cooking in enclosed or partly enclosed spaces, such as small gasoline engines, stoves, generators, lanterns, gas ranges, charcoal or wood. Built-up carbon monoxide from these sources can poison people and animals.
- **Hazards when reentering and cleaning flooded homes and buildings—**Flooded buildings can pose significant health hazards to people entering them. Electrical power systems can become hazardous. Gas leaks can trigger fire and explosion. Flood debris—such as broken bottles, wood, stones and walls—may cause injuries to those cleaning damaged buildings. Containers of hazardous chemicals may be buried under flood debris. Hazardous dust and mold can circulate through a building and be inhaled by those engaged in cleanup and restoration.
- **Mental stress and fatigue—**People who live through a devastating flood can experience long-term psychological impact. The expense and effort required to repair flood-damaged homes places severe financial and psychological burdens on the people affected. Post-flood recovery can cause, anxiety, anger, depression, lethargy, hyperactivity, and sleeplessness. There is also a long-term concern among the affected that their homes can be flooded again in the future.

Current loss estimation models such as Hazus are not equipped to measure public health impacts. The best level of mitigation for these impacts is to be aware that they can occur, educate the public on prevention, and be prepared to deal with these vulnerabilities in responding to flood events.

12.6.2 Property

Loss Estimates

Table 12-5 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. The almost 80,000 tons of estimated debris from a 1-percent-annual-chance flood event is enough to fill nearly 3,200 25-ton trucks.

Table 12-5. Estimated Impact of a Flood Event in the Planning Area

Damage Type	100-Year Flood	500-Year Flood
Structure Debris (Tons)	15,251	44,596
Buildings Impacted	4,235	1,270
Total Value (Structure + Contents) Damaged	$233 million	$854 million
Damage as % of Total Value	1.6%	5.9%

Repetitive Loss Properties

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

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

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

FEMA-sponsored programs, such as the CRS, require participating communities to identify repetitive loss areas. A repetitive loss area is the portion of a floodplain holding structures that FEMA has identified as meeting the definition of repetitive loss. Identifying repetitive loss areas helps to identify structures that are at risk but are not on FEMA's list of repetitive loss structures because no flood insurance policy was in force at the time of loss. Figure 12-8 shows the repetitive loss areas in the planning area. FEMA's list of repetitive loss properties identifies 6 such properties in the planning area as of December 31, 2015. The breakdown of the properties by jurisdiction is shown in Table 12-6.

Table 12-6. Repetitive Loss Properties in Chelan County

	Repetitive Loss Properties	Properties That Have Been Mitigated	Number of Corrections	Corrected Number of Repetitive Loss Properties
Cashmere	2	1	0	1
Chelan	1	0	0	1
Leavenworth	2	0	0	2
Unincorporated	1	0	0	1
Total	6	1	0	5

Based on FEMA Report of Repetitive Losses, 12/31/2015

A further review of the repetitive loss data found that all dates of repetitive losses coincide with dates of known flooding in the County. Additionally, all of the identified properties are within a FEMA designated special flood hazard area (SFHA). This indicates that the overall cause of repetitive flooding is the same as has been profiled in this plan and is covered by available mapping. With the potential for flood events every two to five years, Chelan County considers all of the mapped floodplain areas as susceptible to repetitive flooding. These areas are subject to provisions of flood damage prevention ordinances in effect within Chelan County. Once the County enrolls in the CRS program, flood protection information will be disseminated to these areas on an annual basis.

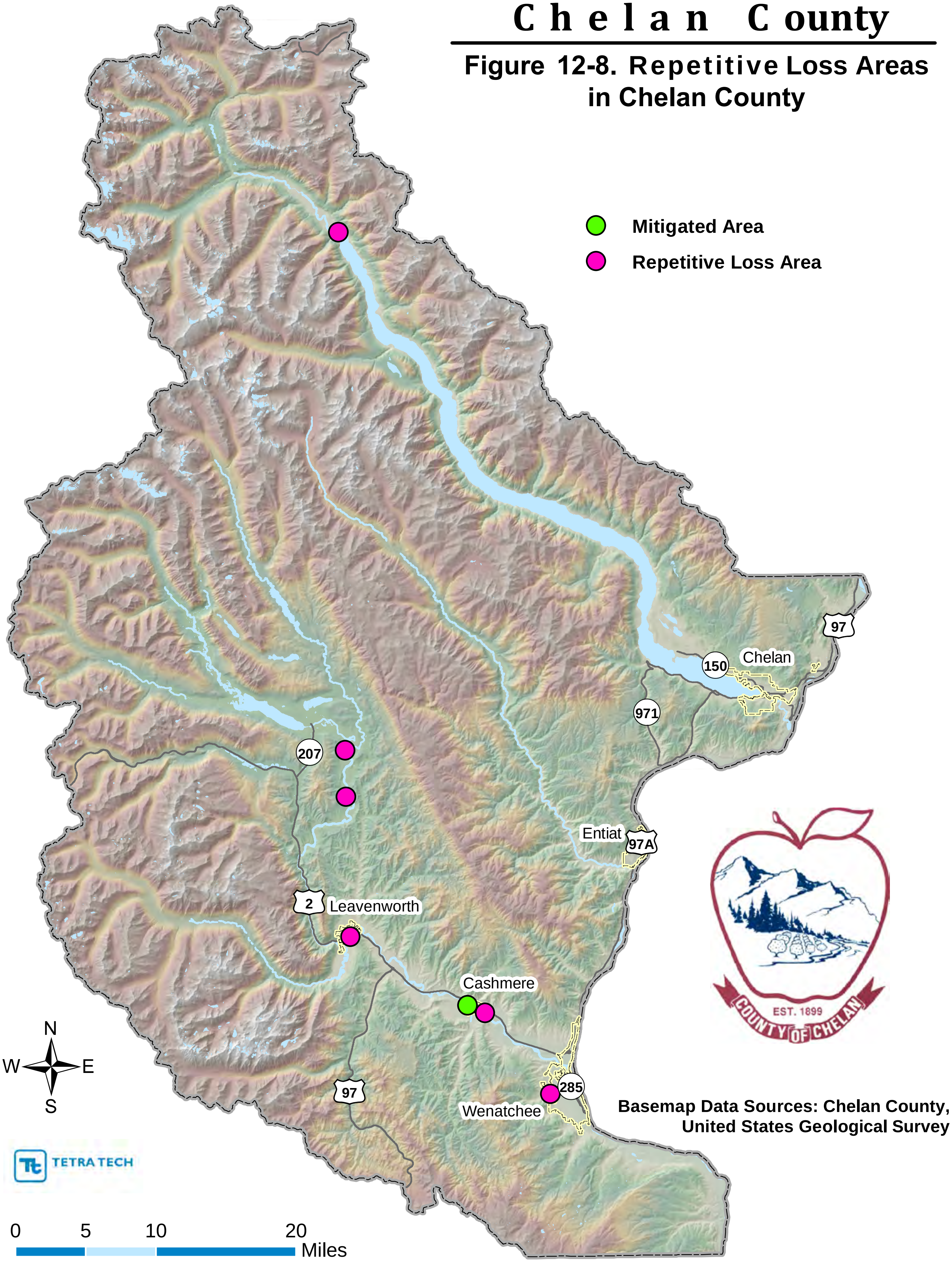
There are six repetitive loss properties in Chelan County that have had 11 losses (there may have been more but the six are the ones listed by FEMA as not having been mitigated, i.e., if there are others, they were mitigated and are no longer repetitive loss properties).

- Single-family residence in Monitor area (lower Wenatchee River). Losses occurred 11/27/95 and 11/22/90. Total losses for both floods were just over $29,600 for the building.
- Single-family residence near Chelan. Losses occurred 12/1/95 and 11/25/90. Total losses for both floods were just over $23,725 for the building.
- Single-family residence near Lake Wenatchee (Nason Creek). Losses occurred 11/30/95 and 11/24/90. Total losses for both floods were about $59,700 for building and $3,290 for contents.
- Nonresidential structure near Cashmere. Losses occurred 2/9/96 and 5/28/93. Total losses for both floods were about $32,270 for building and $56,300 for contents.
- Single-family residence near Leavenworth (Icicle Creek). Losses occurred 11/11/06, 5/18/06 and 11/29/95. Total losses for the 3 floods were about $22,400 for building and $35,560 for contents.
- Single-family residence in Stehekin. Losses occurred 5/15/2001, 7/16/99, 6/10/97 and 6/11/96. Total losses for the 4 floods were about $40,844 for building and $9,142 for contents.

There are no severe repetitive loss properties in Chelan County.

Chelan County

Figure 12-8. Repetitive Loss Areas in Chelan County



12.6.3 Critical Facilities and Infrastructure

Hazus assesses the potential damage to critical facilities from flooding using depth/damage function curves. Based on historical averages, these curves indicate potential damage amounts as a percentage of the value of structures or contents. Actual damage to facilities may be less than these conservative estimates. For critical buildings, Hazus also estimates functional down-time, which is the time it might take to restore a facility to 100 percent of its functionality after flood damage occurs. Results for the 100-year and 500-year flood events are summarized in Table 12-7 through Table 12-9.

Table 12-7. Estimated Damage to Critical Facilities from 100-Year Flood

	Number of Facilities Affected	% of Total Value Damaged (Each Facility)		Days to 100% Functionality
		Building	Contents	
Protective Function	2	7%	8%	480
Schools	7	5%	27%	480
Other	5	5% – 13%	27% – 73%	480 – 630

Table 12-8. Estimated Damage to Critical Facilities from 500-Year Event

	Number of Facilities Affected	% of Total Value Damaged (Each Facility)		Days to 100% Functionality
		Building	Contents	
Medical and Health	5	3%	19%	384
Government Function	15	Less than 1%	5%	32
Protective	6	23%	4%	160
Hazardous Materials	5	5%	15%	—
Schools	19	12%	10%	177
Other	13	0% -14%	18% -58%	0-630

Table 12-9. Estimated Damage to Critical Infrastructure from Flood Events

	100-Year Flood		500-Year Flood	
	Number of Facilities Affected	% of Total Value Damaged (Each Facility)	Number of Facilities Affected	% of Total Value Damaged (Each Facility)
Bridges	73	Less than 1%	90	Less than 1%
Wastewater	0	N/A	2	7%
Power	6	12%	15	11%
Communications	1	2%	1	2%
Other	0	N/A	5	5%

The assessment shows that the percentage of critical facilities and infrastructure expected to experience any damage at all is small, and that the amount of damage for each affected facility is small:

- Of the 153 inventoried critical facilities identified in the planning area (see Table 4-3), only 14 are within the 100-year floodplain (see Table 12-7). All of these facilities would be expected to experience damage from a 100-year event (see Table 12-7). Estimated damages range from 5 to 13 percent of the total building value.
- Of 379 critical infrastructure items in the planning area (see Table 4-4), only 80 are located within the 100-year floodplain (see Table 12-9). Of these facilities seven would be expected to experience more than negligible damage (see Table 12-9). Seventy-three bridges in the planning area may also experience damage; however, this damage is expected to negligible based on the parameters of the Hazus model.

12.6.4 Environment

The environment vulnerable to the flood hazard is the same as the environment exposed to the hazard. The principle environmental impact from flood is the loss of aquatic habitat.

12.7 FUTURE TRENDS IN DEVELOPMENT

Chelan County has experienced a 3.87-percent average annual growth rate since 1990, making it one of the faster growing counties in the State of Washington. Since 2006, the population of the County has increased by 10.5 percent. In 1990, Washington State adopted the Growth Management Act, which among other things required Chelan County to establish urban growth boundaries, rural areas and natural resource lands. The County and all of the cities have adopted plans and development regulations that are currently in compliance with the Growth Management Act.

Several comprehensive plans guide development in unincorporated parts of Chelan County, as described in Section 5.2.2. The County's Comprehensive Plan has adopted goals, objectives, policies and actions with regards to frequently flooded areas. These plan components strive to steer future trends in development away from increasing flood risks in Chelan County. Chelan County's critical areas regulations regulate how development and redevelopment can safely occur on lands that contain critical areas, as described in Section 5.2.4. Additionally, Chelan County and its cities participate in the NFIP and have adopted flood damage prevention ordinances in response to its requirements. Chelan County has committed to maintaining its good standing under the NFIP through actions identified in this plan.

12.8 SCENARIO

The primary water courses in the planning area have the potential to flood at regular intervals (two to five years on the average), generally in response to a succession of intense winter storms. Storm patterns of warm, moist air usually occur between early November and late March. The worst-case scenario is a series of storms in a short time that flood numerous drainage basins that have been burned over by wildfire. This could overwhelm response and flood hazard management capabilities in the planning area. Major roads could be blocked, preventing critical access for many residents and responders. High flows could cause water course scouring, possibly washing out roads and creating additional isolation issues. In a multi-basin flood event, resources would be stretched thin resulting in delays in repairing and restoring critical facilities and infrastructure. The mapped and identified floodplains in the County are where most impacts from flooding would be concentrated; however, groundwater flooding issues typical for the planning area would be significantly enhanced as the ground reaches saturation.

12.9 ISSUES

The planning team has identified challenges, data gaps and issues associated with full identification and understanding of flood hazards in the planning area. These are, include but not limited to the following:

- The currently available flood hazard mapping for the County does not accurately reflect the true flood risk.
- 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 potential mitigation projects.
- Ongoing flood hazard mitigation will require funding from multiple sources.
- Existing floodplain-compatible uses such as agricultural and open space need to be maintained. During times of moderate to high growth there is pressure to convert these areas to more intensive uses.
- There needs to be a coordinated flood hazard mitigation effort among county jurisdictions affected by flood hazards.

- Education for residents in flood hazard areas about flood preparedness and the resources available during and after floods should continue.
- There is a lack of consistency in regional flood hazard management policy in the planning area.
- As the planning area continues to grow, there will be increased pressures for development in areas subject to flood risk.
- The potential impact of climate change on flood conditions in the planning area is unknown and needs to be monitored.
- Wildfires will likely continue to impact the planning area. Post-fire best management practices will need to be maintained to limit the impacts of these fires on flooding. The County should continue to coordinate with the U.S. Forest Service.
- The capability for prediction forecast modeling needs to be enhanced.
- There are significant gaps in the flood threat recognition capabilities within the planning area (i.e.: the Doppler radar gap)
- Flood warning capability should be tied to flood phases.
- Enhanced modeling is needed to better understand the true flood risk.
- Floodplain restoration/reconnection opportunities should be identified as a means to reduce flood risk.
- Post-flood disaster response and recovery actions need to be clearly identified.
- Current or greater staff capacity is required to maintain the existing level of flood hazard management within the planning area.
- Flood hazard management actions require interagency coordination.
- Predetermined flood stages and corresponding actions are need for those stream gages within the County that currently do not have flood forecasting capabilities.

13. LANDSLIDE

13.1 GENERAL BACKGROUND

13.1.1 Landslide Types

Landslides are commonly categorized by the type of initial ground failure. Common types of slides are shown on Figure 13-1 through Figure 13-4. 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

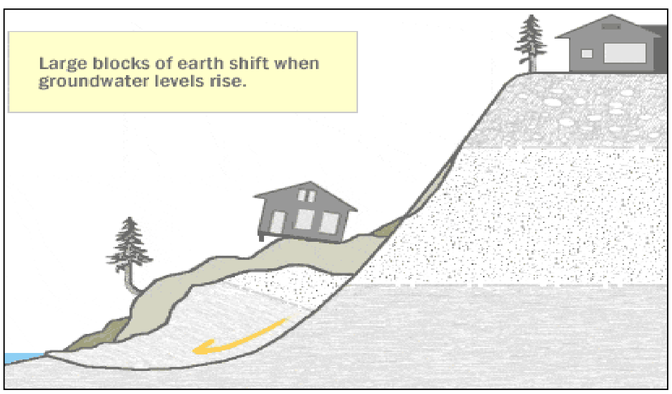


Figure 13-1. Deep Seated Slide

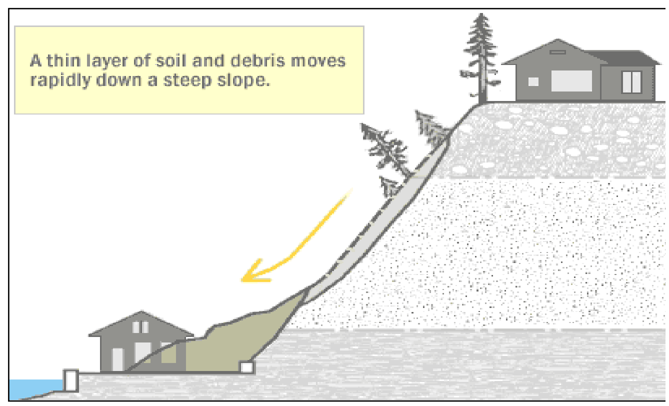


Figure 13-2. Shallow Colluvial Slide

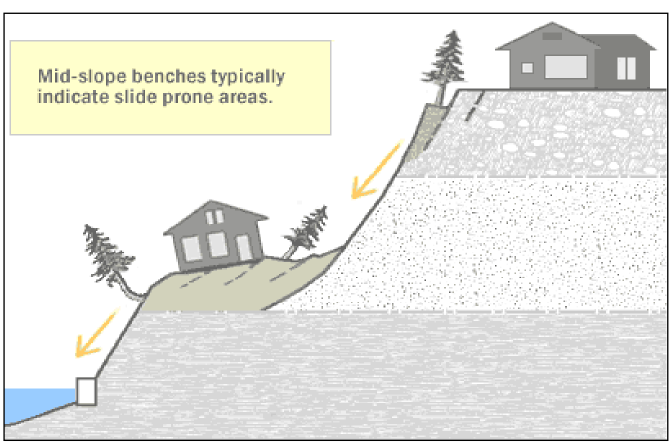


Figure 13-3. Bench Slide

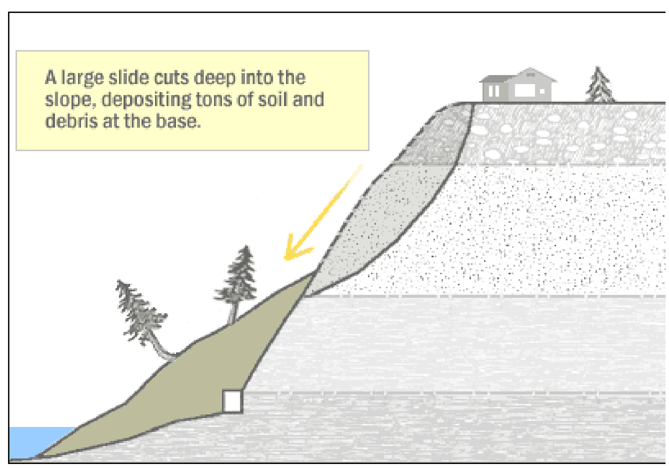


Figure 13-4. Large Slide

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.
- **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.

13.1.2 Landslide Causes

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. The following human activities have particular influence on the landslide hazard:

- **Construction Earthwork—**Excavation, grading and fill during construction of buildings or roads on sloping terrain can steepen the terrain and increase weight loads on slopes, potentially increasing the landslide hazard.
- **Drainage and Groundwater Alterations—**Activities that increase the amount of water flowing into landslide-prone slopes can increase the landslide hazard. This can include broken or leaking water or sewer lines, water retention facilities that direct water onto slopes, lawn irrigation, minor alterations to small streams, and ineffective stormwater management measures. Development that increases impervious surface may redirect surface water to other areas. Road and driveway drains, gutters, downspouts, and other constructed drainage facilities can concentrate and accelerate flow.
- **Changes in Vegetation—**Removal of vegetation from very steep slopes, by wildfire or land clearing, can increase landslide hazards. In addition, woody debris in stream channels (both natural and man-made) may cause the impacts from debris flows to be more severe.

Other factors that can contribute to landslide include the following:

- Change in slope of the terrain
- Increased load on the land, shocks and vibrations
- Change in water content
- Groundwater movement
- Frost action
- Weathering of rocks
- Removing or changing the type of vegetation covering slopes.
- Erosion by rivers, glaciers, or ocean waves that create over-steepened slopes.

13.1.3 Landslide Management

While small landslides are often a result of human activity, the largest landslides are often naturally occurring phenomena with little or no human contribution. The sites of large landslides are typically areas of previous landslide movement that are periodically reactivated by significant precipitation or seismic events. Such naturally occurring landslides can disrupt roadways and other infrastructure lifelines, destroy private property, and cause flooding, bank erosion and rapid channel migration. Landslides can create immediate, critical threats to public safety, and engineering solutions to protect structures from large active landslides are often prohibitively expensive.

In spite of their destructive potential, landslides can serve beneficial functions to the natural environment. They supply sediment and large wood to a stream network, contributing to complexity and dynamic channel behavior critical for aquatic and riparian ecological diversity. Effective landslide management should include the following elements:

- Continuing investigation to identify natural landslides, understand their mechanics, assess their risk to public health and welfare, and understand their role in ecological systems
- Regulation of development in or near existing landslides or areas of natural instability.
- Preparation for emergency response to landslides to facilitate rapid, coordinated action among local government and state and federal agencies, and to provide emergency assistance to affected or at-risk residents.
- Evaluation of options including landslide stabilization or structure relocation where landslides are identified that threaten critical public structures or infrastructure.

Critical area ordinances at the local level reduce the impacts of human alterations on critical areas, which include geologically hazardous areas such as areas prone to landslide, erosion, mass-wasting, debris flows and rock falls. The designation of critical areas, including geologically hazardous areas, is a requirement of the Washington State Growth Management Act (WAC 365-190-080(4).

13.2 HAZARD PROFILE

13.2.1 Past Events

Some damaging slides have occurred in and near to Chelan County. On December 14, 1872, a slide triggered by an earthquake caused a massive rock slide, which cut off the flow of the Columbia River. This slide occurred a few miles north of the present location of the town of Entiat. A handful of small-scale landslides have occurred in Chelan County over the years, usually the result of significant precipitation. Two significant landslides occurred between 2004 and 2010. In January 2007, a landslide occurred at Dirty Face Mountain and closed the Lake Wenatchee Highway temporarily. In February 2008, a landslide destroyed one home in the Kahler Glen development at Lake Wenatchee. Some landslide events have resulted in fatalities, as noted in Table 13-1.

Table 13-1. Landslide Deaths in Chelan County

Year	Location	Type	Fatalities
1942	Tenas George	Mud	8
1965	Leavenworth	Mud	1
1973	Preston Creek	Mud	4
1995	SR 97A	Rock	2

13.2.2 Location

Slides can occur in urban and rural areas throughout the County. In general, landslide hazard areas are where the land has characteristics that contribute to the risk of the downhill movement of material, such as the following (Washington Department of Community, Trade and Economic Development, 2007):

- Areas of historical failures
- Areas with all three of the following characteristics:
    - Slopes steeper than 15 percent
    - Hillsides intersecting geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock
    - Springs or groundwater seepage
- Areas that have shown movement within the last 11,000 years or that are underlain or covered by mass wastage debris of that time period
- Slopes that are parallel or subparallel to planes of weakness (such as bedding planes, joint systems, and fault planes) in subsurface materials
- Slopes with gradients steeper than 80 percent subject to rock-fall during seismic shaking
- Areas potentially unstable as a result of rapid stream incision, stream bank erosion, and undercutting by wave action
- Areas that show evidence of, or that are at risk from, snow avalanches
- Areas in a canyon or on an active alluvial fan, presently or potentially subject to inundation by debris flows or catastrophic flooding
- Any area with a slope of 40 percent or steeper and with a vertical relief of 10 or more feet, except areas composed of consolidated rock.

The Washington State Hazard Mitigation Plan defines six major landslide provinces. Chelan County is in the Columbia River Basin province, which largely consists of thick lava flows known as Columbia River Basalts. Landslides in this province include slope failures in bedrock along soil interbeds and in overlying catastrophic flood sediments. Bedrock slope failures are often large deep-seated translational landslides, slumps or earth flows, triggered by over-steepening of a slope or removal of the toe of a slope.

Figure 13-5 and Figure 13-6 combine Chelan County and Washington Department of Natural Resources datasets to show historical, potential or active landslide hazard areas.

13.2.3 Frequency

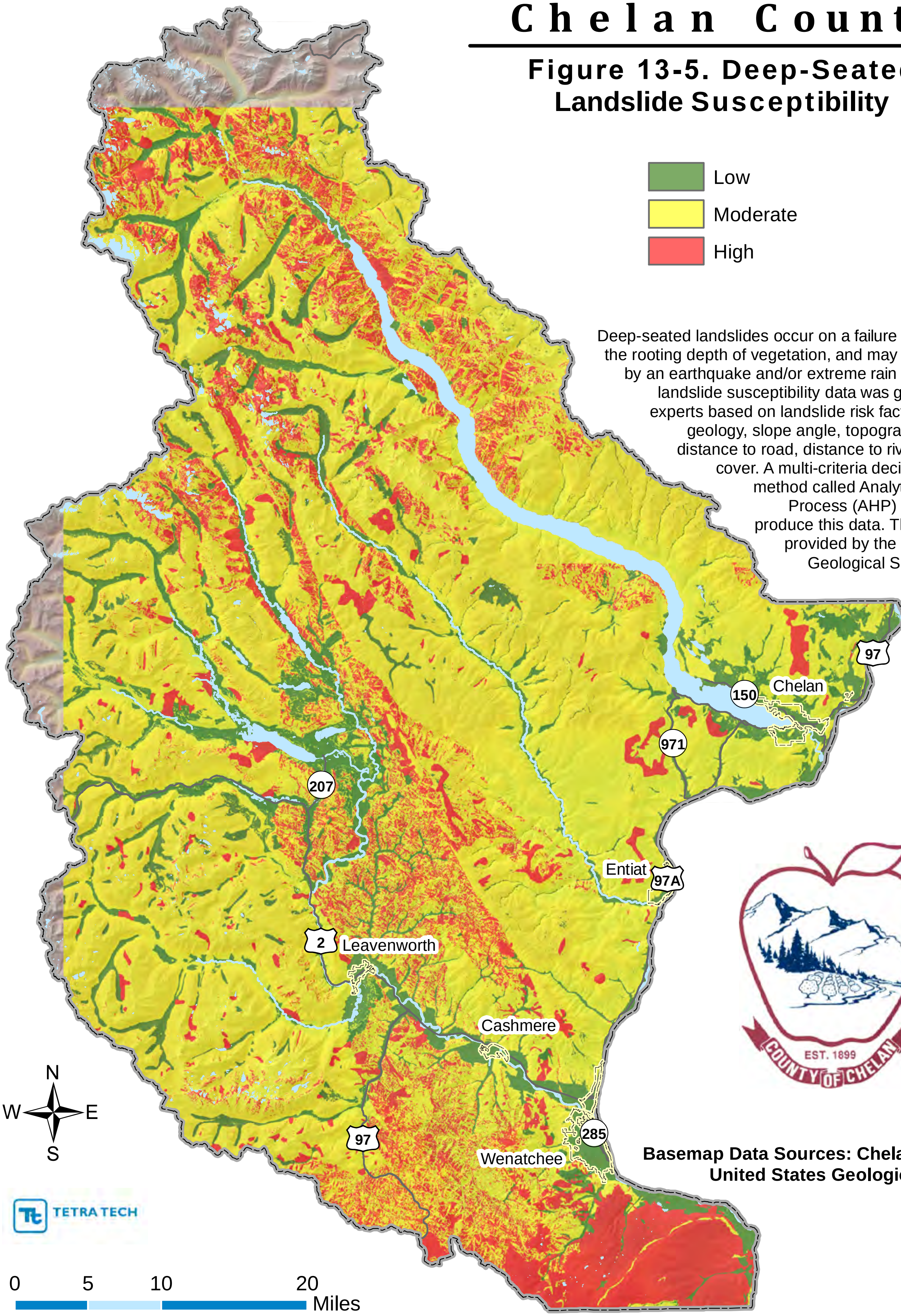
Landslides are relatively uncommon in Chelan County even though over 85 percent of the county is in steeply sloped areas of the Cascade Range Landslide Province as identified in the Washington State Hazard Assessment (Draft). Much of the underlying earthen material is bedrock and therefore less susceptible to landslides.

Landslides are not one of the County’s top natural hazard threats. Slides often occur on steep slopes after severe storms, wildfires, earthquakes or construction activity in slide prone areas. Because of the steep topography and narrow valleys of Chelan County, the potential for slides is high all year round. Under the right conditions any steep sloped area of Chelan County may be classified as a potential hazard area.

According to the 2018 Washington State Enhanced Hazard Mitigation Plan, Chelan County has experienced 23 significant landslide events since 1960, tied for the highest number of events during that period with Skagit County. This would equate to an annual probability of 39.7% or a recurrence interval of 2.52 years for that period. A lot of this frequency can be associated with post fire impacts within the County.

Chelan County

Figure 13-5. Deep-Seated Landslide Susceptibility



Deep-seated landslides occur on a failure plane below the rooting depth of vegetation, and may be triggered by an earthquake and/or extreme rain events. This landslide susceptibility data was generated by experts based on landslide risk factors such as geology, slope angle, topographic aspect, distance to road, distance to river, and land cover. A multi-criteria decision-making method called Analytic Hierarchy Process (AHP) was used to produce this data. This data was provided by the Washington Geological Survey in July 2018.

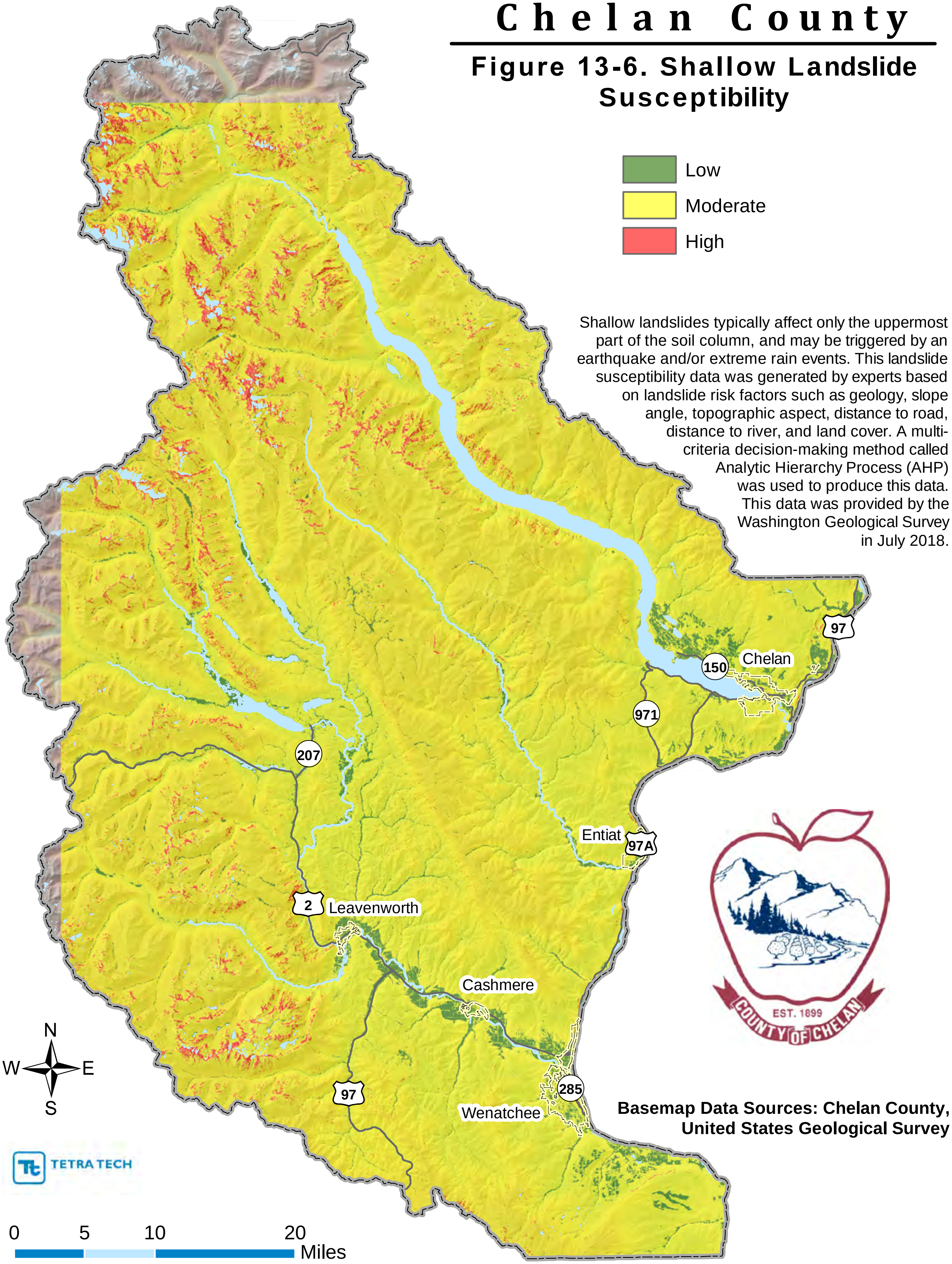
COUNTY OF CHELAN EST. 1899

Basemap Data Sources: Chelan County, United States Geological Survey

TETRA TECH

Chelan County

Figure 13-6. Shallow Landslide Susceptibility



Shallow landslides typically affect only the uppermost part of the soil column, and may be triggered by an earthquake and/or extreme rain events. This landslide susceptibility data was generated by experts based on landslide risk factors such as geology, slope angle, topographic aspect, distance to road, distance to river, and land cover. A multi-criteria decision-making method called Analytic Hierarchy Process (AHP) was used to produce this data. This data was provided by the Washington Geological Survey in July 2018.

Basemap Data Sources: Chelan County, United States Geological Survey

13.2.4 Severity

Landslides destroy property and infrastructure and can take the lives of people. 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 State Road 530 landslide that occurred in Oso, Washington showed the devastating damage that can be caused by landslides. On March 22, 2014, the slide traveled over 60 mph, covering over a square mile of land and depositing a thickness of 15 to 75 feet in some areas. The slide caused 43 fatalities and 12 injuries, destroyed 37 homes, and destroyed State Route 530 for over a mile. The debris blocked the North Fork Stillaguamish River for over 24 hours, backing up a pool of water that flooded the valley about 2 miles upstream and reached approximately 20 feet deep, inundating an additional 6 homes. Total property damage was estimated at $60 million (NOAA 2015). Although Oso is west of the Cascades and Chelan County is to the east, the magnitude of this event as well as its occurrence in the same state have heightened the awareness of the severity of this hazard in the planning area.

Numerous landslides have occurred in Chelan County, but there is no consolidated database of them. Landslide events often occur concurrently with other hazard events, so damage estimates specifically related to landslide are difficult to obtain. There are no records of fatalities attributed to mass movement in the County. However, deaths have occurred in neighboring Washington counties and across the west coast as a result of slides and slope collapses.

13.2.5 Warning Time

Mass movements can occur suddenly or slowly. The velocity of movement may range from inches per year to many feet per second, depending on slope angle, material and water content. 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 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.

Some methods used to monitor mass movements can provide an idea of the type of movement and the amount of time prior to failure. Assessing the geology, vegetation and amount of predicted precipitation for an area can help in predictions of what areas are generally at risk. Currently, there is no practical warning system for individual landslides. The standard operating procedure is to monitor situations on a case-by-case basis and respond after an event has occurred.

The Washington Division of Geology and Earth Resources, in cooperation with NOAA, has developed a generalized landslide warning system for shallow landslides that is currently in beta testing. The forecasting model is based on recent and predicted rainfall data. The warning system is not intended to forecast individual landslide events before they occur, but it will be a useful system for alerting residents to be more vigilant about landslide risk. The landslide warning map associated with this system provides additional information by county for residents (Washington Department of Natural Resources, 2016b).

13.3 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.

13.4 EXPOSURE

A quantitative assessment of exposure to the landslide hazard was conducted using the WDNR susceptibility class mapping for both deep seated and shallow seated landslides as shown in Figure 13-5 and Figure 13-6 and the asset inventory developed for this plan. Detailed results are provided in Appendix D and summarized below.

13.4.1 Population

Population was estimated using the residential building count in each mapped hazard area and multiplying by the 2018 Washington Office of Financial Management estimated average population per household. Using this approach, the estimated population living in mapped severe of moderate landslide hazard areas for deep seated landslides is 11.86 percent of the total planning area population (9,225 people) and is 18.01% (14,015 people) for shallow seated landslides. Population exposure estimates by susceptibility class are shown in Table 13-2 and Table 13-3. In addition to these resident populations, motorists driving on landslide prone roadways and those engaged in recreation activities such as hiking or camping may be exposed to the landslide hazard.

Table 13-2. Chelan County Population Exposure to Deep Seated Landslide Hazard

Susceptibility Class	Population Exposed	% of Total Population
High	1,345	1.73%
Moderate	7,880	10.13%
Low	68,575	88.14%
Total	77,800	100.00%

Table 13-3. Chelan County Population Exposure to Shallow Seated Landslide Hazard

Susceptibility Class	Population Exposed	% of Total Population
High	0	0%
Moderate	14,015	18.01%
Low	63,785	81.99%
Total	77,800	100.00%

13.4.2 Property

Figure 13-7 shows the percentage and count, by land use type, of planning area structures in the high susceptibility classes for deep seated landslides. An estimated 96 percent of these (575 structures) are residential. Figure 13-8 shows the percentage and count, by land use type, of planning area structures in the moderate susceptibility classes for shallow seated landslides. An estimated 98 percent of these (6,037 structures) are residential.

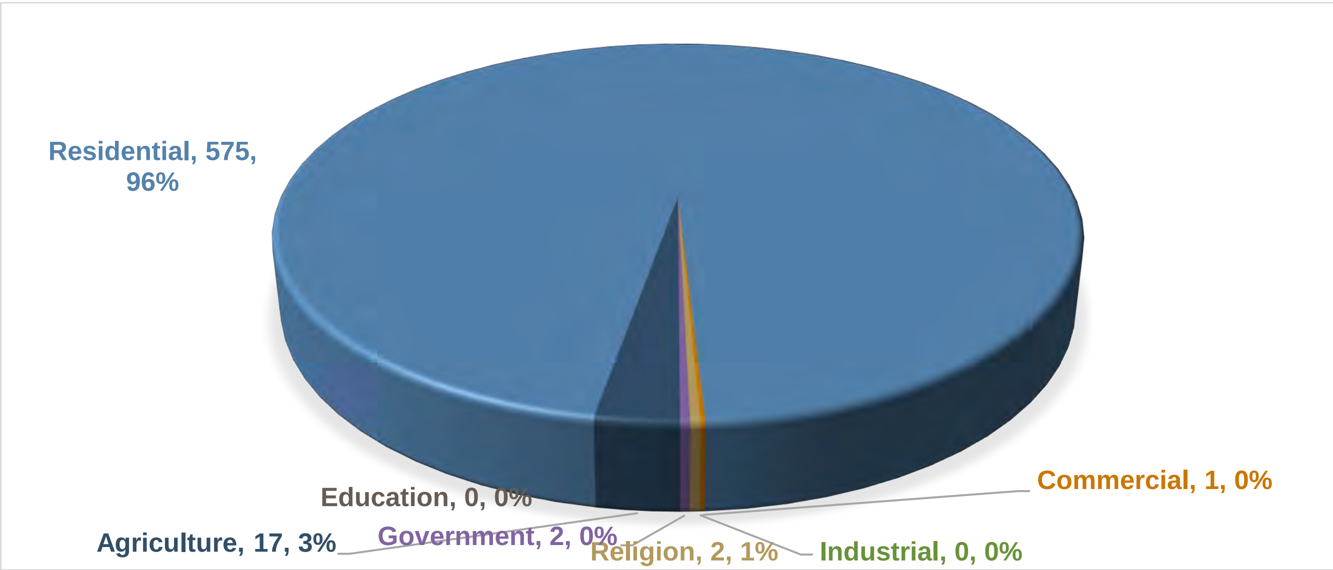


Figure 13-7. Structures in High Landslide Susceptibility Classes for Deep Seated Landslides, by Land Use Type

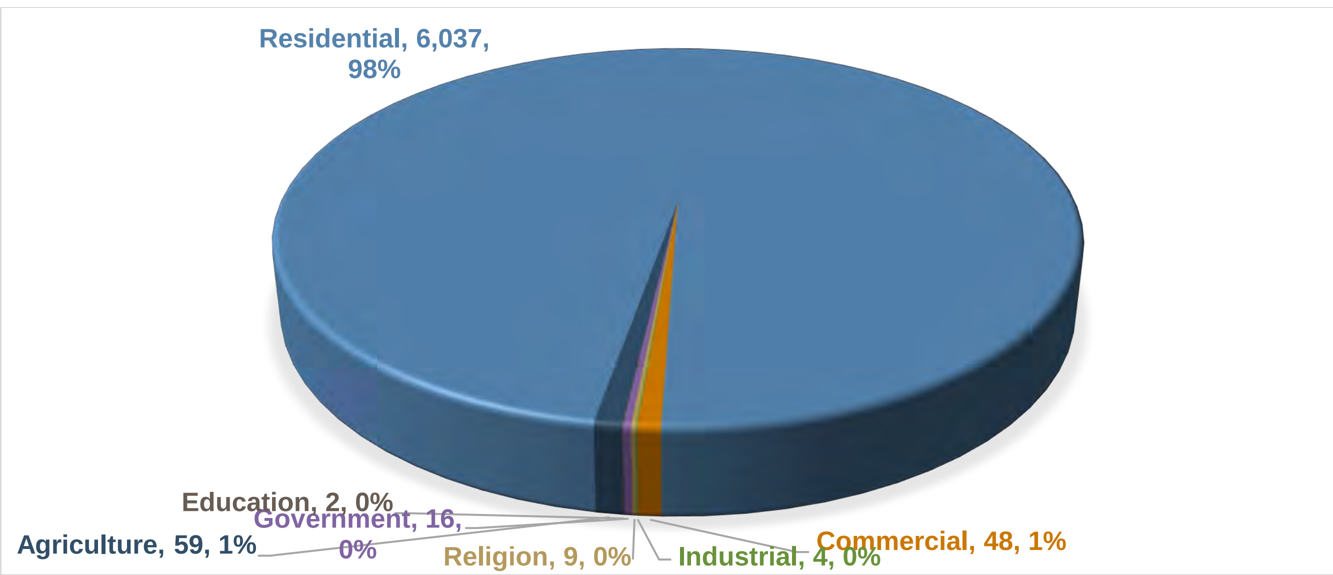


Figure 13-8. Structures in the Moderate Landslide Susceptibility Classes for Shallow Seated Landslides, by Land Use Type

The total replacement value of property in the high susceptibility classes for deep seated landslide hazards are more than $172 million—1.19 percent of the planning area total. The total replacement value of property in the moderate susceptibility classes for shallow seated landslide hazards are more than $1.8 billion—12.56 percent of the planning area total.

13.4.3 Critical Facilities and Infrastructure

Critical facilities and infrastructure exposed to the landslide hazard represent 30 percent of the total critical infrastructure and facilities in the planning area. Only 22.5 percent (119 facilities) are located in high or Moderate susceptibility classes in deep seated landslide areas. 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 13-9.

13.4.4 Environment

All natural resources in the mapped landslide susceptibility class areas are exposed to the landslide hazard.

13.5 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.

13.5.1 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.

13.5.2 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 13-3. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure.

Table 13-3. Loss Potential in the Landslide Hazard Areas

Susceptibility Class	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
Deep Seated-High	$172.6 million	$17.3 million	0.12%	$51.8 million	0.36%	$86.3 million	0.6%
Deep Seated-Moderate	$1.09 billion	$108.8 million	0.75%	$326.4 million	2.26%	$543.9 million	3.77%
Shallow Seated-Moderate	$1.814 Billion	$181.5 million	1.26%	$544.4 million	3.77%	$907.3 million	6.28%

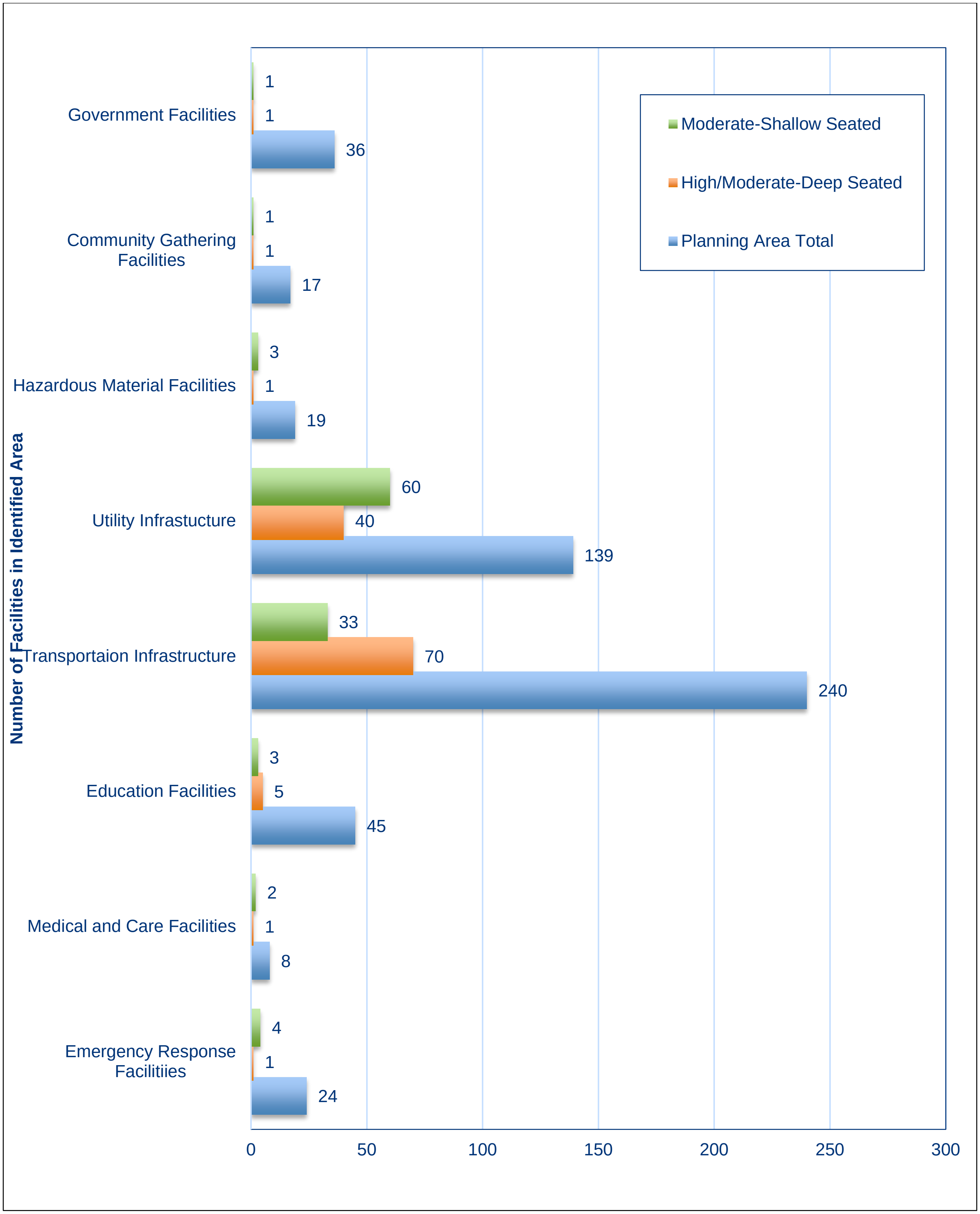


Figure 13-9. Critical Facilities and Infrastructure in Mapped Landslide Susceptibility Classes and Countywide

13.5.3 Critical Facilities and Infrastructure

All exposed critical facilities and infrastructure are vulnerable to the landslide hazard. Landslides can have a range of impacts on critical facilities and infrastructure:

- **Roads**—Access to major roads after a disaster is crucial to safety and to response operations. Landslides can block roads, isolating neighborhoods and causing problems for public and private transportation. This can result in economic losses for businesses.
- **Bridges**—Landslides can significantly impact road bridges. They can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use.
- **Power Lines**—Power lines are generally elevated above steep slopes; but the towers supporting them can be subject to landslides. A landslide could trigger failure of the soil underneath a tower, causing it to collapse and ripping down the lines. Power and communication failures due to landslides can create problems for vulnerable populations and businesses and may generate significant communication issues.

13.5.4 Environment

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

13.6 FUTURE TRENDS IN DEVELOPMENT

The ever-increasing pressure for development in or near the mountains and narrow valleys bring added exposure to people and their structures. Increasingly, more and more people are recreating, working and building in potentially hazardous areas with little caution or preparation. Development pressure in rural areas and at recreation sites in the mountains brings added exposure to people and their structures. Slide effects on individual or public organizations include partial damages or destruction of significant portions of highways and railroads, utility lines, private and public property. Other major effects involve the loss of natural resources and the cost of debris removal.

The State of Washington has adopted the International Building Code by reference in its Washington Building Standards Code. The International Building Code includes provisions for geotechnical analyses in steep slope areas that have soil types considered susceptible to landslide hazards. These provisions ensure that new construction is built to standards that reduce vulnerability to the landslide risk. In addition, all municipal planning partners have comprehensive plans that define landslide hazard areas as critical areas and have adopted critical areas ordinances that regulate development in landslide-prone areas. This will facilitate wise land use decisions as future growth impacts landslide hazard areas. It is anticipated that some new development will be exposed to landslide risk, as runout models do not yet exist and it is likely that not all landslide hazard areas have been identified.

13.7 SCENARIO

Major landslides in Chelan County occur as a result of soil conditions that have been affected by wildfire, 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 repeated severe storms with heavy rain and flooding in areas ravaged by wildfire.

13.8 ISSUES

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

- Landslide activity within the planning area is frequent and can be severe
- Although known landslide hazard areas and steep slopes are subject to regulation under critical area ordinances, continued development pressures could lead to more homes in landslide risk areas. Furthermore, landslides may occur that threaten people and property outside of the mapped risk areas.
- 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.”
- An estimated 2.13 percent of the replacement value of the planning area ($3.14 billion) is located in landslide hazard areas; 80 percent of this is in unincorporated areas of the county.
- Areas with significant landslide risk should be monitored, to the extent possible, immediately following a possible triggering event. Officials may need to focus the majority of attention on emergency response; however, the possibility for a secondary event should not be disregarded.
- Current maps show areas that might be unstable, but do not offer a complete picture of areas at risk, as they do not indicate runout (where a landslide might go). Mapping and assessment of landslide hazards are constantly evolving. As new data and science become available, assessments of landslide risk should be reevaluated.
- Facilities that contain hazardous materials located in landslide hazard areas may present additional risks.
- It is estimated that more than 23,240 people (29.8 percent of the population) reside within landslide risk areas. This does not include residences that may be in landslide runout areas.
- Landslides in the County often impact transportation corridors limiting ingress and egress and creating issues of isolation.
- Landslides may cause negative environmental consequences, including water quality degradation.
- 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.
- Landslides may result in loss of water quality to the environment and for drinking purposes, due to increased sediment delivery into surface waterways.
- The impact of climate change on landslides is uncertain. Climate change impacts that alter vegetation patterns, increase the occurrence of wildfires, or alter precipitation patterns may increase exposure to landslide risks.
- 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.
- There are 119 critical facilities located in mapped landslide hazard areas in the planning area. Most of these facilities are transportation and utility facilities in the unincorporated County areas.
- 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.
- 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.
- There are more than 10,200 structures in landslide hazard areas. About 98 percent of them are residential.

14. SEVERE WEATHER

14.1 GENERAL BACKGROUND

Severe weather refers to any dangerous meteorological event 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 winter storms, severe thunderstorms, and high winds. For this risk assessment, any use of 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.
- These weather event types have no 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.

Severe local storms occur when the interior of British Columbia is under the influence of high barometric pressure, and a deep low-pressure center from over the Pacific approaches the Washington coast. At this latitude, severe storms normally approach Chelan County from the south or southeast.

14.1.1 Winter Storms

A winter storm is defined for this plan as a storm with significant snowfall, ice, and/or freezing rain; the quantity of precipitation varies by elevation. Heavy snowfall is 4 inches or more in a 12-hour period, or 6 or more inches in a 24-hour period in non-mountainous areas; and 12 inches or more in a 12-hour period or 18 inches or more in a 24-hour period in mountainous areas. Severe winter storms occur when there is significant precipitation and the temperature is low enough that the precipitation completely or partially freezes. Figure 14-1 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.

Extreme cold occurs when temperatures are in dangerous ranges that may cause frostbite or hypothermia to people who are exposed. Extreme cold can occur as a result of low temperatures or a combination of low temperatures with wind chill. Figure 14-2 shows how wind can make temperatures feel colder than they really are. Extreme cold events often occur during severe winter storms.

14.1.2 Severe Thunderstorms

NOAA classifies a thunderstorm as a storm with lightning and thunder, usually with gusty winds, heavy rain, and sometimes hail. Thunderstorms are usually short (seldom more than two hours). A severe thunderstorm is defined for this plan as a thunderstorm with winds of 58 mph or greater, or three-quarter inch or larger hail.

Hail occurs when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere where they freeze into ice. Super-cooled water may accumulate on frozen particles near the back-side of a storm as they are pushed forward across and above the updraft by the prevailing winds near the top of the storm. Eventually, the hailstones encounter downdraft air and fall to the ground.

Source: NOAA, NWS, 2018b

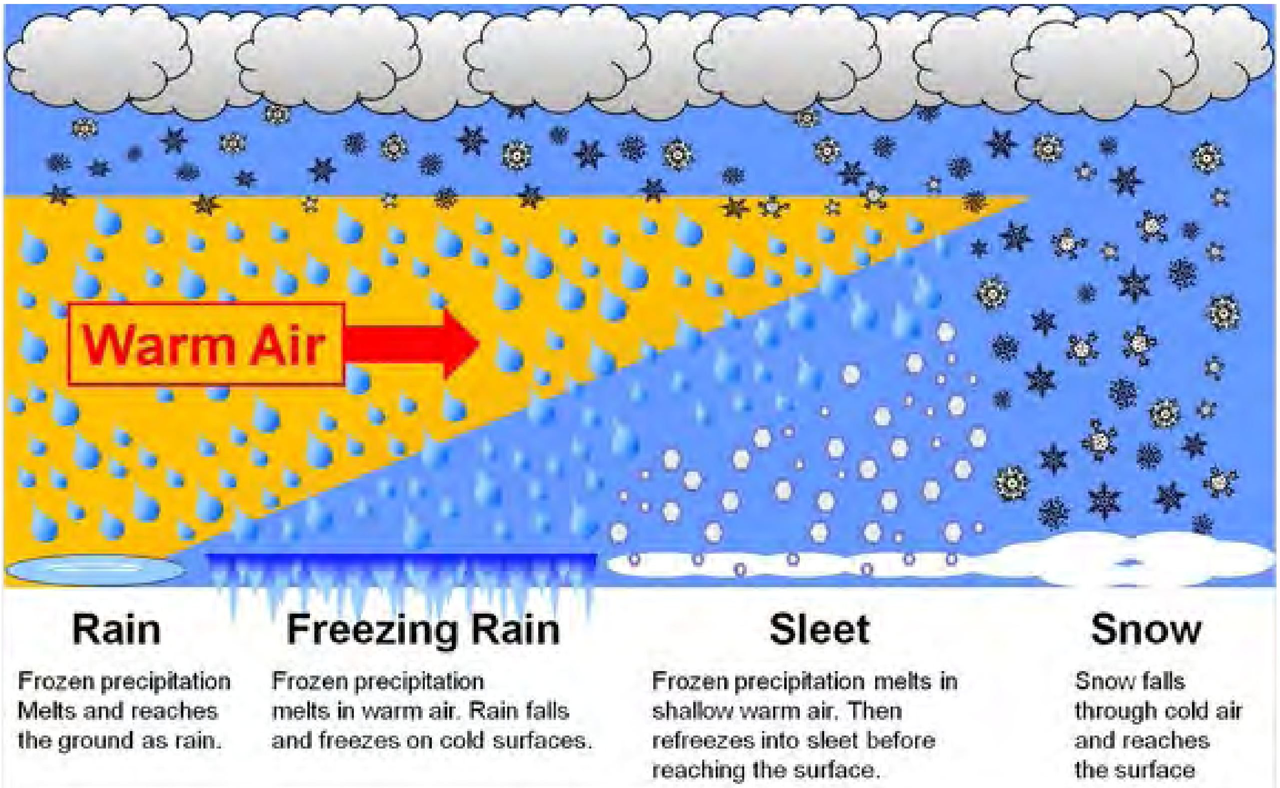


Figure 14-1. Effects of Air Temperature on Winter Precipitation Events

Temperature (°F)

Wind (mph) / Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes; 10 minutes; 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Figure 14-2. Wind Chill Chart

Lightning associated with thunderstorms 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.

14.1.3 High Winds

High winds are defined for this plan as sustained winds of 40 mph or gusts of 58 mph or greater, not caused by thunderstorms, that are expected to last for an hour or more. The National Weather Service classifies wind from 38 to 55 mph as gale force winds; 56 to 74 mph as storm force winds and any winds over 75 mph as hurricane force winds. Destructive winds normally occur in the planning area between October and March.

14.2 HAZARD PROFILE

14.2.1 Past Events

Historically, Chelan County has been subject to many types of storms. These have varied in intensity from mild to severe. Common types of storms in this area include thunder, hail, wind, winter-related blizzards, etc. While not all of these have caused major long-term problems, they all have disrupted people’s day-to-day activities and posed a burden, especially on the poor and elderly. Table 14-1 lists notable severe storms in Chelan County.

Table 14-1. Notable Recent Severe Storms in Chelan County

Date	Type	Description
January 1950	Snow	Eastern Washington received up to 50 inches of snow
October 1950	Wind	Entire state, Max. velocity 57 60 MPH
March 1956	Wind	Entire state, Max. velocity 48 60 MPH
December 1968	Snow	Chelan Co. extensive snowfall
March 1972	Rain	Wenatchee area record rainfall for 24 hour period. Flash flood on 1970 burn
June 1972	Hail	Wenatchee area, extensive soft fruit damage
August 1979	Thunder	Entiat & Chelan area, ignited largest wildfires in the nation for 1970s
January 1983	Wind	Wenatchee area, peak gusts 52+ MPH
March 1988	Wind	Entire county, unofficial gust 100+ in the Manson and Wenatchee areas.
January 1996	Snow	Several structures damaged due to snow loads
January 1997	Snow	Passes closed two days due to heavy snow and avalanche danger.
December 2006	Wind	Widespread power outage in Lake Wenatchee and Entiat Valley
January 2007	Snow	Power outages Countywide
January 2007	Wind	A strong lee side trough east of the Cascades led to strong damaging gravity wave winds. Where these gravity waves mixed down to the surface, extensive to catastrophic damages occurred causing over $10 million in property damages
December 2012	Snow	Several rounds of heavy snow fell across the East Slopes of the Washington Cascades between December 16th and the 24th causing $5.6 million in property damages within the region.
January 2018	Wind	The Wenatchee World Newspaper reported numerous trees downed by strong wind gusts in excess of 71 knots in and around Wenatchee between 3 pm and 5 pm. At least two large trees fell on houses in Wenatchee and East Wenatchee and numerous power lines were taken out by falling trees.

14.2.2 Location

All areas of Chelan County are vulnerable to the threat of severe storms. Due to topography and climatological conditions, the higher mountainous areas are often the most exposed to the effects of these storms. Normally the mountainous terrain and the north/south orientation of the Cascades tend to isolate severe storms into localized areas of the County, although individual storms can generate the force to impact the entire County at one time. Severe thunder, hail, wind and winter storms are common in all parts of Chelan County.

14.2.3 Frequency

Many of the recorded severe weather events for Chelan County have been related to high winds and severe winter weather. The planning area can expect to experience exposure to some type of severe weather event at least annually. According to records, in 55 years, the county has experienced 153 severe weather events, for an average of 2 to 3 events per year.

According to the Washington State Hazard Mitigation Plan, Chelan County is vulnerable to high winds. Counties considered vulnerable to high winds are those that were most affected by conditions that lead to high winds and those with a recurrence rate of 100 percent (i.e., that experienced at least one damaging high wind event per year).

Chelan County is also considered one of the counties most vulnerable to winter storms. This means that the county has a recurrence rate of at least 50 percent, or it experiences at least one damaging winter storm event every two years.

Six instances of extreme heat events are listed for the planning area between 1996 and 2015; however, this data likely underestimates the occurrence of such events in the planning area. Extreme heat events can occur several times per year, especially in the summer. Three extreme cold events were reported between 1996 and 2015. The actual number may be underreported, and some extreme cold events may be entered under another category, such as winter weather; the more visible impacts of a winter storm or blizzard may reduce the attention paid to extreme cold temperatures.

14.2.4 Severity

The most common problems associated with severe storms are immobility and loss of utilities. Fatalities are uncommon but can occur. Roads may become impassable due to flooding, downed trees or a landslide. Power lines may be downed due to high winds or ice accumulation, and services such as water or phone may not be able to operate without power. Lightning can cause severe damage and injury. Physical damage to homes and facilities can be caused by wind or accumulation of snow or ice. Even a small accumulation of snow can cause havoc on transportation systems due to a lack of snow clearing equipment and experienced drivers and the hilly terrain.

Chelan County has been vulnerable to severe winter storms when significant snowfall has immobilized local and state transportation routes as well as utility systems. All areas of the County have been subject to these events, which appear to occur at least once every five to ten years. Primary effects normally vary with the intensity of the storm. In some cases, transportation accidents can occur from accumulation of snow, ice, hail or dust from accompanying winds. Physical damage to facilities can occur from accumulation of snow, ice, hail or dust and from accompanying winds.

Windstorms can be a frequent problem in the planning area and have been known to cause damage to utilities. The predicted wind speed given in wind warnings issued by the National Weather Service is for a one-minute average; gusts may be 25 to 30 percent higher. Lower wind speeds typical in the lower valleys are still high enough to knock down trees and power lines and cause other property damage. Mountainous sections of the County experience much higher winds under more varied conditions. Although the intensity of major storms has often been reduced by the Cascades, winds over exposed peaks can reach 100 mph, with peak gusts of 125 to 150 mph as the storm moves inland.

Ice storms accompanied by high winds can have especially destructive impacts, especially on trees, power lines, and utility services. While sleet and hail can create hazards for motorists when they accumulate, freezing rain can cause the most dangerous conditions within the planning area. Ice buildup can bring down trees, communication towers and wires, creating hazards for property owners, motorists and pedestrians. Rain can fall on frozen streets, cars, and other sub-freezing surfaces, creating dangerous conditions.

Lightning severity is typically investigated for both property damage and life safety (injuries and fatalities). The number of reported injuries from lightning is likely to be low. County infrastructure losses can be up to thousands of dollars each year.

Tornadoes are potentially the most dangerous of local storms, but they are not common in the planning area. If a major tornado were to strike within the populated areas of the county, damage could be widespread. Businesses could be forced to close for an extended period or permanently, fatalities could be high, many people could be homeless for an extended period, and routine services such as telephone or power could be disrupted. Buildings could be damaged or destroyed.

14.2.5 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. The Seattle and Spokane Offices of the National Weather Service (NWS) monitor weather stations and issue watches and warnings when appropriate. Watches and warnings are broadcast over NOAA weather radio and are forwarded to local media for re-transmission using the Emergency Alert System.

14.3 SECONDARY HAZARDS

Depending upon the time of year, additional hazards resulting from a severe storm can include wildfires, flash floods, avalanches or landslides. Secondary effects can include severe wind erosion of dry soils, overtaxing of electric utilities during severe weather conditions, crop damage from hail, agricultural losses resulting from inflated prices, and temporary shortages of necessities in a storm-impacted area.

14.4 EXPOSURE

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

14.5 VULNERABILITY

14.5.1 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. 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:

- **Winter Storms**—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. Death and injury may also result from flooding from severe winter storms. 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).
- **Severe Thunderstorms**—Since the 1940s, lightning has caused more deaths in the United States than tornadoes, floods, or hurricanes (NOAA, NWS, 2018d). Thunderstorm related deaths and injuries in the planning area are most likely to result from accompanying wind and flood events.
- **High 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 seeking shelter inside.

14.5.2 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:

- **Winter Storms**—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.
- **Severe Thunderstorms**—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.
- **High Winds**—Mobile homes can be seriously damaged by wind gusts over 80 mph, even if they are anchored (National Severe Storms Laboratory, 2018). According to the American Community Survey, there are about 2,000 mobile homes in the planning area. 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.

According to the Chelan County Assessor records used for this analysis, there are 39,485 structures within the planning area. Most of these buildings (98.3 percent) are residential. All of these buildings are considered to be exposed to the severe weather hazard. No modeling is available for quantitative loss estimations for the severe weather hazard. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the replacement value of exposed structures. Detailed results are provided in Appendix D and summarized below.

- Loss of 10 percent of planning area replacement value—$1.44 billion
- Loss of 30 percent of planning area replacement value—$4.33 billion
- Loss of 50 percent of planning area replacement value—$7.22 billion.

14.5.3 Critical Facilities and Infrastructure

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

- **Winter Storms and Severe 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.
- **High Winds**—Critical facilities located near trees or power lines that are likely to fall are vulnerable. Roads and other transportation infrastructure could be blocked by downed trees or other debris.

14.5.4 Environment

The environment is highly vulnerable to severe weather events. Natural habitats such as streams and trees are vulnerable to the elements during a severe storm and risk major damage and destruction. 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. According to the 2018 Washington State Enhanced Hazard Mitigation Plan, Severe weather events are a part of the natural climatic cycle. As such these events play an important role in maintenance and sustenance of local biodiversity. Climate change is a major driver impacting weather patterns and, in turn, the natural environment. For example, as there are fewer freezing days along the eastern Cascade slopes, fewer bark beetles are dying, severely stressing existing forests. Different species will fill this vacated niche. This, as with all adaption, this will benefit some and adversely impact others.

14.6 FUTURE TRENDS IN DEVELOPMENT

All future development will be affected by severe weather. 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 Washington State mandates. This code is equipped to deal with the impacts of severe weather events. Land use policies identified in comprehensive plans within the planning area also address many of the secondary impacts (flood and landslide) of the severe weather hazard. To combat the effects of urban heat island effect, communities can implement design standards and urban planning principles that reduce the impacts of excessive heat events. With these tools, the planning partnership is well equipped to deal with future growth and the associated impacts of severe weather.

14.7 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.

14.8 ISSUES

Severe local storms are probably the most common widespread hazard. They affect large numbers of people in the planning area when they occur. Severe storms can quickly overwhelm city and county resources. Residents should be prepared for these types of storms: family plans should be developed, disaster kits should be put in homes, workplaces, schools and cars, and every family member should be taught how to shut off household utilities. Early dismissal from schools and businesses is an effective mitigation measure and should be encouraged.

Severe weather cannot be prevented, but measures can be taken to mitigate the effects. Critical infrastructure and utilities can be hardened to prevent damage during an event. The secondary effect of flooding can be addressed through decreasing runoff and water velocity. Important issues associated with severe weather in the planning area include the following:

- Dead or dying trees are more susceptible to falling during severe storm events.
- Debris management (downed trees, etc.) must be addressed, because debris can impact the severity of severe weather events, requires coordination efforts, and may require additional funding.
- 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.
- 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 winter weather effects such as snow loads or high winds. Mobile homes are also vulnerable to damaging winds.
- Power outages that disrupt land line service could cause significant communication disruption.
- Priority snow removal routes should continue to be cleared first to ensure navigable routes through and between jurisdictions.
- Public education on dealing with the impacts of severe weather needs to continue so that residents can be better informed and prepared for severe weather events.
- Redundancy of power supply throughout the planning area must be evaluated to better understand what areas may be vulnerable.
- Street tree management programs should be evaluated to help reduce impacts from tree-related damages.
- The capacity for backup power generation is limited.
- The County has numerous isolated population centers.

15. WILDFIRE

15.1 GENERAL BACKGROUND

> **Note:**
>
> Chelan County recently completed its update to the Chelan County Community Wildfire Protection Plan (CWPP). The CWPP update process overlapped with the development of this hazard mitigation plan update. Excerpts from the CWPP are included in this chapter, and the CWPP is hereby integrated with this mitigation plan by reference. The two documents work in concert to mitigate the wildfire hazard in Chelan County.

A wildfire is an uncontrolled fire on undeveloped or developed land that in most cases, but not all, requires fire suppression. Wildfires can be ignited by lightning or by human activity such as smoking, campfires, equipment use and arson. Wildfires occur when an ignition source in a wooded or grassy area is brought into contact with a combustible material such as vegetation, with an adequate supply of oxygen from the ambient air.

A wildfire front is the portion of a wildfire sustaining continuous flaming combustion, where unburned material meets active flames. As the front approaches, the fire heats both the surrounding air and vegetative material through convection and thermal radiation. First, vegetative material is dried as water in it is vaporized at a temperature of 212ºF. Next, the wood releases flammable gases at 450ºF. Finally, wood can smolder at 720ºF, and ignite at 1,000ºF. Before the flames of a wildfire arrive at a particular location, heat transfer from the wildfire front can warm the air to 1,470ºF, which pre-heats and dries flammable materials, causing them to ignite faster and allowing the fire to spread faster. High temperature and long-duration surface wildfires may encourage flashover or torching: the drying of tree canopies and their subsequent ignition from below.

Large wildfires may affect air currents by the stack effect: air rises as it is heated, so large wildfires create powerful updrafts that draw in new, cooler air from surrounding areas in thermal columns. Great vertical differences in temperature and humidity encourage fire-created clouds, strong winds, and fire whirls with the force of tornadoes at speeds of more than 50 mph. Rapid rates of spread, prolific crown fires, the presence of fire whirls, and strong convection columns signify extreme conditions.

15.1.1 Factors Affecting Wildfire Risk

An informed discussion of fire mitigation is not complete until basic concepts that govern fire behavior are understood. In the broadest sense, wildland fire behavior describes how fires burn; the manner in which fuels ignite, how flames develop and how fire spreads across the landscape. The three major physical components that determine fire behavior are the fuels supporting the fire, the topography in which the fire is burning, and the weather and atmospheric conditions during a fire event. At the landscape level, both topography and weather are beyond our control. We are powerless to control winds, temperature, relative humidity, atmospheric instability, slope, aspect, elevation, and landforms. It is beyond our control to alter these conditions, and thus impossible to alter fire behavior through their manipulation. When we attempt to alter how fires burn, we are left with manipulating the third component of the fire environment; fuels which support the fire. By altering fuel loading and fuel continuity across the landscape, we have the best opportunity to control or affect how fires burn.

Topography

Fires burn differently under varying topographic conditions. Topography alters heat transfer and localized weather conditions, which in turn influences vegetative growth and resulting fuels. Changes in slope and aspect can have significant influences on how fires burn. Generally speaking, north slopes tend to be cooler, wetter, more productive sites. This can lead to heavy fuel accumulations, with high fuel moistures, later curing of fuels, and lower rates of spread. In contrast, south and west slopes tend to receive more direct sun, and thus have the highest temperatures, lowest soil and fuel moistures, and lightest fuels. The combination of light fuels and dry sites leads to fires that typically display the highest rates of spread. These slopes also tend to be on the windward side of mountains. Thus, these slopes tend to be “available to burn” a greater portion of the year.

Slope also plays a significant role in fire spread, by allowing preheating of fuels upslope of the burning fire. As slope increases, rate of spread and flame lengths tend to increase. Therefore, we can expect the fastest rates of spread on steep, warm south and west slopes with fuels that are exposed to the wind.

Fuels

Fuel is any material that can ignite and burn. This includes organic material, dead or alive, in the fire environment—Grasses, brush, branches, down woody material, forest floor litter, conifer needles, and buildings. The physical properties of fuels govern how fires burn. Fuel loading, size and shape, moisture content, and continuity and arrangement all have an effect on fire behavior. Generally speaking, the smaller and finer the fuels, the faster the potential rate of fire spread. Small fuels such as grass, needle litter and other fuels less than a quarter inch in diameter are most responsible for fire spread. In fact, “fine” fuels, with high surface to volume ratios, are considered the primary carriers of surface fire. This is apparent to anyone who has ever witnessed the speed at which grass fires burn. As fuel size increases, the rate of spread tends to decrease due to a decrease in the surface to volume ratio. Fires in large fuels generally burn at a slower rate but release much more energy and burn with much greater intensity. This increased energy release, or intensity, makes these fires more difficult to control. Thus, it is much easier to control a fire burning in grass than to control a fire burning in timber.

When burning under a forest canopy, the increased intensities can lead to torching (single trees becoming completely involved) and potential development of crown fires. That is, they release much more energy. Fuels are found in combinations of types, amounts, sizes, shapes, and arrangements. It is the unique combination of these factors, along with the topography and weather, which determines how fires will burn.

The study of fire behavior recognizes the dramatic and often-unexpected effect small changes in any single component have on how fires burn. It is impossible to speak in specific terms when predicting how a fire will burn under any given set of conditions. However, through countless observations and repeated research, some of the principles that govern fire behavior have been identified and are recognized.

Weather

Of all the factors influencing wildfire behavior, weather is the most variable. Extreme weather leads to extreme events, and it is often a moderation of the weather that marks the end of a wildfire’s growth and the beginning of successful containment. High temperatures and low humidity can produce vigorous fire activity. The cooling and higher humidity brought by sunset can dramatically quiet fire behavior.

Fronts and thunderstorms can produce winds capable of sudden changes in speed and direction, causing changes in fire activity. The rate of spread of a fire varies directly with wind velocity. Winds may play a dominant role in directing the course of a fire. The most damaging firestorms are usually marked by high winds. The radical and devastating effect that wind can have on fire behavior is a primary safety concern for firefighters. In a 1994 fire in Colorado, a sudden change in wind speed and direction led to a blowup that claimed the lives of 14 firefighters.

15.1.2 Wildfire Types

Fire types can be generally characterized by their fuels as follows:

- **Ground fires** are fed by roots and other buried organic matter. Ground fires typically burn by smoldering and can burn slowly for days to months.
- **Crawling or surface fires** are fueled by low-lying vegetation such as tree litter, grass, and low shrubbery.
- **Ladder fires** consume material between low-level vegetation and tree canopies, such as small trees, downed logs and vines. Invasive plants that scale trees may encourage ladder fires.
- **Crown, canopy or aerial fires** burn suspended material at the canopy level, such as tall trees, vines and mosses. The ignition of a crown fire, depends on the density of the suspended material, canopy height, canopy continuity, and the presence of surface and ladder fires to reach the tree crowns.

15.2 HAZARD PROFILE

15.2.1 Fire History

Fire was once an integral function within most ecosystems in Washington. The seasonal cycling of fire across most landscapes was as regular as the July, August and September lightning storms plying across the east slopes of the Cascades. Depending on the plant community composition, structural configuration, and buildup of plant biomass, fire resulted from ignitions with varying intensities and extent across the landscape. Shorter return intervals between fire events often resulted in less dramatic changes in plant composition. These fires burned from 1 to 47 years apart, with most at 5- to 20-year intervals. With infrequent return intervals, plant communities tended to burn more severely and be replaced by vegetation different in composition, structure, and age. Native plant communities in this region developed under the influence of fire, and adaptations to fire are evident at the species, community, and ecosystem levels.

Historical fire history data for Chelan County is largely unknown. Local knowledge suggests that Native Americans did frequently burn which played an important role in shaping the vegetation throughout the County. Figure 15-1 shows the fire ignition history and perimeter data in Chelan County from 1980-2016.

The following are some of the more significant fires within the planning area:

- **2018 Cougar Creek Fire—**A fire was reported 10 miles northwest of the Entiat on July 28th. The fire was ignited by lightning and burned over 42,000 acres according to InciWeb. Fuels involved in the wildland fire included; lodgepole pine/mixed conifer stands and stands of beetle killed trees. This fire also burned through an old fire scar (Tyee 1994) with dense lodgepole regeneration, snags and dead/down material.
- **2015- Chelan Complex Fires—**"These fires burned over 95,000 acres and destroyed over 50 homes in the First Creek Neighborhood and the City of Chelan. The entire Lake Chelan area lost power for three days, which affected their communications network and their ability to pump water from the city fire hydrants".
- **2015 Wolverine Fire—**"This fire ignited earlier than the Chelan Complex fire but burned through the summer. This fire destroyed 4 structures and threatened numerous others including in the Chiwawa Valley and the Ponderosa Neighborhood."
- **2015 Sleepy Hollow Fire—**"This fire burned 3,000 acres and destroyed 30 residences in the Broadview neighborhood located in the western foothills of Wenatchee. The city also experienced fire starts in the center of town at several warehouses due to embers from the burning homes."

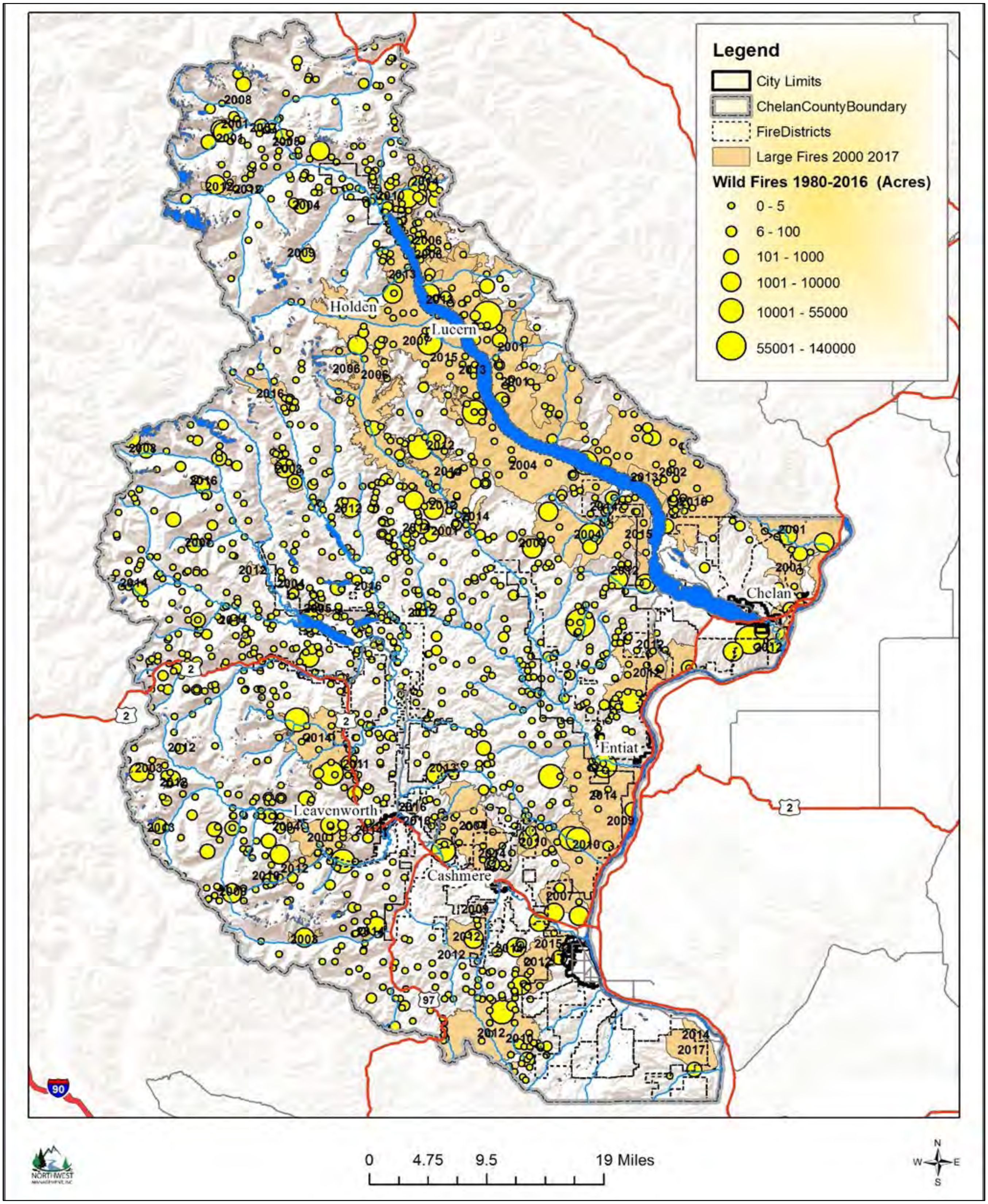


Figure 15-1. Ignition History in Chelan County from 1980-2016

15.2.2 Ignition profile

Detailed records of wildfire ignitions and extents from the Washington Department of Natural Resources and Bureau of Land Management (BLM) have been analyzed. In interpreting these data, it is important to keep in mind that the information represents only the lands protected by the agency specified and may not include all fires in areas covered only by local fire departments or other agencies.

The federal and state agencies database of wildfire ignitions (1980-2016) used in this analysis includes ignition and extent data within their jurisdictions and is provided in Table 15-1. During this period, the agencies recorded an average of 46 wildfire ignition per year resulting in an average total burn area of over 15,000 acres per year. The highest number of ignitions (104) occurred 1990, while the greatest number of acres burned in a single year occurred in 1994 with over 185,671 acres burned. According to this dataset, the clear majority of fires occurring in Chelan County are naturally caused (lightning); however, human caused fires do occur.

Table 15-1. Summary of Cause from State and Federal Databases 1980-2016

General Cause	Number of Ignitions	Percent of Total Ignitions	Acres Burned	Percent of Total Acres
Human-Caused	637	37%	78,878	14%
Natural Ignition	966	57%	406,143	73%
Unknown	107	6%	72,591	13%
Total	1,710	100%	557,612	100%

Based on the agencies' combined datasets specific to Chelan County, there is an upward trend in the number of human caused ignitions per year since 1980 but the number of acres burned annually remains relatively constant regardless of cause (see Figure 15-2). The upward trend in human ignitions could be attributed to a higher amount of people moving to more rural areas of Chelan County.

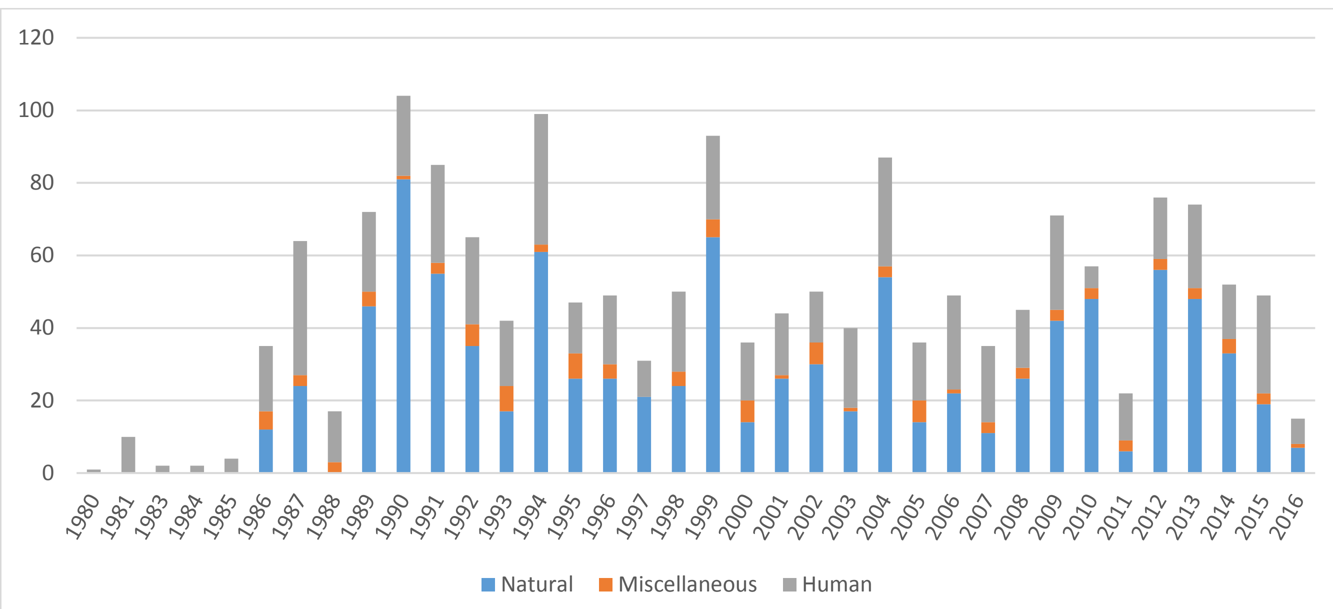


Figure 15-2. Summary of Chelan County State and Federal Ignitions by Cause

The data reviewed above provides a general picture regarding the level of wildland-urban interface fire risk within Chelan County. There are several reasons why the fire risk may be even higher than suggested above, especially in developing wildland-urban interface areas.

- Large fires may occur infrequently, but statistically they will occur. One large fire could significantly change the statistics. In other words, 40 years of historical data may be too short to capture large, infrequent wildland fire events.
- The level of fire hazard depends profoundly on weather patterns. A several year drought period would substantially increase the probability of large wildland fires in Chelan County. For smaller vegetation areas, with grass, brush and small trees, a much shorter drought period of a few months or less would substantially increase the fire hazard.
- The level of fire hazard in wildland-urban interface areas is likely significantly higher than for wildland areas due to the greater risk to life and property. The probability of fires starting in interface areas is much higher than in wildland areas because of the higher population density and increased activities. Many fires in the wildland urban interface are not recorded in agency datasets because the local fire department responded and successfully suppressed the ignition without mutual aid assistance from the state or federal agencies.

15.2.3 Extent Profile

Across the west, wildfires have been increasing in extent and cost of control. Data summaries for 2008 through 2017 are provided in Table 15-2 and demonstrate the variability of the frequency and extent of wildfires nationally.

Table 15-2. Statistical Highlights of Wildfires from 2008 -2017 Nationally.

	Number of Fires	10-year Average Ending with Indicated Year	Area Burned (million acres)	10-year Average Ending with Indicated Year (million acres)	Structures Destroyed	Estimated Cost of Fire Suppression (Federal Agencies Only)
2008	78,979	79,919	5.3	6.91		$1.85 billion
2009	78,792	78,549	5.9	6.94		$1.24 billion
2010	71,971	76,521	3.4	6.54	788	$1.13 billion
2011	74,126	75,526	8.7	7.05	5,246	$1.73 billion
2012	67,774	74,958	9.2	7.25	4,244	$1.9 billion
2013	47,579	73,353	4.3	7.28	2,135	$1.7 billion
2014	63,212	73,128	3.6	6.83	1,953	$1.5 billion
2015	68,151	73,267	10.1	6.97	4,636	$2.1 billion
2016	67,743	70,403	5.5	6.53	4,312	$1.98 billion
2017	71,499	68,983	10	6.6	12,306	$2.9 billion

The National Interagency Fire Center and the National Incident Coordination Center maintains records of fire costs, extent, and related data for the entire nation. Table 15-3 summarizes relevant wildland fire data for the nation and trends that are likely to continue unless targeted fire mitigation efforts are implemented and maintained. According to these data, the total number of fires is trending downward while the total number of acres burned is trending upward (see Figure 15-3). Since 1980 there has been a significant increase in the number of acres burned. In 2015, Washington was second behind California for the highest structure loss per state, with 343 residences, 23 commercial and 182 outbuildings destroyed during the 2015 fire season.

These statistics are based on end-of-year reports compiled by all wildland fire agencies after each fire season. The agencies include: Bureau of Land Management, Bureau of Indian Affairs, National Park Service, US Fish and Wildlife Service, Forest Service, and all state agencies.

Table 15-3. Summary of National Ignitions and Acres Burned Annually (1980-2017).

Year	Fires	Acres	Year	Fires	Acres
2017	71,499	10,026,086	1998	81,043	2,329,709
2016	67,595	5,503,538	1997	89,517	3,672,616
2015	68,151	10,125,149	1996	115,025	6,701,390
2014	63,212	3,595,613	1995	130,019	2,315,730
2013	47,579	4,319,546	1994	114,049	4,724,014
2012	67,774	9,326,238	1993	97,031	2,310,420
2011	74,126	8,711,367	1992	103,830	2,457,665
2010	71,971	3,422,724	1991	116,953	2,237,714
2009	78,792	5,921,786	1990	122,763	5,452,874
2008	68,594	4,723,810	1989	121,714	3,261,732
2007	85,822	9,321,326	1988	154,573	7,398,889
2006	96,385	9,873,745	1987	143,877	4,152,575
2005	66,753	8,689,389	1986	139,980	3,308,133
2004	77,534	6,790,692	1985	133,840	4,434,748
2003	85,943	4,918,088	1984	118,636	2,266,134
2002	88,458	6,937,584	1983	161,649	5,080,553
2001	84,079	3,555,138	1982	174,755	2,382,036
2000	122,827	8,422,237	1981	249,370	4,814,206
1999	93,702	5,661,976	1980	234,892	5,260,825

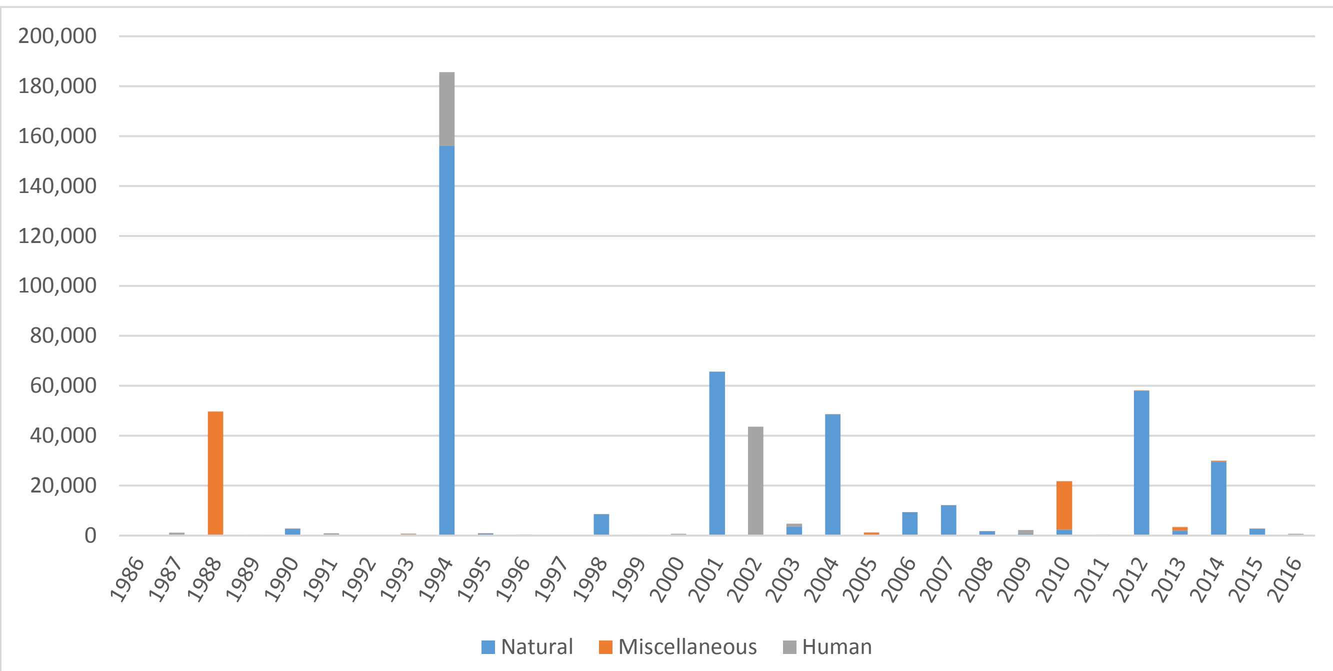


Figure 15-3. Summary of Chelan County State and Federal Acres Burned by Cause

The fire suppression agencies in Chelan County respond to numerous wildland fires each year, but few of those fires grow to a significant size. According to national statistics, only 2% of all wildland fires escape initial attack. However, that 2% accounts for the majority of fire suppression expenditures and threatens lives, properties, and natural resources. These large fires are characterized by a size and complexity that require special management organizations drawing suppression resources from across the nation. These fires create unique challenges to local communities by their quick development and the scale of their footprint.

15.2.4 Location

Wildfires, particularly in the urban interface, are one of Chelan County's greatest natural hazards. Chelan County's dry summer climate, topography, large forested area, and open grasslands, combined with heavy recreational use makes the entire county susceptible to wildfire. The county contains several urban interface communities that are considered to be at high risk to wildfire as designated by the State Forester, including the cities of Cashmere, Entiat, Leavenworth, and Wenatchee and the rural communities of Stehekin, Peshastin, and Manson.

According to the Washington State Emergency Management Division, areas of significant fire hazards are mapped based on fire behavior potential, fire protection capability, and risk to social, cultural and community resources. Risk is determined based on area fire history, type and density of vegetative fuels, extreme weather conditions, topography, number and density of structures and their distance from fuels, location of municipal watershed, and likely loss of housing or business (Washington Emergency Management Division, 2014).

The recently completed Community Wildfire Protection Plan (CWPP) for Chelan County includes two (2) layers of mapping to support the wildfire hazard assessment of the plan. These layers are the Landscape Level Wildfire Hazard and the Local level Wildfire Hazard, described as follows:

Both of these layers have been used in this hazard assessment to identify the extent and location of the wildfire hazard within the planning area. Figure 15-4 shows the landscape-level wildfire hazard area and Figure 15-5s hows the local-level wildfire hazard area in the Chelan County planning area.

Landscape-Level Wildfire Hazard

This scale represents the likelihood (probability) of a fire occurring and intensity of the fire at the landscape level based on the inherent landscape characteristics including broad existing vegetation, biophysical settings, fire regimes and fire histories. The polygon boundaries are based on the U.S. Geological Survey Hydrological Unit Code (HUC) 12 (subwatershed) boundaries. The subwatersheds range in size from 13 to 75 mi2, with an average of 36 mi2. The landscape level hazard assessment is delineated into the following rankings:

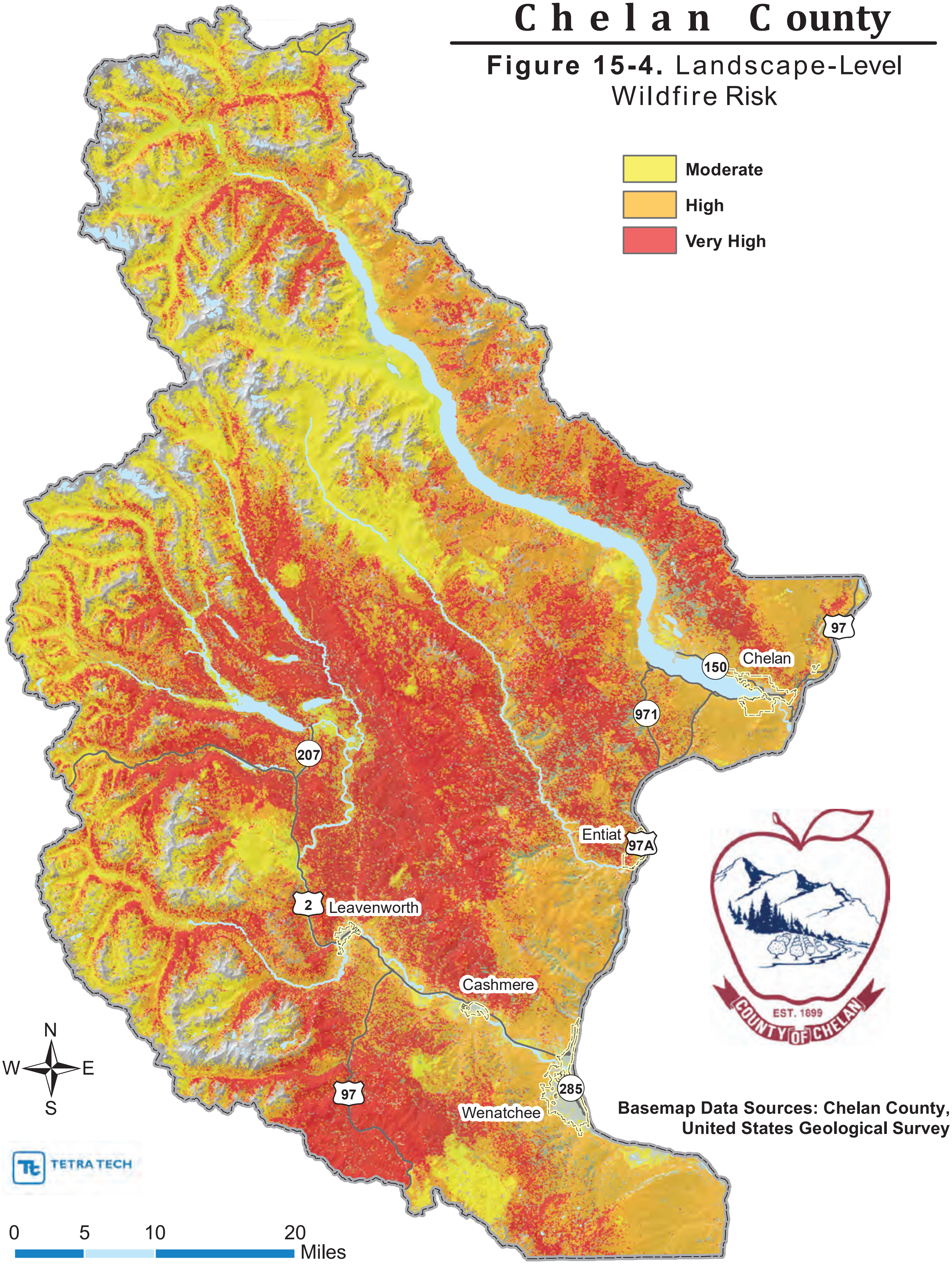
- Moderate
- High
- Very High

The factors influencing these rankings can be used to determine the potential landscape level exposure that a development will be subject to. The ranking at this scale is difficult to change at the local/parcel level. Mitigation affecting change at this scale is typically done by large scale disturbances such as insect mortality, fires or landscape level mitigation. Many of the very high ranked polygons are present on federal lands and would require mitigation by federal land management agencies.

This informs land use planners on the general areas where fires are most likely to occur, and collaborative, multi-agency large-scale fire management planning and mitigation is necessary.

Chelan County

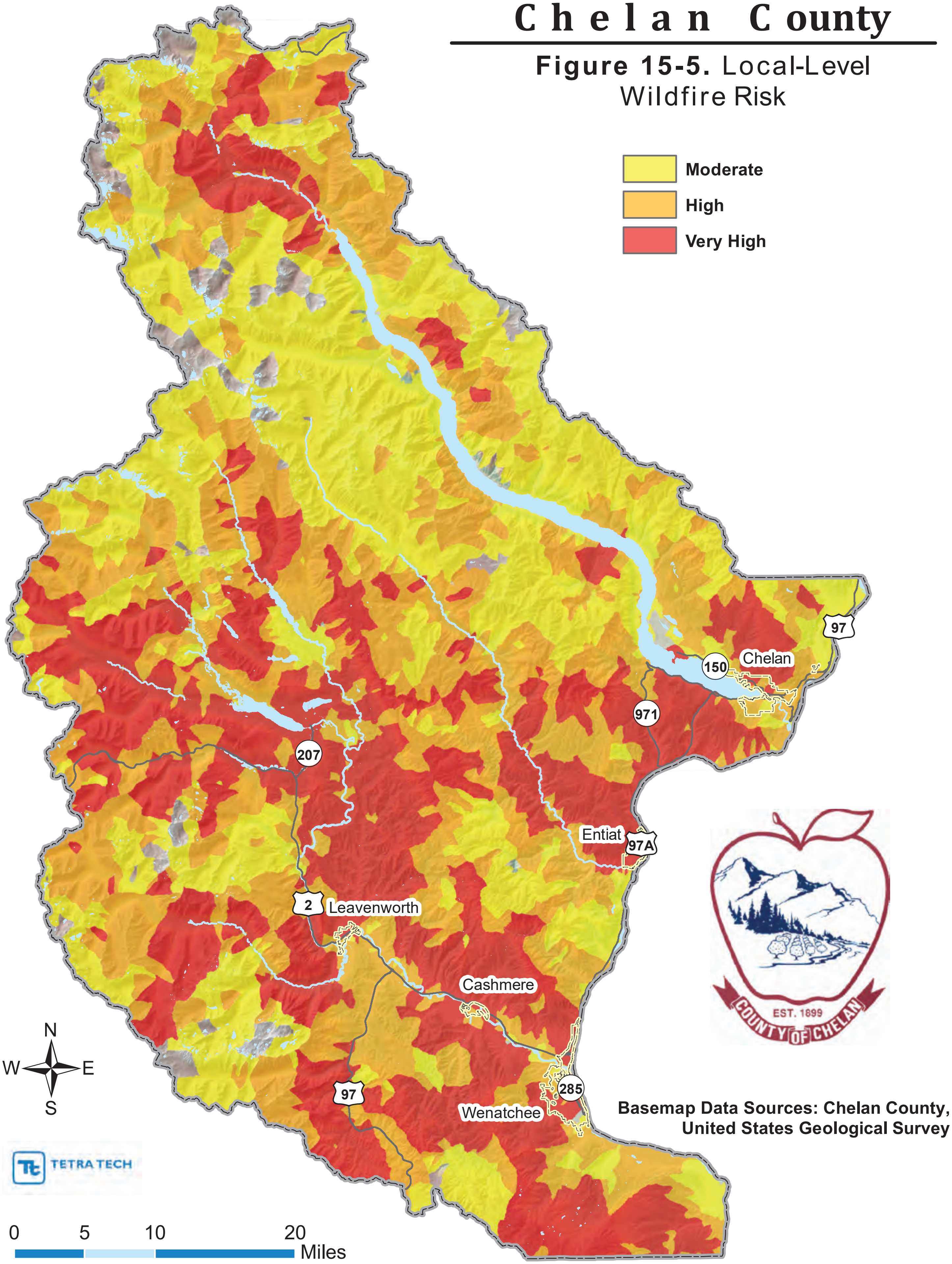
Figure 15-4. Landscape-Level Wildfire Risk



Basemap Data Sources: Chelan County, United States Geological Survey

Chelan County

Figure 15-5. Local-Level Wildfire Risk



Basemap Data Sources: Chelan County, United States Geological Survey

Local-Level Wildfire Hazard

This scale is based on an extreme event (worst fire days). The polygon boundaries are based on the catchment boundaries with the HUC 12 boundaries. This does not show the likelihood of a fire occurring but does shows where fires are likely to burn at high intensity. For example, a fire that starts in an area where the local hazard is high can spread fast and burn at high intensity creating significant wildfire exposure to any structures in the area. The same rankings used at the landscape scale are used at this local scale:

- Moderate
- High
- Very High

As part of the wildfire hazard analysis the potential ember transport was assessed using a number of approaches and all outcomes indicated that the entire county is susceptible to ember impingement.

This informs land use planners on the relative worst-case (hottest, driest, windiest days during a fire season) wildfire exposure (radiant, convective and ember) that can be expected in any given polygon where development exists or is planned for.

15.2.5 Frequency

Seasonality

The probability of a wildfire starting at a particular location depends on fuel conditions and topography, time of year, weather conditions and the level of human activities occurring that day. For most years, wildfire season in the State of Washington runs from mid-May through October. In Eastern Washington, any prolonged period of low precipitation presents a potentially dangerous problem. The thunderstorm season of late July and early August brings dry lightning. During this period each year, hundreds of ground strikes by lightning are recorded. Wildfires in the summer are difficult to suppress. However, wildfires have occurred in almost every month of the year. Drought, snow pack, and local weather conditions can expand the length of the fire season. The early and late shoulders of the fire season usually are associated with human-caused fires, with the peak period of July, August and early September related to thunderstorms and lightning strikes.

Historical Fire Regime

Historical variability in fire regime is a conservative indicator of ecosystem sustainability, and thus, understanding the natural role of fire in ecosystems is necessary for proper fire management. Fire is one of the dominant processes in terrestrial systems that constrain vegetation patterns, habitats, and ultimately, species composition. Land managers need to understand historical fire regimes, the fire return interval (frequency) and fire severity prior to settlement by Euro-Americans, to be able to define ecologically appropriate goals and objectives for an area. Moreover, managers need spatially explicit knowledge of how historical fire regimes vary across the landscape.

“Natural” fires in Chelan County would have been disproportionately caused by Native Americans. Aboriginal peoples intentionally set fires throughout the region for the purposes of controlling tree and shrub expansion and for the cultivation of select plants. When we describe “natural” in the Range of Natural Variability we are including indigenous peoples as natural disturbance agents and contributors to perceptions of what is “natural”.

A primary goal in ecological restoration is often to return an ecosystem to a previously existing condition that no longer is present at the site, under the assumption that the site’s current condition is somehow degraded or less desirable than the previous condition and needs improvement

Land managers in Chelan County must determine if the past, Native American influenced condition of the County was necessarily healthier, had a higher level of integrity, and was more sustainable than the current condition. In other words, is "restoration" an appropriate course of action? After a prolonged absence, if fire is reintroduced to these ecosystems the result could be damaging. Fuel loads throughout most of the County today are quite high and most of the County is inhabited by people, homes, and infrastructure. The ecosystem was adapted to fire in the past, but is no longer adapted today, especially considering the human component.

In the absence of intensive Native American burning, a condition has developed where fire could/should not be reintroduced without some significant alteration of the current ecosystem structure. This would also require a significant assessment of social acceptance and financial contribution.

Many ecological assessments are enhanced by the characterization of the historical range of variability which helps managers understand:

- How the driving ecosystem processes vary from site to site
- How these processes affected ecosystems in the past;
- How these processes might affect the ecosystems of today and the future.

Historical fire regimes are a critical component for characterizing the historical range of variability in fire-adapted ecosystems. Furthermore, understanding ecosystem departures provides the necessary context for managing sustainable ecosystems. Land managers need to understand how ecosystem processes and functions have changed prior to developing strategies to maintain or restore sustainable systems. In addition, the concept of departure is a key factor for assessing risks to ecosystem components. For example, the departure from historical fire regimes may serve as a useful proxy for the potential of severe fire effects from an ecological perspective.

Table 15-4 summarizes historical fire regimes in Chelan County. This model uses only the current vegetation types to determine the historic fire regime. Native Americans reportedly burned throughout the county on a regular basis. The vegetation types were much different pre-Euro-American settlement than they are today and believed to be a more grassland dominated landscape. A map depicting the historic fire regime is provided in Figure 15-6.

Table 15-4. Historical Fire Regimes in Chelan County

Historic Fire Regime	Description	Percent of Total
Fire Regime Group I	<= 35 Year Fire Return Interval, Low and Mixed Severity	28%
Fire Regime Group II	<= 35 Year Fire Return Interval, Replacement Severity	<2%
Fire Regime Group III	35 – 200 Year Fire Return Interval, Low and Mixed Severity	27%
Fire Regime Group IV	35 – 200 Year Fire Return Interval, Replacement Severity	9%
Fire Regime Group V	> 200 Year Fire Return Interval, Any Severity	26%
Water	Water	3%
Barren	Barren	5%
Sparsely Vegetated	Sparsely Vegetated	<1%
Total		100%

Fire Regime Condition Class

A natural fire regime is a general classification of the role fire would play across a landscape in the absence of modern human mechanical intervention but including the influence of aboriginal burning. Coarse scale definitions for historic fire regimes have been developed by Hardy et al and Schmidt et al and interpreted for fire and fuels management by Hann and Bunnell.

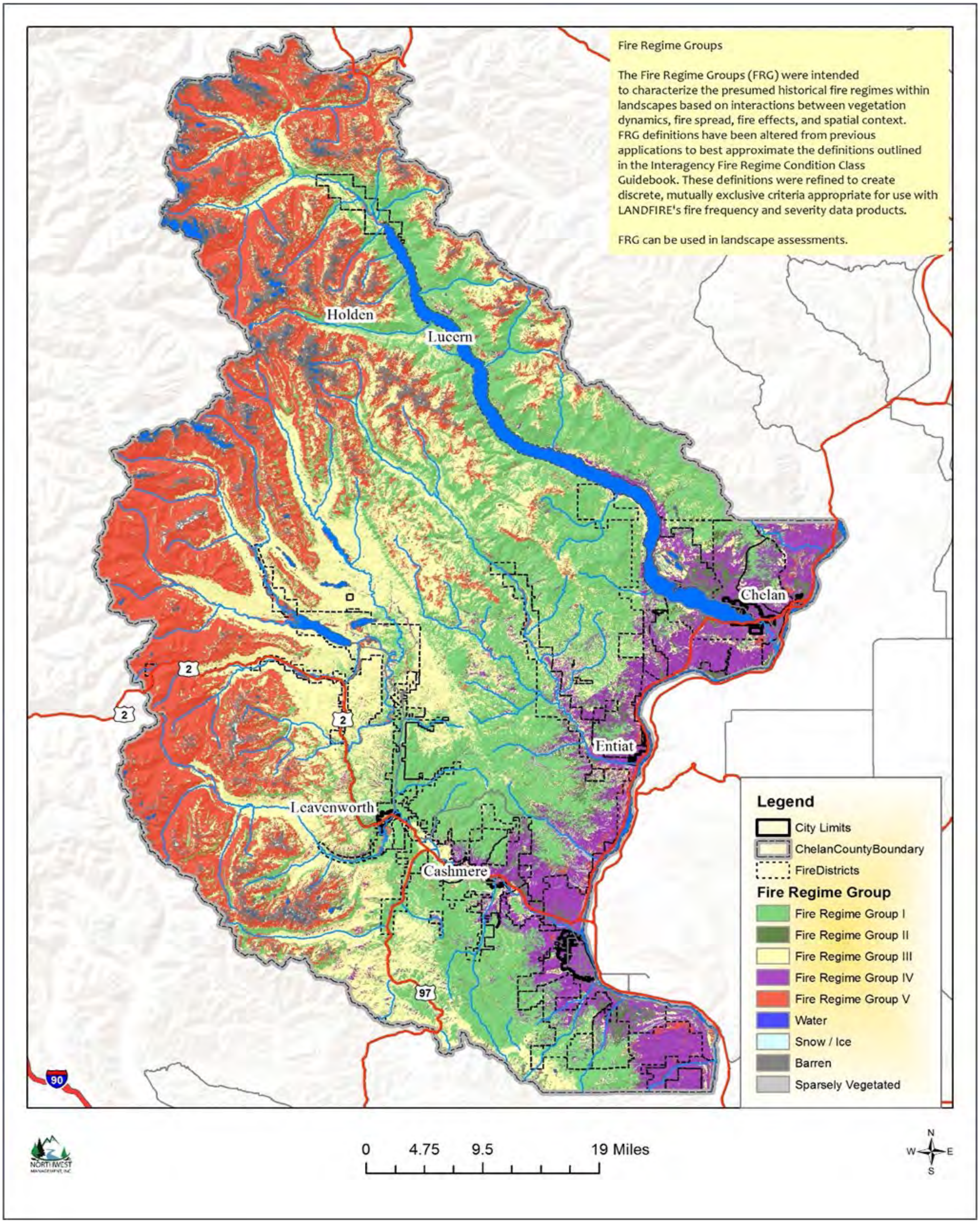


Figure 15-6. Historical Fire Regime for Chelan County

A fire regime condition class (FRCC) is a classification of the amount of departure from the historical regime. The three classes are based on low (FRCC 1), moderate (FRCC 2), and high (FRCC 3) departure from the central tendency of the historical regime. The central tendency is a composite estimate of vegetation characteristics (species composition, structural stages, stand age, canopy closure, and mosaic pattern); fuel composition; fire frequency, severity, and pattern; and other associated natural disturbances. Low departure is considered to be within the natural (historical) range of variability, while moderate and high departures are outside.

An analysis of Fire Regime Condition Classes in Chelan County shows that a slight majority of the land in the county is considered moderately departed (37%) from its historic fire regime and associated vegetation and fuel characteristics (see Table 15-5). Less than one third of the vegetation has a low departure and 23% is considered highly departed.

Table 15-5. Fire Regime Condition Class in Chelan County

Fire Regime Condition Class	Description	Percent of Total
Condition Class I	Low Vegetation Departure	27%
Condition Class II	Moderate Vegetation Departure	37%
Condition Class III	High Vegetation Departure	23%
Agriculture	Agriculture	<2%
Water	Water	3%
Urban	Urban	3%
Barren & Sparsely Vegetated	Barren & Sparsely Vegetated	5%
Total		**100%**

The current Fire Regime Condition Class model shows that there is an even distribution of the Fire Regime Groups throughout the County. The highly departed condition classes occur around the higher concentrations of human development and along the ridges in the more remote western portion of the County. Much of the county is dominated by various pine species with a grass/shrub understory. The current structure and density of the forestlands in many areas makes it susceptible to health issues from competition, insects, and disease. The current fire severity model suggests that a higher severity fire than historical norms would be expected in these areas. A map depicting Fire Regime Condition Class is provided in Figure 15-7.

15.2.6 Severity

Significant effects of wildfire include loss of lives, personal injury, damage to private and public property and economic impact. Fires in the past—especially the 1994 fires—caused economic impact on local business. This impacts not only business, but also government due to loss of tax revenue.

Wildfires also cause negative impacts on watersheds which, among other things, increases the soil erosion and stream degradation that contributes to potential flooding in the County. Short-term loss caused by a wildfire can include the destruction of timber, wildlife habitat, scenic vistas, and watersheds; vulnerability to flooding increases due to the destruction of watersheds. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, and destruction of cultural and economic resources and community infrastructure.

15.2.7 Warning Time

Wildfires are often caused by humans, intentionally or accidentally. There is no way to predict when a human-caused wildfire 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.

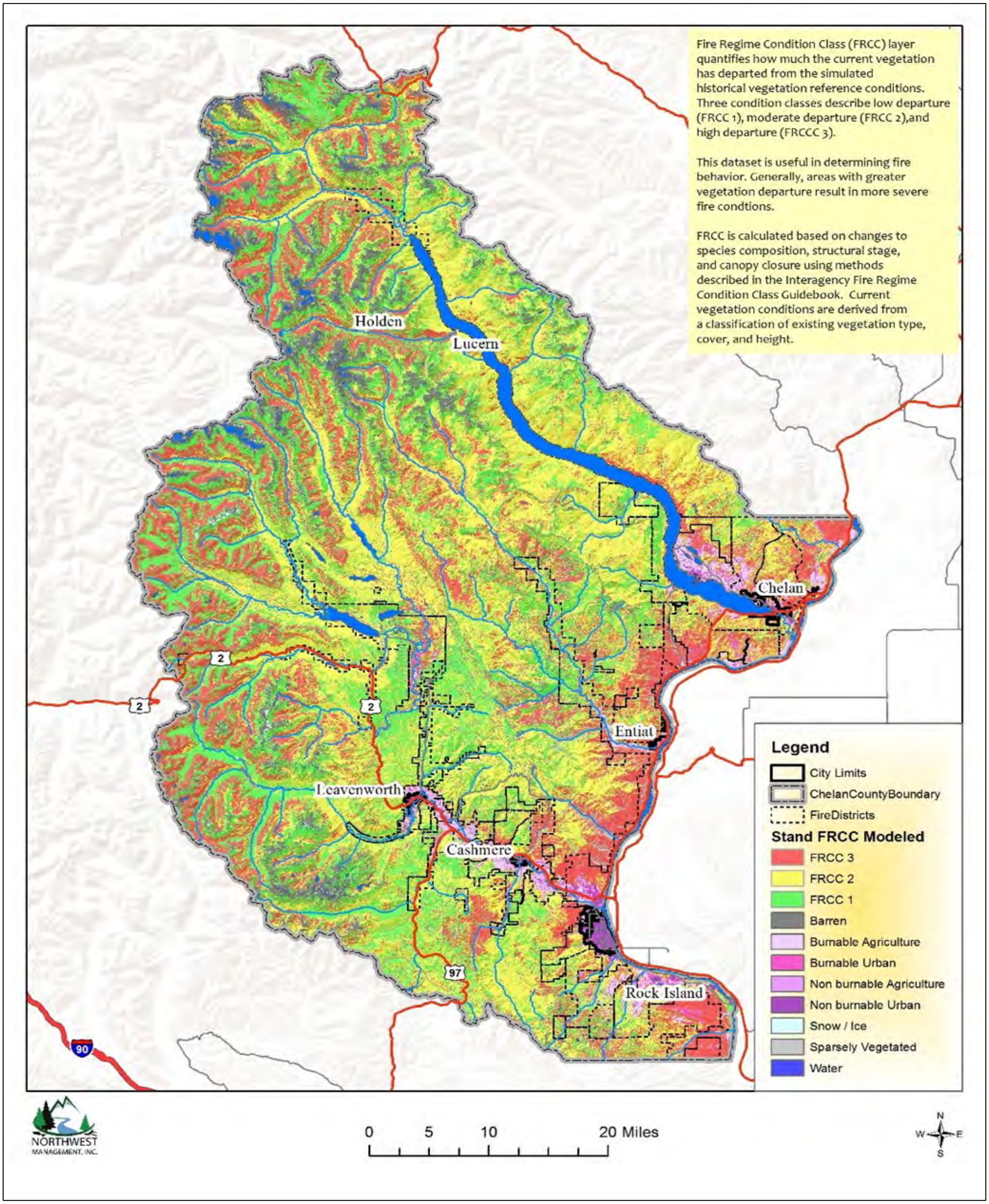


Figure 15-7. Fire Regime Condition Class

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.

The Washington Department of Natural Resources maintains an online Burn Risk Map. Residents can view current information about the wildfire danger in Washington, as well as any information on outdoor burning restrictions. This site provides information on when conditions are right for destructive wildfires (Washington Department of Natural Resources, 2016).

15.3 SECONDARY HAZARDS

Wildfires can generate a range of secondary effects, some of which 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. Landslides can be a significant secondary hazard of wildfires. Wildfires strip slopes of vegetation, exposing them to greater amounts of rain and run-off. 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.

15.4 EXPOSURE

A quantitative assessment of exposure to the wildfire hazard was conducted using the fire risk zone mapping shown in Figure 15-4 and Figure 15-5 and the asset inventory developed for this plan. Detailed results are provided in Appendix D and summarized below.

15.4.1 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 landscape-level wildfire risk areas is 34.3 percent of the planning area population (26,715 people), and 95.7 percent of the planning area population (74,520 people) live in the local-level wildfire risk area. The population exposure estimates by risk area are shown in Table 15-6. 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 15-6. Chelan County Population Exposure to the Wildfire Hazard

	Population Exposed	% of Total Population
Landscape Level Fire Hazard		
Moderate	6,450	8.3
High	16,617	21.4
Very High	3,648	4.7
Total	26,715	34.3
Local Level Fire Hazard	Population Exposed	% of Total Population
Moderate	8,292	10.7
High	26,893	34.6
Very High	39,335	50.6
Total	74,520	95.7

15.4.2 Property

Figure 15-8 shows the percentage and count, by land use type, of planning area structures in the Landscape Level wildfire hazard severity zones. Figure 15-8 shows the percentage and count, by land use type, of planning area structures in the Local Level wildfire hazard severity zones.

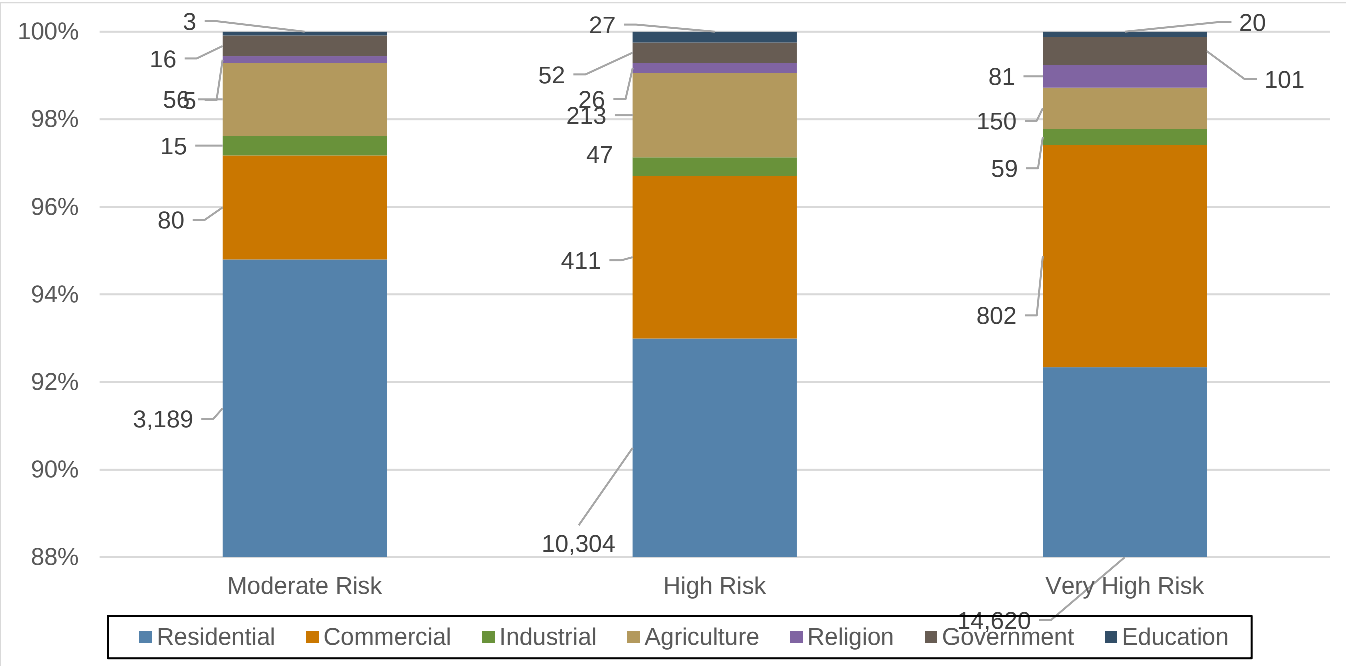


Figure 15-8. Structures in the Landscape Level Wildfire Hazard Severity Zones, by Land Use Type

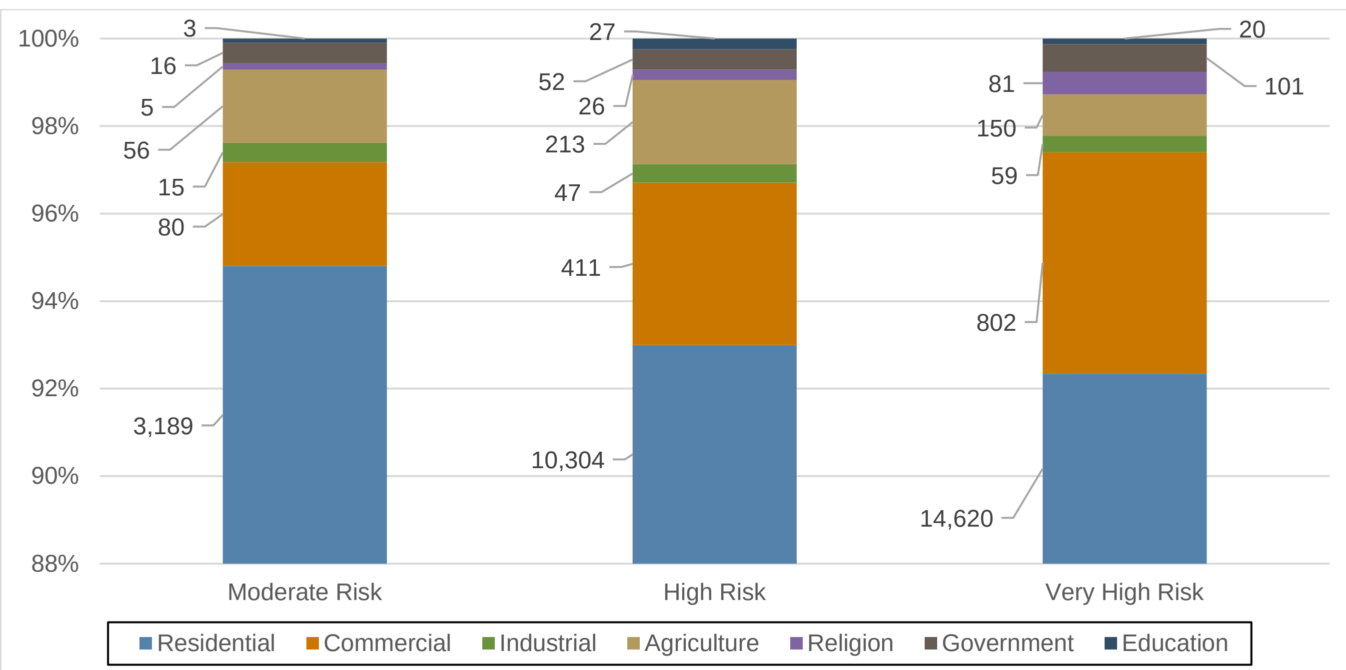


Figure 15-8. Structures in Local Level Wildfire Hazard Severity Zones, by Land Use Type

The total replacement value of property in the landscape-level wildfire hazard area is more than $3.619 billion, or 25 percent of the planning area total:

- Moderate: $911,294,637 (6.3% of planning total AV)
- High: $2,281,851,907 (15.8% of planning area AV)
- Very High: $426,594,239 (3.0% of planning area AV)

The total replacement value of property in the local-level wildfire hazard area is more than $14.025 billion, or 97 percent of the planning area total:

- Moderate: $7,368,652,907 (51.0% of planning total AV)
- High: $4,566,930,028 (31.6% of planning area AV)
- Very High: $2,090,338,122 (14.5% of planning area AV)

15.4.3 Critical Facilities and Infrastructure

Critical facilities and infrastructure exposed to the wildfire hazard represent 43 percent of the total critical infrastructure and facilities in the planning area. The breakdown of exposure by the landscape-level wildfire hazard area and facility type is shown in Figure 15-9 and those in the local-level wildfire hazard area is shown in Figure 15-10. The breakdown of exposure by the Local Level Wildfire Hazard severity zone and facility type is shown in Figure 15-9. Almost a third of critical facilities in the planning area are in very high severity zones. Linear, above-ground infrastructure, such as power lines, is also exposed to damage from wildfire.

15.4.4 Environment

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

15.5 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.

15.5.1 Population

All people exposed to the wildfire hazard are potentially vulnerable to wildfire impacts. 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.

15.5.2 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.

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 15-7. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure.

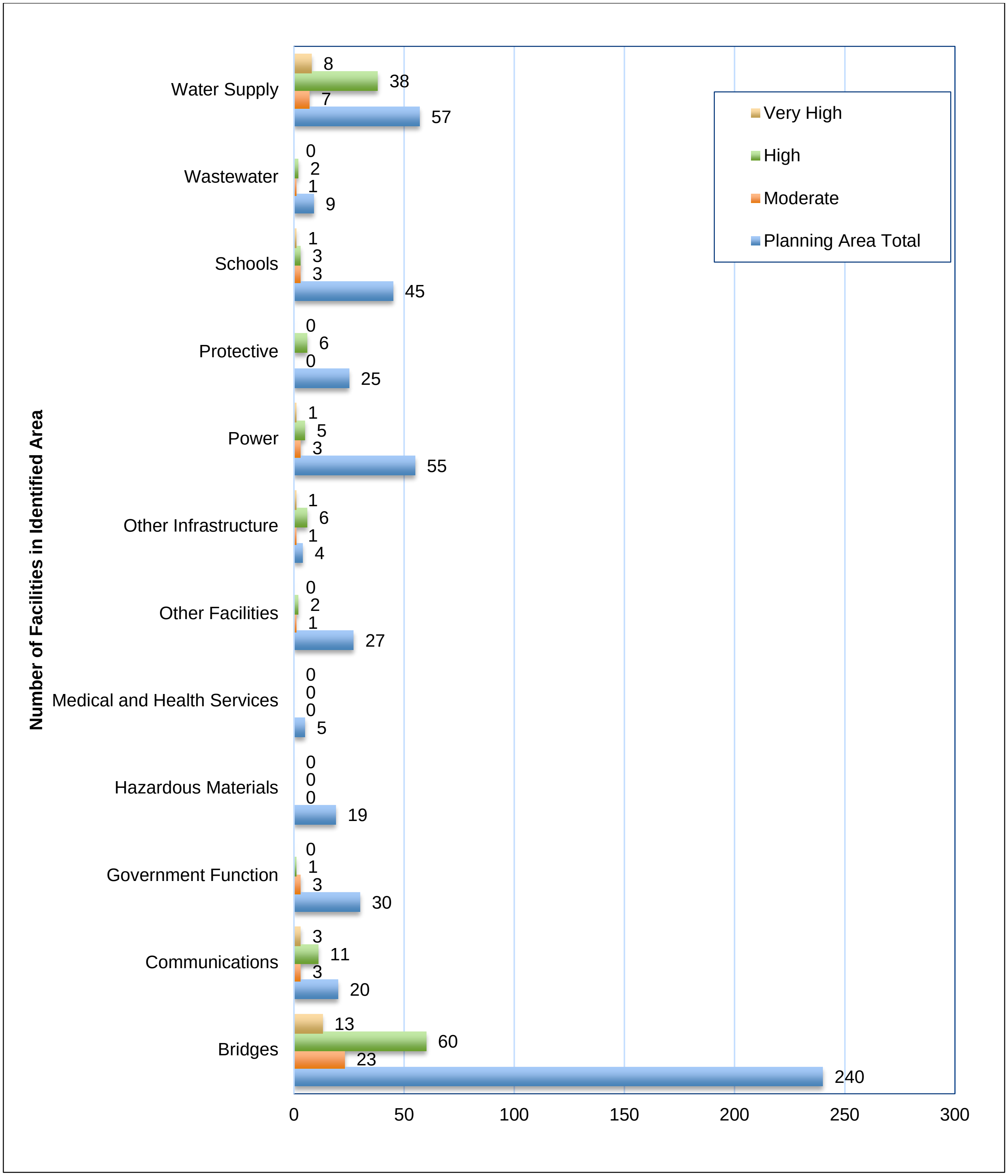


Figure 15-9. Critical Facilities and Infrastructure in Landscape-Level Wildfire Hazard Severity Zones and Countywide

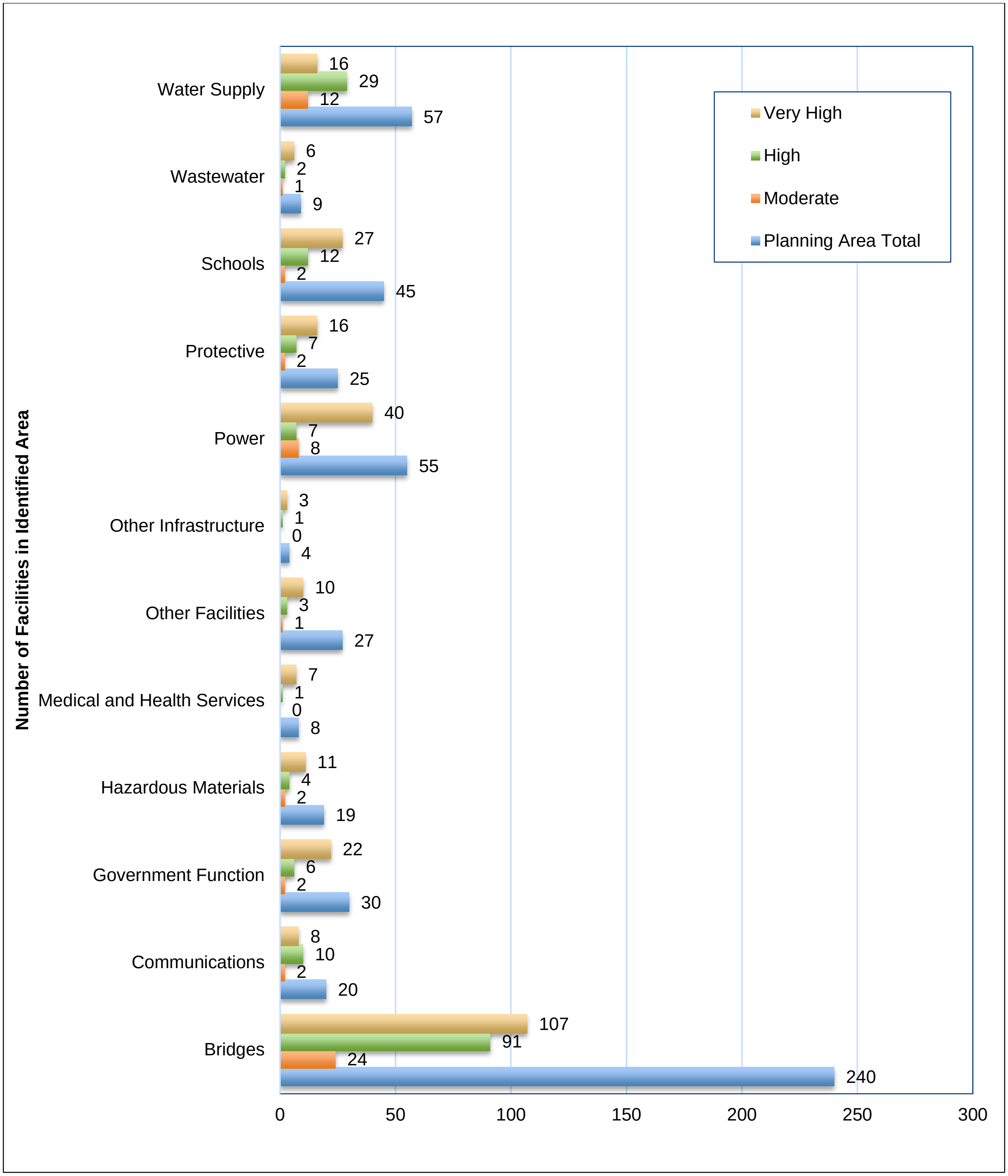


Figure 15-10. Critical Facilities and Infrastructure in the Local-Level Wildfire Hazard Severity Zones and Countywide

Table 15-7. Loss Estimates for Fire Hazard Zones

		Damage = 10% of Exposed Value		Damage = 30% of Exposed Value		Damage = 50% of Exposed Value	
	Exposed Value	Loss	% of Total Replacement Value	Loss	% of Total Replacement Value	Loss	% of Total Replacement Value
Landscape Level							
Moderate	$911,294,637	$91,129,464	0.63	$273,388,391	1.89	$455,647,319	3.15
High	$2,281,851,907	$228,185,191	1.58	$684,555,572	4.74	$1,140,925,954	7.9
Very High	$426,594,239	$42,659,424	0.30	$127,978,272	0.89	$213,297,119	1.48
Total	$3,619,740,783	$361,974,079	2.5	$1,085,922,235	7.51	$1,809,870,392	12.53
Local Level							
Moderate	$2,090,338,122	$209,033,812	1.45	$627,101,437	4.34	$1,045,169,061	7.24
High	$4,566,930,028	$456,693,003	3.16	$1,370,079,008	9.48	$2,283,465,014	15.81
Very High	$7,368,652,907	$736,865,291	5.1	$2,210,595,872	15.3	$3,684,326,453	25.51
Total	$14,025,921,057	$1,402,592,106	9.7	$4,207,776,317	29.1	$7,012,960,528	48.5

15.5.3 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 road and railroads would be without damage 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:

- **Utility Infrastructure**— While most if not all this type of infrastructure could be considered vulnerable to wildfires, they can often be the source of an event, caused by downed power lines or arcing transformers. Thirty-five (35) units of utility infrastructure as defined for this plan within the very high or high fire severity zones within the planning area.
- **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. Eight (8) facilities with hazardous materials were identified in the very high or high fire severity zones within the planning area.
- **Communication Facilities**—If these facilities are damaged and become inoperable, it would exacerbate already difficult communication in the planning area.
- **Fire Stations**—There are twelve (12) fire stations as well as facilities that support firefighting efforts located in these risk areas.

15.5.4 Environment

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

- **Damaged Fisheries**—Critical fisheries can suffer from increased water temperatures, sedimentation, and changes in water quality.
- **Soil Erosion**—The protective covering provided by foliage and dead organic matter is removed, leaving the soil fully exposed to wind and water erosion. Accelerated soil erosion occurs, causing landslides and threatening aquatic habitats.

- **Spread of Invasive Plant Species**—Non-native woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes, and become difficult and costly to control.
- **Disease and Insect Infestations**—Unless diseased or insect-infested trees are swiftly removed, infestations and disease can spread to healthy forests and private lands. Timely active management actions are needed to remove diseased or infested trees.
- **Destroyed Endangered Species Habitat**—Fire can have negative consequences for endangered species.
- **Soil Sterilization**—Some fires 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.
- **Damaged Cultural Resources**—Scenic vistas can be damaged, access to recreational areas can be reduced and destruction of cultural resources may occur.

The sections below provide further detail on environmental elements that can experience harmful impacts from wildfire.

Natural Resources

Natural resources are highly valued by residents of Chelan County for their contribution to the local quality of life, and as an economic development asset that attracts tourist-related expenditures. Fire can destroy natural assets that are highly valued by the community.

Many ecosystems are adapted to historical patterns of fire. These patterns, called "fire regimes," include temporal attributes (e.g., frequency and seasonality), spatial attributes (e.g., size and spatial complexity), and magnitude attributes (e.g., intensity and severity), each of which have ranges of natural variability. Ecosystem stability is threatened when any of the attributes for a given fire regime diverge from its range of natural variability.

Air Quality

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).

Agricultural and Timber Resources

Agricultural resources include rangelands, timberlands, cultivated farmlands and dairy lands. Agricultural lands are an important element of the Chelan County identity and economy. Although fire has been used as a tool in rangeland and timber management, wildfire can have disastrous consequences on such resources, removing them from production and necessitating lengthy restoration programs.

15.6 FUTURE TRENDS IN DEVELOPMENT

As Chelan County grows and citizens continue to build in the wildland urban interface, wildfire potential grows and the probability of fire starts increases. Combined with a lack of public understanding and the lack of preventive measures on the part of the public, the potential for devastating losses continues to increase. The expansion of the wildland urban interface can be managed with strong land use and building codes. The planning area is well equipped with these tools and this planning process has asked each planning partner to assess its capabilities with regards to the tools. The recent completion of the County's Community Wildfire Protection Plan

(CWPP) will be a critical tool available to the County and its planning partners in managing future growth in the interface and intermix areas of the County. The integration of the CWPP with this plan will strengthen the capabilities of both documents.

15.7 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 lighting storm could trigger a multitude of small isolated fires.

The embers from these smaller fires could be carried miles by hot, dry winds. The deposition zone for these embers would be deep in the forests and interface zones. Fires that start in flat areas move slower, but wind still pushes them. It is not unusual for a wildfire pushed by wind to burn the ground fuel and later climb into the crown and reverse its track. This is one of many ways that fires can escape containment, typically during periods when response capabilities are overwhelmed. These new small fires would most likely merge. Suppression resources would be redirected from protecting the natural resources to saving more remote subdivisions.

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

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.

15.8 ISSUES

The major issues for wildfire are the following:

- Human activities have been the cause of 63 percent of wildfires in the planning area.
- More than 50 percent of the planning area population lives in the Very High, Local Level wildfire risk areas.
- An estimated 93 percent of the critical facilities in the planning area are located in Local Level wildfire risk areas and an estimated 14 percent of these facilities are located in the Landscape level 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.
- Several vulnerable and isolated populations are in areas of high and very high risk for wildfire.
- Since people start the vast majority of wildfires, wildfire prevention education and enforcement programs can significantly reduce the total number of wild land fires. 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.

- Residents should know the proper way to handle fire. Public education programs on fire safety, fire alarms and fire response are important. People should be encouraged to purchase fire insurance if not included in standard homeowner or renter policies and understand building codes.
- An effective early fire detection program and an emergency communications system are essential. The importance of immediately reporting any wildfire must be impressed upon local residents and persons using forest areas.
- An effective warning system is essential to notify local inhabitants and persons in the area of the fire. An evacuation plan detailing primary and alternate escape routes is also important.
- Fire-safe development planning should be done with local government planners to reduce the risk to local residents and businesses. Safety recommendations to implement could include the following:

  - Sufficient fuel-free areas around structures
  - Fire-resistant roofing materials
  - Adequate two-way (ingress and egress) routes and turnarounds for emergency response units
  - Adequate water supplies with backup power generation equipment or other means to cost-effectively support firefighting efforts
  - Development of local ordinances to control human-caused fires (from debris burning, fireworks, campfires, etc.)

- Road criteria to ensure adequate escape routes for new sections of development in forest areas.
- Road closures to be increased during peak fire periods to reduce the access to fire-prone areas.
- Steps by the public to better protect lives, property, and the environment from wildfires:

  - Maintaining defensible space around homes
  - Providing adequate access routes (two-way with turnaround) to homes for emergency equipment
  - Minimizing “fuel hazards” adjacent to homes
  - Using fire-resistant roofing materials
  - Maintaining adequate water supplies
  - Ensuring home addresses are visible to first responders.

- Some forest fires should be allowed to burn in limited areas as part of forest management.
- During peak wildfire season, if resources from Chelan County are deployed to other areas of the State, the availability of firefighting resources could play a role in the severity of wildfire and the size of area effected.

16. CLIMATE CHANGE

16.1 GENERAL BACKGROUND

16.1.1 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 16-1).

Source: EPA, 2016

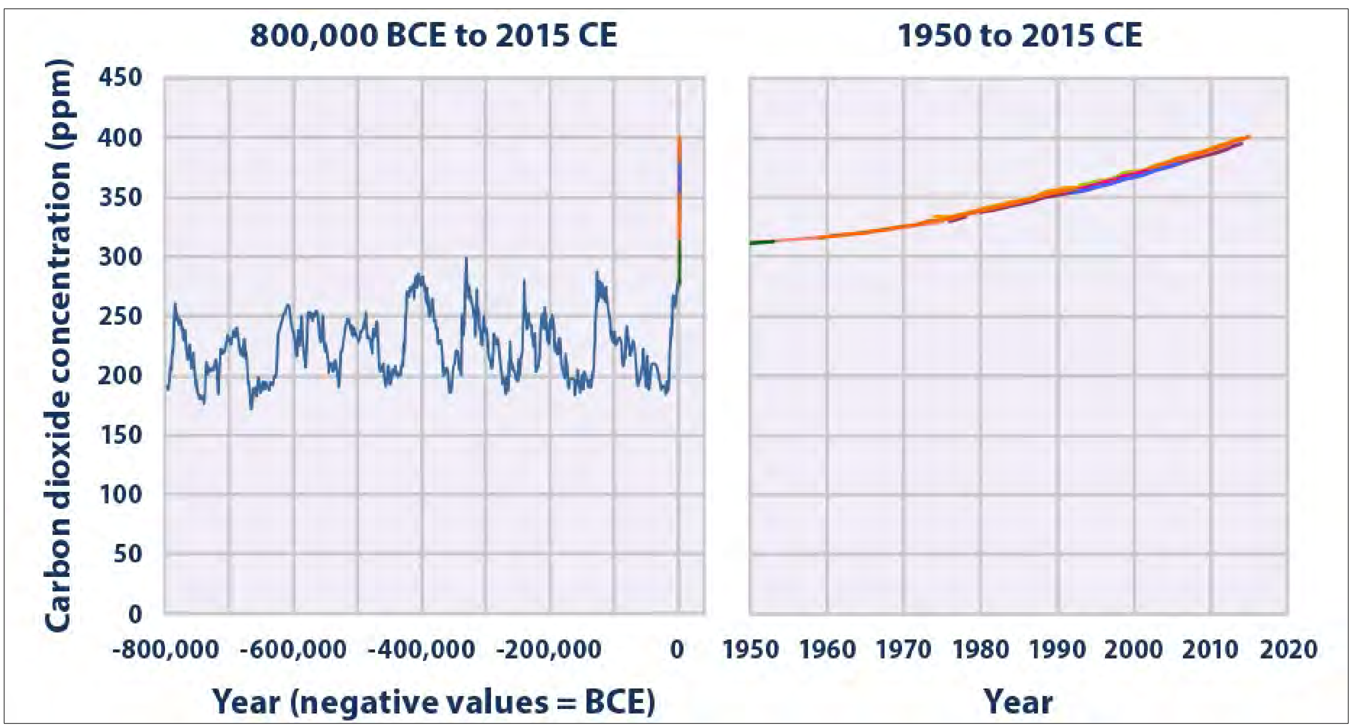


Figure 16-1. Global Carbon Dioxide Concentrations Over Time

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.

16.1.2 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.

16.1.3 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.

16.1.4 Projected Future 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.

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 16-1.

Table 16-1. 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
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

16.1.5 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.

16.2 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.

16.2.1 Avalanche

Climate Change Impacts on the Hazard

Avalanches are caused by a combination of geological factors (like the incline of a mountain or natural events like earthquakes), weather and the structure of the snow. Warmer weather can weaken a mountain's snow pack and make it more difficult for the layers of snow to stick together. Mix in another element, like particularly gusty wind or trembling earth, and you've got a mountain primed for avalanche. It has been shown that changing atmospheric conditions influence the formation and evolution of the seasonal mountain snow cover and therefore determine the avalanche hazard. The Intergovernmental Panel on Climate Change warned that warming temperatures have destabilized mountain climates, leading to more avalanches, melting glaciers and more intense storms.

Exposure, Sensitivity and Vulnerability

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

- **Population**—Population exposure and vulnerability to the avalanche hazard are unlikely to change as a result of climate change.
- **Property**—Property exposure and vulnerability to the avalanche 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.
- **Environment**—The exposure and vulnerability of the environment to avalanche could lead to more significant changes to the landscape as the frequency of events increase, namely the destruction of trees and forests that lie in the paths of these avalanches.
- **Economy**—Changes in the avalanche 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.

16.2.2 Dam or Levee Failure

Climate Change Impacts on the Hazard

On average, changes in 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.

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.

16.2.3 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.

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.

16.2.4 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.

16.2.5 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.

16.2.6 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.

16.2.7 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.

16.2.8 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**—It is unlikely that the population exposed to the wildfire risk would increase directly; however, more people may be impacted by wildfire events on average as more acreage burns each year. In addition, increased burning would result in more smoke impacts, potentially increasing the risk from poor air quality in the planning area.
- **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.

16.3 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 and thunderstorms.
- Heavy rain events may result in inland stormwater flooding after stormwater management systems are overwhelmed.

17. SUMMARY OF RISKS TO AGRICULTURE

Agriculture, Forestry and fishing is the largest employment sector for Chelan County, accounting for 24.1% of the employment within the County. According to the Chelan County Comprehensive Plan, *Agriculture plays a significant role in the economic base of the County. Diversity of the agricultural economy strengthens the County's economic base*. Many of Chelan County's nonfarm industries such as food manufacturing/processing, warehousing and shipping, transportation (trucking) etc. are heavily dependent on the fortunes of agriculture and define much of the local industry makeup. This chapter attempts to acknowledge the importance of agriculture to the planning area by looking at each of the hazards assessed by this plan and their potential impact on agriculture. Additionally, a brief profile on Fire Blight, a disease that can inflict fruit trees, has been provided due to its potential impacts on fruit production in the County.

17.1 FIRE BLIGHT

Fire blight is an important disease effecting pear and apple. Infections commonly occur during bloom or on late blooms during the three weeks following petal fall. Fire blight is caused by *Erwinia amylovora*, a gram-negative, rod-shaped bacterium. The bacteria grow by splitting its cells and this rate of division is regulated by temperature. Cell division is minimal below 50°F, and relatively slow at air temperatures between 50°F to 70°F. At air temperatures above 70°F, the rate of cell division increases rapidly and is fastest at 80°F. Above 95°F cell density on and in the plant can actually decline (Pusey and Curry 2004). The plant disease is oftentimes influenced by seasonal weather and generally attacks the plant's blossoms, gradually moving to the twigs, and then the branches. Fire blight gets its name from the burnt appearance of affected blossoms and twigs.

Once established in the tree, fire blight quickly invades through the current season's growth into older growth. Fire blight can be spread from diseased to healthy plants by rain, wind, and pruning tools. The bacterium can survive the winter in sunken cankers on infected branches. In spring, the bacteria ooze out of the cankers and attract bees and other insects. Insects also help spread the disease to healthy plants. The bacteria spread rapidly through the plant tissue in warm temperatures (65 degrees F or higher) and humid weather.

Fire blight can be spread from diseased to healthy plants by rain, wind, and pruning tools. The bacterium can survive the winter in sunken cankers on infected branches. In spring, the bacteria ooze out of the cankers and attract bees and other insects. Insects also help spread the disease to healthy plants.

17.2 AVALANCHE

The land zoned within the planning area for agricultural uses does not interface with areas know to be susceptible to avalanches with the planning area. Therefore, it is not likely that future avalanches would significantly impact the agriculture industry, other than indirectly by obstructing transportation corridors for a short-term following event. Direct impacts are assumed to be none.

17.3 DAM AND LEVEE FAILURE

As shown in Table 9-1, there are 25 State of Washington listed “High-Hazard” dams within the planning area. As noted in chapter 9, the true risk associated these dam’s is not currently known, as the mapping needed to assess that risk is not readily available. However, since the floodplains of these river systems that have these high hazard dams are often ideally suited to support agricultural production, it is a logical assumption that a dam failure on any of these 25 high hazard facilities would have a negative impact on agriculture in the inundation area. However, understanding that probability of occurrence is a function of risk as defined in chapter 18, the risk to agriculture from a dam failure would be considered to be low due to the low probability of occurrence for these type events. It is important to note that having a good understanding of the potential extent and location of a hazard in mission critical to understanding true risk. As noted in chapter 9, obtaining dam failure inundation mapping for all high hazard dam’s within the planning area should be a priority for the planning partnership.

17.4 DROUGHT

One of the reasons that Chelan County is ideally suited to support agriculture is water supply. The presence of Lake Chelan, the Columbia River and the aquifers that supply them, support the kind of agriculture production that has helped Chelan County to flourish. Any prolonged drought in the region could possibly impact these water supplies by diverting water to downstream needs taxed by the drought. Water rights would drive that discussion, but it is not likely that the length and duration of droughts typical for the region would divert the supply beyond the needs for the agricultural production within the planning area. However, population growth and the conversion of land use from rural to more urban uses could alter these impacts. But, for the performance period for this plan (5-years), drought impacts on agriculture would be considered low.

17.5 EARTHQUAKE

Earthquake impacts on agriculture would depend on the severity of the event, and proximity of the planning area to the source. The direct impacts are likely to be nominal, associated with damage to structures and facilities used for process and production of agriculture production. The indirect impacts associated with damages to transportation corridors and loss of power are likely to be far greater than the direct impacts. Disruption of transportation corridors would likely impact distribution of agricultural products and the loss of power would interrupt processing operations. Once again, probability of occurrence will play a role in the degree of risk to agriculture. Therefore, the overall risk to agriculture from earthquake is considered to be low.

17.6 FLOODING

Floodplains are often well suited for agricultural production because of the quality and fertility of the soil’s floodplains can provide. Agricultural uses of floodplains are promoted by FEMA programs such as the Community Rating System (CRS) because it limits the density of development exposed to the flood risk. With all of that said, flooding can adversely impact agricultural production by causing delays in and reduction of crop harvest. If soil is too wet it can result in poor conditions for the crops to grow; when soil is well drained then the oxygen, nutrients and trace elements that the plant needs are available.

Flooded soils create significant challenges for agricultural lands. The floods have many direct impacts, the most prominent being:

- Deposition of sand and debris on productive lands;
- Erosion of agricultural soils; and
- Flooded soil syndrome—loss of beneficial fungi which mobilize soil-based plant nutrients.

As a result of these effects after floods, farmers are challenged by yield losses and devastation of arable land. Subsequently, producers need to plan for the slow recovery of their arable soils.

17.7 LANDSLIDE

The steep slopes and soil types that are susceptible to landslides are not typically ideally suited for agricultural production. So, the direct impacts from landslides to agriculture is considered to be little or none. However, there are indirect impacts from landslides that could have some significant impacts on agricultural productions such as:

- In situations like Oso, WA where there is a significant amount of "runout" of the slide, agricultural production areas could be impacted by that runout.
- Key transportation corridors could be disrupted, thus impacts the distribution of agricultural products.
- Landslides could impact communication and power utilities, this indirectly impacting those services
- Landslides could impact water supplies by relocating river channels or diverting flows.

17.8 SEVERE WEATHER

Severe weather other than heat and cold can cause loss and devastation to a farm. Most farmers can't avoid the results of extreme weather no matter where their farm is located. Diverse extreme weather can affect farms in different ways. Because of this, it's important that farmers have crop insurance, which protects against severe weather.

Tornadoes are probably the scariest type of severe weather. The wind that comes with tornadoes can have damaging effects such as the dispersal of seeds, plus a lot of clean up from the serious damage to farms. Similar to tornados, wind storms can cause another type of critical damage that is not typically considered. Wind storms can tear crops out of the ground or pound them flat. The wind can dry out wet plants, move soil, and cause erosion, as well as disperse seeds.

Too much water can cause damage to a farm. Floods can postpone the planting of crops along with oxygen depletion after they are planted. Flooding enhances the possibility of disease and triggers nitrogen loss in crops. Different crops react differently to flooding but they all risk loss from too much water.

When you hear that a hail storm is coming, you usually try to protect your vehicles. Farmers have similar feelings about their crops. The damage done by a hailstorm depends on the size of the hail and regularity of the storm. Obviously, the larger the hail, the greater the damage. Hail can bruise fruits and vegetables or totally destroy a crop.

Some farms are helped while some are hurt by what's happening with the climate. It's a slow process to determine if a farm is helped or hurt. In the short term, it is hard to notice changes, but over 10 or 20 years the changes are more obvious.

17.9 WILDFIRE

The obvious impacts from wildfires on agriculture would be the destruction of crops by the fire. However, since most agricultural lands are irrigated and actively maintained to assure their production, these activities actually reduce the exposure to the key components that drive wildfire, namely fuels. Most of the agricultural lands within the planning area were identified as having moderate fire risk. Therefore, associated risk from wildfire to agriculture is considered to be moderate to low.

17.10 CLIMATE CHANGE

Agriculture is highly dependent on the climate. Increases in temperature and carbon dioxide (CO2) can increase some crop yields in some places. But to realize these benefits, nutrient levels, soil moisture, water availability, and other conditions must also be met. Changes in the frequency and severity of droughts and floods could pose challenges for farmers and ranchers and threaten food safety. Overall, climate change could make it more difficult to grow crops, raise animals, and catch fish in the same ways and same places as we have done in the past. The effects of climate change also need to be considered along with other evolving factors that affect agricultural production, such as changes in farming practices and technology.

18. 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 8 through 16. 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.

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.

18.1 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 18-1 summarizes the probability assessment for each natural hazard of concern for this plan.

18.2 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:

Table 18-1. Probability of Hazards

Hazard Event	Probability (high, medium, low)	Probability Factor
Avalanche	High	3
Dam or Levee Failure	Low	1
Drought	High	3
Earthquake[a]	Medium	2
Flooding[b]	High	3
Landslide	High	3
Severe Weather	High	3
Wildfire	High	3

a. Earthquake risk ranking is based on Cascadia M9.0 scenario.
b. Flood risk ranking is based on 1 percent-annual-chance flood zone (otherwise known as the special flood hazard area).

- **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 and flooding 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)

Each hazard category was assigned a weighting factor to reflect its significance. 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 18-2, Table 18-3 and Table 18-4 summarize the impacts for each hazard.

Table 18-2. Impact on People from Hazards

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (3)
Avalanche	Low	1	1x3=3
Dam or Levee Failure	Low	1	1x3=3
Drought[a]	None	0	0x3=0
Earthquake	High	3	3x3=9
Flooding[b]	High	3	3x3=9
Landslide[c]	Medium	2	2x3=6
Severe Weather	High	3	3x3=9
Wildfire[d]	High	3	3x3=9

a. Drought generally does not directly cause death or injury to people.
b. Based on population exposed to the 500-year floodplain
c. Landslide risk ranking impacts are based on very high and high landslide susceptibility zones.
d. Wildfire risk ranking impacts are based on very high and high fire severity zone

Table 18-3. Impact on Property from Hazards

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (2)
Avalanche	Low	1	1x2=2
Dam or Levee Failure	Low	1	1x2=2
Drought[a]	None	0	0x2=0
Earthquake	High	3	3x2=6
Flooding[b]	High	3	3x2=6
Landslide	Medium	2	2x2=4
Severe Weather	High	3	3x2=6
Wildfire	High	3	3x2=6

a. Although all property is exposed to drought, direct impacts on property are limited.
b. Based on structures exposed to the 500-year floodplain

Table 18-4. Impact on Economy from Hazards

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (1)
Avalanche	Low	1	1x1=1
Dam or Levee Failure	Low	1	1x1=1
Drought[a]	High	3	3x1=3
Earthquake[b]	Medium	2	2x1=2
Flooding	Medium	2	2x1=2
Landslide[b]	*Low*	1	1x1=1
Severe Weather	Medium	2	2x1=2
Wildfire[b]	High	3	3x1=3

a. Drought may have economic impacts on water using industries and agriculture
b. Based on the Chelan M7.2 scenario
c. Impacts on economy were assumed to be half of exposure for landslide and wildfire

18.3 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 18-5. Based on these ratings, a priority of high, medium or low was assigned to each hazard. Table 18-6 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 18-5. Hazard Risk Rating

Hazard Event	Probability Factor	Sum of Weighted Impact Factors	Total (Probability x Impact)
Avalanche	3	3+2+1=6	3x6=18
Dam or Levee Failure	1	3+2+1=6	1x6=6
Drought	3	0+0+3	3x3=9
Earthquake	2	9+6+2=17	2x17=34
Flooding	3	9+6+2=17	3x17=51
Landslide	3	6+4+1=11	3x11=33
Severe Weather	3	9+6+2=17	3x17=51
Wildfire	3	9+6+3=18	3x18=54

Table 18-6. Hazard Risk Ranking

Hazard Ranking	Hazard Event	Category[a]
1	Wildfire	High
2	Flooding	High
2	Severe Weather	High
4	Earthquake	Medium
5	Landslide	Medium
6	Avalanche	Medium
7	Drought	Low
8	Dam Failure	Low

a. Scores of 35 or greater are rated as "high," scores of 15 to 34 are "medium," and scores of less than 15 are "low"

Part 3. MITIGATION PLAN

19. 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 mission statement and goals from the 2010 Hazard Mitigation Plan. It was determined that the 2010 plan's mission statement and goals still reflect community priorities and the results of the risk assessment. Therefore, only minor changes were made to clarify intent and meaning. No objectives were identified within the 2010 plan, so the Steering Committee completed an exercise and identified 12 objectives. The mission statement and 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.

19.1 PLAN MISSION STATEMENT

A plan's mission statement 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 mission statement for this hazard mitigation plan is as follows:

The mission of the Plan is: *To promote sound public policy designed to protect citizens, critical facilities, infrastructure, private property and the environment from natural hazards by increasing public awareness, documenting the resources for risk reduction and loss-prevention, and identifying activities to guide Chelan County towards building a safer, more sustainable community.*

19.2 GOALS

The following are the mitigation goals for this plan:

1. **To Protect People and Property** by making Chelan County homes, businesses, infrastructure, critical facilities, and other property more resilient and resistant to losses from natural hazards
2. **To Protect the Economy** by developing mechanisms that ensure commerce, trade, and essential business activities remain viable in the event of a natural disaster
3. **To Protect the Environment** by preserving, rehabilitating, and enhancing natural systems to serve natural hazard mitigation functions
4. **To Strengthen Emergency Services** by increasing collaboration, coordination, and capabilities among public agencies, non-profit organizations, business, and industry
5. **To Increase Public Awareness and Education** by providing the public information, tools, and funding resources for implementing mitigation activities to prevent future losses from natural hazards
6. **To Establish and Strengthen Partnerships for Implementation** through coordination and collaboration of the whole community, including public agencies, citizens, non-profit organizations, businesses, tribes, and industries whose authorities and capabilities will support implementation of planning for a disaster-resistant Chelan County.

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

19.3 OBJECTIVES

The selected objectives meet multiple goals, as listed in Table 19-1. 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 19-1. Objectives for the Hazard Mitigation Plan

Objective Number	Objective Statement	Goals for Which It Can Be Applied
O-1	Improve and protect early warning emergency response systems and plans.	1, 4
O-2	Sustain continuity of local emergency and government operations, including the operation of identified critical facilities, during and after a disaster.	2, 4, 6
O-3	Provide/improve fire protection thru proactive fuels management programs.	1, 2, 3
O-4	Seek mitigation projects that provide the highest degree of hazard protection in a cost-effective manner.	2, 6
O-5	Encourage and incentivize mitigation of private property through programs such as the Community Rating System, Firewise and Storm Ready programs.	1, 2, 5
O-6	Reduce natural hazard-related risks and vulnerability to populations, critical facilities and infrastructure within the planning area.	1, 4, 6
O-7	Collect, use and share the best available data, science and technologies to improve understanding of the location and potential impacts of natural hazards, the vulnerability of building types, and community development patterns and the measures needed to protect life safety and natural and built environments.	1, 5
O-8	Seek mitigation projects that will provide protection to the natural and built environments.	3, 6
O-9	Enhance emergency response partnership capabilities to include mitigation of vulnerable critical facilities and infrastructure.	1, 4, 6
O-10	Create and enhance partnerships among all levels of government and the business community to coordinate mutually beneficial mitigation strategies.	2, 6
O-11	Strengthen codes so that new construction can withstand the impacts of identified natural hazards and lessen the impact of that development on the environment's ability to absorb the impact of natural hazards.	1, 2, 3

20. MITIGATION BEST PRACTICES AND ADAPTIVE CAPACITY

20.1 MITIGATION BEST PRACTICES

Catalogs of hazard mitigation best practices were developed that present a broad range of alternatives to be considered for use in Chelan 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 be prepared 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 20-1 through Table-20-8.

Table 20-1. Alternatives to Mitigate the Avalanche Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• Manipulate the hazard: ❖ Stabilize slope (armor, terrace slope) ❖ 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 avalanche prone- areas) • Reduce vulnerability to the hazard: ❖ Retrofit homes on avalanche-prone slopes • Build local capacity to respond to or be prepared for the hazard: ❖ Institute warning system and develop evacuation plan ❖ Increase capability by having cash reserves for reconstruction ❖ Educate yourself on risk reduction techniques for avalanche hazards	• Manipulate the hazard: ❖ Stabilize slope (armor, terrace slope) ❖ 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 avalanche prone- areas) • Reduce vulnerability to the hazard: ❖ Retrofit at risk facilities • Build local capacity to respond to or be prepared for the hazard: ❖ Institute warning system and develop evacuation plan ❖ Increase capability by having cash reserves for reconstruction ❖ Develop and implement a Continuity of Operations Plan (COOP) ❖ Educate your employees on the potential exposure to avalanche hazards and your emergency response protocol	• Manipulate the hazard: ❖ Stabilize slope (armor, terrace slope) ❖ 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 avalanche prone- areas) • Reduce vulnerability to the hazard: ❖ Adopt higher regulatory standards for new development within avalanche-prone areas ❖ Armor/retrofit critical infrastructure from the impact of avalanches • Build local capacity to respond to or be prepared 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 (COOP) ❖ Educate the public on the avalanche hazard and appropriate risk reduction alternatives

Table 20-2. Alternatives to Mitigate the Dam or Levee 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 be prepared 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 be prepared 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 be prepared 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-20-3. 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) • Build local capacity to respond to or be prepared 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 • Build local capacity to respond to or be prepared 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 • Build local capacity to respond to or be prepared 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

Table-20-4. 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 be prepared 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 be prepared 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 be prepared 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. ❖ Consider the probable impacts of climate change on the risk associated with the drought hazard

Table-20-5. Alternatives to Mitigate the Flood 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 be prepared 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 be prepared 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 ❖ Implement Assembly Bill 162 (2007) requiring flood hazard information in local comprehensive plans • Build local capacity to respond to or be prepared 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

Table-20-6. 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 be prepared 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 be prepared 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 be prepared 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-20-7. 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 be prepared 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 be prepared 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 be prepared 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-20-8. Alternatives to Mitigate the Wildfire Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• 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-retardant building materials ❖ Create defensible spaces around home • Build local capacity to respond to or be prepared 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.	• 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-retardant building materials ❖ Use fire-resistant plantings in buffer areas of high wildfire threat. • Build local capacity to respond to or be prepared for the hazard: ❖ Support Firewise USA community initiatives. ❖ Create /establish stored water supplies to be utilized for fire fighting.	• 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-retardant 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 • Build local capacity to respond to or be prepared 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 ❖ 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-urban interface areas ❖ 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

20.2 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:

- 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 comprehensive plan safety elements and local hazard mitigation plans.
- Implement comprehensive 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 (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.

21. AREA-WIDE ACTION PLAN

21.1 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 21-1 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.

21.2 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 21-1. Action Plan

Hazards Addressed	Funding Options	Timeframe	Objectives Met	In Previous Plan?
CW-1—To the extent possible based on available resources, provide coordination and technical assistance in the application for grant funding that includes assistance in cost vs. benefit analysis for grant eligible projects **Responsible Agency:** County				
All	Existing County programs; grant funding	Short-term, ongoing	2,7,9,10	No
CW-2—Encourage the development and implementation of a county-wide hazard mitigation public-information strategy that meets the needs of all planning partners. Leverage public outreach partnering capabilities to inform and educate the public about hazard mitigation and preparedness. Seek opportunities to promote the mitigation of natural hazards within the planning area, utilizing information contained within this plan. **Responsible Agency:** County with participation of all planning partners				
All	Cost sharing from the Partnership, General Fund Allocations, Cost sharing with Stakeholders	Short-term, depends on funding	7,10	No
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 comprehensive planning. **Responsible Agency:** Governing body of each eligible planning partner.				
All	General funds	Short-term, ongoing	3,10,11	No
CW-4—Sponsor and maintain a natural hazards informational website to include information such as: • 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 • CRS creditable information • Links to Planning Partners' pages, FEMA, Red Cross, NOAA, USGS and the National Weather Service. • Information such as progress reports, mitigation success stories, update strategies, Steering Committee meetings. **Responsible Agency:** County				
All	County general fund through existing programs, grant funding	Short-term, ongoing	5,7,10	No
CW-5—The Steering Committee will remain as a functioning 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. **Responsible Agency:** County				
All	Funded through existing, ongoing programs	Short-term	9,10	No
CW-6—Amend or enhance this hazard mitigation plan as needed to comply with state or federal mandates as compliance guidelines become available. **Responsible Agency:** County with participation of all planning partners				
All	Ongoing programs, grant funding depending on the mandate	Long-term Ongoing	6,7,9,10	No
CW-7— Support the collection of improved data (hydrologic, geologic, topographic, volcanic, historical, etc.) to better assess risks and vulnerabilities. **Responsible Agency:** All planning partners				
All	Ongoing programs grant funding	Short-term Ongoing	7,10	No
CW-8—All planning partners that fully participated in this planning effort will formally adopt this plan once pre-adoption approval has been granted by Washington State Emergency Management Division and FEMA and will adhere to the plan maintenance protocol identified in Chapter 23. **Responsible Agency:** All planning partners				
All	All	All	2,7,10	No
CW-9-Utilize information within this plan to support updates to other emergency management plans in effect within the planning area. **Responsible Agency:** County				
All	Can be funded under existing programs	Short-term Ongoing	6,7,9,10	No

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.

21.3 ACTION PLAN PRIORITIZATION

Table 21-2 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 21-2. 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	4	Medium	Low	Yes	No	Yes	High	N/A
CW-2	2	Medium	Medium	Yes	No	Yes	High	N/A
CW-3	3	Medium	Low	Yes	No	Yes	High	N/A
CW-4	3	Low	Low	Yes	No	Yes	High	N/A
CW-5	2	Low	Low	Yes	No	Yes	High	N/A
CW-6	4	Medium	Medium	Yes	Yes	No	Medium	High
CW-7	2	Medium	Medium	Yes	Yes	No	Medium	High
CW-8	3	Low	Low	Yes	No	Yes	High	N/A
CW-9	4	Low	Low	Yes	No	Yes	High	N/A

21.4 CLASSIFICATION OF MITIGATION ACTIONS

Each recommended action was classified based on the hazard it addresses and the type of mitigation it involves. Table 21-3 shows these classifications.

Table 21-3. 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
Avalanche	CW-1, 2, 3, 4, 7,	CW-3	CW-2, 4		CW-10		CW-7	CW-5, 6, 7, 8
Dam Failure	CW-1, 2, 3, 4, 7,	CW-3	CW-2, 4		CW-10		CW-7	CW-5, 6, 7, 8
Drought	CW-1, 2, 3, 4, 7,	CW-3	CW-2, 4		CW-10		CW-7	CW-5, 6, 7, 8
Earthquake	CW-1, 2, 3, 4, 7,	CW-3	CW-2, 4		CW-10		CW-7	CW-5, 6, 7, 8
Flooding	CW-1, 2, 3, 4, 7,	CW-3	CW-2, 4		CW-10		CW-7	CW-5, 6, 7, 8
Landslide	CW-1, 2, 3, 4, 7,	CW-3	CW-2, 4		CW-10		CW-7	CW-5, 6, 7, 8
Severe Weather	CW-1, 2, 3, 4, 7,	CW-3	CW-2, 4		CW-10		CW-7	CW-5, 6, 7, 8
Wildfire	CW-1, 2, 3, 4, 7,	CW-3	CW-2, 4		CW-10		CW-7	CW-5, 6, 7, 8

a. See Section 21.4 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.
- **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.

21.5 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.

The Chelan County Natural Resources Department will assume lead responsibility for facilitating hazard mitigation plan implementation. 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.

21.6 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 comprehensive 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 comprehensive plans and the hazard mitigation plan as complementary documents to achieve the ultimate goal of reducing risk exposure to citizens of the planning area. An update to a comprehensive 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 comprehensive 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:

- Capital improvement programs
- Climate action/adaptation plans
- Community design guidelines
- Critical areas regulations
- Debris management plans
- Emergency response plans
- Municipal codes
- Post-disaster action/recovery plans
- Stormwater management programs
- Water system vulnerability assessments
- Water-efficient landscape design guidelines.

All planning partners have identified opportunities and strategies for integration in their annexes in Volume 2 of this plan.

22. PLAN ADOPTION AND MAINTENANCE

22.1 PLAN ADOPTION

A hazard mitigation plan must document that it has been formally adopted by the governing body of the jurisdiction requesting federal approval of the plan (44 CFR Section 201.6(c)(5)). For multi-jurisdictional plans, each jurisdiction requesting approval must document that is has been formally adopted. This plan will be submitted for a pre-adoption review prior to adoption to Washington State Emergency Management Division and FEMA’s Community Rating System contractor, the Insurance Services Office. Once pre-adoption approval has been provided, all planning partners will formally adopt the plan. All partners understand that DMA compliance and its benefits cannot be achieved until the plan is adopted. Copies of the resolutions adopting this plan for all planning partners can be found in Appendix E of this volume.

22.2 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 22-1 summarizes the plan maintenance strategy. The sections below further describe each element (except “integration into other planning mechanisms,” which is discussed in Section 21.6).

22.2.1 Plan Monitoring

Chelan County will be the lead agency responsible for monitoring the plan, and each partner will 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 22-1.

Table 22-1. Plan Maintenance Matrix

Approach	Timeline	Lead Responsibility[a]
Integration into Other Planning Mechanisms		
Create a linkage between the hazard mitigation plan and individual jurisdictions' comprehensive plans or similar plans identified in the core capability assessments	Continuous over the 5-year performance period of the plan	Chelan County, City of Wenatchee, City of Cashmere, City of Entiat, City of Leavenworth, City of Chelan, Chelan County Flood Control Zone District, Chelan County Fire Districts 1, 3, 5, 6, 8, 9, Cascadia Conservation District
Plan Monitoring[b]		
Track the implementation of actions over the performance period of the plan	Bi-annually (Year 2 and Year 4)	Chelan County Natural Resources Department will be the lead agency responsible for the plan, all planning partners will monitor themselves and report to Chelan County Emergency Management. 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	Bi-annually (Year 2 and Year 4)	Chelan County, City of Wenatchee, City of Cashmere, City of Entiat, City of Leavenworth, City of Chelan, Chelan County Flood Control Zone District, Chelan County Fire Districts 1, 3, 5, 6, 8, 9, Cascadia Conservation District
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	Chelan County Natural Resources Department 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 update to comprehensive plan or major disaster; funding and organizing for plan update will begin in FY 2021/2022	The governing body for all planning partners covered by this plan
Continuing Public Participation		
Chelan County Natural Resources Department will keep the website maintained, post bi-annual progress reports online, 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	Chelan County Natural Resources Department will be the lead agency responsible, supported by Chelan County Emergency Management. 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

22.2.2 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.

22.2.3 Grant Monitoring and Coordination

Chelan County Natural Resources Department 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. Chelan County Natural Resources Department 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.

22.2.4 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 comprehensive 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 comprehensive plan).
- The draft update will be sent to appropriate agencies and organizations for comment.
- The public will be given an opportunity to comment on the update prior to adoption.
- Partners' governing bodies will adopt their respective portions of the updated plan.

Because plan updates can require a year or more to complete, the Chelan County Natural Resources Department will initiate efforts to update the plan before it expires. Chelan County Natural Resources Department 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 fall of 2023.

22.2.5 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. Chelan County Natural Resources Department 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 North Central Regional Library.

Bi-annually, in years 2 and 4, the Chelan County Emergency Management and Chelan County Natural Resources Department will request a progress report from planning partners which summarizes the status or implementation of plan actions, any changes to risk, evaluates the success of plan integration, or summarizes other changes to plan content. The progress reports will be combined and posted on the County website for public review.

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

UPDATE REFERENCE LIST BEFORE FINAL DOCUMENT SUBMITTAL

Andonaegui, Carmen. 1999. Water Resource Inventory Area (WRIA) 46: Salmon and Steelhead Habitat Limiting Factors Report for the Entiat Watershed. Version 3.

Andonaegui, Carmen. 2001. Salmon, Steelhead, and Bull Trout Habitat Limiting Factors For the Wenatchee Subbasin (Water Resource Inventory Area 45) and Portions of WRIA 40 within Chelan County (Squilchuck, Stemilt and Colockum drainages); Final Report. WA State Conservation Commission, Olympia, Washington. November 2001

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.

Burns, Scott F., William J. Burns, David H. James, Jason C. Hinkle. 1998. Landslides in the Portland, Oregon Metropolitan Area Resulting from the Storm of February 1996: Inventory Map, Database and Evaluation. Available online at http://nwdata.geol.pdx.edu/Landslides/PDX-Landslide/metrosld.pdf

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

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). 2009. Climate and Health: Heat Waves. The website of the CDC, last updated December 14, 2009, http://www.cdc.gov/climateandhealth/effects/heat.htm.

Centers for Disease Control and Prevention (CDC). 2012. "Drought and Health." Accessed February 2017. http://www.cdc.gov/nceh/drought/.

Centers for Disease Control and Prevention (CDC). 2013. Emergency Preparedness and Response: Lightning: Victim Data. The website of the CDC, last reviewed December 23, 2013, http://www.bt.cdc.gov/disasters/lightning/victimdata.asp.

Centers for Disease Control and Prevention (CDC). 2014a. Extreme Cold: A Prevention Guide to Promote Your Personal Health and Safety. Accessed March 2014 at http://www.bt.cdc.gov/disasters/winter/pdf/extreme-cold-guide.pdf.

Centers for Disease Control and Prevention (CDC). 2014b. Climate Change: Extreme Heat. The website of the CDC, last updated July 1, 2014, http://ephtracking.cdc.gov/showClimateChangeExtremeHeat.action

Chelan County Conservation District. 2004. Entiat Subbasin Plan. Prepared for the Northwest Power & Conservation Council. May 28, 2004. Accessed online at https://www.nwcouncil.org/fw/subbasinplanning/entiat/plan/

Chelan County Flood Control Zone District. 2014. Interim Operating Guidelines. Prepared by Chelan County Public Works. Wenatchee, WA. August 27, 2014.

Chelan County. 2011. Chelan County Multi-Jurisdiction Natural Hazard Mitigation Plan 2011 Plan Update. Prepared by Chelan County Emergency Management Council and its member jurisdictions.

Chelan County. 2013. Flood Control Zone District; Frequently Asked Questions. Prepared by Chelan County Public Works. Wenatchee, WA. October 2013.

Chelan County Natural Resources Department. 2019a. Peshastin Fishway web page. Accessed at: http://www.co.chelan.wa.us/natural-resources/pages/peshastin-fishway?parent=Water%20Resources

Chelan County Natural Resources Department. 2019b. CCNRD Cashmere Pond Off-Channel Habitat web page. Accessed at: http://hwsconnect.ekosystem.us/project.aspx?sid=290&id=7102&stat=on

Chelan County Natural Resources Department. 2019c. CCNRD Nason Creek 2007 Oxbow Reconnection web page. Accessed at: http://hwsconnect.ekosystem.us/project.aspx?sid=290&id=1888&stat=on

Chelan County Natural Resources Department. 2019d. CCNRD Irwin Riparian Restoration RM 24.3 web page. Accessed at: http://hwsconnect.ekosystem.us/project.aspx?sid=290&id=1688&stat=on

Chelan County Natural Resources Department. 2019e. CCNRD Icicle Revegetation Fromm 7 web page. Accessed at: http://hwsconnect.ekosystem.us/project.aspx?sid=290&id=1764&stat=on

City of Covington. 2005. Hazard Identification and Vulnerability Analysis. http://www.covingtonwa.gov/docs/hiva.pdf

City of Crescent City. 2001. *City of Crescent City General Plan.* Accessed 2018. http://www.crescentcity.org/planning.html

Cohen, Jack. 2008. "The Wildland-Urban Interface Fire Problem: A Consequence of the Fire Exclusion Paradigm." Forest History Today: Fall 2008. Available online at http://www.fs.fed.us/rm/pubs_other/rmrs_2008_cohen_j002.pdf

Dalton, M.M., P.W. Mote, and A.K. Snover [Eds.]. 2013. Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities. Washington, DC: Island Press. Accessed online at: http://cses.washington.edu/db/pdf/snoveretalsok2013sec2.pdf

Dalton, Meghan M., Philip W. Mote, and Amy K. Snover. 2013. Climate Change in the Northwest: Implications for Our Landscapes, Waters and Communities. Island Press. http://cses.washington.edu/db/pdf/daltonetal678.pdf

Drought Impact Reporter. 2018. The website of the National Drought Mitigation Center. Accessed 2018. http://drought.unl.edu/monitoringtools/droughtimpactreporter.aspx

Earthquake Early Warning. 2016. ShakeAlert. Last accessed January 2016. Available online at http://www.shakealert.org/

Federal Emergency Management Agency (FEMA). 2004. Using Hazus-MH for Risk Assessment, How-to Guide, FEMA (433). August 2004

Federal Emergency Management Agency (FEMA). 2008. National Response Framework. Federal Emergency Management Agency. Washington, D.C. January 2008.

Federal Emergency Management Agency (FEMA). 2010. http://www.fema.gov. Website accessed 2009, 2010, 2011

Federal Emergency Management Agency (FEMA). 2013. FEMA, National Flood Insurance Program, Community Rating System; CRS Coordinator's Manual FIA-15/2013 OMB No. 1660-0022

Federal Emergency Management Agency (FEMA). 2013b. Federal Guidelines for Dam Safety: Emergency Action Planning for Dams. FEMA 64/July 2013. Available online at: http://www.fema.gov/media-library-data/5b20db599c212f77fd5e85d256f471a3/EAP+Federal+Guidelines_FEMA+P-64.pdf

Federal Emergency Management Agency (FEMA). 2015a. Federal Emergency Management Agency Community Status Book Report, Nation; Communities Participating in the National Flood Program. Accessed online August 5, 2015 at http://www.fema.gov/cis/nation.pdf

Federal Emergency Management Agency (FEMA). 2015a. Hazard Mitigation Assistance Program Digest 2015. Available online at http://www.fema.gov/media-library-data/1444240033001-518cdc8d447ef79a1360763e3145d17e/HMA_Program_Digest_508.pdf

Federal Emergency Management Agency (FEMA). 2015b. FEMA Disaster Declarations Summary—Open Government Dataset. Accessed online August 5, 2015 at http://www.fema.gov/media-library/assets/documents/28318?id=6292

Federal Emergency Management Agency (FEMA). 2015b. Loss Statistics: Washington. As of November 30, 2015. Data is updated regularly and is available at http://bsa.nfipstat.fema.gov/reports/1040.htm#53

Federal Emergency Management Agency (FEMA). 2015c. Disaster Declarations for Washington. Website of FEMA. Last accessed 2015. Available online at https://www.fema.gov/disasters/grid/state-tribal-government/89

Federal Emergency Management Agency (FEMA). 2015c. Policy & Claim Statistics for Flood Insurance. Accessed online August 6, 2015 at http://www.fema.gov/policy-claim-statistics-flood-insurance/policy-claim-statistics-flood-insurance/policy-claim-13

Federal Emergency Management Agency (FEMA). 2015d. Executive Order 11988: Floodplain Management. The website of FEMA. Last updated April 23, 2015. Accessed online at http://www.fema.gov/disaster/4253

Federal Emergency Management Agency (FEMA). 2015d. Policy Statistics. As of November 30, 2015. Data is updated regularly and is available online at http://bsa.nfipstat.fema.gov/reports/1011.htm#WAT

Federal Emergency Management Agency (FEMA). 2015e. Washington Severe Winter Storm, Straight-Line Winds, Flooding, Landslides, Mudslides, and a Tornado (DR-4253). The website of FEMA. Last updated February 2016. Available online at https://www.fema.gov/executive-order-11988-floodplain-management

Federal Emergency Management Agency (FEMA). 2016. Executive Order 11988: Floodplain Management. The website of FEMA. Last updated April 23, 2015. Available online at http://www.fema.gov/disaster/4253

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 Energy Regulatory Commission. (FERC). "Dam Safety Performance Monitoring Program." January 1, 2005. Accessed January 20, 2015. http://ferc.gov/industries/hydropower/safety/guidelines/eng-guide/chap14.pdf.

Floodplains by Design. 2016. The website of Floodplains by Design. Last accessed June 2016. Available online at http://www.floodplainsbydesign.org/new-approach/

Gibbs, Margaret, and Kim Montagnino. 2006. “Disasters. A psychological perspective.” In Disciplines, Disasters and Emergency Management: The Convergence and Divergence of Concepts, Issues and Trends from the Research Literature. 2006. ed. David A. McEntire, University of North Texas. FEMA Emergency Management Institute. Accessed online at https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwiX95Gd_anVAhVCMSYKHQ3CC3IQFggtMAA&url=https%3A%2F%2Ftraining.fema.gov%2Fhiedu%2Fdocs%2Femt%2Fgibbspsychology.doc&usg=AFQjCNEBuLjroS7UV47rUNFAqKxT4c3pCQ

Governor’s Ad hoc Executive Water Emergency Committee. 1977. History of Droughts in Washington State. Olympia, Washington: State of Washington Office of the Governor.

Hann, W.; Shlisky, A.; Havlina, D.; Schon, K.; Barrett, S.; DeMeo, T.; Pohl, K.; Menakis, J.; Hamilton, D.; Jones, J.; Levesque, M.; Frame, C. 2004. Interagency Fire Regime Condition Class Guidebook. Last update January 2008: Version 1.3.0 [Homepage of the Interagency and The Nature Conservancy fire regime condition class website, USDA Forest Service, US Department of the Interior, The Nature Conservancy, and Systems for Environmental Management]. [Online]. Available: www.frcc.gov.

Homeland Security. 2011. Dams Sector: Estimating Economic Consequences for Dam Failure Scenarios. Available online at: http://www.damsafety.org/media/Documents/Security/DamsSectorConsequenceEstimation-EconomicConsequences.pdf

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/.

International Strategy for Disaster Reduction. 2008. Disaster Risk Reduction Strategies and Risk Management Practices: Critical Elements for Adaptation to Climate Change. 11/11/2008.

Kendra, Will and Lynn Singleton. 1987. Morphometry of Lake Chelan; Ecology Report No. 87-1. Washington Department of Ecology Water Quality Investigations Section. Olympia, Washington. January 1987. Accessed online at https://fortress.wa.gov/ecy/publications/publications/871.pdf

Kirk, Todd, Phil Kerr, and Hank Riddle. 1995. Initial Watershed Assessment Water Resources Inventory Area 46, Entiat River Watershed; Open File Report 95-02. Washington Department of Ecology Central Regional Office. Yakima, Washington. February 10, 1995.

Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014: Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program.

Mote, P., A. K. Snover, S. Capalbo, S. D. Eigenbrode, P. Glick, J. Littell, R. Raymondi, and S. Reeder, 2014: Ch. 21: Northwest. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 487-513. doi:10.7930/J04Q7RWX.

Municipal Research and Services Center of Washington (MRSC). 2016. “The National Flood Insurance Program and the Impacts of the Biological Opinion,” website accessed June 9, 2016, available online at http://mrsc.org/Home/Explore-Topics/Public-Safety/Emergency-Services/Flood-Hazard-Management-Planning-(1)/The-National-Flood-Insurance-Program-and-the-Impac.aspx

National Aeronautics and Space Administration (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). 2016. Global Climate Change: Vital Signs of the Planet. The website of NASA. Last updated September 15, 2016. Accessed online at: http://climate.nasa.gov/vital-signs/carbon-dioxide/

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 Archives. 2016. Federal Register: Executive Order 11990—Protection of wetlands. The website of the National Archives. Last visited June 2016. Available online at http://www.archives.gov/federal-register/codification/executive-order/11990.html

National Archives. 2016. Federal Register: Executive Order 11990—Protection of wetlands. The website of the National Archives. Last accessed June 2016. Accessed online at http://www.archives.gov/federal-register/codification/executive-order/11990.html

National Center for Environmental Information. 2018. "Drought—February 2018." The website of NOAA. Accessed 2018. https://www.ncdc.noaa.gov/sotc/drought/201802

National Center for Environmental Information. 2018a. "Drought Indices and Data." The website of NOAA. Accessed 2018. https://www.ncdc.noaa.gov/temp-and-precip/drought/nadm/indices

National Drought Mitigation Center. 2006. Types of Drought. Website of the National Drought Mitigation Center. Last accessed 2006. Available online at http://drought.unl.edu/DroughtBasics/TypesofDrought.aspx

National Drought Mitigation Center. 2017. "Drought Affecting People." Accessed February 2017. http://drought.unl.edu/droughtbasics/ensoandforecasting.aspx.

National Integrated Drought Information System (NIDIS). 2016. "About the Pacific Northwest DEWS." Website of the U.S. Drought Portal. Accessed February 2016, https://www.drought.gov/drought/dews/pacific-northwest/about

National Lightning Safety Institute (NLSI). 2008. Lightning Costs and Losses from Attributed Sources. The website of the NLSI. Last updated June 11, 2016. Available online at http://lightningsafety.com/nlsi_lls/nlsi_annual_usa_losses.htm

National Oceanic and Atmospheric Administration (NOAA). 2014. NOAA Severe Weather website. Accessed 2014 at http://www.noaawatch.gov/themes/severe.php

National Oceanic and Atmospheric Administration (NOAA). 2015. National Centers for Environmental Information Climate Data Online website, accessed December 31, 2015: http://www.ncdc.noaa.gov/cdo-web/datatools/findstation

National Oceanic and Atmospheric Administration (NOAA). 2015. NOAA National Climatic Data Center website. Accessed 2015 at http://www.ncdc.noaa.gov/climate-information/extreme-events/us-tornado-climatology.

National Oceanic and Atmospheric Administration (NOAA). 2016. Billion-Dollar Weather and Climate Disasters: Mapping." Website of the National Oceanic and Atmospheric Administration. Accessed March 2016, http://www.ncdc.noaa.gov/billions/mapping

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 Resources Conservation Service. 2016. Emergency Watershed Protection Program. The website of the USDA. Last accessed 2016. Available online at http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp/

National Severe Storms Laboratory. 2015. Severe Weather 101: Tornado Basics." The website of the National Severe Storms Laboratory. Last accessed 2015. Available online at http://www.nssl.noaa.gov/education/svrwx101/tornadoes/

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 Weather Service. 2010. Average Number of Thunderstorm Days in the U.S. Available online at http://www.srh.noaa.gov/jetstream/tstorms/tstorms_intro.htm

National Weather Service. 2014. Heat: A Major Killer. Last updated June 20, 2014, http://www.nws.noaa.gov/os/heat/index.shtml.

National Wildlife Federation. 2006. The Evaluation of the National Flood Insurance Report. Available online at http://www.fema.gov/media-library-data/20130726-1602-20490-1463/nfip_eval_final_report.pdf

NOAA. 2015. NOAA National Centers for Environmental Information Data Tools Website: 1981-2010 Normals. Accessed online at http://www.ncdc.noaa.gov/cdo-web/datatools/normals

Office of Federal Lands Highway. 2016. Emergency Relief for Federally Owned Roads. The website of Federal Highway Administration. Last accessed June 2016. Available online at https://flh.fhwa.dot.gov/programs/erfo/

Office of the Press Secretary. 2015. Executive Order—Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input. The website of the White House. Posted online January 30, 2015. Available online at: https://www.whitehouse.gov/the-press-office/2015/01/30/executive-order-establishing-federal-flood-risk-management-standard-and-

Office of the Washington State Climatologist (OWSC). No date. WA State Records. Last accessed 2015. Available online at http://www.climate.washington.edu/facts.html

Pacific Northwest Seismic Network. 2018. “Cascadia Subduction Zone.” Website accessed 2018. https://pnsn.org/outreach/earthquakesources/csz

Payne, J. T., A. W. Wood, A. F. Hamlet, R.N. Palmer, and D. P. Lettenmaier. 2004. Mitigating the effects of climate change on the water resources of the Columbia River basin. Climatic Change 62(1-3):233-256.

Port of Chelan County. 2015. Large Employers List for Chelan and Douglas Counties, June 2015. Accessed online August 5, 2015 at http://www.portofchelancounty.com/large-employers-list/

RH2. 2007. Water Quantity Assessment; WRIA 40A (Squilchuck/Stemilt). Prepared for the WRIA 40A Technical Subcommittee by RH2 Engineering, Inc. East Wenatchee, Washington. February 2007.

RS Means. 2015. RS Means Square Foot Costs. RS Means Company.

Rufat, Samuel, Eric Tate, Christopher G. Burton and Abu Sayeed Maroof. 2015. “Social vulnerability to floods: Review of case studies and implications for measurement.” International Journal of Disaster Risk Reduction 14 (2015) 470–486. Accessed online at http://www.sciencedirect.com/science/journal/22124209/14/part/P4?sdc=1

Silver Jackets. 2016. Washington. The website of the Silver Jackets. Last accessed June 2016. Available online at http://silverjackets.nfrmp.us/State-Teams/Washington

Townsend, Katherine L and John T. Figge. 2002. “Northwest Origins: An Introduction to the Geological History of Washington State. the website of the Burke Museum, last accessed March 2014, http://www.burkemuseum.org/static/geo_history_wa/index.htm.

U.S. Army Corp of Engineers. 2011. Safety of Dams—Policy and Procedures. Engineer Regulation 1110-2-1156. Available online at http://planning.usace.army.mil/toolbox/library/ERs/ER1100_2_1156_28Oct11.pdf

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. 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. Department of Agriculture (USDA). 2014. SNOTEL and Snow Survey & Water Supply Forecasting. Last revised January 2014, http://www.wcc.nrcs.usda.gov/snotel/SNOTEL-brochure.pdf

U.S. Department of Agriculture (USDA). 2015. “Disaster Designation Information.” Website of the United States Department of Agriculture. Accessed February 2016, http://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/disaster-designation-information/index

U.S. Department of Agriculture. (USDA). 2015b. USDA Rural Development Programs: Washington State. Available online at http://www.rd.usda.gov/files/WA_Program_Guide_2015.pdf

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). 2006. Excessive Heat Events Guidebook. EPA 430-B-06-005. Available online at http://www.epa.gov/heatisld/about/pdf/EHEguide_final.pdf.

U.S. Environmental Protection Agency (EPA). 2013. Climate Change Indicators in the United States: Snowfall. http://www.epa.gov/climatechange/science/indicators/snow-ice/snowfall.html.

U.S. Environmental Protection Agency (EPA). 2015. Heat Island Impacts. The website of the EPA. Last updated October 1, 2015. Available online at http://www2.epa.gov/heat-islands/heat-island-impacts

U.S. Environmental Protection Agency (EPA). 2016. “Climate Change Indicators in the United States.” 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. Fish and Wildlife Service. 2018. Information for Planning and Consultation viewer. Accessed 2018. https://ecos.fws.gov/ipac/location/index

U.S. Forest Service (USFS). 1998. Squilchuck Watershed Assessment, United States Department of Agriculture Forest Service, Leavenworth Ranger District, Wenatchee National Forest, Chelan County, Washington.

U.S. Geological Survey (USGS). 1978. “Washington: earthquake History.” The website of the USGS. Abridges from Earthquake Information Bulletin, Volume 10, Number 1, January-February 1978, Carl A. von Hake. Available online at http://earthquake.usgs.gov/earthquakes/states/washington/history.php

U.S. Geological Survey (USGS). 1997. Lateral Blast. The website of the USGS. Last updated June 25, 1997. Available online at http://pubs.usgs.gov/gip/msh/lateral.html

U.S. Geological Survey (USGS). 2001. Socioeconomic and environmental Impacts of Landslides in the Western Hemisphere. USGS Open-File report 01-0276. Available online at http://pubs.usgs.gov/of/2001/ofr-01-0276/

U.S. Geological Survey (USGS). 2003. Effects of Urban Development on Floods. U.S. Geological Survey Fact Sheet 076-03. Prepared for the USGS by C.P. Konrad. November 2003. Accessed online at https://pubs.usgs.gov/fs/fs07603/.

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). 2012a. 'Earthquake Hazards Program: Pacific Northwest." Last modified July 18, 2012. Available on-line at http://earthquake.usgs.gov/regional/pacnw/.

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). 2014. 2014 National Seismic hazard Maps—Source Parameters. The website of the USGS. Last accessed January 24, 2016. Available online at http://geohazards.usgs.gov/cfusion/hazfaults_2014_search/view_fault.cfm?cfault_id=880

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.

UNESCO-IHE. 2016. Flood Vulnerability Indices (FVI). Accessed September 2016 at: http://unescoihefvi.free.fr/vulnerability.php

University of Washington Climate Impacts Group. 2013. Northwest Climate Assessment Report (2013). Available online at https://cig.uw.edu/resources/special-reports/

Washington Department of Community, Trade and Economic Development. 2007. Critical Areas Assistance Handbook: Protecting Critical Areas within the Framework of the Washington State Growth Management Act. Available online at http://www.commerce.wa.gov/Documents/GMS-Critical-Areas-Assist-Handbook.pdf.

Washington Department of Ecology. 1995a. Wenatchee River Watershed Initial Assessment. Prepared by Montgomery Water Group, Adolfson Associates, Inc. and associated firms. Draft. May 1995. Online: https://fortress.wa.gov/ecy/publications/documents/95160.pdf

Washington Department of Ecology. 1995b. Entiat River Watershed Initial Assessment. Prepared by Montgomery Water Group, Adolfson Associates, Inc. and associated firms. Draft. February 1995. Online: https://fortress.wa.gov/ecy/publications/documents/95151.pdf

Washington Department of Ecology. 1995c. Chelan Watershed Initial Assessment. Prepared by Montgomery Water Group, Adolfson Associates, Inc. and associated firms. Draft. May 1995. Online: https://fortress.wa.gov/ecy/publications/documents/95161.pdf

Washington Department of Ecology. 2006. 2005 Drought Response: Report to the Legislature. Publication number 06-11-001, https://fortress.wa.gov/ecy/publications/publications/0611001.pdf.

Washington Department of Ecology. 2007. Facts about Washington's retreating glaciers and declining snow pack. Publication 07-11-016. https://fortress.wa.gov/ecy/publications/publications/0711016.pdf

Washington Department of Ecology. 2012. Preparing for a Changing Climate: Washington State's Integrated Climate Response Strategy. https://fortress.wa.gov/ecy/publications/documents/1201004.pdf

Washington Department of Ecology. 2015a. Inventory of Dams in the State of Washington. Report data current to November 2015. Publication #94-16. Available online at: https://fortress.wa.gov/ecy/publications/documents/94016.pdf

Washington Department of Ecology. 2015b. "Washington Drought 2015." Website of the Washington Department of Ecology. Last updated December 27, 2015, http://www.ecy.wa.gov/drought/index-2015.html

Washington Department of Ecology. 2016. State Environmental Policy Act website of the Washington Department of Ecology. Accessed June 2016. Available online at, http://www.ecy.wa.gov/programs/sea/sepa/e-review.html

Washington Department of Ecology. 2016a. "Climate Change Effects on Water Resources." Website of the Washington Department of Ecology. Accessed February 2016, http://www.ecy.wa.gov/climatechange/2012ccrs/water.htm

Washington Department of Ecology. 2016b. State Environmental Policy Act website of the Washington Department of Ecology. Accessed June 2016. Available online at, http://www.ecy.wa.gov/programs/sea/sepa/e-review.html

Washington Department of Natural Resources. 2015. Forest Health Highlights in Washington-2014. Available online at http://file.dnr.wa.gov/publications/rp_fh_2014_forest_health_highlights.pdf

Washington Department of Natural Resources. 2016a. "Fire Danger and Outdoor Burning." The website of the Washington Department of Natural Resources. Last accessed March 2016, https://fortress.wa.gov/dnr/protection/firedanger/

Washington Department of Natural Resources. 2016b. Shallow Landslide Hazard Forecast Map. The website of the Washington Department of Natural Resources. Accessed June 2016. Available online at http://www.dnr.wa.gov/slhfm

Washington Emergency Management Division. 2013. 2013 Washington State Enhanced Hazard Mitigation Plan. FEMA Approval October 1, 2013. Available online: http://mil.wa.gov/other-links/enhanced-hazard-mitigation-plan

Washington Emergency Management Division. 2016. Incident Command System (ICS) and the National Incident Management System (NIMS). The website of the Washington Emergency Management Division. Last accessed 2016. Available online at http://mil.wa.gov/emergency-management-division/training-and-exercise/incident-command-system-ics-and-the-national-incident-management-system-nims

Washington Employment Security Department (ESD). 2014. Chelan County Profile 2014. Accessed on-line May 19, 2015 at https://fortress.wa.gov/esd/employmentdata/docs/regional-reports/chelan-county-data-tables.xlsx

Washington Employment Security Department (ESD). 2015. Historical Estimates of Local Unemployment Statistics, Not Seasonally Adjusted. Retrieved December 30, 2015, from Washington Employment Security Department: https://fortress.wa.gov/esd/employmentdata/reports-publications/regional-reports/local-unemployment-statistics

Washington Office of Financial Management (OFM). 2012. Decennial Census Counts of Population for the State, Counties, Cities and Towns. Prepared by the Forecasting and Research Division of the Office of Financial Management. October 12, 2012. Accessed online at http://www.ofm.wa.gov/pop/april1/hseries/default.asp

Washington Office of Financial Management (OFM). 2014. Growth Management Act Population Change, April 1, 2004 to April 1, 2014. Prepared by the State of Washington Office of Financial Management Forecasting Division. June 2, 2014.

Washington Office of Financial Management (OFM). 2015a. State of Washington 2015 Population Trends. Prepared by the Forecasting and Research Division of the Office of Financial Management. September 2015. Accessed online at http://www.ofm.wa.gov/pop/april1/poptrends.pdf

Washington Office of Financial Management (OFM). 2015b. Postcensal Estimates of April 1 Population, 1960 to Present. Prepared by the Forecasting and Research Division of the Office of Financial Management. June 25, 2015. Accessed online at http://www.ofm.wa.gov/pop/april1/hseries/default.asp

Washington State Recreation and Conservation Office. 2016a. Land and Water Conservation Fund. The website of the Washington State Recreation and Conservation Office. Last accessed June 2016. Available online at http://www.rco.wa.gov/grants/lwcf.shtml

Washington State Recreation and Conservation Office. 2016b. Salmon Recovery Grants. The website of the Washington State Recreation and Conservation Office. Last accessed June 2016. Available online at http://www.rco.wa.gov/grants/salmon.shtml

Washington State. 2015. Washington State Tribal Directory. Prepared by the Governor's Office of Indian Affairs. Olympia, WA. Updated March 2015. Accessed online: http://www.goia.wa.gov/Tribal-Directory/TribalDirectory.pdf

Wenatchee River Watershed Steering Committee. 1996. Wenatchee River Watershed Action Plan Addendum—Wenatchee River Watershed Ranking Report Addendum; Technical Supplement 1. Developed by the Wenatchee River Watershed Steering Committee with support from the Chelan County Conservation District. March 1996.

Wenatchee River Watershed Steering Committee. 1998. Wenatchee River Watershed Action Plan. Developed by the Wenatchee River Watershed Steering Committee and Technical Advisory Committee, with support from the Chelan County Conservation District. Draft. August 1996.

Western Regional Climate Center (WRCC). 2014. "Climate of Washington." Last accessed 2015, http://www.wrcc.dri.edu/narratives/WASHINGTON.htm

Western States Seismic Policy Council. 2016. Washington: Washington Earthquake Hazards Mitigation Legislation. The website of the Western States Seismic Policy Council. Last accessed January 2016. Available online at http://www.wsspc.org/public-policy/legislation/washington/

Wilma, David. 2006. Chelan County—Thumbnail History. Prepared for HistoryLink.org. Accessed at http://www.historylink.org/index.cfm?DisplayPage=output.cfm&file_id=7624

Winters, Chris. 2015. Living in a slide zone. The website of the Seattle Times. Published on June 10, 2011 and updated October 26, 2015. Available online at http://www.seattletimes.com/business/real-estate/living-in-a-slide-zone/

LIST OF ACRONYMS

ADA—American with Disabilities Act

BLM—Bureau of Land Management

CCNRD—Chelan County Natural Resources Department

CDBG-DR—Community Development Block Grant Disaster Recovery

CFR—Code of Federal Regulations

CRS—Community Rating System

CWA—Clean Water Act

CWPP—Community Wildfire Protection Plan

DMA —Disaster Mitigation Act

EPA—U.S. Environmental Protection Agency

ESA—Endangered Species Act

ESD—Employment Security Department (Washington State)

EWP—Emergency Watershed Protection

FEMA—Federal Emergency Management Agency

FERC—Federal Energy Regulatory Commission

FIRM—Flood Insurance Tate Map

FRCC—Fire regime condition class

GIS—Geographic Information System

Hazus—Hazards, United States

HMGP—Hazard Mitigation Grant Program

IPCC—Intergovernmental Panel on Climate Change

Mw—Moment Magnitude Scale

mph—Miles per hour

NASA—National Aeronautics and Space Administration

NEHRP—National Earthquake Hazards Reduction Program

NFIP—National Flood Insurance Program

NIDIS—National Integrated Drought Information System

NIMS—National Incident Management System

NOAA—National Oceanic and Atmospheric Administration

NPS—National Park Service

NRCS—Natural Resources Conservation Service

NWS—National Weather Service

OFM—Office of Financial Management (Washington State)

PDM—Pre-Disaster Mitigation Grant Program

PGA—Peak Ground Acceleration

RCW—Revised Code of Washington

SEPA—State Environmental Policy Act

SFHA—Special flood hazard area

USDA—U.S. Department of Agriculture

USGCRP—U.S. Global Change Research Program

USGS—U.S. Geological Survey

WAC—Washington Administrative Code

WDNR—Washington Department of Natural Resources

WPPSS—Washington Public Power Supply System

WRIA—Water Resource Inventory Area

Chelan County Multi-Jurisdiction Natural Hazard Mitigation Plan

Appendix A. Public Involvement Materials

STEERING COMMITTEE MEETINGS

Agenda

Chelan County Natural Hazard Mitigation Plan Update
"Kick-Off" Meeting
Tuesday, June 12, 2018
10:00 AM – 12:00 PM
Chelan County FD #1-Station 11
206 Easy Street, Wenatchee, WA

Objectives

- Why are you here?
- Disaster Mitigation Act Overview
- The 2018 Plan Update
- Next Steps

Welcome and Introductions — **Hillary Heard & Mike Kaputa, Chelan County**

- Introductions
- Review Agenda - changes /additions

Why are you here? — **Rob Flaner, Tetra Tech, Inc**

- "Stakeholder's" defined
- What is a local Government?
- What is mitigation

Disaster Mitigation Act-and Overview

- Provisions of the Disaster Mitigation Act (DMA)
- Benefits to hazard mitigation planning
- Chelan County's response to the DMA
- Plan Updates

The 2018 Plan Update

- The Planning Team
- Work Plan
- Timeline
- Planning Partner Expectations
- The Jurisdictional Annex process
- The Steering Committee
- Status of the current Plan and eligibility for FEMA funding
- Matching contributions from Planning Partners

Next Steps

- Deadline to submit Letter of interest (LOI)
- Initiate Steering Committee process
- Mine data for the Risk assessment
- Initiate the Jurisdictional Annex Process

Questions & Answers

Next meeting date & Adjourn

MEETING SUMMARY

Date/Time of Meeting:	Tuesday – June 12, 2018; 10:00am to Noon
Location:	Chelan County Fire District #1, Station 11, 206 Easy Street Wenatchee, WA
Subject:	Kick-Off Meeting
Project Name:	Chelan County Natural Hazards Mitigation Plan Update
In Attendance (See Attachment):	**Attendees:** Jason Detamore, Mike Kaputa, Todd Kilpatrick (conference call), Arnold Balier, Alex Roberts, Mike Cushman, Cliff Burdick, Craig Gildroy, Jim Brooks, Rob Jammerman, Kent Sisson, Jon Riley, Brian Brett **Planning Team:** Rob Flaner, Christina Wollman, Hillary Heard
Not Present:	N/A
Summary Prepared by:	Christina Wollman (6/15/2018)
Quorum – Yes or No	N/A

Item	Action

<u>Welcome and Introductions</u>

- Mike Kaputa opened the Chelan County Natural Hazard Mitigation Plan (HMP) Update Kick-Off meeting with introductions and project history.
- The following handouts were provided: Agenda, Draft Planning Partner Expectations, Scope of Services, and Presentation.

<u>Why are you here? 2018 Plan Update.</u>

- Rob Flaner gave a presentation and provided an overview of the Disaster Mitigation Act and the HMP Update planning process. He discussed stakeholders, definition of local government, the five phases of emergency management, and examples and benefits of mitigation. He also discussed the planning update process, timeline, expectations, and levels of effort for the planning partnership. New Letters of Intent (LOI) will need to be signed by all jurisdictions that want to participate, and a steering committee will need to be formed.
- Rob also discussed the grant programs that jurisdictions become eligible for with an approved HMP, which include the Pre-Disaster Mitigation and Hazard Mitigation Grant Programs. He explained that if the jurisdiction's HMP is expired, the State Emergency Management Division must request extraordinary

Item	Action

circumstances to apply for the HMGP grant, and the plan must be updated prior to grant award, but for a PDM grant the jurisdiction must have an approved plan at time of application and time of award. For this reason the plan is on an expedited planning process, with a draft completed by December and final approval in February.

Next Steps

- The group discussed funds available to pay for the plan update. Two $25,000 FEMA grants were received by the County to pay for the update, but the update will cost $69,000. The County and State have tried to get more funding from FEMA, but no additional funding is available so planning partners are being asked to participate financially. Some meeting participates noted that they may need to go to political leaders for approval to provide financial support.
- Different ideas were discussed, such as splitting the $19,000 evenly between all planning partners, or some larger jurisdictions paying more to assist the smaller jurisdictions who may not have discretionary funds in the budget.
- Mike Kaputa stressed that no jurisdiction will be left out of the plan if they do not have the funds to participate.
- The group decided to include a statement on the LOIs that ask how much each jurisdiction is able to contribute to the planning effort with the hope that some of the jurisdictions can contribute more and take some pressure off the smaller jurisdictions.
- The first steering committee meeting will be held in July. The Planning Team will begin to develop a list of potential steering committee members, which will include representation outside of the Planning Partnership.
- The Community Wildfire Protection Plan is under development through a separate process and will be incorporated into the HMP. The CWPP process has been extended until March. Action development between HMP and CWPP will occur between September and October. A CWPP leader will be asked to sit on the Steering Committee.

Meeting was adjourned at 12:00 PM

The next meeting will the first Steering Committee meeting, date and time TBD.

Natural Hazard Mitigation Plan Update Kick Off Meeting

June 12, 2018; 10:00 AM-12:00 PM

Sign In Sheet

Name	Organization	Phone #	Email
Christina Wollman	Tetra Tech	509-988-0661	christina.wollman@tetratech.com
Arnold Baker	Chelan Co Fire Dist 5	509-670-2775	arnoldb@mansonfire.org
Alex Roberts	Chelan Co. Dist #3	509-548-7711	alex@ChelanFD3.org
Mike Cushman	Cascadia CD	509-436-1601	MikeC@cascadiacd.org
Cliff Burdick	City of Wenatchee	888-3257	cburdick@wenatcheewa.gov
Craig Gildroy	City of Chelan	682-8020	cgildroy@cityofchelan.us
Jim Brooks	City of Entiat	679-1527	Jbrooks.city@entiatwa.us
Rob Jammerman	City of Wenatchee	888-3205	RJammerman@wenatcheewa.gov
Jason Detamore	CCPW	667-6573	Jason.Detamore@co.chelan.wa.us
Kent Sisson	C.C. Emergency Mgmnt	630-7506	kent.sisson@co.chelan.wa.us
Jon Riley	CCFD #1	509-662-4734	jriley@chelancountyfire.com
Brian Brett	CCFD #1	509-662-4734	

Agenda

Chelan County Hazard Mitigation Plan Update
1st Planning/Steering Committee Meeting
Thursday, July 19, 2018
10:00am – 12:00PM
Confluence Technology Center
285 Technology Center Way, Suite 102
Wenatchee WA

Welcome and Introductions

- Introductions
- Review Agenda – changes / additions

Planning Partnership Status

- Letter of Intent (LOI) received to date
- Cost sharing status
- Grant status

The Steering/Planning Committee Organization

- Steering Committee purpose & definition
- Steering Committee expectations
- Steering Committee Organization
- Steering Committee ground rules
    - Consensus vs. voting
    - Leadership
    - Attendance
- Meeting dates/times

Plan Review

- Discuss and Confirm Hazards of Concern
- Discuss Current Plan Goals/Objectives
- Discuss Mission/Vision Statement

Public Involvement Strategy

- Public Engagement Meetings
- Additional Outreach Capabilities (suggestions welcomed)
    - Website
    - Questionnaire
    - Press/media
    - Social Media

Action Items and Next Steps

- Document and Data Request
- Provide review comments on existing HMPs – County and State
    - Identify changes/enhancements to be included in existing HMP
- Confirm Hazards of Concern, Goals, and Public Involvement Strategy
- Define and Confirm Critical Facilities
- Update the Risk Assessment

Questions & Answers

Next Meeting date & Adjourn

MEETING SUMMARY

Date/Time of Meeting:	Thursday July 19, 2018; 10:00 am to Noon
Location:	Confluence Technology Center, 285 Technology Center Way Wenatchee, WA
Subject:	Kick-Off Meeting
Project Name:	Chelan County Natural Hazards Mitigation Plan Update
In Attendance **(See Attachment):**	**Attendees:** Jason Detamore, Mike Kaputa, Mike Cushman, Cliff Burdick, Craig Gildroy, Brian Brett, Tim Cook (EMD), Debbie Meador (EMD), John RIcardi, Mick Lamar, Stan Smoke, Luis Gonzalez, Bob Plumb, Jim Fletcher **Planning Team:** Rob Flaner (call in), Christina Wollman, Hillary Heard
Not Present:	City of Leavenworth, City of Entiat, Kent Sisson, Fire Districts 3, 5, 6, 7, and 8.
Summary Prepared by:	Christina Wollman (7/19/2018)
Quorum – Yes or No	Yes

Item	Action

Welcome and Introductions

- Mike Kaputa opened the Chelan County Natural Hazard Mitigation Plan (HMP) Update Kick-Off meeting with introductions.
- The agenda was updated to include a presentation from guest speaker Tim Cook about the new HMGP Post Fire grant program.
- The following handouts were provided: Agenda, Draft Steering Committee Ground Rules.

Planning Partnership Status

- Hillary Heard gave an update on the status of the Letters of Intent and funding contributions. As of today, Wenatchee has agreed to contribute $5,000, CCFD #1 $2,714, and CCCD $1,000 or more. Requests for the remaining cities, districts, and the County are in the process of being decided. The PDM grant award has been postponed from its original June date, and is not expected to be awarded until August or September.

HMGP Post Fire Presentation

Item | **Action**

- Tim Cook provided the committee information about the new Post Fire Hazard Mitigation Grant Program, which provides mitigation grant funds after a FMAG fire is declared. He passed out a handout which summarized the new grant program. The County in which the fire occurred is prioritized for the funding. Chelan County is prioritized for funding due to a FMAG declaration from 2017.
- Because the County's current HMP is expired, the County is not eligible to receive HMGP funding. However, because the plan is actively being updated the state may be able to claim extenuating circumstances if enough progress can be shown in November to allow the state to feel certain the plan will be completed on time.

Action:

- The Planning Team will discuss the level of effort that needs to be shown in November with Derrick Hiebert of EMD.
- The County will discuss a process to internally prioritize projects submitted for grant application.

Steering Committee Organization

- The committee discussed the draft ground rules and decided on the following:
  - Chief Brett, FD#1 will be Chair and John RIcardi, City of Wenatchee will be Vice Chair.
  - Quorum will be 5 Steering Committee members.
  - Alternates will be fully interchangeable.
  - Decisions will be made by consensus.
  - Hillary Heard will be the spokesperson.
  - Meetings will be the third Thursdays from 10:00 – 12:00.

Plan Review

- Christina outlined the topics for the next Steering Committee meeting, which include discussing and confirming the hazards of concern, reviewing the plan's goals and objectives and mission statement.
- The committee will be asked to review the new Washington State Hazard Mitigation Plan to determine which hazards should be included in the updated plan. The plan's goals also need to correspond with the state's plan.

Action:

- A link to the newly updated state plan will be provided to the SC members, along with additional guidance on the review that needs to occur prior to the next meeting.

Public Involvement Strategy

- Christina and Rob outlined the two public open houses which will occur during the planning process. The first will occur after the risk assessment is completed, and the second will occur after the draft plan is completed. Similar to the CFHMP process, the committee prefers that each meeting be held in three locations: Wenatchee, Leavenworth, and Chelan. The first public meeting is tentatively scheduled for September.

Item	Action
• Outreach will include using social media. The committee agreed that the County's Emergency Management Facebook feed is the most popular and should be the primary account. Other agencies, if they have their own accounts, can share the EM posts. ***<u>Action Items and Next Steps</u>*** • The consultant team will continue with the update to the risk assessment and may request data or documents from committee members. • Critical facilities will be reviewed and updated.	• Committee members will provide their alternates to Hillary by July 31.

Meeting was adjourned at 11:55 AM

The next meeting will the second Steering Committee meeting, August 21, 2018 at 10:00 am at the CTC.

MEETING SUMMARY

Project Chelan County HMP Update

Subject Steering Committee #1

Prepared by

Project No.

Date 7/19/18

PERTEET

Name	org	phone/email
1. Tim Cook	WA EMD	tim.cook@mil.wa.gov
2. Debbie Meador	WA EMD	Debera.Meador@mil.wa.gov
3. John Ricardi	City of Wenatchee	jricardi@wenatchee wa.gov
4. Cliff Burdick	" " "	cburdick@wenatcheewa.gov
5. Mick Lamar	Lake Wen. Fire	lwfrchief@nwi.net
6. Stan Smoke	CC EM	Stan.smoke@co.chelan.wa.u
7. BRIAN BRETT	CCFD #1	on file
8. Luis Gonzalez	City of Chelan	lgonzalez@cityofchelan.US
9 Craig Gildroy	" "	cgildroy@cityofchelan.us
10 Bob Plumb	CC Fire, Life safety & Inv.	bob.plumb@co.chelan.wa.u
11 MIKE CUSHMAN	CASCADIA CD	MIKEC@CASCADIACD.ORG
12 JASON DETAMORE	CCPW/FCZD	JASON.DETAMORE@CO.CHELAN.WA.US
13 Mike Kaputa	CCNRD	mike.kaputa@co.chelan.wa.us
14 Jim Fletcher	Mayor Cashmere	
15 Christina Wollman	perteet	
16 Hillary Heard	CCNRD	

Agenda

Chelan County Hazard Mitigation Plan Update

2nd Planning/Steering Committee Meeting
Tuesday, August 21, 2018
10:00am – 12:00pm
Confluence Technology Center
285 Technology Center Way, Suite 102
Wenatchee WA

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1. Welcome and Introductions

- Group Introductions
- Review Agenda
- Planning Partners Status Update
- Review/Approve SC meeting #1 summary
- Review/Approve Final SC Ground Rules

2. Plan Review

- State Plan review
  - What Hazards did the State identify for Chelan?
  - What are the State Plan Goals?
- Chelan County HMP review
  - What do you like or not like about the plan, content, and layout?

3. Hazards of Concern

- Based on your review of both the State plan and the prior Chelan County plan, what hazards of concern should this plan update address?
  - Natural Hazards? (mandatory)
  - Non-natural hazards? (optional)
- CWPP Integration - Status of the CWPP update

4. Goal Setting

- The prior plan identified a Mission statement. Has that changed for this plan update?
- Based on the review of the State plan and the prior Chelan County plan, should the goals from the prior plan be revised, enhanced, replaced?
- Do the goals clearly address the mission?
- Goal setting exercise

5. Public Involvement Strategy

- Website - What is the status?
- Press release announcing the process
- Social media options
- Hazard Mitigation Survey - Do we want to do one?
  - Craft language for Chelan County (if applicable)
- Public Meeting schedule

6. Action Items and Next Steps

- Document and Data Request
- Identify objectives for the plan
- Define Critical Facilities/Infrastructure
- Risk Assessment update

7.0 Adjourn

MEETING SUMMARY

Date/Time of Meeting:	Tuesday, August 21, 2018; 10:00 am to Noon
Location:	Confluence Technology Center, 285 Technology Center Way Wenatchee, WA
Subject:	Steering Committee Meeting #2
Project Name:	Chelan County Natural Hazards Mitigation Plan Update
In Attendance (See Attachment):	**Attendees:** Jason Detamore, Mike Cushman, Cliff Burdick, Craig Gildroy, Brian Brett, John Ricardi, Stan Smoke, Bob Plumb, Joel Walinski, Kirk Holmes, Jon Riley, Katherine Kiendl **Planning Team:** Rob Flaner (call in), Christina Wollman, Hillary Heard
Not Present:	City of Cashmere, City of Entiat,
Summary Prepared by:	Christina Wollman (8/22/2018)
Quorum – Yes or No	Yes

Item	Action

Welcome and Introductions

- Christina Wollman opened the Chelan County Natural Hazard Mitigation Plan (HMP) Update Kick-Off meeting with introductions.
- The agenda was updated to include questions and answers at the end of the meeting.
- The following handouts were provided: Agenda, Final Draft Steering Committee Ground Rules, Meeting Summary #1, Example Survey, Goals Setting Exercise, excerpts from the State Hazard Mitigation Plan and current County HMP.

Planning Partnership Status

- Hillary Heard gave an update on the status of the Letters of Intent and funding contributions. Letters of Intent have been received from Wenatchee, Leavenworth, Chelan, Chelan County FCZD, Cascadia Conservation District, Fire District 1 and the City of Cashmere. The City of Leavenworth has the letter on the agenda at their next Council meeting. Hillary is following up with the status of the letter from the City of Entiat and the County Commissioners.

Meeting Summary and Ground Rules Approval

Item	Action

- The meeting summary was reviewed. Joel Walinski motioned to approve the meeting summary. Jason Detamore seconded the motion. The motion passed.
- The Steering Committee Ground Rules were reviewed by the committee. John Ricardi motioned to approve the Ground Rules. Craig Gildroy seconded the motion. The motion passed.

Plan Review

- The committee discussed the State Enhanced Hazard Mitigation Plan. Cliff Burdock noted he questioned the state's assessment of the County's avalanche risk. Rob Flaner explained this project will utilize the same data for the risk assessment. We can provide the state more accurate information if our risk assessment has different results.
- Christina explained the plan format. The plan will be in two volumes. General information about the planning process and county-wide hazard data will be within the first volume, and annexes will be within the second volume.

Hazards of Concern

- The Committee discussed the hazards that are within the state HMP and current County HMP. The County's plan currently includes volcano as a risk, while the state plan does not identify risk for the County. The committee agreed to remove volcano from the plan update. Additional hazards identified within the county which are not in the state plan include seiche, dams, and climate change. The committee agreed to include these hazards into the risk assessment. Climate change will be a profile chapter similar to the Flood Management Plan.
- The committee discussed non-natural hazards, including cyber hazards related to crypto currency mining. The committee agreed that this hazard should be monitored and included in the next plan update if necessary.
- Bob Plumb noted concerns with agriculture and issues such as Fire Blight. The committee discussed the importance of agriculture and the vulnerability to different hazards. The committee agreed to include an agriculture chapter which summarizes all of the potential impacts.
- A brief CWPP update was given by Mike Cushman. Due to fire season, the plan's progress has moved slowly. It is expected to resume next month as fire season winds down.

Goal Setting

Item	Action
• Christina explained the need to review and if necessary update the goals and mission statement. The County's goals must align with the State HMP goals. • The committee reviewed the mission statement. John Ricardi motioned to recommend no updates to the mission statement Joel Walinski seconded the motion. The motion passed. • The committee reviewed the current goals. Although they liked the goals in general, they identified three phrases they would like incorporated into the goals: resiliency, prevention, and whole community. They also agreed that goals should not be in a priority order in the plan update. The committee requested Christina to wordsmith the current goals to include the three phrases for review and approval at the next meeting. John Ricardi suggested combining the first and second goal into one.	• Christina will update the goals statements to include the four new phrases. The updated goals will be sent out to the committee to review prior to the next meeting.
<u>Public Involvement Strategy</u> • Christina discussed the public involvement strategy, which includes the county website, social media, press releases, and public meetings. All Planning Partners are requested to provide a link to the County HMP website on their website and social media. The committee discussed that the social media effort should include the press release, and it will be released by the County EMD Facebook page and be shared by other social media sites. • The public meeting strategy was discussed. It is still unknown if the CWPP process will be ready to join in the public meetings, scheduled for October 9-11. The committee discussed the need to include additional partners at the meetings to promote public involvement, and identified partners such as DNR, CCC, FCZD, EMD, and USFS who may be able to attend and provide information. • Mike Cushman noted that if the proposed funding program for fuels reduction type projects on private property will be discussed, the cost sharing should be clarified, as it has been a point of confusion in the past. • The committee agreed they would like to have a survey to gain public insight. Due to a lack of time at the meeting, the survey questions were not reviewed. Christina requested the committee review the survey over the next two weeks and provide comment back to Hillary. The committee also noted that the survey must be released in both English and Spanish. Jason Detamore noted his department has a translator than can help with the survey questions.	• The committee will review the survey questions and provide comment to Hillary within the next two weeks.

Item	Action
Action Items and Next Steps	

- The consultant team will continue with the update to the risk assessment and may request data or documents from committee members.
- Critical facilities will be reviewed and updated.
- Objectives will be identified.

Meeting was adjourned at 12:00 PM

The next meeting will the second Steering Committee meeting, August 21, 2018 at 10:00 am at the CTC.

MEETING SUMMARY

CHELAN COUNTY HAZARD MITIGATION PLAN UPDATE

Steering Committee Meeting #2 – Sign-In Sheet

August 21, 2018

Name	Agency	Contact Info
JASON DETAMORE	CCPW/CCFC2D	ON FILE
Joel Walinski	City of LEAVENWORTH	file
MIKE CUSHMAN	CASCADIA CO	"
Kirk Holmes	Perteet	kirk.holmes@perteet.com
Christina Wollman	perteet	
BRIAN BRETT	CCFD #1	ON FILE
Hillary Heard	CCNRD	Hillary.Heard@CO.CHELAN.WA
Bob Plumb	Chelan County Fire Prevention + [illegible]	bob.plumb@co.chelan.wa.us
Stan Smoke	CCEM	on file
Craig Gildroy	City of Chelan	cgildroy@cityofchelan.us
Cliff Burdick	City of Wenatchee	On File
John Ricardi	City of Wenatchee	on file
JON RILEY	CCFD #1	jriley@chelancountyfire.com
Katharine Kiendl	CCFD #1	KKiendl@chelancountyfire.com

Chelan County Hazard Mitigation Plan
3rd LHMP Update Steering Committee Meeting
Thursday – September 20, 2018
10:00am – 12:00PM
Confluence Technology Center
285 Technology Center Way, Suite 102
Wenatchee WA

Welcome and Introductions

- Group Introductions
- Review Agenda
- Planning Partners Status Update
- Review/Approve SC meeting #2 summary
- Review/Approve proposed Goal revisions

Risk Assessment Update

- Status report of the development of the risk assessment

Objectives

- An "objective" is the result or achievement toward which effort is directed or aimed. Objectives are intended to be clear and measurable.
- The 2010 Plan did not clearly define objectives.
- For this update, we will define objectives which will provide the plan more flexibility in the grant arena.
- These will be linear planning components, meaning objectives will be identified that meat multiple goals, and stand on their own merit
- Review the Catalog of objective statements and identify which objectives will meet multiple goals.
- Identify the objectives for the plan

Defining Critical Facilities

- A key objective for these plans is to target vulnerable critical facilities/infrastructure as defined the process for mitigation actions.
- To target CF/CI for mitigation, we need to assess vulnerability
- To assess vulnerability, we need to inventory the CF/CI in the planning area
- To inventory, we need to define
- CF/CI was not really defined in the 2010 plan
- So, how should we define CF/CI for this plan update?
- Review example definitions

Public Involvement Strategy

- Website-What is the status?
- Press release announcing the process
- Confirm Survey Content and dissemination schedule

Action Items and Next Steps

- Phase 1-Jurisdictiona Annex Process
- Hazard specific scenarios for the risk assessment
- Introduction to SWOO!

Adjourn

MEETING SUMMARY

Date/Time of Meeting:	Thursday, September 20, 2018; 10:00 am to Noon
Location:	Confluence Technology Center, 285 Technology Center Way Wenatchee, WA
Subject:	Steering Committee Meeting #3
Project Name:	Chelan County Natural Hazards Mitigation Plan Update
In Attendance (See Attachment):	**Attendees:** Josh Patrick, Bob Plumb, Cliff Burdick, Craig Gildroy, Mick Lamar, Brian Brett, Mike Cushman, Joel Walinski, John Ricardi, Jon Riley **Planning Team:** Rob Flaner, Hillary Heard
Not Present:	City of Entiat, City of Cashmere, FD #3
Summary Prepared by:	Rob Flaner (10/11/2018)
Quorum – Yes or No	Yes

Item	Action
Welcome and Introductions	
• Chief Brett opened the Chelan County Natural Hazard Mitigation Plan (HMP) Update Kick-Off meeting with introductions. • The agenda was updated to include questions and answers at the end of the meeting. • The following handouts were provided: Agenda, Meeting # 2 summary, Risk Assessment update memo, proposed goal revisions, Critical facility exercise, catalog of objective statements, and a sample hazard mitigation survey.	
Planning Process	
• The meeting summary from SC meeting #2 was reviewed and approved.	
• Planning Partner status-Hillary informed that she has received confirmation or participating from 2 fire districts (#1 and #3). Rob stated to the SC that we needed to establish a cut line for when we would accept LOI's. Hillary had been asked to come speak to the County Fire Chiefs meeting to make one list pitch to the Fire District. It was decided that the deadline for accepting LOI's would be by the next SC meeting (10/18//2018).	Hillary to meet with County Fire Chiefs.
• Goals- The SC reviewed proposed revisions to the Goals that were reviewed at the last meeting. These revisions were reviewed and	

Item	Action

approved as proposed. The final goals for this plan update are as follows:

1. ***To Protect People and Property*** *by making Chelan County homes, businesses, infrastructure, critical facilities, and other property more resilient and resistant to losses from natural hazards*

2. ***To Protect the Economy*** *by developing mechanisms that ensure commerce, trade, and essential business activities remain viable in the event of a natural disaster*

3. ***To Protect the Environment*** *by preserving, rehabilitating, and enhancing natural systems to serve natural hazard mitigation functions*

4. ***To Strengthen Emergency Services*** *by increasing collaboration, coordination, and capabilities among public agencies, non-profit organizations, business, and industry*

5. ***To Increase Public Awareness and Education*** *by providing the public information, tools, and funding resources for implementing mitigation activities to prevent future losses from natural hazards*

6. ***To Establish and Strengthen Partnerships for Implementation*** *through coordination and collaboration of the whole community, including public agencies, citizens, non-profit organizations, businesses, tribes, and industries whose authorities and capabilities will support implementation of planning for a disaster-resistant Chelan County*

Risk Assessment Update

- Rob walked the SC the Risk assessment update memo. In summary, the items discussed were as follows:
    - All data for base mapping and general building stock updates have been mined and are being formatted for analysis.
    - The flood hazard depth grids for developed for the Chelan County Comprehensive Flood Hazard Management Plan will be utilized to the flood risk assessment.
    - USGS Shake maps for the Chelan (M7.2) fault scenario and the Cascadia (M9.0) fault scenario have been obtained by

Item	Action
the planning team. Rob asked the SC if there were a strong opinion on which scenarios should be analyzed for the risk assessment. No strong opinion was presented, and the Committee deferred that decision to the opinion of the planning ream based on which scenarios have the most impacts on the planning area.	

Objectives

Rob explained to the SC, that now that goals have been confirmed by the SC, it is time to identify objectives for the plan. An "objective" is the result or achievement toward which effort is directed or aimed. Objectives are intended to be clear and measurable. The 2010 Plan did not clearly define objectives. Robe stated that for this update, we will define objectives which will provide the plan more flexibility in the grant arena. These will be linear planning components, meaning objectives will be identified that meat multiple goals, and stand on their own merit. The SC was provided a catalog of example goal statements from other mitigation plans in Eastern Washington to review.

The Catalog spurred some productive conversation as to how the objectives would apply to each planning partner, Joel Walinski from the City Leavenworth asked, "what if the City did not want to adopt a certain objective"? Rob stated that it was the intent of the multi-jurisdictional planning effort to have 1 set of goals and objectives that applied to the entire planning partnership. This process was not set up for identifying individual goals and objectives for each planning partner. Rob then stated that since the objectives will be utilized to help prioritize actions, that a community could identify actions outside of the purview of a specific objective, if they did not agree with a specific objective. After much discussion, it was decided that the SC need more time to review the objective alternatives before confirming the final objectives for the plan. Rob asked the SC to review the objective catalog handout prior to the next SC meeting, where the SC will do an exercise that looks to identify the objectives that meet the most goals, and then select objective statement from that pool of alternatives.

Action: SC to review the Objective Catalog handout prior to the next meeting.

Defining Critical Facilities

For this segment, the SC reviewed some various definitions of "Critical facilities/Infrastructure" for other hazard mitigation plans. Rob explained that a key objective for mitigation plans is to target vulnerable critical facilities/infrastructure as defined the process for mitigation actions. To target CF/CI for mitigation, we need to assess vulnerability and to assess vulnerability, we need to inventory the CF/CI in the planning area. To inventory, we need to define what facilities and infrastructure in the planning area are critical to support the response and recovery from the

Item	Action
impacts of hazards. Rob stated that CF/CI were not really defined in the 2010 plan. It is the planning team's recommendation that the SC consider the definition utilized in the County's Comprehensive Flood Plan, namely for consistency. Rob asked if the County's Emergency Operations Plan had defined CF/CI. No one in attendance new the answer to that question. Hillary stated that she would reach out to County Emergency Management Staff to find out the answer. It was the direction of the SC that the mitigation plan should have a CF/CI definition that is consistent with other definitions in use in the County. The SC wanted to table the confirmation of this definition to allow more time to determine this level of consistency. The CF/CI definition will be confirmed at the next meeting on 10/18.	Hillary to reach out to County EM staff to see how the County's EOP addresses CF/CI. SC to confirm definition of CF/CI at 10/18 SC meeting
<u>Public Involvement Strategy</u> Under this segment, the SC discussed the Public involvement strategy for the plan. Key points discussed were as follows:	
• Website- The mitigation plan website is up and running. It is housed on the County Natural Resources Planning page at: https://www.co.chelan.wa.us/natural-resources/pages/natural-hazard-mitigation-plan Rob asked that planning partners and SC members that have web pages create links to this site on their pages.	SC members and planning partners to establish links to the website.
• Press release- Rob stated that now that the web page is up and running, we need to get out a press release announcing the plan update process as well as the website for information on the plan update process. Rob stated that the planning team would get an example press release to Hillary as soon as possible.	Planning team to distribute press release announcing the website
• Hazard Mitigation Survey- The SC went through an example survey form a planning effort that included both a mitigation plan and a CWPP update. The SC went through each of the 41 questions in the survey and edited accordingly for application in Chelan County. The resulting product was a 40-question survey, specific to the Chelan County planning area. The planning team will format the survey using "Survey Monkey" and have it ready for deployment prior to the public meetings. The survey will be bi-lingual in both English and Spanish.	Planning team to format the survey in Survey monkey and ready the survey for deployment prior to the phase 1 public meetings
• Phase 1 Public meetings- The phase 1 public meetings have been scheduled for October 9,10 and 11. The meetings will be held in the evening, from 6:00 pm to 8:00 pm in Wenatchee on October 9th at Wenatchee City Hall, in Leavenworth on October 10th at Leavenworth City Hall, and in Chelan on October 11th at Chelan County Fire District 7. A press release announcing meeting dates and times will be distributed by the planning team	Planning team to distribute press release announcing the phase 1 public meetings

Item	Action

Action Items and Next Steps

- SC to review objectives catalog
- SC to review/conform CF/CI definition
- Phase 1 public meetings
- Phase 1 jurisdictional Annex process

Meeting was adjourned at 12:00 PM

The next meeting will the second Steering Committee meeting, October 18, 2018 at 10:00 am at the CTC.

MEETING SUMMARY

CHELAN COUNTY HAZARD MITIGATION PLAN UPDATE

Steering Committee Meeting #3 – Sign-In Sheet

September 20, 2018

Name	Agency	Contact Info
Josh Patrick	Chelan County FCZD	
~~Dave Nalle~~	~~dave@chelanfd3.org~~	~~CCFD #3~~
Bob Plumb	Chelan County Fire Prevention & Inv.	
Cliff Burdick	City of Wenatchee	
~~Chris Gonzalez~~ Craig Bidiman	City of Chelan	
Mick Lismar	Lake Wen. F&R (CCFD9)	
Brian Brett	CCFD#1	on file
Mike Cushman	Cascadia CD	" "
Jarl Walinski	City of Leavenworth	File
John Ricardi	City of Wenatchee	" "
Hillary Heard	Chelan County	on file
Jon Riley	CFD1	" "

Agenda

Chelan County Hazard Mitigation Plan Update

4th Planning/Steering Committee Meeting
Thursday, October 18, 2018
10:00am – 12:00pm
Confluence Technology Center
285 Technology Center Way, Suite 102
Wenatchee WA

1.0 Welcome and Introductions

- Group Introductions
- Review Agenda
- Planning Partners Status Update
- Review/Approve SC Meeting #3 summary
- Confirm Critical Facilities definition

2.0 Risk Assessment Update

3.0 Objectives Exercise

- An “objective” is the result or achievement toward which effort is directed or aimed. Objectives are intended to be clear and measurable.
- The 2010 Plan did not clearly define objectives. For this update, we will define objectives which will provide the plan more flexibility in the grant arena.
- These will be linear planning components, meaning objectives will be identified that meet multiple goals, and stand on their own merit.
- Review the catalog of objective statements and identify which objectives will meet multiple goals.
- Identify the objectives for the plan
- Complete Exercise
- Confirm Objectives

4.0 Phase 1, Jurisdictional Annex process

- Plan will be reformatted for this update, 2 Volume approach
- The basis for volume 2 will be jurisdiction specific annexes for each planning partner
- These annexes will be completed in the following 3 phases:
  - Phase 1-Juursdiction Profile
  - Phase 2-Core Capability Assessment
  - Phase 3-Risk Ranking /Action Plan development
- The Phase 1 templates and instructions will be sent to all planning partners by 10/26/2018
- 30-Days to complete

5.0 Public Involvement Strategy

- Survey - What is the status?
- Public meetings recap

6.0 Action Items and Next Steps

- Phase 2-Jurisdictional Annex Process
- Plan maintenance strategy
- Introduction to SWOO

Agenda

Chelan County Hazard Mitigation Plan Update

4th Planning/Steering Committee Meeting
Thursday, October 18, 2018
10:00am – 12:00pm
Confluence Technology Center
285 Technology Center Way, Suite 102
Wenatchee WA

7.0 Adjourn

MEETING SUMMARY

Date/Time of Meeting:	Thursday, October 18, 2018; 10:00 am to Noon
Location:	Confluence Technology Center, 285 Technology Center Way Wenatchee, WA
Subject:	Steering Committee Meeting #4
Project Name:	Chelan County Natural Hazards Mitigation Plan Update
In Attendance (See Attachment):	**Attendees:** Jason Detamore, Alex Roberts, Dave Nalle, Bob Plumb, Cliff Burdick, Luis Gonzalez, Mick Lamar, Brian Brett, Mike Cushman, Joel Walkinski, John Ricardi, Kent Sisson, Stan Smoke, Jon Riley **Planning Team:** Christina Wollman, Hillary Heard
Not Present:	City of Entiat, City of Cashmere
Summary Prepared by:	Christina Wollman (10/19/2018)
Quorum – Yes or No	Yes

Item	Action

Welcome and Introductions

- Chief Brett opened the Chelan County Natural Hazard Mitigation Plan (HMP) Update Kick-Off meeting with introductions.
- The following handouts were provided: Agenda, Meeting #3 Summary, risk assessment update memo, objectives exercise, Critical facility definitions, Phase 1 Annex exercise for districts and municipalities.

Planning Process

- The meeting summary from SC meeting #3 was reviewed and approved, with the amendment to update the attendees list.
- Christina explained that as decided at the last meeting the deadline for joining this planning process is today's meeting. As of the meeting LOIs from all five cities, the FCZD and CCD, and Fire Districts #1, 3 and 9 have been received.

Critical Facility Definition

- The SC decided to use the definition from the Chelan County CFHMP but amend it to include more description of utilities taken

Item	Action

from the Spokane County example. The definition of critical facilities approved by the SC is:

A critical facility is defined as a local (non-State or Federal) facility or infrastructure in either the public or private sector that provides essential products and services to the general public, such as preserving the quality of life in Chelan County and fulfilling important public safety, emergency response, and disaster recovery functions. Loss of a critical facility would result in a severe economic or catastrophic impact and would affect the County's ability to provide those essential services that protect life and property. The critical facilities profiled in this plan include but are not limited the following:

- Government facilities, such as departments, agencies, and administrative offices
- Emergency response facilities, including police, fire, and Emergency Operations Centers
- Educational facilities, including K-12
- Medical and Care facilities, such as hospitals, nursing homes, continuing care retirement facilities and housing likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a hazard event
- Community gathering places, such as parks, museums, libraries, and senior centers
- Public and private utilities and infrastructure vital to maintaining or restoring normal services to areas damaged by hazard events. These facilities include but are not limited to:
    - Public and private water supply infrastructure, water and wastewater treatment facilities and infrastructure, potable water pumping, flow regulation, distribution and storage facilities and infrastructure
    - Public and private power generation (electrical and non-electrical), regulation and distribution facilities and infrastructure
    - Data and server communication facilities
    - Structures that manage or limit the impacts of natural hazards such as regional flood conveyance systems, potable water truck, main interconnect systems and redundant pipes crossing fault lines and reservoirs
    - Major road and rail systems including bridges, airports and marine terminal facilities
- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic, and/or water-reactive materials

Item	Action
Risk Assessment Update	
• Christina walked the SC though the risk assessment update memo. The availability and type of avalanche data was questioned. The following data is still required: o Dam inundation zones, if available. Both Kent and Jason can help to secure this data. o Updated land use data.	Christina to provide Tt assistance with securing the remaining data.

Objectives Exercise

Christina followed up the objectives discussion from the previous SC meeting. An "objective" is the result or achievement toward which effort is directed or aimed. Objectives are intended to be clear and measurable. The 2010 Plan did not clearly define objectives. The SC was provided an exercise with a catalog of example goal statements from other mitigation plans in Eastern Washington. They were asked to review the objectives and identify which objectives met the goals of the plan. After they completed, Hillary and Christina compiled the results and presented the SC with the results. The SC discussed the results and combined similar results and edited the chosen objectives. The objectives as approved by the SC are:

1. Improve and protect early warning emergency response systems and plans.
2. Sustain continuity of local emergency and government operations, including the operation of identified critical facilities, during and after a disaster.
3. Provide/improve fire protection thru proactive fuels management programs.
4. Encourage and incentivize mitigation of private property through programs such as the Community Rating System, Firewise and Storm Ready programs.
5. Reduce natural hazard-related risks and vulnerability to populations, critical facilities and infrastructure within the planning area.
6. Reduce natural hazard-related risks and vulnerability to populations, critical facilities and infrastructure within the planning area.
7. Collect, use and share the best available data, science and technologies to improve understanding of the location and potential impacts of natural hazards, the vulnerability of building types, and community development patterns and the measures needed to protect life safety and natural and built environments.

Item	Action

8. Seek mitigation projects that will provide protection to the natural and built environments.
9. Enhance emergency response partnership capabilities to include mitigation of vulnerable critical facilities and infrastructure.
10. Create and enhance partnerships among all levels of government and the business community to coordinate mutually beneficial mitigation strategies.
11. Strengthen codes so that new construction can withstand the impacts of identified natural hazards and lessen the impact of that development on the environment's ability to absorb the impact of natural hazards.

Public Involvement Strategy

Christina reported that no members of the public attended last week's open houses. For the next round of public meetings, a different strategy will need to be used. The SC mentioned attending other meetings or choosing locations where the public will already be, such as city council meeting or Pibus market.

SC to consider different public involvement opportunities for next round of public meetings.

The survey has been translated into Spanish and both links are available on the County HMP website. The steering committee was asked to place links to the survey on their social media websites.

Phase 1 Annex Process

Christina passed out handouts for the districts and municipalities. She explained that additional information would be provided by email by the end of next week, and that planning partners would have until November 30th to complete their Phase 1 annex.

Planning partners to provide links to surveys on social media.

The annex development process will include three phases. The second phase will be discussed during the next meeting and the third phase will occur during a workshop with mandatory attendance by the planning partners.

Action Items and Next Steps

- Planning partners to complete Phase 1 annex
- Phase 2-Jurisdictional Annex Process
- Plan maintenance strategy
- Introduction to SWOO
- SC to review/conform CF/CI definition

Meeting was adjourned at 12:00 PM

The next meeting will the second Steering Committee meeting, November 15, 2018 at 10:00 am at the CTC.

MEETING SUMMARY

CHELAN COUNTY HAZARD MITIGATION PLAN UPDATE

Steering Committee Meeting #4 – Sign-In Sheet

October 18, 2018

Name	Agency	Contact Info
JASON DETAMORE	CC FCZD	
Alex Roberts	CCFD3	Alex@ChelanFD3.org
DAVE NALLE	CCFD #3	dave@CHELANFD3.ORG
Bob Plumb	Chelan County Fire Prevention Inc.	bob.plumb@co.chelan.wa.us
Cliff Burdick	City of Wenatchee	
Luis Gonzalez	City of Chelan	lgonzalez@cityofchelan.us
MICK LAMAR	Lake Wen FR (CCFD5)	lwfrchief@nwi.net
BRIAN BRETT	CCFD #1	ON FILE
MIKE CUSHMAN	CASCADIA CD	" "
Joel Walinski	City of Leavenworth	file
John Ricardi	City of Wenatchee	" "
KENT SISSON	CHELAN Co EMERGENCY MGMT	on file
Stan Smoke	CCEM	on file
Hillary Heard	Chelan County	on file
JON RILEY	CCFD1	ON FILE

Chelan County Hazard Mitigation Plan
5th HMP Update Steering Committee Meeting
Thursday – November 15, 2018
1:00 PM – 3:00 PM
Confluence Technology Center
285 Technology Center Way, Suite 102
Wenatchee WA

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1. Welcome and Introductions

- Group Introductions
- Review Agenda
- Planning Partners Status Update
- Review/Approve SC meeting #4 summary
- Phase 1 Jurisdictional Annex Status (**phase 1 deadline is 11/30/2018**)
- Update on the CWPP status (Hillary)

2. Risk Assessment Update

- Flood/ Earthquake General Building Stock results

3. Plan Maintenance Strategy

- What is required?
  - Triggers for updates
  - Plan integration
  - Continuing public involvement
- Optional elements
  - Progress reporting
- Review example strategy

4. Mitigation Alternatives / SWOO

- The plan must not only include identified actions to reduce risk within the planning area, it must also show what was considered. What alternatives were considered in the development of the action plan?
- Tetra Tech utilizes the mitigation catalog concept to meet this requirement
- What is a mitigation Catalog?
- How can this be augmented by looking at strengths, weaknesses, obstacles and opportunities within the planning area?

5. Phase 2, Jurisdictional Annex process

- The focus for phase 2 are the core capabilities
  - Legal and regulatory
  - Development and permitting
  - fiscal capabilities
  - Administrative and technical
  - Education and outreach
  - National Flood Insurance Program (NFIP) compliance
  - Classifications under various community mitigation programs
  - The community's adaptive capacity for the impacts of climate change
- The Phase 2 templates and instructions will be sent to all planning partners by the week of 12/3/2018
- 30-Days to complete
- If you did not complete your phase 1, you must complete it as well by the phase 2 deadline.

Chelan County Hazard Mitigation Plan
5th HMP Update Steering Committee Meeting
Thursday – November 15, 2018
1:00 PM – 3:00 PM
Confluence Technology Center
285 Technology Center Way, Suite 102
Wenatchee WA

6. **Public Involvement Strategy**

- Survey-What is the status?

7. Action Items and Next Steps

- Next SC meeting is optional
- TBD

8. Adjourn

MEETING SUMMARY

Date/Time of Meeting:	Thursday, November 15, 2018; 1:00 pm to 3:00
Location:	Confluence Technology Center, 285 Technology Center Way Wenatchee, WA
Subject:	Steering Committee Meeting #5
Project Name:	Chelan County Natural Hazards Mitigation Plan Update
In Attendance (See Attachment):	**Attendees:** Jill Fitzsimmons (for Jason Detamore), Bob Plumb, Craig Gildroy, Mick Lamar, Jon Riley (for Brian Brett), Patrick Haggerty (for Mike Cushman), Lillith Vespier (for Joel Walkinski), John Ricardi, Kent Sisson, Stan Smoke, Jim Brooks, Arnold Baker, Steve Croci **Planning Team:** Christina Wollman, Hillary Heard, Rob Flaner (phone)
Not Present:	FD 3
Summary Prepared by:	Christina Wollman (11/16/2018)
Quorum – Yes or No	Yes

Item	Action

Welcome and Introductions

- Jon Riley, alternate for Chief Brett, opened the Chelan County Natural Hazard Mitigation Plan (HMP) Update Kick-Off meeting with introductions.
- The following handouts were provided: Agenda, Meeting #3 Summary, risk assessment update memo, objectives exercise, Critical facility definitions, Phase 1 Annex exercise for districts and municipalities.
- Vice Chair John Ricardi arrived and assumed responsibility for the meeting.
- The meeting summary from October 18th was reviewed and approved by motion from Mick Lamar and second from Jon Riley. The decision was unanimous.
- Two fire districts have approached Hillary to inquire about joining the planning partnership. They have been provided LOI templates and have been asked to complete the Phase 1 annex document with the other planning partners.
- Hillary gave a brief update on the CWPP process which is still on track for completion as planned.

Item	Action
Risk Assessment Update	
Hazus data loss was provided for all hazards except fire. The fire data from the CWPP has not been received by Tetra Tech. Christina walked the SC though the Hazus outputs and loss matrix and will provide the data to the Steering Committee for their review.	Tt will update the wildfire risk assessment after data is received. The risk assessment will be sent to the steering committee for their review.
Plan Maintenance Strategy	
Rob explained the plan maintenance requirements to the committee. A sample strategy was provided to the committee. The minimum requirements involve a trigger for updates (5-year federal trigger), plan integration (addressed in the phase 2 annex), and continuing public involvement (keep plan available on website). The committee can choose to do progress reports which are not necessary for this plan because it is not being used for CRS credit. However, the benefit of progress reports is to provide opportunity to update the mitigation action plans before the required 5-year update without going through the planning process again. This is beneficial because the planning partners may overlook a mitigation action item or new mitigation may become necessary within the 5-year timeframe. Ken Sisson recommended to include bi-annual progress reporting in the plan maintenance strategy, with a progress report planned in year 2 and year 4. The committee agreed this was the most beneficial option. Chelan County Emergency Management and Natural Resources Department will share the responsibility. The next meeting (January) will include review and approval of the plan maintenance strategy. An example progress report template will also be provided.	Tt will develop a plan update strategy which includes the provision for progress reporting agreed upon by the committee. The draft will be reviewed and approved at the January meeting.
Mitigation Alternatives / SWOO	
Christina presented the Catalog of Risk Reduction Measures to the committee. Rob explained this catalog has been developed over time to replace the SWOO process as all steering committees often had the same answers in the exercise. The catalog now serves to demonstrate that many more options were considered beyond those identified in the mitigation action plan, which is a planning requirement. The committee reviewed some of the hazards included and discussed mitigation actions which they have the opportunity or ability to conduct that are not included in the catalog. Some of these included installing generators at fire stations and other critical facilities to increase the capability of responders during an event, performing evacuation	Committee members should continue to think about mitigation actions which will benefit their community. If those actions are not within the catalog they should note them to be added during the next meeting.

Item	Action
contingency planning to decrease vulnerability, adopting WUI code, and gathering liquefaction data to reduce exposure. The additional mitigation actions identified during the meeting will be included into the catalog and provided to the committee members. Additional actions may be included at any time, and any actions that are identified in the annexes by the planning partners which are not currently within the catalog will also be added. The catalog will be included in the plan update.	
Phase 2 Annex Process Christina reminded the planning partner attendees the Phase 1 annex is due on November 30th. By December 3rd the Phase 2 annex instructions and template will be provided to the planning partnership and they will have 30 days to complete. The Phase 2 annex process involves identifying core capabilities of the jurisdiction, such as fiscal, administrative, legal, regulatory and technical. The Phase 3 annex will be presented during a mandatory meeting in January for all planning partners.	Planning partners need to complete their Phase 1 annex by November 30th and be prepared to begin Phase 2 in early December.
Public Involvement Strategy Rob reported that over 80 responses to the survey have been received. Christina reported that no responses to the Spanish language version have been received. Lillith suggested sending a press release to the Spanish language newspaper. The committee agreed this would be a good method to reach the Spanish language community.	A Spanish version press release will be sent to the Spanish language newspaper with a link to the survey.
Action Items and Next Steps • Planning partners to complete Phase 1 annex by November 30 • Phase 2 Annex Process distributed by December 3 • Plan maintenance strategy approval *Meeting was adjourned at 2:30 PM by Vice Chair Ricardi.* ***The next meeting will be in January at the CTC.***	

MEETING SUMMARY

CHELAN COUNTY HAZARD MITIGATION PLAN UPDATE

Steering Committee Meeting #5 – Sign-In Sheet

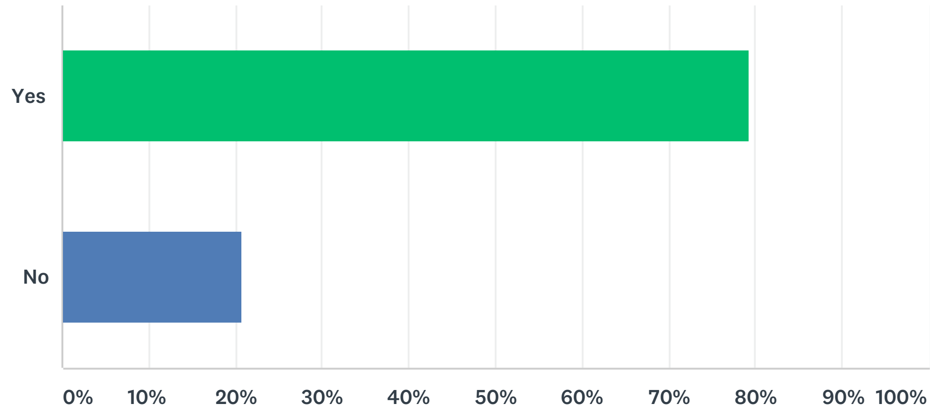
November 15, 2018

Name	Agency	Contact Info
Lilith Vespier	City of Leavenworth	on file
Steve Croci	City of Cashmere	steve@cityofcashmere.org or 782-3513
MICK LAMMAR	LWFK	on file
Craig Gildroy	City of Chelan	cgildroy@cityofchelan.us
MIKE ASHER	CCFD #8	ON FILE
JON RILEY	CCFD #1	ON FILE
Hillary Heard	Chelan County	ON FILE
PATRICK HAGGERTY	CASCADIA CD	PATRICK H @ CASCADIACD.ORG
John Ricardi	City of Wenatchee	on file
Jill FitzSimmons	CC Public Works/FCZD	jill.fitzsimmons@co.chelan.wa.us
KENT SISSON	CC EM	kent.sisson@co.chelan.wa.us
Jim Brooks	City of Entiat	Jbrooks.city@entiatwa.us
Arnold Baker	Chelan Co Fire Dist 5	arnoldb@mansonfire.org
Bob Plumb	Chelan County Fire Prevention Inv.	bob.plumb@co.chelan.wa.us

SURVEY RESULTS

Q1 Do you live in Chelan County?

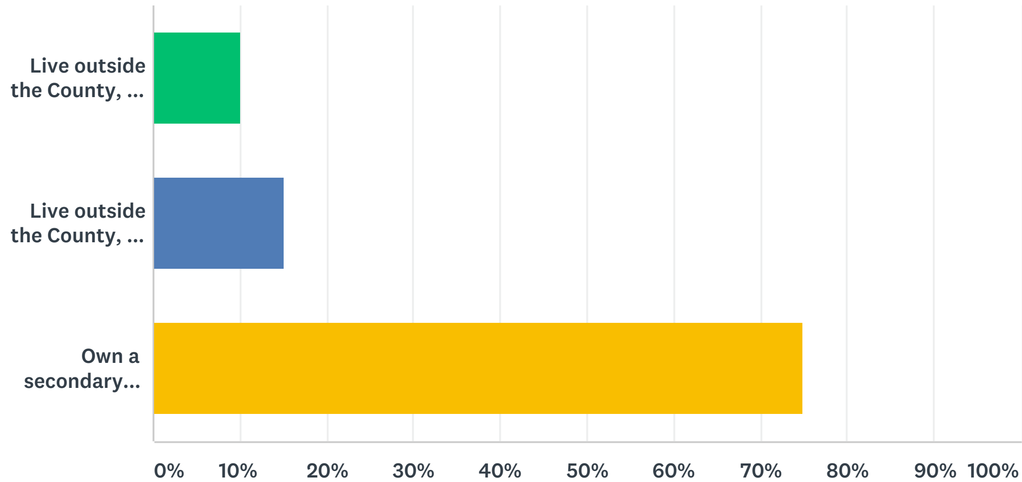
Answered: 87 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	79.31%	69
No	20.69%	18
TOTAL		87

Q2 If you do not live in Chelan County, do you:

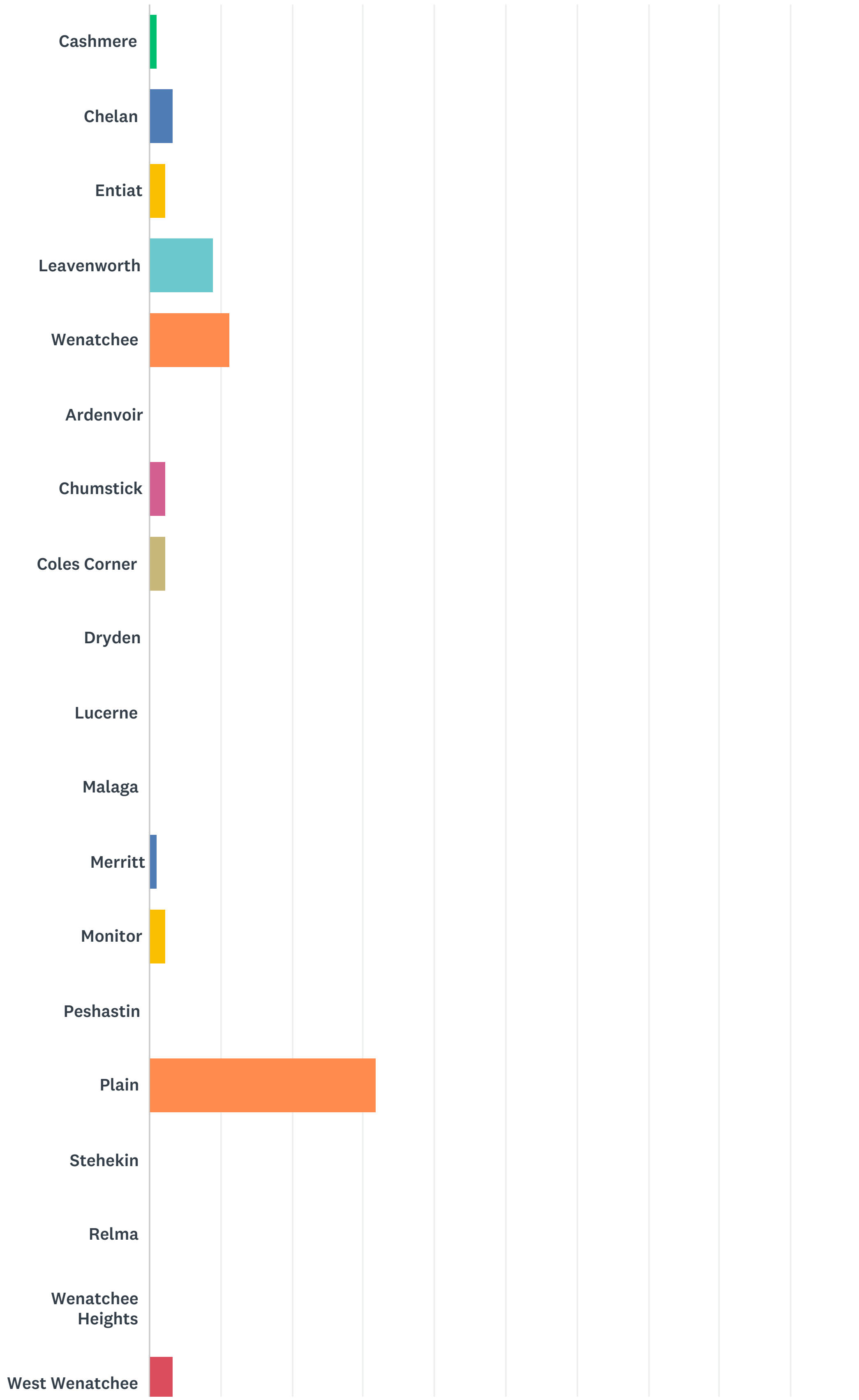
Answered: 20 Skipped: 68

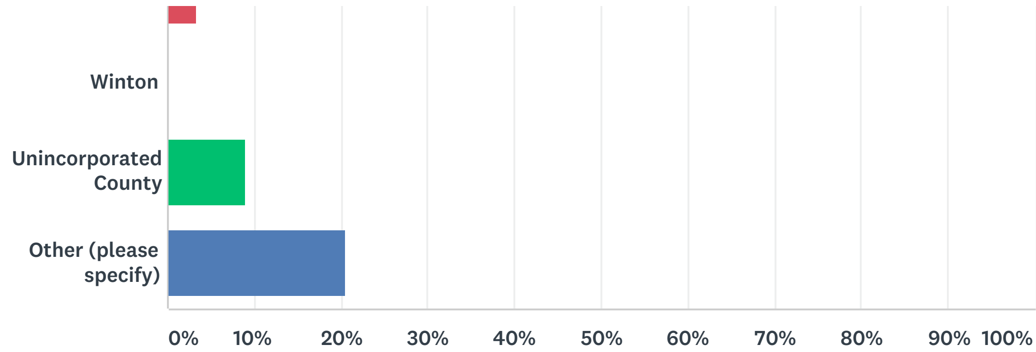


ANSWER CHOICES	RESPONSES	
Live outside the County, but work in the County?	10.00%	2
Live outside the County, but recreate in the County	15.00%	3
Own a secondary property within the County?	75.00%	15
TOTAL		20

Q3 Where in Chelan County do you live?

Answered: 88 Skipped: 0

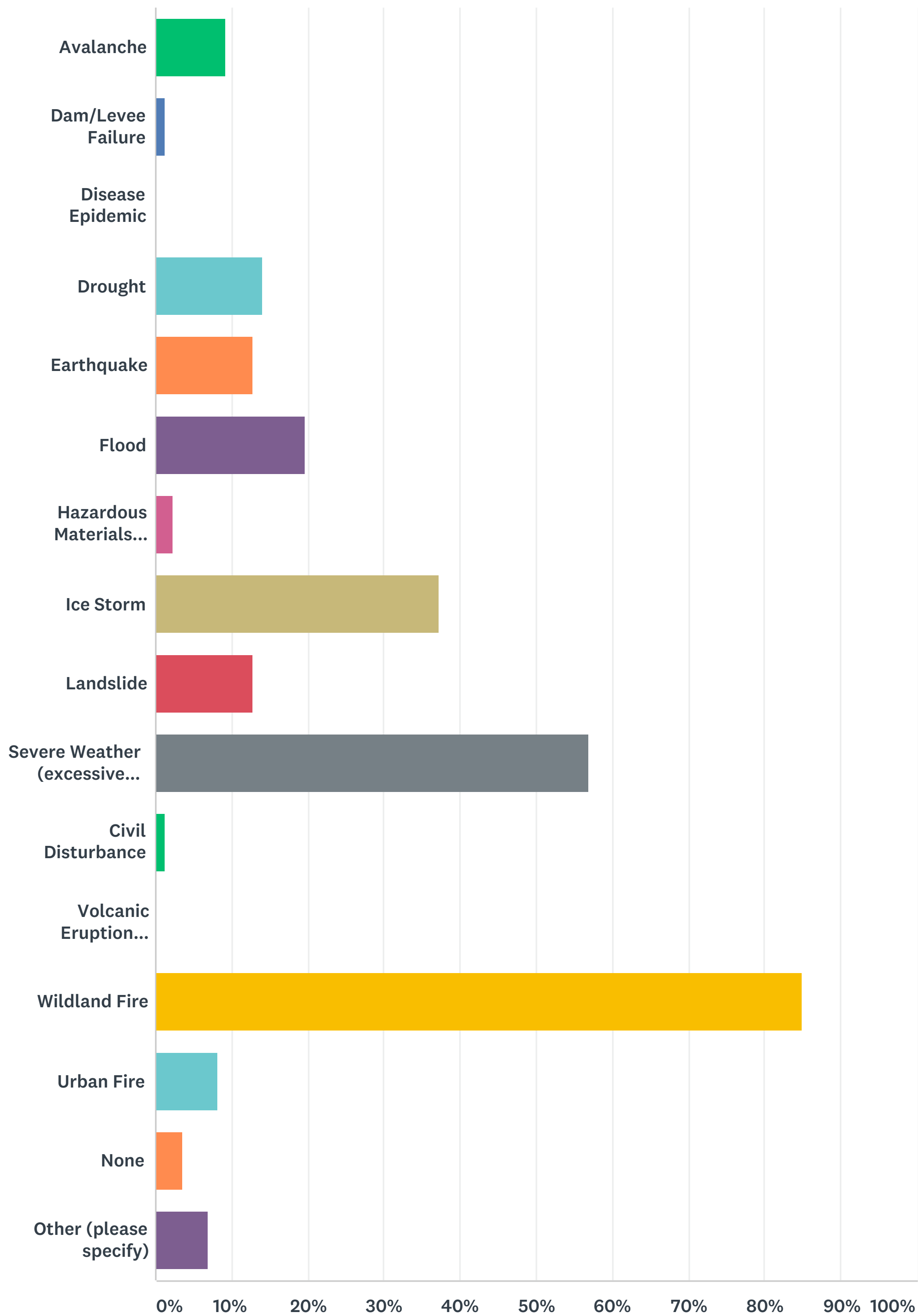




ANSWER CHOICES	RESPONSES	
Cashmere	1.14%	1
Chelan	3.41%	3
Entiat	2.27%	2
Leavenworth	9.09%	8
Wenatchee	11.36%	10
Ardenvoir	0.00%	0
Chumstick	2.27%	2
Coles Corner	2.27%	2
Dryden	0.00%	0
Lucerne	0.00%	0
Malaga	0.00%	0
Merritt	1.14%	1
Monitor	2.27%	2
Peshastin	0.00%	0
Plain	31.82%	28
Stehekin	0.00%	0
Relma	0.00%	0
Wenatchee Heights	0.00%	0
West Wenatchee	3.41%	3
Winton	0.00%	0
Unincorporated County	9.09%	8
Other (please specify)	20.45%	18
TOTAL		88

Q4 Which of the following natural hazard events have you or has anyone in your household experienced in the past 20 years within Chelan County? (Check all that apply)

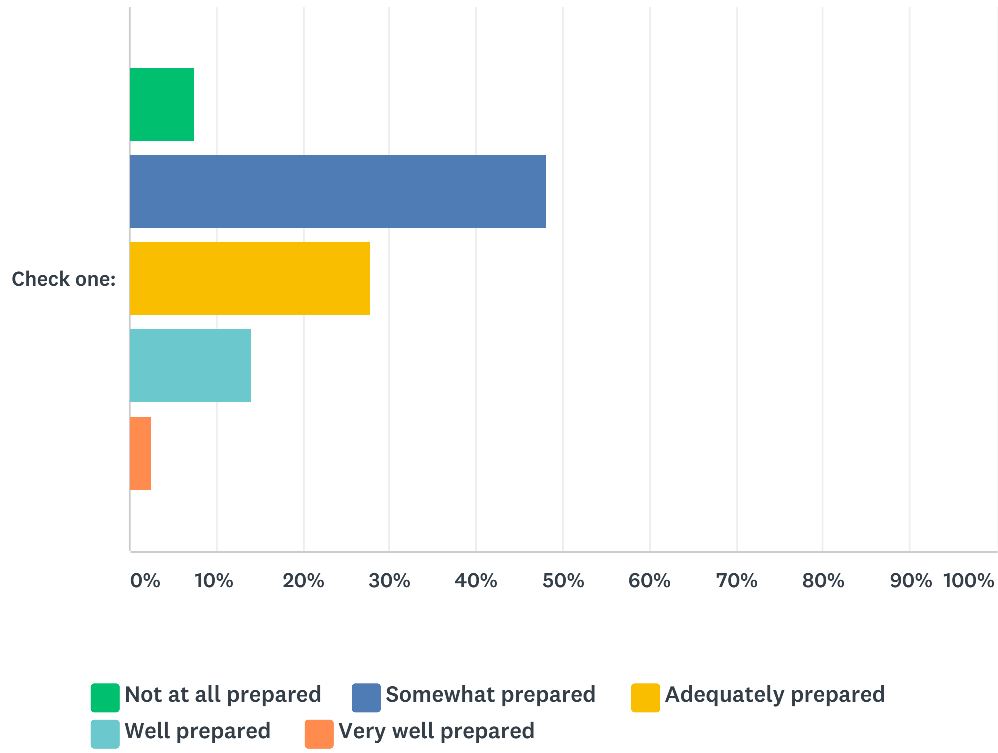
Answered: 86 Skipped: 2



ANSWER CHOICES	RESPONSES	
Avalanche	9.30%	8
Dam/Levee Failure	1.16%	1
Disease Epidemic	0.00%	0
Drought	13.95%	12
Earthquake	12.79%	11
Flood	19.77%	17
Hazardous Materials Incident	2.33%	2
Ice Storm	37.21%	32
Landslide	12.79%	11
Severe Weather (excessive heat/cold, wind, lightning, snow/winter storm, etc.)	56.98%	49
Civil Disturbance	1.16%	1
Volcanic Eruption (lahar, ash fall)	0.00%	0
Wildland Fire	84.88%	73
Urban Fire	8.14%	7
None	3.49%	3
Other (please specify)	6.98%	6
Total Respondents: 86		

Q5 How prepared is your household is to deal with a natural hazard event?

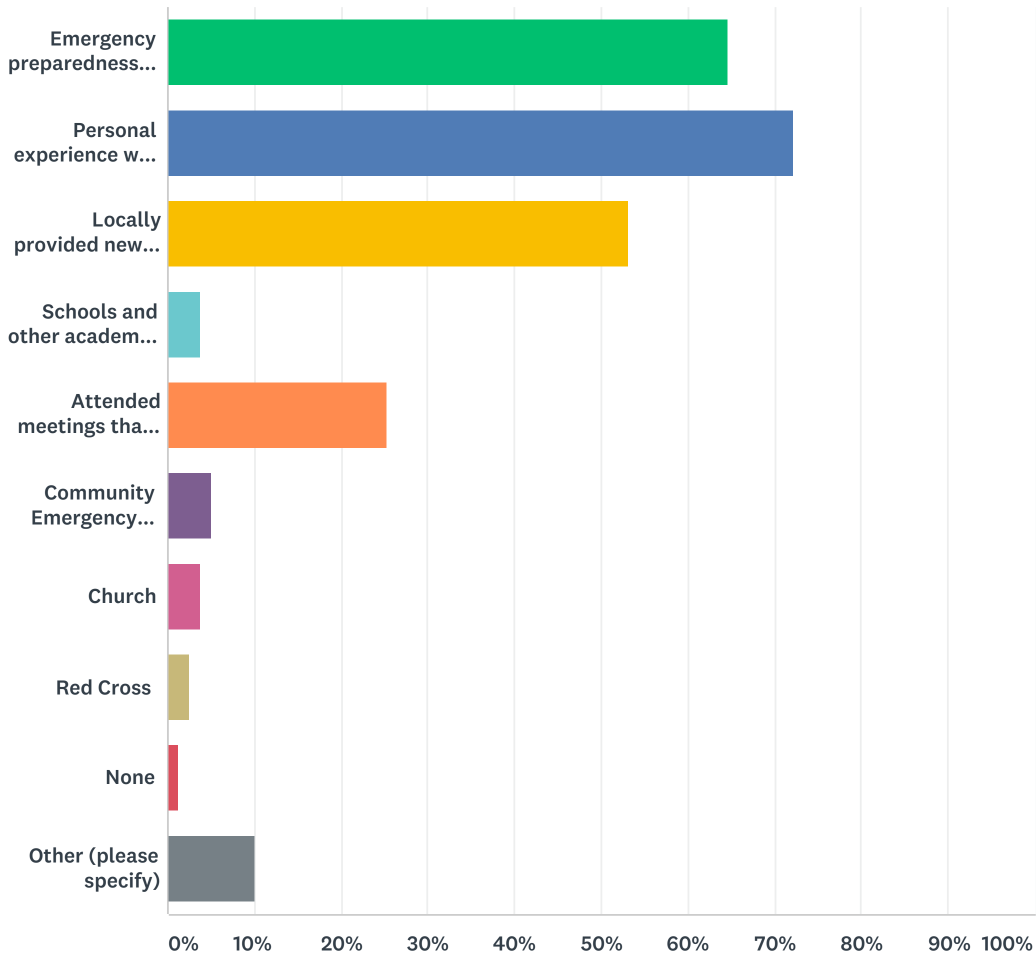
Answered: 79 Skipped: 9



	NOT AT ALL PREPARED	SOMEWHAT PREPARED	ADEQUATELY PREPARED	WELL PREPARED	VERY WELL PREPARED	TOTAL	WEIGHTED AVERAGE
Check one:	7.59% 6	48.10% 38	27.85% 22	13.92% 11	2.53% 2	79	2.56

Q6 Which of the following have provided you with useful information to help you be prepared for a natural hazard event? (Check all that apply)

Answered: 79 Skipped: 9

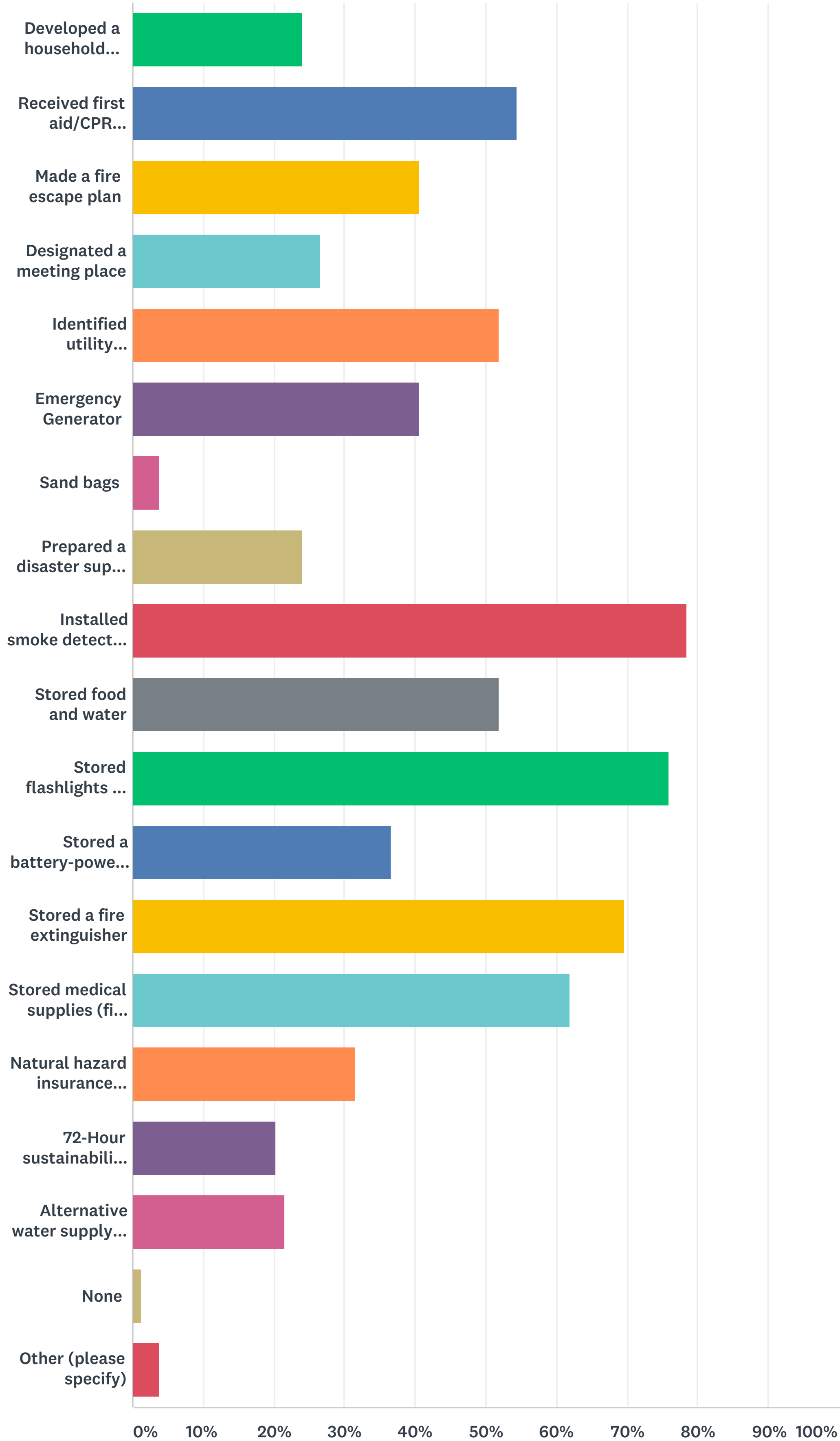


ANSWER CHOICES	RESPONSES	
Emergency preparedness information from a government source (e.g., federal, state, or local emergency management)	64.56%	51
Personal experience with one or more natural hazards/disasters	72.15%	57
Locally provided news or other media information	53.16%	42
Schools and other academic institutions	3.80%	3
Attended meetings that have dealt with disaster preparedness	25.32%	20
Community Emergency Response Training (CERT)	5.06%	4
Church	3.80%	3
Red Cross	2.53%	2
None	1.27%	1
Other (please specify)	10.13%	8

Total Respondents: 79	

Q7 Which of the following steps has your household taken to prepare for a natural hazard event? (Check all that apply)

Answered: 79 Skipped: 9

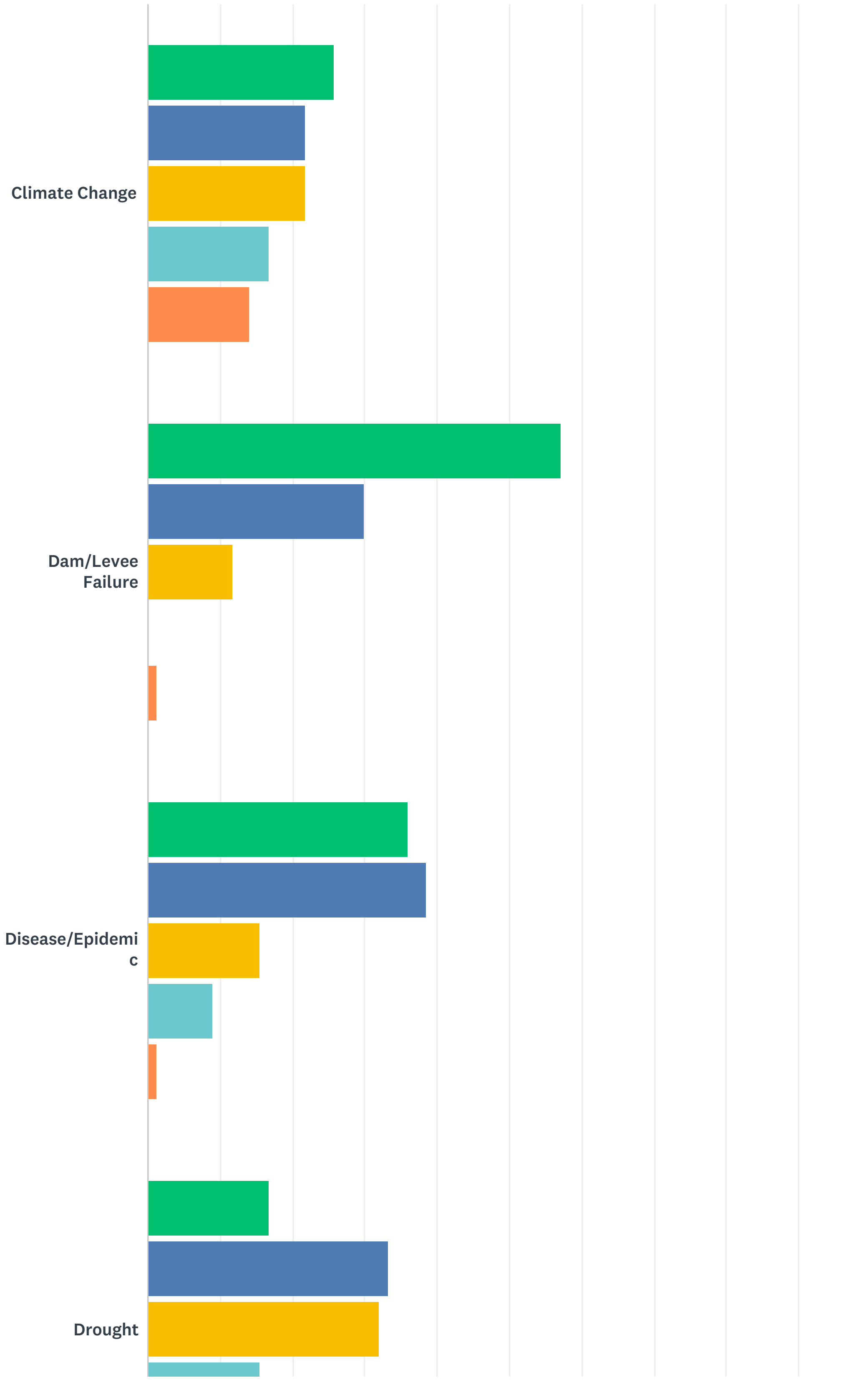


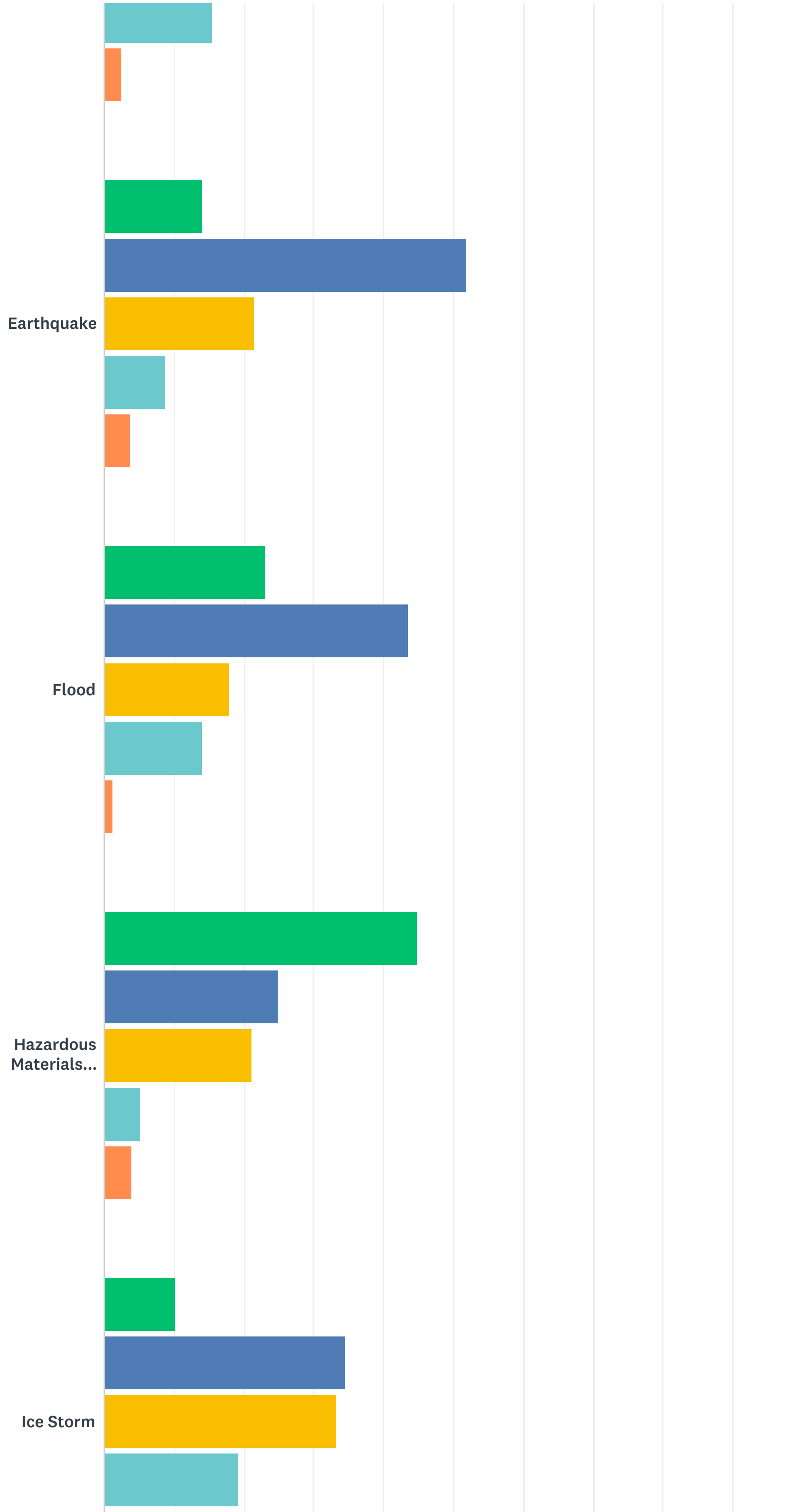
ANSWER CHOICES	RESPONSES

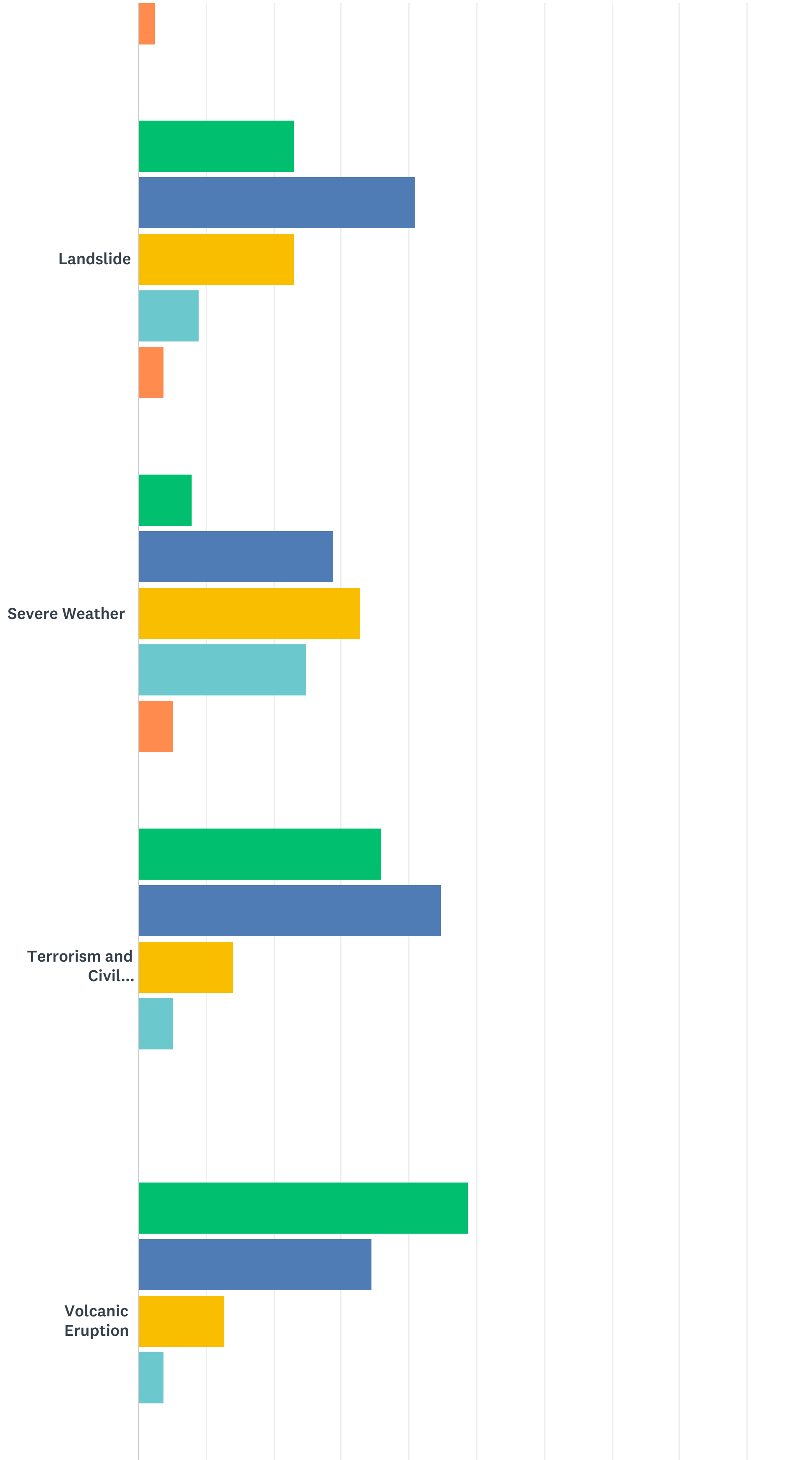
Developed a household emergency response plan addressing a variety of hazards	24.05%	19
Received first aid/CPR training	54.43%	43
Made a fire escape plan	40.51%	32
Designated a meeting place	26.58%	21
Identified utility shutoffs	51.90%	41
Emergency Generator	40.51%	32
Sand bags	3.80%	3
Prepared a disaster supply kit	24.05%	19
Installed smoke detectors on each level of the house	78.48%	62
Stored food and water	51.90%	41
Stored flashlights and batteries	75.95%	60
Stored a battery-powered radio	36.71%	29
Stored a fire extinguisher	69.62%	55
Stored medical supplies (first aid kit, medications)	62.03%	49
Natural hazard insurance (Flood, Earthquake, Wildfire)	31.65%	25
72-Hour sustainability kit	20.25%	16
Alternative water supply for fire fighting	21.52%	17
None	1.27%	1
Other (please specify)	3.80%	3
Total Respondents: 79		

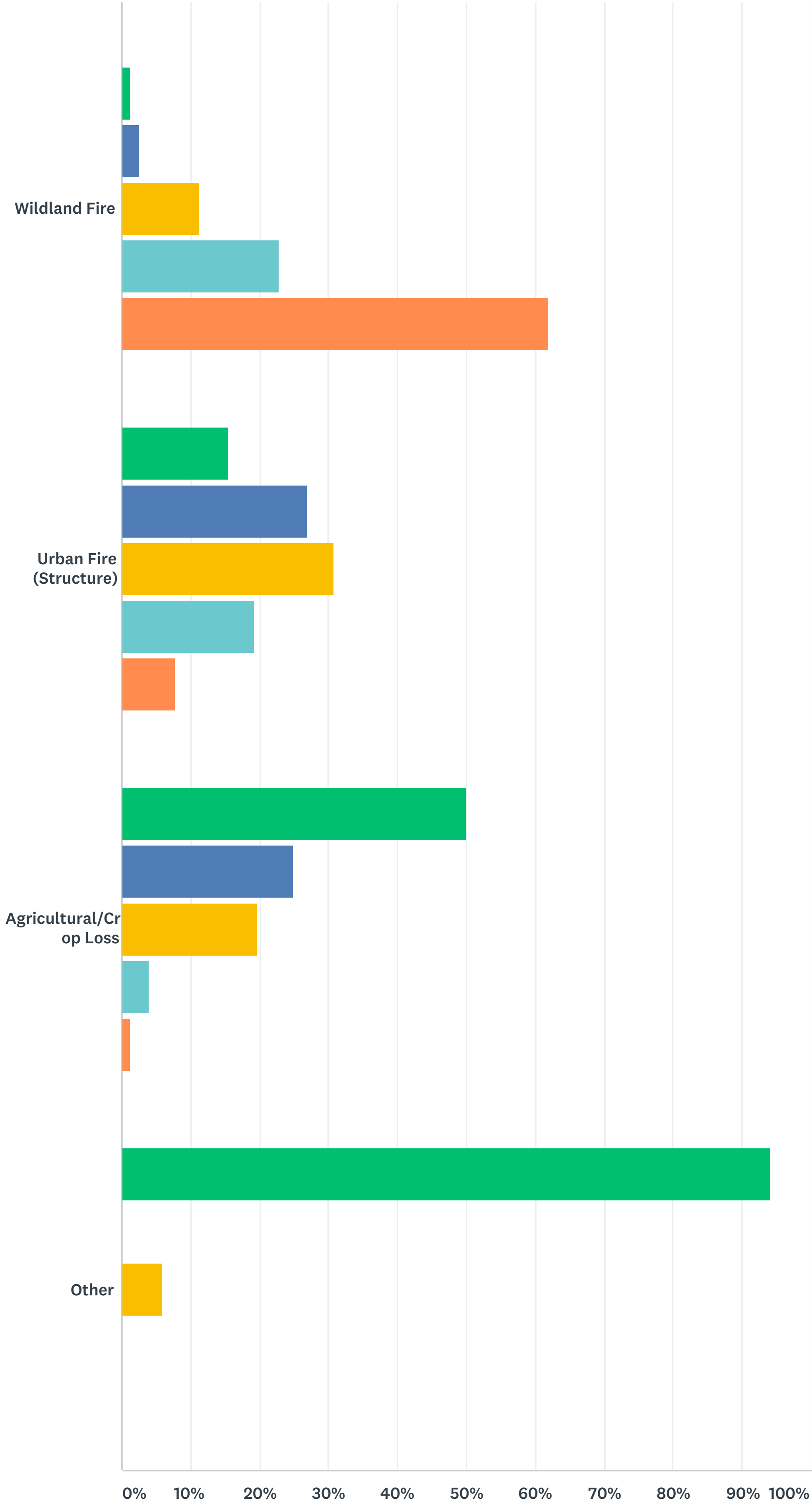
Q8 How concerned are you about the following natural hazards in Chelan County? (Check one response for each hazard)

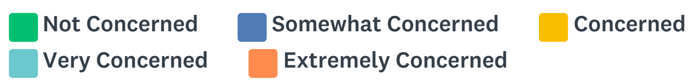
Answered: 79 Skipped: 9




Earthquake
Flood
Hazardous Materials...
Ice Storm


Landslide
Severe Weather
Terrorism and Civil...
Volcanic Eruption

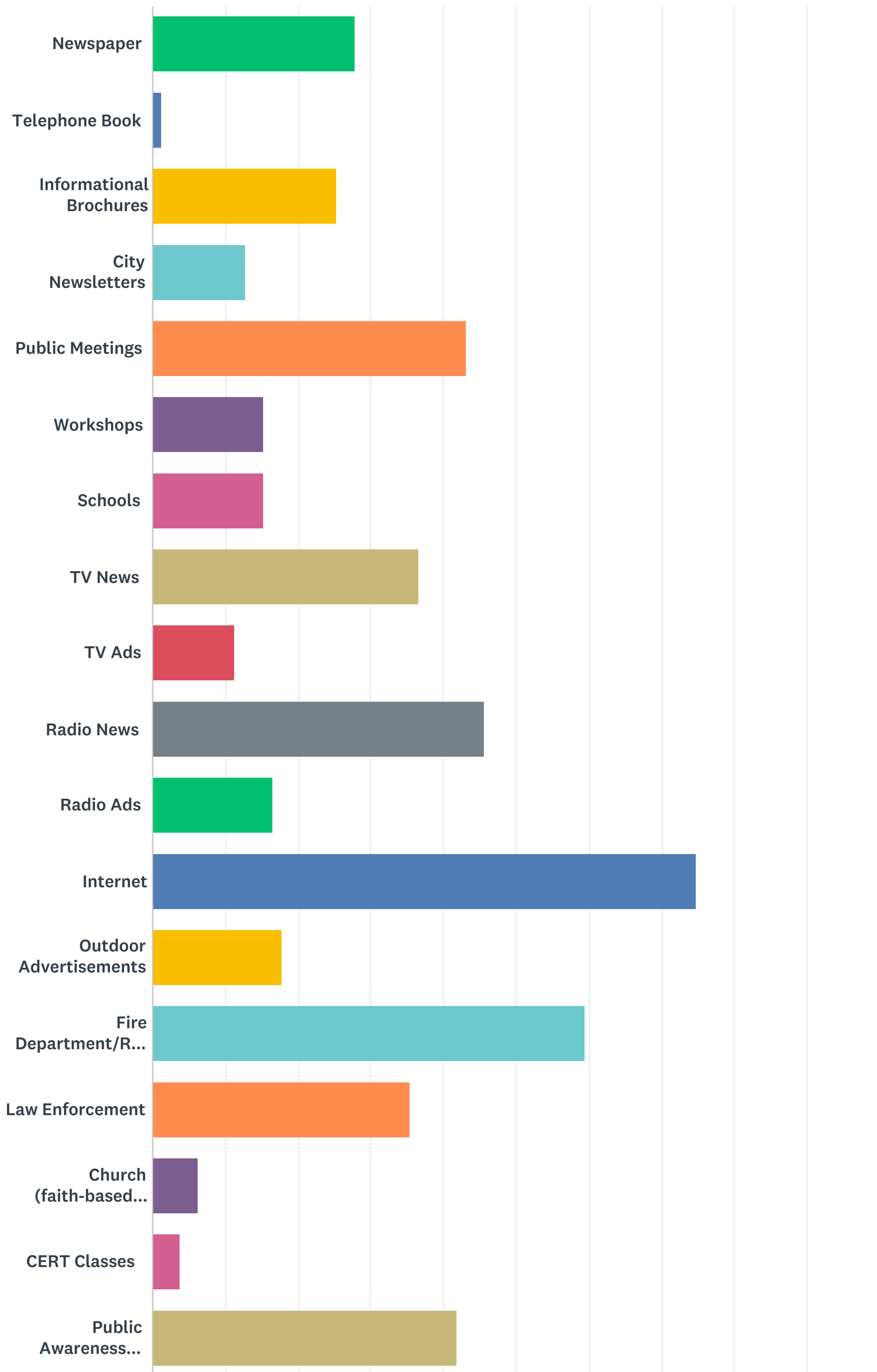

Wildland Fire
Urban Fire (Structure)
Agricultural/Crop Loss
Other
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

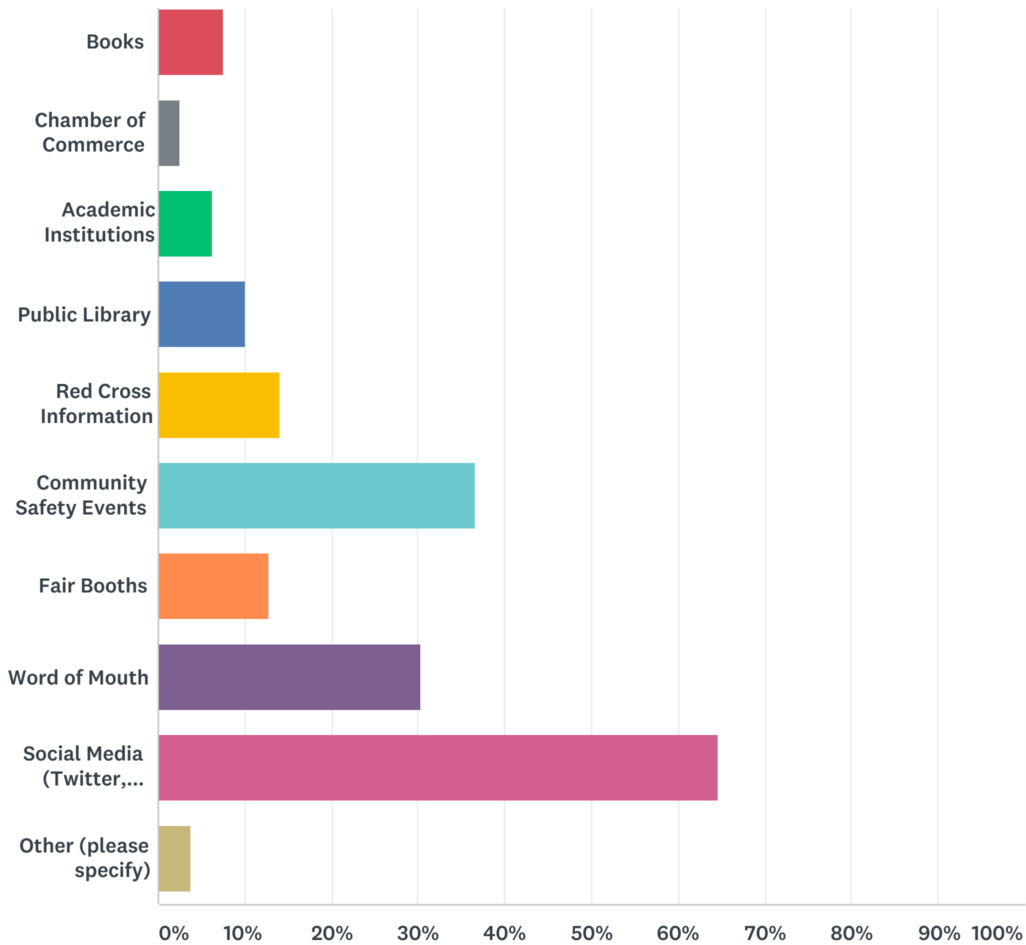


	NOT CONCERNED	SOMEWHAT CONCERNED	CONCERNED	VERY CONCERNED	EXTREMELY CONCERNED	TOTAL	WEIGHTED AVERAGE
Climate Change	25.64% 20	21.79% 17	21.79% 17	16.67% 13	14.10% 11	78	2.72
Dam/Levee Failure	57.14% 44	29.87% 23	11.69% 9	0.00% 0	1.30% 1	77	1.58
Disease/Epidemic	35.90% 28	38.46% 30	15.38% 12	8.97% 7	1.28% 1	78	2.01
Drought	16.67% 13	33.33% 26	32.05% 25	15.38% 12	2.56% 2	78	2.54
Earthquake	13.92% 11	51.90% 41	21.52% 17	8.86% 7	3.80% 3	79	2.37
Flood	23.08% 18	43.59% 34	17.95% 14	14.10% 11	1.28% 1	78	2.27
Hazardous Materials Incident	44.74% 34	25.00% 19	21.05% 16	5.26% 4	3.95% 3	76	1.99
Ice Storm	10.26% 8	34.62% 27	33.33% 26	19.23% 15	2.56% 2	78	2.69
Landslide	23.08% 18	41.03% 32	23.08% 18	8.97% 7	3.85% 3	78	2.29
Severe Weather	7.89% 6	28.95% 22	32.89% 25	25.00% 19	5.26% 4	76	2.91
Terrorism and Civil Disturbance	35.90% 28	44.87% 35	14.10% 11	5.13% 4	0.00% 0	78	1.88
Volcanic Eruption	48.72% 38	34.62% 27	12.82% 10	3.85% 3	0.00% 0	78	1.72
Wildland Fire	1.27% 1	2.53% 2	11.39% 9	22.78% 18	62.03% 49	79	4.42
Urban Fire (Structure)	15.38% 12	26.92% 21	30.77% 24	19.23% 15	7.69% 6	78	2.77
Agricultural/Crop Loss	50.00% 38	25.00% 19	19.74% 15	3.95% 3	1.32% 1	76	1.82
Other	94.12% 16	0.00% 0	5.88% 1	0.00% 0	0.00% 0	17	1.12

Q9 Which of the following methods do you think are most effective for providing hazard and disaster information? (Check all that apply)

Answered: 79 Skipped: 9



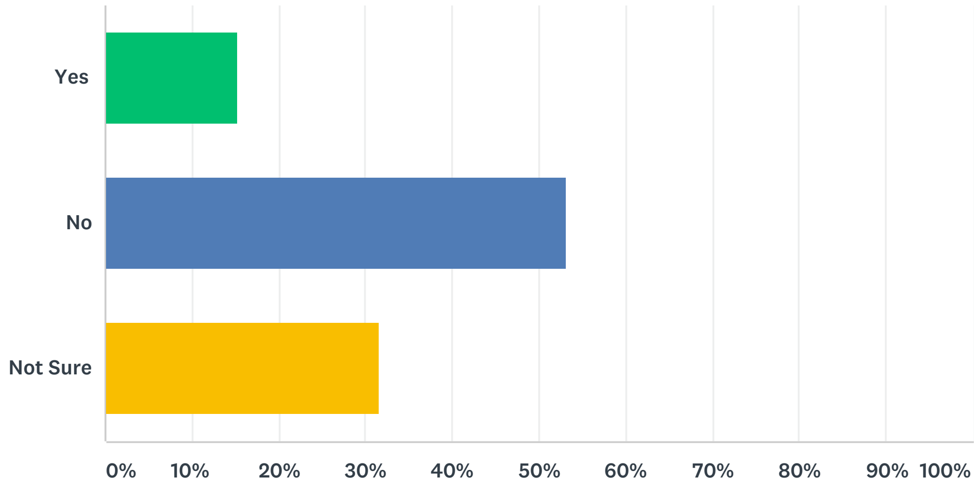


ANSWER CHOICES	RESPONSES	
Newspaper	27.85%	22
Telephone Book	1.27%	1
Informational Brochures	25.32%	20
City Newsletters	12.66%	10
Public Meetings	43.04%	34
Workshops	15.19%	12
Schools	15.19%	12
TV News	36.71%	29
TV Ads	11.39%	9
Radio News	45.57%	36
Radio Ads	16.46%	13
Internet	74.68%	59
Outdoor Advertisements	17.72%	14
Fire Department/Rescue	59.49%	47
Law Enforcement	35.44%	28

Church (faith-based institutions)	6.33%	5
CERT Classes	3.80%	3
Public Awareness Campaign (e.g., Flood Awareness Week, Winter Storm Preparedness Month)	41.77%	33
Books	7.59%	6
Chamber of Commerce	2.53%	2
Academic Institutions	6.33%	5
Public Library	10.13%	8
Red Cross Information	13.92%	11
Community Safety Events	36.71%	29
Fair Booths	12.66%	10
Word of Mouth	30.38%	24
Social Media (Twitter, facebook, Linkdin)	64.56%	51
Other (please specify)	3.80%	3
Total Respondents: 79		

Q10 Is your property located in or near a FEMA designated floodplain?

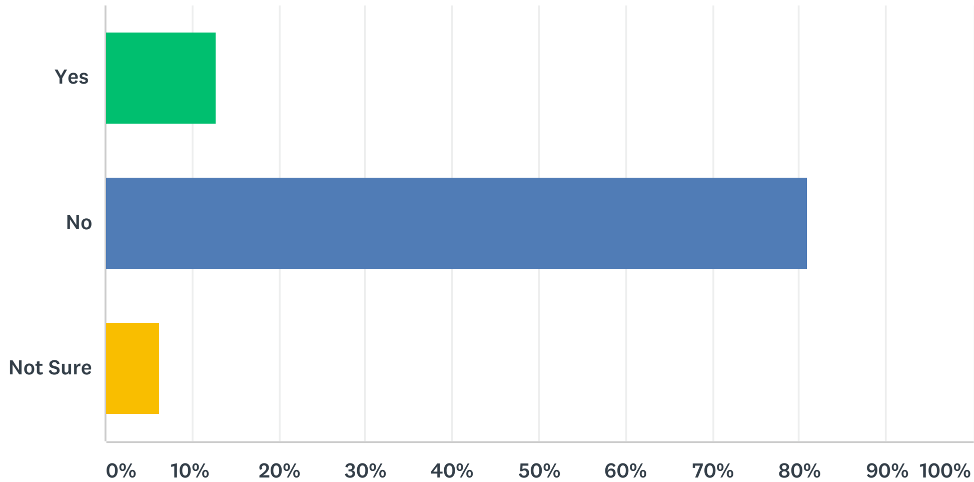
Answered: 79   Skipped: 9



ANSWER CHOICES	RESPONSES	
Yes	15.19%	12
No	53.16%	42
Not Sure	31.65%	25
TOTAL		79

Q11 Do you have flood insurance?

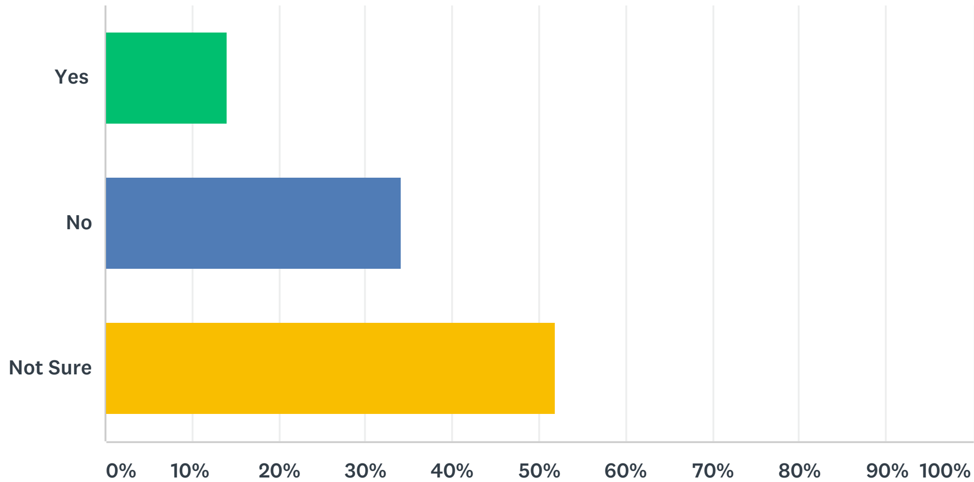
Answered: 79   Skipped: 9



ANSWER CHOICES	RESPONSES	
Yes	12.66%	10
No	81.01%	64
Not Sure	6.33%	5
TOTAL		79

Q12 Is your property located near an earthquake fault?

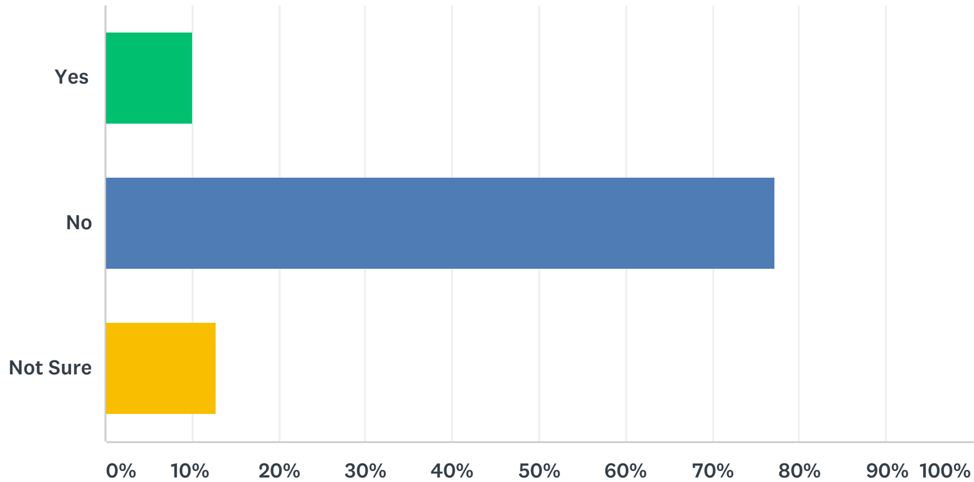
Answered: 79 Skipped: 9



ANSWER CHOICES	RESPONSES	
Yes	13.92%	11
No	34.18%	27
Not Sure	51.90%	41
TOTAL		79

Q13 Do you have earthquake insurance?

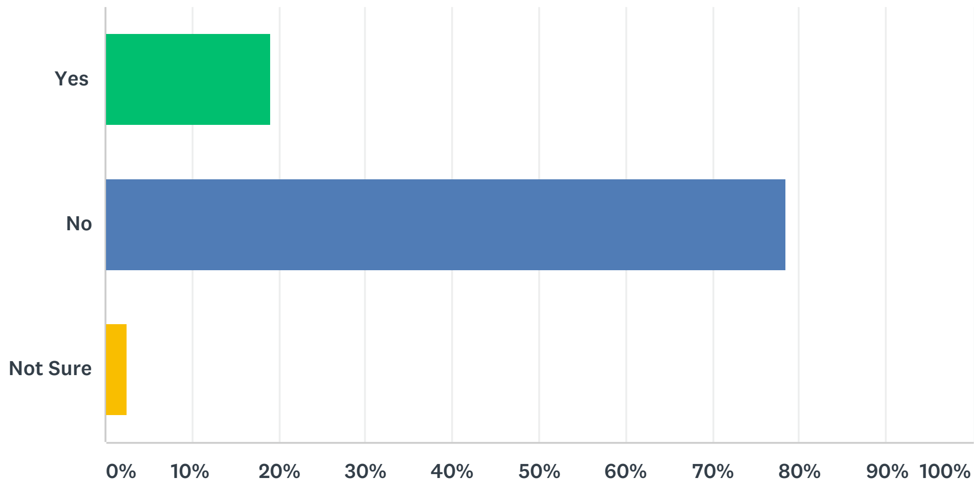
Answered: 79 Skipped: 9



ANSWER CHOICES	RESPONSES	
Yes	10.13%	8
No	77.22%	61
Not Sure	12.66%	10
TOTAL		79

Q14 Have you ever had problems getting homeowners or renters insurance due to risks from natural hazards?

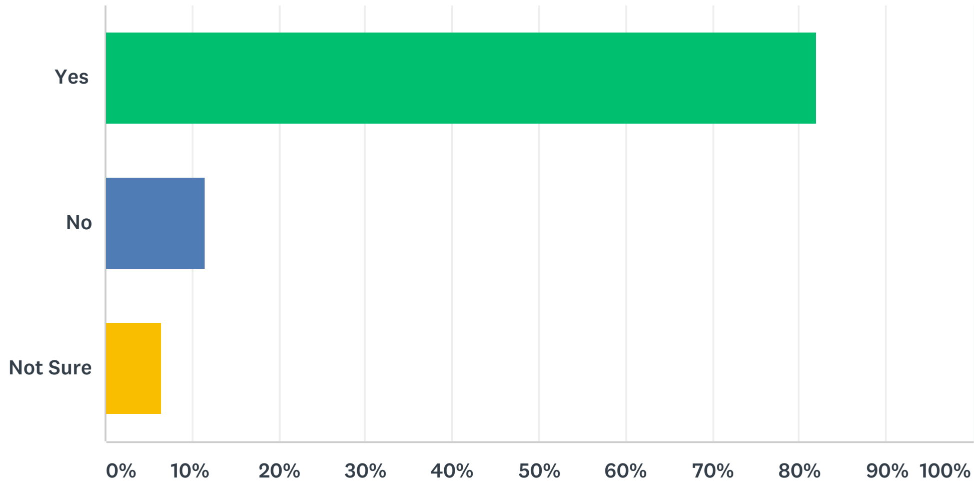
Answered: 79 Skipped: 9



ANSWER CHOICES	RESPONSES	
Yes	18.99%	15
No	78.48%	62
Not Sure	2.53%	2
TOTAL		79

Q15 Is your property located in an area at risk for wildfires?

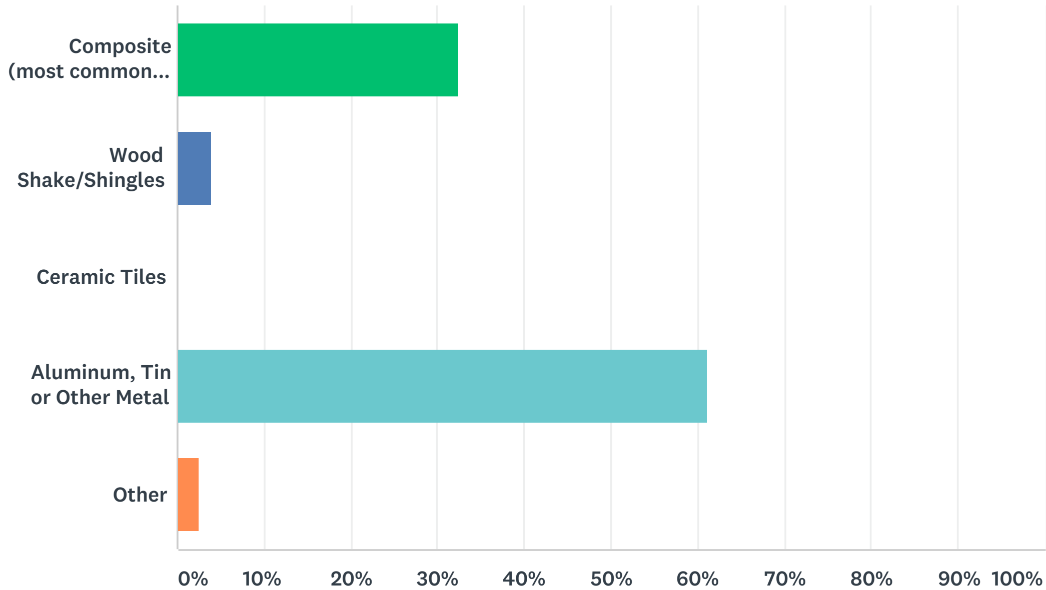
Answered: 78 Skipped: 10



ANSWER CHOICES	RESPONSES	
Yes	82.05%	64
No	11.54%	9
Not Sure	6.41%	5
TOTAL		78

Q16 What type of roof does your home have?

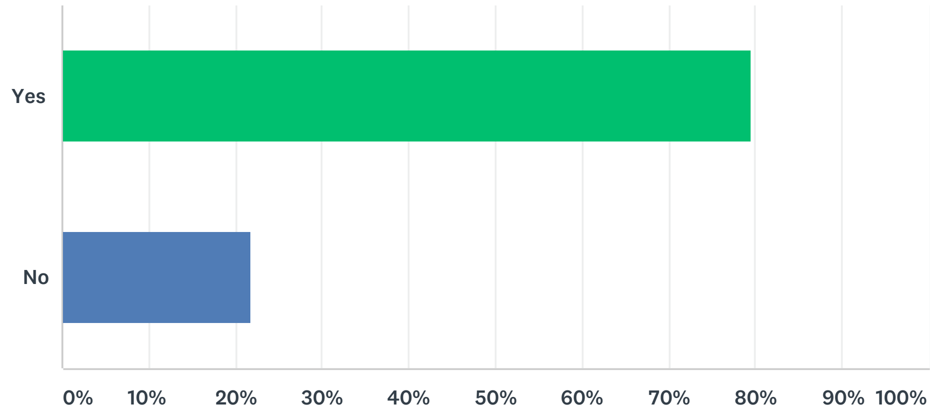
Answered: 77 Skipped: 11



ANSWER CHOICES	RESPONSES	
Composite (most common roofing material)	32.47%	25
Wood Shake/Shingles	3.90%	3
Ceramic Tiles	0.00%	0
Aluminum, Tin or Other Metal	61.04%	47
Other	2.60%	2
TOTAL		77

Q17 Do you have a defensible space surrounding your home?

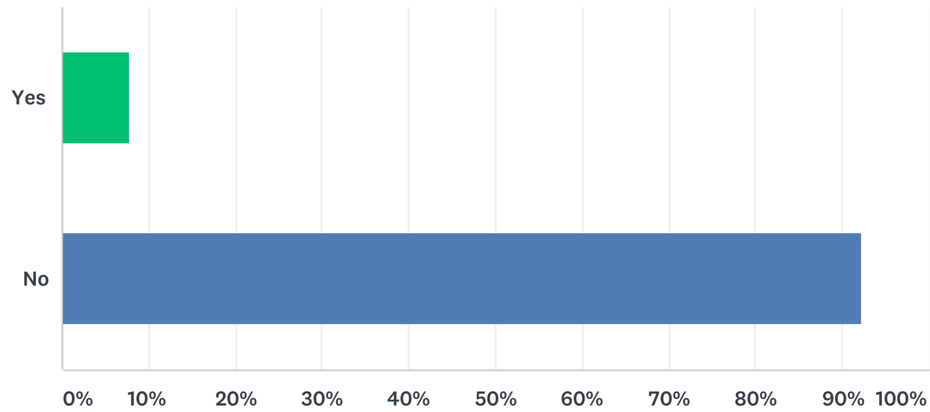
Answered: 78 Skipped: 10



ANSWER CHOICES	RESPONSES	
Yes	79.49%	62
No	21.79%	17
Total Respondents: 78		

Q18 Do livestock (cattle, horses, sheep) graze the grasses and shrubs around your home?

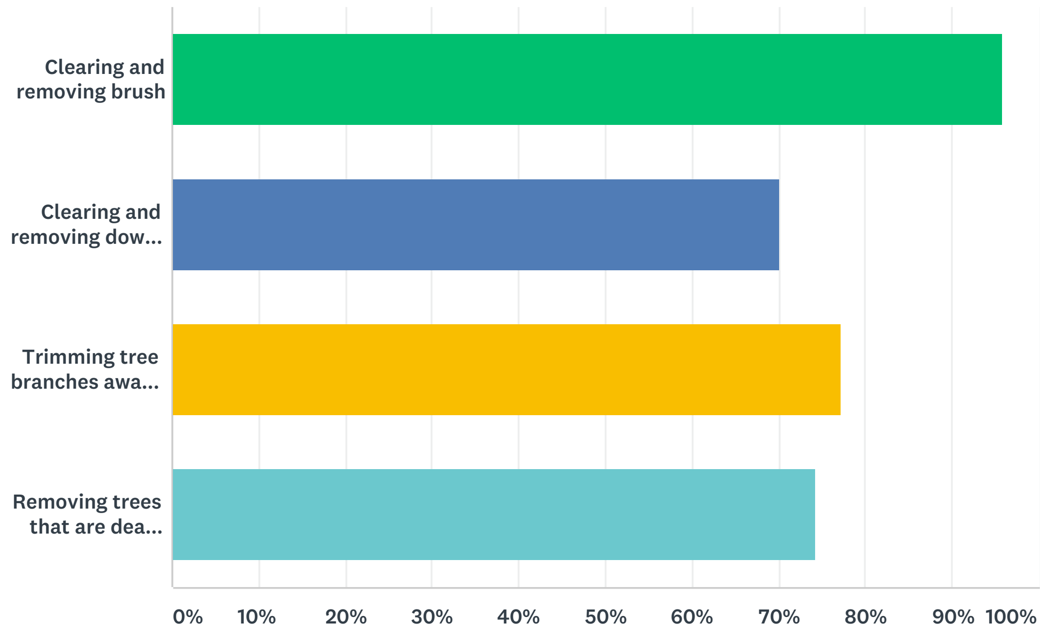
Answered: 78   Skipped: 10



ANSWER CHOICES	RESPONSES	
Yes	7.69%	6
No	92.31%	72
Total Respondents: 78		

Q19 Do you conduct periodic fuels reduction activities near your home site such as:

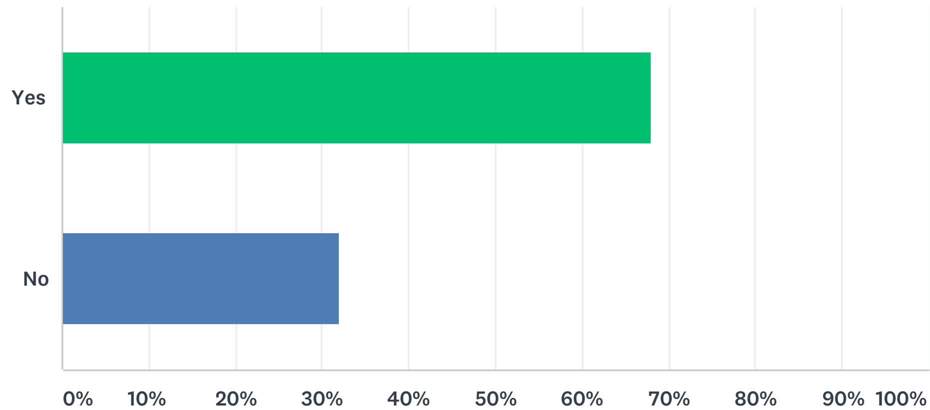
Answered: 70   Skipped: 18



ANSWER CHOICES	RESPONSES	
Clearing and removing brush	95.71%	67
Clearing and removing downed tree limbs on your property	70.00%	49
Trimming tree branches away from your home	77.14%	54
Removing trees that are dead or infested that pose a risk to your home	74.29%	52
Total Respondents: 70		

Q20 If the primary access to your home were cut off because of wildfire or other hazard, would you have an alternate escape route?

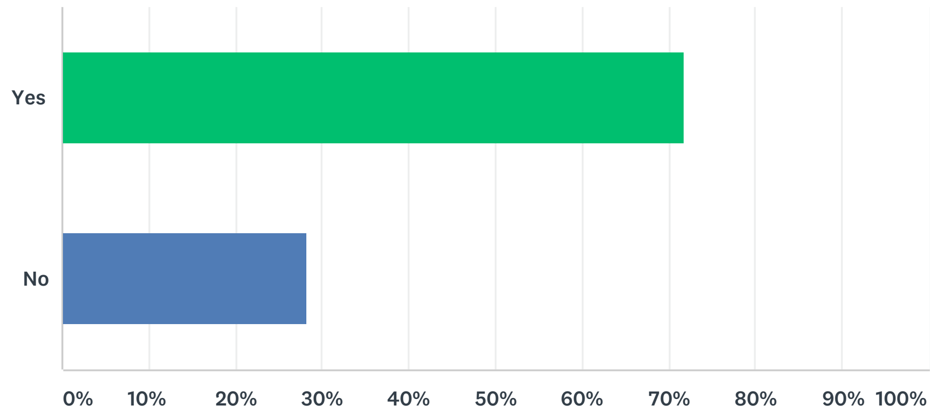
Answered: 78 Skipped: 10



ANSWER CHOICES	RESPONSES	
Yes	67.95%	53
No	32.05%	25
TOTAL		78

Q21 Do you live in a "Firewise" Community? (https://www.nfpa.org/Public-Education/By-topic/Wildfire/Firewise-USA)

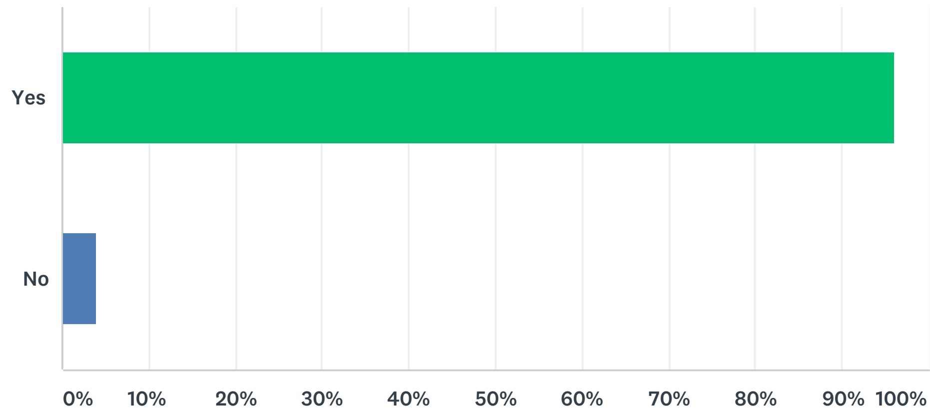
Answered: 78 Skipped: 10



ANSWER CHOICES	RESPONSES	
Yes	71.79%	56
No	28.21%	22
TOTAL		78

Q22 Are you familiar with the "Level 1,2,3" evacuation protocol for wildfire response?

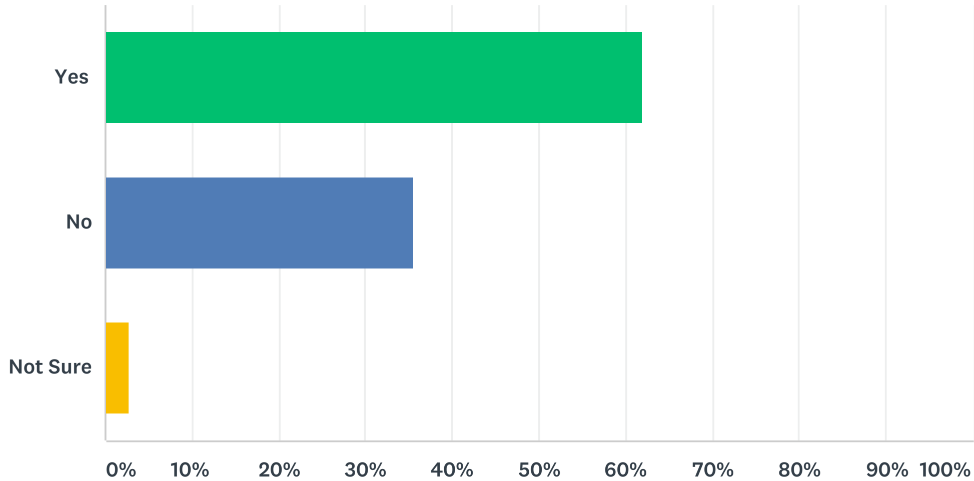
Answered: 77 Skipped: 11



ANSWER CHOICES	RESPONSES	
Yes	96.10%	74
No	3.90%	3
TOTAL		77

Q23 When you moved into your home, did you consider the impact a natural disaster could have on your home?

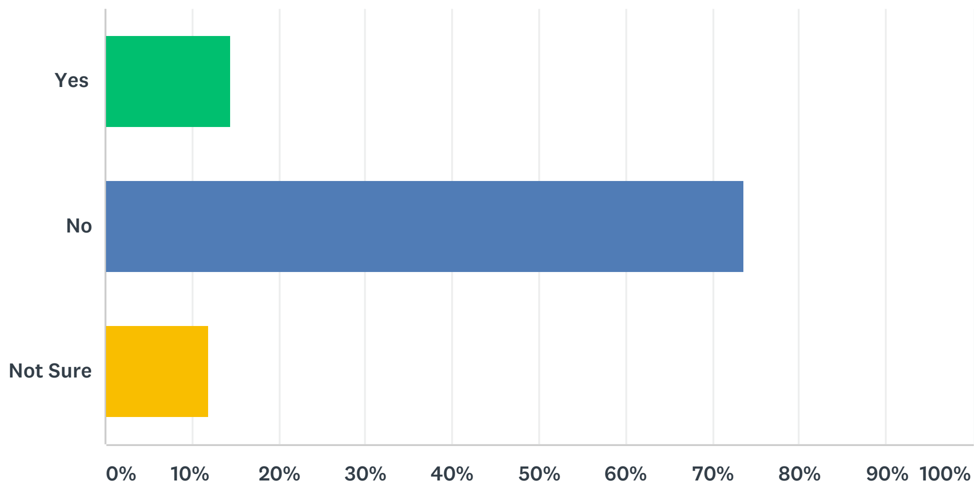
Answered: 76 Skipped: 12



ANSWER CHOICES	RESPONSES	
Yes	61.84%	47
No	35.53%	27
Not Sure	2.63%	2
TOTAL		76

Q24 Was the presence of a natural hazard risk zone (e.g., dam failure zone, flood zone, landslide hazard area, high fire risk area) disclosed to you by a real estate agent, seller, or landlord before you purchased or moved into your home?

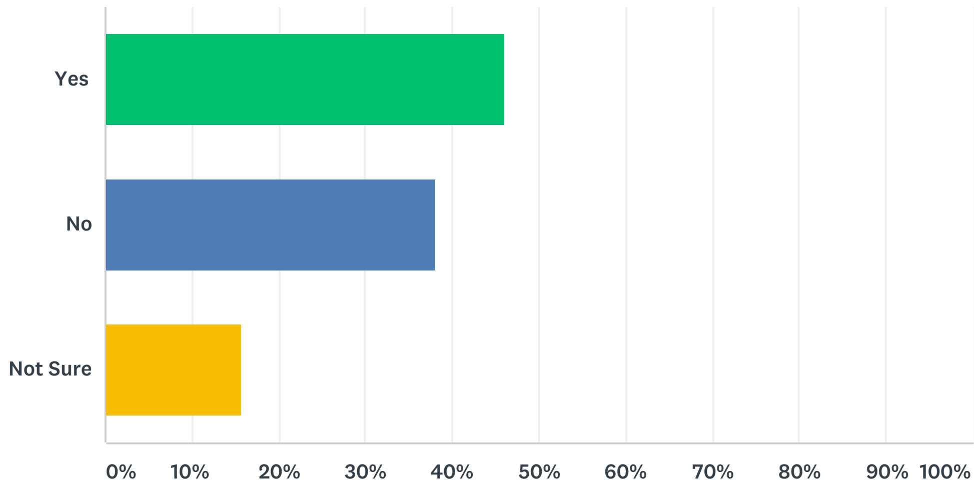
Answered: 76 Skipped: 12



ANSWER CHOICES	RESPONSES	
Yes	14.47%	11
No	73.68%	56
Not Sure	11.84%	9
TOTAL		76

Q25 Would the disclosure of this type of natural hazard risk information influence your decision to buy or rent a home?

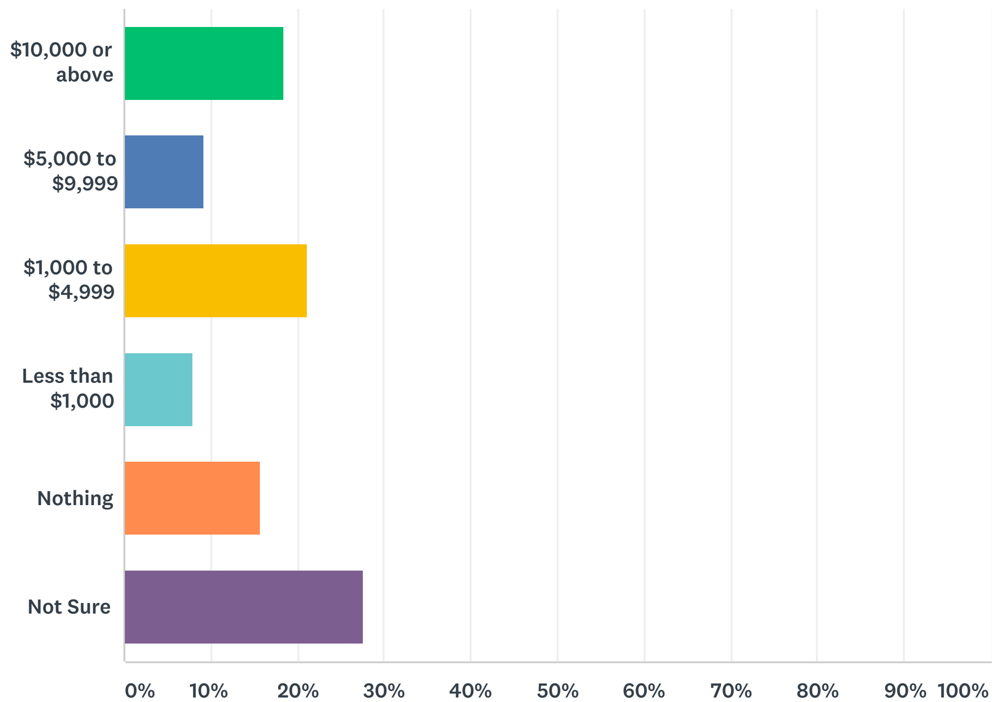
Answered: 76 Skipped: 12



ANSWER CHOICES	RESPONSES	
Yes	46.05%	35
No	38.16%	29
Not Sure	15.79%	12
TOTAL		76

Q26 How much money would you be willing to spend to retrofit your home to reduce risks associated with natural disasters? (for example, by elevating a home above the flood level, performing seismic upgrades, or replacing a combustible roof with non-combustible roofing)

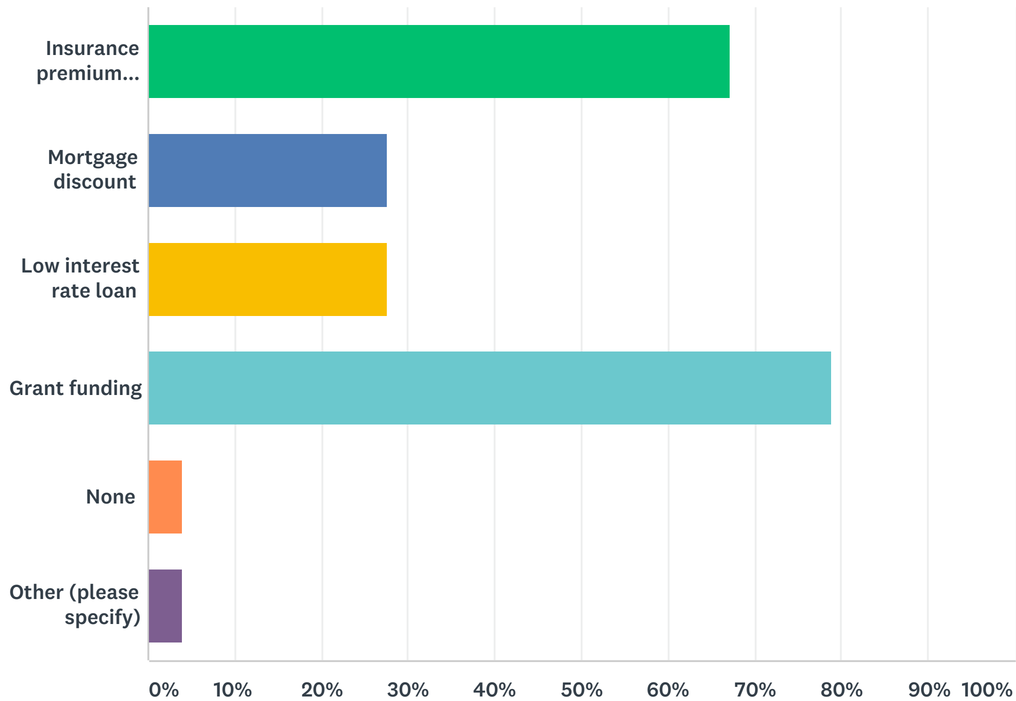
Answered: 76 Skipped: 12



ANSWER CHOICES	RESPONSES	
$10,000 or above	18.42%	14
$5,000 to $9,999	9.21%	7
$1,000 to $4,999	21.05%	16
Less than $1,000	7.89%	6
Nothing	15.79%	12
Not Sure	27.63%	21
TOTAL		76

Q27 Which of the following incentives would encourage you to spend money to retrofit your home to protect against natural disasters? (Check all that apply)

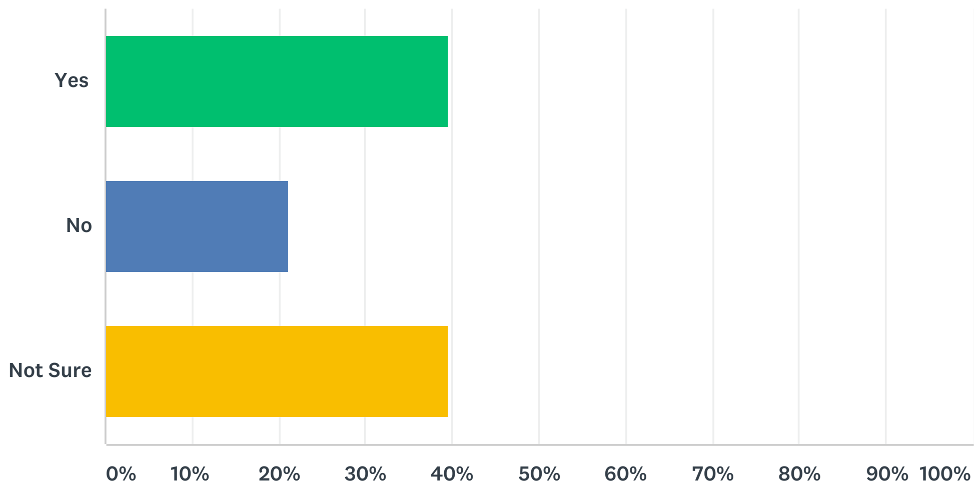
Answered: 76 Skipped: 12



ANSWER CHOICES	RESPONSES	
Insurance premium discount	67.11%	51
Mortgage discount	27.63%	21
Low interest rate loan	27.63%	21
Grant funding	78.95%	60
None	3.95%	3
Other (please specify)	3.95%	3
Total Respondents: 76		

Q28 If your property were located in a designated “high hazard” area or had received repetitive damages from a natural hazard event, would you consider a ”buyout” offered by a public agency?

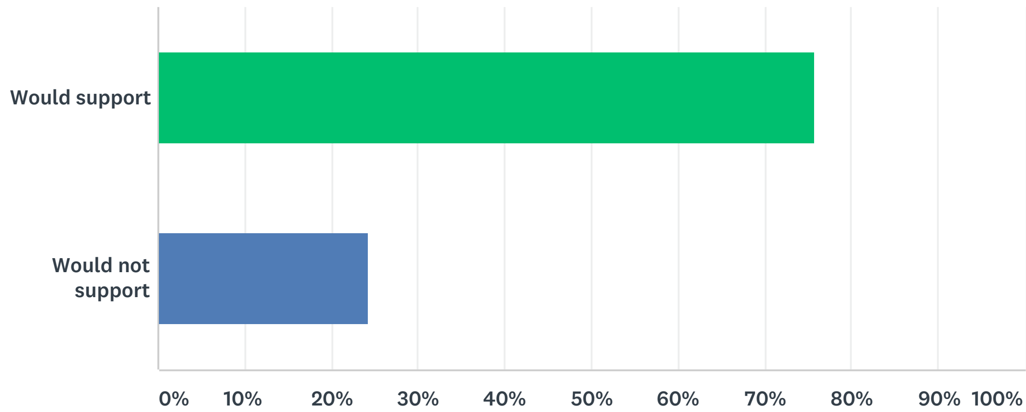
Answered: 76 Skipped: 12



ANSWER CHOICES	RESPONSES	
Yes	39.47%	30
No	21.05%	16
Not Sure	39.47%	30
TOTAL		76

Q29 Would you support the regulation (restriction) of land uses within known high hazard areas?

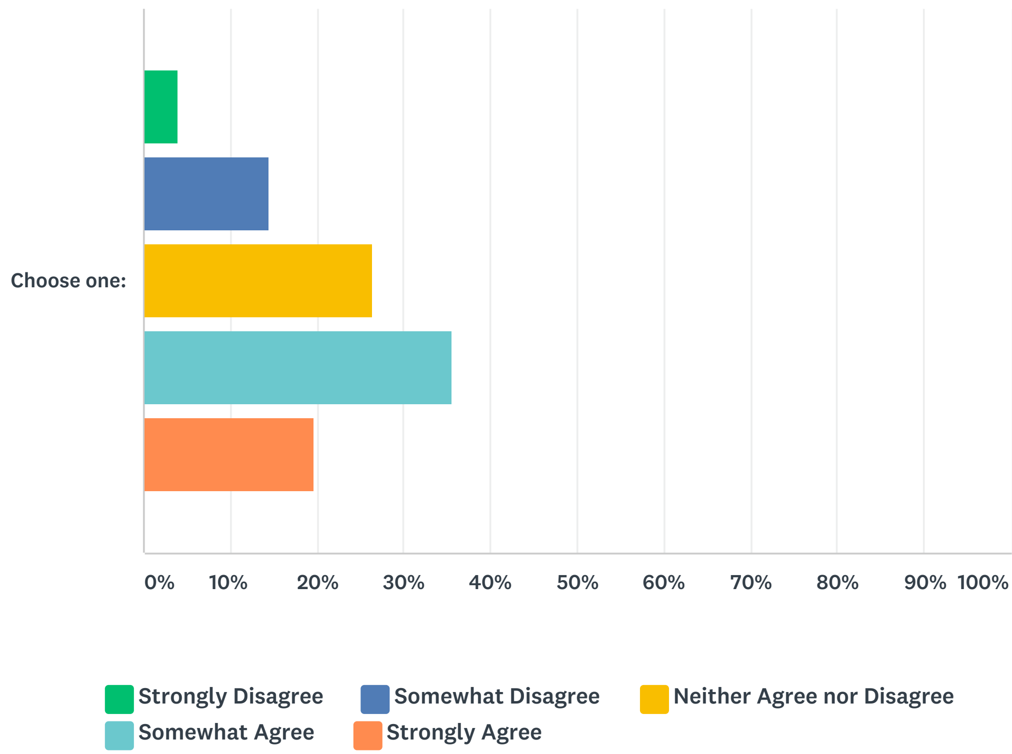
Answered: 74   Skipped: 14



ANSWER CHOICES	RESPONSES	
Would support	75.68%	56
Would not support	24.32%	18
TOTAL		74

Q30 Please indicate how you feel about the following statement:It is the responsibility of government (local, state and federal) to provide education and programs that promote citizen actions that will reduce exposure to the risks associated with natural hazards.

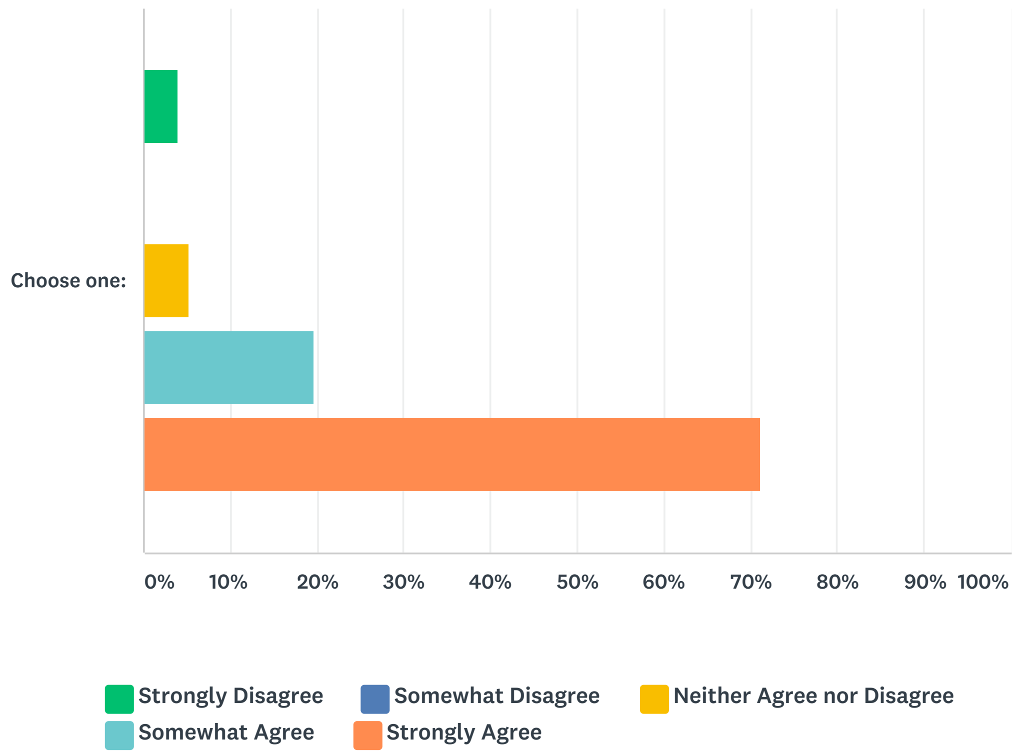
Answered: 76 Skipped: 12



	STRONGLY DISAGREE	SOMEWHAT DISAGREE	NEITHER AGREE NOR DISAGREE	SOMEWHAT AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
Choose one:	3.95% 3	14.47% 11	26.32% 20	35.53% 27	19.74% 15	76	3.53

Q31 Please indicate how you feel about the following statement:It is my responsibility to educate myself and take actions that will reduce my exposure to the risks associated with natural hazards.

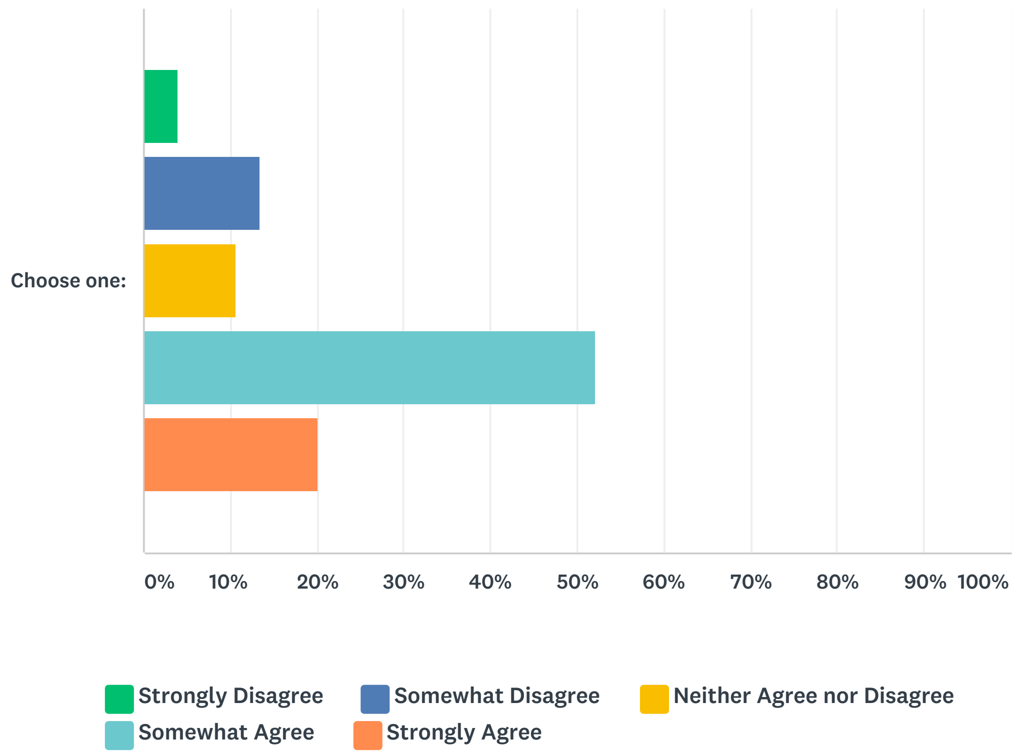
Answered: 76 Skipped: 12



	STRONGLY DISAGREE	SOMEWHAT DISAGREE	NEITHER AGREE NOR DISAGREE	SOMEWHAT AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
Choose one:	3.95% 3	0.00% 0	5.26% 4	19.74% 15	71.05% 54	76	4.54

Q32 Please indicate how you feel about the following statement:Information about the risks associated with natural hazards is readily available and easy to locate.

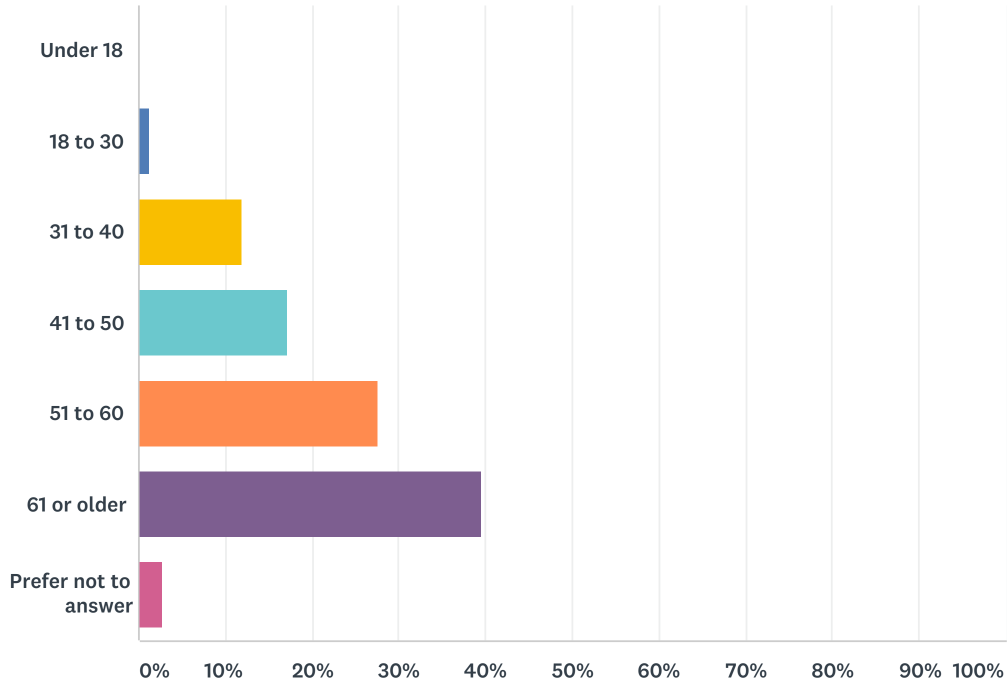
Answered: 75 Skipped: 13



	STRONGLY DISAGREE	SOMEWHAT DISAGREE	NEITHER AGREE NOR DISAGREE	SOMEWHAT AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
Choose one:	4.00% 3	13.33% 10	10.67% 8	52.00% 39	20.00% 15	75	3.71

Q33 Please indicate your age range:

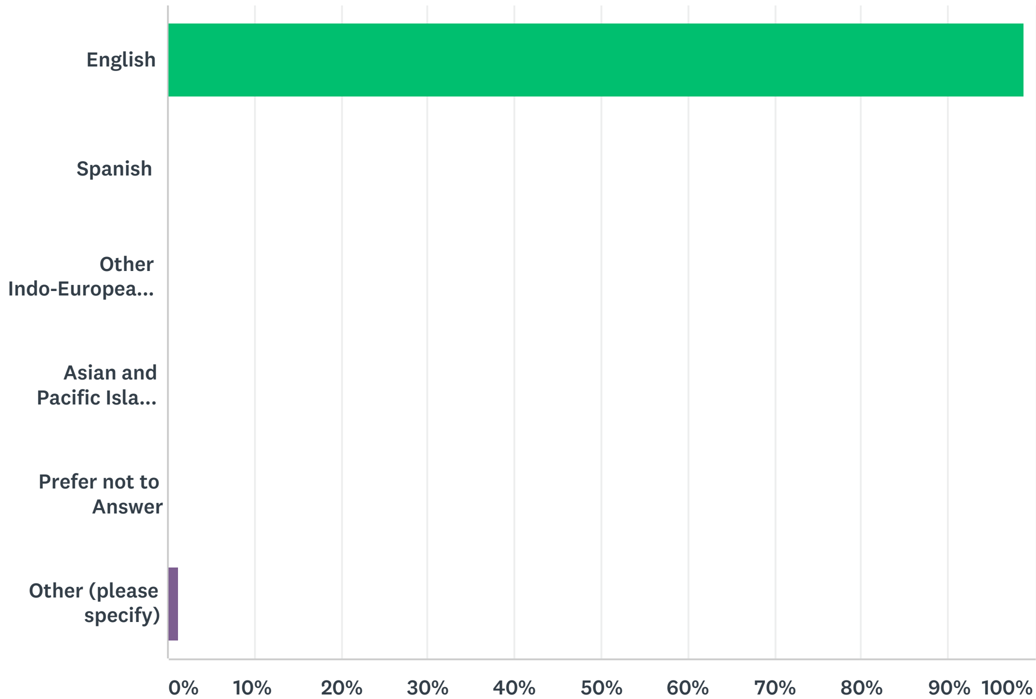
Answered: 76 Skipped: 12



ANSWER CHOICES	RESPONSES	
Under 18	0.00%	0
18 to 30	1.32%	1
31 to 40	11.84%	9
41 to 50	17.11%	13
51 to 60	27.63%	21
61 or older	39.47%	30
Prefer not to answer	2.63%	2
TOTAL		76

Q34 Please indicate the primary language spoken in your household.

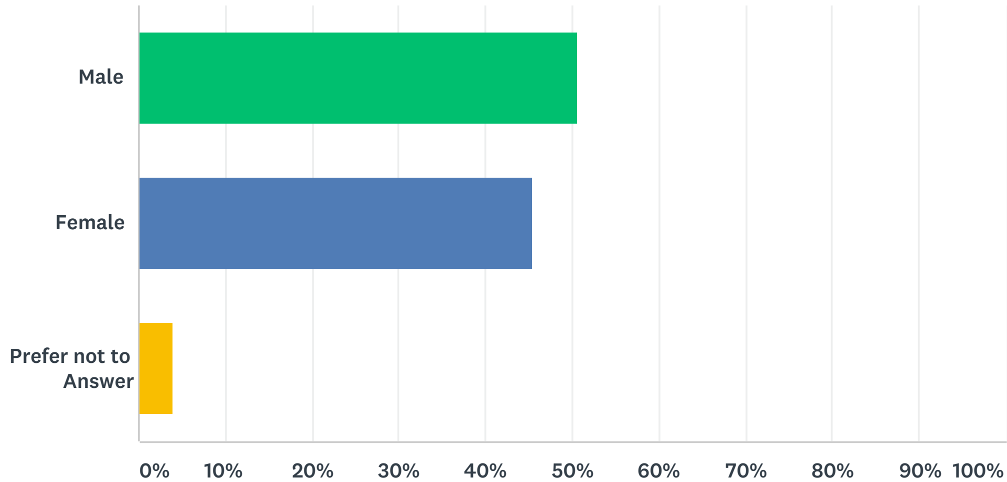
Answered: 76 Skipped: 12



ANSWER CHOICES	RESPONSES	
English	98.68%	75
Spanish	0.00%	0
Other Indo-European Languages	0.00%	0
Asian and Pacific Island Languages	0.00%	0
Prefer not to Answer	0.00%	0
Other (please specify)	1.32%	1
TOTAL		76

Q35 Please indicate your gender:

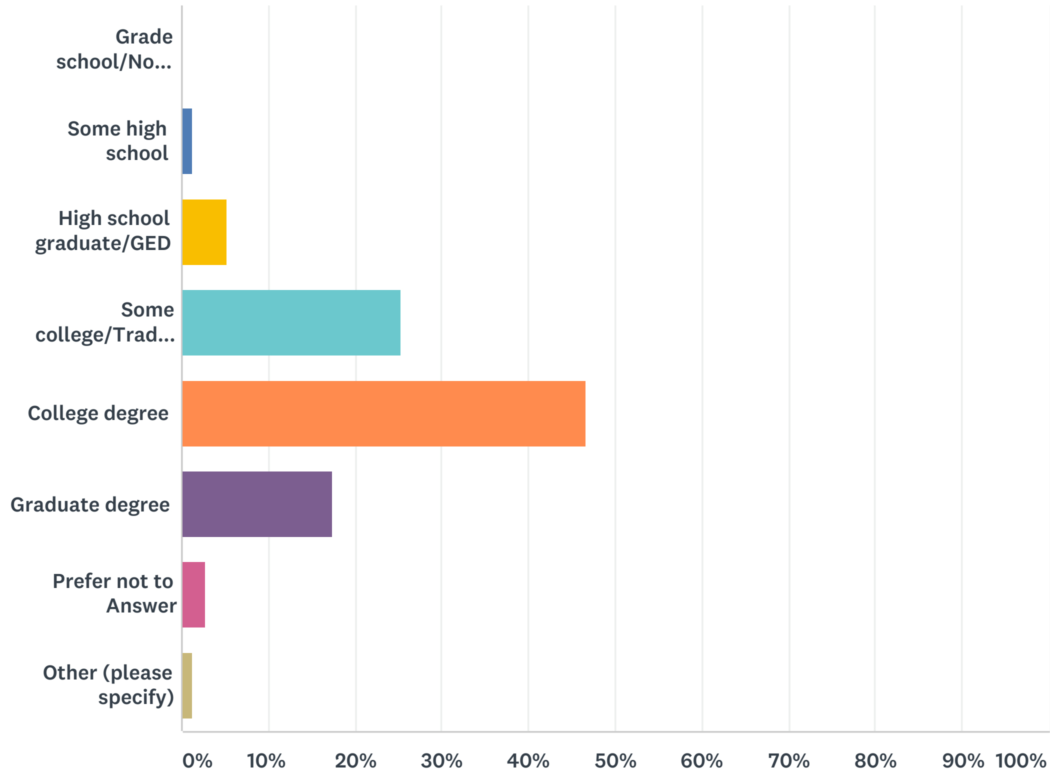
Answered: 75 Skipped: 13



ANSWER CHOICES	RESPONSES	
Male	50.67%	38
Female	45.33%	34
Prefer not to Answer	4.00%	3
TOTAL		75

Q36 Please indicate your highest level of education.

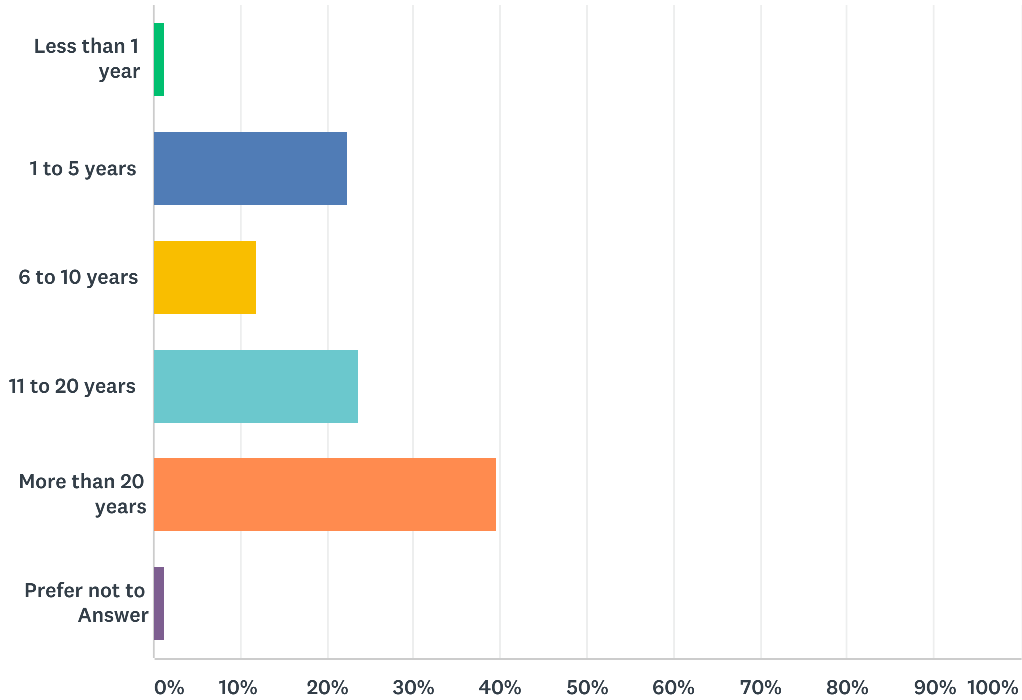
Answered: 75 Skipped: 13



ANSWER CHOICES	RESPONSES	
Grade school/No schooling	0.00%	0
Some high school	1.33%	1
High school graduate/GED	5.33%	4
Some college/Trade school	25.33%	19
College degree	46.67%	35
Graduate degree	17.33%	13
Prefer not to Answer	2.67%	2
Other (please specify)	1.33%	1
TOTAL		75

Q37 How long have you lived in Chelan County?

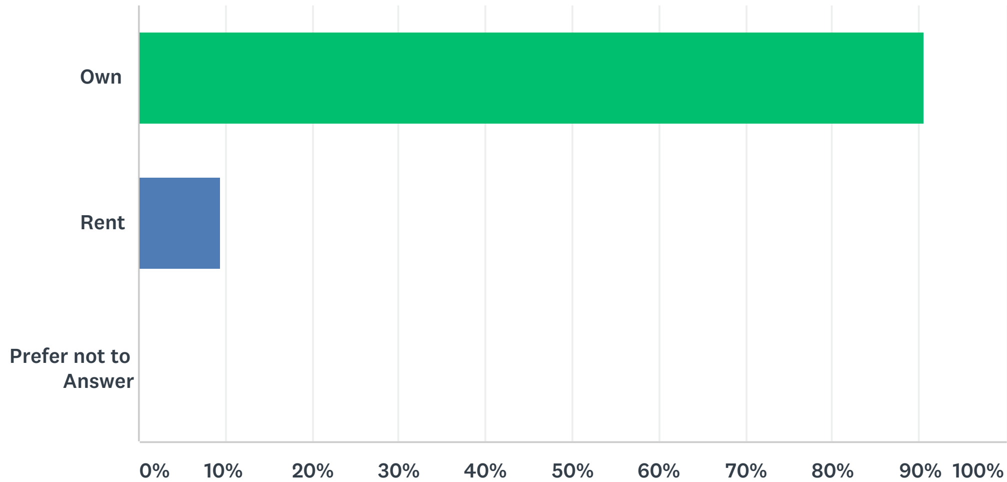
Answered: 76 Skipped: 12



ANSWER CHOICES	RESPONSES	
Less than 1 year	1.32%	1
1 to 5 years	22.37%	17
6 to 10 years	11.84%	9
11 to 20 years	23.68%	18
More than 20 years	39.47%	30
Prefer not to Answer	1.32%	1
TOTAL		76

Q38 Do you own or rent your place of residence?

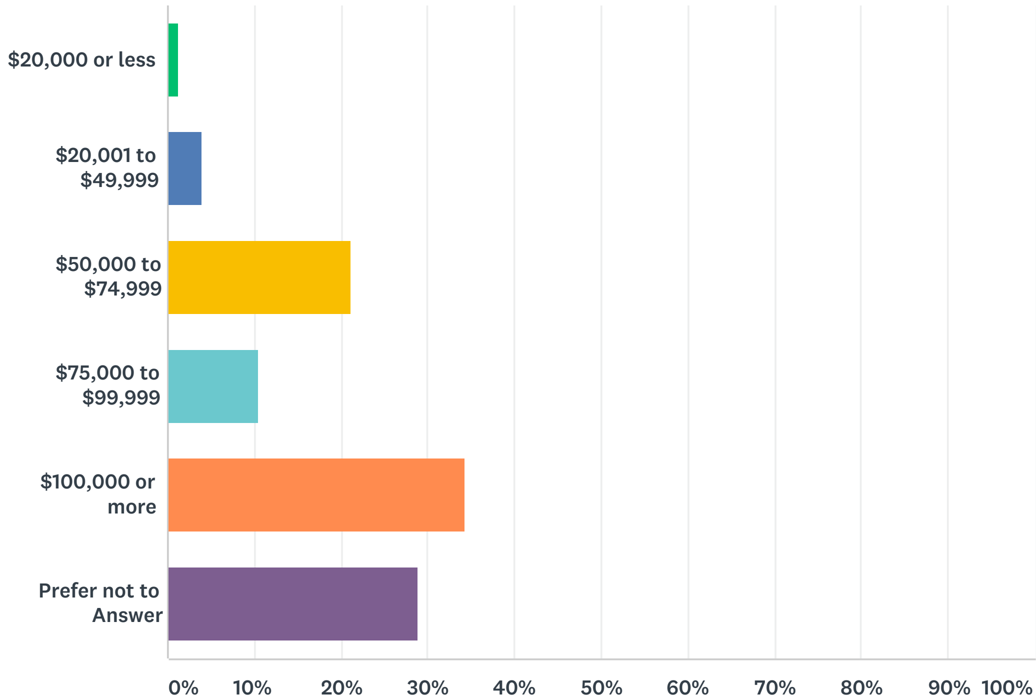
Answered: 74 Skipped: 14



ANSWER CHOICES	RESPONSES	
Own	90.54%	67
Rent	9.46%	7
Prefer not to Answer	0.00%	0
TOTAL		74

Q39 How much is your gross household income?

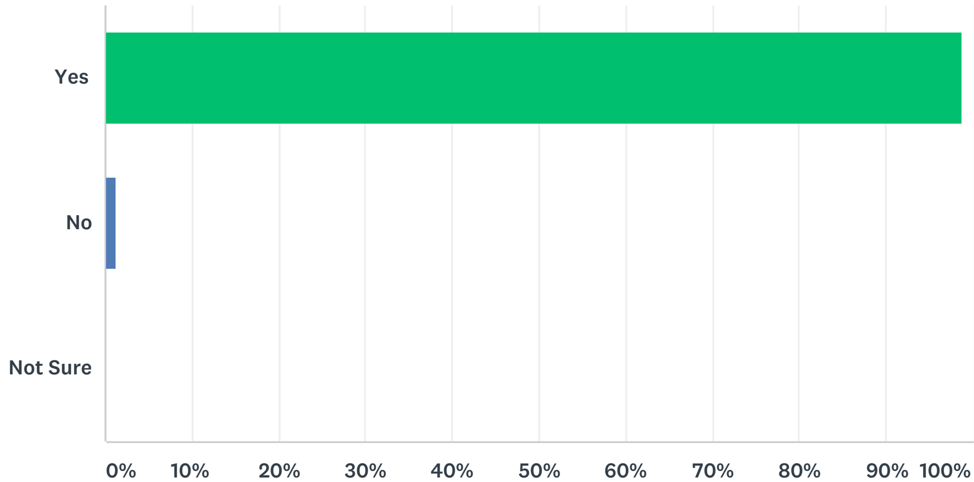
Answered: 76 Skipped: 12



ANSWER CHOICES	RESPONSES	
$20,000 or less	1.32%	1
$20,001 to $49,999	3.95%	3
$50,000 to $74,999	21.05%	16
$75,000 to $99,999	10.53%	8
$100,000 or more	34.21%	26
Prefer not to Answer	28.95%	22
TOTAL		76

Q40 Do you have regular access to the Internet?

Answered: 76 Skipped: 12



ANSWER CHOICES	RESPONSES	
Yes	98.68%	75
No	1.32%	1
Not Sure	0.00%	0
TOTAL		76

Q41 Comments

Answered: 18 Skipped: 70

Appendix B. Federal and State Agencies, Programs and Regulations

B. 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' 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.

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 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.

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 NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in participating communities. For most participating communities, FEMA has prepared a detailed Flood Insurance Study. 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.

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

- New buildings and those undergoing substantial improvements must, at a minimum, be elevated to protect against damage by the 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.

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. Chelan County and all cities 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.

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, North Cascades National Park

The National Park Service (NPS) provides wildland and structure fire protection, and conducts wildfire management within the NPS 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 U.S. Army Corps of Engineers has several civil works authorities and programs related to flood risk and 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.

All of these authorities and programs are available to the planning partners to support any intersecting 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 employs 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 primarily 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

Building Code

The Washington State Building Code Council adopted the 2015 editions of national model codes, with some amendments (RCW 19.27.074). The Council also adopted changes to the Washington State Energy Code. Washington's state-developed codes are mandatory statewide for residential and commercial buildings. The residential code exceeds the 2006 International Energy Conservation Code standards (as amended) for most homes, and the commercial code meets or exceeds standards of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE 90.1-2004). For residential construction covered by ASHRAE 90.1-2007 (buildings with four or more stories), the state code is more stringent. The 2015 International Building Code went into effect as the Washington model code on July 1, 2016.

The adoption and enforcement of appropriate building codes is a significant component for hazard mitigation loss avoidance. Using the most up to date and relevant codes reduces risk and increases capability.

Comprehensive Emergency Management Planning

Washington's Comprehensive Emergency Management Planning law (RCW 38.52) establishes parameters to ensure that preparations of the state will be adequate to deal with disasters, to ensure the administration of state and federal programs providing disaster relief to individuals, to ensure adequate support for search and rescue operations, to protect the public peace, health and safety, and to preserve the lives and property of the people of the state. It achieves the following:

- Provides for emergency management by the state, and authorizes the creation of local organizations for emergency management in political subdivisions of the state.
- Confers emergency powers upon the governor and upon the executive heads of political subdivisions of the state.
- Provides for the rendering of mutual aid among political subdivisions of the state and with other states and for cooperation with the federal government with respect to the carrying out of emergency management functions.

- Provides a means of compensating emergency management workers who may suffer any injury or death, who suffer economic harm including personal property damage or loss, or who incur expenses for transportation, telephone or other methods of communication, and the use of personal supplies as a result of participation in emergency management activities.
- Provides programs, with intergovernmental cooperation, to educate and train the public to be prepared for emergencies.

It is policy under this law that emergency management functions of the state and its political subdivisions be coordinated to the maximum extent with comparable functions of the federal government and agencies of other states and localities, and of private agencies of every type, to the end that the most effective preparation and use may be made of manpower, resources, and facilities for dealing with disasters.

Washington Department of Ecology Dam Safety Program

The Dam Safety Office (DSO) of the Washington Department of Ecology regulates over 1,000 dams in the state that impound at least 10 acre-feet of water. The DSO has developed dam safety guidelines to provide dam owners, operators, and design engineers with information on activities, procedures, and requirements involved in the planning, design, construction, operation and maintenance of dams in Washington. The authority to regulate dams in Washington and to provide for public safety is contained in the following laws:

- State Water Code (1917)—RCW 90.03
- Flood Control Act (1935)—RCW 86.16
- Department of Ecology (1970)—RCW 43.21A.

Where water projects involve dams and reservoirs with a storage volume of 10 acre-feet or more, the laws provide for the Department of Ecology to conduct engineering review of the construction plans and specifications, to inspect the dams, and to require remedial action as necessary to ensure proper operation, maintenance, and safe performance. The DSO was established within Ecology’s Water Resources Program to carry out these responsibilities.

The DSO’s five-year periodic inspection program for dams with high and significant hazard classifications achieves the following purposes (Washington Department of Ecology, 2015a):

- Assess the structural integrity and stability of project elements.
- Identify obvious defects, especially due to aging.
- Assess the stability of the structure under earthquake conditions.
- Determine the adequacy of the spillways to accommodate major floods.
- Evaluate project operation and maintenance.

The inspections, performed by professional engineers from the DSO, consist of the following elements (Washington Department of Ecology, 2015a):

- Review and analysis of available data on the design, construction, operation and maintenance of the dam and its appurtenances
- Visual inspection of the dam and its appurtenances
- Evaluation of the safety of the dam and its appurtenances, which may include an assessment of hydrological and hydraulic capabilities, structural stabilities, seismic stabilities, and any other condition that could constitute a hazard to the integrity of the structure
- Evaluation of the downstream hazard classification
- Evaluation of the operation, maintenance and inspection procedures employed by the owner and/or operator

- Review of the emergency action plan for the dam, including review or update of the dam-breach inundation map.

The DSO provides assurance that impoundment facilities will not pose a threat to lives and property, but dam owners bear primary responsibility for the safety of their structures, through proper design, construction, operation, and maintenance.

Department of Ecology Grants

Washington's first flood control maintenance program, passed in 1951, was called the Flood Control Maintenance Program. In 1984, the state Legislature established the Flood Control Assistance Account Program (FCAAP) to assist local jurisdictions in comprehensive planning and flood control maintenance (RCW 86.26; WAC 173-145). This is one of the few state programs in the country that provides grant funding to local governments for flood hazard management planning and implementation. The account is funded at $4 million per state biennium, unless modified by the Legislature. Projects include comprehensive flood hazard management planning, maintenance projects, feasibility studies, purchase of flood-prone properties, matches for federal projects, and emergency projects. FCAAP grants for non-emergency projects may not exceed $500,000 per county. Due to funding cuts, applications to this program are currently being accepted only for emergency projects.

In 2013, the Legislature authorized $44 million in new funding for integrated projects consistent with Floodplains by Design, an emerging partnership of local, state, federal and private organizations focused on coordinating investment in and strengthening the integrated management of floodplain areas. A similar level of funding was authorized for the 2015-17 and 2017-19 bienniums. The Department of Ecology's Floods and Floodplain Management Division administers the Floodplains by Design grant program. Ecology awards grants on a competitive basis to eligible entities for collaborative and innovative projects in Washington that support the integration of flood hazard reduction with ecological preservation and restoration. Proposed projects may also address other community needs, such as preservation of agriculture, improvements in water quality, or increased recreational opportunities, provided they are part of a larger strategy to restore ecological functions and reduce flood hazards.

Enhanced Mitigation Plan

The 2013 Washington State Enhanced Hazard Mitigation Plan provides guidance for hazard mitigation throughout Washington (Washington Emergency Management Division, 2013). The plan identifies hazard mitigation goals, objectives and actions for state government to reduce injury and damage from natural hazards. By meeting federal requirements for an enhanced state plan (44 CFR Parts 201.4 and 201.5), the plan allows the state to seek significantly higher funding from the Hazard Mitigation Grant Program following presidential declared disasters (20 percent of federal disaster expenditures vs. 15 percent with a standard plan).

The *Chelan County Multi-Jurisdictional Natural Hazard Mitigation Plan* must be consistent with the Washington State Plan. One major example of this is that the Chelan County plan must, at a minimum, address those hazards identified in the state plan as impacting Chelan County.

Environmental Policy Act

The State Environmental Policy Act (SEPA) provides a way to identify possible environmental impacts of governmental decisions. These decisions may be related to issuing permits for private projects, constructing public facilities, or adopting regulations, policies, or plans. Information provided during the SEPA review process helps agency decision-makers, applicants, and the public understand how a proposal will affect the environment. This information can be used to change a proposal to reduce likely impacts, or to condition or deny a proposal when adverse environmental impacts are identified. Actions identified in hazard mitigation plans are frequently subject to SEPA review requirements before implementation (Washington Department of Ecology, 2016).

Floodplain Management Law

Washington's floodplain management law (Revised Code of Washington (RCW) 86.16, implemented through Washington Administrative Code (WAC) 173-158) states that prevention of flood damage is a matter of statewide public concern and places regulatory control with the Department of Ecology. RCW 86.16 is cited in floodplain management literature, including FEMA's national assessment, as one of the first and strongest in the nation. A 1978 major challenge to the law—Maple Leaf Investors Inc. v. Department of Ecology—is cited in legal references to flood hazard management issues. The court upheld the law, declaring that denial of a permit to build residential structures in the floodway is a valid exercise of police power and did not constitute a taking. RCW Chapter 86.12 (Flood Control by Counties) authorizes county governments to levy taxes, condemn properties and undertake flood control activities directed toward a public purpose.

Growth Management Act

The 1990 Washington State Growth Management Act (RCW Chapter 36.70A) mandates that local jurisdictions adopt land use ordinances to protect the following critical areas:

- Wetlands
- Critical aquifer recharge areas
- Fish and wildlife habitat conservation areas
- Frequently flooded areas
- Geologically hazardous areas.

The Growth Management Act regulates development in these areas, and therefore has the potential to affect hazard vulnerability and exposure at the local level.

Planning for natural hazards is an integral element of Washington's statewide land use planning program under the Growth Management Act. Other related parts of the planning framework include the Shoreline Master Program rules and guidelines, which now provide for the integration of master programs and comprehensive plans. Natural Hazard Mitigation Elements are an optional element under the Growth Management Act. The continuing challenge faced by local officials and state government is to keep a network of coordinated local plans effective in responding to changing conditions and needs of communities. This is particularly true in the case of planning for natural and technological hazards, where communities must balance development pressures with detailed information on the nature and extent of hazards. Washington's land use program has given its communities and residents a unique opportunity to ensure that natural and technological hazards are addressed in the development and implementation of local comprehensive plans.

Hydraulic Code

Washington's Hydraulic Code states that any person or government agency intending to undertake a hydraulic project shall, before commencing work, secure a Hydraulic Project Approval from the Washington Department of Fish and Wildlife verifying the adequacy of the proposed means for protecting fish (RCW 77.55.021 (1)). The code defines a hydraulic project as work that will use, divert, obstruct, or change the natural flow or bed of any salt or freshwaters of the state. Approval is required for projects at or waterward of the ordinary high water line and for projects landward of the ordinary high water line that are immediately adjacent to waters of the state.

Land and Water Conservation Fund

Congress established the Land and Water Conservation Fund in 1965 and authorized the Secretary of the Interior to provide financial assistance to the states for the acquisition and development of public outdoor recreation areas. The Washington State Recreation and Conservation Office administers the program in Washington. Funding comes from a portion of federal revenue from selling and leasing off-shore oil and gas resources. Eligible projects include land acquisition and development or renovation projects, such as natural areas and open space. The Washington State Recreation and Conservation Office administers the program (Washington State Recreation and Conservation Office, 2016a).

Salmon Recovery Fund

In 1999, the Washington State Legislature created the Salmon Recovery Funding Board. The board provides grants to protect or restore salmon habitat. Funded projects may include activities that protect existing, high quality habitat for salmon or that restore degraded habitat to increase overall habitat health and biological productivity. Funding also is available for feasibility assessments to determine future projects and for other salmon related activities. Projects may include the actual habitat used by salmon and the land and water that support ecosystem functions and processes important to salmon (Washington State Recreation and Conservation Office, 2016b).

Shoreline Management Act

The 1971 Shoreline Management Act (RCW 90.58) was enacted to manage and protect the shorelines of the state by regulating development in the shoreline area. A major goal of the act is to prevent the “inherent harm in an uncoordinated and piecemeal development of the state’s shorelines.” Its jurisdiction includes all water areas of the state, including reservoirs, and their associated shorelands, together with the lands underlying them, except: shorelines of statewide significance; streams upstream of where the mean annual flow is 20 cubic feet per second or less; and lakes smaller than 20 acres.

Shoreline management activities “implement policies and regulations to help protect water quality for our marine waters, lakes and stream systems; increase protection of lives and property from flood and landslide damage; protect critical habitat as well as fish and wildlife; promote recreational opportunities in shoreline areas.” Often these policies and programs complement or are critical in mitigation programs for communities. Shoreline management programs are local capabilities relevant to mitigation activities.

Silver Jackets

The Washington Silver Jackets team was formed in 2010 and is a mix of federal and state agencies that work together to address flood risk priorities in the state. Federal agencies include the Corps of Engineers, which facilitates coordination within the group, FEMA, the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Geological Survey (USGS). Participating state agencies include the Department of Ecology, the Emergency Management Division, and the Department of Transportation. The team’s projects are intended to address state needs and improve flood risk management throughout the full flood life cycle (Silver Jackets, 2016).

Washington Administrative Code 118-30-060(1)

Washington Administrative Code (WAC) 118-30-060 (1) requires each political subdivision to base its comprehensive emergency management plan on a hazard analysis, and makes the following definitions related to hazards:

- Hazards are conditions that can threaten human life as the result of three main factors:

- ➢ Natural conditions, such as weather and seismic activity
- ➢ Human interference with natural processes, such as a levee that displaces the natural flow of floodwaters
- ➢ Human activity and its products, such as homes on a floodplain.

- The definitions for hazard, hazard event, hazard identification, and flood hazard include related concepts:

  - ➢ A hazard may be connected to human activity.
  - ➢ Hazards are extreme events.

Hazards generally pose a risk of damage, loss, or harm to people and/or their property

Watershed Management Act

Washington's Watershed Management Act of 1998 encourages local communities to develop plans for protecting local water resources and habitat. Lawmakers wanted local governments and citizens to develop plans since they know their own regions best. WRIA is an acronym for "Water Resource Inventory Area." WRIAs are watershed planning areas established by the Department of Ecology. Washington State is divided into 62 WRIAs, each loosely drawn around a natural watershed or group of watersheds. A watershed is an area of land that drains into a common river, lake or the ocean.

Appendix C. Concepts and Methods Used for Hazard Mapping

C. CONCEPTS AND METHODS USED FOR HAZARD MAPPING

EARTHQUAKE MAPPING

Liquefaction is a natural phenomenon in which saturated, sandy soils lose their strength and behave as liquid. Liquefaction mapping contains polygons that provide information regarding the relative liquefaction potential for Washington State. This data is part of a geodatabase that contains statewide seismic ground response data.

The seismic ground response geodatabase (version 2.0 published June 2010) was downloaded from the Washington State Department of Natural Resources' Geology GIS Data and Databases website (https://www.dnr.wa.gov/programs-andservices/geology/publications-and-data/gis-data-and-databases) in June 2018.

FLOOD MAPPING

FEMA flood hazard boundaries shown in this hazard mitigation plan are a combination of FEMA Digital FIRM Detailed Study Areas and FEMA Digitized Q3 Data. These data were compiled for the *Chelan County Comprehensive Flood Hazard Management Plan* (July 2017).

Hazus-modeled flood boundaries were generated using a combination of Hazus (v3.1) hydrology and hydraulics output and 1-meter Lidar Digital Elevation Model data. These data were generated for the *Chelan County Comprehensive Flood Hazard Management Plan* (July 2017).

Mass Zone A (MZA), or basic approximate, analyses are used by FEMA to address program challenges including the validation of Zone A studies and the availability of flood risk data in the early stages of a Risk Mapping, Assessment and Planning (Risk MAP) project. The STARR team conducted an MZA analysis for the Wenatchee watershed in July 2016. Data downloaded from the Washington Department of Ecology's RiskMAP website in June 2018

LANDSLIDE MAPPING

Deep-seated landslides occur on a failure plane below the rooting depth of vegetation, and may be triggered by an earthquake and/or extreme rain events. Deep-seated landslide susceptibility data was generated by experts based on landslide risk factors such as geology, slope angle, topographic aspect, distance to road, distance to river, and land cover. A multi-criteria decision-making method called Analytic Hierarchy Process (AHP) was used to produce the data, which was provided by the Washington Geological Survey in July 2018.

Shallow landslides typically affect only the uppermost part of the soil column, and may be triggered by an earthquake and/or extreme rain events. Shallow landslide susceptibility data was generated by experts based on landslide risk factors such as geology, slope angle, topographic aspect, distance to road, distance to river, and land cover. A multi-criteria decision-making method called Analytic Hierarchy Process (AHP) was used to produce the data, which was provided by the Washington Geological Survey in July 2018.

WILDFIRE MAPPING

The landscape-level wildfire risk data represents the likelihood (probability) of a fire occurring and intensity of the fire at the landscape level, based on inherent landscape characteristics including broad existing vegetation, biophysical settings, fire regimes and fire histories. (Chelan County Community Wildfire Protection Plan 2018 Update; http://cascadiacd.org/images/site_graphics/Chelan_County_Public_Review--1--2018.pdf). The risk level is categorized as moderate, high, or very high. The data was produced in a raster format with a 120-meter pixel resolution, and was provided by Northwest Management Inc.

The local-level wildfire risk data is based on an extreme event (worst fire days). The data does not show the likelihood of a fire occurring but shows where fires are likely to burn at high intensity. For example, a fire that starts in an area where the local hazard is high can spread fast and burn at high intensity creating significant wildfire exposure to any structures in the area. (Chelan County Community Wildfire Protection Plan 2018 Update; http://cascadiacd.org/images/site_graphics/Chelan_County_Public_Review--1--2018.pdf). The risk level is categorized as moderate, high, or very high. The data was produced in a raster format with a 30-meter pixel resolution, and was provided by Northwest Management Inc.

Chelan County Multi-Jurisdiction Natural Hazard Mitigation Plan

Appendix D. Detailed Risk Assessment Results

D. DETAILED RISK ASSESSMENT RESULTS

TABLES TO BE UPDATED BEFORE FINAL DOCUMENT SUBMITTAL

DAM FAILURE

Exposure in the Dam Failure Inundation Zone

	Estimated Exposure in the Dam Failure Inundation Zone						
	Population Exposed[a]	% of Population Exposed	Buildings Exposed[b]	Structure Value Exposed[b]	Contents Value Exposed[b]	Total Value Exposed (Structure + Contents)[b]	% of Total Value Exposed
Cashmere							
Chelan							
Entiat							
Leavenworth							
Wenatchee							
Unincorporated County							
Total							

a. Percent of residential buildings exposed multiplied by the estimated population.
b. Values based on tax parcel data.
c. 8-Mile Lake dam inundation area

Structures in the Dam Failure Inundation Zone by Land Use Type

	Number of Structures within Dam Failure Inundation Zone[a]							
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Cashmere								
Chelan								
Entiat								
Leavenworth								
Wenatchee								
Unincorporated County								
Total								

a. Values based on tax parcel data.

Critical Facilities and Infrastructure in the Dam Failure Inundation Zone

	Number of Facilities in the Dam Failure Inundation Zone						
	Cashmere	Chelan	Entiat	Leavenworth	Wenatchee	Unincorporated County	Total
Bridges							
Communication							
Fuel Storage							
Government Function							
Hazardous Materials							
Medical & Health							
Other Critical Function							
Power							
Protective Function							
Schools							
Societal Function							
Wastewater							
Water Supply							
Total							

Loss Estimates for Structures in Dam Failure Inundation Area[a]

	Estimated Loss Associated with Dam Failure			% of Total Replacement Value
	Building	Contents	Total	
Cashmere				
Chelan				
Entiat				
Leavenworth				
Wenatchee				
Unincorporated County				
Total				

a. These estimates are derived from the planning scenario event, not for all possible dam failure risk in the county.

Buildable Lands in Planning Area Urban Growth Areas that Intersect Dam Inundation Areas[a]

	Residential		Commercial (acres)	Industrial (acres)	Total (acres)
	Acres	Units			
Cashmere					
Chelan					
Entiat					
Leavenworth					
Wenatchee					
Unincorporated County					
Total					

a. Buildable lands information for planning purposes only. Discrepancies may exist between these estimates and official records maintained by participating jurisdictions. Acreage covers only mapped parcels; it excludes rights of way and major water features.

EARTHQUAKE

Exposure in the Earthquake Hazard Area

	Estimated Exposure to the Earthquake Hazard[c]				
	Population Exposed[a]	% of Population Exposed	Buildings Exposed[b]	Total Value Exposed (Structure + Contents)[b]	% of Total Value Exposed
Cashmere					
Chelan					
Entiat					
Leavenworth					
Wenatchee					
Unincorporated County					
Total					

a. Estimated population calculated as Census population multiplied by the countywide percent change in population.
b. Values based on tax parcel data.
c. The entire planning area is exposed to the earthquake hazard, so the exposure estimates are equal to the planning area totals, and are the same for all modeled earthquake scenarios.

Critical Facilities and Infrastructure in the Earthquake Hazard Area

	Number of Facilities in the Earthquake Hazard Area[a]						
	Cashmere	Chelan	Entiat	Leavenworth	Wenatchee	Unincorporated County	Total
Bridges							
Communication							
Fuel Storage							
Government Function							
Hazardous Materials							
Medical & Health							
Other Critical Function							
Power							
Protective Function							
Schools							
Societal Function							
Wastewater							
Water Supply							
Total							

a. The entire planning area is exposed to the earthquake hazard, so the numbers of exposed critical facilities and infrastructure are the same as the total planning area critical facility and infrastructure counts, and are the same for all modeled earthquake scenarios.

Potential Damage in the Earthquake Hazard Area

	Estimated Potential Damage						
	Structure Debris (x 1,000 Tons)[a]	Number of Displaced Households[a]	People Requiring Short-Term Shelter[a]	Value of Structure Damaged[a]	Value of Contents Damaged[a]	Total Value (Structure + Contents) Damaged[a]	Damage as % of Total Value
100-YEAR PROBABILISTIC							
Cashmere							
Chelan							
Entiat							
Leavenworth							
Wenatchee							
Unincorporated County							
Total							
CHELAN M7.2							
Cashmere							
Chelan							
Entiat							
Leavenworth							
Wenatchee							
Unincorporated County							
Total							
CASCADIA M9.0							
Cashmere							
Chelan							
Entiat							
Leavenworth							
Wenatchee							
Unincorporated County							
Total							

a. Calculated using a Census tract level, general building stock analysis in Hazus 4.0.

FLOOD

Area and Structures Within the 100-Year Floodplain by Municipality

	Area (acres)	Number of Structures							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Cashmere	75	75	0	2	0	1	0	0	78
Chelan	53	75	0	0	0	0	0	0	75
Entiat	27	0	0	0	0	0	0	0	0
Leavenworth	104	5	0	0	0	0	0	0	5
Wenatchee	1,073	2,446	12	1	0	6	2	1	2,468
Unincorporated County	24,492	980	6	1	7	2	15	0	1,011
Total	25,824	3,581	18	4	7	9	17	1	3,637

Area and Structures Within the 500-Year Floodplain by Municipality

	Area (acres)	Number of Structures							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Cashmere	277	524	55	10	1	12	1	0	603
Chelan	53	75	0	0	0	0	0	0	75
Entiat	27	0	0	0	0	0	0	0	0
Leavenworth	113	5	0	0	0	0	0	0	5
Wenatchee	3,772	7,418	633	68	7	43	10	4	8,183
Unincorporated County	25,438	1,294	11	2	9	4	16	0	1,336
Total	29,680	9,316	699	80	17	59	27	4	10,202

Value of Structures in the 100-Year Floodplain by Municipality

	Value Exposed[a]			% of Total Replacement Cost
	Structure	Contents	Total	
Cashmere	$13,748,297	$7,985,766	$21,734,063	2.9%
Chelan	$9,769,030	$4,884,515	$14,653,545	0.9%
Entiat	$0	$0	$0	0.0%
Leavenworth	$1,062,934	$531,467	$1,594,401	0.2%
Wenatchee	$540,458,616	$303,876,379	$844,334,995	12.5%
Unincorporated County	$156,872,035	$84,111,183	$240,983,219	3.3%
Total	$721,910,912	$401,389,310	$1,123,300,223	6.4%

a. Exposure estimated derived from Hazus analysis.

Value of Structures in the 500-Year Floodplain by Municipality

	Value Exposed[a]			% of Total Structure
	Structure	Contents	Total	
Cashmere	$267,613,862	$239,942,708	$507,556,570	67.9%
Chelan	$9,769,030	$4,884,515	$14,653,545	0.9%
Entiat	$0	$0	$0	0.0%
Leavenworth	$1,062,934	$531,467	$1,594,401	0.2%
Wenatchee	$3,235,383,204	$2,560,537,691	$5,795,920,895	85.8%
Unincorporated County	$218,649,840	$126,562,481	$345,212,321	4.7%
Total	$3,732,478,870.00	$2,932,458,862.00	$6,664,937,732.00	37.9%

a. Exposure estimated derived from Hazus analysis.

Land Use in the Floodplain

Land Use Category[a]	100-Year Floodplain		500-year Floodplain	
	Area (acres)	% of total	Area (acres)	% of total
Agriculture	444.96	1.7%	576.80	1.9%
Commercial	825.25	3.2%	1,321.75	4.5%
Education	101.85	0.4%	236.26	0.8%
Forest	1,043.63	4.0%	1,059.74	3.6%
Government	3,685.98	14.3%	4,033.48	13.6%
Industrial	37.22	0.1%	104.60	0.4%
Open Space	605.67	2.4%	674.76	2.3%
Other (right-of-way, easements)	48.47	0.2%	60.34	0.2%
Religion	26.24	0.1%	65.26	0.2%
Residential	3,851.66	14.9%	5,559.62	18.7%
Undeveloped Land	429.19	1.7%	473.91	1.6%
Uncategorized	14,722.84	57.0%	15,513.53	52.3%
Total	25,822.96	100%	29,680.05	100%

a. Land use designations were derived from County Assessor data.

Critical Facilities in the Floodplain

	Number of Facilities in the 100-Year Floodplain	Number of Facilities in the 500-Year Floodplain
Medical and Health Services	0	5
Government Function	0	15
Protective	2	6
Hazardous Materials	0	5
Schools	7	19
Other	5	13
Total	14	63

Critical Infrastructure in the Floodplain

	Number of Facilities in the 100-Year Floodplain	Number of Facilities in the 500-Year Floodplain
Bridges[a]	73	90
Water Supply	0	0
Wastewater	0	2
Power	6	15
Communications	1	1
Other	0	5
Total	80	113

a. County, state and federally owned. Does not include privately owned bridges.

Estimated Flood Impact on Persons

	100-Year Flood[a]		500-Year Flood[a]	
	Displaced Persons	Persons Requiring Short-Term Shelter[b]	Displaced Persons	Persons Requiring Short-Term Shelter[b]
Cashmere	42	25	1,214	1,077
Chelan	6	1	7	1
Entiat	0	0	0	0
Leavenworth	2	2	2	2
Wenatchee	6,156	5,769	25,261	24,295
Unincorporated	306	149	565	331
Total	6,512	5,946	27,049	25,706

a. Results shown are not precise, but are estimates of needs that may occur as the result of the modeled flood.
b. The number of persons requiring publicly provided shelter is less than the number of displaced persons because not all households will require public assistance to find short-term shelter.

Loss Estimates for 100-Year Flood Event

	Structures Impacted[a]	Estimated Loss Associated with Flood			% of Total Replacement Cost
		Structure	Contents	**Total**	
Cashmere	49	$1,160,285	$598,309	$1,758,595	0.2%
Chelan	20	$778,346	$354,526	$1,132,872	0.1%
Entiat	0	$0	$0	$0	0.0%
Leavenworth	2	$78,325	$44,907	$123,232	Less than 0.1%
Wenatchee	1,255	$56,001,910	$25,614,855	$81,616,765	1.2%
Unincorporated County	712	$26,560,267	$17,308,072	$43,868,299	0.6%
Total	2,038	$84,579,133	$43,920,669	$128,499,763	0.7%

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

Notes: Values in this table are only for purposes of comparison among results.

Loss Estimates for 500-Year Flood Event

	Structures Impacted[a]	Estimated Loss Associated with Flood			% of Total Replacement Cost
		Structure	Contents	Total	
Cashmere	167	$5,848,969	$3,813,835	$9,662,804	1.3%
Chelan	22	$739,176	$356,850	$1,096,026	0.1%
Entiat	0	$0	$0	$0	0.0%
Leavenworth	3	$179,846	$107,253	$287,099	Less than 0.1%
Wenatchee	2,825	$355,636,665	$486,122,571	$841,759,236	12.5%
Unincorporated County	860	$35,505,093	$24,569,765	$60,074,858	0.8%
Total	3,877	$397,909,749	$514,970,274	$912,880,023	5.2%

a. Impacted structures are those structures with finished floor elevations below the Hazus-estimated 500-year water surface elevation. These structures are the most likely to receive damage in a 500-year flood event

Notes: Values in this table are only for purposes of comparison among results.

Estimated Damage to Critical Facilities from 100-Year Flood

	Number of Facilities Affected	% of Total Value Damaged (Each Facility)		Days to 100% Functionality
		Building	Contents	
Protective Function	2	7%	8%	480
Schools	7	5%	27%	480
Other	5	5% – 13%	27% – 73%	480 – 630

Estimated Damage to Critical Facilities from 500-Year Event

	Number of Facilities Affected	% of Total Value Damaged (Each Facility)		Days to 100% Functionality
		Building	Contents	
Medical and Health	5	3%	19%	384
Government Function	15	Less than 1%	5%	32
Protective	6	23%	4%	160
Hazardous Materials	5	5%	15%	—
Schools	19	12%	10%	177
Other	13	0% -14%	18% -58%	0-630

Estimated Damage to Critical Infrastructure from Flood Events

	100-Year Flood		500-Year Flood	
	Number of Facilities Affected	% of Total Value Damaged (Each Facility)	Number of Facilities Affected	% of Total Value Damaged (Each Facility)
Bridges	73	Less than 1%	90	Less than 1%
Wastewater	0	N/A	2	7%
Power	6	12%	15	11%
Communications	1	2%	1	2%
Other	0	N/A	5	5%

Estimated Flood-Caused Debris

	Debris to Be Removed (tons)[a]	
	100-Year Flood Event	500-Year Flood Event
Cashmere	258	971
Chelan	230	229
Entiat	77	67
Leavenworth	1,245	1,300
Wenatchee	4,365	38,117
Unincorporated County	8,996	11,181
Total	15,171	51,865

a. The Hazus flood debris model focuses on building-related debris, and does not address contents removal or additional debris loads such as vegetation and sediment.

LANDSLIDE

Exposure in the Deep-Seated Landslide Hazard Area

	Estimated Exposure in the Landslide Hazard Area						
	Population Exposed	% of Population Exposed	Buildings Exposed	Structure Value Exposed	Contents Value Exposed	Total Value Exposed (Structure + Contents)	% of Total Value Exposed
High Landslide Susceptibility Zone							
Cashmere							
Chelan							
Entiat							
Leavenworth							
Wenatchee							
Unincorporated County							
Total							
Moderate Landslide Susceptibility Zone							
Cashmere							
Chelan							
Entiat							
Leavenworth							
Wenatchee							
Unincorporated County							
Total							
Low Landslide Susceptibility Zone							
Cashmere							
Chelan							
Entiat							
Leavenworth							
Wenatchee							
Unincorporated County							
Total							

Exposure in the Shallow Landslide Hazard Area							
	Estimated Exposure in the Landslide Hazard Area						
	Population Exposed	% of Population Exposed	Buildings Exposed	Structure Value Exposed	Contents Value Exposed	Total Value Exposed (Structure + Contents)	% of Total Value Exposed
High Landslide Susceptibility Zone							
Cashmere							
Chelan							
Entiat							
Leavenworth							
Wenatchee							
Unincorporated County							
Total							
Moderate Landslide Susceptibility Zone							
Cashmere							
Chelan							
Entiat							
Leavenworth							
Wenatchee							
Unincorporated County							
Total							
Low Landslide Susceptibility Zone							
Cashmere							
Chelan							
Entiat							
Leavenworth							
Wenatchee							
Unincorporated County							
Total							

Structures in the Deep-Seated Landslide Hazard Area

	Number of Structures within the Landslide Hazard Area							
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
High Landslide Susceptibility Zone								
Cashmere								
Chelan								
Entiat								
Leavenworth								
Wenatchee								
Unincorporated County								
Total								
Moderate Landslide Susceptibility Zone								
Cashmere								
Chelan								
Entiat								
Leavenworth								
Wenatchee								
Unincorporated County								
Total								
Low Landslide Susceptibility Zone								
Cashmere								
Chelan								
Entiat								
Leavenworth								
Wenatchee								
Unincorporated County								
Total								

Structures in the Shallow Landslide Hazard Area

	Number of Structures within the Landslide Hazard Area							
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
High Landslide Susceptibility Zone								
Cashmere								
Chelan								
Entiat								
Leavenworth								
Wenatchee								
Unincorporated County								
Total								
Moderate Landslide Susceptibility Zone								
Cashmere								
Chelan								
Entiat								
Leavenworth								
Wenatchee								
Unincorporated County								
Total								
Low Landslide Susceptibility Zone								
Cashmere								
Chelan								
Entiat								
Leavenworth								
Wenatchee								
Unincorporated County								
Total								

Critical Facilities and Infrastructure in the Deep-Seated Landslide Hazard Area

	Number of Facilities in the Landslide Hazard Area						
	Cashmere	Chelan	Entiat	Leavenworth	Wenatchee	Unincorporated County	Total
High Landslide Susceptibility Zone							
Bridges							
Communication							
Fuel Storage							
Government Function							
Hazardous Materials							
Medical & Health							
Other Critical Function							
Power							
Protective Function							
Schools							
Societal Function							
Wastewater							
Water Supply							
Total							
Moderate Landslide Susceptibility Zone							
Bridges							
Communication							
Fuel Storage							
Government Function							
Hazardous Materials							
Medical & Health							
Other Critical Function							
Power							
Protective Function							
Schools							
Societal Function							
Wastewater							
Water Supply							
Total							
Low Landslide Susceptibility Zone							
Bridges							
Communication							
Fuel Storage							
Government Function							
Hazardous Materials							
Medical & Health							
Other Critical Function							
Power							
Protective Function							
Schools							
Societal Function							
Wastewater							
Water Supply							
Total							

Critical Facilities and Infrastructure in the Shallow Landslide Hazard Area							
	Number of Facilities in the Landslide Hazard Area						
	Cashmere	Chelan	Entiat	Leavenworth	Wenatchee	Unincorporated County	Total
High Landslide Susceptibility Zone							
Bridges							
Communication							
Fuel Storage							
Government Function							
Hazardous Materials							
Medical & Health							
Other Critical Function							
Power							
Protective Function							
Schools							
Societal Function							
Wastewater							
Water Supply							
Total							
Moderate Landslide Susceptibility Zone							
Bridges							
Communication							
Fuel Storage							
Government Function							
Hazardous Materials							
Medical & Health							
Other Critical Function							
Power							
Protective Function							
Schools							
Societal Function							
Wastewater							
Water Supply							
Total							
Low Landslide Susceptibility Zone							
Bridges							
Communication							
Fuel Storage							
Government Function							
Hazardous Materials							
Medical & Health							
Other Critical Function							
Power							
Protective Function							
Schools							
Societal Function							
Wastewater							
Water Supply							
Total							

WILDFIRE

Exposure in the Wildfire Hazard Area

	Estimated Exposure in the Wildfire Hazard Area						
	Population Exposed[a]	% of Population Exposed	Buildings Exposed[b]	Structure Value Exposed[b]	Contents Value Exposed[b]	Total Value Exposed (Structure + Contents)[b]	% of Total Value Exposed
Very High Fire Severity Zone							
Cashmere							
Chelan							
Entiat							
Leavenworth							
Wenatchee							
Unincorporated County							
Total							
High Fire Severity Zone							
Cashmere							
Chelan							
Entiat							
Leavenworth							
Wenatchee							
Unincorporated County							
Total							
Moderate Fire Severity Zone							
Cashmere							
Chelan							
Entiat							
Leavenworth							
Wenatchee							
Unincorporated County							
Total							

a. Percent of residential buildings exposed multiplied by the estimated population
b. Values based on tax parcel data.

Structures in the Wildfire Hazard Area by Land Use Type								
	Number of Structures within the Wildfire Hazard Area							
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Very High Fire Severity Zone								
Cashmere								
Chelan								
Entiat								
Leavenworth								
Wenatchee								
Unincorporated County								
Total								
High Fire Severity Zone								
Cashmere								
Chelan								
Entiat								
Leavenworth								
Wenatchee								
Unincorporated County								
Total								
Moderate Fire Severity Zone								
Cashmere								
Chelan								
Entiat								
Leavenworth								
Wenatchee								
Unincorporated County								
Total								

Critical Facilities and Infrastructure in the Shallow Landslide Hazard Area

	Number of Facilities in the Landslide Hazard Area						
	Cashmere	Chelan	Entiat	Leavenworth	Wenatchee	Unincorporated County	Total
Very High Fire Severity Zone							
Bridges							
Communication							
Fuel Storage							
Government Function							
Hazardous Materials							
Medical & Health							
Other Critical Function							
Power							
Protective Function							
Schools							
Societal Function							
Wastewater							
Water Supply							
Total							
High Fire Severity Zone							
Bridges							
Communication							
Fuel Storage							
Government Function							
Hazardous Materials							
Medical & Health							
Other Critical Function							
Power							
Protective Function							
Schools							
Societal Function							
Wastewater							
Water Supply							
Total							
Moderate Fire Severity Zone							
Bridges							
Communication							
Fuel Storage							
Government Function							
Hazardous Materials							
Medical & Health							
Other Critical Function							
Power							
Protective Function							
Schools							
Societal Function							
Wastewater							
Water Supply							
Total							

Appendix E. Plan Adoption Resolutions from Planning Partners

E. Plan Adoption Resolutions from Planning Partners

TO BE PROVIDED WITH FINAL DRAFT