Mason County
2018 Multi-Jurisdiction
Hazard Mitigation Plan Update
Volume 1: Planning-Area-Wide Elements

May 2018

BRIDGEVIEW CONSULTING

MASON COUNTY MULTI-JURISDICTION

2018 HAZARD MITIGATION PLAN UPDATE

VOLUME 1: PLANNING-AREA-WIDE ELEMENTS

FINAL

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Prepared for:
Mason County Department of Emergency Management
100 Public Works Drive
Shelton, WA 98584
(360) 427-9670

Prepared by:

Bridgeview Consulting LLC
915 No. Laurel Lane
Tacoma, WA 98406
(253) 301-1330

Mason County 2018 Multi-Jurisdiction Hazard Mitigation Plan Update
Volume 1—Planning-Area-Wide Elements

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EXECUTIVE SUMMARY

The federal Disaster Mitigation Act (DMA) promotes proactive pre-disaster planning by making it a condition of receiving financial assistance under the Robert T. Stafford Act. The DMA established a Pre-Disaster Mitigation Program and new requirements for the national post-disaster Hazard Mitigation Grant Program.

The DMA encourages state and local authorities to work together on pre-disaster planning, promoting sustainability as a strategy for disaster resistance. Sustainable hazard mitigation addresses the sound management of natural resources and local economic and social resiliency, and it recognizes that hazards and mitigation must be understood in a broad social and economic context. The 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.

A planning partnership made up of Mason County and local governments worked together to create this Mason County 2018 Multi-Jurisdiction Hazard Mitigation Plan Update to fulfill the DMA requirements for all fully participating partners.

PLAN UPDATE

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

Initial Response to the DMA in Mason County

The inevitability of natural hazards and the growing population and activities within the planning region created an urgent need to develop information, concepts, strategies, and a coordination of resources to increase public awareness of the hazards of concern and the risk associated with those hazards. In an effort to reduce the impact of the hazards and assist the public in protecting life, property and the economy, the County determined that it was in the best interests of its citizenry to develop the 2004 and 2010 Mason County Hazard Mitigation Plans. Those plans, once completed, served as the base for several other planning efforts throughout the planning region, including the Mason County Flood Hazard Mitigation Plan. This 2018 Hazard Mitigation Plan is a continued update of the 2004 and 2010 plans.

As time progressed, new technologies, information and increased awareness brought about a wealth of information to enhance the validity of the initial plan, providing the opportunity, through development of the 2018 update to the Mason County Multi-Jurisdiction Hazard Mitigation Plan, to increase the resilience of the planning region.

The 2018 Mason County Plan Update—What has changed?

The updated plan differs from the initial plan for a variety of reasons:

- Better guidance now exists on what is required to meet the intent of the DMA.
- Science and technology have improved since the development of the initial plan.

- Newly available data and tools provide for a more detailed and accurate risk assessment.

Mason County is using the five-year update process to enhance the Mason County Multi-Jurisdictional Mitigation Plan in scope and content. Based on availability of new data and a better understanding of the Federal Emergency Management Agency's (FEMA's) guidance to develop mitigation plans, the following changes have been incorporated in the 2018 plan which differ from the previous edition:

- The layout of the plan varies significantly for ease in use by the planning partners. The 2018 edition utilizes a two-volume approach. Volume 1 includes general planning information and hazard profile data which is consistent with all entities involved, as well as the County-specific data. Volume 2 includes each jurisdiction's separate annex, as well as the linkage procedure for partners wishing to join at a later date.
- Hazards of concern were modified for this 2018 update. Drought was added due to the unknown impact of Climate Change on the Drought hazard, especially in light of the County's economic reliance on shellfish harvesting, and reliance on wells for drinking water. Wildfire was significantly enhanced, due to the increase in wildfire occurrences throughout Washington over the course of the last several wildfire seasons, and the large amount of wooded lands. Severe Storm was expanded to Sever Weather, now inclusive of additional elements such as excessive heat and cold, wind, thunderstorms, and hail. Hazmat was included within each hazard profile as relevant. A new Climate Change section was also included to address potential impacts on the hazards of concern; however, no risk assessment was performed as there currently is no damage function which addresses such impact. Terrorism, which was addressed by a one-page summary, was removed. Homeland Security Region 3 has developed a Threat Hazard Identification and Risk Assessment for the area, which will be used in its stead. That document, protected from public disclosure, allows for a more detailed and accurate assessment. The County felt that including terrorism within this document was repetitive in nature, and allowed for the potential of conflicting data. Tsunami was again discussed, but based on the lack of relevant data on which to base impact, the Planning Team determined it would not include Tsunami during this update, but would again review the option to include it in future updates. Volcano was reviewed, but also tabled during this update process due to limited historic impact.
- The risk assessment was expanded to use additional methodologies and new studies to define risk and determine vulnerability. This edition is based on analysis using both GIS and Hazus (FEMA's hazard-modeling program), and focuses on determining impacts on people, property, environment, and the economy. The previous plan utilized primarily only GIS, with no outputs from Hazus included. This edition also utilizes FEMA's 2017 Risk Map data, as well as enhanced structure data using the County's Assessor's data base.
- Critical infrastructure data was expanded and updated to include new structures within the planning area as identified throughout the process.
- The risk assessment has been prepared to better support future grant applications by providing risk and vulnerability information that will directly support the measurement of "cost-effectiveness" required under FEMA mitigation grant programs.
- The method of risk ranking was expanded slightly and is now based on a Calculated Priority Risk Index Ranking. While similar in nature, this edition includes an expanded assessment, including extent and location when addressing risk and vulnerability.
- A new vulnerability table was included, which addresses the social aspect of risk. The risk assessment was also broken down by planning partnership as appropriate, to include an analysis of the unincorporated areas of the County, and further by each planning partner involved. This

will allow planning partners to annually review and determine accuracy of the greatest hazards of concern based on their impact, versus the entire planning area.

- All charts, graphs and maps have been updated with the most current data.
- All Census and Census-related data has been updated with the most current data available.
- Goals and objectives were reviewed and updated appropriately with only slight modifications.
- Strategies from the 2010 edition were updated, and new strategies identified. A new method of prioritizing strategies was used, including benefit cost analysis.
- Four new planning partners were included: City of Shelton, PUD 1, Fire District 16, and Central Mason Fire & EMS. PUD 3 was a previous planning partner, and is updating their annex with this edition. Mason General Hospital District elected to not be part of this update process with the County.
- A new plan maintenance strategy was developed for use with the 2018 plan.

THE PLANNING PARTNERSHIP

The planning partnership assembled for this plan consists of Mason County, the City of Shelton, PUDs 1 and 3, Central Mason Fire and Emergency Services, and Fire District 16, all defined as “local governments” under the Disaster Mitigation Act. Of these six planning partners, all completed the required phases of this plan’s development. Jurisdictional annexes for those partners are included in Volume 2 of the plan. Jurisdictions not covered by this process can link to this plan at a future date by following the linkage procedures identified in Volume 2 of this plan.

PLAN DEVELOPMENT METHODOLOGY

Update of the Mason County hazard mitigation plan included seven phases:

- **Phase 1, Organize resources**—–Under this phase, grant funding was secured to fund the effort, the planning partnership was formed, and other stakeholders were assembled to oversee development of the plan. Also under this phase were coordination with local, state, and federal agencies and a comprehensive review of existing programs that may support or enhance hazard mitigation.
- **Phase 2, Assess risk**—Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from natural hazards. This process focuses on the following parameters:
  - Identification of new hazards and updating hazard profiles
  - The impact of hazards on physical, social, and economic assets
  - Vulnerability identification
  - Estimates of the cost of damage or costs that can be avoided through mitigation.

  Phase 2 occurred simultaneously with Phase 1, with the two efforts using information generated by one another.
- **Phase 3, Involve the public**—Under this phase, a public involvement strategy was developed that used multiple media sources to give the public multiple opportunities to provide comment on the plan. The strategy focused on three primary objectives:
  - Assess the public’s perception of risk.

  - Assess the public's perception of vulnerability to those risks.
  - Identify mitigation strategies that will be supported by the public.
- **Phase 4, Identify goals, objectives, and actions**—Under this phase, the goals and objectives were reviewed and updated, as well as a range of potential mitigation actions for each natural hazard identified. A "mitigation catalog" was used by each planning partner to guide the selection of recommended mitigation initiatives to reduce the effects of hazards on new development and existing inventory and infrastructure. A process was created under this phase for prioritizing, implementing, and administering action items based in part on a review of project benefits versus project costs.
- **Phase 5, Develop a plan maintenance strategy**—Under this phase, a strategy for long-term mitigation plan maintenance was created, with the following components:
  - A method for monitoring, evaluating, and updating the plan on a five-year cycle
  - A protocol for a progress report to be completed annually on the plan's accomplishments
  - A process for incorporating requirements of the mitigation plan into other planning mechanisms
  - Ongoing public participation in the mitigation plan maintenance process
  - "Linkage procedures" that address potential changes in the planning partnership.
- **Phase 6, Develop the plan**—The internal planning group for this effort assembled key information into a document to meet DMA requirements. The document was produced in two volumes: Volume 1 including all information that applies to the entire planning area; and Volume 2, including jurisdiction-specific information.
- **Phase 7, Implement and adopt the plan**—Once pre-adoption approval has been granted by the Washington Emergency Management Division and FEMA, the final adoption phase will begin. Each planning partner will be required to adopt the plan according to its own protocols.

MITIGATION GOALS

The 2010 goals were reviewed and modified slightly for the 2018 update during the initial kick-off meeting. Objectives, not previously included in the 2010 plan, were also established for the current update of the mitigation plan.

The goals and objectives were utilized to allow further assessment of mitigation strategies. Strategies were assessed to determine association with several general categories related not only to emergency management as a whole, but also inclusive of the Community Rating System, as follows:

- Prevention
- Public Information and Education
- Property Protection
- Emergency Services / Response
- Natural resources
- Structural projects
- Recovery

MITIGATION INITIATIVES

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

Although one of the driving influences for preparing this plan was grant funding eligibility, its purpose is more than just access to federal funding. It was important to the planning partnership to look at initiatives that will work through all phases of emergency management. Some of the initiatives outlined in this plan are not grant eligible; grant eligibility was not the primary focus of the selection. Rather, the focus was the initiatives' effectiveness in achieving the goals of the plan and whether they are within each entities' capabilities.

This planning process resulted in the identification of mitigation actions to be targeted for implementation by individual planning partners. These initiatives and their priorities can be found in Volume 2 of this plan. In addition, the planning partnership identified countywide initiatives benefiting the whole partnership that will be implemented by pooling resources based on capability. These countywide initiatives are identified in Chapter 17.

CONCLUSION

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

CHAPTER 1.
INTRODUCTION

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

1.1 AUTHORITY

The federal Disaster Mitigation Act (DMA) (Public Law 106-390) required state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. Prior to 2000, federal disaster funding focused on disaster relief and recovery, with limited funding for hazard mitigation planning. The DMA increased the emphasis on planning for disasters before they occur. DMA 2000 amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act (the Act) by repealing the previous mitigation planning section (409) and replacing it with a new mitigation planning section (322). This new section emphasizes the need for state and local entities to closely coordinate mitigation planning and implementation efforts. To implement the DMA 2000 planning requirements, the Federal Emergency Management Agency (FEMA) published an Interim Final Rule in the Federal Register on February 26, 2002. This rule (Part 201 of Title 44 of the Code of Federal Regulations (44 CFR 201)) established the mitigation planning requirements for states and local communities. In 2010, the guidance was further enhanced and expanded, with this document incorporating all required changes.

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

The Mason County Hazard Mitigation Plan 2018 Update has been developed pursuant to the requirements of 44 CFR 201.6. The plan meets FEMA's guidance for multi-jurisdictional mitigation planning.

1.2 ACKNOWLEDGEMENTS

Many groups and individuals have contributed to development of the Mason County Hazard Mitigation Plan Update. The Mason County Emergency Management Division provided support for all aspects of plan development. Mason County GIS also provided some assistance, including providing data identifying critical facilities and infrastructure. The planning partners met on a regular basis to guide the project, identify the hazards most threatening to the County, develop and prioritize mitigation projects, review draft deliverables, and attend public meetings.

Local communities participated in the planning process by attending public meetings and contributed to plan development by reviewing and commenting on the draft plan. Several planning partners provided assistance and guidance to support the efforts of smaller entities by providing data and information to help develop specific annex documents. Citizens' participation was exceptionally good during the plan's development, with citizens attending various public outreach sessions and providing invaluable information with respect to concerns, strategy ideas, and hazard information. Input was incorporated as appropriate throughout the document.

1.3 PURPOSE OF PLANNING

This hazard mitigation plan identifies resources, information, and strategies for reducing risk from natural hazards. Elements and strategies in the plan were selected because they meet a program requirement and because they best meet the needs of the planning partners and their citizens. 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. FEMA encourages multi-jurisdictional planning under its guidance for the DMA. The plan will help guide and coordinate mitigation activities throughout Mason County. It was developed to meet the following objectives:

- Meet or exceed requirements of the DMA.
- Enable all planning partners to continue using federal grant funding to reduce risk through mitigation.
- Meet the needs of each planning partner as well as state and federal requirements.
- Create a risk assessment that focuses on Mason 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 initiatives and projects to mitigate possible disaster impacts are funded and implemented.

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

1.4 PLAN ADOPTION

44 CFR 201.6(c)(5) requires documentation that a hazard mitigation plan has been formally adopted by the governing body of the jurisdiction requesting federal approval of the plan. For multi-jurisdictional plans, each jurisdiction requesting approval must document that is has been formally adopted. This plan will be submitted for a pre-adoption review to the Washington State Division of Emergency Management and FEMA prior to adoption. Once pre-adoption approval has been provided, all planning partners will formally adopt the plan. All partners understand that DMA compliance and its benefits cannot be achieved until the

plan is adopted. Copies of the resolutions adopting the plan as well as the FEMA approval letter can be found in Appendix C of this volume.

1.5 SCOPE AND PLAN ORGANIZATION

The process followed to update the Mason County Hazard Mitigation Plan included the following:

- Review and prioritize disaster events that are most probable and destructive.
- Update and identify new critical facilities.
- Review and update areas within the community that are most vulnerable.
- Update and identify new goals for reducing the effects of a disaster event.
- Review and identify new projects to be implemented for each goal.
- Review and identify new procedures for monitoring progress and updating the hazard mitigation plan.
- Review the draft hazard mitigation plan.
- Adopt the updated hazard mitigation 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 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 initiatives, and a plan maintenance strategy.
- Volume 2 includes all federally required jurisdiction-specific elements, assimilated into specific annexes for each participating jurisdiction. Volume 2 also includes a description of the participation requirements for planning partners. 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, as well as contact information to obtain the annex template and instructions.

All planning partners will adopt Volume 1 and the associated appendices in their entirety, as well as each partner’s jurisdiction-specific annex contained in Volume 2.

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

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

CHAPTER 2.
PLANNING PROCESS

To develop the Mason County hazard mitigation plan, the County applied the following primary objectives:

- Secure grant funding
- Form an internal planning group
- Establish a planning partnership
- Coordinate with individual and agency stakeholders
- Review existing plans and studies
- Engage the public:
  - Conduct a hazard survey
  - Hold public meetings
  - Review the draft hazard mitigation plan.

These objectives are discussed in the following sections.

2.1 SECURE GRANT FUNDING

This planning effort was supplemented by a Hazard Disaster Mitigation Grant Program (HMGP) grant from FEMA. Mason County was the applicant agent for the grant. The grant was applied for originally in 2014, and funding was appropriated in 2016. It covered 75 percent of the cost for development of this plan; the County and its planning partners covered 12.5 percent of the cost through in-kind contributions, and the state of Washington provided the balance.

2.2 INTERNAL PLANNING GROUP FORMATION

Through an open solicitation process, Mason County hired Bridgeview Consulting, LLC to assist with development and implementation of the plan. The Bridgeview Consulting project manager assumed the role of the lead planner, reporting directly to a County-designated project manager. An internal planning group was formed to lead the planning effort, made up of the following members:

- Tammi Wright, Mason County Project Manager
- Ross McDowell, Mason County Emergency Management Director
- Beverly O'Dea, Bridgeview Consulting (Lead Project Planner)
- Adam Palmer, Bridgeview Consulting (Research and Planning)

2.3 PLANNING PARTNERSHIP

A primary focus of this effort was to re-engage the original planning partnership from the 2010 plan, and to open this process to eligible local governments. Mason County opened this planning effort to those eligible entities within the county which expressed an interest in participating in the planning process. Emergency Management personnel made presentations at various meetings beginning January 2015, soliciting letters of intent to participate to support the County's grant application.

Due to the time that had lapsed between the original Letters of Intent to Participate and award of the grant, the County felt it prudent to again solicit a second Letter of Intent to Participate. Table 2-1 summarizes the received letters of intent to participate by the planning partners. In addition to a Press Release announcing the County's initiation of the planning effort, an email was distributed inviting participation. The email was accompanied with a letter detailing the process which would be followed to allow planning partners with a knowledge base on which to form their decision of whether or not to participate. Each jurisdiction wishing to join the planning partnership was asked to provide an executed Letter of Intent to Participate. That letter designated a point of contact for the jurisdiction and confirmed the jurisdiction's commitment to the process and understanding of expectations.

For those jurisdictions invited but who could not participate, linkage procedures have been established (see Volume 2 of this plan) for any jurisdiction wishing to join the Mason County plan in the future; the process was revised from the previous plan to include more of the required items for this 2017 edition.

Table 2-1
Letters of Intent to Participate

Jurisdiction	Point of Contact	Title
Mason County	Ross McDowell	Emergency Management Director
	Tammi Wright	Emergency Management Coordinator
City of Shelton	Darrin Moody	Police Chief
Central Mason Fire & EMS	Tim McKern	Fire Chief
Mason County Fire District 16	Matthew Welander	Fire Chief
PUD 1	Kristin Masteller	Director of Business Services
PUD 3	Joel Myer	Public Information Officer

Responsibilities of the planning partners included participating in conference calls to discuss plan development, providing data for analysis in the risk assessment, attending public meetings, providing input and feedback on mitigation strategies, developing an annex document, reviewing the draft plan document, and supporting the plan throughout the adoption process.

The initial kickoff planning workshop took place on April 26, 2017. Key workshop objectives were as follows:

- Provide an overview of the Disaster Mitigation Act.
- Describe the reasons for a plan.
- Outline the County work plan.
- Outline and adopt planning partner expectations necessary to establish a jurisdictional annex to the County's Plan.
- Confirm hazards of concern.
- Review and update, as appropriate, the Goals and Objectives.
- Establish the Planning Partnership's definition of Critical Facilities.
- Establish a Public Outreach Strategy for use during this update cycle.

During the initial workshop, the planning partners also established meeting guidelines, which identified staffing, elected a chairperson to act as spokesperson for the planning effort, identified a minimum attendance by planning team members to gain an active level of participation, established the decision-making method (quorum or attendance), identified the concept of alternative representatives for planning team members unable to attend, and identified the method in which the public would address the planning team during meetings. Specific guidelines established are available upon request to the Mason County Emergency Management Division.

During the initial workshop meeting, Ross McDowell was elected Chairperson of the planning team, and the team determined that decisions would be made based on the majority of members in attendance.

Conference calls were held with the planning partners while the plan was being drafted. In advance of each meeting, an agenda and materials to be discussed (i.e. example mitigation strategies, examples of projects eligible for FEMA funding, etc.) were sent to meeting participants. All members issuing letters of intent were engaged as a planning partner throughout this process.

2.4 COORDINATION WITH AGENCIES AND OTHER STAKEHOLDERS

Hazard mitigation planning enhances collaboration and support among diverse parties whose interests can be affected by hazard losses. 44 CFR requires that opportunities for involvement in the planning process be provided to neighboring communities, local and regional agencies involved in hazard mitigation, agencies with authority to regulate development, businesses, academia, and other private and nonprofit interests (Section 201(6)(b)(2)). Stakeholders were identified and invited to participate in this effort:

- County stakeholders included Board of County Commissioners, emergency managers, the floodplain coordinator, the Community Development Director, the GIS Department, the Public Administrator, Search and Rescue, the Health Department, 911 dispatch, and the Sheriff's Office. Their participation included providing data, attending public meetings, and reviewing the draft hazard mitigation plan.
- Stakeholders from throughout the County were invited, as well as members of the Skokomish and Squaxin Tribes. Invitations were also distributed to members of various other county departments, police and fire chiefs, representatives from the local PUDs, hospital, and port districts, Red Cross, and others. Their participation included providing data, attending public meetings, and reviewing the draft hazard mitigation plan.
- Washington State stakeholders and information included representatives from the Department of Natural Resources, Department of Ecology, Department of Corrections, and Department of Transportation, the State Hazard Mitigation Officer, and the Hazard Mitigation Grant Program Officer. Their participation included providing data, attending meetings, and reviewing the draft hazard mitigation plan.
- Federal agency stakeholders and information included the FEMA Region X, National Weather Service (NWS), U.S. Army Corps of Engineers, U.S. Geologic Survey, U.S. Forest Service, and U.S. Fish and Wildlife Service. These agencies provided information on plan development, attended public meetings, and were invited to review the draft hazard mitigation plan.
- Non-government stakeholders included the American Red Cross, Chamber of Commerce, and the University of Washington, among others.

The County's Emergency Management email distribution list was utilized, which reaches in excess of 95 individuals from various departments and organizations throughout the region. Many of these entities provided information for plan development, attended the public meetings, and/or reviewed the draft hazard mitigation plan update.

Stakeholders received a variety of information during the project, including meeting notices, documents for review, and the draft mitigation strategy. Stakeholders also provided input on the plan, particularly for the risk assessment. Table 2-2 lists planning team members, stakeholders and (regular) meeting attendance.

Table 2-2
Planning Team Stakeholder Membership and Attendance

Name	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Ross McDowell, Director Mason County Division of Emergency Management (360) 427-9670 x806	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tammi Wright, Emergency Management Coordinator Mason County Division of Emergency Management (360) 427-9670 x800	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Andrew Bales Mason County Risk Management 427-9670 x643		✓	✓	✓	✓	✓	✓			✓	✓	
Jason Wells Mason County GIS (360) 427-9670 x526	✓	✓		✓								
Chief Tim McKern Central Mason Fire & EMS	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	
Chief Darrin Moody, Shelton Police Dept. City of Shelton	✓	✓	✓			✓	✓					
Kristin Masteller, Director of Business Services PUD No. 1	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	
Joel Myer, Public Information Officer PUD 3	✓	✓	✓	✓		✓	✓		✓	✓	✓	
Ali Lund PUD 3	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	
Chief Matthew Welander Mason County Fire District #16	✓			✓	✓	✓	✓	✓	✓	✓	✓	
Kelly Stone FEMA Region X	✓		✓			✓						
Sadie Whitener Mason County Resident and Washington State Department of Ecology swhi461@ECY.WA.GOV	✓	✓	✓			✓		✓	✓	✓		
Tim Walsh Washington State Department of Natural Resources, Geologist		✓				✓	✓			✓		

Table 2-2
Planning Team Stakeholder Membership and Attendance

Name	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Beverly O'Dea, Consultant/Lead Planner Bridgeview Consulting, LLC bevodea@bridgeviewconsulting.org (253) 301-1330	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
GIS Analysts Bridgeview Consulting, LLC (253) 301-1330	✓		✓		✓	✓	✓	✓	✓	✓		
Adam Palmer, Planner/Fiscal Bridgeview Consulting, LLC (253) 301-1330		✓	✓	✓	✓		✓	✓				

2.5 REVIEW OF PLANS AND STUDIES

44 CFR states that hazard mitigation planning must include review and incorporation as appropriate of existing plans, studies, reports, and technical information (Section 201.6.b(3)). Laws and ordinances in effect in the planning area that can affect hazard mitigation initiatives are reviewed in Chapter 14. The list of references at the end of this volume presents sources used to capture information necessary to complete this planning effort. Plans, studies, and reports used for this process include, but are not limited to:

- Mason County Hazard Mitigation Plan (2010)
- Mason County Comprehensive Emergency Management Plan (CEMP)
- Mason County Comprehensive Land Use Management Plan (1996, 2005, 2017)
- Regional Catastrophic Plan
- Flood Insurance Study; Mason County and Incorporated Areas (2017)
- WRIA 14 Kennedy-Goldsborough Watershed Focus Sheet (2016)
- WRIA 14 Kennedy-Goldsborough Watershed Plan (2006)
- WRIA 16 Skokomish-Dosewallips Fact Sheet (2012)
- WRIA 16 Watershed Management Plan (2006)
- Washington State Enhanced Hazard Mitigation Plan (2010 and 2013)
- Washington Department of Natural Resources (WDNR) Landslide Report
- Coastal erosion data (various)
- Climate change data
- Washington Department of Ecology Coastal Zone Atlas
- Washington State Department of Ecology Drought Studies/Data (2015, 2016)
- Washington Department of Ecology Hazardous Materials Annual Report for Mason County
- FEMA Region X Risk Report (2017).

Data obtained from the plan and regulation review was incorporated into various sections of the hazard mitigation plan. The risk assessments in Chapter 5 through Chapter 11 refer to plans and ordinances that affect the management of each hazard. Section 15.2 describes how mitigation can be implemented through existing programs. An assessment of all planning partners' regulatory, technical, and financial capabilities to implement hazard mitigation initiatives is presented in the jurisdiction-specific annexes in Volume 2 and in Chapter 14. Many of these relevant plans, studies and regulations are cited in the capability assessment.

2.6 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), 201.6(c)(1)(i) and 201.6(c)(1)(ii)).

The County and its planning partners did extensive outreach and used different methods to increase involvement, such as pairing meetings with existing council and commission meetings, holding web-based meetings, and scheduling conference calls that allowed participation by agencies and individuals. Interviews with individuals and specialists from outside organizations identified common concerns related to natural and manmade hazards, and key long- and short-term activities to reduce risk. Interviews included public safety personnel, planning department personnel, natural resources personnel, cultural resource personnel, and representatives from other government agencies from surrounding jurisdictions. The public outreach strategy for involving the public in this plan emphasized the following elements:

- Include members of the public on the planning team.
- Use a questionnaire to determine general perceptions of risk and support for hazard mitigation and to solicit direction on alternatives. The questionnaire was available to anyone wishing to respond via the website and was distributed by hard copy for those without computer access (hard-copy results were entered by the consultant). The County published a news release in local papers and identified the survey on the hazard mitigation website. Several Planning Team Members throughout the County also posted the link to the survey on their various Facebook and Twitter accounts (PUDs 1 and 3).
- Attempt to reach as many citizens as possible using multiple formats. This is important because of the somewhat geographically remote areas on the islands in the county.
- Identify and involve planning area stakeholders.
- Provide newsletter articles about mitigation efforts, such as the update of FEMA flood maps, etc.
- Include safety fairs from the various planning partners and utilize existing email distribution lists to announce planning milestones (PUD 1 Employee Safety Fair, Mason County Emergency Management Distribution Lists).

2.6.1 Planning Team Input

Most members of the planning team live or work in the planning area. Planning team participation by individuals with varied backgrounds and from varied organizations added details and information that were valuable in identifying direction for the plan development process.

The County created a new webpage, which hosted a mitigation section, wherein all notices and survey links were posted. During meetings within the planning area or attended elsewhere by planning team members, individuals were directed to the website to gain better insight of the County's endeavors and to solicit input. The planning team identified stakeholders to target through the public involvement strategy. Members of the planning team attending conferences or meetings provided updates to those in attendance, asking for input and review of the plan. Some of the outreach sessions are identified in Table 2-3. This list is not all-inclusive, but rather demonstrative of the various efforts of the planning team.

Table 2-3
Public Outreach Events

Date	Jurisdiction	Description	Attendance
2017			
March	Countywide	Press release announcing the up-coming project	N/A
March 21	Countywide	Coordinated planning effort with FEMA for NFIP and HMP outreach. Flyer presented regarding County's website, survey, etc.	25+
March	Countywide	Survey deployed	
April	Countywide	Hazard mitigation plan website established; survey, frequently asked questions, agenda, and minutes were posted	N/A
Monthly Meetings	Countywide	Discussions and presentation on status of project to Emergency Management Planning Group which included representatives from all local communities, county departments, and local departments	15-20 monthly
April	Countywide Fire Chiefs' Meeting	Hazard Mitigation Planning Effort discussed; current plan status and level of effort to complete annex documents discussed.	~15
April	Countywide	Notice posted setting kickoff meeting date	N/A
April	Countywide	Kick-off meeting held, including planning partners, volunteers, and citizens.	~15
April and May	Countywide	Planning Team Members (general emergency management planning team – beyond Mitigation Planning Team) posted a link on their Facebook accounts concerning the availability of the County's survey.	N/A
July	Public Outreach	This was a publicized, regularly scheduled meeting of the Planning Commission. Ross McDowell attended the Planning Commission meeting on behalf of the Hazard Mitigation Planning Team. During the meeting, the new FEMA flood maps were again presented, and adopted. In addition to the flood maps, maps and posters for of all of the hazards addressed in the HMP were displayed. Citizens were advised that the maps and posters will remain available for public review and comment.	+25
August	Countywide	Risk Maps were made available via the County's website, as well as posted throughout the lobby of the County's Public Works Building, in which permitting and the County's Planning Department exist. An email announcing the availability of maps for review and viewing was also distributed to over 400 individuals.	400+

Table 2-3
Public Outreach Events

Date	Jurisdiction	Description	Attendance
Sept. 5	City of Shelton Council Meeting	Chief Darrin Moody presented an update to the planning process during the City Council Meeting. Chief Moody invited citizens to take the survey, reviewed hazard maps posted in council chambers, and directed individuals to the County's mitigation planning website for additional information; also advised attendees that the draft plan will be available for review on the County's website at the end of October	Televised / Recorded
Sept. 7	Washington State DOC	DOC distributed maps and information to DOC staff and incorporated hazard risk maps in Emergency Cabinet Manuals	NA
Sept. 12	PUD 1	During the regularly, advertised Board meeting, planning team members presented information on the hazard risks, including identification of structures at risk based on structure analysis. While that specific data was not made public (privileged), the maps were presented, and attendees were asked to provide any comments. The PUD also distributed links via social media re: the County's website and the availability of the survey.	8 + social media
Sept. 13	Countywide	The Monthly Planning Team Meeting (all planners from all disciplines countywide) were presented with an update on the HMP, provided an overview of the risk maps, and provided the hazard ranking as defined by the County. The strategies were also identified and discussed with the intent of seeking additional input and data. Team members were asked to further disseminate information concerning the risk assessment and the availability of risk maps on the County's website, as well as posted within county facilities.	18
Sept. 26	PUD 3	PUD 3 made presentations to their respective Boards concerning the risk associated with the hazards of concern. Specific critical facilities information was available to the Board Members, but due to the nature of the structures (critical infrastructure) the list itself was not made public. However, maps of hazard areas were displayed and discussed.	+15
Sept. 27	City of Shelton, County	Chief Moody, Ross McDowell and Tammi Wright made a presentation concerning the risk data, risk ranking, and strategy development during the *Shelton Out Loud-Community Engagement Forum*. The presenters also advised of the up-coming availability of the draft plan for review on the County's website.	+150
December 14, 2017	Mason County	Press Release (Mason County Journal) announcing plan availability for review on Website and hard copy available for review at Mason County Emergency Management. Email notification to all County employees, countywide planning team email notice provided (+20 planning team members from outside agencies and jurisdictions).	+150
December 18, 2017	Mason County - Board of County Commissioners	Plan review before Commissioners; invitation extended to citizens to review existing plan; announcement of website address and that hard a copy is available for review at the office of Mason County Emergency Management.	~40

Table 2-3
Public Outreach Events

Date	Jurisdiction	Description	Attendance
December-January	Countywide	Plan distributed for public review via printed versions and website availability. Notice of availability published via newspaper, website, and other social media. No comments received.	Unknown

2.6.2 Hazard Questionnaire

A hazard mitigation plan questionnaire developed by the planning team was used to gauge household preparedness for natural hazards and the level of knowledge of tools and techniques for reducing risk and loss from natural hazards. This questionnaire was designed to help identify areas vulnerable to one or more natural hazards. The answers to its questions helped guide the planning partners in selecting goals, objectives, and mitigation strategies. Hard copies were disseminated throughout the planning area, and a web-based version was made available on the hazard mitigation plan website which was distributed and announced during meetings (https://www.surveymonkey.com/r/Mason_County_Mitigation_Survey).

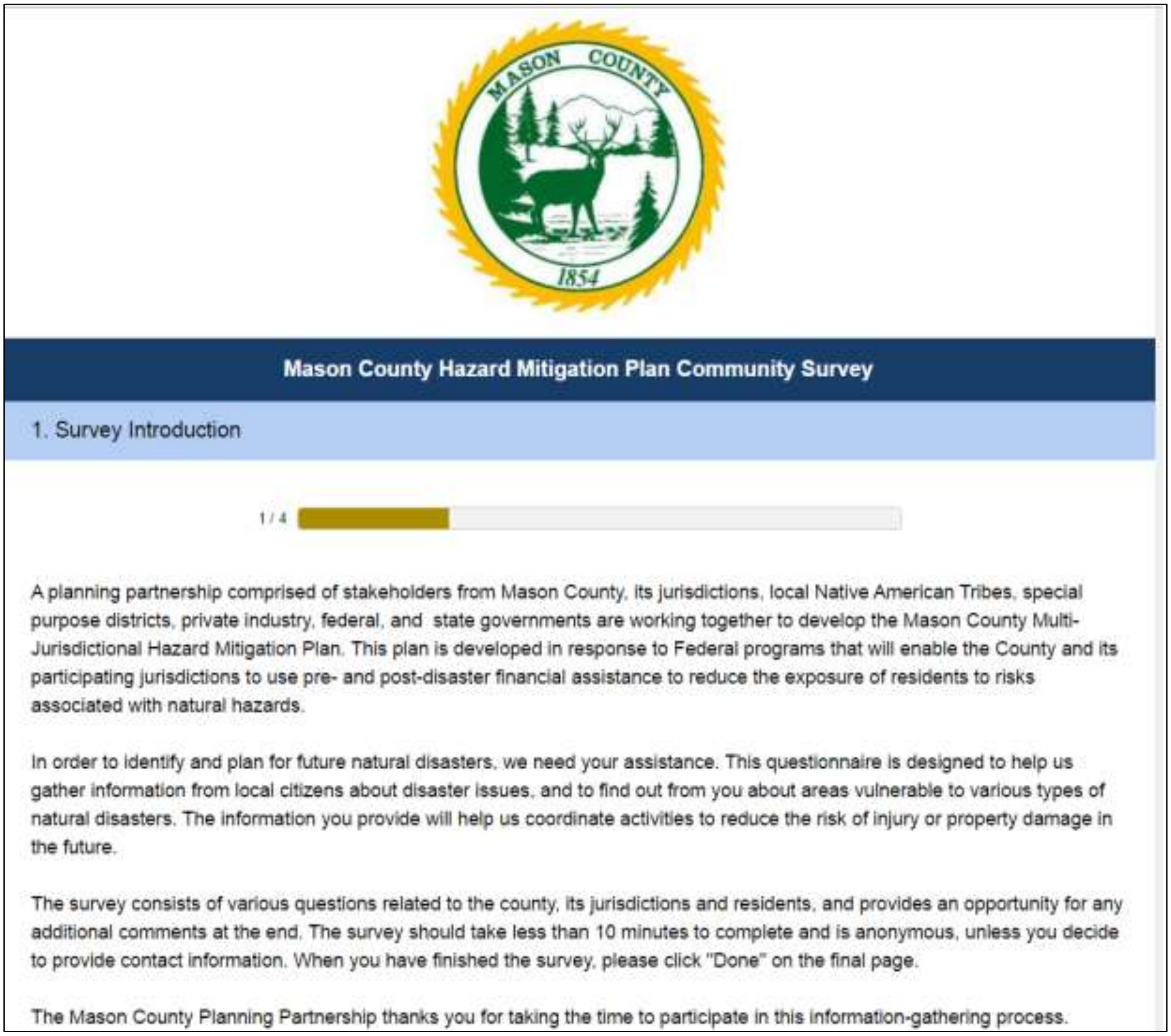
Over 78 questionnaires were completed. Appendix B presents the questionnaire and a summary of its findings. Figure 2-1 shows a sample from the web-based questionnaire. Figure 2-2 illustrates additional survey outreach conducted by the Planning Team. Survey responses indicate a close match between respondents' hazards of greatest concern and hazards identified through the Planning Team's risk ranking.

Additional points of interest from the survey results include:

- 73 percent of respondents have experienced an earthquake over the last 20 years; 72 percent had experienced a severe weather event. Severe weather events are the majority of hazards that have impacted the County in the last 20 years.
- 83 percent of respondents have experienced a disaster incident while living in Mason County, while 55 percent indicate that such incident(s) did not impact their ability to utilize their residence due to damages. Of those responding, approximately 40 percent have lived in Mason County for more than 20 years.
- Respondents ranked hazards of concern as follows:
  - Earthquake
  - Wildland Fire
  - Severe weather
  - Landslide
  - Flood
  - Climate Change
- Drought, tsunami, and volcanic eruption were the hazards of least concern.
- Most respondents identified the hazards to which their residences were at risk (flood, fire, landslide hazard area), with over 51 percent of respondents indicating that the impact of disaster incidents played a role in their decision to purchase their residence. 97 percent of respondents

indicate they have homeowners' or renters' insurance. 25 percent of respondents indicate they have hazard-specific homeowners' insurance.

- When queried about their level of preparedness, 50 percent indicate they are somewhat prepared, while 35 percent indicate they are adequately prepared, maintaining a surplus of extra medical supplies, food, water, identifying utility shut-off valves, and having fire escape plans in place.
- Demographic data indicates an equal split between male/female respondents, with over 39 percent having a college degree, followed by some college and technical trade schooling. 40 percent of respondents indicate they are 61 years or older, followed by 22 percent between the ages of 41-50, and approximately 17 percent were 40 and under.
- General comments include very positive feedback for the county's and the PUDs' use of social media during times of incidents as television and radio stations seldom provide relevant data.
- The internet and social medial are the preferred methods for distributing information to citizens in the County.
- 53 percent of respondents indicated some level of self-preparedness, although less than 5 percent have flood insurance through the NFIP. Approximately 20 percent of respondents have earthquake coverage.
- Over half of respondents indicated that data concerning potential hazards and risk information is readily available. 196 respondents confirmed the significance of self-education and mitigation efforts to reduce the impact of hazards.



Mason County Hazard Mitigation Plan Community Survey

1. Survey Introduction

1 / 4

A planning partnership comprised of stakeholders from Mason County, its jurisdictions, local Native American Tribes, special purpose districts, private industry, federal, and state governments are working together to develop the Mason County Multi-Jurisdictional Hazard Mitigation Plan. This plan is developed in response to Federal programs that will enable the County and its participating jurisdictions to use pre- and post-disaster financial assistance to reduce the exposure of residents to risks associated with natural hazards.

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

The survey consists of various questions related to the county, its jurisdictions and residents, and provides an opportunity for any additional comments at the end. The survey should take less than 10 minutes to complete and is anonymous, unless you decide to provide contact information. When you have finished the survey, please click "Done" on the final page.

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

Figure 2-1 Sample Mason County Survey Web Page

HAZARD MITIGATION PLAN PUBLIC SURVEY

ARE YOU AWARE OF THE HAZARDOUS CONDITIONS THAT MAY OCCUR AT ANY TIME HERE IN MASON COUNTY OR THE CITY OF SHELTON?

DO YOU HAVE A PLAN OF ACTION AND SUPPLIES TO BE SELF SUFFICIENT UNTIL HELP CAN ARRIVE?

MASON COUNTY DEPARTMENT OF EMERGENCY MANAGEMENT IS IN THE PROCESS OF UPDATING OUR MULTI-JURISDICTIONAL HAZARD MITIGATION PLAN. WE ARE ASKING ALL CITIZENS WHO LIVE OR WORK IN MASON COUNTY OR THE CITY OF SHELTON TO COMPLETE THE FOLLOWING MITIGATION SURVEY AT:

https://www.surveymonkey.com/r/Mason_County_Mitigation_Survey

THANK YOU IN ADVANCE FOR ASSISTING US WITH THIS PROJECT AND FOR MAKING MASON COUNTY AND THE CITY OF SHELTON A MORE PREPARED PLACE TO LIVE AND WORK!

G. ROSS MCDOWELL, MANAGER
MASON COUNTY DEPARTMENT OF EMERGENCY MANAGEMENT

Figure 2-2 Flyer Distributed During Plan Development for Survey

2.6.3 News Releases

A news release was published on March 9, 2017 to draw attention to the County's update process and the survey (see Figure 2-3). The County published a separate news release concerning an invitation to the general public to learn about emergency management as a whole, including presentation of risk data and hazard maps. When the draft plan was available for public review, notice was published in an effort to draw in as many comments as possible.

Mason County to update Hazard Mitigation Plan

In response to federal mandates, Mason County is updating a planning process from 2010 to prepare for impacts of natural disasters.

The planning process, funded by a grant from the Federal Emergency Management Agency, is being led by county Emergency Management Coordinator, Tammi Wright, assisted by Beverly O'Dea of hired technical consulting firm Bridgeview Consulting, and is expected to take approximately seven to nine months to complete. A Hazard Mitigation Planning Team will oversee the process.

An informational website on the plan can be found at http://bit.ly/2mib4IO.

Figure 2-3 March 9, 2017 Mason County Press Release – Mason County Journal

2.6.4 Internet

At the beginning of the plan development process, a website was created to keep the public posted on plan development milestones and to solicit input (see Figure 2-4). The plan was provided via a file-transfer site, which allowed for the plan downloading for review. The County intends to keep a website active after the plan's completion to keep the public informed about successful mitigation projects and future plan updates.

The County's website address (http://www.co.mason.wa.us/dem/2017-hazard-mitigation-plan-update.php) was publicized in all press releases, mailings, questionnaires, and public meetings. Information on the plan development process, the planning team, the questionnaire, and phased drafts of the plan was made available to the public on the site throughout the process. Hazard maps were published on this site, and were available for download. A link was also made available to the County's survey, available at: https://www.surveymonkey.com/r/Mason_County_Mitigation_Survey. The County also utilized its Facebook page to distribution information.

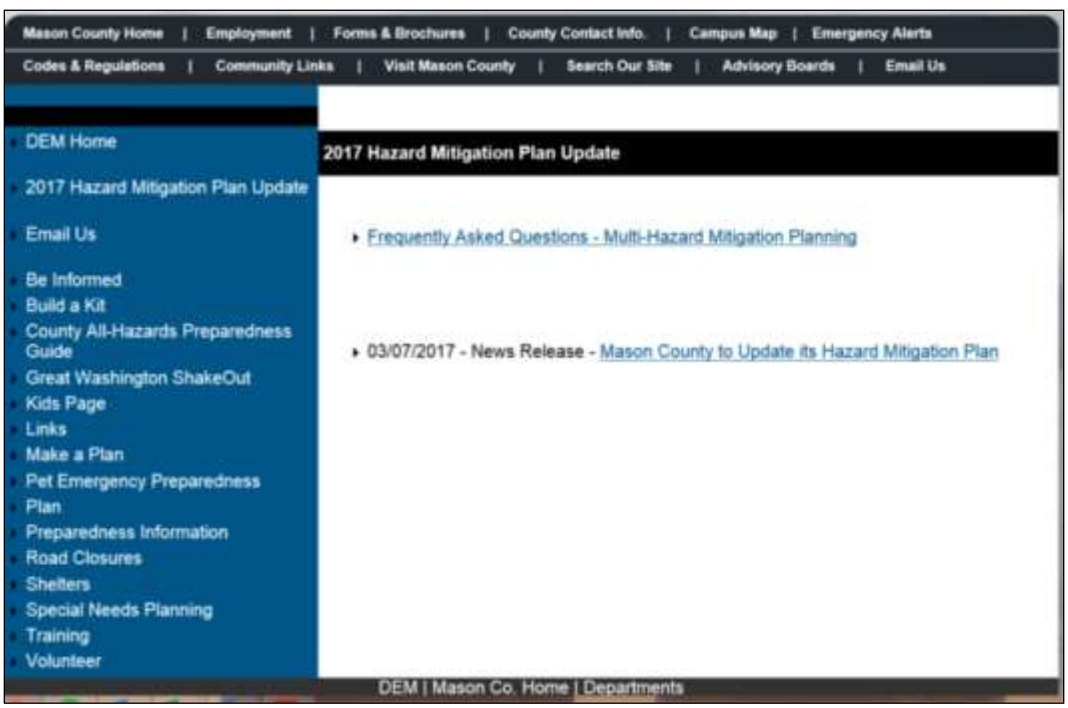


Figure 2-4 Mitigation Plan Website

2.6.5 Public Meetings and Outreach

Several public meetings and events which were open to the public were held during this effort. All planning meetings were also open to the public, and citizens did attend those meetings, providing information and input. Once completed, the hazard maps were presented and made available for review at meetings, posted in public buildings, and made available via the County's webpage. Email notifications and press releases were distributed at various stages announcing the availability of the information, as well as data of its availability distributed via various social media tools. Table 2-3 (above) highlights some of the public outreach efforts conducted during this planning effort. Each citizen attending was also asked to complete a questionnaire, and each was given an opportunity to provide written comments to Planning Team members. While questionnaires were completed,

The kickoff meeting on April 26, 2017 was open to the public and was publicized in the local paper. During the kickoff meeting, the 2010 plan was reviewed in detail and hazards were identified for the 2017 update. Table 2-4 summarizes the review and analysis of the 2010 plan discussed at that meeting.

Table 2-4
Review and Analysis of 2010 Hazard Mitigation Plan

2010 PDM Sections	How Reviewed and Analyzed
Section 1—Introduction and Purpose	Reviewed existing section through discussion at public meeting. No analysis needed.
Section 2—Planning Process	Reviewed and analyzed existing section through discussion at public meeting. Planning process expanded by utilizing project website and scoring hazards using Calculated Priority Risk Index.
Section 3—Hazard Identification and Vulnerability Analysis	Reviewed and analyzed existing section through discussion during public meeting and Planning Partner conference calls. Reviewed and updated hazards, critical facilities, and vulnerable populations. Updated section with recent hazard data.
Section 4—Critical Facilities and Infrastructure	CIKR data was reviewed and planning partners were asked to update the data for the 2017 edition. This information, when completed, will be incorporated into the CDMS layer for the Hazus model, and utilized during the risk assessment portion of the planning effort.
Section 5—Mitigation Initiatives	Reviewed by planning partners during conference calls, public meeting and subsequent mitigation workshop. New projects developed, existing projects re-worded and/or deleted, completed projects documented.
Section 6—Plan Maintenance	Reviewed and analyzed existing section through discussion during Planning Partner conference calls. Determined that plan maintenance procedures outlined in previous plan had not been implemented.

Hazard Risk Maps Presentations:

- In July 2017, Emergency Management Director Ross McDowell made a presentation at the Planning Commission meeting concerning the various risk maps which were developed during the effort, as well as giving a background on the hazards of concern.
- PUD 1 presented information concerning the risk assessment during their September Commissioner's Meeting. Large poster-size maps were displayed, as well as a detailed assessment of the PUD's structures at risk. Planning team members also provided a brief power point presentation concerning the process followed to date, and the availability of additional information on the County's website.

- PUD 3 made a presentation at its September 26, 2017 Board meeting, during which time a power point presentation was made, as well as maps presented.
- The City of Shelton and the County made a presentation on September 27, 2017 at the *Shelton Out Loud – Community Engagement Forum* discussing the risk maps, mitigation planning process, identified strategies to-date, and discussed the plan's availability for public review and comment on the County's website. The meeting was recorded for viewing and is available at: https://www.youtube.com/watch?v=3nRw4Bnk7ss
- The County distributed via Facebook updates on the mitigation planning process and the risk assessment maps once completed (see Figure 2-6 below). The County itself has over 220 followers.
- The City of Shelton utilized the Shelton Out Loud event occurring on October 27th to illustrate the process and risk maps (see Figure 2-7).
- Fire District #16 and Central Mason Fire & EMS made presentations at various community meetings, as well as during the Fire Chiefs' quarterly meetings. In addition, Mason County Emergency Management Director Ross McDowell also made presentations and discussed the planning process with the fire chiefs throughout the course of the plan's development, capturing relevant data from the Chiefs, and discussing the risks to the specific facilities.
- The risk maps were also posted to the County's website beginning August 2017, with blast email distributions made to over 400 county residents and employees. Figure 2-5 is an illustration of the County's Hazard Mitigation Website on which the risk maps were posted for viewing by citizens. The county intends to maintain the maps on its website once this planning process is completed.

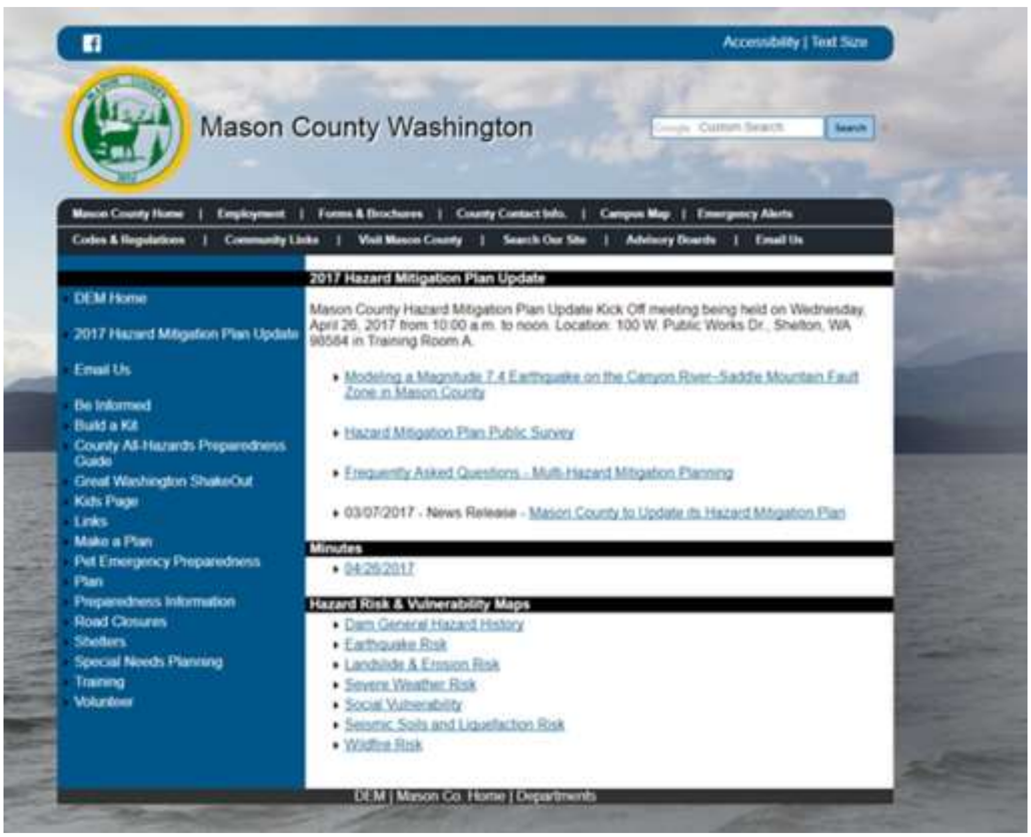


Figure 2-5 Website with Hazard Risk & Vulnerability Maps

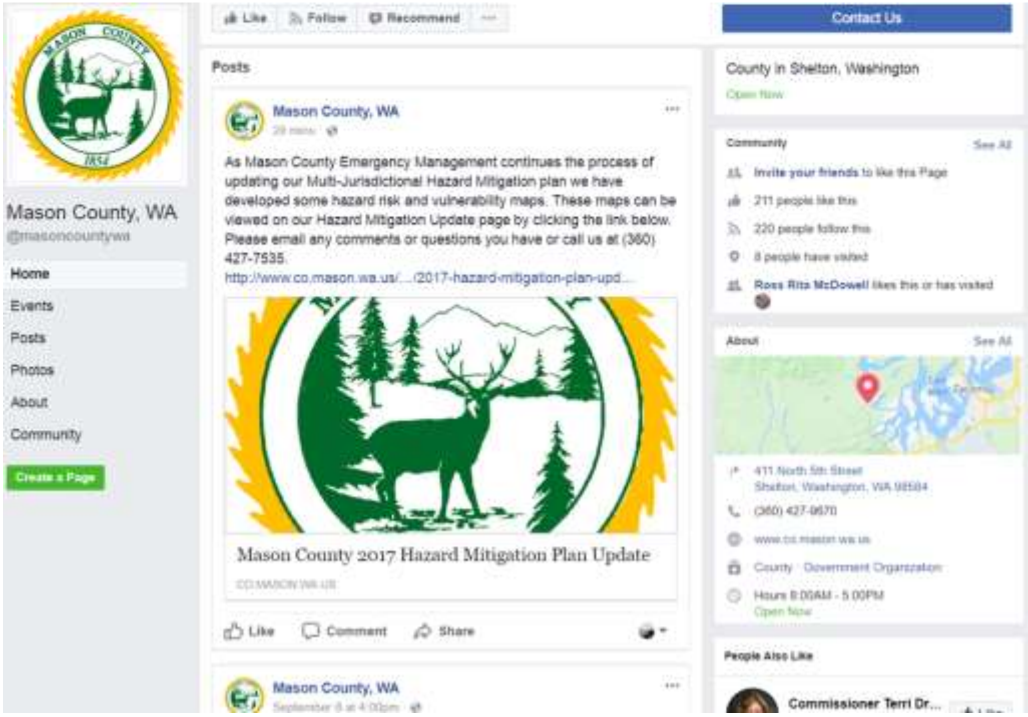


Figure 2-6 Facebook Post of the County's Risk Assessment and Mitigation Planning Process

Figure 2-7 Shelton Out Loud Public Outreach Event

Draft Plan Review

Once the draft plan was completed, the public was invited to provide comments on the hazard mitigation plan. The final public review period began December 15, 2017 lasting through January 8, 2018. The County and its planning partners completed the following outreach activities:

- During the December 2017 Commissioner's Meeting, Emergency Management Director Ross McDowell announced that the draft plan was available for review, and citizens were asked to review the draft plan and provide comments. Approximately 40 people were in attendance; however, no public comments were received.
- The draft plan was posted on the project website and stakeholders were notified through press releases and e-mail messages of its availability, including Twitter and Facebook.
- Planning partners provided notification of the plan's availability for review during their respective council and commission meetings, advising citizens of the plan's availability.
- Each planning partner held their own final public meeting, at which the plan was presented to their commission or council and the approving authority adopting the plan.

Once the review period closed, final comments by the planning team were addressed, and the plan was submitted to FEMA for review. Once pre-adoption approval was received from FEMA, the plan was provided to the Mason County Board of County Commissioners (BOCC) and the incorporated communities for adoption. After adoption, final copies of the plan were submitted to the Washington State Department of Emergency Management and FEMA. Appendix C includes the adoption resolutions.

The final plan will remain on the County's website over the next five years. Future comments on the plan should be addressed to:

Tammi Wright
Mason County Division of Emergency Management Division
100 West Public Works Drive
Shelton, WA 98584
Office: 360-427-9670 Extension 800

2.7 PLAN DEVELOPMENT MILESTONES

Table 2-5 summarizes important milestones in the development of the Mason County Multi-Jurisdiction Hazard Mitigation Plan.

Table 2-5
Plan Development Milestones

Date	Event	Description	Attendance
2014			
2014	Submit grant application	Seek funding for plan development process	N/A
2016			
2016	Receive notice of grant award	Funding secured.	N/A

Table 2-5
Plan Development Milestones

Date	Event	Description	Attendance
12/24	Initiate consultant procurement	Seek a planning expert to facilitate the process	N/A
2017			
2/01	Select Bridgeview Consulting to facilitate plan development	Facilitation contractor secured	N/A
2/22	Commission Presentation	Identification of Hazard Mitigation Project discussed; vendor selection identified; contract with consultant approved by BOCC	
3/10	Begin identifying planning team members	Begin formation of the planning team; Consultant begins review of various documentation and assimilating data, reports, studies, etc.	N/A
3/9	Press Release	Press release announced concerning HMP development process; published in local newspapers and local TV	
3/10	Identify planning team	Formation of the planning team and core project management team. Continue review of existing plan and existing documentation supporting effort (e.g., studies, other planning documents, etc.)	N/A
3/21	Public Outreach	County and FEMA personnel conduction Public Presentation concerning current NFIP map updates; DEM Director and GIS Analyst provide update on County's current Hazard Mitigation Planning Process; distribute flyer concerning website for Survey, and website for mitigation data	25
4/26	Planning Team Kick-Off meeting	Presentation on plan process, hazards, goals, objectives, and public outreach strategy. Review of 2010 plan. General plan template discussed. Discussed hazards to be addressed in plan update; discussed methodology which would be used to conduct the analysis. Hazards to be addressed was reviewed and confirmed. The planning team discussed public presentation of hazard maps at September/October Safety Fair. Goals and objectives were reviewed, updated, and confirmed.	10
7/6	Planning Team Meeting	Initial maps were presented to the planning team for review and comment.	10
7/17	Public Outreach	This was a publicized, regularly scheduled meeting of the Planning Commission. Ross McDowell attended the Planning Commission meeting on behalf of the Hazard Mitigation Planning Team. During the meeting, the new FEMA flood maps were again presented, and adopted. In addition to the flood maps, maps and posters for of all of the hazards addressed in the HMP were displayed. Citizens were advised that the maps and posters will remain available for public review and comment.	25
8/27	Planning Team Meeting	Risk ranking exercise completed and confirmed for county; strategy/action items reviewed and discussed; incorporation of risk data into other planning mechanisms discussed (e.g., land use, CEMP, evacuation plans, etc.)	15
9/26	Public Outreach PUD 3	Presentation made during regularly scheduled meeting. Planning team members discussed the process, identified facilities at risk and provided general information to Commissioners and citizens in attendance.	+15

Table 2-5
Plan Development Milestones

Date	Event	Description	Attendance
9/27	Public Outreach City of Shelton and County	Attendance by Tammi Wright, Ross McDowell, and Chief Darrin Moody at the "Shelton Out Loud – Community Engagement Forum" where the HMP process was discussed, the risk maps were again presented for review, and 2017 strategies were discussed with attendees.	150+/ – (publicly recorded for viewing)
11/15	Draft Plan Internal Review	Draft provided by planning team to Planning Team (additional strategies added during review process)	All Planning Team
12/14	Public Review Opens	Draft provided on website with press releases inviting citizens to review and comment until January 8, 2018. Notice was distributed via email to all county personnel, as well as to various planning groups which includes county, local jurisdictions, PNP's and special purpose districts countywide.	Unknown
12/19	Plan Presentation	EM Director Ross McDowell announced at the Board of County Commissioner's meeting the plan's availability for review, as well as providing a brief overview and requesting input from citizens. No citizen comments were received.	40+
2018			
January	State Review	Draft plan submitted to Washington State for review	
February	FEMA Review	Draft plan submitted to FEMA for review	
March	Approved Pending Adoption	FEMA approved the plan, pending adoption by County and all of its Planning Partners	
May	Approved	FEMA issued Plan Approval Letter and County adopted plan.	

CHAPTER 3.
COMMUNITY PROFILE

This section of the hazard mitigation plan presents an overview of Mason County, the incorporated communities of Allyn, Belfair, Shelton, and the unincorporated areas of the County. It provides baseline information on the characteristics of the county, the communities, economy and land use patterns, and presents the backdrop for this mitigation planning process.

The planning area for this hazard mitigation plan is defined as all incorporated and unincorporated areas of Mason County. All partners to this plan have jurisdictional authority within their defined planning areas.

3.1 PHYSICAL SETTING

Mason County is comprised of a total land mass of ~972 square miles. The County has ~92 square miles of marine shoreline, nearly 100 freshwater lakes, two major rivers, and a number of smaller tributaries and creeks.

The County is located in western Washington at the southwest end of Puget Sound. It is bordered to the north by Jefferson County, to the west and southwest by Grays Harbor County, and to the southeast by Thurston County. The County's eastern boundary----shared with Kitsap, Pierce, and Thurston Counties----is primarily delineated by the rugged contours of Hood Canal and Case Inlet. The City of Shelton, the only incorporated area in Mason County, includes approximately 4.77 square miles, or less than one percent of the County's total land area. Two Native American Tribes, the Skokomish and the Squaxin Island Tribes, have reservations within the boundaries of Mason County.

Like neighboring Thurston County, Mason's topography was heavily influenced by prehistoric glacial activity. After the ice retreated, the more mountainous areas in the County's interior evolved into dense forest land. This is particularly true in the north County, much of which is incorporated in the Olympic National Forest and Olympic National Park (elevations in this part of the county reach 6,000 feet above sea level). The lower elevations (where they are not forested) consist of fertile, but gravelly, loam. Past glacial activity accounts for nearly 100 lakes that dot the county. The larger of these bodies are Lake Cushman, Mason Lake, Lake Limerick, Isabella Lake, Timber Lake, and Spencer Lake. Hood Canal and Puget Sound account for most of Mason County's 90 square miles of water. Two-thirds of Hood Canal runs through Mason County. Two-to-three miles wide in certain places, Hood Canal enters the county from the north and, in the course of its 30-plus mile stretch, turns northeasterly at the Great Bend to form a lopsided ''V.'' Case Inlet forms the lower half of Mason's eastern boundary. Lying in County waters are two big islands----Harstine and Squaxin----and three smaller ones: Hope, Reach, and Stretch. Of the innumerable inlets that break up the county's shore, two deserve mention: Hammersley Inlet (Shelton's access to Puget Sound) and Little Skookum Inlet (Kamilche's access to Puget Sound).

Three geological provinces combine to form Mason County. They include the Puget Sound Lowland, the Olympic Mountains, and the Black Hills. Additionally, seven watersheds exist within Mason County. They include Case Inlet, Chehalis, Lower Hood Canal, Oakland Bay, Skokomish, Totten-Little Skookum, and West Hood Canal.

The longest and most powerful river in Mason County is the Skokomish. Formed high in the Olympic Mountains, the Skokomish flows southeasterly through Mason County before emptying at the Great Bend of the Hood Canal. One fork of the Skokomish feeds Lake Cushman and the hydroelectric power plant at

Potlatch (built by the City of Tacoma). The Skokomish River is the largest source of freshwater to Hood Canal and of critical importance to the overall health of Hood Canal.

Other notable rivers in Mason County are the Satsop and Hamma Hamma. Originating in the south County, the Satsop flows southwesterly to Grays Harbor and the Pacific Ocean. The Hamma Hamma runs east near the County's northern border before flowing into Hood Canal.

Combined national, state, and private forest currently account for 56.8 percent of the County's land. Mineral deposits underlie Mason County's top soils, with open space in the County hosting wildlife habitat, undeveloped natural areas, and many developed park and recreation sites.

3.2 CLIMATE

Mason County lies on the southeast side of the Olympic Coastal Range, which influences prevailing wind and precipitation patterns. Mason County's climate can be characterized as moderate-maritime, influenced by the Pacific Ocean, yet sheltered by the Olympic Mountains. Average temperatures range from a high of 77° F. in July to 33° F. in January. The average daily temperature in Mason County is 51° F. The County receives an average of 66 inches of precipitation annually, with average monthly rainfalls ranging from a low in July of 0.9 inches, to a high of 10.4 inches in January. Table 3-1 summarizes local climate data. Figure 3-1 identifies the prevailing wind path for the Olympic Mountains.

Table 3-1
Climate Summaries

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mason County (1981-2010 Monthly Climate Summary)													
Average Max. Temperature (F)	44.5	49.1	53.4	59.5	66.9	71.8	77.1	76.9	71.9	60.9	50.7	45.0	60.6
Average Min. Temperature (F)	33.1	34.5	35.7	38.9	44.2	49.2	52.3	52.6	48.1	42.1	37.6	34.4	41.9
Average Total Precipitation (in.)	10.5	8.41	6.93	4.37	2.26	1.67	0.94	1.29	2.50	5.84	10.43	11.09	66.19
Average Total Snow Fall (F)	3.9	0.7	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	2.1	8.2
Shelton (1981-2010 Monthly Climate Summary)													
Average Max. Temperature (F)	45.7	49.3	54.1	60.0	67.7	72.2	77.6	78.4	72.4	60.3	50.2	44.1	61.1
Average Min. Temperature (F)	33.3	32.5	35.2	38.0	43.4	48.0	51.5	51.7	47.2	41.3	36.5	32.4	41.0
Average Total Precipitation (in.)	10.8	7.32	7.00	5.17	2.74	1.87	0.79	1.05	2.15	5.73	11.12	10.10	65.88
Average Total Snow Fall (in.)	4.7	0.9	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.9	9.0

Sources: Western Regional Climate Center DRI http://www.wrcc.dri.edu/summary/Climsmwa.html, Accessed March 14, 2017

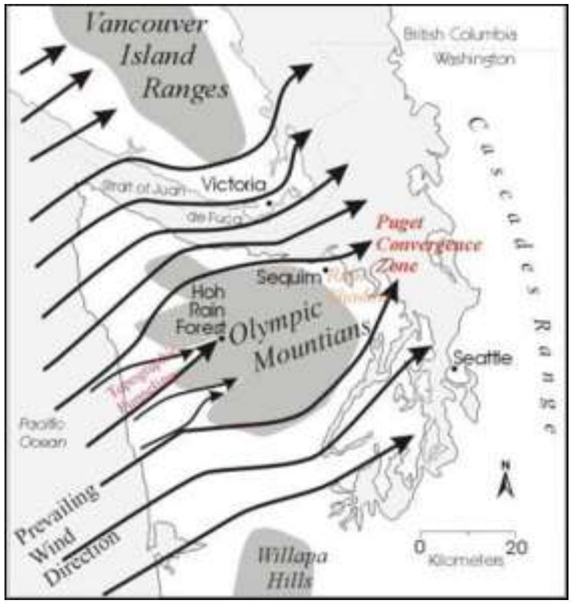


Figure 3-1 Prevailing Wind Path for Olympic Mountains

3.3 MAJOR PAST HAZARD EVENTS

Major hazard events are often identified by federal disaster declarations, which are issued for hazard events that cause more damage than state and local governments can handle without assistance. FEMA categorizes disaster declarations as one of three types (FEMA, 2012a):

- **Presidential major disaster declaration**—Major disasters are hurricanes, earthquakes, floods, tornados, or major fires that the President determines warrant supplemental federal aid. The event must be clearly more than state or local governments can handle alone. Funding comes from the President's Disaster Relief Fund, managed by FEMA and disaster aid programs of other participating federal agencies. A presidential major disaster declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, to help disaster victims, businesses, and public entities.
- **Emergency declaration**—An emergency declaration is more limited in scope and without the long-term federal recovery programs of a presidential major disaster declaration. Generally, federal assistance and funding are provided to meet a specific emergency need or to help prevent a major disaster from occurring.
- **Fire management assistance declaration** (44 CFR 204.21)—FEMA approves declarations for fire management assistance when a fire constitutes a major disaster, based on the following criteria:
  - Threat to lives and improved property, including threats to critical facilities and critical watershed areas
  - Availability of state and local firefighting resources
  - High fire danger conditions, as indicated by nationally accepted indices such as the National Fire Danger Ratings System
  - Potential major economic impact.

Since 1956, 21 federal disaster declarations have affected Mason County, as listed in Table 3-2 (FEMA, 2012b). Review of these events helps identify targets for risk reduction and ways to increase a community's capability to avoid large-scale events in the future. Still, many natural hazard events do not trigger federal disaster declaration protocol but have significant impacts on their communities. These events are also important to consider in establishing recurrence intervals for hazards of concern.

Table 3-2
Disaster Declarations for Hazard Events in Mason County

Disaster Number	Programs Declared: IA	Programs Declared: PA	Declaration Date	Incident: Type	Incident: Title	Incident Date	Unincorporated County	Shelton, City of	Central Mason Fire & EMS	Mason County Fire District #16	PUD 1	PUD 3	Total Number Impacted	Comments/ Dollar Losses (if available)
4253	N	Y	2/2/2016	Flood	Severe Winter Storm, Straight-Line Winds, Flooding, Landslides, Mudslides	12/1/ to 12/14/ 2015	X	X				X		PUD 3: $103,500
4249	N	Y	1/15/2016	Severe Storm	Severe Storms, Straight-Line Winds, Flooding, Landslides, Mudslides	11/12/ to 11/21/ 2015	X				X	X		PUD 3: $271,668
4056	N	Y	3/5/2012	Severe Storm	Severe Winter Storm, Flooding, Landslides, Mudslides	1/14/ to 1/23/ 2012	X	X				X		PUD 3: $507,645
1825	N	Y	3/2/2009	Severe Storm	Severe Winter Storm And Record And Near Record Snow	12/12/2008 to 1/5/ 2009	X	X			X	X		PUD 3: $174,206
1817	N	Y	1/30/2009	Flood	Severe Winter Storm, Landslides, Mudslides, Flooding	1/6/ to 1/16/ 2009	X	X				X		PUD 3: $61,239

Table 3-2
Disaster Declarations for Hazard Events in Mason County

Disaster Number	Programs Declared		Declaration Date	Incident		Incident Date	Unincorporated County	Shelton, City of	Central Mason Fire & EMS	Mason County Fire District #16	PUD 1	PUD 3	Total Number Impacted	Comments/ Dollar Losses (if available)
	IA	PA		Type	Title									
1734	Y	Y	12/8/2007	Severe Storm	Severe Storms, Flooding, Landslides, Mudslides	12/1 to 12/17/ 2007	X	X			X	X		PUD 3: $800,706
1682	N	Y	2/14/2007	Severe Storm	Severe Winter Storm, Landslides, Mudslides	12/14 to 12/15/ 2006	X	X			X	X		PUD 3: +$1.4M
1641	N	Y	5/17/2006	Severe Storm	Severe Storms, Flooding, Tidal Surge, Landslides, Mudslides	1/27 to 2/4/2006	X				X	X		
1499	Y	Y	11/7/2003	Severe Storm	Severe Storms and Flooding	10/15 to 10/23/ 2003	X				X			Disaster also included Drought for some counties in state.
1361	Y	Y	3/1/2001	Earth-quake	Earthquake	2/28/ to 3/16/ 2001	X	X				X		
1172	Y	Y	4/2/1997	Flood	Heavy Rains, Snow Melt, Flooding, Land- and Mud-slides	3/18/ to 3/28/ 1997	X	X				X		
1159	Y	Y	1/17/1997	Severe Storm	Severe Winter Storms, Land- & Mud-slides, Flooding	12/26/1996 to 2/10/ 1997	X	X			X	X		
1079	Y	Y	1/3/1996	Severe Storm	Severe Storms, High Wind, Flooding	11/7 to 12/18/ 1995	X	X			X	X		
981	N	Y	3/4/1993	Severe Storm	Severe Storms and High Wind	1/20 to 1/21/ 1993	X	X				X		

Table 3-2
Disaster Declarations for Hazard Events in Mason County

Disaster Number	Programs Declared		Declaration Date	Incident		Incident Date	Unincorporated County	Shelton, City of	Central Mason Fire & EMS	Mason County Fire District #16	PUD 1	PUD 3	Total Number Impacted	Comments/ Dollar Losses (if available)
	IA	PA		Type	Title									
883	Y	Y	11/26/1990	Flood	Severe Storms and Flooding	11/9 to 12/20/ 1990	X	X						
623	Y	Y	5/21/1980	Volcano	Volcanic Eruption, Mt. St. Helens	5/21/ 1980	X							
612	Y	N	12/31/1979	Flood	Storms, High Tides, Mudslides, Flooding	12/31/ 1979	X	X						
492	Y	Y	12/13/1975	Flood	Severe Storms & Flooding	12/13/ 1975	X	X						
414	Y	Y	1/25/1974	Flood	Severe Storms, Snowmelt, Flooding	1/25/ 1974	X	X						
196	Y	Y	5/11/1965	Earth-quake	Earthquake	5/11/ 1965	X							
185	Y	Y	12/29/1964	Flood	Heavy Rains and Flooding	12/29/ 1964	X	X						
Local Level Incidents														
NA				Snow	Snow Storm, Landslides	12-21-24-2012					X			
NA				Wind	Severe Wind Storm	3/10-13/2016					X			
NA				Wildfire	240 Acres burned by PUD 3 Headquarters	10/2014			X					

*=Loss data identified within hazard profiles if available;

** - PUD 1 outage logs

3.4 CRITICAL FACILITIES AND INFRASTRUCTURE

3.4.1 Definition

Critical facilities and infrastructure are those that are essential to the health and welfare of the population. Loss of a critical facility could also result in a severe economic or catastrophic impact. These facilities become especially important after a hazard event. Critical facilities typically include police and fire stations, schools, and emergency operations centers. Critical infrastructure can include the roads and bridges that provide ingress and egress and allow emergency vehicles access to those in need, and the utilities that provide water, electricity, and communication services to the community. Also included are "Tier II" facilities and railroads, which hold or carry significant amounts of hazardous materials with a potential to impact public health and welfare in a hazard event.

For purposes of this planning effort, the Planning Team utilized a pre-existing definition of critical facilities which has historically been utilized throughout the County during various planning efforts. The previously developed list was reviewed and updated during this 2018 process, and encompasses the following:

- Police stations, fire stations, vehicle and equipment storage facilities, communication centers and towers, and emergency operations centers needed for disaster response before, during, and after hazard events
- Public and private utilities and infrastructure vital to maintaining or restoring normal services to areas damaged by hazard events. These include, but are not limited to:
  - Public and private water supply infrastructure, water and wastewater treatment facilities and infrastructure, potable water pumping, flow regulation, distribution and storage facilities and infrastructure.
  - Public and private power generation (electrical and non-electrical), regulation and distribution facilities and infrastructure.
  - Data and server communication facilities.
  - Structures that manage or limit the impacts of natural hazards such as regional flood conveyance systems, potable water trunk main interconnect systems and redundant pipes crossing fault lines and reservoirs.
  - Major road and rail systems including bridges, airports, and marine terminal facilities.
- Hospitals, nursing homes, and care facilities, including facilities that provide critical medical services.
- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic, and/or water-reactive materials (e.g., hazmat facilities).
- Public gathering places used as evacuation centers during large-scale disasters.
- Governmental facilities central to governance and quality of life along with response and recovery actions taken as a result of a hazard event.

3.4.2 Comprehensive Data Management System Update

This process included an update of the database contained in FEMA's Hazus software (a hazard-modeling program). Concurrent with this planning process, FEMA was updating flood maps and Hazus data for the County. FEMA data provided to the County in March 2017 was incorporated into the Comprehensive Data Management System (CDMS) update and joined with the critical facilities data gathered by the Planning

Team. All critical infrastructure data and the assessor's data for the county has therefore been updated with the most current data available as of March 2017. Limitations associated with the updated CDMS data and the FEMA dataset are discussed in Chapter 4.

While all critical facilities identified are incorporated into this planning process, due to the sensitivity of this information, a detailed list of facilities is not provided. The list is on file with each planning partner. Table 3-3 and Table 3-4 provide summaries of the general types of critical facilities and infrastructure. These tables indicate the location of critical facilities and infrastructure, not jurisdictional ownership. All critical facilities/infrastructure were analyzed in Hazus to help rank risk and identify mitigation actions. The risk assessment for each hazard qualitatively discusses critical facilities with regard to that hazard.

Figure 3-2 shows the location of critical facilities and infrastructure in unincorporated areas of the county.

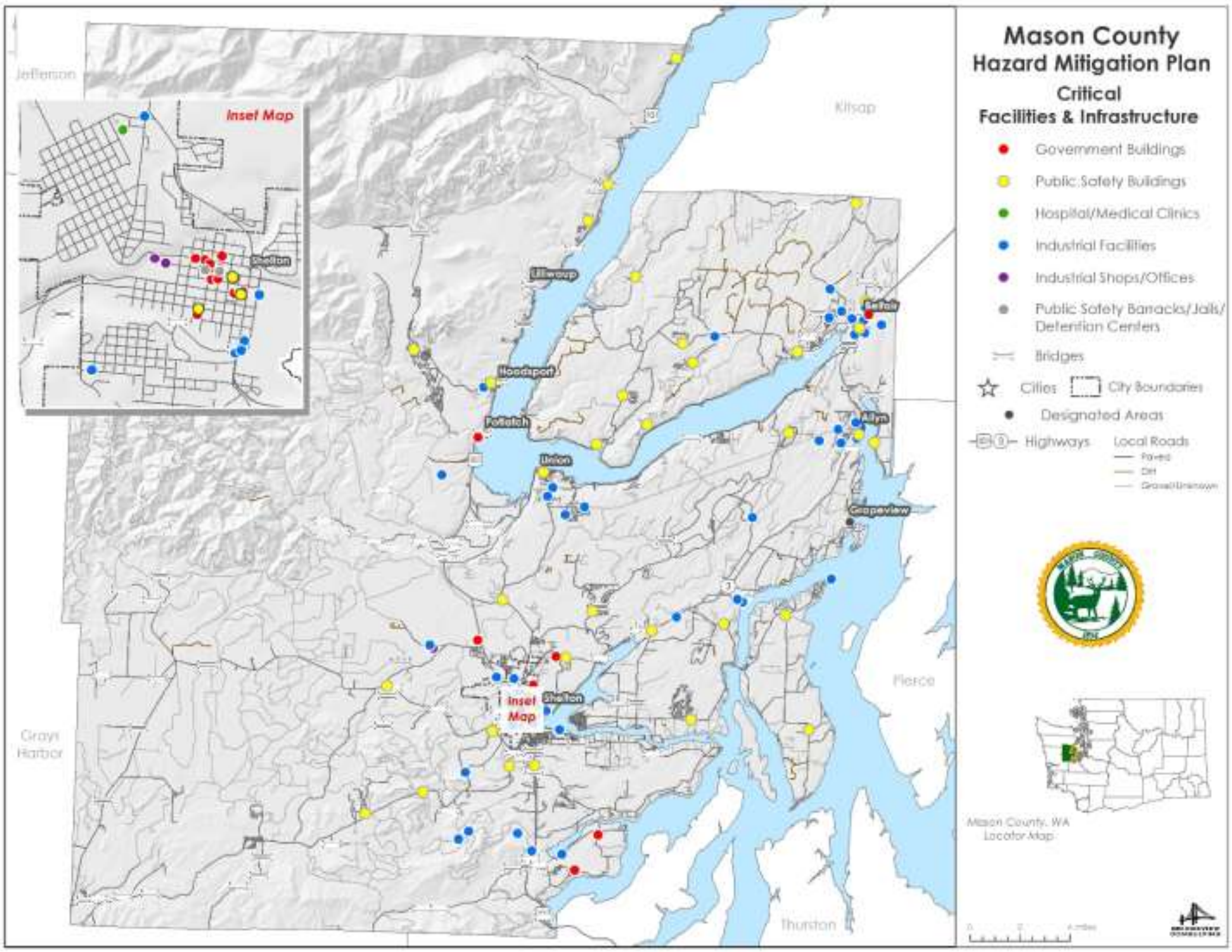


Figure 3-2 Planning Area Critical Facilities and Infrastructure

Table 3-3
Mason County Critical Facilities

Jurisdiction	Medical and Health	Government Functions	Protective Functions**	Hazmat	Other*	Total
Unincorporated Mason County	0	3	31	0	5	39
Shelton, City of	1	15	4	4	0	26
Allyn	0	0	1	0	0	1
Belfair	0	1	3	0	0	4
Total	**1**	**19**	**39**	**1**	**7**	**70**

*Includes Landfills in Unincorporated County and Government Buildings in Shelton
**Includes Police, Fire, EOC, Jail, & Shelters

Table 3-4
Mason County Critical Infrastructure

Jurisdiction	Bridges*	Water Supply	Wastewater	Power	Communications	Total
Unincorporated Mason County	79	3	13	17	2	114
Shelton, City of	4	9	4	3	1	2
Allyn	0	0	5	0	0	5
Belfair	7	4	4	1	0	16
Total	90	16	26	21	3	156

* Bridge locations provided by USDOT National Inventory Asset GIS Layer – July 2017

3.5 POPULATION

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

Knowledge of the composition of the population, how it has or may change in the future is needed for informed planning decisions. 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. As of 2015, Mason County is the 20th most populous county in Washington, with 60,699 residents. Table 3-5 presents Mason County population, area, and density data as established by the U.S. Census Bureau.

Table 3-5
2010 Population, Area, and Density Figures

Geographic area	Population	Housing units	Area in square miles: Total area	Water area	Land area	Density per square mile of land area: Population	Housing units
Mason County	60,699	32,518	1,051.02	91.60	959.42	63.3	33.9
CENSUS DESIGNATED PLACES							
Allyn	1,963	1,001	1.66	0.08	1.58	1,244.5	634.6
Belfair	3,931	1,634	7.35	0.00	7.35	534.8	222.3
Grapeview	954	797	7.75	4.08	3.67	260.0	217.2
Hoodsport	376	233	1.05	0.00	1.05	356.8	221.1
Shelton, City of	9,834	3,847	6.09	0.33	5.76	1,708.7	668.4
Skokomish	617	200	6.92	0.22	6.70	92.1	29.8
Union	631	412	1.62	0.00	1.62	390.1	254.
CENSUS CIVIL DIVISIONS							
Belfair-Tahuya CCD	8,737	4,865	122.59	17.60	104.99	83.2	46.3
Remainder of Belfair-Tahuya CCD	4,806	3,231	115.23	17.60	97.64	49.2	33.1
Kamilche CCD	3,276	1,513	71.50	3.03	68.47	47.8	22.1
Shelton CCD	20,843	7,752	55.14	4.96	50.18	415.3	154.5
Remainder of Shelton CCD	11,009	3,905	49.05	4.62	44.43	247.8	87.9
Skokomish Reservation CCD	730	292	8.43	0.22	8.21	88.9	35.6
Remainder of Skokomish Reservation CCD	113	92	1.51	0.00	1.51	75.0	61.1
Timber Lake-Harstine Island CCD	7,343	4,702	78.46	23.33	55.13	133.2	85.3
Union-Grapeview CCD	13,303	8,085	105.80	17.19	88.61	150.1	91.2
Remainder of Union-Grapeview CCD	9,755	5,875	94.77	13.02	81.75	119.3	71.9
West Mason CCD	6,467	5,309	609.10	25.28	583.82	11.1	9.1
Remainder of West Mason CCD	6,091	5,076	608.05	25.28	582.77	10.5	8.7

CDP = Census Designated Places: Concentration of population defined by Census Bureau for statistical purposes only used as counterparts of incorporated places such as cities, towns, and villages for purposes of gathering and correlating statistical data.

CCD = Census Civil Divisions: statistical subdivision of a county that have not been legally established, do not have a governmental or administrative purpose, but are known to the public as areas of the community.

3.5.1 Population Trends

Population changes are useful socio-economic indicators. A growing population generally indicates a growing economy, while a decreasing population signifies economic decline. Between 1970 and 1980 the County had a relatively large population boost; however, in the decades to follow the increases declined by more than half and continue to do so. Between 1970 and 1980, the County experienced a population increase of 49% percent (10,266 people), an average annual rate of 4.9%. The decade between 1980 and 1990 saw a reduction in population increases for Mason County of more than 50%[1] going from 49% in 1980 to 23% in 1990. A slight increase in this percent was seen in 2000 with a 28.9% upward trend; however, by 2010 the percent increase had decreased to just fewer than 2000 levels coming in at 22.9%.

The state has seen higher growth rates than the county over that period, but the trends of accelerating and decelerating growth have been generally the same for both. The Washington State Office of Financial Management (OFM) updates county and state long-range population forecasts every five years to support Growth Management Act planning (discussed in Section 14.1.2). The most recent forecasts, which project out to 2040, were issued in May 2012 and are shown in Table 3-6.

Table 3-6
County and State Population Projections

	Census	Projections					
	2010	2015	2020	2025	2030	2035	2040
Washington	6,724,540	7,022,200	7,411,977	7,793,173	8,154,193	8,483,628	8,790,981
Adams	18,728	20,257	21,640	22,964	24,289	25,690	27,205
Asotin	21,623	21,818	22,033	22,196	22,313	22,358	22,356
Benton	175,177	184,882	197,806	210,803	223,689	236,007	247,856
Chelan	72,453	75,180	78,586	81,885	84,778	87,168	89,246
Clallam	71,404	71,868	73,616	75,022	76,112	76,786	77,224
Clark	425,363	447,201	477,884	508,124	536,717	562,207	585,137
Columbia	4,078	4,047	4,013	3,968	3,895	3,800	3,700
Cowlitz	102,410	105,130	108,588	111,706	114,158	115,798	116,897
Douglas	38,431	40,603	43,619	46,662	49,583	52,256	54,762
Ferry	7,551	7,619	7,706	7,751	7,754	7,740	7,692
Franklin	78,163	87,755	100,926	115,142	130,284	146,103	162,900
Garfield	2,266	2,238	2,220	2,210	2,202	2,175	2,143
Grant	89,120	95,822	104,078	112,525	121,204	129,779	138,337
Grays Harbor	72,797	73,575	74,408	75,529	76,428	76,905	77,070
Island	78,506	80,337	82,735	85,073	87,621	90,239	93,205
Jefferson	29,872	30,469	32,017	33,678	35,657	37,914	40,093
King	1,931,249	2,012,782	2,108,814	2,196,202	2,277,160	2,350,576	2,418,850
Kitsap	251,133	262,032	275,546	289,265	301,642	311,737	320,475
Kittitas	40,915	42,592	45,255	47,949	50,567	53,032	55,436
Klickitat	20,318	20,606	20,943	21,225	21,430	21,492	21,439
Lewis	75,455	77,621	80,385	82,924	85,165	87,092	88,967
Lincoln	10,570	10,616	10,707	10,800	10,865	10,862	10,817
Mason	60,699	63,203	67,545	71,929	76,401	80,784	84,919
Okanogan	41,120	42,230	43,163	43,978	44,619	45,127	45,707
Pacific	20,920	20,860	20,990	21,261	21,495	21,736	22,042
Pend Oreille	13,001	13,289	13,692	13,977	14,129	14,149	14,116
Pierce	795,225	831,944	876,565	923,912	967,601	1,006,614	1,042,341

Table 3-6
County and State Population Projections

	Census	Projections					
	2010	2015	2020	2025	2030	2035	2040
San Juan	15,769	15,907	16,256	16,606	16,939	17,216	17,443
Skagit	116,901	121,624	128,249	136,410	144,953	153,632	162,738
Skamania	11,066	11,282	11,548	12,014	12,447	12,816	13,082
Snohomish	713,335	750,358	805,015	857,939	908,807	955,281	997,634
Spokane	471,221	489,491	513,910	537,428	558,614	576,763	592,969
Stevens	43,531	44,262	45,212	46,447	47,834	49,340	50,929
Thurston	252,264	266,224	288,265	307,930	326,426	343,019	358,031
Wahkiakum	3,978	3,931	3,877	3,830	3,772	3,716	3,669
Walla Walla	58,781	60,015	61,685	63,368	64,978	66,378	67,655
Whatcom	201,140	210,050	225,307	241,138	256,643	271,142	284,901
Whitman	44,776	46,139	47,826	49,346	50,577	51,563	52,504
Yakima	243,231	256,341	269,347	282,057	294,445	306,636	318,494

Note: OFM Forecasting – May 2012
Differences in 2010 figures compared to other tables due to census corrections.
Data may not add due to rounding; unrounded figures are not meant to imply precision.

OFM considers the medium projection the most likely (RCW 43.62.035) because it is based on assumptions that have been validated with past and current information. The high and low projections represent the range of uncertainty that should be considered when using these projections for planning. As of OFM's 2016 annual report, Mason County is ranked 4th statewide for "Rank by Percent Change" in population from 2010 to 2014. Table 3-7 identifies the population change within Mason County for the period 2000-2010. Table 3-8 lists population trends in Mason County compared to the State of Washington. Figure 3-3 is a graphic prepared by Office of Financial Management which illustrates the population trend in Mason County.

Table 3-7
Population Change April 1, 2000 to April 1, 2010

	Census		Total Change 2000-2010		
Area	2000	2010	Numeric Change	Percent Change	Rank by Percent Change
Washington	5,894,143	6,724,540	830,397	17.09	--
Mason County	49,405	60,699	11,294	22.86	4

Source: Office of Financial Management http://www.ofm.wa.gov/pop/april1/poptrends.pdf

Table 3-8
County and State Population Trends

Year	Mason County Population	% change from previous census	State of Washington Population	% change from previous census	United States Population	% change from previous census
2010	60,699	22.86%	6,724,540	14.1%	308,745,538	9%
2000	49,405	28.9%	5,894,121	21.1%	281,424,602	12%
1990	38,341	23%	4,866,692	17.8%	248,709,873	9%
1980	31,184	33%	4,132,156	21.2%	226,542,199	10%
1970	20,918	22.3%	3,409,169	19.5%	203,302,031	12%

Source: U.S. Census Bureau, 2015

Source: OFM, 2012c

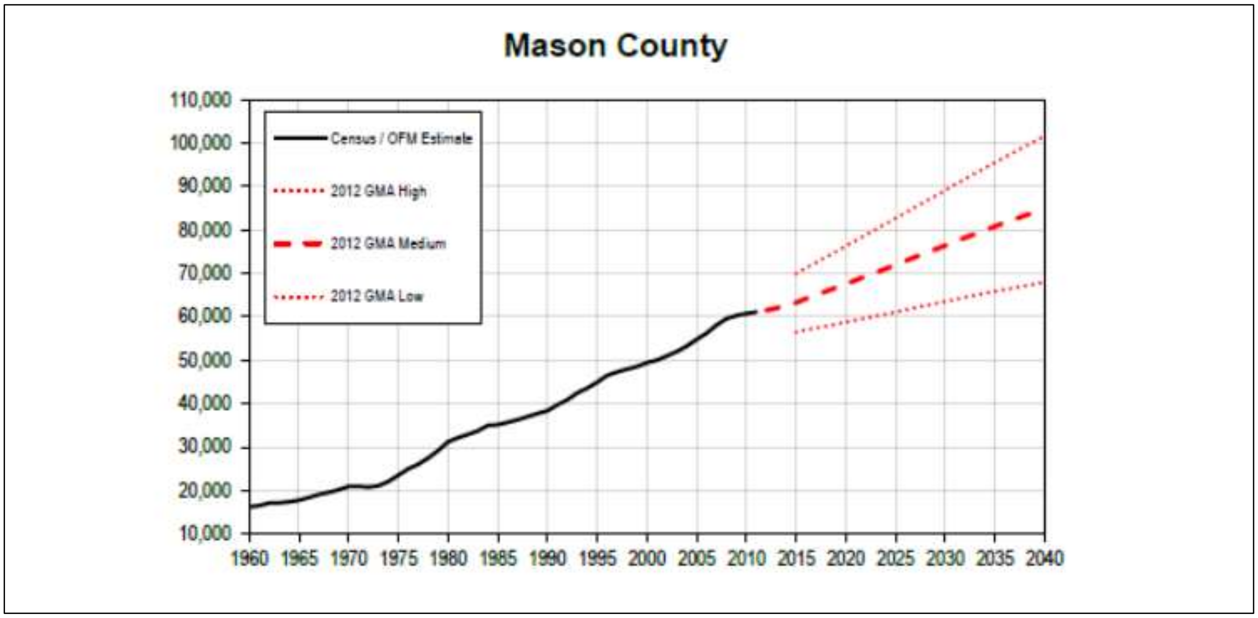
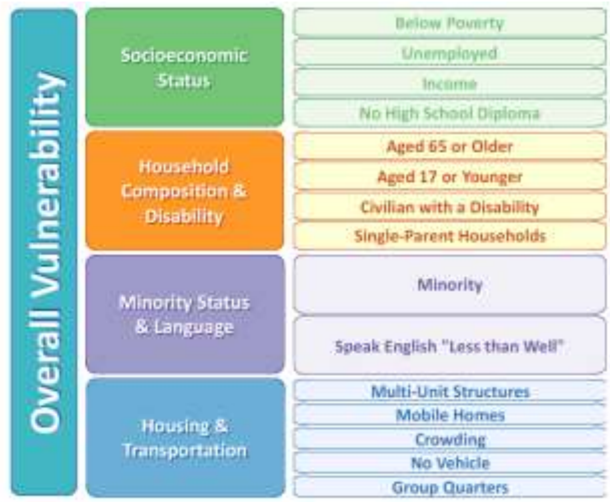


Figure 3-3 Mason County Population Trends and Projects - 1960-2040

3.5.2 Social Vulnerability

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



During emergencies, real-time evacuation information may not be provided to people with limited English proficiency, the hearing and visually impaired, and other special needs group. Many low-income people may be stranded because they have no personal transportation, and no mass transit (especially during emergencies) is available. For the poor, they are less likely to have the income, or assets needed to prepare for a possible disaster, or to recover after a disaster. Although the monetary value of their property may be less than that of other households, it likely represents a larger portion of the total household assets. As such, lost property is proportionately more expensive to replace, especially without insurance. Additionally, unemployed persons do not have employee benefits that provide health cost assistance. High-income populations who suffer higher household losses (absolute terms) find their overall position mitigated by insurance policies and other financial investments not available to lower income households.

3.5.3 Age Distribution

As a group, the elderly are more apt to lack the physical and economic resources necessary for response to hazard events and 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 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.

Mason County is an older community compared to both the State of Washington and the United States, with a median age almost eight (8) years older. Mason County has both a smaller percentage of young and a larger percentage of elderly residents, but the latter is more pronounced. As of 2015, an estimated 20 percent of county residents were older than 65; over 6 percent higher than the State and national averages. Approximately 19 percent of county residents are younger than 18, compared to approximately 23 percent both statewide and nationwide. When compared to the national average, the City of Shelton has a higher percentage of residents under 18, but a similar percentage of residents over 65. Table 3-9 illustrates the increase of the aged population within Mason County during the time period 1990-2016.

Table 3-9
Population Age 65 Years and Over

Area	Census 1990	Census 2000	Census 2010	Estimate 2011	Estimate 2012	Estimate 2013	Estimate 2014	Estimate 2015	Estimate 2016	Percent of 2016 Population
Washington	571,403	662,142	827,677	852,412	895,629	939,497	982,836	1,027,663	1,072,637	14.93
Mason	6,251	8,149	11,112	11,412	11,715	12,349	12,806	13,268	13,722	22.02

Source: Office of Financial Management (2016)

Children under 5 are particularly vulnerable to disasters because of their dependence on others for basic necessities. Very young children are additionally 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. Table 3-123-10 illustrates population by age and sex. Figure 3-4 and Figure 3-5 illustrate density of age populations 5 and under, and 65 and over throughout Mason County.

Table 3-10
Census Population Data By Age And Sex (April 2015)

Age	Total	Male	Female	Age	Total	Male	Female
0-4	3,129	1,599	1,530	50-54	4,292	2,210	2,082
5-9	3,400	1,754	1,646	55-59	4,839	2,428	2,411
10-14	3,471	1,784	1,687	60-64	4,958	2,416	2,542
15-19	3,312	1,767	1,545	65-69	4,597	2,249	2,349
20-24	3,664	2,004	1,661	70-74	3,464	1,707	1,757
25-29	3,560	1,975	1,585	75-79	2,352	1,164	1,187
30-34	3,482	1,911	1,571	80-84	1,585	754	831
35-39	3,390	1,849	1,541	85+	1,540	679	861
40-44	3,451	1,870	1,581	Total	62,200	32,084	30,116
45-49	3,714	1,963	1,751	Median Age	45.32	43.74	47.03

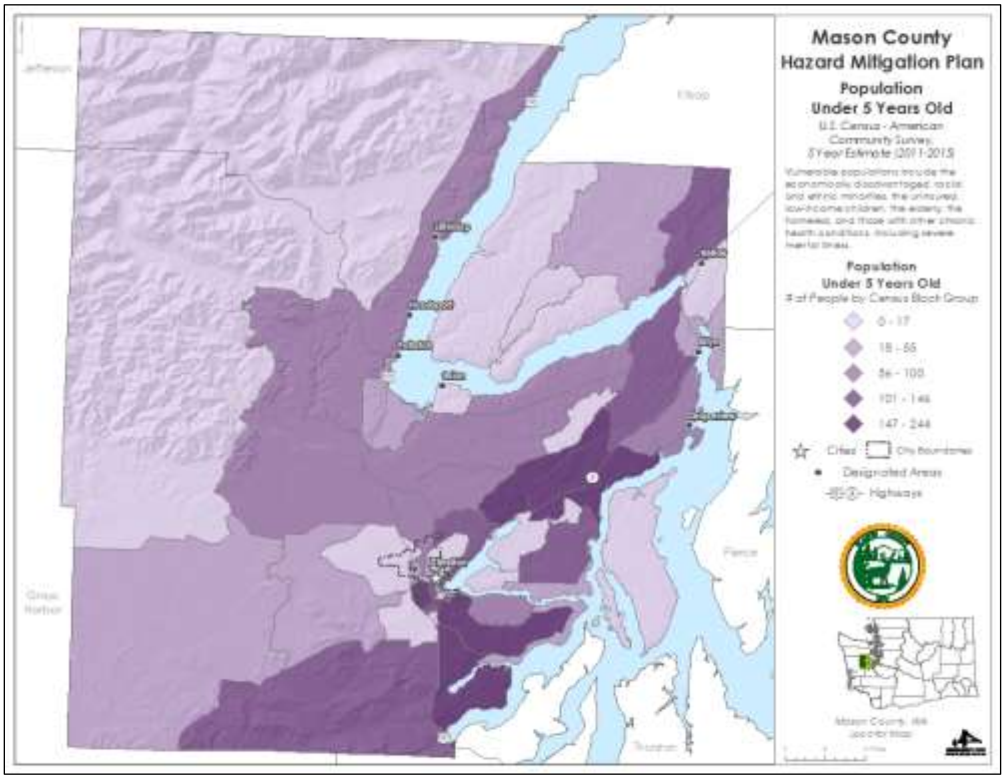


Figure 3-4 Distribution of Population Under 5 Years of Age

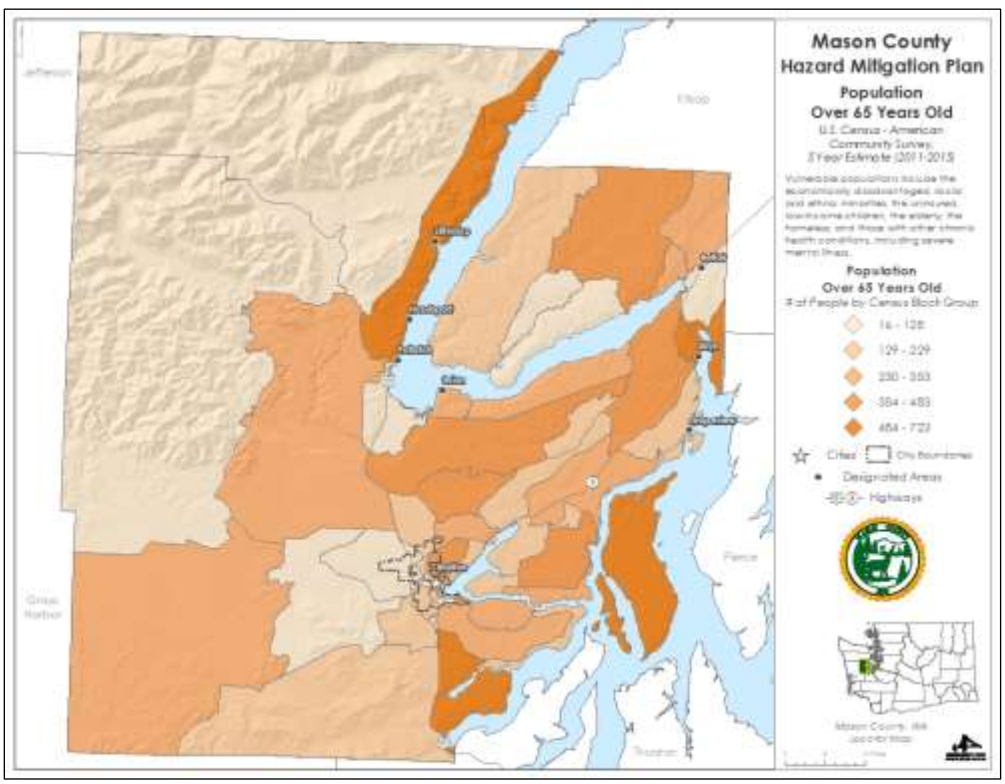


Figure 3-5 Distribution of Population Over 65 Years of Age

3.5.4 Race, Ethnicity, and Language

Research shows that minorities are less likely to be involved in pre-disaster planning and experience higher mortality rates during a disaster event. Post-disaster recovery can be ineffective and is often characterized by cultural insensitivity. Since higher proportions of ethnic minorities live below the poverty line than the majority white population, poverty can compound vulnerability.

According to the 2015 U.S. Census Bureau's QuickFacts (see Table 3-11), racial makeup of the county was 86.1% white, 3.7% American Indian, 1.2% Asian, 1.1% black or African American, 0.4% Pacific islander, 3.4% from other races, and 4.1% from two or more races. Those of Hispanic or Latino origin made up 8.0% of the population.

Table 3-11
AIAN Census Data Population By Race And Hispanic Origin

	Total	White	Black	AIAN	Asian	NHOPI	2 or More
2010 Census Non-Hisp.	55,855	50,450	611	1,874	697	217	2,006
2010 Census Hispanic	4,844	3,736	86	714	63	29	216
2015 Est. Non-Hisp.	56,502	50,570	636	1,923	764	236	2,373
2015 Est. Hispanic	5,698	4,336	97	841	69	32	323

AIAN: American Indian and Alaska Native, NHOPI: Native Hawaiian and Other Pacific Islander

3.5.5 Disabled Populations

People with disabilities are more likely than the general population to have difficulty responding to a hazard event. As disabled populations are increasingly integrated into society, they are more likely to require assistance during the 72 hours after a hazard event, the period generally reserved for self-help. There is no "typical" disabled person, which can complicate disaster-planning processes that attempt to incorporate them. Disability is likely to be compounded with other vulnerabilities, such as age, economic disadvantage, and ethnicity, all of which mean that housing is more likely to be substandard. Table 3-12 identifies the population of citizens within Mason County who have a reported disability. In 2015, 20.8 percent of Mason County residents were living with a disability, which is 8 percent higher than both the State and national averages. The City of Shelton and the Skokomish Reservation also have close to 1-in-5 residents living with a disability.

Table 3-12
2015 Population Totals with Disability

Total population with reported disability	12,362	20.8%
Under 18 years of age with a disability	910	7.6%
Between the ages of 18-64 with a disability	6,519	18.5%
65 years and over with a disability	4,933	40.5%

Source: American Fact Finder
https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk

3.5.6 Homeless Population

In emergency planning, the needs of homeless people are usually categorized within the needs of all "special populations." People who are homeless have limited resources to evacuate, stockpile food, store medications, and shelter in place. In addition, people who are homeless have limited access to Internet and television, and are often the last to know about emergencies. Most do not own vehicles for evacuation purposes, and do not know safe locations to which to evacuate. For these reasons, communities often struggle in their approach to prepare homeless people for disasters. While informational leaflets, coupled with personal trainings, have been effective in helping homeless people prepare for disasters, most jurisdictions are unaware of the number of homeless in their community, and even where they are located.

Mason County has been proactive in identifying the needs of the homeless, and have identified a total of 276 individuals based on 2017 outreach. Of those, 118 are sheltered homeless, while 158 are unsheltered. A total of 81 individuals are considered Chronically Homeless, meaning they are an "unaccompanied homeless individual with a disabling condition, who has either been continuously homeless for a year or more, or has had at least four (4) episodes of homelessness in the past three (3) years (HUD).[1] Working with Commerce and Public Health Departments, the County will continue to develop information which can be utilized to address the needs of vulnerable populations during disaster incidents. Identifying this need, the County has developed a strategy within this plan in coordination with the Commerce and Public Health Departments to work on potential efforts in this regard.

3.6 ECONOMY

Knowing the economic characteristics of a community can assist in the analysis of the community's ability to prepare, respond, and rebuild safer after a natural hazard. Categorizing economic vulnerability can encompass many factors, including median household income, poverty rates, employment and unemployment rates, housing tenure, and community building inventory.

Natural resource industries currently support Mason County's economy and are expected to be as important in the future. The County is highly specialized in the production of forestry and aquaculture commodities. This specialization focuses on both raw materials and value-added products in these industries. Heavy construction and government service also anchor the County's economy.

Government is the County's largest employer. Over 22 percent of Mason County's total employment was provided by the government sector. The service industry was the largest private employer, followed closely by the retail industry.

3.6.1 Income and Employment

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

[1] https://www.hudexchange.info/resources/documents/Defining-Chronically-Homeless-Final-Rule.pdf

with potential losses. Personal household economics also significantly impact people's decisions on evacuation. Individuals who cannot afford gas for their cars will likely decide not to evacuate.

Based on ACS estimates, median income for a household in the county was $50,406 and $61,062 at the state level (2015 dollars). The median income for a family was $56,809. Males had a median income of $44,992 versus $33,982 for females.

Census Quick Facts identify the per capita income for the county was $25,015, while the state level was $31,762. Approximately 17 percent of the population were below the poverty line; state level was approximately 13 percent of population base.[2] County poverty levels include 21 percent under age 18 and 9.0 percent of those age 65 or over. The poverty rate for the county was higher than the national rate, and 4 percent higher than the state rate (Figure 3-6).

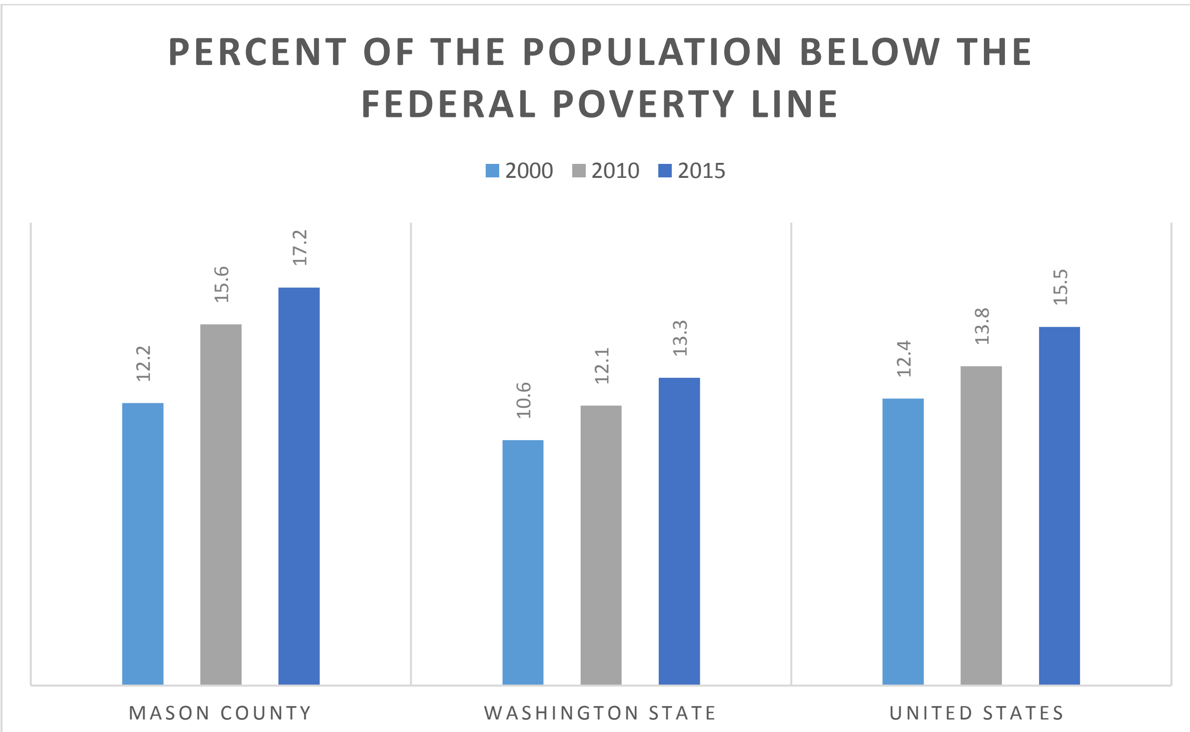


Figure 3-6 Percent of Population Below Federal Poverty Line 2000-2015

The poverty rate was much higher in the City of Shelton, where over 28 percent of residents live in poverty. Poverty rates for Tribal communities also appear to be consistently higher than county, State, and national averages. The estimated poverty rate for the Skokomish Tribe in 2010 was approximately 29 percent (with a margin of error of +/-4.4 percent).

Economic sustainability is encouraged through employment and job security. The higher the employment rate, the more financial stability is accomplished on an individual level. In addition, a healthy job market brings economic growth to communities.

[2] Census Quick Facts https://www.census.gov/quickfacts/table/PST045216/53045,53

In 2017, the employment rate in Mason County was almost 14 percent lower than the nation employment rate, at 8.5 percent (see Figure 3-7). Additionally, the unemployment rate for the County was 12.9 percent in 2015, compared to 7.9 percent in Washington and 8.3 percent Nationwide.

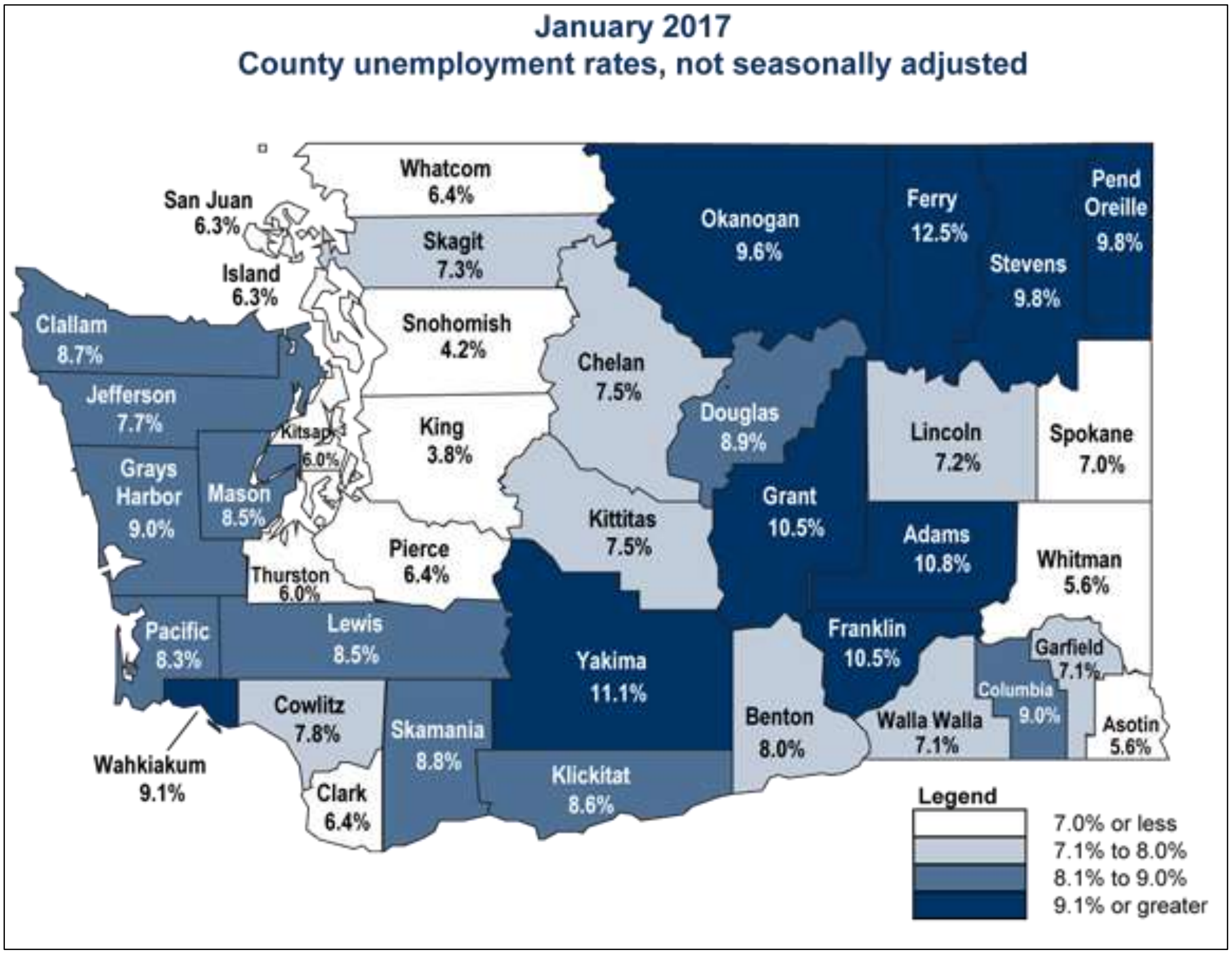


Figure 3-7 Mason County 2017 Unemployment Rates

Review of the Local Employment Dynamics data indicates that during 2015, the largest jobholder age group in Mason County was the 55 and older age category, making up 26.1 percent of employment across all industries. The next largest share was among persons aged 45 to 54 with 21.5 percent of employment.[3]

In 2015, the county's workers mirrored state patterns with workers ages 14 to 24 dominating the accommodation and food services jobs in the county with over 31.2 percent of the positions. This age group was also well represented in arts, entertainment and recreation and retail trade.

[3] Washington State Employment Security Department – [Mason County] Community Profile. Accessed March 16, 2017. Available at: https://esd.wa.gov/labormarketinfo/county-profiles/mason (Data captured from Bureau of Labor Statistics, Bureau of Economic Analysis, US Census Bureau, American Community Survey, and Washington Employment Security Dept.

Workers in the 55 year and older age category were prevalent in educational services (41.2 percent), transportation and warehousing (32.2 percent), real estate and rental and leasing (37.7 percent), and other services (34.0 percent).

Females made up 51.1 percent of the labor force in Mason County with males making up the difference at 48.9 percent in 2015. Men were more often represented in higher paying industries.

- Male-dominated industries included agriculture (75.4 percent), construction (79.3 percent), manufacturing (77.9 percent) and transportation and warehousing (71.3 percent).
- Female-dominated industries included finance and insurance (82 percent), healthcare and social assistance (81.4 percent) and educational services (72.1 percent).

The September 2016 total of 13,640 jobs increased by 380 jobs than in September 2015. The largest industries in the Mason County economy remain government (5,610) and trade, transportation, and utilities (2,330). The manufacturing industry accounted for 1,090 jobs (as of September 2016), and saw a gain of 90 jobs over the year. The 2016 industry employment level represents a small loss in total nonfarm employment compared to the first nine months of 2015. This trend will likely be the norm heading into 2017, although manufacturing will continue to face significant headwinds.

Forest products became the largest industry in the county, and expanded greatly when the railroads made it possible to feed the various mills in the area. Work on creating a terminus for the transcontinental railroad in Union came to an abrupt halt with the Panic of 1893, the most serious economic crisis in the nation's history. Mason County was fortunate, however, in that banker Alfred Anderson partnered with loggers to get them back to work and then with Sol Simpson to create the Simpson Logging Company, which became the largest employer in the state. In the 1980s, the Forest Service eliminated most timber sales to protect the spotted owl.

The prison in Shelton added hundreds of beds during this period, helping to offset job losses in the forest industry. Recreation as well as oyster and seafood production and processing also have increased in importance. Mason County also has become an important bedroom community for commuters to Thurston and Pierce counties. In 2014, 52.3 percent of earned income came from residents working outside the county.

3.6.2 Housing Stock

According to *A Social Vulnerability Index for Disaster Management* (Journal of Homeland Security and Emergency Management, 2011), housing quality is an important factor in assessing disaster vulnerability. It is closely tied to personal wealth: people in lower income brackets often live in more poorly constructed homes that are especially vulnerable to strong storms or earthquakes. Mobile homes are not designed to withstand severe weather or flooding, and typically do not have basements. They are frequently found outside of metropolitan areas and, therefore, may not be readily accessible by interstate highways or public transportation. Also, because mobile homes are often clustered in communities, their overall vulnerability is increased.

The American Community Survey estimates that Mason County has in excess of 5,900 mobile homes within its boundaries. The 2015 Census estimates that Mason County has 32,642 housing units, with a median value of $204,300.

3.6.3 Building Stock Age

The age of a building in determining vulnerability is a significant factor, as it helps identify the building code to which a structure was built. Homes built prior to 1975 are considered pre-code since there was no statewide requirement to include specific standards to address the various hazards of concern (e.g., there were no seismic provisions contained within the building code). Structures built after 1975 are considered of moderate code. It was at that point in time in which all Washington jurisdictions were required to adhere to the provision of the most recently adopted version of the Uniform Building Code (UBC) (Noson et al., 1988).

In 2015, Mason County reported that a high percentage of its buildings had been built after 1960. Additionally, when compared with Washington and the Nation, the Mason County had the lowest percentage of buildings built between 1940 and 1959, and the least amount of buildings built before 1940 (Figure 3-8). Almost 40 percent of buildings in the City of Shelton were built before 1960, a much higher percentage than Mason County, the State, and the Nation.

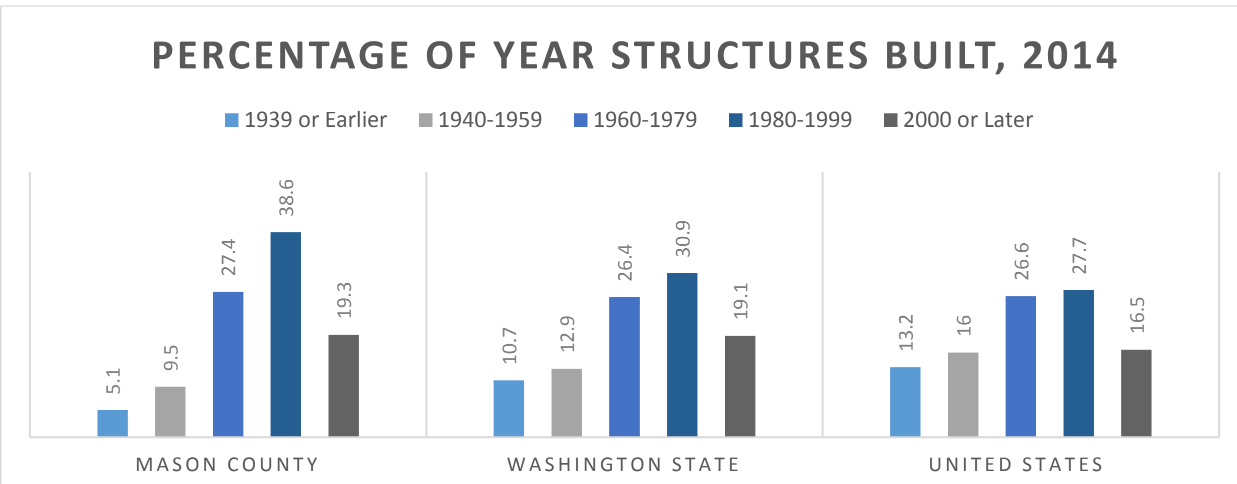


Figure 3-8 Mason County Year Structures Built

Building codes were updated with higher earthquake standards in the 1980s. In Mason County 57.9 percent of structures were built after 1980, a higher percentage than both State and national averages. The Skokomish Tribe and the Squaxin Tribe also had a high percentage of construction after 1980 (54.3 and 72.9 percent respectively). In the City of Shelton only 34 percent of structures were built after 1980, meaning a high percentage of Shelton buildings could be impacted by ground shaking during an earthquake (FEMA Risk Report, 2017).

It should be noted, however, that the data may be slightly skewed due to the fact that actual building code adoption dates may vary slightly by jurisdiction. Also, the data provided is captured from the Assessor's data. Structures may have undergone remodel, or improvements which changed the building code classification, increasing the level of code applied. That data may not have been captured or applied in a manner which would reflect a change in the year of construction. Additionally, while building codes may not have been in place, houses may have been constructed to higher standards. Therefore, this data should be used for planning purposes only. Questions concerning actual structural integrity should be determined by appropriate subject matter experts in the field.

3.7 LAND USE PLANNING AND FUTURE DEVELOPMENT TRENDS

The County Comprehensive Plan includes components that help to guide the vision for the County: Planning Policies, Future Land Use Analysis, Critical Areas, and Capital Facilities. Within Washington State, the State Growth Management Act (GMA) requires state and local governments to manage Washington's growth by identifying and protecting critical areas and natural resource lands, designating urban growth areas, preparing comprehensive plans and implementing them through capital investments and development regulations.

Washington's Growth Management Act (GMA) requires that jurisdictions select a population projection to use for planning projections. The Office of Financial Management considers the medium projection the most likely (RCW 43.62.035) because it is based on assumptions that have been validated with past and current information. The high and low projections represent the range of uncertainty that are considered when using these projections for planning purposes. Counties must select a population projection that falls within these ranges to determine their GMA planning projection. Mason County selected the medium forecast as its base (with some modifications) for GMA planning purposes. That information is used in determining other aspects of the County's growth management, including identification of critical areas.

Critical areas are environmentally sensitive natural resources that have been designated for protection and management in accordance with the requirements of the GMA. Protection and management of these areas is important to the preservation of ecological functions of our natural environment, as well as the protection of the public health, safety, and welfare of our community. Information from this mitigation plan will help identify the critical areas throughout the county and its incorporated jurisdictions. That information will be used during update of the comprehensive plan.

The County's Comprehensive Plan is currently under review and update. The County has adopted a comprehensive plan that governs its land use decision- and policy-making process in accordance with GMA guidelines. 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 Mason County. Table 3-13 identifies current land use classifications, acres in such classification, and the percent of total land area within the County.

The County's Planning Department is responsible for updating the Comprehensive Land Use Plan and for overseeing and regulating land use and development in unincorporated Mason County to protect the health, safety, and welfare of County residents. The department is also responsible for floodplain management in the County. The department works with other government departments (including emergency management); various agencies and municipalities (including special purpose districts); the general public; land-owners; special interest groups; and businesses to oversee development in unincorporated Mason County, ensuring land use remains consistent with federal, state and county regulations.

Utilzing estimated population growth statistics, the county has estimated how the future growth in population will be distributed among the different districts created in the Comprehensive Plan. Figure 3-9 illustrates the future land use within Mason County as identified within its 2016 Comprehensive Plan update. The future land use has three Urban Growth Areas (UGAs), three Rural Activity Centers, and eleven Hamlets.

Table 3-13
Present Land Use in Planning Area

Present Use Classification	Area (acres)	% of total
Agri/Aquaculture	15,375	1.7
Commercial	9,721	1.1
Forest	556,015	60.4
Governmental Services	17,779	1.9
Mining	320	0.0
Parks	4,211	0.5
Residential	82,010	8.9
Transportation	5,468	0.6
Utility/Easement/Right of Way	4,101	0.4
Uncategorized (includes vacant and resource lands)	225,362	24.5
Total	**920,360**	**100**

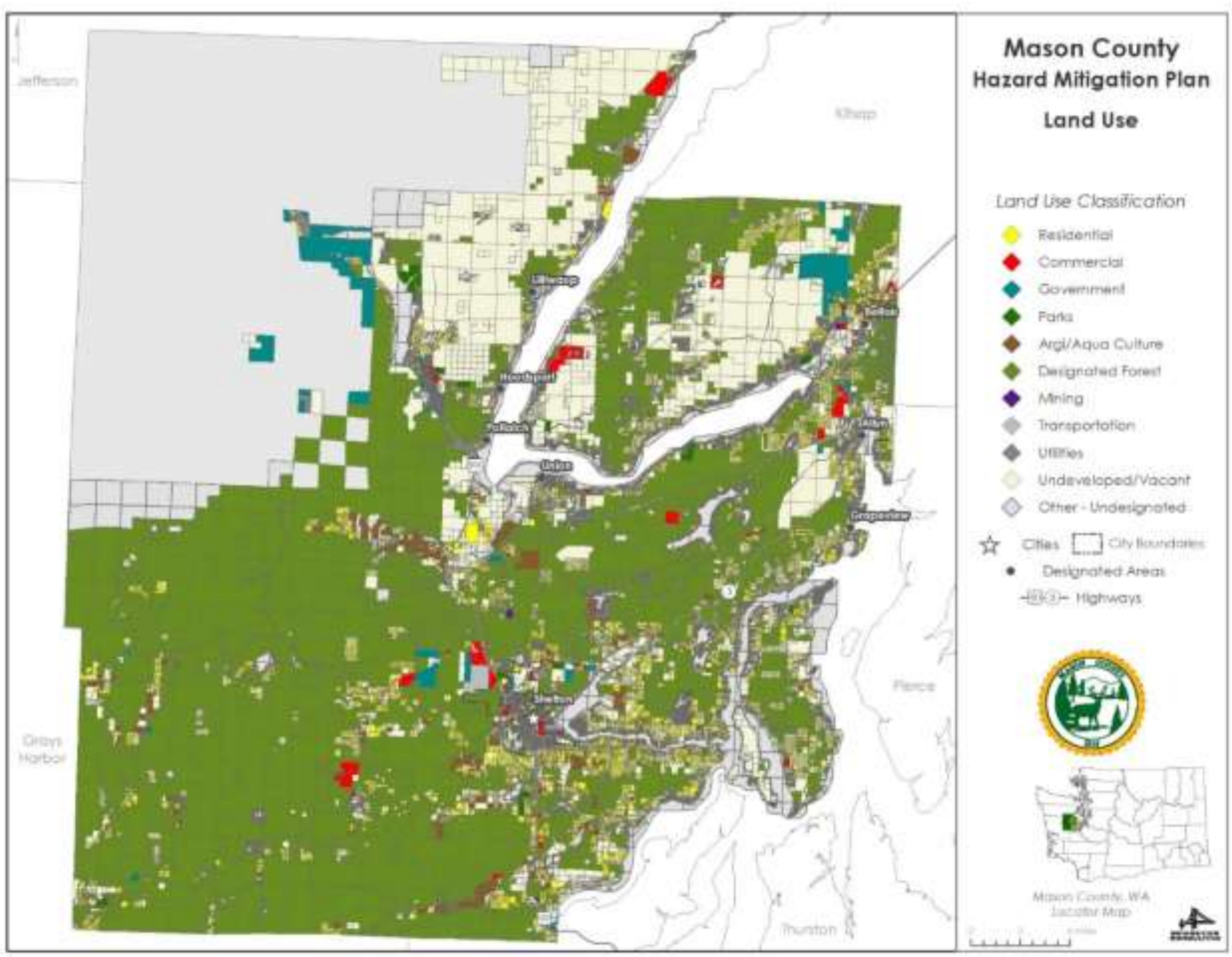


Figure 3-9 Mason County Land Use Classifications (2016)

The UGAs include the City of Shelton and the communities of Allyn and Belfair. The Rural Activity Centers include Union, Hoodsport, and Taylor Town. The Hamlets include Bayshore, Dayton, Deer Creek, Eldon, Grapeview, Lake Cushman, Lilliwaup, Matlock, Potlatch, Spencer Lake, and Tahuya. The rural area is divided into several different areas that reflect different allowed residential densities of one dwelling per 2.5 acres, one dwelling per 5 acres, one dwelling per 10 acres and one dwelling per 20 acres. Also among the rural lands are Rural Tourist/Recreational Areas and Commercial/Industrial Areas.

Research in the area of growth management has demonstrated that communities experiencing economic growth who are able to invest in new development, including mitigation efforts, increase the resilience of both existing and new buildings and infrastructure. Newly constructed buildings and infrastructure are more resilient to hazards of concern and the associated impact by those hazards (e.g., ground shaking) as they are built to higher building code standards. The use of data within plans such as these play a significant role in education with respect to identifying those areas of concern addressed within Growth Management.

A total of 111 building permits were issued within the County in 2015; statewide levels totaled 40,374. Table 3-14 identifies the types of land use countywide.

Table 3-14
Mason County Issued Permits 2009-2015

Year	2009	2010	2011	2012	2013	2014	2015
Total Units	160	140	134	121	135	108	111
Single-Family Units	149	140	134	121	120	108	111
Multi-Family Units	11	0	0	0	15	0	0

All municipal planning partners will seek to incorporate by reference the Mason County hazard mitigation plan in their comprehensive plans. This will assure that all future development can be established with the benefits of the information on risk and vulnerability to natural hazards identified in this plan. On next update of its Comprehensive Land Use Plan, this hazard mitigation plan will provide information that will be utilized to support that effort.

Each planning partner's specific annex to this plan (see Volume 2) includes an assessment of regulatory, technical, and financial capability to carry out proactive hazard mitigation. Refer to these annexes for a review of regulatory codes and ordinances applicable to each planning partner. In addition, Chapter 14 of this plan provides a general overview of the municipalities' regulatory authority.

CHAPTER 4.
RISK ASSESSMENT METHODOLOGY

4.1 OVERVIEW

The DMA requires measuring potential losses to critical facilities and property resulting from natural hazards. A hazard is an act or phenomenon that has the potential to produce harm or other undesirable consequences to a person or thing. Natural hazards can exist with or without the presence of people and land development. However, hazards can be exacerbated by societal behavior and practice, such as building in a floodplain, along a sea cliff, or on an earthquake fault. Natural disasters are inevitable, but the impacts of natural hazards can, at a minimum, be mitigated or, in some instances, prevented entirely.

The goal of the risk assessment is to determine which hazards present the greatest risk and what areas are the most vulnerable to hazards. Mason County and its planning partners are exposed to many hazards. The risk assessment and vulnerability analysis help identify where mitigation measures could reduce loss of life or damage to property in the planning region. Each hazard-specific risk assessment provides risk-based information to assist Mason County and its planning partners in determining priorities for implementing mitigation measures.

The risk assessment approach used for this plan entailed using geographic information system (GIS), Hazus hazard-modeling software, and hazard-impact data to develop vulnerability models for people, structures and critical facilities, and evaluating those vulnerabilities in relation to hazard profiles that model where hazards exist. This approach is dependent on the detail and accuracy of the data used. In all instances, this assessment used Best Available Science and data to ensure the highest level of accuracy possible.

The risk assessment is broken down into three phases, as follows:

> The first phase, hazard identification, involves the identification of the geographic extent of a hazard, its intensity, and its probability of occurrence (discussed below). This level of assessment typically involves producing a map. The outputs from this phase can be used for land use planning, management, and development of regulatory authority; public awareness and education; identifying areas which require further study; and identifying properties or structures appropriate for mitigation efforts, such as acquisition or relocation.
>
> The second phase, the vulnerability assessment, combines the information from the hazard identification with an inventory of the existing (or planned) property and population exposed to the hazard. It then attempts to predict how different types of property and population groups will be impacted or affected by the hazard of concern. This step assists in justifying changes to building codes or regulatory authority, property acquisition programs, such as those available through various granting opportunities; developing or modifying policies concerning critical or essential facilities, and public awareness and education.
>
> The third phase, the risk analysis, involves estimating the damage, injuries, and costs likely to be incurred in the geographic area of concern over a period of time. Risk has two measurable components:
>
> 1. The magnitude of the harm that may result, defined through the vulnerability assessment; and
> 2. The likelihood or probability of harm occurring.

Utilizing those three phases of assessment, information was developed which identifies the hazards that affect the planning area, the likely location of natural hazard impact, the severity of the impact, previous occurrences, and the probability of future hazard events. That data, once complete, is utilized to complete the Risk Ranking process described in Chapter 12, which applies all of the data capture to the Calculated Priority Risk Index (CPRI).

The following is provided as the foundation for the standardized risk terminology:

- Hazard: Natural (or human caused) source or cause of harm or damage, demonstrated as actual (deterministic/historical events) or potential (probabilistic) events.
- Risk: The potential for an unwanted outcome resulting from a hazard event, as determined by its likelihood and associated consequences. For this plan, where possible, risk includes potential future losses based on probability, severity, and vulnerability, expressed in dollar losses when possible. In some instances, dollar losses are based on actual demonstrated impact, such as through the use of the Hazus model. In other cases, losses are demonstrated through exposure analysis due to the inability to determine the extent to which a structure is impacted.
- Location: The area of potential or demonstrated impact within the area in which the analysis is being conducted. In some instances, the area of impact is within a geographically defined area, such as a floodplain. In other instances, such as for severe weather, there is no established geographic boundary associated with the hazard, as it can impact the entire area.
- Severity/Magnitude: The extent or magnitude upon which a hazard is ranked, demonstrated in various means, e.g., Richter Scale.
- Vulnerability: The degree of damage, e.g., building damage or the number of people injured.
- Probability of Occurrence and Return Intervals: These terms are used as a synonym for likelihood, or the estimation of the potential of an incident to occur.

4.2 METHODOLOGY

The risk assessment for this hazard mitigation plan evaluates the risk of natural hazards prevalent in Mason County and meets requirements of the DMA (44 CFR Section 201.6(c)(2)). The methodology used to complete the risk assessment is described below.

4.2.1 Hazard Identification and Profiles

For this plan, the planning partners and stakeholders considered the full range of natural hazards that could impact the planning area and then listed hazards that present the greatest concern. 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 natural hazards and the perceived vulnerability of the planning area’s assets to them was also used.

The planning team discussed the potential for addressing Drought in this update edition. Review of data included the 2016 Department of Ecology report, which identified impacts resulting from the reduced rainfall during 2015. The report did identify potential impact to a drought situation, including the densely wooded areas within the County's boundaries, and the potential for adverse economic impact with respect to shellfish harvesting, the fishing industry, recreational/tourism industry, and the increased fire danger experienced during drought conditions. The planning team therefore elected to address Drought in this update.

The Planning Team also reviewed the Tsunami hazard for consideration in this update, but elected to not do so. This decision was reached, in part, on the fact that there are currently no scenarios available on which to run analysis to determine vulnerability. However, with the inclusion of Tsunami in the newly-released Hazus model, it was suggested that this hazard be again reviewed during the next update cycle. It is hoped that developers will create a scenario on which potential impact can be determined. In the interim, review of FEMA's Risk Map data indicates that based on a M9.0 Cascadia Earthquake Scenario, FEMA and Washington State DNR estimate that a tsunami would arrive at Mason County approximately three (3) hours after the triggering incident, creating a 5-6-foot wave height, impacting Lynch Cove.

The Volcano hazard was also discussed, but the County had little historic impact from previous occurrences, and therefore the hazard was also tabled during this update, but will again be reviewed for inclusion in future updates.

The planning team further reviewed the hazards considered during the 2004 and 2010 plan update. Based on the review, the planning team, at its April 26, 2017 meeting, confirmed the following natural hazards that this plan addresses as the hazards of concern:

- Climate Change (New with qualitative assessment)
- Drought (New)
- Earthquake (Expanded to include scenario and probabilistic events)
- Flood (Expanded to include identification of dams)
- Landslide (Expanded to include updated DNR data)
- Severe Weather (Expanded to include additional related hazard types)
- Wildfire (Expanded with new risk assessment)

This is a change from the previous plan editions. Three new hazards are included—Climate Change, Drought, and Wildfire, as well as a more detailed identification and review of dam failure. The 2010 one-page review on terrorism was removed.

The hazard profiles describe the risks associated with identified hazards of concern. Each chapter describes the hazard, the planning area's vulnerabilities, and, when possible, probable event scenarios. The following steps were used to define the risk of each hazard:

Identify and profile the following information for each hazard:

- General overview and description of hazard;

[4] Washington State Department of Ecology 2014-2015 Drought: Groundwater Level/Storage Response. http://waecy.maps.arcgis.com/apps/MapSeries/index.html?appid=b64d6f24e4894b878e47a209020b73a9

- Identification of previous occurrences;
- Geographic areas most affected by the hazard;
- Event frequency estimates;
- Severity estimates;
- Warning time likely to be available for response;
- Risk and vulnerability assessment, which includes identification of impact on people, property, economy, and the environment.

4.2.2 Risk Assessment Process and Tools

The hazard profiles and risk assessments contained in the hazard chapters describe the risks associated with each identified hazard of concern. Each chapter describes the hazard, the planning area's vulnerabilities, and probable event scenarios.

Once the profiles identified above were completed, the following steps were used to define the risk of each hazard:

- Determine exposure to each hazard—Exposure was determined by overlaying hazard maps with an inventory of structures, facilities, and systems to determine which of them would be exposed to each hazard.
- Assess the vulnerability of exposed facilities—Vulnerability of exposed structures and infrastructure was determined by interpreting the probability of occurrence of each event and assessing structures, facilities, and systems that are exposed to each hazard. Tools such as GIS and Hazus (discussed below) were used in this assessment.
- Where specific quantitative assessments could not be completed, vulnerability was measured in general, qualitative term, summarizing the potential impact based on past occurrences, spatial extent, and subjective damage and casualty potential. Those items were categorized utilizing the criteria established in the CPRI index.
- The final step in the process was to determine the cumulative results of vulnerability based on the risk assessment and Calculated Priority Risk Index (discussed below) scoring, assigning a final qualitative assessment based on the following classifications:
  - Extremely Low—The occurrence and potential cost of damage to life and property is very minimal to nonexistent.
  - Low—Minimal potential impact. The occurrence and potential cost of damage to life and property is minimal.
  - Medium—Moderate potential impact. This ranking carries a moderate threat level to the general population and/or built environment. Here the potential damage is more isolated and less costly than a more widespread disaster.
  - High—Widespread potential impact. This ranking carries a high threat to the general population and/or built environment. The potential for damage is widespread. Hazards in this category may have occurred in the past.
  - Extremely High—Very widespread with catastrophic impact.

4.2.3 Hazus and GIS Applications

Earthquake and Flood Modeling Overview

In 1997, FEMA developed the standardized Hazards U.S., or Hazus, model to estimate losses caused by earthquakes and identify areas that face the highest risk and potential for loss. Hazus was later expanded into a multi-hazard methodology, Hazus-MH, with new models for estimating potential losses from hurricanes and floods. The most recent model, Hazus 4.0, now allows for Tsunami modeling, although no scenario exists for Mason County, and impact is currently believed to be minimal. As Hazus 4.0 was released after the planning process and analysis was already underway, Hazus 3.2 was utilized in this assessment. In addition, FEMA's on-going Risk Map project which was completed for the County also utilized 3.2. To remain consistent, the County elected to use the same modeling software unless otherwise indicated.

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 facility, transportation and utility lifeline, and multiple models to estimate potential losses from natural disasters. The program maps and displays hazard data and the results of damage and economic loss estimates for buildings and infrastructure. Its advantages include the following:

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

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.

Building Inventory

A User Defined Facilities (UDFs) approach was used to model exposure and vulnerability. GIS building data utilizing detailed structure information for facilities was loaded into the GIS and Hazus model. Building information was developed using best available Assessor's data, including building address points, aerial imagery, and staff resources. Building and content replacement values were estimated using values from the Assessor's data base, data from within the previous hazard mitigation plan, insurance policy data, and national replacement cost estimating guides as appropriate. Emphasis was put on developing the most accurate representation of buildings using best available resources. Building inventory included in excess of 30,000 structures, inclusive of general building stock and critical infrastructure.

During the development of this plan, FEMA's RiskMap Program was concurrently developing new NFIP Flood Maps for the County. The process utilized by FEMA closely mirrored the process utilized by the County during this plan update with respect to the UDF update; therefore, FEMA provided data sets to the County which served as the base for portions of the risk analysis, as identified within the hazard profiles. Specific processes followed for FEMA data should be gained from review of FEMA Region X's 2017 Risk Report for Mason County, available from Mason County Emergency Management, or FEMA Region X.

Hazus Application for this Plan

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

- **Flood**—A Hazus Level 2 analysis was performed. Analysis was based on current FEMA regulatory 100- and 500-year flood hazard data based on the 2017 Flood Study.
- **Earthquake**—A Hazus Level 2 Hazus analysis was performed to assess earthquake risk and exposure. Earthquake shake maps and probabilistic data prepared by the U.S. Geological Survey (USGS) were used for the analysis of this hazard. A modified version of the National Earthquake Hazard Reduction Program (NEHRP) soils inventory was used. The three scenario-based shake map events utilized were Cascadia, Nisqually, and Canyon River.

  In addition, FEMA's Risk Report also identifies the Earthquake Design Code. Based on that, the following codes were used in the UDF database and Hazus earthquake analysis. Pre-code is any building built prior to 1941. Moderate code is any building built post-1941. These values are the Hazus defaults. The dates differ for the building code analysis since additional research was done to understand the building codes in Washington. An additional Hazus analysis will have to be completed to incorporate updated pre-code for structures prior to 1975 and moderate code for structures after 1975, which will result in higher damages for those buildings that are between 1941 and 1975.

GIS Application for this Plan

Drought, Dam, Landslide, Severe Weather, and Wildfire - For drought, dam, landslide, severe weather, and wildfire, historical data is not adequate to model future losses as no specific damage functions have been developed. However, GIS is able to map hazard areas and calculate exposure if geographic information is available with respect to the location of the hazard and inventory data. Areas and inventory susceptible to some of the hazards of concern were mapped and exposure was evaluated. For other hazards, a qualitative analysis was conducted using the best available data and professional judgment. Locally relevant information was gathered from a variety of sources. Frequency and severity indicators include past events and the expert opinions of geologists, tribal staff, emergency management personnel and others. The primary data source was Mason County GIS data, augmented with state and federal data sets, including FEMA's RiskMap data. Additional data sources for specific hazards were as follows:

- **Drought**—The risk assessment methodologies used for this plan focus on damage to structures. Because drought does not impact structures, the risk assessment for drought was limited to a qualitative assessment.
- **Dam Failure**—Inundation data was unavailable for the high- or medium-hazard dams in the County. Therefore, available dam data was used only to identify the location and hazard classification of dams located within the planning area.
- **Landslide**—Historic landslide hazard data was used to assess exposure to landslides using Washington DNR 2016 Landslide Susceptibility data. This data depicts landslide susceptibility at a 10-meter resolution, across the state of Washington. Landslide exposure is illustrated based on the number of structures which intersect a slope greater than or equal to 40 percent (or =/>21.8 degree).
- **Severe Weather**—Severe weather data was downloaded from the Natural Resources Conservation Service and the National Climatic Data Center, as well as PRISM Precipitation, Average Low, and Average High data.
- **Wildfire—**Information on wildfire analysis was captured from various sources, including Washington DNR Wildfire History data, Wildfire Protection data, US Forest Service data, LAND FIRE data, and Wildland Urban Interface Zone data, among other sources.

4.2.4 Calculated Priority Risk Index Scoring Criteria

Vulnerabilities are described in terms of critical facilities, structures, population, economic values, and functionality of government which can be affected by the hazard event. Hazard impact areas describe the geographic extent a hazard can impact a jurisdiction and are uniquely defined on a hazard-by-hazard basis. Mapping of the hazards, where spatial differences exist, allows for hazard analysis by geographic location. Some hazards can have varying levels of risk based on location. Other hazards cover larger geographic areas and affect the area uniformly. Therefore, a system must be established which addresses all elements (people, property, economy, continuity of government) in order to rate each hazard consistently. The use of the Calculated Priority Risk Index allows such application, based on established criteria of application to determine the risk factor. For identification purposes, the six criteria on which the CPRI is based are probability, magnitude, geographic extent and location, warning time/speed of onset, and duration of the event. Those elements are further defined as follows:

Probability

Probability of a hazard event occurring in the future was assessed based on hazard frequency over a 100-year period (where available). Hazard frequency was based on the number of times the hazard event occurred divided by the period of record. If the hazard lacked a definitive historical record, the probability was assessed qualitatively based on regional history and other contributing factors. Probability of occurrence was assigned a 40% weighting factor, and was broken down as follows:

Rating	Likelihood	Frequency of Occurrence
1	Unlikely	Less than 1% probability in the next 100 years.
2	Possible	Between 1% and 10% probability in the next year, or at least one chance in the next 100 years.
3	Likely	Between 10% and 100% probability in next year, or at least one chance in the next 10 years.
4	Highly Likely	Greater than 1 event per year (frequency greater than 1).

Magnitude

The magnitude of potential hazard events was evaluated for each hazard. Magnitude is a measure of the strength of a hazard event, usually determined using specific technical measures. Magnitude was calculated for each hazard where property damage data was available, and was assigned a 25% weighting factor. (Magnitude calculation was determined using the following mathematical equation: *(Property Damage / Number of Incidents) / $ of Building Stock Exposure = Magnitude.)* Magnitude was broken down as follows:

Rating	Magnitude	Percentage of People and Property Affected
1	Negligible	Less than 5% Very minor impact to people, property, economy, and continuity of government at 90%.
2	Limited	6% to 24% Injuries or illnesses minor in nature, with only slight property damage and minimal loss associated with economic impact; continuity of government only slightly impacted, with 80% functionality.
3	Critical	25% to 49% Injuries result in some permanent disability; 25-49% of population impacted; moderate property damage ; moderate impact to economy, with loss of revenue and facility impact; government at 50% operational capacity with service disruption more than one week, but less than a month.
4	Catastrophic	More than 50% Injuries and illness resulting in permanent disability and death to more than 50% of the population; severe property damage greater than 50%; economy significantly impacted as a result of loss of buildings, content, inventory; government significantly impacted; limited services provided, with disruption anticipated to last beyond one month.

Extent and Location

The measure of the percentage of the people and property within the planning area impacted by the event, and the extent (degree) to which they are impacted. Extent and location was assigned a weighting factor of 20%, and broken down as follows:

Rating	Magnitude	Percentage of People and Property Affected
1	Negligible	Less than 10% Few if any injuries or illness. Minor quality of life lost with little or no property damage. Brief interruption of essential facilities and services for less than four hours.
2	Limited	10% to 24% Minor injuries and illness. Minor, short term property damage that does not threaten structural stability. Shutdown of essential facilities and services for 4 to 24 hours.
3	Critical	25% to 49% Serious injury and illness. Major or long-term property damage, that threatens structural stability. Shutdown of essential facilities and services for 24 to 72 hours.
4	Catastrophic	More than 50% Multiple deaths Property destroyed or damaged beyond repair Complete shutdown of essential facilities and services for 3 days or more.

Warning Time/Speed of Onset

The rate at which a hazard occurs, or the time provided in advance of a situation occurring (e.g., notice of a cold front approaching or a potential hurricane, etc.) provides the time necessary to prepare for such an event. Sudden-impact hazards with no advanced warning are of greater concern. Warning Time/Speed of onset was assigned a 10% weighting factor, and broken down as follows:

Rating	Probable amount of warning time
1	More than 24 hours warning time.
2	12-24 hours warning time.
3	5-12 hours warning time.
4	Minimal or no warning time.

Duration

The time span associated with an event was also considered, the concept being the longer an event occurs, the greater the threat or potential for injuries and damages. Duration was assigned a weighting factor of 5%, and was broken down as follows:

Rating	Duration of Event
1	6-24 hours
2	More than 24 hours
3	Less than 1 week
4	More than 1 week

Chapter 12 summarizes all of the analysis conducted by way of completion of the Calculated Priority Risk Index (CPRI) for hazard ranking.

4.3 PROBABILITY OF OCCURRENCE AND RETURN INTERVALS

Natural hazard events with relatively long return periods, such as a 100-year flood or a 500- or 1,000-year earthquake, are often thought to be very unlikely. In reality, the probability that such events occur over the next 30 or 50 years is relatively high, having significant probabilities of occurring during the lifetime of a building:

- Hazard events with return periods of 100 years have probabilities of occurring in the next 30 or 50 years of about 26 percent and about 40 percent, respectively.
- Hazard events with return periods of 500 years have about a 6 percent and about a 10 percent chance of occurring over the next 30 or 50 years, respectively.
- Hazard events with return periods of 1,000 years have about a 3 percent chance and about a 5 percent chance of occurring over the next 30 or 50 years, respectively.

For life safety considerations, even natural hazard events with return periods of more than 1,000 years are often deemed significant if the consequences of the event happening are very severe (extremely high damage and/or substantial loss of life). For example, the seismic design requirements for new construction are based on the level of ground shaking with a return period of 2,475 years (2 percent probability in 50 years). Providing life safety for this level of ground shaking is deemed necessary for seismic design of new buildings to minimize life safety risk. Of course, a hazard event with a relatively long return period may occur tomorrow, next year, or within a few years. Return periods of 100 years, 500 years, or 1,000 years mean that such events have a 1 percent, a 0.2 percent or a 0.1 percent chance of occurring in any given year.

4.4 COMMUNITY VARIATIONS TO THE RISK ASSESSMENT

Each planning partner within their respect annex describes where or how their risk varies from what is described in the hazard profiles and risk ranking. Variations are documented in the risk assessment section in their annex to the plan, if appropriate. In some instances, declared disaster events may not have impacted a specific jurisdiction or entity. Similarly, there may have been incidents of significance which did not rise to a level of a disaster declaration, but were nonetheless significant to the jurisdiction or entity. As such, those differences are noted where applicable.

4.5 LIMITATIONS

The models and information presented in this document does not replace or supersede any official document or product generated to meet the requirements of any state, federal, or local program, which may be much more detailed and encompassing beyond the scope of this project. This document is intended for planning purposes only. This document and its contents have been prepared and are intended solely for Mason County and its planning partners' information and use with respect to hazard mitigation planning, incorporating other relevant data into other planning mechanisms as appropriate. While this process utilized best available science and scientific data, the planning team, consultant, nor any of the planning partners conducted any scientific analysis within this document, and none should be construed. Our process only reproduced existing data in different ways to meet the guidelines and requirements of 33 CFR 201.6. All data layers utilized are identified within the various sections of this document should reviewers wish greater clarification and information.

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

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

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

Some assumptions were made by the planning partnership in an effort to capture as much data as necessary to supplant any significant data gaps. One example of this is the valuation for structures within the assessed data, most commonly as it relates to the general building stock. For structures for which data was not provided, the missing information was determined using averages of similar types of structures, determining square footage and applying a multiplier. This process is identified in the Hazus User's Guide.

Some hazards, such as earthquake, are pre-loaded with scientifically determined scenarios which are used during the modeling process. This does not allow for manipulation of the data as with other hazards, such as flood. In the case of earthquake, greater reliance existed on the use of the Hazus default data, which is known to be less accurate, most often causing higher loss values. Therefore, while loss estimates are provided, they should be viewed with this flaw in mind. A much more in-depth scientific analysis is necessary to rely on this type of data with a high degree of accuracy. Readers should view this document as a baseline or starting point, and information should be further studied and analyzed by scientists and other subject matter experts in specific hazard fields.

CHAPTER 5.
CLIMATE CHANGE

5.1 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 more than 1.4ºF over the last 100 years (NRC, 2010). 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, and changes in land use. According to the U.S. Environmental Protection Agency (EPA), carbon dioxide concentrations measured about 280 parts per million (ppm) before the industrial era began in the late 1700s and have risen 41 percent since then, reaching 394 ppm in 2012 (see Figure 5-1). The EPA attributes almost all of this increase to human activities (U.S. EPA, 2013f).

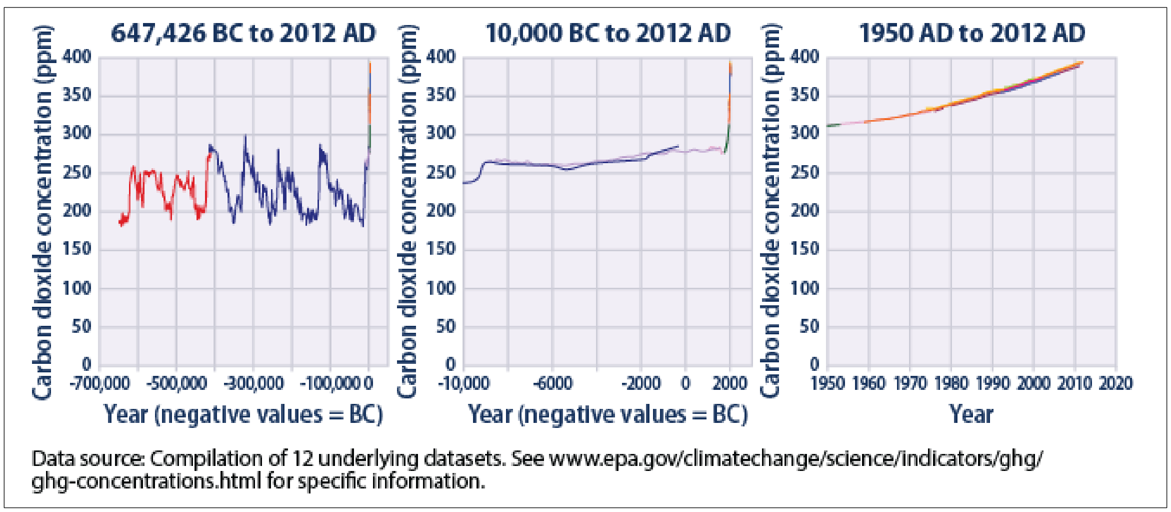


Figure 5-1 Global Carbon Dioxide Concentrations Over Time

Climate change will affect the people, property, economy, and ecosystems of Mason County in a variety of ways. Some impacts will have negative consequences for the region and others 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.

5.2 HOW CLIMATE CHANGE AFFECTS HAZARD MITIGATION

An essential aspect of hazard mitigation is predicting the likelihood of hazard events in a planning area. 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 five years for the past 100 years, then it can be expected to continue to flood an average of once every five 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. The risks of avalanche, landslide, severe weather, severe winter weather 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 to provide a context for the recommendation and implementation of hazard mitigation measures.

Table 5-1 identifies the relationship between climate change risk and its influence on the various hazards of concern within the planning region. When reviewing the Table, the downward leftmost column identifies the climate risks. Column headings across the table identify the natural hazards identified in the County's Plan. Cells with an X or P show which climate risks will affect the frequency, intensity, magnitude, or duration of each natural hazards. The "P" identifies the primary relationship between the risk and the identified hazard. The "X" identifies a secondary relationship. The blue cells in the body of the table show where climate change risk and a natural hazard are essentially the same thing. The first two highlighted risks rows—increased temperatures and changes in hydrology—are two of the primary climate drivers for many of the natural hazards. The other climate risks represent known environmental or ecosystem responses to one or both of the primary drivers. With respect to Volcanic activity, the impact from climate change on a volcano is unknown; however, volcanic activity itself can influence climate change with respect to absorption of terrestrial radiation by volcanic clouds, lowering temperatures in the lower atmosphere and changing atmospheric circulation patterns.

Table 5-1
Relationship Between Climate Change and Identified County Hazards

CLIMATE RISKS	Coastal Erosion	Drought	Earthquake	Flood	Landslide	Severe Weather			Wildfire	Tsunami	Volcano*
						Cold	Heat	Winter storms			
Increased temperatures	X	P		X	X	X	X	X	P		
Changes in Hydrology	X	P	X	P	P			X	X	X	
Increased Wildfires		X		X	X				P		
Increase in ocean temperatures and changes in ocean chemistry	P			X				P			
Increased Drought		P									

Table 5-1
Relationship Between Climate Change and Identified County Hazards

						Severe Weather					
CLIMATE RISKS	Coastal Erosion	Drought	Earthquake	Flood	Landslide	Cold	Heat	Winter storms	Wildfire	Tsunami	Volcano*
Increased Costal Erosion	P									X	
Changes in habitat	X	X		X	X				X		
Increase in Invasive Species and Pests		X		X	X		X		P		
Decrease in natural vegetation	X	X		P	P	X		X	P		
Loss of Wetland ecosystems and services	X	P		P	X				X		
Increased frequency of extreme precipitation events and flooding				P	P			X			
Increased Landslides	X	X		X	P			X	X		

5.3 CURRENT INDICATIONS OF CLIMATE CHANGE

5.3.1 Global Indicators

The major scientific agencies of the United States—including the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA)—agree that climate change is occurring (NOAA Technical Report, 2012; U.S. EPA, 2013). Multiple temperature records from all over the world have shown a warming trend (U.S. EPA, 2011). According to NOAA, the decade from 2000 to 2010 was the warmest on record, and 2010 was tied with 2005 as the warmest year on record (NOAA, 2011). Worldwide, average temperatures have increased more than 1.4ºF over the last 100 years (NRC, 2010). Many of the extreme precipitation and heat events of recent years are consistent with projections based on that amount of warming (USGCRP, 2009).

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. 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 (U.S. EPA, 2010). Global sea level has risen approximately nine (9) inches, on average, in the last 140 years (U.S. EPA, 2010). This has already put some coastal homes, beaches, roads, bridges, and wildlife at risk (USGCRP, 2009).

For our coastal communities, this has, and will continue, to exacerbate erosion issues to levels not previously seen.

5.4 PROJECTED FUTURE IMPACTS

5.4.1 Global Projections

Scientists project that Earth's average temperatures will rise between 2ºF and 12ºF by 2100 (NRC, 2011a). Some research has concluded that every increase of 2ºF in average global average temperature can have the following impacts (NRC, 2011b):

- 3 to 10 percent increases in the amount of rain falling during the heaviest precipitation events, which can increase flooding risks
- 200 to 400 percent increases in the area burned by wildfire in parts of the western United States
- 5 to 10 percent decreases in stream flow in some river basins
- 5 to 15 percent reductions in the yields of crops as currently grown.

The amount of sea level rise (SLR) expected to occur as a result of climate change will increase the risk of coastal flooding for millions to hundreds of millions of people around the world, many of whom would have to permanently leave their homes (IPCC, 2007). While no widely accepted method is currently available for producing probabilistic projects of sea level rise at actionable scales (i.e. regional and local), a 2012 NOAA study identified advancements in satellite measurements indicating ice sheet loss as a greater contributor to global SLR than thermal expansion over the period of 1993-2008 (NOAA, 2012).

According to the 2012 report, review of historical SLR rate derived from tide gauge records beginning in 1900, global sea level has risen 0.2 meters (8 inches). By 2100, sea level is expected to rise another 1.5 to 3 feet (NRC, 2011b). There is a highly significant correlation between observations of global mean SLR and increasing global mean temperature, and the IPCC and more recent studies anticipate that global mean sea level will continue to rise even if warming ceases. As such, continually rising seas will make coastal storms and the associated storm surges more frequent and destructive. What is currently termed a once-in-a-century coastal flooding event could occur as frequently as once per decade (USGCRP, 2009).

5.4.2 Projections for Washington State

The Climate Impacts Group (CIG, 2009) at the University of Washington used multiple climate models to evaluate potential climate change in Washington State and the Pacific Northwest region. Likewise, NOAA (2012) also completed various studies and technical reports. The following are key findings of those studies that are relevant for hazard mitigation planning:

- Climate models project increases in annual temperature (compared to 1970 – 1999 and averaged across all models) of 2.0°F by the 2020s, 3.2°F by the 2040s, and 5.3°F by the 2080s.
- Projected changes in annual precipitation, averaged over all models, are small (+1 to +2 percent), but some models project an enhanced seasonal precipitation cycle with changes toward wetter autumns and winters and drier summers.
- Regional climate models generally predict increases in extreme high precipitation over the next half-century, particularly around Puget Sound.
- April 1 snowpack is projected to decrease (compared with the 1916 – 2006 historical average) by 28 percent across the state by the 2020s, 40 percent by the 2040s, and 59 percent by the 2080s.
- Due to increased summer temperature and decreased summer precipitation, the area burned by fire in the U.S. portion of the Columbia River basin is projected to double by the 2040s and triple by the 2080s. The probability that more than 2 million acres in that area will burn in a given year is projected to increase from 5 percent today to 33 percent by the 2080s.

- Projected warming would likely result in 101 additional deaths during heat events in the greater Seattle area among persons 45 and older in 2025 and 156 additional deaths in 2045.

5.5 RESPONSES TO CLIMATE CHANGE

5.5.1 Mitigation and Adaptation

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 (CEQ, 1978).
- 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 (U.S. EPA, 2013g).
- Mitigation in emergency management is typically defined as the effort to reduce loss of life and property by lessening the impact of disasters (FEMA, 2013).

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.

Adaptation refers to adjustments in natural or human systems in response to the actual or anticipated effects of climate change and associated impacts. These adjustments may moderate harm or exploit beneficial opportunities (U.S. EPA, 2013g).

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 initiatives and actions can both reduce greenhouse gas emissions and support adaptation to likely future conditions. Likewise, assessing mitigation efforts to include impact from climate change is a logical approach to enhance resilience of a community.

Societies across the world are facing the need to adapt to changing conditions associated with natural disasters and climate change. 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.

Most ecosystems show a remarkable ability 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.

5.5.2 Response To Climate Change in the Northwest

The State of Washington has adopted greenhouse gas reduction requirements that aim to reduce emissions to 1990 levels by 2020, to 25 percent below 1990 levels by 2035 and to 50 percent below 1990 levels by 2050 (RCW 47.01.440). Scientists have known for more than a decade that carbon pollution is the primary cause of climate change. Recognizing the need to take action, in 2015 Gov. Jay Inslee directed Ecology to cap and reduce carbon pollution under Washington's Clean Air Act. Under the new rule, businesses that are responsible for 100,000 metric tons of carbon pollution annually will be required to cap and then gradually reduce their emissions. Natural gas distributors, petroleum fuel producers and importers, power plants, metal manufacturers, waste facilities, and state and federal facilities need to show their emissions are declining by an average of 1.7 percent a year starting in 2017.[5]

Within Mason County, the PUDs serve approximately 40% of Washington State's electric needs, yet emit only 3% of the reported total greenhouse gas emissions in the state as a result of the PUDs' clean energy portfolios. In addition, the critical areas ordinance within Mason County specifically identifies areas which are to be left undeveloped, as open space to help ensure that water levels which will increase as a result of climate change are managed in ways which have less negative impact and help sustain and support the natural environment.

5.6 POTENTIAL CLIMATE CHANGE IMPACT ON HAZARDS

An understanding of the basic features of climate change allows for a qualitative assessments of impacts on hazards of concern addressed in this hazard mitigation plan. This overview serves as a basis for evaluating how risk will change as a result of future climate change impacts. The vulnerabilities identified in this plan update will ultimately be used to inform other aspects of emergency management planning, such as the Comprehensive Emergency Management Plan.

5.6.1 Avalanche

Snow avalanches are rarely used as indicators of climate change. The effects of climate change on avalanche frequency and magnitude are uncertain and will likely be dependent on local climate change impacts, such as changes in snowfall events and temperature series. Some studies have indicated that the types of avalanche events (wet or dry) may shift as a result of changes in snow cover (Martin et al., 2001). Avalanches, however, are not influenced by snow cover alone, but by several interrelated factors including forest structure, surface energy balance, melt water routing, precipitation, air temperature and wind (Teich et al., 2012; Lazar and Williams, 2008).

Secondary and tertiary impacts of climate change may also alter avalanche events. For example, climate change may modify the distribution of tree species across mountain landscapes. Some case studies in the Swiss and French Alps indicate that climate change impacts may reduce the frequency or severity of such events, while other assessments indicate that events may occur more frequently in other mountain regions (Kohler, 2009; Teich et al. 2012). No studies assessing the relative frequency and severity of avalanches in the Cascade Range were located, but an analysis of wet avalanche hazards in an Aspen ski area indicated that such effects may occur more frequently under high-emission scenarios (Lazar and Williams, 2008). Feedback loops affecting snow cover, forest structure, meteorological averages, and land use planning decisions are all likely to influence the future frequency and severity of impacts from avalanche events.

[5] Mason WebTV http://masonwebtv.com/archives/21930

5.6.2 Dam Failure

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

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

5.6.3 Earthquake

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

Secondary impacts of earthquakes could be magnified by climate change. Soils saturated by repetitive storms could experience liquefaction 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. There are currently no models available to estimate these impacts.

5.6.4 Flood

According to University of Washington scientists, global climate changes resulting in warmer, wetter winters are projected to increase flooding frequency in most Western Washington river basins. Future floods are expected to exceed the capacity and protective abilities of existing flood protection facilities, threatening lives, property, major transportation corridors, communities, and regional economic centers.

Changes in Hydrology

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

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

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

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

Sea Level Rise

Sea level and temperature are interrelated (U.S. EPA, 2013e). Warmer temperatures result in the melting of glaciers and ice sheets. This melting means that less water is stored on land and, thus, there is a greater volume of water in the oceans. Water also expands as it warms, and the heat content of the world's oceans has been increasing over the last several decades. According to the EPA, there is likely to be 13 inches of sea level rise in the Puget Sound basin by 2100. According to the Washington State Department of Ecology the impacts of sea level rise could include the following: increased coastal community flooding, coastal erosion and landslides, seawater well intrusion, acidification of waters, and lost wetlands and estuaries (see Figure 5-2).

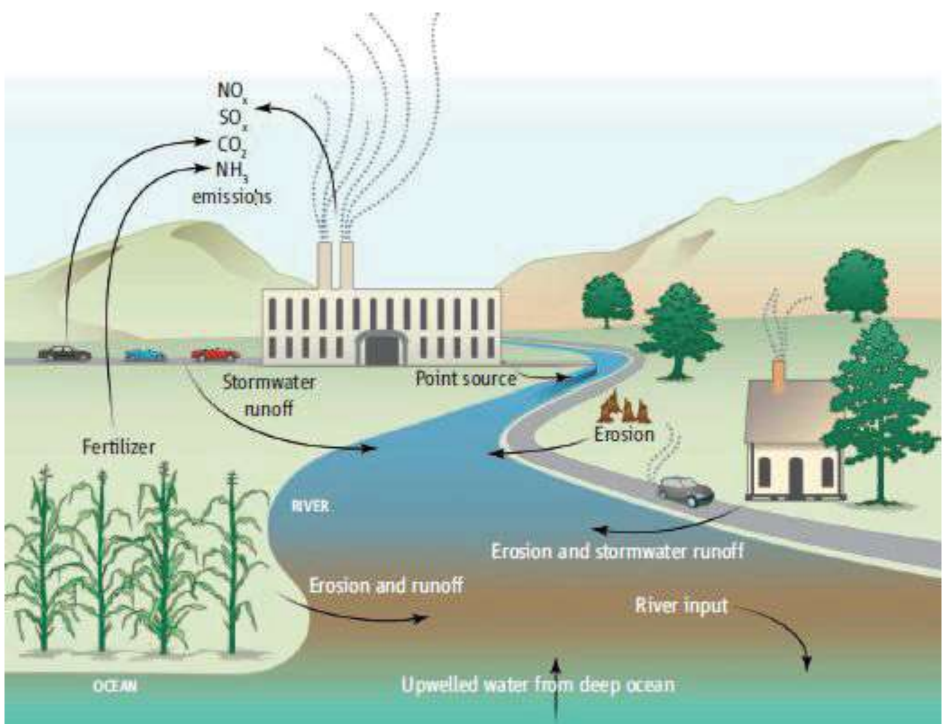


Figure 5-2 Contributors to acidification

5.6.5 Landslide

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

5.6.6 Severe Weather

Climate change presents a challenge for risk management associated with severe weather. The frequency of severe weather events has increased steadily over the last century. The number of weather-related disasters during the 1990s was four times that of the 1950s, and cost 14 times as much in economic losses. Historical data shows that the probability for severe weather events increases in a warmer climate (see Figure 7-2). According to the EPA, "Since 1901, the average surface temperature across the contiguous 48 states has risen at an average rate of 0.14°F per decade. Average temperatures have risen more quickly since the late 1970s (0.36 to 0.55°F per decade). Seven of the top 10 warmest years on record for the contiguous 48 states have occurred since 1998, and 2012 was the warmest year on record (U.S. EPA, 2013b)." This increase in average surface temperatures can also lead to more intense heat waves that can be exacerbated in urbanized areas by what is known as urban heat island effect. Additionally, the changing hydrograph caused by climate change could have a significant impact on the intensity, duration, and frequency of storm events. All of these impacts could have significant economic consequences.

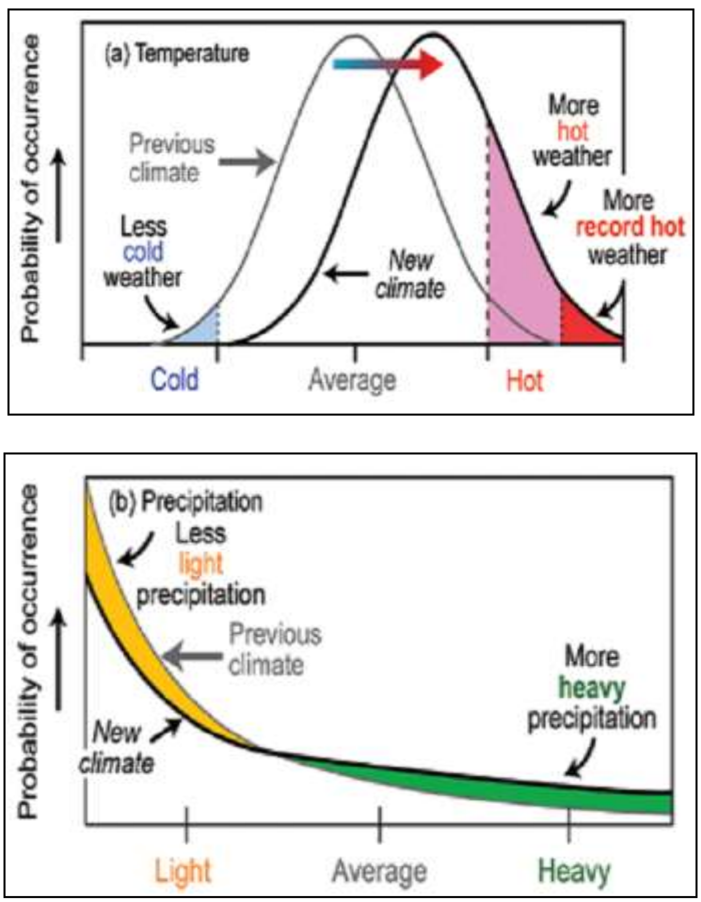


Figure 5-3 Severe Weather Probabilities in Warmer Climates

5.6.7 Severe Winter Weather

One impact of climate change is an increase in average ambient temperatures. Since the 1980s, unusually cold temperatures have become less common in the contiguous 48 states (U.S. EPA, 2013c). This trend is expected to continue, and the frequency of winter cold spells will likely decrease.

As ambient temperatures increase, more water evaporates from land and water sources. The timing, frequency, duration, and type of precipitation events will be affected by these changes. In general, more precipitation will fall as rain rather than snow; however, the amount of snowfall may increase where temperatures remain below freezing (U.S. EPA, 2013d). Snowfall may also change if typical storm track patterns are altered. Snowfall is already changing in the United States. According to the EPA (see Figure 7-3; U.S. EPA, 2013d):

- Total snowfall has decreased in most parts of the country since widespread observations became available in 1930, with 57 percent of stations showing a decline.
- More than three-fourths of the stations across the contiguous 48 states have experienced a decrease in the proportion of precipitation falling as snow.
- Snowfall trends vary by region. The Pacific Northwest has seen a decline in both total snowfall and the proportion of precipitation falling as snow.[6]

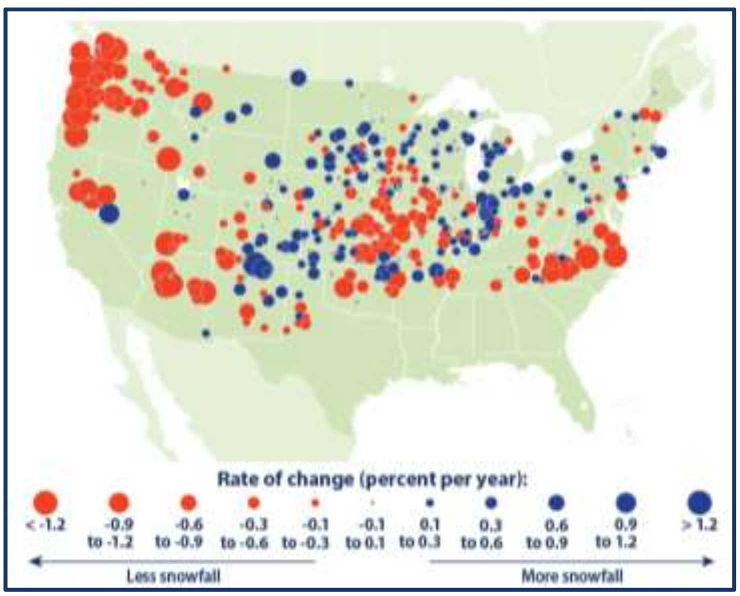


Figure 5-4 Change in Snowfall, 1930-2007

From 1950 to 2000, snowpack has declined in most of the western United States, compared to historical averages. Western Washington, western Oregon and northern California have seen the greatest declines (U.S. EPA, 2013d). These changes will impact ecosystems, recreation opportunities, the hydroelectric power supply, and drinking water systems. The timing and magnitude of flooding may also be impacted by

[6] https://www.epa.gov/climate-indicators/climate-change-indicators-snowfall

changes in the region's hydrograph, due to a greater percentage of precipitation falling as rain and earlier spring melt times.[7]

5.6.8 Tsunami

The impacts of climate change on the frequency and severity of tsunami events could be significant in regions with vulnerable coastline. Global sea-level rise will affect all coastal societies, especially densely populated low-lying coastal areas. Sea level rise has two effects on low-lying coastal regions: any structures located below the new level of the sea will be flooded; and the rise in sea level may lead to coastal erosion that can further threaten coastal structures.

5.6.9 Volcano

While there are no volcanoes in Mason County, the accumulation of ash from an eruption could occur; however, significant impact is limited in probability and severity due to the westerly winds flowing on-shore which would push ash in a more easterly direction. Climate change is not likely to affect the risk associated with volcanoes; however, volcanic activity can affect climate change. Volcanic clouds absorb terrestrial radiation and scatter a significant amount of incoming solar radiation. By reducing the amount of solar radiation reaching the Earth's surface, large-scale volcanic eruptions can lower temperatures in the lower atmosphere and change atmospheric circulation patterns. The massive outpouring of gases and ash can influence climate patterns for years following a volcanic eruption.

5.6.10 Wildfire

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. Climate change also may increase winds that spread fires. Forest response to increased atmospheric carbon dioxide could contribute to more tree growth and thus more fuel for fires, although the effects of carbon dioxide on mature forests are still largely unknown. In turn, increased high-elevation wildfires could release stores of carbon and further contribute to the buildup of greenhouse gases.

The extent of area burned by wildfires each year appears to have increased since the 1980s. According to National Interagency Fire Center data, of the 10 years with the largest acreage burned, nine have occurred since 2000, including the peak year in 2015. This period coincides with many of the warmest years on record nationwide.[8]

Wildfire in western ecosystems is determined by climate variability, local topography, and human intervention. Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. Hot dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation. When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. Climate change also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods.

Historically, drought patterns in the West are related to large-scale climate patterns in the Pacific and Atlantic oceans. The El Niño–Southern Oscillation in the Pacific varies on a 5- to 7-year cycle, the Pacific

[7] https://www.epa.gov/climate-indicators

[8] https://www.epa.gov/climate-indicators/climate-change-indicators-wildfires Accessed 30 May 2017.

Decadal Oscillation varies on a 20- to 30-year cycle, and the Atlantic Multidecadal Oscillation varies on a 65- to 80-year cycle. As these large-scale ocean climate patterns vary in relation to each other, drought conditions in the U.S. shift from region to region. El Niño years bring drier conditions to the Pacific Northwest and more fires.

Climate scenarios project summer temperature increases between 2ºC and 5°C and precipitation decreases of up to 15 percent. Such conditions would exacerbate summer drought and further promote high-elevation wildfires, releasing stores of carbon, and further contributing to the buildup of greenhouse gases. Forest response to increased atmospheric carbon dioxide could also contribute to more tree growth and thus more fuel for fires, but the effects of carbon dioxide on mature forests are still largely unknown. High carbon dioxide levels should enhance tree recovery after fire and young forest regrowth, as long as sufficient nutrients and soil moisture are available, although the latter is in question for many parts of the western United States because of climate change.

5.7 MASON COUNTY IMPACT

According to the Mason County Shoreline Inventory and Characterization Report (2011), climate change is likely to have an impact on future water resources in the County. Over the next decades, increased regional temperatures are anticipated to lead to a reduction in snowpack and receding glaciers in the Olympic Mountains. Since many of the tributary streams in WRIA 16 and 22 depend upon snowmelt and glacier melt waters, these streams may be affected over time. Anticipated effects include decreased summer baseflows as snowpack and glaciers are reduced. Spring peak flows are also predicted to occur two to six weeks earlier than they do normally (CIG, 2009). Further, streams without snowmelt or headwaters in the mountains will also be affected (as in WRIA 14 and 15), perhaps more strongly, as streams currently have low in-stream flows.

Additionally, the communities in Mason County that are low-lying and located adjacent to South Puget Sound and Hood Canal could be affected by sea level rise. Sea levels in Puget Sound are projected to rise between 3.0 inches and 22.0 inches by Year 2050 (Mote, 2008). Sea level rise will allow high tides to reach farther into low-lying coastal areas and rise higher on existing flood control structures such as dikes and bulkheads. Coastal flooding will persist longer and could lead to faster rates of erosion on beaches and coastal bluffs (Shipman, 2009). Ecology has directed local governments to consider preparing for sea level rise during the Shoreline Master Program update process.

5.8 RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from Climate Change throughout the area is highly likely. While there are still many uncertainties associated with climate change, indicators of impact already exist. The area has previously experienced drought conditions, with a drought incident occurring only a short period ago (2015). As of this 2018 update, the State is experiencing one of its driest summers on record. With anticipated increase in temperatures as a result of climate change, drought situations will only intensify. The impact of Climate Change on Earthquake, while relatively unknown, could be exacerbated as a result of increased liquefaction, due to increased flooding issues. Anticipated sea level rise would impact the coastal areas of the County, increasing storm surge impact as well as increasing the potential for flooding in areas which customarily experienced no or limited flooding. Historical hydrologic patterns of weather events would become increasingly inaccurate, increasing potential vulnerability due to uncertainty for water supplies, flood management, and ecological functions. Increased temperatures would also impact snow levels, decreasing water supplies in the various watersheds, even those outside of the planning area. Higher temperatures anticipated with climate change would increase vulnerability of the population due to excessive heat. Based on the potential impact, the Planning Team determined the CPRI score to be 2.4, with overall vulnerability determined to be a medium level.

CHAPTER 6.
DROUGHT

6.1 GENERAL BACKGROUND

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

Droughts originate from a deficiency of precipitation resulting from an unusual weather pattern. If the weather pattern lasts a short time (a few weeks or a couple of 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.

Drought is a prolonged period of dryness severe enough to reduce soil moisture, water, and snow levels below the minimum necessary for sustaining plant, animal, and economic systems. Droughts are a natural part of the climate cycle. For this plan, the County has elected to use Washington's statutory definition of drought (RCW Chapter 43.83B.400), which is based on both of the following conditions occurring:

- The water supply for the area is below 75 percent of normal.
- Water uses and users in the area will likely incur undue hardships because of the water shortage.

6.2 HAZARD PROFILE

6.2.1 Extent and Location

Drought can have a widespread impact on the environment and the economy, depending upon its severity, although it typically does not result in loss of life or damage to property, as do other natural disasters. The National Drought Mitigation Center uses three categories to describe likely drought impacts:

- Agricultural—Drought threatens crops that rely on natural precipitation, while also increasing the potential for infestation.
- Water supply—Drought threatens supplies of water for irrigated crops, for communities and for fish and salmon and other species of wildlife.
- Fire hazard—Drought increases the threat of wildfires from dry conditions in forest and rangelands.

In Washington, where hydroelectric power plants generate nearly three-quarters of the electricity produced, drought also threatens the supply of electricity. Unlike most disasters, droughts normally occur slowly but last a long time. Drought conditions occur every few years in Washington. The droughts of 1977 and 2001 (discussed below), the worst and second worst in state history, provide good examples of how drought can affect the state.

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

Drought affects groundwater sources, but generally not as quickly as surface water supplies, although groundwater supplies generally take longer to recover. Reduced precipitation during a drought means that groundwater supplies are not replenished at a normal rate. This can lead to a reduction in groundwater levels and problems such as reduced pumping capacity or wells going dry. Shallow wells are more susceptible than deep wells. About 16,000 drinking water systems in Washington get water from the ground; these systems serve about 5.2 million people. Reduced replenishment of groundwater affects streams. Much of the flow in streams comes from groundwater, especially during the summer when there is less precipitation and after snowmelt ends. Reduced groundwater levels mean that even less water will enter streams when steam flows are lowest. Reduced water levels in wells also means that the wells are subject to saltwater intrusion.

Much of the area depends on well water, which currently supplies a large portion of Mason County residents with their drinking water. Drought conditions within the planning area increase pressure on local aquifers, with increased pumping potentially resulting in saltwater intrusion into freshwater aquifers. This, in turn, could cause restrictions on economic growth and development.

A 2015 Department of Ecology report completed, in part, as a result of the lower-than-normal water levels experienced in 2015 stated that on "the west side of the mountains, only two Ecology monitored wells (near Sequim) exhibited 2015 water levels that consistently fell below the wells normal water level range" (WA DOE, 2016). The report went on to state that "both wells have experienced significant on-going water level declines in recent years however, which suggests their lower than normal water levels this past year [2015] may not be drought related.

A drought directly or indirectly impacts all people in affected areas. A drought can result in farmers not being able to plant crops or the failure of planted crops. This results in loss of work for farm workers and those in related food processing jobs. Other water- or electricity-dependent industries are commonly forced to shut down all or a portion of their facilities, resulting in further layoffs. A drought can also harm recreational companies that use water (e.g., swimming pools, water parks, and river rafting companies) as well as landscape and nursery businesses because people will not invest in new plants if water is not available to sustain them. With much of Washington's energy coming from hydroelectric plants, a drought means less inexpensive electricity coming from dams and probably higher electric bills. All people would pay more for water if utilities increase their rates. This has become an issue within Washington State as a whole previously, when a lack of snow pack has decreased hydroelectric generating capacity, and raised the electric prices, impacting residents.

6.2.2 Previous Occurrences

In the past century, Washington has experienced a number of drought episodes, including several that lasted for more than a single season—1928 to 1932, 1992 to 1994, and 1996 to 1997. Table 6-1 identifies additional drought occurrences in the state. The 1977 drought was the worst on record, but the 2001 drought came close to surpassing it in some respects. Table 6-2 has data on how the two droughts affected Washington by late September of their respective years.

[9] Washington State Department of Ecology 2014-2015 Drought: Groundwater Level/Storage Response. http://waecy.maps.arcgis.com/apps/MapSeries/index.html?appid=b64d6f24e4894b878e47a209020b73a9

Table 6-1
Drought Occurrences

July-August 1902	No measurable rainfall in Western Washington
August 1919	Drought and hot weather occurred in Western Washington
July – August 1921	Drought in all agricultural sections.
June-August 1922	The statewide precipitation averaged 0.10 inches.
March – August 1924	Lack of soil moisture retarded germination of spring wheat.
July 1925	Drought occurred in Washington
July 21-August 25, 1926	Little or no rainfall was reported.
June 1928-March 1929	Most stations averaged less than 20 percent of normal rainfall for August and September and less than 60 percent for nine months.
July – August 1930	Drought affected the entire state. Most weather stations averaged 10 percent or less of normal precipitation.
April 1934-March 1937	The longest drought in the region's history – the driest periods were April-August 1934, September-December 1935, and July-January 1936-1937.
May – September 1938	Driest growing season in Western Washington.
1952	Every month was below normal precipitation except June. The hardest hit areas were Puget Sound and the central Cascades.
January – May 1964	Drought covered the southwestern part of the state. Precipitation was less than 40 percent of normal.
Spring 1966	Drought throughout Washington
June – August 1967	Drought throughout Washington
January – August 1973	Dry in the Cascades.
October 1976 – September 1977	Worst drought in Pacific Northwest history. Below normal precipitation in Olympia, Seattle, and Yakima. Crop yields were below normal and ski resorts closed for much of the 1976-77 season.
2001	Governor declared statewide Stage 2 drought in response to severe dry spell.
June – September 2003	Federal disaster number 1499 assigned to 15 counties. The original disaster was for flooding but several jurisdictions were included because of previous drought conditions.
March 10, 2005 Governor Declared Drought	Precipitation levels was below or much below the average from November through February, with extremely warm fall and winter months, adversely affecting the state's mountain snow pack. A warm mid-January removed much of the remaining snow pack, with March projections at 66 percent of normal, indicating that Washington might be facing a drought as bad as, or worse, than the 1977 drought. Late March rains filled reservoirs to about 95 percent. State legislature approved $12 million supplemental budget that provided funds to buy water, improve wells, and implement other emergency water supply projects. Wildfires numbers was about 75 percent of previous five years, but acreage burned was three times greater.

Table 6-1 **Drought Occurrences**	
2015	2015 was the year of the "snowpack drought." Washington State had normal or near-normal precipitation over the 2014-2015 winter season. However, October through March the average statewide temperature was 40.5 degrees Fahrenheit, 4.7 degrees above the 20th century long-term average and ranking as the warmest October through March on record. Washington experienced record low snowpack because mountain precipitation that normally fell as snow instead fell as rain. The snowpack deficit then was compounded as precipitation began to lag behind normal levels in early spring and into the summer. With record spring and summer temperatures, and little to no precipitation over many parts of the state, the snowpack drought morphed into a traditional precipitation drought, causing injury to crops and aquatic species. Many rivers and streams experienced record low flows. (See Figure 6-1.)

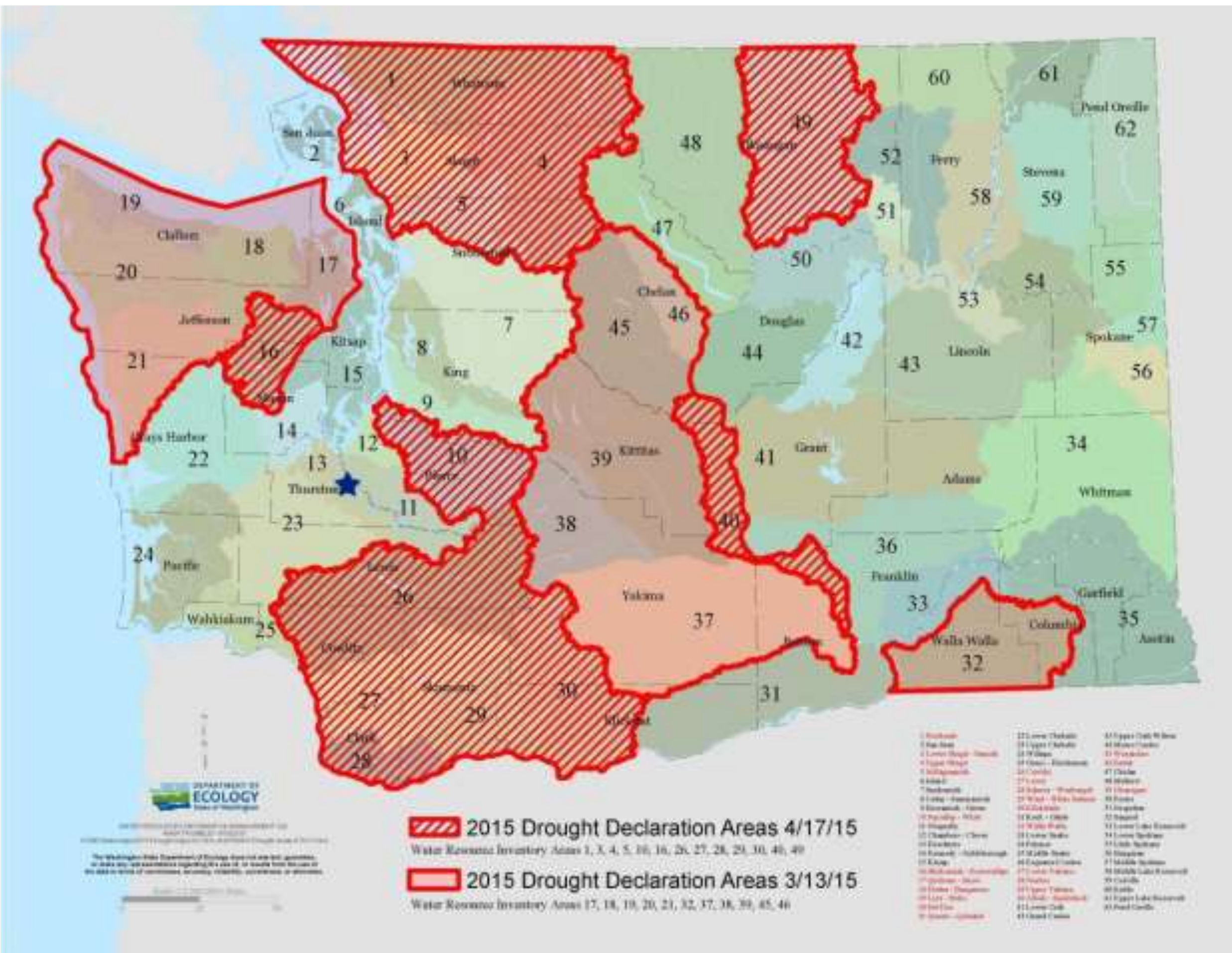


Figure 6-1 Washington State Department of Ecology 2015 Drought Map

Table 6-2 Comparison Of Impacts Of 1977 Drought To 2001 Drought		
Impact	1977 Drought	2001 Drought
Precipitation	Precipitation at most locations ranged from 50 to 75% of normal levels, and in parts of Eastern Washington as low as 42 to 45% of normal.	Precipitation was 56 to 74% of normal. U.S. Bureau of Reclamation – Yakima Project irrigators received only 37% of their normal entitlements. At the end of the irrigation season, the Bureau of Reclamation's five reservoirs stored only 50,000 acre-feet of water compared with 300,000 acre-feet typically in storage.
Wildland Fire	1,319 wildland fires burned 10,800 acres. State fire-fighting activities involved more than 7,000 man-hours and cost more than $1.5 million.	1,162 wildland fires burned 223,857 acres. Firefighting efforts cost the state $38 million and various local, regional, and federal agencies another $100 million.
Fish	In August and September 1977, water levels at the Goldendale and Spokane trout hatcheries were down. Fish had difficulties passing through Kendall Creek, a tributary to the north fork of the Nooksack River in Whatcom County.	A dozen state hatcheries took a series of drought-related measures, including installing equipment at North Toutle and Puyallup hatcheries to address low water flow problems.
Emergency Water Permits	Department of Ecology issued 517 temporary groundwater permits to help farmers and communities drill more wells.	Department of Ecology issued 172 temporary emergency water-right permits and changes to existing water rights.
Economic Impacts	The state's economy lost an estimated $410 million over a two-year period. The drought hit the aluminum industry hardest. Major losses in agriculture and service industries included a $5 million loss in the ski industry. 13,000 jobs were lost because of layoffs in the aluminum industry and in agriculture.	The Bonneville Power Administration paid more than $400 million to electricity-intensive industries to shut down and remain closed for the duration of the drought. Thousands lost their jobs for months, including 2,000-3,000 workers at the Kaiser and Vanalco plants. Federal agencies provided more than $10.1 million in disaster aid to growers. More than $7.9 million in state funds paid for drought-related projects; these projects enabled the state to provide irrigation water to farmers with junior water rights and to increase water in fish-bearing streams.

The County has the following information on drought issues, including years of low precipitation and snow pack, as well as sources of power, drinking water and the fishing industry:

- Three energy curtailments resulted from drought periods prior to 1977, which caused temporary unemployment within various industry sectors.
- In the summer of 2001, the governor declared a statewide Stage 2 drought in response to the worst dry spell since records began in 1929.

- In 2003, the state and county were in another drought when the county went for over 60 days without substantial rain. The Office of the State Climatologist stated that the summer of 2003 was the driest summer (at that time) since records were officially kept. Mason County was included in Presidential Disaster Declaration 1499.
- In March 2005, Washington Department of Ecology declared a statewide drought. The state legislature approved a $12 million supplemental budget request for buying water, improving wells, implementing other emergency water-supply projects, and hiring temporary state staff to respond to the drought emergency, conduct public workshops and undertake drought-related studies. In March, the water supply forecast was 66 percent of normal, signaling an extremely poor water year and a possible reduction in electricity production. By late spring, due to record precipitation in March and April, water filled reservoirs to about 95 percent of capacity, more than enough to meet projected electricity demands. Despite projected drought impacts of up to $300 million, unexpected spring rains combined with reallocation of water and conservation measures by farmers largely mitigated the drought's impacts. Harvest of most crops was near normal levels. While statewide harvests were near normal, local farmers who did not receive the spotty rains experienced poor harvests. Statewide, the number of wildfires was about 75 percent of average for the previous five years, but the acreage burned was three times greater. The largest – the School fire – burned 52,000 acres of state-protected lands, 109 homes and 106 other buildings, and cost more than $15 million to extinguish. The fire also destroyed half of the elk and bighorn sheep and a third of the deer in the Tucannon Game Management Unit.
- Unlike classic droughts, characterized by extended precipitation deficits, 2015 was the year of the "snowpack drought." Washington State had normal or near-normal precipitation over the 2014-2015 winter season. However, October through March the average statewide temperature was 40.5 degrees Fahrenheit, 4.7 degrees above the 20th century long-term average and ranking as the warmest October through March on record. Washington experienced record low snowpack because mountain precipitation that normally fell as snow instead fell as rain. The snowpack deficit then was compounded as precipitation began to lag behind normal levels in early spring and into the summer. With record spring and summer temperatures, and little to no precipitation over many parts of the state, the snowpack drought morphed into a traditional precipitation drought, causing injury to crops and aquatic species. Many rivers and streams experienced record low flows. The Governor declared drought on March 13, 2015, for three regions of the state—the Olympic Peninsula, the east slopes of the central Cascades and the Walla Walla Basin. The state-level drought declaration was extended on April 17, 2015, to include more watersheds, and then was extended statewide on May 15, 2015. Water Resource Inventory Areas (WRIA) 16, which includes Skokomish-Dosewallips watersheds in Mason and Jefferson Counties, were impacted. In May, the Water Supply Availability and Emergency Water Executive committees determined that 48 of the 62 watersheds had water supply conditions below 75 percent of normal, an area representing 85 percent of the state's geographic area.

6.2.3 Severity

Droughts impact individuals (farm owners, tenants, and farm laborers), the agricultural industry, and other agriculture-related sectors. Lack of snow pack has forced ski resorts into bankruptcy. There is increased danger of forest and wildland fires. Millions of board feet of timber have been lost. Loss of forests and trees increases erosion, causing serious damage to aquatic life, irrigation, and power development by heavy silting of streams, reservoirs, and rivers.

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

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

- The ***Palmer Crop Moisture Index*** measures short-term drought on a weekly scale and is used to quantify drought's impacts on agriculture during the growing season.
- The ***Palmer Z Index*** measures short-term drought on a monthly scale. Figure 6-2 shows this index for July 2017.
- The ***Palmer Drought Index*** measures the duration and intensity of long-term drought-inducing circulation patterns. Long-term drought is cumulative, so the intensity of drought during a given month is dependent on the current weather patterns plus the cumulative patterns of previous months. Weather patterns can change quickly from a long-term drought pattern to a long-term wet pattern, and this index can respond fairly rapidly. Figure 6-3 shows this index for July 2017.

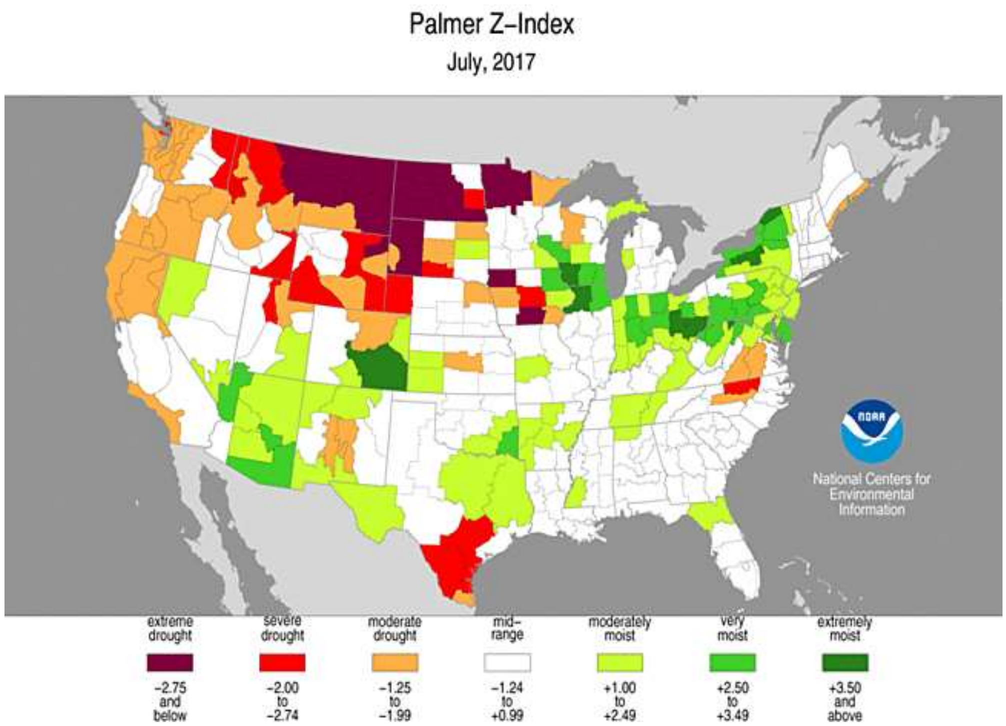


Figure 6-2 Palmer Z Index Short-Term Drought Conditions (July 2017)

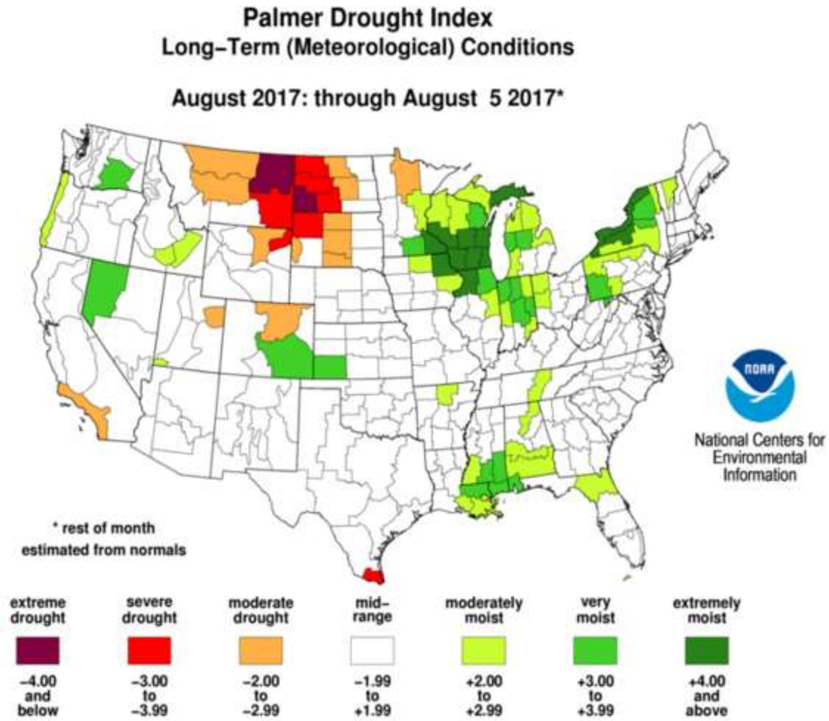


Figure 6-3 Palmer Drought Index Long-Term Drought Conditions

- The hydrological impacts of drought (e.g., reservoir levels, groundwater levels, etc.) take longer to develop and it takes longer to recover from them. The ***Palmer Hydrological Drought Index***, another long-term index, was developed to quantify hydrological effects. This index responds more slowly to changing conditions than the Palmer Drought Index.
- While the Palmer indices consider precipitation, evapotranspiration and runoff, the ***Standardized Precipitation Index*** considers only precipitation. In this index, a value 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.

Additional information and current monthly data are available from the NOAA website: http://www.ncdc.noaa.gov/oa/climate/research/prelim/drought/palmer.html

6.2.4 Frequency

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

In temperate regions, including Washington, long-range forecasts of drought have limited reliability. In the tropics, empirical relationships have been demonstrated between precipitation and El Niño events, but few such relationships have been demonstrated above 30º north latitude. Meteorologists do not believe that reliable forecasts are attainable at this time a season or more in advance for temperate regions.

A great deal of research has been conducted in recent years on the role of interacting systems in explaining regional and even global patterns of climatic variability. These patterns tend to recur periodically with enough frequency and with similar characteristics over a sufficient length of time that they offer opportunities to improve the ability for long-range climate prediction. However, too many variables exist in determining the frequency with which a drought will occur.

According to the Washington State Hazard Mitigation Plan data (2012) "At this time, reliable forecasts of drought are not attainable for temperate regions of the world more than a season in advance. However, based on a 100-year history with drought, the state as a whole can expect severe or extreme drought at least 5 percent of the time in the future, with most of eastern Washington experiencing severe or extreme drought about 10 to 15 percent of the time." (EMD, 2012)

The potential for improved drought predictions in the near future differs by region, season, and climatic regime. Based on Palmer Z Short-Term predictions (Figure 6-2), the planning area experienced a "moderate drought" situation within the area. Figure 6-3 demonstrates mid-range meteorological conditions for the two-year period encompassed within NOAA's long-term analysis.

6.3 VULNERABILITY ASSESSMENT

6.3.1 Overview

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 associated with 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.

All people, property and environments in the planning area could be exposed to some degree to the impacts of moderate to extreme drought. Areas densely wooded, especially areas in parks throughout the County which host campers, increase the exposure to forest fires. Additional exposure comes in the form of economic impact should a prolonged drought occur that would impact fishing, recreation, agriculture, and timber harvesting—primary sources of income in the planning area. Prolonged drought would also decrease capacity within the watersheds, thereby reducing fish runs and, potentially, spawning areas.

Methodology

The Washington State Enhanced Hazard Mitigation plan defines jurisdictions as being vulnerable to drought if they meet at least five of the following criteria:

- History of severe or extreme drought conditions:
  - The jurisdiction must have been in serious or extreme drought at least 10-15 percent of the time from 1895 to 1995.
- Demand on water resources based on:
  - Acreage of irrigated cropland. The acreage of the jurisdiction's irrigated cropland must be in the top 20 in the state.
  - Percentage of harvested cropland that is irrigated. The percentage of the jurisdiction's harvested cropland that is irrigated must be in the top 20 in the state.
  - Value of agricultural products. The value of the jurisdiction's crops must be in the top 20 in the state.

  - Population growth greater than the state average. The population growth from 2000 to 2006 must be greater than state average of 8.17 percent.
- A County's inability to endure the economic conditions of a drought, based on:
  - The jurisdiction's median household income being less than 75 percent of the state median income of $51,749 in 2005.
  - The jurisdiction's being classified as economically distressed in 2005 because its unemployment rate was 20 percent greater than the state average from January 2002 through December 2004.

Presently, Mason County is not among the nine counties referenced as vulnerable to drought in the Washington State Enhanced Hazard Mitigation Plan. The County does not meet at least five of the State's criteria to be considered vulnerable to drought.

Warning Time

A drought is not a sudden-onset hazard. Droughts are climatic patterns that occur over long periods, providing for some advance notice. In many instances, annual situations of low water levels are identified months in advance (e.g., snow pack at lower levels are identified during winter months), allowing for advanced planning for water conservation.

Meteorological drought is the result of many causes, including global weather patterns that produce persistent, upper-level high-pressure systems along the West Coast resulting in less precipitation. Only general warning can take place, due to the numerous variables that scientists have not pieced together well enough to make accurate and precise predictions. It is often difficult to recognize a drought before being in the middle of it. Droughts do not occur spontaneously, they evolve over time as certain conditions are met.

Scientists do not know how to predict drought more than a month in advance for most locations. Predicting drought depends on the ability to forecast precipitation and temperature. Weather anomalies may last from several months to several decades. How long they last depend on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of weather systems on the global scale. In temperate regions such as Washington, long-range forecasts of drought have limited reliability. Meteorologists do not believe that reliable forecasts are attainable at this time a season or more in advance for temperate regions.

6.3.2 Impact on Life, Health, and Safety

Wildfires are often associated with drought. A prolonged lack of precipitation dries out vegetation, which becomes increasingly susceptible to ignition as the duration of the drought extends. This increases the risk to the health and safety of the residents within the planning area, especially those in wildland-urban interface areas. Smoke and particles embedded within the smoke are of significant concern for the elderly and very young, especially those with breathing problems.

The County and its jurisdictions have the ability to minimize impacts on residents and water consumers within the planning area should several consecutive dry years occur.

6.3.3 Impact on Property

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

6.3.4 Impact on Critical Facilities and Infrastructure

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

6.3.5 Impact on Economy

Economic impact from a drought is associated with different aspects, including potential loss of agri- and aqua-cultural production. Review of Mason County economic data identifies a quotient factor of 2.92 for crop and animal production, with the state average of 2.72 – indicating a higher level than state average.[10] The County's economy relies heavily on aquaculture, ranking number one in the state in U.S. Department of Agriculture's 2012 County profile (most recent available).[11] Also ranking high with respect to agricultural dependency is Christmas trees and short rotation woody crops, ranking fourth statewide. Combined, the impact from a drought situation on the County's agri- and aqua-cultural markets for economic sustainability could be high. Of Mason County's largest employers, Taylor Shellfish, Inc., ranks fifth (2014 statistics). A drought situation such that has previously occurred statewide which impacted the fishing industry could have a negative impact on both Christmas tree production, and the shellfish industry.

Additional economic impact stems from the potential loss of critical infrastructure due to fire damage and impacts on industries that depend on water for their business, such as fishing industries, water-based recreational activities, and public facilities and recreational areas.

Problems of domestic and municipal water supplies have historically been corrected by building another reservoir, a larger pipeline, new well, or some other facility. With drought conditions increasing pressure on aquifers and increased pumping, which can result in saltwater intrusion into fresh water aquifers, resultant reductions or restrictions on economic growth and development could occur. Given potential political issues, a drought situation, if prolonged, could restrict building within specific areas due to lack of supporting infrastructure, thereby impacting the tax base and economy of the region by limiting growth. In addition, impact to or the lack of hydroelectric generating capacity associated with drought conditions as a result of reduced precipitation levels could raise electric prices throughout the region.

6.3.6 Impact on Environment

Environmental losses from drought are associated with aquatic life, plants, animals, wildlife habitat, air and water quality, forest fires, landscape quality, biodiversity, and soil erosion. Some effects are short-term and conditions quickly return to normal after the drought. Other effects linger or even become permanent. Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes, and vegetation, but many species will eventually recover from this effect. Degraded landscape quality, including soil erosion, may lead to a more permanent loss of biological productivity. Life-cycles for fish spawning in the area would have environmental impacts years into the future.

Public awareness and concern for environmental quality has led to greater attention to these effects. Drought conditions within the planning area could increase the demand for water supplies. Water shortages would have an adverse impact on the environment, relied upon by the planning partnership, causing social and

[10] http://choosemason.com/wp-content/uploads/2017/03/Biz-Report-EDCMC-2016-Draft-v-3.pdf
[11] https://www.agcensus.usda.gov/Publications/2012/Online_Resources/County_Profiles/Washington/cp53045.pdf

political conflicts. If such conditions persisted for several years, the economy of Mason County could experience setbacks, especially in water dependent industries.

6.4 FUTURE DEVELOPMENT TRENDS

Mason County and the City of Shelton have a relatively high amount of land available. The U.S. Department of Agriculture has indicated a 20% reduction in the amount of farm lands within Mason County during the time period of 2007 to 2012 (USDA, 2012). With the increase in population, the rezoning of land from agricultural to residential would have the propensity to increase water demands, as well as increase demands on other infrastructure, and increase the potential for wildfires. The City of Shelton and Mason County have established comprehensive plans that includes policies directing land use and dealing with issues of water supply and the protection of water resources, as well as fire regulations. Those plans are currently in the update phase. 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.

The planning area continues to move forward in developing policies directing land use and dealing with zoning, density and permitting for any new development. This will provide the capability to protect future development from the impacts of drought.

6.5 ISSUES

An extreme drought could impact the region with little warning. Combinations of low precipitation and unusually high temperatures could occur over several consecutive years, especially in response to climate change. Intensified by such conditions, extreme wildfires could break out throughout the area, increasing the need for water. Surrounding communities, also in drought conditions, could increase their demand for water, causing social and political conflicts. Low water tables could increase issues of life, safety, and health, while also impacting the economy both for loss of potential agricultural income, but also with respect to decreased ability to construct new housing due to lack of ability to provide water. If such conditions persisted for several years, the economy of the region could experience setbacks, especially in water dependent industries.

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

- The need for alternative water sources should a prolonged drought occur;
- Use of groundwater recharge to stabilize the groundwater supply;
- The probability of increased drought frequencies and durations due to climate change;
- The promotion of active water conservation even during non-drought periods;
- The potential impact on businesses in the area;
- The potential impact on the livelihood of those employed in industries that could be impacted by drought, such as agriculture, fishing, forestry, and tourism.

6.6 RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from Drought throughout the area is highly likely. The area has experienced drought conditions, with a drought incident occurring only a short period ago (2015). As of this 2018 update, the State is experiencing one of its driest summers on record for the last 30 years. With anticipated increase in temperatures as a result of climate change, drought situations will only intensify. With the planning area's dependence on aqua- and agri-culture, there is a significant potential economic loss in the region. In addition, higher temperatures anticipated with climate change would increase vulnerability of the population due to excessive heat, while also potentially impacting power supplies at the hydro-dams in the area. Based on the potential impact, the Planning Team determined the CPRI score to be 2.6, with overall vulnerability determined to be a medium level.

CHAPTER 7.
EARTHQUAKE

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. Its epicenter is the point on the earth's surface directly above the hypocenter of an earthquake. The location of an earthquake is described by the geographic position of its epicenter and by its focal depth. Earthquakes many times occur along a fault, which is a fracture in the earth's crust.

> **DEFINITIONS**
>
> **Earthquake**—The shaking of the ground caused by an abrupt shift of rock along a fracture in the earth or a contact zone between tectonic plates.
>
> **Epicenter**—The point on the earth's surface directly above the hypocenter of an earthquake. The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth.
>
> **Fault**—A fracture in the earth's crust along which two blocks of the crust have slipped with respect to each other.
>
> **Focal Depth**—The depth from the earth's surface to the hypocenter.
>
> **Hypocenter**—The region underground where an earthquake's energy originates
>
> **Liquefaction**— Loosely packed, water-logged sediments losing their strength in response to strong shaking, causing major damage during earthquakes.

7.1 GENERAL BACKGROUND

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.

Geologists classify faults by their relative hazards. Active faults, which represent the highest hazard, are those that have ruptured to the ground surface during the Holocene period (about the last 11,000 years). Potentially active faults are those that displaced layers of rock from the Quaternary period (the last 1,800,000 years). Determining if a fault is "active" or "potentially active" depends on geologic evidence, which may not be available for every fault.

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

It is generally agreed that three source zones exist for Pacific Northwest quakes: a shallow (crustal) zone; the Cascadia Subduction Zone; and a deep, intraplate "Benioff" zone. These are shown in Figure 7-1. More than 90 percent of Pacific Northwest earthquakes occur along the boundary between the Juan de Fuca plate and the North American plate.

An earthquake will generally produce the strongest ground motions near the epicenter (the point on the ground above where the earthquake initiated) with the intensity of ground motions diminishing with increasing distance from the epicenter. The intensity of ground shaking at a given site depends on four main factors:

- Earthquake magnitude
- Earthquake epicenter
- Earthquake depth
- Soil or rock conditions at the site, which may amplify or de-amplify earthquake ground motions.

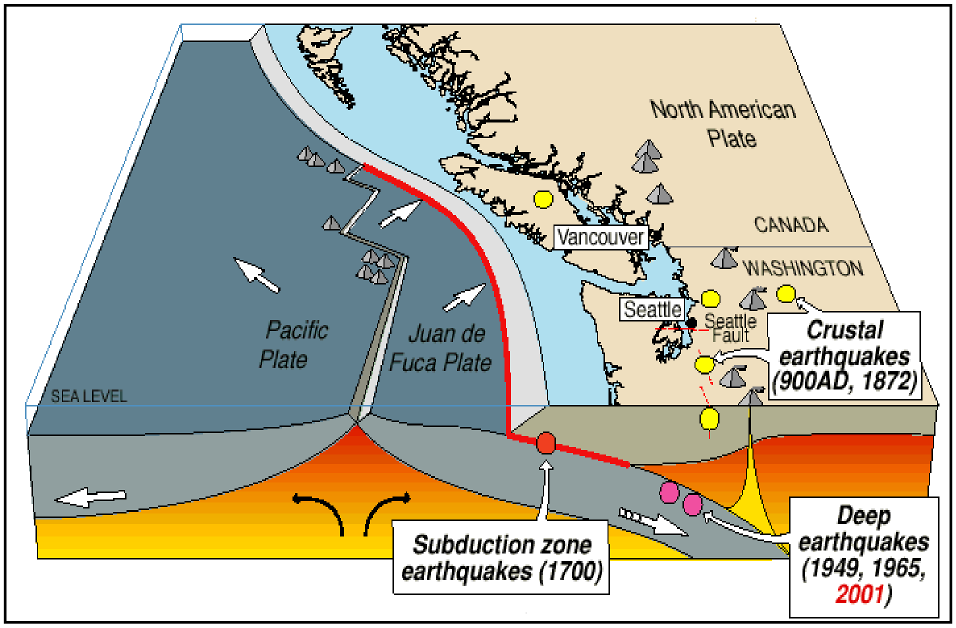


Figure 7-1 Earthquake Types in the Pacific Northwest

For any given earthquake, there will be contours of varying intensity of ground shaking with distance from the epicenter. The intensity will generally decrease with distance from the epicenter, and often in an irregular pattern, not simply in concentric circles. The irregularity is caused by soil conditions, the complexity of earthquake fault rupture patterns, and directionality in the dispersion of earthquake energy.

7.1.1 Earthquake Classifications

Earthquakes are typically classified in one of two ways: By the amount of energy released, measured as **magnitude** (size or power based on the Richter Scale); or by the impact on people and structures, measured as **intensity** (based on the Mercalli Scale). Magnitude is related to the amount of seismic energy released at the hypocenter of an earthquake. It is determined by the amplitude of the earthquake waves recorded on instruments. Magnitude is represented by a single, instrumentally determined value for each earthquake event. Intensity indicates how the earthquake is felt at various distances from the earthquake epicenter.

Magnitude

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

- Great—$M_W \geq 8$
- Major—$M_W = 7.0$—7.9
- Strong—$M_W = 6.0$—6.9

- Moderate—M_W = 5.0—5.9
- Light—M_W = 4.0—4.9
- Minor—M_W = 3.0—3.9
- Micro—M_W < 3

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

Intensity

There are many measures of the severity or intensity of earthquake ground motions. The Modified Mercalli Intensity scale (MMI) (Table 7-1) was widely used beginning in the early 1900s. MMI is a descriptive, qualitative scale that relates severity of ground motions to the types of damage experienced. MMI values range from I to XII (USGS, 1989):

Table 7-1
Modified Mercalli Intensity (MMI) Scale Descriptions

MMI VALUE	DESCRIPTION
I	Not felt except by a very few under especially favorable conditions
II	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it is an earthquake. Standing cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like a heavy truck striking building. Standing cars rocked noticeably.
V	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Felt by all; many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Damage negligible in buildings of good design and construction; slight in well-built ordinary structures; considerable in poorly built or badly designed structures. Some chimneys broken.

VIII	Damage slight in specially designed structures; considerable damage in ordinary buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
XI	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
X	Damage total. Lines of sight and level are distorted. Objects thrown into the air.

More accurate, quantitative measures of the intensity of ground shaking have largely replaced the MMI and are used in this mitigation plan. These scales use terms that can be physically measured with seismometers, such as the acceleration, velocity, or displacement (movement) of the ground. The intensity may also be measured as a function of the frequency of earthquake waves propagating through the earth. In the same way that sound waves contain a mix of low-, moderate- and high-frequency sound waves, earthquake waves contain ground motions of various frequencies. The behavior of buildings and other structures depends substantially on the vibration frequencies of the building or structure versus the frequency of earthquake waves. Earthquake ground motions also include both horizontal and vertical components.

Ground Motion

Earthquake hazard assessment is also based on expected ground motion. This involves determining the probability that certain ground motion accelerations will be exceeded over a time period of interest. A common physical measure of the intensity of earthquake ground shaking, and the one used in this mitigation plan, is peak ground acceleration (PGA). PGA is a measure of the intensity of shaking relative to the acceleration of gravity (g). For example, an acceleration of 1.0 g PGA is an extremely strong ground motion, which does occur near the epicenter of large earthquakes. With a vertical acceleration of 1.0 g, objects are thrown into the air. With a horizontal acceleration of 1.0 g, objects accelerate sideways at the same rate as if they had been dropped from the ceiling. A PGA equal to 10% g means that the ground acceleration is 10 percent that of gravity, and so on.

Damage levels experienced in an earthquake vary with the intensity of ground shaking and with the seismic capacity of structures. The following generalized observations provide qualitative statements about the likely extent of damage for earthquakes with various levels of ground shaking (PGA) at a given site:

- Ground motions of only 1% g or 2% g are widely felt by people; hanging plants and lamps swing strongly, but damage levels, if any, are usually very low.
- Ground motions below about 10% g usually cause only slight damage.
- Ground motions between about 10% g and 30% g may cause minor to moderate damage in well-designed buildings, with higher levels of damage in more vulnerable buildings. At this level of ground shaking, some poorly built buildings may be subject to collapse.

- Ground motions above about 30% g may cause significant damage in well-designed buildings and very high levels of damage (including collapse) in poorly designed buildings.
- Ground motions above about 50% g may cause significant damage in most buildings, even those designed to resist seismic forces.

PGA is the basis of seismic zone maps that are included in building codes such as the International Building Code. Building codes that include seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake. PGA values are directly related to these lateral forces that could damage "short period structures" (e.g. single-family dwellings). Longer period response components determine the lateral forces that damage larger structures with longer natural periods (apartment buildings, factories, high-rises, bridges). The amount of earthquake damage and the size of the geographic area affected generally increase with earthquake magnitude:

- Earthquakes below M5 are not likely to cause significant damage, even near the epicenter.
- Earthquakes between about M5 and M6 are likely to cause moderate damage near the epicenter.
- Earthquakes of about M6.5 or greater (e.g., the 2001 Nisqually earthquake in Washington) can cause major damage, with damage usually concentrated fairly near the epicenter.
- Larger earthquakes of M7+ cause damage over increasingly wider geographic areas with the potential for very high levels of damage near the epicenter.
- Great earthquakes with M8+ can cause major damage over wide geographic areas.
- An M9 mega-quake on the Cascadia Subduction Zone could affect the entire Pacific Northwest from British Columbia, through Washington and Oregon, and as far south as Northern California, with the highest levels of damage nearest the coast.

Table 7-2 lists damage potential and perceived shaking by PGA factors, compared to the Mercalli scale.

Table 7-2
Comparison Of Mercalli Scale and Peak Ground Acceleration

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

7.1.2 Effect of Soil Types

Liquefaction is a secondary effect of an earthquake in which soils lose their shear strength and flow or behave as liquid, thereby damaging structures that derive their support from the soil. Liquefaction generally occurs in soft, unconsolidated sedimentary soils. The National Earthquake Hazard Reduction Program (NEHRP) creates maps based on soil characteristics to help identify locations subject to liquefaction. Table 7-3 summarizes NEHRP soil classifications. NEHRP Soils B and C typically can sustain ground shaking without much effect, dependent on the earthquake magnitude. Areas that are commonly most affected by ground shaking and susceptible to liquefaction have NEHRP Soils D, E and F.

Table 7-3
NEHRP Soil Classification System

NEHRP Soil Type	Description	Mean Shear Velocity to 30 Meters (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)	

Table 7-4
Acres of NEHRP Soil Classification by Type Countywide

NEHRP Soil Type	Description	Mean Shear Velocity to 30 Meters (m/s)	# of Acres w/n Mason County	# of Acres w/in Shelton	# of Acres w/in Allyn	# of Acres w/in Belfair
A	Hard Rock	1,500	0	0	0	0
B	Firm to Hard Rock	760-1,500	220,707.8	0.0	0.0	0.0
C	Dense Soil/Soft Rock	360-760	259,940.8	1,659.3	811.7	2,238.1
D	Stiff Soil	180-360	108,100.7	1,781.9	172.1	1,863.6
E	Soft Clays	< 180	34,397.0	241.3	77.5	593.4
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays >36 m thick)		0.0	0.0	0.0	0.0

7.1.3 Fault Classification

The U.S. Geologic Survey defines four fault classes based on evidence of tectonic movement associated with large-magnitude earthquakes during the Quaternary period, which is the period from about 1.6 million years ago to the present:

- Class A—Geologic evidence demonstrates the existence of a Quaternary fault of tectonic origin, whether the fault is exposed by mapping or inferred from liquefaction or other deformational features.
- Class B—Geologic evidence demonstrates the existence of Quaternary deformation, but either (1) the fault might not extend deep enough to be a potential source of significant earthquakes, or (2) the currently available geologic evidence is too strong to confidently assign the feature to Class C but not strong enough to assign it to Class A.
- Class C—Geologic evidence is insufficient to demonstrate (1) the existence of tectonic faulting, or (2) Quaternary slip or deformation associated with the feature.
- Class D—Geologic evidence demonstrates that the feature is not a tectonic fault or feature; this category includes features such as joints, landslides, erosional or fluvial scarps, or other landforms resembling fault scarps but of demonstrable non-tectonic origin.

7.2 HAZARD PROFILE

Seismic-related hazards in Mason County include ground motion from shallow (less than 20 miles deep) or deep faults; liquefaction and differential settling of soil in areas with saturated sand, silt, or gravel; and tsunamis that result from seismic activities. Earthquakes also can cause damage by triggering landslides or bluff failure. The Puget Sound region is entirely within Seismic Risk Zone 3, requiring that buildings be designed to withstand major earthquakes measuring 7.5 in magnitude. It is anticipated, however, that earthquakes caused from subduction plate stress can reach a magnitude greater than 8.0.

High-magnitude earthquakes are possible in Mason County when the Juan de Fuca slips beneath the North American plates. Deep zone or Benioff zone quakes have occurred within the San De Fuca plate (1949, 1965, and 2001) and can be expected in the future.

7.2.1 Extent and Location

Washington State as a whole is one of the most seismically active states in United States. Figure 7-2 depicts the faults and seismogenic folds known or suspected to be active according to the 2013 Washington State Hazard Mitigation Plan.

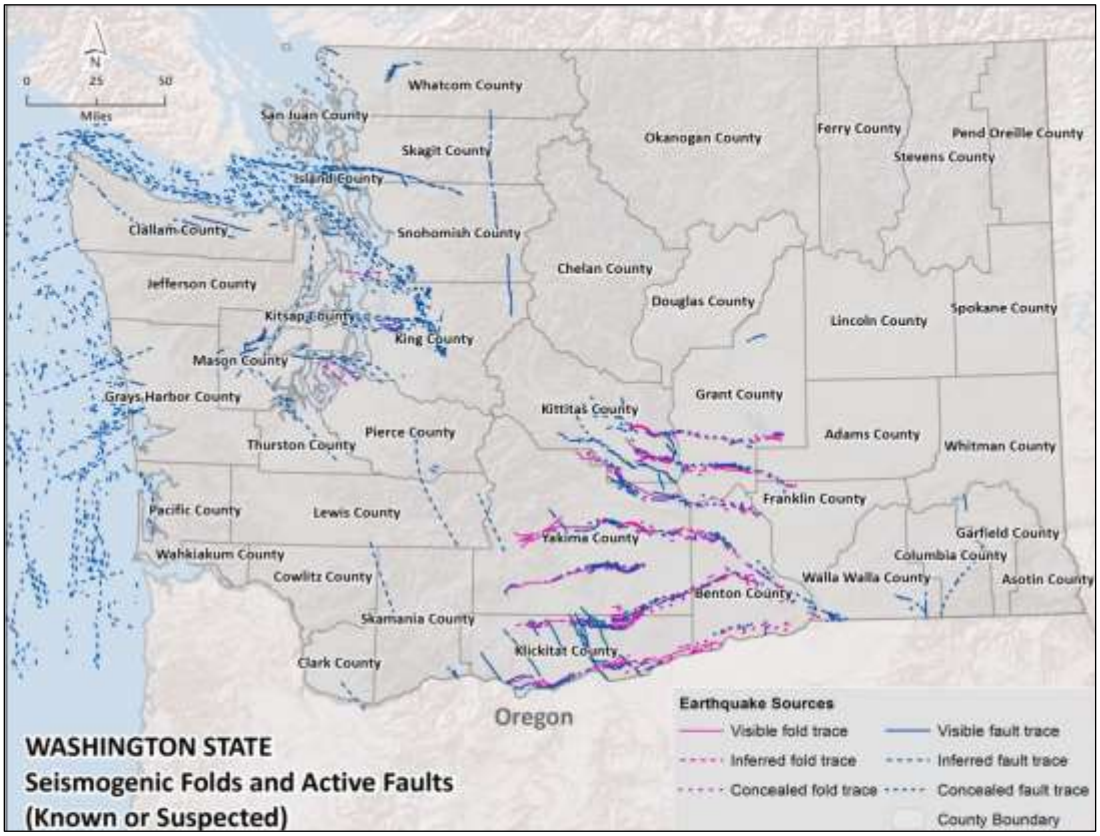


Figure 7-2 Washington State Seismogenic Folds and Active Faults

Local Faults

There are a number of faults running near or through Mason County (see Figure 7-3), including the Saddle Mountain East Fault, Frigid Creek Fault, and Canyon Creek Fault, which are located north and west of Hoodsport near the Olympic National Forest (USGS, 2015a). The Saddle Mountain fault was first recognized in the early 1970's. Drowned trees and trench excavations demonstrate that the fault produced a MW 6.5-7.0 earthquake 1,000-1,300 years ago, likely occurring with the MW 7.5 Seattle fault earthquake 1,100 years ago.

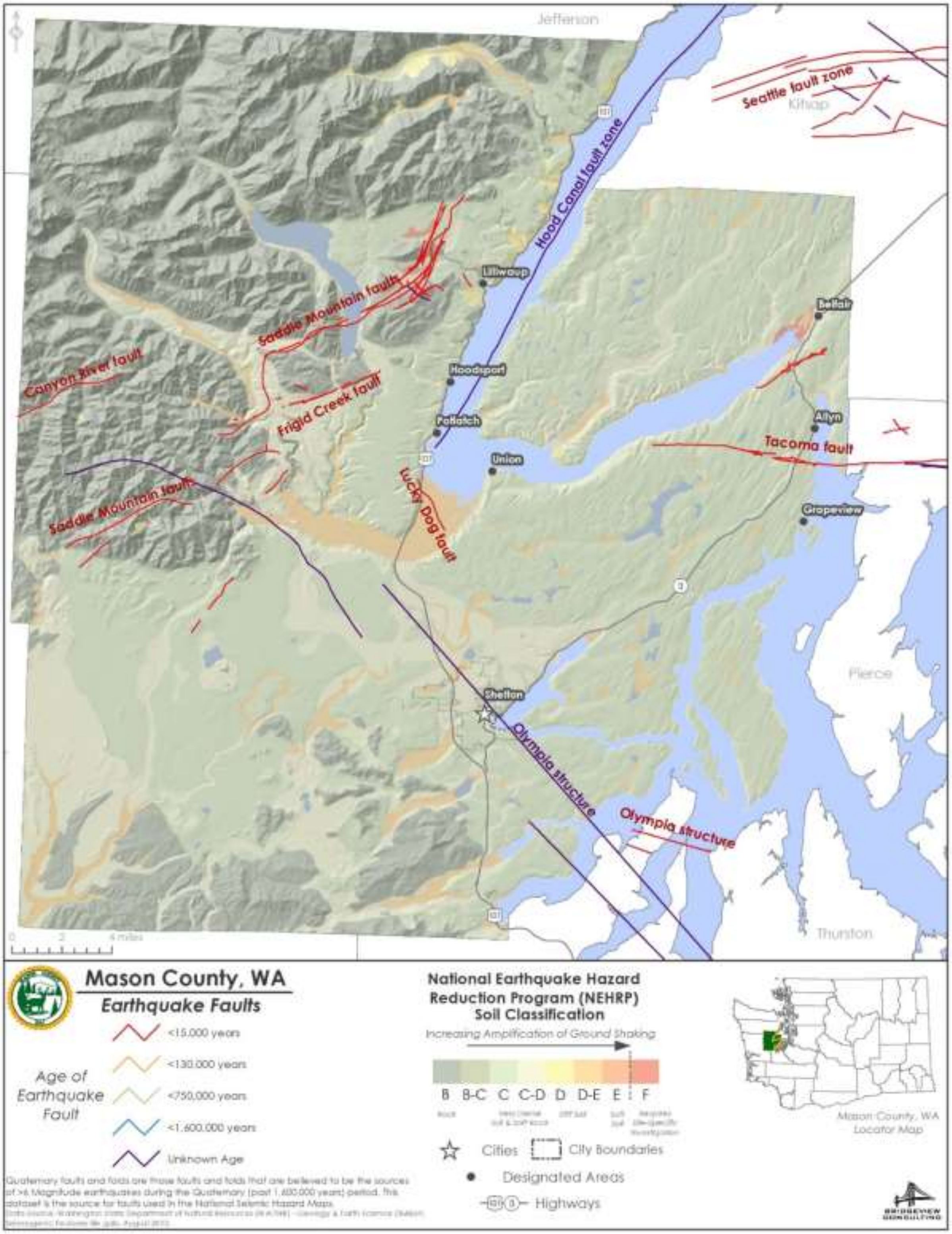


Figure 7-3 Mason County Faults

Hazard Mapping

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

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

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

Shake Maps

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

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

- A probabilistic seismic hazard map shows the hazard from earthquakes that geologists and seismologists agree could occur. The maps are expressed in terms of probability of exceeding a certain ground motion, such as the 10 percent probability of exceedance in 50 years. This level of ground shaking has been used for designing buildings in high seismic areas. Hazard maps for the 100-year and 500-year probabilistic earthquakes are shown on Figure 7-4 and 7-5.
- Earthquake scenario maps describe the expected ground motions and effects of hypothetical large earthquakes for a region. Maps of these scenarios can be used to support all phases of emergency management. Three scenarios were chosen for this plan:
  - Canyon River (Price Lake) Scenario (see Figure 7-6)
  - Nisqually Fault Scenario (see Figure 7-7)
  - Cascadia Subduction Zone Earthquake (see Figure 7-8).

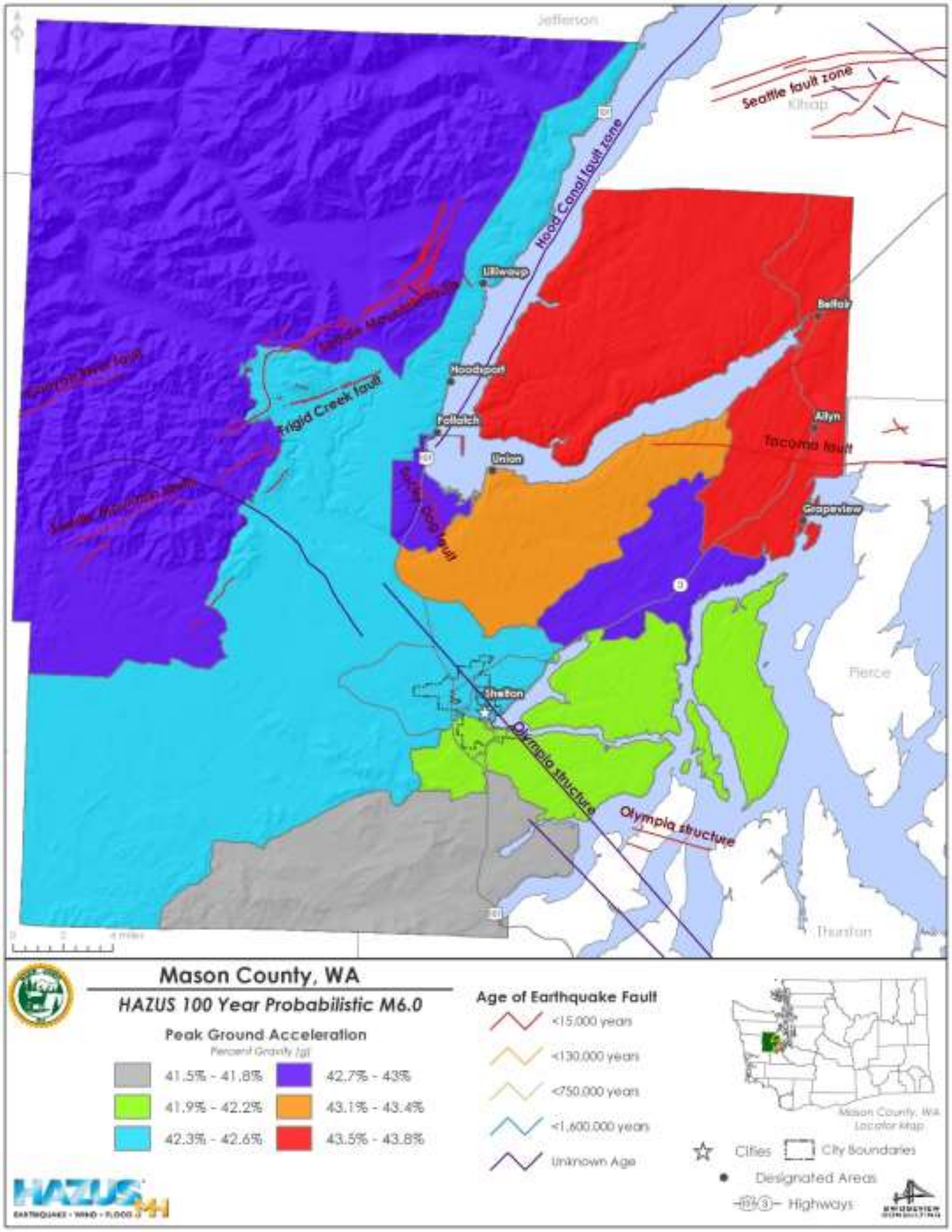


Figure 7-4 100-Year Probabilistic Earthquake Event

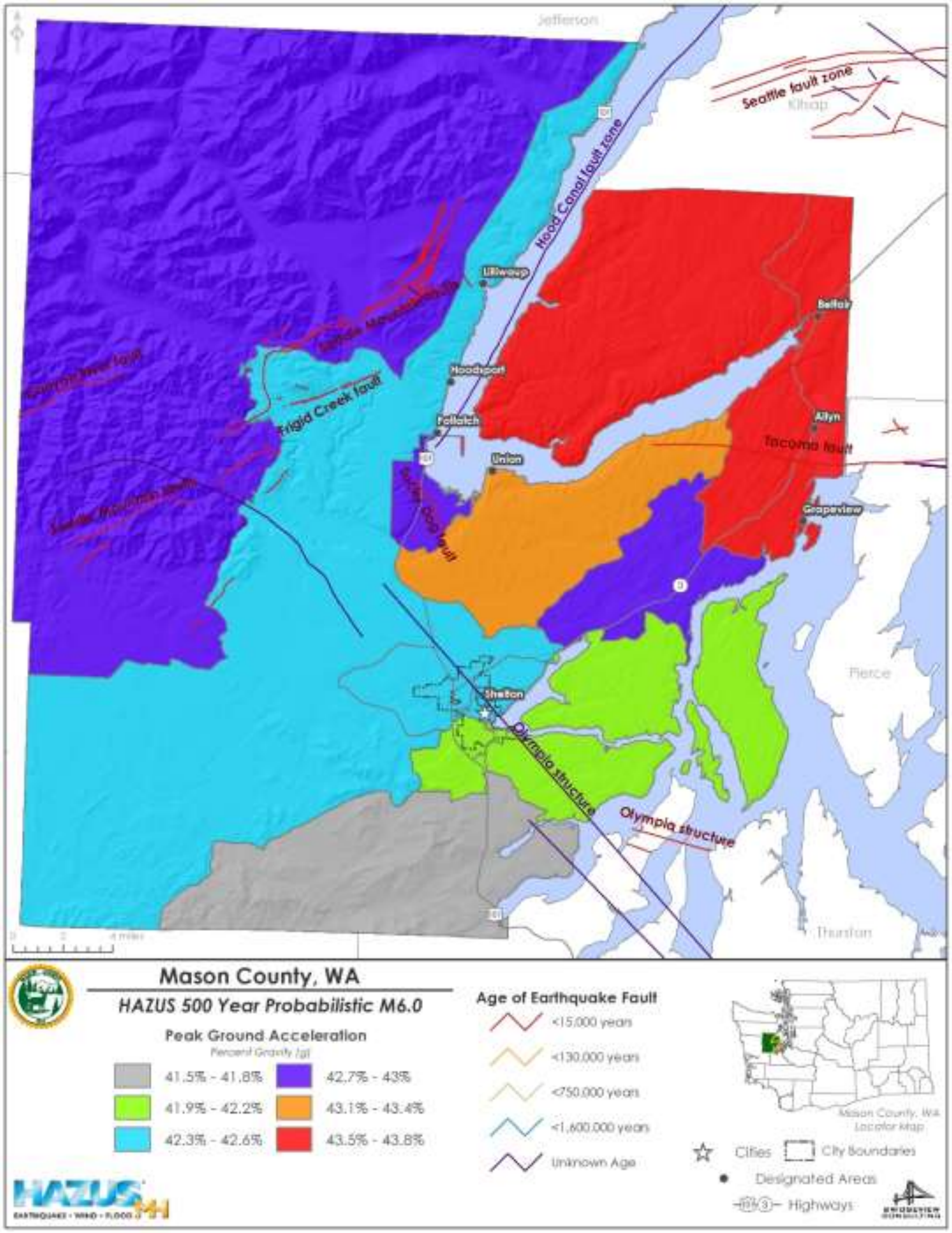


Figure 7-5 500-Year Probabilistic Earthquake Event

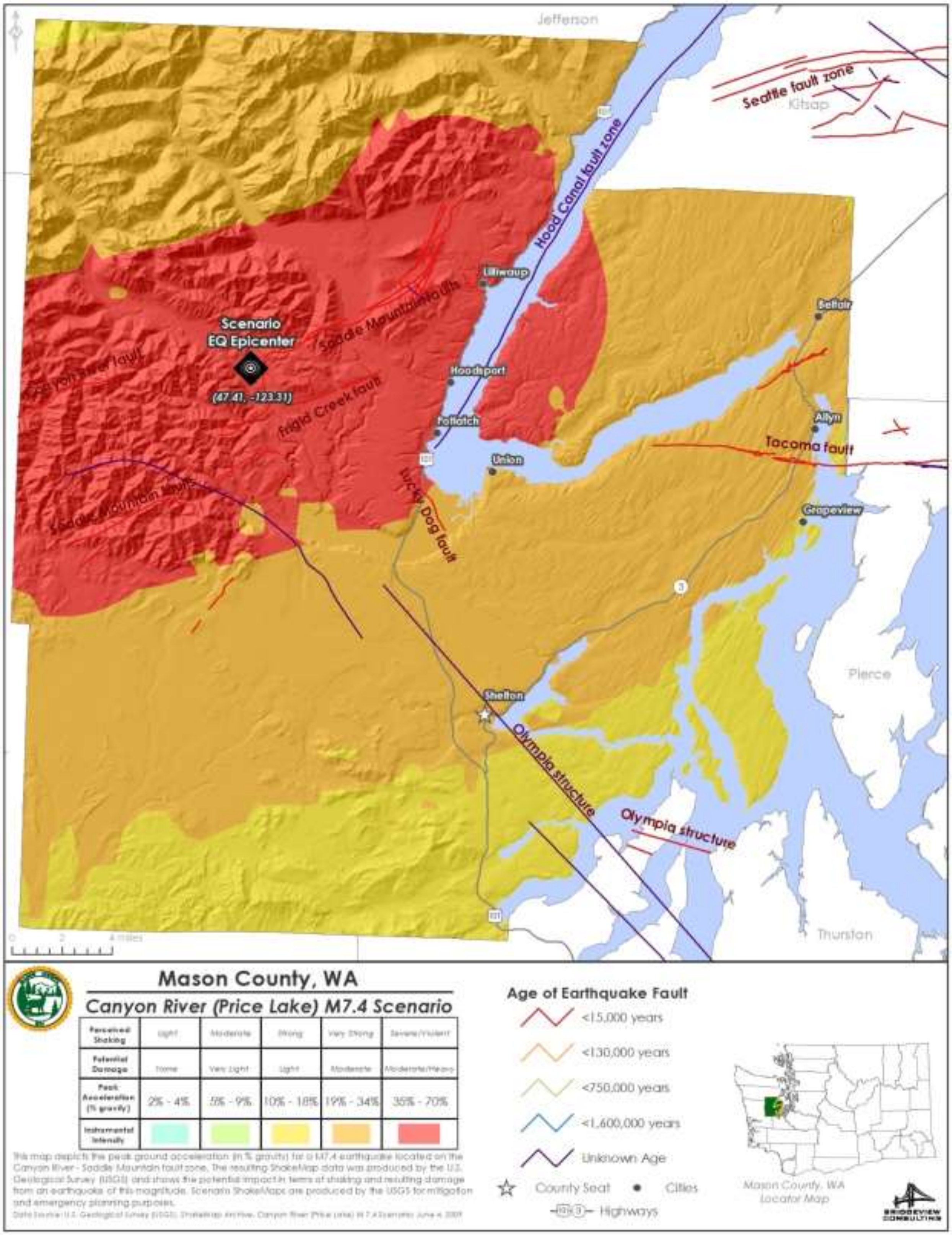


Figure 7-6 Canyon River (Price Lake) Scenario

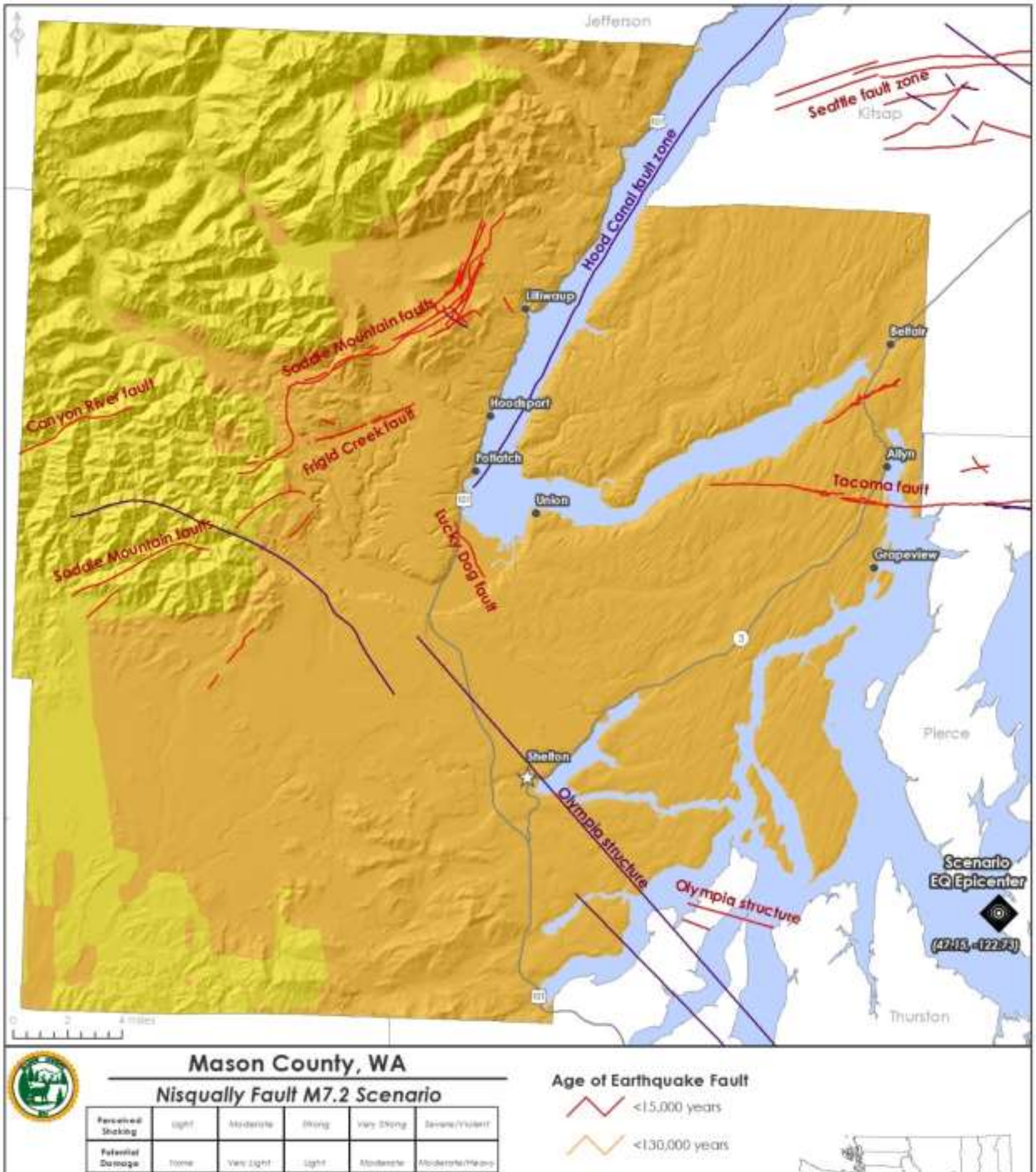


Figure 7-7 Nisqually Fault Scenario

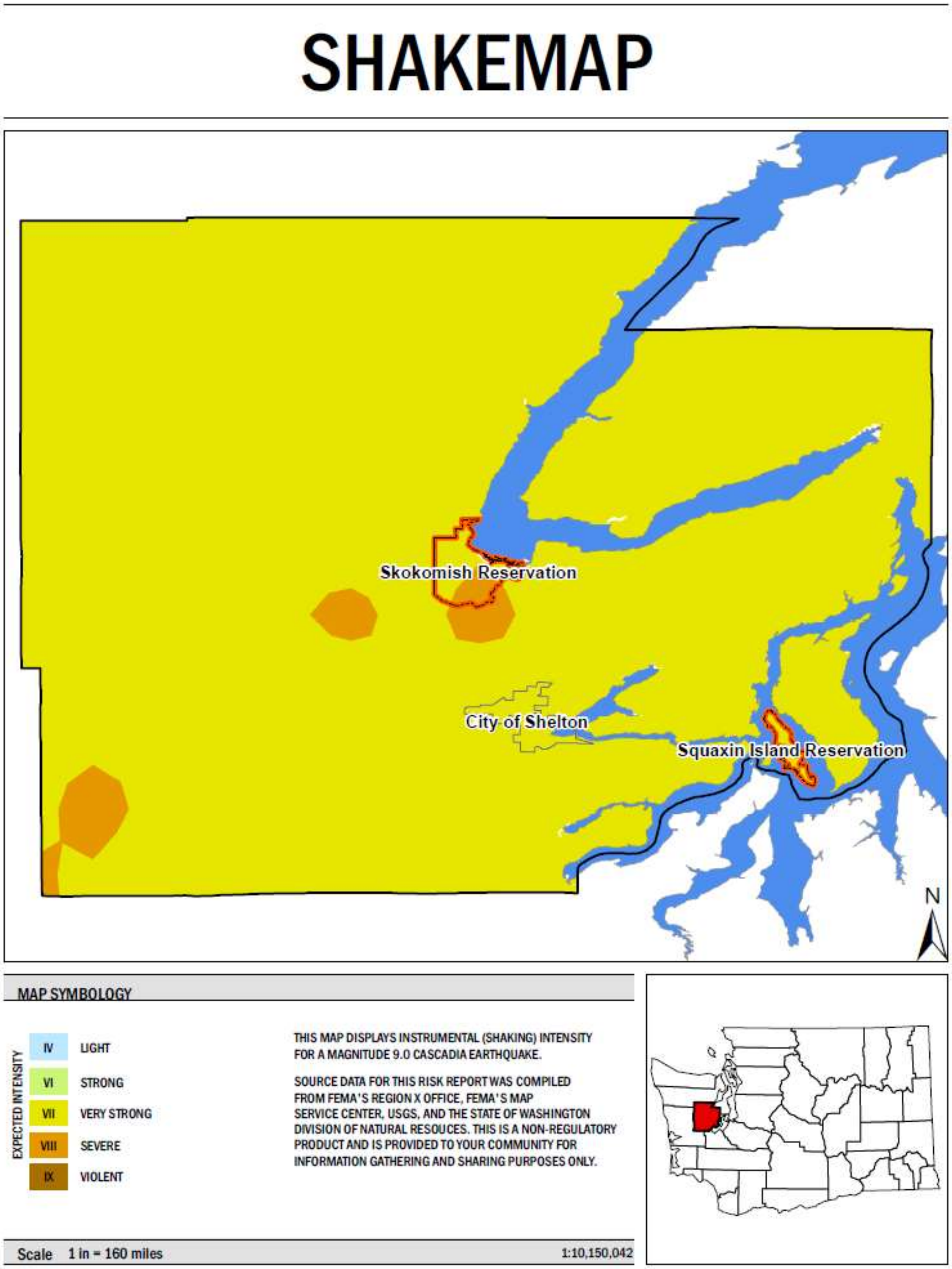


Figure 7-8 Cascadia M9.0 Fault Scenario (Source: FEMA Risk Map, 2017)

NEHRP Soil Maps

NEHRP soil types define the locations that will be significantly impacted by an earthquake. NEHRP Soils B and C typically can sustain low-magnitude ground shaking without much effect. The areas that are most commonly affected by ground shaking have NEHRP Soils D, E, and F. Figure 7-9 shows NEHRP soil classifications in Mason County.

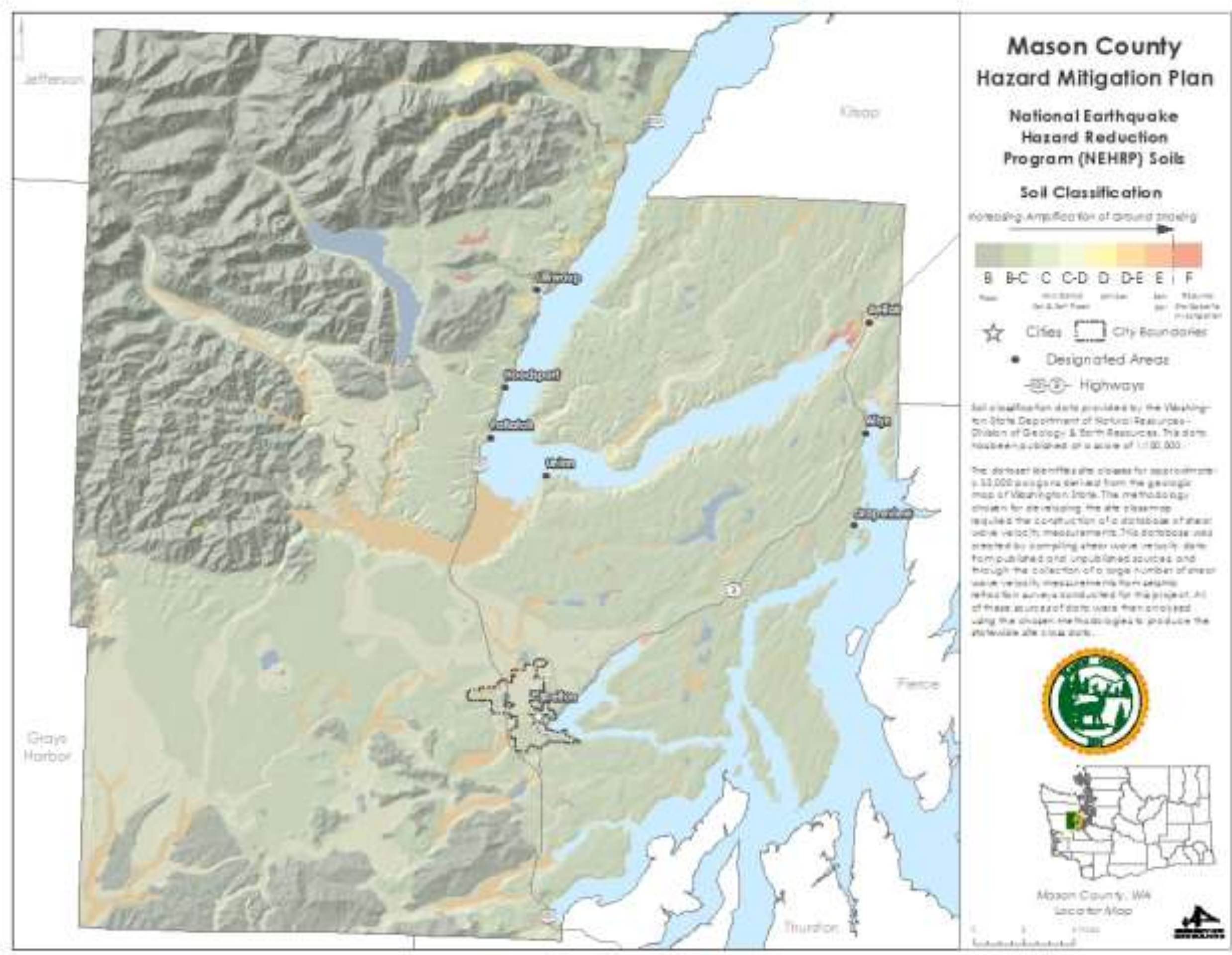


Figure 7-9 NEHRP Soils

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 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 and creating sand boils. Figure 7-10 shows liquefaction susceptibility throughout the County. TABLE 7-5 identifies the acres of the various susceptible liquefiable soil types countywide. Based on FEMA analysis completed in association with the Risk Map Project, FEMA identified potential structure losses associated with moderate-high liquefaction zones in Mason County as identified in Table 7-6 (FEMA Risk Report, 2017).

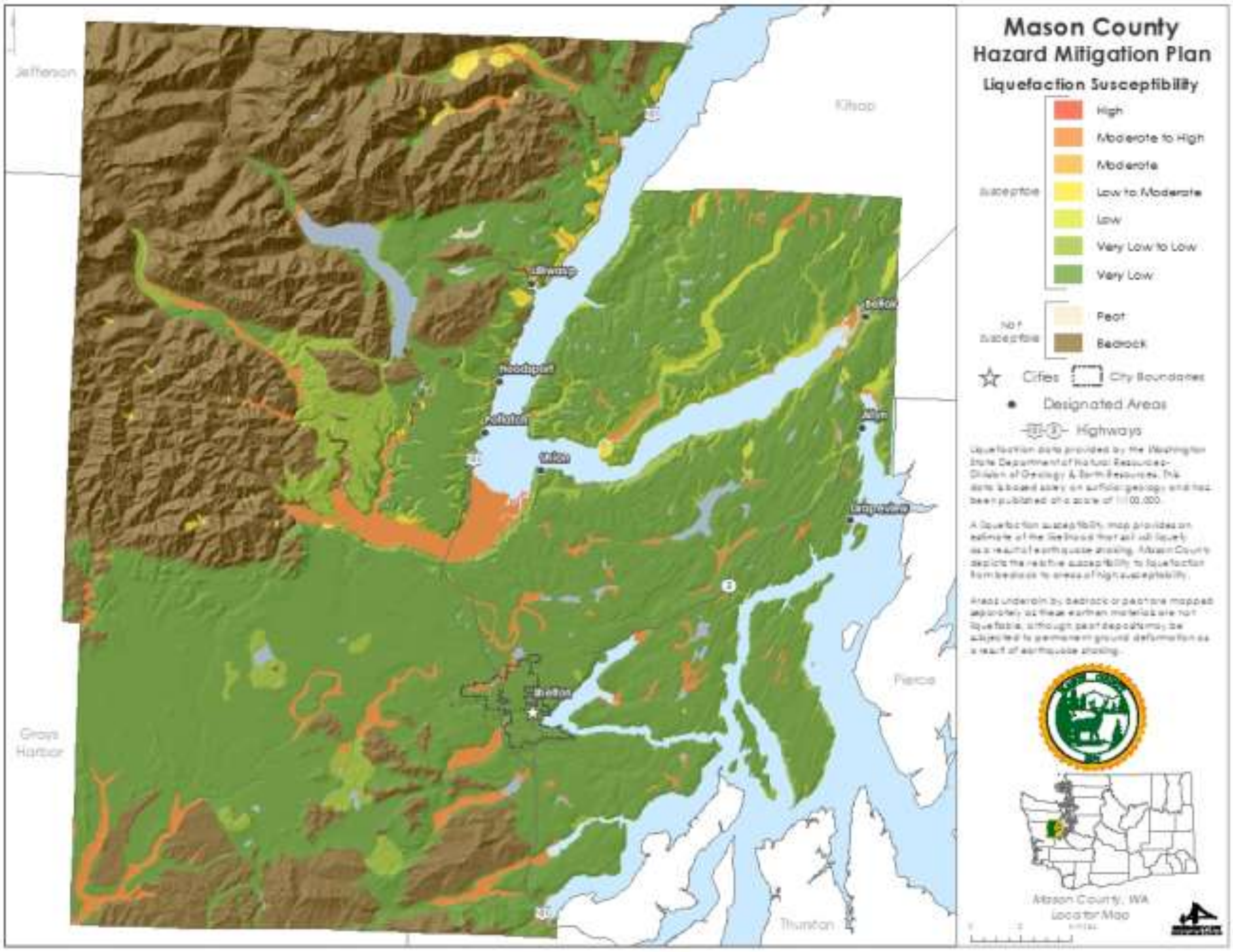


Figure 7-10 Liquefaction Susceptibility Zones

TABLE 7-5
LIQUEFIABLE SOILS BY ACRES

Liquefaction Susceptibility Type/Zone		# of Acres w/n Mason County	# of Acres w/n Shelton	# of Acres w/n Allyn	# of Acres w/n Belfair
Susceptible	High	0.0	0.0	0.0	0.0
	Moderate to High	25,547.2	215.6	37.3	213.7
	Moderate	0.0	0.0	0.0	0.0
	Low to Moderate	4,910.2	0.0	0.0	0.0
	Low	3,651.1	0.0	118.4	529.6
	Very Low to Low	36,906.2	0.0	53.6	1,307.1
	Very Low	322,574.0	3,441.2	811.7	2,265.0
Not Susceptible	Peat	786.0	0.0	0.0	0.0
	Bedrock	220,707.8	0.0	0.0	0.0

TABLE 7-6
POTENTIAL BUILDING IMPACT FROM LIQUEFACTION ZONES IN MASON COUNTY

Community	Total Estimated Building Value	Total Number of Buildings	Number of Buildings in the Moderate – High Liquefaction Zone	Percent of Buildings in the Moderate-High Liquefaction Zone
Shelton	$422.7M	3,279	28	0.85%
Skokomish Indian Tribe*	$36.5M	381	186	48.82%
Unincorporated Mason County	$3.5B	27,118	1,747	6.44%
Total	**$4.0B**	**30,778**	**1,961**	**6.38%**

*The Skokomish Indian Tribe was not a planning partner in the County's update. Impact data was captured from FEMA's Risk Map project.

7.2.2 Previous Occurrences

Mason County is subject to Modified Mercalli Intensity VII or IX from several sources: the Canyon River-Price Lake fault zone (Walsh and Logan, 2007; Barnett and others, 2012), which generated earthquakes about 1,000, 1,800, and 3,500 years ago; the Seattle and Tacoma faults, which generated large earthquakes about 1,000 years ago (Nelson and others, 2003; Sherrod and others, 2004); and the Cascadia subduction zone, which generated large magnitude earthquakes as recently as a few hundred years ago. Abundant physical evidence for an earthquake in AD 1700 on the Cascadia subduction zone includes evidence for abrupt tectonic subsidence. This event was probably about an M9 and is the largest earthquake in the Pacific Northwest in the historic or paleoseismic record. The evidence for this earthquake is documented in Atwater and others (2005) and Goldfinger and others (2012). This fault has an average recurrence interval of approximately 500 years for earthquakes of about M9, making it the most active fault that can affect Mason County. Significant losses would also result from repeat of a Benioff Zone earthquake such as the Nisqually earthquake. These earthquakes can be larger than the M6.8 Nisqually earthquake, and the project team modeled an M7.2 scenario in about the same place (FEMA Risk Report, 2017).

Based on geologic evidence along the Washington coast, the Cascadia Subduction Zone has ruptured and created tsunamis at least seven times in the past 3,500 years and has a considerable range in recurrence intervals, from as little as 140 years between events to more than 1,000 years. The last Cascadia Subduction Zone-related earthquake is believed to have occurred on January 26, 1700, and researchers predict a 10 to 14 percent chance that another could occur in the next 50 years. Table 7-7 lists past seismic events that have affected the areas in and around Mason County.[12] Those which directly impacted Mason County are highlighted. The County has received two disaster declarations as a result of earthquake damage – the Nisqually Earthquake, which occurred on February 28, 2001, and the May 11, 1965 earthquake. Figure 7-11 is a newspaper article concerning the 1946 earthquake impacting the area, while Figure 7-12 (source unknown) illustrates impact from the April 29, 1965 earthquake.


SECOND QUAKE WAKENS SLEEPERS!

GREEN RAPS NEW PRICE-WAGE PLAN

The Seattle Daily Times

SUNSET FINAL

LATEST CITY NEWS

WHERE BRICK WALL FELL IN QUAKE

MOST OF STATE BADLY SHAKEN; LOSSES HEAVY

Lebanon Asks Immediate Removal Of All Forces

Daily Non-Stop L. A.-to-N. Y. Flights Begin

U. S. ASKS DATA

1 Dead, 17 Hurt As Police Roof

F. R. Handed Note, Dec. 4.

Asylum Aides Quit; Patients Roam Streets

Figure 7-11 Seattle Times Article - February 14, 1946 Earthquake

[12] PNSN, 2017

Figure 7-12 April 29, 1965 Earthquake

Table 7-7 Historical Earthquakes Impacting The Planning Area			
Year	Magnitude	Epicenter	Type
2/28/2001 (DR 1361)	6.8	Olympia (Nisqually)	Benioff
6/10/2001	5.0	Matlock	Benioff
7/3/1999	5.8	8.0 km N of Satsop	Benioff
6/23/1997	4.7	Bremerton	Shallow Crustal
5/3/1996	5.5	Duvall	Shallow Crustal
1/29/1995	5.1	Seattle-Tacoma	Shallow Crustal
2/14/1981	5.5	Mt. St. Helens (Ash)	Crustal
9/9/76	4.5	Union	Benioff Zone (28 miles deep)
5/11/1965 (DR 196)	6.6	18.3 KM N of Tacoma	Benioff
4/29/1965	6.5	12 miles North of Tacoma	Benioff
1/13/1949	7.0	12.3 KM ENE of Olympia	Benioff
6/23/1946	7.3	Strait of Georgia	Benioff
2/14/1946	6.3	Puget Sound	Benioff
4/1945	5.7	Northbend (8 miles south/southeast)	Unknown
1939	5.8	Puget Sound – Near Vashon Island	Unknown
1932	5.3	Central Cascades	Unknown
1/23/1920	5.5	Puget Sound	Unknown
12/6/1918	7.0	Vancouver Island	Unknown
8/18/1915	5.6	North Cascades	Unknown
1/11/1909	6.0	Puget Sound	Unknown
4/30/1882	5.8	Olympia area	Unknown
12/15/1872	6.8	Pacific Coast	Unknown

7.2.3 Severity

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

Small, local faults produce lower magnitude quakes, but ground shaking can be strong, and damage can be significant in areas close to the fault. In contrast, large regional faults can generate earthquakes of great magnitudes but, because of their distance and depth, they may result in only moderate shaking in an area.

USGS ground motion maps based on current information about fault zones show the PGA that has a certain probability (2 or 10 percent) of being exceeded in a 50-year period. The PGA is measured in %g. Figure 7-13 shows the PGA with a 2 percent exceedance chance in 50 years in Washington.

Effects of a major earthquake in the Puget Sound basin area could be catastrophic, providing the worst-case disaster short of drought-induced wild fire sweeping through a suburban area. Hundreds of residents could be killed, and a multitude of others left homeless.

Although recorded damage sustained to date in Mason County has been relatively minor and has been restricted to some incidence of cracked foundations, walls and chimneys, and damage to private wells, depending on the time of day and time of year, a catastrophic earthquake could cause hundreds of injuries, deaths, and hundreds of thousands of dollars in property damage.

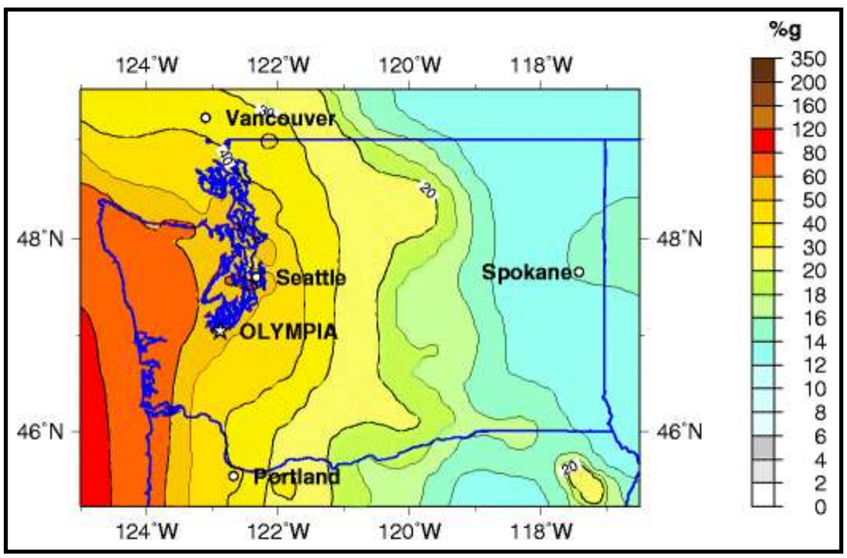


Figure 7-13 PGA with 2-Percent Probability of Exceedance in 50 Years, Northwest Region

7.2.4 Frequency

Scientists are currently developing methods to more accurately determine when an earthquake will occur. Recent advancements in determining the probability of an earthquake in a given period use a log-normal, Brownian Passage Time, or other probability distribution in which the probability of an event depends on the time since the last event. Such time-dependent models produce results broadly consistent with the elastic rebound theory of earthquakes. The USGS and others are beginning to develop such products as new geologic and seismic information regarding the dates of previous events along faults becomes more and more available (USGS, 2015a).

Scientists currently estimate that a Magnitude-9 earthquake in the Cascadia Subduction Zone occurs about once every 500 years. The last one was in 1700. Paleoseismic investigations have identified 41 Cascadia Subduction Zone interface earthquakes over the past 10,000 years, which corresponds to one earthquake about every 250 years. About half were M9.0 or greater earthquakes that represented full rupture of the fault zone from Northern California to British Columbia. The other half were M8+ earthquakes that ruptured only the southern portion of the subduction zone.

The 300+ years since the last major Cascadia Subduction Zone earthquake is longer than the average of about 250 years for M8 or greater and shorter than some of the intervals between M9.0 earthquakes.

Scientists currently estimate the frequency of deep earthquakes similar to the 1965 Magnitude-6.5 Seattle-Tacoma event and the 2001 Magnitude-6.8 Nisqually event as about once every 35 years. The USGS estimates an 84-percent chance of a Magnitude-6.5 or greater deep earthquake over the next 50 years.

Scientists estimate the approximate recurrence rate of a Magnitude-6.5 or greater earthquake anywhere on a shallow fault in the Puget Sound basin to be once in about 350 years. There have been four earthquakes of less than Magnitude 5 in the past 20 years.

Earthquakes on the Seattle Faults have a 2-percent probability of occurrence in 50 years. A Benioff zone earthquake has an 85 percent probability of occurrence in 50 years, making it the most likely of the three types.

7.3 VULNERABILITY ASSESSMENT

7.3.1 Overview

Several faults within the planning region have the potential to cause direct impact. The area also is vulnerable to impact from an event outside the County, although the intensity of ground motions diminishes with increasing distance from the epicenter. As a result, the entire population of the planning area is exposed to both direct and indirect impacts from earthquakes. The degree of direct impact (and exposure) is dependent on factors including the soil type on which homes are constructed, the proximity to fault location, the type of materials used to construct residences and facilities, etc. Indirect impacts are associated with elements such as the inability to evacuate the area as a result of earthquakes occurring in other regions of the state as well as impact on commodity flow for goods and services into the area, many of which are serviced only by one roadway in or out. Impact from other parts of the state could require shipment of supplies via a barge. Evacuation points of potential concern include:

- Landslides associated with an earthquake occurring along Highway 101 and
- Impact on State Route 3, which connects to Highway 101.

Methodology

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

Warning Time

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

7.3.2 Impact on Life, Health, and Safety

The entire population of the planning area is potentially exposed to direct and indirect impacts from earthquakes. Two of the most vulnerable populations to a disaster incident such as this are the young and the elderly. Mason County has a fairly high population of retirees and individuals with disabilities, both higher than the state averages. The need for increased rescue efforts and/or to provide assistance to such a large population base could tax the first-responder resources in the area during an event. Although many injuries may not be life-threatening, people will require medical attention and, in many cases, hospitalization. Potential life-threatening injuries and fatalities are expected; these are likely to be at an increased level if an earthquake happens during the afternoon or early evening.

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

The number of people without power or water will be high, especially given the number of wells on which the County relies to supply water to individuals who most likely do not have generators to run pumps on the wells. This need will increase the number of individuals seeking shelter assistance.

Analysis for the 100-year probabilistic earthquake indicates that 21 people will seek temporary shelters, while 31 households will be displaced due to the earthquake. Analysis for the 500-year probabilistic earthquake indicates that 207 people will seek temporary shelters, while 302 households will be displaced due to the earthquake. For the Cascadia M9.0 scenario, the model indicates that 155 households will be displaced, with 113 individuals seeking temporary shelter. It should be noted that the 100- and 500-year probabilistic events utilized Hazus 4.0. For the Cascadia event, Hazus 3.2 was utilized, which is presumed to be less accurate than Hazus 4.0. It is important to remember that these are planning numbers only based on impact to structures. In many instances, people will shelter with family and friends after such an event, and therefore the numbers may be significantly off.

7.3.3 Impact on Property

There are over 30,700 buildings in the planning area, with an estimated total replacement value of $4.0 billion. Most of the buildings are residential, and most of the building stock is of considerable age and not supported by building codes which increase resilience to seismic events. Portions of these buildings are constructed out of unreinforced masonry; many have chimneys that may be in need of repair, and many, because of the age of the building stock, may contain some level of asbestos in building components such as the boiler room, ceiling tiles, carpeting, or glue. Since all structures in the planning area are susceptible to earthquake impacts to varying degrees (including liquefaction and landslides), these figures represent total numbers region-wide for property exposure to seismic events.

Property losses were estimated through the Level 2 Hazus analysis for the Cascadia, Canyon River, and Nisqually earthquake scenarios events (utilizing the USGS/Washington State Department of Natural Resources scenario catalog data and FEMA GIS datasets). A summary of the total potential building-related loss is identified below, and in Table 7-8. These figures represent structure loss only. It should be noted that in some instances, such as with pump houses, no separate content value is associated with the structures, as the structure value is inclusive of the mechanisms affixed to the ground within those structures. In addition to the earthquake scenarios, additional basic analysis was conducted on the 100- and 500-year probabilistic events.

When reviewing analysis from the 100-year probabilistic event, Hazus estimates that 2,825 buildings will be at least moderately damaged. This is over 9.00 % of the buildings in the region. There are an estimated 34 buildings that will be damaged beyond repair.

When reviewing analysis from the 500-year probabilistic event, Hazus estimates that about 10,939 buildings will be at least moderately damaged. This is over 33.00 % of the buildings in the region. There are an estimated 1,278 buildings that will be damaged beyond repair.

For the Cascadia M9.0 event, Hazus estimates that about 8,268 buildings will be at least moderately damaged. This is over 25 % of the buildings in the region. There are an estimated 385 buildings that will be damaged beyond repair. Figure 7-14 illustrates the damages by Occupancy Type as identified within the Hazus 3.2 model for a Cascadia M9.0 event.

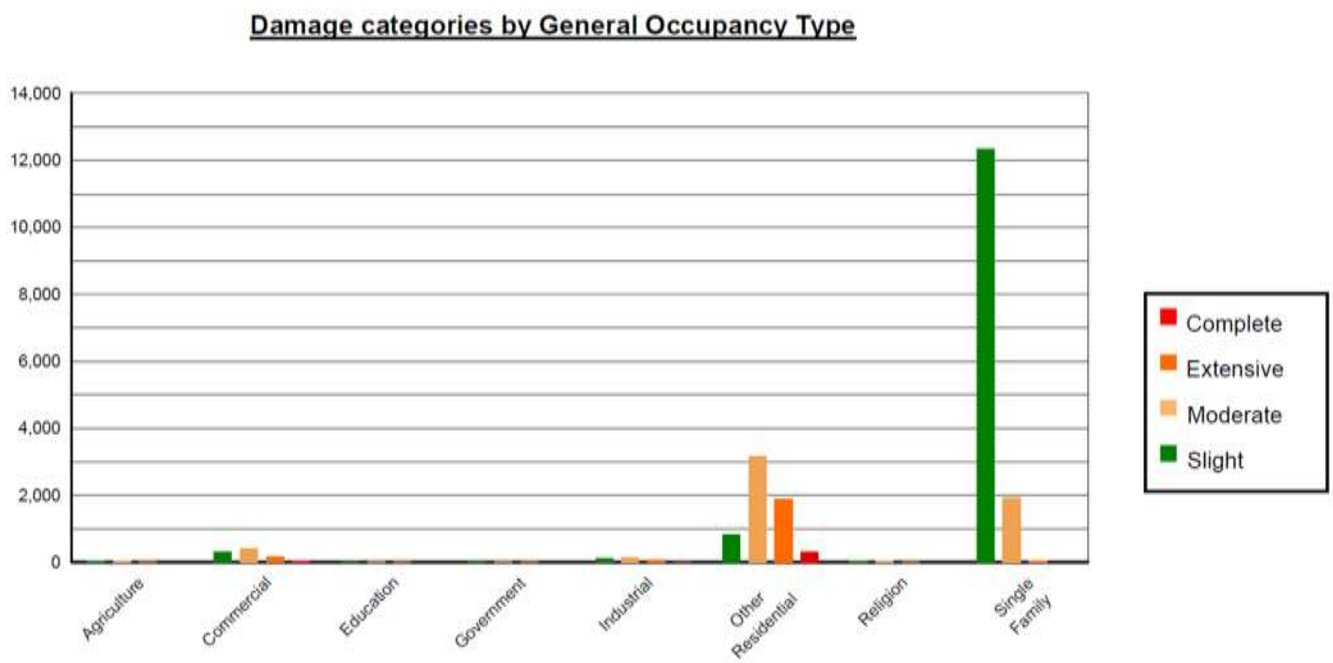


Figure 7-14 Hazus Output Illustrating Damages by Occupancy Type for a M9.0 Cascadia Scenario

Based on review of results in the below table and Figure 7-15, it is apparent that a Cascadia M9.0 Earthquake generates a much higher rate of impact (FEMA Risk Report, 2017).

TABLE 7-8
BUILDING STRUCTURE VALUES IMPACTED BY EARTHQUAKE SCENARIOS

Community	Total Estimated Building Value	Total Number of Buildings	Canyon River M7.4 Earthquake	Nisqually M7.2 Earthquake	Cascadia M9.0 Earthquake
Unincorporated Mason County	$3.3B	25,632	$221.2M	$9.8M	$464.4M
Allyn	$158.5M	1,007	$3.0M	$175.0K	$9.6M
Belfair	$68.9M	456	$2.0M	$88.4K	$7.6M
City of Shelton	$422.7M	3,279	$11.4M	$460.3K	$74.0M
Skokomish Indian Reservation*	$36.5M	381	$5.7M	$121.7K	$7.0M
Total	$4.0B	30,755	$243.3M	$10.6M	$562.6M

*The Skokomish Tribe was not a participant in the planning process as they were developing their own plan simultaneous with the County's effort. Data incorporated in this assessment was derived from FEMA's Risk Map data.
*Direct Economic and Social Losses utilize demographic and building square footage data to determine losses. In some instances, square footage of structures was estimated due to the lack of data. This deficiency is identified as a strategy for future plan updates.

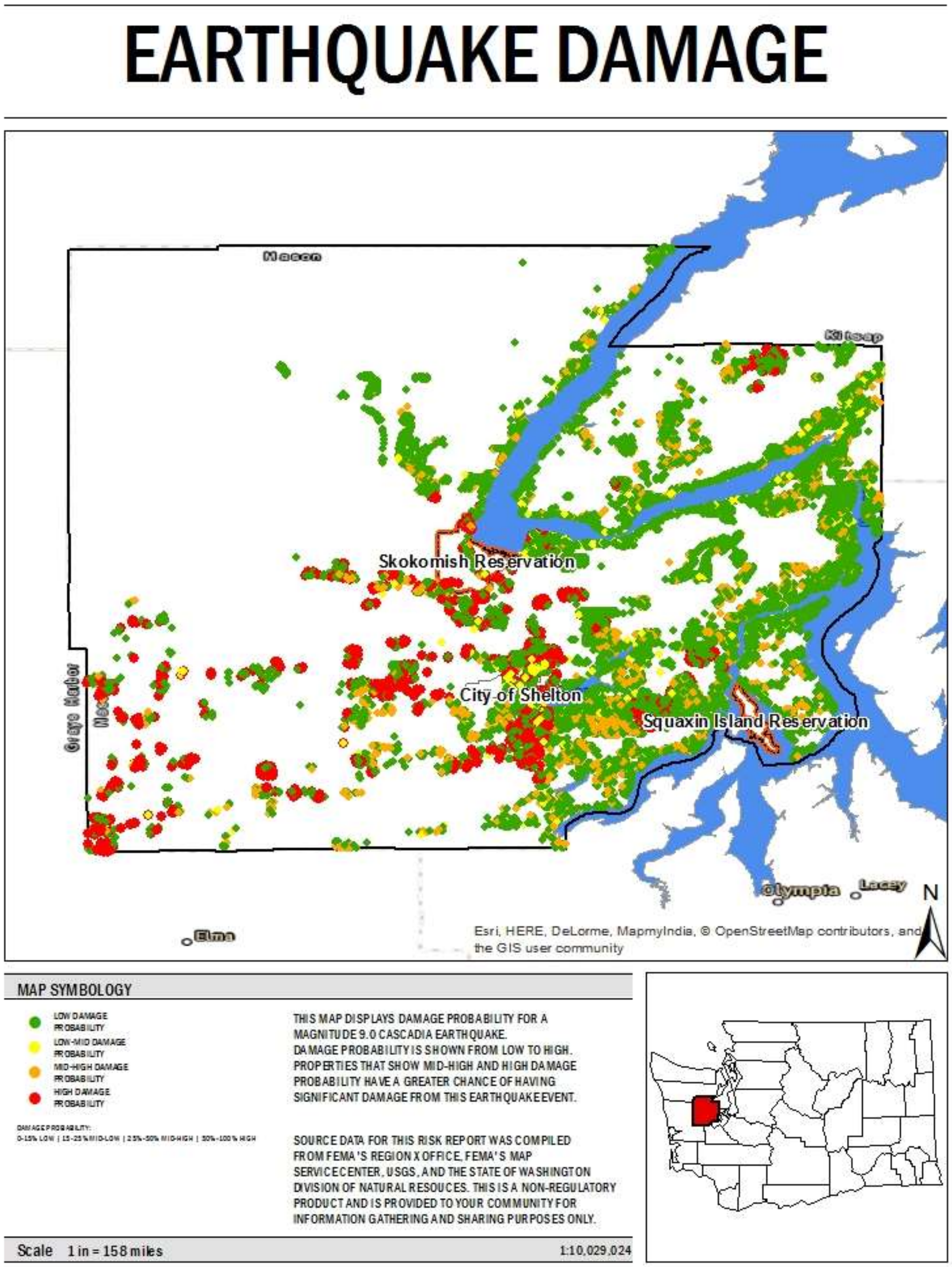


Figure 7-15 Mason County Earthquake Damage Based on M9.0 Cascadia Event

Building Age

Structures that are in compliance with the Uniform Building Code (UBC) of 1970 or later are generally less vulnerable to seismic damage because 1970 was when the UBC started including seismic construction standards based on regional location. This stipulated that all structures be constructed to at least seismic risk Zone 2 standards.

The State of Washington adopted the UBC as its state building code in 1972, so it is assumed that buildings in the planning area built after 1972 were built in conformance with UBC seismic standards and have less vulnerability. Issues such as code enforcement and code compliance could impact this assumption. Construction material is also important when determining the potential risk to a structure. However, for planning purposes, establishing this line of demarcation can be an effective tool for estimating vulnerability. In 1994, seismic risk Zone 3 standards of the UBC went into effect in Washington, requiring all new construction to be capable of withstanding the effects of 0.3 g. More recent housing stock is in compliance with Zone 3 standards. In July 2004, the state again upgraded the building code to follow International Building Code Standards. While the "zones" are still referenced, they are, in large part, no longer used in the capacity they once were as there can be different zones within political subdivisions, making it difficult to apply. For instance, within Washington, there are both Seismic Zones 2B and 3.

Based on data, it is estimated that 8.77 percent of the building stock in the planning area was constructed pre-code (before 1949); 23.22 percent were constructed 1950-1974); 55 percent were built to moderate codes, with the remaining structures, or 13 percent build to high code, constructed after 2004. Table 7-9 and Table 7-10 show the results of this analysis.

Table 7-9
Timeline of Building Code Standards

Time Period	Code Significance for Identified Time Period
Pre-1974	No standardized earthquake requirements in building codes. Washington State law did not require the issuance of any building permits, or require actual building officials
1975-2003	UBC seismic construction standards were adopted in Washington.
1994-2003	Seismic Risk Zone 3 was established within the Uniform Building Code in 1994, requiring higher standards.
2004-Present	Washington State upgrades its building codes to follow the International Building Code Standard. As upgrades occur, the State continues to adopt said standards.

Table 7-10
Age Of Structures Within Planning Area

Community	Number of Pre-Code Buildings (Pre- 1949)	Number of Low Code Buildings (1950 - 1974)	Number of Moderate Code Buildings (1975 - 2003)	Number of High Code Buildings (Post 2004)	Total Number of Buildings	Percentage of Pre-Code Buildings
Allyn	27	98	639	243	1,007	2.68%
Belfair	41	77	303	35	456	8.99%
Shelton	1,133	925	1,018	203	3,279	34.55%
Unincorporated Mason County	1,496	6,042	14,957	3,518	26,013	13.33%
Total	**2,697**	**7,142**	**16,917**	**3,999**	**30,755**	**8.77%**

7.3.4 Impact on Critical Facilities and Infrastructure

All critical facilities in Mason County are exposed to the earthquake hazard. Additionally, hazardous materials releases can occur during an earthquake from fixed facilities or transportation-related incidents. Transportation corridors can be disrupted during an earthquake, leading to the release of materials to the surrounding environment. Facilities holding hazardous materials are of particular concern because of possible isolation of residences surrounding them. During an earthquake, structures storing these materials could rupture and leak into the surrounding area or an adjacent waterway, having a disastrous effect on the environment. As a portion of the county is a coastal community, this is of particular concern as spills into water bodies, including the coastline or significant rivers in the area, could have devastating impact. Additionally, the potential for landslide-induced roadway closure is of significant concern. Closure of major arterials could require increased evacuation periods in some instances by several hours.

Level of Damage

The Hazus model classifies the vulnerability of facilities to earthquake damage in five categories: no damage, slight damage, moderate damage, extensive damage, or complete damage. The model was used to assign a vulnerability category to selected occupancy types in the planning area except hazmat facilities and "other infrastructure" facilities, for which there are no established damage functions. The analysis was performed for the 100- and 500-year probabilistic events. The results are summarized in Table 7-11 and Table 7-12.

Table 7-11
Expected Building Damage By Occupancy From100-Year Probabilistic Earthquake

Category	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Agriculture	65	16	8	2	0
Commercial	698	180	122	32	4
Government Functions	28	7	4	1	0
Industrial	237	65	48	13	1
Other Residential	3,121	1,518	1,368	311	21
Single Family	19,545	4,549	835	28	8
Schools	30	7	5	1	0

Table 7-12
Expected Building Damage By Occupancy From 500-Year Probabilistic Earthquake

Category	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Agriculture	26	23	23	13	7
Commercial Functions	220	218	310	186	102
Government	9	8	12	8	4
Industrial	68	72	112	72	40
Other Residential	296	758	2,044	2,219	1,023
Single Family	10,779	9,488	4,245	361	82
Schools	11	10	12	7	4

Debris

The Hazus analysis also estimated the amount of earthquake-caused debris in the planning area for the various earthquake events as summarized in Table 7-13.

Table 7-13.
Estimated Earthquake Caused Debris

Event	Amount of Debris to be Removed
100-Year Earthquake (M6)	28 million tons or 1,200 truckloads*
500- Year Probabilistic Earthquake (M6)	230 million tons or 9,200 truckloads*

Note: Values in this table are accurate only for purposes of comparison among results presented in this plan. Data limitations exist as defined. Analysis for the 100- and 500-year probabilistic events utilized Hazus 4.0; the Cascadia Shake Map was not updated to a useable format in Hazus 4.0 at the time the analysis was conducted, and therefore is not included in this table.

*Truck loads are determined for 25 tons/truck.

7.3.5 Impact on Economy

Economic losses due to earthquake damage include damage to buildings, including the cost of structural and non-structural damage, damage to contents, and loss of inventory, loss of wages and loss of income. Loss of tax base both from revenue and lack of improved land values will increase the economic loss to the County and its planning partners. In addition, loss of goods and services may hamper recovery efforts, and even preclude residents from rebuilding within the area. No specific loss data is available with respect to loss of inventory, wages, or loss of income; however, economic loss with respect to building impact is identified in Table 7-8 – Building Structure Values based on the two scenarios.

7.3.6 Impact on Environment

Earthquake-induced landslides can significantly impact habitat. It is also possible for streams to be rerouted after an earthquake. This can change water quality, possibly damaging habitat and feeding areas. There is a possibility of streams fed by groundwater drying up because of changes in underlying geology.

7.4 FUTURE DEVELOPMENT TRENDS

Mason County continues to utilize the International Building Code, which requires structures to be built at a level which supports soil types and earthquake hazards (ground shaking). As existing buildings are renovated, provisions are in place which require reconstruction at higher standards.

7.5 ISSUES

While the area has a high probability of an earthquake event occurring within its boundaries, an earthquake does not necessarily have to occur in the planning area to have a significant impact as such an event would disrupt transportation to and from the region as a whole and impact commodity flow. As such, any seismic activity of 6.0 or greater on faults in or near the planning area would have significant impact. Potential warning systems could give approximately 40 seconds notice that a major earthquake is about to occur. This would not provide adequate time for preparation. Earthquakes of this magnitude or higher would lead to massive structural failure of property on NEHRP C, D, E, and F soils. Levees and revetments built on these poor soils would likely fail, representing a loss of critical infrastructure. These events could cause secondary hazards, including landslides and mudslides that would further damage structures. River valley hydraulic-fill sediment areas are also vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction would occur in water-saturated sands, silts, or gravelly soils.

Earthquakes can cause large and sometimes disastrous landslides and mudslides. River valleys are vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction occurs when water-saturated sands, silts or gravelly soils are shaken so violently that the individual grains lose contact with one another and float freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink into what was previously solid ground. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people. Earthen dams and levees are highly susceptible to seismic events and the impacts of their eventual failures can be considered secondary risks for earthquakes. Earthquakes at sea can generate destructive tsunamis. Important issues associated with an earthquake include, but are not limited to the following:

- More information is needed on the exposure and performance of construction within the planning area. Much information on the age, type of construction, or updated work on facilities is not readily available in a useable format for a risk assessment of this type.
- It is presently unknown to what standards portions of the planning area's building stock were constructed or renovated.
- Based on the modeling of critical facility performance for this plan, a high number of facilities in the planning area are expected to have complete or extensive damage from scenario events. These facilities are prime targets for structural retrofits.
- The County and its planning partners are encouraged to create or enhance continuity of operations plans using the information on risk and vulnerability contained in this plan.
- Geotechnical standards should be established that take into account the probable impacts from earthquakes in the design and construction of new or enhanced facilities.
- Dam failure warning, evacuation plans and procedures should be updated (and maintained) to reflect dam risk potential associated with earthquake activity in the region, with said information being distributed to the County and its planning partners to allow for appropriate planning to occur.
- Earthquakes could trigger other natural hazard events such as a tsunami, which would have far-reaching impacts.

7.6 RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from an Earthquake throughout the area is highly likely. A Cascadia-type event, such as that utilized as one of the scenarios modeled for this update, has a high probability of occurring within the region. The Cascadia M9.0 earthquake scenario generates the largest amount of damage. The highest loss ratio for a Cascadia M9.0 scenario earthquake would occur in the City of Shelton with 17 percent of buildings affected by the shaking. The losses related to earthquake scenarios are largely due to the proximity to the faults. In addition, the Skokomish Reservation and the Unincorporated Areas of Mason County have large percentage of buildings located in the moderate-high liquefaction zone. Over 23 percent of buildings in the City of Shelton are designated as pre-code buildings. Due to the age of these buildings and the absence of building codes at time of construction, they may not perform as well during an earthquake compared to structures built after code implementation. Based on the potential impact, the Planning Team determined the CPRI score to be 3.6, with overall vulnerability determined to be a high level.

CHAPTER 8.
FLOOD

Floods are one of the most common natural hazards in the U.S. They can develop slowly over a period of days or develop quickly, with disastrous effects that can be local (impacting a neighborhood or community) or regional (affecting entire river basins, coastlines and multiple counties or states) (FEMA, 2010). Most communities in the U.S. have experienced some kind of flooding, after spring rains, heavy thunderstorms, coastal storms, or winter snow thaws. Floods are one of the most frequent and costly natural hazards in terms of human hardship and economic loss, particularly to communities that lie within flood-prone areas or floodplains of a major water source.

DEFINITIONS

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

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

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

Floodway—The channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height.

8.1 GENERAL BACKGROUND

Flooding is a general and temporary condition of partial or complete inundation on normally dry land from the following:

- Riverine flooding, including overflow from a river channel, flash floods, alluvial fan floods, dam-break floods, and ice jam floods;
- Local drainage or high groundwater levels;
- Fluctuating lake levels;
- Coastal flooding;
- Coastal erosion;
- Unusual and rapid accumulation or runoff of surface waters from any source;
- Mudflows (or mudslides);
- Collapse or subsidence of land along the shore of a lake or similar body of water that result in a flood, caused by erosion, waves or currents of water exceeding anticipated levels (Floodsmart.gov, 2012);
- Sea level rise;
- Climate Change (USEPA, 2012).

8.1.1 Flooding Types

Many floods fall into one of three categories: riverine, coastal, or shallow (FEMA, 2005). Other types of floods include alluvial fan floods, dam failure floods, and floods associated with local drainage or high groundwater. For this hazard mitigation plan and as deemed appropriate by the County, riverine/stormwater flooding are the main flood types of concern for the planning area.

Riverine

Riverine floods are the most common flood type. They occur along a channel, and include overbank and flash flooding. Channels are defined ground features that carry water through and out of a watershed. They may be called rivers, creeks, streams, or ditches. When a channel receives too much water, the excess water flows over its banks and inundates low-lying areas (FEMA, 2005).

Flash Floods

A flash flood is a rapid, extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within six hours of the causative event (e.g., intense rainfall, dam failure, ice jam). The time may vary in different areas. Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising floodwaters (NWS, 2009).

Coastal Flooding

Coastal flooding is the flooding of normally dry, low-lying coastal land, primarily caused by severe weather events along the coast, estuaries, and adjoining rivers. These flood events are some of the more frequent, costly, and deadly hazards that can impact coastal communities. Factors causing coastal flooding include:

- Storm surges, which are rises in water level above the regular astronomical tide caused by a severe storm’s wind, waves, and low atmospheric pressure. Storm surges are extremely dangerous, because they are capable of flooding large coastal areas.
- Large waves, whether driven by local winds or swell from distant storms, raise average coastal water levels and individual waves roll up over land.
- High tide levels are caused by normal variations in the astronomical tide cycle.
- Other larger scale regional and ocean scale variations are caused by seasonal heating and cooling and ocean dynamics.

Coastal floods are extremely dangerous, and the combination of tides, storm surge, and waves can cause severe damage. Coastal flooding is different from river flooding, which is generally caused by severe precipitation. Depending on the storm event, in the upper reaches of some tidal rivers, flooding from storm surge may be followed by river flooding from rain in the upland watershed. This increases the flood severity. Within the National Flood Insurance Flood Maps (discussed below), coastal flood zones identify special flood hazard areas (SFHA) which are subject to waves with heights of between 1.5 and 3 feet during a 1-percent annual chance storm (100-year event). Figure 8-1 illustrates the various SFHA zones.

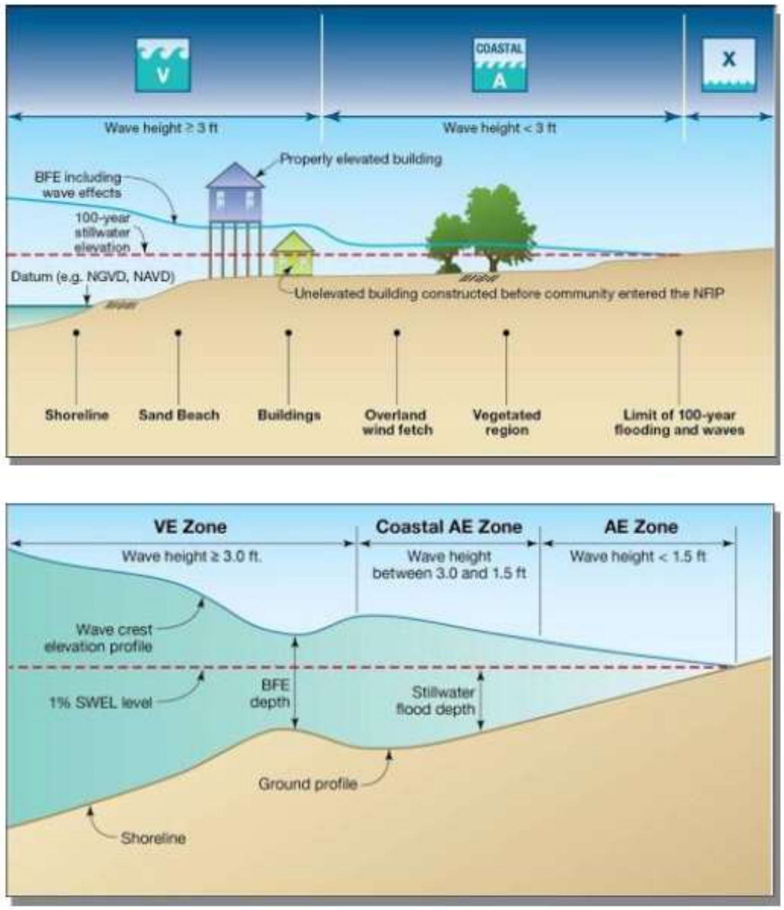


Figure 8-1 Schematic of Coastal Flood Zones within the National Flood Insurance Program

8.1.2 Dam Failure

Dam failures in the United States typically occur in one of four ways (Association of State Dam Safety Officials, 2012):

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

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

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

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

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 provides reasonable 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. The DSO regulates dams with the sole purpose of reasonably securing public safety; environmental and natural resource issues are addressed by other state agencies. The DSO neither advocates nor opposes the construction and operation of dams.

U.S. Army Corps of Engineers Dam Safety Program

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

Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) cooperates with a large number of federal and state agencies to ensure and promote dam safety. There are 3,036 dams that 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 staff inspects hydroelectric projects on an unscheduled basis to investigate the following:

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

Every five years, an independent 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 staff monitors and evaluates seismic research and applies it in investigating and performing structural analyses of hydroelectric projects. FERC staff also evaluates the effects of potential and actual large floods on the safety of dams. During and following floods, FERC staff visits dams and licensed projects, determines the extent of damage, if any, and directs any necessary studies or remedial measures the licensee must undertake. The FERC publication *Engineering Guidelines for the Evaluation of Hydropower Projects* guides the FERC engineering staff and licensees in evaluating dam safety. The publication is frequently revised to reflect current information and methodologies.

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

Mason County does have two FERC regulated hydro dams within its boundaries which are owned by the City of Tacoma, both of which are high-hazard dams (Cushman 1 and 2). In addition, it also has the Cushman Dam spillway, which is also considered a high-hazard dam.

Hazard Ratings

The DSO classifies dams and reservoirs in a hazard rating system based solely on the potential consequences to downstream life and property that would result from a failure of the dam and sudden release of water. The following codes are used as an index of the potential consequences in the downstream valley if the dam were to fail and release the reservoir water:

- 1A = Greater than 300 lives at risk (High hazard);
- 1B = From 31 to 300 lives at risk (High hazard);
- 1C = From 7 to 30 lives at risk (High hazard);
- 2 = From 1 to 6 lives at risk (Significant hazard);
- 3 = No lives at risk (Low hazard).

The Corps of Engineers developed the hazard classification system for dam failures shown in Table 8-1. The Washington and Corps of Engineers hazard rating systems are both based only on the potential consequences of a dam failure; neither system takes into account the probability of such failures.

Table 8-1
Corps of Engineers Hazard Potential Classification

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

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

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

Mason County has 22 dams within its boundaries identified by the Washington State Department of Ecology Dam Safety Program. Those dams are identified below, which is an excerpt from Ecology's website (some are also illustrated in Figure 8-2).[13] Based on review of the data, Mason County has eight (8) high hazard dams (one being the spillway head for Cushman Dam) within its boundary. One of those high-hazard dams is owned by the County, the Mason County Belfair Wastewater Treatment Plant Water Storage facility. The County also owns one Hazard Class 2 dam – the North Bay Water Reclamation Pond, and one Hazard Class 3 dam – the Haven Lake Dam on the Tahuya River.

[13] https://fortress.wa.gov/ecy/publications/documents/94016.pdf

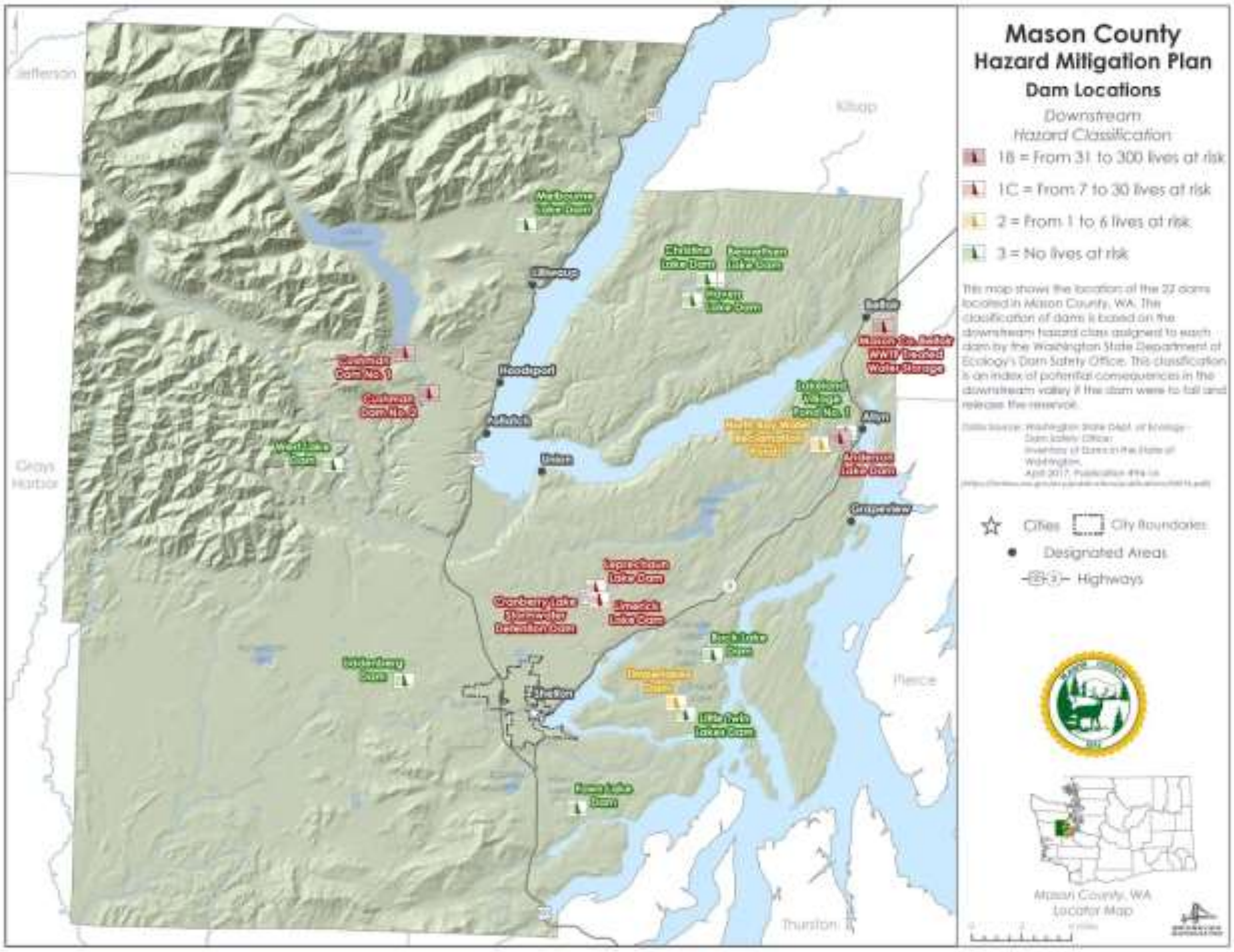


Figure 8-2 Select Mason County Dams and Hazard Classification

The owner of a dam is responsible for developing an inundation map, which is used in determining exposure to a potential dam failure or breech during development of dam response plans. Presently, no such information is available for any of the dams in Mason County. Therefore, it is not possible to estimate the population living within the inundation zone beyond the information designated in the dam classification analysis. Without the ability to perform an inundation study, it is also not possible to estimate property losses from a dam failure which could ultimately affect the planning area. While no dam failure inundation studies are available at this time, dam inundation areas may in some instances coincide with flood hazard areas. Review of the flood profile may provide a general concept of structures at risk, although, based on the size of the dams, damage would vary. As development occurs downstream of dams, it is necessary to review the dams' emergency action plans and inundation maps to determine whether the dams require reclassification based on the established standards. The County and its planning partners will continue to work with dam owners in the area to gain information for high-hazard dams.

Mason County Dam List

Dam Inventory for Mason County

Name of Dam	River or Stream	Dam Types	Reservoir Purposes	Name of Owner	Impoundment Name	Crest Len	Dam Ht	Surface Area	State ID	Latitude	Storage	National ID	Longitude	Max Storage	Yr Completed	Sec Twn Rnge	Max Discharge	Hazard Class	WRIA	Drainage Area
Anderson Lake Dam	Unnamed Tr-Sherwood Creek	RE	R	Lakeland Village Community Club	Lake Anderson	240 ft	28 ft	44.0 acres	MA14-114	47.3795200 deg	370 acre-ft	WA00114	122.848751 deg	600 acre-ft	1966	T22 NR01 WS19	520 cfs	1B	14	0.95 sq mi
Bennettsen Lake Dam	Tr-Tahuya River	RE	R	WA DNR State Land Divisions	Lake Bennettsen	150 ft	11 ft	26.0 acres	MA15-351	47.4682740 deg	253 acre-ft	WA00351	122.959727 deg	270 acre-ft	1971	T23 NR02 WS20	37 cfs	3	15	0.18 sq mi
Buck Lake Dam	Tr-Jones Creek	RE	R	Buck Lake Cmpgd Assn	unnamed	140 ft	12 ft	4.0 acres	MA14-1316	47.2512210 deg	4 acre-ft	WA01316	122.951327 deg	15 acre-ft	1973	T20 NR02 WS05	0 cfs	3	14	0.00 sq mi
Christine Lake Dam	Tr-Tahuya River	RE	R	Lake Christine Comm Club Inc	Lake Christine	130 ft	18 ft	14.1 acres	MA15-117	47.4696020 deg	104 acre-ft	WA00117	122.96679 deg	140 acre-ft	1967	T23 NR02 WS20	180 cfs	3	15	1.00 sq mi
Cranberry Lake Stormwater Detention Dam	Cranberry Creek	RE	C	Lake Limerick Country Club Inc	Cranberry Lake	350 ft	8 ft	450.0 acres	MA14-594	47.2839900 deg	2600 acre-ft	WA00594	123.063477 deg	3425 acre-ft	1990	T21 NR03 WS28	655 cfs	1C	14	5.84 sq mi
Cushman Dam No. 1	North Fork Skokomish River	VA	C, H, R	Tacoma City Public Utilities	Lake Cushman	1111 ft	275 ft	4,010.0 acres	MA16-145	47.4214800 deg	453350 acre-ft	WA00145	123.222936 deg	473400 acre-ft	1926	T22 NR04 WS05	40750 cfs	1B	16	95.00 sq mi
Cushman Dam No. 1 - Spillway Headworks	North Fork Skokomish River	PG, RE	H, R	Tacoma City Public Utilities	Cushman Lake	430 ft	76 ft	4,010.0 acres	MA16-604	47.4184810 deg	453350 acre-ft	WA00604	123.223908 deg	473400 acre-ft	1990	T22 NR04 WS05	40750 cfs	1B	16	95.00 sq mi
Cushman Dam No. 2	North Fork Skokomish River	VA	H, R	Tacoma City Public Utilities	Lake Kokanee	460 ft	235 ft	150.0 acres	MA16-146	47.3981470 deg	8000 acre-ft	WA00146	123.201268 deg	8600 acre-ft	1930	T22 NR04 WS16	35000 cfs	1B	16	103.00 sq mi
Fawn Lake Dam	Tr-Puget Sound	RE	R	Fawn Lake Maintenance Commission	Fawn Lake	240 ft	36 ft	56.0 acres	MA14-91	47.1613040 deg	580 acre-ft	WA00091	123.063093 deg	640 acre-ft	1966	T19 NR03 WS04	80 cfs	3	14	0.74 sq mi
Haven Lake Dam	Tr-Tahuya River	PG	F	Mason County	unnamed	100 ft	4 ft	69.0 acres	MA15-525	47.4574050 deg	69 acre-ft	WA00525	122.977016 deg	130 acre-ft	1965	T23 NR02 WS30	2 cfs	3	15	1.13 sq mi
Lakeland Village Pond No. 1	Tr-Sherwood Creek	RE	C, R	Lakeland Village Community Club	unnamed	150 ft	18 ft	12.0 acres	MA14-1457	47.3839960 deg	12 acre-ft	WA01457	122.84388 deg	25 acre-ft	1970	T22 NR01 WS19	10 cfs	3	14	0.10 sq mi
Leprechaun Lake Dam	Tr-Cranberry Creek	RE	R	Lake Limerick Country Club Inc	Lake Leprechaun	162 ft	13 ft	6.7 acres	MA14-113	47.2879100 deg	38 acre-ft	WA00113	123.056076 deg	86 acre-ft	1966	T21 NR03 WS22	135 cfs	1C	14	0.30 sq mi
Limerick Lake Dam	Cranberry Creek	RE	R	Lake Limerick Country Club Inc	Lake Limerick	400 ft	34 ft	130.0 acres	MA14-130	47.2804860 deg	920 acre-ft	WA00130	123.0461 deg	1528 acre-ft	1966	T21 NR03 WS27	1710 cfs	1C	14	13.00 sq mi
Little Twin Lakes Dam	Tr-Campbell Creek	RE	R	Timberlake Community Club Inc	Little Twin Lake	480 ft	25 ft	5.5 acres	MA14-90	47.2164950 deg	77 acre-ft	WA00090	122.972425 deg	104 acre-ft	1966	T20 NR02 WS18	21 cfs	3	14	0.20 sq mi
Mason Co. Belfair WWTP Treated Water Storage	Coulter Creek		Q	Brian K. Matthews	unnamed	1700 ft	70 ft		MA15-728	47.4453040 deg	180 acre-ft	WA00728	122.812262 deg	209 acre-ft	2011	T23 NR01 WS33	139 cfs	1B	15	12.70 sq mi
Melbourne Lake Dam	Tr-Eagle Creek	RE	F, R	WDFW	Melbourne Lake	100 ft	9 ft	35.0 acres	MA16-245	47.4981470 deg	136 acre-ft	WA00245	123.122935 deg	238 acre-ft	1957	T23 NR03 WS07	0 cfs	3	16	2.17 sq mi
North Bay Water Reclamation Pond 1	Sherwood Creek - Offstream	RE	Q	Mason County	North Bay Water Reclamation Pond	1000 ft	14 ft	4.6 acres	MA14-1828	47.3757800 deg	0 acre-ft	WA01828	122.863346 deg	21 acre-ft	2000		0 cfs	2	14	0.00 sq mi
Rosand Dam	Tr-Johns Creek	CB	R	Donald & Cheryl Hornal	unnamed	11 ft	4 ft	15.0 acres	MA14-1069	47.2518500 deg	15 acre-ft	WA01069	123.098122 deg	15 acre-ft	1970	T20 NR03 WS06	15 cfs	3	14	0.00 sq mi
Timberlakes Dam	Tr-Campbell Creek	RE	R	Timberlake Community Club	Big Twin Lake	205 ft	29 ft	15.2 acres	MA14-89	47.2237450 deg	828 acre-ft	WA00089	122.981868 deg	904 acre-ft	1968	T20 NR02 WS18	404 cfs	2	14	2.15 sq mi
Trask Lake Dam	Tr-Shumocher Creek	RE	R	Lake Trask Timber Trails Assn	Trask Lake	80 ft	10 ft	13.0 acres	MA14-521	47.3321920 deg	40 acre-ft	WA00521	122.987962 deg	50 acre-ft	1969	T21 NR02 WS06	95 cfs	2	14	0.85 sq mi
Uddenberg Dam	North Fork Goldsborough Creek	RE	R	West Coast Latvian Education Center	unnamed	500 ft	10 ft	80.0 acres	MA14-1283	47.2308280 deg	80 acre-ft	WA01283	123.212707 deg	150 acre-ft	1968	T20 NR04 WS08	0 cfs	3	14	0.00 sq mi
West Lake Dam	Tr-Skokomish River	RE	F, R	WDFW	West Lake	72 ft	6 ft	16.5 acres	MA16-248	47.3536180 deg	150 acre-ft	WA00248	123.2803 deg	300 acre-ft	1959	T22 NR05 WS35	0 cfs	3	16	0.80 sq mi

Source: Washington State Department of Ecology

8.1.3 Measuring Floods and Floodplains

A floodplain is the area adjacent to a river, creek or lake that becomes inundated during a flood. Floodplains may be broad, as when a river crosses an extensive flat landscape, or narrow, as when a river is confined in a canyon. Connections between a river and its floodplain are most apparent during and after major flood events. These areas form a complex physical and biological system that not only supports a variety of natural resources but also provides natural flood and erosion control. When a river is separated from its floodplain with levees and other flood control facilities, natural, built-in benefits can be lost, altered, or significantly reduced.

In the case of riverine or flash flooding, once a river reaches flood stage, the flood extent or severity categories used by the NWS include minor flooding, moderate flooding, and major flooding. Each category has a definition based on property damage and public threat (NWS, 2011):

- Minor Flooding—Minimal or no property damage, but possibly some public threat or inconvenience.
- Moderate Flooding—Some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations are necessary.
- Major Flooding—Extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations.

8.1.4 Flood Insurance Rate Maps

According to FEMA, flood hazard areas are defined as areas that are shown to be inundated by a flood of a given magnitude on a map (see Figure 8-3). These areas are determined using statistical analyses of records of river flow, storm tides, and rainfall; information obtained through consultation with the community; floodplain topographic surveys; and hydrologic and hydraulic analyses. Three primary areas make up the flood hazard area: the floodplains, floodways, and floodway fringes. Figure 8-4 depicts the relationship among the various designations, collectively referred to as the special flood hazard area.

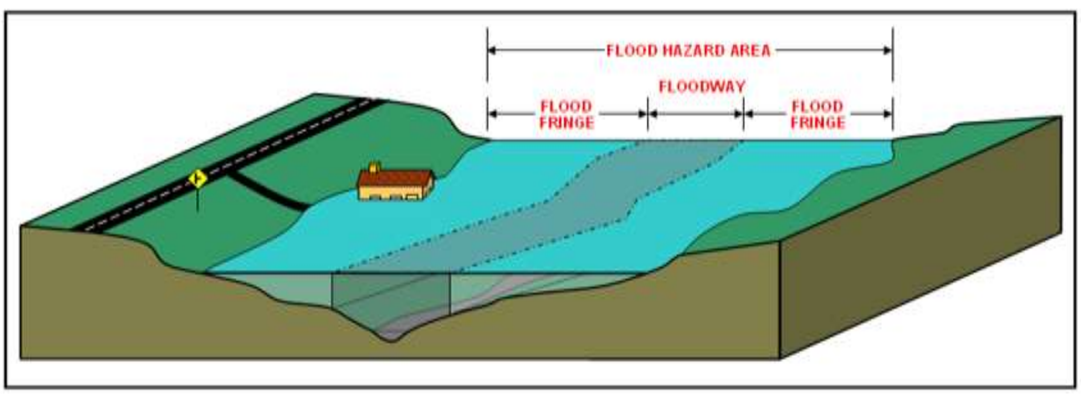


Figure 8-3 Flood Hazard Area Referred to as a Floodplain

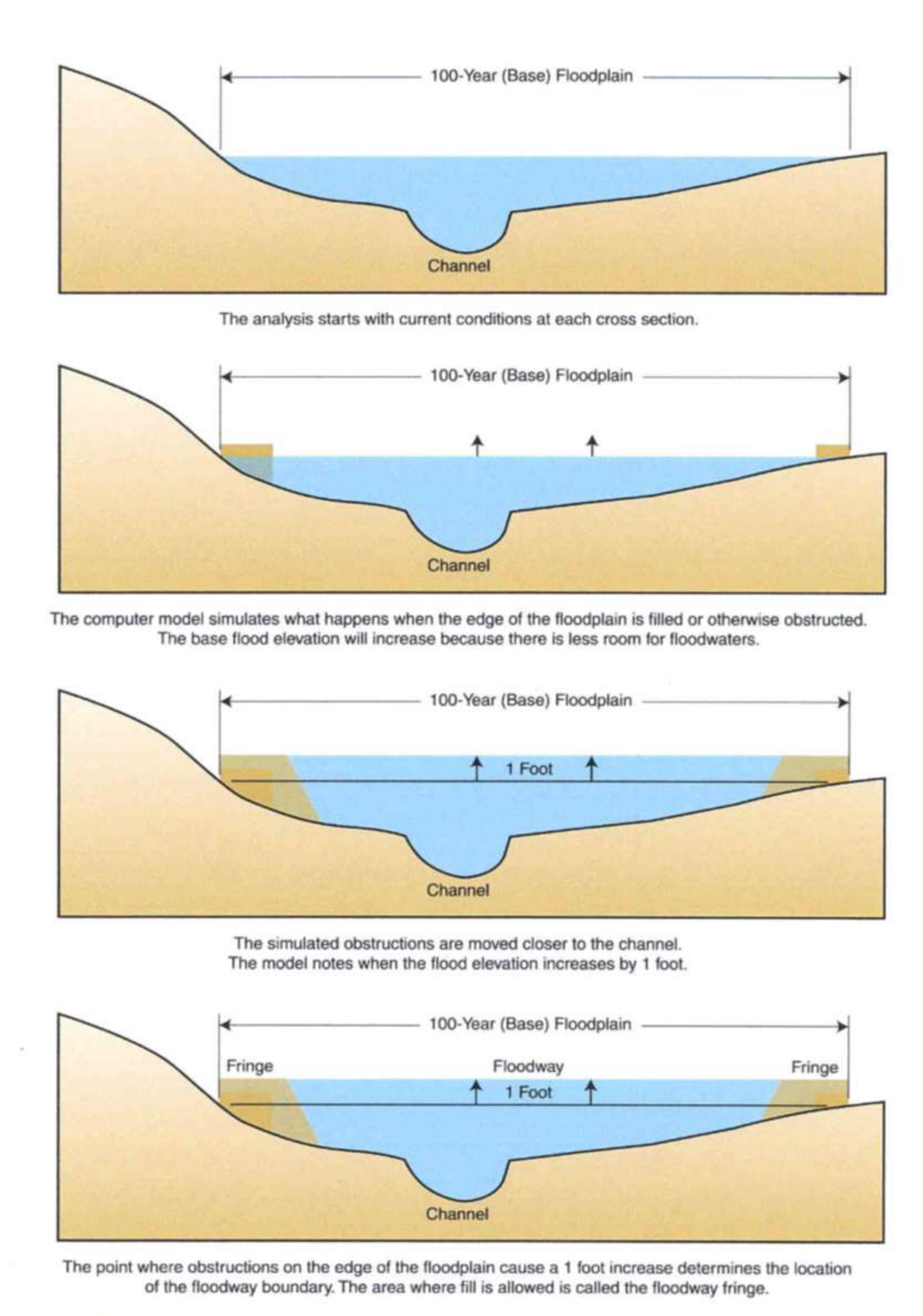


Figure 8-4 Special Flood Hazard Area

Flood hazard areas are delineated on FEMA's Flood Insurance Rate Maps (FIRM), which are official maps of a community on which the Federal Insurance and Mitigation Administration has indicated both the special flood hazard areas and the risk premium zones applicable to the community. These maps identify the special flood hazard areas; the location of a specific property in relation to the special flood hazard area; the base (100-year) flood elevation at a specific site; the magnitude of a flood hazard in a specific area; and undeveloped coastal barriers where flood insurance is not available. The maps also locate regulatory floodways and floodplain boundaries—the 100-year and 500-year floodplain boundaries (FEMA, 2003; FEMA, 2005; FEMA, 2008).

The frequency and severity of flooding are measured using a discharge probability, which is a statistical tool used to define the probability that a certain river discharge (flow) level will be equaled or exceeded within a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels.

The 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, 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.

A structure located within a 1 percent (100-year) floodplain has a 26 percent chance of suffering flood damage during the term of a 30-year mortgage. The 100-year flood is a regulatory standard used by federal agencies and most states to administer floodplain management programs. The 1 percent (100-year) annual chance flood is used by the NFIP as the basis for insurance requirements nationwide. FIRMs also depict 500-year flood designations, which is a boundary of the flood that has a 0.2-percent chance of being equaled or exceeded in any given year (FEMA, 2003; FEMA, 2005). It is important to recognize, however, that flood events and flood risk are not limited to the NFIP delineated flood hazard areas.

8.1.5 National Flood Insurance Program (NFIP)

The NFIP is a federal program enabling property owners in participating communities to purchase insurance as a protection against flood losses in exchange for state and community floodplain management regulations that reduce future flood damage. The U.S. Congress established the NFIP with the passage of the National Flood Insurance Act of 1968 (FEMA’s 2002 *National Flood Insurance Program (NFIP): Program Description*). There are three components to the NFIP: flood insurance, floodplain management and flood hazard mapping. Nearly 20,000 communities across the U.S. and its territories participate in the NFIP by adopting and enforcing floodplain management ordinances to reduce future flood damage. In exchange, the NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in these communities. Community participation in the NFIP is voluntary.

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 (the 500-year flood). Base flood elevations and the boundaries of the 100- and 500-year floodplains are shown on Flood Insurance Rate Maps (FIRMs), which are the principle tool for identifying the extent and location of the flood hazard. FIRMs are the most detailed and consistent data source available, and for many communities they represent the minimum area of oversight under their floodplain management program.

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

- New buildings and those undergoing substantial improvements must, at a minimum, be elevated to protect against damage by the 100-year flood.

- New floodplain development must not aggravate existing flood problems or increase damage to other properties.
- New floodplain development must exercise a reasonable and prudent effort to reduce its adverse impacts on threatened salmonid species.

NFIP Status and Severe Loss/Repetitive Loss Properties

Mason County is a member in good standing in the NFIP, and does incorporate regulatory authority within its land use planning. Table 8-2 presents the NFIP policy status as of January 31, 2017.

Table 8-2
NFIP Insurance Policies in Force

Community Name	Policies In-Force	Insurance In-Force	Premiums In-Force
Mason County	421	100,439,800	412,997
Shelton, City of	22	4,157,000	37,590
Skokomish Indian Tribe	5	1,387,800	11,076

Source: http://bsa.nfipstat.fema.gov/reports/1011.htm#WAT

Repetitive Flood Claims

Residential or non-residential (commercial) properties that have received one or more NFIP insurance payments are identified as repetitive flood properties under the NFIP. Such properties are eligible for funding to help mitigate the impacts of flooding through various FEMA programs, subject to meeting certain criteria and based on the State's Hazard Mitigation Plan maintaining a Repetitive Loss Strategy. Washington State's 2013 Hazard Mitigation Plan does contain such a strategy. Specifically, the Repetitive Loss Strategy must identify the specific actions the State has taken to reduce the number of repetitive loss properties, which must include severe repetitive loss properties, and specify how the State intends to reduce the number of such repetitive loss properties. In addition, the hazard mitigation plan must describe the State's strategy to ensure that local jurisdictions with severe repetitive loss properties take actions to reduce the number of these properties, including the development of local hazard mitigation plans.

Repetitive flood claims provide funding to reduce or eliminate the long-term risk of flood damage to structures insured under the NFIP that have had one or more claim payments for flood damages.

Severe Repetitive Loss Program

The severe repetitive loss program is authorized by Section 1361A of the National Flood Insurance Act (42 U.S.C. 4102a), with the goal of reducing flood damages to residential properties that have experienced *severe* repetitive losses under flood insurance coverage and that will result in the greatest savings to the NFIP in the shortest period of time. A severe repetitive loss property is a residential property that is covered under an NFIP flood insurance policy and:

- a) That has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or
- b) For which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

For both (a) and (b) above, at least two of the referenced claims must have occurred within any 10-year period, and must be greater than 10 days apart.

The Community Rating System

The Community Rating System (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.

Flood claim, repetitive loss, and severe repetitive loss property data is indicated in Table 8-3, which also identifies the CRS Community Status in the County. At present, the planning partnership does not feel the level of effort to become a CRS community is warranted, nor within the capacity of the present staffing levels to facility such an endeavor.

Table 8-3
Community Status and Claims

Community Name	Total Population	CRS Community	Flood Claims	Total Losses Paid	Repetitive Loss Properties*	Severe Repetitive Loss (SRL) Properties*	(SRL) Losses Paid
City of Shelton	9,810	N	8	$133K	3	2	$185K
Unincorporated Areas of County	49,732	N	192	$3.7M	27	1	$82K
Squaxin Island Tribe	405	N	--	--	--	--	--
Skokomish Indian Tribe	730	N	1	<$1K	1		
TOTAL	**60,791**	**--**	**201**	**$3.8M**	**30**	**3**	**$267K**

Note: Repetitive Loss (12/2016) and Severe Repetitive Loss Data (2/2016) from State and FEMA sources (variations exist, but worst-case scenario presented); Population data obtained from 2015 US Census Bureau. Unincorporated County population statistics were calculated by subtracting the populations of the City of Shelton, the Squaxin Island Reservation, and the Skokomish Indian Reservation from Mason County (FEMA Risk Report). *= Residential Structures.

8.2 HAZARD PROFILE

8.2.1 Extent and Location

Flooding is the most common hazard occurring in Mason County, and is mostly due to riverine and urban flooding. Riverine flooding is seen on all main rivers and tributaries in the rural portions of the county. Urban flooding generally occurs within the boundaries of the City of Shelton, and the Belfair and Allyn urban growth areas. In addition, the County is also subject to coastal flooding.

FEMA 2017 Flood Maps

FEMA performed a new flood study for Mason County that resulted in the creation of new flood maps which were adopted in March 2017. The project updated flood modeling along the Mason County coastline, as well as multiple riverine and lake analyses throughout the county. In addition to new FIRMs, FEMA also developed the flood risk assessment products used in their Risk Report, which supports much of the flood data utilized throughout this HMP update.

Mason County's 100- and 500-year flood areas are illustrated in Figure 8-5. It should be noted that only a very small area, or 0.3863 square miles of land fall within the 500-year flood hazard area based on the 2017 FIRMs.

As a result of the new FIRMS, FEMA developed depth grids for the 1-percent-annual-chance flood for the coastal and riverine areas, as well as 2-percent and 0.2-percent-annual-chance flood depth grids for Union River, Tahuya River, Coffee Creek, and Goldsborough Creek. FEMA also generated the depth grids from the flood model, which show the level of flooding in feet. The project team used the depth grids in the risk assessment to determine which properties are affected by flooding. The 1-percent-annual-chance depth grid for the City of Shelton area is shown Figure 8-6. Detailed information containing all data in the report is available for download from FEMA's website, or available for viewing from the County's Floodplain Manager.

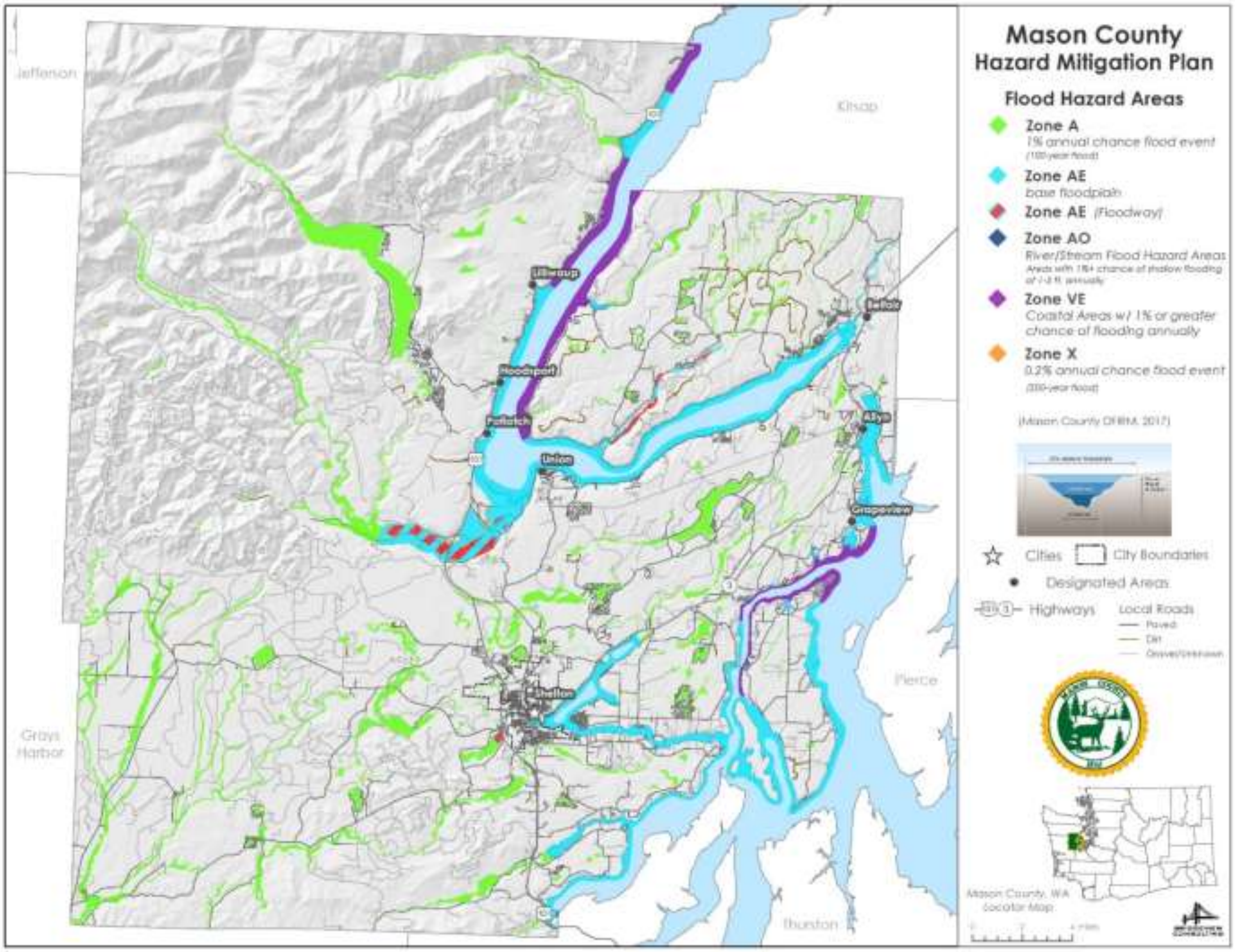


Figure 8-5 Mason County 100-and 500-Year Flood Hazard Areas

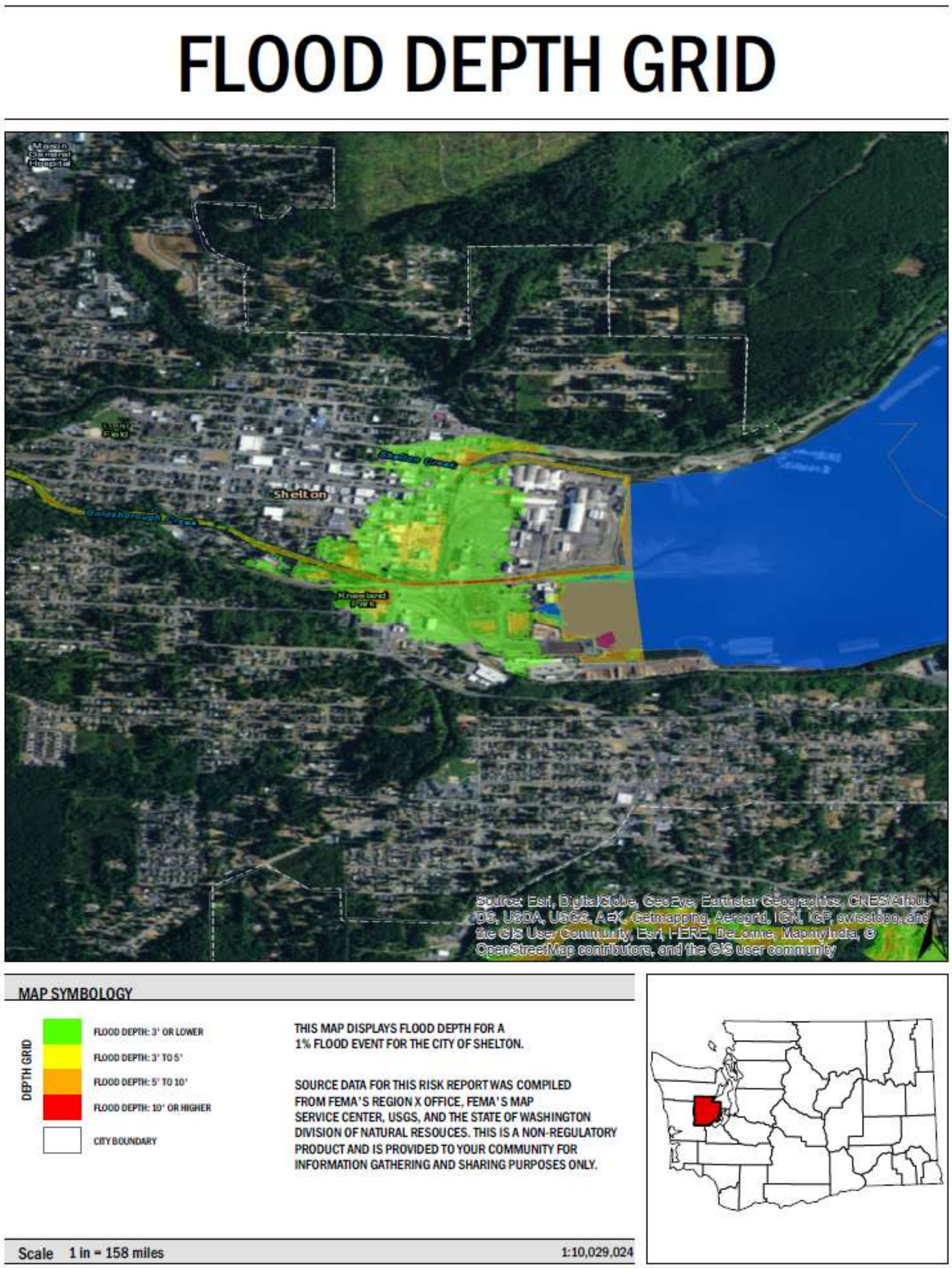


Figure 8-6 100-Year Flood Hazard Depth Grid for the City of Shelton (FEMA 2017 Risk Report)

Principal Flooding Sources

Most flooding in Mason County is due to river and urban flooding. Riverine flooding is seen on all main rivers and tributaries in the rural portions of the county. Urban flooding generally occurs within the boundaries of the Shelton, Belfair, and Allyn urban growth areas.

Principal flooding sources in Mason County are influenced by several rivers, including the Satsop, Tahuya, Union, and Skokomish Rivers. Flooding in the first three rivers can effectively cut off pockets of residents due to mudslides and water over the roadways. The primary flood concern in Mason County is the Skokomish River. The National Weather Service (NWS) refers to the Skokomish River as the "flashiest river in Washington, where a teaspoon of rain can result in flooding." Flooding on the Skokomish River causes closure of U. S. Highway 101, the main north-south route through Mason County, at least once annually.

The Skokomish River Basin, located on the Great Bend of Hood Canal, is a natural fjord-like arm of the Puget Sound and water of national significance identified by the U.S. Environmental Protection Agency (EPA). The Skokomish River is the largest source of freshwater to Hood Canal and of critical importance to the overall health of Hood Canal, draining approximately 240 square miles of forested terrain into Hood Canal. According to a 2015 study conducted by the US Army Corps of Engineers (USACE), the ecosystem in the Skokomish River Basin, which includes the Skokomish Indian Reservation, has been significantly degraded, with high sediment load, reduced flows, and encroachment on the floodplain by human-made structures causing continued degradation of natural ecosystem structures, functions, and processes throughout the basin. Channel capacity of the mainstem and South Fork Skokomish Rivers, as well as Vance Creek have been significantly reduced due to sediment accumulation. The mainstem has lost about 10,000 cfs of flow capacity since 1941 (USACE, 2015, p. 77). Aggradation is suspected to have been occurring since 1912 as a result of flooding evidence experienced at that time. During storms, gravel eroded from landslides deposits and is transported to lower channels as bedload. As floodwaters recede, the streams and rivers do not have enough stream energy to transport the bedload, causing accumulation in channels, increasing the level of floodwaters over the banks due to lower stream capacity. Over the course of time, this has, and will continue to increase flooding both in frequency and size in the area.

Areas of the Tahuya Peninsula have been severely impacted by flooding from both the Tahuya and Union Rivers, in addition to the majority of the smaller creeks. Incidents such as the December 2007 severe storm event impacted several small creeks along US Highway 101 between Hoodsport and Lilliwaup. These creeks include Finch, Clark, Miller, and Sund Creeks (see Figure 8-7 below). Incidents such as the December 2007 storm event resulted in large quantities of alluvial material being deposited in the lower stream reaches. These streams now exhibit significant aggradation, which has elevated the streambeds and consequently will likely continue to cause flooding. Finch Creek experienced severe bank erosion. At least six (6) property owners required bank armoring in order to protect homes and septic systems. Several homes in the Holiday Beach area (Miller Creek) experienced flooding.

Tidal changes from Hood Canal combined with increased runoff from the Olympics have produced a history of frequent flooding in Mason County.

8.2.2 Previous Occurrences

Major floods in the planning area have resulted from intense rainstorms customarily between October and April. Table 8-4 highlights typical historical flood events. It should be noted that due to the disaster typing which occurs at the FEMA level, there are other types of events which also include flooding, but due to the typing, those are not referenced within this chapter. Specific examples of this include Severe Weather events which include flooding as a hazard of impact. Viewers should also review the Severe Weather hazard profile for additional information.

8.2.3 Severity

The severity of a flood depends not only on the amount of water that accumulates in a period of time, but also on the land's ability to manage this water. One element is the size of rivers and streams in an area; but an equally important factor is the land's absorbency. When it rains, soil acts as a sponge. When the land is saturated or frozen, infiltration into the ground slows and any more water that accumulates must flow as runoff (Harris, 2001).

The principal factors affecting flood damage are flood depth and velocity. The deeper and faster flood flows become, the more damage they can cause. Shallow flooding with high velocities can cause as much damage as deep flooding with slow velocity. This is especially true when a channel migrates over a broad floodplain, redirecting high velocity flows and transporting debris and sediment. Flood severity is often evaluated by examining peak discharges. Figure 8-8 and Figure 8-9 illustrates the December 3, 2007 Severe Storm event (DR-1734), when U.S. Highway 101 was inundated due to approximately four feet of floodwaters crossing the roadway.

Other areas of the Tahuya Peninsula have been severely impacted by flooding from both the Tahuya and Union Rivers, but also the majority of the smaller creeks. One of the County's identified action items in the 2010 plan was to work with the USGS and other agencies to install river gauges or other technology on rivers other than the Skokomish. The County is aware of two (2) repetitive flood loss properties within the Tahuya River watershed, but without accurate frequency determinations it is extremely difficult to develop cost-effective mitigation solutions. This 2010 project has been brought forward to the 2018 plan update.

The December 2007 storm event impacted several small creeks along US Highway 101 between Hoodsport and Lilliwaup that previously had not had a significant documented history of flooding. These creeks include Finch, Clark, Miller, and Sund Creeks (see Figure 8-7). During the 2007 storm event, a large quantity of alluvial material was deposited in the lower stream reaches. These streams now exhibit significant aggradation, which has elevated the streambeds and consequently will likely continue to cause flooding. Finch Creek experienced severe bank erosion. At least six (6) property owners required bank armoring in order to protect homes and septic systems. Several homes in the Holiday Beach area (Miller Creek) experienced flooding.

These types of incidents indicate that more areas are becoming prone to flooding. As of 2017, there are approximately 58.675089 square miles of land within the 100-year and 0.3863 sq. miles of land within the 500-year flood hazard areas based on the identified flood hazard area within the 2017 FIRMs. In 2010, during the last HMP update process, there were approximately 23 square miles of land within the flood hazard area.

8.2.4 Frequency

Mason County experiences some level of flooding on an annual basis. What customarily constituted the "normal" flood season of October through April in Western Washington does not necessarily apply to the Skokomish River, which has received Flood Warnings issued by the National Weather Service during the month of July.

Large floods that can cause property damage have occurred eight times during the time period 1964 through 2016. Frequency for this calculation was based on the period covering 1964 to 2016, and the number of events averaged based on years and number of floods. It should be noted that this does not reflect the recurrence interval, as that calculation is specific on varying factors, such as the incident type, discharge rate, etc., and that type of analysis was not included in this process. Based on this method of assessment, the return interval is 6.5 years, or a 15 percent chance of some level of a flood event occurring every year.

Figure 8-7 Finch, Clark, Miller and Sund Creeks

Table 8-4
Flood Events Impacting Planning Area 1964-2016

Disaster Number	Declaration Date	Disaster Type	Incident Type	Title	Incident Begin Date	Incident End Date	PA Dollars Obligated or Losses (State)
4253	2/2/2016	DR	Flood	Severe Winter Storm, Straight-Line Winds, Flooding, Landslides, and Tornado	12/1/2015	12/14/2015	$3,166,346
Several days of heavy rain in December 2015 resulted in widespread flooding of roadways, homes, and property. On February 2, 2016, Federal disaster aid was made available to the State of Washington to supplement state, tribal, and local recovery efforts in the Mason County and other areas affected by the flooding.							
1817	1/30/2009	DR	Flood	Severe Winter Storm, Landslides, Mudslides, & Flooding	1/6/2009	1/16/2009	
January 2009- Washington State was hit with severe winter storms that brought heavy rains and warmer temperatures, resulting in snow melting causing flooding, land- and mudslides. ~12 county roads were impacted by flooding; three homes were destroyed; two had major damage; three had minor damage; and 12 more were affected. Costs for damages due to flooding were estimated at $750,000. Mason County received $65,000 of HMGP funds to update their HMP.							
1172	4/2/1997	DR	Flood	Heavy Rains, Snow Melt, Flooding, Land Slides	3/18/1997	3/28/1997	$50,889,413
A week of torrential rain in late March 1997 created flooding and landslides in multiple places in Washington State. In Mason County, multiple roads were closed and five homes were posted for evacuation.							
883	11/26/1990	DR	Flood	Severe Storms & Flooding	11/9/1990	12/20/1990	$2.9 million
Two individuals died as a result of this incident statewide. Over the Thanksgiving weekend, between 8 and 15 inches of rain fell. County road damage, including replacement costs for a bridge over Mission Creek, totaled $260,000. Several homes were extensively damaged in the Skokomish Valley and two homes were uninhabitable. Twenty-five people were evacuated from the Skokomish Valley. Highways and roads were closed. Residents lost power. On November 26, 1990, Federal disaster aid was made available. Mason County received $754,238 of HMGP funds for the East Bourgault Road area property acquisition project.							
612	12/31/1979	DR	Flood	Storms, High Tides, Mudslides & Flooding	12/31/1979	12/31/1979	
Heavy rains and snowmelt caused floods, mudslides, and road washouts. Twenty-eight Skokomish Valley residents were evacuated. Damage to county roads was estimated at $375,000 to $515,000 and damage to other property was estimated at $160,000.							
492	12/13/1975	DR	Flood	Severe Storms & Flooding	12/13/1975	12/13/1975	
Damage to county roads totaled ~ $185,000. Flooding in Skokomish Valley damaged a number of levees. Numerous residences had water damage. Several persons were evacuated from their homes by boat. The total estimate of damage to private and farm land was $300,000.							
414	1/25/1974	DR	Flood	Severe Storms, Snowmelt & Flooding	1/25/1974	1/25/1974	Unknown
Impacts included roadway closures resulting from flooding and landslides in the area.							
185	12/29/1964	DR	Flood	Heavy Rains & Flooding	12/29/1964	12/29/1964	
In December 1964, snow and heavy rains caused slides and run-off knocking two houses 12 feet off of their foundations, covering half of Hwy 21 above Alderbrook. One house was unoccupied. The other residents were not injured. Slides and running water closed the Purdy Cut-Off Road. Snow accumulation amounted to 20 inches in Union and Hoodsport areas, 19 inches at Lilliwaup, 16 inches at							

Table 8-4 Flood Events Impacting Planning Area 1964-2016
Dayton, 20 inches in the Matlock area, and 36 inches at the upper end of Lake Cushman. Shelton, Kiamichi, and Mary M. Knight schools were closed for 1 day. Falling branches and the weight of the snow caused numerous power outages. Numerous reports were received of roofs of barns, sheds, carports, and garages collapsing under the weight of the snow. Snow (4 ½ feet deep) closed logging operations at Camps Grisdale and Govey. Dairymen in the Skokomish Valley couldn't operate milking machines or water cattle due to power outages. At the height of the storm only 150 of the 1600 PUD customers had electricity. Cost of the storm damage was estimated between $25,000 and $30,000.

Figure 8-8 December 3, 2007 Incident Highway 101 North of Shelton

Figure 8-9 Belfair-Tahuya Bridge on the Tahuya River December 2007 (DR 1734)

8.3 VULNERABILITY ASSESSMENT

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For this planning purpose, the flood hazard areas identified include the 1-percent (100-year) floodplain and the coastal floodplain. The following text evaluates and estimates the potential impact of flooding in Mason County.

8.3.1 Overview

All types of flooding can cause widespread damage throughout rural and urban areas, including but not limited to: water-related damage to the interior and exterior of buildings; destruction of electrical and other expensive and difficult-to-replace equipment; injury and loss of life; proliferation of disease vectors; disruption of utilities, including water, sewer, electricity, communications networks and facilities; loss of agricultural crops and livestock; placement of stress on emergency response and healthcare facilities and personnel; loss of productivity; and displacement of persons from homes and places of employment.

Methodology

The 1 percent (100-year) annual chance Riverine flood and the 1 percent (100-year) Coastal events were examined to evaluate Mason County's risk and vulnerability to the flood hazard. These events are generally those considered by planners and evaluated under federal programs such as the NFIP.

In completing the analysis, a modified Level 1/Level 2 (for updated critical facilities and user defined facilities) Hazus protocol was used to assess exposure to flooding in the planning area. This type of analysis has a level of accuracy acceptable for planning purposes. Where possible, the Hazus default data was enhanced using critical infrastructure and building data provided by the County, as well as data from the state and federal sources.

As indicated, the County's FIRMs were adopted during this HMP planning cycle in March 2017. As such, that data was determined to be the best available science for use in this update. The project team completed the flood risk assessment using local parcel and assessors' data from Mason County, in addition to coastal and riverine flood depth grids derived from this Risk MAP project. For this assessment, the FEMA team used a coastal flood depth grid for the coastal area.

The team also completed an assessment for riverine areas, incorporating individual building data into Hazus, which allows losses to be reported at the building level.

During the HMP update, the planning team also developed a new list of critical facilities, which was also loaded into Hazus and utilized throughout the various processes.

Warning Time

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

8.3.2 Impact on Life, Health, and Safety

The impact of flooding on life, health and safety is dependent upon several factors including the severity of the event and whether or not adequate warning time is provided to residents. Exposure represents the population living in or near floodplain areas that could be impacted should a flood event occur. Additionally, exposure should not be limited to only those who reside in a defined hazard zone, but everyone who may be affected by the effects of a hazard event (e.g., people are at risk while traveling in flooded areas, or their access to emergency services is compromised during an event). The degree of that impact will vary and is not measurable.

Of significant concern within the planning area is the number of tourists who can be impacted during periods of flooding. Tourism is a fairly large economy within the planning area (the Olympic National Forest, water sports, large recreational camping locations, Little Creek Casino, owned by the Squaxin Tribe), with many tourists traveling through the area to view the scenic area. In addition, tourism is increased as a result of recreational activities, especially during summer months.

To estimate the population exposed to the 1 percent and 0.2 percent annual chance (100- and 500-year) flood events, the DFIRM floodplain boundaries were intersected with residential parcels (based off of Mason County Assessor data) whose centers intersect the floodplain. Total population was estimated by multiplying the number of residential structures by the average Mason County household size of 2 persons per household. Table 8-5 lists the estimated population located within these flood zones by municipality.

Table 8-5 Vulnerable Populations within Flood Hazard Areas		
Jurisdiction	Population in the 1% annual chance event (100- Year) Flood Boundary	Population in the 0.2% annual chance (500-Year) Flood Boundary
Unincorporated Mason County	1,818	742
Shelton, City of	486	512
Allyn	0	0
Belfair	22	0
Total	2,326	1,254
**Based on residential structures within the 100-year and 500-year floodplains and an estimate of 2 persons per residential structure*		

Of the population exposed, the most vulnerable include the economically disadvantaged and the population over the age of 65. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on the net economic impact on their family. The population over the age of 65 is also more vulnerable because they are more likely to seek or need medical attention which may not be available due to isolation during a flood event and they may have more difficulty evacuating.

The number of injuries and casualties resulting from flooding is generally limited based on advance weather forecasting, blockades, and warnings. Therefore, injuries and deaths generally are not anticipated if proper warning and precautions are in place. Ongoing mitigation efforts should help to avoid the most likely cause of injury, which results from persons trying to cross flooded roadways or channels during a flood.

8.3.3 Impact on Property

Table 8-6 summarizes the total number of structures and losses by coastal and riverine hazards, and number of structures within the SFHAs which would be inundated by the 1-percent-annual-chance flood. Figure 8-10 illustrates the general building stock at risk as determined during FEMA's 2017 flood study.

TABLE 8-6 STRUCTURES AT RISK										
Community	Total Estimated Building (Bldg) Value	Total Number Of Bldg	Bldg Dollar Loss For A 1% Annual Chance Coastal Flood Event	Loss Ratio (Dollar Losses/ Total Bldg Value)	Bldg Dollar Loss For A 1% Annual Chance Riverine Flood Event	Loss Ratio (Dollar Losses/ Total Bldgs Value)	Number Of Bldgs Within The VE Zone	Number Of Bldgs within the AE or A Zones	Number of Bldgs within the SFHA	Per-Cent Of Bldgs in the SFHA
City of Shelton	$422.6 M	3,279	-	-	$1.4M	<1%	0	93	93	2.8%
Skokomish Indian Reservation	$36.4 M	381	$69.7k	<1%	<$3.1k	<1%	0	31	31	8.1%
Squaxin Island Reservation*	--	--	-	-	-	-	-	-	-	-
Unincorporated Mason County	$3.5B	$27,118	$13.2M	<1%	$22.0M	<1%	135	1986	2121	7.8%
Total	**$4.0B**	**30,778**	**$13.3M**	**<1%**	**$23.5M**	**<1%**	**135**	**2110**	**2245**	**7.3%**

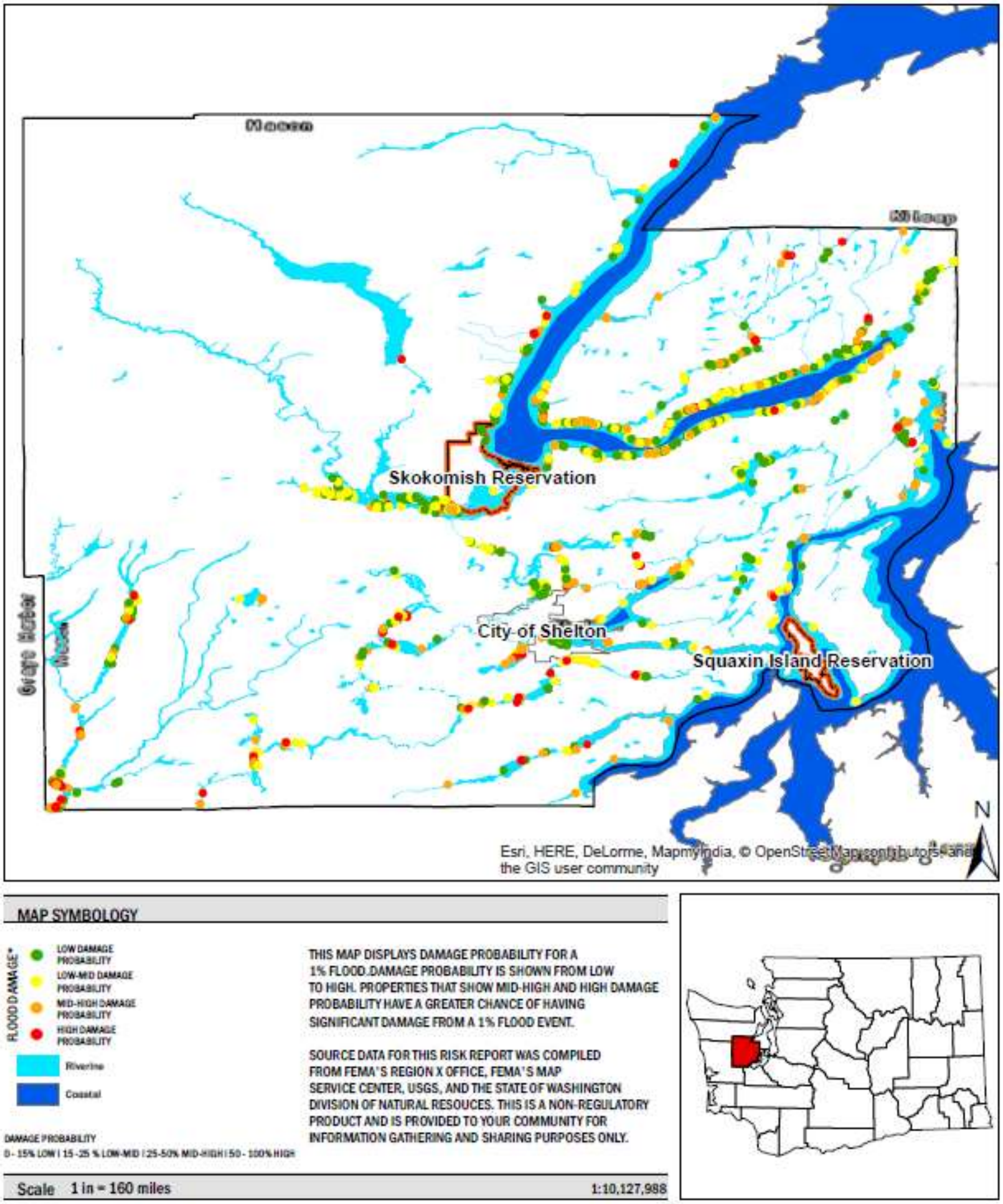


Figure 8-10 FEMA Coastal and Riverine Flood Damage in Mason County (2017 Risk Map)

8.3.4 Impact on Critical Facilities and Infrastructure

In addition to considering general building stock at risk, the risk of flood to critical facilities and utilities was evaluated. Hazus-MH was used to estimate critical facilities exposed to the 100- and 500-year flood risk. This process was conducted outside of FEMA's Risk Map process as part of the HMP development utilizing the critical facilities database and Hazus 3.2. Table 8-7 through Table 8-11 list critical facilities and infrastructure located in the FEMA 100-year and 500-year flood hazard area. Figure 8-11 illustrates all critical facilities and proximity to the 100- and 500-year flood zones.

Table 8-7
Critical Facilities in the 100-Year Floodplain

Jurisdiction	Medical and Health Services	Government Function	Protective	Hazardous Materials	Other	**Total**
Unincorporated	0	0	1	0	4	**5**
Shelton, City	0	4	3	0	2	**9**
Allyn	0	0	0	0	0	**0**
Belfair	0	0	0	0	0	**0**
Total	**0**	**4**	**4**	**0**	**6**	**14**

Table 8-8
Critical Infrastructure in the 100-Year Floodplain

Jurisdiction	Water Supply	Wastewater	Power	Communications	Other	**Total**
Unincorporated	0	0	0	0	0	**0**
Shelton, City	2	1	3	0	0	**6**
Allyn	0	0	0	0	0	**0**
Belfair	0	0	0	0	0	**0**
Total	2	1	3	0	0	**6**

Table 8-9
Critical Facilities in the 500-Year Floodplain

Jurisdiction	Medical and Health Services	Government Function	Protective Services	Hazardous Materials	Other	**Total**
Unincorporated	0	0	2	0	0	**2**
Shelton, City	0	4	4	0	2	**10**
Allyn	0	0	0	0	0	**0**
Belfair	0	0	0	0	0	**0**
Total	**0**	**4**	**6**	**0**	**2**	**12**

Table 8-10 Critical Infrastructure in the 500-Year Floodplain						
Jurisdiction	Water Supply	Wastewater	Power	Communications	Other	**Total**
Unincorporated	0	0	0	0	0	**0**
Shelton, City	2	1	3	0	0	**6**
Allyn	0	0	0	0	0	**0**
Belfair	0	0	0	0	0	**0**
Total	**2**	**1**	**3**	**0**	**0**	**6**

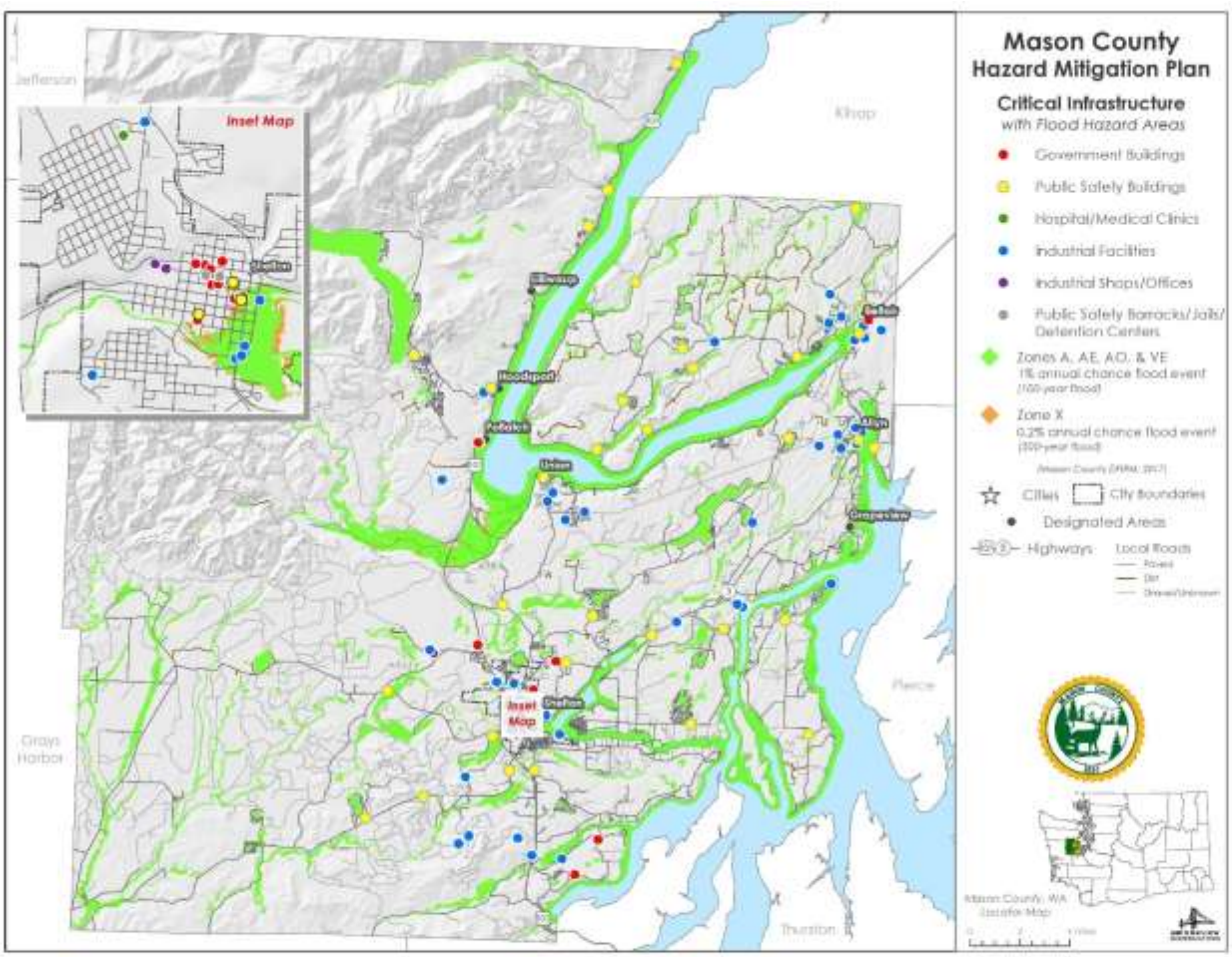


Figure 8-11 Critical Facilities Impacted by 100- and 500-Year Flood Hazard Areas

In cases where short-term functionality is impacted by a hazard, other facilities of neighboring municipalities may need to increase support response functions during a disaster event. Mitigation planning should consider means to reduce impact on critical facilities and ensure sufficient emergency and school services remain when a significant event occurs.

8.3.5 Impact on Economy

Impact on the economy related to a flood event in Mason County would include loss of property and associated tax revenue, as well as potential loss of businesses. Depending on the duration between onset of the event and recovery, businesses within the area may not be able to sustain the economic loss of their business being disrupted for an extended period of time. Historical data has demonstrated that those businesses impacted by a disaster are less likely to reopen after an event.

8.3.6 Impact on Environment

Flooding is a natural event, and floodplains provide many natural and beneficial functions. Nonetheless, with human development factored in, flooding can impact the environment in negative ways.

Figure 8-12 Migrating Fish in Flooded Skokomish River Basin

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. Migrating fish can wash into roads or over dikes into flooded fields, with no possibility of escape (see Figure 8-12).[14] Pollution from roads, such as oil, and hazardous materials can wash into rivers and streams. During floods, these can settle onto normally dry soils, polluting them for agricultural uses. Human development such as bridge abutments and levees, and logjams from timber harvesting can increase stream bank erosion, causing rivers and streams to migrate into non-natural courses. In 2014, the US Army Corp of Engineers developed an Integrated Feasibility Report and Environmental Impact Statement specifically for the Skokomish River Basin. Review of the report identifies the fact that high sediment load, reduced flows, and encroachment on the floodplain by human-made structures have, and continue to degrade the natural ecosystem structures, functions, and processes throughout the basin. That degradation has caused a significant decline in populations of four anadromous fish species under the Endangered Species Act (ESA) (e.g., Chinook salmon, chum salmon, steelhead, and bull trout) that use the river as their primary habitat. The impaired ecosystem has also adversely affected critical riverine, wetland, and estuarine habitats used by other wildlife species such as bears, bald eagles, and river otters to name a few. In an effort to mitigate the negative impacts, the Corps identified potential restoration projects, including, among others, the following:

- Removal of a levee at the confluence of the North and South Forks of the Skokomish River near river mile 9;
- Installation of large woody debris and engineered logjams on the South Fork Skokomish River, between river miles 9 and 11; and

[14] US Army Corps of Engineers. (2015). Skokomish River Basin Integrated Feasibility Report and EIS.

- Reconnection of an historical side channel of the Skokomish River, between river miles 4.5 and 5.5; and, Restoration of wetland habitat on the south bank of the Skokomish River between river miles 8.3 and 9.2 (the River Mile 9 site) and river miles 7.5 and 8.0 (the Grange site).

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

8.4 FUTURE DEVELOPMENT TRENDS

Mason County and its planning partners are subject to the provisions of the Washington State Growth Management Act (GMA), which regulates identified critical areas. Mason County critical areas regulations include frequently flooded areas, defined as the FEMA 100-year mapped floodplain. The GMA establishes review and evaluation programs that monitor commercial, residential, and industrial development and the densities at which this development has occurred under each jurisdiction's GMA comprehensive plan and development regulations. An evaluation is required at least every five years of the sufficiency of remaining land within urban growth areas to accommodate projected residential, commercial, and industrial growth at development densities observed since the adoption of GMA plans. This buildable lands report compares planned versus actual urban densities in order to determine whether original plan assumptions were accurate.

Mason County's buildable lands report is currently under review and update, which included land use map changes. It excludes areas designated as "critical areas" from consideration as buildable lands due to the scope of regulations affecting them. Some floodplains in the planning area can be developed, but are subject to regulatory provisions in the codes of Mason County and its partner cities. The buildable lands analysis assumes that these regulations will discourage development from these areas. Section 3 of this plan discusses the County's land use designations, including identification of critical areas.

The floodplain portions of the planning area are regulated under the GMA and the NFIP. Development will occur in the floodplain; however, it will be regulated such that the degree of risk will be reduced through building standards and performance measures. As NFIP map updates have occurred, those updates will be utilized to further expand, modify, and enhance planning efforts occurring within the County.

8.5 ISSUES

A large portion of the planning area has the potential to flood, generally in response to a succession of winter rainstorms. Storm patterns of warm, moist air are normal events, usually occurring between October and April can cause severe flooding in the planning area, although flooding can occur at any time.

A worst-case scenario for a flood event within the County would be a series of storms that result in high accumulations of runoff surface water within a relatively short time period. This could overwhelm response capabilities within Mason County. Major roads could be blocked as has previously occurred, preventing critical access for residents and critical functions in portions of the planning region. High in-channel flows could cause watercourses to scour, possibly washing out roads or impacting bridges, creating more isolation problems, and further exacerbating erosion along the coastline. In the case of multi-basin flooding, repairs could not be made quickly enough to restore critical facilities and infrastructure. While human activities influence the impact of flooding events, human activities can also interface effectively with a floodplain as long as steps are taken to mitigate the activities' adverse impacts on floodplain functions.

The following flood-related issues are relevant to the planning area:

- While flooding on the Skokomish River is well documented, other rivers in the County, such as the Tahuya River in North Mason, have also experienced flooding. However, since there are no USGS river gauges outside the Skokomish watershed this significantly impacts the County's ability to monitor and develop effective mitigations actions.
- The lack of current flood hazard mapping is a difficult obstacle to overcome when attempting to develop a strategy for hazard prone areas in land use planning and for development of this mitigation plan. This issue will be addressed when new flood maps, currently under development, are released and adopted by the planning area.
- The risk associated with the flood hazard overlaps the risk associated with other hazards such as severe storm events, earthquake, and landslide. This provides an opportunity to seek mitigation goals with multiple objectives to reduce the risk of multiple hazards.
- Potential climate change may impact flood conditions throughout the County.
- More information is needed on flood risk with respect to structure type, year built, elevation, etc., to support the concept of risk-based analysis of capital projects.
- There needs to be a sustained effort to gather historical damage data, such as high-water marks on structures and damage reports, to measure the cost-effectiveness of future mitigation projects.
- Ongoing flood hazard mitigation will require funding from multiple sources.
- There needs to be a coordinated hazard mitigation effort between the County, the City of Shelton, the Skokomish and Squaxin Island Tribes, and the Washington Department of Transportation as it relates to flooding and flood induced issues and the potential for areas to experience isolation as a result of limited ingress and egress to certain areas of the County during storm/flooding events.
- Floodplain residents need to continue to be educated about flood preparedness and the resources available during and after floods.
- The promotion of flood insurance as a means of protecting property from the economic impacts of frequent flood events should continue.
- Existing floodplain-compatible uses such as agricultural and open space need to be maintained.

8.6 RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from Flood throughout the area is highly likely. The area experiences some level of flood almost annually. The City of Shelton and the Unincorporated Areas of Mason County have the largest percentage of buildings located in the SFHA. In addition, these two areas have the highest projected dollar loss. While structural damage may vary due to flood depths and existing floodplain management regulations, there is a fairly high rate of property ownership that does not have flood insurance. Based on the potential impact, the Planning Team determined the CPRI score to be 3.25, with overall vulnerability determined to be a high level.

CHAPTER 9.
LANDSLIDE

A landslide is defined as the sliding movement of masses of loosened rock and soil down a hillside or slope. Such failures occur when the strength of the soils forming the slope is exceeded by the pressure acting upon them, such as weight or saturation. Earthquakes provide many times more energy than needed to initiate soil liquefaction, enhancing not only the probability of a landslide, but also its magnitude. Washington State climate, topography, and geology create a perfect setting for landslides, which occur in the state every year.

In Western Washington, most landslides are triggered during fall and winter after storms dump large amounts of rain or snow (Washington Department of Natural Resources, 2015). Landslides can be shallow or deep. Shallow landslides typically occur in winter in Western Washington and summer in Eastern Washington, but are possible at any time. They often form as slumps along roadways or fast-moving debris flows down valleys or concave topography. They are commonly called “mudslides” by the news media. Deep-seated landslides are often slow moving, but can cover large areas and devastate infrastructure and housing developments.

A mudslide or debris flow is a fast-moving fluid mass of rock fragments, soil, water, and organic material with more than half of the particles being larger than sand size. Generally, these types of movement occur on steep slopes or in gullies and can travel long distances. Typically, debris flows result from unusually high rainfall, or rain-on-snow events.

A rock fall is the fall of newly detached segments of bedrock of any size from a cliff or steep slope. The rock descends by free fall, bouncing, or rolling. Movements are very rapid to extremely rapid, and may not be preceded by minor movements.

9.1 GENERAL BACKGROUND

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

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

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

The occurrence of a landslide is dependent on a combination of site-specific conditions and influencing factors. Most commonly, the factors that contribute to landslides fall into four broad categories:

- Climatic or hydrologic (rainfall or precipitation);
- Geomorphic (slope form and conditions, e.g., slope, shape, height, steepness, vegetation, and underlying geology);
- Geologic/geotechnical/hydrogeological (groundwater);
- Human activity.

Change in slope of the terrain, increased load on the land, shocks and vibrations, change in water content, groundwater movement, frost action, weathering of rocks, and removing or changing the type of vegetation covering slopes are all contributing factors. 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:

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

Flows and slides are commonly categorized by the form of initial ground failure. Common types of slides are shown on Figure 9-1 through Figure 9-4 (Washington State Department of Ecology, 2014). The most common is the shallow colluvial slide, occurring particularly in response to intense, short-duration storms, where antecedent conditions are prevalent (Baum, et. al, 2000). The largest and most destructive are deep-seated slides, although they are less common.

Deep-seated landslides are much larger than shallow landslides and can occur at any time of the year. Soil degradation can happen over years, decades, and centuries with little to no warning to people above ground. The most notable and deadliest deep-seated landslide event in the United States was SR 530 (also known as the Oso Landslide) that took the lives of 43 people in Oso, Washington, in 2014.

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

Erosion is the process by which material is removed from a region of the earth’s surface. It can occur by weathering and transport of solids (sediment, soil, rock, and other particles) in the natural environment. This also leads to the deposition of these materials elsewhere, which can increase the impacts from flood events. Erosion usually occurs as a result of transport of solids by wind, water or ice, and by down-slope creep of soil and other material under the force of gravity, similar to landslides. It can also be caused by animals burrowing, reducing soil stability.

Although erosion is a natural process, as with landslides, human land use policies have an effect on erosion, especially industrial agriculture, deforestation, and urban sprawl. Land that is used for industrial agriculture generally experiences a significantly greater rate of erosion than land with natural vegetation or land used for sustainable agricultural. This is particularly true if tillage is used in farm practices, which reduces vegetation cover on the surface of the soil and disturbs both soil structure and plant roots that would otherwise hold the soil in place.

Improved land use practices can limit erosion, using techniques such as terracing or terrace-building, no or limited tilling, limited logging or replanting after logging, and the planting of vegetation to limit erosion through ground cover.

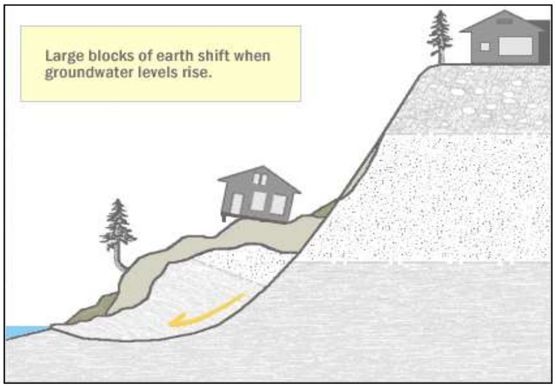


Figure 9-1 Deep Seated Slide

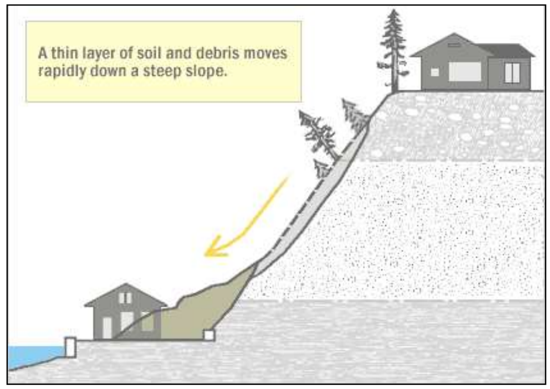


Figure 9-2 Shallow Colluvial Slide

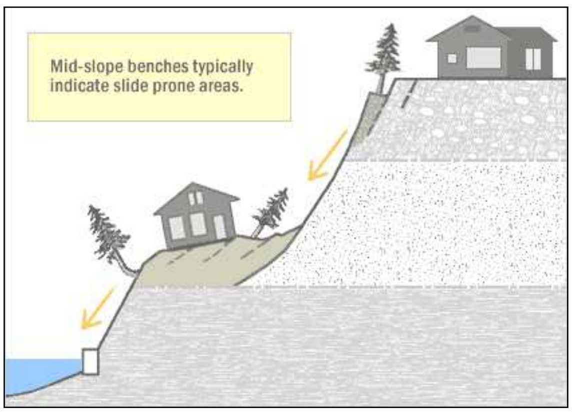


Figure 9-3 Bench Slide

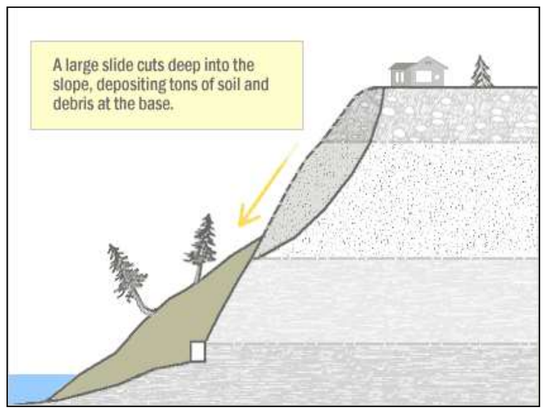


Figure 9-4 Large Slide

While a certain amount of erosion is natural and healthy for an ecosystem—such as gravel continuously moving downstream in watercourses—excessive erosion causes serious problems, such as receiving water sedimentation, ecosystem damage and loss of soil and slop stability. Erosion can cause a loss of forests and trees, which causes serious damage to aquatic life, irrigation, and power development by heavy silting of streams, reservoirs, and rivers. Concentrated surface water runoff in drainages and swales can lead to channel-confined slope failures, involving the rapid transport of fluidized debris, known as debris flows.

Mason County Classified Landslide Hazard Areas

Within Mason County's Resource Ordinance (Revised June 2009), the following are classified as Landslide Hazard Areas:

a) Areas with any indications of earth movement such as debris slides, earthflows, slumps, and rock falls;
b) Areas with artificial over-steepened or un-engineered slopes, i.e. cuts or fills.
c) Areas with slopes containing soft or potentially liquefiable soils.
d) Areas over-steepened or otherwise unstable as a result of stream incision, stream bank erosion, and undercutting by wave action.

e) Slopes greater than 15% (8.5 degrees) and having the following:
   1. Hillsides intersecting geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock (e.g. sand overlying clay); and
   2. Springs or groundwater seepage.

f) Any area with a slope of forty percent or steeper and with a vertical relief of ten or more feet except areas composed of consolidated rock. A slope is delineated by establishing its toe and top and measured by averaging the inclination over at least ten feet of vertical relief.

9.2 HAZARD PROFILE

9.2.1 Extent and Location

The best predictor of where slides and earth flows might occur is the location of past movements. Past landslides can be recognized by their distinctive topographic shapes, which can remain in place for thousands of years. Most landslides recognizable in this fashion range from a few acres to several square miles. Most show no evidence of recent movement and are not currently active. A small portion of them may become active in any given year. The recognition of ancient dormant mass movement sites is important in the identification of areas susceptible to flows and slides because they can be reactivated by earthquakes or by exceptionally wet weather. Also, because they consist of broken materials and frequently involve disruption of groundwater flow, these dormant sites are vulnerable to construction-triggered sliding. A 2007 USGS Landslide Hazard area which occurred for the Seattle, Washington area further confirms that "when slopes are dry, steepness and strength control potential instability. However, where ground water perches on lower permeability clay layers, extended wet winter conditions can increase the water table near the bluff face. Elevated ground-water pressures can lower slope stability" (USGS, 2007).

Within Mason County, as a coastal community, the County is also subject to beach erosion of feeder bluffs, which is a coastal bluff that delivers sediment to the beach over an extended period time, and contributes sediment. The term Feeder Bluff is widely used on Puget Sound to describe actively eroding bluffs and provide sediments to nearby beaches. Mason County is subject to landslides and soil erosion due to wind, water, and flooding at all times of the year; the landslides and soil erosion are largely concentrated on coastal bluffs on a fairly large percent of the total marine shoreline within the County (Washington State Department of Ecology, 1980). Bluff retreat by erosion can be more than 2 feet per year or can be less than 1 inch per year, but can be punctuated by landslides that can set a bluff back by more than 20 feet in a few hours (Thorsen and Shipman, 1998).

A study conducted by the Department of Earth and Space Sciences at the University of Washington found that most of the bluff slopes in the Puget Sound region are composed of unconsolidated sediment, deposited during glacial and/or interglacial periods (ESS, 2013).

Within Mason County, there are over 709 miles of shorelines. Of those 709 miles, 96 miles, or 44 percent, were categorized as unstable (Mason County 2010 HMP; Washington State Department of Ecology Coastal Atlas, 1980). This equates to approximately 60 percent of the total marine shoreline (Washington Department of Ecology, 1980).

The Hood Canal area has experienced significant slides in the past, with major efforts occurring to stabilize the landslides with drainage and structural improvements (see Figure 9-5).

Approximately 10% of the landscape in Mason County (excluding Olympic National Forest and Olympic National Park areas) has a slope of 15-30%, and approximately 3% has steeper slopes of 30-45% (Mason County COMP Plan, 2017). Within Mason County, slides may occur in association with fine grained lakebed or fluvial sediments. Figure 9-6 illustrates the landslide hazard Critical Areas identified within the

County's Comprehensive Plan (for reference purposes only) (Mason County Comprehensive Plan, 2017). Photo courtesy of the Dept. of Ecology (5/8/1999, #99-25-2).

Figure 9-5 House destroyed by landslide in Lilliwaup during 1998-1999 winter

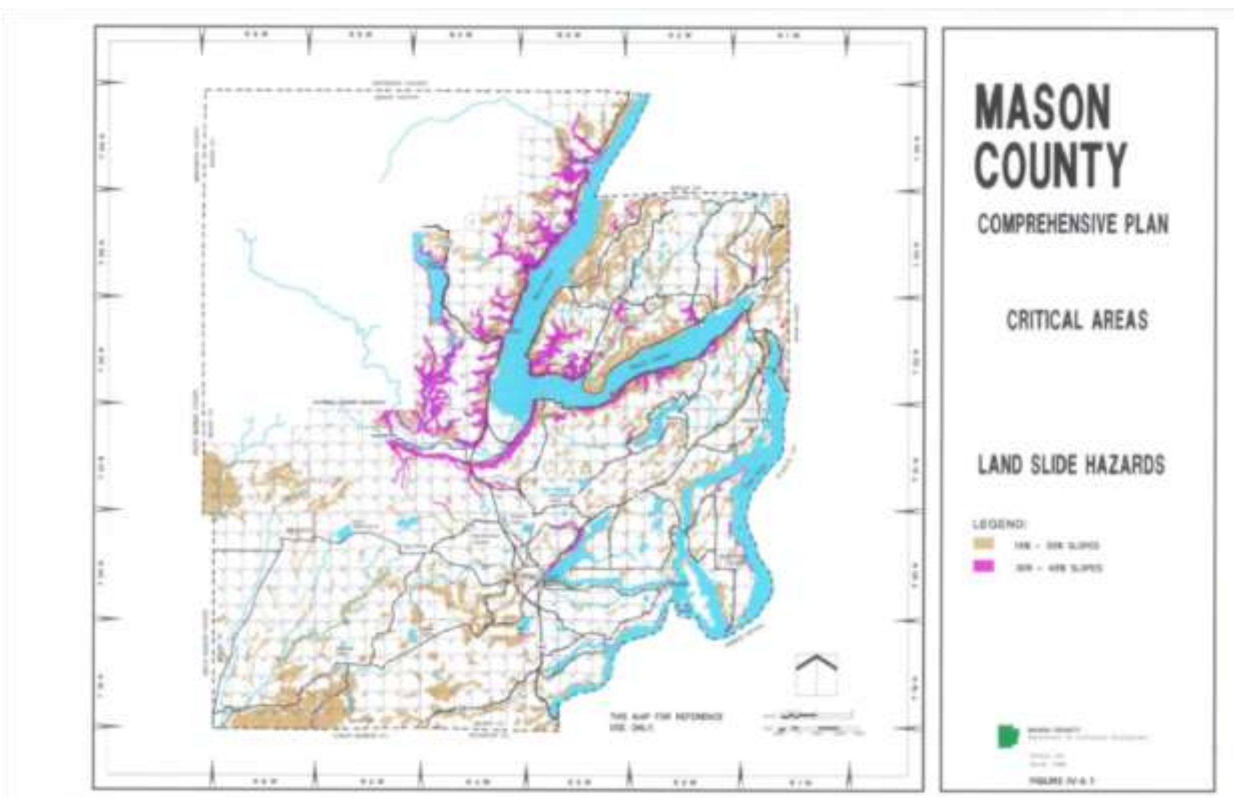


Figure 9-6 Comprehensive Plan Identified Critical Areas - Landslide Hazard Area

9.2.2 Previous Occurrences

Landslides within the planning area are fairly common, as identified by FEMA and the Spatial Hazard Events and Losses Database for the United States (SHELDUS). Landslides have been associated with disaster declarations for severe storms and flooding events in Mason County, as listed in Table 9-1. There is one record of a fatality due to landslide in the County occurring when a landslide struck a residence during the 2007 storm event. Since 1964, a total of 10 weather events have included impact from landslides. However, the County has never received a disaster declaration specifically typed *Landslide* by FEMA. As a result of DR1817 for the 2009 event, Mason County received $65,000 to develop its 2010 Hazard Mitigation Plan.

Table 9-1
Mason County FEMA-Declared Events 1964 - 2016

Disaster Number	IA Program Declared	PA Program Declared	Declaration Date	Incident Type	Title	Incident Begin Date	Incident End Date
4253	No	Yes	2/2/2016	Flood	Severe Winter Storm, Straight-Line Winds, Flooding, Landslides, Mudslides	12/1/2015	12/14/2015
4249	No	Yes	1/15/2016	Severe Storm(s)	Severe Storms, Straight-Line Winds, Flooding, Landslides, And Mudslides	11/12/2015	11/21/2015
4056	No	Yes	3/5/2012	Severe Storm(s)	Severe Winter Storm, Flooding, Landslides, And Mudslides	1/14/2012	1/23/2012
1817	No	Yes	1/30/2009	Flood	Severe Winter Storm, Landslides, Mudslides, And Flooding	1/6/2009	1/16/2009
1734	Yes	Yes	12/8/2007	Severe Storm(s)	Severe Storms, Flooding, Landslides, And Mudslides	12/1/2007	12/17/2007
1682	No	Yes	2/14/2007	Severe Storm(s)	Severe Winter Storm, Landslides, And Mudslides	12/14/2006	12/15/2006
1641	No	Yes	5/17/2006	Severe Storm(s)	Severe Storms, Flooding, Tidal Surge, Landslides, And Mudslides	1/27/2006	2/4/2006

Table 9-1
Mason County FEMA-Declared Events 1964 - 2016

Disaster Number	IA Program Declared	PA Program Declared	Declaration Date	Incident Type	Title	Incident Begin Date	Incident End Date
1172	Yes	Yes	4/2/1997	Flood	Heavy Rains, Snow Melt, Flooding, Land & Mud Slides	3/18/1997	3/28/1997
1159	Yes	Yes	1/17/1997	Severe Storm(s)	Severe Winter Storms, Land & Mudslides, Flooding	12/26/1996	2/10/1997
612	Yes	No	12/31/1979	Flood	Storms, High Tides, Mudslides & Flooding	12/31/1979	12/31/1979

The recorded landslide history to state highways in Mason County dates as far back as 1925. The information listed in Table 9-2 was provided by Washington State Department of Transportation. The following data provides additional information with respect to the impact and mitigation activities taken to correct issues.

Mason County's landslide history includes landslides during the winter storms of 1998-1999 (see Figure 9-7) and the declared event of December 3, 2007 (DR 1734), which caused both Highways 101 and 106 to close several times in the vicinity of Lilliwaup, Eldon and Union. The Tahuya Peninsula was severely impacted by landslides. Landslides and erosion during this storm caused millions of dollars in damage.

As a result of the 2007 storm event, in Mason and Jefferson Counties, there were 214 landslides recorded. Of these slides, there were 80 shallow undifferentiated landslides, 23 debris flows, 108 debris slides, 1 deep-seated landslide, and two hyper-concentrated flows. At least 12 houses were damaged during the storm. U.S. Highway 101 was damaged or blocked by 16 slides, State Route 106 was damaged or blocked by two (2) slides, and five (5) slides blocked or damaged various other roads.

In the aftermath of the December 2007 storm (including severe storms, flooding, landslides, and mudslides), 581 people applied for Individual and Household Assistance with FEMA. The amount approved for Mason County was $1,128,094.

Following the winter storm of 2007, the Washington Division of Geology and Earth Resources of the Washington Department of Natural Resources did a landslide reconnaissance. The purpose of the study was to understand where and why slope failures and flooding occur in order to mitigate losses during future catastrophic landslide events. The study focused on the areas hit hardest by the storm. Mason, Lewis, and Thurston Counties were the main targets for the reconnaissance as they had the highest concentration of landslides.

Figure 9-7 Highway Closure at Jorstad Landslide – Winter 1998-1999

Photo Source: Department of Ecology 5/8/1999, #99-25-7

In addition, the winter 2009 incident, which was not a declared disaster event, also caused landslides in the area. Figure 9-8 is a photo illustrating a head scarp of a landslide which had approximately 4 feet of vertical movement and 2 feet of horizontal movement in sandy glacial till at Lake Kokanee. The head scarp was approximately 60 feet above the lake level. The crevasse formed by the scarp was approximately 3 feet deep, and based on the lack of forest debris and recent ravel in place at the time, it was estimated that the formation had been very recent, occurring within a few weeks of the photo being taken in April 2009.

Figure 9-8 Lake Kokanee Landslide, South of Lake Cushman

Photo Courtesy of Washington State Division of Geology and Earth Resources Geologists, taken April 9, 2009

Figure 9-9 illustrates a portion of SR 302 (North of East Victor Road) that has been repeatedly damaged as a result of erosion under the surface of the highway. New culverts and replacement of the structure was underway as of this update (May 2017). The culverts running under this section of SR 302 were moving downslope. WSDOT replaced the two culverts and permanently installed a structure to defend against continued erosion and slide.

Figure 9-9 SR 302 Slope Erosion

As a result of continued unstable slopes adjacent to US 101 in the Purdy Canyon area, in 2013, WSDOT removed 76,000 cubic yards (~7,600 dump truck loads) of dirt and material to reshape the slope of the adjacent hillside with the intent of slope stabilization. The area had been plagued with falling rocks and slope destabilization.

Heavy rains during the week of December 8, 2014 washed out approximately 75 feet of the northbound US 101 shoulder 2.2 miles south of Beacon Point Road. Crews working for WSDOT built a large retaining wall and repaired a broken culvert on US 101 at milepost 316.5 to help stabilize a steep slope below the highway. By installing the retaining wall and repairing the broken culvert, the State reduced the potential for future slides. See Figure 9-10 for the before and after illustrations of the project.

Figure 9-10 Before and After Pictures of SR 101/ 2.2 miles South of Beacon Pt. Road

Utilizing the Washington State Department of Natural Resource's 2016 updated data, Figure 9-11 and Figure 9-12 illustrates the areas of previous landslides, as well as areas of steep slopes of 40 percent or greater. Figure 9-13 identifies Feeder Bluffs within the County.

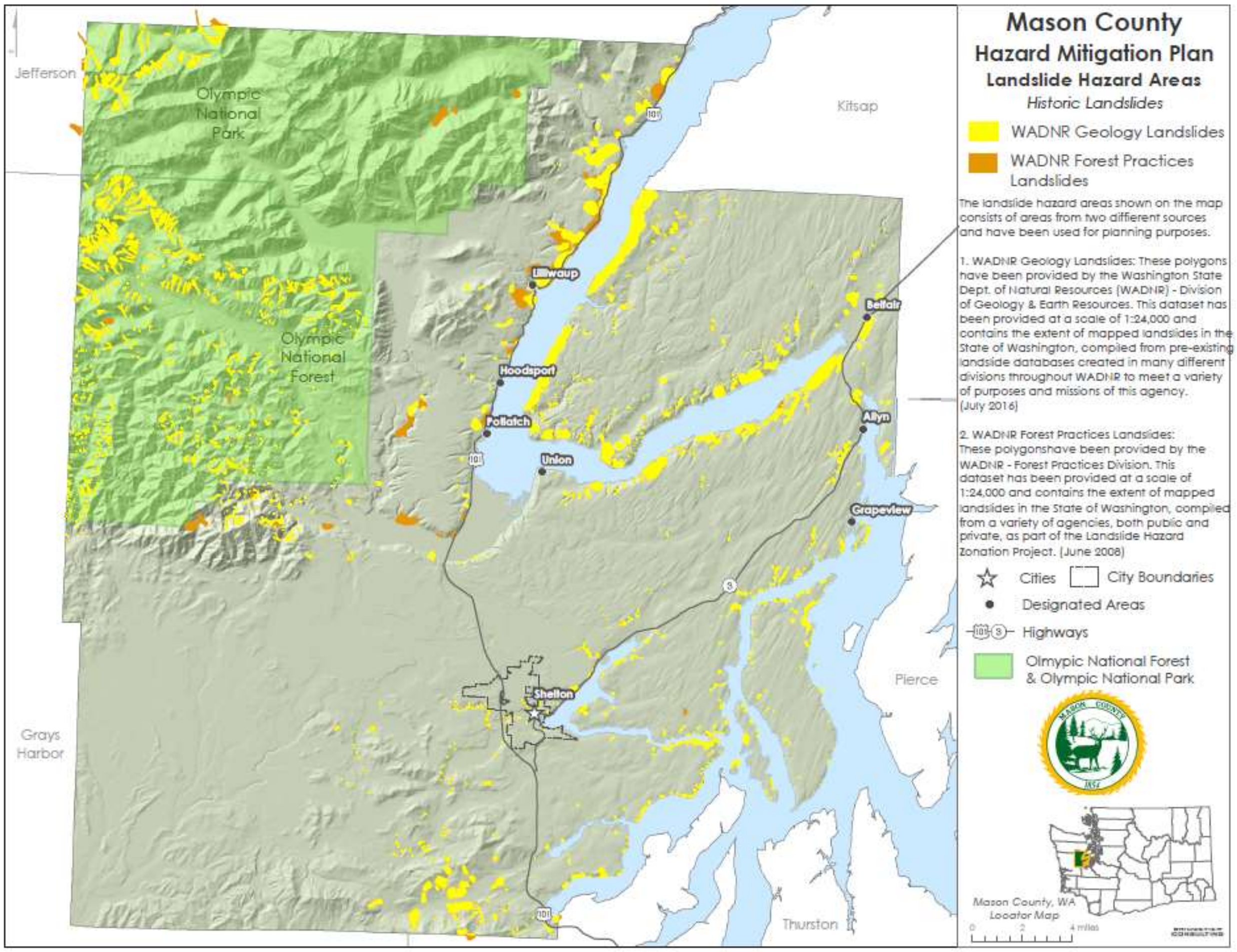


Figure 9-11 Washington DNR Recorded Landslide Data

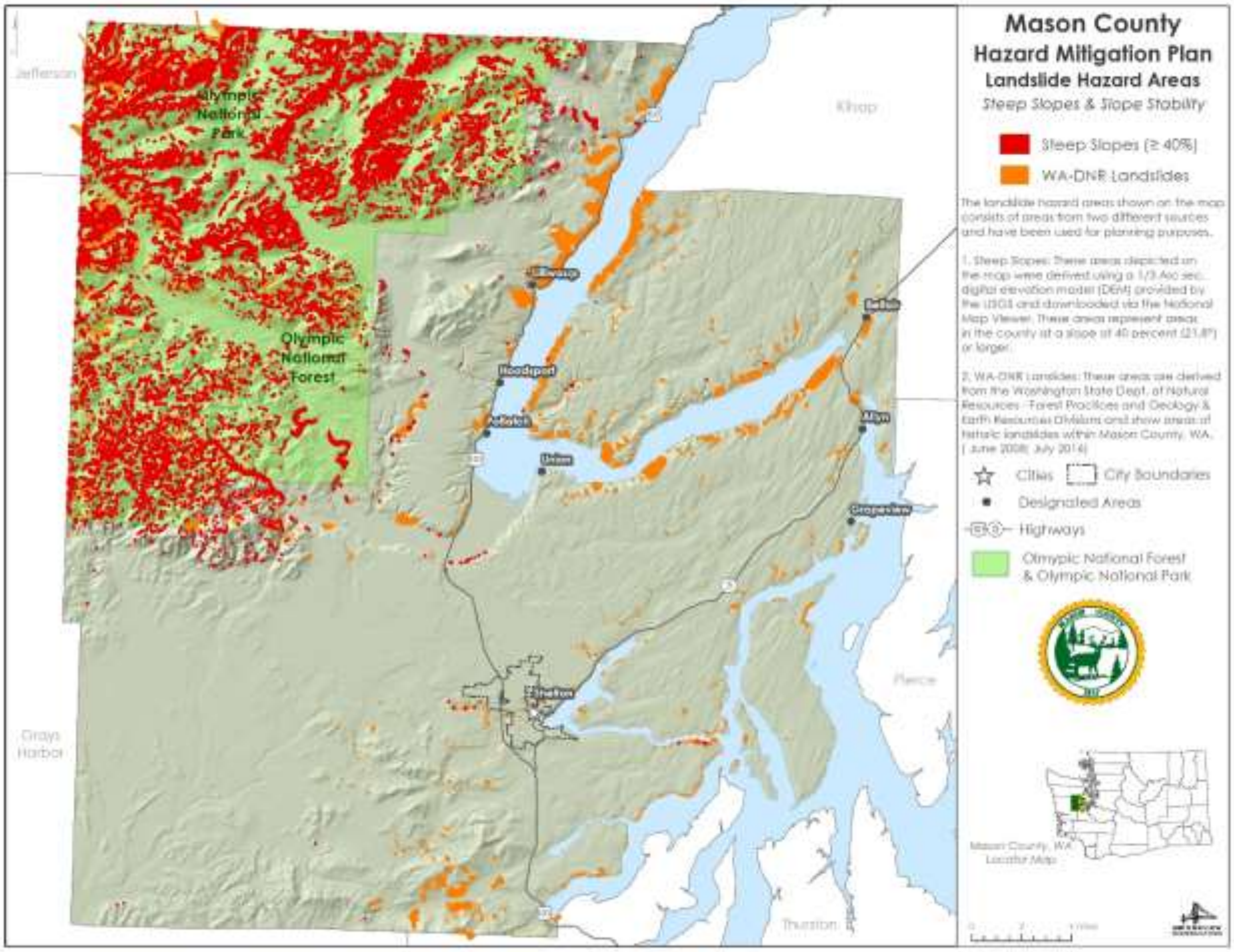


Figure 9-12 Landslide Hazard Areas

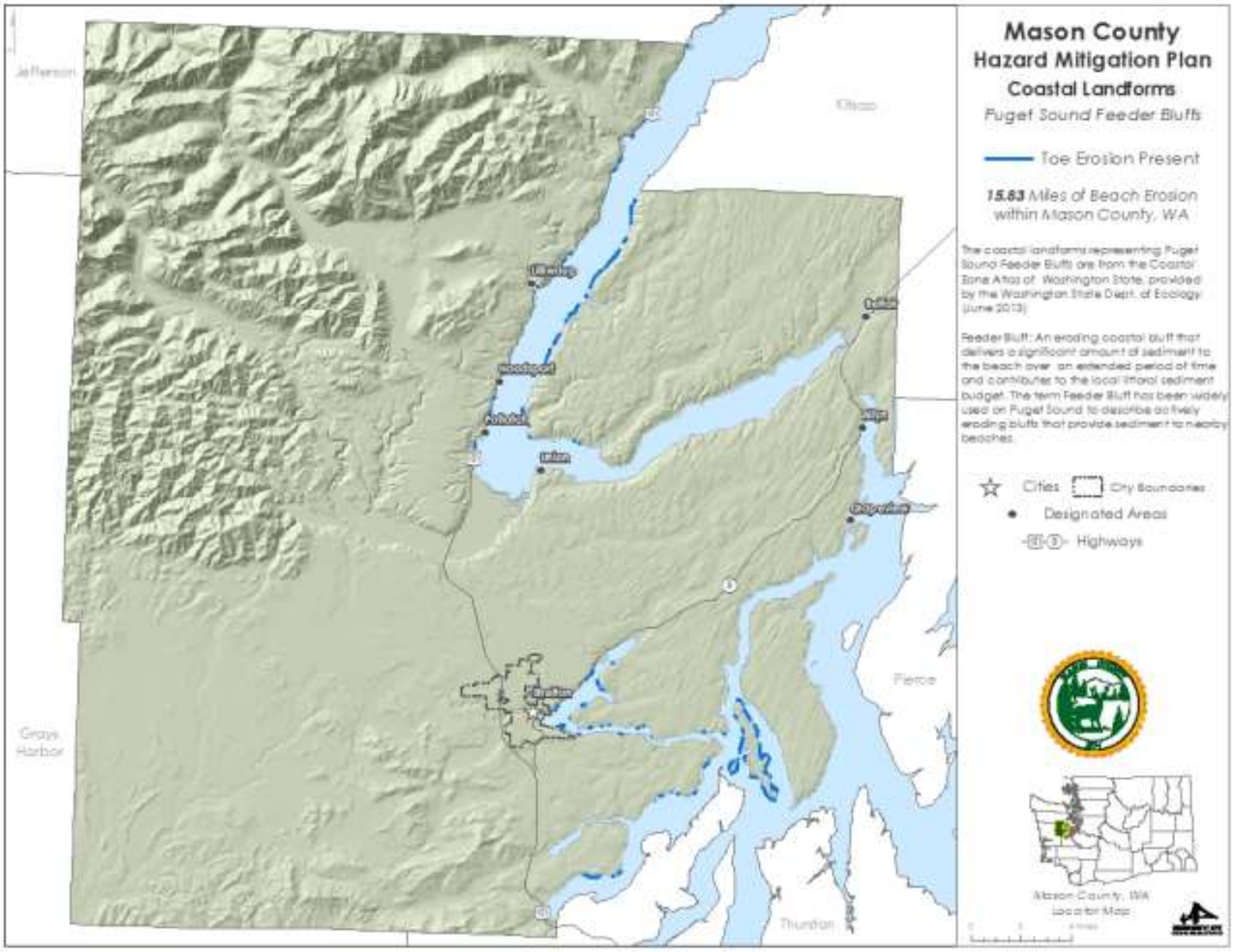


Figure 9-13 Mason County Feeder Bluffs

Table 9-2
Mason County State Highways Slide Repair Costs (1925-2009)

Route	Date	Project	Cost*
US 101	1925	Hoodsport/Duckabush Slides	$10,594.00
US 101	8/31/1965	Lilliwaup Slope Stabilization	$45,353.00
SR 3	5/13/1970	Belfair Vicinity Slide	$106,153.00
US 101	1/27/1975	Jorstad Creek Slide	$95,391.00
US 101	7/19/1999	Hoodsport Slide	$296,203.00
SR 3	11/29/2001	Allyn Vicinity Slide	$2,746,402.00
US 101	7/27/2000	Lilliwaup Vicinity Slide	$733,831.00
US 101	8/1/2000	MP 322.3 Slide	$576,067.00
US 101	2/5/2001	MP 321 and 322 vicinity slides	$3,371,919.00
US 101	1/28/2008	Lilliwaup Vicinity Slide	$940,916.00
US 101	8/1/2008	Sunnyside Slope	$420,659.00
US 101	2008	Holiday Hills	$463,095.00
US 101	2009	Hoodsport Vicinity Slope	$179,973.00
SR 108	2009	Slide Repair .8 miles West of Eich Road	$150,000.00
Total			**$10,136,556.00**

*Figures represent estimated contract costs from WSDOT files; design and construction oversight was additional; figures represent costs incurred at time of construction – not inflated.

9.2.3 Severity

Landslides destroy property and infrastructure, and can have a long-lasting effect on the environment and can take the lives of people. Nationally, landslides account for more than $2 billion in losses annually and result in an estimated 25 to 50 deaths a year (Spiker and Gori, 2003; Schuster and Highland, 2001; Schuster, 1996).

Washington is one of seven states listed by the Federal Emergency Management Agency as being especially vulnerable to severe land stability problems. Topographic and geologic factors cause certain areas of Mason County to be highly susceptible to landslides. Ground saturation and variability in rainfall patterns are also important factors affecting slope stability in area susceptible to landslides. Strong earthquake shaking can cause landslides on slopes that are otherwise stable.

9.2.4 Frequency

Landslides are often triggered by other natural hazards such as earthquakes, heavy rain, floods, or wildfires, so landslide frequency is often related to the frequency of these other hazards. Landslides typically occur during and after major storms, so the potential for landslides largely coincides with the potential for sequential severe storms and flood events that saturate steep, vulnerable soils.

While the County has not received a disaster declaration specifically for a landslide, there have been 10 disaster declarations which have included mud- or land-slides which occurred in conjunction with severe storm events over the course of the last 20 years. However, some type of landslide event occurs almost annually within the planning region. A specific recurrence interval has not been established by geologists, but historical data indicates several successive years of slide activities, followed by dormant periods.

Landslides are most likely to occur during periods of higher than average rainfall. The ground in many instances is already saturated prior to the onset of a major storm, which increases the likelihood of significant landslides to occur.

Precipitation influences the timing of landslides on three scales: total annual rainfall, monthly rainfall, and single precipitation events. In general, landslides are most likely during periods of higher than average rainfall.

The ground must be saturated prior to the onset of a major storm for significant landsliding to occur. Studies conducted by the USGS have identified two precipitation thresholds to help identify when landslides are likely (USGS, 2007) [15]:

- Cumulative Precipitation Threshold (Figure 9-14)—A measure of precipitation over the last 18 days, indicating when the ground is wet enough to be susceptible to landslides. Rainfall of 3.5 to 5.3 inches is required to exceed this threshold, depending on how much rain falls in the last 3 days.
- Intensity Duration Threshold (Figure 9-15)—A measure of rainfall during a storm, indicating when it is raining hard enough to cause multiple landslides if the ground is already wet.

These thresholds are most likely to be crossed during the rainy season. The 2007 USGS study indicates that by comparing recent and forecast rainfall amounts to the thresholds, meteorologists, geologists, and city officials can help people know when to be prepared for landslides. The thresholds as developed and tested are accurate, but imperfect indicators of when landslides may occur. During the study, statistical analysis of landslides that occurred between 1978 and 2003 showed that 85% occurred when the Cumulative Precipitation Threshold was exceeded. "While the thresholds are felt to work best in areas along the east side of Puget Sound, from Tacoma to Everett….they can also give preliminary guidance in the eastern part of Mason County" (USGS, 2007)

Review of existing data illustrates that slide events in the planning area most commonly occur from December through April, with one event occurring in May, but always after water tables have risen.

[15] USGS Landslide Hazards in the Seattle, Washington, Area. Accessed 20 Aug 2017. Available at: https://pubs.usgs.gov/fs/2007/3005/pdf/FS07-3005_508.pdf

Review of historic disasters provides the following breakdown: January experienced three (3) landslides - the month in which most landslides historically have occurred, followed by February and December, each having two disaster-level recorded weather events which included landslide.

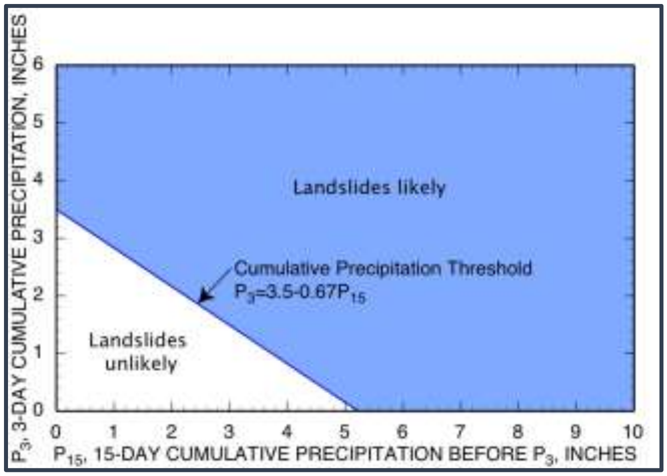


Figure 9-14 Cumulative Precipitation Threshold

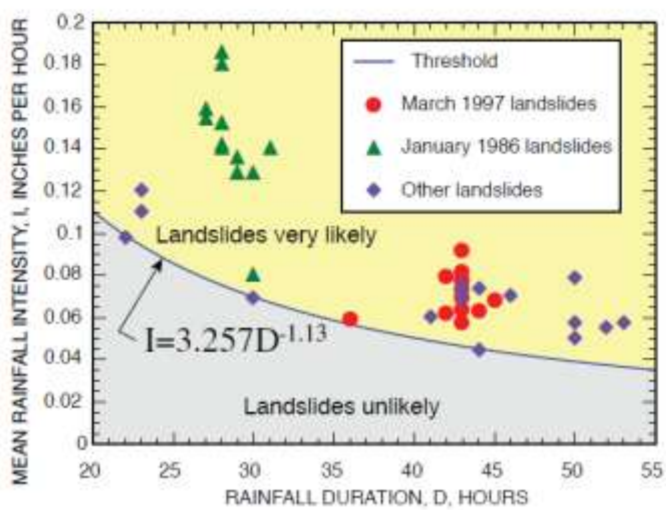


Figure 9-15 Landslide Intensity Duration Threshold

9.3 VULNERABILITY ASSESSMENT

9.3.1 Overview

Landslides have the potential to cause widespread damage throughout both rural and urban areas. While some landslides are more of a nuisance-type event, even the smallest of slides has the potential to injure or kill individuals and damage infrastructure. Given Mason County's relatively steep slopes in certain areas, its soil type, and its historical patterns of previous slide occurrences, the landslide hazard is a significant concern for the planning partners.

Review of the DNR data illustrates high areas of vulnerability in the Hood Canal area, as well as in the Olympic National Forest. Areas within Lilliwaup, Hoodsport, Potlatch, and Belfair all have a high number of previously reported landslides.

Methodology

Historical occurrences, combined with analysis of the slope and the type of soil, are the most effective indicator of areas at risk to landslide. The Washington Department of Natural Resources collects data to use in determining historical events and landslide danger; however, because no damage figures have been developed for the landslide hazard, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the assessed value of exposed structures.

Landslide hazard areas are those identified by Washington State DNR as having previous landslide events, and includes areas of slopes with a slope greater than or equal to 40 percent (or 21.8 degrees). *This data is for mitigation planning purposes only, and should not be considered for life safety matters. No landslide hazard analysis was conducted, but rather, only reprojection of existing data. Additional landslide data is available at:* http://www.dnr.wa.gov/programs-and-services/geology/geologic-hazards/landslides

Warning Time

Unlike flood hazards which often are predictable, mass movements or landslides are generally unpredictable, with little or no advanced warning. The speed of onset and velocity associated with a slide event can have devastating impacts. While some methods used to monitor mass movements can provide an idea of the type of movement and provide some indicators (potentially) with respect to the amount of time prior to failure, exact science is not available.

Mass movements can occur suddenly or slowly. The velocity of movement may range from a slow creep of inches per year to many feet per second, depending on slope angle, material, and water content. Generally accepted warning signs for landslide activity include:

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

It is possible, based on historical occurrences, to determine what areas are at a higher risk. Assessing the geology, vegetation, and amount of predicted precipitation for an area can help in these predictions; such an analysis is beyond the scope of this planning effort. However, there is no practical warning system for individual landslides. Historical events remain the best indicators of potential landslide activity, but it is generally impossible to determine with precision the size of a slide event or when an event will occur. Increased precipitation in the form of snow or rain increases the potential for landslide activity. Steep slopes also increase the potential for slides, especially when combined with specific types of soil.

Within Washington State, in a partnership with the National Oceanic and Atmospheric Administration (NOAA) and the National Weather Service, Washington State Department of Natural Resources monitors conditions that could produce shallow landslides. Landslide warning information can be viewed at https://fortress.wa.gov/dnr/protection/landslidewarning/.

9.3.2 Impact on Life, Health, and Safety

A population estimate was made using the structure count of residential buildings within the landslide hazard areas, and applying the census value of two (2) persons per household for Mason County. Using this approach, the population living in the landside risk area is identified in Table 9-3. It should be noted that areas identified within this document were based on existing data; no geotechnical or scientific analyses were conducted for development of this hazard mitigation plan as such analyses far exceed the intent of this document; therefore, no data should not be relied upon for life safety measures, or anything other than informing emergency managers of potential risk for planning purposes.

Table 9-3
Population and Residential Impact in Landslide Risk Area*

Jurisdiction	Residential Building Count	Population Exposed[a]
Unincorporated County	1,030	2,060
Shelton, City of	0	0
Allyn	3	6
Belfair	108	216
Total	1,141	2,282

* For these planning purposes, risk area is defined as slopes 40% (21.8°) and above, and areas identified within WADNR mapped historic landslides.
a. Based on factor of 2 per person/household

Also to be taken into account when determining affected population are the area-wide impacts on transportation systems and the isolation of residents who may not be directly impacted but whose ability to ingress and egress is restricted, such as areas along Highway 101 in the Hood Canal Area, which has a high transient population of tourists, especially during summertime months. Finally, Mason County's population of retirees may increase the level of first-responder requirements for residents whose structures were not directly impacted but who were affected by power outages, lack of logistical support, etc. Landslides can also damage water treatment facilities, potentially harming water quality.

9.3.3 Impact on Property

Landslides affect private property and public infrastructure and facilities. The predominant land use in the planning area is single-family residential, much of it supporting multiple families. In addition, there are many small businesses in the area as well as large commercial industries and government facilities. Development in landslide hazard area is guided by building code and the critical area ordinance to prevent the acceleration of manmade and natural geological hazards, and to neutralize or reduce the risk to the property owner or adjacent properties from development activities.

The Mason County Resource Ordinance requires, a at a minimum, a geological assessment for development within 300 feet of slopes between 15% and 40%, and a geotechnical report for slopes over 40% (see https://www.co.mason.wa.us/code/Community_Dev/resource_ord_june_2009.pdf). The ordinance also requires a 50-foot vegetated buffer at the top or toe of a slope.

For mitigation planning purposes only (not specific to the County's ordinance), the Washington State Department of Natural Resources Landslide Dataset was utilized to identify areas of historic events. In addition, slopes identified as being forty (40) percent or steeper were included in this analysis. The area and percent of the total planning area exposed to the landslide hazard in the planning area are summarized in Table 9-4. Data presented in these maps and tables are not a substitute for site-specific investigations by qualified practitioners.

Because no damage figures have been developed for the landslide hazard, additional loss estimates were developed representing 10 percent, 30 percent and 50 percent of the assessed value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction. Table 9-5 shows these estimates.

Table 9-4
Percent of Land Area in Landslide Risk Areas

Jurisdiction	Area in Landslide Risk (acres)	% of Total Planning Area
Unincorporated Mason County	26,368.1	4.23%
Shelton, City of	15.3	0.002%
Allyn	20.1	0.003%
Belfair	252.3	0.04%
Total	26,655.8	4.28%

Table 9-5
Potential Building Losses in Landslide Risk Area

Jurisdiction	Building Count*	Estimated Value	Content Value	10% Damage	30% Damage	50% Damage
Unincorporated County	1,030	$ 141,214,812	$70,638,670	$21,185,348	$63,556,045	$105,926,741
Shelton, City of	0	$0	$0	$0	$0	$0
Allyn	3	$ 473,195	$236,598	$70,979	$212,938	$354,897
Belfair	114	$14,485,420	$7,827,772	$2,231,319	$6,693,958	$11,156,596

*Building count is inclusive of residential (Table 9-3 above) and all other types of structures

9.3.4 Impact on Critical Facilities and Infrastructure

Figure 9-16 illustrates the proximity of the critical facilities and infrastructure to the established landslide areas. No loss estimation of these facilities was performed due to the lack of established damage functions for the landslide hazard. Losses for those structures exposed are included in the tables above.

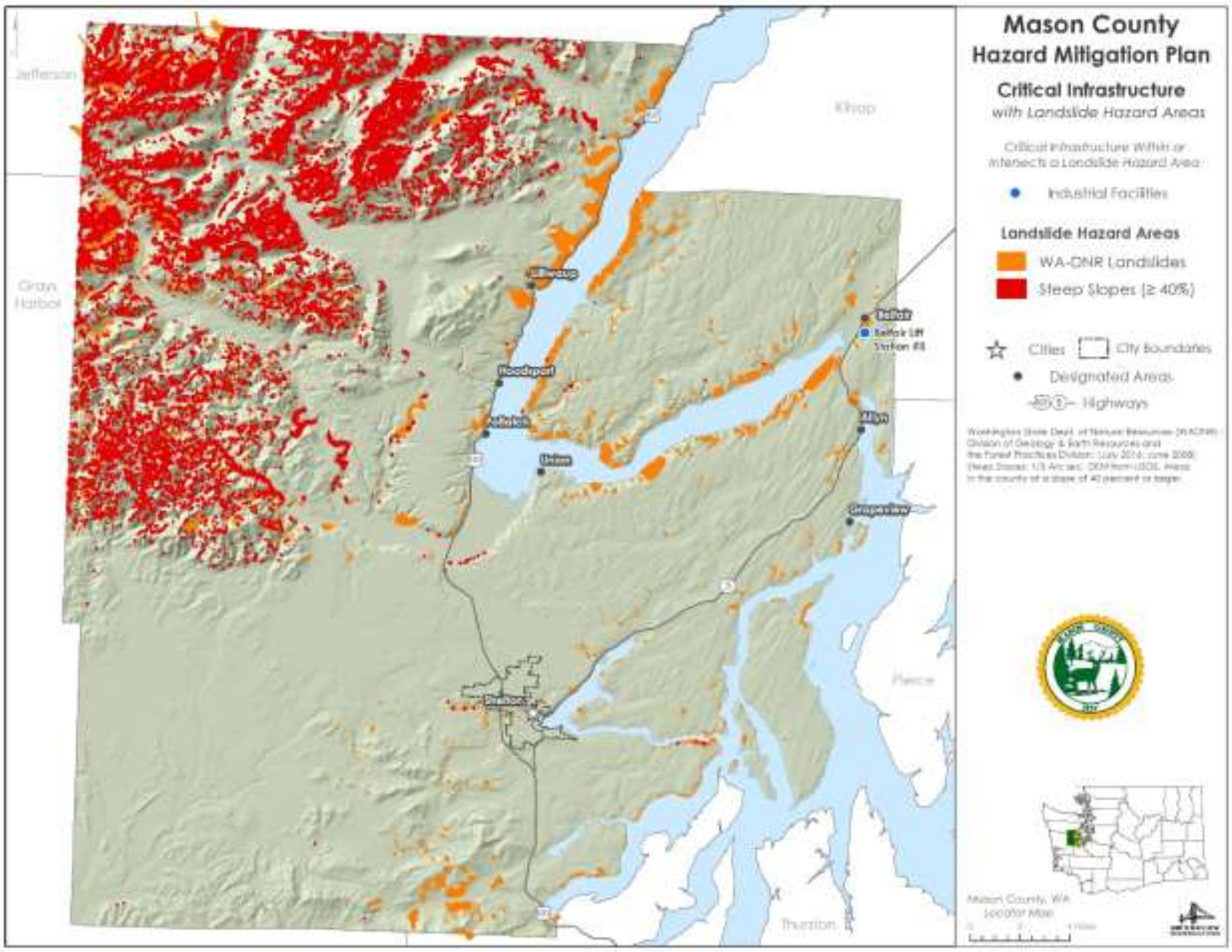


Figure 9-16 Critical Facilities and Infrastructure Exposed to Landslide Risk

Several types of infrastructure are exposed to mass movements, including transportation facilities, airports, bridges, and water, sewer, and power infrastructure. Highly susceptible areas include mountain and coastal roads and transportation infrastructure. All infrastructure and transportation corridors identified as exposed to the landslide hazard are considered vulnerable until more information becomes available. Significant infrastructure in the planning region exposed to mass movements includes the following:

- **Roads**—Access to major roads is crucial to life-safety after a disaster event and to response and recovery operations. Landslides can block egress and ingress on roads, causing isolation for neighborhoods, traffic problems and delays for public and private transportation. This can result in economic losses for businesses.

- **Bridges and Boat/Ferry Docks**—Landslides can significantly impact road bridges and boat/ ferry docks. Mass movements can knock out bridge and dock abutments, causing significant misalignment and restricting access and usages, as well as significantly weaken the soil supporting the structures, 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 beneath 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.

9.3.5 Impact on Economy

A landslide can have catastrophic impact on both the private sector and governmental agencies. Economic losses include damage costs as well as lost revenue and taxes. Damaged bridges, roadways, marinas, boat docks, municipal airports all can have a significant impact on the economy. Damages in this capacity could have a significant economic impact on not only Mason County, but also other areas of the state.

The impact on commodity flow from a significant landslide shutting down major access routes would not only limit the resources available for citizens' use, but also would cause economic impact on businesses in the area. Debris could impact cargo staging areas and lands needed for business operations. With highway 101 serving as a primary transportation route in the area, use of the highway reduces travel time between the inland Puget Sound area and the peninsula region, compared to requiring vehicles to travel much greater distances around the sound on land. Impacts would also significantly reduce the tourism industry within the County.

9.3.6 Impact on Environment

Environmental problems as a result of mass movements can be numerous. Landslides that fall into water bodies, wetlands or streams may significantly impact fish and wildlife habitat, as well as affecting water quality. Hillsides that provide wildlife habitat can be lost for prolonged periods of time due to landslides. With impact already occurring due to increased sediment loads in the floodplain, landslides could cause additional impact within the Skokomish River watersheds.

9.4 FUTURE DEVELOPMENT TRENDS

Under the Growth Management Act, the County is required to address geologic hazards within its Critical Areas Ordinance, which it does. Continued application of land use and zoning regulations, as well as implementation of the International Building Codes, will assist in reducing the risk of impact from landslide hazards.

Mason County has experienced a relatively steady growth over the past 10 years. The region is attempting to expand its business base, which will increase economic vitality by providing businesses that stimulate retail sales and services and increased tourism. As a relatively high retirement and tourist destination for Washington, continued land use supported by regulatory authority which supports economic growth but practices smart planning will be vital. All planning partners are committed to assessing the landslide risk and developing mitigation efforts to reduce impact or enhance resiliency. There are four basic strategies to mitigate landslide risk:

- Stabilization
- Protection
- Avoidance

- Maintenance and monitoring.

Stabilization seeks to counter one or more key failure mechanisms necessary to prevent slope failure. The other three strategies seek to avoid, protect against or limit associated impacts. Development of this mitigation plan creates an opportunity to enhance and develop wise land use decision-making policies. It allows for the expansion of capital improvement plans to sustain future growth through the use of these four basic strategies.

Climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration which can saturate soils beyond capacity. Increase in global temperature could further exacerbate this by affecting the snowpack and its ability to hold and store water, further raising sea levels, and increasing beach erosion along the County's coastline. 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. As parts of the County maintain fairly dense forested areas, such an incident would be significant. All of these factors would increase the probability of landslides.

9.5 ISSUES

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

Mass movements are becoming more of a concern as development moves outside of urban centers and into areas less developed in terms of infrastructure. While most mass movements would be isolated events affecting specific areas, the areas impacted can be very large. It is probable that private and public property, including infrastructure, will be affected. Mass movements could affect bridges that pass over landslide prone ravines and knock out ferry services. Road obstructions caused by mass movements would create isolation problems for residents and businesses in sparsely developed areas, and impact commodity flows. Property owners exposed to steep slopes may suffer damage to property or structures. Landslides carrying vegetation such as shrubs and trees may cause a break in utility lines, cutting off power and communication access to residents; they may block ingress and egress to areas of the County, especially for areas with limited roadways.

Important issues associated with landslides throughout Mason County include the following:

- There are existing homes in landslide risk areas throughout the County. The degree of vulnerability of these structures depends on the codes and standards the structures were constructed to. Information to this level of detail is not currently available.
- Future development could lead to more homes in landslide risk areas.
- Portions of the County are surrounded by fairly steep banks and cliffs. Coastal erosion causes landslides as the ground washes away.

- Mapping and assessment of landslide hazards are constantly evolving. As new data and science become available, assessments of landslide risk should be re-evaluated. LiDAR data would greatly enhance the ability to determine landslide hazards, as well as other hazards.
- While the impact of climate change on landslides in general is uncertain, the impact of sea level rise caused by increased temperatures has already enhanced coastal erosion within the planning area. As climate change continues to impact atmospheric conditions, the exposure to landslide risks is likely to increase.
- Landslides cause many negative environmental consequences, including water quality degradation, degradation of fish spawning areas, and destruction of vegetation along waterways, ultimately impacting the flow of water bodies.
- 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 goals with multiple objectives that can reduce risk for multiple hazards.

9.6 RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from Landslide throughout the area is highly likely, but the impact is more limited with respect to geographic extent. The area experiences some level of landslides almost annually. The coastal bluff areas, and areas within the unincorporated areas of the County have identifiable landslide risk. While there are areas where no landslide risk areas are identified, landslides can nonetheless occur on fairly low slopes, and areas with no slopes can be impacted by slides at a distance. Construction in critical areas, which includes geologically sensitive areas such as landslide areas, is regulated; however, beyond the structural impact, secondary impact to infrastructure causing isolation or commodity shortages also has the potential to impact the region. Based on the potential impact, the Planning Team determined the CPRI score to be 2.95, with overall vulnerability determined to be a high level.

CHAPTER 10.
SEVERE WEATHER

Severe weather refers to any dangerous meteorological phenomena with the potential to cause damage, serious social disruption, or loss of human life. It includes thunderstorms, downbursts, wind, tornadoes, waterspouts, and snowstorms. Severe weather differs from extreme weather, which refers to unusual weather events at the extremes of the historical distribution.

General severe weather covers wide geographic areas; localized severe weather affects more limited geographic areas. The severe weather event that most typically impacts the planning area is a damaging windstorm, which causes storm surges exacerbating coastal erosion. Flooding associated with severe weather is discussed in Chapter 8.

DEFINITIONS

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

Hail Storm—Any thunderstorm which produces hail that reaches the ground is known as a hailstorm. Hail has a diameter of 0.20 inches or more. Hail is composed of transparent ice or alternating layers of transparent and translucent ice at least 0.04 inches thick. Although the diameter of hail is varied, in the United States, the average observation of damaging hail is between 1 inch and golf ball-sized 1.75 inches. Stones larger than 0.75 inches are usually large enough to cause damage.

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

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

Tornado— Most tornadoes have wind speeds less than 110 miles per hour are about 250 feet across, and travel a few miles before dissipating. The HYPERLINK "http://en.wikipedia.org/wiki/1999_Bridge_Creek_%E2%80%93_Moore_tornado" \o "1999 Bridge Creek – Moore tornado" most extreme tornadoes can attain wind speeds of more than 300 miles per hour, stretch more than two miles across, and stay on the ground for dozens of miles They are measured using the Enhanced Fujita Scale, ranging from EF0 to EF5.

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

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

10.1 GENERAL BACKGROUND

Mason County has a predominantly maritime climate, influenced by the Olympic Mountain Range.

10.1.1 Semi-Permanent High- and Low-Pressure Areas Over the North Pacific Ocean

During summer and fall, the circulation of air around a high-pressure area over the north Pacific brings a prevailing westerly and northwesterly flow of comparatively dry, cool, and stable air into the Pacific Northwest. As the air moves inland, it becomes warmer and drier, resulting in a dry season. In the winter and spring, the high pressure is further south and low pressure prevails in the northeast Pacific. Circulation of air around both pressure centers brings a prevailing southwesterly and westerly flow of mild, moist air into the Pacific Northwest. Condensation occurs as the air moves inland over the cooler land and rises along the windward slopes of the mountains. This results in a wet season beginning in late October or November, reaching a peak in winter, and gradually decreasing by late spring.

West of the Cascade Mountains, summers are cool and relatively dry while winters are mild, wet, and generally cloudy. Measurable rainfall occurs on 150 days each year in interior valleys and on 190 days in the mountains and along the coast.

Thunderstorms occur up to 10 days each year over the lower elevations and up to 15 days over the mountains. Damaging hailstorms are rare in western Washington. During July and August, the driest months, two to four weeks can pass with only a few showers; however, in December and January, the wettest months, precipitation is frequently recorded on 25 days or more each month. Snowfall is light in the lower elevations and heavier in the mountains. During the wet season, rainfall is usually of light to moderate intensity and continuous over a long period rather than occurring in heavy downpours for brief periods; heavier intensities occur along the windward slopes of the mountains.

10.1.2 Thunderstorms

A thunderstorm is a rain event that includes thunder and lightning. A thunderstorm is classified as “severe” when it contains one or more of the following: hail with a diameter of three-quarter inch or greater, winds gusting in excess of 50 knots (57.5 mph), or tornado. Thunderstorms have three stages (see Figure 10-1):

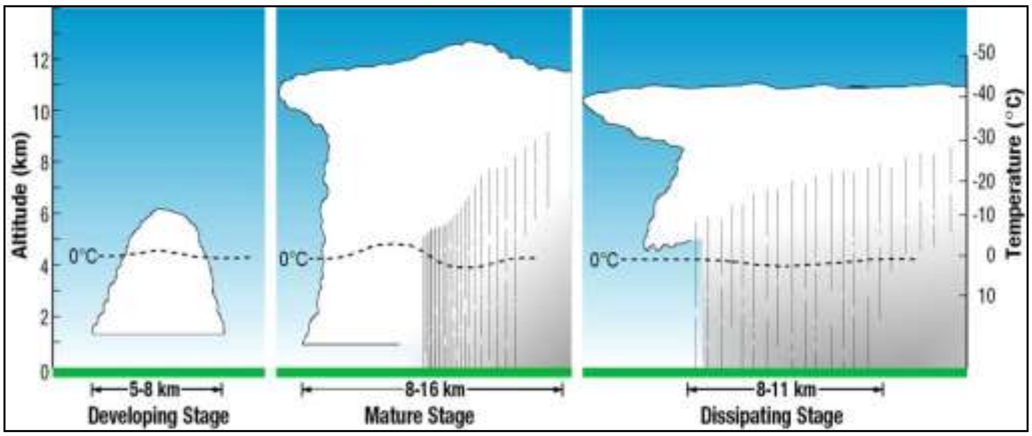


Figure 10-1 The Thunderstorm Life Cycle

Three factors cause thunderstorms: moisture, rising unstable air (air that keeps rising once disturbed), and a lifting mechanism to provide the disturbance. The sun heats the surface of the earth, which warms the air above it. If this warm surface air is forced to rise (hills or mountains can cause rising motion, as can the interaction of warm air and cold air or wet air and dry air) it will continue to rise as long as it weighs less and stays warmer than the air around it. As the air rises, it transfers heat from the earth surface to the upper atmosphere (the process of convection). The water vapors it contains begins to cool and it condenses into a cloud. The cloud eventually grows upward into areas where the temperature is below freezing. Some of the water vapor turns to ice and some of it turns into water droplets. Both have electrical charges. Ice particles usually have positive charges, and rain droplets usually have negative charges. When the charges build up enough, they are discharged in a bolt of lightning, which causes the sound heard as thunder. There are four types of thunderstorms:

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

about 20 minutes; the multi-cell cluster itself may persist for several hours. This type of storm is usually more intense than a single cell storm.

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

As Figure 10-2 illustrates, Washington ranks 50th nationwide in deaths associated with lightning strikes, having five deaths during the time period 1959-2016. Washington ranks 49th with respect to cloud-to-ground flash densities during the time period 2007-2016.[16] Annually, 30 percent of all power outages nationwide are lightning related, with total costs approaching $1 billion dollars (CoreLogic, 2015). Lightning starts approximately 4,400 house fires each year, with estimated losses exceeding $280 million.

Source: Vaisala, 2017

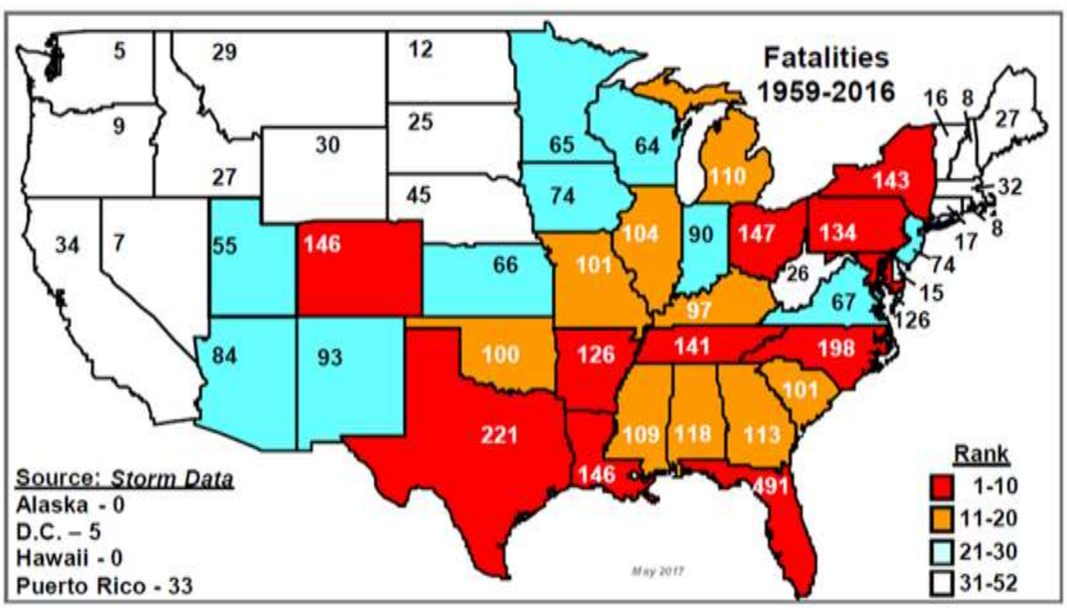


Figure 10-2 Lightening Fatalities by State, 1959-2016

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[16] NOAA Lightning Safety. Accessed 14 August 2017. http://www.lightningsafety.noaa.gov/stats/59-16_State_Ltg_Fatality+Fatality_Rate_Maps.pdf

10.1.3 Damaging Winds

Damaging winds are classified as those exceeding 60 mph. Damage from such winds accounts for half of all severe weather reports in the lower 48 states and is more common than damage from tornadoes. Wind speeds can reach up to 100 mph and can produce a damage path extending for hundreds of miles. There are seven types of damaging winds:

- **Straight-line winds —**Any thunderstorm wind that is not associated with rotation; this term is used mainly to differentiate from tornado winds. Most thunderstorms produce some straight-line winds as a result of outflow generated by the thunderstorm downdraft.
- **Downdrafts —**A small-scale column of air that rapidly sinks toward the ground.
- **Downbursts—**A strong downdraft with horizontal dimensions larger than 2.5 miles resulting in an outward burst or damaging winds on or near the ground. Downburst winds may begin as a microburst and spread out over a wider area, sometimes producing damage similar to a strong tornado. Although usually associated with thunderstorms, downbursts can occur with showers too weak to produce thunder.
- **Microbursts—**A small concentrated downburst that produces an outward burst of damaging winds at the surface. Microbursts are generally less than 2.5 miles across and short-lived, lasting only 5 to 10 minutes, with maximum wind speeds up to 168 mph. There are two kinds of microbursts: wet and dry. A wet microburst is accompanied by heavy precipitation at the surface. Dry microbursts, common in places like the high plains and the intermountain west, occur with little or no precipitation reaching the ground.
- **Gust front—**A gust front is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Gust fronts are characterized by a wind shift, temperature drop, and gusty winds out ahead of a thunderstorm. Sometimes the winds push up air above them, forming a shelf cloud or detached roll cloud.
- **Derecho—**A derecho is a widespread thunderstorm wind caused when new thunderstorms form along the leading edge of an outflow boundary (the boundary formed by horizontal spreading of thunderstorm-cooled air). The word “derecho” is of Spanish origin and means “straight ahead.” Thunderstorms feed on the boundary and continue to reproduce. Derechos typically occur in summer when complexes of thunderstorms form over plains, producing heavy rain and severe wind. The damaging winds can last a long time and cover a large area.
- **Bow Echo—**A bow echo is a linear wind front bent outward in a bow shape. Damaging straight-line winds often occur near the center of a bow echo. Bow echoes can be 200 miles long, last for several hours, and produce extensive wind damage at the ground.

There are four main types of windstorm tracks that impact the Pacific Northwest as identified in Figure 10-3. These four tracks are distinguished by two basic windstorm patterns that have emerged in the Puget Sound Region: the South Wind Event and the East Wind Event. South wind events are generally large-scale events that affect large portions of Western Washington and possibly Western Oregon. On occasional cases, they have reached as far south as Northern California.

Source: Oregon Climate Service, 2015

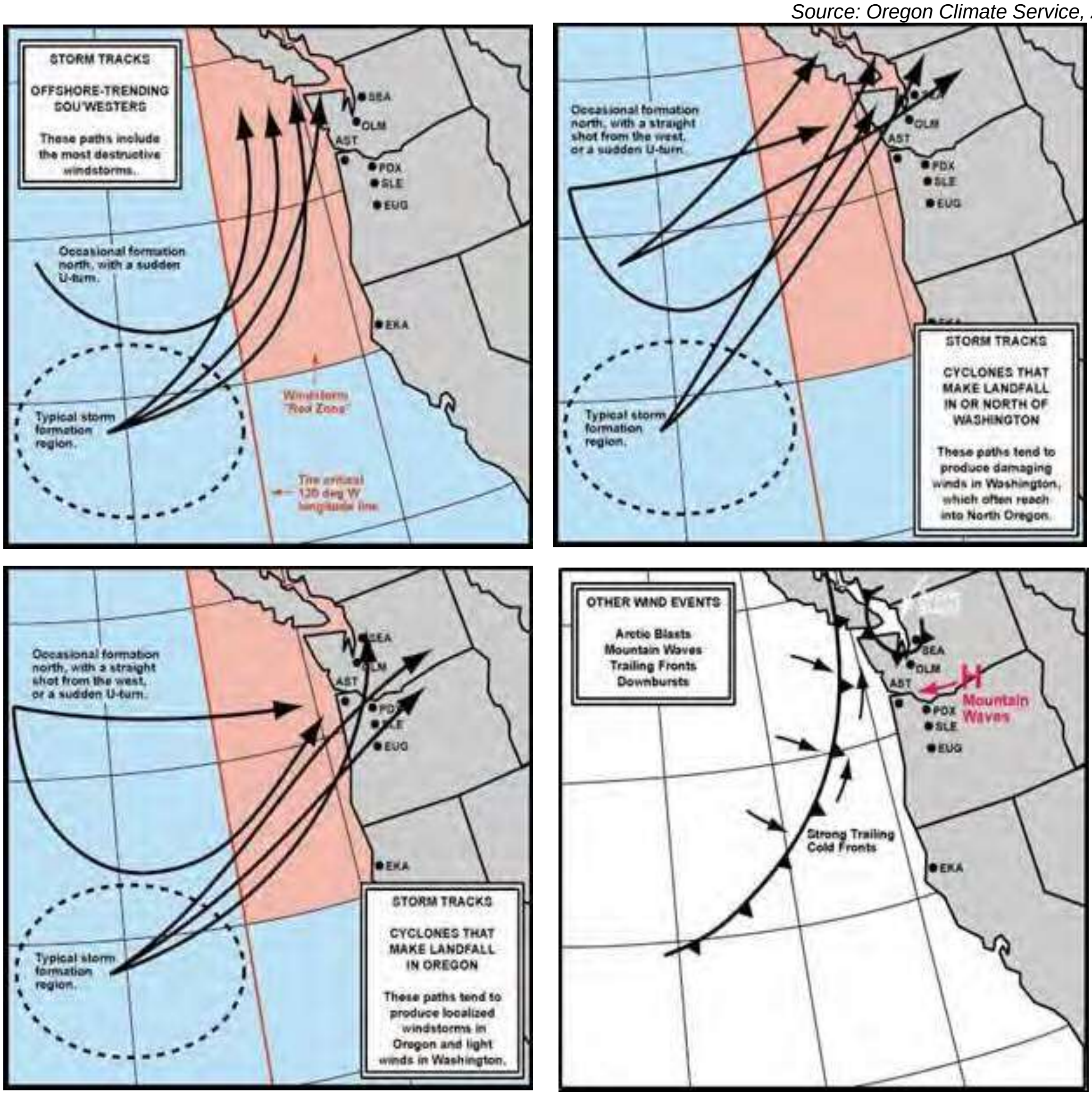


Figure 10-3 Windstorm Tracks Impacting the Pacific Northwest

In contrast, easterly wind events are more limited. High pressure on the east side of the Cascade Mountain Range creates airflow over the peaks and passes, and through the funneling effect of the valleys, the wind increases dramatically in speed. As it descends into these valleys and then exits into the lowlands, the wind can pick up enough speed to damage buildings, rip down power lines, and destroy fences. Once it leaves the proximity of the Cascade foothills, the wind tends to die down rapidly.

All of Mason County is in an 85-mph wind zone. Within this zone there are four (4) zones of exposure, three (3) of which are identified in Mason County and that are utilized to guide structure development (2006 International Building Code). These exposure zones further identify areas that are at higher risk from impacts of high winds. The closer development is to open waters and on top of steep cliffs, the higher the design criteria that is required through building code. Based on the International Building Code, the zones are broken down into surface roughness categories and are defined as follows:

- Surface Roughness B. Urban and suburban areas, wooded areas or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger.
- Surface Roughness C. Open terrain with scattered obstructions having heights generally less than 30 feet (9144 mm). This category includes flat open country, grasslands, and all water surfaces in hurricane-prone regions.
- Surface Roughness D. Flat, unobstructed areas, and water surfaces outside hurricane-prone regions. This category includes smooth mud flats, salt flats and unbroken ice.

Windstorms impact all of Mason County on a regular basis. The strongest winds are generally from the south or southwest and occur during fall and winter. Some are much more damaging than others. For those like the Hanukkah Eve Windstorm of 2006 (see Figure 10-4 and Figure 10-5), the impact on the public can be severe.

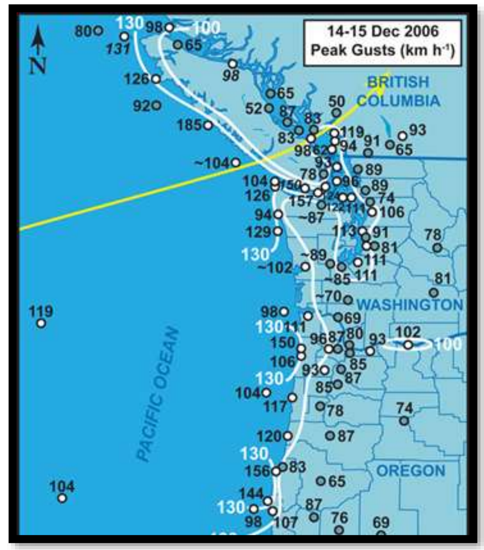
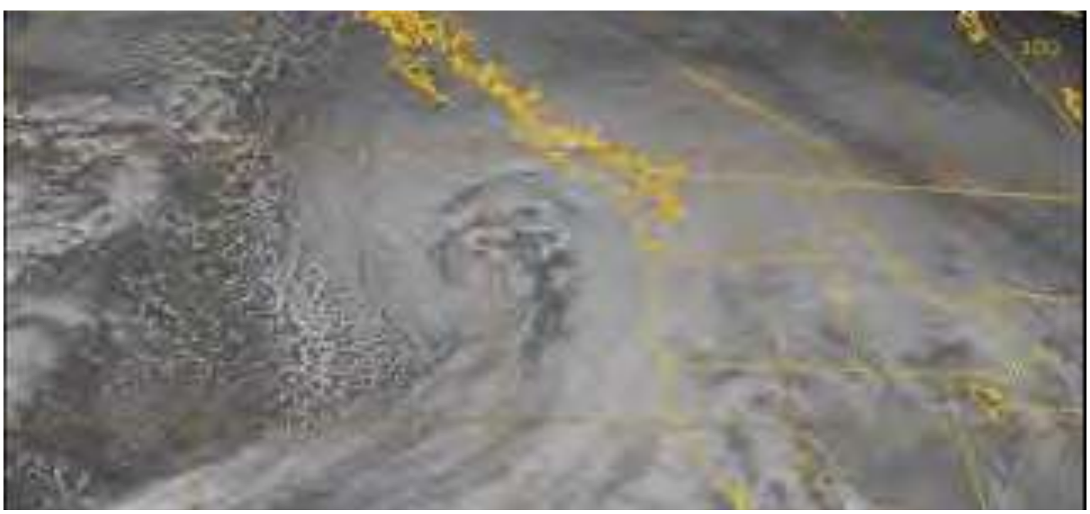


Figure 10-4 Hanukkah Eve Peak Wind Gusts

Mason County was significantly impacted. Torrential rains overwhelmed sewage treatment plants, and when plants lost power, raw sewage flooded into Puget Sound in Mason County.



Source: NOAA Satellite Photo

Figure 10-5 Hanukkah Eve Windstorm of December 13, 2006

The strongest windstorm was the 1962 Columbus Day Storm, which was the strongest non-tropical windstorm to hit the lower 48 states. It traveled about 40 mph from Northern California to the Canadian border and east as far as Montana. The storm killed 46 people, destroyed more than 50,000 homes, left another 469,000 without power, caused $235 million in property damage and flattened 15 billion board feet of timber worth an estimated $750 million. Severe winds also occurred during the Inauguration Day storm of 1993 (see Figure 10-6) . Other severe storms that have severely impacted Mason County have occurred in 1971, 1973, 1979, 1980, 1985, 1986, 2006, 2007, 2009, 2012 and 2016 (2 events).

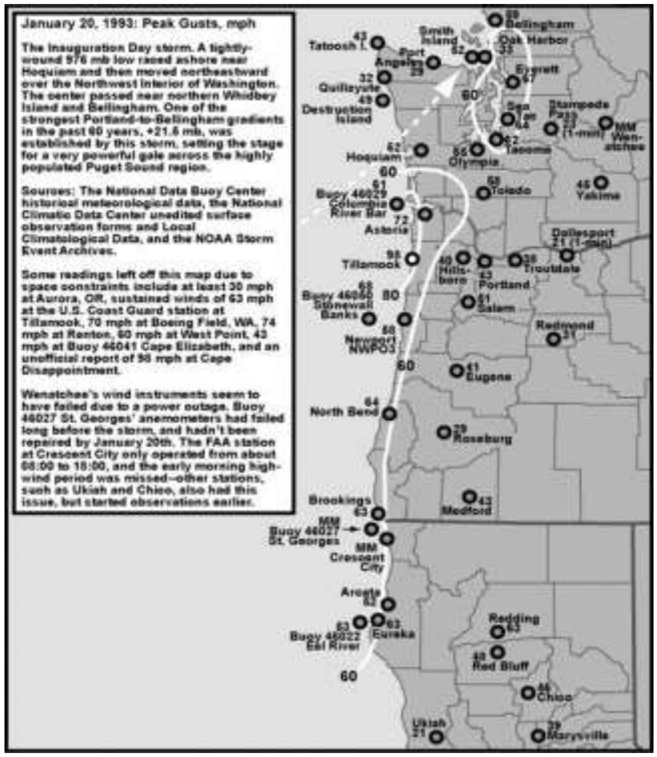


Figure 10-6 Inauguration Day Storm Peak Wind Gusts

10.1.4 Hail Storms

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

Hailstones grow two ways: by wet growth or dry growth. In wet growth, a tiny piece of ice is in an area where the air temperature is below freezing, but not super cold. When the tiny piece of ice collides with a super-cooled drop, the water does not freeze on the ice immediately. Instead, liquid water spreads across tumbling hailstones and slowly freezes. Since the process is slow, air bubbles can escape, resulting in a layer of clear ice. Dry growth hailstones grow when the air temperature is well below freezing and the water droplet freezes immediately as it collides with the ice particle. The air bubbles are "frozen" in place, leaving cloudy ice.

10.1.5 Ice Storms

The National Weather Service defines an ice storm as a storm that results in the accumulation of at least 0.25 inches of ice on exposed surfaces. Ice storms occur when rain falls from a warm, moist, layer of atmosphere into a below freezing, drier layer near the ground. The rain freezes on contact with the cold ground and exposed surfaces, causing damage to trees, utility wires, and structures (see Figure 10-7).

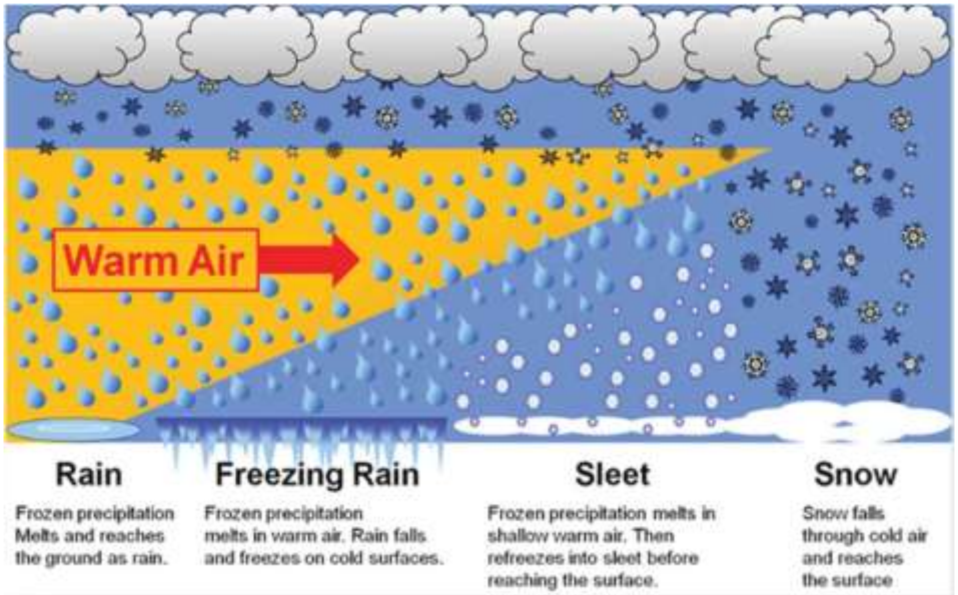


Figure 10-7 Types of Precipitation

10.1.6 Extreme Temperatures

Extreme temperature includes both heat and cold events, which can have a significant impact on human health, commercial/agricultural businesses and primary and secondary effects on infrastructure (e.g., burst pipes and power failure). What constitutes "extreme cold" or "extreme heat" can vary across different areas of the country, based on what the population is accustomed to within the region (CDC, 2014).

Extreme Cold

Extreme cold events are when temperatures drop well below normal in an area. In regions relatively unaccustomed to winter weather, near freezing temperatures are considered "extreme cold." Extreme cold can often accompany severe winter storms, with winds exacerbating the effects of cold temperatures by carrying away body heat more quickly, making it feel colder than is indicated by the actual temperature (known as wind chill). Figure 10-8 demonstrates the value of wind chill based on the ambient temperature and wind speed.

Exposure to cold temperatures, whether indoors or outside, can lead to serious or life-threatening health problems such as hypothermia, cold stress, frostbite or freezing of the exposed extremities such as fingers, toes, nose, and ear lobes. Hypothermia occurs when the core body temperature is <95ºF. If persons exposed to excessive cold are unable to generate enough heat (e.g., through shivering) to maintain a normal core body temperature of 98.6ºF, their organs (e.g., brain, heart, or kidneys) can malfunction. Extreme cold also can cause emergencies in susceptible populations, such as those without shelter, those who are stranded, or those who live in a home that is poorly insulated or without heat. Infants and the elderly are particularly at risk, but anyone can be affected.

Extremely cold temperatures often accompany a winter storm, so individuals may have to cope with power failures and icy roads. Although staying indoors as much as possible can help reduce the risk of car crashes and falls on the ice, individuals may also face indoor hazards. Many homes will be too cold—either due to a power failure or because the heating system is not adequate for the weather. The use of space heaters and fireplaces to keep warm increases the risk of household fires and carbon monoxide poisoning.

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 10-8 NWS Wind Chill Index

During cold months, carbon monoxide may be high in some areas because the colder weather makes it difficult for car emission control systems to operate effectively. Carbon monoxide levels are typically higher during cold weather because the cold temperatures make combustion less complete and cause inversions that trap pollutants close to the ground (USEPA, 2009).

Extreme Heat

Temperatures that hover 10 degrees or more above the average high temperature for the region and last for several days or weeks are defined as extreme heat (FEMA, 2006; CDC, 2006). An extended period of extreme heat of three or more consecutive days is typically called a heat wave and is often accompanied by high humidity (Ready America, Date Unknown; NWS, 2005). There is no universal definition of a heat wave because the term is relative to the usual weather in a particular area. The term heat wave is applied both to routine weather variations and to extraordinary spells of heat which may occur only once a century (Meehl and Tebaldi, 2004). A basic definition of a heat wave implies that it is an extended period of unusually high atmosphere-related heat stress, which causes temporary modifications in lifestyle and which may have adverse health consequences for the affected population (Robinson, 2000). Figure 10-9 identifies some of those consequences and associated temperatures. [17]

Certain populations are considered vulnerable or at greater risk during extreme heat events. These populations include, but are not limited to the following: the elderly age 65 and older, infants and young children under five years of age (see Figure 10-10), pregnant woman, the homeless or poor, the overweight, and people with mental illnesses, disabilities, and chronic diseases (NYS HMP, 2008).

[17] NCDC, 2000

Relative Humidity (%)	Temperature (°F)															
	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Category	Heat Index	Health Hazards
Extreme Danger	130 °F – Higher	Heat Stroke / Sunstroke is likely with continued exposure.
Danger	105 °F – 129 °F	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Extreme Caution	90 °F – 105 °F	Sunstroke, muscle cramps, and/or heat exhaustions possible with prolonged exposure and/or physical activity.
Caution	80 °F – 90 °F	Fatigue possible with prolonged exposure and/or physical activity.

Figure 10-9 Heat Stress Index

Wind-Chill Factor Chart (in Fahrenheit)

Air Temperature	Wind Speed in mph: Calm	5	10	15	20	25	30	35	40
40	40	36	34	32	30	29	28	28	27
30	30	25	21	19	17	16	15	14	13
20	20	13	9	6	4	3	1	0	-1
10	10	1	-4	-7	-9	-11	-12	-14	-15
0	0	-11	-16	-19	-22	-24	-26	-27	-29
-10	-10	-22	-28	-32	-35	-37	-39	-41	-43

Comfortable for out door play Caution Danger

Heat Index Chart (in Fahrenheit %)

Air Temperature (F)	Relative Humidity (Percent): 40	45	50	55	60	65	70	75	80	85	90	95	100
80	80	80	81	81	82	82	83	84	84	85	86	86	87
84	83	84	85	86	88	89	90	92	94	96	98	100	103
90	91	93	95	97	100	103	105	109	113	117	122	127	132
94	97	100	103	106	110	114	119	124	129	135			
100	109	114	118	124	129	130							
104	119	124	131	137									

Figure 10-10 Temperature Index for Children

Figure 10-11 Average Number of Weather Related Fatalities in the U.S.

Figure 10-11 shows the number of weather fatalities based on 10-year and 30-year averages[18]. Extreme heat is the number one weather-related cause of death in the U.S. over the 30-year average. On average, more than 1,500 people die each year from excessive heat. Heat again ranked highest in causes of weather related deaths for the 30-year average; however, tornadoes ranked the highest for the 10-year average (2007-2016), while flood ranked the number one weather-related fatality for the year 2016.

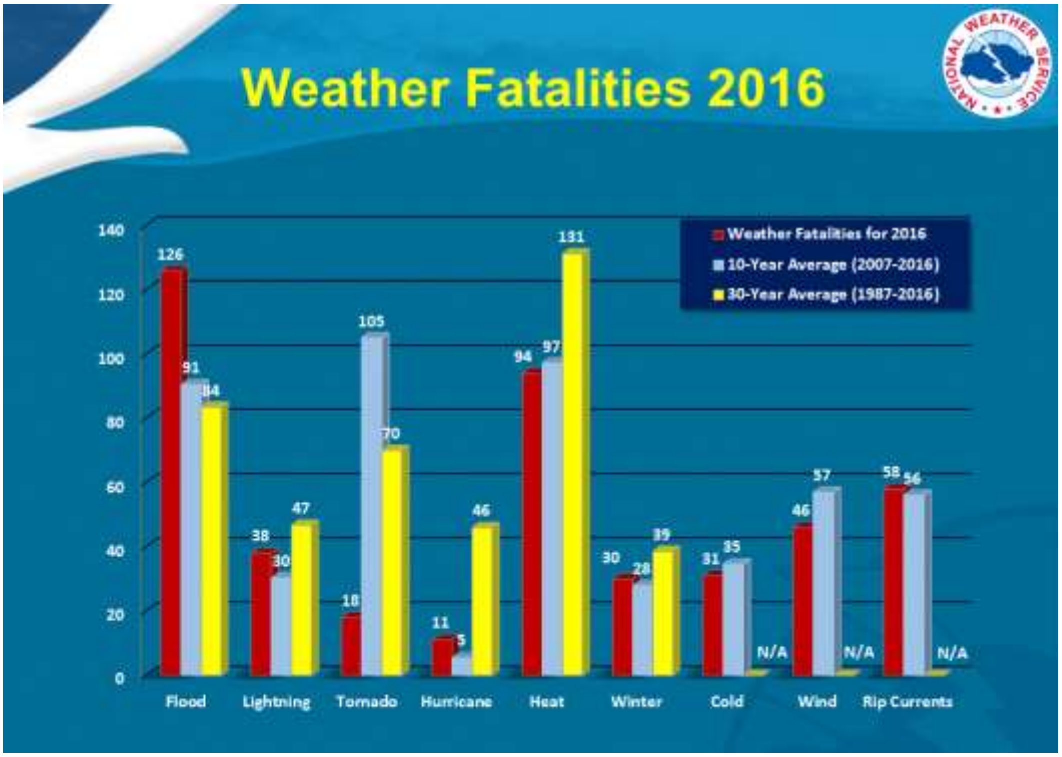


Figure 10-11 Average Number of Weather Related Fatalities in the U.S.

Depending on severity, duration, and location; extreme heat events can create or provoke secondary hazards including, but not limited to, dust storms, droughts, wildfires, water shortages and power outages (FEMA, 2006; CDC, 2006). This could result in a broad and far-reaching set of impacts throughout a local area or entire region. Impacts could include significant loss of life and illness; economic costs in transportation, agriculture, production, energy, and infrastructure; and losses of ecosystems, wildlife habitats and water resources (Adams, Date Unknown; Meehl and Tebaldi, 2004; CDC, 2006; NYSDPC, 2008).

[18] NOAA, 2014 (http://www.nws.noaa.gov/om/hazstats.shtml) (Most recently available at time of update.)

10.2 HAZARD PROFILE

10.2.1 Extent and Location

The entire planning area is susceptible to the impacts of severe weather. Severe weather events customarily occur during the months of October to April, although they have occurred year-round. The County has been impacted by strong winds, rain, snow, or other precipitation, and often are accompanied by thunder or lightening (Mason County, 2010). Considerable snowfall does not customarily occur throughout the region.

Communities in low-lying areas next to coastlines, rivers, streams, or lakes are more susceptible to flooding as a result of storm surge. Wind events are most damaging to areas of Mason County. Winds coming off of the Pacific Coast can have a significant impact on the planning region as a result of both the wind and associated storm surge (Hood Canal area). For the planning region as a whole, wind events are one of the most common weather-related incidents to occur, often times leaving the area without power, although customarily not for long, extended periods.

Severe storms and weather affect transportation and utilities. Access across certain parts of the County is unpredictable as roads are vulnerable to damage from severe storms, storm surges, and landslide/erosion. Severe storms and storm surges can also cause flooding and channel migration.

The distribution of average weather conditions over the County is shown on Figure 10-12 through 10-15.

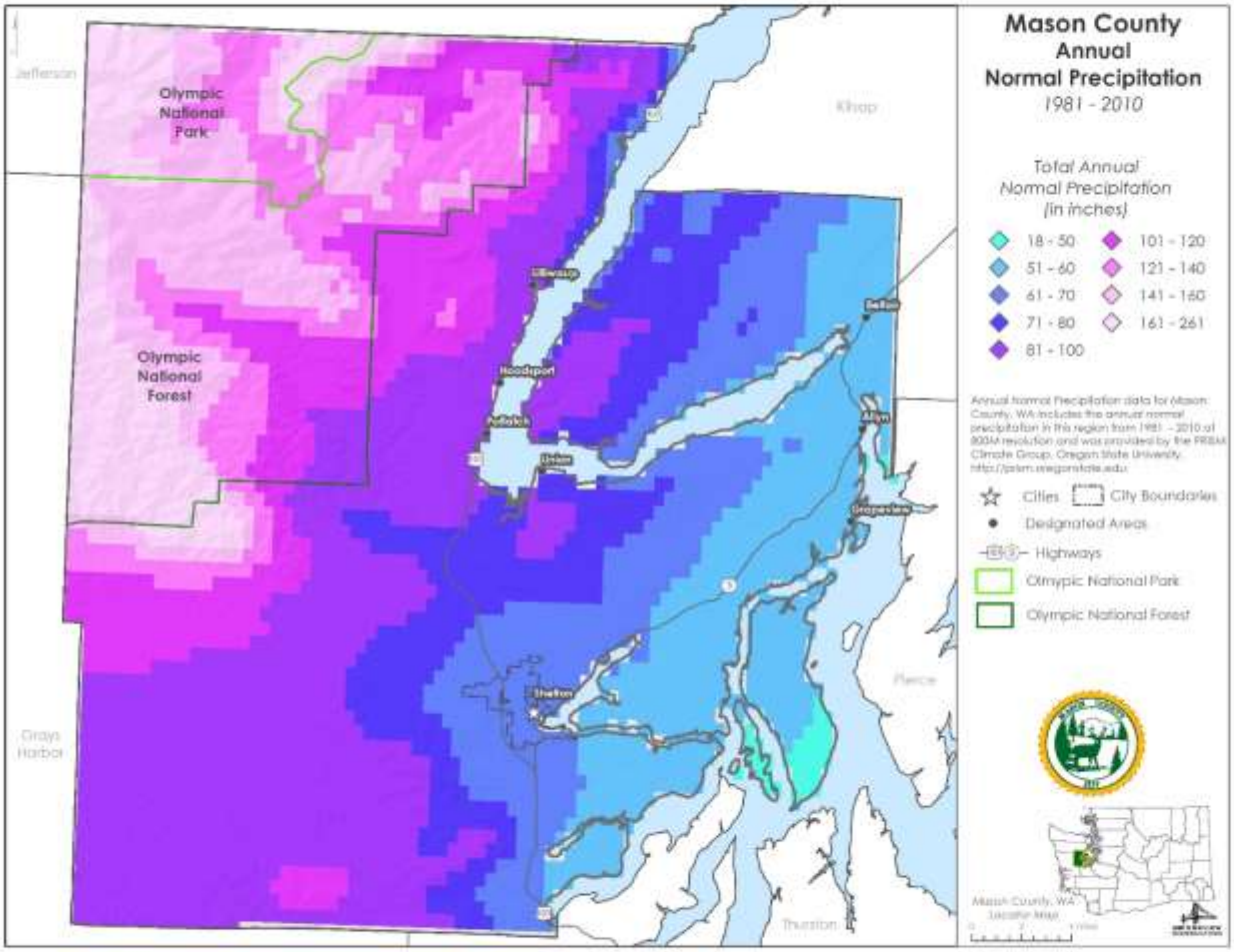


Figure 10-12 Mason County Average Annual Precipitation

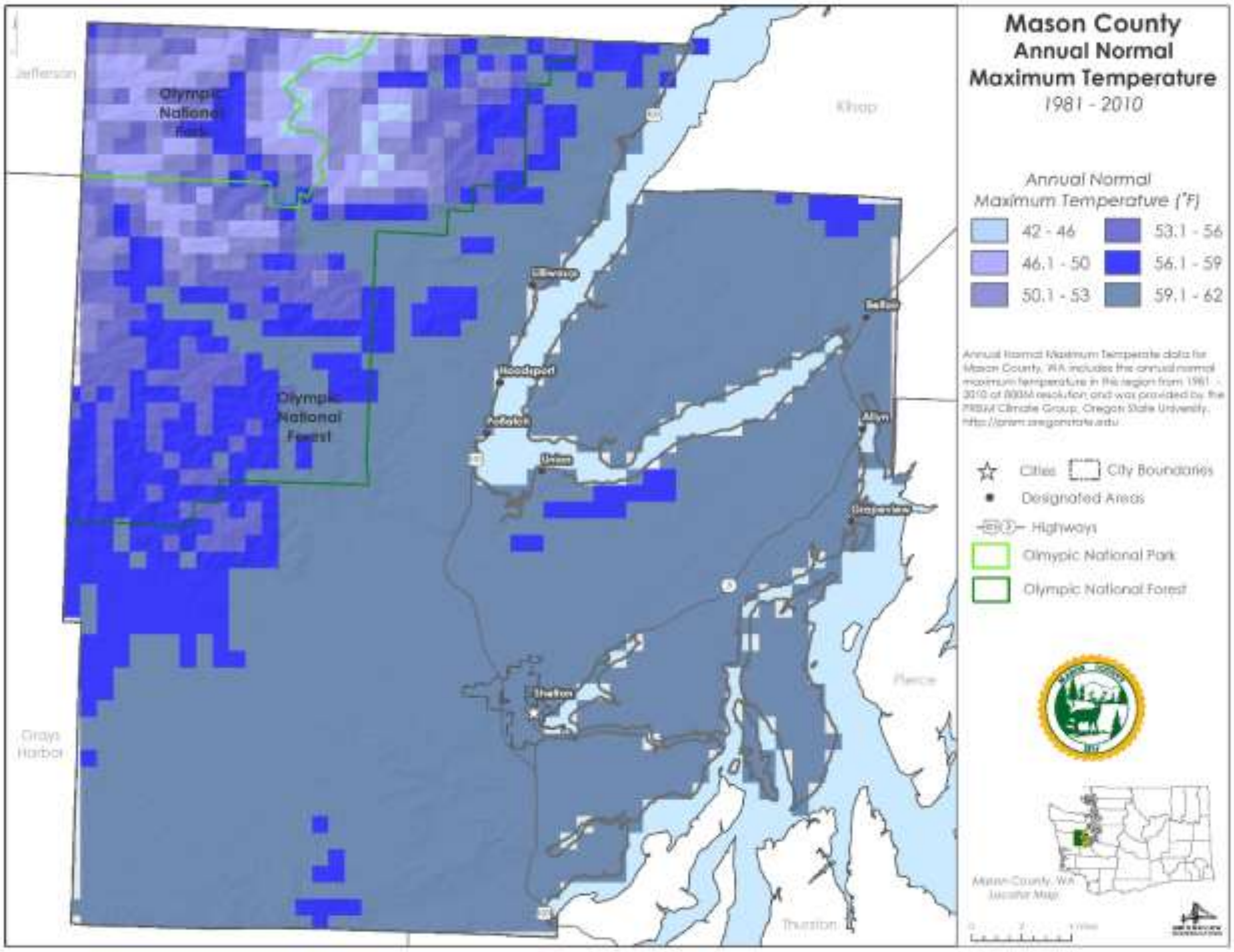


Figure 10-13 Mason County Average Maximum Temperature

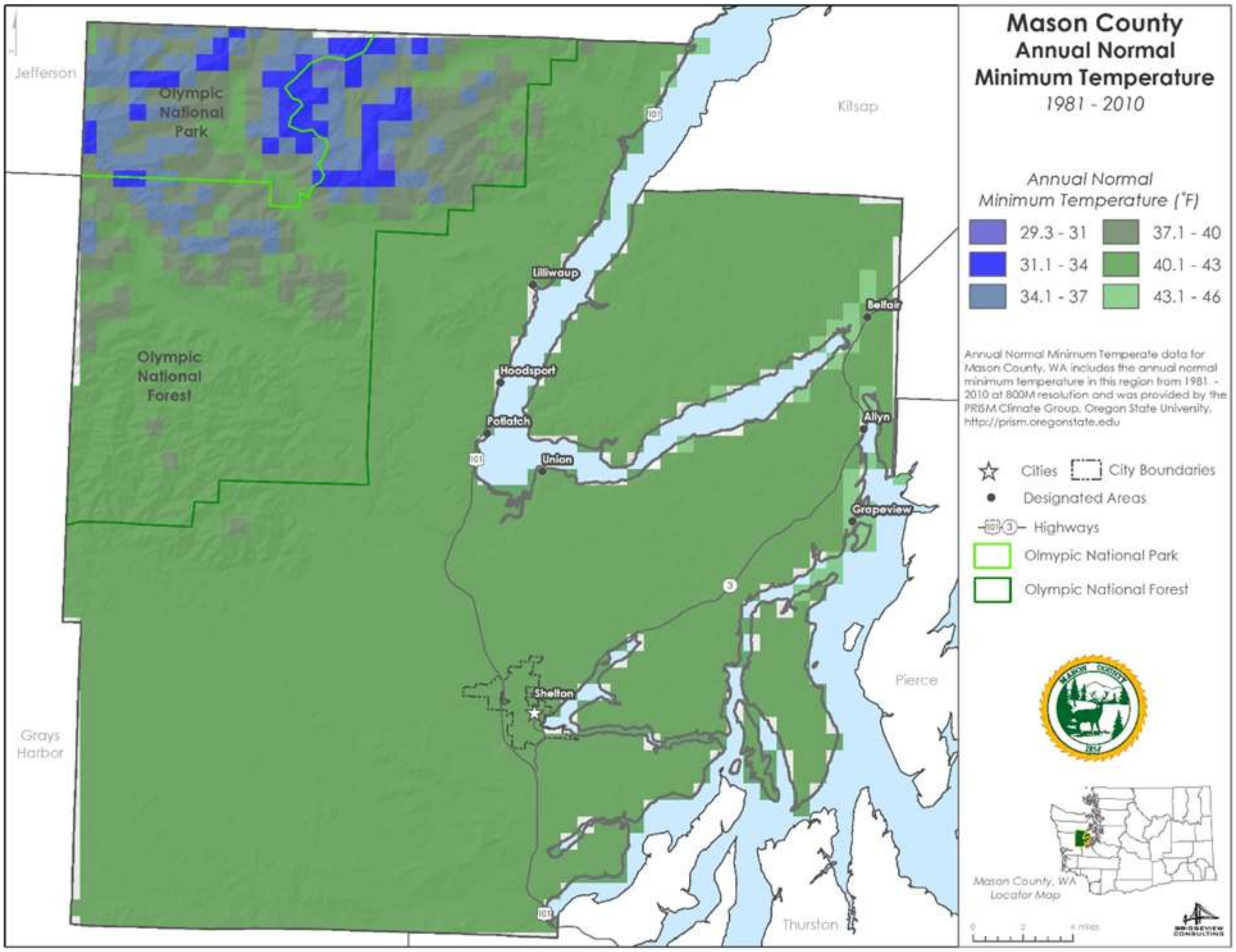


Figure 10-14 Mason County Average Minimum Temperature

Source: USA.com

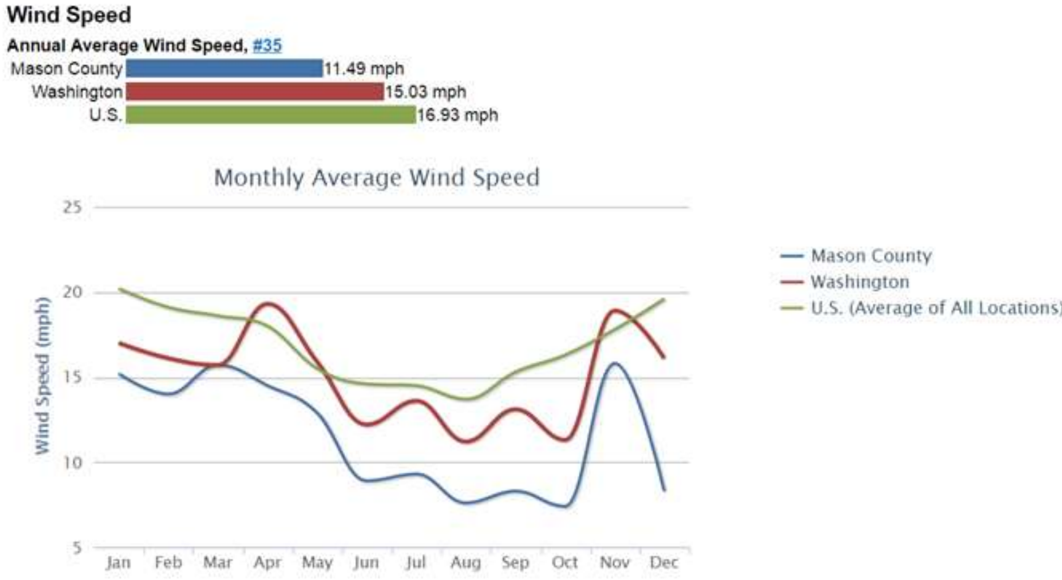


Figure 10-15 Mason County Monthly Average Wind Speed

10.2.2 Previous Occurrences

Table 10-1 summarizes severe weather events in Mason County since 1960, as recorded by the National Oceanic and Atmospheric Administration (NOAA), Spatial Hazard Events and Losses Database for the United States (SHELDUS), other local area plans, and FEMA websites.

SHELDUS utilizes a variety of NOAA data sources, and covers severe weather events from 1960 through 2000 that caused more than $50,000 in property and/or crop damage. Data obtained from the National Climatic Data Center include weather events causing more than $100,000 in property and/or crop damage from 1993 through 2003 (except June and July 1993, for which data is not available), with the following exceptions:

- Tornado information is from 1950 to 1992.
- Thunderstorm wind and hail information is from 1955 to 1992.

In addition to the federally declared events, Mason County regularly sustains impact from severe wind events which do not rise to the level of a declaration, but have significant impact on the region. Wind and associated storm effects impact a much greater area than incidents associated only with floods in most instances.

For example, the great Coastal Gale of December 1-3, 2007 impacted the entire western coastline from northern California to Canada. Over a period of three days, two separate storms lashed the area with hurricane-force gusts and heavy rain. The region between Newport, OR and Hoquiam, WA received the strongest gale since the great Columbus Day Storm of 1962. Figure 10-16 compares the 1962 Columbus Day Storm to the 2007 event.[19]

[19] http://www.climate.washington.edu/stormking/

There have been no reported tornado incidents hitting within Mason County, although there have been incidents in surrounding communities (see Figure 10-17).

Table 10-1
Severe Weather Events Impacting Planning Area Since 1960

Date	Type	Deaths or Injuries	Property Damage
October 1962 DR 137	Wind storm	7 in Washington; 46—combined all state's impacted	$235 million in property damage; 15 billion board feet of timber valued at $750 million
Description: Most powerful non-tropical storm to impact lower 48 states. Impact felt in Washington, Oregon, and California. Damaged over 50,000 buildings throughout regions impacted. Power in some areas out for 3+ weeks. Wind speeds ranged from 88 mph in Tacoma to 160 mph in Naselle, WA. FEMA datasets provide no information on actual counties declared, other than the reference to Washington Counties.			
December 1974 (Disaster #414)	(Listed as Flood) Severe storm, flooding, and snowmelt	Unknown	$5.1 million combined from all 10 affected counties*
Description: Strong winds, snowfall and flooding affected 10 counties in Washington.			
December 1975 (Disaster 492)	(Listed as Flood) Severe Storms & Flooding	Unknown	Unknown
Description: Severe storms and flooding on December 13, 1975.			
November 1990 (Disaster 883)	Severe Storms & Flooding	Unknown	Unknown
Description: Strong winds, snowfall and flooding affected 10 counties in Washington.			
January 1993 (Disaster 981*)	Severe storm and high wind	Unknown	
Description: A powerful low-pressure system swept through central Western Washington, causing great destruction, numerous injuries, and the loss of five lives. Winds averaging 50 miles per hour with gusts to over 100 miles per hour caused trees to fall and knocked out power to 965,000 customers.			
November 1995 (Disaster 1079)	Flooding, severe storm, and high winds	Unknown	
Description: Heavy rains lead to flooding throughout the region.			
Dec. 1996—Jan. 1997 (Disaster 1159)	Severe winter storm, flooding, landslides, and mudslides.	24 deaths statewide	Statewide: Stafford Act assistance $83 million; SBA $31.7 million; total losses $140 million statewide
Description: Saturated ground combined with snow, freezing rain, rain, rapid warming, and high winds within a five-day period produced flooding and landslides. 37 counties were impacted, with large power outages throughout the impacted counties.			
October 2003 (Disaster 1499)	Severe Storm and Flooding	Unknown	Statewide losses PA >$9 million IA >$5.5 million
Description: Heavy rains, severe storms.			
January 2006 (Disaster 1641)	Severe winter storm, flood, landslide, mudslide, tidal surge	Unknown	Unknown
Description: Heavy rains			
December 2006 DR 1682	Severe winter storm, wind, landslides, and mudslides	Unknown	
Description: Severe winter storm caused landslides and mudslides throughout region.			

Table 10-1
Severe Weather Events Impacting Planning Area Since 1960

Date	Type	Deaths or Injuries	Property Damage
December 2007 (Disaster 1734)	Severe storm, flooding, landslides, and mudslides	Unknown	Unknown
Description: Severe winter storm, including record and near record snowfall and heavy rains and winds.			
December 2008 (Disaster 1825)	Severe winter storm, record and near record snow	Unknown	Public Assistance to all declared counties was over $5.5 million
Description: Severe winter storm, including record and near record snowfall and heavy rains and winds.			
January 2009 (Disaster 1817)	(Listed as Flood) Severe winter storm, landslides, mudslides and flooding	Unknown	PA program only available, no IA.
Description: Severe winter storm, including heavy rains and land/mud slides.			
January 2012 (Disaster 4056)	Severe winter storm, flooding, landslides, and mudslides	Unknown	PA program only available, no IA.
Description: Severe winter storm, including heavy rains, which caused flooding, landslides and mudslides.			
November 2015 (Disaster 4249)	Severe storm, straight-line winds, flooding, landslides and mudslides	Unknown	PA program only available, no IA.
Description: Severe storm, including straight-line winds, flooding, landslides and mudslides.			
December 2015 (Disaster 4253)	(Listed as Flood) Severe winter storm, straight-line winds, flooding, landslides and mudslides	Unknown	PA program only available, no IA.
Description: Severe winter storm, including record and near record snowfall and heavy rains and winds.			

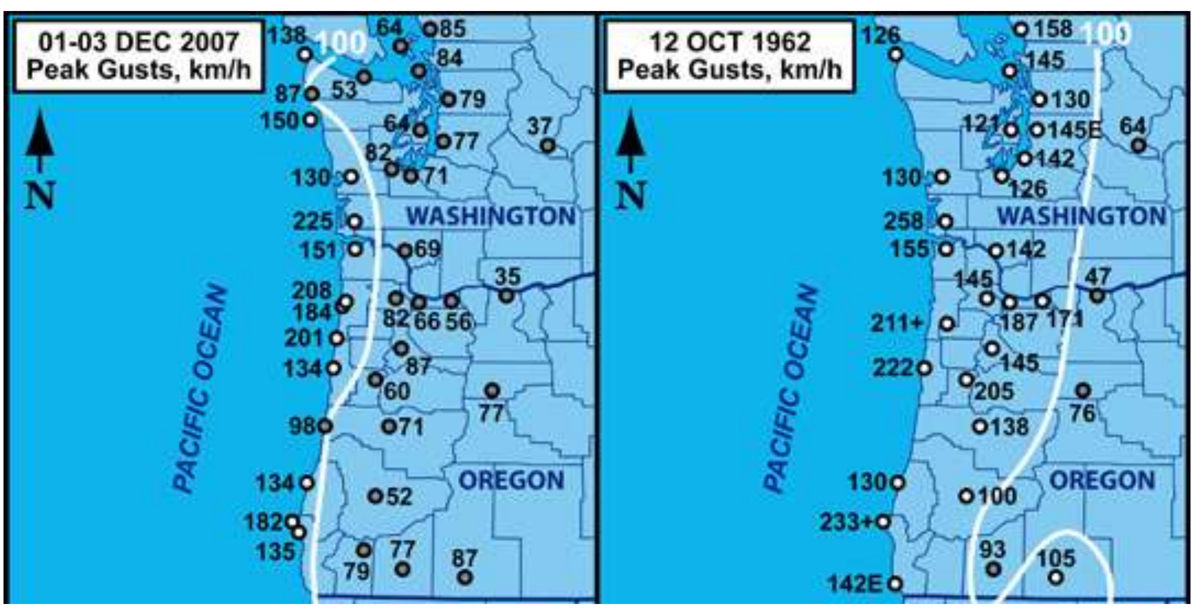


Figure 10-16 Peak Gust Comparison- 2007 Great Coastal Gale and 1962 Columbus Day Storm

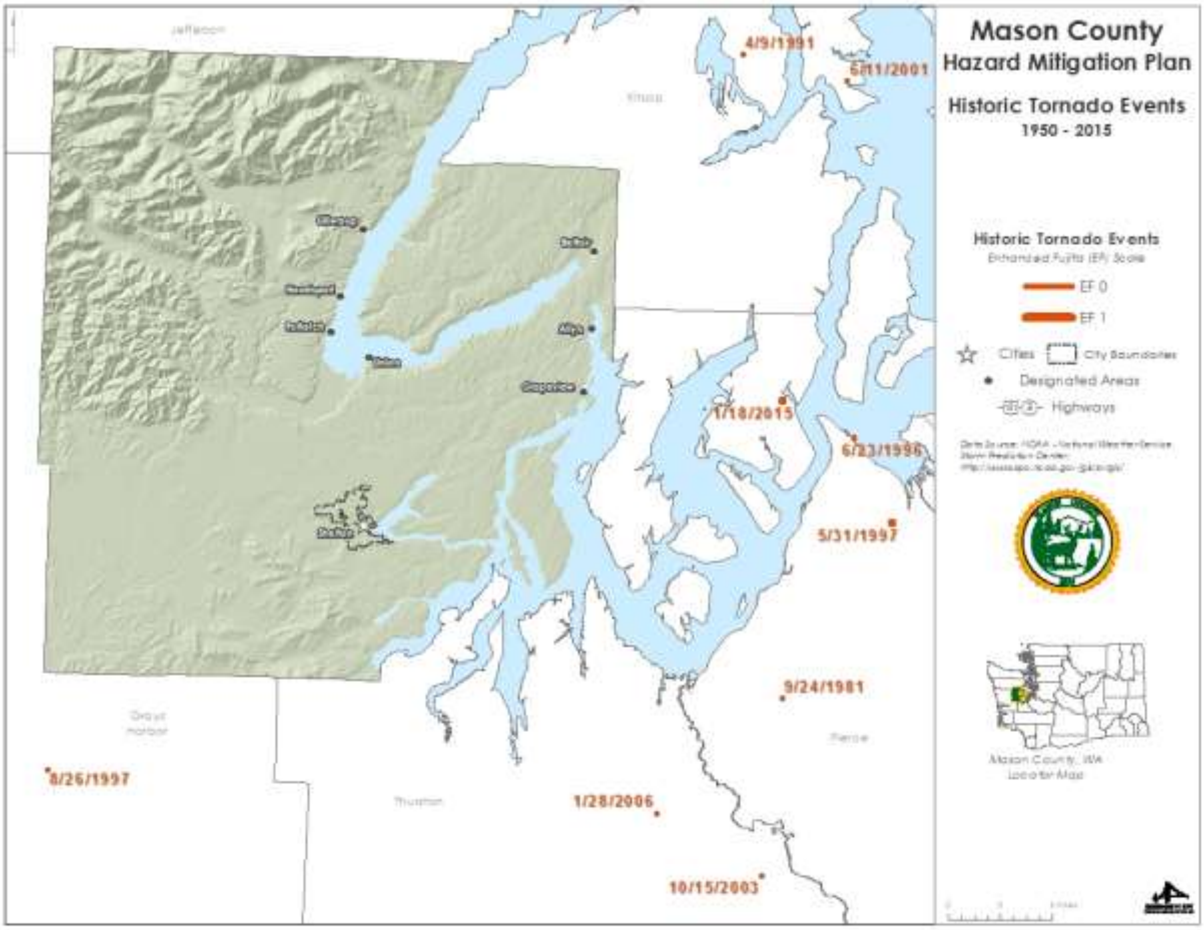


Figure 10-17 Tornadoes within Planning Region

10.2.3 Severity

The most common problems associated with severe storms are immobility and loss of utilities. Fatalities are uncommon, but can occur. Roads may become impassable due to flooding, downed trees, ice or snow, or a landslide. Power lines may be downed due to high winds or ice accumulation, and services such as water or phone may not be able to operate without power. Lightning can cause severe damage and injury. Physical damage to homes and facilities caused by wind, or by accumulation of snow or ice can also occur. Due to the limited amount of snow we customarily receive in our region, even a small accumulation of ice or snow can, and has, caused havoc on transportation systems due to hilly terrain, the level of experience of drivers to maneuver in snow and ice conditions, and the lack of snow clearing equipment and resources within the region.

Ice storms, especially when accompanied by high winds, can have an especially destructive impact within the planning region, with both being able to close major transportation corridors and bridges. Accumulation of ice on trees, power lines, communication towers and wiring, or other utility services can be crippling, and create additional hazards for residents, motorists and pedestrians.

During the last 30 years, Western Washington has had an average annual snowfall of 11.4 inches per year, with the snowfall customarily occurring during November through March, although snow has fallen as late as April. Within Mason County, snowfall ranges an average of 3-5 inches, with approximately 2 days (averaged) per year with snow depths of 1 inch or more.[20] Historical records in Western Washington are as follows:

- January 1950 – One-day record for snow accumulation – 21 inches
- January 1950 – One-month record for snow accumulation – 57 inches
- 1968-1969 – Winter season record for snow accumulation – 67 inches

Windstorms are common in the planning area, occurring many times throughout the year within Mason County. They are especially concerning for PUDs 1 and 3. The predicted wind speed given for wind warnings issued by the National Weather Service is for a one-minute average, during which gusts may be 25 to 30 percent higher.

Tornadoes are potentially the most dangerous of local storms, but they are not common in the planning area. If a major tornado were to strike within the planning area, damage could be widespread. As a result of building stock age, fatalities could be high, with many people homeless for an extended period of time. Routine services such as telephone or power could be disrupted. Businesses could be forced to close for an extended period, impacting commodities available for citizens. As a result of the heavily forested areas, debris accumulations would be high, causing additional difficulties with access along major arterials connecting the area to other parts of the state, further impacting logistical support and commodities.

The extent (severity or magnitude) of extreme cold temperatures are generally measured through the wind chill temperature index. Wind Chill Temperature is the temperature that people and animals feel when outside and it is based on the rate of heat loss from exposed skin by the effects of wind and cold. As the wind increases, the body is cooled at a faster rate causing the skin's temperature to drop (NWS, 2009).

On November 1, 2001, the NWS implemented a new wind chill temperature index. It was designed to more accurately calculate how cold air feels on human skin. Figure 10-8 (above) shows the new wind chill temperature index[21]. The Index includes a frostbite indicator, showing points where temperature, wind speed and exposure time will produce frostbite to humans. The chart shows three shaded areas of frostbite danger. Each shaded area shows how long a person can be exposed before frostbite develops (NWS, 2009).

The extent of extreme temperatures is generally measured through the heat index shown in Figure 10-9 and Figure 10-10 (above). Created by the NWS, the Heat Index accurately measures apparent temperature of the air as it increases with the relative humidity. The Heat Index can be used to determine what effects the temperature and humidity can have on the population (NCDC, 2000).

10.2.4 Frequency

The severe weather events for Mason County shown in Table 10-1 are often related to high winds and associated other winter storm-type events such as heavy rains and landslides, and to a much lesser extent, snow. The planning area can expect to experience exposure to some type of severe weather event at least annually.

[20] USA.Com Mason County Weather: http://www.usa.com/mason-county-wa-weather.htm#

[21] NWS, 2008

10.3 VULNERABILITY ASSESSMENT

10.3.1 Overview

Severe weather incidents can and regularly do occur throughout the entire planning area. Similar events impact areas within the planning region differently, even though they are part of the same system. While in some instances some type of advanced warning is possible, as a result of climatic differences, topographic and relative distance to the coastline, the same system can be much more severe in certain areas of the County. Therefore, preparedness plays a significant contributor in the resilience of the citizens to withstand such events.

Methodology

A lack of data separating severe weather damage from flooding, windstorms, and landslide damage prevented a detailed analysis for exposure and vulnerability. For planning purposes, it is assumed that the entire planning area is exposed to some extent to severe weather. Certain areas are more exposed due to geographic location and local weather patterns, as well as the response capabilities of local first responders.

Warning Time

Meteorologists can often predict the likelihood of some severe storms. In some cases, this can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity of the storm, and the rapid changes which can also occur significantly increasing the impact of a weather event.

10.3.2 Impact on Life, Health and Safety

The entire planning area is susceptible to severe weather events. Populations living at higher elevations with large stands of trees or above-ground power lines may be more susceptible to wind damage and black out conditions, while populations in low-lying areas are at risk for possible flooding and landslides associated with the flooding as a result of heavy rains. Increased levels of precipitation in the form of snow also vary by area, with higher elevations being more susceptible to increased accumulations. Resultant secondary impacts from power outages during cold weather event, when combined with the high population of retired and elderly residents significantly impacts response capabilities and the risk factor associated with such weather incidents. Within the densely wooded areas, increased fire danger during extreme heat conditions increases the likelihood of fire, which increases fire danger.

Particularly vulnerable populations are the elderly and very young, low income, linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Extreme temperature variations, either heat or cold, are of significant concern on both the elderly and the young, increasing vulnerability of those populations.

A number of storm events have cut off primary access routes to areas of the County for days at a time – these storm events include both declared and non-declared incidents, as even minor incidents have the potential to impact ingress and egress. Such issues are of concern as a result of limited access for evacuation purposes by first responder if vital ALS is required, as well as for general evacuation purposes during a period where power is out, and individuals attempt to leave the area. Travel time can be increased significantly if alternate routes are used.

PUDs 1 and 3 provide electricity to the planning area. Severe weather events can and have disrupted electricity in the planning area, on average though only a few times each year. When most power outages occur, they last for only a few hours, except in extreme outlying areas. The most significant event which caused power to be out for in excess of seven days was as a result of the 1996 ice storm.

The fairly large population of retirees (~8 percent higher than other areas of the state) and the higher rate of disabled individuals (20.8 percent within Mason County versus 12.6 percent statewide) are of significant concern to the planning partners throughout the region when severe weather events occur due to the higher levels of vulnerable populations.

10.3.3 Impact on Property

Currently data identifies that there are in excess of 30,000 buildings in the planning area. Most of these buildings are residential. Within Mason County, approximately 58 percent of structures were built after 1980; however, in the City of Shelton, only 34 percent of structures were built after 1980, meaning a high percentage of structures in Shelton could be impacted by significant weather events as many were built without the influence of a structural building code with provisions for wind loads.

For planning purposes, all properties and buildings within the planning area are considered to be exposed to the severe weather hazard, but structures in poor condition or in particularly vulnerable locations (hilltops or exposed open areas) may be at risk for the most damage. The frequency and degree of damage will depend on specific locations and severity of the weather pattern impacting the region. It is improbable to determine the exact number of structures susceptible to a weather event, and therefore emergency managers and public officials should establish a maximum threshold, or worst-case scenario, of susceptible structures.

Loss estimations for severe weather hazards are not based on modeling utilizing damage functions, as no such functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the assessed value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 10-2 shows loss estimates for the severe weather risk by jurisdiction at the identified percent damages, as well as the potential dollar losses for residential and non-residential structures.

Table 10-2
Potential Building Losses Due to Severe Weather Hazard

Jurisdiction	Building Count	Exposed Value	10% Damage	30% Damage	50% Damage
Unincorporated Mason County	24,799	$4,872,689,853	$487,268,985	$1,461,806,956	$2,436,344,927
Allyn	1,001	$236,320,776	$23,632,078	$70,896,233	$118,160,388
Belfair	1,684	$312,528,444	$31,252,844	$93,758,533	$156,264,222
Shelton	3,272	$724,404,122	$72,440,412	$217,321,237	$362,202,061
Total	30,756	$6,145,943,195	$614,594,319	$1,843,782,959	$3,072,971,598

10.3.4 Impact on Critical Facilities and Infrastructure

No loss estimation of critical facilities was performed due to the lack of established damage functions for the severe weather hazard. Therefore, it should be assumed that all critical facilities are vulnerable to some degree. As many of the severe weather events include multiple hazards, information such as that identifying facilities exposed to flooding or landslides (see Flood and Landslide profiles) are also likely exposed to severe weather. Additionally, facilities on higher ground may also be exposed to wind damage or damage from falling trees. The most common problems associated with severe weather are loss of utilities. Downed power lines can cause blackouts, leaving large areas isolated. Such was the case that the county experienced as a result of the 1996 ice storm, which left much of the area without power for days. As a result of that event, PUD 3 significantly increased their tree-trimming operations to reduce the potential impact from wind, ice and snow events. In addition to power, phone, water and sewer systems may also not function properly during severe weather events. Roads may become impassable due to ice or snow or from secondary hazards such as landslides. Within the planning region, Tacoma Public Utilities has two hydroelectric dams which produce a significant amount of power to areas well outside of the planning area. Major power lines travel from the various dams through a large swath of Mason County. As such, wind events occurring in Mason County also have the potential to impact power supplies in large metropolitan areas well outside of Mason County.

Incapacity and loss of roads are the primary transportation failures, most of which are associated with secondary hazards. Landslides that block roads are caused by heavy prolonged rains. High winds can cause significant damage to trees and power lines, with obstructing debris blocking roads, incapacitating transportation, isolating population, and disrupting ingress and egress. Snowstorms at higher elevations can impact the transportation system and the availability of public safety services. Of particular concern are roads providing access to isolated areas and to the elderly.

Severe windstorms, downed trees, and ice can create serious impacts on power and above-ground communication lines. Freezing of power and communication lines can cause them to break, disrupting both electricity and communication for households. Loss of electricity and phone connection would result in isolation because some residents will be unable to call for assistance.

10.3.5 Impact on Economy

Prolonged obstruction of major routes due to severe weather can disrupt the shipment of goods and other commerce. Severe windstorms, downed trees, and ice can create serious impacts on power and above-ground communication lines. Freezing rain/snow on power and communication lines can cause them to break, disrupting electricity and communication, further impacting business within the region. Prolonged outages would impact consumer and tax base as a result of lost revenue, (food) spoilage, lack of production, etc. Large, prolonged storms can have negative economic impacts for an entire region. All severe weather events have the potential to also impact tourism, an industry on which much of the planning region is dependent.

10.3.6 Impact on Environment

The environment is highly exposed to severe weather events. Natural habitats such as streams and trees are exposed to the elements during a severe storm and risk major damage and destruction. Prolonged rains can saturate soils and lead to slope failure. Flooding events caused by severe weather or snowmelt can produce river channel migration or damage riparian habitat, also impacting spawning grounds and fish populations for many years. Within the planning area, there are four fish hatcheries, which, if impacted, could result in decreased numbers of salmon and trout in the area, as the hatcheries release the fish annually. Should this occur, this would impact the area for years to come due to the life-cycle of the returning salmon. Storm surges can erode beachfront bluffs and redistribute sediment loads. Extreme heat can raise temperatures of rivers, impacting oxygen levels in the water, threatening aquatic life.

10.4 FUTURE DEVELOPMENT TRENDS

All future development will be affected by severe storms. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. The County does have land use regulations in place, which includes implementation of the International Building Codes as well as additional land use authority. These codes are equipped to deal with the impacts of severe weather incidents by identifying construction standards which address wind speed, roof load capacity, elevation and setback restrictions.

While under the Growth Management Act, public power utilities are required by law to supply safe, cost effective and equitable service to everyone in the service area requesting service, most lines in the area are above-ground, causing them to be more susceptible to high winds or other severe weather hazards. However, growth management is also a constraint, which could possibly lead to increased outages or even potential shortages, as while most new development expects access to electricity, they do not want to be in close proximity to sub stations. The political difficulty in sighting these sub-stations makes it difficult for the utility to keep up with regional growth.

Land use policies currently in place, when coupled with informative risk data such as that established within this mitigation plan and such other projects like FEMA's new flood maps, will also address the severe weather hazard. With the land use tools currently in place, the County and its planning partners will be well-equipped to deal with future growth and the associated impacts of severe weather.

10.5 ISSUES

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

- Older building stock in the planning area is built to low code standards or none at all. These structures could be highly vulnerable to severe weather events such as windstorms.
- Redundancy of power supply must be evaluated and increased planning-region wide in order to more fully understand the vulnerabilities in this area.
- The capacity for backup power generation is limited and should be enhanced, especially in areas of potential isolation due to impact on major thoroughfares or evacuation routes.
- Isolated population centers exist.
- Climate change may increase the frequency and magnitude of winter flooding or storm surges, thus exacerbating severe winter events.
- Proximity to coastline enhances flooding potential through storm surges, as well as severe storms in general.

10.6 RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from a severe weather event throughout the area is highly likely, but the impact is more limited with respect to geographic extent when removing resulting flood and landslide events from the severe weather category. The area experiences some severe storm event annually. While snow and ice do occur, impact is somewhat limited. The more significant issue would be a severe storm which causes a landslide or flood event, isolating areas or blocking ingress and egress. Wind is also a significant factor, which can cause power outages. While the PUDs maintain excellent records for low incidents of long-term power outages, the possibility does exist. Based on the potential impact, the Planning Team determined the CPRI score to be 3.0, with overall vulnerability determined to be a high level.

CHAPTER 11.
WILDFIRE

A wildfire is any uncontrolled fire occurring on undeveloped land that requires fire suppression. Wildfires can be ignited by lightning or by human activity such as smoking, campfires, equipment use, and arson. The wildfire season in Washington usually begins in April, picks up in early July, and generally ends in late September; however, wildfires have occurred every month of the year. Drought, snow pack, and local weather conditions can expand the length of the fire season.

People start most wildfires; major causes include arson, recreational fires that get out of control, smoker carelessness, debris burning, and children playing with fire. Wildfires started by lightning burn more state-protected acreage than any other cause, an average of 10,866 acres annually; human caused fires burn an average of 4,404 state-protected acres each year. Fires during the early and late shoulders of the fire season usually are associated with human-caused fires; fires during the peak period of July, August and early September often are related to thunderstorms and lightning strikes.

11.1 GENERAL BACKGROUND

Wildland-Urban Interface Areas

The wildland urban-interface (WUI) is the area where development meets wildland areas. This can mean structures built in or near natural forests, or areas next to active timber and rangelands. The federal definition of a WUI community is an area where development densities are at least three residential, business, or public building structures per acre. For less developed areas, the wildland-intermix community has development densities of at least one structure per 40 acres. Review of the 2013 Washington State Enhanced Hazard Mitigation Plan does designate Mason County as a County with WUI Communities.

In 2001, Congress mandated the establishment of a Federal Register which identifies all urban wildland interface communities within the vicinity of Federal lands, including Indian trust and restricted lands that are at high-risk from wildfire. The list assimilated information provided from States and Tribes, and is intended to identify those communities considered at risk. Review of the Federal Registry lists in excess of 10 communities within Mason County at high-risk within the vicinity of Federal lands.[22]

When identifying areas of fire concern, in addition to the Federal Register, the Washington Department of Natural Resources and its federal partners also determine communities at risk based on fire behavior potential, fire protection capability, and risk to social, cultural and community resources. These risk factors include areas with fire history, the type and density of vegetative fuels, extreme weather conditions, topography, number and density of structures and their distance from fuels, location of municipal watersheds, and likely loss of housing or business. The criteria for making these determinations are the same as those used in the National Fire Protection Association's *NFPA 299 Standard for Protection of Life and Property from Wildfire*. Based on these criteria, Mason County is considered to be at high to moderate risk based on Washington State Department of Natural Resources analysis (see Figure 11-1 and Figure 11-2)[23].

[22] https://www.federalregister.gov/documents/2001/01/04/01-52/urban-wildland-interface-communities-within-the-vicinity-of-federal-lands-that-are-at-high-risk-from

[23] http://mil.wa.gov/uploads/pdf/HAZ%20MIT%20PLAN/Wildland_Fire_Hazard_Profile.pdf

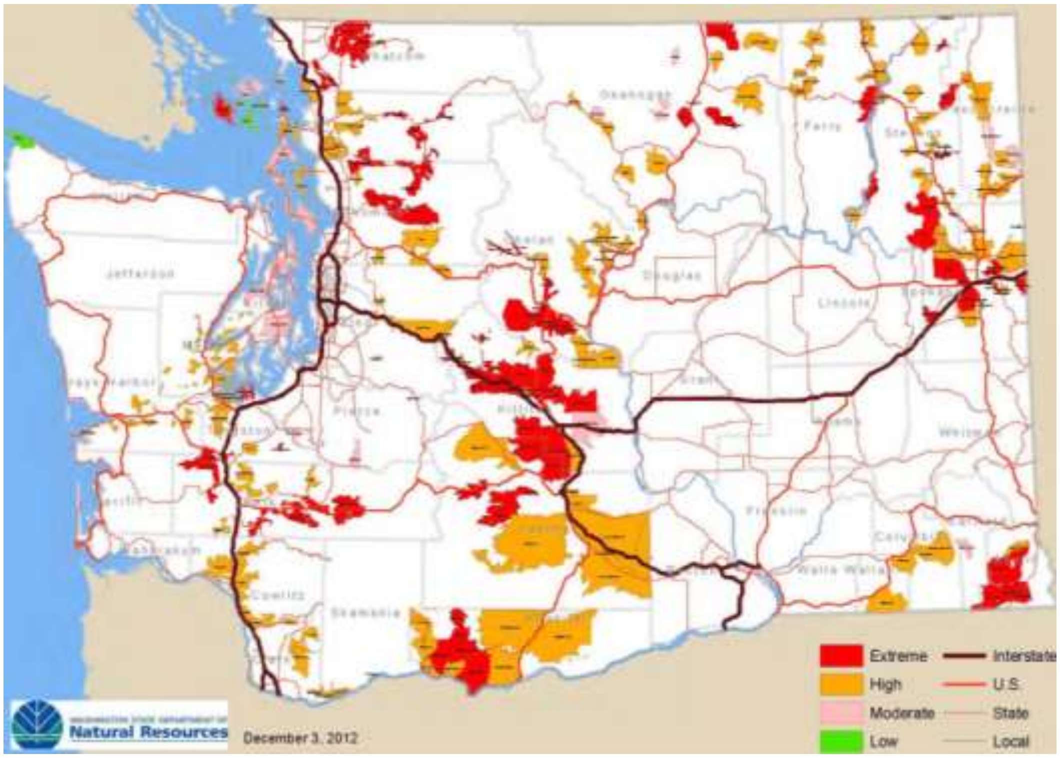


Figure 11-1 Risk Level for Wildland Urban Interface Communities

(WDNR 2011)

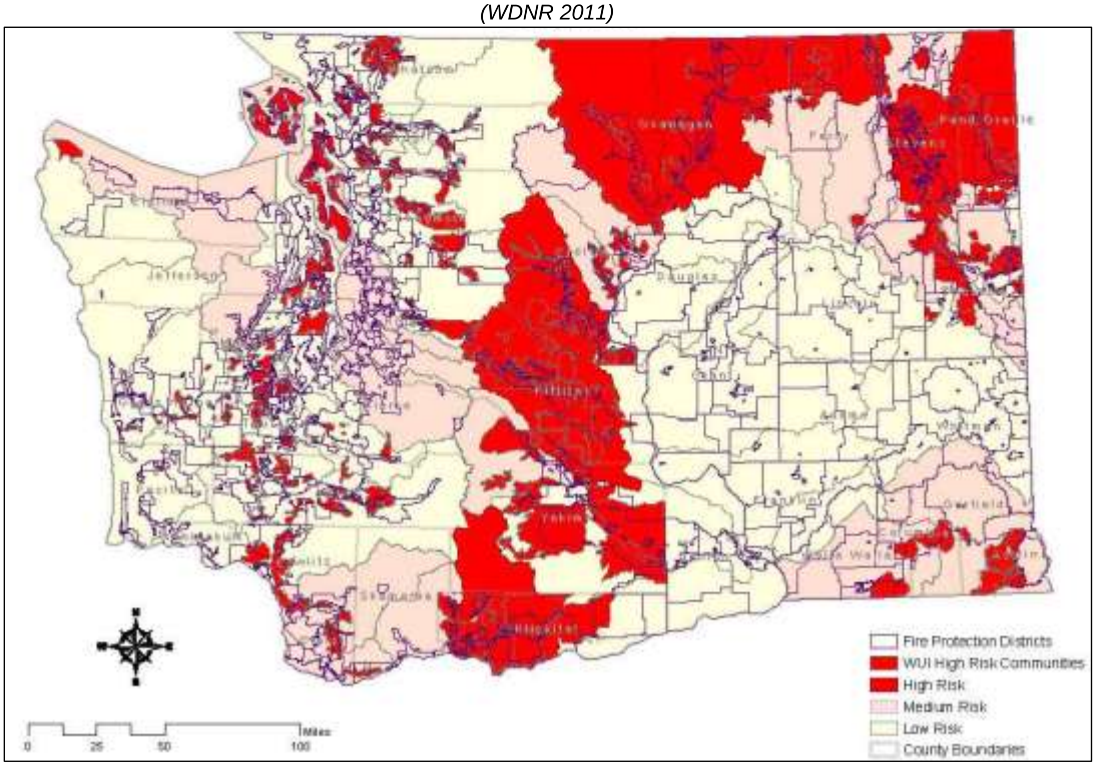


Figure 11-2 Washington WUI High Risk Communities, July 2011 Wildfire Behavior

The wildfire triangle (see Figure 11-3; DeSisto et al., 2009) is a simple graphic used in wildland firefighter training courses to illustrate how the environment affects fire behavior. Each point of the triangle represents one of three main factors that drive wildfire behavior: weather, vegetation type (which firefighters refer to as “fuels”), and topography. The sides represent the interplay between the factors. For example, drier and warmer weather combined with dense fuel loads (e.g., logging slash) and steeper slopes will cause more hazardous fire behavior than light fuels (e.g., short grass fields) on flat ground.

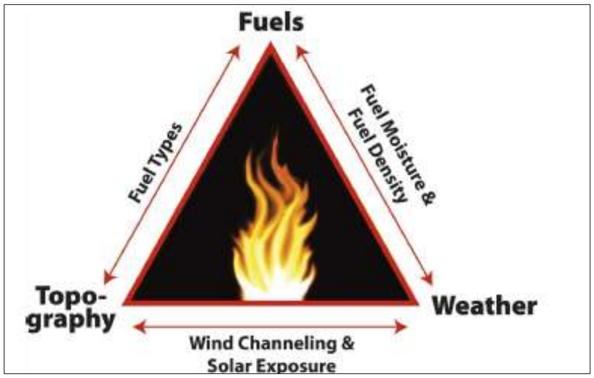


Figure 11-3 Wildfire Behavior Triangle

The following are key factors affecting wildfire behavior:

- **Fuel**—Lighter fuels such as grasses, leaves and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs and trunks take longer to warm and ignite. Snags and hazard trees—those that are diseased, dying, or dead—are larger but less prolific west of the Cascades than east of the Cascades. In 2002, about 1.8 million acres of the state’s 21 million acres of forestland contained trees killed or defoliated by forest insects and diseases.
- **Weather**— Relevant weather conditions include temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount and duration, and the stability of the atmosphere. Of particular importance for wildfire activity are wind and thunderstorms:
  - Strong, dry winds produce extreme fire conditions. Such winds generally reach peak velocities during the night and early morning hours. East wind events can persist up to 48 hours, with wind speed reaching 60 miles per hour. Being a coastal community, the County experiences significant winds on a fairly regular basis during all times of the year.
  - The thunderstorm season typically begins in June with wet storms, and turns dry with little or no precipitation reaching the ground as the season progresses into July and August.
- **Topography—**Topography includes slope, elevation and aspect. The topography of a region influences the amount and moisture of fuel; the impact of weather conditions such as temperature and wind; potential barriers to fire spread, such as highways and lakes; and elevation and slope of land forms (fire spreads more easily uphill than downhill).
- **Time of Day**—A fire’s peak burning period generally is between 1 p.m. and 6 p.m.
- **Forest Practices—**In densely forested areas, stands of mixed conifer and hardwood stands that have experienced thinning or clear-cut provide an opportunity for rapidly spreading, high-intensity fires that are sustained until a break in fuel is encountered.

Fires can be categorized by their fuel types as follows:

- **Smoldering**—Involves the slow combustion of surface fuels without generating flame, spreading slowly and steadily. Smoldering fires can linger for days or weeks after flaring has ceased, resulting in potential large quantities of fuel consumed. They heat the duff and mineral layers, affecting the roots, seeds, and plant stems in the ground. These are most common in peat bogs, but are not exclusive to that vegetation.
- **Crawling**—Surface fires that consume low-lying grass, forest litter and debris.
- **Ladder**—Fires that consume material between low-level vegetation or forest floor debris and tree canopies, such as small trees, low branches, vines, and invasive plants.
- **Crown**—Fires that consume low-level surface fuels, transition to ladder fuels, and also consume suspended materials at the canopy level. These fires can spread rapidly through the top of a forest canopy, burning entire trees, and can be extremely dangerous (sometimes referred to as a “Firestorm”).

Wildfires may spread by jumping or spotting, as burning materials are carried by wind or firestorm conditions. Burning materials can also jump over roadways, rivers, or even firebreaks and start distant fires. Updraft caused by large wildfire events draws air from surrounding area, and these self-generated winds can also lead to the phenomenon known as a firestorm.

11.1.1 Wildfire Impact

Short-term loss caused by a wildfire can include the destruction of timber, wildlife habitat, scenic vistas, and watersheds. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, and destruction of cultural and economic resources and community infrastructure. Vulnerability to flooding increases due to the destruction of watersheds. The potential for significant damage to life and property exists in WUI areas, where development is adjacent to densely vegetated areas (DeSisto et al., 2009).

Forestlands in the planning area are susceptible to disturbances such as logging slash accumulation, forest debris due to weather damage, and periods of drought and high temperature. Forest debris from western red cedar, western hemlock, and Sitka spruce can be especially problematic and at risk to wildfires when slash is accumulated on the forest floor, because such debris resists deterioration. When ignited, these fuels can be explosive and serve as ladder fuels carrying fire from the surface to the canopy.

11.1.2 Identifying Wildfire Risk

Risk to communities is generally determined by the number, size and types of wildfires that have historically affected an area; topography; fuel and weather; suppression capability of local and regional resources; where and what types of structures are in the WUI; and what types of pre-fire mitigation activities have been completed. Identifying areas most at risk to fire or predicting the course a fire will take requires precise science. The following data sets are most useful in assessing risk in the area:

- **Topography (slope and aspect) and Vegetation (fire fuels)**—These are two of the most important factors driving wildfire behavior.
- **Weather**—Regional and microclimate variations can strongly influence wildfire behavior. Because of unique geographic features, weather can vary from one neighborhood to another, leading to very different wildfire behavior.
- **Critical Facilities/Asset Location**—A spatial inventory of assets—including homes, roads, fire stations, and natural resources that need protection—in relation to wildfire hazard helps prioritize protection and mitigation efforts.

11.1.3 Community Wildfire Protection Plan

In response to several significant fires occurring throughout the United States from 1995 to 2000, Congress implemented the National Fire Plan—now called the National Cohesive Wildland Fire Management Strategy (Cohesive Strategy)—to seek national solutions for wildfire management. To participate, a community must identify its WUIs and then develop strategies to reduce their impact. This often includes development of a Community Wildfire Protection Plan (CWPP). Many communities also elect to become a Firewise Community (discussed below).

A CWPP identifies communities at risk, prioritizes hazardous fuel treatments, and recommends ways to reduce structural ignitability. Mason County currently does have a Community Wildfire Protection Plan dated 2012. For purposes of developing this Hazard Mitigation Plan Update, and in support of future CWPP development, some components of a CWPP are referenced in this plan; however, a fire analysis was not conducted. Rather, WDNR's assessment of high to medium is deemed appropriate. Over the course of the next five years, the County and its planning partners may elect to pursue grant funding to update the existing CWPP. In addition to the CWPP, Mason County also has three Firewise Communities.

Firewise Communities USA™

The NFPA's Firewise USA program encourages local solutions for safety by involving homeowners in taking individual responsibility for preparing their homes from the risk of wildfire. Firewise is a key component of Fire Adapted Communities – a collaborative approach that connects all those who play a role in wildfire education, planning and action with comprehensive resources to help reduce risk. Currently, Harstene Pointe, Lake Cushman and Colony Surf are all Firewise Communities, taking additional steps to help reduce the impact from wildfires in their communities.

11.1.4 Secondary Hazards

Wildfires can generate a range of secondary effects, which in some cases may cause more widespread and prolonged damage than the fire itself. Fires can cause direct economic losses in the reduction of harvestable timber and indirect economic losses in reduced tourism. Wildfires cause the contamination of reservoirs, destroy transmission lines and contribute to flooding. They strip slopes of vegetation, exposing them to greater amounts of runoff. This in turn can weaken soils and cause failures on slopes. Major landslides can occur several years after a wildfire. Most wildfires burn hot and for long durations that can bake soils, especially those high in clay content, thus increasing the imperviousness of the ground. This increases the runoff generated by storm events, thus increasing the chance of flooding.

11.2 HAZARD PROFILE

11.2.1 Extent and Location

According to the Washington State Enhanced Hazard Mitigation Plan (2013) and FEMA (2017), Mason County has never received a state or federal disaster declaration for a fire event. The State HMP does identify the County has being high-risk to wildfire danger. Given its rural land use complexity and its proximity to the various large park systems (both federal and state), the entire region is susceptible to impact from wildfire, either as a direct result, or as a secondary result from health or economic impact.

11.2.2 Previous Occurrences

Wildfires have been a common occurrence throughout Washington as a whole for thousands of years. Evidence from tree rings or fire-scarred trees indicates cycles of prehistoric fires burned in many locations in both Eastern and Western Washington. Natural fire occurrence is directly related, but not proportional, to lightning incidence levels. It is rare for a summer to pass without at least one period of lightning activity. Lightning incidence is greatest during July and August, though storms capable of igniting fires have occurred from early spring to mid-October. Lightning storms generally track across the park in a southwest to northeast direction. At a national level, lightning starts over 4,000 house fires each year, which can ignite wildland fires through ember ignition and as a result of proximity to wildland areas. Lightning-caused fires cause over 10 times more acreage damage than human-caused fires, requiring great resource allocation.

Within Washington, lightning storms are typically followed by light to moderate amounts of precipitation. The rainfall may extinguish the fires, while high fuel moisture inhibits spread. However, prolonged periods of warm, dry weather, especially in combination with east winds, often reveal numerous latent "sleepers." While most lightning fires are less than a quarter acre in size, occasional large fires during dry periods account for most of the burned acreage.

During the time period 2009-2016, Mason County as a whole has had 269 wildfires, burning a total of 928.33 acres. When averaged, that equates to 33.6 fires per year. That figure does not reflect the recurrence interval for fires within the County, but rather an average calculation as to the number of wildland fires which have historically occurred within the area during the period reflected.

Table 11-1 identifies the wildfires occurring within Mason County which burned 5 acres or more during the time period, as well as the typing of fires and acres burned. Table 11-2 identifies the total number of fires, regardless of size, and the total acres burned. Some additional historic events are identified in Table 11-3.

Table 11-1
Mason County Historic Fire Events 5 Acres or Greater

Date	Name	Acres Burned	Complexity
7/7/2004	Island Shore Fire	10.4	Unknown
4/25/2006	Razor Fire	5.6	Unknown
8/29/2006	South Loop Fire	15	Unknown
9/2/2006	Dewatto 2 Fire	61	Unknown
9/7/2006	Pipeline 2 Fire	5	Unknown
7/12/2007	Shelton Valley Rd. Fire	13	Unknown
7/1/2007	Martin Road Fire	15	Unknown
9/7/2008	East Cushman	10	Unknown
8/2/2009	Eels Hill Road	13.2	4
8/25/2009	Vance Creek	16.3	3

Table 11-1
Mason County Historic Fire Events 5 Acres or Greater

Date	Name	Acres Burned	Complexity
8/15/2010	Richert Road	84.4	3
8/17/2011	Eells Hill	51.20	3
9/11/2012	School	10.4	4
9/12/2012	Carney Lake	5	4
9/26/2012	Powerline	9.3	4
10/4/2012	Powerline 2	229	2
8/10/2014	Mill 5	21	4
8/11/2014	Haven Lake	185	2
9/6/2014	Boyer Road	11	4
11/16/2014	WC 131	37	4
6/22/2015	Kamilche	5	4
7/31/2015	Deckerville	107	3
8/27/2015	Sunnyside	58	3
5/27/2016	Lynch Pit	7.1	4

Table 11-2
Total Number Wildfire Events 2009-2016

Year	Total Number of Wildland Fires	Total Acres Burned
2009	26	42.90
2010	17	91.31
2011	26	55.52
2012	42	262.94
2013	18	4.44

Table 11-2
Total Number Wildfire Events 2009-2016

Year	Total Number of Wildland Fires	Total Acres Burned
2014	33	261.77
2015	54	183.65
2016	53	25.8
Total	269	928.33

Table 11-3
Additional Historic Wildfire Incidents

8/1985	One of the largest fires in area history began with an illegal campfire caused the Beaver Fire just north of Staircase. Approximately 400 firefighters and 3 water-dumping helicopters fought the blaze. Smoke from the fire drifted at least 140 miles and over the Cascade Mountains creating a haze as far away as Wenatchee in Eastern Washington. Twenty backcountry hikers were evacuated from the Flapjacks Lakes area and another forty people in the area were taken out by park rangers supported by packhorses. The blaze charred over 1,000 acres and thousands of trees – some 200 to 300 years old – were destroyed. Only three minor injuries were reported among firefighters. The cost to fight the fire was over $500,000.
9/1995	A blaze consumed 25 acres of logged land on Harstine Island and involved almost 150 firefighters and suppression support personnel costing $135,000 to fight. Cause of fire was from a hunter's cigarette. The following day 36 acres of reforested land burned at Morrow Lake, an area south of Lake Nahwatzel. East winds pushed flames in the opposite direction from homes along the shore. The cost of fighting the fire was $65,000. A total of 200 firefighters were involved in the two battles.
5/1997	The Lake Limerick fire, pushed by strong southwest winds, burned 594 acres, including 100 acres of wetlands, between Lake Limerick and Emerald Lake. The fire burned Christmas trees, slash, young replanted trees, wetland areas, and second growth Douglas fir trees. The cost of fighting the fire was approximately $94,000. Firefighters from districts in Mason, Kitsap and Pierce Counties assisted the effort along with 70 Cedar Creek Correctional Center inmates. ~112 people from DNR and Cedar Creek completed the firelines. At the same time a second blaze consumed about 8 acres off Eagle Point Road.
7/2006	A wildfire burned from July to December, blackening a total of 1,085 acres on steep terrain in the Bear Gulch area, threatening the Lake Cushman community. Cost of fighting the fire was approximately $1.8 million. US Forest Service Rd. was closed for about 1 year to prevent injuries from rock and debris slides. This road is the major access to the popular Staircase area and several summer homes located on the west side of Lake Cushman.

11.2.3 Severity

Potential losses from wildfire include human life, structures and other improvements, and natural resources. Smoke and air pollution from wildfires can be a health hazard, especially for sensitive populations such as children, the elderly and those with respiratory and cardiovascular diseases. Wildfire may also threaten the health and safety of those fighting the fires. Wildfire can lead to ancillary impacts such as landslides in steep ravine areas and flooding due to the impacts of silt in local watersheds. The destruction of forestlands can have a significant impact on salmon rearing for generations.

Extreme fires, when they occur, are characterized by more intense heat and preheating of surrounding fuels, stronger flame runs, potential tree crowning, increased likelihood of significant spot fires, and fire-induced weather (e.g., strong winds, lightning cells). Extreme fire behavior is significantly more difficult to combat and suppress, and can drastically increase the threat to homes and communities. Several factors contribute to the severity of a fire, most of which are utilized when completing a Community Wildfire Protection Plan (CWPP), and developing a component based hazard ranking.

Due to years of fire suppression, logging, and other human activities, the forests and rangelands have changed. Areas that historically experienced frequent, low-severity wildfires now burn with much greater intensity due to the build-up of understory brush and trees. At times, this equates to fires which are larger and more severe, killing the trees and vegetation at all levels. The combination of steep slopes, canyons, open rangeland, and fuel type have a history and potential for fast moving and fast spreading wildfires.

The Mason County planning area is vulnerable to wind-driven fires, whose embers could ignite grasses and weeds, and cause spot fires in more populated areas. Typical summer conditions could prove to be problematic due to a fire moving uphill from a structure fire on a lower slope, or from a wildland fire pushing upslope through the trees on a windy day, endangering multiple homes simultaneously in a very short period of time. Residents would have very short notice of an approaching fire.

Review of historic wildfires in the County demonstrate there are several different causes, the most common being debris burning and recreational-related fires. Table 11-4 identifies those causes identified within the planning area. The cause of fires in many instances could not be determined, or remain under investigation.

Table 11-4
Wildfire Incidents by Cause

Cause / Year	**Arson**	**Children**	**Debris Burning**	**Lightning**	**Miscellaneous**	**Rail-road**	**Recreation**	**Smoker**	**Undetermined or Under Investigation**
2009	5		4	1	11		3	2	2
2010	3	1	1		6		4	2	
2011	3	3	4		11		6		
2012	10	2	3		5		5		2
2013		2	2		7	1	6	1	
2014		`	5	1	11				14
2015	1	2	3	1	18		6	3	21
2016	1		15		6		7	2	18

Table 11-4
Wildfire Incidents by Cause

Cause / Year	Arson	Children	Debris Burning	Lightning	Miscellaneous	Rail-road	Recreation	Smoker	Undetermined or Under Investigation
Total	**23**	**10**	**37**	**3**	**75**	**1**	**37**	**10**	**45**

11.2.4 Frequency

As previously indicated, none of Washington State's most significant wildfires have occurred in Mason County, although smaller fires have occurred in the region annually. Fires historically burn on a regular cycle, recycling carbon and nutrients stored in the ecosystem, and strongly affecting species within the ecosystem. The burning cycle in western Washington is approximately every 100 to 150 years.

Historically, drought patterns are related to large-scale climate patterns in the Pacific and Atlantic oceans. The El Niño–Southern Oscillation varies on a 5- to 7-year cycle, the Pacific Decadal Oscillation varies on a 20- to 30-year cycle, and the Atlantic Multidecadal Oscillation varies on a 65- to 80-year cycle. As these large-scale ocean climate patterns vary in relation to each other, drought conditions in the U.S. shift from region to region. El Niño years bring drier conditions to the Pacific Northwest and more fires.

Historic Fire Regime

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. A fire regime refers to the frequency and intensity of natural fires occurring in various ecosystem types. Alterations of historical fire regimes and vegetation dynamics have occurred in many landscapes in the U.S., including Mason County through the combined influence of land management practices, fire exclusion, insect and disease outbreaks, climate change, and the invasion of non-native plant species. Anthropogenic influences on wildfire occurrence have been witnessed through arson, incidental ignition from industry (e.g., logging, railroad, sporting activities), and other factors. Likewise, wildfire abatement practices have reduced the spread of wildfires after ignition. This has reduced the risk to both the ecosystem and the urban populations living in or near forestlands, such as portions of Mason County.

The LANDFIRE Project produces maps of simulated historical fire regimes and vegetation conditions using the LANDSUM landscape succession and disturbance dynamics model. The LANDFIRE Project also produces maps of current vegetation and measurements of current vegetation departure from simulated historical reference conditions. These maps support fire and landscape management planning outlined in the goals of the National Fire Plan, Federal Wildland Fire Management Policy, and the Healthy Forests Restoration Act. The simulated historical mean fire return interval data layer quantifies the average number of years between fires under the presumed historical fire regime. This data is derived from simulations using LANDSUM. LANDSUM simulates fire dynamics as a function of vegetation dynamics, topography, and spatial context, in addition to variability introduced by dynamic wind direction and speed, frequency of extremely dry years, and landscape-level fire characteristics. The historical fire regime groups simulated in LANDFIRE categorize mean fire return interval and fire severities into five regimes defined in the Interagency Fire Regime Condition Class Guidebook:

- Regime 1: 0-35-year frequency, low to mixed severity
- Regime II: 0-35-year frequency, replacement severity
- Regime III: 35-200-year frequency, low to mixed severity
- Regime IV: 35 -200-year frequency, replacement severity
- Regime V: 200+ year frequency, any severity

Large wildfires have historically been infrequent in the coastal regions of the Pacific Northwest. While 269 fires have occurred in the planning area since 2009, due to firefighting efforts, many have been contained with limited impact on acreage burned (~928 acres). Fire regimes in Mason County are listed in Table 11-5 and illustrated in Figure 11-4. It should be noted that not all regime classes fall within the county boundary.

The Mean Fire Return Interval (MFRI) layer quantifies the average period between fires under the presumed historical fire regime. MFRI is intended to describe one component of historical fire regime characteristics. As illustrated, the average Mean Fire Return Interval for the majority of Mason County is every 70-100 years.

Table 11-5
Mason County Acres in Wildfire Regime Groups

Fire Regime Group	Total Acres Mason County	Total Acres Shelton	Total Acres Allyn	Total Acres Belfair	Total Acres Olympic National Park	Total Acres Olympic National Forest
Barren	3,934.2	2.8	3.2	6.8	839.2	1,350.2
Fire Regime Group I	1,529.1	537	0.7	6.9	0.9	4.1
Fire Regime Group III	253,453.2	1637.4	507.9	1917	5,426.5	55,582.6
Fire Regime Group IV	0.6	0	0	0	30,376.0	75,891.7
Fire Regime Group V	351,373.0	1991.5	493.5	2722.2	1,170.8	869.0
Snow / Ice	2,039.9	0	0	0	30.9	44.7
Sparsely Vegetated	103.3	0	0	0	104.3	2,408.4
Water	10,664.4	45.5	54.1	38.5	839.2	1,350.2

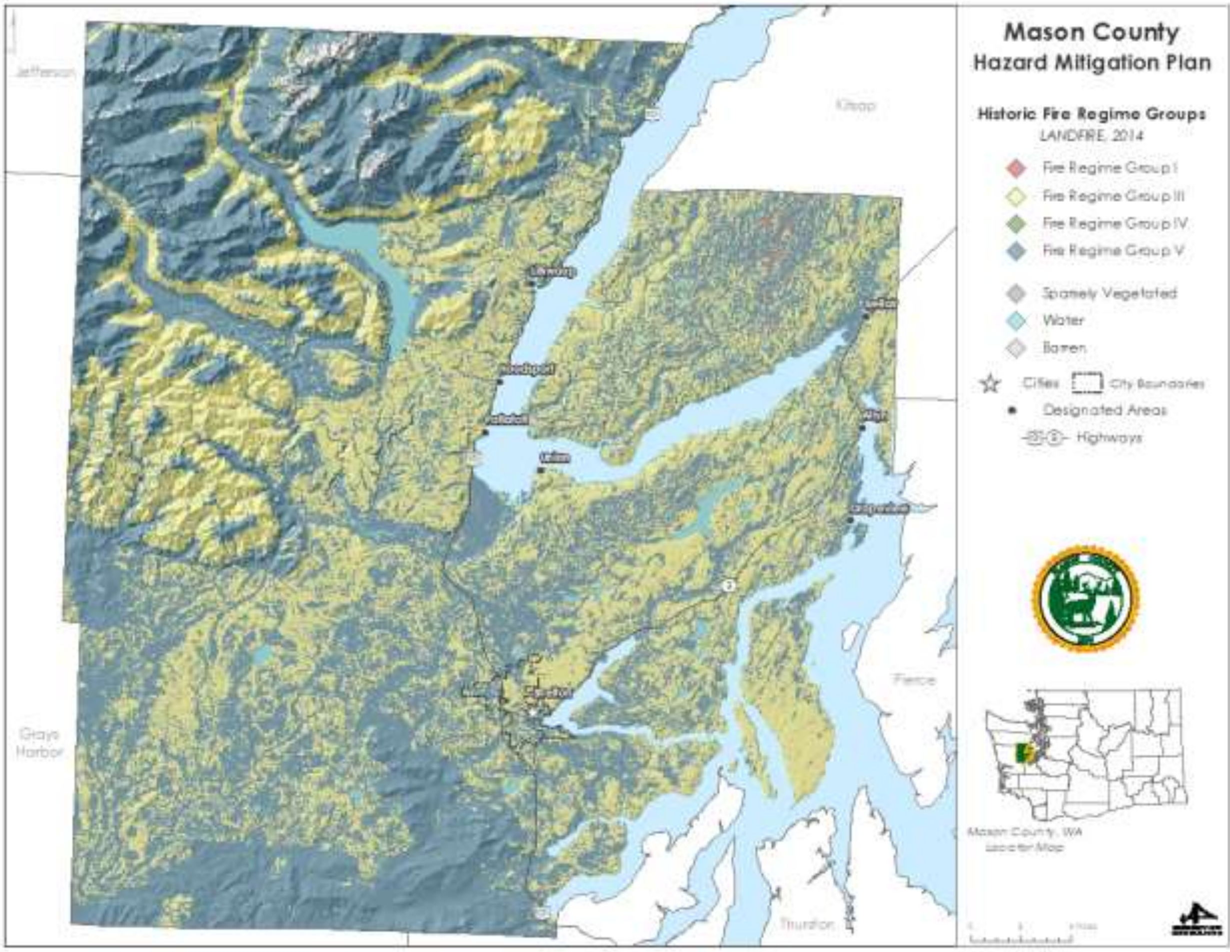


Figure 11-4 LANDFIRE Fire Regimes in Mason County

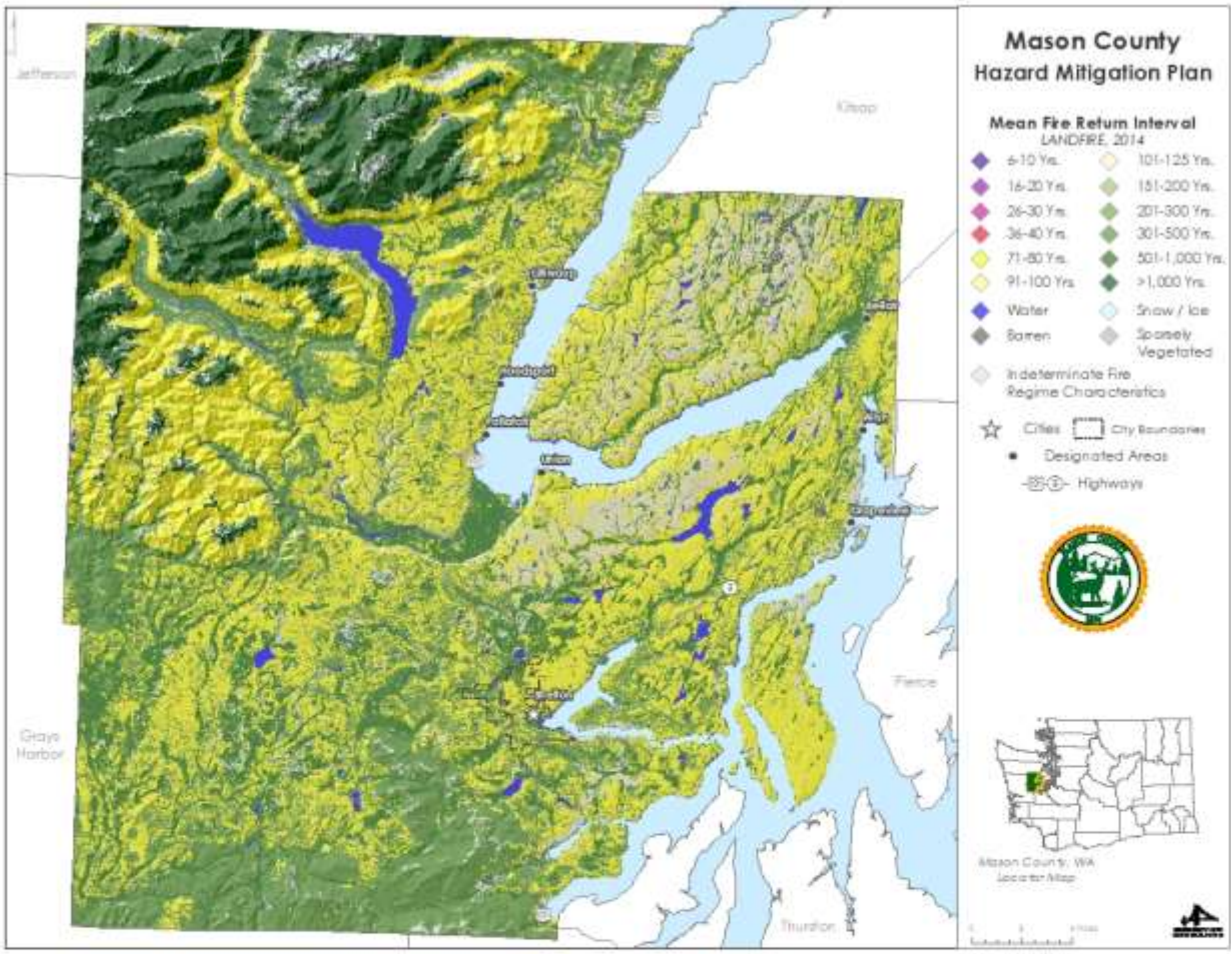


Figure 11-5 Mean Fire Return Interval

The existing Vegetation Condition Class (VCC) is identified in Figure 11-6. VCC represents a simple categorization of the associated Vegetation Departure (VDEP) layer and indicates the general level to which current vegetation is different from the simulated historical vegetation. The classes of variation range are low, medium and high. The variation of vegetation class directly influences fire.

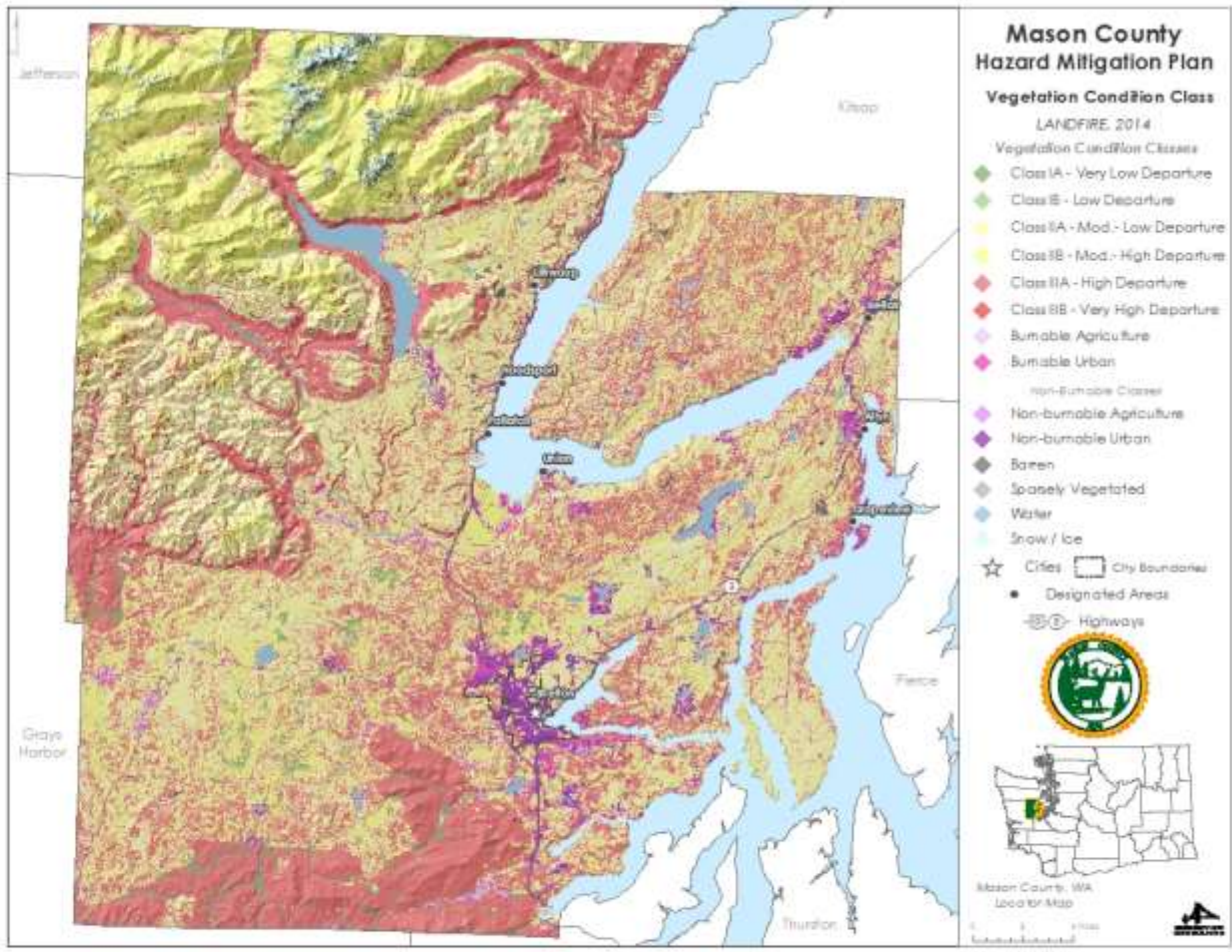


Figure 11-6 Vegetation Condition Class

11.3 VULNERABILITY ASSESSMENT

11.3.1 Overview

Structures, above-ground infrastructure, critical facilities and natural environments are all vulnerable to the wildfire hazard.

Methodology

There is currently no validated damage function available to support wildfire mitigation planning because no such damage functions have been generated. Instead, dollar loss estimates were developed by calculating the assessed value of exposed structures identified utilizing the various LANDFIRE Fire Regime (1-5) datasets. Population impact also utilized the various Fire Regimes, with population estimated using the exposed structure count of buildings in each Fire Regime area and applying the census value of two (2) persons per household for Mason County.

Warning Time

Wildfires are often caused by humans, intentionally or accidentally. There is no way to predict when one might break out. Since fireworks often cause brush fires, extra diligence is warranted around the Fourth of

July when the use of fireworks is highest. Dry seasons and droughts are factors that greatly increase fire likelihood. Dry lightning may trigger wildfires. Severe weather can be predicted, so special attention can be paid during weather events that may include lightning. Reliable National Weather Service lightning warnings are available on average 24 to 48 hours prior to a significant electrical storm.

Understanding the relationship between weather, potential fire activity, and geographical features enhances the ability to prepare for the potential of wildfire events. This knowledge, when paired with emergency planning and appropriate mitigation measures, creates a safer environment.

Wildfire studies can analyze weather data to assist firefighters in understanding the relationship between weather patterns and potential fire behavior. Fire forecasting examines similarities between historical fire weather and existing weather and climate values. These studies have determined that for areas such as Mason County, any combination of two of the following factors can create more intense and potentially destructive fire behavior, known as extreme fire behavior:

- Sustained winds from the east
- Relative humidity less than 40 percent
- Temperature greater than 72º Fahrenheit
- Periods without precipitation greater than 14 days in duration
- 1,000-hour fuel moisture less than 17 percent.

If a fire breaks out and spreads rapidly, residents may need to evacuate within a short timeframe. A fire's peak burning period generally is between 1 p.m. and 6 p.m. In normal situations, fire alerting would commence quickly, helping to reduce the risk. However, in more remote locations of the County, or in areas where cell phone services are sporadic at times, warning time and calls for assistance may be reduced.

11.3.2 Impact on Life Health & Safety

While there are no recorded fatalities from wildfire in the planning area, a statistical number of the population vulnerable to impact from fire is impossible to determine with any accuracy, due to the high number of variables that impact fire scenarios. The population at risk must also take into consideration tourists given the County's proximity to the parklands and other Washington high-tourist destinations. With its relatively high tourism rate, especially during summer months, there is an increase in the population vulnerability to fire. Given the increased in tourism during the summer months, when fire danger is at its greatest, increased consideration must be taken into account for fire response.

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. Mason County has a high population of retirees and individuals over 65, further increasing the potential impact on the fire hazard. Smoke generated by wildfire consists of visible and invisible emissions that contain particulate matter (soot, tar, water vapor, and minerals), gases (carbon monoxide, carbon dioxide, nitrogen oxides), and toxics (formaldehyde, benzene). Emissions from wildfires depend on the type of fuel, the moisture content of the fuel, the efficiency (or temperature) of combustion, and the weather. Public health impacts associated with wildfire include difficulty in breathing, odor, and reduction in visibility. Wildfire also threatens the health and safety of those fighting fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke. The county does have a high number of elderly citizens.

Exposure to wildfire in Mason County is dependent upon many factors. The maps used in the analysis show areas of relative importance in determining fire risk, though they do not provide sufficient data for a statistical estimation of exposed population. For purposes of this assessment, the various Fire Regimes were used with population estimated using the structure count of buildings exposed within the various Fire Regime areas, and applying the census value of two persons per household for Mason County. These estimates are shown in Table 11-6. Not calculated within the potential impact is the number of tourists who may be visiting the area at any given time. Table 11-6 illustrates the population within the various fire regimes, noting that there is no Regime 2, and Regime 4 contains no structures.

Table 11-6
Population Within Fire Regime Areas

	Fire Regime 1		Fire Regime 3		Fire Regime 4**		Fire Regime 5	
	Population	% of Total	Population	% of Total	Population	% of Total	Population	% of Total
Unincorporated	210	94.6%	22,950	83.9%	0		23,102	77.1%
Shelton, City of	6	2.7%	2,356	8.6%	0		3,646	12.2%
Allyn	2	0.9%	1,008	3.7%	0		978	3.3%
Belfair	4	1.8%	1,032	3.8%	0		2,242	7.4%
Total	222	100%	27,346	100%	0		29,968	100%

*Not all Fire Regimes exist in planning area, such as Regime 2. Therefore, Regime 2 is not listed.

**There is no population within Regime 4 – the area represents less than 0.5 acres within the forestland.

11.3.3 Impact on Property

Property damage from wildfires can be severe and can significantly alter entire communities. WDNR identifies Mason County as being of medium and high risk (Figure 11-2). The potential exposure of the structures in the County should a fire occur is high, depending on the area, with the unincorporated county and the City of Shelton all having some degree of exposure to wildfire hazards. Details on the number and value of structures exposed to LANDFIRE Wildfire Regime are in Table 11-7. Not all regimes are applicable to the county, and as in the case of Regime 4, no structures exist within the area.

Density and the age of building stock in Mason County are contributing factors in assessing property vulnerability to wildfire. Many of the buildings in the planning area are of significant age, with many being constructed with wood frames and shingle roofs.

Table 11-7
Planning Area Structures Exposed to LANDFIRE Fire Regime 1

	Buildings Exposed	Estimated Value			% of Total Value
		Structure	Contents	Total	
Unincorporated	105	$14,115,920	$7,057,960	$21,173,880	96.9%
Shelton, City of	3	$98,225	$49,113	$147,336	0.7%
Allyn	1	$134,660	$67,330	$201,990	0.9%
Belfair	2	$224,205	$112,103	$336,308	1.5%
Total	**111**	**$14,573,010**	**$7,286,506**	**$21,859,514**	**100%**

Planning Area Structures Exposed To LANDFIRE Fire Regime 3

	Buildings Exposed	Estimated Value			% of Total Value
		Structure	Contents	Total	
Unincorporated	11,539	$1,424,429,758	$748,722,504	$2,173,152,262	79.1%
Shelton, City of	1,295	$208,834,699	$155,726,219	$364,560,917	13.3%
Allyn	504	$83,099,107	$41,549,554	$124,648,661	4.5%
Belfair	517	$57,529,648	$28,862,334	$86,391,982	3.1%
Total	**13,855**	**$1,773,893,212**	**$974,860,611**	**$2,748,753,822**	**100%**

Planning Area Structures Exposed To LANDFIRE Fire Regime 5

	Buildings Exposed	Estimated Value			% of Total Value
		Structure	Contents	Total	
Unincorporated	11,679	$1,464,625,139	$776,627,594	$2,241,252,733	77.2%
Shelton, City of	1,967	$201,795,337	$128,438,746	$330,234,083	11.4%
Allyn	490	$72,958,049	$36,527,899	$109,485,948	3.8%
Belfair	1,133	$145,543,121	$76,421,991	$221,965,111	7.6%
Total	**15,269**	**$1,884,921,645.2**	**$1,018,016,230**	**$2,902,937,875**	**100%**

11.3.4 Impact on Critical Facilities and Infrastructure

Critical facilities of wood frame construction are especially vulnerable during wildfire events. In the event of wildfire, there would likely be little damage to most infrastructure. Most roads and railroads would be without damage except in the worst scenarios. Fueling stations could be significantly impacted. Power lines are also significantly at risk from wildfire because most poles are made of wood and susceptible to burning. Fires can create conditions that block or prevent access and can isolate residents and emergency service providers. Wildfire in Mason County could also impact wood-structured bridges, peers, and docks, which are utilized to moor watercraft, launch search and rescue vessels, dam safety inspections, shellfish harvesting, fishing vessels, or other private boats associated with tourism. Table 11-8 identifies critical facilities exposed to the wildfire hazard.

Hazardous Material Involved Fire Impact on Critical Facilities and Infrastructure

Currently there are 50 registered Tier II hazardous material containment sites throughout Mason County (based on 2016 reporting to Washington State Dept. of Ecology). During a wildfire event, hazardous material storage containers 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 the materials could leak into surrounding areas, saturating soils and seeping into surface waters, having a disastrous effect on the environment.

11.3.5 Impact on Economy

Wildfire impact on the economy can be far reaching, ranging from damage to transportation routes to non-use of park facilities and campsites impacting tourism, to loss of structures influencing tax base from lost revenue. Secondary hazards associated with wildfire, such as increased landslides and flooding potential, would further impact the economy.

Table 11-8
Critical Facilities and Infrastructure Exposed to Fire Regime Areas

	Regime 1	Regime 3	Regime 4*	Regime 5
Medical and Health Services	0	1	0	0
Government Function	0	2	0	17
Protective Function	0	14	0	25
Hazmat	0	4	0	0
Other Critical Function	0	0	0	3
Water	0	9	0	7
Wastewater	0	14	0	12
Power	0	13	0	8
Communications	0	1	0	2
Total	0	58	0	74

*There is no Regime 2 in the County. There are no structures located in Regime 4.

11.3.6 Impact on Environment

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

- Damaged Fisheries—Critical fisheries can suffer from increased water temperatures, sedimentation, and changes in water quality.
- Soil Erosion—The protective covering provided by foliage and dead organic matter is removed, leaving the soil fully exposed to wind and water erosion. Accelerated soil erosion occurs, causing landslides and threatening aquatic habitats.
- Spread of Invasive Plant Species—Non-native woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes, and become difficult and costly to control.

- Disease and Insect Infestations—Unless diseased or insect-infested trees are swiftly removed, infestations and disease can spread to healthy forests and private lands. Timely active management actions are needed to remove diseased or infested trees.
- Destroyed Endangered Species Habitat—Catastrophic fires can have devastating consequences for endangered species.
- Soil Sterilization—Topsoil exposed to extreme heat can become water repellant, and soil nutrients may be lost. It can take decades or even centuries for ecosystems to recover from a fire. Some fires burn so hot that they can sterilize the soil.

11.4 FUTURE DEVELOPMENT TRENDS

The County is optimistic that increased population growth will occur throughout the region. As areas of the County become more urbanized, the potential exists that the fire risk may increase as urbanization tends to alter the natural fire regime, and the growth will expand the urbanized areas into undeveloped wildland areas. However, the County feels that this expansion of the wildland-urban interface can be managed with strong land use and building codes. A growing body of research suggests that “the only effective home protection treatment is treatment in, on, and around the house (see Figure 11-7); homeowners must be responsible for protecting that property” (Nowicki 2001, p. 1:3). U.S. Forest Service research scientist, Jack Cohen has stated that “home ignitions are not likely unless flames and firebrand ignitions occur within 40 meters [131 feet] of the structure; the WUI fire loss problem primarily depends on the home and its immediate site.”

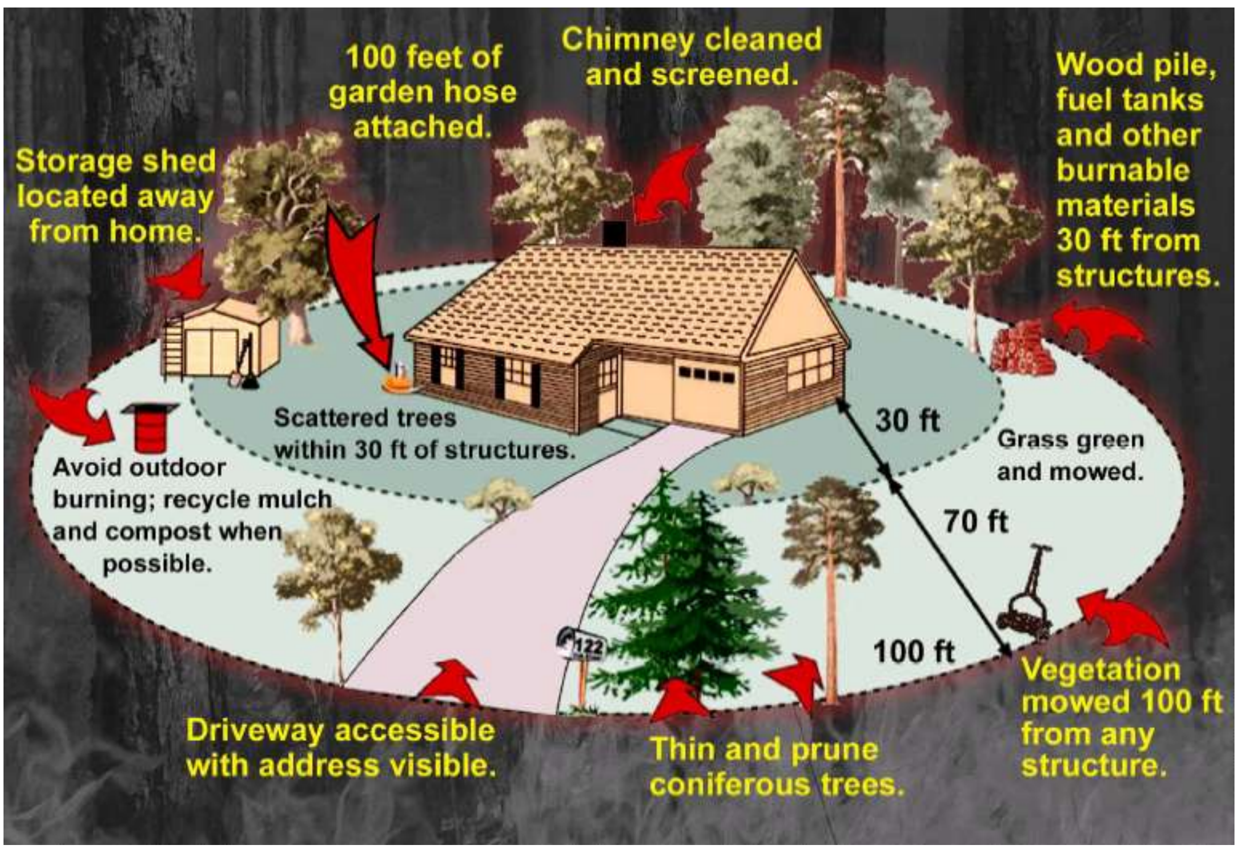


Figure 11-7 Measures to Protect Homes from Wildfire

11.5 ISSUES

The major issues for wildfire in Mason County are the following:

- Public education and outreach to people living in or near the fire hazard zones should include information about and assistance with mitigation activities such as defensible space, and advance identification of evacuation routes and safe zones.
- Wildfires could cause landslides as a secondary natural hazard.
- Climate change will affect the wildfire hazard.
- Future growth into interface areas should continue to be managed.
- Vegetation management activities should include enhancement through expansion of target areas as well as additional resources.
- Building code standards need to be enhanced, including items such as residential sprinkler requirements and prohibitive combustible roof standards.
- Increased fire department water supply is needed in high-risk wildfire areas.
- Obtain and maintain certifications and qualifications for fire department personnel. Ensure that firefighters are trained in basic wildfire behavior, basic fire weather, and that company officers and chief level officers are trained in the wildland command and strike team leader level.

A worst-case scenario would include an active fire season throughout the American west, spreading resources thin. Firefighting teams would be exhausted or unavailable. Many federal assets would be responding to other fires that started earlier in the season. While local fire districts would be extremely useful in the urban interface areas, they have limited wildfire capabilities or experience, and they would have a difficult time responding to the ignition zones. Even though the existence and spread of the fire is known, it may not be possible to respond to it adequately, so an initially manageable fire can become out of control before resources are dispatched.

To further complicate the problem, heavy rains could follow, causing flooding and landslides and releasing tons of sediment into rivers, permanently changing floodplains and damaging sensitive habitat and riparian areas. Such a fire followed by rain could release millions of cubic yards of sediment into streams for years, creating new floodplains and changing existing ones. With the forests removed from the watershed, stream flows could easily double. Flood 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 the flood elevations would increase.

11.6 RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from Wildfire throughout the area is likely, but the impact is more limited with respect to geographic extent. The area experiences some level of wildfire almost annually, but the acreage burned has, thankfully, been more limited in nature due in large part to response activities.

Construction into the wildfire hazard areas undoubtedly will continue to expand, thereby increasing the risk of fires. Implementation of mitigation strategies which help reduce wildfire risk, such as landscaping regulations and mandatory sprinkler systems, could potentially help reduce the number of structures at risk. Based on the potential impact, the Planning Team determined the CPRI score to be 2.60, with overall vulnerability determined to be a medium level.

CHAPTER 12.
HAZARD RANKING

12.1 CALCULATED PRIORITY RISK INDEX

In ranking the hazards, the Planning Team completed a Calculated Priority Risk Index worksheet for each hazard identified below. The index examines five criteria for each hazard as discussed in Chapter 4 (probability, magnitude/severity, extent/location, warning time, and duration), defines a risk index for each according to four levels, then applies a weighting factor. The result is a score that has been used to rank the hazards at the County level. All planning partners also completed their own hazard rankings, using the same process. Table 12-1 presents the results of the Calculated Priority Risk Index scoring for all hazards Countywide. Table 12-2 is a summary of the hazard ranking for the jurisdiction planning partners.

Table 12-1
Countywide Calculated Priority risk Index ranking scores

Hazard	Probability	Magnitude and/or Severity	Extent and Location	Warning Time	Duration	Calculated Priority Risk Index Score
Climate Change	3	2	2	1	4	2.4
Drought	3	2	3	1	4	2.6
Earthquake	4	3	4	4	1	3.6
Flood	4	3	3	2	2	3.25
Landslide	4	2	2	4	1	2.95
Severe Weather	4	2	3	2	2	3.0
Wildfire	3	2	2	4	2	2.6

The Calculated Priority Risk Index scoring method has a range from 0 to 4. “0” being the least hazardous and “4” being the most hazardous situation.

Table 12-2
Hazard Ranking Summary

	County		City of Shelton		PUD 1		PUD 3		FD 16		CMFE	
Hazard	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score
Climate Change	6	2.4	7	1.15	7	2.4	4	2.45	7	1.15	2	3.1
Drought	5	2.6	6	2.2	5	2.6	5	2.15	6	2.2	6	2.05
Earthquake	1	3.6	3	3.05	1	3.6	1	3.4	1	3.6	1	3.55
Flood	2	3.25	4	2.9	3	3.25	3	2.8	4	2.9	4	2.4
Landslide	4	2.95	5	2.45	2	2.8	5	2.15	5	2.45	3	2.9
Severe Weather	3	3.0	1	3.5	4	3.55	2	3	2	3.5	5	2.35
Wildfire	5	2.6	2	3.1	6	2.55	5	2.15	3	3.1	2	3.1

12.1.1 Calculated Priority Rate Index

CPRI Category	Degree of Risk			Assigned Weighting Factor
	Impact/ Level ID	Description	Impact Factor	
Probability	Unlikely	• Rare with no documented history of occurrences or events. • Annual probability of less than 1% (~100 years or more).	1	40%
	Possible	• Infrequent occurrences; at least one documented or anecdotal historic event. • Annual probability that is between 1% and 10% (~10 years or more).	2	
	Likely	• Frequent occurrences with at least two or more documented historic events. • Annual probability that is between 10% and 90% (~10 years or less).	3	
	Highly Likely	• Common events with a well-documented history of occurrence. • Annual probability of occurring. (1% chance or 100% Annually).	4	
Magnitude/ Severity	Negligible	• People – Injuries and illnesses are treatable with first aid; minimal hospital impact; no deaths. Negligible impact to quality of life. • Property – Less than 5% of critical facilities and infrastructure impacted and only for a short duration (less than 24-36 hours such as for a snow event); no loss of facilities, with only very minor damage/clean-up. • Economy – Negligible economic impact. • Continuity of government operating at 90% of normal operations with only slight modifications due to diversion of normal work for short-term response activity. Disruption lasts no more than 24-36 hours. • Special Purpose Districts: No Functional Downtime.	1	25%
	Limited	• People – Injuries or illness predominantly minor in nature and do not result in permanent disability; some increased calls for service at hospitals; no deaths; 14% or less of the population impacted. Moderate impact to quality of life. • Property – Slight property damage -greater than 5% and less than 25% of critical and non-critical facilities and infrastructure. • Economy – Impact associated with loss property tax base limited; impact results primarily from lost revenue/tax base from businesses shut down during duration of event and short-term cleanup; increased calls for emergency services result in increased wages. • Continuity of government impacted slightly; 80% of normal operations; most essential services being provided. Disruption lasts >36 hours, but <1 week. • Special Purpose Districts: Functional downtime 179 days or less.	2	
	Critical	• People – Injuries or illness results in some permanent disability or significant injury; hospital calls for service increased significantly; no deaths. 25% to 49% of the population impacted. • Property – Moderate property damages (greater than 25% and less than 50% of critical and non-critical facilities and infrastructure). • Economy - Moderate impact as a result of critical and non-critical facilities and infrastructure impact, loss of revenue associated with tax base, lost income. • Continuity of government ~50% operational capacity; limited delivery of essential services. Services interrupted for more than 1 week, but <1 month. • Special Purpose Districts: Functional downtime 180-364 days.	3	
	Catastrophic	• People - Injuries or illnesses result in permanent disability and death to a significant amount of the population exposed to a hazard. >50% of the population impacted. • Property – Severe property damage >50% of critical facilities and non-critical facilities and infrastructure impacted. • Economy – Significant impact - loss of buildings /content, inventory, lost revenue, lost income. • Continuity of government significantly impacted; limited services provided (life safety and mandated measures only). Services disrupted for > than 1 month. • Special Purpose Districts: Functional Downtime 365 days or more.	4	
Geographic Extent and Location	Limited	Less than 10% of area impacted.	1	20%
	Moderate	10%-24% of area impacted.	2	
	Significant	25%-49% of area impacted.	3	
	Extensive	50% or more of area impacted.	4	
Warning Time / Speed of Onset	<6 hours	Self-explanatory.	4	10%
	6 to 12 hours	Self-explanatory.	3	
	12 to 24 hours	Self-explanatory.	2	
	> 24 hours	Self-explanatory.	1	
Duration	< 6 hours	Self-explanatory.	1	5%
	< 24 hours	Self-explanatory.	2	
	<1 week	Self-explanatory.	3	
	>1 week	Self-explanatory.	4	

12.2 SOCIAL VULNERABILITY

Once the hazard ranking was completed, the Planning Team then conducted a Social Vulnerability Assessment for those priority hazards identified in Table 12-1 and Table 12-2. Several different assessments were completed with respect to social vulnerability, including data contained within the Community Profile section (Chapter 3), within each hazard profile, within the various tables in this section, and a qualitative assignment based on the CPRI analysis.

When determining risk, it is significant to remember that risk is measured by not only the hazard, but also on how resilient a population is, or will be during the hazard. Resilience is influenced by many factors, including: age or income; available social networks, and neighborhood characteristics, all of can be used to measure the social vulnerability of the area and its citizens. Based on a study completed by the University of North Carolina, factors that contribute to the level of vulnerability of a population are associated with four areas of impact, which, in part, are utilized within this assessment with a few modifications to the original study, as indicated:

- Socioeconomic status:
  - Below Poverty Level
  - Employment Status
  - Income level
  - No High School Diploma
- Household composition:
  - Age 65 or older
  - Age 5 or younger (the North Carolina study references age 17 or younger)
  - Disability (the North Carolina study referenced “Older than Age 5 with a Disability”)
  - Single Parent Households
- Minority Status and Language:
  - Minority – race or ethnicity
  - Language barrier (Speak English “Less than Well”
- Housing/transportation:
  - Multi-Unit Structures, including Group Quarters
  - Mobile Homes
  - Crowding
  - No Vehicle

The purpose of the classifications is to better understand whose needs are not being addressed through traditional service providers or who cannot safely access and use the standard resources offered for disaster preparedness, relief and recovery. Special focus on these groups during emergency situations is crucial because not only are they more likely to be impacted by an event, but they are many times also less likely to recover. As this planning process expands over the next five years, the County intends to expand this section to include data for all vulnerable classifications.

12.2.1 Classifications

Socioeconomic status considers things such as income, poverty, employment status, and education level. Those who are economically disadvantaged will be affected by an event more significantly. The monetary value of their possessions may be less, but they represent a larger proportion of total household assets. These groups are less likely to have renters or homeowner's insurance, so their possession will be costlier to replace, and individuals are less likely to evacuate in order to ensure the protection of their belongings. In the event of injury or death, those who are unemployed will not have the benefits or the income to assist with costs for recovery. In addition, in most cases, the poor lack the assets and the resources to prepare for a disaster in advance, and once impacted, to recover.

Household composition and disability grouping is comprised of age (those under the age of 5 and above the age of 65), single parent homes, and any disability. These groups are more likely to need financial support, transportation, medical care, or assistance with day to day activities during disasters. The elderly and the children, especially the younger ones often lack the resources, knowledge, or life experiences to effectively address the situation and cannot protect themselves. Elderly living alone, and people who have a physical, sensory, or cognitive challenges are more likely to be vulnerable during an incident. These groups often need a higher level of assistance than others, and may have caretakers who are less able to assist during a crisis if those caretakers have families of their own. This places a heavier burden on medical and first responders.

Minority status and language includes race, ethnicity, and proficiency of the English language. The social and economic marginalization of certain racial and ethnic groups have made these populations more likely to be vulnerable at all stages, and are automatically associated with a higher vulnerability rate. Many citizens are not fluent in English, which makes providing them with real time information difficult. Because Spanish is the most prominent second language, there are often translators available, and many times emergency notifications are provided in Spanish; however, those who speak other languages are at greater risk if notifications are not provided in the appropriate languages. These groups often rely on family, friends, neighbors and social media for information.

Housing and transportation considers the structure of the home (e.g., building codes, age of structure, etc.), crowding, and access to vehicles or public transportation. The quality of the housing is crucial when calculating vulnerability and is often tied to the person's wealth. Those who are economically disadvantaged often live in poorly constructed houses or mobile homes, neither of which are designed to withstand strong winter storms (ice and snow loads), wind events, earthquakes, or flooding. In addition, mobile homes are often located in places without easy access to highways or public transportation, are in cluster communities, and many times not tied down to a foundation, all of which add another layer of vulnerability. Multi-unit housing in densely populated areas are difficult to evacuate because of the limited amount of space and crowding. Urban areas often have a lower automobile ownership rate (e.g., walkable communities), especially in the lower income populations, which can make evacuations more challenging. Despite the lower proportion of people with vehicles, urban areas often have to deal with congestion on highways and major roads because of crowding. Group quarters are another housing situation that cause concern during evacuations, especially nursing homes and long-term care facilities because many institutions are unprepared to quickly remove staff and residents, and as with private group/independent living homes, the data that such facilities exist is not publicly known and/or identified.

All of these factors contribute to a community's social vulnerability which impacts all phases of emergency management, and should be taken into consideration in various planning efforts. Table 12-3 identifies those factors and classifications which contribute to a community's social vulnerability. Table 12-4 identifies the percent of special population within the County based on US Census data, augmented with County-specific data where available.

12.2.2 Results and Discussion

For purposes of this assessment, summary of the vulnerable populations were identified through the social vulnerability analysis focusing on the classifications identified. This analysis will be further expanded to include additional data as time allows. In conjunction with Table 12-3 and Table 12-4, Table 12-5 identifies the general building values exposed to each hazard, followed by the area exposed by each hazard in Table 12-6.

For this HMP update, a generalized impact assessment of vulnerable populations and the potential spatial distribution of impact were discussed in Table 12-7.

Table 12-3
Vulnerable Populations

Population Group	Percent of Total Population
Households Children 5 and Under	5
Populations 65 and Older	20
Populations 65 and Older Living Alone	12
Population Below Poverty Level	17
Population Below Poverty Level Under 18	36
Language Other Than English	8.1
At Least One Disability	21
At Least One Disability 65 and over	41
Households No Vehicles	4
Households No Telephone	2
Percent Housing Units Mobile Homes	18

Sources: Based on 2015 US Census Data
https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk

Table 12-4
Population Exposure

	Population			Special Populations			
				65+ years		< 18 years	
Threat	Total	% Base	Density (pop/sq. mi)	#	%	#	%
Base	**60,791**	**100%**	**63**	**8,149**	**16%**	**11,619**	**24%**
Earthquake	6,759	14%	142	1,376	20%	1,549	23%
Flood	7,530	15%	325	1,457	19%	1,679	22%
Landslide	6,610	13%	47	1,503	23%	1,279	19%
Severe Storm	49,405	100%	53	8,149	16%	11,619	24%

Table 12-5
General Infrastructure Exposure

Threat	Land Value			Improved Value			Total Assessed Value		
	Total ($)	% Base	Avg. Value ($)	Total ($)	% Base	Avg. Value ($)	Total ($)	% Base	Avg. Value ($)
Base	**$5,387,989,640**	**100**	**$89,421**	**$4,864,488,058**	**100**	**$80,733**	**$10,252,277,698**	**100**	**$170,154**
Earthquake	$122,080,830	2.27	$54,018	$119,679,390	2.46	$52,955	$241,760,220	2.36	$106,974
Flood	$234,524,150	4.35	$76,542	$171,811,459	3.53	$56,074	$406,335,609	3.96	$132,616
Landslide	$27,028,420	0.50	$54,165	$27,187,135	0.56	$54,483	$54,215,555	0.53	$108,648
Severe Storm	$5,387,989,640	100	$89,421	$4,864,488,058	100	$80,733	$10,252,277,698	100	$170,154

Table 12-6
General Exposure

Threat	Area: Square Miles		Parcels	
	Total	% Base	Total	% Base
Base	**940.82**	**100%**	**60,254**	**100%**
Earthquake	47.58	5.06%	2,260	3.75%
Flood	23.15	2.46%	3,064	5.06%
Landslide	140.69	14.95%	499	0.83%
Severe Storm	940.82	100%	60,254	100%

Once the Social Vulnerability was determined, the Planning Team conducted a qualitative assessment combining the value of the CPRI, and summarizing the potential impact based on past occurrences, spatial extent, and subjective damage and casualty potential. Those items were categorized into the following levels:

- Extremely Low—The occurrence and potential cost of damage to life and property is very minimal to nonexistent.
- Low—Minimal potential impact. The occurrence and potential cost of damage to life and property is minimal.
- Medium—Moderate potential impact. This ranking carries a moderate threat level to the general population and/or built environment. Here the potential damage is more isolated and less costly than a more widespread disaster.
- High—Widespread potential impact. This ranking carries a high threat to the general population and/or built environment. The potential for damage is widespread. Hazards in this category may have occurred in the past.
- Extremely High—Very widespread with catastrophic impact.

Table 12-7
Vulnerability Overview

Hazard	Synopsis of Potential Impact	Population Groups Impacted (By Group Type): Business	Children	Disabled	Elders	Families	Low Income	Language	Level of Impact High, Medium, Low	Summarized Extent and Location
Climate Change	Climate change is measured in terms of impact on other hazards of concern. Impact varies, but can include physical drought conditions, water shortage, increased flood incidents, or increased wildfire danger.	X	X	X	X	X	X	X	Medium	Climate change itself customarily does not impact structures; however, the entire population and natural resources of the area will be impacted by climate change.
Drought	Drought is typically measured in terms of water availability in a defined geographical area, and is not a sudden-onset hazard, allowing some preparation. Socioeconomic droughts occur when physical water shortage begins to affect people, individually and collectively. Social impacts mainly involve public safety, health, reduced quality of life, and inequities in the distribution of impacts and disaster relief. Many impacts identified as economic and/or environmental also have a social component. During warm seasons, water suppliers are often faced with more demand for water than they are able to distribute. This may lead to rationing and curtailment, with business that rely heavily on water usage (landscapers, golf courses, car washes, etc.) may suffer financially. Most socioeconomic definitions of drought associate it with supply, demand, and economic goods.	X	X	X	X	X	X		Medium	Drought customarily does not impact structures, but would adversely impact people, resources, and aqua- and agri-cultural businesses (among others) within the area. Therefore, all populations would be susceptible, although the degree would be determined by the severity of the drought in place, the availability of water, increased fire danger and response times, and the economic impact from water-dependent industries.

Table 12-7
Vulnerability Overview

Hazard	Synopsis of Potential Impact	Population Groups Impacted (By Group Type): Business	Children	Disabled	Elders	Families	Low Income	Language	Level of Impact High, Medium, Low	Summarized Extent and Location
Earthquake	Older structures (pre ~1970) have high probability of collapse due to building code standards; Non-English speakers may have issues gaining hazard information for preparedness. Low-income individuals may not be able to stockpile supplies or medications. Elderly populations are vulnerable due to health issues, the lack of physical strength to extricate themselves, etc. Businesses many times do not carry insurance which will help them recover from losses.	X	X	X	X	X	X	X	High	Many structures in the area were built pre-1970, when lower codes were in place, making the structures more vulnerable to collapse, increasing the potential for injury. Also of concern with earthquake are landslides and slope stability. Stability in the area could be significantly undermined. The majority of the entire area is susceptible to the impacts from an earthquake to some degree. Older structures would be more susceptible to collapse during shaking, increasing the number and degree of injuries. Elderly and young would be susceptible because of the decreased ability to survive injury, and the decreased ability to physically extract themselves from debris if buried beneath collapsed structures.

Table 12-7
Vulnerability Overview

Hazard	Synopsis of Potential Impact	Population Groups Impacted (By Group Type): Business	Children	Disabled	Elders	Families	Low Income	Language	Level of Impact High, Medium, Low	Summarized Extent and Location
Landslide	The probability for impact from Landslide is more limited with respect to geographic extent. The area experiences some level of landslides almost annually. The coastal bluff areas, and areas within the unincorporated areas of the County have identifiable landslide risk. While there are areas where no landslide risk, landslides can occur on fairly low slopes, and areas with no slopes can be impacted by slides at a distance. Construction in critical areas, which includes geologically sensitive areas such as landslide areas, is regulated; however, beyond the structural impact, secondary impact to infrastructure causing isolation or commodity shortages also has the potential to impact the region.		X	X	X	X	X	X	High	A significant portion of the planning area has some level of susceptibility to landslides, especially along the major roadways in the County. As such, evacuation in the area could be impacted by a landslide event. With the increased risk factor during the rainy season, a landslide could occur anywhere in the county where soils can become saturated. This could impact the ability of citizens to leave areas where flooding occurs, or evacuate after a major earthquake if a landslide has blocked major arterials. This could also impact responders accessing areas. Vulnerable populations would be less likely to be able to evacuate, increasing their risk.

Table 12-7
Vulnerability Overview

Hazard	Synopsis of Potential Impact	Population Groups Impacted (By Group Type): Business	Children	Disabled	Elders	Families	Low Income	Language	Level of Impact High, Medium, Low	Summarized Extent and Location
Flood	Year of construction will influence the building code and the height to which the structures were built when compared to the Base Flood Elevation. In most instances, weather patterns which cause flooding are identified in advance, allowing pre-planning for evacuation, thereby potentially reducing the individuals at risk. Individuals without homeowner's insurance which covers flooding may suffer extreme financial risk. Businesses impacted many times do not carry insurance which will help them recover from losses. In many instances, those businesses do not return to the area because they cannot overcome the financial loss.	X	X	X	X	X	X	X	High	Flooding in the area has been significant, especially within the Skokomish basin and the City of Shelton. Flooding in the area has also impacted transportation, causing roadways to be blocked, and causing landslides which also block major arterials. This has caused issues with evacuation in certain areas. All areas within the floodplain would be vulnerable. Given the higher-than-average population of elderly and young, the level of vulnerability is higher than when compared to other areas. The County also has increased populations from visitors who frequent the local Tribal Casino Resort (Little Creek), as well as increased populations to the Olympic National Forest, and the large campgrounds in the area. For planning purposes, a significant increase in citizens in the area should be considered especially during the summertime to include annual volumes of tourists and residents with vacation homes.

Table 12-7
Vulnerability Overview

Hazard	Synopsis of Potential Impact	Population Groups Impacted (By Group Type): Business	Children	Disabled	Elders	Families	Low Income	Language	Level of Impact High, Medium, Low	Summarized Extent and Location
Severe Weather – inclusive of heat, cold, wind, snow, ice, hail, Thunder-storm, lightening	Severe weather occurs regularly throughout the planning area. In most instances, weather patterns are forecasted in advance, allowing for preparation. Individuals with lower income may not have the ability to stock supplies, nor afford the cost of increased energy costs for both heating or cooling, depending on the weather event. In snow or ice conditions, secondary impacts from driving or shoveling snow increases the risk of impact. Elderly and young children are especially susceptible to ice and heat conditions. Lighting strikes also occur throughout the planning area, although in a limited capacity. In densely wooded areas, such as the Olympic National Forest, fires could go un-noticed for a period of time, allowing the fire to gain strength and severity, especially during drought situations. Lightning risk also increases due to the large waterbodies in the area, and the time it takes for boaters to get to safety. The area also has a number of golf courses, which are open and provide little cover from lightning strikes.	X	X	X	X	X	X	X	High	The entire region is susceptible to severe weather incidents, including impact to people, property, and the environment. Incidents of some nature and degree occur annually. Depending on the type of event, roadways may be impassible. Significant power outages do not occur often, and do not customarily last for a long period of time. However, when coupled with cold conditions, the impact to vulnerable populations increases. With extreme heat events, physical manifestation on the young and elderly rise. In addition, the increased fire danger impacts the entire area.

Table 12-7
Vulnerability Overview

Hazard	Synopsis of Potential Impact	Population Groups Impacted (By Group Type): Business	Children	Disabled	Elders	Families	Low Income	Language	Level of Impact High, Medium, Low	Summarized Extent and Location
Wildfire	Impact from wildfires has increased over time due to effective suppression tactics. This has now caused fires to burn with greater intensity, with the traditional fire regimes being modified. Embers from wildfires can be carried significant distances (miles). With climate change impacting drought conditions, the potential for wildfire increases as moisture content is depleted. Lightning strikes and people are the major causes of wildfires, which can spread very quickly, leaving little to no time to evacuate. Individuals with access and functional needs, the young and elderly are at greater risk due to their potential dependence on others to assist with evacuation. Individuals, including the young and elderly, with health concerns are impacted significantly by smoke. Increased rates of death due to smoke is not uncommon.	X	X	X	X	X	X	X	Medium	Wildfire danger can impact the entire planning area; however, there has been limited impact to date. The various Fire Regimes do identify areas of higher levels of risk, although wildfires can occur in any area with vegetation. Not all Fire Regimes exist in the area. Due to the wind patterns in the area, including the shift of winds during afternoon hours, embers have the potential to travel great distances (miles) and ignite fires in areas which are densely wooded. In some instances, these fires can burn for periods of time, going un-noticed until ignition consumes a large area, making containment difficult. Elderly, young and individuals with breathing/health issues are more vulnerable due to smoke and particulates. Language may also be a barrier for non-English speaking populations due to the inability to understand evacuation orders, which can be very short-notice.

CHAPTER 13.
MITIGATION STRATEGY

The development of a mitigation strategy allows the community to create a vision for preventing future disasters. This is accomplished by establishing a common set of mitigation goals and objectives, a common method to prioritize actions, and evaluation of the success of such actions. Specific mitigation goals, objectives and projects were developed for Mason County and its planning partners by the Planning Team in their attempt to establish an overall mitigation strategy by which the jurisdictions would enhance resiliency of the planning area.

13.1 HAZARD MITIGATION GOALS AND OBJECTIVES

During the April 26, 2017 meeting, the Planning Team reviewed the 2010 existing goals. For the 2018 update, the planning team used the existing goals as a base, making modifications to support a countywide effort of enhanced capabilities which support resilience through protection of life, property, the economy and the environment. The goals as written for the 2018 update more accurately describe the overall direction that Mason County and its planning partners can take to work toward mitigating risk from natural hazards and avoid long-term vulnerabilities to the hazards of concern. Mitigation goals for this plan are listed below.

13.1.1 Goals

Goals for the 2017 mitigation strategy are as follows:

1. Reduce or prevent hazard-related injuries or loss of life, as well as reducing impact to property, the environment, and the economy.
2. Encourage the development and implementation of multi-objective opportunities and long-term, cost-effective, and environmentally sound mitigation projects and initiatives.
3. Enhance community capabilities and resilience through proactive measures, increased public awareness, and readiness.
4. Promote disaster-resistant and resilient communities by leveraging public and private partnering opportunities.

13.1.2 Objectives

The previous plan had no objectives identified. Therefore, during the kick-off meeting, the planning team established objectives for the 2017 mitigation strategy are presented in Table 13-1.

Table 13-1 Objectives 2017		
Objective Number	Objective Statement	Applicable Goals
O-1	Acquire (purchase), retrofit, or relocate structures in high hazard areas.	1, 2, 3, 4,
O-2	Encourage open space uses in hazardous areas or ensure that if building occurs in these high-risk areas that it is done in such a way as to minimize risk.	1, 2, 3, 4
O-3	Use best available data, science, and technologies to improve understanding of location and potential impacts of hazards, and to promote disaster resilient communities that minimize risk.	1, 2, 3, 4,
O-4	Consider the impacts of natural hazards in all planning mechanisms that address current and future land use.	1, 2, 3, 4
O-5	Increase resilience and the continuity of operations of identified critical facilities throughout the County.	1, 2, 3, 4
O-6	Continue established partnerships among the County Government and business leaders within surrounding area to improve and implement methods to protect life, property, and the environment, while enhancing government and business continuity within the planning area.	1, 2, 3, 4
O-7	Enhance community capabilities to prepare for, protect from, respond to, recover from, and mitigate the impact of hazards.	3
O-8	Encourage the development and implementation of long-term, cost-effective and environmentally sound mitigation projects by encouraging use of incentives.	1, 2, 3
O-9	Develop or improve emergency warning response and communication systems and evacuation procedures.	1, 3
O-10	Provide/improve fire protection activities through various means, including: public education and outreach activities, defensible space, fire-resistant landscaping, spatial distribution of development, fuel treatment activities, and enhanced water supply systems where appropriate and feasible.	1, 2, 3, 4
O-11	Encourage hazard mitigation measures that result in the least adverse effect on the natural environment and that use natural processes, while preserving and maintaining the environmental elements of the planning area.	2, 3

13.2 HAZARD MITIGATION ALTERNATIVES

After the goals and objectives were established, the planning team developed specific action items to further increase resilience. FEMA's 2013 catalog of *Mitigation Ideas* was presented to the planning team. This document includes a broad range of alternatives to be considered for use in the planning area, in compliance with 44 CFR (Section 201.6.c.3.ii), and can be applied to both existing structures and new construction. The catalog provides a baseline of mitigation alternatives that are backed by a planning process, are consistent with the planning partners' goals and objectives, and are within the capabilities of the partners to implement. It presents alternatives that are categorized in two ways:

- By what the alternative would do:
  - Manipulate a hazard
  - Reduce exposure to a hazard
  - Reduce vulnerability to a hazard

  - Increase the ability to respond to or be prepared for a hazard
- By who would have responsibility for implementation:
  - Individuals
  - Businesses
  - Government.

Hazard mitigation initiatives recommended in this plan were selected from among the alternatives presented in the catalogs, as well as projects identified by the planning partners and interested stakeholders specific to their jurisdiction. Some were carried over from the previous plan. Some may not be feasible based on the selection criteria identified for this plan, but are included nonetheless as the planning team felt they are viable actions to be taken to reduce hazard influence in some manner.

13.3 SELECTED MITIGATION INITIATIVES

For the 2018 update, particular attention was given to new and existing buildings and infrastructure, and developing appropriate mitigation strategies for these facilities. The planning team determined that some initiatives from the mitigation catalogs could be implemented to provide hazard mitigation benefits countywide. Table 13-2 lists the recommended countywide initiatives. Table 13-3 identifies County-specific initiatives.

13.4 ANALYSIS OF MITIGATION INITIATIVES

In addition to identifying potential funding sources available for each project, the Planning Team also developed strategies/action items that are categorized and assessed in several ways:

- By what the alternative would impact – new or existing structures, to include efforts which:
  - Manipulate/mitigate a hazard;
  - Reduce exposure to a hazard;
  - Reduce vulnerability to a hazard;
- By who would have responsibility for implementation:
  - Individuals;
  - Businesses;
  - Government (Tribal, County, Local, State and/or Federal);
- By the timeline associated with completion of the project, based on the following parameters:
  - 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;
- By who benefits from the initiative, as follows:
  - A specific structure or facility;
  - A local community;
  - County-level efforts;
  - Regional level benefits.

Table 13-2
Countywide Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency*	Estimated Cost	Funding Sources	Timeline	In Previous Plan?	Initiative Type	Who Benefits ?
CW-1 Continue data gathering for facility information to continue to improve the risk assessment and identification of infrastructure countywide.									
New/ Existing	All	3, 6, 10,	DEM, All planning partners	Low	HLS/EMPG, PDM, HMGP, HUD, General Funds	Ongoing	No	Structural Projects, Property Protection	Regional
CW-2 Work with County and state agencies to establish a protocol and advance permitting for transporting of hazardous materials for identification during an incident.									
New	Hazardous Materials	3, 4, 5, 6, 7, 9	PH, Fire, DEM, PW, WDOT, WDOE	Low	General Funds, HLS (EMPG), CDC grants	Long-Term	No	Prevention, Public Information and Education, Natural Resource Protection, Emergency Services/ Response	Regional
CW-3 Develop points of distribution in areas of potential isolation.									
New	All	3, 6, 7, 9	PH, DEM, PW	Low	EMPG, HUD	Short-Term	No	Public Information and Education, Emergency Services / Response, Recovery	Regional
CW-4 Work with Public Health and Human Services to develop an information bank identifying individuals with access and functional needs. This will assist the County in determining shelter locations requiring specific resources to meet the needs of those individuals. NOTE: This is not an attempt to gather medical-related data, but rather to determine access and functional needs of citizens – e.g., citizens in wheel chairs need more space and shower/restroom facilities; hearing impaired need to have an area which allows them to be near to their signer, the use of oxygen tanks increases space requirements, etc.									
New	All	3, 4, 5, 6, 7, 9, 11	PH, DEM, HS	Low	Health and Human Service Grants, HUD, HMGP	Long-Term	No	Public Information and Education, Emergency Services / Response, Recovery	Commu-nity Level

Table 13-2
Countywide Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency*	Estimated Cost	Funding Sources	Timeline	In Previous Plan?	Initiative Type	Who Benefits ?
CW-5 Coordinating with Assessor's Office, Permitting and other County offices, update Assessor's parcel data to include more building-specific information which may be utilized within the GIS and Hazus programs for enhanced risk assessments to provide a detailed loss estimation.									
New and Existing	All	3, 5, 6	Assessor's Office; GIS; PW, DEM; CD	Medium	General Fund, HMGP	Short-Term	No	Structural Projects, Property Protection, Recovery	County and Local
CW-6 Coordinate among all jurisdictions to seek out and apply for grants for site hardening of facilities.									
New/ Existing	EQ, F, LS, SW	1, 2, 4, 6, 7, 10, 11	DEM	Medium	Earthquake and Tsunami Program, HMGP, PDM, HUD, DOT, EPA	Long-Term	No	Structural Projects, Property Protection, Natural Resource Protection	Facility Specific
CW-7 Maintain and regularly update fire hydrant layer countywide.									
New/ Existing	WF	3, 5, 7, 10	DEM, GIS, Fire	Low	HMGP, HUD, SAFER	Long-Term	No	Property Protection, Emergency Services/ Response	County-wide
CW-8 Continue implementation of public education program within Mason County to educate citizens about the hazards faced and the appropriate preparedness and response measures, including, but not limited to, NFIP information and insurance.									
New/ Existing	All	All	DEM, Local and County CD	Low	EMPG, General Fund	Ongoing	Yes	Prevention, Public Information and Education	County and Commu-nity
CW-9 Continue to expand CERT training, involving local teams in exercises and training with first responders.									
New/ Existing	All	6, 7	DEM	Low	EMPG	Ongoing	Yes	Prevention, Public Information and Education, Emergency Services, Response, Recovery	County and Commu-nity

Table 13-2
Countywide Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency*	Estimated Cost	Funding Sources	Timeline	In Previous Plan?	Initiative Type	Who Benefits ?
CW-10 Develop and prepare a fueling plan, addressing both automotive and heating fuels, in case of prolonged interruption of normal distribution to Mason County locations.									
New and Existing	EQ, F, LS, SW, T	3, 4, 5, 6, 7, 8, 11	DEM, Sheriff, LE, Fire, PW and Local PW	Low	General Fund, various grants.	Long-Term	No	Response, Recovery	County and Local
CW-11 Evaluate current coverage and equipment and provide a strategic emergency communications plan that provides better coverage to all areas of Mason County for first responders and emergency amateur radio communications.									
Existing	All	6, 9	DEM, Communica-tions Group	Low	General Funds	Short-Term	No	Emergency Services/ Response, Prevention, Public Information and Education	County and Local
CW-12 Review designated emergency shelter structural and utility readiness for occupancy after a significant incident.									
New/ Existing	All	1, 5, 6, 9, 11	DEM	Medium	PDM, HMGP, General Funds	Short-Term	No	Prevention, Public Information Emergency Services/ Response	Regional
CW-13 Provide steep slope stability recommendations and education to owners of structures above steep bluffs or below steep bluffs. Increase monitoring of county bluffs involving beach communities or access to beach communities.									
New/ Existing	EQ, F, LS, SW	1, 2, 3, 4, 6, 7	DEM, County and Local PW, CD, WDNR	Medium	PDM, HMGP, General Funds	Long-Term	No	Structural Projects, Property Protection	County and Local
CW-14 Conduct a needs assessment to determine logistical requirements for equipment and parts for wells and water distribution sources to ensure a surplus allowing for continued supply of water in case commodity flow is impacted by a major event.									
New/ Existing	All	3	PH, DEM PW, WDOE	Medium	Earthquake and Tsunami Program Grant Funds, EPA, EMPG	Ongoing	No	Response, Recovery	County and Local

Table 13-2
Countywide Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency*	Estimated Cost	Funding Sources	Timeline	In Previous Plan?	Initiative Type	Who Benefits ?
CW-15 Promote a “FireWise” program in County to increase fire safety zones around businesses and residences. Encourage owners to reduce woodland fuel loads on their property.									
New/ Existing	D, WF	3, 8, 10	DEM, Fire	Low	Fire Grants, PDM, HMGP	Ongoing	No	Property Protection, Natural Resource Protection, Prevention	Local
CW-16 Work with local jurisdiction and planning partners to develop various emergency planning efforts to help ensure continuity of business and resiliency.									
New/ Existing	All	5, 6, 9	DEM, ED, Chamber	Medium	EMPG Funds, General Funds	Long-Term	No	Recovery	County, Local
CW-17 Identify and establish redundant or back-up emergency operations center locations throughout the County in case of road closures which restrict access to areas of the County.									
New	All	5, 6, 7, 8, 9	DEM, Public Officials - County and Local	Medium	EMPG and General Funds	Short-Term	No	Emergency Services/ Response, Recovery	County and Local
CW-18 Partner with Washington State Department of Transportation to expand earthquake assessment, and to expand and implement training and exercises throughout the county which support transportation-related issues and potential isolation.									
New/ Existing	All	3, 4, 6, 7, 9, 11	DEM, PW, WSDOT	Medium	US DOT and WSDOT Grants, HLS	Long-Term	No	Emergency Services/ Response, Recovery	Regional
CW-19 Continue to promote and establish a countywide emergency management actions, projects, and programs, working with City of Shelton and special purpose districts, to enhance resiliency and maintain consistency in mitigation activities, emergency management programs, and capabilities. This includes seeking grant funding to support such initiatives.									
New/ Existing	All	3, 4, 5, 6, 7, 8, 9 10, 11	DEM, Fire, Hospitals	Medium	General Funds, Grant Opportunities as they arise	Long-Term	No	Prevention, Public Information and Education, Emergency Services/ Response, Recovery	County and Local

Table 13-2
Countywide Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency*	Estimated Cost	Funding Sources	Timeline	In Previous Plan?	Initiative Type	Who Benefits?
CW-20 Strive to capture time-sensitive, perishable data such as high-water marks, extent and location of hazard, and loss information following hazard events to support future updates to the risk assessment and in support of future grant applications to demonstrate impact.									
New/ Existing	All	4, 8, 9, 10	DEM	Medium	General Funds	Long-Term	No	Emergency Services/ Response, Recovery	County and Local
CW-21 Continue to enhance local emergency planning committee involvement with all fire organizations throughout the County with the goal of quarterly meetings.									
Existing	WF	4, 8, 9, 10	DEM, Fire	Low	General Funds	Ongoing	No	Prevention, Emergency Services/ Response, Recovery	County and Local
CW-22 Seek grant funding to develop a countywide mass care and evacuation exercise, which includes all fire and police departments, Hospital District, Public Health, County Transit, Emergency Management and search-and-rescue, as well as other planning partners as identified during exercise design.									
New and Existing	All	3, 4, 5, 6, 7, 8, 9, 10	DEM, Fire, Hospitals, PH, PW, WSDOT; Sheriff, LE	High	EMPG, DOJ Grants, Fire Training Grants, EMPG	Long-Term	No	Emergency Services/ Response, Recovery	County and Local
CW-23 Continue to integrate mitigation planning data into ongoing land-use planning to assist in providing information necessary to enforce existing building codes, floodplain and critical areas ordinances, and shoreline protection.									
New and Existing	F, EQ, LS, SW	1, 3, 5, 7, 8, 14, 15, 18	DEM	Low	FEMA	Short-Term	Y	Prevention, Emergency Services, Planning, Response, Recovery	Local and County
CW-24 Develop countywide mutual aid agreements with both public and private agencies in support of preparedness and response activities.									
New	All	4, 5, 6	DEM	Medium	General Funds	Ongoing	No	Emergency Services/ Response, Recovery	County and Local
CW-25 Capture data concerning the number of portable generators at fueling stations and local grocery outlets to determine need to acquire generators to ensure fuel availability and food items during significant events which may impact transportation flows, reducing commodities in the planning area. If necessary, seek grant opportunities to purchase generators for use during such events.									
New/ Existing	All	6, 7, 8, 9, 10	DEM	Low	General Funds	Ongoing	No	Emergency Services/ Response, Recovery	County and Local

Table 13-2
Countywide Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency*	Estimated Cost	Funding Sources	Timeline	In Previous Plan?	Initiative Type	Who Benefits ?
CW-26 Capture information concerning the surplus supply maintained by local fueling stations and grocery outlets to determine quantities available should commodities be interrupted as a result of a significant incident.									
New/ Existing	All	6, 7, 8, 9, 10	PW	Low	General Funds	Ongoing	No	Emergency Services/ Response, Recovery	County and Local
CW-27 Develop countywide debris management plan.									
New/ Existing	EQ, F, LS, SW, WF	3, 5, 6, 9, 11	PW	High	Grant Sources TBD	Long-Term	No	Recovery	County and Local
CW-28 Work with various communications organizations within the area to identify location of cell towers and capacity to support area during disaster incidents.									
New/ Existing	All	6, 7, 8, 9, 10	PW	Low	General Funds	Ongoing	No	Emergency Services/ Response, Recovery	County and Local

* CD=Community Development (local and county); ED=Economic Development; DEM= Emergency Management (Interlocal Agreement whereby County provides services to city); Fire=Districts and Depts.; HS=Human Services; LE=Law Enforcement; PH=Public Health; PW=Public Works (local and county); WSDOT=Washington State Dept. of Transportation; WDOH=Washington State Dept. of Health; WDNR=Washington State Dept. of Natural Resources; WDOE=Washington Dept. of Ecology

Table 13-3
County-Specific Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Funding Sources	Timeline	In Previous Plan?	Initiative Type	Who Benefits?
C-1 Study and retrofit county owned facilities to better withstand damage from earthquake, flood, severe weather.									
Existing	All	1, 3, 4 5, 7, 8, 11	DEM, Facilities	High	HLS/EMPG, PDM, HMGP, HUD, General Funds	Ongoing	No	Structural Projects, Property Protection	Facility
C-2 Evaluate and enhance the current capital improvements program for county roads, including the Skokomish Valley and Cloquallum Roads, as well as drainage projects to provide better flood control in known flood problem areas, including drainage system maintenance plans and sediment and debris clearance to ensure unobstructed flow of floodwaters.									
New/ Existing	F, SW	1, 2, 3, 4 5, 8, 11	PW	High	General Funds, HLS (EMPG), CDC grants	Long-Term	Partial	Property Protection, Structural Projects, Natural Resource Protection	County and Local
C-3 Seek steep slope stability project funding or relocation funding for county roads with histories of instability.									
Existing	EQ, F, LS, SW, WF	1, 2, 3, 4 5, 8, 10, 11	PW	High	PDM, HMGP, USDOT, WSDOT	Long-Term	No	Property Protection, Structural Projects, Natural Resource Protection	County
C-4. Seek grant funding for acquisition of properties in high-hazard areas, with special attention to repetitive loss properties.									
Existing	All	1, 2, 4	BOCC, DEM	High	PDM, HMGP, FMA	Long-Term	Yes	Property Protection, Structural Projects,	Facility and County
C-5. Obtain and install river gauges on the Tahuya River.									
New/ Existing	F, SW	3, 6, 9	DEM, PW, USGS	High	HMGP, USGS Grant	Ongoing	Yes	Response, Recovery	County
C-6. Seek granting fund to address areas in high landslide areas, such as the Purdy Cutoff and Northshore Roads. When funding received, complete project.									
New	LS	3, 4, 6, 7	DEM, PW/Roads, WSDOT	Low	General Fund, DOH	Short-Term	Yes	Prevention Public Information and Education, Response, Recovery	County and Local

Table 13-3
County-Specific Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Funding Sources	Timeline	In Previous Plan?	Initiative Type	Who Benefits?
C-7 Continue participation in the NFIP; considering implementing various steps which will increase CRS scores to help lower insurance premiums.									
New/ Existing	F, SW	1, 2, 3, 4, 5, 7, 11	DEM, Planning	Medium	General Fund	Long-Term	Yes	Prevention, Mitigation	County
C-8 Continue working with the Skokomish Watershed Action Team (SWAT) to support on-going mitigation activities within the Skokomish Watershed.									
New/ Existing	F, SW, LS	3, 4, 5, 6, 7	DEM, SWAT, PW	Low	General Fund	Ongoing	No	Mitigation, Recovery	County and Local
C-9 Continue to design and build facilities to meet or exceed seismic and code standards, including redundant essential equipment. Apply current seismic, wind and snow-load standards to all renovation or replacement of existing facilities, and/or equipment.									
New/ Existing	EQ, LS, SW	1, 3, 4, 5, 6, 7, 8, 11	Building	High	PDM, HMGP	Ongoing	No	Structural Projects, Property Protection	County
C-10 Conduct activities that support mitigation efforts to reduce the negative influence of natural hazards impacting Mason County, such as appropriate hazard identification, warning, dissemination of relevant information and data, and public outreach.									
New	All	All	CD, PH, DEM	Low	General Fund, various grants.	Ongoing	No	Structural Projects, Public Information and Education, Natural Resource Protection	County, Facility, Local
C-11 Work with local public and private entities to review infrastructure control systems and ensure appropriate level of security and protection measures are in place. As appropriate, conduct audit of policies and procedures to ensure consistency and accuracy in application of security devices in place.									
Existing	All	3, 4, 6, 7, 9	DEM, PUDs, IT	Low	General Funds	Short-Term	No	Prevention, Property Protection, Emergency Services	Regional
C-12 Implement cost-effective measures to address vulnerability of facilities at risk to sea level rise, extreme high tides and storm surges as they relate to potential inflow of saltwater. This includes working with local private water purveyors.									
New/ Existing	CC, EQ, F, LS, SW	1, 2, 3, 4, 5, 6, 7	DEM, PH, PW, WDNR, WDOH, WDOE	Medium	PDM, HMGP, General Funds, Ecology, DOH, HLS	Long-Term	No	Structural Projects, Property Protection, Natural Resource Protection	County

Table 13-3
County-Specific Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Funding Sources	Timeline	In Previous Plan?	Initiative Type	Who Benefits?
C-13 Utilize data gathered during risk assessment to identify capital projects that, when modified, increase the resilience of the County's structures and conveyances to damage, or that allow a more expedited process for recovery from the impact of disaster incidents.									
New/ Existing	All	1All	DEM, PW, Planning, FEMA, WDNR	Medium	Earthquake and Tsunami Program Grant Funds, General Funds, PDM, HMGP	Short-Term	No	Structural Projects, Property Protection, Recovery	Facility, County
C-14 Consider projects enhancing resistance of county structures to impact from hazards of concern, such as seismic bracing of equipment, piping and fixtures, removal of high hazard beams, access road reinforcement, or seismic upgrades of underwater interceptors.									
New/ Existing	EQ, LS	1, 2, 3, 4, 5, 6, 7, 8, 11	DEM, PW	High	Earthquake and Tsunami Grant Program, PDM, HMGP	Ongoing	No	Property Protection, Structural Projects	Facility, County
C-15 Implement a recovery system to ensure maximum FEMA reimbursement for disaster response, repair, mitigation and recovery, which will capture and track emergency activities, associated expenses (mileage, supplies, expendables, outside vendors, etc.), employee time and dedicated resources.									
New/ Existing	All	6, 8, 9	DEM, Risk, Finance, PW	Medium	EMPG Funds, General Funds	Long-Term	No	Recovery	County
C-16 Utilize data from the current risk assessment and comprehensive land use planning effort currently underway to update GIS capacity and capabilities.									
New	All	1, 2, 3, 4, 5, 8, 11	County GIS, Planning, DEM	Medium	HMGP, EMPG and General Funds	Short-Term	No	Response, Recovery	County
C-17 Develop a web-based application to capture damage assessment from citizens, which can be verified by emergency personnel to expedite damage assessment. This may include an interface between the Assessor's office for property values, as well as a mechanism for rapid windshield assessment by first responders.									
New/ Existing	All	3, 5, 6 7, 9	IT, Assessor's Office, Risk Mgmt. DEM	Medium	General Funds, HLS, HMGP	Short-Term	No	Recovery	County
C-18 Assess the County's communications systems to determine its current vulnerability. This will include a review of the number of radios necessary to allow for adequate communications during emergency situations with field units, emergency response personnel, and emergency managers.									
Existing	All	9	DEM, IT, PW	Low	General Funds	Ongoing	No	Emergency Services, Response	County and Local

Table 13-3
County-Specific Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Funding Sources	Timeline	In Previous Plan?	Initiative Type	Who Benefits?
C-19 In accordance with OSHA/WISHA requirements for all employees performing emergency response activities (post-disaster), identify and train County staff and volunteers that will be utilized for these efforts. Training to be considered includes: ATC 20/45, Disaster Site Worker Training, and Emergency Response Training, Damage Assessment.									
New/ Existing	All	3, 6, 7, 9	BOCC, DEM, All County Depts.	High	EMPG, DOJ Grants, Fire Training Grants,	Ongoing	No	Emergency Services, Response, Recovery	County l
C-20 Develop (or update) plans to ensure response and recovery efforts. This includes working with the BOCC to develop appropriate committees, such as a continuity of operations team, which will develop a countywide continuity of operations plan, and an emergency communications team which will look at communications and interoperability issues.									
Existing	All	3, 5, 6, 9,	DEM, BOCC	Low	Various	Long-Term	No	Response and Recovery	County
C-21 Develop public outreach which supports community participation in incentive-based programs, such as FireWise and StormReady.									
New/ Existing	All	3, 6, 9, 10,	DEM	Low	General Funds	Ongoing	No	Public Information and Education, Emergency Services/ Response	County

13.5 CRS ANALYSIS OF MITIGATION INITIATIVES

Each Planning Partner further reviewed its recommended initiatives to classify them based on the hazard it addresses and the type of mitigation it involves. This analysis incorporated, among others, the Community Rating System scale, identifying each mitigation action item by type. 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. This includes planning and zoning, floodplain laws, capital improvement programs, open space preservation, and stormwater management regulations.
- Public Information and Education - Public information campaigns or activities which inform citizens and elected officials about hazards and ways to mitigate them – a public education or awareness campaign, including efforts such as: real estate disclosure, hazard information centers, and school-age and adult education, all of which bring awareness of the hazards of concern.

- Structural Projects —Efforts taken to secure against acts of terrorism, manmade, or natural disasters. Types of projects include levees, reservoirs, channel improvements, or barricades which stop vehicles from approaching structures to protect.
- Property Protection – Actions taken that protect the properties. Types of efforts include: structural retrofit, property acquisition, elevation, relocation, insurance, storm shutters, shatter-resistant glass, sediment and erosion control, stream corridor restoration, etc. Protection can be at the individual homeowner level, or a service provided by police, fire, emergency management, or other public safety entities.
- Emergency Services / Response —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 (e.g., sandbagging).
- Natural Resource Protection – Wetlands and floodplain protection, natural and beneficial uses of the floodplain, and best management practices. These include actions that preserve or restore the functions of natural systems. Includes sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.
- Recovery —Actions that involve the construction or re-construction of structures in such a way as to reduce the impact of a hazard, or that assist in rebuilding or re-establishing a community after a disaster incident. It also includes advance planning to address recovery efforts which will take place after a disaster. Efforts are focused on re-establishing the planning region in such a way as enhance resiliency and reduce impacts to future incidents. Recovery differs from response, which occurs during, or immediately after an incident. Recovery views long-range, sustainable efforts.

13.6 BENEFIT/COST REVIEW

Once the general analysis was completed for each mitigation initiative, 44 CFR requires the prioritization of the initiatives or action items according to a benefit/cost analysis of the proposed projects and their associated costs (Section 201.6.c.3iii). The benefit/cost analysis conducted during this planning process is 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. Rather, parameters were established for assigning subjective ratings (high, medium, and low) to the costs and benefits of these projects. Cost ratings were defined as follows:

- **High** —Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).
- **Medium**—The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.
- **Low**—The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.

Benefit ratings were defined as follows:

- **High—**Project will provide an immediate reduction of risk exposure for life and property.
- **Medium—**Project will have a long-term impact on the reduction of risk exposure for life and property, or project will provide an immediate reduction in the risk exposure for property.

- **Low—**Long-term benefits of the project are difficult to quantify in the short term.

Using this approach, projects with positive benefit versus cost ratios (such as high over high, high over medium, medium over low, etc.) are considered cost-beneficial and are prioritized accordingly. Prioritization of the projects in such a manner serves as a guide for choosing and funding projects.

13.7 PRIORITIZATION OF INITIATIVES

The method for prioritizing initiatives for the 2018 update differs from the method used for the previous mitigation initiatives. While the factors involved in the ranking remain similar, there is now a consistent category or level (high/medium/low) assigned with those identified factors to ensure consistency. Table 13-4 lists the priority of each countywide initiative. Table 13-5 lists the priority for each county-specific initiative. A qualitative benefit-cost review as described above was performed for each of these initiatives.

Table 13-4.
Prioritization of Countywide Mitigation Initiatives

Initiative #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Project Grant Eligible?	Can Project Be Funded under Existing Programs/ Budgets?	Priority (High, Med., Low)
1	4	H	L	Y	Y	Y	H
2	2	H	L	Y	Y	Y	H
3	4	H	L	Y	Y	Y	H
4	7	H	L	Y	Y	Y	H
5	3	H	M	Y	N	Y	M
6	7	H	M	Y	N	Y	M
7	4	M	L	Y	N	Y	M
8	11	H	L	Y	Y	Y	H
9	2	H	L	Y	Y	Y	H
10	7	H	L	Y	N	Y	H
11	2	H	L	Y	N	Y	H
12	5	H	M	Y	Y	Y	H
13	6	H	M	Y	Y	Y	H
14	1	M	M	Y	Y	N	M
15	3	M	L	Y	Y	N	L
16	3	M	M	Y	Y	Y	M
17	5	H	M	Y	Y	Y	M
18	6	M	M	Y	Y	N	M
19	9	H	M	Y	N	N	M
20	4	H	L	Y	Y	N	H
21	4	M	L	Y	N	Y	M
22	8	H	H	Y	Y	N	M
23	8	L	M	N	Y	N	L
24	3	H	M	Y	N	Y	M
25	6	M	L	Y	N	Y	M

Table 13-4.
Prioritization of Countywide Mitigation Initiatives

Initiative #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Project Grant Eligible?	Can Project Be Funded under Existing Programs/ Budgets?	Priority (High, Med., Low)
26	5	M	L	Y	N	Y	M
27	5	H	H	Y	Y	N	M
28	5	M	L	Y	N	Y	M

Table 13-5.
Prioritization of County-Specific Hazard Mitigation Initiatives

Initiative #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Project Grant Eligible?	Can Project Be Funded under Existing Programs/ Budgets?	Priority (High, Med., Low)
1	7	H	H	Y	Y	N	H
2	7	M	H	N	Y	N	M
3	8	H	H	Y	Y	Y	H
4	3	M	H	Y	Y	Y	M
5	3	H	H	Y	Y	N	H
6	4	H	H	Y	Y	N	H
7	7	H	L	Y	N	Y	H
8	5	H	L	Y	Y	Y	H
9	8	H	H	Y	N	N	L
10	11	H	L	Y	Y	N	H
11	5	H	L	Y	Y	Y	H
12	7	M	M	Y	Y	N	M
13	11	M	M	Y	N	N	L
14	9	H	H	Y	Y	N	H
15	3	H	M	Y	N	Y	M
16	6	H	H	Y	Y	Y	H
17	5	H	M	Y	Y	Y	H
18	1	M	L	Y	N	Y	L
19	4	H	H	Y	N	Y	H
20	4	H	L	Y	Y	N	M
21	4	H	L	Y	Y	Y	H

The priorities are defined as follows:

- **High Priority**—A project that meets multiple objectives (i.e., multiple hazards), has benefits that exceed cost, has funding secured or is an ongoing project and meets eligibility requirements for the HMGP or PDM grant program. High priority projects can be completed in the short term (1 to 5 years).
- **Medium Priority**—A project that meets goals and objectives, that has benefits that exceed costs, and for which funding has not been secured but that is grant eligible under HMGP, PDM or other grant programs. Project can be completed in the short term, once funding is secured. Medium priority projects will become high priority projects once funding is secured.
- **Low Priority**—A project that will mitigate the risk of a hazard, that has benefits that do not exceed the costs or are difficult to quantify, for which funding has not been secured, that is not eligible for HMGP or PDM grant funding, and for which the time line for completion is long term (1 to 10 years). Low priority projects may be eligible for other sources of grant funding from other programs.

For many of the strategies identified in this action plan, the partners may seek financial assistance under the HMGP or PDM programs, both of which require detailed benefit/cost analyses. These analyses will be performed on projects at the time of application using the FEMA benefit-cost model. For projects not seeking financial assistance from grant programs that require detailed analysis, the partners reserve the right to define "benefits" according to parameters that meet the goals and objectives of this plan.

Because this is a multi-jurisdictional plan, the prioritization of initiatives specific to the remaining jurisdictions must also be done at the individual level based on the needs and programs of that body, and accomplished as resources can be secured. Funding to complete any initiative will likely be acquired from a variety of sources, with the lack of funding alone preventing an initiative from being implemented. As such, the less formal approach used during this process is more appropriate because some projects may not be implemented for up to 10 years, and associated costs and benefits could change dramatically in that time.

The method of prioritization utilized also allows for the inclusion of new projects throughout the life cycle of this plan without having to numerically re-value each of the projects based on an assigned value of 1, 2, 3, etc. Further, it supports the plan maintenance strategy for review, addition, and reprioritization of initiatives on an annual basis, reducing the level of effort involved in a numeric system of ranking, and enhancing the likelihood that the annual review will occur as a reduced level of effort will be required.

13.8 2010 ACTION PLAN STATUS

A comprehensive review of the 2010 action plan was performed to determine which countywide actions were completed, which should carry over to the updated plan, and which were no longer feasible and should be removed from the plan. Table 13-6 identifies the results of this review. PUD 3's annex update contains information concerning their strategies.

Table 13-6 2017 Status of 2010 Action Plan													
	Associated Hazards									2017 Status			
Mitigation Strategy	Climate Change	Drought	Earthquake	Flood	Landslide	Severe Weather	Wildland Fire	2010 Timeline Short-Term <5 years; Long-Term >5 years; Ongoing	2017 Project Status	Completed	Continual /Ongoing Nature	Removed /No Longer Relevant	Carried Over to 2017 Plan
Sponsor public outreach activities to promote flood/disaster awareness and provide NFIP information along with disaster preparedness materials to citizens (CW-8)	✓	✓	✓	✓	✓	✓	✓	Ongoing	County continues to work with FEMA on the NFIP Program. Updated maps currently under review for adoption during this planning process; other hazard data will be distributed once risk assessment is completed. Project intent will be carried over to 2018 plan and incorporated into new strategies.	✓	✓		✓
GIS Data Gap Analysis (CW-1, 5)			✓	✓	✓	✓	✓	Ongoing	Some previous identified gaps have been addressed. However, this is a continual, ongoing process. Completion of this HMP edition will provide additional and new information which to utilize.	✓	✓		✓
Update, implement and enforce existing building codes, floodplain, critical areas and shoreline ordinances. (CW-23)			✓	✓	✓	✓	✓	Ongoing	COMP plan, which is currently under review, will address these topics. As new data from this HMP or any of the state stakeholders who develop hazard information is identified, that information will be reviewed as the COMP plan is revised and updated, that information is incorporated as appropriate.	✓	✓		✓
GIS Hazard Mapping (CW-1, 5)	✓	✓	✓	✓	✓	✓	✓	Ongoing	Ongoing efforts. Maps currently being updated. As new data becomes available, new maps are continually created and updated for use within the County.	✓	✓		✓

Table 13-6
2017 Status of 2010 Action Plan

	Associated Hazards									2017 Status			
Mitigation Strategy	Climate Change	Drought	Earthquake	Flood	Landslide	Severe Weather	Wildland Fire	2010 Timeline Short-Term <5 years; Long-Term >5 years; Ongoing	2017 Project Status	Completed	Continual /Ongoing Nature	Removed /No Longer Relevant	Carried Over to 2017 Plan
Earthquake – Bridge Assessment (CW-18)			✓					Long-Term	Still a viable project. No action completed. Project will be carried forward into new plan with hopes of possibly working with WSDOT to assess some of the bridges in the County.		✓		✓
Work with other stakeholders, such as the Skokomish Watershed Action Team (SWAT) to develop watershed restoration projects that will enhance/restore stream and wetland buffers and increase the flood storage capacity (CW-19)				✓	✓	✓		Long-Term	Initial study completed in 2015 (*Skokomish River Basin/Mason County, Washington/Ecosystem Restoration, USACE*) and utilized within the risk assessment portion of the plan. Mitigation efforts identified within the study. Working with other impacted areas, the county will work with those agencies to identify potential funding sources to begin implementing more of the mitigation projects identified. The County continues to assist as staffing allows, supporting the various on-going efforts.	✓	✓		✓
Develop and implement a drainage system maintenance plan, such as sediment and debris clearance, to ensure unobstructed flow of floodwaters. (C-2)				✓		✓		Short-Term	Still a viable project. Staff limitations have impacted the ability to complete this task during this plan cycle. It is still a viable strategy to be carried forward into new plan.				✓
GIS Risk Analysis mapping for wildland/WUI fires.							✓	Short-Term	CWPP completed. However this edition of the Mitigation Plan will provide more wildfire analysis data.	✓			

Table 13-6
2017 Status of 2010 Action Plan

	Associated Hazards									2017 Status			
Mitigation Strategy	Climate Change	Drought	Earthquake	Flood	Landslide	Severe Weather	Wildland Fire	2010 Timeline Short-Term <5 years; Long-Term >5 years; Ongoing	2017 Project Status	Completed	Continual /Ongoing Nature	Removed /No Longer Relevant	Carried Over to 2017 Plan
Prepare a Community Wildfire Protection Plan.							✓	Short-Term	Completed; however, updated version will be required during next few years to remain current.	✓			
Obtain and install river gauges on the Tahuya River. (C-5)				✓		✓			Budgeting for this project has not been gained.				✓
Acquire and/or elevate flood-damaged structures, with special attention to repetitive loss properties. (low to medium cost/high benefit) (C-4)				✓		✓		Long-term	No action during 2010 life cycle. However will continue to address as grant funds become available.				✓
Landslide – Purdy Cutoff (C-3, 6)			✓		✓	✓		Short-Term	WSDOT has completed some work on the Purdy Bridge; however, additional work still needs to be completed. As such, the County will continue to work with DOT in an effort to further enhance the roadway and will carry the project forward into new plan.	✓			✓
Landslide – Northshore Road (C-3, 6)			✓		✓	✓		Short-Term	Still a viable project. No action completed. Carry forward into new plan.				✓
Flood – Skokomish Valley Road (Dips) (C-2)				✓	✓	✓		Long-Term	Funding is impacting the ability to complete this project; however, it is still a viable project and will be carried forward into new plan with the hopes of obtaining grant funding to complete the project.				✓

Table 13-6
2017 Status of 2010 Action Plan

	Associated Hazards									2017 Status			
Mitigation Strategy	Climate Change	Drought	Earthquake	Flood	Landslide	Severe Weather	Wildland Fire	2010 Timeline Short-Term <5 years; Long-Term >5 years; Ongoing	2017 Project Status	Completed	Continual /Ongoing Nature	Removed /No Longer Relevant	Carried Over to 2017 Plan
Participate in the National Flood Insurance Program's (NFIP) Community Rating System (CRS) (C-7)				✓				Ongoing	New flood maps have been created and utilized for this 2017 edition. Public outreach has been provided to identify the hazard areas at risk. The County will continue working with FEMA and the NFIP program. CRS is still a potential, and something that the County will continue to assess as staffing allows.	✓			✓
Flood – Satsop Cloquallum Road (C-2)				✓	✓	✓		On-Gong; Long-Term	The County has attempted to address this issue; however, reduction in staffing and budgets have impacted our ability to address this issue. We will continue to seek grant funding and working in partnership with other state agencies in an attempt to address the flooding issue along Cloquallum Road.				✓

13.9 ADDITIONAL MITIGATION ACTIVATES:

In addition to the projects identified above, additional efforts include:

- Twanoh Falls Improvement Project on SR 106, completed by Washington State DOT in 2014. The project replaced a culvert to improve creek flow, while also allowing for fish passage and reducing sediment build up. The larger culvert and raised highway allows water to flow freely, reducing flooding that had previously occurred along the roadway.[24]

[24] http://www.wsdot.wa.gov/Projects/SR106/TwanohFallsImprovements/

- Completed in 2009 by WSDOT, the Purdy Creek bridge project improved flood conveyance, lowering flood depths immediately upstream of Highway 101. (USACE Report, 2015.)
- The Green Diamond Resource Company has worked with The Trust for Public Lands to retire thousands of acres of timberland into conservation easements over the next several years. By 2020, it is anticipated that Green Diamond will have retired more than 1,700 units of potential residential development in this conservation process. All of the timberland is in the rural areas; some designated as Long Term Commercial Forest, but mostly zoned rural residential 5, 10 and 20. Rural residential districts are distinguished by the minimum number of acres required for each dwelling unit (e.g. rural residential 5 require a minimum of 5 acres per unit). The total number of units as estimated by Green Diamond to be just over 1,700 was the result of reviewing the build out potential by each zoning district. Calculating the potential population that would have occupied those residential units reduces growth in the rural areas by 4,369 people.[25] Reduction of this development will maintain open space to assist with reduced potential flooding due to runoff, and decrease potential landslide susceptibility.
- The Skokomish Watershed Action Team has completed a number of stewardship projects since completion of the last plan. Highlights include timber sale, the funds from which will be used to replace faulty road culverts and other restoration activities in the upper watershed. The group is also in the final stages of a feasibility study of three potential options for realigning the Skokomish Valley Road.
- Volunteers from the SWAT Committee have completed inspections on road culverts in need of replacement, establishing a list for proposed restoration projects which the Forest Service will incorporate into the Big Creek stewardship contract during the 2017 fall/winter.
- The Forest Service's Olympic Peninsula Resource Advisory Committee awarded $18,000 of Title II Secure Rural School funds for road maintenance in the South Fork Skokomish watershed.

13.10 FUNDING OPPORTUNITIES

Although a number of the mitigation projects listed may not be eligible for FEMA funding, Mason County and its planning partners may secure alternate funding sources to implement these projects in the future including federal and state grant programs, and funds made available through the county. In order to be eligible for some of those grant funds, completion of a hazard mitigation plan may be required. Table 13-7 identifies some of those grant requirements. Additional funding sources identified in Table 13-8 are also available which support various types of mitigation efforts on a countywide basis.

Grant funds for Mason County over the course of the last three years have included the Homeland Security Grant and the State Homeland Security Program grants funds. Those funds have paid for communications equipment and generators to support first responders and alternative EOCs.

In addition, as a result of the November 2015 wind-rain storms D16-628-4249 and December 2015 wind-rain storms D16-734-4253, Mason County Public Works has received Public Assistance Funding through FEMA for those disasters to reconstruct roadways, culverts, debris removal and emergency protective

[25] American Fact Finder, 2010-2014 American Community Survey 5 year Estimates, 2.57 average household size for Mason County in 2014. 1700 units x 2.57 persons = 4,369.

measures. The funding goes through January of 2020. To date, DR 4249 has provided $62,575.36 in funds to the County, while DR 4253 has provided $152,837 with some project not yet completed.

The USACE has provided funding and support with respect to the Skokomish Watershed Restoration. The project is currently in the Planning, Engineering, and Design phase, which will result in a bid package. The project includes details on the ground survey and soil investigation, along with final project design.

Alternate funding sources which may further support mitigation efforts of various types include, but are not limited to, the following:

- **U.S. Department of Housing and Urban Development, Community Development Block Grants (CDBG)—**The CDBG program is a flexible program that provides communities with resources to address a wide range of community development needs. CDBG money can be used to match FEMA grant money. More information: http://www.hud.gov/offices/cpd/communitydevelopment/programs/
- **U.S. Fish & Wildlife Service Rural Fire Assistance Grants—**Each year, the U.S. Fish & Wildlife Service provides Rural Fire Assistance grants to neighboring community fire departments to enhance local wildfire protection, purchase equipment, and train volunteer firefighters. U.S. Fish & Wildlife Service fire staff also assist directly with community projects. These efforts reduce the risk to human life and better permit U.S. Fish & Wildlife Service firefighters to interact and work with community fire organizations when fighting wildfires. The Department of the Interior receives a budget each year for the Rural Fire Assistance grant program. The maximum award per grant is $20,000. The assistance program targets rural and volunteer fire departments that routinely help fight fire on or near Department of Interior lands. More information: http://www.fws.gov/fire/ living_with_fire/rural_fire_assistance.shtml

Table 13-7
Grant Opportunities

Program	Enabling Legislation	Funding Authorization	Hazard Mitigation Plan Requirement	
			Grantee	Sub-Grantee
Public Assistance, Categories A-B (e.g., debris removal, emergency protective measures)	Stafford Act	Presidential Disaster Declaration	☐	☐
Public Assistance, Categories C-G (e.g., repair of damaged infrastructure, publicly owned buildings)	Stafford Act	Presidential Disaster Declaration	☑	☐
Individual Assistance (IA)	Stafford Act	Presidential Disaster Declaration	☐	☐
Fire Management Assistance Grants	Stafford Act	Fire Management Assistance Declaration	☑	☐
Hazard Mitigation Grant Program (HMGP) Planning Grant	Stafford Act	Presidential Disaster Declaration	☑	☐
HMGP Project Grant	Stafford Act	Presidential Disaster Declaration	☑	☑
Pre-Disaster Mitigation (PDM) Planning Grant	Stafford Act	Annual Appropriation	☐	☐
PDM Project Grant	Stafford Act	Annual Appropriation	☑	☑
Flood Mitigation Assistance (FMA)	National Flood Insurance Act	Annual Appropriation	☑	☑

Table 13-7
Grant Opportunities

Program	Enabling Legislation	Funding Authorization	Hazard Mitigation Plan Requirement: Grantee	Hazard Mitigation Plan Requirement: Sub-Grantee
Severe Repetitive Loss (SRL)	National Flood Insurance Act	Annual Appropriation	☑	☑
Repetitive Flood Claims (RFC)	National Flood Insurance Act	Annual Appropriation	☑	□
Homeland Security	Dept. of Homeland Security	Annual Appropriation	☑	□

☑ = Hazard Mitigation Plan Required
□ = No Hazard Mitigation Plan Required

Table 13-8
Countywide Fiscal Capabilities which support mitigation planning efforts

Financial Resources	Accessible or Eligible to Use?
Community Development Block Grants	Y
Capital Improvements Project Funding	Y
Authority to Levy Taxes for Specific Purposes	Y
User Fees for Water, Sewer, Gas or Electric Service	N
Incur Debt through General Obligation Bonds	Y
Incur Debt through Special Tax Bonds	Y
Incur Debt through Private Activity Bonds	Y
Withhold Public Expenditures in Hazard-Prone Areas	N
State Sponsored Grant Programs	Y
Development Impact Fees for Homebuyers or Developers	Y

- **U.S. Department of Homeland Security—**Enhances the ability of states, local and tribal jurisdictions, and other regional authorities in the preparation, prevention, and response to terrorist attacks and other disasters, by distributing grant funds. Localities can use grants for planning, equipment, training and exercise needs. These grants include, but are not limited to areas of critical infrastructure protection, equipment and training for first responders, and homeland security. More information: http://www.dhs.gov/
- **FEMA, Hazard Mitigation Grant Program (HMGP)—**The HMGP provides grants to states, Indian tribes, local governments, and private non-profit organizations to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. More information: http://www.fema.gov/ government/grant/hmgp/
- **FEMA, Pre-Disaster Mitigation (PDM) Competitive Grant Program—**The PDM program provides funds to states, territories, Indian tribal governments, communities, and universities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. Funding these plans and projects reduces overall risks to the population and structures, while also reducing reliance on funding from actual disaster declarations. PDM grants are to be awarded on a competitive basis and without reference to state allocations, quotas, or other formula-based allocation of funds. More information: http://www.fema.gov/government/grant/pdm/index.shtm
- **U.S. Bureau of Land Management (BLM), Community Assistance Program—**BLM provides funds to communities through assistance agreements to complete mitigation projects, education and planning within the wildland urban interface. More information: http://www.blm.gov/nifc/st/en/prog/fire/community_assistance.html
- **U.S. Department of Agriculture Community Facilities Loans and Grants—**Provides grants (and loans) to cities, counties, states and other public entities to improve community facilities for essential services to rural residents. Projects can include fire and rescue services. Funds have been provided to purchase fire-fighting equipment for rural areas. No match is required.
- **General Services Administration Sale of Federal Surplus Personal Property—**This program sells property no longer needed by the federal government. The program provides individuals, businesses and organizations the opportunity to enter competitive bids for purchase

of a wide variety of personal property and equipment. Normally, there are no restrictions on the property purchased. More information: http://www.gsa.gov/portal/category/21045

- **FEMA Readiness, Response and Recovery Directorate, Fire Management Assistance Grant Program—**Program provides grants to states, tribal governments and local governments for the mitigation, management and control of any fire burning on publicly (non-federal) or privately owned forest or grassland that threatens such destruction as would constitute a major disaster. The grants are made in the form of cost sharing with the federal share being 75 percent of total eligible costs. Grant approvals are made within 1 to 72 hours from time of request. More information: http://www.fema.gov/ government/grant/fmagp/index.shtm

- **Hazardous Materials Emergency Preparedness Grants—**Grant funds are passed through to local emergency management offices and Hazmat teams having functional and active local emergency planning committees. More information: http://www.phmsa.dot.gov/hazmat/grants

CHAPTER 14.
CAPABILITY ASSESSMENT

14.1 LAWS AND ORDINANCES

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

14.1.1 Federal

Disaster Mitigation Act

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

Endangered Species Act

The 1973 Endangered Species Act (ESA) was enacted 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. The ESA outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species. 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. 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 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."

The following are critical sections of the ESA:

- **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, 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.

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

With the listing of salmon and trout species as threatened or endangered, the Pacific Coast states have been impacted by mandates, programs and policies based on the presumed presence of listed species. Most West Coast jurisdictions must now take into account the impact of their programs on habitat.

Coastal Zone Management Act

All states with federally approved coastal programs delineate a coastal zone consistent with the general standards act set forth in the Coastal Zone Management Act of 1972 (CZMA). According to the CZMA, the coastal zone area should encompass all important coastal resources including transitional and intertidal areas, salt marshes, beaches, coastal waters, and adjacent shorelines where activities could have the potential to impact the coastal waters. Federal land is excluded from the state coastal zone by the CZMA. Washington State has established the Washington State Coastal Zone Management Program, which was approved by the federal government in 1976, making it the first to be approved, applying to 15 coastal counties which front on salt water.

The Clean Water Act

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

Evolution of CWA programs over the last decade has included a shift from a program-by-program, source-by-source, 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. A full array of issues are addressed, not just those subject to CWA regulatory authority. Involvement of stakeholder groups in the development and implementation of strategies for achieving and maintaining water quality and other environmental goals is a hallmark of this approach.

National Flood Insurance Program

The National Flood Insurance Program (NFIP) provides federally backed flood insurance in exchange for communities enacting floodplain regulations. Participation and good standing under NFIP are prerequisites to grant funding eligibility under the Robert T. Stafford Act. The County and its Cities and Towns participate in the NFIP and have adopted regulations that meet the NFIP requirements. At the time of the preparation of this 2015 edition, all participating jurisdictions in the partnership were in good standing with NFIP requirements. Also occurring at the time of this update was the expected delivery of updated flood maps, with an anticipated delivery of mid- to late-2015. Additional NFIP data can be found within the Flood Hazard Profile, and within each partners' annex document.

Presidential Disaster Declarations

Presidentially declared disasters are disaster events that cause more damage than state and local governments/resources can handle without federal assistance. A Presidential Major Disaster Declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, and designed to help disaster victims, businesses, and public entities. A Presidential Emergency Declaration can also be declared, but assistance is limited to specific emergency needs.

14.1.2 State-Level Planning Initiatives

Washington State Enhanced Mitigation Plan

The Washington State Enhanced Hazard Mitigation Plan approved by FEMA in 2013 provides guidance for hazard mitigation throughout Washington. The plan identifies hazard mitigation goals, objectives, actions and initiatives 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 versus 15 percent with a standard plan).

Growth Management Act

The 1990 Washington State Growth Management Act (Revised Code of Washington (RCW) Chapter 36.70A) mandates that local jurisdictions adopt land use ordinances which 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 (GMA) regulates development in these areas, and therefore has the potential to affect hazard vulnerability and exposure at the local level.

Coastal Zone Management Program

Washington State has established the Washington State Coastal Zone Management Program in conjunction with the federal Coastal Zone Management Act, which was approved by the federal government in 1976, making it the first to be approved, applying to 15 coastal counties which front on salt water.

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 the Pacific Ocean shoreline and the shorelines of Puget Sound, the Strait of Juan de Fuca, and rivers, streams and lakes above a certain size. It also regulates wetlands associated with these shorelines.

Wild and Scenic River

A federal designation that is intended to protect the natural character of rivers and their habitat without adversely affecting surrounding property.

Zero-Rise Floodway

A 'zero-rise' floodway is an area reserved to carry the discharge of a flood without raising the base flood elevation. Some communities have chosen to implement zero-rise floodways because they provide greater flood protection than the floodway described above, which allows a one foot rise in the base flood elevation.

Washington State Building Code

The Washington State Building Code Council adopted the 2015 editions of national model codes, with some amendments. The Council also adopted changes to the Washington State Energy Code and Ventilation and Indoor Air Quality Code. Washington's state-developed codes are mandatory statewide for residential and commercial buildings.

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 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

Washington State Floodplain Management Law

Washington's floodplain management law (RCW 86.16, implemented through 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 major challenge to the law in 1978, *Maple Leaf Investors v. Ecology,* is cited in legal references to floodplain 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.

Flood Control Assistance Account Program

Washington's first flood control maintenance program was passed in 1951, and was called the Flood Control Maintenance Program (FCMP). In 1984, RCW 86.26 (State Participation in Flood Control Maintenance) established the Flood Control Assistance Account Program (FCAAP), which provides funding for local flood hazard management. FCAAP rules are found in WAC 173-145. Ecology distributes FCAAP matching grants to cities, counties and other special districts responsible for flood control. This is one of the few state programs in the U.S. that provides grant funding to local governments for floodplain management. The program has been funded for $4 million per Biennium since its establishment, with additional amounts provided after severe flooding events.

To be eligible for FCAAP assistance, flood hazard management activities must be approved by Ecology in consultation with the Washington Department of Fish and Wildlife (WDFW). A comprehensive flood hazard management plan must have been completed and adopted by the appropriate local authority or be in the process of being prepared in order to receive FCAAP flood damage reduction project funds. This policy evolved through years of the FCMP and early years of FCAAP in response to the observation that poor management in one part of a watershed may cause flooding problems in another part.

Local jurisdictions must participate in the NFIP and be a member in good standing to qualify for an FCAAP grant. Grants up to 75 percent of total project cost are available for comprehensive flood hazard management planning. Flood damage reduction projects can receive grants up to 50 percent of total project cost, and must be consistent with the comprehensive flood hazard management plan. Emergency grants are available to respond to unusual flood conditions. FCAAP can also be used for the purchase of flood prone properties, for limited flood mapping and for flood warning systems.

14.1.3 Local Programs

Each planning partner has prepared a jurisdiction-specific annex to this plan contained in Volume 2, which identifies its regulatory, technical and financial capability to carry out proactive mitigation efforts. Additional jurisdiction-specific information is available for review within each of those annexes. The following sections present additional regulatory information that applies to the planning partnership.

Puget Sound Regional Catastrophic Disaster Coordination Plan

The Regional Catastrophic Planning Team was formed to guide and manage the Puget Sound Regional Catastrophic Preparedness Grant Program funded by FEMA. Supporting the coordination of regional all-hazard planning for catastrophic events that may impact the region, the effort includes the development of integrated planning communities, plans, protocols, and procedures to manage a catastrophic event. The Regional Catastrophic Planning Team consists of representatives from designated emergency management interests across an eight-county area (see Figure 14-1), including Mason County.

Figure 14-1 Counties in Puget Sound Regional Catastrophic Planning Region

Comprehensive Land Use Plans

Comprehensive plans are long-range in nature and serve as policy guides for how a jurisdiction plans to manage growth and development with respect to the natural environment and available resources. Washington State law (36.70A.040 RCW) requires that jurisdictions operating under the Growth

Management Act develop comprehensive plans and development regulations that are consistent with the comprehensive plans and implement them (36.70A RCW).

The GMA requires that comprehensive plans consist of the following elements: land use, housing, capital facilities, utilities, rural (for counties), transportation, economic development, and park and recreation (RCW 36.70A.070). A comprehensive plan may also include additional optional elements that relate to physical development, such as conservation, historic preservation, and subarea plans (RCW 36.70A.080).

Mason County's last completed major update to its Comprehensive Land Use Plan as required under the GMA was made in 2005. In response to new county policies and state requirements, the County is currently in the process of updates to the existing plan. Since the original plan was written, amendments to various elements of the comprehensive plan have been made on an almost-annual basis as allowed by law (RCW 36.70A.130(2)(a)). The GMA requires that jurisdictions periodically review their comprehensive plans and implement development regulations in their entirety and revise them if needed. Mason County is required to have this review and revision completed every eight years thereafter (RCW 36.70A.130(5)(b)). Opportunities for public participation in this process will be provided (see RCW 36.70A.035).

14.2 MITIGATION-RELATED REGULATORY AUTHORITY

Hazard mitigation builds on a community's existing capabilities in place, including financial, regulatory, programmatic and planning capabilities. The County's capabilities to implement mitigation projects include community planners, engineers, floodplain managers, GIS personnel, emergency managers, and financial, legal and regulatory requirements (zoning, building codes, subdivision regulations, and floodplain management ordinances). These resources have the responsibility to provide overview of past, current, and ongoing pre- and post-disaster mitigation planning projects, including capital improvement programs, wildfire mitigation programs, stormwater management programs, and NFIP compliance projects. The following information and tables identify the County's capabilities with respect to (mitigation) efforts of varying types. Each planning partner also completed the same tables within their respective Annex documents.

Regulatory, Technical, Community Organizations, Programs and Social Systems

Regulatory capabilities currently available are summarized in Table 14-1. In addition to the financial and regulatory capabilities summarized in Table 14-2, there are other programs available, some of which provide incentives for citizens. Such programs further enhance resiliency throughout the County. Two such programs include the National Flood Insurance Program, and the Community Rating System, both of which are discussed in detail in Chapter 8 – Flood.

Social systems can be defined as community organizations and programs that provide social and community-based services, such as health care or housing assistance, to the public. In planning for natural hazard mitigation, it is important to know what social systems exist within the community because of their existing connections to the public.

Table 14-1
Mason County Legal and Regulatory Capability

	Local Authority	Other Jurisdictional Authority	State Mandated	Comments
Codes, Ordinances & Requirements				
Building Code Version Year	Yes	Yes	Yes	2015 International Building Code as required by the State
Zoning Ordinance	Yes		Yes	MCC Title 17
Subdivision Ordinance	Yes		Yes	MCC Title 16
Floodplain Ordinance	Yes	Yes	Yes	FEMA Requirements
Stormwater Management	Yes			MCC Resource Ordinance
Post Disaster Recovery	No			
Real Estate Disclosure	No	No	Yes	
Growth Management	Yes		Yes	2016 Comprehensive Plan Update underway
Site Plan Review	Yes			
Public Health and Safety	Yes	Yes	Yes	
Coastal Zone Management	Yes	Yes	Yes	
Climate Change Adaptation	Yes			Some plans have begun to address this issue.
Shoreline Master Program	Yes			Adopted RCW 90.58
Natural Hazard Specific Ordinance (stormwater, steep slope, wildfire, etc.)	Yes		Yes	Mason County Resource Ordinance
Environmental Protection	Yes	Yes	Yes	
Planning Documents				
General or Comprehensive Plan	Yes		Yes	
Is the plan equipped to provide linkage to this mitigation plan? Yes				
Floodplain or Basin Plan	Yes			(See below)
Stormwater Plan	Yes			Various plans are in place such as: the Skokomish River Comprehensive Flood Hazard Management Plan; the Belfair Stormwater Basin Plan, the Allyn Urban Growth Area Plan which manages stormwater; the Hoodsport Rural Activity Center Stormwater Plan, and the Countywide Comprehensive Stormwater Management Plan.
Capital Improvement Plan	Yes		Yes	
Habitat Conservation Plan	No			Critical Areas Ordinance and Shoreline Master Plan only.
Economic Development Plan	Yes		Yes	

Table 14-1
Mason County Legal and Regulatory Capability

	Local Authority	Other Jurisdictional Authority	State Mandated	Comments
Shoreline Management Plan	Yes		Yes	Mason County Code, Section 17.50
Community Wildfire Protection Plan	Yes		No	
Belfair Urban Growth Area Sub-Area Plan	Yes			Establishes the vision for an enhanced, multi-dimensional community with mixed-use development in identified areas.
Shelton Urban Growth Area Sub-Area Plan	Yes			Establishes guiding goals and policies for future development within Shelton UGA.
Transportation Plan	Yes		Yes	
Response/Recovery Planning				
Comprehensive Emergency Management Plan	Yes		Yes	
Threat and Hazard Identification and Risk Assessment	Yes		No	Homeland Security Region 3 Plan
Terrorism Plan	Yes			
Post-Disaster Recovery Plan	No			Nothing beyond ESF14
Continuity of Operations Plan	Draft			In-progress
Public Health Plans	Yes			Various public health plans are in place both through the Health Department and through the hospital districts.
Administration, Boards and Commission				
Planning Commission	Yes		Yes	
Mitigation Planning Committee	Yes			
Maintenance programs to reduce risk (e.g., tree trimming, clearing drainage systems, chipping, etc.)	Yes			Various programs in place, including tree trimming, drainage systems, etc.
Mutual Aid Agreements / Memorandums of Understanding				MOAs: Area Agency on Aging – Area Agency provides information concerning high priority clients to enable (when possible) emergency management to assist with health and welfare checks for individuals with access and functional needs; Mason Transit – preparedness and disaster response including the potential for assistance in evacuating individuals with access and functional needs; DOC – Mission Creek Center for Women (for evacuation purposes to ensure protection and continuity).

Table 14-2
Administrative and Technical Capability

Staff/Personnel Resources	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Y	Planning Unit, Emergency Management
Professionals trained in building or infrastructure construction practices (building officials, fire inspectors, etc.)	Y	Planning Unit
Engineers specializing in construction practices?	Y	Planning Unit
Planners or engineers with an understanding of natural hazards	Y	Planning Unit
Staff with training in benefit/cost analysis	Y	Planning Unit
Surveyors	Y	Public Works
Personnel skilled or trained in GIS applications	Y	Planning Unit
Personnel skilled or trained in Hazus use	Y	Contracted Service
Scientist familiar with natural hazards in local area	Y	The county has hazard-specific subject matter experts on staff in various departments, available via contracting mechanisms, and available through state resources.
Emergency Manager	Y	Emergency Management Division with trained personnel and volunteers.
Grant writers	Y	Planning Unit; Various County departments have internal personnel who write grants; county staff to monitor and write grants.
Warning Systems/Services (Reverse 9-1-1, outdoor warning signs or signals, flood or fire warning program, etc.?)	Y	Alert Sense (no reverse 9-1-1); Public Works signage available as needed.
Hazard data and information available to public	Y	Planning Unit
Maintain Elevation Certificates	Y	Through Planning Department.

Often, actions identified by the plan involve communicating with the public or specific subgroups within the population (e.g. elderly, children, low income). The County and its planning partners can use existing social systems as resources for implementing such communication-related activities because these service providers already work directly with the public on a number of issues, one of which could be natural hazard preparedness and mitigation.

The following highlights organizations and programs that are active within Mason County, which may be potential partners for implementing mitigation actions. The various tables include information on each organization or program's service area, types of services offered, populations served, and how the organization or program could be involved in natural hazard mitigation. The three involvement methods are defined below.

- Education and outreach – organization could partner with the community to educate the public or provide outreach assistance on natural hazard preparedness and mitigation.

- Information dissemination – organization could partner with the community to provide hazard-related information to target audiences.
- Plan/project implementation – organization may have plans and/or policies that may be used to implement mitigation activities or the organization could serve as the coordinating or partner organization to implement mitigation actions. Table 14-1 through Table 14-3 identify several of the ongoing efforts which assist in notification and social service programs, further enhancing the resilience of the County.

Table 14-3
Education and Outreach

Program/Organization	Available?	Department/Agency/Position and Brief Description
Local citizen groups or non-profit organizations focused on emergency preparedness?	Y	CERT and SAR trained personnel
Local citizen groups or non-profit organizations focused on environmental protection?	Y	Mason Conservation District
Organization focused on individuals with access and functional needs populations	Y	Voluntary Special Needs Registry in which Mason County residents can self-register if they have special medical needs (e.g. require oxygen or life support systems, have physical disabilities that would make independent evacuation difficult).
Ongoing public education or information program (e.g., responsible water use, fire safety, household preparedness, environmental education)	Y	Various agencies at the county and state levels which promote educational efforts such as Firewise, Forestland-Urban Interface Fire Protection Act, and Fire Adapted Communities from the National Cohesive Wildfire Strategy.
Natural disaster or safety related school programs?	Y	Pursuant to the RCW, schools are required to develop and exercise hazard-specific response plans.
Public-private partnership initiatives addressing disaster-related issues?	Y	Various public education outreach; provide information and presentations; NFIP insurance; outreach for Continuity Planning.
Multi-seasonal public awareness program?	Y	The County maintains information on its website to address specific hazards at issue; also, as situations arise, the website, email lists and local area broadcasting provides public service announcements and information.

14.3 WASHINGTON STATE RATING BUREAU LEVELS OF SERVICE

In Washington, the Washington State Rating Bureau (WSRB) helps determine standards on which insurance rates are set. WSRB, like most other states, utilizes the Insurance Service Office, Inc. (ISO) to determine levels of protection based on a prescribed level of service. Two such levels of services assessed are the Public Protection Classification Program and the Building Code Effectiveness Grading Schedule.

14.3.1 Public Protection Classification Program

The Public Protection Classification (PPC) program recognizes the efforts of communities to provide fire protection services for citizens and property owners. A community's investment in fire mitigation is a proven and reliable predicator of future fire losses. Insurance companies use PPC information to help establish fair premiums for fire insurance — generally offering lower premiums in communities with better protection. By offering economic benefits for communities that invest in their firefighting services, the program provides an additional incentive for improving and maintaining public fire protection.

In order to establish appropriate fire insurance premiums for residential and commercial properties, insurance companies utilize up-to-date information about the Community's fire-protection services. Through analysis of relevant data, communities are able to evaluate their public fire-protection services, and secure lower fire insurance premiums for communities with better protection. This program provides incentives and rewards in those areas with improved firefighting services. This program has gathered extensive information on more than 46,000 fire-response jurisdictions. Once all of the data is reviewed and analyzed, communities are assigned a PPC from 1 to 10. Class 1 generally represents superior property fire protection, while Class 10 indicates that the area's fire-suppression program is not as robust.

The most significant benefit of the PPC program is its effect on losses. Statistical data on insurance losses bears out the relationship between excellent fire protection — as measured by the PPC program — and low fire losses. PPC helps communities prepare to fight fires effectively. The program also provides help for fire departments and other public officials as they plan, budget for, and justify improvements.

Table 14-4 identifies Public Protection Classifications for Mason County and the City of Shelton.

Table 14-4
Countywide Public Protection Classification

Community	Protection Class Grade
Shelton, City of *	5
Fire District #1	6
Fire District #2**	5
Fire District #3	7
Fire District #4	7
Fire District #5*	6
Fire District #6	5
Fire District #8**	7
Fire District #9	6
Fire District #11	6
Fire District #12	8
Fire District #13	7
Fire District #16	7
Fire District #17	7
Fire District #18	8

*City of Shelton Fire Dept. and FD #5 merged and are now *Central Mason Fire & EMS*
**Fire District 2 and Fire District 8 combined into a regional fire authority, now called *North Mason Regional Fire Authority*.
Data effective as of June 2017

14.3.2 Building Code Effectiveness Grading Schedule

The Building Code Effectiveness Grading Schedule (BCEGS) assesses building codes and amendments adopted in a community and evaluates that community's commitment to enforce them. The concept is simple: Municipalities with well-enforced, up-to-date codes should demonstrate better loss experience, and insurance rates can reflect that. The prospect of reducing damage and ultimately lowering insurance costs provides an incentive for communities to enforce their building codes rigorously. Table 14-5 identifies the BCEGS for the planning partnership.

Table 14-5
Building Code Effectiveness Grading

Community	Commercial	Dwelling
Mason County	3	3
City of Shelton	2	2

Data effective as of June 2017

14.3.3 Public Safety Programs

Access and Functional Needs

One of the most important roles of local government is to protect their citizens from harm, including helping people prepare for and respond to emergencies. Making local government emergency preparedness and response programs accessible to people with special needs is a critical part of this responsibility.

Mason County Division of Emergency Management (DEM) has the mission to assess and plan for hazards and emergencies and work with other public safety and local government agencies to ensure public welfare. In an effort to provide services to all individuals county-wide, the County has developed a Special Needs Registry, which helps support individuals with access and functional needs. As a pre-planning tool, the Special Needs Registry should be considered strongly for all people who have special medical needs (i.e. oxygen or life support systems that are dependent upon electrical power) or have physical disabilities that would make it difficult to evacuate independently if the need arose. More information on the program is available at: http://www.co.mason.wa.us/forms/dem/special_needs_planning.pdf

Mason County Fire Districts

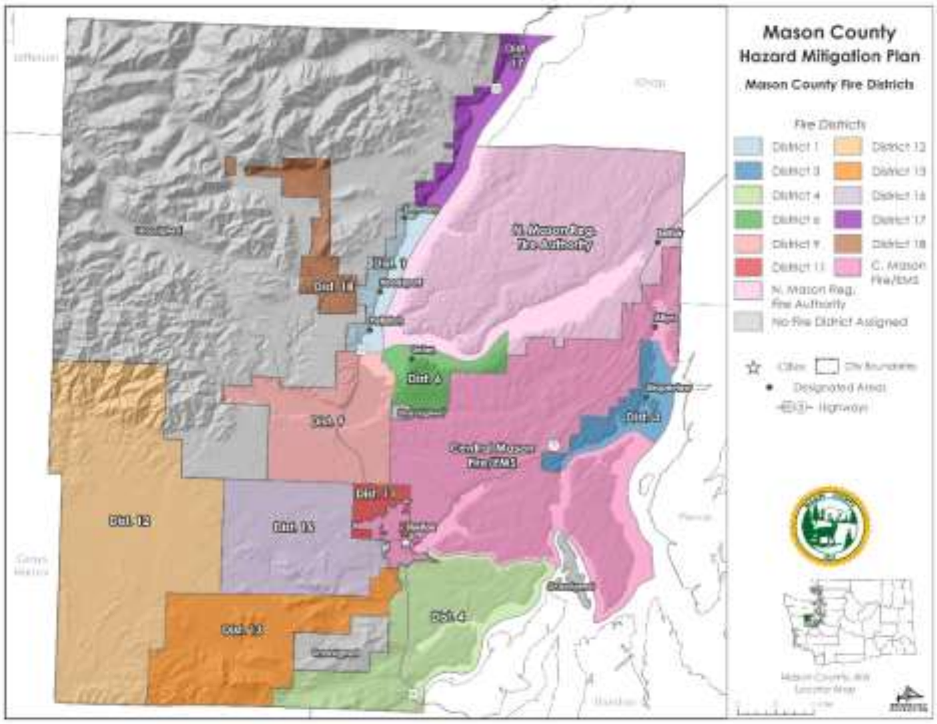


Figure 14-2 Mason County Fire Districts, Departments, and Regional Fire Authority

Mason County has a total of 13 fire districts serving its citizens. Within these fire districts, there are over 50 fire stations and structures owned by the various fire districts which protect the county during emergency situations. Fire prevention in Mason County is mainly focused on rural and wildland areas and is done through a Firewise community program in coordination with the WA DNR and the USFS.

The purpose of Mason County Fire Districts is the provision of fire prevention services, fire suppression services, emergency medical services, and for the protection of life and property. Mason County Fire Districts enjoy a working relationship with Mason County Government through an Interlocal Agreement addressing fire investigations. The Mason County Fire Chiefs Association, (in partnership with local law enforcement agencies) provides fire investigation services on behalf of the Mason County Fire Marshal's Office. Mason County Department of Community Development is authority for inspections of all building sites prior to permit issuance, to include burn permits. Where there is limited or improper access to building(s), the Mason County fire protection plan calls for mandatory residential sprinkler system.

Mason County StormReady County

Mason County is also a recognized StormReady County under the National Weather Service Program (see Figure 14-3). Achieving such status requires a significant level of effort. Being part of a Weather Ready Nation is about preparing for your community's increasing vulnerability to extreme weather and water events. The StormReady program helps arm America's communities with the communication and safety skills needed to save lives and property--before, during and after the event. StormReady helps community leaders and emergency managers strengthen local safety programs.

Mason County
Division of Emergency Management (DEM)
100 W. Public Works Drive
Shelton, WA 98584

FOR IMMEDIATE RELEASE:

Mason County recognized as a *StormReady* county by the National Weather Service

Shelton, Washington – July 6, 2016 – The Mason County Division of Emergency Management (DEM) manages the hazardous weather preparedness program as part of the county's all-hazards preparedness program. In recognition of our efforts the National Weather Service has renewed Mason County's *StormReady* designation for the period 2016 to 2019.

StormReady is a voluntary program that provides guidance and incentive to officials interested in improving their hazardous weather operations. Once recognized as a *StormReady* community, residents, business owners and visitors know the county is committed to safety and preparedness. The citizens of Mason County should take great pride and comfort in having been awarded this designation.

For more information on the National Weather Service *StormReady* program visit the NWS website at http://www.nws.noaa.gov/stormready/. For information on the next Skywarn Weather Spotter training class contact the county Division of Emergency Management (DEM) at 360-427-7535 or e-mail: MCDEM@co.mason.wa.us

Contact:
Henry Cervantes
henryc@co.mason.wa.us
Mason County Division of Emergency Management (DEM)
100 W. Public Works Drive, Shelton, WA 98584
360-427-9670 ext 801

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Figure 14-3 Storm Ready Press Release

CHAPTER 15.
PLAN MAINTENANCE STRATEGY

In accordance with 44 CFR 201.6(c)(4), a hazard mitigation plan must present a plan maintenance process that includes the following:

- A section describing the method and schedule of monitoring, evaluating and updating the mitigation plan over its five year life-cycle
- A process by which local governments incorporate the requirements of mitigation plans into other planning mechanisms, such as comprehensive land use plans (as appropriate)
- A discussion on how the community will continue to engage public participation in mitigation planning `efforts.

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

The Mason County Emergency Management Coordinator will maintain lead responsibility for overseeing the plan implementation and maintenance strategy. Plan implementation and evaluation will be a shared responsibility among all planning partnership members and agencies identified as lead agencies in the mitigation action plans (see planning partner annexes in Volume 2 of this plan).

15.1 MONITORING, EVALUATION AND UPDATING THE PLAN

15.1.1 Progress Report - 2010 Plan Status

The 2010 Hazard Mitigation Plan identified a maintenance strategy which included regular reviews during the life cycle of the plan; however, due to lack of staffing and transition of emergency management personnel, the plan was not reviewed as originally intended. While the plan review did not occur as intended, the County and its planning partners were effective in completing several of the strategies and action items identified in the plan. Lists of the historic action items are provided within each jurisdiction's annex. The status of countywide mitigation projects is shown in Table 13-6. Significant projects completed since 2010 include the following:

- Public Education—The County and its planning partners have been very active in this area. Regular (almost monthly) outreach sessions have occurred where risk and updated hazard specific data are discussed.
- Flood Reduction - During the spring of 2015, the County, along with the Skokomish Tribe, were involved in an Environmental Impact Study conducted by the US Army Corps of Engineers. The study related to, among other things, the repeated flooding issue and

degradation of fish spawning grounds along the Skokomish River. This degradation has led to accretion of sediment along the river, causing a rise in water levels, increasing the impact of flooding in the area. The study included several mitigation projects which may be completed during the life cycle of this 2018 plan. These are joint efforts involving federal, state, county and Tribal entities.

- Community Emergency Response Team (CERT) Training—The County and its planning partners have continued to provide CERT training throughout the area, with the CERT team now reaching well in excess of 100 trained individuals who will be able to provide safe and effective assistance to their communities after a disaster incident occurs.
- Search and Rescue Teams – The County has a robust Search and Rescue Team which assists in locating citizens statewide. Members train regularly to assist wherever needed. The team is experienced in water rescues, steep terrain/ rappelling, and mountain rescues, among others.
- Fuels Plan—The County has worked with local fuel providers and is in the process of developing memorandums of understanding with service providers to ensure an adequate supply and availability of fuel is available throughout the County should a regional event occur. This will help ensure fuel availability for generators, as well as vehicles needed for response and recovery efforts.
- Transportation Issues—The County, through the Regional Catastrophic Preparedness Grant Program, in conjunction with eight other Washington counties, developed a transportation plan addressing accessibility to areas of the county with limited access. Involvement in the Catastrophic Planning Group required an extensive level of commitment on the part of the County, and involvement in this capacity has increased the resilience of the planning area by developing plans to support recovery and response activities.
- Flood Hazard **-** Enhance county roads and drainage projects—The Mason County Public Works Department has completed several upgrades to enhance county roads and drainage issues, and continues to work with citizens throughout the county to help ensure safety. Public works also work with homeowners to provide information concerning proper drainage to reduce slides resulting from hydrologic issues associated with high water tables and large amounts of water traveling through the ground, causing and exacerbating slides in the area.
- Landslide Hazard – Working with Washington State Department of Transportation, several roadways throughout the County have been shored up with bank stabilization to help reduce the potential for landslides, allowing for evacuation in areas previously impacted by slides which occurred as a result of heavy rains.

15.1.2 Plan Implementation and Maintenance

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

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

- A presidential disaster declaration that impacts the planning area.

- A hazard event that causes loss of life.
- A comprehensive update of the County or participating city/town's comprehensive plan.

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

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

The hazard mitigation plan will be reviewed annually and a progress report prepared. These reviews may be more or less frequent, as deemed necessary by the Emergency Management Director, but there will be a minimum of one review per year. The minimum task of each planning partner will be the evaluation of the progress of its individual action plan during a 12-month performance period. This review will include the following:

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

A template to guide the planning partners in preparing a progress report has been created as part of this planning process (see Appendix D). The Emergency Management Coordinator will then prepare a formal annual report on the progress of the plan. This report should be used as follows:

- Posted on the Mason County website page dedicated to the hazard mitigation plan.
- Provided to the local media through a press release.
- Presented to planning partner governing bodies to inform them of the progress of actions implemented during the reporting period.

Use of the progress report will be at the discretion of each planning partner. Annual progress reporting is not a requirement specified under 44 CFR. However, it may enhance the planning partnership's opportunities for funding. While failure to implement this component of the plan maintenance strategy will not jeopardize a planning partner's compliance under the DMA, completion of the annual review will reduce the level of effort involved in future plan updates, and is highly encouraged by FEMA.

In addition to the annual review, three years after adoption of the hazard mitigation plan, the Director may decide to apply for a planning grant through FEMA to start the 2022 update. Upon receipt of funding, the County will solicit bids under applicable contracting procedures and hire a contractor to assist with the project. The proposed schedule for completion of the plan update is one year from award of a contract, to coincide with the five-year adoption date of the 2017 hazard mitigation plan update.

The Director will be responsible for the plan update. Before the end of the five-year period, the updated plan will be submitted to FEMA for approval. When concurrence is received that the updated plan complies with FEMA requirements, it will be submitted to the Board of County Commissioners, the City of Shelton Council, and the Special Purpose District Commissioners for adoption. The County will send an e-mail to individuals and organizations on the stakeholder list to inform them that the updated plan is available on the County website.

15.2 IMPLEMENTATION THROUGH EXISTING PROGRAMS

Mason County will have the opportunity to implement hazard mitigation projects through existing programs and procedures through plan revisions or amendments. The hazard mitigation plan will be incorporated into the plans, regulations and ordinances as they are updated in the future or when new plans are developed.

The County's Comprehensive Plan and the comprehensive plans of the planning partners are considered to be integral parts of this plan. The County and the City of Shelton, through adoption of comprehensive plans and zoning ordinances, have planned for the impact of natural hazards. The plan development process provided the County and the City with the opportunity to review and expand on policies contained within these planning mechanisms. The planning partners used their comprehensive plans and the hazard mitigation plan as complementary documents that work together to achieve the goal of reducing risk exposure to the citizens of the Mason County. An update to a comprehensive plan may trigger an update to the hazard mitigation plan.

All planning partners are committed to creating a linkage between the hazard mitigation plan and their individual comprehensive and other plans by identifying a mitigation initiative to do so and giving that initiative a high priority. Other planning processes and programs to be coordinated with the recommendations of the hazard mitigation plan include the following:

- Partners' emergency response plans
- Capital improvement programs
- Municipal codes
- Building codes
- Critical areas regulation
- Growth management
- Water resource inventory area planning
- Basin planning
- Community design guidelines
- Water-efficient landscape design guidelines

- Stormwater management programs
- Water system vulnerability assessments
- Master fire protection plans
- Coastal Zone Atlas information
- Landslide reports and planning
- Evacuation planning
- Transportation planning

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

15.3 CONTINUED PUBLIC INVOLVEMENT

Mason County is dedicated to involving the public directly in review and updates of the hazard mitigation plan. The public will continue to be apprised of the plan’s progress through the Mason County website and the annual progress reports that will be provided to the media. All planning partners have agreed to provide links to the County hazard mitigation plan website on their websites to increase avenues of public access to the plan. The Mason County Division of Emergency Management has agreed to maintain the hazard mitigation plan website. This site will not only house the final plan, it will become the one-stop shop for information regarding the plan, the partnership and plan implementation. Upon initiation of future update processes, a new public involvement strategy will be initiated. This strategy will be based on the needs and capabilities of the planning partnership at the time of the update. At a minimum, this strategy will include the use of social media and local media outlets within the planning area.

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APPENDIX A
ACRONYMS AND DEFINITIONS

APPENDIX A
ACRONYMS AND DEFINITIONS

ACRONYMS

ASHRAE—American Society of Heating, Refrigerating, and Air-Conditioning Engineers
BOR—U.S. Bureau of Reclamation
CFR—Code of Federal Regulations
cfs—cubic feet per second
CIP—Capital Improvement Plan
CRS—Community Rating System
DFIRM—Digital Flood Insurance Rate Maps
DHS—Department of Homeland Security
DMA —Disaster Mitigation Act
DSO—Dam Safety Office
EAP—Emergency Action Plan
EPA—U.S. Environmental Protection Agency
ESA—Endangered Species Act
FCAAP—Flood Control Assistance Account Program
FCMP—Flood Control Maintenance Program
FEMA—Federal Emergency Management Agency
FERC—Federal Energy Regulatory Commission
FIRM—Flood Insurance Rate Map
FIS—Flood Insurance Study
GIS—Geographic Information System
GMA—Growth Management Act
Hazus-MH—Hazards, United States-Multi Hazard
HMGP—Hazard Mitigation Grant Program
IBC—International Building Code
IRC—International Residential Code
MM—Modified Mercalli Scale
NEHRP—National Earthquake Hazards Reduction Program
NFIP—National Flood Insurance Program
NFPA—National Fire Protection Association
NFR—Natural fire rotation
NOAA—National Oceanic and Atmospheric Administration
NWS—National Weather Service
PDM—Pre-Disaster Mitigation Grant Program
PDI—Palmer Drought Index
PGA—Peak Ground Acceleration
PHDI—Palmer Hydrological Drought Index
RCW—Revised Code of Washington
SCS—U.S. Department of Agriculture Soil Conservation Service
SFHA—Special Flood Hazard Area
SHELDUS—Special Hazard Events and Losses Database for the US
SPI—Standardized Precipitation Index
USGS—U.S. Geological Survey

WAC—Washington Administrative Code
WDFW—Washington Department of Fish and Wildlife
WUI— Wildland Urban Interface

DEFINITIONS

100-Year Flood: The term "100-year flood" can be misleading. The 100-year flood does not necessarily occur once every 100 years. Rather, it is the flood that has a 1 percent chance of being equaled or exceeded in any given year. Thus, the 100-year flood could occur more than once in a relatively short period of time. The Federal Emergency Management Agency (FEMA) defines it as the 1 percent annual chance flood, which is now the standard definition used by most federal and state agencies and by the National Flood Insurance Program (NFIP).

Acre-Foot: An acre-foot is the amount of water it takes to cover 1 acre to a depth of 1 foot. This measure is used to describe the quantity of storage in a water reservoir. An acre-foot is a unit of volume. One acre foot equals 7,758 barrels; 325,829 gallons; or 43,560 cubic feet. An average household of four will use approximately 1 acre-foot of water per year.

Asset: An asset is any constructed or natural feature that has value, including, but not limited to, people; buildings; infrastructure, such as bridges, roads, sewers, and water systems; lifelines, such as electricity and communication resources; and environmental, cultural, or recreational features such as parks, wetlands, and landmarks.

Base Flood: The flood having a 1% chance of being equaled or exceeded in any given year, also known as the "100-year" or "1% chance" flood. The base flood is a statistical concept used to ensure that all properties subject to the National Flood Insurance Program (NFIP) are protected to the same degree against flooding.

Basin: A basin is the area within which all surface water—whether from rainfall, snowmelt, springs, or other sources—flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains, and ridges. Basins are also referred to as "watersheds" and "drainage basins."

Benefit: A benefit is a net project outcome and is usually defined in monetary terms. Benefits may include direct and indirect effects. For the purposes of benefit-cost analysis of proposed mitigation measures, benefits are limited to specific, measurable, risk reduction factors, including reduction in expected property losses (buildings, contents, and functions) and protection of human life.

Benefit/Cost Analysis: A benefit/cost analysis is a systematic, quantitative method of comparing projected benefits to projected costs of a project or policy. It is used as a measure of cost effectiveness.

Building: A building is defined as a structure that is walled and roofed, principally aboveground, and permanently fixed to a site. The term includes manufactured homes on permanent foundations on which the wheels and axles carry no weight.

Capability Assessment: A capability assessment provides a description and analysis of a community's current capacity to address threats associated with hazards. The assessment includes two components: an inventory of an agency's mission, programs, and policies, and an analysis of its capacity to carry them out. A capability assessment is an integral part of the planning process in which a community's actions to reduce losses are identified, reviewed, and analyzed, and the framework for implementation is identified. The following capabilities were reviewed under this assessment:

- Legal and regulatory capability
- Administrative and technical capability
- Fiscal capability

Community Rating System (CRS): The CRS is a voluntary program under the NFIP that rewards participating communities (provides incentives) for exceeding the minimum requirements of the NFIP and completing activities that reduce flood hazard risk by providing flood insurance premium discounts.

Critical Area: An area defined by state or local regulations as deserving special protection because of unique natural features or its value as habitat for a wide range of species of flora and fauna. A sensitive/critical area is usually subject to more restrictive development regulations.

Critical Facility: Facilities and infrastructure that are critical to the health and welfare of the population. These become especially important after any hazard event occurs. For the purposes of this plan, critical facilities include:

- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic and/or water reactive materials;
- Hospitals, nursing homes, and housing likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a hazard event.
- Police stations, fire stations, vehicle and equipment storage facilities, and emergency operations centers that are needed for disaster response before, during, and after hazard events, and
- Public and private utilities, facilities and infrastructure that are vital to maintaining or restoring normal services to areas damaged by hazard events.
- Government facilities.

Cubic Feet per Second (cfs): Discharge or river flow is commonly measured in cfs. One cubic foot is about 7.5 gallons of liquid.

Dam: Any artificial barrier or controlling mechanism that can or does impound 10 acre-feet or more of water.

Dam Failure: Dam failure refers to a partial or complete breach in a dam (or levee) that impacts its integrity. Dam failures occur for a number of reasons, such as flash flooding, inadequate spillway size, mechanical failure of valves or other equipment, freezing and thawing cycles, earthquakes, and intentional destruction.

Debris Avalanche: Volcanoes are prone to debris and mountain rock avalanches that can approach speeds of 100 mph.

Debris Flow: Dense mixtures of water-saturated debris that move down-valley; looking and behaving much like flowing concrete. They form when loose masses of unconsolidated material are saturated, become unstable, and move down slope. The source of water varies but includes rainfall, melting snow or ice, and glacial outburst floods.

Debris Slide: Debris slides consist of unconsolidated rock or soil that has moved rapidly down slope. They occur on slopes greater than 65 percent.

Disaster Mitigation Act of 2000 (DMA); The DMA is Public Law 106-390 and is the latest federal legislation enacted to encourage and promote proactive, pre-disaster planning as a condition of receiving financial assistance under the Robert T. Stafford Act. The DMA emphasizes planning for disasters before they occur. Under the DMA, a pre-disaster hazard mitigation program and new requirements for the national post-disaster hazard mitigation grant program (HMGP) were established.

Drainage Basin: A basin is the area within which all surface water- whether from rainfall, snowmelt, springs or other sources- flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains and ridges. Drainage basins are also referred to as **watersheds** or **basins**.

Drought: Drought is a period of time without substantial rainfall or snowfall from one year to the next. Drought can also be defined as the cumulative impacts of several dry years or a deficiency of precipitation over an extended period of time, which in turn results in water shortages for some activity, group, or environmental function. A hydrological drought is caused by deficiencies in surface and subsurface water supplies. A socioeconomic drought impacts the health, well-being, and quality of life or starts to have an adverse impact on a region. Drought is a normal, recurrent feature of climate and occurs almost everywhere.

Earthquake: An earthquake is defined as a sudden slip on a fault, volcanic or magmatic activity, and sudden stress changes in the earth that result in ground shaking and radiated seismic energy. Earthquakes can last from a few seconds to over 5 minutes, and have been known to occur as a series of tremors over a period of several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties may result from falling objects and debris as shocks shake, damage, or demolish buildings and other structures.

Exposure: Exposure is defined as the number and dollar value of assets considered to be at risk during the occurrence of a specific hazard.

Extent: The extent is the size of an area affected by a hazard.

Fire Behavior: Fire behavior refers to the physical characteristics of a fire and is a function of the interaction between the fuel characteristics (such as type of vegetation and structures that could burn), topography, and weather. Variables that affect fire behavior include the rate of spread, intensity, fuel consumption, and fire type (such as underbrush versus crown fire).

Fire Frequency: Fire frequency is the broad measure of the rate of fire occurrence in a particular area. An estimate of the areas most likely to burn is based on past fire history or fire rotation in the area, fuel conditions, weather, ignition sources (such as human or lightning), fire suppression response, and other factors.

Flash Flood: A flash flood occurs with little or no warning when water levels rise at an extremely fast rate

Flood Insurance Rate Map (FIRM): FIRMs are the official maps on which the Federal Emergency Management Agency (FEMA) has delineated the Special Flood Hazard Area (SFHA).

Flood Insurance Study: A report published by the Federal Insurance and Mitigation Administration for a community in conjunction with the community’s Flood Insurance rate Map. The study contains such background data as the base flood discharges and water surface elevations that were used to prepare the FIRM. In most cases, a community FIRM with detailed mapping will have a corresponding flood insurance study.

Floodplain: Any land area susceptible to being inundated by flood waters from any source. A flood insurance rate map identifies most, but not necessarily all, of a community's floodplain as the Special Flood Hazard Area (SFHA).

Floodway: Floodways are areas within a floodplain that are reserved for the purpose of conveying flood discharge without increasing the base flood elevation more than 1 foot. Generally speaking, no development is allowed in floodways, as any structures located there would block the flow of floodwaters.

Floodway Fringe: Floodway fringe areas are located in the floodplain but outside of the floodway. Some development is generally allowed in these areas, with a variety of restrictions. On maps that have identified and delineated a floodway, this would be the area beyond the floodway boundary that can be subject to different regulations.

Fog: Fog refers to a cloud (or condensed water droplets) near the ground. Fog forms when air close to the ground can no longer hold all the moisture it contains. Fog occurs either when air is cooled to its dew point or the amount of moisture in the air increases. Heavy fog is particularly hazardous because it can restrict surface visibility. Severe fog incidents can close roads, cause vehicle accidents, cause airport delays, and impair the effectiveness of emergency response. Financial losses associated with transportation delays caused by fog have not been calculated in the United States but are known to be substantial.

Freeboard: Freeboard is the margin of safety added to the base flood elevation.

Frequency: For the purposes of this plan, frequency refers to how often a hazard of specific magnitude, duration, and/or extent is expected to occur on average. Statistically, a hazard with a 100-year frequency is expected to occur about once every 100 years on average and has a 1 percent chance of occurring any given year. Frequency reliability varies depending on the type of hazard considered.

Fujita Scale of Tornado Intensity: Tornado wind speeds are sometimes estimated on the basis of wind speed and damage sustained using the Fujita Scale. The scale rates the intensity or severity of tornado events using numeric values from F0 to F5 based on tornado wind speed and damage. An F0 tornado (wind speed less than 73 miles per hour (mph)) indicates minimal damage (such as broken tree limbs), and an F5 tornado (wind speeds of 261 to 318 mph) indicates severe damage.

Goal: A goal is a general guideline that explains what is to be achieved. Goals are usually broad-based, long-term, policy-type statements and represent global visions. Goals help define the benefits that a plan is trying to achieve. The success of a hazard mitigation plan is measured by the degree to which its goals have been met (that is, by the actual benefits in terms of actual hazard mitigation).

Geographic Information System (GIS): GIS is a computer software application that relates data regarding physical and other features on the earth to a database for mapping and analysis.

Hazard: A hazard is a source of potential danger or adverse condition that could harm people and/or cause property damage.

Hazard Mitigation Grant Program (HMGP): Authorized under Section 202 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, the HMGP is administered by FEMA and provides grants to states, tribes, and local governments to implement hazard mitigation actions after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to disasters and to enable mitigation activities to be implemented as a community recovers from a disaster

Hazards U.S. Multi-Hazard (Hazus-MH) Loss Estimation Program: Hazus-MH is a GIS-based program used to support the development of risk assessments as required under the DMA. The Hazus-MH software program assesses risk in a quantitative manner to estimate damages and losses associated with natural hazards. Hazus-MH is FEMA's nationally applicable, standardized methodology and software program and contains modules for estimating potential losses from earthquakes, floods, and wind hazards. Hazus-MH has also been used to assess vulnerability (exposure) for other hazards.

Hydraulics: Hydraulics is the branch of science or engineering that addresses fluids (especially water) in motion in rivers or canals, works and machinery for conducting or raising water, the use of water as a prime mover, and other fluid-related areas.

Hydrology: Hydrology is the analysis of waters of the earth. For example, a flood discharge estimate is developed by conducting a hydrologic study.

Intensity: For the purposes of this plan, intensity refers to the measure of the effects of a hazard.

Inventory: The assets identified in a study region comprise an inventory. Inventories include assets that could be lost when a disaster occurs and community resources are at risk. Assets include people, buildings, transportation, and other valued community resources.

Landslide: Landslides can be described as the sliding movement of masses of loosened rock and soil down a hillside or slope. Fundamentally, slope failures occur when the strength of the soils forming the slope exceeds the pressure, such as weight or saturation, acting upon them.

Lightning: Lightning is an electrical discharge resulting from the buildup of positive and negative charges within a thunderstorm. When the buildup becomes strong enough, lightning appears as a "bolt," usually within or between clouds and the ground. A bolt of lightning instantaneously reaches temperatures approaching 50,000ºF. The rapid heating and cooling of air near lightning causes thunder. Lightning is a major threat during thunderstorms. In the United States, 75 to 100 Americans are struck and killed by lightning each year (see http://www.fema.gov/hazard/thunderstorms/thunder.shtm).

Liquefaction: Liquefaction is the complete failure of soils, occurring when soils lose shear strength and flow horizontally. It is most likely to occur in fine grain sands and silts, which behave like viscous fluids when liquefaction occurs. This situation is extremely hazardous to development on the soils that liquefy, and generally results in extreme property damage and threats to life and safety.

Local Government: Any county, municipality, city, town, township, public authority, school district, special district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate government entity, or agency or instrumentality of a local government; any Indian tribe or authorized tribal organization, or Alaska Native village or organization; and any rural community, unincorporated town or village, or other public entity.

Magnitude: Magnitude is the measure of the strength of an earthquake, and is typically measured by the Richter scale. As an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

Mass movement: A collective term for landslides, mudflows, debris flows, sinkholes and lahars.

Mitigation: A preventive action that can be taken in advance of an event that will reduce or eliminate the risk to life or property.

Mitigation Actions: Mitigation actions are specific actions to achieve goals and objectives that minimize the effects from a disaster and reduce the loss of life and property.

Objective: For the purposes of this plan, an objective is defined as a short-term aim that, when combined with other objectives, forms a strategy or course of action to meet a goal. Unlike goals, objectives are specific and measurable.

Peak Ground Acceleration: Peak Ground Acceleration (PGA) is a measure of the highest amplitude of ground shaking that accompanies an earthquake, based on a percentage of the force of gravity.

Preparedness: Preparedness refers to actions that strengthen the capability of government, citizens, and communities to respond to disasters.

Presidential Disaster Declaration: These declarations are typically made for events that cause more damage than state and local governments and resources can handle without federal government assistance. Generally, no specific dollar loss threshold has been established for such declarations. A Presidential Disaster Declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, designed to help disaster victims, businesses, and public entities.

Probability of Occurrence: The probability of occurrence is a statistical measure or estimate of the likelihood that a hazard will occur. This probability is generally based on past hazard events in the area and a forecast of events that could occur in the future. A probability factor based on yearly values of occurrence is used to estimate probability of occurrence.

Repetitive Loss Property: Any NFIP-insured property that, since 1978 and regardless of any changes of ownership during that period, has experienced:

- Four or more paid flood losses in excess of $1000.00; or
- Two paid flood losses in excess of $1000.00 within any 10-year period since 1978 or
- Three or more paid losses that equal or exceed the current value of the insured property.

Return Period (or Mean Return Period): This term refers to the average period of time in years between occurrences of a particular hazard (equal to the inverse of the annual frequency of occurrence).

Riverine: Of or produced by a river. Riverine floodplains have readily identifiable channels. Floodway maps can only be prepared for riverine floodplains.

Risk: Risk is the estimated impact that a hazard would have on people, services, facilities, and structures in a community. Risk measures the likelihood of a hazard occurring and resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate, or low likelihood of sustaining damage above a particular threshold due to occurrence of a specific type of hazard. Risk also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Risk Assessment: Risk assessment is the process of measuring potential loss of life, personal injury, economic injury, and property damage resulting from hazards. This process assesses the vulnerability of people, buildings, and infrastructure to hazards and focuses on (1) hazard identification; (2) impacts of hazards on physical, social, and economic assets; (3) vulnerability identification; and (4) estimates of the cost of damage or costs that could be avoided through mitigation.

Risk Ranking: This ranking serves two purposes, first to describe the probability that a hazard will occur, and second to describe the impact a hazard will have on people, property, and the economy. Risk estimates for the County are based on the methodology that the County used to prepare the risk assessment for this plan. The following equation shows the risk ranking calculation:

Risk Ranking = Probability + Impact (people + property + economy)

Robert T. Stafford Act: The Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 100-107, was signed into law on November 23, 1988. This law amended the Disaster Relief Act of 1974, Public Law 93-288. The Stafford Act is the statutory authority for most federal disaster response activities, especially as they pertain to FEMA and its programs.

Sinkhole: A collapse depression in the ground with no visible outlet. Its drainage is subterranean. It is commonly vertical-sided or funnel-shaped.

Special Flood Hazard Area (SFHA): The base floodplain delineated on a Flood Insurance Rate Map. The SFHA is mapped as a Zone A in riverine situations and Zone V in coastal situations. The SFHA may or may not encompass all of a community's flood problems

Stakeholder: Business leaders, civic groups, academia, non-profit organizations, major employers, managers of critical facilities, farmers, developers, special purpose districts, and others whose actions could impact hazard mitigation.

Stream Bank Erosion: Stream bank erosion is common along rivers, streams and drains where banks have been eroded, sloughed or undercut. However, it is important to remember that a stream is a dynamic and constantly changing system. It is natural for a stream to want to meander, so not all eroding banks are "bad" and in need of repair. Generally, stream bank erosion becomes a problem where development has limited the meandering nature of streams, where streams have been channelized, or where stream bank structures (like bridges, culverts, etc.) are located in places where they can actually cause damage to downstream areas. Stabilizing these areas can help protect watercourses from continued sedimentation, damage to adjacent land uses, control unwanted meander, and improvement of habitat for fish and wildlife.

Steep Slope: Different communities and agencies define it differently, depending on what it is being applied to, but generally a steep slope is a slope in which the percent slope equals or exceeds 25%. For this study, steep slope is defined as slopes greater than 33%.

Sustainable Hazard Mitigation: This concept includes the sound management of natural resources, local economic and social resiliency, and the recognition that hazards and mitigation must be understood in the largest possible social and economic context.

Thunderstorm: A thunderstorm is a storm with lightning and thunder produced by cumulonimbus clouds. Thunderstorms usually produce gusty winds, heavy rains, and sometimes hail. Thunderstorms are usually short in duration (seldom more than 2 hours). Heavy rains associated with thunderstorms can lead to flash flooding during the wet or dry seasons.

Tornado: A tornado is a violently rotating column of air extending between and in contact with a cloud and the surface of the earth. Tornadoes are often (but not always) visible as funnel clouds. On a local scale, tornadoes are the most intense of all atmospheric circulations, and winds can reach destructive speeds of more than 300 mph. A tornado's vortex is typically a few hundred meters in diameter, and damage paths can be up to 1 mile wide and 50 miles long.

Vulnerability: Vulnerability describes how exposed or susceptible an asset is to damage. Vulnerability depends on an asset's construction, contents, and the economic value of its functions. Like indirect damages, the vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power. Flooding of an electric substation would affect not only the substation itself but businesses as well. Often, indirect effects can be much more widespread and damaging than direct effects.

Watershed: A watershed is an area that drains down gradient from areas of higher land to areas of lower land to the lowest point, a common drainage basin.

Wildfire: These terms refer to any uncontrolled fire occurring on undeveloped land that requires fire suppression. The potential for wildfire is influenced by three factors: the presence of fuel, topography, and air mass. Fuel can include living and dead vegetation on the ground, along the surface as brush and small trees, and in the air such as tree canopies. Topography includes both slope and elevation. Air mass includes temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount, duration, and the stability of the atmosphere at the time of the fire. Wildfires can be ignited by lightning and, most frequently, by human activity including smoking, campfires, equipment use, and arson.

Windstorm: Windstorms are generally short-duration events involving straight-line winds or gusts exceeding 50 mph. These gusts can produce winds of sufficient strength to cause property damage. Windstorms are especially dangerous in areas with significant tree stands, exposed property, poorly constructed buildings, mobile homes (manufactured housing units), major infrastructure, and aboveground utility lines. A windstorm can topple trees and power lines; cause damage to residential, commercial, critical facilities; and leave tons of debris in its wake.

Zoning Ordinance: The zoning ordinance designates allowable land use and intensities for a local jurisdiction. Zoning ordinances consist of two components: a zoning text and a zoning map.

APPENDIX B
PUBLIC OUTREACH MATERIALS AND RESULTS

APPENDIX B
PUBLIC OUTREACH MATERIALS AND RESULTS

Insert Relevant Materials

APPENDIX C
PLAN ADOPTION RESOLUTIONS FROM PLANNING PARTNERS

APPENDIX C
PLAN ADOPTION RESOLUTIONS FROM PLANNING PARTNERS AND FEMA APPROVAL LETTER

U.S. Department of Homeland Security
FEMA Region 10
130 – 228th Street, SW
Bothell, Washington 98021

FEMA

June 13, 2018

The Honorable Randy Zeatherlin
Chair, Board of County Commissioners
Mason County
411 N. 5th St.
Shelton, Washington 98584

Dear Chair Zeatherlin:

On April 30, 2018, the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) Region 10, approved the *Mason County Hazard Mitigation Plan* as a multi-jurisdictional local plan as outlined in Code of Federal Regulations Title 44 Part 201. This approval provides the below jurisdictions eligibility to apply for the Robert T. Stafford Disaster Relief and Emergency Assistance Act's, Hazard Mitigation Assistance (HMA) grants projects through April 29, 2023, through your state:

Mason County	Public Utility District No. 3	Public Utility District No. 1
City of Shelton	Central Mason Fire and EMS	

The updated list of approved jurisdictions includes the City of Shelton that recently adopted their respective addendum. To continue eligibility, jurisdictions must review, revise as appropriate, and resubmit the plan within five years of the original approval date.

If you have questions regarding your plan's approval or FEMA's mitigation grant programs, please contact Derrick Hiebert, State Mitigation Strategist with Washington Emergency Management Division, at (253) 512-7142, who coordinates and administers these efforts for local entities.

Sincerely,

Mark Carey, Director
Mitigation Division

cc: Tim Cook, Washington Emergency Management Division

BH:vl

www.fema.gov

RESOLUTION No. 25-18
A RESOLUTION OF MASON COUNTY
AUTHORIZING THE ADOPTION OF THE
MASON COUNTY MULTI-JURISDICTION HAZARD MITIGATION PLAN

WHEREAS, all of Mason County has exposure to natural hazards that increase the risk to life, property, environment and the County's economy; and

WHEREAS; pro-active mitigation of known hazards before a disaster event can reduce or eliminate long-term risk to life and property; and

WHEREAS, The Disaster Mitigation Act of 2000 (Public Law 106-390) established requirements for pre and post disaster hazard mitigation programs requiring that "local and tribal government applicants for sub-grants must have an approved local mitigation plan in accordance with 44 CFR 201.6 prior to receipt of a Hazard Mitigation Grant Program sub-grant funding." The purpose of such local mitigation plan is to represent the Multi-Jurisdcition's commitment to reduce risks from natural and man-made hazards; and

WHEREAS, pursuant to 44 CFR 201.6, a coalition of Mason County stakeholders with like planning objectives was formed to pool resources and create consistent mitigation strategies to be implemented within each partner's identified capabilities within the Mason County Planning Area; and

WHEREAS, the coalition has completed a planning process that engages the public, assesses the risk and vulnerability to the impacts of natural hazards, develops a mitigation strategy consistent with a set of uniform goals and objectives, and creates a plan for implementing, evaluating and revising this strategy; and

WHEREAS, pursuant to 44 CFR 201.6, the Mason County Multi-Jurisdiction Hazard Mitigation Plan has been reviewed and found to meet the regulatory criteria, and following adoption by participating jurisdictions, will be approved by FEMA, making all adopting jurisdictions eligible for mitigation project grants.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF MASON COUNTY COMMISSIONERS to adopt the Mason County Multi-Jurisdiction Hazard Mitigation Plan is hereby adopted in its entirety, including the Partnering Jurisdictional Annex, which represents each planning partner's commitment to reduce risks from natural and man-made hazards.

Dated this 10th day of April, 2018:

BOARD OF COUNTY COMMISSIONERS
MASON COUNTY, WASHINGTON

ATTEST:

Melissa Drewry, Clerk of the Board

Randy Neatherlin, Chair

APPROVED AS TO FORM:

Terri Drexler, Commissioner

Tim Whitehead, Deputy Prosecuting Attorney

Kevin Shutty, Commissioner

Mason County Fire District 5
DBA: Central Mason Fire & EMS

RESOLUTION #363

A RESOLUTION of Mason County Fire Protection District 5 (dba Central Mason Fire and EMS) recognizes the threat that natural hazards pose to people, property, and the environment within Mason County; and

WHEREAS, pro-active mitigation of known hazards before a disaster event can reduce or eliminate long-term risk to life and property; and

WHEREAS, The Disaster Mitigation Act of 2000 (Public Law 106-390) established requirements for pre and post disaster hazard mitigation programs requiring that "local and tribal government applicants for sub-grants must have an approved local mitigation plan in accordance with 44 CFR 201.6 prior to receipt of a Hazard Mitigation Grant Program sub-grant funding." The purpose of such local mitigation plan is to represent the Multi-Jurisdiction's commitment to reduce risks from natural and man-made hazards; and

WHEREAS, pursuant to 44 CFR 201.6, a coalition of Mason County stakeholders with like planning objectives was formed to pool resources and create consistent mitigation strategies to be implemented within each partner's identified capabilities within the Mason County Planning Area; and

WHEREAS, the coalition has completed a planning process that engages the public, assesses the risk and vulnerability to the impacts of natural hazards, develops a mitigation strategy consistent with a set of uniform goals and objectives, and creates a plan for implementing, evaluating and revising this strategy; and

WHEREAS, pursuant to 44 CFR 201.6, the Mason County Multi-Jurisdiction Hazard Mitigation Plan has been reviewed and found to meet the regulatory criteria, and following adoption by participating jurisdictions, will be approved by FEMA, making all adopting jurisdictions eligible for mitigation project grants.

NOW, BE IT RESOLVED, by Mason County Fire Protection District 5 (dba Central Mason Fire and EMS) that; the Mason County Multi-Jurisdiction Hazard Mitigation Plan is hereby adopted in its entirety, including the Mason County Fire Protection District 5 (dba Central Mason Fire and EMS) Jurisdictional Annex, which represents each planning partner's commitment to reduce risks from natural and man-made hazards; and

ADOPTED by the Board of Commissioners of Mason County Fire Protection District 5, DBA Central Mason Fire & EMS, Mason County Washington, at a regular open public meeting of the Board on the 18th day of April, 2018, the following Commissioners being present and voting:

Chairperson Tom Taylor

Commissioner Tom Nevers

Commissioner Del Griffey

Secretary Pro-tem Mandy Curtis

PUBLIC UTILITY DISTRICT NO. 1
OF MASON COUNTY
N. 21971 Hwy. 101
Shelton, Washington 98584

BOARD OF COMMISSIONERS
MIKE SHEETZ, Commissioner
JACK JANDA, Commissioner
RON GOLD, Commissioner

RESOLUTION NO. 1098

A RESOLUTION AUTHORIZING THE ADOPTION OF THE
MASON COUNTY MULTI-JURISDICTION HAZARD MITIGATION PLAN

WHEREAS, all of Mason County has exposure to natural hazards that increase the risk to life, property, environment and the County's economy; and

WHEREAS; pro-active mitigation of known hazards before a disaster event can reduce or eliminate long-term risk to life and property; and

WHEREAS, The Disaster Mitigation Act of 2000 (Public Law 106-390) established requirements for pre and post disaster hazard mitigation programs requiring that "local and tribal government applicants for sub-grants must have an approved local mitigation plan in accordance with 44 CFR 201.6 prior to receipt of a Hazard Mitigation Grant Program sub-grant funding." The purpose of such local mitigation plan is to represent the Multi-Jurisdcition's commitment to reduce risks from natural and man-made hazards; and

WHEREAS, pursuant to 44 CFR 201.6, a coalition of Mason County stakeholders with like planning objectives was formed to pool resources and create consistent mitigation strategies to be implemented within each partner's identified capabilities within the Mason County Planning Area; and

WHEREAS, the coalition has completed a planning process that engages the public, assesses the risk and vulnerability to the impacts of natural hazards, develops a mitigation strategy consistent with a set of uniform goals and objectives, and creates a plan for implementing, evaluating and revising this strategy; and

WHEREAS, pursuant to 44 CFR 201.6, the Mason County Multi-Jurisdiction Hazard Mitigation Plan has been reviewed and found to meet the regulatory criteria, and following adoption by participating jurisdictions, will be approved by FEMA, making all adopting jurisdictions eligible for mitigation project grants.

NOW, THEREFORE, BE IT RESOLVED that:

The Mason County Multi-Jurisdiction Hazard Mitigation Plan is hereby adopted in its entirety, which represents each planning partner's commitment to reduce risks from natural and man-made hazards; and.

PASSED AND ADOPTED on this 27th day of March, 2018.

Mike Sheetz, Secretary

Jack Janda, President

Ron Gold, Vice President

Regular Meeting – District Office/Potlatch
A Resolution Authorizing the Adoption of the Mason County Multi-Jurisdiction Hazard Mitigation Plan
Date: March 27, 2018
No. 1098

RESOLUTION NO. 1707

A RESOLUTION AUTHORIZING THE ADOPTION OF THE MASON COUNTY MULTI-JURISDICTION HAZARD MITIGATION PLAN

WHEREAS, all of Mason County has exposure to natural hazards that increase the risk to life, property, environment and the County's economy; and

WHEREAS, pro-active mitigation of known hazards before a disaster event can reduce or eliminate long-term risk to life and property; and

WHEREAS, The Disaster Mitigation Act of 2000 (Public Law 106-390) established requirements for pre and post disaster hazard mitigation programs requiring that "local and tribal government applicants for sub-grants must have an approved local mitigation plan in accordance with 44 CFR 201.6 prior to receipt of a Hazard Mitigation Grant Program sub-grant funding." The purpose of such local mitigation plan is to represent the Multi-Jurisdcition's commitment to reduce risks from natural and man-made hazards; and

WHEREAS, pursuant to 44 CFR 201.6, a coalition of Mason County stakeholders with like planning objectives was formed to pool resources and create consistent mitigation strategies to be implemented within each partners' identified capabilities within the Mason County Planning Area; and

WHEREAS, the coalition has completed a planning process that engages the public, assesses the risk and vulnerability to the impacts of natural hazards, develops a mitigation strategy consistent with a set of uniform goals and objectives, and creates a plan for implementing, evaluating and revising this strategy; and

WHEREAS, pursuant to 44 CFR 201.6, the Mason County Multi-Jurisdiction Hazard Mitigation Plan has been reviewed and found to meet the regulatory criteria, and following adoption by participating jurisdictions, will be approved by FEMA, making all adopting jurisdictions eligible for mitigation project grants.

NOW, THEREFORE, BE IT RESOLVED that the Board of Commissioners does hereby adopt Resolution No. 1707, Authorizing the Adoption of the Mason County Multi-Jurisdiction Hazard Mitigation Plan.

ADOPTED by the board of Commissioners of Public Utility District No. 3 of Mason County, Washington, this 10th of April, 2018.

Bruce E. Jorgenson, President

Thomas J. Farmer, Vice President

ATTEST:

Linda R. Gott, Secretary

APPENDIX D
EXAMPLE TEMPLATE FOR FUTURE PROGRESS REPORTS

APPENDIX D
EXAMPLE TEMPLATE FOR FUTURE PROGRESS REPORTS

Mason County
Hazard Mitigation Plan
Annual Progress Report

Reporting Period: (Insert reporting period)

Background: Mason County and participating cities and special purpose districts in the county developed a hazard mitigation plan to reduce risk from all hazards by identifying resources, information, and strategies for risk reduction. The federal Disaster Mitigation Act requires state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. To prepare the plan, the participating partners organized resources, assessed risks from natural hazards within the county, developed planning goals and objectives, reviewed mitigation alternatives, and developed an action plan to address probable impacts from natural hazards. By completing this process, these jurisdictions maintained compliance with the Disaster Mitigation Act, achieving eligibility for mitigation grant funding opportunities afforded under the Robert T. Stafford Act. The plan can be viewed on-line at:

Insert web address

Summary Overview of the Plan's Progress: The performance period for the hazard mitigation plan became effective on ____, 2018, with the final approval of the plan by FEMA. The initial performance period for this plan will be 5 years, with an anticipated update to the plan to occur before ______, 2023. As of this reporting period, the performance period for this plan is considered to be __ percent complete. The hazard mitigation plan has targeted __ hazard mitigation initiatives to be pursued during the 5-year performance period. As of the reporting period, the following overall progress can be reported:

- __ out of __ initiatives (__%) reported ongoing action toward completion.
- __ out of __ initiatives (__%) were reported as being complete.
- __ out of __ initiatives (___%) reported no action taken.

Purpose: The purpose of this report is to provide an annual update on the implementation of the action plan identified in the Mason County Hazard Mitigation Plan. The objective is to ensure that there is a continuing and responsive planning process that will keep the hazard mitigation plan dynamic and responsive to the needs and capabilities of the partner jurisdictions. This report discusses the following:

- Natural hazard events that have occurred within the last year
- Changes in risk exposure within the planning area (all of Mason County)
- Mitigation success stories
- Review of the action plan
- Changes in capabilities that could impact plan implementation
- Recommendations for changes/enhancement.

The Hazard Mitigation Plan Planning Team: The Hazard Mitigation Plan Planning Team, made up of planning partners and stakeholders within the planning area, reviewed and approved this progress report at its annual meeting held on _____, 2019. It was determined through the plan's development process that a planning team would remain in service to oversee maintenance of the plan. At a minimum, the planning team will provide technical review and oversight on the development of the annual progress report. It is anticipated that there will be turnover in the membership annually, which will be documented in the progress reports. For this reporting period, the planning team membership is as indicated in Table 1.

TABLE 1
PLANNING TEAM MEMBERS

Name	Title	Jurisdiction/Agency

Natural Hazard Events within the Planning Area: During the reporting period, there were __ natural hazard events in the planning area that had a measurable impact on people or property. A summary of these events is as follows:

- ______________________________
- ______________________________

Changes in Risk Exposure in the Planning Area: *(Insert brief overview of any natural hazard event in the planning area that changed the probability of occurrence or ranking of risk for the hazards addressed in the hazard mitigation plan)*

Mitigation Success Stories: *(Insert brief overview of mitigation accomplishments during the reporting period)*

Review of the Action Plan: Table 2 reviews the action plan, reporting the status of each initiative. Reviewers of this report should refer to the hazard mitigation plan for more detailed descriptions of each initiative and the prioritization process.

Address the following in the "status" column of the following table:

- *Was any element of the initiative carried out during the reporting period?*
- *If no action was completed, why?*
- *Is the timeline for implementation for the initiative still appropriate?*
- *If the initiative was completed, does it need to be changed or removed from the action plan?*

TABLE 2
ACTION PLAN MATRIX

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O,✓)
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				

Completion status legend:
✓= Project Completed
O = Action ongoing toward completion
X = No progress at this time

Changes That May Impact Implementation of the Plan: *(Insert brief overview of any significant changes in the planning area that would have a profound impact on the implementation of the plan. Specify any changes in technical, regulatory and financial capabilities identified during the plan's development)*

Recommendations for Changes or Enhancements: Based on the review of this report by the Hazard Mitigation Plan Planning Team, the following recommendations will be noted for future updates or revisions to the plan:

- ______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________

Public review notice: The contents of this report are considered to be public knowledge and have been prepared for total public disclosure. Copies of the report have been provided to the governing boards of all planning partners and to local media outlets and the report is posted on the Mason County hazard mitigation plan website. Any questions or comments regarding the contents of this report should be directed to: