Spokane County

Hazard Mitigation Plan
Volume 1: Planning-Area-Wide Elements

April 2020

Final Adopted Version

BRIDGEVIEW CONSULTING

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

APRIL 2020

FINAL ADOPTED VERSION

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

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EXECUTIVE SUMMARY

The Disaster Mitigation Act (DMA) is federal legislation that requires proactive, pre-disaster planning as a prerequisite for some funding available under the Robert T. Stafford Act. The DMA encourages state and local authorities to work together on pre-disaster planning. The enhanced planning network called for by the DMA helps local governments' articulate accurate needs for mitigation, resulting in faster allocation of funding and more cost-effective risk reduction projects.

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

Spokane County and a partnership of local governments have developed and maintained a hazard mitigation plan to reduce risks from natural disasters and to comply with the DMA. This plan will, and has, acted as the keyway to federal funding afforded under FEMA hazard mitigation grant programs.

PLAN UPDATE – WHAT'S NEW – WHAT'S DIFFERENT

Federal regulations require monitoring, evaluation and updating of hazard mitigation plans. 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 no longer in compliance with the DMA.

Initial Response to the DMA in Spokane County

On May 2, 2007, FEMA Region X approved the County's first multi-jurisdiction hazard mitigation plan for Spokane County and the cities of Spokane and Spokane Valley.

Recognizing limitations in the initial plan, the Spokane Department of Emergency Management (DEM) used the plan update requirements to significantly enhance the Spokane County Hazard Mitigation Plan in scope and content with development of the 2015 Multi-Jurisdiction Hazard Mitigation Plan, which greatly increased the planning partnership. In continuation of that effort, the County again moved forward with the 2020 update, inviting additional planning partners while also updating the scope and content of the new edition.

2020 Hazard Mitigation Plan Update - Changes

With development of the 2020 update, the County is again taking the initiative to not only increase the planning partnership to include additional partners, but further expanding the data contained within the plan.

The 2020 updated plan differs from previous plan editions for the following reasons:

- Updated guidance on what is required to meet the intent of the DMA.

- Further expansion of the scope of the plan to include Special Purpose District and Tribal planning partners not involved in previous editions. These planning partners are true stakeholders in mitigation within the planning area.

- New data and tools provide for an enhanced risk assessment, further expanding on the use of tools such as FEMA's Hazards U.S. Multi-Hazard (HAZUS-MH) computer model.

- New studies and reports will be integrated to the various hazards of concern as appropriate.

- All maps, charts, and census data information have been updated as appropriate.

- The risk assessment has again 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.

- A new hazard ranking methodology is utilized for the 2020 update, which is more user-friendly for any planning partners wishing to join on at a later date through an established linkage procedure.

- This plan is written to support the DEM's quest to obtain Emergency Management Accreditation Program (EMAP) standards through the International Association of Emergency Managers (IAEM).

- The plan identifies mitigation action items which meet multiple objectives that are measurable, so that each planning partner can measure the effectiveness of their mitigation actions. Previous action items have been updated to their current status, and new action items developed for this update process.

- The hazards of concern remain the same; however, the non-natural hazard section of this plan, *Chapter 14 Hazards of Interest*, have been removed as the information is repetitive in both the County's and Region's THIRA documents.

Updating the plan consisted of the following phases:

- **Phase 1, Organize and Review**—A planning team was assembled to provide technical support for the plan update, consisting of key staff from DEM and a technical consultant. The first step in developing the plan update was to re-organize the planning partnership. The initial planning effort covered 3 local governments. This partnership was increased to 22 as identified in Chapter 2, an increase from the 2015 effort of 10 planning partners.

  The planning team led the plan update, consisting of planning partner staff and other stakeholders in the planning area. Coordination with other county, state and federal agencies involved in hazard mitigation occurred throughout the plan update process. This phase included a comprehensive review of the existing plan, the Washington State Hazard Mitigation Plan, and existing programs that may support or enhance hazard mitigation actions.

- **Phase 2, Update the Risk Assessment**— Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from natural hazards. This process assesses the vulnerability of people, buildings and infrastructure to natural hazards. It focuses on the following parameters:

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

The risk assessment for this hazard mitigation plan meets requirements outlined in Chapter 44 of the Code of Federal Regulations (44 CFR 201.6). Phase 2 occurred simultaneously with Phase 1, with the two efforts using information generated by one another to create the best possible risk assessment. This was the most comprehensive phase of the plan update process. All facets of the risk assessment of the plan were visited by the planning team and updated with the best available data and technology.

- **Phase 3, Engage the Public**—A public involvement strategy developed by the planning team was implemented, and included public meetings to present the risk assessment as well as the draft plan, distribution of a hazard mitigation survey, a County-sponsored website for the plan update, and multiple media releases.

- **Phase 4, Assemble the Updated Plan**—The planning team assembled key information into a document to meet the DMA requirements for all planning partners. The updated plan contains two volumes. Volume 1 contains components that apply to all partners and the broader planning area. Volume 2 contains all components that are jurisdiction-specific. Each planning partner has a dedicated chapter in Volume 2.

- **Phase 5, Plan Adoption/Implementation**—Once pre-adoption approval was granted by Washington State Emergency Management Division and FEMA Region X, the final adoption phase began. Each planning partner individually adopt the updated plan. The plan maintenance process includes a schedule for monitoring and evaluating the plan's progress periodically and producing a plan revision every 5 years. This plan maintenance strategy also includes process for continuing public involvement and integration with other programs that can support or enhance hazard mitigation.

IMPLEMENTATION

Full implementation of the recommendations of this plan will require time and resources. The measure of the plan's success will be its ability to adapt to the changing climate of planet earth as well as the field of hazard mitigation. Funding resources are always evolving, as are state and federal mandates. Spokane County and its planning partners will assume responsibility for adopting the recommendations of this plan and committing resources toward implementation. The framework established by this plan commits all planning partners to pursue initiatives when the benefits of a project exceed its costs. The planning partnership developed this plan with extensive public input, and public support of the actions identified in this plan will help ensure the plan's success.

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

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

1.1.1 Local Concerns

Natural hazards impact citizens, property, the environment and the economy of Spokane County. Flooding, landslides, windstorms, severe winter storms, volcanoes and earthquakes have exposed Spokane County residents and businesses to the financial and emotional costs of recovering after natural disasters. Other events, such as urban fire, terrorism and hazardous material spills, also pose dangers to the population of Spokane County. The risk associated with natural hazards increases as more people move to areas affected by hazards.

The inevitability of natural hazards and the growing population and activity within Spokane County create an urgent need to develop strategies, coordinate resources and increase public awareness to reduce risk and prevent loss from future hazard events. Identifying risks posed by hazards, and developing strategies to reduce the impact of a hazard event can assist in protecting life and property of citizens and communities. Local residents and businesses can work together with the County to create a hazard mitigation plan that addresses the potential impacts of hazard events.

1.1.2 Purposes for Hazard Mitigation 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. The Federal Emergency Management Agency (FEMA) encourages multi-jurisdictional planning under its guidance for the DMA. The plan will help guide

and coordinate mitigation activities throughout Spokane 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 Spokane County hazards of concern.
- Create a single planning document that integrates all planning partners into a framework that supports partnerships within the county, and puts all partners on the same planning cycle for future updates.
- Meet the planning requirements of FEMA's Community Rating System (CRS), allowing planning partners that wish to participate in the CRS program to maintain or enhance their CRS classifications (currently there are no CRS communities within Spokane County).
- 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 Spokane 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.

1.2 PLAN LAYOUT

This plan has been set up in two volumes so that elements that are jurisdiction-specific can easily be distinguished from those that apply to the whole planning area:

- **Volume 1**—Volume 1 includes all federally required elements of a disaster mitigation plan that apply to the entire planning area. This includes the description of the planning process, public involvement strategy, goals and objectives, countywide hazard risk assessment, countywide mitigation initiatives, and a plan maintenance strategy.
- **Volume 2**—Volume 2 includes all federally required jurisdiction-specific elements, in annexes for each participating jurisdiction. It includes a description of the participation requirements established by the planning team. Volume 2 also includes "linkage" procedures for eligible jurisdictions that did not participate in development of this plan but wish to adopt it in the future.

All planning partners will adopt Volume 1 in its entirety, in addition to each partner's jurisdiction-specific annex and the appendices 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 — Glossary of acronyms and definitions
- Appendix B — Public outreach information questionnaire/survey
- Appendix C — A template for progress reports to be completed as this plan is implemented
- Appendix D — Plan Adoption Resolutions from Planning Partners

1.3 PLAN INTEGRATION

This plan update includes the integration of other comprehensive planning documents that are in effect within the planning area. These plans include:

- The Spokane County Community Wildfire Protection Plan (CWPP);
- The Spokane County Threat and Hazard Identification and Risk Assessment; and
- The Comprehensive Plans for Spokane County and all incorporated cities within the County.

Spokane County completed a threat and hazard identification and risk assessment (THIRA) that is compliant with federal guidance. The THIRA was completed at both the County and Regional levels. Key components of the THIRA development were originally completed during the 2015 plan update process. These components, while not discoverable under public disclosure, serve as the County's documentation and analysis for the non-natural hazard. This linkage will continue through all subsequent updates to the Hazard Mitigation Plan (HMP). The THIRA will remain a stand-alone document for security purposes as the HMP and THIRA are two entirely different documents created for entirely different program directives.

Comprehensive Plans are mandated by Washington statute (Revised Code of Washington (RCW) 36.70A.070) adopted under its Growth Management Act. The comprehensive plan of a county or city that is required or chooses to plan under RCW 36.70A.040 shall consist of a map or maps, and descriptive text covering objectives, principles, and standards used to develop the comprehensive plan. The plan shall be an internally consistent document and all elements shall be consistent with the future land use map. All municipal planning partners have adopted comprehensive plans pursuant to the Growth Management Act. Recognizing the value of the information contained in the Hazard Mitigation Plan in making wise land use decisions, each municipal planning partner has adopted action(s) that promote the integration of the Hazard Mitigation Plan and the comprehensive plans in effect within the planning area. These actions can be found in the jurisdictional annexes contained in Volume 2 of this plan.

1.4 PLAN ADOPTION

44 CFR Section 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. FEMA Region X granted final approval of the 2020 Hazard Mitigation Plan Update to Spokane County and its eligible planning partners in April 2020. Copies of the resolutions adopting the plan as well as the FEMA approval letter can be found in Appendix C.

CHAPTER 2.
PLANNING PROCESS

2.1 PLAN DEVELOPMENT

Spokane County's hazard planning process originally began in the spring of 2002 with the Department of Emergency Management and several committee groups coordinating planning efforts to prepare a hazard identification and vulnerability analysis ranking hazards based on probability and priority. A final updated hazard identification and vulnerability analysis was completed in February 2004.

In September 2005, the All Hazards Mitigation Committee was formed, representing city and county departments, disciplines that support emergency services, and citizens throughout the county. The Department of Emergency Management contacted incorporated communities within the county about their interest in being actively involved in a process to prepare a hazard mitigation plan. Most cities decided to not participate, so the plan focused on three major areas: unincorporated Spokane County, the City of Spokane, and the City of Spokane Valley. The All Hazards Mitigation Committee held several meetings with consultants to develop the plan.

In 2014, the County again initiated an update to the then existing Hazard Mitigation Plan, which culminated in the adoption of the 2015 Hazard Mitigation Plan, which included 12 planning partners. The current update, the 2020 Spokane County Hazard Mitigation Plan, followed a similar process to that previously utilized, with the exception of those changes identified within the Executive Summary and the integration of EMAP Standards for IAEM Accreditation of the Emergency Management organization.

It should be noted that the risk assessments in the initial plan and this plan update were both conducted under differing methodologies. The initial risk assessment was more subjective utilizing qualitative analyses and assumptions, while the updated plan utilized a more quantitative approach built upon data and science. Based on these differences, it is not possible to simply compare the results of the two risk assessments to see if risk has increased during the performance period. Now that the planning area is equipped with tools such as a HAZUS model for the planning area, this type of comparative analysis will be possible for future updates to this plan.

During its initial kick-off meeting, the planning team reviewed the critical infrastructure list utilized for the 2015 plan update, and determined that no new structures had been built. This data was further confirmed through review of the various annual reports (such as the County Assessor's Annual Reports for the periods covering 2013-2019), and discussions with the various planning partners. The County has developed a specific initiative for maintenance of the critical facilities list, which will ensure continuation of an up-to-date document for use in other emergency management and public safety initiatives.

2.2 CHANGES IN DEVELOPMENT

44 CFR Section 201.6(d)(3) requires that plan updates be revised to reflect changes in development that occurred within the planning area during the past performance period of the plan. The plan must describe changes in development that have occurred in hazard prone areas and increased or decreased the vulnerability of each jurisdiction since the last plan was approved. If no changes in development impacted the jurisdiction's overall vulnerability, plan updates may validate the information in the previously approved plan. The intent of this requirement is to ensure that the mitigation strategy continues to address

the risk and vulnerabilities to existing and potential development, and takes into consideration possible future conditions that can impact the vulnerability of the community.

The planning area previously experienced a 13.80 percent increase in population between 2000 and 2012. During the time period of 2010-2018, population increased 9.2 percent. The County and its cities have adopted comprehensive plans that govern land use decision and policy making in their jurisdictions as well as building codes and specialty ordinances based on state and federal mandates. Decisions on land use are governed by these programs. It has been assumed by this planning process that new development triggered by this increase in population interfaced with hazard areas assessed by this plan. All new development is regulated pursuant to the programs and initiatives discussed throughout this plan, including flood, landslide, wildfire, and load capacity for snow and ash. Therefore, even though exposure may have increased, it has been assumed that vulnerability did not due to the strength of these land use regulations and programs.

2.3 PROCESS FOLLOWED

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

- Secure grant funding;
- Form a core planning work group within the County (as grant recipient) to lead the effort;
- Establish a planning partnership of municipalities, special purpose districts, and stakeholders in the planning area;
- Define the planning area;
- Establish a planning team of who will develop annex templates;
- Coordinate with other agencies to gain information and stakeholder involvement;
- Review existing programs, plans and studies in place, and
- Engage the public.

These objectives are discussed in the following sections.

2.4 GRANT FUNDING

This planning effort was supplemented by a Pre-Disaster Mitigation Grant from FEMA. Spokane County was the applicant agent for the grant. The grant was applied for in 2017, and funding was appropriated in 2018. It covered 75 percent of the cost for development of this plan; the County and its planning partners covered the balance of the cost through in-kind contributions.

2.5 FORMATION OF THE PLANNING TEAM

Spokane 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 team was formed to lead the planning effort, made up of the following members:

- Gerry Bozarth, Spokane Department of Emergency Management, Spokane County Project Manager;
- Chandra Fox, Spokane Department of Emergency Management Deputy Director, Alternate Project Manager;
- Beverly O'Dea, Bridgeview Consulting, Lead Project Planner;
- David O'Dea, Bridgeview Consulting, Strategic Analyst and Lead Facilitator; and
- Cathy Walker, Bridgeview Consulting (GIS)

2.6 PLANNING PARTNERSHIP

Spokane County opened this planning effort to all eligible local governments and tribes within the county. Combined, these members formed the hazard mitigation planning team. During the County's kick-off meeting, County representatives and Consultant made a presentation to all planning partners on May 22, 2019 to introduce the mitigation planning process and solicit additional planning partners. Key meeting objectives were as follows:

- Provide an overview of the Disaster Mitigation Act.
- Describe the reasons for a plan.
- Outline the County work-plan.
- Outline planning partner expectations.
- Seek commitment to the planning partnership.

Each jurisdiction wishing to join the planning partnership was asked to provide a "letter of intent" to participate in the planning process. That letter designated a point of contact for the jurisdiction and confirmed the jurisdiction's commitment to the process and understanding of expectations. Linkage procedures have been established (see Volume 2 of this plan) for any jurisdiction wishing to link to the Spokane County plan in the future. The planning partners covered under this plan are shown in Table 2-1.

Table 2-1.
Hazard Mitigation Planning Partners and Level of Participation

County, City, Town or Entity Represented	Primary Point of Contact	Alternate Point(s) of Contact	Date of Previous Plan	Letter of Participation	Kick-Off Meeting	Completed Risk Ranking	Completed Annex Template	Draft Plan Review	Final Plan Review	Adoption Month
County DEM	Gerry Bozarth, Project Manager	Chandra Fox, Deputy Director		X	X	X	X	X	X	
County IT/GIS	Kirsten Frost-Anderson									
County (Various)	Colleen Little Floodplain Manager	Wendy Iris Road Maintenance Engineer								
Municipalities										
Airway Heights, City of	Chief Mitch Metzger	Nate Whannell		X	X	X	X	X	X	
Cheney, City of	Chief Tom Jenkins			X	X	X	X	X	X	
Deer Park, City of	Roger Krieger, Community Services Director			X	X	X	X	X	X	
Fairfield, Town of	Mayor KayDee Gilkey	Ken Fuchs		X	X	X	X	X	X	
Liberty Lake, City of	Chief Brian Asmus	Sgt. Darin Morgan		X	X	X	X	X	X	
Medical Lake, City of	Doug Ross, City Administrator	J. Mayfield		X	X	X	X	X	X	
Spokane Valley, City of	Mark Calhoun, City Manager	John Hohman, Deputy City Manager Marci Patterson, Executive Assistant		X	X	X	X	X	X	
Special Purpose Districts and Stakeholders										
Spokane County Conservation District	Garth Davis Forestry Program Manager			X	X	X	X	X	X	
Newman Lake Flood Control Zone District	Malcolm Hamilton, PE			X	X	X	X	X	X	
Fire Districts										
Spokane Valley Fire	Chief Shawn Arold			X	X	X	X	X	X	
Spokane County FD 3	Chief Cody Rohrbach	Bill Dennstaedt		X	X	X	X	X	X	
Spokane County FD 4	Chief Randy Johnson	A/Chief Howard Johnson		X	X	X	X	X	X	

County, City, Town or Entity Represented	Primary Point of Contact	Alternate Point(s) of Contact	Date of Previous Plan	Letter of Participation	Kick-Off Meeting	Completed Risk Ranking	Completed Annex Template	Draft Plan Review	Final Plan Review	Adoption Month
Spokane County FD 5	Commissioner Bonita Cobb			X	X	X	X	X	X	
Spokane County FD 8	A/C Lonnie Rash	Chief Tony Nielsen		X	X	X	X	X	X	
Spokane County FD 10	Chief K. Johnson			X	X	X	X	X	X	
Consultants and Planning Team Facilitators										
Bridgeview Consulting, LLC **Beverly O'Dea, Project Manager and Lead Planner** **David O'Dea, Strategic Analyst, Facilitator, Planning** **Cathy Walker, GIS**										

2.7 DEFINING THE PLANNING AREA

The planning area consists of all of Spokane County. All partners to this plan have jurisdictional authority over specific locations within this planning area.

2.8 COORDINATION WITH OTHER AGENCIES

Title 44 of the Code of Federal Regulations (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). Involvement by various agencies and stakeholders is identified in the table below, but included hazard input information, invitation to serve on the planning team, review of data, information and the draft and pre-adopted plan. Those identified were provided an opportunity to provide input, review and/or comment on this plan throughout the effort as they elected to do so, with information provided via the hazard mitigation plan website (see Section 2.10.1), at various public outreach efforts, or via email. It should be noted that this is an overview, and is not all-encompassing.

Stakeholders			Data and/or Information Provided
Eastern WA University	Geology Dept.		Earthquake Data
FEMA/FEMA Region X	John Schelling, Mitigation Manager FEMA Region X		Plan Review, National Flood Hazard Data
National Earthquake Hazard Reduction Program (NEHRP)	https://www.nehrp.gov/		Earthquake, Liquefaction, Soils data information
Pend Oreille County	JoAnn Bogs, Emergency Management Deputy Director		Region 9 HLS and LEPC plan discussions, review opportunity, public outreach attendance
Red Cross of Spokane			(Invited but declined to participate; did receiving briefings during various meetings)
USGS	https://www.usgs.gov/natural-hazards/earthquake-hazards/research		Earthquake, Liquefaction Data; Earthquake Scenarios
WA DEM	Tim Cook, SHMO Michael Levkowitz, Mitigation Strategist	Kevin Zerbe, Mitigation Strategist Stacey McClain, Mitigation & Recovery Section Manager	Attended kick-off and other meetings, provided information concerning strategies, grant opportunities, NFIP, RFC/SRL data, plan review input.
WA DNR	Various Myron Boles, Wildfire Landowner Assistance	Steve Harris, Wildfire & Forest Practices Asst. Manager	Landslide, Wildfire data
WA DOE	Jerry Franklin, RiskMap Coordinator		Flood data, SRL and CRS data and information
WA DOE	Diane Fowler, Community Right to Know Specialist		Reporting Hazmat sites in county
Whitman County DEM	Bill Tensfeld, Emergency Management Director		Region 9 HLS and LEPC plan discussions, review opportunity, public outreach attendance

2.9 REVIEW OF EXISTING REPORTS, STUDIES AND PROGRAMS

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

- Spokane County Comprehensive Land Use Plan (2018 plus updates)
- Spokane County WRIA 54 (Lower Spokane Watershed Plan) (Reviewed 2019)
- Spokane County Critical Areas Ordinance
- Spokane County Code (Titles 1-20)
- Spokane County Shorelines Master Program
- Spokane County Comprehensive Emergency Management Plan (1999)
- Spokane County Recovery Annex
- Spokane County Community Wildfire Protection Plan (2015)
- Washington State Enhanced Hazard Mitigation Plan (2013, 2018)
- Comprehensive plans for each incorporated planning partner
- Spokane County Assessor's Annual Reports (2013-2019)

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

2.9.1 Related Hazard Planning Documents

To leverage the planning process and technical resources utilized for the plan update process, the County also maintains its Community Wildfire Protection Plan and has previously developed a regional and county-specific threat hazard identification and risk assessment, and a county level, FEMA approved debris management plan.

Community Wildfire Protection Plan (CWPP)

The CWPP for Spokane County is the result of analyses and collaboration with state, county and local agencies, and includes an assessment of the wildfire risk with the intent to reduce the potential for wildfires which threaten people, structures, infrastructure and unique ecosystems in Spokane County. The CWPP, in its entirety, provides supplemental information for the wildfire chapter of Spokane County's Hazard Mitigation Plan update.

Threat and Hazard Identification and Risk Assessment (THIRA)

The THIRA is a tool that allows a jurisdiction to understand its threats and hazards, and how the impacts may vary according to time of occurrence, season, location, and other community factors. The THIRA document, while risk-based, was completed utilizing a different type of analysis to determine the level and

probability of risk based on established criticality factors when assessed against core capabilities and target capabilities established by the planning team during assessment. The THIRA is intended to inform risk-based decision making with respect to capabilities of the jurisdiction. While there are distinct overlaps between a THIRA and a local hazard mitigation plan, they are two very distinctly different documents. While a mitigation plan is developed via an open public process, the THIRA is fact-based on previous incidents, and because of the confidential information, the process and end document are developed in a more secure environment due to the sensitivity of the information being collected and analyzed. As the THIRA document is updated, data used in the development of the hazard mitigation plan will be used to support the development of the THIRA as they relate to the natural hazards, with the non-natural hazards maintained wholly in the THIRA. As such, the two documents will be kept and maintained separately by Spokane County Emergency Management, with the THIRA document not available for public review.

Debris Management Plan

The Federal Emergency Management Agency (FEMA) encourages State and local governments, tribal authorities, and private non-profit organizations to take a proactive approach to coordinating and managing debris removal operations as part of their overall emergency management plan. Communities with a debris management plan are better prepared to restore public services and ensure the public health and safety in the aftermath of a disaster, and they are better positioned to receive the full level of assistance available to them from FEMA and other participating entities.

The core components of a comprehensive debris management plan incorporate best practices in debris removal, reflect FEMA eligibility criteria, and are tailored to the specific needs and unique circumstances of each applicant. The intent for development of a debris management plan is to provide applicants with a programmatic and operational framework for structuring their own debris management plan or ensuring that their existing plan is consistent with FEMA's eligibility criteria.

Key elements from the risk assessment portion of the hazard mitigation planning will again be utilized to further support and update the County's Debris Management Plan during its update (which is underway as of October 2019). The Debris Management Plan will utilize results from the HAZUS model for flood and earthquake, which identified debris amounts for specific incidents.

2.10 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. 44 CFR requires that the public have opportunities to comment on disaster mitigation plans during the drafting stages and prior to plan approval (Section 201.6.b.1).

2.10.1 Strategy

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).

- Several Planning Team Members throughout the County posted links to the survey and information concerning the mitigation planning effort on their various Facebook and Twitter accounts.

- The planning team attempted to reach as many citizens as possible using multiple formats. This is important because of the somewhat geographically remote areas in the county.

- Identify and involve planning area stakeholders.

- Newsletter articles about mitigation efforts, such as the of FEMA flood maps, National Flood Insurance Program, and other hazard-specific outreach, etc. were provided and distributed at various outreach events which occurred during the plan development period.

Of interesting note, one element addressed within the County's survey involved citizens' identification of the various means they felt were most appropriate for obtaining disaster-related information, or information about the hazards of concern. Of the survey respondents, well over half identified the use of the Internet being most effective, followed by respondents identifying Social Media as being additional as effective. Approximately less than one-third of the respondents indicated that a separate public meeting was an effective tool to disseminate related information. Such information assisted in validating the public outreach strategy identified at the onset of the planning process as being effective for the planning area. Such information will further help support the planning partners in their continued public outreach efforts related to the Plan Maintenance Strategy for the HMP.

2.10.2 Hazard Questionnaire

A web-based hazard mitigation plan questionnaire was developed by the planning team. The questionnaire was used to gauge household preparedness for natural hazards and the level of knowledge of tools and techniques that assist in reducing risk and loss from natural hazards. This questionnaire was designed to help identify areas vulnerable to one or more natural hazards.

Hard copies of the questionnaires were also made available and discussed at public meetings. The survey was advertised via press releases and advertised the website.

The Survey also provided an opportunity for citizens to provide comments during the entire process, from the initial drafting stages when the survey was deployed, until the draft plan was available for review. Comments received, which were relevant to the planning process and provided applicable information to the various sections of the plan were incorporated as appropriate.

Generally, most comments received were of the "response" nature with respect to evacuation areas in the event of a tsunami or earthquake, and various mechanisms and efforts citizens have performed already to prepare themselves – an information exchange.

Over 144 questionnaires were completed during the course of this planning process. The complete questionnaire and a summary of its findings can be found in Appendix B.

ANSWER CHOICES		RESPONSES	
Avalanche		0.00%	0
Dam/Levee Failure		1.39%	2
Disease Epidemic		13.19%	19
Drought		31.94%	46
Earthquake		31.25%	45
Flood		25.00%	36
Hazardous Material Incident		14.58%	21
Ice Storm		59.72%	86
Landslide		6.94%	9
Severe Weather (excessive heat/cold, wind, lightning, snow/winter storm, etc.)		85.42%	123
Civil Disturbance		13.19%	19
Volcanic Eruption (lahar, ash fall)		8.33%	12
Wildland Fire		63.19%	91
Urban Fire		9.72%	14
None		1.39%	2
Other (please specify)	Responses	2.08%	3
Total Respondents: 144			

2.10.3 Survey Results

Additional points of interest from the survey results include:

31.25 percent of respondents have experienced an earthquake; 8.33 percent have experienced a volcanic eruption, and 85.42 percent have experienced a severe weather event.

Of the 15 disaster declarations occurring in the County, 11 have been as a result of Severe Weather (which may include flooding as a component), while four (4) have been as a result of Flood events. Severe Weather events are the majority of hazards that have impacted the County since 1951.

Severe Weather and Wildfire are the hazards of greatest concern to citizens, with the prioritized scoring closely mirroring that identified by the HMP Planning Team, confirming the hazards of greatest concern by both the planning team, and the citizens of the area. Severe Weather and Wildfire were in the same order of significance.

Approximately 32 percent of citizens responded that they considered Drought of higher concern in the planning area than Earthquake.

2.10.4 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. 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 was publicized in all press releases, mailings, questionnaires and public meetings. Information on the plan development process, the use of a Planning Team, the questionnaire and phased drafts of the plan were 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.

In addition, several of the planning partners also posted information on their respective websites, posting frequently asked questions, and asking for citizen comments. As comments were received, they were reviewed by the planning team and integrated into the plan as appropriate.

2.10.5 Social Media

In addition to the website, the County also has a Twitter account and a Facebook account which has approximately 5,000 followers (see figure right). Both were utilized to distribute information concerning the plan's update; to distribute information concerning the survey; advise citizens of the availability of the hazard maps for review and comment; announcing public outreach events, and when the final plan was complete, alerting citizens to the draft plan, asking for review and comment during the open public comment period.

Figure 2-1. Spokane County Facebook Page

Various Planning Team members also utilized established accounts to distribute information, such as the City of Spokane Valley, which created a news article/webpage (http://www.spokanevalley.org/qcontent/NewsFeed.aspx?FeedID=6544), and provided updated information on its Facebook and Twitter accounts.

2.10.6 Public Meetings

Several public meetings and events which were open to the public were held during this effort, including regular use of the LEPC meetings, safety fairs, presentation at Veterans Day events, etc. All planning meetings were open to the public, and citizens did attend those meetings, providing information and input. The figures below highlight some of the public outreach efforts conducted. In addition, some public meetings which were held in conjunction with County Commissioner's Meetings were also recorded for viewing at a later date by citizens or other interested parties.

The various Fire Districts also held regular monthly and quarterly meetings, all of which were open to the public, during which various elements of the HMP process were discussed, in addition to the hazard risks associated with each district, and potential mitigation strategies. These sessions were advertised via the website, press coverage and flyers posted throughout the planning area.

The LEPC was also involved in this process. Project Manager Bozarth regularly updated the LEPC members during the entire process, giving regular updates at every meeting, and presenting risk information and posters, soliciting input and information from all LEPC members in attendance.

The meeting format allowed attendees to examine maps and handouts and have direct conversations with project staff. Reasons for planning and information generated for the risk assessment were shared with attendees. Planning partners and the planning team were present to answer questions. Each citizen attending the open houses was asked to complete a questionnaire, and each was given an opportunity to provide written comments to the steering committee. Local media outlets were informed of the open houses by a press release from the County.

During the public comment period, several meeting were held to inform the public about the draft plan and how to review and comment on it. Approximately three weeks prior to the plan becoming available on-line, planning team members, during other public meetings and forums, announced the impending availability of the plan, inviting citizens to review the plan by downloading it from the County's website.

In addition, Project Manager Bozarth also provided a power point presentation to several of the local municipalities at the completion of the risk assessment and strategy development portion of the plan, as well as during the adoption phase. During those sessions, which were open to the public and advertised, a 15-minute presentation on the draft plan was given

Press Releases

Press releases were distributed to all media outlets over the course of the plan's development as key milestones were achieved. Interviews with County Project Manager Bozarth and Deputy Emergency Management Director Fox also occurred concerning various aspects of the plan, including identification of hazards concerning, with a key focus on unreinforced masonry structures in the County (as well as other hazards of concern), and information of the mitigation planning process and survey information by the Deputy Director.

2.11 PLAN DEVELOPMENT CHRONOLOGY/MILESTONES

Table 2.2 summaries important milestones in the development of the plan.

Table 2-2.
Plan Development Milestones

Date	Event	Description	Attendance
2019			
April	Contractor Selection	County selects Bridgeview Consulting, LLC to facilitate the development of the mitigation plan update	N/A
April	Public Outreach Strategy	Initial press release on the planning process disseminated by Spokane Department of Emergency Management	N/A
May	Kick-off meeting	Kick-off meeting held to organize planning partnership – Confirmed Goals & Objectives – Confirmed Hazards – Confirmed definition of Critical Facility – Provided information on methodology for Risk Assessment – Identified Public Outreach Strategy	~35
May	Public Outreach Strategy	Hazard Mitigation Plan website established on Spokane Department of Emergency Management website; Facebook and Twitter Accounts utilized to announce effort.	N/A
May	Public Outreach Strategy	Hazard Mitigation survey posted on Spokane Department of Emergency Management website.	N/A
6/1/19	Public Outreach	Project Manager Gerry Bozarth presented information concerning the HMP update at the Community Organizations Active in Disasters (COAD) meeting.	
6/19/19	LEPC Meeting	Project Manager Gerry Bozarth presented information concerning the HMP update. Topics of discussion during the LEPC meeting included water purveyors and the risk from associated hazmat sites and a review of the natural hazards of concern.	17
Aug	Planning Team Meeting	Topics of discussion during the planning team meeting included review of the initial hazard maps, confirming the countywide risk assessment, and working through the process for each planning team member to conduct their internal hazard ranking based on the confirmed risk assessment.	
8/12	Public Outreach	City of Spokane Valley established Facebook and Twitter announcements concerning planning process and survey link. The PIO developed a news article and webpage to disseminate information and provide a link to the plan. http://www.spokanevalley.org/qcontent/NewsFeed.aspx?FeedID=6544	

Table 2-2.
Plan Development Milestones

Date	Event	Description	Attendance
9/10	Primera Safety Fair	Planning team members coordinated information at the Primera Safety Fair that talked about various risks and hazards, and how citizens can prepare themselves.	
9/11	Interview - Spokesman Review	EMD Deputy Director Chandra Fox was interviewed by the Spokesman Review for Preparedness Month. Discussions included an update on the mitigation plan process, identification of the risks and hazards of concern, and a review of the survey questions. Deputy Director Fox also advised that the risk assessment has been completed, and maps are available for review.	
9/18	LEPC Meeting	During the monthly LEPC meeting, Project Manager Gerry Bozarth made a presentation of the risk findings, risk maps, and the risk ranking information via a Power Point. Topics also involved the strategy development, and availability of the draft plan for review by citizens.	21
Various	Public Outreach Strategy	Public notices via County website of upcoming meetings, Facebook and Twitter posters, and website announcements were made concerning the open houses to review the various hazards maps and provide input to the planning team members.	N/A
10/1/19	Public Outreach – Presentation of Risk	The countywide risk assessment was provided by consultant, with the majority of all planning team members present. Information was exchanged concerning the hazard, areas of greatest concern, and the results of the hazard ranking. Citizen results from the survey were also presented, with additional surveys available for response during the meeting.	~25
10/1/19	Planning Team Meeting	After the public outreach event occurred (12-3) a Mandatory workshop was held to assist with Strategy Development by the planning team members. Several examples were discussed, with FEMA's Mitigation Ideas guidebook presented, along with other cheat-sheets and information. At the completion of the planning team meeting, the Jurisdictional Annex workshop was held for all planning partners to go over completion of their jurisdictional annex template.	~16
11/12/19	Spokane Conservation District	Planning Partner Garth Davis provided an overview of the hazard mitigation planning process, the risk assessment and the Conservation District's planning annex to the Board of Supervisors, a meeting which is advertised and open to the public.	Unknown
11/14/19	Planning Team Review	The draft of the base plan was provided to the planning team members, with a two week period provided for comments.	
12/10	Public Outreach Strategy	Initiation of final public comment period. Various planning team members made announcements of the plan's availability during open meetings; the County issued a separate press release announcing that the draft plan was available for review and comment for a 14 day period.	N/A
1/2	Public Outreach Strategy	End of final public comment period	N/A
2020			
1/6	Plan submittal	Draft plan submitted to the Washington Emergency Management Division for pre-adoption review and approval.	N/A
Feb	Plan submittal	Draft plan submitted to FEMA	N/A
March	Pre-adoption approval	Approval Pending Adoption (APA) letter issued by FEMA	N/A
March / April	Adoption	Adoption window of final plan opens	N/A
April	Plan approval	Final plan approved by FEMA	N/A

Figure 2-2. June LEPC Meeting

Figure 2-3. Strategy and Template Development Workshop

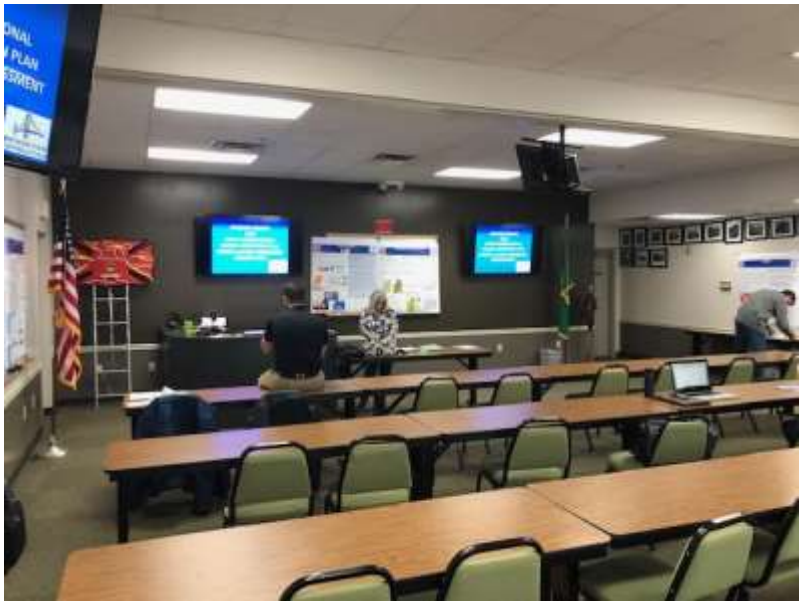


Figure 2-4. Presentation of Risk Findings(Meeting Setup)

Figure 2-5. September LEPC Meeting Risk Presentation

CHAPTER 3.
SPOKANE COUNTY PROFILE

Spokane County is located in northeastern Washington adjacent to the Idaho border (see Figure 3.1). The County has an array of landscapes ranging from the mountainous area in the northeast, including Mount Spokane, to the semiarid basalt plains in the southwest. Between these extremes are the rolling wheat lands of the Palouse area, the channeled scablands created by the glacial floods, and the Spokane metropolitan area. The total County area is approximately 1,763 square miles, making it 19th in size among the state's counties, with a population of 514,631 (2018 census). Spokane County is rectangular, except for the northwest corner, which is bounded by the Spokane River (see Figure 3-1). Pend Oreille and Stevens Counties provide its northern boundary, Lincoln County its western boundary, Whitman County its southern boundary, and the State of Idaho its eastern boundary.

3.1 JURISDICTIONS AND ATTRACTIONS

Spokane County has 13 incorporated communities:

- City of Airway Heights
- City of Cheney
- City of Deer Park
- Town of Fairfield
- Town of Latah
- City of Liberty Lake
- City of Medical Lake
- City of Millwood
- Town of Rockford
- City of Spangle
- City of Spokane
- City of Spokane Valley
- Town of Waverly

One way to describe Spokane County is by the major, unique landscapes and landforms and past geologic processes. The features and soils seen now are the result of past cataclysmic events of floods, uplift (mountain building) and volcanic activity. The county is divided in two parts by the Spokane River flowing east to west, eventually joining the Columbia River. The river having carved its path through the basalt is flanked above by outwash terraces and plains in the valleys to the north and the loess covered and scoured basalt plateau to the south. Multiple flood events from glacial Lake Missoula have made their mark in Spokane County. They have sculpted the basalt plateau by scouring and depositing soil material along the way, leaving in their wake, a wide swath of unique features, called the channeled scablands. Also in the southern part of the county are the fertile, rolling, loess hills of the Palouse.

The southeastern part of the county is in the Palouse Hills Region, which is characterized by rolling to hilly topography and deep soils that formed in silty material deposited by wind. Basalt is the base rock, but there are a few promontories of quartzite, shale and sandstone in the region. Tekoa Mountain, the highest part of this region, rises to an elevation of 3,900 feet.

The Northern part of the county is in the Okanogan Highlands. This region consists of mountains, foot slopes, glaciated valleys, broad glacial lake terraces, and outwash terraces. It includes Mount Spokane, the

highest point in the county, which has an elevation of 5,882 feet. Glacial scouring and damming by deposits by glacial meltwater created Newman, Liberty and Eloika Lakes. With its unique range of outdoor recreational opportunities, Spokane County has much to offer outdoor enthusiasts. The four distinct seasons and holdings of public lands have made this area an increasingly popular place in which to recreate. Fishing and hunting, skiing, equestrian activities, snowmobiling, hiking and biking are some of the more popular types of outings (Spokane County, 2012a).

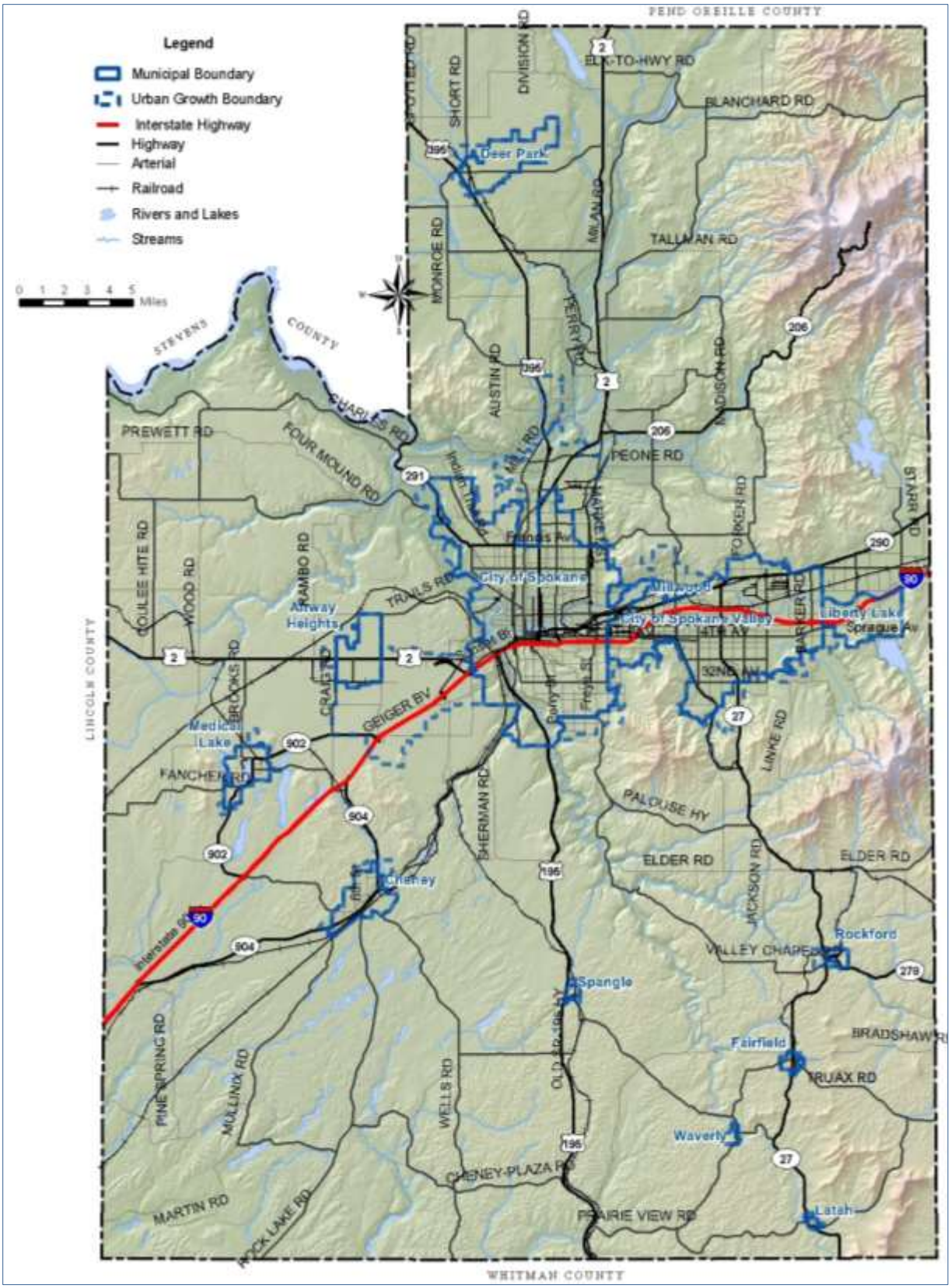


Figure 3-1. Main Features of Spokane County

3.2 HISTORICAL OVERVIEW

The City of Spokane was an early hub for the mining, timber and railroad industries of the Inland Northwest, while cattle ranging and wheat farming became important in the surrounding areas. Today, the city and county of Spokane serve as a medical, financial and commercial center for region from the Cascades to western Montana. Fairchild Air Force Base is the county's largest employer, and agriculture remains important. The following are key events in the history of the Spokane County area (HistoryLink.org, 2012 and Spokane County, 2012b):

- Before European and American settlement of the area, three bands of Spokane Indians—Upper, Middle and Lower—lived in the Spokane River watershed and the Coeur d'Alene Tribe lived along the river near the present-day border with Idaho.

- In 1810, the British fur-trading North West Company sent two men to establish a trading house in the territory. They built Spokane House at the confluence of the Spokane and Little Spokane Rivers, the first long-term European settlement in what is now Washington.

- European/American settlement of the area through the 1840s and 1850s led to a period of conflicts with the Native American population. The end of hostilities in 1858 opened the region to further American settlement and development.

- On January 29, 1858, Spokane County was created by the Territorial Assembly. Pinkney City, a small trading post near Colville, was the first county seat.

- In 1863, Idaho Territory was created, cutting off two-thirds of Spokane County.

- On January 19, 1864, Spokane County was annexed to Stevens County by act of the Territorial Legislature.

- The 1870s saw the rise of Spokane Falls from a homestead and gristmill to a village to a city of a few hundred by the time of incorporation in 1881.

- In 1879, Spokane County was again established as a separate county.

- In 1880, the first county seat election was held, and the City of Cheney became the county seat for six years.

- Spokane County boomed during the 1880s with the arrival of the Northern Pacific Railroad in 1881 and with mining in the mountains to the north and east. Although no mining took place in Spokane County itself, the city of Spokane became the commercial and residential center for the mining industry and the railroads in the Inland Northwest.

- In 1883, Lincoln County was subdivided from Spokane County, establishing the present county boundaries.

- In 1886, the county seat was moved to Spokane after a second election.

- In 1893, construction of the present County Courthouse began. Its initial cost was $273,600. All county officials moved into quarters in the new courthouse by November 20, 1895.

- By 1900, Spokane County had a population of 57,500 in more than 20 towns.

- The area's economic growth slowed by the 1920s, as older mines in Idaho that had contributed wealth to Spokane began to play out. With the Great Depression, the area entered a long period of economic stagnation and lack of growth.

- During the 1930s, construction of the Grand Coulee Dam, 75 miles to the west, and other New Deal programs drew people to the area and provided employment for those already in the county.

- During the early years of World War II, several units of the Army Air Corps occupied the newly completed Geiger Field, just west of Spokane. Three years after the war, the War Department returned Geiger Field to the city; it would become Spokane International Airport.

- In 1943 the War Department opened the Galena aircraft maintenance and supply depot on donated farmland. The depot's mission changed and grew during the postwar years and in 1951 it became Fairchild Air Force Base.

- The Spokane County Courthouse was extensively remodeled in 1946, and a new wing was added in 1956, which cost more than the original building: $525,000.

- In recent decades, the population growth of Spokane County has been largely outside the City of Spokane; between 1970 and 2000, the population of Spokane grew 15 percent while the population in other areas of the county increased 90 percent.

- The county is drained by two principal streams: the Palouse and Spokane Rivers. All the water ultimately drains into the Columbia River. Approximately 400 square miles of the southwestern part of the county lie within the Palouse River basin. All streams in this part of the county, except North Pine Creek, are intermittent. This area has many lakes and poorly drained depressions.[1]

- The Spokane River has only two perennial tributaries: the Little Spokane River from the north and Hangman Creek from the south. The little Spokane River drains the entire northern part of the county through Dragoon, Dry, Deer and Deadman Creeks. Hangman Creek drains all of the southeastern part of the county, but it discharges very little water into the Spokane River except spring runoff from melting snow.

- The City of Spokane straddles the Spokane River from approximately 2 river miles downstream from its confluence with Hangman Creek to approximately 9 river miles upstream from the confluence. Except for the southern part, the city is located almost entirely on the surface of the gravel fill of the Spokane Valley. Most of the city lies at elevations from 1900 to 2100. The City of Spokane consists of rich farmlands, both non-irrigated and irrigated, extensive mineral deposits, and thousands of acres of commercial timber. However, the city is not noted for employment in these fields of activity, but rather the secondary type industries, such as trade, transportation, finance and services. Historically, these areas of employment that tend to experience a relatively stable existence. As a result, variations in business activity within

[1] USDA Soil Survey, Spokane County, WA. (1968). Accessed 10/8/19. Available at: https://books.google.com/books?id=vKIMcjrd1j8C&pg=PA1&lpg=PA1&dq=spokane+county+is+drained+by+two+principal+streams&source=bl&ots=RNLEJDrc2j&sig=ACfU3U0klgCrGHzSTFvHnBrcGGbZW2f9gg&hl=en&sa=X&ved=2ahUKEwisyYn5i43lAhXXjp4KHaKxDYwQ6AEwCHoECAcQAg#v=onepage&q=spokane%20county%20is%20drained%20by%20two%20principal%20streams&f=false

Spokane have been less pronounced than elsewhere in Washington. These conditions are expected to continue relatively unchanged.

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 1964, 15 federal disaster declarations have affected Spokane County, as listed in Table 3-1 (FEMA, 2019)[2]. In addition, four declarations prior to 1964 are Washington-statewide, not Spokane County specific as FEMA did not begin distinguishing declarations by county until 1964. There are also four Emergency Management Declarations for the County, which did not rise to the level of a Federal Declaration, but did significantly impact the County. There is also one Fire Mobilization Declaration which occurred. 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.

[2] FEMA Disaster Declarations Summary. Accessed May 9, 2019. Available at: https://www.fema.gov/media-library/assets/documents/28318?id=6292

Table 3-1.
Disaster Declarations in Spokane County

Disaster Number[a]	Declaration Date	Incident Type/ Title
DR-50[b]	2/25/1956	Flood/ Flood
DR-70[b]	3/6/1957	Flood/ Flood
DR-137[b]	10/20/1962	Severe Storm/ Severe Storm
DR-146[b]	3/2/1963	Flood/ Flood
DR-185	12/29/1964	Flood/ Heavy Rains & Flooding
DR-623	5/21/1980	Volcano/ Volcanic Eruption, Mt. St. Helens
DR-769	7/26/1986	Flood/ Severe Storms and Flooding
DR-922	11/13/1991	Fire/ Fires
DR-1100	2/9/1996	Flood/ High Winds, Severe Storms and Flooding
DR-1152	1/7/1997	Snow/ Severe Ice Storm
DR-1159	1/17/1997	Severe Storm/ Severe Winter Storms, Land- and Mud-slides, Flooding
DR-1172	4/2/1997	Flood/ Heavy Rains, Snow Melt, Flooding, Land- and Mud-slides
DR-1825	3/2/2009	Severe Storm/ Severe Winter Storm And Record and Near-Record Snow
DR-4249	1/15/2016	Severe Storms, Straight-line winds, Flooding, Landslides and Mudslides
DR-4309	4/21/2017	Flood, Severe Winter Storms, Flooding, Land- and Mud-slides
Emergency Declarations		
EM-3372	8/21/2015	Wildfires
EM-3037	3/31/1977	Drought/ Drought
EM-3086	8/19/1982	Flood/ Threat Of Flooding At Spirit Lake
EM-3227	9/7/2005	Coastal Storm/ Hurricane Katrina Evacuation
Fire Mobilization		
FM-2783	7/11/2008	Fire/ Spokane Valley Fire

a. Declaration number codes as follows: DR = Major disaster declaration; EM = Emergency declaration; FM = Fire management assistance declaration
b. Declarations prior to 1964 are Washington-statewide, not Spokane County specific; FEMA did not begin distinguishing declarations by county until 1964

3.4 PHYSICAL SETTING

Spokane County's terrain is varied. The northern county is forested and rugged. Mount Spokane, the highest point in the county, is 5,878 feet. The southeast county is a rich agricultural area among fertile Palouse soils. The southwest county has channeled-scabland rock outcroppings and big lakes. Much of this region is part of the Turnbull National Wildlife Refuge.

The diversity of Spokane County's natural environment is illustrated by ecosystems that range from sub-alpine forests to semi-desert scablands. This diversity supports a broad spectrum of wildlife, from the moose of Mt. Spokane to the western painted turtles of Granite Lake. Numerous lakes, rivers and wetland areas provide linkages and corridors for wildlife. Spokane County's natural environment also includes the Spokane-Rathdrum aquifer, which is one of the most productive aquifers in the United States (Spokane County, 2012a).

The county has two rivers. The Little Spokane River flows south from Pend Oreille County to the Spokane River in the center of the county. The Spokane River, outlet for Lake Coeur d'Alene, flows west from Idaho into central Spokane County and through the cities of Spokane and Spokane Valley. The river turns to the northwest, joining the Little Spokane River at the northwestern boundary of the county, eventually emptying into the Columbia River.

The lowest point in the county is the Spokane River behind Long Lake Dam (boundary of Stevens County) at 1538 feet (468 m) above sea level. (There is virtually no change in elevation between the dam and the mouth of the Little Spokane River inside Riverside State Park.) The highest point in the county is the summit of Mount Spokane at 5,883 feet (1793 m).

The Spokane River originates in Coeur d'Alene Lake in Idaho, which is fed by the Coeur d'Alene and St. Joe Rivers. The watershed of the Spokane River in Idaho is largely forested mountains. From the Washington-Idaho border, the Spokane River flows westerly across Spokane County through a flat alluvial valley, averaging from 2-3 miles in width, to the eastern corporate limits of the City of Spokane. There it enters a canyon that extends through the city. The tributary area of Coeur d'Alene Lake is approximately 3,700 square miles, and it drains mountainous, forested area with elevations ranging from 2,120 feet at Coeur d'Alene Lake to 6,500 at the crest of the Bitterroot Mountains. Coeur d'Alene Lake is a natural lake and has a natural outlet; it can regulate flows of up to 15,000 cubic feet per second (cfs) at a lake level of 2,131.9 feet. When the lake stage exceeds 2,131.9 feet, the control passes from the dam to the natural lake outlet.

Hangman Creek drains an area that is predominantly dry-farmed in wheat on Palouse soils with rolling topography. Its total basin above the confluence with the Spokane River is 689 square miles, of which 203 square miles are in Idaho. It enters Spokane in the southwestern part of the city and flows north-northwesterly to the confluence with the Spokane River.

3.4.1 Geology

The structural features of the Spokane Valley are the result of a complex sequence of intense folding and faulting. Geologic structures within the planning area fall into two units based on their permeability. The consolidated Precambrian and Tertiary rocks, composing one unit, are relatively impermeable and allow delineation of the bottom and the sides of the valley. Unconsolidated Quaternary deposits compose the second unit and define the extent and thickness of the valley fill. This unit consists mainly of poorly sorted, reworked, glaciofluvial deposits of sand and gravel.

Over time, local geology and the dry, temperate climate have developed soils, aquifers and water bodies that interact in complex ways. Groundwater is located in soil pore spaces and in the fractures of rock formations. In addition to supplying water for human needs such as drinking, crop irrigation and industrial use, groundwater plays a critical role in the environment. Water that moves from the subsurface into streams maintains a base level of flow in the streams during the summer when there is relatively little contribution from precipitation and snowmelt. Therefore, increased use of groundwater

could impact surface water resources, where there is hydraulic continuity. Management of the watershed's water resources requires a thorough understanding of the watershed's hydrogeology. Generally, principal aquifers in the watershed lie within unconsolidated sands and gravels, basalt, and basement rocks. The unconsolidated and basalt aquifers are the most suitable for extracting groundwater of sufficient quantity for municipal distribution systems.

The Natural Resources Conservation Service and the Spokane County Conservation District completed an update of the Spokane County Soil Survey in 2011. The soil survey covers over 1.1 million acres of agricultural, forest, range and urban lands within three Major Land Resource Areas:

- 9 - Palouse and Nez Perce Prairies
- 44A - Northern Rocky Mountain Valleys
- 43A - Northern Rocky Mountains.

Spokane County possesses a diverse topography that is dominated by the Cascade and Wenatchee Mountains. From the high Cascades, the land slopes generally downward to the east and south to the Columbia River. The eastern part of the county consists of low, rolling to moderately steep glacial terraces and long, narrow valleys. The southeast section of the county is characterized by moderately steep to steep glacial terraces and steep, rough, broken mountain foothills. The Spokane Valley- Rathdrum Prairie Aquifer in Washington and Idaho study area has undergone a complex series of geologic events that have resulted in the surface and subsurface geologic framework that exists today.

Seismic Features

The structural features of the Spokane Valley are the result of a complex sequence of intense folding and faulting. Geologic structures within the planning area fall into two units based on their permeability. The consolidated Precambrian and Tertiary rocks, composing one unit, are relatively impermeable and allow delineation of the bottom and the sides of the valley. Unconsolidated Quaternary deposits compose the second unit and define the extent and thickness of the valley fill. This unit consists mainly of poorly sorted, reworked, glaciofluvial deposits of sand and gravel.

Geologically hazardous areas are susceptible to earthquakes, erosion, landslides or other geologic events. Typically, they are not suited for commercial, residential or industrial development without mitigation. Geologic hazards are categorized as critical and sensitive areas under the Critical Areas Ordinance. Geologic hazards and constraints include erodible soils, alluvium, landslide deposits and Latah formation. Spokane County is in a region with a moderate risk of seismic activity. The Uniform Building Code classifies the area as Seismic Zone 2B.

Erosion

Spokane County defines erodible soils as those soil associations which have been found to have severe potential of erosion according to the U.S. Soil Conservation Service and/or which have a slope of 30 percent or greater. There are a few small areas of erodible soils located along the planning area border, primarily northwest of Mica Peak, east of Millwood, and in the northern portion of the North Spokane service area. Erodible soil types are found primarily in the northeastern and southeastern portions of the County. Small areas with these characteristics can also be found northeast and southeast of the City of Spokane, north and west of the City of Cheney, and west of the City of Medical Lake.

Landslide

Landslide hazard areas have been defined by areas with a history of landslide deposits, Alluvium, or the Latah formation. Landslide hazard areas are primarily located in pockets in the northern and central portions

of the County. These areas are associated with the Little Spokane River and with the foothills and mountainous areas north of the City of Spokane. Small areas are also present north and west of the City of Cheney. There are no Latah formations within the planning area boundaries; however, landslide deposits are found in a few areas bordering the planning area.

Soils

The planning area follows the Spokane River, resulting in level to gently sloping topography and consistent soil types. The soils of this area consist of the Garrison Marble-Springdale soil association, which is excessively drained sandy and gravelly soils formed in glacial outwash. The soils within the planning area are very porous in nature with a rapid water-intake rate and low water-holding capacity. These soils also have moderate resistance to erosion, high shear strength, and high load-carrying capacity. The high level of permeability is a concern for aquifer health, which is located directly under the planning area [ii].

Soils characteristics in other parts of the County outside of the planning area may be relevant to some wastewater management alternatives. These characteristics are described below.

- The southwestern part of the County consists of a broad basalt plateau. Only small remnants of pre-glacial soils, characterized by deep to shallow, gravelly or rocky soils with moderate permeability and low water-holding capacity, remain from the glacial floods.

- The southeastern part of the County is described by rolling to hilly topography with deep soils that formed from wind deposits of silty material. The soils are characterized as medium to fine-textured soils with moderate to slow permeability and high to moderate water-holding capacity. Basalt is the most prominent geologic formation, with quartzite, shale and sandstone also found in the region. The area consists of rolling loess uplands, glacial till plains, and mountain foot slopes.

- The Okanogan Highlands makes up the northern part of the County and consists of mountains, foot slopes, glaciated valleys, broad glacial lake terraces, and outwash terraces. Soils in the eastern area are characteristically deep, medium-textured soils of the hilly and mountainous areas with moderately rapid permeability and moderate water-holding capacity. Soils in the northwest consist of gravelly and sandy soils with rapid permeability and moderate water-holding capacity that formed in glacial materials.

3.4.2 Hydrology

Spokane County has a large number of surface water bodies that provide a variety of economic, recreational and aesthetic benefits and use. The county has two rivers. The Little Spokane River flows south from Pend Oreille County to the Spokane River in the center of the county. The Spokane River, outlet for Coeur d'Alene Lake, flows west from Idaho into central Spokane County and through the Cities of Spokane and Spokane Valley. The river turns to the northwest, joining the Little Spokane River at the northwestern boundary of the county, eventually emptying into the Columbia River. Almost all the perennial streams within the County are listed within the State's "303d" inventory as having impaired water quality.

Flow on the Spokane River is regulated by a series of dams. There are seven hydroelectric dams on the Spokane River, from Post Falls Dam at the outlet from Lake Coeur d'Alene to Little Falls Dam at river mile 29. One dam, the Upriver Dam, is owned and operated by the City of Spokane Water Department; the others are owned by Avista Corporation. Other major dams along the Spokane River include the Nine Mile Dam, Long Lake Dam and Little Falls Dam. They were constructed in 1908, 1915 and 1910, respectively. Grand Coulee Dam is located on the Columbia River and creates the Spokane Arm of Lake Roosevelt. Four smaller dams listed in the Ecology dam database are associated with mining ponds—two in the Chamokane

Creek drainage; one in an unnamed drainage within the Spokane Indian Reservation, and one along the south shoreline of Lake Spokane.

Grand Coulee Dam has a significant effect on the watershed, with backwater from Lake Roosevelt impacting the lower 30 miles of the Spokane River. Water levels throughout this lower reach fluctuate throughout the year, with levels reaching a low point in the spring before refilling to a maximum level, usually by July 4. Monthly average flows on the Spokane River are shown in Table 3-2.

Table 3-2.
Monthly Average Spokane River Flow at Long lake dam

Month	Average Flow (cfs)	Month	Average Flow (cfs)
January	7,112	July	3,454
February	8,860	August	2,019
March	10,589	September	2,276
April	15,350	October	2,909
May	18,308	November	4,033
June	11,302	December	6,334

Bodies of water with a mean annual flow of greater than 20 cubic feet per second (in the case of flowing water) and an area greater than 20 acres (in the case of standing water) are considered Shorelines of the State and are subject to the Shoreline Management Act. The Act's area of jurisdiction is the body of water together with an adjacent strip of land generally 200 feet wide, measured landward from the ordinary high watermark. In compliance with the Shoreline Management Act, Spokane County adopted a Shoreline Management Program in 1975. The Shoreline Management Program established goals, policies and regulations to protect shoreline areas. Developments after 1975 have been conditioned to comply with the Shoreline Master Program.

3.4.3 Climate

The climate pattern in the County is related to a gradual increase in elevation from west to east. The County lies between the Rocky Mountains on the east, the Cascade Mountains on the west, mountains near the Canadian border on the north and Blue Mountains on the south. Eastern Washington climate is a function of maritime and continental influences. The marine influence is most noticeable in winter when the prevailing westerly winds are strongest and most persistent.

The County generally experiences seasonable weather patterns characteristic of eastern Washington. Warm, dry summers are usually experienced, although heavy rain and hail infrequently accompany thunderstorm activity. Mid-summer temperatures range in the middle and upper 80s; winter highs are usually in the 30s. Extreme temperatures can range from 110ºF to -30ºF.

Spokane County resides within Water Resource Inventory Area (WRIA) 54. Based on state data for WRIA 54, the average annual precipitation is 15.8 inches; approximately half of that amount falls as snow, which peaks between October and the end of March. November is the wettest month in the watershed, with average precipitation of 2.13 inches. July is the driest month in the watershed, averaging 0.57 inches of precipitation.

Table 3-3 shows the average monthly and annual rainfall in WRIA 54. Historic precipitation trends are illustrated in Figure 3-2.[3]

Table 3-3.
Average Monthly and Annual Rainfall in WRIA 54

Month	Month Average Precipitation (inches)	Month	Month Average Precipitation (inches)
January	1.89	July	0.57
February	1.52	August	0.59
March	1.39	September	0.82
April	1.08	October	1.15
May	1.40	November	2.13
June	1.20	December	2.08
		Annual Total	**15.82**

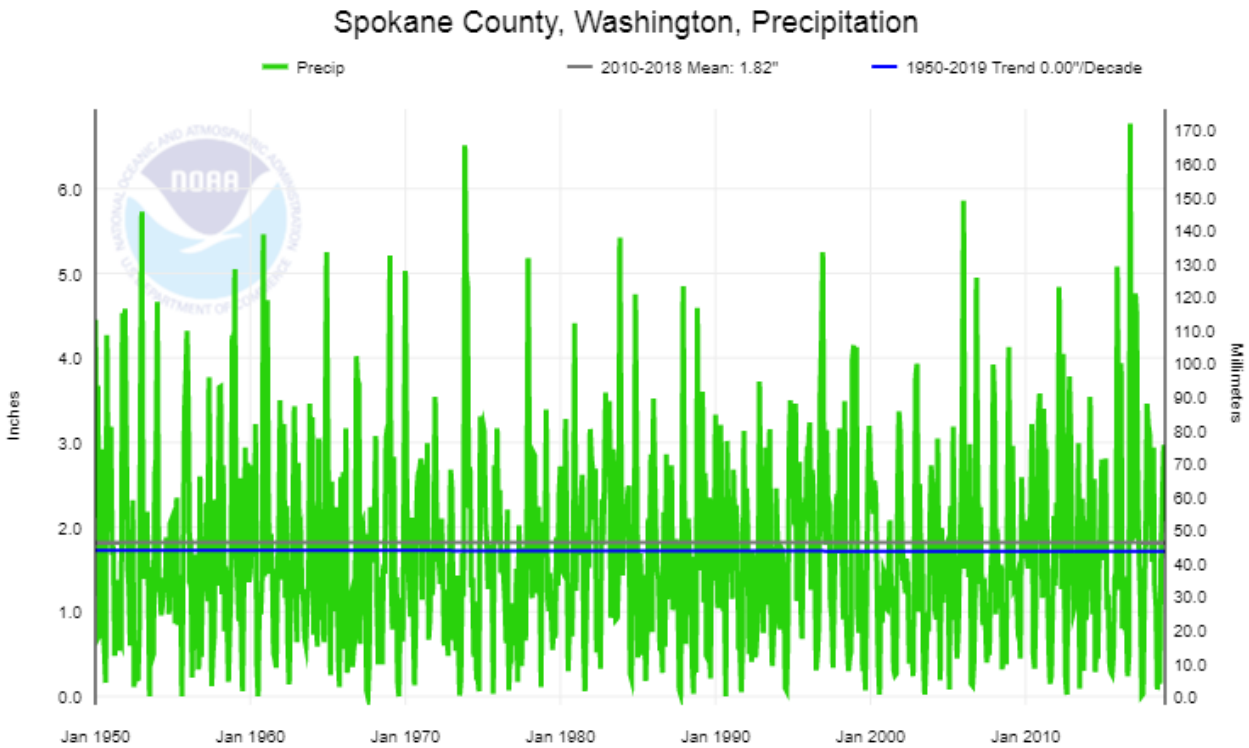


Figure 3-2. Precipitation Trends 1950-2019

[3] NOAA. Accessed June 18, 2019. Available at: https://www.ncdc.noaa.gov/cag/county/time-series/WA-063/pcp/all/5/1950-2019?base_prd=true&firstbaseyear=2010&lastbaseyear=2018&trend=true&trend_base=10&firsttrendyear=1950&lasttrendyear=2019

Snow, the dominant form of precipitation due to winter coinciding with the rainy season, accumulates to a depth of 10 to 15 inches and remains on the ground from December through February. Annual average precipitation increases from west to east, with the western portion of the County receiving less than 12 inches and the eastern part receiving over 24 inches. The average amount of snowfall that Spokane County receives annually is about 28 inches.

3.5 DEMOGRAPHICS

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

3.5.1 Population Characteristics

Knowledge of the composition of the population and how it has changed in the past and how it may change in the future is needed for making informed decisions about the future. Information about population is a critical part of planning because it directly relates to land needs such as housing, industry, stores, public facilities and services, and transportation.

As of 2017 (most recent data available as of the commencement of this update), Spokane County is the fourth largest county in the state by population, with 499,800 residents, and the eighth most densely populated county in the state, with 283 residents per square mile. Population changes are useful socio-economic indicators as a growing population generally indicates a growing economy, while a decreasing population signifies economic decline. Even though Washington State has seen higher growth rates than Spokane County during the period 2010-2017 at 10.1 percent versus 7.4 percent respectively, the trends of accelerating and decelerating growth have been generally the same for both. Table 3-4 summarizes 2017 population in the county by jurisdiction, demonstrating a 7.4 percent growth for the period 2010-2017, with only one jurisdiction, Spangle, decreasing in population (down by 5 people). The average number of persons per household in Spokane County was 2.43 according to the U.S. Census Bureau.

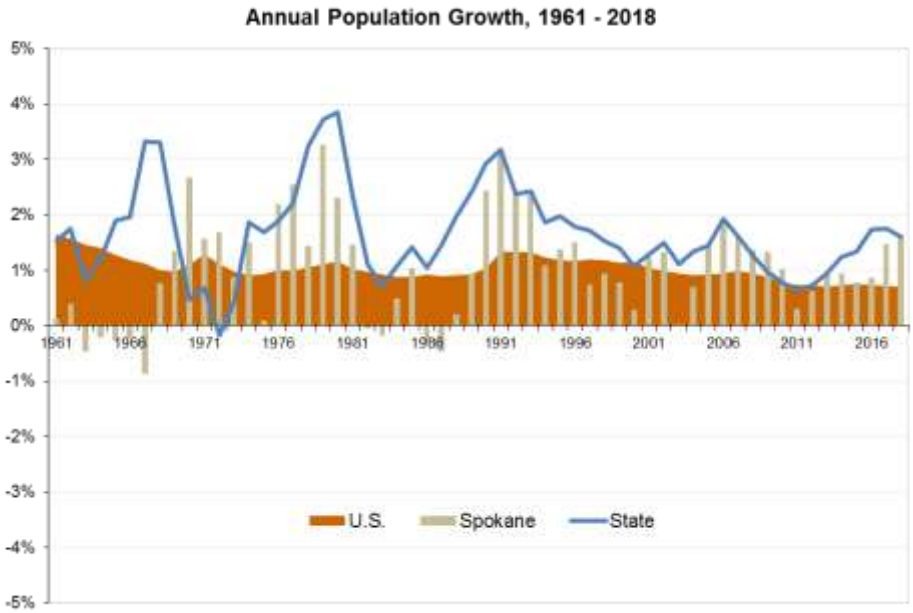


Figure 3-3. Annual Population Growth 1961-2018

Source: Washington Office of Financial Management, US Bureau of Economic Analysis (2018).

Table 3-4.
2017 Spokane County Population by Jurisdiction

Jurisdiction	Population as of April 1, 2017
Airway Heights	8,460
Cheney	11,800
Deer Park	4,105
Fairfield	620
Latah	195
Liberty Lake	9,910
Medical Lake	4,990
Millwood	1,790
Rockford	480
Spangle (declined by 5)	275
Spokane	217,300
Spokane Valley	94,890
Waverly	117
Unincorporated	144,788
Total	**499,720**

Source: Washington State Office of Financial Management, 2019 (2017 data most current)
https://www.ofm.wa.gov/sites/default/files/public/dataresearch/databook/pdf/53063.pdf

3.5.2 Income

In the United States, individual households are expected to use private resources to prepare for, respond to and recover from disasters to some extent. This means that households living in poverty are automatically disadvantaged when confronting hazards. Additionally, the poor typically occupy more poorly built and inadequately maintained housing. Mobile or modular homes, for example, are more susceptible to damage in earthquakes and floods than other types of housing. In urban areas, the poor often live in older houses and apartment complexes, which are more likely to be made of un-reinforced masonry, a building type that is particularly susceptible to damage during earthquakes. Furthermore, residents below the poverty level are less likely to have insurance to compensate for losses incurred from natural disasters. This means that residents below the poverty level have a great deal to lose during an event and are the least prepared to deal with potential losses. 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 the U.S. Census Bureau's American Community Survey (ACS) estimates, per capita income reached $42,028 in 2016, 23rd in the state. This is 14.7 percent below the U.S. average and 23 percent below the state average of $54,579. Median household income over the period 2012 to 2016 was $50,550, well below the state's $62,848, according to the U.S. Census Bureau QuickFacts. Over the period 2012 to 2016, 13.3 percent of the population was living below the poverty level in Spokane County. This is well above 11 percent for the state.[4]

Poverty by age and gender for 2017 is illustrated in Figure 3-4.[5]

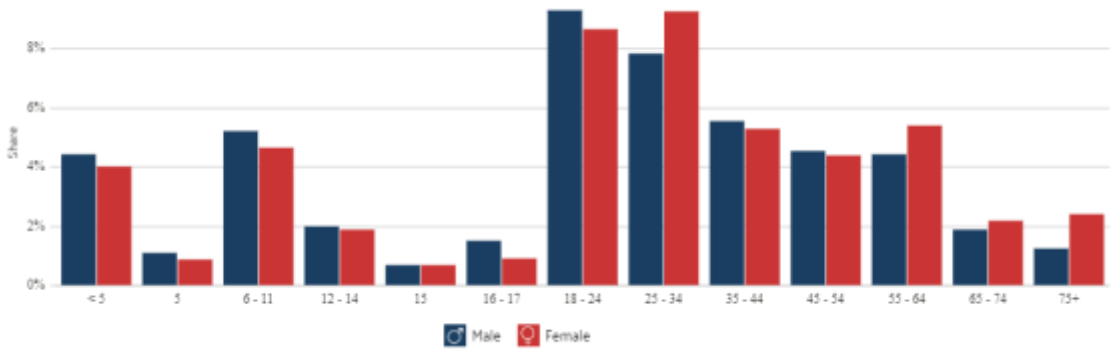


Figure 3-4. Poverty by Age and Gender

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 are more likely to suffer health-related consequences making recovery slower. They are more likely to be vision, hearing and/or mobility impaired, and more likely to experience mental impairment or dementia. Additionally, the elderly are more likely to live in assisted-living facilities where emergency preparedness occurs at the discretion of facility operators. These facilities are typically identified as "critical facilities" by emergency managers because they require extra notice to implement evacuation. Elderly residents living in their own homes may have more difficulty evacuating their homes and could be stranded

[4] Washington State Employment Security Department. Accessed May 9, 2019. Available online at: https://esd.wa.gov/labormarketinfo/county-profiles/spokane

[5] Data USA Accessed May 9, 2019. Available online at: https://datausa.io/profile/geo/spokane-county-wa/#housing

in dangerous situations. This population group is more likely to need special medical attention, which may not be readily available during natural disasters due to isolation caused by the event. Specific planning attention for the elderly is an important consideration given the current aging of the American population.

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

Based on U.S. Census estimates, 15.7 percent of Spokane County's population as of 2017 is 65 or older, compared to the state average of 15.1 percent. Within Spokane County, that represents a 2.4 percent higher percentage than in 2015, which identified 13.3 percent of the population 65 or older, demonstrating an aging population (see Table 3-5). Of the county's over-65 population, 6.8 percent are in the poverty rate, which is lower than the State's average of 8.0 percent, and beneath the U.S. average of 9.3 percent.

It is also estimated that 6.1 percent of the county's population is 5 or younger, compared to the state average of 6.2 percent and 22.2 percent of the county's population is 18 or younger, which is the same as the state's average of 22.2 percent. Children under 18 account for 16.7 percent of individuals who are below the poverty rate, compared to 14.3 percent at the State level, and the U.S. average of 18.4 percent (US Census QuickFacts).

Table 3-5.
2017 Percent Comparison Population by Age

Age Range	U.S.	State	Spokane
0-19	25.3	25.1	26.1
20-39	27.2	27.4	26.2
40-59	25.9	25.8	25.0
60+	21.6	21.7	22.7

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 2017, U.S. Census QuickFacts, the racial composition of Spokane County is predominantly white, at about 89.3 percent. The largest minority population is Asian at 3 percent. The Hispanic population represents 6.7 percent of the county total. Other than English, the most commonly spoken language in Spokane County is Spanish. The census estimates ~4 percent of the county's residents speak English "less than very well."

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.

According to 2013-2017 ACS data, 10.9 percent of the county's population under the age of 65 years has some form of a disability, while 37.5 percent of the population 65 and over has some form of disability. Total population with a disability status is estimated to be at 38,104 countywide.[6]

3.6 ECONOMY

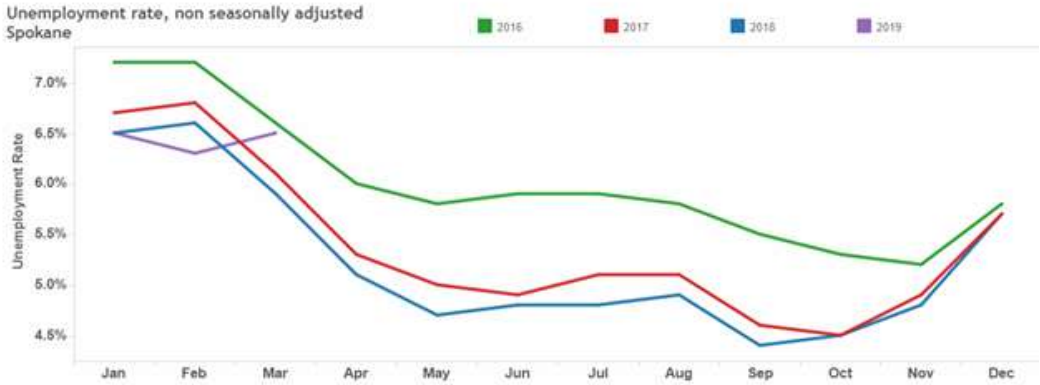
3.6.1 Employment Trends

Spokane County is the economic hub of the area known as the Inland Northwest. Medical services constitute the largest economic sector in the county. It also has strong and diversified manufacturing, wholesale trade and finance sectors. Other functions include a large agricultural community and a strong retail trade and services sector. The City of Spokane is the retail trade and services hub, and a regional center for arts and entertainment. Spokane County is also the home of Fairchild Air Force Base, the home of a refueling tanker unit, located in the western part of the county. U.S. Census data for 2011 show that Spokane County's economy is strongly based in education, health care and social assistance, with 26.5 percent of employees, followed by Retail Trade at 12.6 percent and arts, entertainment, recreation, accommodation and food services at 9.8 percent.

Unemployment in the area is higher than the state averages, which were 4.8 percent in 2018 and 5.0 in 2017 versus the 5.9 percent for 2018, and 6.1 percent for 2017 within Spokane County (see Figure 3-5).[7]

[6] American Fact Finder Accessed May 10, 2019. Available online at: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF

[7] Washington State Department of Labor Accessed May 10, 2019. Available online at: https://esd.wa.gov/labormarketinfo/labor-area-summaries



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	7.2%	7.2%	6.6%	6.0%	5.8%	5.9%	5.9%	5.8%	5.5%	5.3%	5.2%	5.8%
2017	6.7%	6.8%	6.1%	5.3%	5.0%	4.9%	5.1%	5.1%	4.6%	4.5%	4.9%	5.7%
2018	6.5%	6.6%	5.9%	5.1%	4.7%	4.8%	4.8%	4.9%	4.4%	4.5%	4.8%	5.7%
2019	6.5%	6.3%	6.5%									

Employment and unemployment, not seasonally adjusted
Spokane

	2019		2018	2017
	February	March	March	March
Civilian Labor Force	254,360	254,600	243,244	239,250
Employment	238,432	237,966	228,953	224,540
Unemployment	15,928	16,634	14,291	14,710
Unemployment Rate	6.3%	6.5%	5.9%	6.1%

Figure 3-5. Spokane County Unemployment Rates 2016-2019

3.7 LAND USE

The area of the various land use categories within Spokane County are shown in Table 3-6 and illustrated in Figure 3-6. Urban uses have replaced farms in the urban core of Spokane County. Urbanization is particularly evident in the center of the County along the Interstate 90 corridor. Prime farmland consists of rural land with excellent physical and chemical characteristics for the production of food, feed, forage, fiber and oilseed crops. There is prime farmland scattered throughout the County. Much of the best agricultural land in Spokane County was protected from development under the Comprehensive Plan. High quality agricultural soils in portions of southern and western Spokane County sustain dry land crops such as wheat in those areas. Spokane County has the second-highest number of farms in the state with 2,425; Yakima County has the highest number of farms, with 2,952.[8]

Under current zoning, densities range from fifteen units per acre to one unit per 40 acres. The High Density Residential zone allows a density of fifteen units per acre. The Low density Residential, Rural-5, Small Tract Agricultural, Rural Conservation, and large tract agricultural allow for a density range of six structures per acre to one unit per 40 acres. The lowest density in the county is in the Large Tract Agricultural Zone, where the assigned density is one unit per 40 acres.

[8] USDA Agricultural Publications (2017). Accessed May 9, 2019. Available at: https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_2_County_Level/Washington/st53_2_0001_0001.pdf

Table 3-6.
Existing Unincorporated Area Zoning By Acreage

Zone	Area (Acres)	Zone	Area (Acres)
Rural Traditional	250,285	Low Density Residential	13,863
Rural-5	5,483	Medium Density Residential	531
Rural Conservation	337,949	High Density Residential	223
Small Tract Ag	53,703	Mixed Use Area	527
Large Tract Ag	298,006	Community Center	79
Forest Land	48,501	Urban Activity Center	311
Mineral Land	5,243	Neighborhood Commercial	71
Limited Development Area Commercial/Industrial	466	Community Commercial	74
Limited Development Area Residential	837	Regional Commercial	751
Rural Activity Center	1,178	Light Industrial	4,913
Urban Reserve	21,780	Heavy Industrial	1,871
Low Density Residential Plus	325	**Total**	**1,046,970**

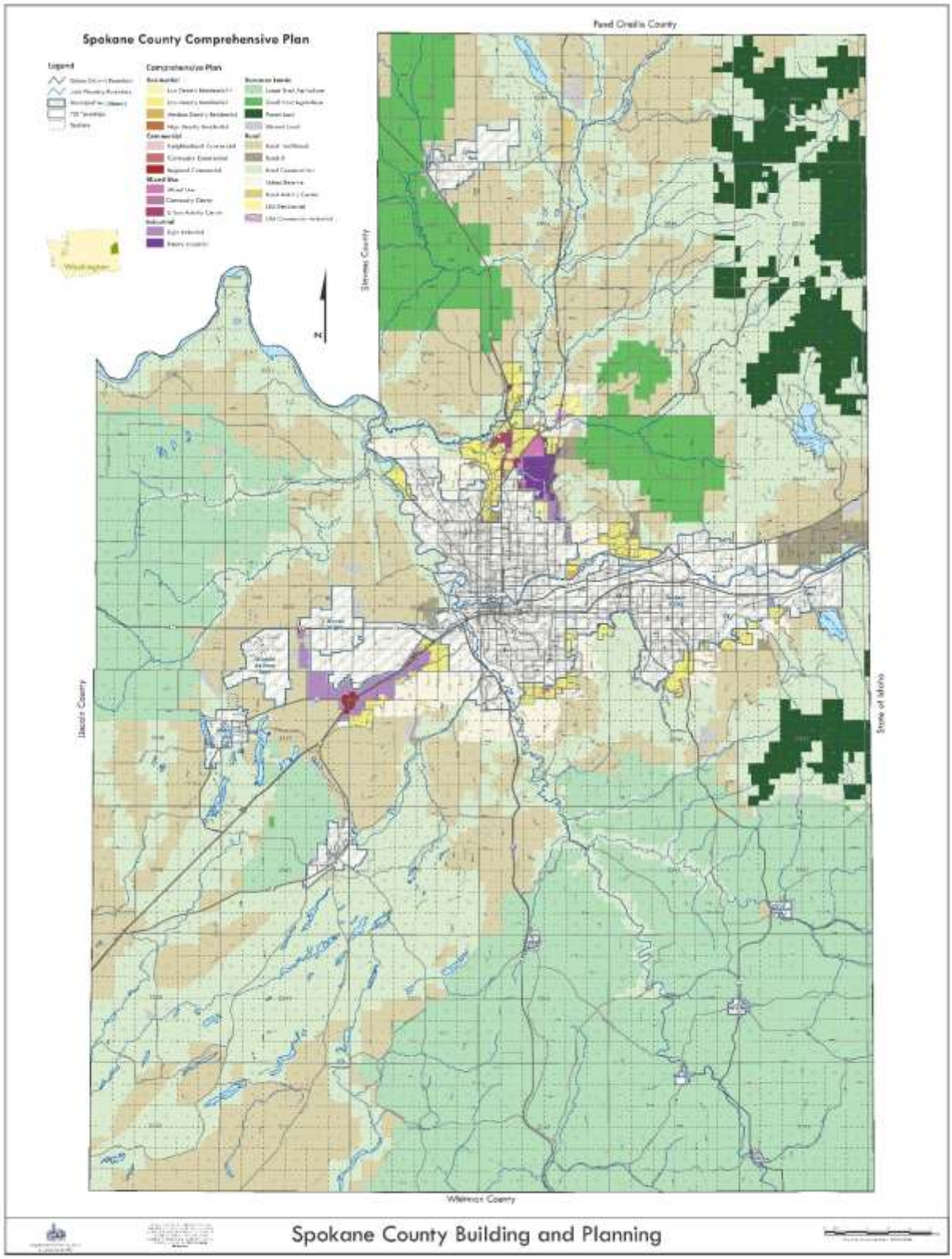


Figure 3-6. Spokane County Land Distribution
Source: Spokane County Comprehensive Land Use Plan

3.8 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.

Office of Financial Management's Forecasting Division provides data on Housing Units by Structure Type for Spokane County and its cities. Table 3-7 identifies structure types by jurisdiction.

Table 3-7.
Spokane County Housing Units By Structure Type (2018)

Jurisdiction	Total	Mobile Home/Special
Unincorporated Spokane County	59,196	9,592
Incorporated Spokane County	158,625	4,398
Airway Heights	3,389	531
Cheney	5,026	128
Deer Park	1,741	172
Fairfield	238	43
Latah	90	9
Liberty Lake	4,511	132
Medical Lake	1,874	133
Millwood	789	14
Rockford	214	61
Spangle	125	42
Spokane	98,630	1,570
Spokane Valley	41,943	1,534
Waverly	55	29
TOTAL	**217,821***	**13,990**

Source: Office of Financial Management Forecasting Division April 2018.
*Inclusive of total number of mobile homes.
Data accessible at: https://www.ofm.wa.gov/washington-data-research/population-demographics/population-estimates/april-1-official-population-estimates

3.8.1 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).

Customarily, within FEMA's Hazus Program, homes built prior to 1941 are considered pre-code; they were constructed before any type of earthquake building codes were put in place. Homes constructed after 1941 are considered moderate code as they may include some earthquake building components.

Data from 2017 U.S. Census data for Spokane County reported the highest percentage of its buildings had been built during the time period 1970-1979, with the second highest construction period occurring prior to 1939. Table 3-8 identifies the percent of homes constructed during the identified time periods. [9]

It should be noted that the data may be slightly skewed due to the fact that actual building code adoption dates may vary slightly by jurisdiction. Also, 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.

Table 3-8.
Spokane County Year / Percent House Built Distribution (Excludes Mobile Homes)

Year Structure Built	Total Number	Percent Total
Total housing units	217,821	217,827
Built 2014 or later	6,814	3.1%
Built 2010 to 2013	5,342	2.5%
Built 2000 to 2009	30,593	14.5%
Built 1990 to 1999	29,899	14.2%
Built 1980 to 1989	19,094	9.0%
Built 1970 to 1979	38,627	18.3%
Built 1960 to 1969	14,672	7.0%
Built 1950 to 1959	23,115	11.0%
Built 1940 to 1949	14,034	6.7%
Built 1939 or earlier	33,357	15.8%

3.9 CRITICAL FACILITIES AND INFRASTRUCTURE

Critical facilities and infrastructure are those that are essential to the health and welfare of the population. These become especially important after a hazard event. Critical facilities are typically defined to 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.

[9] https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF

The Planning Team reviewed the 2015 definition of critical facility, and made some slight modifications for the 2020 update to be more in line with the intent and capabilities of the County and its planning partners. As such, the definition for this hazard 2020 Hazard Mitigation Plan is as follows:

- Police stations, fire stations, city/county/tribal government facilities (including those that house critical information technology and communication infrastructure), vehicle and equipment storage facilities, communications center (dispatch), and emergency operations centers needed for disaster response before, during, and after hazard events.
- Public and private utilities and infrastructure vital to maintaining or restoring normal services to areas damaged by hazard events. These facilities include but are not limited to:
    - Public and private water supply infrastructure, water and wastewater treatment facilities and infrastructure, potable water pumping, flow regulation, distribution and storage facilities and infrastructure.
    - Public and private power generation (electrical and non-electrical), regulation and distribution facilities and infrastructure.
    - Data and server communication facilities.
- Structures that manage or limit the impacts of natural hazards such as regional flood conveyance systems, potable water truck, main interconnect systems and redundant pipes crossing fault lines and reservoirs.
- Major road and rail systems including bridges, airports, bus and marine terminal facilities.
- Educational facilities, including K-12 and community college.
- Hospitals and major medical/health care facilities.
- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic, and/or water-reactive materials.

Once the definition of critical facilities was confirmed, facilities within the planning area that fit the definition were inventoried using the comprehensive data management system extension to HAZUS-MH. Data was collected from a variety of sources. Data attributes on identified critical facilities were provided to the planning team, who developed an overlay map of the critical facilities. This map was compared with Spokane County hazard maps in order to identify which critical facilities are located in hazardous areas. To maintain confidentiality, the risk to these facilities is presented generically without giving location or estimated replacement costs. These data are presented by broad planning areas. This list of critical facilities resides with Department of Emergency Management, who over the course of time, will continue to update the list with new structures as they are identified or constructed. The planning team is aware that there may be structures currently not included on the list, and have established a means to ensure new structures are added for future evaluation. Figure 3-7 identifies the location of critical facilities and infrastructure in the planning area. Table 3-9 and Table 3-10 provide summaries of the general types of critical facilities and infrastructure. All critical facilities/infrastructure were analyzed in the risk assessment process to help rank risk and identify mitigation actions. The risk assessment for each hazard qualitatively discusses critical facilities with regard to that hazard.

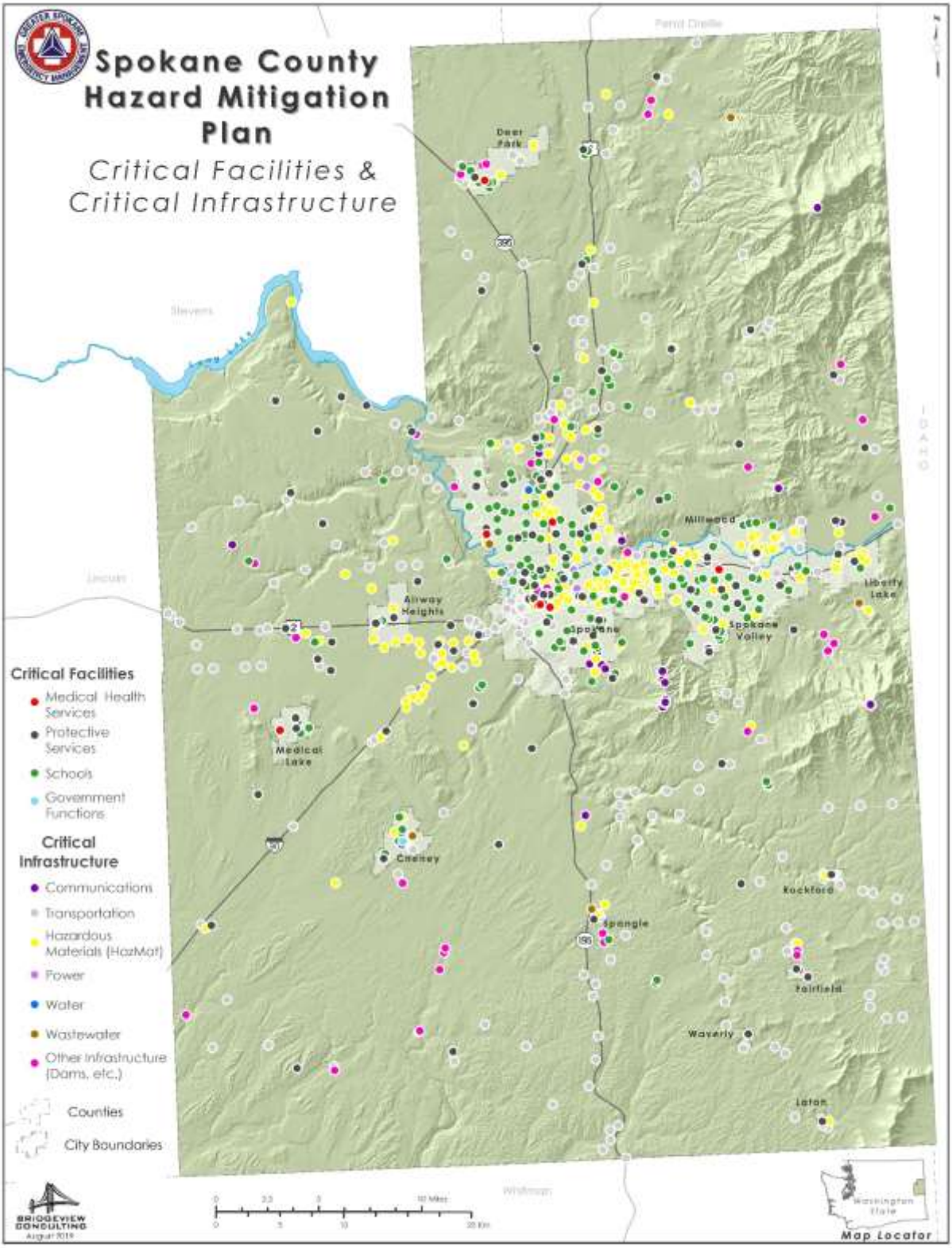


Figure 3-7. Spokane County Critical Facilities and Infrastructure

Table 3-9.
Spokane County Critical Facilities

Jurisdiction	Medical and Health	Government Functions	Protective Functions	Schools	Hazmat	Other Critical Functions	**Total**
Airway Heights	0	0	3	1	6	0	**10**
Cheney	0	1	4	7	6	0	**18**
Deer Park	1	0	2	5	3	0	**11**
Fairfield	0	0	2	0	0	0	**2**
Latah	0	0	1	0	1	0	**2**
Liberty Lake	0	0	2	1	6	0	**9**
Medical Lake	1	0	2	4	0	0	**7**
Millwood	0	0	2	2	1	0	**5**
Rockford	0	0	1	0	3	0	**4**
Spangle	0	0	1	0	2	0	**3**
Spokane	6	1	35	74	106	0	**219**
Spokane Valley	1	0	14	50	91	0	**156**
Waverly	0	0	1	0	1	0	**2**
Unincorporated	0	0	46	51	71	0	**171**
Total	**9**	**2**	**116**	**195**	**297**	**0**	**619**

Table 3-10.
Spokane County Critical Infrastructure

Jurisdiction	Bridges	Water Supply	Wastewater	Power	Communications	Other	**Total**
Airway Heights	0	0	0	0	0	0	**0**
Cheney	1	0	1	0	0	0	**2**
Deer Park	1	0	0	0	0	6	**7**
Fairfield	0	0	0	0	0	0	**0**
Latah	0	0	0	0	0	0	**0**
Liberty Lake	3	0	0	0	0	0	**3**
Medical Lake	0	0	0	0	0	0	**0**
Millwood	2	0	0	0	0	0	**2**
Rockford	3	0	1	0	0	0	**4**
Spangle	4	0	0	0	0	0	**4**
Spokane	134	0	1	2	9	12	**150**
Spokane Valley	37	0	0	1	1	5	**43**
Waverly	2	0	0	0	0	0	**2**
Unincorporated	196	1	4	10	27	42	**280**
Total	**383**	**1**	**7**	**13**	**37**	**65**	**497**

*Other Infrastructure includes airport facilities and runways, bus facilities, dams, highway tunnels, natural gas facilities, and rail.

3.9.1 Hazardous Materials

All communities located near Spokane County's major transportation corridors (land, rail and air) are subject to the probability of a significant hazardous materials release. Hazardous materials are transported over or near numerous wetlands, environmentally sensitive areas, and through densely populated centers. For example, the major east-west rail corridor is three blocks and Interstate 9 is one-half block north of a high school and both major regional hospitals. In addition, the rail lines pass near residential development areas, blocking traffic into/out of the developments. This is particularly true within Cheney, who has identified this issue as a potential mitigation strategy to potentially develop an alternate route for ingress and egress into areas which are impacted by rail lines on a daily basis when loading and unloading cargo.

Beginning September 2012, oil from North Dakota has been shipped through Spokane County en route to the refineries in Anacortes on a daily basis, and it is anticipated that the number of trips will increase over the course of the next few years.

In addition, coal shipments have also become an issue of concern for many citizens, citing the impact from coal dust on health. The State Transportation Department identified in excess of 25 crossing and highway intersections, most of them in Western Washington and Spokane County, that may need improvements to accommodate increased coal traffic. Coal dust has become an issue of concern for communities through which coal is transported. Those individuals with respiratory issues could be more susceptible with increased exacerbation of conditions with increased volumes of coal dust. As of this 2020 update, several crossings are scheduled for replacement, but exact dates of construction have not yet been determined.

Natural disasters like floods, landslides and earthquakes can trigger hazardous material incidents. Illegal drug labs used for methamphetamine manufacturing and illegal dumping of drug paraphernalia and items used to cook drugs present yet another hazardous materials concern. Recent history shows an increase in the national threat from terrorists' use of hazardous materials. The combination of possible sources of exposure to Spokane's sizable population and workforce presents complex problems to responders.

Past Events

The various fire departments throughout the County do respond on a fairly regular basis to spill calls, but fortunately, these have been fairly routine in nature, and not of major significance. While no significant events have occurred to date within Spokane County, given the high farm and agricultural areas and the use of chemicals in those industries, when coupled with the major transportation routes being utilized, the potential for a significant type event does exist due to both the amount of chemicals stored and transported throughout the region.

Location

With respect to locations of impact or concern from hazardous materials incidents, the most vulnerable areas are those associated with the storage of hazardous materials, and those areas adjacent to the major transportation corridors. Spokane County, being a high agricultural producer, maintains high quantities of two types of potentially dangerous fertilizers. Ammonium nitrate, which was used in the 1995 Oklahoma City bombing and other attacks -- including an attempt at the World Training Center in 1993, and Anhydrous ammonia, which is on the top 10 list of chemicals leaked across the country.

Major transportation corridors are often adjacent to highly populated commercial and residential centers. The greatest threat appears to be the transportation corridor through the City of Spokane. However, other areas of the City of Spokane Valley and unincorporated areas are equally as vulnerable. Also of concern are illegal operations such as laboratories for methamphetamine pose a significant threat. Laboratory residues are often dumped along roadways, left in rented hotel rooms, transported in the back of vehicles,

or cooked within residential structures. All of these scenarios create a serious health threat to unsuspecting individuals, first responders, hazmat clean-up entities, and to the environment.

Illegal dumping sites for hazardous wastes such as used motor oil, solvents, and paint often dumped in remote areas or along roadways, creating a potential health threat to unsuspecting individuals and to the environment. Chemicals leaking from containers seep into ground-water, or are carried distances by vehicles traveling through the sites. These chemicals also increase fire danger as many are highly flammable and can cause fires to spread more quickly by acting as a fuel source.

Accidental releases of pesticides, fertilizers, and other agricultural chemicals may be harmful to both humans and the environment. Agricultural pesticides are transported daily in and around Spokane County. As an agricultural community, Spokane County has large quantities of pesticides, fertilizers and other agricultural chemicals year round, with increased quantities during the growing seasons.

Licensed carriers also transport radioactive materials along several transportation routes through Spokane County. The Spokane Region as a whole is highly engaged in the health and academia sectors for research, hospital treatment and labs, which utilize radioactive materials. While the quantities in these sectors are not extreme, there are increased radioactive materials disbursed throughout the County.

Frequency

Hazardous material incidents may occur at any time in Spokane County. To determine an actual frequency interval is not possible given the presence of transportation routes crossing the County which carry hazardous materials in unknown quantities and at unknown intervals. Additionally, the locations of businesses and industry, hospitals, medical facilities and laboratories that use hazardous materials, as well as the presence of scattered illegitimate clandestine drug laboratories and the improper disposal of hazardous waste demonstrate unknown risk factors which make frequency determination in a quantitative manner impossible due to the unknown variables. However, based on the review of the existing data, in a qualitative assessment, the likelihood of occurrence of some level of hazardous material incident is relatively high, although the County has thus far been fortunate in not having a major incident.

Severity

Hazardous material incidents are another significant issue within Spokane County due, in part, to the unknown quantities and types being shipped through the County, as well as the amount of hazardous materials known to exist for the various purposes mentioned. While hazardous material incidents can be both intentional and/or unintentional releases of a material, because of their chemical, physical or biological nature, they pose a potential greater risk to life, health, environment or property. Each incident's impact and resulting response depend on a multitude of interrelated variables that range from the quantity and specific characteristic of the material to the conditions of the release and area/population centers involved. Releases may be small and easily handled with local response resources or rise to catastrophic levels with long-term consequences, such as was recently experienced in West, Texas with the destruction of the West Fertilizer Company. Fifteen people were killed as a result of the explosion, with hundreds injured. Approximately 37 square blocks of the surrounding community were destroyed, including businesses, schools, residences and a nursing home. The USGS recorded the explosion as a Magnitude 2.1 tremor. Damage from the explosion was estimated by the Insurance Council of Texas to exceed $100 million of insured losses; the town received a Presidential Disaster Declaration and sought recovery in excess of $57 million.

3.9.2 Infrastructure and Utility Failure

Societal norms indicate that we are fully dependent upon information technology and information infrastructure. At the core of the information infrastructure upon which we rely is the Internet, which

connects one computer to another, networking the nation's infrastructure and essential services. Services such as electrical transforms, water distribution centers, security systems (radar), and economic sectors (stock markets) all exist with the infrastructure at its nexus.

While a technological incident of cyber-failure can occur internal to organizations or be a widespread incidents due to an accident or resulting from a natural hazard, loss of information networks can have serious consequences, such as disruption of critical operations, loss of revenue or intellectual property, or loss of life. Of primary concern is the lack of redundant systems (or security measures) which could impact infrastructure to the extent capable of causing debilitating disruption, including compromising computer functions, and prolonged disruption of service. Those impacted by such cyber failures, including potential data loss, can include government and private sector owned control systems for transportation and communications, industrial processes, power and other utility generation and distribution.

Past Events

Infrastructure and utility failure can result from a multitude of incidents covering large areas. Incidents can range from computer input or operator error to a lone vehicle striking a major power distribution line as a result of an accident.

Cyber failure can and does occur throughout the County, including both public and private organizations, but most often goes unreported for tracking purposes. The most frequent local cyber issues involve disruption of service due to internal problems, and are more centralized in location of impact. However, with the reliability on fiber optic cables, the exchange of information relying on the Internet, and the reliability on control systems for delivery of service illustrates that impacts from technological incidents do not have to be focused on incidents occurring within Spokane County, or even Washington State, but can occur great distances away.

The failure of the North Eastern power grid of 2003 resulting from operator error impacted 50 million customers in eight US states and the province of Ontario. The September 2011 event impacting portions of the Western power grid - Arizona, Southern California, Baja California and Mexico - affected nearly three million customers. Inter-dependence on critical infrastructure such as power generation encompasses mass areas susceptible to potential impact from a technological incident. Fortunately, Washington and Spokane County have not experienced similar type wide-spread disruptions. Rather, most disruptions occur as a result of natural hazard impact such as a severe weather event, and are more locally focused.

Location

All areas of the County are susceptible to infrastructure failure or disruption of service as a result of technological hazard. The impact to computer systems can include government and private sector owned control systems for transportation and communications, industrial processes, power and other utility generation and distribution.

Frequency

The utility infrastructure may also be impacted as a result of various hazard-related events, or through accidental events. Routinely, the County and its jurisdictions can expect at least one incident of power failure annually based on review of historic records. The length associated with the power disruption can vary from a few hours, to in excess of weeks as was the case with the 1996 power outage resulting from an ice storm. As part of the Western Electricity Coordinating Council, major power distributors in the County work with regulatory agencies to ensure protection of our power distribution centers.

Cyber-infrastructure failure resulting from non-terrorist related attacks against computers, networks and/or information stored thereon, can occur at any time with no advanced warning. Cyber failure occurs with

regular frequency as a result of server failure, power outages, lines being severed, etc. The time involved can be from minutes, to days depending on the issue.

Severity

The length associated with the power disruption can vary from a few hours, to in excess of weeks as was the case with the 1996 power outage resulting from an ice storm. The issues surrounding the primary cause of the power failure has the potential to increase severity, such as extreme heat or cold weather, which has the potential to increase impact to health and safety.

3.9.3 Transportation

The range of magnitude of impact from transportation incidents varies depending upon the mode of transportation involved. Incidents involving commercial vehicles carrying hazardous materials; impact from incidents involving structural integrity of bridges; air traffic traveling over jurisdictions, or railway incidents carrying passengers during rush hour traffic can have a devastating impact on the County. Given the amount of rail freight and other cargo moved over public access routes, the potential for a major transportation issue is relatively high.

Past Events

Transportation issues occur regularly throughout the County. Daily accidents disrupt commutes. Train derailments have occurred throughout the County, shutting down both passenger and cargo lines. The five public airports throughout the County have experienced flight cancelations and delays due to various types of events, including computer issues.

Location

All transportation facilities all have the potential for impact related to a technological hazards, which have the potential to impact commodity flow. Spokane transportation routes include rail, highways, river traffic, air and bridges. As a major transportation corridor, all areas and modes of transportation can be impacted from the various technological hazards. Air and rail transportation can be disrupted through cyber-failures; highway and marine traffic can be impacted from hazardous materials incidents. Bridges can be shut down as a result of a vehicle striking the bridge structure itself.

Frequency

Over the course of time, the number of transportation conveyances has grown significantly throughout the County, with increased populations traversing the roadways

Severity

Several of the primary critical infrastructure routes, as well as the other forms of transportation offer the potential for a mass-casualty incident because of the heavy volume of traffic, although no highway or surface street is exempt from this hazard. The railroad tracks traversing Spokane County, carrying Amtrak passengers as well as freight, have the potential of mass-casualty incidents, as do the air corridors above the county. Mass-casualty incidents may also result from hazardous materials incidents due to the potential number of individuals impact. Adverse weather may also play a role in roadway, air or rail accidents, enhancing the potential for a mass-casualty incident. However, mass-casualty incidents can occur throughout the County, day or night, at any time of the year.

3.10 FUTURE TRENDS IN DEVELOPMENT

The County and its cities have adopted comprehensive plans that govern land use decision and policy making within their jurisdictions. They have also adopted building codes and specialty ordinances based on state and federal mandates. Decisions on land use are governed by these programs. This plan will work

together with these programs to support wise land use in the future by providing vital information on the risk associated with natural hazards in Spokane County.

As of this 2020 update, there are two on-going efforts which clearly demonstrate the connection between mitigation planning efforts, and land use development trends.

Within both the unincorporated county below Cheney and within the City of Cheney, an area of land is currently being reviewed for future residential development, possibly during the life cycle of this plan. That area, as current maps project, could be impacted by the rail lines traveling the County, as the only ingress and egress to the planned development requires the crossing of the rail lines, which are shut down several times daily for extended periods of time when the rail system loads and unloads its train cars. Those cars also carry Bakken Oil. This is of particular concern to emergency management and first responders due to the potential need for evacuation, and the limited capacity to do that if the rail line has the access roads blocked. All parties are looking to identify potential solutions to this problem.

The City of Liberty Lake has recently annexed additional land to its City boundary. That area will include, among other things, a new school. While none of those areas currently fall within identified hazard areas of concern, the City will none-the-less continue to utilize information from this plan as it continues to grow and expand. In an effort to be proactive, the City is currently in the process of establishing regulatory authority with respect to development in the floodplain in its quest to become an NFIP Community.

All municipal planning partners will seek to incorporate by reference the Spokane County Hazard Mitigation Plan in their comprehensive plans, and will utilize the risk data identified as applicable. This will assure that all future trends in development can be established with the benefits of the information on risk and vulnerability to natural hazards identified in this plan.

3.11 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 in its jurisdictional annex, presented in Volume 2.

3.11.1 Federal

Disaster Mitigation Act

The DMA is federal legislation addressing hazard mitigation. 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 federal 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.

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

National Flood Insurance Program

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

3.11.2 State

Washington State Enhanced Mitigation Plan

The Washington State Enhanced Hazard Mitigation Plan approved by FEMA in 2018 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 rather than 15 percent with a standard plan).

Growth Management Act

The 1990 Washington State Growth Management Act (RCW 36.70A) mandates that local jurisdictions adopt land use ordinances 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.

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.

Washington State Building Code

The Washington State Building Code is comprised of several different codes. Most are national model codes adopted by reference and amended at the state level. Others, such as the Washington State Energy Code, are state-written state-specific codes.

The Washington State Building Code Council adopted the 2015 International Building Code, as well as previous editions of the codes and the various amendments. 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. 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. 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 Flood Control Maintenance Program 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. Funding currently is running about 60 percent for planning and 40 percent for projects.

3.12 LAND USE DEVELOPMENT IN THE LOCAL MUNICIPALITIES

During this process, all planning partners collectively participated in discussions regarding the hazards of concern, and issues which specifically impacted their own municipalities. Such discussions included land use development trends that have occurred since the last plan was completed specific to their jurisdictions, or special purpose district whose service trends are impacted by growth and development. These discussions also included future land use trends, specifically as they relate to the built environment within hazard-prone areas. The general consensus by all planning team members, both municipal and special purpose districts, is that the expansion and growth experienced throughout the county has not increased their respective vulnerability beyond the normal aspects of more citizens and structures for which they must now account, and to which they must provide services. The County and its planning partners are fortunate in this regard, in that expansion has not caused an increase in risk or vulnerability, nor created new hazards of concern.

The Planning Team Members felt that existing land use regulations would continue to ensure that new development was constructed in such a way as to not increase vulnerability, but still allow the municipalities to grow and expand, increasing their economic vitality. Planning Team Members also felt that the integration of planning efforts in place with respect to Growth Management and the review of the hazard areas identified within this document would also help ensure compliance, and the least-negative impact with respect to identification of the hazard areas. Such discussions were particularly relevant as the risk assessment was developed to ensure that the planning partnership was addressing and identifying specific geographic areas of concern not previously identified in earlier plans, including impact from land use development.

One of the first questions posed during the plan development at the kick-off meeting was the element of growth and expansion throughout the county and its municipalities. This was also particularly relevant with respect to the update of the critical facilities list which was used in this update process.

Throughout the County, there have been large-area development projects that have occurred since completion of the last plan. In some cases, new Public Development Authorities (PDA) have been created, such as the West Plains/Airport Area Public Development Authority (see Figure 3-8).

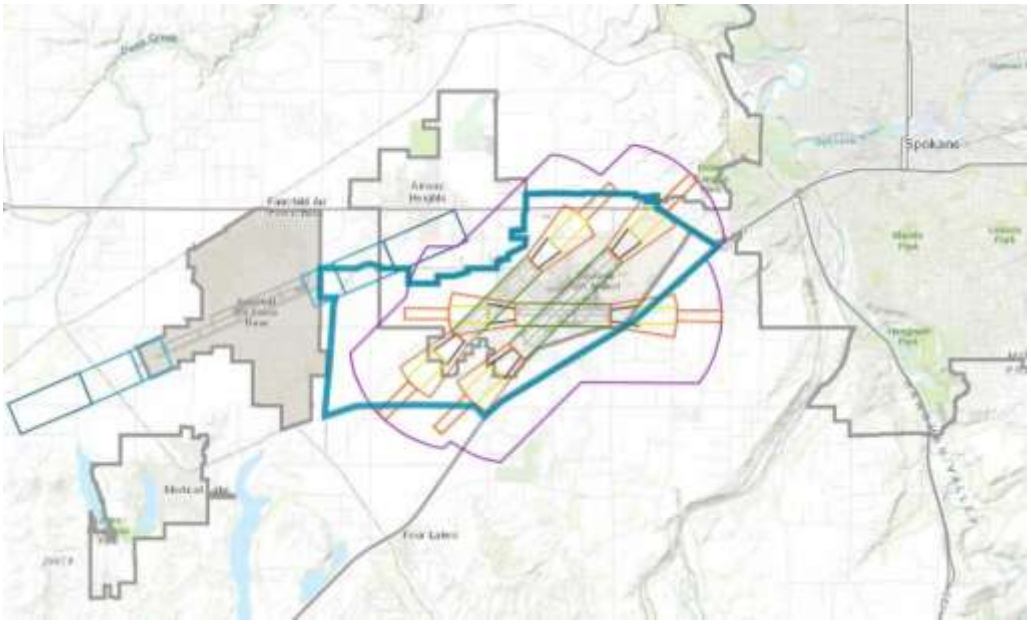


Figure 3-8 West Plains/Airport Area Public Development Area

While West Plains PDA is but one example of such entities in place throughout Spokane County (there are multiple), in general, the purpose of Authorities such as this is to provide a legal entity organized under RCW 35.21.730 - .757 to undertake, assist with and otherwise facilitate the acquisition, construction, development, leasing, operation and maintenance of public benefit projects within the PDA boundaries in order to assist all parties involved in their ability to improve the economic conditions in and around their specific areas of authority. Such Authorities, during their development phases, conduct extensive outreach with the public, local land use planners, tribal partners, and state agencies to ensure compliance of all regulatory authority in place, including land use to ensure minimal negative impact in all areas of the community's development.

In the case of the West Plains area of the County, this is the portion where the largest amount of commercial development has occurred, including the Amazon Fulfillment Center. The surrounding area encompasses primarily Airway Heights and Medical Lake. This area, referred to as the "northern side of the freeway" has experienced the most rapid and largest amount of commercial expansion since the last plan's completion. Similarly, the "southside of the freeway," which encompasses primarily the City of Cheney, has been and continues to be the area designated primarily for residential development. The City of Deer Park in the northern portion of the County, has also increased in size since the last plan's completion, with approximately 300 new residential structures anticipated over the life cycle of this plan. The City of Liberty Lake near the County's eastern border has also increased its number of multi-family housing units at a moderate growth.

As a result of the development of the Amazon Fulfillment Center, Fire District 3 has been impacted with respect to increased service calls in general, but not as a result of an increased vulnerability to the hazards. Fire District 3 has also been impacted as a result of the City of Medical Lake's election to no longer provide fire services, thereby annexing its boundaries into Fire District 3's response areas.

All municipal planning partners, with the exception of one, the City of Cheney, have indicated that development such that has occurred since completion of their last plan has not negatively impacted their municipalities with respect to increased hazard risk, nor do they anticipate negative impact, with the exception of general "growing pains" and the ability to meet all service-related needs.

The one exception to this is the City of Cheney, specifically as it relates to an area of housing development access being restricted by railroad tracks, not with respect to an increase in risk associated with the hazards of concern, but rather, response capabilities. This issue is also a concern for the County, and both the City of Cheney and the County have identified a strategy to work with the rail transportation carrier to identify a method to address this issue. The City of Cheney does address this issue in more detail in their annex.

The City of Medical Lake historically has had concerns with respect to a dwindling aquifer, but has established a second water source, which is anticipated to come on-line early 2020. The impact from a drought on its "dwindling" aquifer could cause a potential issue if the new system does not come on-line as anticipated. Such limitation has impacted the City's ability to expand to some degree, but it is anticipated to change with the new system in place.

The general consensus by the planning team members is that the expansion and growth experienced throughout the county has not increased their respective vulnerability beyond the normal aspect of there being more citizens and structures for which they must now account, and to which they must provide services, potentially impacting budgets. Likewise, development itself has not caused additional hazards of concern. The one exception to this perhaps is with respect to response capabilities within the new developments. Due to the increased density, there is an increased risk to public safety personnel in response capacity due to the close proximity of structures, and the increased population.

In addition to the items identified in this section of the plan, each planning partner has prepared a jurisdiction-specific annex to this plan. In preparing these annexes, each partner completed a capability assessment that looked at its regulatory, technical and financial capability to carry out proactive hazard mitigation, including the ability of the planning partners to address future land use development in such a manner so as to not increase the risk or exposure from the hazards of concern. Such information, is contained in these annexes, which identify regulatory codes and ordinances applicable to each planning partner. Each hazard profile also provides information on countywide land use development trends.

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. Spokane 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 Spokane County and its planning partners in determining priorities for implementing mitigation measures.

4.2 METHODOLOGY

The risk assessment for this hazard mitigation plan evaluates the risk of natural hazards prevalent in Spokane County and meets requirements of the DMA (44 CFR, Section 201.6(c)(2)). 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 output of the data allows emergency management personnel the ability to plan by identifying potential hazards and vulnerable assets. The process focuses on the following elements:

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

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). Each planning partner completes this process for their own community, as well as conducting the analysis on a countywide level.

The following elements were utilized in the risk assessment process, and provide 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/Extent: 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.

4.2.1 Hazard Identification

For this plan, the planning team considered the full range of natural hazards that could impact the planning area and then listed hazards that present the greatest concern. This plan does not include non-natural (human caused) hazards, as they are addressed by the THIRA. 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. Based on the review, the planning team confirmed the hazards to be addresses in this plan as follows:

- Drought
- Earthquake
- Flood (including dam failures)
- Landslide
- Severe weather
- Volcano (ash fall)
- Wildfire

Climate Change

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

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

4.2.2 Hazard Profiles

The hazard profiles describe the risks associated with identified hazards of concern. Each chapter describes the hazard and the planning area's vulnerabilities. For those municipal planning partners with defined geographic boundaries, this data is identified within the associated tables in the base plan in which the risk at the county level is also identified. The following steps were used to define the risk of each hazard:

- General overview and description of hazard;
- 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.

4.2.3 Risk Assessment Process

Once the profiles identified above were completed, the following steps were used by each planning partner 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. Occurrences are frequent, with more documented historic events.
  - 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 have occurred in the past, and have a high probability of reoccurring.
  - Extremely High—Very widespread with catastrophic impact. Hazards in this category may have occurred in the past, and have a high probability for reoccurring.

4.2.4 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 of Hazus now allows for Tsunami modeling to occurring in certain regions.

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. In order to calculate losses due to flooding, HAZUS uses the following inputs about the built environment: structure location, occupancy type, square footage, first floor height above grade, as well as replacement and content values.

- 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

The Spokane County parcel layer was downloaded from Spokane County GIS data site on May 19, 2019. This parcel layer consisted of 204,662 parcels. In order to be able to work with this large amount of data, the parcel data layer was converted from a polygon layer to a point layer. From this new point layer representing each of the 204,662 parcels, the exposure to each hazard included in this plan was determined using spatial queries to determine whether the parcel was inside or outside of the hazard zone for each hazard.

For the Flood hazard zones, the most current flood hazard data layer was downloaded from the FEMA map service center which was dated to be current as of March 15, 2019. The 100 year and 500 year flood zones were determined based on the attributes of the Special Flood Hazard polygon layer contained in the data downloaded from FEMA. Spokane County parcels were determined to be inside and or outside the 100 and 500 year flood zones using spatial query methods within ArcGIS Desktop.

A critical facilities analysis was also conducted (inside and outside of HAZUS) and was based on general exposure rather than estimated losses for some hazards of concern. Risk to structures is identified based on the structure location and the corresponding exposure to hazard location, where geographically established. A list of critical facilities developed by the County and its planning partners included geospatial data for fire, police, schools, medical facilities, etc.

On completion of the analysis, each planning partner was provided the critical facilities list, on which impact from each hazard is identified for each critical facility. That data was then utilized by each planning partner to determine dollar impact (e.g., magnitude and severity within the Calculated Priority Risk Index discussed below). The critical facilities list as a whole is considered privileged in nature from public disclosure; however, each planning partner was left to make the determination as to how they wished to

identify specific structures based on their policies in place. In addition, specific critical facility structure impact data is further identified within the various Critical Facilities tables contained in each hazard profile, identified by critical facility type, e.g., power, water, wastewater, etc.

Building impact was further identified in Loss Matrix Tables, which provide the breakdown to each of the jurisdictional planning partners for use in completing their risk assessment. That data further identifies the number of structures impacted and the population impacted (where possible) based on the specific hazard of concern. As appropriate, that data is also identified within the various public outreach documents and posters developed for the public outreach efforts. It should be noted that with all data, the critical facilities list is continually in an update process, and should not be considered to be all-encompassing.

Hazus Application for this Plan

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

- **Flood**—A Hazus (modified) Level 1 analysis was performed for the 2015 plan. Analysis was based on current FEMA regulatory 100- and 500-year flood hazard data based on the 2010 Flood Study. No new FEMA flood study existed, and therefore the planning team felt it was not relevant to re-do the similar Hazus analysis for the 2020 update. Focus instead was placed on a GIS analysis to identify population and critical infrastructure at risk based on the established list and utilizing the County's 2019 Assessor's database. (Flood Insurance maps are available on the County's website here, as well as being downloadable from the FEMA Map Center)

- **Earthquake**—A Hazus Level 1 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 one scenario-based shake map event utilized was the M5.5 Spokane Fault event, replacing the 2015 scenario event of a M7.0 Latah Creek Fault.

GIS Application for this Plan

Dam, Hazardous Materials, Landslide, Severe Weather, Volcano, and Wildfire **-** For these hazards, 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 critical facilities 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, staff, emergency management personnel, and others. The primary data source was Spokane County GIS data, augmented with state and federal data sets, including FEMA, USGS, NOAA, WADOE, and WADNR data. Additional data sources for specific hazards are identified within the various profiles. In general analysis was completed as follows:

- **Climate Change** – Existing information was utilized to present future impact of climate change on the planning area. No specific analysis was conducted; however, existing data which illustrates potential impact was incorporated to the greatest extent possible in a qualitative manner.

- **Dam Failure**—Inundation data was unavailable for all of the high- or medium-hazard dams in the County. Therefore, available dam data was used to identify the location and hazard classification of dams located within the planning area.

- **Flood** – Inundation data from the previous FEMA Flood Maps were utilized and intersected to identify exposure analysis for the 100- and 500-year floods utilizing the 2019 Assessor's Database and the 2020 critical infrastructure and facilities data to determine impact to people and property.

- **Hazardous Materials** – Hazardous materials data was utilized, captured from the Department of Ecology's FY2018 Tier II reporting data, which requires updates by March of each year within the State of Washington Rail lines were also illustrated, as they many times transport chemicals into the area. Hazardous materials sites were incorporated into the critical facilities data.

- **Landslide**—Historic landslide hazard data was used to assess exposure to landslides using Washington DNR Landslide Susceptibility data, in conjunction with Spokane County landslide data. This data depicts landslide susceptibility at a 10 meter resolution across the state of Washington. Landslide damages are illustrated based on the number of parcels intersecting the landslide zone and within a 100' buffer.

- **Severe Weather**—Severe weather data was downloaded from various sources, including the Natural Resources Conservation Service and the National Climatic Data Center, as well as PRISM Precipitation, Average Low, and Average High data. Tornado Project data was utilized to identify any events which have occurred in the planning area.

- **Wildfire**—Information on wildfire analysis was captured from various sources, including Washington DNR Wildfire History data, Wildfire Protection data, US Forest Service data, and LAND FIRE data, among other sources. The County also maintains a Comprehensive Wildfire Protection Plan (CWPP). Readers should view the CWPP to obtain additional information.

4.2.5 Calculated Priority Risk Index Scoring Criteria

For the 2020 update, the Planning Team utilized a Calculated Priority Risk Index (CPRI) score for each hazard of concern, addressing impact both at the county level, and at the Planning Partner level. The same process was followed for both the County and by each Planning Partner. While the base plan defines the process followed, each jurisdictional annex provides only the outputs rather than re-describing the entire process.

Vulnerabilities are described in terms of impact to critical facilities, structures, population, economic values, and functionality of government which can be affected by the hazard event as identified in the below tables.

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, and in a manner which addresses the functionality of each Planning Partner involved (e.g., municipality, fire district, public utility district, etc.).

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 five criteria on which the CPRI is based are probability, magnitude, geographic extent and location, warning time/speed of onset, and duration of the event (see Figure 4-1).

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	

Figure 4-1. Calculated Priority Risk Index (CPRI)

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 and is usually determined using technical measures specific to the hazard. 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: *Property Damage / Number of Incidents) / $ of Building Stock Exposure = Magnitude.* In some cases, the Hazus model provided specific people/dollar impact data. For other hazards, a GIS exposure analysis was conducted. 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 were 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

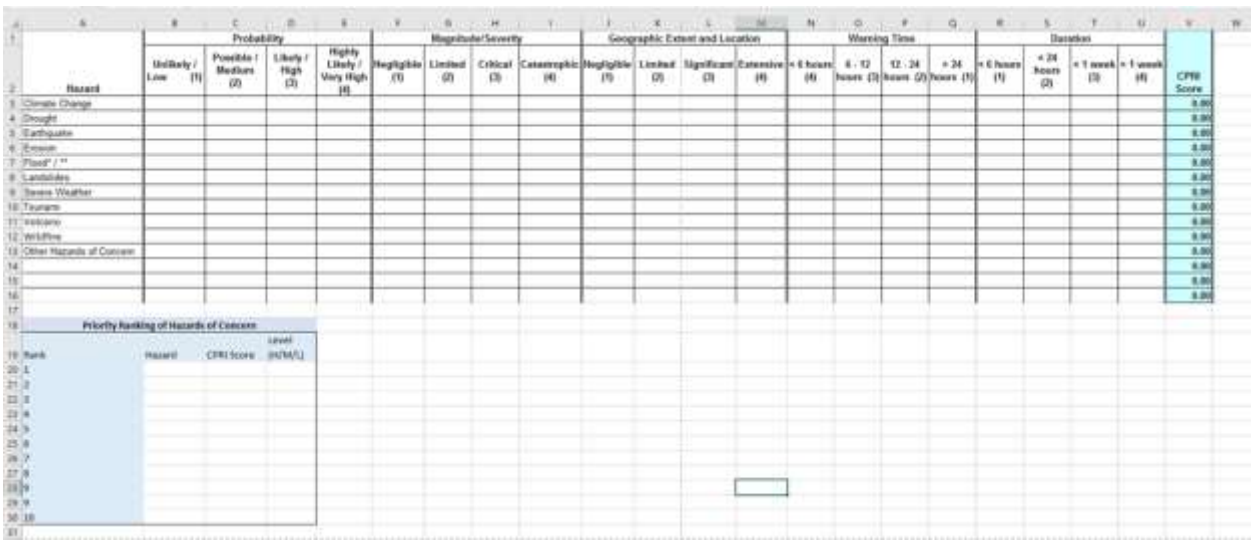
The time span associated with an event was also considered, the concept being the longer an event occurs, the greater the threat or potential for injuries and damages. Duration was assigned a weighting factor of 5%, and was broken down as follows:

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. It should again be emphasized that each planning partner utilized the outputs from the risk assessment to compute their CPRI for their own respective jurisdiction, following the process identified.

In completion of this scoring process, each planning partner is provided not only the hazard profiles completed during this process, but also a summary report, various loss matrix tables, maps, charts and graphics identifying information at the jurisdiction-level, and also a copy of the critical facilities and infrastructure table established at the onset of the process. The critical facilities spreadsheet is not published within the document due to its confidential nature; however, each planning partner is provided the list for use in identifying specific structures within their planning area which are at risk.

The rating is then incorporated into an Excel Workbook, which calculates the CPRI Score. Each planning partner's completed worksheet is summarized in Chapter 12. An example worksheet is illustrated in Figure 4-2.



	Probability				Magnitude/Severity				Geographic Extent and Location				Warning Time				Duration				
Hazard	Unlikely / Low (1)	Possible / Medium (2)	Likely / High (3)	Highly Likely / Very High (4)	Negligible (1)	Limited (2)	Critical (3)	Catastrophic (4)	Negligible (1)	Limited (2)	Significant (3)	Extensive (4)	< 6 hours (4)	6 - 12 hours (3)	12 - 24 hours (2)	> 24 hours (1)	< 6 hours (1)	< 24 hours (2)	< 1 week (3)	> 1 week (4)	CPRI Score
2																					
3 Climate Change																					0.00
4 Drought																					0.00
5 Earthquake																					0.00
6 Erosion																					0.00
7 Flood* / **																					0.00
8 Landslides																					0.00
9 Severe Weather																					0.00
10 Tsunami																					0.00
11 Volcano																					0.00
12 Wildfire																					0.00
13 Other Hazards of Concern																					0.00
14																					0.00
15																					0.00
16																					0.00

Priority Ranking of Hazards of Concern

19 Rank	Hazard	CPRI Score	Level (H/M/L)
20 1			
21 2			
22 3			
23 4			
24 5			
25 6			
26 7			
27 8			
28 9			
29 9			
30 10			

Figure 4-2. Hazard Ranking Worksheet with Weighted Factors

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.

Seismic Design Categories based on statewide site class map assess for Spokane County are Categories B and C for residential construction.[10]

4.4 CONSEQUENCE ANALYSIS

While not necessary for purposes of gaining FEMA plan approval as identified with 44 CFR 201.6, a Consequence Analysis was completed for each of the hazards identified to assist the County in meeting accreditation standards in its quest to achieve accreditation through the Emergency Management Accreditation Program (EMAP). The EMAP standard for hazard identifications requires the County to include a consequence analysis for hazards identified. The consequence analysis should consider the impact on the public; responders; continuity of operations including delivery of services; property, facilities and infrastructure; the environment; the economic condition of the county, and public confidence in the county's governance. In some cases, such as those instances which are wide-spread and not contained within Spokane County, such as the case with earthquakes, droughts, pandemic/health related, wildfires, terrorism incidents, etc., the analysis also considers impact at those levels as well.

Impact on the Public:

Based on the risk assessment in the Hazard Mitigation Plan (HMP), there is neither record of a historical event or impacts as identified in the vulnerability analysis that would be considered catastrophic from a countywide perspective. Historically, other than emerging disease/pandemic outbreaks or the potential of a terrorist-related event in the highly populated areas, hazard events in Washington in general and Spokane County specifically have tended to be moderate in size – possibly approaching widespread, but not rising to the level of catastrophic.

Three natural hazard events that may have a broader impact on the public at the state and county levels would be a large earthquake on the Cascadia Subduction Zone (CSZ) fault, a statewide severe winter storm (including higher levels of precipitation in the form of snow or rain) or a significant wildfire season (such as experienced in 2015 and 2017).

While the CSZ earthquake is not anticipated to have significant, direct impact on Spokane County from ground shaking, the influx of citizens from the western portion of the state (either in need of emergency services or evacuation), and the potential impact to commodity flow would be significant. This is particularly true given the fact that Spokane County is identified as the alternate location for the Emergency Operations Center for Washington State and are designated as a staging area as well for State Operations.

With the exception of the CSZ (and potential ensuing Tsunami), the impacts on the public from these events would be moderate. The hazards with the greatest impact on the public (in terms of numbers of individuals adversely affected) would be a CSZ earthquake (and potential Tsunami), an emerging disease/pandemic

[10] https://www.dnr.wa.gov/programs-and-services/geology/geologic-hazards/geologic-hazard-maps#seismic-design-categories

outbreak, a terrorism event that included a nuclear dispersion device in the populated areas, or a severe wildfire season, which would potentially tax resources nationwide as has occurred over the course of the last few years.

The proximity of Fairchild Airforce Base in Spokane County does have the potential to increase risk with respect to a nuclear device as far as Fairchild being identified as a target, but Fairchild itself does not maintain nuclear devices; the primary purpose of the installation is as a refueling base for tanker aircraft. Such service could (potentially) increase the risk associated with hazardous materials spills. While the runways for the base are well maintained and secured, the flight path of the aircraft leaving the runways does cross over residential (and other) areas.

Impact on Responders:

Because it is unlikely that a hazard event would be widespread enough in Spokane to be "catastrophic," existing mutual aid mechanisms and the ability to exercise Emergency Management Assistance Compact (EMAC), should be sufficient to handle any hazard event. The exceptions to this may be an emerging disease/pandemic outbreak, a terrorist event, wide-spread wildfire season, or a Cascadia Subduction Zone earthquake as it relates to the influx of citizens from the Western portion of the state, and the activation of Spokane County's EOC as the state's alternate EOC.

Continuity of Operations (COOP) and Continuity of Government (COG):

Spokane County Government does have a COOP and COG for use in the event facilities and/or agencies are impacted. The County's emergency management agency and several primary County departments maintain the COOP and COG, as well as other disaster recovery plans. It is expected that affected agencies would exercise their COOP/COG or recovery/response plans as appropriate. Private sector businesses are encouraged to develop business continuity plans, but they are not mandated by the state.

Property, Facilities, and Infrastructure:

The HMP has collected and created risk assessments and vulnerability analyses for the different hazards it profiled countywide from all planning partners. The process included the development of a critical facilities list, and use of the Assessor's database for general building stock.

One cautionary note in utilizing the data is that in some cases, depending on the hazard and the risk assessment tool utilized (Hazus vs. GIS), aggregate dollar damage amounts are based on census blocks versus the actual facility affected. Losses may be identified by the community (e.g., city or town) versus the ownership of a facility or structure. In some instances, losses may overlap when identified as countywide losses, and then within each jurisdictional annex. The HMP does not imply that the whole region would actually have an event occurring countywide where the maximum damages are sustained by all of the cities and towns identified in the county.

Environment:

Any hazard event has the potential for environmental impact. Flood events, for example, may result in pollution of streams and rivers due to combined sewage overflows or hazardous materials; a tornado/wind event will disperse materials, trash and debris over a widespread area; wildfires increase the potential for flooding, while volcanic ash can cause acid rain and acidic properties that kill fish or livestock. A drought may affect the environment in a different way by drying up wetlands, and weakening/killing trees and forestlands. The three hazards that have a significant potential for environmental impact are: CBRNE (not covered in this plan), emerging disease/pandemic outbreak (covered in a separate plan by the Health Department), and wildfire (addressed within the HMP, but also within the County's CWPP maintained separately).

Economic Condition of the County:
Because most hazards in Spokane County would not result in a countywide catastrophe, the economic impacts, while potentially significant, would be recoverable. The County, while high in agricultural lands, has a very diverse and expanding economy even though there are areas where certain segments of the economy are concentrated.

From a geographic perspective, an event that would affect the Spokane region would also have the potential to have a greater impact statewide. For example, an invasive species or pest that would affect the wheat crop in Spokane County, would also more likely than not impact other wheat producing communities statewide. Or, as occurred during 2019, a drought might result in a more widespread deterioration of the economic condition on one side of the state than the other, such as the current drought condition in Western Washington, while the majority of Eastern Washington, the primary agricultural area of the state, has not experienced the severity of the drought to date. Finally, an event affecting the City of Spokane, the hub of county government, could have a significant impact countywide as the centralized area for processing of payments (accounts receivable and payable) and operations for a variety of programs that could be interrupted.

Public Confidence in Governance:
As has been demonstrated in catastrophic events in other counties, states, and countries, public confidence in governance is tightly linked to the government's response to a hazard event. Even in more regionalized or local disasters, this is the case although the effect of the disaster on public confidence is customarily regionalized or localized except in those instances of horrific catastrophic impact which draws attention from outside areas. The hazards most likely to have a widespread effect on public confidence in county governance are those that either have the probability of statewide effect (earthquake, drought, severe winter storm), those that have a high impact or consequence (terrorism, nuclear detonation/dispersion, emerging disease/pandemic outbreak) and those that have a short speed of onset (terrorism, earthquake).

4.5 COMMUNITY VARIATIONS TO THE RISK ASSESSMENT

Each planning partner within their respective 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.

4.6 LIMITATIONS

Various data sets were utilized in developing the risk assessment incorporated into this planning effort. In attempting to utilize the various sources, discrepancies may exist. 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 Spokane 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. The process reproduced existing data only in different ways to meet the guidelines and requirements of 44 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; and
- The amount of advance notice residents have available to prepare for a specific hazard event.

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate and are for planning purposes only; not life safety measures. The results do not predict precise results and should be used only to understand relative risk. Over the long term, as is customary with all such planning efforts, Spokane County and its planning partners will continue to collect additional data to assist in better estimating potential losses associated with other hazards as science increases the validity of data.

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. 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.
DROUGHT

5.1 GENERAL BACKGROUND

Drought is a prolonged period of dryness severe enough to reduce soil moisture, water and snow levels below the minimum necessary for sustaining plant, animal and economic systems. Washington has a statutory definition of drought (Revised Code of Washington Chapter 43.83B.400). According to state law, an area is in a drought condition when:

- 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.

DEFINITIONS

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

Hydrological Drought—Deficiencies in surface and subsurface water supplies.

Socioeconomic Drought—Drought impacts on health, well-being and quality of life.

Drought is a normal phase in the climatic cycle of most geographical regions. According to the National Drought Mitigation Center, drought originates from a deficiency of precipitation over an extended period of time, usually a season or more. This results in a water shortage for some activity, group or environmental sector. Drought is the result of a significant decrease in water supply relative to what is "normal" in a given location. There are four generally accepted "operational" definitions of drought (National Drought Mitigation Center, 2006):

- **Meteorological drought** is an expression of precipitation's departure from normal over some period of time. Meteorological measurements are the first indicators of drought. Definitions are usually region-specific, and based on an understanding of regional climatology. A definition of drought developed in one part of the world may not apply to another, given the wide range of meteorological definitions.
- **Agricultural drought** occurs when there is not enough soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought happens after meteorological drought but before hydrological drought. Agriculture is usually the first economic sector to be affected by drought.
- **Hydrological drought** refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow and as lake, reservoir and groundwater levels. There is a time lag between lack of rain and less water in streams, rivers, lakes and reservoirs, so hydrological measurements are not the earliest indicators of drought. After precipitation has been reduced or deficient over an extended period of time, this shortage is reflected in declining surface and subsurface water levels.
- **Socioeconomic drought** occurs when a physical water shortage starts to affect people, individually and collectively. Most socioeconomic definitions of drought associate it with the supply and demand of an economic good.

Washington has a statutory definition of drought (RCW 43.83B.400), defining an area as being in a drought condition when the water supply for the area is below 75 percent of normal and water uses and users in the area are likely to incur undue hardships because of the water shortage.

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.

It should be noted that water supply is controlled not only by precipitation, but also by other factors, including evaporation (which is increased by higher than normal heat and winds), transpiration (the use of water by plants), and human use. 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.

5.2 HAZARD PROFILE

5.2.1 Extent and Location

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

- The ***Palmer Crop Moisture Index*** measures short-term drought on a weekly scale and is used to quantify drought's impacts on agriculture during the growing season.

- The ***Palmer Z Index*** measures short-term drought on a monthly scale. Figure 5-2 shows this index for May 2019.

- The ***Palmer Drought Severity 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 the Palmer Drought Severity Index can respond fairly rapidly. Figure 5-3 shows this index for May 2019.

- 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. The Palmer Hydrological Drought Index responds more slowly to changing conditions than the Palmer Drought Index. Figure 5-4 shows this index for May 2019.

- While the Palmer indices consider precipitation, evapotranspiration and runoff, the ***Standardized Precipitation Index*** considers only precipitation. In the Standardized Precipitation Index, an index of zero indicates the median precipitation amount; the index is negative for drought and positive for wet conditions. The Standardized Precipitation Index is computed for time scales ranging from one month to 24 months. Figure 5-5 shows the 12-month Standardized Precipitation Index map for June 2018 through June 2019.

- Soil moister indices also help establish baselines from which anomalies can be established. Soil moisture is not only important for the agricultural aspect, but also for increased fire danger (see Figure 5-7)[11].

Nearly all areas of Washington are vulnerable to drought (see Figure 5-6). The coastal areas of Washington, the Olympic Peninsula, and areas in Central Washington just east of the Cascades are particularly vulnerable. High quality agricultural soils exist in portions of southern and western Spokane County. These areas of the county sustain dry land crops such as wheat that are dependent upon moisture through the winter and spring and dry arid conditions in the summer.

5.2.2 Previous Occurrence

Droughts recur every few years in Washington, although FEMA reports no presidentially declared drought situations affecting Spokane County. In the past century, Washington State 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. The droughts of 1977 and 2001, the worst and second worst in state history, respectively, provide good examples of how drought can affect the state. The following are the most notable droughts recorded in Washington:

- **June – August 1922—**From June 10 to August 20, the statewide precipitation average was only 0.10 inches.

- **April 1934 – March 1937—**The mid-1930s saw the longest drought in the region's history. The driest periods were April to August 1934, September to December 1935, and July 1936 to January 1937.

- **1977—**The 1977 drought led to widespread water shortages and severe water conservation measures throughout Washington. More than 70 public and private drinking-water operations reported water-supply problems. Wheat and cattle were the most seriously affected agricultural products in the state. The Federal Power Commission ordered public utilities on the Columbia River to release water to help fish survive. Agriculture experienced drought-related losses of more than $400 million.

- **2001**—The 2001 drought came on fairly rapidly. Between November 2000 and March 2001, most of the state's rainfall and snowpack totals were only about 60 percent of normal. The 2001 event was a result of warm weather melting snowpack into streams a month earlier than normal. Nine large utility companies statewide advised the Washington State Department of Health that they were highly vulnerable to the drought. Washington declared a statewide drought emergency on March 14, 2001. As a result of the 2001 drought, 90,000 acres of agricultural land were taken out of production; thousands of acres of orchards were unused, and the sugar beet industry was out of production.

- **2005**— Water year 2005 (October 1, 2004, through September 30, 2005) got off to a good start. October precipitation ranged from normal to well-above normal for most of the state. However, precipitation was below average for much of the state from November through February, and the fall and winter were extremely warm, which adversely affected the state's mountain snowpack. A warm mid-January storm removed much of the remaining snowpack. February was warm and dry, and by early March projections showed Washington might be facing a

[11] https://www.cpc.ncep.noaa.gov/products/Drought/Monitoring/monthly-weasd-anom.shtml

drought as bad as or worse than the 1977 drought. A statewide drought emergency was declared on March 10, 2005. The state Legislature approved a $12 million supplemental budget request that provided funds for buying water, improving wells, implementing other emergency water-supply projects, and hiring temporary state staff to respond to the drought emergency. The emergency proclamation expired on December 31, 2005.

2019 – As of May 20, 2019, Governor Jay Inslee issued an emergency drought declaration in 24 watersheds statewide (see Figure 5-1). According to the Washington State Department of Ecology, very dry conditions over the last several months and a diminished snowpack impacted streamflow, which was identified to be well below normal conditions across most of the state. Watersheds west of the Cascades crest, which are more rain dependent than rivers on the east side, flowed at much below normal levels. Some rivers set record daily lows for historic May flows. Statewide, only four (4) percent of rivers were flowing at levels above normal. Stream flows were strong in the southeast corner of the state. Twenty-seven out of 62 watersheds were declared for drought as of May 20, 2019. Spokane County was not among the Counties identified as having a drought emergency. As an agricultural area, droughts do have an impact on the County as a whole.

The total social and economic impacts of these events on the Spokane County planning area are not known at this time specific to impact to Spokane County; however, the State's 2018 Hazard Mitigation Plan indicates that in the last two decades, the two major droughts which Washington has experienced identify that in both cases, water levels were less than 75 percent of the normal water supply and caused undue hardship. Both droughts also inflicted significant impacts throughout the state, which included the following: increased production costs and reduced revenue in the agricultural sector; reduced deliveries to junior water rights holders; reduced power generation; increased power costs; reduced survival of adult and juvenile salmonid; and reduced visitation to ski areas. Estimates of drought damages to agriculture ranged from $270 million - $400 million in 2001 and $195 million - $299 million in 2005 (Stephens et al., 2005).

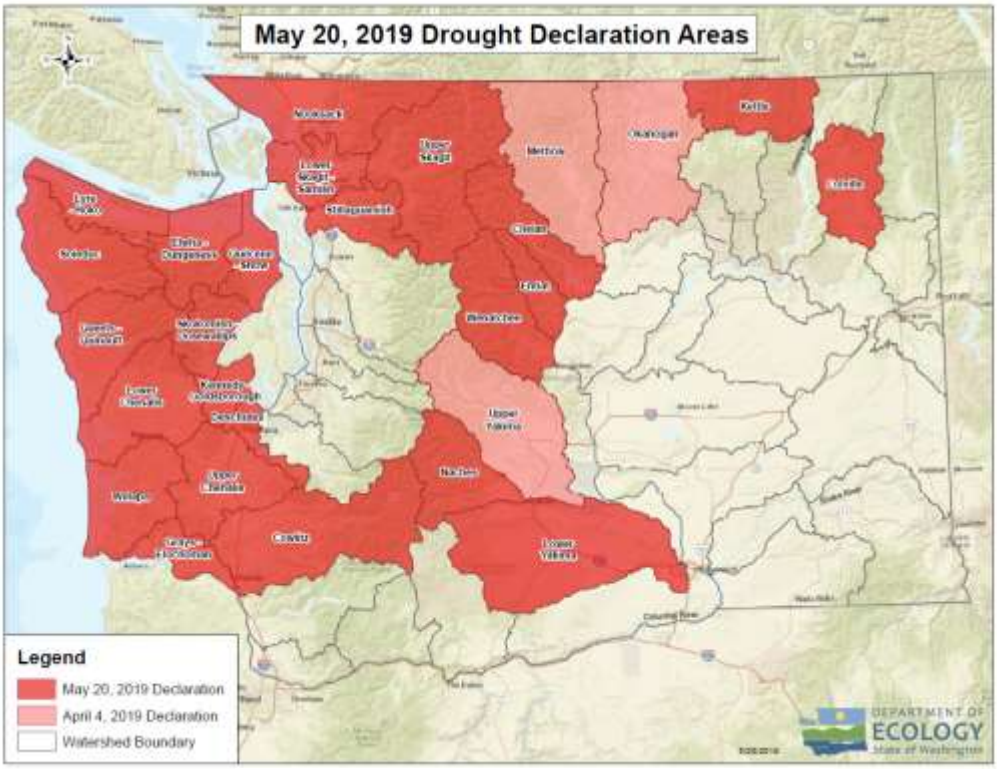


Figure 5-1. May 2019 Drought Declaration Areas

The 2015 Governor-declared drought on March 13 for the three regions of the State (the Olympic Peninsula, the east slopes of the central Cascades, and the Walla Walla Basin) resulted in the Washington State Legislature approving $16 million for Ecology to support drought relief work for the biennium. As the 2019 drought remains on-going, the ultimate cost is unknown.

5.2.3 Frequency

Drought conditions occur every few years in Washington. According to the 2010 Washington State Enhanced Hazard Mitigation Plan, Spokane County has experienced serious or extreme drought conditions 10 to 15 percent of the time from 1895 to 1995 and 20 to 30 percent of the time from 1985 to 1995. Thus it can be predicted that Spokane County may experience the effects of drought at least once every decade.

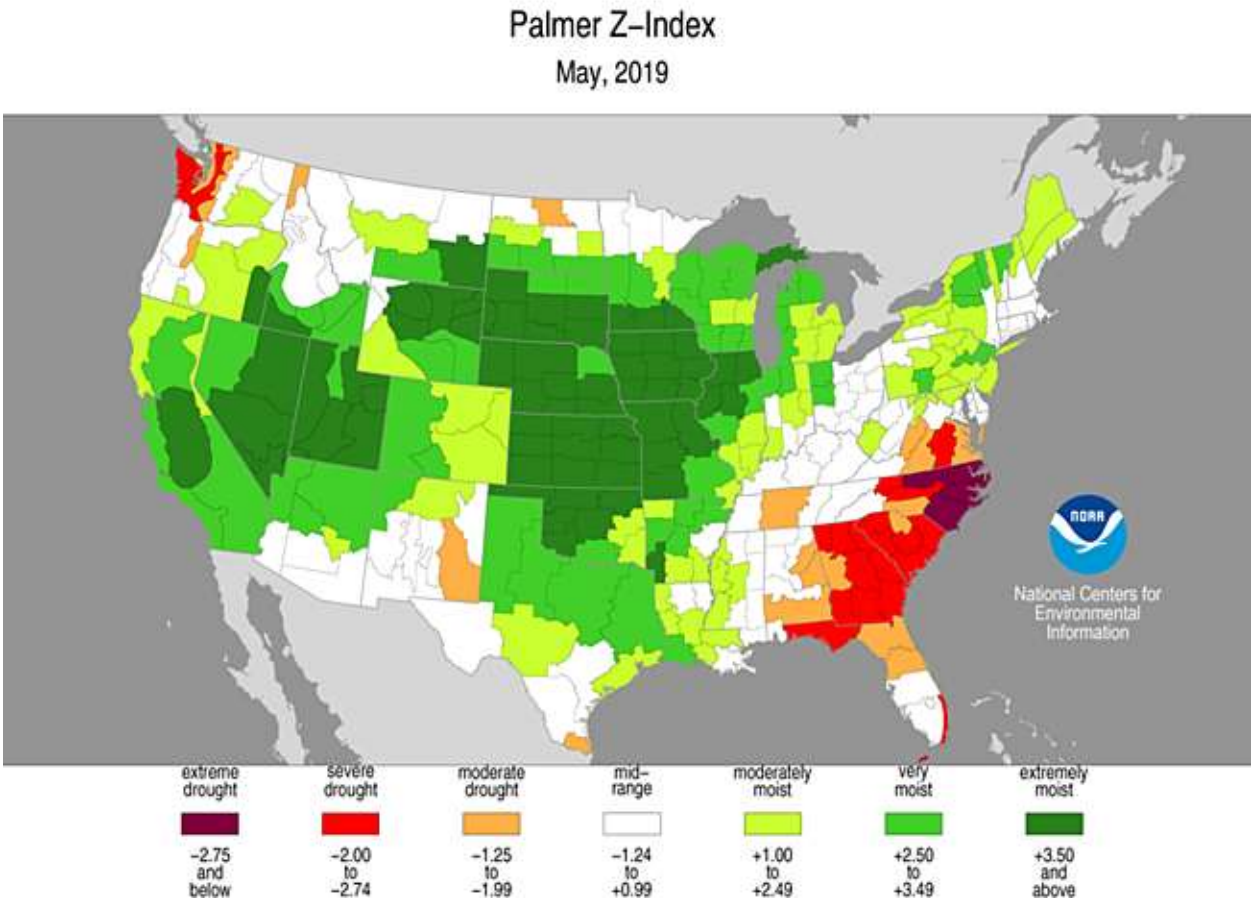


Figure 5-2. Palmer Z Index Short-Term Drought Conditions (May 2019)

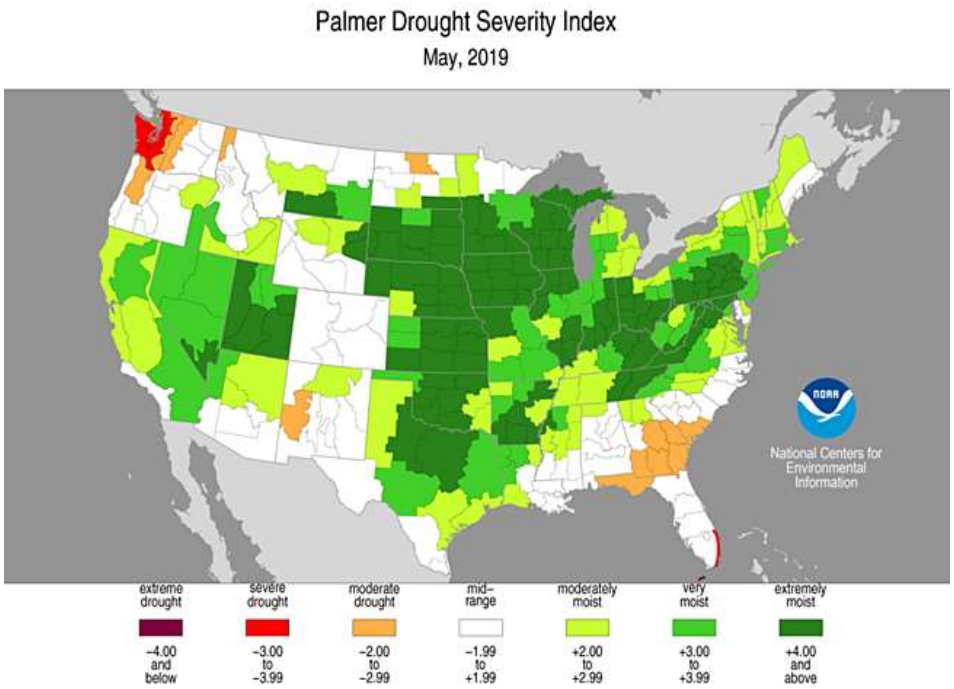


Figure 5-3. Palmer Drought Severity Index - May 2019

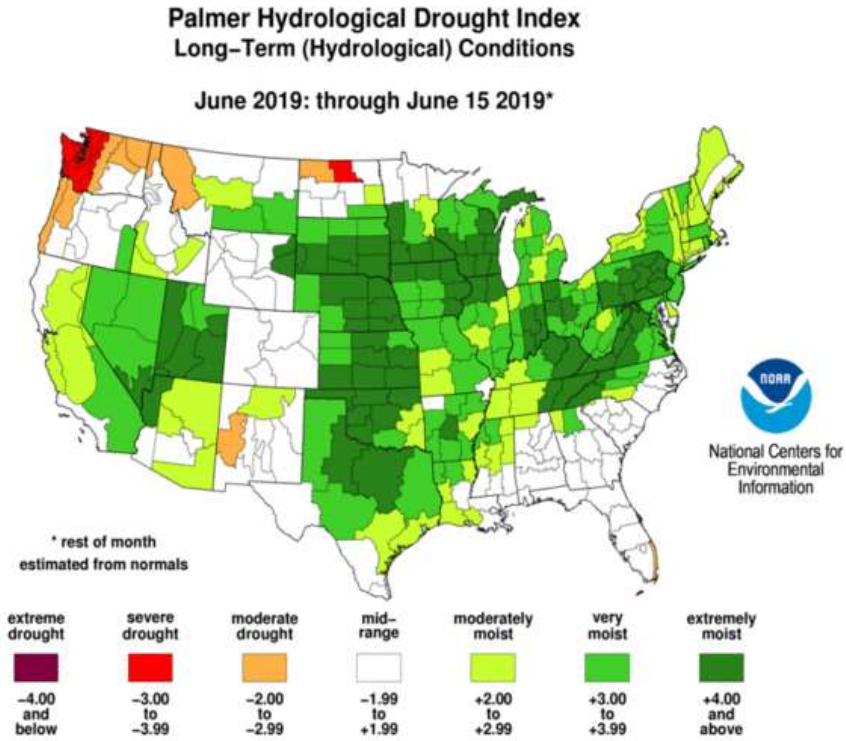


Figure 5-4. Palmer Hydrological Drought Index Long-Term Hydrologic Conditions (June 2019)

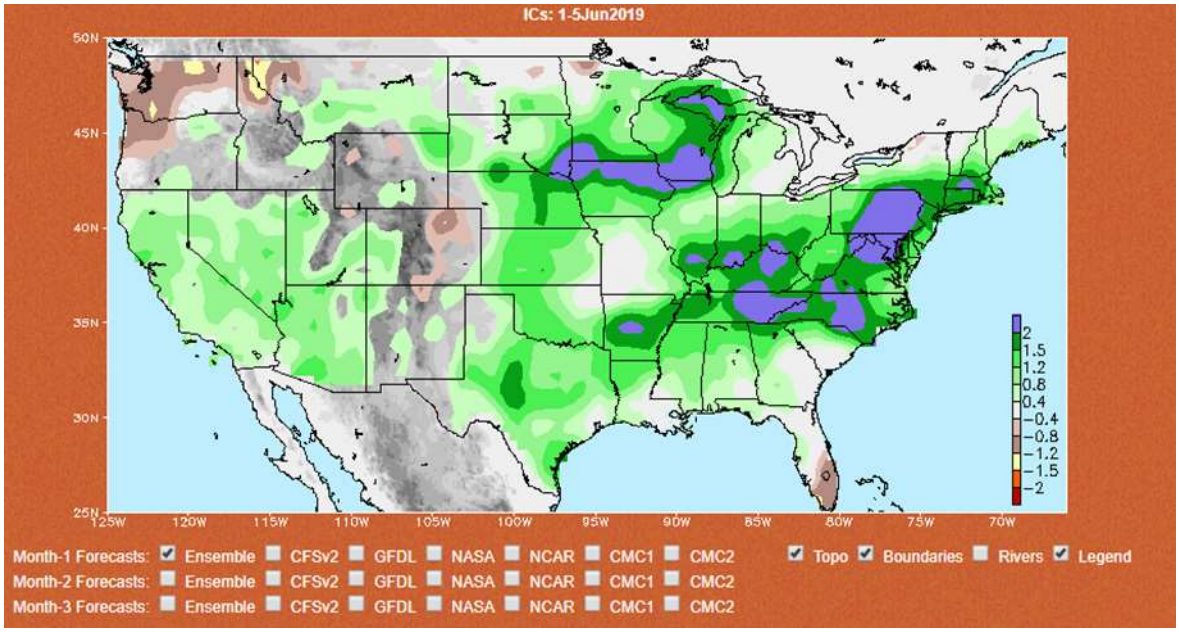


Figure 5-5. 24-Month Standardized Precipitation Index (June 2018—June 2019)

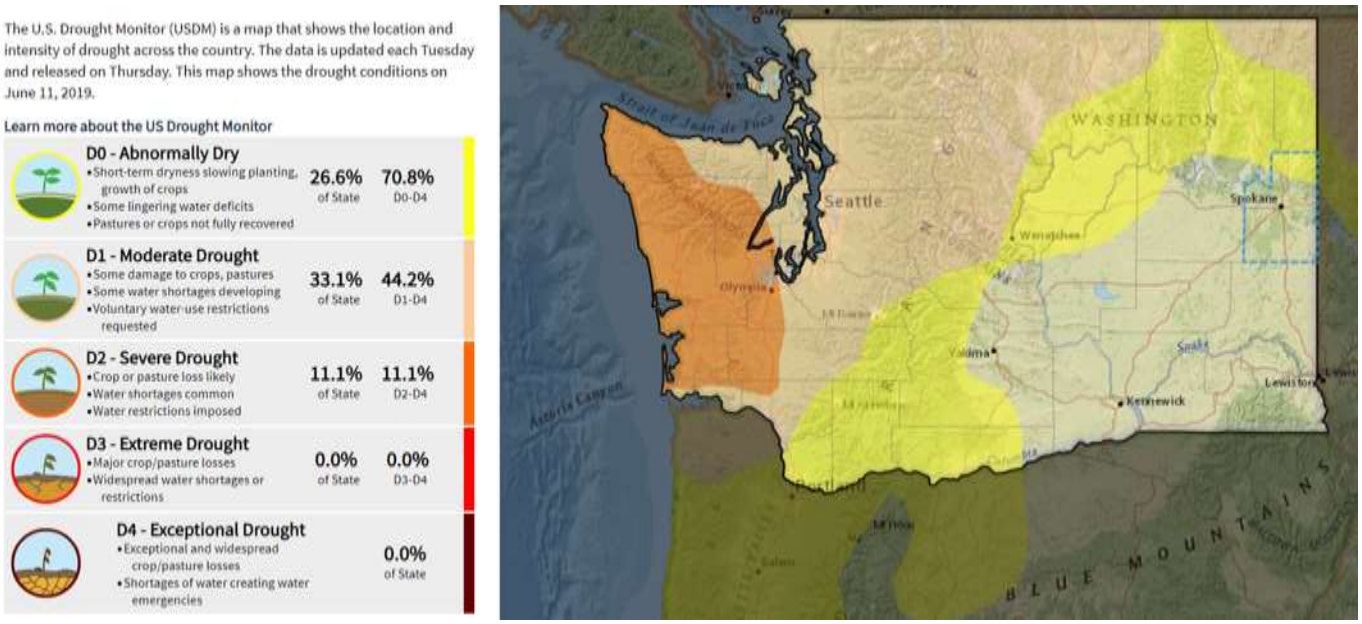


Figure 5-6. NIDIS Drought In Washington as of June 11, 2019
Source: https://www.drought.gov/drought/states/washington

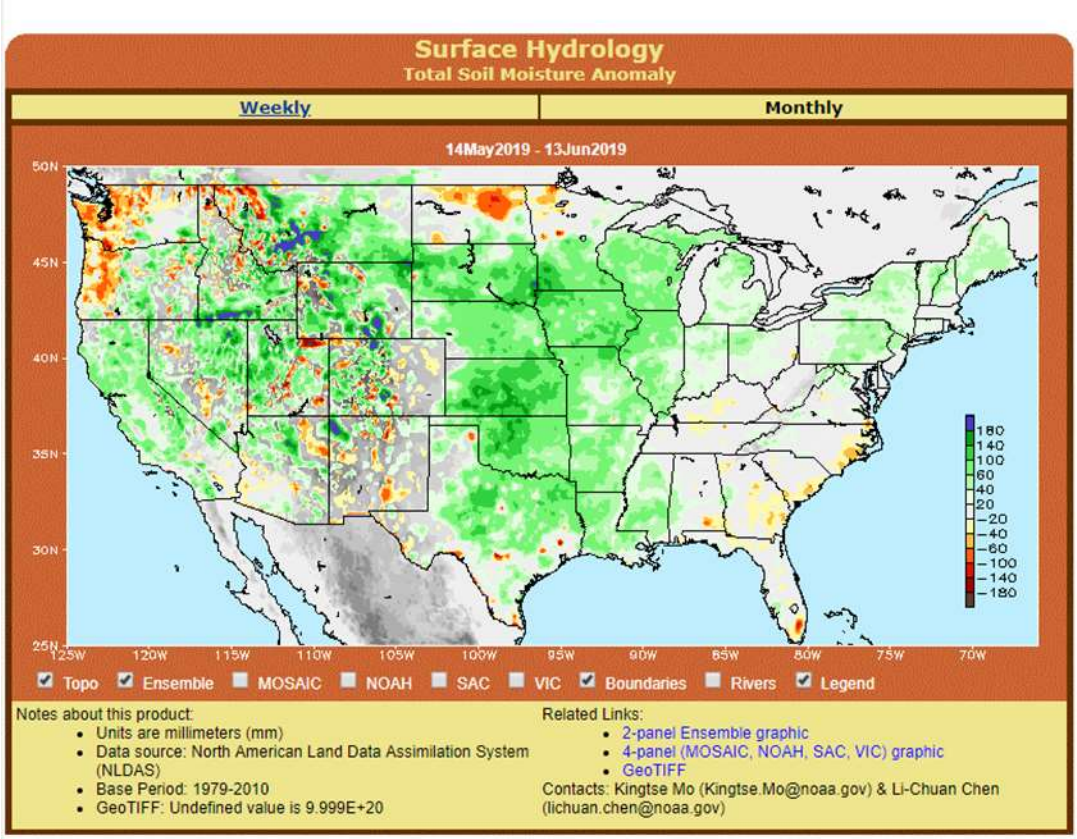


Figure 5-7. Soil Moisture Impact

5.2.4 Severity

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

Unlike most disasters, droughts normally occur slowly, but can last a long time. 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:

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

On average, the nationwide impacts of drought are greater than those 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 generally does not affect groundwater sources as quickly as surface water supplies, although groundwater supplies generally take longer to recover. Drought conditions increase the demand for irrigation and begin to deplete underground aquifers as deep as 100 feet. 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.

The most direct impact of drought is economic rather than loss of life or immediate destruction of property. A drought directly or indirectly impacts all people in affected areas:

- In every drought, agriculture is adversely impacted, especially in non-irrigated areas such as dry land farms and rangelands. 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 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. A lack of snow-pack has forced ski resorts into bankruptcy.

- In Washington, where hydroelectric power plants generate nearly three-quarters of the electricity produced, a drought means less inexpensive electricity coming from dams and probably higher electric bills. All people could pay more for water if utilities increase their rates.

- Fire dangers, which are extremely high in the normal dry seasons, become more hazardous under drought conditions. Control of fires strains the budgets of fire districts. This increases manpower and equipment use and equipment failure. Millions of board feet of timber have been lost, and in many cases, erosion occurred, which caused serious damage to aquatic life, irrigation and power production by heavy silting of streams, reservoirs and rivers.

The Spokane Valley–Rathdrum Prairie aquifer is the sole source of drinking water for over 400,000 residents in Spokane County, Washington, and Bonner and Kootenai Counties, Idaho. Recent and projected urban, suburban and industrial/commercial growth has raised concerns about potential future effects on water availability and water quality in the aquifer and the Spokane and Little Spokane Rivers.

While Spokane County does experience droughts, they are generally mild and do not cause damage to the area. Thus, the likelihood of severe hardship due to drought in Spokane County is more limited in nature. Crop losses would more than likely be isolated to the southern and western portions of the county. Cities could experience water shortages.

5.2.5 Warning Time

Droughts are climatic patterns that occur over long periods. 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 generalized 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.

5.3 SECONDARY HAZARDS

The secondary hazard most commonly associated with drought is wildfire. A prolonged lack of precipitation dries out vegetation, which becomes increasingly susceptible to ignition as the duration of the drought extends. 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. Low stream flows have created high temperatures, oxygen depletion, disease and lack of spawning areas for our fish resources.

Often, drought is accompanied by extreme heat. When temperatures reach 90ºF and above, people are vulnerable to sunstroke, heat cramps and heat exhaustion. Pets and livestock are also vulnerable to heat-related injuries. Crops can be vulnerable as well. In past Washington state droughts, wheat has been scorched, apples have sunburned and peeled and yields were significantly lessened.

5.4 CLIMATE CHANGE IMPACTS

Research conducted by the Climate Impacts Group at the University of Washington indicates that the temperature of Eastern Washington is increasing. As temperatures increase there will be less water stored as ice and snow. This reduction may not result in a net change in annual precipitation, but it will result in lower late spring and summer river flows. Accordingly there will be increased competition between power, sport fishing and environmentalists, and farmers dependent on irritation.

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

- Growing populations
- Increased competition for available water
- Poor water quality
- Environmental claims
- Uncertain reserved water rights

- Groundwater overdraft
- Aging urban water infrastructure.

With a warmer climate, droughts could become more frequent, more severe, and longer-lasting. From 1987 to 1989, losses from drought in the U.S. totaled $39 billion (OTA, 1993). More frequent extreme events such as droughts could end up being more cause for concern than the long-term change in temperature and precipitation averages. This would be the result of less water stored as ice and snow in the hills and mountains to the east. This would ultimately result in decreased stream flows in the spring in local rivers. Competition for water would increase. Spokane County farmers and residents may be less affected than those depending on irrigation for their water source. Crop insurance has provided the cushion to mitigate the most adverse impacts of drought in the County. As the effects of regionally based changes in climate begin to be felt, the County may consider building structures that compensate for the expected reduction in natural storage and enhance aquifer recharge.

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

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

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

5.5 VULNERABILITY

5.5.1 Overview

All people, property and environments in the Spokane County planning area would be exposed to some degree to the impacts of moderate to extreme drought conditions. Drought produces impacts that span many sectors of the economy and reach well beyond the physical area experiencing the drought. This complexity exists because water is integral to the ability to produce goods and provide services. Drought can affect a wide range of economic, environmental and social activities. The vulnerability of an activity to the effects of drought usually depends on its water demand, how the demand is met, and what water supplies are available to meet the demand.

According to the 2018 Washington State Enhanced Hazard Mitigation Plan, Spokane County is among the 75 percent of total land area of the state estimated to be at medium or higher exposure from droughts (see

Figure 5-8). When applying the State's severity risk index, Spokane County gained a "High" rating based on the State's Drought Risk Index (WA EMD) (see Figure 5-9).[12]

The State's plan indicates that all census tracts in the County are ranked medium or higher for drought exposure. At current indicators (June 2019), Spokane County is not among those counties declared in the May 2019 drought situation; however, based on the low levels of precipitation, when reviewing the high wildfire danger impacting in particular the eastern portion of Washington State over the course of the last several years, it is clear that drought situations in the short-term significantly increase the long-range fire prediction models, indicating drought as a clear and significant hazard of concern.

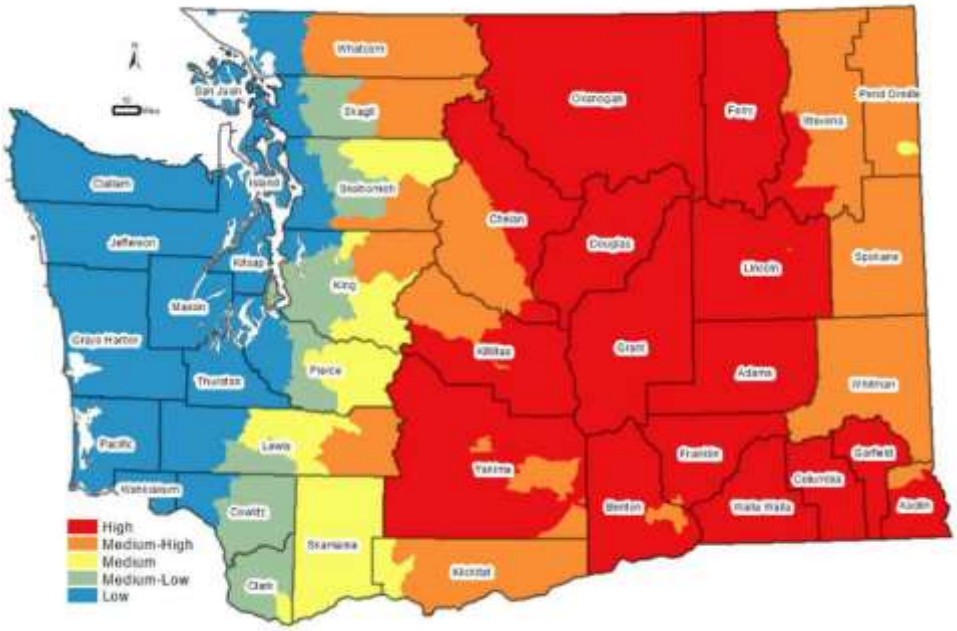


Figure 5-8. Drought Hazard In Washington State (WA HMP, 2018)

[12] Washington State Enhanced Hazard Mitigation Plan (2018) https://mil.wa.gov/enhanced-hazard-mitigation-plan

Figure 5-9. WA EMD Illustration of Drought Risk Index (2018)

5.5.2 Impact on Life, Health, and Safety

The planning partnership has the ability to minimize any impacts on residents and water consumers in the county should several consecutive dry years occur. No significant life or health impacts are anticipated as a result of drought within the planning area. While the entire population is at risk to being exposed to a drought impact, Spokane County has less than five (5) percent of its population ranked medium or higher when considering the social vulnerability impacts (WA EMD, p. 116, 2018).

5.5.2 Impact on Property

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

5.5.3 Impact on Critical Facilities

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

5.5.4 Impact on Economy

Economic impact will be largely associated with industries that use water or depend on water for their business. For example, agricultural/farm areas will be significantly impacted. Likewise, landscaping

businesses historically were affected in the droughts of the past as the demand for service significantly declined because landscaping was not watered. Agricultural industries will continue to be impacted if water usage is restricted for irrigation.

Review of Spokane County Census of Agriculture data (2012 – most recent available for 2019 update), the County ranks among the top five producers statewide in production of lentils, hay, wheat, sheep (including goats, wool mohair, and milk), horses (including ponies, mules, burros and donkeys).[13] The County is also considered top producers nationwide in several of these products. Combined, the impact from a drought situation on the County's export markets for economic sustainability could be high.

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 freshwater 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.

5.5.5 Impact on Environment

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

5.6 FUTURE TRENDS IN DEVELOPMENT

The U.S. Geological Survey's water use figures for Washington State show that public supply—domestic, commercial, industrial, and thermoelectric generation—uses about one gallon of every eight. Growing counties will find their rate of water use grow as their population grows. Spokane County's average annual growth rate was above the state average. This rate of growth is anticipated to remain consistent during the performance period of this plan update due to economic growth which the County is currently experiencing.

Each municipal planning partner in this effort has an established comprehensive plan that includes policies directing land use and dealing with issues of water supply and the protection of water resources. These plans provide the capability at the local municipal level to protect future development from the impacts of drought. All planning partners reviewed their general plans under the capability assessments performed for

[13] https://www.nass.usda.gov/Publications/AgCensus/2012/Online_Resources/County_Profiles/Washington/cp53063.pdf Accessed 8 July 2019.

this effort. Deficiencies identified by these reviews can be identified as mitigation actions to increase the capability to deal with future trends in development.

An extreme multiyear drought more intense than the 1977 drought could impact the region with little warning. Combinations of low precipitation and unusually high temperatures could occur over several consecutive years. Intensified by such conditions, extreme wildfires could break out throughout Spokane County, increasing the need for water. Surrounding communities, also in drought conditions, could increase their demand for water supplies relied upon by the planning partnership, causing social and political conflicts. If such conditions persisted for several years, the economy of Spokane County could experience setbacks, especially in water dependent industries. Spokane County may experience a period of prolonged drought. The lack of precipitation would not affect crops or domestic water supplies for towns, but may increase the risk of wildfires. Also affected would be electric rates.

5.7 ISSUES

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

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

5.8 CONSEQUENCE ANALYSIS

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

First responders would sustain some level of impact due to potential decreased water supplies to fight fires, as well as increased calls for service in responding to medical calls; hospitals, due to the heat customarily associated with a drought situation, could also be impacted due to health-related issues; local governments may be required to open cooling shelters as a result of the increased heat, or institute conservation plans to help ensure water supplies.

In addition, drought conditions could impact the ability to fight wildfires due to low water availability. Table 5-1 identifies the Consequence Analysis for the Drought hazard.

Table 5-1.
Consequence Analysis

	L	ML	M	MH	H	VH
Likelihood / Probability					X	
Geographic Boundary					X	
Population		X				
Vulnerable Population		X				
Built Environment	X					
Critical Infrastructure	X					
Facilities	X					
First Responders			X			
Economic Consequences						X
Environmental Impact						X
Government's Ability to Continue Operations						X

L=Low; ML=Medium-Low; M=Medium; MH=Medium-High; H=High; VH=Very High

5.9 RESULTS

Washington State's 2018 Hazard Mitigation Plan indicates that all census tracts in the County are ranked medium or higher for drought exposure. As indicated, at current indicators (June 2019), Spokane County is not among those counties declared in the May 2019 drought situation; however, based on the low levels of precipitation, and when taking into account the impact of a drought situation on the high wildfire danger impacting the eastern portion of the state over the course of the last several years, it is clear that drought is a significant hazard of concern as the impact to the agricultural community (both crops and livestock) would also be of significance. Based on those findings, the Planning Team determined the Drought Hazard to be of medium concern, ranking a score of 2.75.

CHAPTER 6.
EARTHQUAKE

6.1 GENERAL BACKGROUND

6.1.1 How Earthquakes Happen

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

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.

Earthquakes in the Pacific Northwest have been studied extensively. 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 6-1. More than 90 percent of Pacific Northwest earthquakes occur along the boundary between the Juan de Fuca plate and the North American plate.

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.

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

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.

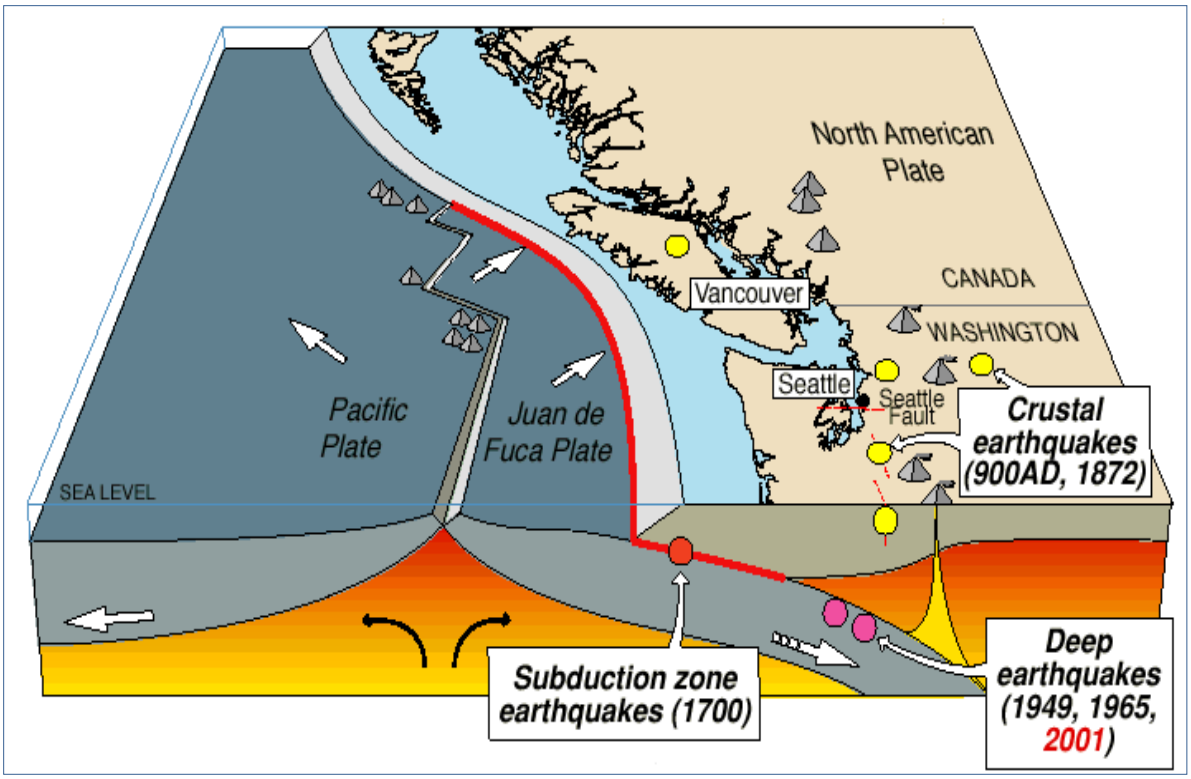


Figure 6-1. Earthquake Types in the Pacific Northwest

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.

6.1.2 Earthquake Classifications

Earthquakes are classified according to the amount of energy released as measured by magnitude or intensity scales. Currently the most commonly used scales are the moment magnitude (Mw) scale, and the modified Mercalli intensity scale. Estimates of moment magnitude roughly match the local magnitude scale (ML) commonly called the Richter scale. One advantage of the moment magnitude scale is that, unlike other magnitude scales, it does not saturate at the upper end. That is, there is no value beyond which all large earthquakes have about the same magnitude. For this reason, moment magnitude is now the most often used estimate of large earthquake magnitudes. Table 6-1 presents a classification of earthquakes according to their magnitude. Table 6-2 compares the moment magnitude scale to the modified Mercalli intensity scale.

Table 6-1.
Earthquake Magnitude Classes

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

Table 6-2.
Earthquake Magnitude and Intensity

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

6.1.3 Ground Motion

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

Maps of PGA values form the basis of seismic zone maps that are included in building codes such as the International Building Code. Building codes that include seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake. PGA values are directly related to these lateral forces that could damage "short period structures" (e.g. single-family dwellings). Longer period response components determine the lateral forces that damage larger structures with longer natural periods (apartment buildings, factories, high-rises, bridges). Table 6-3 lists damage potential and perceived shaking by PGA factors, compared to the Mercalli scale.

Table 6-3.
Mercalli Scale and Peak Ground Acceleration Comparison

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

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

6.1.4 Effect of Soil Types

The impact of an earthquake on structures and infrastructure is largely a function of ground shaking, distance from the source of the quake, and liquefaction, a secondary effect of an earthquake in which soils lose their shear strength and flow or behave as liquid, thereby damaging structures that derive their support from the soil. Liquefaction generally occurs in soft, unconsolidated sedimentary soils. A program called the National Earthquake Hazard Reduction Program (NEHRP) creates maps based on soil characteristics to help identify locations subject to liquefaction. Table 6-4 summarizes NEHRP soil classifications NEHRP Soils B and C typically can sustain ground shaking without much effect, dependent on the earthquake magnitude. The areas that are commonly most affected by ground shaking have NEHRP Soils D, E and F. In general, these areas are also most susceptible to liquefaction. Table 6-5 summarizes the NEHRP soils classifications countywide.

Table 6-4.
NEHRP Soil Classification System

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

Table 6-5.
Acres of NEHRP Soils within Spokane County

Jurisdiction	B	B-C	C	C-D	D	D-E	E	F	Water	Total
Airway Heights	228.2	0	3,065.5	0	0.0	0.0	0	0.0	0.0	3,293.7
Cheney	794.9	0	1,437.5	0	526.4	15.0	0	0.0	22.4	2,796.3
Deer Park	0.0	0	3,968.3	0	0.0	40.5	0	0.0	0.0	4,008.8
Fairfield	0.0	0	0.0	0	289.0	289.0	0	0.0	0.0	577.9
Latah	70.9	0	0.0	0	107.8	20.3	0	0.0	0.0	199.0
Liberty Lake	652.6	0	2,822.1	0	339.1	117.4	0	0.0	0.0	3,931.1
Medical Lake	1,953.3	0	150.9	0	70.2	0.0	0	0.0	129.1	2,303.5
Millwood	0.0	0	440.0	0	0.0	0.0	0	0.0	0.2	440.2
Rockford	176.4	0	0.0	0	126.8	122.5	0	0.0	0.0	425.7
Spangle	0.0	0	0.0	0	188.7	35.7	0	0.0	0.0	224.5
Spokane	5,719.1	0	24,961.6	0	7,123.5	45.3	0	0.0	439.6	38,289.1
Spokane Valley	1,284.8	0	22,031.6	0	856.1	0.2	0	0.0	179.1	24,351.8
Waverly	42.7	0	0.0	0	129.5	86.5	0	0.0	0.0	258.8
Unincorporated Spokane Co.	430,840.9	0	232,287.2	0	336,465.6	44,325.2	0	3,938.2	10,247.4	1,058,104.5
Total (Acres)	**441,763.6**	**0**	**291,164.6**	**0**	**346,222.9**	**45,097.6**	**0**	**3,938.2**	**11,017.8**	**1,139,204.8**
% of Planning Area	**38.8%**	**0.0%**	**25.6%**	**0.0%**	**30.4%**	**4.0%**	**0.0%**	**0.3%**	**1.0%**	**100%**

*Planning area for Spokane County calculated at 1,139,204.8 acres

6.2 HAZARD PROFILE

The seismic history of the Spokane area is poorly understood since past events did not result in any major property damage and distant seismograph stations did not pick up many of the low-magnitude earthquakes. Newspaper reports indicate that between 1915 and 1962 nine earthquakes were felt only in the Spokane area (indicating a local source), but none had the characteristics of the 2001 swarm sequence. A number of these historical earthquakes were felt most strongly in the area of the Hangman Creek lineament. Many geologists have mapped the Spokane area, but none had confirmed the presence of any major faults with demonstrated offset that might be capable of producing earthquakes. The linear trace of Hangman Creek, however, was noted by Griggs (1973). It can be traced for nearly 50 miles from the Tekoa Mountain area on the south to beyond Nine Mile Falls on the north. The logical explanation for this was that the creek followed the trace of a fault.

Geologists in the Spokane office of the Division of Geology and Earth Resources have been mapping the geology of four quadrangles west and southwest of downtown Spokane. During the winter of 2013-2014, the geologists evaluated results of whole rock geochemistry tests on basalt samples that were collected to determine basalt stratigraphy in the Hangman Creek area, and found that basalt formations on the west side of the lineament did not correspond directly to those on the east side. The lack of lateral continuity in basalt flows could be attributed to erosion prior to deposition of younger flows. Alternatively, the lack of continuity could be attributed to movement on a fault roughly paralleling the lineament. This proposed fault has been informally named the Latah fault.

6.2.1 Extent and Location

In Eastern Washington, geologists have uncovered evidence of a number of surface faults; however, they have not yet determined how active the faults are, nor determined the extent of the risk they pose to the public. One fault, Toppenish Ridge, appears to have been the source of two earthquakes with magnitudes of 6.5 to 7.3 in the past 10,000 years.

For most residents in the planning area, the 2001 Spokane earthquake swarm is the most memorable. Earthquake swarms are events where a local area experiences sequences of many earthquakes striking in a relatively short period of time, with the length of time used to define the swarm itself varying by days or weeks. The quakes involved in the 2001 swarm were very shallow, with most events within a few miles of the surface. The events occurred near a suspected fault referred to as the Latah Fault; however, the relation between the fault and the swarm is uncertain. Geologists have mapped the Spokane area, but none confirmed the presence of major faults that might be capable of producing earthquakes. State geologists continue to investigate the geology and earthquake risk in Spokane.

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 components:

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

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

Shake Maps

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

Ground motion and intensity maps are derived from peak ground motion amplitudes recorded on seismic sensors (accelerometers), with interpolation based on estimated amplitudes where data are lacking, and site amplification corrections. Color-coded instrumental intensity maps are derived from empirical relations between peak ground motions and Modified Mercalli intensity. Two types of shake maps 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. Figure 6-2 and Figure 6-3 show the estimated ground motion for the 100-year and 500-year probabilistic earthquakes in Spokane County. The analysis completed during the 2015 update remained sound, and as such, the data was determined current for this 2020 update. The maps were updated to reflect the current edition and data input.

- 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. The 2015 plan edition included a scenario on the Latah Creek Fault (M7.0) for which no data existed to support such an event. As such, the planning team determined that the outputs were not a reliable estimation, and removed the event. For this 2020 update, one scenario was chosen: a M5.5 event on the Spokane fault with a shallow depth and epicenter in Spokane County, 10 miles north of Steptoe Butte (see Figure 6-4).

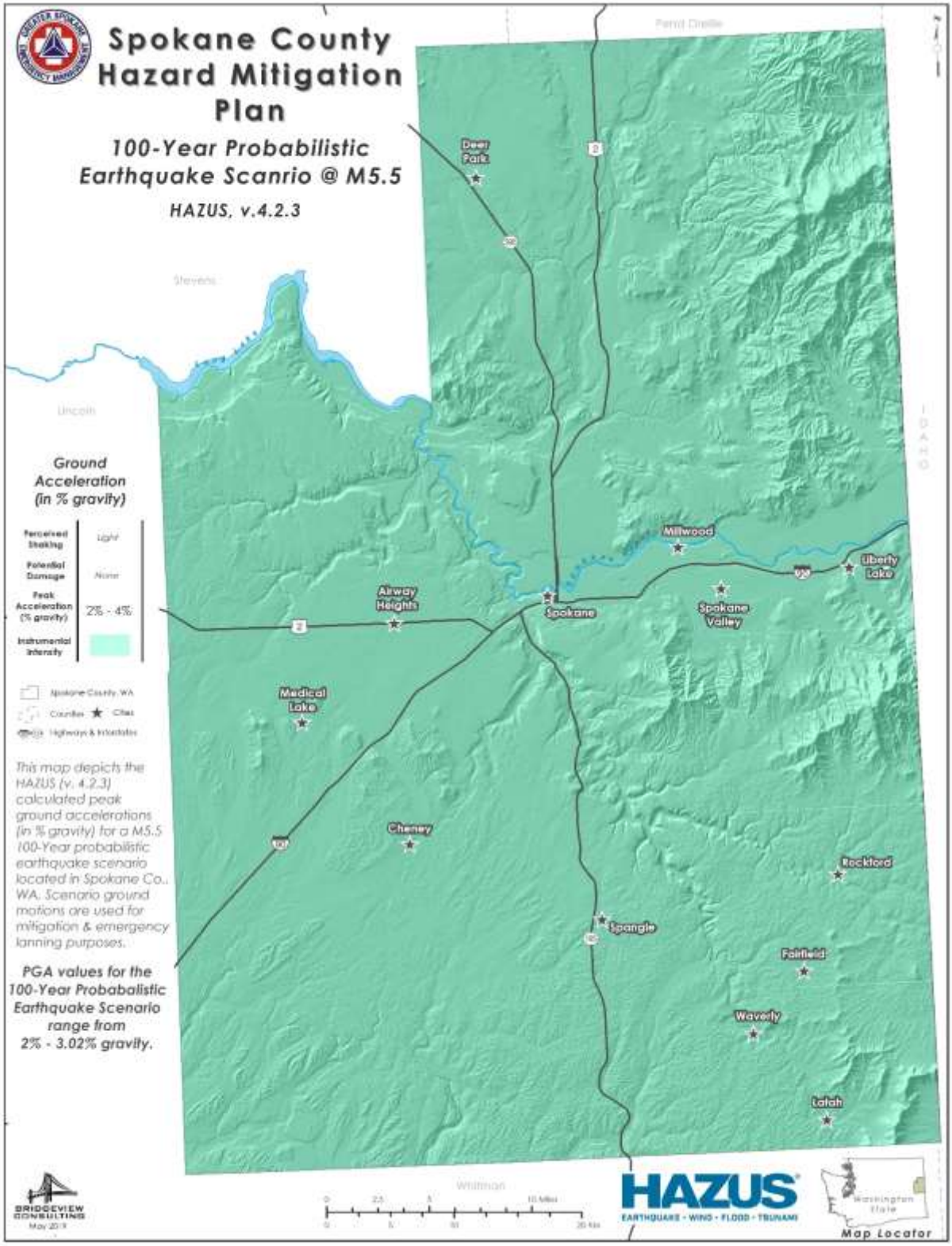


Figure 6-2. Peak Ground Acceleration; 100-Year Probability Event

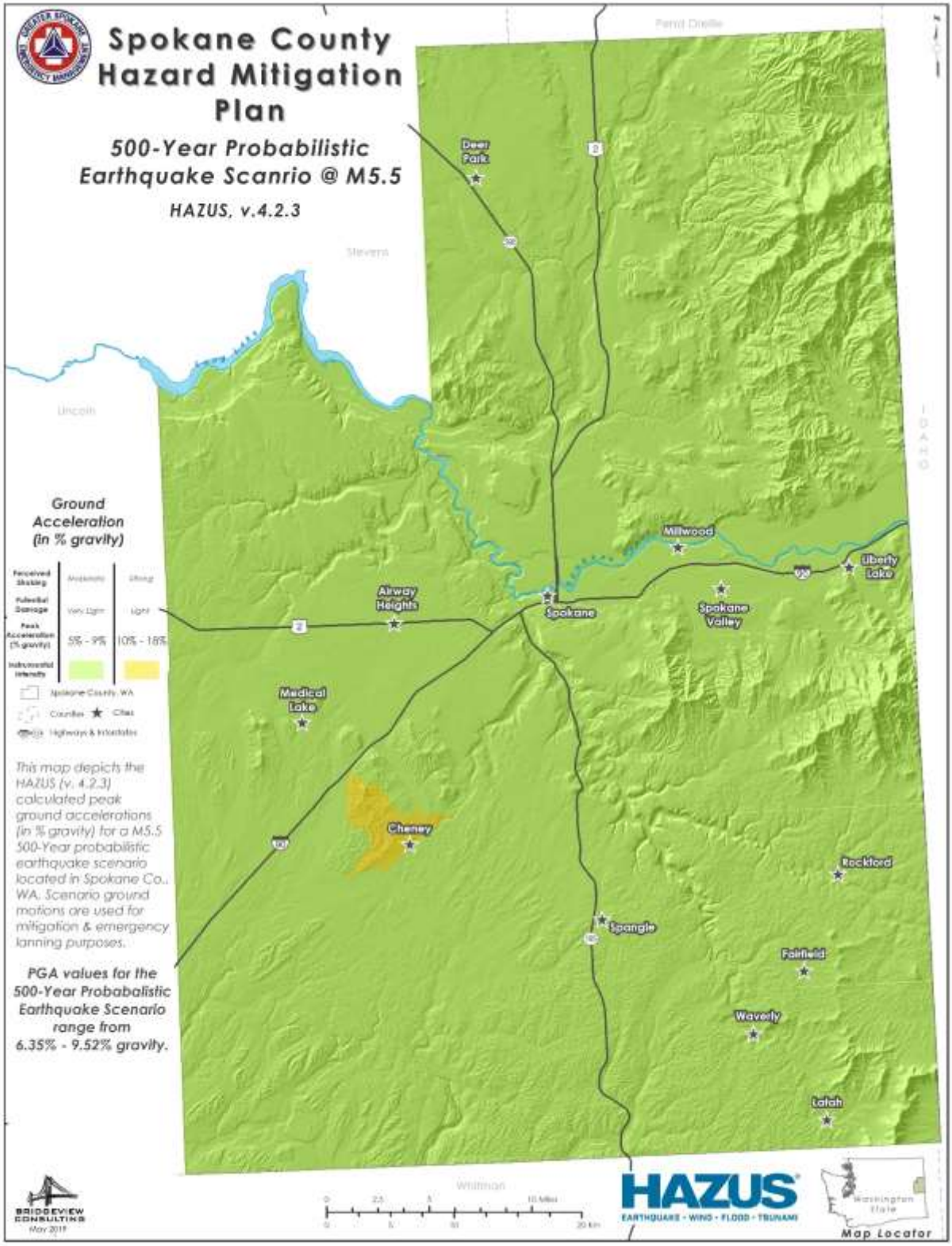


Figure 6-3. Peak Ground Acceleration; 500-Year Probability Event

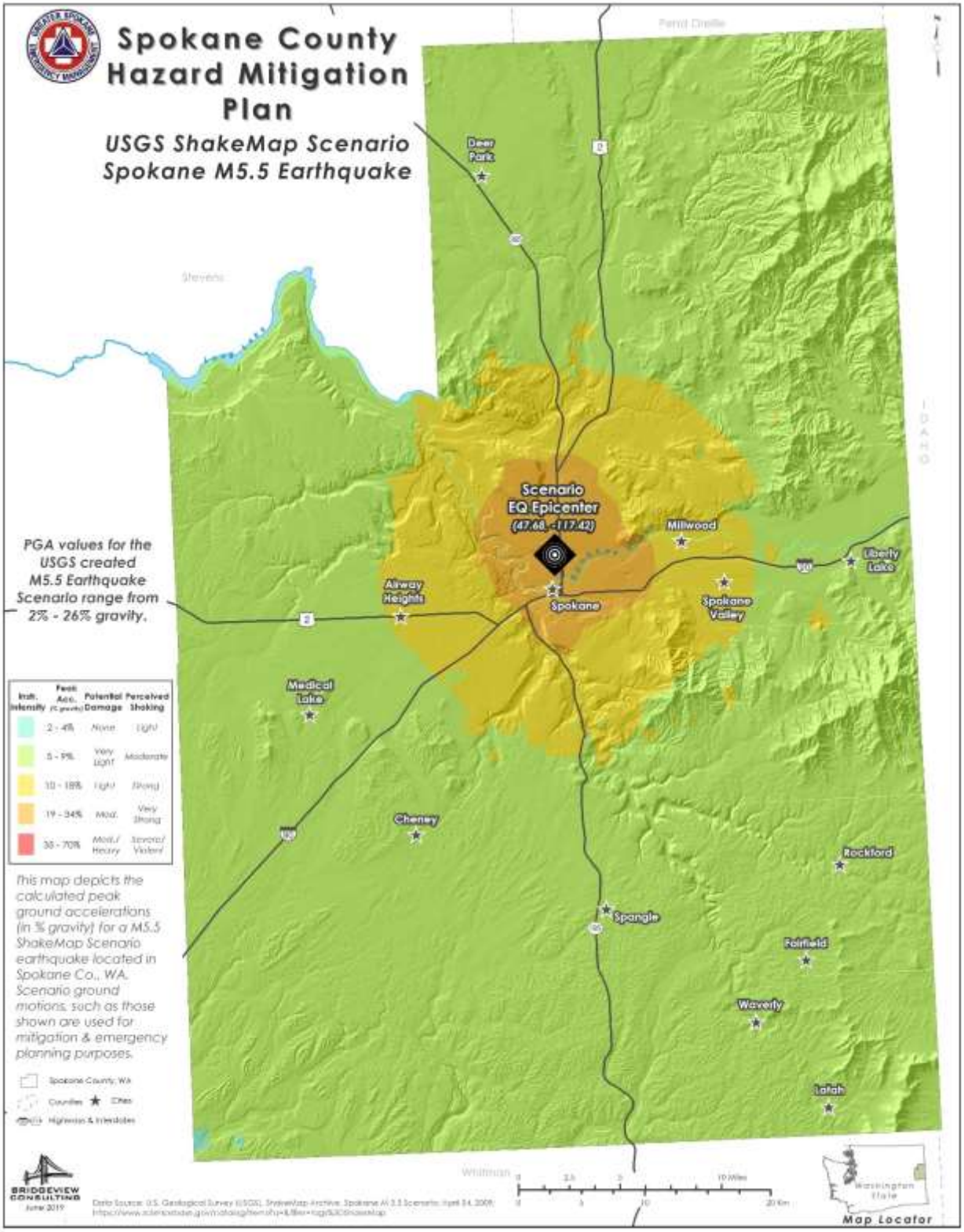


Figure 6-4. Peak Ground Acceleration; Spokane M5.5 Scenario

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 6-6 shows NEHRP soil classifications in the county.

Liquefaction Maps

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

Figure 6-7. Liquefaction Susceptibility

shows the liquefaction susceptibility in Spokane County.

6.2.1 Previous Occurrence

While earthquakes do occur within Spokane County, they are customarily of a lower magnitude as recorded by the U.S. Geological Survey (USGS) (see Figure 6-5)[14]. The most recent earthquake event of a magnitude 4 or higher occurred in 2001, when the county experienced a swarm of earthquakes. The largest earthquake in that swarm had a magnitude of 4.0.

Within the planning region, Washington's two largest crustal earthquakes since European settlement occurred in Eastern Washington: the 1872 quake near Lake Chelan and the 1936 earthquake near Walla Walla. Of these two, only the Walla Walla earthquake caused any damage in Spokane County.

Additional data and impact for historic earthquake events are discussed below.

[14] Earthquake Track. Accessed May 10, 2019. Available online at: https://earthquaketrack.com/us-wa-spokane/recent

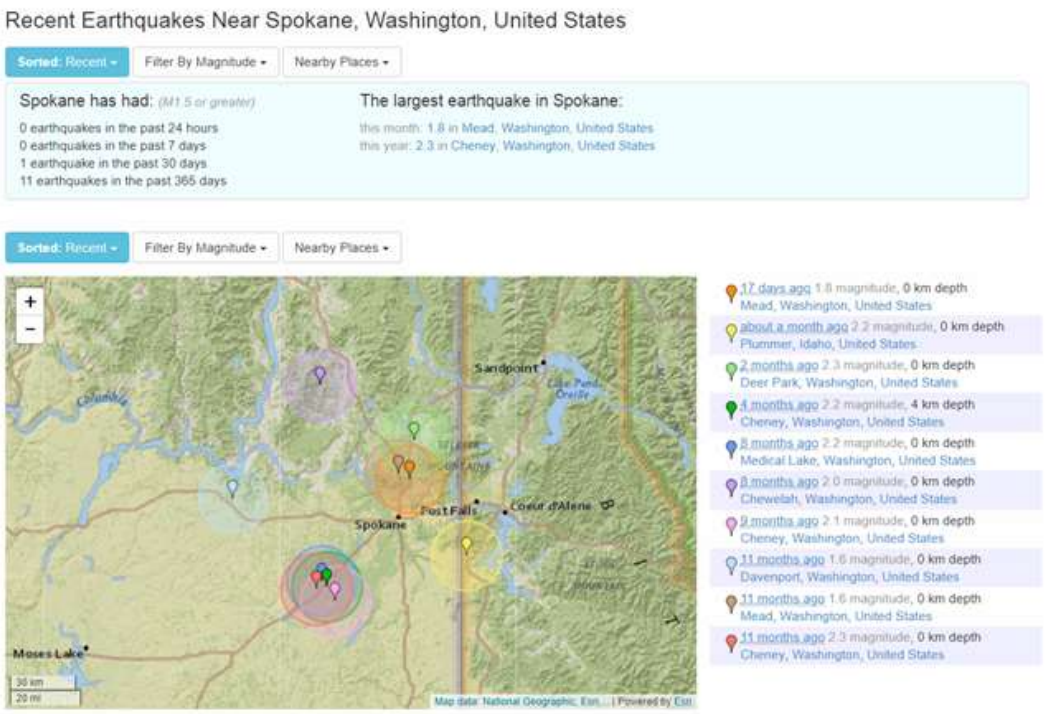


Figure 6-5. Earthquake History June 26, 2019 Spokane County

Lake Chelan, December 14, 1872

The magnitude 6.8 (estimated) Lake Chelan earthquake occurred about 9:40 p.m. and was felt from British Columbia to Oregon and from the Pacific Ocean to Montana. It occurred in a wilderness area that had only a few inhabitants. Reported effects included the following:

- Extensive landslides occurred on shorelines of the Columbia River. One slide, at Ribbon Cliff between Entiat and Winesap, blocked the Columbia River for several hours. Other slides occurred throughout the Cascade Mountains.

- Ground fissures occurred at the east end of Lake Chelan in the area of the Indian camp area; in the Chelan Landing-Chelan Falls area; on a mountain about 12 miles west of the Indian camp area; on the east side of the Columbia River (where three springs formed); and near the top of a ridge on the east side of the Columbia River.

- Water spouted as much as 27 feet in the air from a fissure at Chelan Falls. The geyser activity continued for several days, and, after diminishing, left permanent springs.

- In the area of the epicenter, the quake damaged one log building near the mouth of the Wenatchee River. Ground shaking threw people to the floor, waves were observed in the ground, and loud detonations were heard. The logs on another cabin caved in about 2 miles above the Ribbon Cliff slide area.

- Damaging ground shaking of intensity VI extended to the west throughout the Puget Sound basin and to the southeast beyond the Hanford Site. Individuals in Idaho, Montana, Oregon and Canada felt the earthquake. Aftershocks occurred in the area for two years.

Walla Walla Earthquake, July 15, 1936

This magnitude-6.1 earthquake occurred at 11:05 a.m. about 5 miles south-southeast of Walla Walla. It was widely felt through Oregon, Washington and northern Idaho, with the greatest shaking in northeast Oregon. Property damage was estimated at $100,000 (about $1.35 million in 2004 dollars).

The earthquake moved small objects, rattled windows, and cracked plaster in Colfax, Hooper, Page, Pomeroy, Prescott, Touchet, Wallula and Wheeler; most of the impact and damage was near Walla Walla.

The earthquake knocked down a few chimneys and many loose chimney bricks; damaged a brick home used by the warden at the State Penitentiary that was condemned and declared unsafe; and damaged the local railroad station. Several homes moved an inch or less on their foundations. Five miles southwest of Walla Walla, the quake restored the flow of a weakened 600-foot deep artesian well to close to original strength; the flow had not diminished after several months. Walla Walla residents reported about 15 or 20 aftershocks.

Hebgen Lake (Montana), August 18, 1959

The Hebgen Lake earthquake in Montana was felt in parts of eastern Washington. The magnitude-7.5 event generated Intensity X shaking, killed 28 people as a result of a landslide, formed "Quake Lake," and did $11 million in damage to roads and timber. Many campers in the Yellowstone area were trapped for days and a fishing lodge dropped into a lake. There were six aftershocks of magnitude 5.5 or greater within one day. The initial earthquake was felt in an area of over 450,000 square miles.

Borah Peak (Idaho), October 28, 1983

The Borah Peak earthquake was the largest recorded in Idaho, both in magnitude and in the amount of property damage. At a magnitude of 7.3, it was also the largest earthquake to hit the continental United States since the Hebgen Lake quake. The epicenter was in the Barton Flats area, 10 miles northwest of Mackay and 30 miles southeast of Challis. The maximum observed Intensity was IX (based on surface faulting), and the earthquake was felt in an area over 330,000 square miles. Four aftershocks of magnitude 5.5 or greater were recorded within 1 year.

Spokane Earthquake Swarm, 2001

Spokane in 2001 had the most noticed earthquake swarm in the Northwest in recent decades. Scientists at the Pacific Northwest Seismograph Network in Seattle said the epicenter of the events was 1 mile north of Gonzaga University and 2.9 miles underground. The U.S. Geological Survey stated that a sequence of 105 small (less than magnitude 4) earthquakes occurred beneath Spokane, accompanied by a small increase (1/2 inch) in ground elevation. The shape of the deforming ground surface was consistent with movement on a northeast-trending fault beneath Spokane, yet no known mapped faults in Spokane have been active in the last 1.6 million years."[15] The largest of the quakes was less than a Magnitude 4 event, so little damage done. No property damage or casualties were reported as a result of the events. However, because the fault whose movement caused the swarm was very shallow, even earthquakes of Magnitude 2 and less were felt. In June and November, there were days with numerous quakes.

6.2.2 Frequency

The majority of Eastern Washington, including Spokane County is in a low risk area as defined by the National Earthquake Reduction Program, and is supported by the fact that few earthquakes of significance have occurred in the County. While the County itself may be at low risk, the impact from earthquakes in

[15] USGS Geophysical Study. Accessed 25 June 2019. Available at: https://www.usgs.gov/news/geophysical-studies-reveal-potential-quake-hazard-spokane-area

the western portion of the state will impact Spokane County, and it is therefore important to recognize the frequency of earthquakes in the western portion of the state as well.

The USGS estimated that a Cascadia Subduction Zone earthquake has a 10 to 15 percent probability of occurrence in 50 years, and a crustal zone earthquake has a recurrence interval of about 500 to 600 years. In general, it is difficult to estimate the probability of occurrence of crustal earthquake events. The best estimate for a major crustal earthquake to occur is once every 1000 years. A Benioff zone earthquake has an 85 percent probability of occurrence in 50 years, making it the most likely of the three types.

Because of its location at the boundary of two major tectonic plates, Washington State is particularly vulnerable to earthquakes. FEMA has determined that Washington State ranks second (behind only California) among states most susceptible to damaging earthquakes. According to the Washington State Enhanced Hazard Mitigation Plan, the probability of future occurrence for earthquakes similar to the 1965 Magnitude 6.5 Seattle-Tacoma event and the 2001 Magnitude 6.8 Nisqually event is about once every 35 years. The USGS has estimated that there is an 84-percent chance of a Magnitude 6.5 or greater deep earthquake over the next 50 years.

6.2.3 Severity

The severity of an earthquake can be expressed in terms of intensity or magnitude. Intensity represents the observed effects of ground shaking on people, buildings and natural features. The USGS has created ground motion maps based on current information about several fault zones. These maps show the PGA that has a certain probability (2 percent or 10 percent) of being exceeded in a 50-year period. The PGA is measured in numbers of g's (the acceleration associated with gravity). Figure 6-9 shows the PGAs with a 2-percent exceedance chance in 50 years in Washington. The Eastern Washington area, including Spokane County, is in a low-risk area, with a 2 percent probability in a 50-year period of ground shaking from a seismic event exceeding 0.15 g.

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

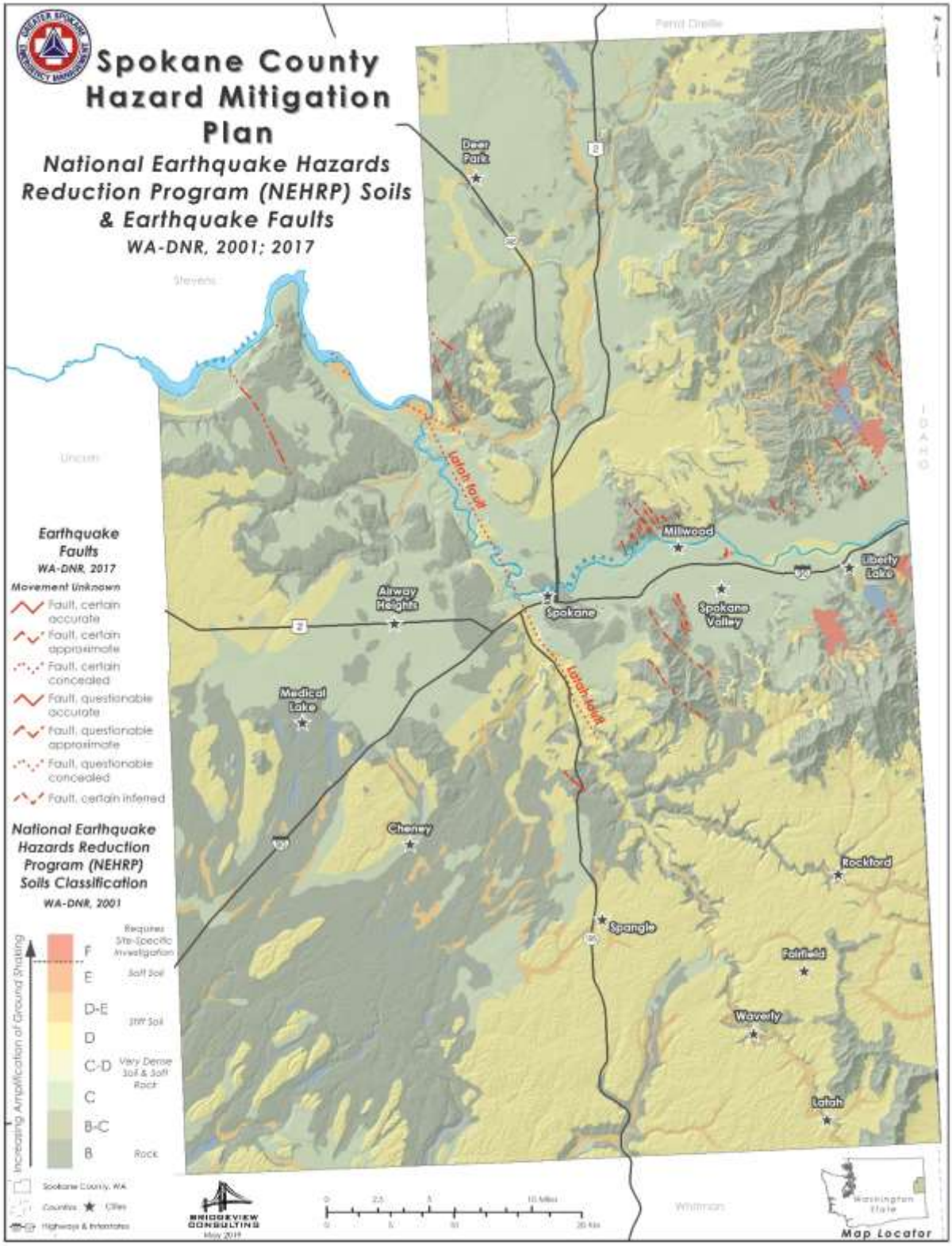


Figure 6-6. National Earthquake Hazard Reduction Program Soil Site Classes

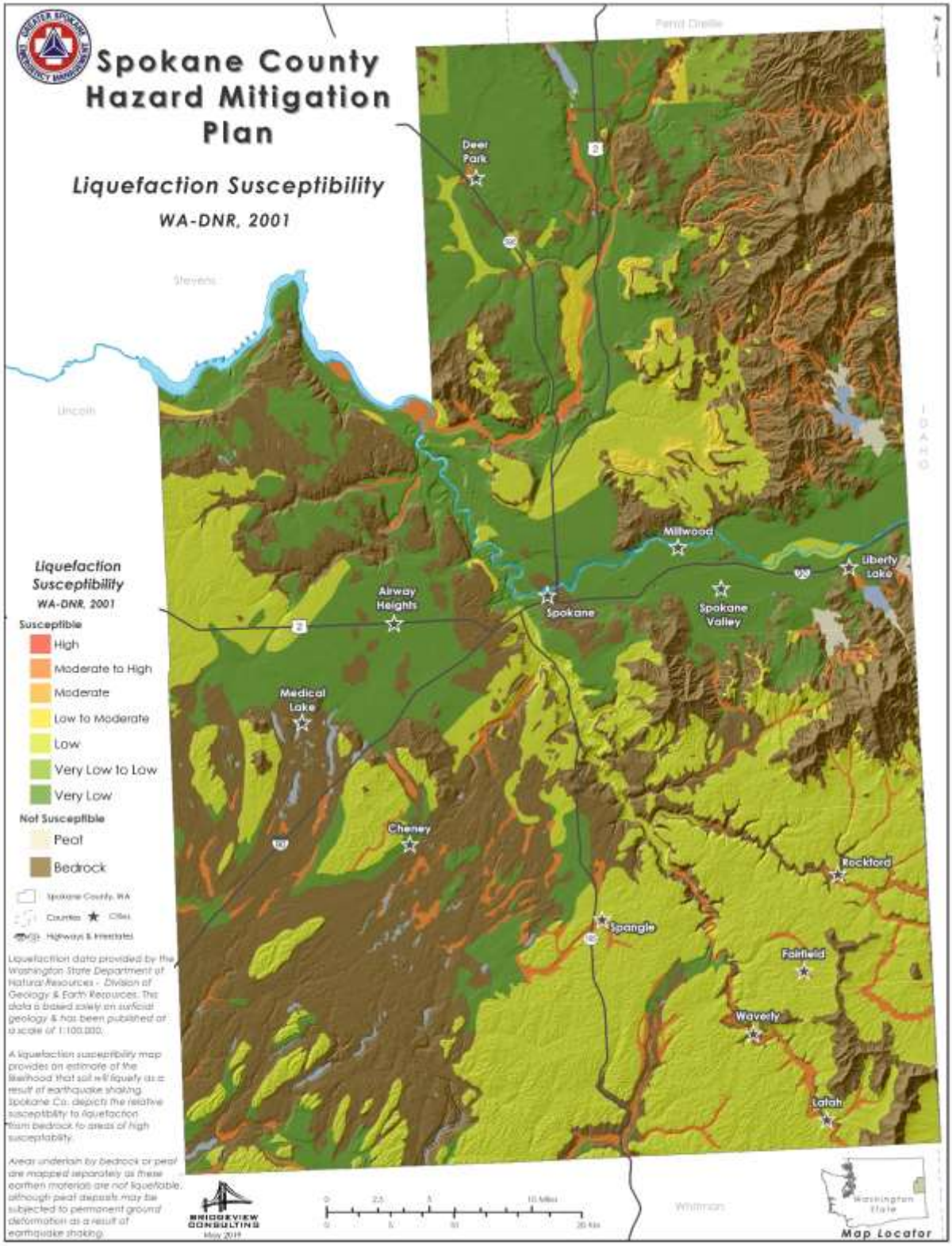


Figure 6-7. Liquefaction Susceptibility

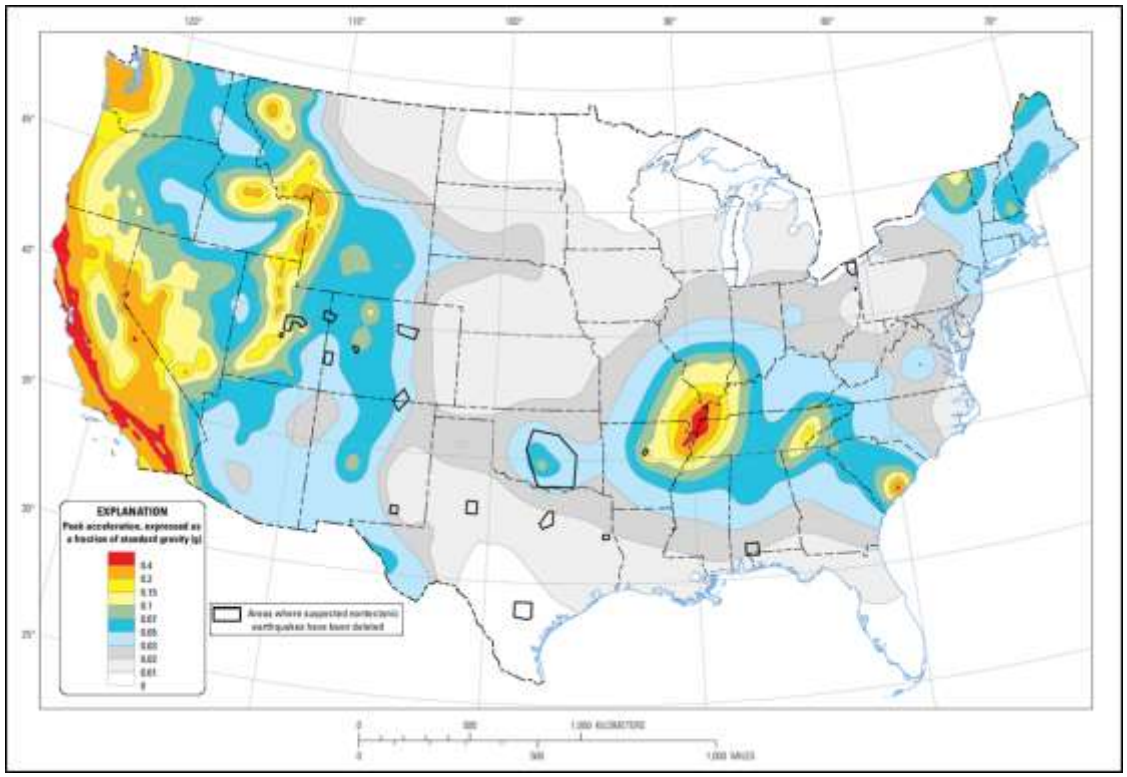


Figure 6-8. Peak Acceleration (%g) with 10% Probability of Exceedance in 50 years - Nationwide

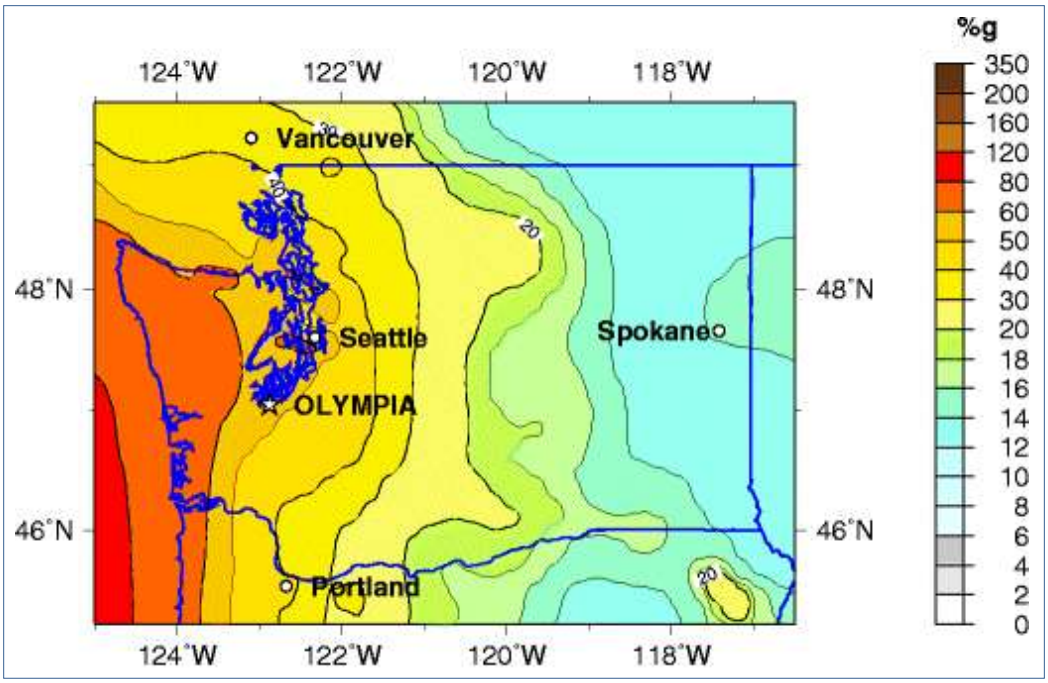


Figure 6-9. PGA with 2-Percent Probability of Exceedance in 50 Years, Northwest Region

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

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

Past events have indicated that an earthquake in the Spokane County area would cause little or no damage. Most crustal earthquakes are in 5.0 to 5.5 magnitude range, and do not have a history of occurrence in the planning area. Nonetheless severity can increase in areas that have softer soils, such as the unconsolidated sediments found in the Spokane River Valley.

6.2.4 Warning Time

There is currently no reliable way to predict the day or month that an earthquake will occur at any given location. Researchers have developed an early warning system that uses the low energy waves that precede major earthquakes, although such systems are not in place within Spokane County. This system can give some advanced notice that a major earthquake is about to occur. While the warning time is short, it could allow for some response activities during surgical procedures, allow equipment to be shut down, or allow someone to get under a desk or step away from a window.

6.3 SECONDARY HAZARDS

Earthquakes can cause large and sometimes disastrous landslides and mudslides. River valleys are vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction occurs

when water-saturated sands, silts or gravelly soils are shaken so violently that the individual grains lose contact with one another and float freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink into what was previously solid ground. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people. Earthen dams and levees are highly susceptible to seismic events and the impacts of their eventual failures can be considered secondary risks for earthquakes.

6.4 CLIMATE CHANGE IMPACTS

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

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

6.5 VULNERABILITY ASSESSMENT

6.5.1 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 rail (if available) or via a barge to different destinations. Evacuation routes from the western portion of the state through Spokane are also of potential concern as a result of the nature of the transient population, and the potential for increased supply and demand for goods and services from evacuees.

Methodology

Earthquake vulnerability data was generated using 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 cleanup.

6.5.2 Impact on Life, Health and Safety

The entire population of Spokane County is potentially exposed to direct and indirect impacts from earthquakes. The degree of exposure is dependent on many factors, including the age and construction type of the structures people live in, the soils type their homes are constructed on, their proximity to fault location, etc. Whether directly or indirectly impact, the entire population will have to deal with the consequences of earthquakes to some degree. Business interruption could keep people from working, road

closures could isolate populations, and loss of functions of utilities could impact populations that suffered no direct damage from an event itself.

Impacts on persons and households in the planning area were estimated for the 100-year and 500-year earthquakes and the scenario event through the use of Hazus analysis. Table 6-6 summarizes the results.

Table 6-6.
Estimated Earthquake Impact on Person and Households

	Number of Displaced Households	Number of Persons Requiring Short-Term Shelter
100-Year Earthquake	5	3
500-year Earthquake	88	52
Spokane M5.5 Scenario	22	14

6.5.3 Impact on Property

All structures in the planning area are susceptible to earthquake impacts to varying degrees. Many structures throughout the county are aged, increasing the potential exposure due to lower building codes. While most structures in the county are residential in nature, in some cases, retrofits or remodels may have occurred which have increased building codes, thereby lowering potential exposure, but such information is not identifiable with a high degree of accuracy based on when the retrofit was completed, and the permitting process in place at the time.

In a recent study completed by Washington State utilizing the Washington Unreinforced Masonry Dashboard (http://www.gartrellgroup.net/WashURMViewer/#7/47.347/-121.029/), over 850 structures (public and private) were identified with a composition of unreinforced masonry and susceptible to damage from earthquakes (March 2019 Bozarth interview with KREM2 TV).[16]

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 times the force of gravity. More recent housing

[16] KREM2 Interview with Spokane County Emergency Management – Gerry Bozarth available at: https://www.krem.com/article/tech/science/environment/more-than-850-buildings-in-spokane-co-could-be-unstable-during-quake-database-says/293-0563dfe0-a0b4-471f-8a49-009aac8f8580

stock is in compliance with Zone 3 standards. In July 2004, the state again upgraded the building code to follow International Building Code Standards.

Based on Census data, the median date of construction for the planning area is 1966. It is estimated that in excess of 40 percent of the building stock in the planning area was constructed prior to 1972. The planning team utilized different data sources, including information from the 2015 HMP, to identify the number of structures within the County by date of construction. Table 6-7 shows the results of this analysis. It should be noted that these are estimates only.

Table 6-7.
Age of Structures in Spokane County

Time Period	Number of Current County Structures Built in Period	Significance of Time Frame
Pre-1972	90,082	No explicit earthquake requirements in building codes. State law did not require local governments to have building officials or issue building permits.
1972-1994	51,329	UBC seismic construction standards adopted in Washington in 1972.
1994-2004	47,418	Seismic risk Zone 3 standards of the UBC went into effect in Washington in 1994
2004 - present	>29,000	Washington upgraded the building code to follow International Building Code Standards in 2004

Due to descriptions within the assessor's database, these numbers are estimates only and are not inclusive of all types of structures. The Assessor's database contains a category named "Other" which includes, among others, items such as barns, sheds, carports and general purpose wood pole frame buildings, which were included in the above calculations.

Loss Potential

Property losses for the 100-year and 500-year earthquakes events were estimated through the 2015 HAZUS-MH analysis process. Table 6-8 shows the results for those Hazus runs, broken down as follows:

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

In addition to the 2015 probabilistic earthquakes, loss potential for the Spokane M5.5 ShakeMap scenario was also completed in 2019, replacing the Latah Creek scenario previously completed. Results from that analysis are illustrated in Figure 6-10, Figure 6-11 and Figure 6-12.

Table 6-8.
Earthquake Building Loss Potential—Probabilistic*

	Estimated Earthquake Loss Value					
	100- Year Probabilistic Earthquake			500- Year Probabilistic Earthquake		
Jurisdiction	Structural	Non-Structural	**Total**	Structural	Non-Structural	**Total**
Airway Heights	$95,540	$7,201	**$102,741**	$1,236,014	$300,714	**$1,536,728**
Cheney	$165,704	$20,690	**$186,394**	$2,148,836	$694,975	**$2,843,811**
Deer Park	$52,774	$5,043	**$57,817**	$754,163	$218,704	**$972,866**
Fairfield	$1,806	$448	**$2,254**	$20,579	$6,461	**$27,039**
Latah	$934	$232	**$1,166**	$10,648	$3,343	**$13,991**
Liberty Lake	$416,047	$106,586	**$522,633**	$5,623,903	$1,931,706	**$7,555,608**
Medical Lake	$9,799	$769	**$10,568**	$157,013	$41,125	**$198,137**
Millwood	$40,988	$6,367	**$47,355**	$694,953	$248,392	**$943,345**
Rockford	$1,946	$483	**$2,429**	$22,177	$6,963	**$29,139**
Spangle	$1,025	$255	**$1,280**	$11,687	$3,669	**$15,356**
Spokane	$4,818,546	$531,584	**$5,350,130**	$69,574,102	$20,423,752	**$89,997,855**
Spokane Valley	$2,339,761	$227,938	**$2,567,699**	$32,758,742	$9,668,369	**$42,427,112**
Waverly	$1,199	$298	**$1,496**	$13,660	$4,289	**$17,948**
Unincorporated	$8,337,242	$1,523,494	**$9,860,736.00**	$110,575,963	$33,748,414	**$144,713,977**
Total	**$16,283,311**	**$2,431,388**	**$18,714,698**	**$223,602,440**	**$67,300,876**	**$291,292,912**

***(Spokane County 2015 HMP)**

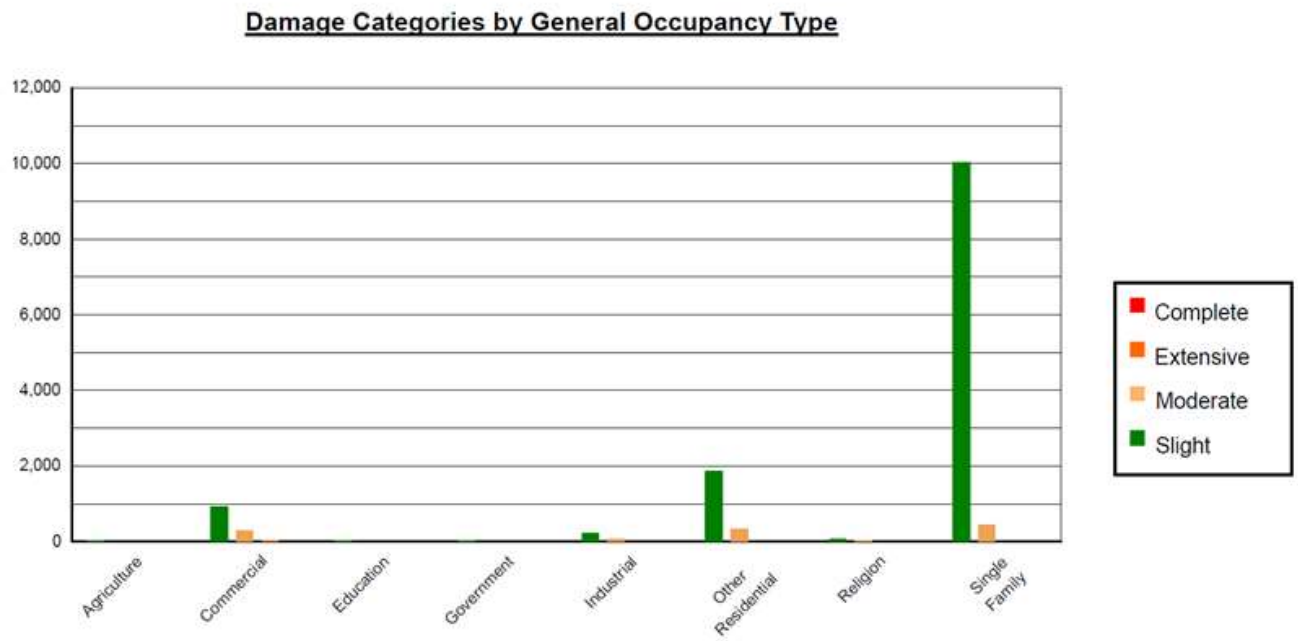


Figure 6-10. Hazus M5.5 Spokane Scenario Damage Categories by General Occupancy Type (2019)

Debris Tonnage

The HAZUS-MH analysis also estimated the amount of earthquake-caused debris in the planning area for the 100-year and 500-year earthquakes and the M5.5 scenario event, as summarized in Table 6-9.

Table 6-9.
Estimated Earthquake-Caused Debris

	Debris to Be Removed (tons)
100-Year Earthquake	12,180
500-Year Earthquake	118,820
5.0 M Spokane Scenario Event	40,000

6.5.4 Impact on Critical Facilities and Infrastructure

All critical facilities in Spokane County are exposed to the earthquake hazard to some degree, either directly, or through secondary impacts such as power loss, or the spread of fire from one structure to another. Contained within Chapter 3, Table 3-9 and Table 3-10 are the number of each type of facility by jurisdiction which could potentially be impacted.

In addition, hazardous materials releases can also occur during an earthquake from fixed facilities or transportation-related incidents. Transportation corridors can be disrupted during an earthquake, leading to the release of materials to the surrounding environment. Facilities holding hazardous materials are of particular concern because of possible isolation of neighborhoods surrounding them. During an earthquake, structures storing these materials could rupture and leak into the surrounding area or an adjacent waterway, having a disastrous effect on the environment.

Level of Damage

Hazus uses five categories of vulnerability of critical facilities to earthquake: no damage, slight damage, moderate damage, extensive damage, or complete damage. The model was used to assign a category to each critical facility in the planning area except hazmat facilities and “other infrastructure” facilities, for which there are no established damage functions. The analysis was performed for the 100-year event. Table 6-810 summarize the results as illustrated in the Spokane County HMP (2015).

Time to Return to Functionality

Hazus estimates the time to restore critical facilities to fully functional use. Results are presented as probability of being functional at specified time increments: 1, 3, 7, 14, 30 and 90 days after the event. For example, Hazus may estimate that a facility has 5 percent chance of being fully functional at Day 3, and a 95-percent chance of being fully functional at Day 90. The analysis of critical facilities in the planning area was performed for the 100-year earthquake event. Table 6-11 summarizes the results (Spokane County HMP, 2015).

Table 6-10.
Critical Facility Vulnerability to 100-Year Earthquake Event

Category	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical and Health	82.90%	16.89%	0.17%	0.00%	0.01%
Government Functions	83.40%	16.43%	0.15%	0.01%	0.00%
Protective Functions	79.45%	20.11%	0.38%	0.04%	0.00%
Schools	81.93%	17.81%	0.22%	0.02%	0.00%
Other Critical Functions	99.84%	0.15%	0.00%	0.00%	0.00%
Bridges	98.78%	1.16%	0.05%	0.00%	0.00%
Water supply	99.53%	0.45%	0.01%	0.00%	0.00%
Wastewater	99.90%	0.09%	0.00%	0.00%	0.00%
Power	99.98%	0.01%	0.00%	0.00%	0.00%
Communications	97.77%	2.22%	0.01%	0.00%	0.00%
Total	**92.35%**	**7.53%**	**0.10%**	**0.01%**	**0.00%**

Table 6-11.
Functionality of Critical Facilities for 100-Year Event

Planning Unit	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical and Health	9	82.89	83.22	99.36	99.77	99.90	99.90
Government Functions	2	83.40	83.70	99.40	99.80	99.90	99.90
Protective Functions	116	79.43	79.85	99.05	99.54	99.88	99.89
Schools	195	81.91	82.27	99.28	99.71	99.89	99.90
Other Critical functions	26	99.91	99.91	99.91	99.91	99.91	99.91
Bridges	383	99.98	99.99	99.99	99.99	99.99	99.99
Water supply	66	99.90	99.90	99.90	99.90	99.90	99.90
Wastewater	7	99.07	99.81	99.90	99.90	99.90	99.90
Power	13	99.75	99.90	99.90	99.90	99.90	99.90
Communications	38	99.90	99.90	99.90	99.90	99.90	99.90
Total/Average	**855**	**92.61**	**92.85**	**99.66**	**99.83**	**99.91**	**99.91**

6.5.5 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. Available loss data generated by Hazus is identified in Figures 6-11 and 6-12, illustrating economic losses by structure, as well as percentage of losses to inventory, wages, or loss of income above based on the 2019 M5.5 ShakeMap scenario event.

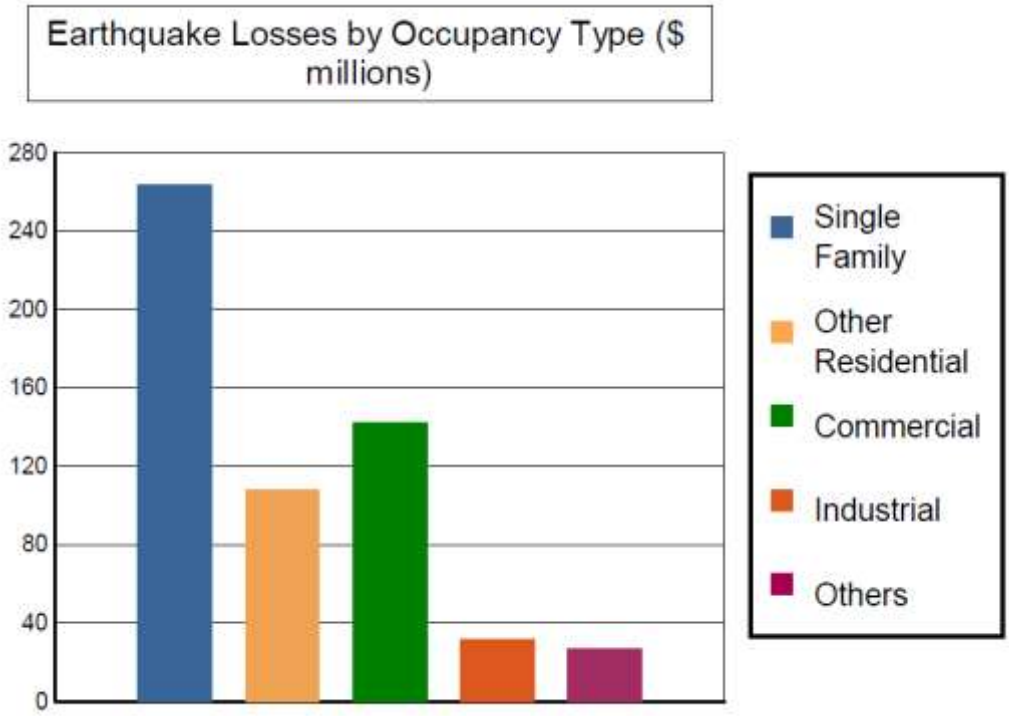


Figure 6-11. Hazus Estimated Dollar Losses by Occupancy Type Spokane M5.5 ShakeMap (2019)

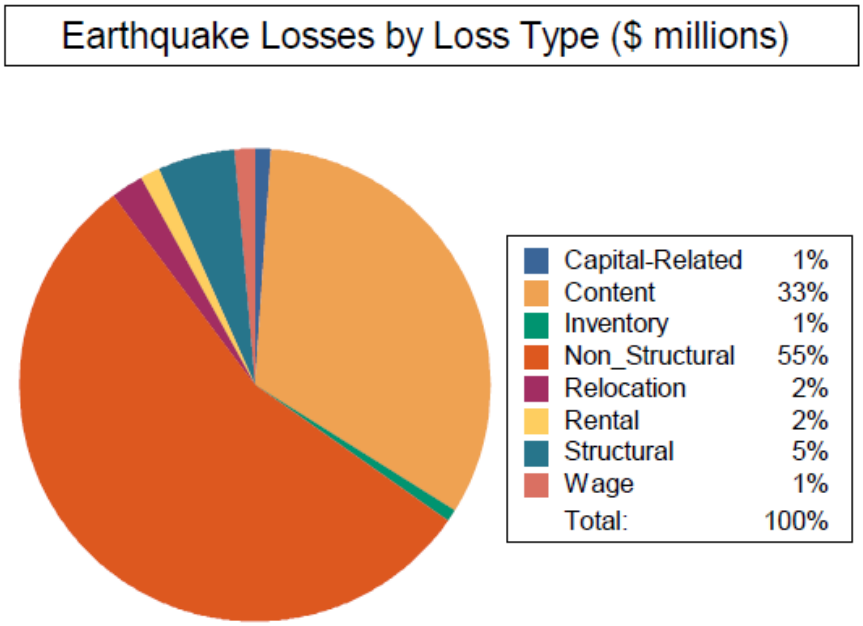


Figure 6-12. Hazus Estimate of Percent of Losses by Loss Type for Spokane M5.5 ShakeMap (2019)

6.5.6 Impact on Environment

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

6.5.7 Secondary Impacts

The secondary impacts are the effects that happen later on. Here are a few examples of possible impacts:

- Earthquakes can trigger landslides, tsunamis and seiches - these can destroy more buildings and cause more injuries and deaths.
- Leaking gas can be ignited, starting fires.
- People may be left homeless.
- There may be a shortage of clean water and a lack of proper sanitation - this makes it easier for diseases to spread.
- Roads may be blocked or destroyed so aid and emergency vehicles cannot get through.
- Businesses may be damaged or destroyed causing unemployment.

6.6 FUTURE TRENDS IN DEVELOPMENT

The land use elements of the comprehensive plans adopted by the municipal planning partners provide a long-range guide to the physical development of the planning area and its urban growth area. As one of the faster growing counties in Washington, Spokane County and its planning partners will need to manage growth in a way that accounts for impacts from potential earthquakes. With tools such as the Washington State Building Code and local critical areas ordinances that define seismic hazard areas, the planning partners are prepared to deal with future growth.

Once the technological capability of the planning partnership is enhanced with tools such as GIS, this assessment should be revisited to provide a better gauge of vulnerability, looking at parameters such as zoned land use and age of structures.

6.7 ISSUES

More research needs to be conducted to determine the exposure and vulnerability of Spokane County and the Columbia Plateau region in general to earthquakes. The County and its communities should inventory and assess older structures and seek ways to retrofit those that are determined most likely to be damaged during an earthquake. Until additional data on the impacts of events typical for this region are developed, non-structural retrofitting techniques should be considered and promoted by the partnership. Important issues associated with an earthquake include but are not limited to the following:

- A more robust assessor data set would significantly enhance the partnership’s ability to assess seismic risk.

- More scenario-based shake map data is need for the region.
- More information is needed on the exposure and performance of soft-story construction within the planning area.
- According to the 2010 U.S. census (most recent available as of this 2020 update), more than 40 percent of the planning area's building stock was built prior to 1972, when seismic provisions became uniformly applied through building code applications.
- Critical facility owners should be encouraged to create or enhance Continuity of Operations Plans using the information on risk and vulnerability contained in this plan.
- Geotechnical standards should be established that take into account the probable impacts from earthquakes in the design and construction of new or enhanced facilities.
- Earthquakes could trigger other natural hazard events such as dam failures and landslides, which could severely impact the county.

6.8 CONSEQUENCE ANALYSIS

There are numerous crustal faults throughout the Columbia Plateau and in areas north and south. These have not been mapped sufficiently for scientists to make any conclusions about the effect they can have on earthquakes, but it is possible that a fault near Spokane County could rupture, causing an earthquake in the County.

Any seismic activity of Magnitude 6.0 or greater on faults within the planning area would have significant impacts. Earthquakes of this magnitude or higher could lead to significant structural failure of property on unstable soils.

Damage would most likely occur to older structures in the downtown areas of some communities located on softer (NEHRP D and E) soils. The majority of the area falls within the NEHRP soils B and C, with the unincorporated areas of Spokane County and the City of Spokane having a fair amount of type D. Review of the NEHRP soils data indicates no land with an E soils classification, and 4 percent of D-E. The County does have a significant number of unreinforced masonry structures, which would also increase vulnerability.

Injuries may occur from debris, such as parapets and chimneys that could topple or be shaken loose and fall on those walking or driving below. With existing areas of the floodplain in the planning area, liquefaction impacts could be more widespread in those areas, as could landslide danger. An earthquake may also cause landslides along unstable slopes. This would be even more likely if the earthquake occurred during the rainy or snowy winter and early spring months.

Potential warning systems could give 40 seconds notice that a major earthquake is about to occur; this would not provide adequate time for preparation, but would allow for some immediate actions to help reduce impact, such as shutting off machinery, location of an area to drop, cover and hold, etc.

Impact to first responders could include unavailability of equipment if facilities were damaged and response vehicles were not accessible. Roadways may be impassable, further hampering response capabilities. Review of Hazus data for a 100-year probabilistic earthquake (2015 run) indicates that approximately 93 percent of critical facilities incorporated into the analysis would be functional on day 1. Table 6-12 identifies the Consequence Analysis for the Earthquake hazard.

Table 6-12.
Consequence Analysis

	L	ML	M	MH	H	VH
Likelihood / Probability			X			
Geographic Boundary				X		
Population			X			
Vulnerable Population		X				
Built Environment			X			
Critical Infrastructure		X				
Facilities		X				
First Responders			X			
Economic Consequences						X
Environmental Impact						X
Government's Ability to Continue Operations						X

L=Low; ML=Medium-Low; M=Medium; MH=Medium-High; H=High; VH=Very High

6.9 RESULTS

Based on review and analysis of the data, the Planning Team has determined that the Spokane M5.5 event, such as that utilized as one of the scenarios modeled for this update, has a medium probability of occurring within the region.

The losses related to earthquake scenarios are largely due to the proximity to the faults. The lack of study in the region does leave questions concerning potential impact, which has yet to be determined to a large extent.

There is a fair amount (~40 percent) of dated construction (pre-1972) which would increase vulnerability, even from a fairly small earthquake. Falling debris from older buildings would increase the potential for risk to citizens and first responders required to assist in evacuations from older structures. Current building codes are of a higher caliber than previous construction standards.

Review of Hazus outputs show that the majority of critical facilities would receive no-to-slight damage, with only 0.10% sustaining moderate damage, and 0.01% sustaining extensive damage. Of the critical infrastructure identified, ~93% would be fully functional at day 1 of the earthquake occurring. It should be noted that such assessment is for planning purposes only, and no engineered study to determine structural integrity of any facilities was completed in this review. As such, no life-safety measures should be based on such analysis as much of the data within Hazus is default data, and not based on engineered reviews.

Spokane County is in a low-risk area with respect to PGA, with a 2 percent probability in a 50-year period of ground shaking from a seismic event exceeding 0.15 g. Limited area falls within the high-hazard soils classifications, with the majority of the area falling in soils types B, or C, with limited D soils type. This equates to very low to a few areas of low-to moderate liquefaction susceptibility, and only a relatively small area in the moderate area, mostly along waterbodies, river valleys, and streams, etc., which would also be more likely to landslide occurring as a result of earthquakes.

Concern within the planning area also includes impact from the Cascadia M9.0 earthquake scenario, which generates the largest amount of damage on the west side of the mountains. While the earthquake itself is not anticipated to impact the county, the influx of residents evacuating the west side to Spokane, which is the second or third largest populated municipality in the state, is expected. Likewise, citizens traveling through Spokane to other parts of the country would also tax local resources. The interruption to commodity flow from a Cascadia-type event, when coupled with increased calls for assistance for mutual aid and impact to local-area commodities is of significant concern to the planning partnership.

Based on the potential impact, the Planning Team determined the CPRI score to be 2.85, with overall vulnerability determined to be a medium level.

CHAPTER 7.
FLOOD AND DAM FAILURE

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7.1 GENERAL BACKGROUND

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.

This chapter will profile the flood and dam failure hazards within the planning area; however, it will not assess the dam failure risk due to the unavailability of dam failure inundation data. This information was not made available to this planning process for security purposes

7.1.1 Flood

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);

DEFINITIONS

Dam—Any artificial barrier and/or any controlling works, together with appurtenant works, that can or does impound or divert water. (Washington Administrative Code, Title 173, Chapter 175.)

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

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

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

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

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

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

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

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

- 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).

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

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

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.

7.1.2 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.

Measuring Floods and Floodplains

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

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

Floodplain Ecosystems

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

Effects of Human Activities

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

7.1.3 National Flood Insurance Program

The National Flood Insurance Program (NFIP) makes federally backed flood insurance available to homeowners, renters and business owners in participating communities. 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.

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

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

Spokane County entered the NFIP on May 17, 1988. Structures permitted or built in the county before then are called "pre-FIRM" structures, and structures built afterwards are called "post-FIRM." The insurance rate is different for the two types of structures. The effective date for the current countywide FIRM is July 6, 2010, which is also the County's DFIRM (digital flood insurance rate map). As of this 2020 update, there are three Letters of Map Amendments issued by FEMA for removal of properties previously identified as being within the floodplain.

7.1.4 NFIP Program Overview

Nine communities within Spokane County participate in the NFIP, as shown in Table 7-1. According to the Washington Department of Ecology, the county and cities are in good standing with the provisions of the NFIP as of this plan update. Program compliance is monitored by the Department of Ecology through Community Assistance Visits (CAV). Specific CAV information, as applicable, is contained within each jurisdictional annex document.

Maintaining compliance under the NFIP is an important component of flood risk reduction. All planning partners that participate in the NFIP have identified initiatives to maintain their compliance and good standing and are committed to doing so through enforcement of programs that at a minimum, meet the NFIP participation requirements. Such enforcement may include items such as restricting development in the floodplain or requiring structures to be built at a higher elevation to avoid impact from flood waters, among other enforcement regulations.

For Spokane County, the Public Works Department - Environmental Programs and Special Projects is tasked with management of the NFIP program. The County does have a dedicated floodplain manager. As a brief overview, in some cases, development is allowed in the floodplain; however, it is subject to the requirements of the Spokane County Flood Ordinance and the NFIP. Developing property, all or a portion of which is in a regulated floodplain, requires a Floodplain Development Permit. This permit identifies the specific requirements for each proposed project. Prior to Floodplain Permit release, all plans must be reviewed to ensure that they meet the requirements of the Spokane County Flood Ordinance. For purposes of development, development includes, but is not limited to: buildings, homes, manufactured and mobile homes, other structures, bridges, culverts, dredging, filling, grading, paving, excavation, docks, boat lifts, seawalls, bulkheads, etc. Structures may also require floodproofing under the ordinance, which requires that residential homes be elevated above the level of the base flood elevation (BFE) and commercial structures have the option to flood proof above the BFE. A licensed engineer or landscape architect must design the flood proofing. The County's flood ordinance also requires Elevation Certifies. The purpose

for an Elevation Certificate is to document compliance with permit conditions as Elevation Certificates are the only official document used by FEMA to determine whether a structure is inside or outside a floodplain, and are also used to determine the proper rate when purchasing flood insurance. Elevation Certificates must be completed and stamped by a surveyor licensed in the State of Washington. Additional information on Spokane County's program is available at https://www.spokanecounty.org/Faq.aspx?QID=293

Table 7-1.
NFIP Status of Spokane County and Incorporated Municipalities

City	CID	Date of Entry into the NFIP	Current FIRM Effective Date
Cheney	530175	11/06/1979	7/06/2010 (M)
Deer Park	530176	12/26/1979	0//06/2010 (M)
Fairfield	530177	10/16/1979	07/06/2010 (M)
Liberty Lake		Pending – Anticipated November 2020	
Millwood	530180	06/15/1979	(C)
Rockford	530181	10/02/1979	07/06/2010
Spangle	530182	09/18/1979	07/06/2010 (M)
Spokane County	530174	05/17/1988	07/06/2010
Spokane Valley	530342	04/01/2004	07/06/2010
Spokane	530183	08/01/1980	07/06/2010

(M) = No elevations determined; All Zone A, C and X.
(C) = No Special Flood Hazard Area - All Zone C

Within the NFIP is the Community Rating System (CRS). The CRS is a voluntary program that encourages expanded floodplain management activities, requiring increased compliance by participating jurisdictions beyond the minimum NFIP requirements. If jurisdictions exceed the minimum requirements, flood insurance premiums are discounted to reflect the reduced flood risk.

At present, Spokane County nor any of its municipalities are part of the CRS program. The majority of the municipalities do not have the capacity to support the CRS activities without adding additional staff and resources.

Flood Insurance Statistics

Table 7-2 lists flood insurance statistics that help identify vulnerability in Spokane County. During the 2015 plan, ten communities in the planning area (including Spokane County) participated in the NFIP, with 420 flood insurance policies in force providing $86.5 million in coverage.

The Town of Latah and City of Liberty Lake do not participate in the NFIP, although flood maps (dated July 6, 2010) do exist for the communities.

Review of data for the 2020 update, the number of policies in force declined to 335, providing $82.34 million in coverage. According to FEMA statistics, a total of 56 flood insurance claims were paid between January 1, 1978 and September 30, 2018 (most recent as of 4/9/19), for a total of $786,034, an average of $14,036 per claim.

Table 7-2.
Flood Insurance Statistics for Spokane County

Jurisdiction	Date of Entry Initial FIRM Effective Date	# of Flood Insurance Policies as of 3/28/19	Insurance In Force	Claims, 1/1/1978 to 12/31/2013	New Claims, 12/31/2013 to 9/30/18	Value of Claims paid, 1/1/1978 to 9/30/18
Cheney	11/06/1979	3	$770,000	1	0	$0
Deer Park	12/26/1979	1	$350,000	0	0	$0
Fairfield	10/16/1979	2	$256,100	0	0	$0
Medical Lake	07/06/2010			0	1	
Millwood	06/15/1979	(NSFHA)		0	0	
Rockford	10/02/1979	2	$51,800	0	0	$0
Spangle	09/18/1979	2	$364,300	4	4	$276,767
Spokane County	05/17/1988	186	$49,049,000	20	11	$387,652
Spokane Valley	04/01/2004	65	$14,066,400	0	2	$8,636
Spokane City	08/01/1980	74	$17,437,200	12	1	$112,978
Total		**335**	**$80,968,700**	**37**	**19**	**$786,033**

Properties constructed after a FIRM has been adopted are eligible for reduced flood insurance rates. Such structures are less vulnerable to flooding since they were constructed after regulations and codes were adopted to decrease vulnerability. Properties built before a FIRM is adopted are more vulnerable to flooding because they do not meet code or are located in hazardous areas. The first FIRMs in Spokane County were available in 1981.

Repetitive Loss

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

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

Repetitive loss properties make up only 1 to 2 percent of flood insurance policies in force nationally, yet they account for 40 percent of the nation's flood insurance claim payments.

FEMA-sponsored programs, such as the CRS, require participating communities to identify repetitive loss areas. A repetitive loss area is the portion of a floodplain holding structures that FEMA has identified as meeting the definition of repetitive loss. Identifying repetitive loss areas helps to identify structures that are at risk but are not on FEMA's list of repetitive loss structures because no flood insurance policy was in force at the time of loss. FEMA's list of repetitive loss properties identifies three (3) such properties in the Spokane County planning area as of May 8, 2019. One property in Spangle has been identified as "severe repetitive loss" according to FEMA criteria.

The breakdown of the properties by jurisdiction is presented in Table 7-3. It should be noted that the Spokane loss is dated 1996; the Spangle losses were in 2014. All three structures are residential in nature.[17] No new structures have been identified as repetitive or severe repetitive structures during the time period 2015-2020.

Table 7-3.
Repetitive and Severe Repetitive Loss Properties in Spokane County

Jurisdiction	Repetitive Loss (RL) Properties	RL Properties That Have Been Mitigated	Severe Repetitive Loss (SRL) Properties	SRL Properties that Have Been Mitigated
Spangle (2014 losses)	2	0	1	0
Spokane (1996 loss)	1	0	0	0
Total	**3**	**0**	**1**	**0**

Based on FEMA Report of Repetitive Losses 05/08/2019 provided by WA DOE Risk Map.

7.1.5 Dam Failure

Causes of Dam Failure

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

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

The remaining 6 percent of U.S. dam failures are due to miscellaneous causes. Many dam failures in the United States 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 Spokane 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.

[17] Information provided via personal communication with John Schelling, FEMA Region X Mitigation Section.

Regulatory Oversight

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

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.

7.2 HAZARD PROFILE

7.2.1 Extent and Location - Flood

The major floods in Spokane County have resulted from intense weather rainstorms or the combination of rain on snow events between November and March. The flooding that has occurred in portions of the county has been extensively documented by gage records, high water marks, damage surveys and personal accounts. This documentation was the basis for the June 6, 2010 FIRMs generated by FEMA for Spokane County. The 2010 Flood Insurance Study is the sole source of data used in this risk assessment to map the extent and location of the flood hazard, as shown in Figure 7-1.

The principal cause of flooding in Spokane County is heavy rainfall brought in with warm Chinook winds, usually in combination with snowmelt over a frozen impermeable ground during the winter or early spring. The sudden increase in runoff overwhelms rivers and creeks, which typically overtop. The Spokane River, for instance, has an average annual discharge of 7,946 cfs, but can experience peak flows of 49,000 cfs. Floods can also be intensified by ice jams against low clearance railroad and road bridges. Floods in Spokane County are typically of short duration, usually less than one day, and flood stages rise and fall rapidly.

Erosion and transported sediment are major secondary hazards of flooding. The intense runoff can strip away topsoil and deposit it elsewhere, usually where it is impeded, such as at bridge abutments. Sediment deposits have been a major effect of flooding in Pullman. The erosion can deposit sediment in river and creek beds, decreasing their capacity to transport water.

The Spokane River, which derives most of its flow from snowmelt in Idaho, is influenced by Coeur d'Alene Lake, resulting in a relatively stabilized flow condition free from the extreme peaks that would result if the lake did not exist; however, damaging floods have occurred. Climate and stream flow records for the Spokane River basin indicate that the region experiences spring snowmelt and winter rain floods. Winter rain floods are caused by warm temperatures and rainfalls that accompany intense Pacific Ocean storms which sometimes move eastward across Washington and Idaho. In such cases, rainfall, snowmelt, and occasionally frozen soil conditions combine to produce short-duration, intense runoff. In most cases, peaks

on the lower Spokane River are reduced by the large storage volume normally available in Coeur d'Alene Lake. The large size of the upper Spokane River basin also tends to moderate the effect of winter floods. Hangman Creek normally experiences its greatest flood peaks during winter storms.

Statistical analysis of stream flow records shows that the 1% annual chance flood discharge on the Spokane River at Spokane is 52,000 cfs. Several historical floods of record have approached this magnitude, including the flood of January 1974, which had a peak discharge of 45,600 cfs. The largest flood for which water-surface data are available is the flood of December 1933, which had a peak discharge of 47,800 cfs.

Flooding along the Little Spokane River is similar to that on Hangman Creek. Statistical analysis of the lower gage on the Little Spokane River gives a 1% annual chance flood flow of 4,355 cfs; the drainage area covered by this gage is 665 square miles. The flood of record was recorded on February 17, 1970, and had a peak discharge of 3,170 cfs. The record flow at the gage located further upstream, at Elk, was 205 cfs on January 16, 1974. The drainage area covered by the upstream gage is 115 square miles.

Extremely high peak flows can be generated on Hangman Creek with little advance warning. The soils in the Hangman Creek valley provide essentially no ground water to sustain flow when there is no precipitation or snowmelt. Also, there are no artificial impoundments. The net result is a stream characterized by extremes. Most of Hangman Creek flows through rural areas where encroachment on the flood plain is minimal.

Flood problems experienced in 1974 are typical of flood damage on Hangman Creek throughout the urban area. Problems in the City of Spokane extended from the vicinity of the 11th Street bridge upstream to a point approximately 1,500 feet south of U.S. Highway 195 and consisted of limited inundation of individual residences and failure of poorly constructed levees subjected to high stream flow velocities. In addition, the Hangman Valley Golf Course, which was constructed with full knowledge of flood problems, suffered extensive damage in 1974. Silt was deposited on fairways, and two pedestrian bridges were destroyed. Flooding problems on Hangman Creek involve bank erosion and undercutting as well as inundation. The flood of record was recorded at 20,600 cfs in February 1963.

Urban flooding can also occur within Spokane County. This type of flooding occurs outside of mapped floodplains, where rainfall/snowmelt runoff exceeds the design capacity of stormwater conveyance facilities or flows overland when no conveyance facilities are available. Urban drainage issues are often exacerbated by increases in impervious areas that can increase runoff rates, or when the ground becomes frozen, allowing for no ground infiltration rainfall runoff. Urban drainage flooding can have significant impacts on the built environment and this hazard can be difficult to assess because of the lack of hazard mapping.

7.2.2 Previous Occurrence

Since 1971 every county within Washington State has received a federal disaster declaration for flooding. Spokane County has declared federal disasters for flooding 10 times since 1964. Table 7-4 list these events since 1964.

Table 7-4.
Spokane County Flood Events 1964-2018

Date	Declaration #	Type of event	Estimated Damage[a]
1/30/2017	4309	Severe Winter Storms, Flooding, Landslides	N/A

Table 7-4.
Spokane County Flood Events 1964-2018

Date	Declaration #	Type of event	Estimated Damage[a]
11/12/2015	4249	Severe Storms, Straight-Line Winds, Flooding	N/A
6/1/2011	--	Flooding	$200,000[a]
5/19/2008	--	Flooding	$1,000,000[a]
3-2-1999	--	Flooding	$700,000[a]
3/18/1997	DR-1172	Storms/Flooding/Landslides/Mudslides	N/A
1/17/1997	DR-1159	Severe Winter Storms/Flooding	N/A
2/9/1996	DR-1100	Severe Storms/Flooding	$33.7 Million for the state
5/20/1986	DR-769	Washington Severe Storms, Flooding	N/A
12/29/1964	DR-185	Heavy Rains & Flooding	N/A

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

The following is an overview of the more significant events during this timeframe in Spokane County.

- March 1963—Flooding occurred in the counties of Columbia, Garfield, Grant, Whitman, and Spokane. Federal disaster number 146 was assigned for the event.
- February 1996—Heavy rains caused flooding in the several counties including Spokane. Snowfall beginning January 26, 1996, followed by heavy rain in February, mild temperatures, and mountain snow melt caused severe flooding throughout the entire northwest. Record floods occurred on Latah Creek. Federal disaster number 1100 was assigned for the event.
- December 1996 - January 1997—Rain, ice, and snow caused flooding. Federal disaster number 1159 was assigned for several counties including Spokane. The Town of Rockford experienced damage to 11 buildings with their sanitary sewer line and streets sustaining $367,860 worth of damage.

7.2.3 Frequency

Spokane County experiences episodes of river flooding almost every winter. Large floods that can cause property damage typically occur every three to seven years. Urban portions of the county annually experience nuisance flooding related to drainage issues. The Washington State Hazard Mitigation Plan (2010) lists Spokane County among the counties with the most frequent flooding in eastern Washington. Major flooding in Spokane County can be expected on average every six to seven years. Figure 7-2 shows the frequency of flooding in Washington by county based on the Washington State Hazard Mitigation Plan (2013).

7.2.4 Severity

The principal factors affecting flood damage are flood depth and velocity. The deeper and faster flood flows become, the more damage they can cause. Shallow flooding with high velocities can cause as much damage as deep flooding with slow velocity. This is especially true when a channel migrates over a broad floodplain,

redirecting high velocity flows and transporting debris and sediment. Flood severity is often evaluated by examining peak discharges; Table 7-5 lists peak flows used by FEMA to map the floodplains of Spokane County.

Warning Time

Floods are the number one natural disaster in the United States in terms of loss of life and property. Floods are generally classed as either slow-rise or flash floods. Slow-rise may be preceded by a warning time from several hours, to days, to possibly weeks. Evacuation and sandbagging for a slow-rise flood may lessen flood damage. Flash floods are the most difficult to prepare for, due to the extremely short warning time, if any is given at all. Flash flood warnings usually require evacuation within an hour.

Each watershed has unique qualities that affect its response to rainfall. A hydrograph, which is a graph or chart illustrating stream flow in relation to time (see Figure 7-3), is a useful tool for examining a stream's response to rainfall. Once rainfall starts falling over a watershed, runoff begins and the stream begins to rise. Water depth in the stream channel (stage of flow) will continue to rise in response to runoff even after rainfall ends. Eventually, the runoff will reach a peak and the stage of flow will crest. It is at this point that the stream stage will remain the most stable, exhibiting little change over time until it begins to fall and eventually subside to a level below flooding stage.

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

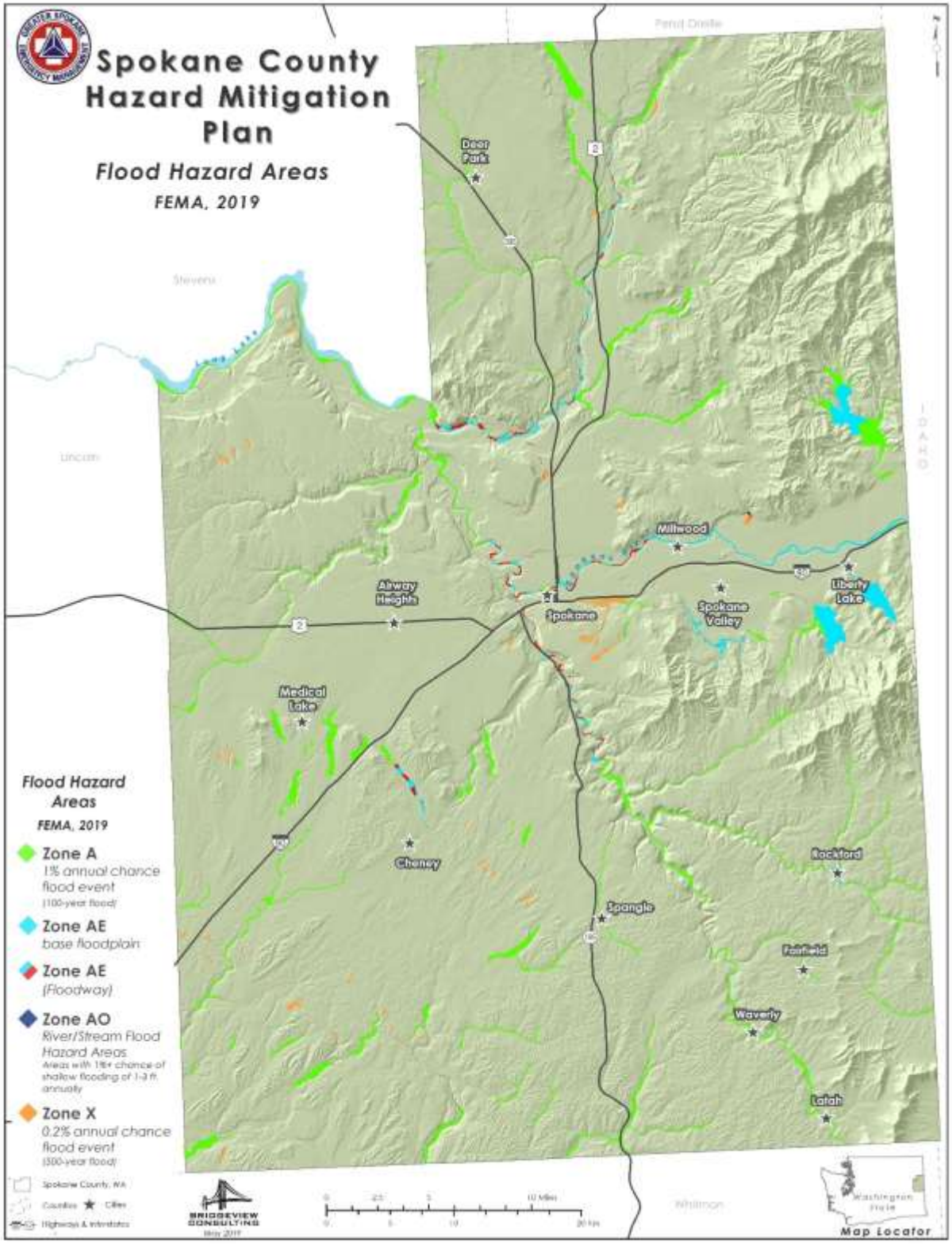


Figure 7-1. FEMA DFIRM Flood Hazard Areas

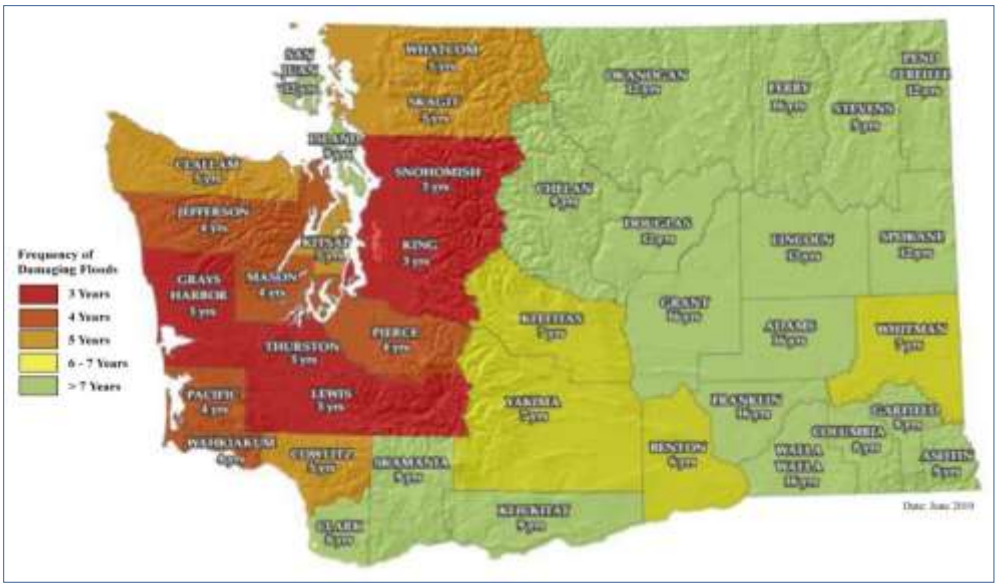


Figure 7-2. Frequency of Major Flooding in Washington by County

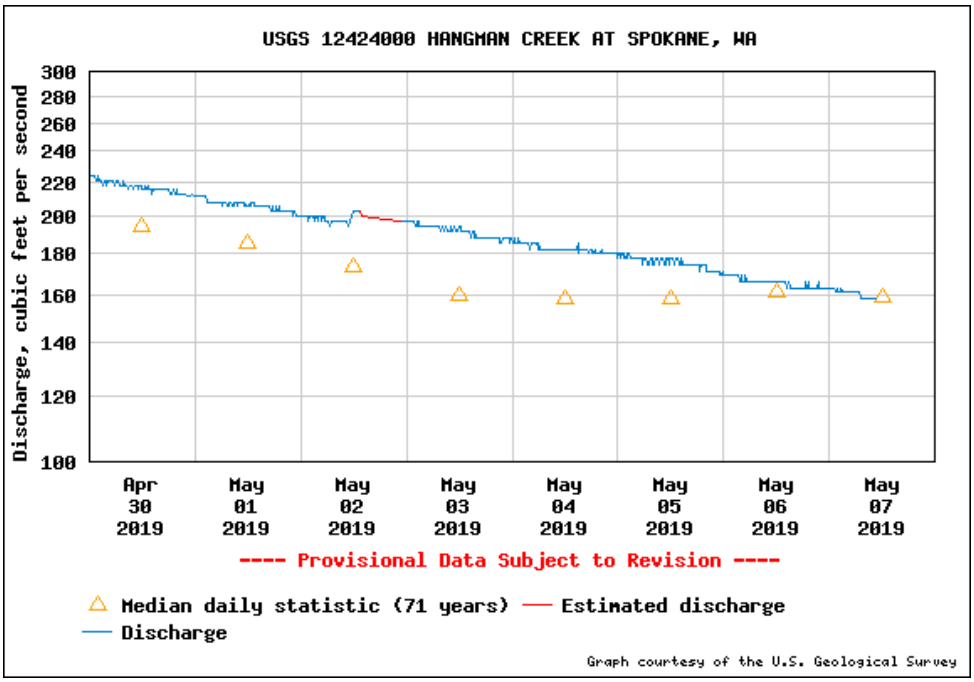


Figure 7-3. Spokane River Hydrograph at Spokane (USGS Station 12424000)

Table 7-5.
Summary of Peak Discharges within Spokane County

Source/Location	Discharge (cubic feet/second)			
	10-Year	50-Year	100-Year	500-Year
Argone Drainage				
At North Boeing Rd	80	140	173	214

Table 7-5.
Summary of Peak Discharges within Spokane County

Source/Location	Discharge (cubic feet/second) 10-Year	50-Year	100-Year	500-Year
At East Upriver Drive	102	180	222	274
Chester Creek				
Near 24th Ave	14	26	34	44
Near Schafer Road	113	137	147	169
Near Thorpe Road	75	104	116	144
Chester Creek Golf Course Overflow				
At Chester Creek	30	54	64	88
Country Homes Drainage				
At Highland Road At Hawthorne Road	165	311	370	551
At Hawthorne Road	138 [a]	249 [a]	293 [a]	349 [a]
At Cascade Way	142	284	293	408
Hangman Creek				
At USGS Gage	14,300	22,200	26,000	36,300
At Hatch Road	12,100	18,800	22,000	37,000
Little Spokane River Near Mouth	2,366 [b]	3,491 [b]	3,884 [b]	5,009 [b]
At USGS Gage Near Dartford	2,589	3,487	4,288	5,563
Above Confluence with Deep Creek	2,545	3,761	4,194	5,454
Below Confluence with Dragoon Creek	2,054	3,011	3,372	4,452
Below Chatteroy	1,001	1,436	1,611	2,166
Below Confluence with Eloika Lake	892	1,260	1,415	1,917
At Milan	727	1,006	1,137	1,590
Saltese Creek				
At Steen Road	65	215	--	531
At Baker Road	31	66	--	101
Spokane River				
At USGS Gage Near Otis Orchard	37,500	47,000	--	65,000
Forker Draw				
At Bigelow Gulch Road	49	88	109	135
Below East Jacob Road	60	108	134	166
At Chursh Driveway	117	209	259	321
Rock Creek				
Below Confluence with Mica Creek	5,190	9,590	11,500	15.900
Above Confluence with Mica Creek	4,410	8,060	9,640	12,990
Mica Creek				
At its mouth	1,190	2,290	--	3,840
Unnamed Tributary to Chester Creek				
At Storage Area	10	14	16	20
At Pines Road	12	24	30	46
At E. 46th Ave.	11	22	28	45
At S. Tolbert Lane	7	14	18	28

a. Decrease Due to Ponding, Pervious Soils, and Storage in Overbanks
b. Not Calculated

The Spokane County flood threat recognition system consists of a network of precipitation gages throughout the watershed and stream gages at strategic locations on the Spokane River that constantly

monitor and report stream levels. This information is fed into a USGS forecasting program, which assesses the flood threat based on the amount of flow in the stream (measured in cubic feet per second as demonstrated in Figure 7-3 above). In addition to this program, data and flood warning information is provided by the National Weather Service. All of this information is analyzed to evaluate the flood threat and possible evacuation needs.

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

Secondary Hazards

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

Climate Change Impacts

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

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

The amount of snow is critical for water supply and environmental needs, but so is the timing of snowmelt runoff into rivers and streams. Rising snowlines caused by climate change will allow more mountain area to contribute to peak storm runoff. High frequency flood events (e.g. 10-year floods) 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, causing increased sediment loads and other water quality impacts.

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

as the design of local sewers and storm drains. The planning area's location on the western flank of the Rocky Mountains gives the area a temperate climate. Summer is mostly warm and dry, interspersed with a few cool, damp days. Winter weather is often damp and foggy, with below-freezing temperatures, characteristic of maritime Polar air mass. Generally, the prime growing season is from mid-April to mid-October.

Annual precipitation in Spokane County ranges from less than 15 inches in the semiarid western edge of the County to more than 25 inches in the hills and mountains on the east side of the County. The annual precipitation in the planning area is approximately 17 to 21 inches.

7.2.5 Extent and Location – Dam Failure

The run-of-the-river dams along the main stem of the Spokane River are Post Falls Dams, Spokane Dam, Upper Falls Dam, Monroe Street Dam, Upriver Dam, Nine Mile Falls Dam and Little Falls Dam. With the exception of Upriver Dam (pictured right), which is operated by the City of Spokane's Water Department, these facilities are operated by Avista Utilities.

Figure 7-4 City of Spokane Upriver Dam

Of these dams, the Post Falls Dam located downstream from the outlet of Lake Coeur d'Alene has the greatest effect on the river hydrograph. Flow through the dam regulates Spokane River flow for four to six months a year during the low flow period. The dam regulates flow to maintain the level of Lake Coeur d'Alene at the agreed upon ordinary high water mark of 2,128 feet. Storing water that would have naturally drained from the lake during the summer modifies the flow characteristics of the river. The current hydrograph shows minimum flows occurring in late August or early September compared to the pre dam hydrograph where minimum occurred in late September of early October. Long Lake Dam, located downstream of the study area also has a storage reservoir adequate to allow minor effects on flow.

The Spokane River flows 112 miles from Post Falls Dam in Idaho to Lake Roosevelt (the Upper Columbia River) in Washington. The river basin encompasses over 6,000 square miles in Washington and Idaho. There are two major tributaries, Latah (Hangman) Creek and the Little Spokane River. There are seven municipal and industrial dischargers with permits to put wastewater into the Spokane River. Water conservation measures have been studied to preserve stream flows for fish, habitat, and recreation.

The Dam Safety Office (DSO) oversees 31 dams in Spokane County. Three are operated by federal agencies, and the rest are under the jurisdiction of the state. Eleven of the dams are listed as high or significant hazard, which means there are lives at risk downstream of the dam. The rest of the dams are ranked as low risk, with no lives at risk downstream of the dam. Table 7-6 lists these high and significant hazard dams within Spokane County.

Table 7-6.
Dams in Spokane County

Name	National ID #	Water Course	Owner	Year Built	Dam Type[a]	Crest Length (feet)	Height (feet)	Surface Area (acres)	Drainage area (sq. mi.)	Hazard Class[b]
Deer Park Sewage Treatment Lagoon	WA00303	Tr-Dragoon Creek	Deer Park	1984	RE	1340	14	21	0.01	2
Deer Park Wastewater Storage Lagoon	WA01468	Tr-Dragoon Creek	Deer Park	1984	RE	3300	14	176.0	0.07	1C
Deer Park Wastewater Storage Lagoon #3	WA0065	Tr-Dragoon Creek	Deer Park	1996	RE	1300	13	3.0	0.00	1C
Fairfield Waste Treatment Aerated Lagoon	WA01849	--	Fairfield	2003	RE	726	14	2.0	0.00	2
Hog Lake Dam	WA00056	Fishtrap Creek	Washington State	1957	RE	330	20	40.0	48	1B
Lower Pine Lake Dam	WA00317	Rock Creek	U.S. Dept. of Interior	1940	ER, RE	450	10	75.0	22.75	2
Nine Mile Dam	WA00068	Spokane River	WA Water Power Co	1908	PG	464	68	440	5110	1B
Reflection Lake North Dam	WA00362	Sheets Creek	Reflection Lake Homeowners Association	1955	RE	200	8	58	0.54	2
Reflection Lake South Dam	WA00050	Sheets Creek	Reflection Lake Comm. Inc.	1955	RE	710	28	58	0.54	1C
Upper Falls Dam	WA00038	Spokane River	WA Water Power Co	1922	PG	366	30	135	4290	2
Upriver Station Control Works	WA00074	Spokane River	Spokane	1935	CN, PG, RE	725	54	160	4215	2

a. RE = Earth Fill Dam; CN, PG = Concrete Gravity Dam
b. See severity discussion for definition of hazard classes

7.2.6 Previous Occurrence

According to DSO records, 15 notable dam failure events have occurred in Washington between 1918 and 2003, which significantly impacted communities. None of those "notable" failures occurred within or impacted Spokane County; however, in May 1986, the Upriver Dam located in the County near Spokane failed by overtopping when lightning struck the system and the turbine shut down. Water continued to rise behind the dam as officials tried to restart the turbine. The backup power systems also failed, and water

could not be timely released from the spillway gates. The incident caused ~$11 million in damage to the facility.[18] No injuries were reported.

While not in Spokane County, as a result of the wildfires which impacted much of Eastern Washington in 2014, the Hawkins Dam in Okanogan County failed due to spillway erosion which was caused as a result of the 2014 wildfires and ensuing heavy rains. The repair to the dam was made in 2017.

The most recent dam-related incident resulted from impact from the 2018 wildfire in Chelan County to the Eightmile Lake Dam. DSO worked with the dam owners, who completed repairs in the summer of 2018.

7.2.7 Frequency

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

7.2.8 Severity

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 7-7. 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.

7.2.9 Warning Time

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

[18] https://fortress.wa.gov/ecy/wrdocs/WaterRights/wrwebpdf/damfailure-ws.pdf

Spokane County and its planning partners have established protocols for flood warning and response to imminent dam failure in the flood warning portion of adopted emergency operations plans. These protocols are tied to emergency action plans created by the dam owners. Not all dams have emergency action plans; only those rated as high hazard are mandated to do so by state and federal regulations.

Secondary Hazards

Dam failure can cause severe downstream flooding, depending on the magnitude of the failure. Other potential secondary hazards of dam failure are landslides around the reservoir perimeter, bank erosion on the rivers, and destruction of downstream habitat. The hazard descriptions in Table 7-7 include secondary hazards of dam failures.

Table 7-7.
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

Climate Change Impacts

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

7.3 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) and 0.2 % (500-year) floodplains. These events are generally those considered by planners and evaluated under federal programs such as the NFIP. The following text evaluates and estimates the potential impact of flooding in Spokane County.

7.3.1 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 following sections assess the vulnerability to the flood hazard only. This assessment did not include data for dam failure due to the unavailability of dam failure inundation mapping for dams within the planning area. Readers should consider the flood hazard areas near the dam when attempting to identify the impact potential for dam failure. Flood exposure numbers were generated using 2019 Spokane County Assessor and parcel data, overlaid with the adopted NFIP flood maps. The County's Critical Facilities list was also utilized to identify exposure to those facilities. All data sources have a level of accuracy acceptable for planning purposes.

7.3.2 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 additional concern within the planning area is the number of tourists who can be impacted during periods of flooding, particularly in high-capacity structures (e.g., Northern Quest Casino) or events which have high turnout, such as Hoopfest. There are also residential structures in the path of potential waterflow with respect to the various dams throughout the County.

While existing data identifies structures at risk, impact to businesses in the area are also of concern, as some businesses have a large number of employees in attendance on a daily basis, such as the Northern Quest Casino and the Amazon Fulfillment Center which will be completed during the life cycle of this plan. Therefore, consideration should also be given to employees working in those potential inundation areas who would also be at potential risk.

Of the population exposed, the most vulnerable include the economically disadvantaged and those over 65 years of age. Economically disadvantaged populations are more vulnerable because they are likely to evaluate risk and make decisions to evacuate based on familial net economic impact. The population over the age of 65 is 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.

Population counts of those living in the floodplain were generated by analyzing County assessor and parcel data that intersect with the 100-year and 500-year floodplains identified on FIRMs. Using GIS, residential structures that intersected the floodplain were identified. An estimate of population was calculated as identified in the footer of Table 7-8. (Note: Tables 7-9 and 7-10 below provide a breakdown of all structure types, including residential.)

Table 7-8.
Populations Based on Residential Structures within Flood Hazard Areas*

	Number of Residential Types within 100-Year Flood Hazard						*Number of Residential Types within 500-Year Flood Hazard*					
	2-4 Units	*5+ Units*	*Condo*	*Mobile Homes*	*Single Family Residential*	Population in the 1% annual chance event (100- Year) Flood Boundary	*2-4 Units*	*5+ Units*	*Condo*	*Mobile Homes*	*Single Family Residential*	Population in the 0.2% annual chance event (500-Year) Flood
Airway Heights	0	0	0	0	0	**0**	0	0	0	0	0	**0**
Cheney	0	0	0	0	1	**2**	0	0	0	0	0	**0**
Deer Park	0	0	0	0	0	**0**	0	0	0	0	0	**0**
Fairfield	0	0	0	0	4	**10**	0	0	0	0	0	**0**
Latah	0	0	0	0	1	**2**	0	0	0	0	0	**0**
Liberty Lake	0	0	0	0	0	**0**	0	0	0	0	0	**0**
Medical Lake	0	0	0	0	0	**0**	0	0	0	0	0	**0**
Millwood	1	0	0	0	2	**15**	0	0	0	0	0	**0**
Rockford	0	1	0	0	8	**32**	0	0	0	0	0	**0**
Spangle	0	0	0	0	11	**27**	0	0	0	0	0	**0**
Spokane	1	1	3	0	40	**192**	95	9	18	0	1450	**4,994**
Spokane Valley	15	0	0	0	138	**481**	5	2	0	0	333	**882**
Waverly	0	0	0	0	0	**0**	0	0	0	0	0	**0**
Unincorporated	5	0	1	3	644	**1,645**	18	0	0	0	157	**556**
Total Population*	**214**	**24**	**97**	**7**	**2,063**	**2,406**	**1,147**	**134**	**437**	**0**	**4,714**	**6,432**

*Based on residential structures within the 100-year and 500-year floodplains and an estimate of 2.43 persons per residential structure.
* Single family residences and Mobile Homes at 2.43 persons per house; 2-4 plexes were 9.72 (2.43 * 4) persons per 2-4 plex, 5+ units were 12.15 (5*2.43) persons per 5+ unit and condominiums were 24.3 (10*2.43) persons per condominium unit.

7.3.3 Impact on Property

Structures in the Floodplain

Table 7-9 and Table 7-10 summarize the total area and number of structures in the floodplain by municipality. Table 7-11 and Table 7-12 summarize the estimated value of exposed buildings in the planning area at over $545 million worth of building-and-contents exposed to the 100-year flood, representing 0.72 percent of the total assessed value of the planning area, and $762 million worth of building-and-contents exposed to the 500-year flood, representing 1.0 percent of the total.

Table 7-9.
Area and Structures Within the 100-Year Floodplain

	Area in Floodplain (Acres)	Number of Structures in Floodplain								
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other*	**Total**
Airway Heights	0.00	0	0	0	0	0	0	0	0	0
Cheney	28.40	1	0	0	0	0	0	0	0	1
Deer Park	4.34	0	1	0	0	0	0	0	0	1
Fairfield	31.44	4	9	0	7	0	0	0	2	22
Latah	21.38	1	1	0	1	0	0	0	2	5
Liberty Lake	31.71	0	1	0	0	0	0	0	1	2
Medical Lake	22.77	0	0	0	0	0	0	0	0	0
Millwood	8.83	3	0	0	0	0	0	0	0	3
Rockford	71.19	9	19	0	0	0	5	0	0	33
Spangle	28.82	11	4	0	5	0	1	0	0	21
Spokane	1,040.23	45	24	1	1	0	52	2	7	132
Spokane Valley	619.66	153	4	1	0	1	6	1	1	167
Waverly	14.45	0	0	0	1	0	0	0	0	1
Unincorporated	27,352.47	653	36	2	210	5	39	1	13	959
Total	**29,275.7**	**880**	**99**	**4**	**225**	**6**	**103**	**4**	**26**	**1,347**

*Other category includes transportation and utilities; Wholesale and Professional Services categories were included in Commercial.

Table 7-10.
Area and Structures Within the 500-Year Floodplain

	Area in Floodplain (Acres)	Number of Structures in Floodplain								
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	**Total**
Airway Heights	0.00	0	0	0	0	0	0	0	0	0
Cheney	0.00	0	0	0	0	0	0	0	0	0
Deer Park	0.00	0	0	0	0	0	0	0	0	0
Fairfield	0.00	0	0	0	0	0	0	0	0	0
Latah	0.00	0	0	0	0	0	0	0	0	0
Liberty Lake	0.00	0	0	0	0	0	0	0	0	0

Table 7-10.
Area and Structures Within the 500-Year Floodplain

	Area in Floodplain (Acres)	Number of Structures in Floodplain								
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	**Total**
Medical Lake	0.00	0	0	0	0	0	0	0	0	0
Millwood	0.00	0	0	0	0	0	0	0	0	0
Rockford	0.00	0	0	0	0	0	0	0	0	0
Spangle	0.00	0	0	0	0	0	0	0	0	0
Spokane	865.18	1,572	103	1	0	5	39	3	6	1,729
Spokane Valley	206.69	340	10	0	0	0	0	1	0	351
Waverly	0.00	0	0	0	0	0	0	0	0	0
Unincorporated	1,169.97	175	1	0	4	0	2	0	3	185
Total	**2,241.84**	**2,087**	**114**	**1**	**4**	**5**	**41**	**4**	**9**	**2,265**

Table 7-11.
Value of Exposed Buildings Within the 100-Year Floodplain

	Estimated Flood Exposure			Percent of Total
	Structure	Contents	**Total**	**Assessed Value**
Airway Heights	$0	$0	**$0**	0.00%
Cheney	$137,210	$68,605	**$205,815**	0.00%
Deer Park	$57,930	$28,965	**$86,895**	0.00%
Fairfield	$3,212,900	$1,606,450	**$4,819,350**	0.01%
Latah	$241,610	$120,805	**$362,415**	0.00%
Liberty Lake	$5,133,670	$2,566,835	**$7,700,505**	0.01%
Medical Lake	$0	$0	**$0**	0.00%
Millwood	$1,309,990	$654,995	**$1,964,985**	0.00%
Rockford	$2,845,580	$1,422,790	**$4,268,370**	0.01%
Spangle	$1,667,290	$833,645	**$2,500,935**	0.00%
Spokane	$61,186,600	$30,593,300	**$91,779,900**	0.12%
Spokane Valley	$34,374,380	$17,187,190	**$51,561,570**	0.07%
Waverly	$66,980	$33,490	**$100,470**	0.00%
Unincorporated	$253,173,695	$126,586,848	**$379,760,543**	0.50%
Total	**$363,407,835**	**$181,703,918**	**$545,111,753**	**0.72%**

* Methodology for determining value: Utilized assessed amount field to determine structure value, contents was calculated at 50% of the structure value, for the 173,416 parcels that were included in the analysis the total of the assessed value is $50,614,614,129 using 50% of this value as content brings the total structure and content value for the county to $75,921,921,914. 1,374 parcel points were calculated within the 100-year floodplain for this analysis with the totals for structure value calculated from the assessed amount field for these 1,374 parcels.

Table 7-12.
Value of Exposed Buildings Within the 500-Year Floodplain

	Estimated Flood Exposure			% of Total
	Structure	Contents	**Total**	Assessed Value
Airway Heights	$0	$0	$0	0.00%
Cheney	$0	$0	$0	0.00%
Deer Park	$0	$0	$0	0.00%
Fairfield	$0	$0	$0	0.00%
Latah	$0	$0	$0	0.00%
Liberty Lake	$0	$0	$0	0.00%
Medical Lake	$0	$0	$0	0.00%
Millwood	$0	$0	$0	0.00%
Rockford	$0	$0	$0	0.00%
Spangle	$0	$0	$0	0.00%
Spokane	$401,245,380	$200,622,690	$601,868,070	0.79%
Spokane Valley	$65,204,780	$32,602,390	$97,807,170	0.13%
Waverly	$0	$0	$0	0.00%
Unincorporated	$41,934,890	$20,967,445	$62,902,335	0.08%
Total	**$508,385,050**	**$254,192,525**	**$762,577,575**	**1.00%**

*Methodology for determining value: Utilized the assessed amount field to determine structure value, contents was calculated at 50% of the structure value, for the 173,416 parcels that were included in the analysis the total of the assessed value is $50,614,614,129 using 50% of this value as content brings the total structure and content value for the county to $75,921,921,914. 2,264 parcel points were calculated within the 500-year floodplain for this analysis with the totals for structure value calculated from the assessed amount field for these 2,264 parcels.

7.3.4 Impact on Critical Facilities and Infrastructure

Table 7-13 through Table 7-16 summarize the critical facilities and infrastructure in the 100-year and 500-year floodplains of Spokane County. 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. Details are provided in the following sections.

Table 7-13.
Critical Facilities in the 100-Year Floodplain

Jurisdiction	Medical and Health Services	Government Function	Protective	Hazardous Materials	Schools	Other	**Total**
Airway Heights	0	0	0	0	0	0	**0**
Cheney	0	0	0	0	0	0	**0**
Deer Park	0	0	0	0	0	0	**0**
Fairfield	0	0	1	0	0	0	**1**
Latah	0	0	0	0	0	0	**0**
Liberty Lake	0	0	0	0	0	0	**0**
Medical Lake	0	0	0	0	0	0	**0**
Millwood	0	0	0	0	0	0	**0**
Rockford	0	0	1	0	0	0	**1**
Spangle	0	0	0	1	0	0	**1**
Spokane	0	0	0	0	0	0	**0**
Spokane Valley	0	0	0	0	1	0	**1**
Waverly	0	0	0	0	0	0	**0**
Unincorporated	0	0	0	0	0	0	**0**
Total	**0**	**0**	**2**	**1**	**1**	**0**	**4**

Table 7-14.
Critical Infrastructure in the 100-Year Floodplain

Jurisdiction	Bridges*	Water Supply	Wastewater	Power	Communications	Other**	**Total**
Airway Heights	0	0	0	0	0	0	**0**
Cheney	0	0	0	0	0	0	**0**
Deer Park	0	0	0	0	0	0	**0**
Fairfield	0	0	0	0	0	0	**0**
Latah	0	0	0	0	0	0	**0**
Liberty Lake	0	0	0	0	0	0	**0**
Medical Lake	0	0	0	0	0	0	**0**
Millwood	0	0	0	0	0	0	**0**
Rockford	0	0	1	0	0	0	**1**
Spangle	0	0	0	0	0	0	**0**
Spokane	8	0	0	0	0	3	**11**
Spokane Valley	3	0	0	0	0	0	**3**
Waverly	0	0	0	0	0	0	**0**
Unincorporated	15	0	0	0	0	9	**24**
Total	**26**	**0**	**1**	**0**	**0**	**12**	**39**

*Bridges include both highway and railway bridges; **Other Infrastructure includes dams and natural gas facilities

Table 7-15.
Critical Facilities in the 500-Year Floodplain

Jurisdiction	Medical and Health Services	Government Function	Protective	Hazardous Materials	Schools	Other	**Total**
Airway Heights	0	0	0	0	0	0	**0**
Cheney	0	0	0	0	0	0	**0**
Deer Park	0	0	0	0	0	0	**0**
Fairfield	0	0	0	0	0	0	**0**
Latah	0	0	0	0	0	0	**0**
Liberty Lake	0	0	0	0	0	0	**0**
Medical Lake	0	0	0	0	0	0	**0**
Millwood	0	0	0	0	0	0	**0**
Rockford	0	0	0	0	0	0	**0**
Spangle	0	0	0	0	0	0	**0**
Spokane	0	0	1	2	2	0	**5**
Spokane Valley	0	0	0	1	2	0	**3**
Waverly	0	0	0	0	0	0	**0**
Unincorporated	0	0	1	0	0	0	**1**
Total	**0**	**0**	**2**	**3**	**4**	**0**	**9**

Table 7-16.
Critical Infrastructure in the 500-Year Floodplain

Jurisdiction	Bridges*	Water Supply	Wastewater	Power	Communications	Other**	**Total**
Airway Heights	0	0	0	0	0	0	0
Cheney	0	0	0	0	0	0	0
Deer Park	0	0	0	0	0	0	0
Fairfield	0	0	0	0	0	0	0
Latah	0	0	0	0	0	0	0
Liberty Lake	0	0	0	0	0	0	0
Medical Lake	0	0	0	0	0	0	0
Millwood	0	0	0	0	0	0	0
Rockford	0	0	0	0	0	0	0
Spangle	0	0	0	0	0	0	0
Spokane	2	0	0	1	0	0	3
Spokane Valley	0	0	0	0	0	0	0
Waverly	0	0	0	0	0	0	0
Unincorporated	0	0	0	0	0	0	0
Total	**2**	**0**	**0**	**1**	**0**	**0**	**3**

Table 7-16.
Critical Infrastructure in the 500-Year Floodplain

Jurisdiction	Bridges*	Water Supply	Wastewater	Power	Communications	Other**	**Total**

*Bridges include both highway and railway bridges; **Other Infrastructure includes dams and natural gas facilities

Utilities and Infrastructure

Roads

The following major roads in Spokane County pass through 100-year floodplains:

- Interstate 90
- State Route 27
- State Route 206
- State Route 290
- State Route 291
- State Route 902
- State Route 904
- U.S. Route 2
- U.S. Route 195
- U.S. Route 395

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

Bridges

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

Water and Sewer Infrastructure

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

7.3.5 Impact to the Economy

Impact on the economy related to a flood event in Spokane 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. Flooding also has impacts on agricultural and forestland. Agricultural land in the County are subject to flooding. Likewise, inundation frequently affects croplands, something on which the County relies as a source of income. Forestland is also vulnerable to floods due to erosion when river and stream banks fail and overflow.

The County has a large amount of commercial and industrial development disbursed countywide. This includes a major rail line traveling across the United States, through Spokane to other areas of the State. Much of the County's transportation and communication infrastructure also falls within in the floodplain in certain areas in order to serve the needs of the community. A flood could impact infrastructure supporting

the commercial and industrial areas, causing impact not only within Spokane, but statewide if rail lines or major transportation routes are impacted.

7.3.6 Impact on the Environment

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

7.4 FUTURE DEVELOPMENT TRENDS

Spokane County and its planning partner cities are subject to the provisions of the Washington GMA, which regulates identified critical areas. County critical areas regulations include frequently flooded areas, defined as the FEMA 100-year mapped floodplain. The GMA establishes programs to monitor the densities at which commercial, residential and industrial development occurs under local GMA comprehensive plans and development regulations.

As participants in the NFIP, Spokane County and the partner cities have adopted flood damage prevention ordinances pursuant to the participation requirements. While these ordinances do not prohibit new development within the floodplain, they include new development provisions that account for the risk inherent to the floodplain.

The combination of the GMA provisions, critical areas regulations and NFIP flood damage prevention provisions equips the municipal planning partners with adequate tools to address new development in the floodplain. As pressures mount for growth into areas with flood risk, these tools could be enhanced with higher regulatory standards to increase the level of risk reduction on new development.

7.5 ISSUES

Homes located in flood plains, are vulnerable to flood damage. Adding to this vulnerability is new growth creating pressure to develop marginal land located near flood plains. As development increases, drainage basins are “built-out,” and the volume of storm water runoff and the area that it floods will increase. As a result, homes that were once outside mapped flood plains face a threat of flooding. Currently, 35-40 percent of the National Flood Insurance claims come from outside the mapped flood plains. Human-made developments within flood plains should be limited to non-structures such as parks, golf courses, and farms. These facilities have the least potential for damage, but maximize land use.

The public should be made aware of hazardous areas and given information on flood insurance, mitigation, preparedness, response, and recovery. Local jurisdiction emergency management plans should establish warning, evacuation, housing, and other emergency procedures.

The National Weather Service has an extensive river and weather monitoring system and provides flood watch and warning information to the public via radio, television, Internet, Teletype, and telephone.

The United States Army Corps of Engineers, under PL 84-99, has the authority to assist public entities in flood fighting and rescue operations and to protect, repair, and restore federally constructed flood control works threatened, damaged, or destroyed by a flood.

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

- The accuracy of the existing flood hazard mapping produced by FEMA in reflecting the true flood risk within the planning area is questionable. Flood maps need to be updated utilizing the best available data, science and technology
- The extent of flood-protection provided by flood control facilities (dams, dikes and levees) is not known due to the lack of an established national policy on flood protection standards.
- The risk associated with the flood hazard overlaps the risk associated with other hazards such as earthquake, landslide and fishing losses. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.
- There is no consistency of land-use practices within the planning area or the scope of regulatory floodplain management beyond the minimum requirements of the NFIP.
- Potential climate change could alter flood conditions in Spokane County.
- More information is needed on flood risk to support the concept of risk-based analysis of capital projects.
- There needs to be a sustained effort to gather historical damage data, such as high water marks on structures and damage reports, to measure the cost-effectiveness of future mitigation projects.
- Ongoing flood hazard mitigation will require funding from multiple sources.
- There needs to be a coordinated hazard mitigation effort between jurisdictions affected by flood hazards in the county.
- Floodplain residents need to continue to be educated about flood preparedness and the resources available during and after floods.
- The concept of residual risk should be considered in the design of future capital flood control projects and should be communicated with residents living in the floodplain.
- The promotion of flood insurance as a means of protecting private property owners from the economic impacts of frequent flood events should continue.
- Existing floodplain-compatible uses such as agricultural and open space need to be maintained. There is constant pressure to convert these existing uses to more intense uses within the planning area during times of moderate to high growth.
- The economy affects a jurisdiction's ability to manage its floodplains. Budget cuts and personnel losses can strain resources needed to support floodplain management.
- A buildable-lands analysis that looks at vacant lands and their designated land use would be a valuable tool in helping decision-makers make wise decisions about future development.
- Dam Failure inundation data needs to be obtained to support future risk assessments of the Dam Failure hazard.

7.6 CONSEQUENCE ANALYSIS

The primary water courses in Spokane County have the potential to flood at irregular intervals, generally in response to a succession of intense winter rainstorms. Storm patterns of warm, moist air usually occur between early November and late March. A series of such weather events can cause severe flooding in the planning area.

The worst-case scenario is a series of storms that flood numerous drainage basins in a short time. This could overwhelm the response and floodplain management capability within the planning area. Major roads could be blocked, preventing critical access for many residents and critical functions. High in-channel flows could cause water courses to scour, possibly washing out roads and creating more isolation problems. In the case of multi-basin flooding, the County may not be able to make repairs quickly enough to restore critical facilities and infrastructure.

Areas within the floodplain are limited in nature when compared to other jurisdictions. Much of the flooding within the urban areas is due to issues with storm drains and culvert capacity.

Citizens customarily are forewarned of severe weather events such as potential heavy rains which could lead to flooding. The county does have plans in place to address response to such events. Historically, impact to structures has been somewhat limited in nature, but events have risen to the level of disaster declarations. Impact to roadways is of concern, potentially impacting first responders, although in most instances, alternate routes are available. While travel time may increase, in most instances, responders would still be able to respond to the call(s), unless secondary hazards such as landslides have also occurred which further block ingress and egress. Table 7-17 identifies the Consequence Analysis for the Flood hazard.

Table 7-17.
Consequence Analysis

	L	ML	M	MH	H	VH
Likelihood / Probability						X
Geographic Boundary			X			
Population		X				
Vulnerable Population		X				
Built Environment		X				
Critical Infrastructure	X					
Facilities	X					
First Responders			X			

Table 7-17.
Consequence Analysis

	L	ML	M	MH	H	VH
Economic Consequences			X			
Environmental Impact					X	
Government's Ability to Continue Operations						X

L=Low; ML=Medium-Low; M=Medium; MH=Medium-High; H=High; VH=Very High

7.7 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 annually, albeit not necessarily to the level of a disaster declaration, and in many instances, creates more of a nuisance flooding than a significant hazard. While structural damage may vary due to flood depths and existing floodplain management regulations, the actual area within the floodplain is limited in nature, with fewer structures exposed; however, 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 3.0, with overall vulnerability determined to be a medium level.

CHAPTER 8.
LANDSLIDE

8.1 GENERAL BACKGROUND

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

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. They can be some of the most destructive events in nature.

DEFINITIONS

Landslide—The sliding movement of masses of loosened rock and soil down a hillside or slope. Such failures occur when the strength of the soils forming the slope is exceeded by the pressure, such as weight or saturation, acting upon them.

Mass Movement—A collective term for landslides, debris flows, falls and sinkholes.

Mudslide (or Mudflow or Debris Flow)—A river of rock, earth, organic matter and other materials saturated with water.

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.

8.2 HAZARD PROFILE

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

- A slope greater than 30 percent as identified in Spokane County's Critical Areas Ordinance[19]
- A history of landslide activity or movement during the last 10,000 years
- Stream or wave activity, which has caused erosion, undercut a bank or cut into a bank to cause the surrounding land to be unstable
- The presence or potential for snow avalanches

[19] https://www.spokanecounty.org/DocumentCenter/View/20132/CAO-2018-final?bidId=

- The presence of an alluvial fan, indicating vulnerability to the flow of debris or sediments
- The presence of impermeable soils, such as silt or clay, which are mixed with granular soils such as sand and gravel.

Flows and slides are commonly categorized by the form of initial ground failure. Figure 8-1 through Figure 8-4 show common types of slides. The most common is the shallow colluvial slide, occurring particularly in response to intense, short-duration storms. The largest and most destructive are deep-seated slides, although they are less common than other types.

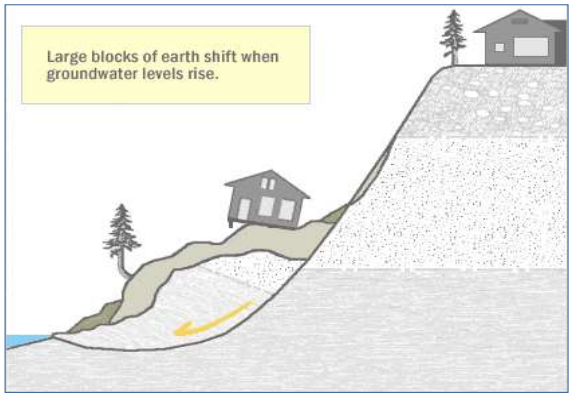


Figure 8-1. Deep Seated Slide

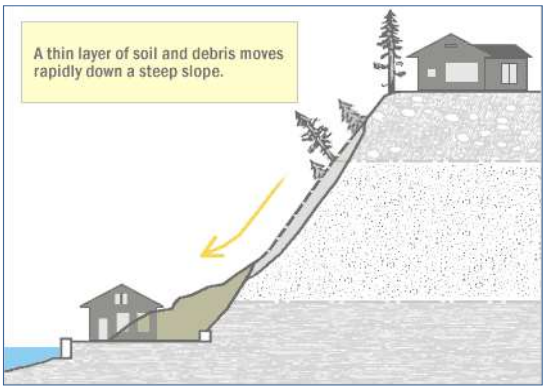


Figure 8-2. Shallow Colluvial Slide

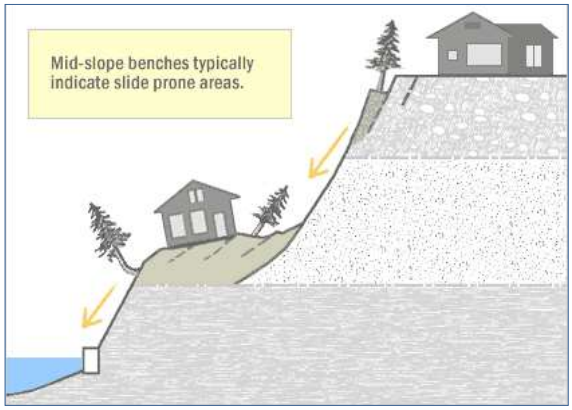


Figure 8-3. Bench Slide

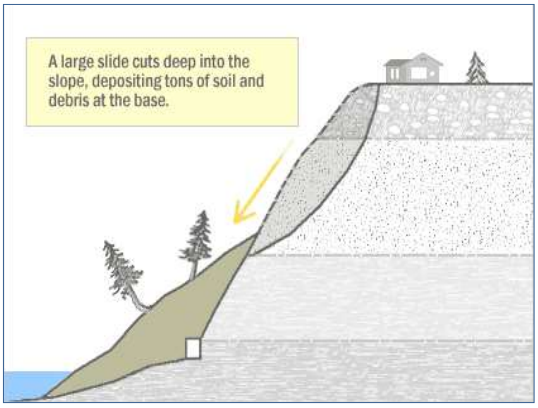


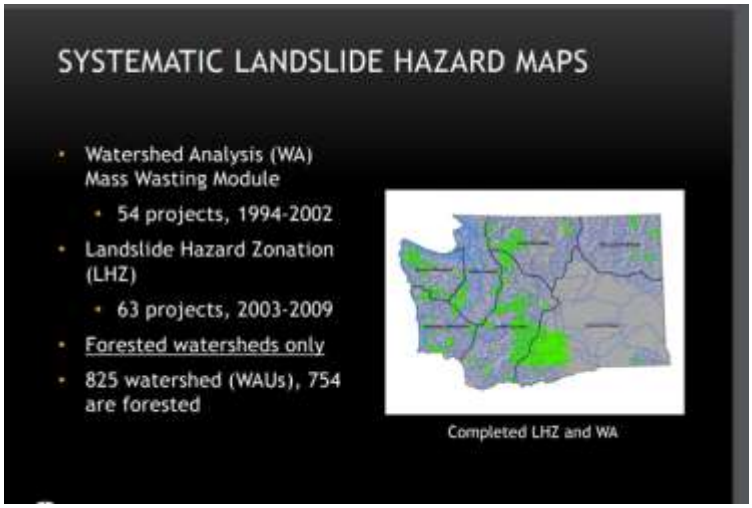
Figure 8-4. Large Slide

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

8.2.1 Extent and Location

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

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



Identifying unstable slopes to aid in mitigating landslide hazards is an integral part of land management and regulation in Washington through the Landslide Hazard Zonation Project prepared by the Forest Practices Division of the Washington Department of Natural Resources. Permanent rules adopted by the Washington Forest Practices Board in 2001 address landslide hazards from specific landforms across the state (WAC 222-16-050 (1)(d)). This methodology was developed to provide standardized methods for landslide inventories and for producing hazard maps to identify unstable slopes in support of forest practices rules. It also provides a framework for monitoring the success of new forest practices related to unstable slopes. At present, due, in part, to the lack of LiDAR data, there are no Landslide Hazard Zonation maps for the Spokane County planning area. The County has identified the collection of LiDAR data as a mitigation strategy to support future development of Landside Hazard Zonation areas within Spokane County. Once collected, future landslide risk assessments should use this data as it becomes available.

While no landslide hazard zonation maps exist, as of this 2020 update, Washington State Department of Natural Resources, in conjunction with USGS (and others) has begun capturing some landslide information for Spokane County, although the data is limited. Review of the Washington Geological Information Portal Natural Hazards Layer indicates the collection of data began in 2017. Readers may wish to continue to check this website as data is updated. https://geologyportal.dnr.wa.gov/#natural_hazards

Landslide hazard areas were defined as all areas with slopes of 30 percent or more in accordance with DNR identification and the County's Critical Areas Ordinance. Figure 8-5 shows those hazard areas. For illustration purposes, the landslide map also identifies those soils type that are more prone to increased landslides, NEHRP Soil Types D or E.

8.2.2 Previous Occurrence

While landslide events do occur, there is little recorded information regarding landslides in Spokane County. The Spatial Hazard Events and Losses Database for the United States (SHELDUS) has a record of one landslide event in Spokane County since 1960—on December 10, 1977. This event coincided with a presidential disaster declaration for severe storms and flooding.

During the January 30, 2017 severe weather (flood) event which resulted in a Presidential Declaration (DR 4309), the County experienced a landslide event which impacted two residential structures. Impact in large part was due to the fact that the structures were not affixed to the foundation, causing the houses to slide off of their foundations.

In April 2019, a Mead-area home (which had been previously abandoned for several years) was partially destroyed by a small landslide occurring along a steep hillside behind the residence. At the time that event occurred, it was not as a result of ground saturation. The incident was reported by an Avista employee who was inspecting gas meters in the area.

During this update process, there was one small landslide event which occurred as a result of the May 16, 2019 thunderstorm event, but no property was damaged. There are no records in the county of fatalities attributed to mass movement. However, deaths as a result of slides and slope collapses have occurred across the west coast.

8.2.3 Frequency

Landslides are often triggered by other natural hazards such as earthquakes, heavy rain, floods or wildfires, so landslide frequency is often related to the frequency of these other hazards. In Spokane County, landslides typically occur during and after major storms, so the potential for landslides largely coincides with the potential for sequential severe storms that saturate steep, vulnerable soils. Landslide events occurred during the winter storms of 2009, 2011, 2016, 2017 and 2019. According to SHELDUS records, the planning area has been impacted by severe storms at least once every other year since 1960, although most have not reached the level of a disaster declaration. Until better data is generated specifically for landslide hazards, this severe storm frequency is appropriate for the purpose of ranking risk associated with the landslide hazard.

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

8.2.4 Severity

Landslides range from shallow debris flows to deep-seated slumps. They typically occur where there is a presence of elevated slopes and fine-grade soil such as sand, which has been oversaturated by heavy rains or flooding. They destroy homes, businesses, and public buildings, undermine bridges, derail railroad cars, interrupt transportation infrastructure, damage utilities, and take lives. Sinkholes, a type of landslide, affect roads and utilities. Losses often go unrecorded because of no claims to insurance companies, no report to emergency management, no media coverage, or the transportation damages which are recorded as maintenance. Landslides destroy property and infrastructure and can take the lives of people. Slope failures in the United States result in an average of 25 lives lost per year and an annual cost to society of about $1.5 billion.

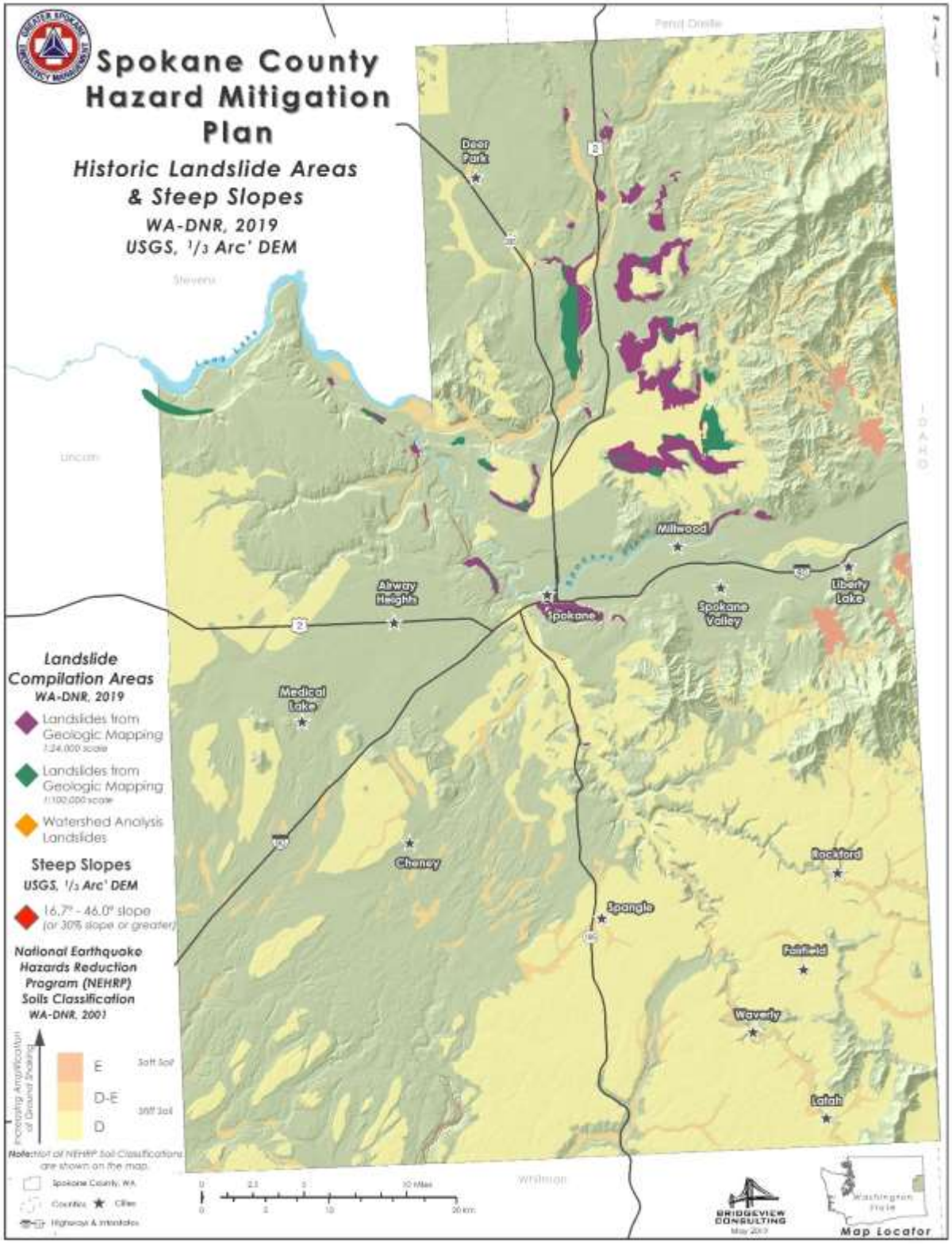


Figure 8-5. Landslide Probability

8.2.5 Warning Time

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

- Springs, seeps, or saturated ground in areas that have not typically been wet before
- New cracks or unusual bulges in the ground, street pavements or sidewalks
- Soil moving away from foundations
- Ancillary structures such as decks and patios tilting and/or moving relative to the main house
- Tilting or cracking of concrete floors and foundations
- Broken water lines and other underground utilities
- Leaning telephone poles, trees, retaining walls or fences
- Offset fence lines
- Sunken or down-dropped roadbeds
- 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.

8.3 SECONDARY HAZARDS

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

8.4 CLIMATE CHANGE IMPACTS

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

8.5 VULNERABILITY ASSESSMENT

8.5.1 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.

8.5.2 Impact on Life, Health, and Safety

A population estimate was made using the structure count of residential buildings intersecting within a 100' buffer within the landslide hazard areas, and applying the census value of 2.43 persons per household for Spokane County. Using this approach, the population living in the landside risk area is identified in Table 8-1. 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.

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, or areas which have a high transient population of tourists, especially during summertime months. Finally, Spokane 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 consumed by residents.

Table 8-1.
Populations and Residential Structure Impact in Landslide Risk Area*

Jurisdiction	Residential Building Count	Population Exposed**
Airway Heights	0	0
Cheney	0	0
Deer Park	0	0
Fairfield	0	0
Latah	0	0
Liberty Lake	0	0
Medical Lake	0	0
Millwood	0	0
Rockford	0	0
Spangle	0	0
Spokane	4,004	13,292

Table 8-1. Populations and Residential Structure Impact in Landslide Risk Area*		
Jurisdiction	**Residential Building Count**	**Population Exposed****
Spokane Valley	14	34
Waverly	0	0
Unincorporated	1,131	2,770
Total	**5,149**	**16,096**

** For these planning purposes, risk area is identified through application of a 100' buffer applied to the County's defined steep slope of 30% and above, and areas identified within WADNR mapped historic landslides.*
***Population is based on Single family residences at 2.43 persons per house; 2-4 plexes were 9.72 (2.43 * 4) persons per 2-4 plex, 5+ units were 12.15 (5*2.43) persons per 5+ unit and condominiums were 24.3 (10*2.43) persons per condominium unit*

8.5.3 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.

Due to population density and desire of people to have a home with a view, an increasing number of structures are built on top of or below slopes subject to land sliding. Inconsistent slope mapping and land use regulations in landslide areas make the public unaware of the risk associated in building in potentially vulnerable areas. Land is not stable indefinitely. People believe that if a bluff has remained stable for the last 50 years, it will remain so for the next 50 years regardless of the development or maintenance. In addition, the different types of soil further increase the danger.

Loss estimations for the landslide hazard are not based on modeling utilizing damage functions, because no such damage functions have been generated. For mitigation planning purposes only, the Washington State Department of Natural Resources Landslide Dataset was utilized to identify areas of historic events. In addition, based on the County's Critical Areas Ordinance, slopes identified as being 30 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 8-2. Applying the principle of a 100' buffer to the 30 percent slope allows assessment of the potential structures within the landslide hazard areas as identified in Table 8-3. Data presented in these maps and tables are not a substitute for site-specific investigations by qualified practitioners.

Table 8-2. Percent of Land Area in Landslide Risk Area		
Jurisdiction	Area in Landslide Risk (Acres)	% of Total Planning Area
Airway Heights	9.34	0.0008%
Cheney	0.00	0.00%
Deer Park	0.00	0.00%
Fairfield	0.00	0.00%

Table 8-2.
Percent of Land Area in Landslide Risk Area

Jurisdiction	Area in Landslide Risk (Acres)	% of Total Planning Area
Latah	0.00	0.00%
Liberty Lake	1.16	0.0001%
Medical Lake	0.00	0.00%
Millwood	0.00	0.00%
Rockford	0.00	0.00%
Spangle	0.00	0.00%
Spokane	2,205.76	0.19%
Spokane Valley	28.29	0.0025%
Waverly	0.00	0.00%
Unincorporated	30,265.10	2.66%
Total	**32,509.65**	**2.85%**

** For these planning purposes, risk area is identified through application of a 100' buffer applied to the County's defined steep slope of 30% and above, and areas identified within WADNR mapped historic landslides.*
***Population is based on factor of 2.43 per person/household per residential structure*
Planning area for Spokane County calculated at 1,139,204.76 acres

Table 8-3.
Spokane County Structures in Landslide Hazard Areas*

Jurisdiction	Buildings Exposed	Assessed Value		
		Structure	Contents	**Total**
Airway Heights	0	$0	$0	$0
Cheney	0	$0	$0	$0
Deer Park	0	$0	$0	$0
Fairfield	0	$0	$0	$0
Latah	0	$0	$0	$0
Liberty Lake	0	$0	$0	$0
Medical Lake	0	$0	$0	$0
Millwood	0	$0	$0	$0
Rockford	0	$0	$0	$0
Spangle	0	$0	$0	$0
Spokane	4,748	$1,529,479,230	$764,739,615	$2,294,218,845
Spokane Valley	18	$3,116,320	$1,558,160	$4,674,480
Waverly	0	$0	$0	$0
Unincorporated	2,062	$515,224,460	$257,612,230	$772,836,690
Total	**6,828**	**$2,047,820,010**	**$1,023,910,005**	**$3,071,730,015**

8.5.4 Impact on Critical Facilities and Infrastructure

Applying the 100' buffer, Table 8-5 identifies the facilities exposed to landslide hazard. Figure 8-6 illustrates the proximity of the critical facilities and infrastructure to the established landslide areas. No dollar loss estimation of these facilities was performed due to the lack of established damage functions for the landslide hazard.

There are 30 critical facilities potentially exposed to the landslide hazard to some degree. A more in-depth analysis of the mitigation measures taken by these facilities to prevent damage from mass movements should be done to determine if they could withstand impacts of a mass movement.

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

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

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

- **Bridges**—Landslides can significantly impact road bridges. Mass movements can knock out abutments or significantly weaken the soil supporting them, making them hazardous for use.

- **Power Lines**—Power lines are generally elevated above steep slopes; but the towers supporting them can be subject to landslides. A landslide could trigger failure of the soil under 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.

Table 8-4.
Critical Facilities Exposed to Landslide Hazards

Facility Type	Number of Exposed Critical Facilities in Risk Area
Medical and Health Services	3
Government Function	0
Protective Function	1
Schools	5
Hazmat	6
Other Critical Function	0
Bridges	14
Water	1
Wastewater	0
Power	0
Communications	0
Total	**30**

* Note: Bridges includes both highway and railway bridges.

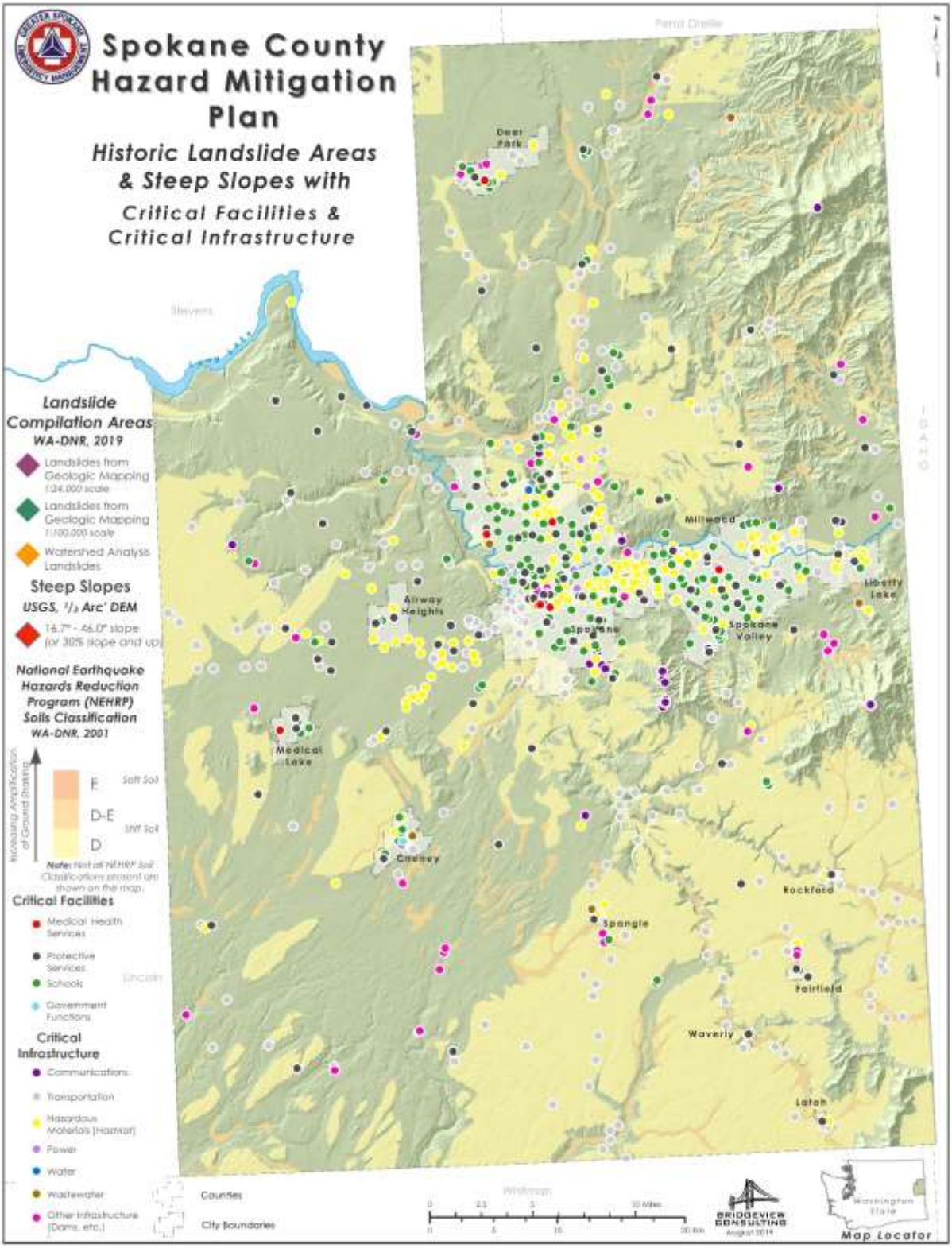


Figure 8-6. Critical Facilities and Infrastructure within Landslide Hazard Area

8.5.5 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 Spokane County, but also other areas of the state particularly as a major transportation corridor between Washington and Idaho, and as a result of the major rail line connecting Washington to other parts of the country for any types of commodities, both importing and exporting.

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 Interstate 90 (among other major roadways) serving as a primary transportation routes, use of the major highways reduces travel times and serves as more direct access. Impacts would also significantly reduce the tourism industry not only within Spokane County, but also vehicles traveling to Pend Oreille County (and others), Idaho, and Canada.

8.5.6 Impact on Environment

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

8.6 FUTURE DEVELOPMENT TRENDS

Landslide hazard areas are included in "geologically hazardous areas," one category of critical areas regulated under the state GMA for Spokane County. They are defined as follows:

- "Landslide hazard areas" means areas potentially subject to mass earth movement based on a combination of geologic, topographic, and hydrologic factors, with a vertical height of 10 feet or more. These include the following:

- Areas of historical landslides as evidenced by landslide deposits, avalanche tracks, and areas susceptible to basal undercutting by streams, rivers or waves

- Areas with slopes steeper than 30 percent that intersect geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock, and which contain springs or groundwater seeps

- Areas located in a canyon or an active alluvial fan, susceptible to inundation by debris flows or catastrophic flooding.

Spokane County and its planning partners appear to be well equipped to deal with future growth and development within the planning area. The landslide hazard portions of the planning area are regulated by County Code as well as by the International Building Code. Development will occur in landslide hazards within the planning area, but it will be regulated such that the degree of risk will be reduced through building standards and performance measures.

By studying the effects of landslides in slide prone areas we can plan for the future. More needs to be done to educate the public and to prevent development in vulnerable areas. WAC 365-190-080 states that

geologically hazardous areas pose a threat to the health and safety of citizens when incompatible development is sited in areas of significant hazard. Some hazards can be mitigated by engineering, design, or construction so that risks are acceptable. When technology cannot reduce the risk to acceptable levels, building in hazardous areas should be avoided. The least expensive and most effective landslide loss reduction measure is by avoidance.

8.7 ISSUES

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

8.8 CONSEQUENCE ANALYSIS

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

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

Continued heavy rains and flooding will complicate the problem further. As emergency response resources are applied to problems with flooding, it is possible they will be unavailable to assist with landslides occurring all over Spokane County. Table 8-5 identifies the Consequence Analysis for the Landslide hazard.

Table 8-5.
Consequence Analysis

	L	ML	M	MH	H	VH
Likelihood / Probability						X
Geographic Boundary			X			
Population			X			
Vulnerable Population			X			
Built Environment			X			
Critical Infrastructure			X			
Facilities			X			
First Responders			X			
Economic Consequences			X			
Environmental Impact				X		
Government's Ability to Continue Operations						X

L=Low; ML=Medium-Low; M=Medium; MH=Medium-High; H=High; VH=Very High

8.9 RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from a landslide throughout the area is highly likely. The area experiences some level of landslide activity annually, although in many instances, there is no structural impact. Thankfully, no injuries have been reported to have occurred as a result of a landslide event, but when the 100' buffer is applied, there are a fair number of residential structures whose access could be impacted. The County's 30 percent slope restrictions with respect to development within the critical area does help reduce the exposure to citizens significantly by limiting construction in high hazard areas.

Customarily, landslide events occur in conjunction with other weather events, such as flooding, earthquake, or other severe weather. As emergency response resources may be applied to the primary issue causing

the landslide, it is possible that first responders may be taxed, with response times impacted. Likewise, impact from a landslide to roadways could also increase response times due to related issues with ingress and egress to areas. Based on the potential impact, the Planning Team determined the CPRI score to be 3.1, with overall vulnerability determined to be a medium level.

CHAPTER 9.
SEVERE WEATHER

9.1 GENERAL BACKGROUND

Severe weather refers to any dangerous meteorological phenomena with the potential to cause damage, serious social disruption, or loss of human life. It includes thunderstorms, downbursts, tornadoes, waterspouts, snowstorms, ice storms, and dust storms. Severe weather can be categorized into two groups: those that form over wide geographic areas are classified as general severe weather; those with a more limited geographic area are classified as localized severe weather. Severe weather, technically, is different from extreme weather, which refers to unusual weather events are at the extremes of the historical distribution for a given area.

9.1.1 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

DEFINITIONS

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

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

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

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

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

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

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.

9.1.2 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 a funnel cloud. Tornadoes are rated by their intensity and damage to vegetation and property. There are two common rating scales, the Fujita scale (F-Scale) and the Enhanced Fujita Scale (EF-Scale). The Fujita scale is a tornado scale introduced in 1971 by Tetsuya Fujita and the scale evaluates total damage. In the United States the Fujita scale was replaced with the Enhanced Fujita scale, which is now the primary scale used the United Sites and Canada. The Enhanced Fujita scale not only considers damage, but also takes into account wind speed. Figure 9-1 illustrates the two tornado rating scales.

On a local-scale, tornadoes are the most intense of all atmospheric circulations and wind 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. Figure 9-2, adapted from FEMA, illustrates the potential impacts and damage from tornadoes of different magnitudes. Tornadoes can occur throughout the year at any time of day but are most frequent in the spring during the late afternoon. As shown in Figure 9-3, Washington has a relatively low risk compared to states in the Midwestern and Southern U.S.; however, the County does have recorded Tornadoes. The Wind Zone Map illustrated in Figure 9-4 illustrates the variations in wind speeds, which correlate to the building code requirements.

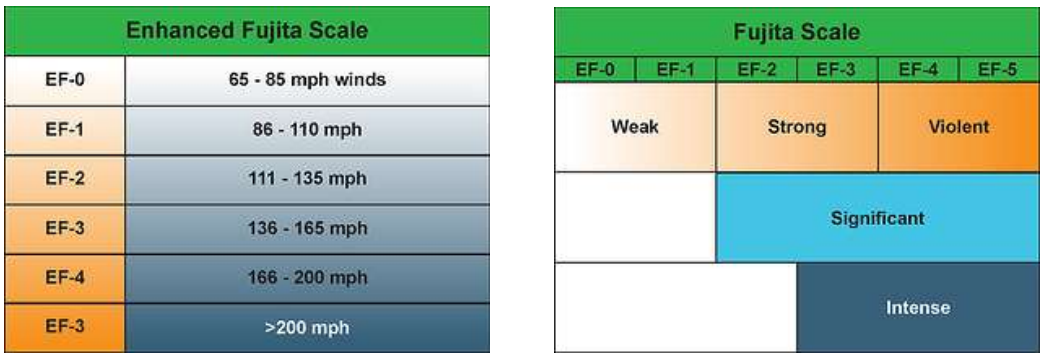
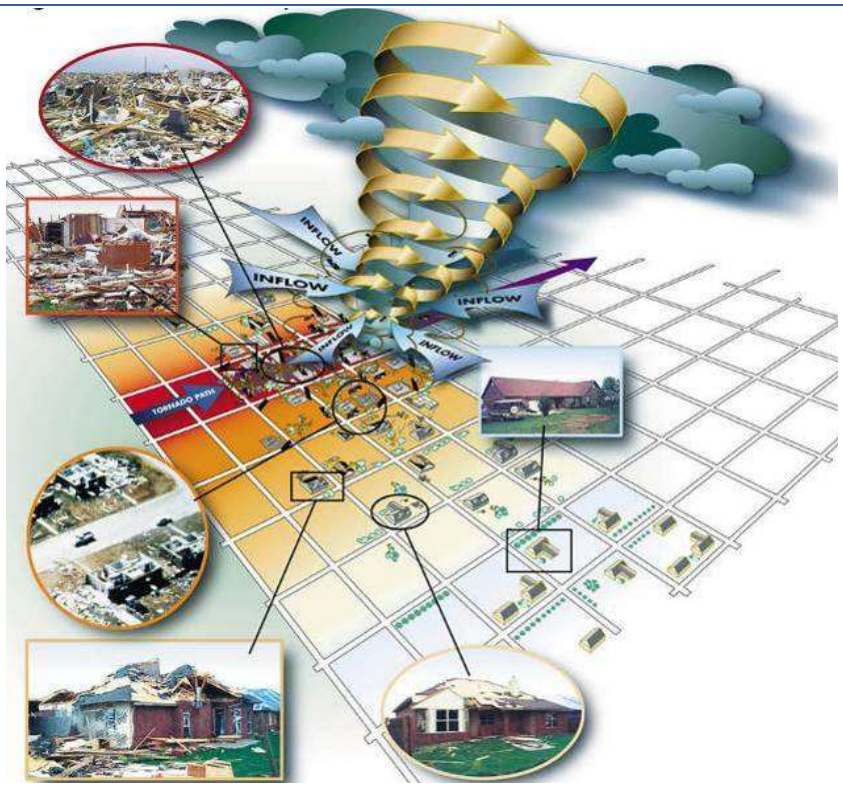
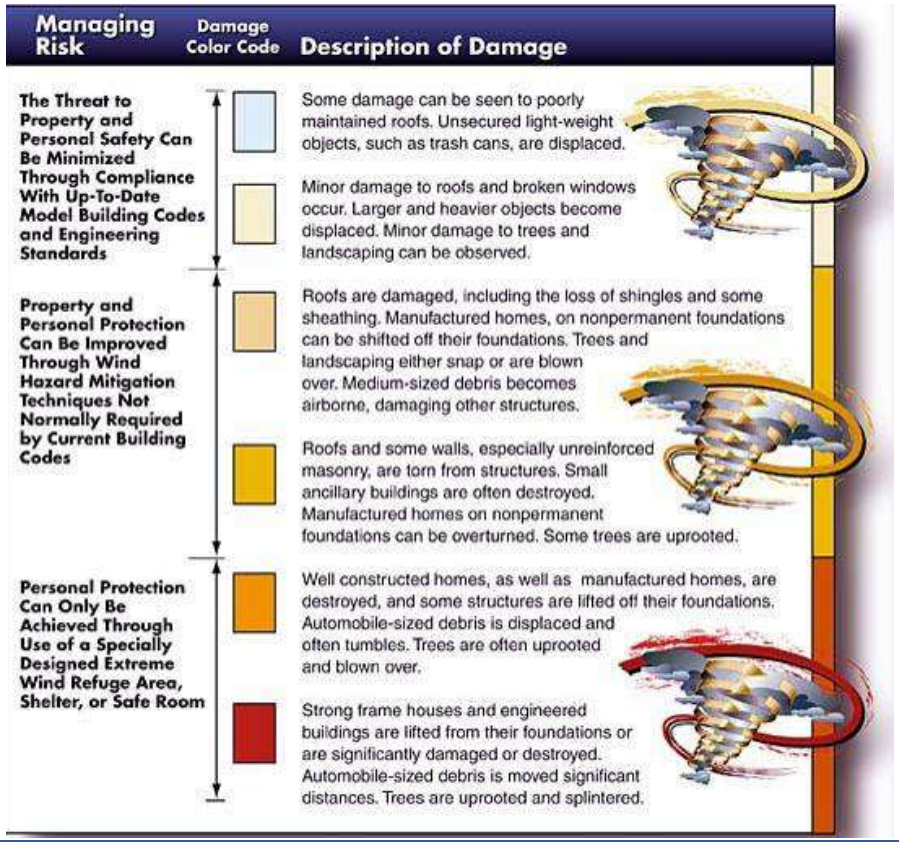


Figure 9-1. Tornado Ratings





Managing Risk	Damage Color Code	Description of Damage
The Threat to Property and Personal Safety Can Be Minimized Through Compliance With Up-To-Date Model Building Codes and Engineering Standards		Some damage can be seen to poorly maintained roofs. Unsecured light-weight objects, such as trash cans, are displaced.
		Minor damage to roofs and broken windows occur. Larger and heavier objects become displaced. Minor damage to trees and landscaping can be observed.
Property and Personal Protection Can Be Improved Through Wind Hazard Mitigation Techniques Not Normally Required by Current Building Codes		Roofs are damaged, including the loss of shingles and some sheathing. Manufactured homes, on nonpermanent foundations can be shifted off their foundations. Trees and landscaping either snap or are blown over. Medium-sized debris becomes airborne, damaging other structures.
		Roofs and some walls, especially unreinforced masonry, are torn from structures. Small ancillary buildings are often destroyed. Manufactured homes on nonpermanent foundations can be overturned. Some trees are uprooted.
Personal Protection Can Only Be Achieved Through Use of a Specially Designed Extreme Wind Refuge Area, Shelter, or Safe Room		Well constructed homes, as well as manufactured homes, are destroyed, and some structures are lifted off their foundations. Automobile-sized debris is displaced and often tumbles. Trees are often uprooted and blown over.
		Strong frame houses and engineered buildings are lifted from their foundations or are significantly damaged or destroyed. Automobile-sized debris is moved significant distances. Trees are uprooted and splintered.

Figure 9-2. Potential Impact and Damage from a Tornado

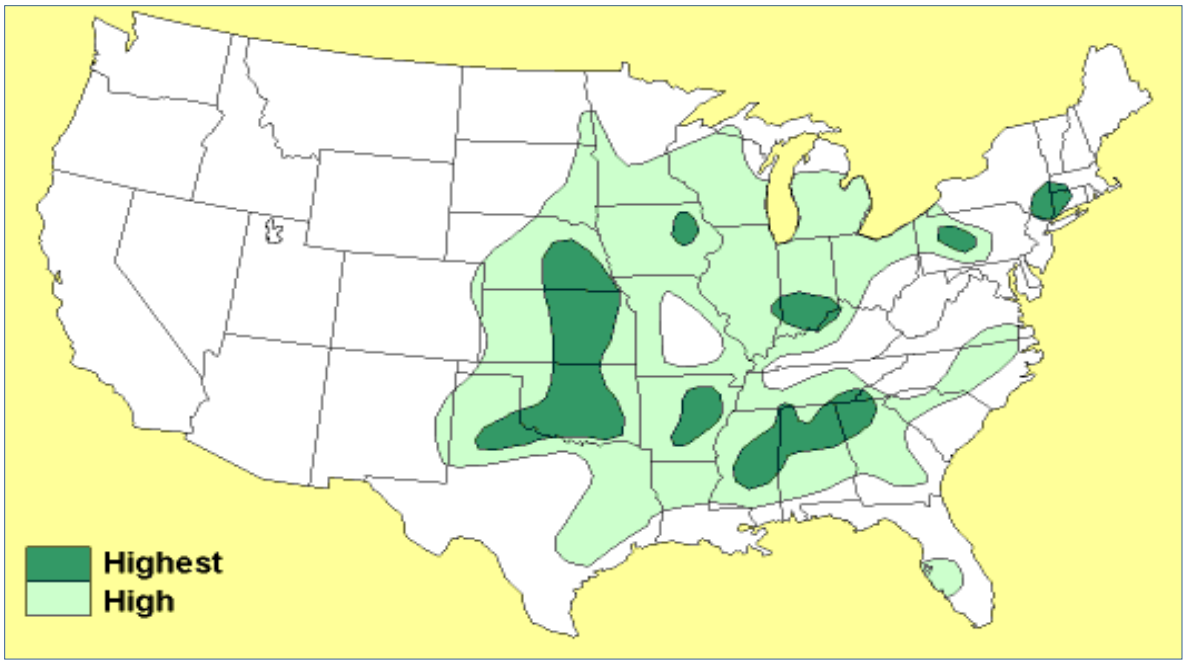


Figure 9-3. Tornado Risk Areas in the United States

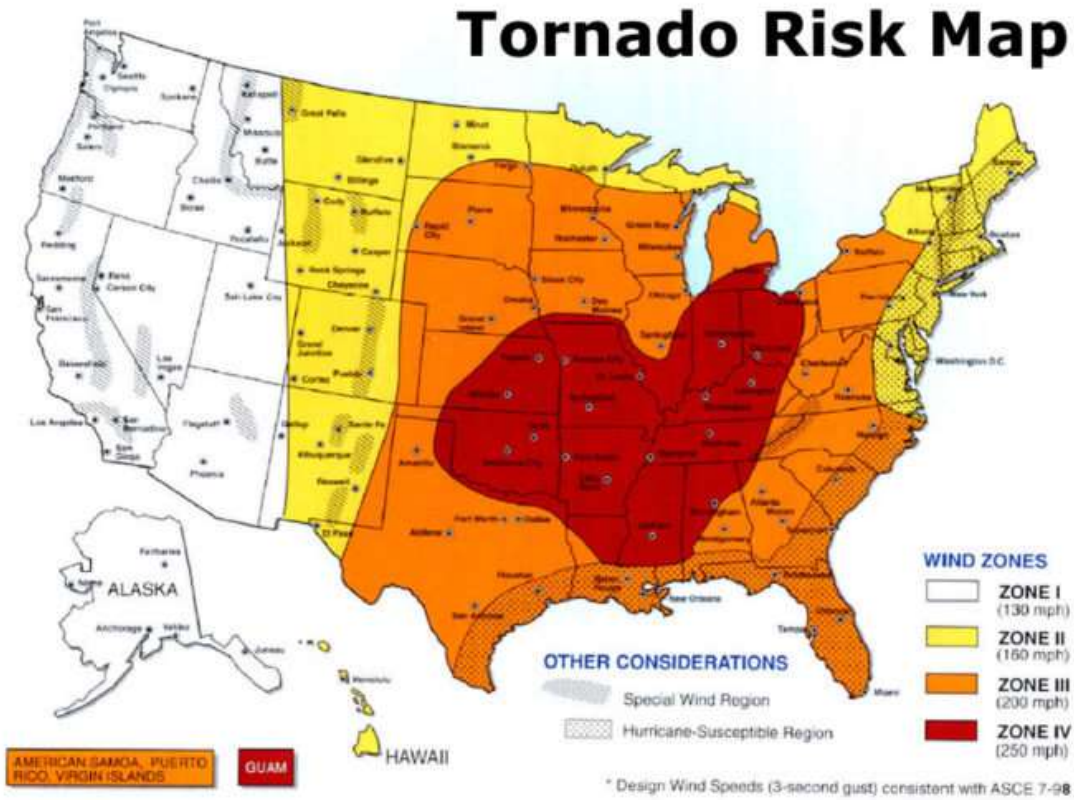


Figure 9-4. Wind Zone Map of U.S.

9.1.3 Blizzards and Snowstorms

The National Weather Service defines a winter storm as having significant snowfall, ice and/or freezing rain; the quantity of precipitation varies by elevation. Heavy snowfall is 4 inches or more in a 12-hour period, or 6 inches or more in a 24-hour period in non-mountainous areas; and 12 inches or more in a 12-hour period or 18 inches or more in a 24-hour period in mountainous areas. There are three key ingredients to a severe winter storm:

- Cold Air—Below-freezing temperatures in the clouds and near the ground are necessary to make snow and/or ice.
- Moisture—Moisture is required in order to form clouds and precipitation. Air blowing across a body of water, such as a large lake or the ocean, is an excellent source of moisture.
- Lift—Lift is required in order to raise the moist air to form the clouds and cause precipitation. An example of lift is warm air colliding with cold air and being forced to rise over the cold dome. The boundary between the warm and cold air masses is called a front. Another example of lift is air flowing up a mountain side.

Strong storms crossing the North Pacific sometimes slam into the coast from California to Washington. The Pacific provides a virtually unlimited source of moisture for storms. If the air is cold enough, snow falls over Washington and Oregon and sometimes in California. As the moisture rises into the mountains, heavy snow closes the mountain passes and can cause avalanches. Cold air from the north has to filter through mountain canyons into the basins and valleys to the south. If the cold air is deep enough, it can spill over the mountain ridge. As the air funnels through canyons and over ridges, wind speeds can reach 100 mph, damaging roofs and taking down power and telephone lines. Combining these winds with snow results in a blizzard.

Heavy snow can immobilize a region and paralyze a city, stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. Accumulations of snow can collapse buildings and knock down trees and power lines. In rural areas, homes and farms may be isolated for days, and unprotected livestock may be lost. In the mountains, heavy snow can lead to avalanches. The cost of snow removal, repairing damages, and loss of business can have large economic impacts on cities and towns.

Areas most vulnerable to winter storms are those affected by convergence of dry, cold air from the interior of the North American continent, and warm, moist air off the Pacific Ocean. Typically, significant winter storms occur during the transition between cold and warm periods.

9.1.4 Ice Storms

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.

With an average elevation over 1,800 feet, Spokane is located on the edge of the Columbia Basin in eastern Washington State. Its location, between the Cascades Range to the west and Rocky Mountains to the east and north, allows cold air to settle into the basin, frequently creating prime conditions for winter weather.

November 19, 1996, produced one of the region’s worst ice storms in 60 years. Before the freezing rain hit, there was already between 2 and 4 inches of snow on the ground around the city. Later that day, up to an inch and a half of freezing rain fell, coating trees, roads, buildings, vehicles, and power lines in a dense slippery glaze. The official weather station for the city at Spokane International Airport recorded a high temperature of only 33°F and 1.24 inches of precipitation, which fell in the form of rain, freezing rain,

freezing drizzle (which are smaller drops than those of rain), snow, and mist. The station also reported freezing fog in the city that day.

Trees came crashing down everywhere under the immense weight of the ice. The mayor of Spokane declared a state of emergency as over half the city's residents lost electricity—their worst power outage in 108 years. Three days after the storm, 100,000 people in the surrounding county were without power, and six days after the storm, 20,000 were still without power. Some area residents were without electricity for up to two weeks following the record-breaking storm.

Throughout the devastating ice storm and its aftermath, four people lost their lives in and around Spokane and Kootenai counties, and total damages were estimated at over $22 million in 1996 dollars—$33 million in 2013 dollars. This ice storm remains one of the most severe on record for the area.

9.1.5 Dust Storms

Dust storms occur east of the Cascades. Wind, following dry periods, blows dirt and light debris aloft. Haboobs are dramatic dust storms produced by strong winds that are generally associated with thunderstorm gust fronts or very strong cold fronts. Haboobs are getting less frequent in eastern Washington as farmers practice better soil conservation approaches, but they still occur if strong winds arise at the end of a hot dry summer.

9.1.6 Thunderstorms

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

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

Thunderstorms have three stages (see Figure 9-5):

- The **developing stage** of a thunderstorm is marked by a cumulus cloud that is being pushed upward by a rising column of air (updraft). The cumulus cloud soon looks like a tower (called towering cumulus) as the updraft continues to develop. There is little to no rain during this stage but occasional lightning. The developing stage lasts about 10 minutes.

- The thunderstorm enters the **mature stage** when the updraft continues to feed the storm, but precipitation begins to fall out of the storm, and a downdraft begins (a column of air pushing downward). When the downdraft and rain-cooled air spread out along the ground, they form a gust front, or a line of gusty winds. The mature stage is the most likely time for hail, heavy rain, frequent lightning, strong winds, and tornadoes. The storm occasionally has a black or dark green appearance.

- Eventually, a large amount of precipitation is produced and the updraft is overcome by the downdraft beginning the **dissipating stage**. At the ground, the gust front moves out a long distance from the storm and cuts off the warm moist air that was feeding the thunderstorm. Rainfall decreases in intensity, but lightning remains a danger.

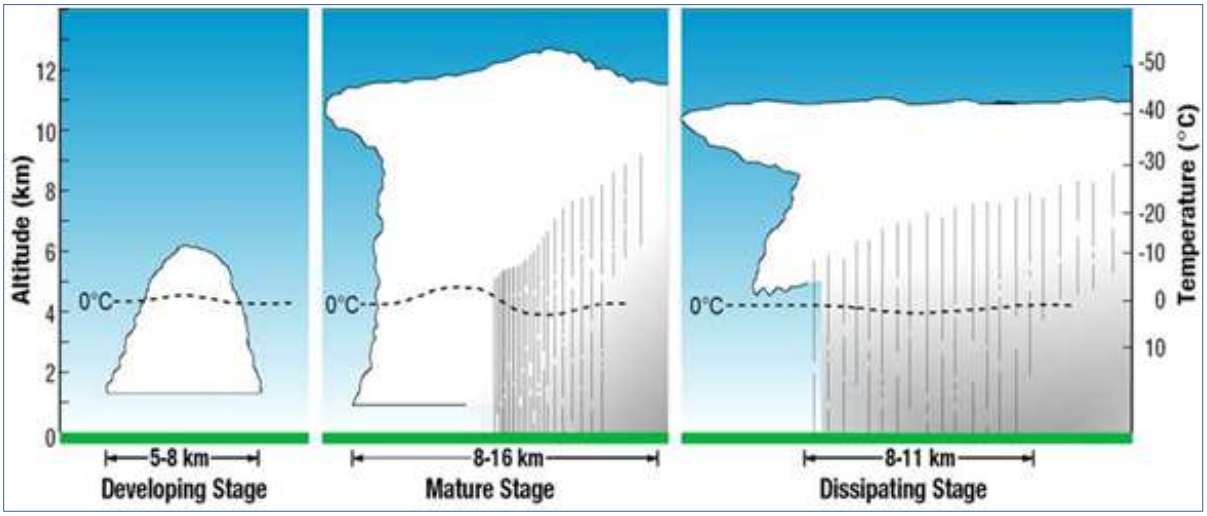


Figure 9-5. The Thunderstorm Life Cycle

There are four types of thunderstorms:

- **Single-Cell Thunderstorms—**Single-cell thunderstorms usually last 20 to 30 minutes. A true single-cell storm is rare, because the gust front of one cell often triggers the growth of another. Most single-cell storms are not usually severe, but a single-cell storm can produce a brief severe weather event. When this happens, it is called a pulse severe storm.

- **Multi-Cell Cluster Storm—**A multi-cell cluster is the most common type of thunderstorm. The multi-cell cluster consists of a group of cells, moving as one unit, with each cell in a different phase of the thunderstorm life cycle. Mature cells are usually found at the center of the cluster and dissipating cells at the downwind edge. Multi-cell cluster storms can produce moderate-size hail, flash floods and weak tornadoes. Each cell in a multi-cell cluster lasts only about 20 minutes; the multi-cell cluster itself may persist for several hours. This type of storm is usually more intense than a single cell storm.

- **Multi-Cell Squall Line—**A multi-cell line storm, or squall line, consists of a long line of storms with a continuous well-developed gust front at the leading edge. The line of storms can be solid, or there can be gaps and breaks in the line. Squall lines can produce hail up to golf-ball size, heavy rainfall, and weak tornadoes, but they are best known as the producers of strong downdrafts. Occasionally, a strong downburst will accelerate a portion of the squall line ahead of the rest of the line. This produces what is called a bow echo. Bow echoes can develop with isolated cells as well as squall lines. Bow echoes are easily detected on radar but are difficult to observe visually.

- **Super-Cell Storm—**A super-cell is a highly organized thunderstorm that poses a high threat to life and property. It is similar to a single-cell storm in that it has one main updraft, but the updraft is extremely strong, reaching speeds of 150 to 175 miles per hour. Super-cells are rare. The main characteristic that sets them apart from other thunderstorms is the presence of rotation. The rotating updraft of a super-cell (called a mesocyclone when visible on radar) helps the super-cell to produce

extreme weather events, such as giant hail (more than 2 inches in diameter), strong downbursts of 80 miles an hour or more, and strong to violent tornadoes.

9.2 HAZARD PROFILE

9.2.1 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. While considerable snowfall does not customarily occur throughout the region, it does occur on a regular basis, and has resulted in significant accumulations on some occasions.

Communities in low-lying areas next to rivers, streams, or lakes are more susceptible to flooding. Wind events are most damaging to areas of Spokane County, and have had a significant impact on the planning region. For the planning region as a whole, wind events are one of the most common weather-related incidents to occur, often times leaving areas without power, although typically not for long, extended periods, particularly in the more densely or heavily wooded areas. Severe storms and weather affect transportation and utilities.

9.2.2 Previous Occurrence

Table 9-1 summarizes severe weather events in Spokane County since 1993, as recorded by FEMA, NOAA, SHELDUS, and the Tornado History Project (2019).[20]

Table 9-1.
Severe Weather Events Impacting Planning Area Since 1993

Date	Type	Deaths or Injuries	Property Damage
7/22/2016 Not Declared.	Tornado	0	$50,000 (Crop) plus five mobile homes destroyed from fire--
Description: *A Canadian cold front moved across northeast Washington during the early afternoon hours of the 12th of August. There were a few embedded thunderstorms with the front that brought severe weather to Spokane, Whitman and Lincoln counties. In Spokane County, a severe thunderstorm dropped 3/4 inch diameter hail across eastern Spokane County. The severe thunderstorm also brought damaging winds to most of the county that same evening. There were at least 29 fires started in Spokane county. An estimated 10,000 customers were without power along with numerous accidents due to visibilities reduced to less than a quarter of a mile in blowing dust. Numerous trees fell due to the severe wind causing property damage and a few injuries. The severe wind caused a fire to start in a mobile home Park near Silver Lake destroying five homes. Property damage throughout the county was estimated to be one hundred thousand dollars. In Whitman county, the severe storm caused numerous power outages along with some property damage due to fallen trees. Crop damage was estimated to be around $50,000 due to the severe thunderstorm's wind. In Lincoln county, the severe wind caused numerous power outages and some downed trees caused property damage. The wind also caused some crop damage. The width was estimated to be approximately 50 yards wide at its widest path. No injuries or fatalities were reported.*			
8/09/2016 Not Declared.	Tornado	0	--

[20] Tornado Project. Accessed 30 July 2019. Available at: http://www.tornadohistoryproject.com/tornado/Washington/Spokane

Table 9-1.
Severe Weather Events Impacting Planning Area Since 1993

Date	Type	Deaths or Injuries	Property Damage
Description: *A tornado was reported at approximately 6:35 on the evening of August 9th. The width was estimated to be approximately 25 yards wide, at its widest path, with its length of travel approximately 0.2 tenths of a mile long. No injuries or fatalities were reported. The tornado did not have a rating on the Fujita scale.*			
11/12/15 DR 4249	Severe storms, winds, Flooding, Landslide	2 deaths (Spokane and Cheney – falling trees) / 3 later died from hypothermia due to lack of power/heat	+$33M statewide ; $5m Spokane of which $2m was for damaged utilities
Description*: This storm brought the highest wind recorded in Spokane from a large Pacific cyclone, the type of storm that customarily prevails from early autumn through early spring, reaching wind gusts of 71 mph, slightly below the hurricane speed of 75 mph. Only a gust from the thunderstorms in 2005 had a stronger gust at 77 mph. Previously, the highest non-thunderstorm wind at Spokane had been 67 mph in January 1972. What made the 2015 windstorm so damaging was the persistence of the lashing winds. The duration allowed damage to pile on top of damage. More than 250,000 customers lost electrical power from Spokane into North Idaho. Many were without power for a week or more. Avista alone reported 180,000 outages. Below the high winds, a low-pressure system developed off the British Columbia coast and tracked inland. High winds cresting over the Cascades gained momentum as they crested the eastern slopes. Mild temperatures in the Columbia Basin allowed warm air to rise from the ground, creating a vacuum to draw the already ferocious winds swooping down from aloft.*			
9/15/2013	Thunderstorm Wind	0	--
Description: *Numerous reports of trees falling onto power lines resulting in over a thousand customers losing power. Damage was reported in Cheney, to Spokane, to Mead and in Deer Park. A large tree toppled over at 21st Street and High Drive in Spokane on South Hill. Other trees reported down or snapped off resulting in damage to homes and/or vehicles. Many tents at the Spokane County Interstate Fair were damaged or flipped over due to the strong winds from the gust front.*			
8/25/2012	Thunderstorm Wind	0	$80,000
Description*: The Spokane NWS clocked a wind gust of 62 mph. Numerous trees, some large, were downed in Nine Mile Falls area, especially along West Charles Road. Some trees were uprooted and others were snapped halfway up the trunk. Trees fell on a combination of roofs, outbuildings, fences and power lines resulting in multiple power outages. A large tree was uprooted along Highway 2 in the Deep Creek community. A large tree fell on a power line in Chattaroy leading to 178 power outages.*			
12/12/2008 DR 1825	Severe Winter Storm	0	$770,000
Description: *Heavy snow and winter storm condition blanketed the Spokane area for 4 days causing damage. Known as the start of the snowiest winter on record, the four day accumulation equaled the same amount of snow that is typical for an average winter in the area. Approximately 24 inches of snow fell within a 24 hour period. Spokane Public Schools and the Spokane Transit Authority shut down operations, as did most businesses.*			
8/31/2007	Hail	0	$10,000
Description: *Data from SHELDUS, No narrative available.*			
12/15/2006	High Winds	0	$207,000
Description: *Data from SHELDUS, No narrative available.*			
8/12/2005	Thunderstorm	0	$100,000

Table 9-1.
Severe Weather Events Impacting Planning Area Since 1993

Date	Type	Deaths or Injuries	Property Damage
Description: *A Canadian cold front moved across northeast Washington during the early afternoon hours of the 12th of August. There were a few embedded thunderstorms with the front that brought severe weather to Spokane, Whitman and Lincoln counties. In Spokane County, a severe thunderstorm dropped 3/4 inch diameter hail across eastern Spokane County. The severe thunderstorm also brought damaging winds to most of the county that same evening. There were at least 29 fires started in Spokane county. An estimated 10,000 customers were without power along with numerous accidents due to visibilities reduced to less than a quarter of a mile in blowing dust. Numerous trees fell due to the severe wind causing property damage and a few injuries. The severe wind caused a fire to start in a mobile home Park near Silver Lake destroying five homes. Property damage throughout the county was estimated to be one hundred thousand dollars. In Whitman county, the severe storm caused numerous power outages along with some property damage due to fallen trees. Crop damage was estimated to be around fifty thousand dollars due to the severe thunderstorm's wind. In Lincoln county, the severe wind caused numerous power outages and some downed trees caused property damage. The wind also caused some crop damage.*			
9/16/2003	Hail	0	$50,000
Description: *During the afternoon of September 19th an isolated rain shower with small hail moved over the Spokane area. On the westbound lane of Interstate 90 drivers were blinded by the low sun shining in their eyes while small hail created slippery conditions. Over 50 cars and trucks were involved in numerous accidents and pileups along a four mile stretch of westbound I-90 in the city of Spokane.*			
7/7/2002	Lightning	0	$18,000
Description: *Lightning struck the roof of an apartment building north of the intersection of Sprague and Argonne, igniting a fire that burned a 6-by-22 foot hole in the roof of the apartment. The residents of the apartment escaped without injury.*			
4/4/2000	Thunderstorm Wind	0	$80,000
Description: *Data from SHELDUS, No narrative available.*			
2/2/1999	High Winds	0	$360,000
Description: *Data from SHELDUS, No narrative available.*			
5/31/1997	Tornado	0	$350,000
Description: *NWS survey team concluded that an F1 tornado touched down and pulled up numerous times as it traveled from Pruffer and Walbridge in SE Stevens county to near Riverside in Spokane county*			
12/26/1996	Severe Storm	Unknown	Unknown
DR 1159			
Description:*. After up to a foot of snow fell on the day after Christmas, heavy rains came a few days later that caused epic slush and flooding.*			
11/19/1996	Ice Storm	1	$1.3 million
DR 1152			
Description:*. Ranked as one of the worst storms in modern memory, a significant ice storm plummeted most of the state. The ice storm on Nov. 19, 1996 ranks as Avista Utilities' second-worst outage event with connections cut to 100,000-plus homes and businesses.*			
11/28/1993	Ice Storm	0	$500,000
Description: *Data from SHELDUS, No narrative available.*			

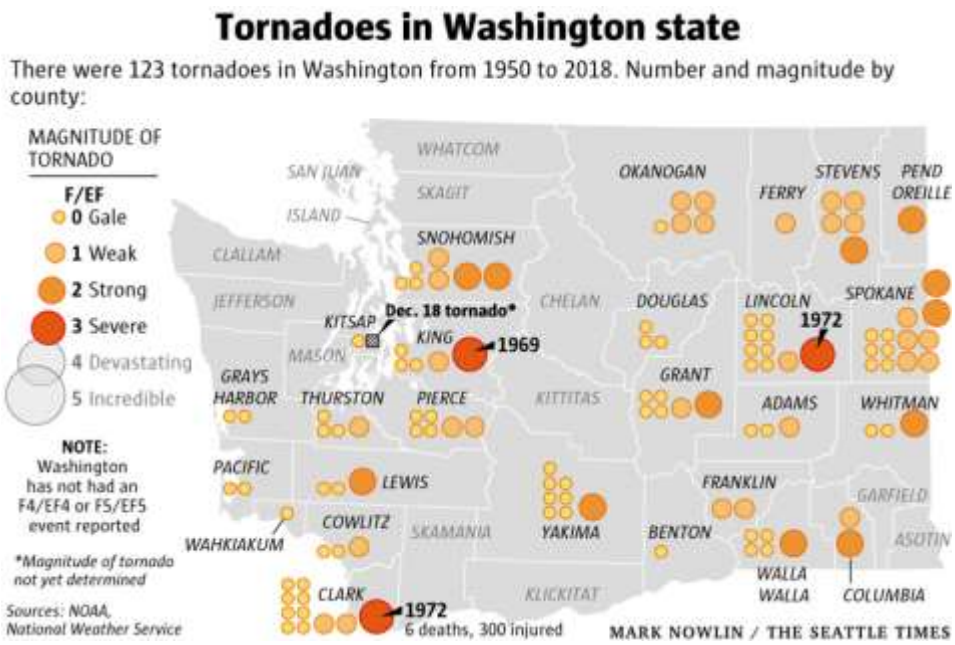


Figure 9-6. Tornado History in Washington 1950-2018

Source: NOAA National Weather Service as cited in the Seattle Times[21]

Figure 9-7. November 2015 Windstorm Damage to Spokane County Resident

Source: Spokesman-Review.[22]

[21] https://www.seattletimes.com/seattle-news/weather/tornado-touches-down-on-kitsap-peninsula-rips-roof-off-home-weather-service-says/

[22] Colin Mulvany / Spokesman-Review. Accessed July 2, 2019. Available online at: https://www.spokesman.com/stories/2016/nov/17/2015-windstorm-whipped-up-by-a-convergence-of-even/

9.2.3 Frequency

The severe weather events for Spokane County shown in Table 9-1 are often related to high winds associated with winter storms and thunderstorms. The planning area can expect to experience exposure to some type of severe weather event at least annually. According to the Washington State Enhanced Hazard Mitigation Plan (2013), Spokane County has a winter storm recurrence rate of 125 percent, which means that historically, the county experiences at least one damaging winter storm every year. The National Weather Service reports that Washington state averages 2.5 tornadoes per year, which ranks in the bottom ten states.[23] Since 1950, Spokane has experienced 13 tornadoes.

Figure 9-8. Downed Power Lines - November 2015 Windstorm

9.2.4 Severity

The most common problems associated with severe storms are immobility and loss of utilities. Fatalities are uncommon, but can and have occurred as a result of severe weather incidents. 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.[24] Lightning can cause severe damage and injury.

Windstorms can be a frequent problem in the planning area and have been known to cause damage to utilities. The predicted wind speed given in wind warnings issued by the National Weather Service is for a one-minute average; gusts may be 25 to 30 percent higher. Under most conditions the County's highest winds come from the south or southwest.

Tornadoes are potentially the most dangerous of local storms, but large events are not common in the planning area, although they have occurred. While unusual, tornadoes that occur in the winter, like the 2018 Port Orchard, Washington Tornado, tend to be more dangerous because they statistically move faster than during the traditional tornado season. The majority of tornadoes occur in May, which historically has been the most active month for tornadoes. Approximately 80 percent of tornadoes in the United States are either EF0 or EF1, with less than 1 percent reading an EF4 or stronger.[25]

If a major tornado were to strike within the populated areas of the county, damage could be widespread. Businesses could be forced to close for an extended period or permanently, fatalities could be high, many people could be homeless for an extended period, and routine services such as telephone or power could be disrupted. Buildings may be damaged or destroyed.

[23] http://mynorthwest.com/1220169/common-tornadoes-washington-state/
[24] http://mynorthwest.com/1220169/common-tornadoes-washington-state/
[25] https://www1.wsrb.com/blog/tornadoes-in-washington-how-common-are-they

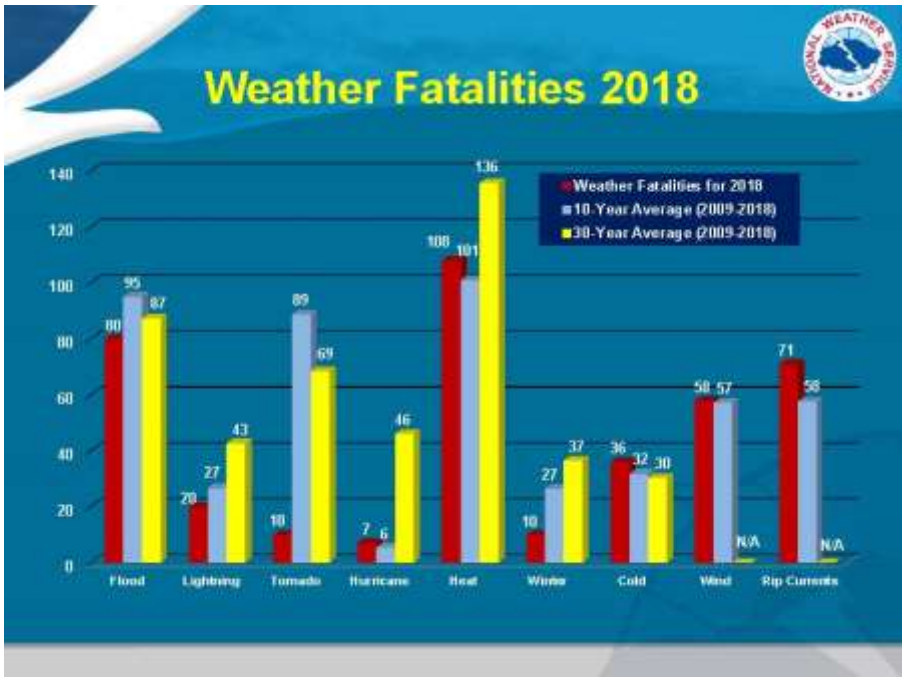


Figure 9-9. National Weather Service Weather Fatalities 2018

9.2.5 Warning Time

Meteorologists can often predict the likelihood of a severe storm. This can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity of the storm. Some storms may come on more quickly and have only a few hours of warning time. As in the case of tornadoes, there may be little warning time, and due to the rare nature in Washington, are not something which citizens would be particularly aware of until the tornado is upon them.

9.3 SECONDARY HAZARDS

The most significant secondary hazards associated with severe local storms are floods, falling and downed trees, landslides and downed power lines. Rapidly melting snow combined with heavy rain can overwhelm both natural and man-made drainage systems, causing overflow and property destruction. Landslides occur when the soil on slopes becomes oversaturated and fails.

9.4 CLIMATE CHANGE IMPACTS

Climate change presents a significant challenge for risk management associated with severe weather. The frequency of severe weather events has increased steadily over the last century. The number of weather-related disasters during the 1990s was four times that of the 1950s, and cost 14 times as much in economic losses. Historical data shows that the probability for severe weather events increases in a warmer climate (see Figure 9-10). 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.

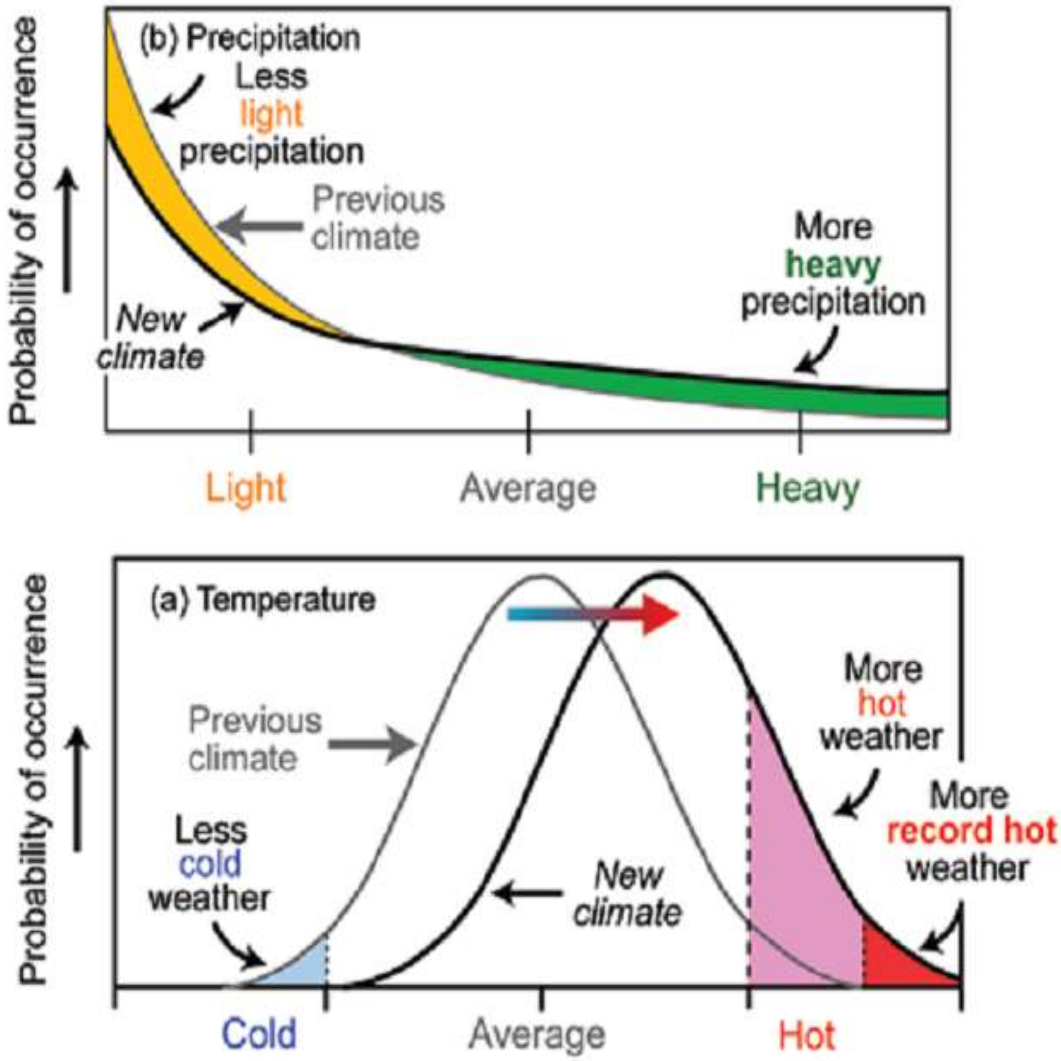


Figure 9-10. Severe Weather Probabilities in Warmer Climates

9.5 VULNERABILITY ASSESSMENT

9.5.1 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.

All critical facilities exposed to flooding are also likely exposed to severe weather. Additional facilities on higher ground may also be exposed to wind damage or damage from falling trees. The most common problems associated with severe weather are loss of utilities. Downed power lines can cause blackouts, leaving large areas isolated. Phone, water and sewer systems may not function. Roads may become impassable due to ice or snow or from secondary hazards such as landslides.

Within the planning region, power generation on the dams 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 the County. As such, wind events occurring also have the potential to impact power supplies in large metropolitan areas well outside of the 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. In addition to power generation, high winds can cause significant damage to trees, further impacting local-area 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 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.

9.5.2 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.

Accommodation and food services account for 6.90 percent of the County's economy, while arts, entertainment and recreation account for 1.82 percent of the economy; transportation and warehousing accounts for 2.53 percent; manufacturing composes 5.81 percent of the economy, with construction at 5.61; agriculture, forestry, fishing and hunting account for 1.34 percent; health care and social assistance 15.24 percent, while wholesale and retail trade accounts for 14.93 percent (OFM).[26] Combined, these occupation categories account for over almost 60 percent of the County's economy. Each of these occupation classes are highly vulnerable to impacts from severe weather events.

9.5.3 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.

[26] https://washington.reaproject.org/analysis/industry-structure/industries_by_region/employment/reports/530063/ Accessed 23 July 2019.

Table 9-2.
Loss Potential to Severe Weather Hazard

	Total Exposed Values (Structure and Content)	Estimated Loss Potential		
		10% Damage	30% Damage	50% Damage
Airway Heights	$759,713,040	$75,971,304.0	$227,913,912.0	$379,856,520.0
Cheney	$1,427,171,370	$142,717,137.0	$428,151,411.0	$713,585,685.0
Deer Park	$564,187,650	$56,418,765.0	$169,256,295.0	$282,093,825.0
Fairfield	$55,034,250	$5,503,425.0	$16,510,275.0	$27,517,125.0
Latah	$15,171,552	$1,517,155.2	$4,551,465.6	$7,585,776.0
Liberty Lake	$2,307,789,015	$230,778,901.5	$692,336,704.5	$1,153,894,507.5
Medical Lake	$538,564,950	$53,856,495.0	$161,569,485.0	$269,282,475.0
Millwood	$383,999,655	$38,399,965.5	$115,199,896.5	$191,999,827.5
Rockford	$45,632,205	$4,563,220.5	$13,689,661.5	$22,816,102.5
Spangle	$24,005,460	$2,400,546.0	$7,201,638.0	$12,002,730.0
Spokane	$30,818,695,125	$3,081,869,512.5	$9,245,608,537.5	$15,409,347,562.5
Spokane Valley	$14,006,485,725	$1,400,648,572.5	$4,201,945,717.5	$7,003,242,862.5
Waverly	$9,443,730	$944,373.0	$2,833,119.0	$4,721,865.0
Unincorporated	$25,161,471,812	$2,516,147,181.2	$7,548,441,543.5	$12,580,735,905.8
Total	**$76,117,365,539**	**$7,611,736,553.85**	**$22,835,209,661.55**	**$38,058,682,769.25**

9.6 VULNERABILITY ASSESSMENT

9.6.1 Impact on Life, Health, and Safety

A lack of data separating severe weather damage from other types of hazards damage (e.g., flooding, landslide, etc.) prevent a detailed analysis for exposure and vulnerability. However, it can be assumed that the entire planning area is exposed to severe weather events to some extent, as these events can occur sporadically. Certain areas are more exposed due to geographic location and local weather patterns. Populations living at higher elevations with large stands of trees or power lines may be more susceptible to wind damage and black out, while populations in low-lying areas are at risk for possible flooding.

Vulnerable populations include the elderly, low income or linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are not served by major roads. Power outages can be life threatening to those dependent on electricity for life support. Isolation of these populations is a significant concern. These populations face isolation and exposure during severe weather events and could suffer more secondary effects of the hazard. Demographic data does illustrate that the County has a higher-than-average population of retirees, as well as individuals with disabilities, increasing vulnerability of the population.

9.6.2 Impact on Property

According to the Spokane County assessor, there are well over 200,000 buildings of all types (including separate garage units, sheds, lean-tos, etc.) within the census tracts that define the planning area. Most of these buildings are residential, and all are considered to be exposed to the severe weather hazard. Properties in poor condition or in particularly vulnerable locations may risk the most damage. The age of the structure is also significant, with a large number of structures being built prior to more effective building codes being in place. Structures in higher elevations and on ridges may also be more prone to wind damage. Those that are located under or near overhead lines or near large trees may be vulnerable to falling ice or may be damaged in the event of a collapse.

For planning purposes, all properties and buildings within the planning area are considered to be exposed to the severe weather hazard and at risk for 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 and contents. 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 9-2 lists the loss estimates to the general building stock inclusive of all types of buildings (structure and content).

9.7 FUTURE TRENDS IN DEVELOPMENT

All future development will be affected by severe storms. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. The planning partners have adopted the International Building Code in response to Washington mandates. This code is equipped to deal with the impacts of severe weather events such as wind and snow loads. Land use policies identified in comprehensive plans within the planning area also address many of the secondary impacts (flood and landslide) of the severe weather hazard. With these tools, the planning partnership is well equipped to deal with future growth and the associated impacts of severe weather.

9.8 SCENARIO

Severe weather could occur during the winter when Chinook winds accompanied by heavy rains drop precipitation over frozen snow and cause heavy runoff and eventually flooding. This scenario could also generate freezing rain that can cause the accumulation of ice on power lines and other ice-related issues. The heavy rain may also knock down ice covered power lines. Also during the winter, Spokane County may experience a blizzard that causes white-out conditions, blocking roads and isolating scattered rural homes and communities. During the summer, an isolated thunderstorm can produce a tornado that occurs near a population center and cause significant damage to property. Lightning strikes during the dry, hot summer can cause wildfires that may spread out of control. Wind events can knock down power and phone lines, cutting off communication and electricity.

9.9 ISSUES

Severe weather cannot be prevented, but measures can be taken to mitigate the effects. Critical infrastructure and utilities can be hardened to prevent damage during an event. The secondary effect of

flooding can be addressed through decreasing runoff and water velocity. Important issues associated with a severe weather in the Spokane County planning area include the following:

- Older building stock in the planning area is built to low code standards or none at all. These structures could be highly vulnerable to severe weather events such as windstorms.
- Redundancy of power supply must be evaluated.
- The capacity for backup power generation is limited.
- The County has numerous isolated population centers.
- Public education on dealing with the impacts of severe weather needs to be provided
- Snow removal measures are required.
- Debris management (downed trees, etc.) must be addressed.

9.10 CONSEQUENCE ANALYSIS

Severe storms have the potential to impact every area of the county in various ways. In areas of steeper slopes, landslides could occur as a result of soil conditions that have been affected by severe storms, groundwater, or human development.

The worst-case scenario for the severe weather hazard in the planning area would generally correspond to a severe storm that had heavy rain, which caused flooding and landslides, followed by a strong wind event.

As landslides are most likely during late winter when the water table is high, a short intense storm could cause saturated soil to move. As rains continue, the groundwater table rises, flash flooding could occur, causing roadways to flood and potentially wash out, restricting ingress and egress to areas, including response capabilities by first responders.

Strong winds can occur any time of the year, but after heavy rains, when soils become more saturated with water and the potential for trees to still maintain a canopy, there is increased potential for risk and damage. The area has experienced tornadoes, although impact has been minimal, with no loss of life or injury reported, although property damage has occurred as a result of tornadoes.

The power distributors maintain excellent records for low incidents of long-term power outages, but the possibility does exist. While snow does occur, it customarily does not snow beyond the capacity of the County to maintain roadways, although there is the potential for increased traffic accidents and calls for service by responders. Impact from a power outage during a snow or cold weather event would exacerbate the issue, increasing potential vulnerability of citizens.

The County is equipped with both cooling and warming shelters, although temperatures customarily are not so significant or of such a long duration that the potential for death increases. The County has a robust public information network that distributes public safety broadcasts to citizens in advance of severe weather events, allowing for preparedness measures by citizens at least to some extent.

Road obstructions caused by mass movements or flooding could create isolation problems for residents and businesses in sparsely developed areas. Property owners may suffer damage to property or structures due to severe weather events impacting trees, while landslides carrying vegetation such as shrubs and trees may

cause a break in utility lines, cutting off power and communication access to residents. Severe weather events and the associated secondary hazards could also affect bridges or overpasses, knocking out rail service or other transportation routes. Commodity flow may be impacted for a short duration due to water over roadways or a landslide event, but historically, no event has ever lasted to such an extent that supplies were not available.

Severe weather events, if they stall, could affect only specific areas, but it is probable that private and public property, including infrastructure, will be affected; however, the degree to that impact is unknown. Table 9-3 identifies the Consequence Analysis for the Severe Weather hazard.

Table 9-3.
Consequence Analysis

	L	ML	M	MH	H	VH
Likelihood / Probability						X
Geographic Boundary						X
Population				X		
Vulnerable Population				X		
Built Environment			X			
Critical Infrastructure			X			
Facilities			X			
First Responders				X		
Economic Consequences					X	
Environmental Impact				X		
Government's Ability to Continue Operations						X

L=Low; ML=Medium-Low; M=Medium; MH=Medium-High; H=High; VH=Very High

9.11 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, as the area experiences some severe storm vent annually, but the impact is more limited with respect to geographic extent when removing resulting flood and landslide events from the severe weather category. 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, although historically such power outages have not been for a significant period of time. Based on the potential impact, the Planning Team determined the CPRI score to be 3.4, with overall vulnerability determined to be a high level.

CHAPTER 10.
VOLCANO

10.1 GENERAL BACKGROUND

Hazards related to volcanic eruptions are distinguished by the different ways in which volcanic materials and other debris are emitted from the volcano. The molten rock that erupts from a volcano (lava) forms a hill or mountain around the vent. The lava may flow out as a viscous liquid, or it may explode from the vent as solid or liquid particles. Ash and fragmented rock material can become airborne and travel far from the erupting volcano to affect distant areas.

Washington State has five active volcanoes: Mount Baker, Glacier Peak, Mount Rainier, Mount St. Helens, and Mount Adams. These volcanoes are all capable of generating destructive lahars, ash fall, lava, pyroclastic flows, and debris avalanches. The phenomena that pose the greatest threat are ash fall and lahars. Mount Hood in Oregon also poses a threat to communities along the Washington side of the Columbia River. All of these volcanoes pose a high to very high threat to life, property, the environment, and civil and military aviation in areas more than a few miles from the mountains' slopes.

DEFINITIONS

Lahar—A rapidly flowing mixture of water and rock debris that originates from a volcano. While lahars are most commonly associated with eruptions, heavy rains, and debris accumulation, earthquakes may also trigger them.

Lava Flow—The least hazardous threat posed by volcanoes. Cascades volcanoes are normally associated with slow moving andesite or dacite lava.

Stratovolcano—Typically steep-sided, symmetrical cones of large dimension built of alternating layers of lava flows, volcanic ash, cinders, blocks, and bombs, rising as much as 8,000 feet above their bases. The volcanoes in the Cascade Range are all stratovolcanoes.

Tephra—Ash and fragmented rock material ejected by a volcanic explosion

Volcano—A vent in the planetary crust from which magma (molten or hot rock) and gas from the earth's core erupts.

10.2 HAZARD PROFILE

10.2.1 Extent and Location

Figure 10-1 shows the location of Cascade Range volcanoes, most of which have the potential to produce a significant eruption, as well as probabilities of tephra accumulation from Cascade volcanoes in the Pacific Northwest. Spokane County is outside the area with more than a 0.01-percent annual probability of 10 centimeters or more accumulation of tephra.

10.2.2 Previous Occurrence

Figure 10-2 and Table 10-1 summarize past eruptions in the Cascades. In the 1980 Mount St. Helens eruption, 23 square miles of volcanic material buried the North Fork of the Toutle River and there were 57 human fatalities. Due to its great distance, and location across the crest of the Cascades, the lava and lahar flow from this eruption did not (and could not) affect Spokane County. The County though is almost directly downwind from the volcano, and thus saw about 3/4-inch of tephra (ash) fall. This tephra fall was more of a curiosity than a hazard. Schools and businesses were closed for day or so, but no major disruptions or harm were done to the County, especially after it was cleaned up within a few days.

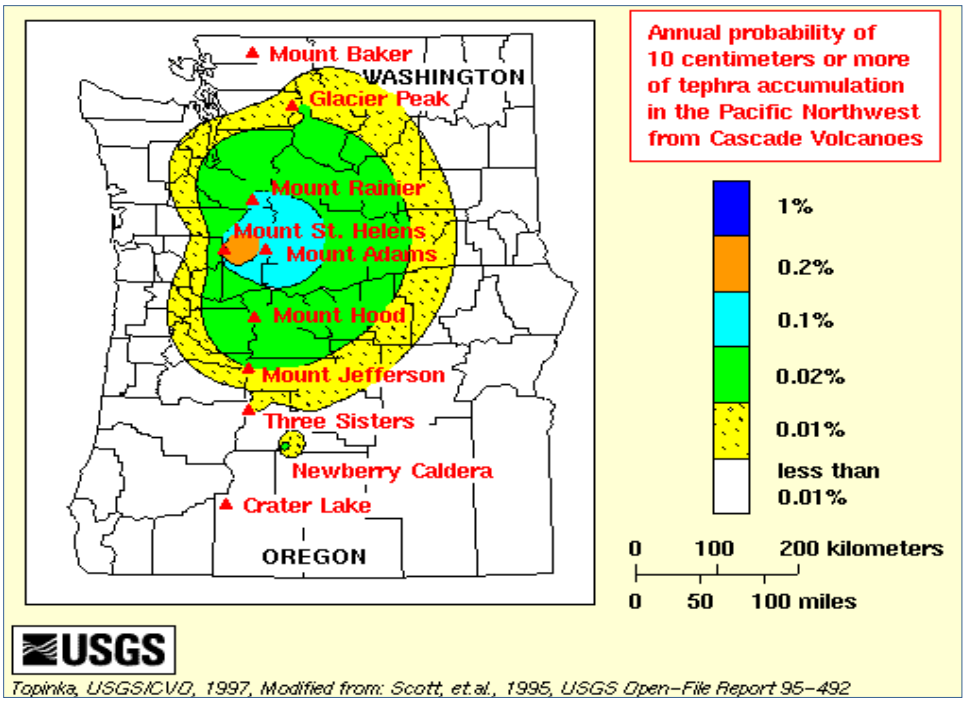


Figure 10-1. Probability of Tephra Accumulation in Pacific Northwest

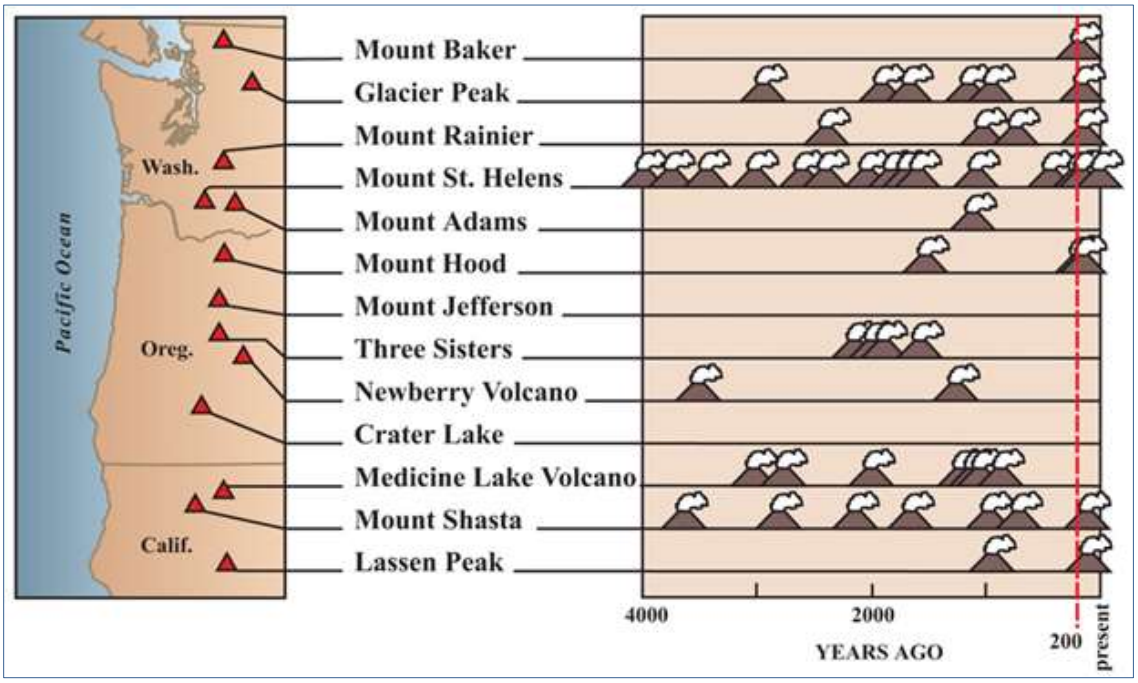


Figure 10-2. Past Eruptions in the Cascade Range

Table 10-1.
Past Eruptions in Washington

Volcano	Number of Eruptions	Type of Eruptions
Mount Adams	3 in the last 10,000 years, most recent between 1,000 and 2,000 years ago	Andesite lava
Mount Baker	5 eruptions in past 10,000 years; mudflows have been more common (8 in same time period)	Pyroclastic flows, mudflows, ash fall in 1843.
Glacier Peak	8 eruptions in last 13,000 years	Pyroclastic flows and lahars
Mount Rainier	14 eruptions in last 9000 years; also 4 large mudflows	Pyroclastic flows and lahars
Mount St Helens	19 eruptions in last 13,000 years	Pyroclastic flows, mudflows, lava, and ash fall

10.2.3 Frequency

Many Cascade volcanoes have erupted in the recent past and will be active again in the foreseeable future. Given an average rate of one or two eruptions per century during the past 12,000 years, these disasters are not part of our everyday experience; however, in the past hundred years, California's Lassen Peak and Washington's Mount St. Helens have erupted with terrifying results. The U.S. Geological Survey classifies Glacier Peak, Mt. Adams, Mt. Baker, Mt. Hood, Mt. St. Helens and Mt. Rainier as potentially active volcanoes in Washington State. Mt. St. Helens is by far the most active volcano in the Cascades, with four major explosive eruptions in the last 515 years.

10.2.4 Severity

The explosive disintegration of Mount St. Helens' north flank in 1980 vividly demonstrated the power that Cascade volcanoes can unleash. A 1-inch deep layer of ash weighs an average of 10 pounds per square foot, causing danger of structural collapse. Ash is harsh, acidic and gritty, and it has a sulfuric odor. Ash may also carry a high static charge for up to two days after being ejected from a volcano. When an ash cloud combines with rain, sulfur dioxide in the cloud combines with the rain water to form diluted sulfuric acid that may cause minor, but painful burns to the skin, eyes, nose and throat.

10.2.5 Warning Time

Constant monitoring of all active volcanoes means that there will be more than adequate time for evacuation before an event. Since 1980, Mount St. Helens has settled into a pattern of intermittent, moderate and generally non-explosive activity, and the severity of tephra, explosions, and lava flows have diminished. All episodes, except for one very small event in 1984, have been successfully predicted several days to three weeks in advance. However, scientists remain uncertain as to whether the volcano's current cycle of explosive activity ended with the 1980 explosion. The possibility of further large-scale events continues for the foreseeable future.

10.3 SECONDARY HAZARDS

Secondary hazards associated with volcanic eruptions are mud flows and landslides as well as traffic disruptions. The mudflow and landslide hazards are not typical for Spokane County, but there could be traffic disruption caused by tephra accumulation.

10.4 CLIMATE CHANGE IMPACTS

Large-scale volcanic eruptions can reduce the amount of solar radiation reaching the Earth's surface, lowering temperatures in the lower atmosphere and changing atmospheric circulation patterns. The massive outpouring of gases and ash can influence climate patterns for years. Sulfuric gases convert to sub-micron droplets containing about 75 percent sulfuric acid. These particles can linger three to four years in the stratosphere. Volcanic clouds absorb terrestrial radiation and scatter a significant amount of incoming solar radiation, an effect that can last from two to three years following a volcanic eruption.

10.5 VULNERABILITY ASSESSMENT

10.5.1 Overview

Spokane County is only moderately exposed to an eruption of a volcano. The County is generally downwind of four volcanoes, and could experience the impacts of a tephra fall from any of these. Using the latest eruption of Mount St. Helens as an indicator, a tephra fall in Spokane County would be anywhere from a half-inch to an inch. Nonetheless, some people, property and elements of the environment are vulnerable to the effects of a tephra fall, as discussed below.

Ash falls, also called "tephra," are from explosive eruptions that blast fragments of rock and ash into the air. Large fragments fall to the ground close to the volcano. Small fragments and ash can travel thousands of miles downwind and rise thousands of feet into the air. The most serious tephra hazard in the region is from Mount St. Helens, the most prolific producer of tephra in the Cascades during the past few thousand years. Figure 10-1 provides estimates of the annual probability of tephra fall of 10 centimeters (about 4 inches) or greater affecting the region from all volcanoes. Probability zones extend farther to the east of the range than to the west because prevailing winds are from the west most of the time.

10.5.2 Impact on Life, Health, and Safety

The whole population of Spokane County is exposed to the effects of a tephra fall. The populations most vulnerable to the effects of the tephra hazard are the elderly, the very young and those already experiencing ear, nose and throat problems. Homeless people, who may lack adequate shelter, are also vulnerable to the effects of a tephra fall, and would require shelter or assistance during an event.

10.5.3 Impact on Property

All of the County would be exposed to tephra accumulation in the event of a volcanic eruption. Impact would be determined by varying factors such as the level of eruption, amount of ash, wind direction, and other weather-related events. Property vulnerable to the effects of a tephra fall includes equipment and machinery left out in the open, such as combines, whose parts can be clogged by the fine dust. Since Spokane County receives snow every year, and roofs are built to withstand snow loads, most roofs are not vulnerable and would be able to withstand the potential load of ash. Infrastructure such as drainage systems is also potentially vulnerable to the effects of a tephra fall, since the fine ash can clog pipes and culverts. This may be more of a problem if an eruption occurs during winter or early spring when precipitation is highest and floods are most likely.

Loss estimations for the volcano hazard are not based on Hazus or GIS 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 and contents. 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 lists the loss estimates to the general building stock inclusive of all types of buildings (structure and content).

Table 10-2.
Estimated Loss Potential for Volcano Hazard

	Total Exposed Values (Structure and Content)	Estimated Loss Potential		
		10% Damage	30% Damage	50% Damage
Airway Heights	$759,713,040	$75,971,304.0	$227,913,912.0	$379,856,520.0
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Unincorporated	$25,161,471,812	$2,516,147,181.2	$7,548,441,543.5	$12,580,735,905.8
Total	**$76,117,365,539**	**$7,611,736,553.85**	**$22,835,209,661.55**	**$38,058,682,769.25**

10.5.4 Impact on Critical Facilities

All critical facilities would be exposed to tephra accumulation in the event of a volcanic eruption. Transportation routes in the direction of wind would be vulnerable to tephra accumulations. Water treatment plants and wastewater treatment plants are vulnerable to contamination from ash fall.

10.5.5 Impact on Economy

Impact to the economy would include agricultural losses due to crops being damaged, disruption of commodity flow through the area, decreased spending throughout the County, and the lost tax revenue from the sales of goods and services. Loss of equipment and machinery due to damage would also have the potential to impact agricultural and commercial industry in the planning area. While a doubtful occurrence given the increased snow-load capacity for structures in the County, buildings which collapse from the

weight of ash accumulations could also impact the property-tax base. Such impact would more likely than not be on older structures. Additional economic impact would include the agricultural element because of the potential acidic nature of ash. Review of Spokane County 2012 Census of Agriculture data (most recent available for 2020 update), the County ranks among the top five producers statewide in production of lentils, hay, wheat, sheep (including goats, wool mohair, and milk), horses (including ponies, mules, burros and donkeys).[27] The acidic nature of ash could potentially impact the agricultural production for several years depending on the amount of ash accrual.

10.5.6 Impact on Environment

The environment is highly exposed to the effects of a volcanic eruption. Even if the related ash fall from a volcanic eruption were to fall elsewhere, it could still be spread throughout the County by the surrounding rivers and streams. A volcanic blast would expose the local environment to many effects such as lower air quality, and many other elements that could harm local vegetation and water quality. Much of the treeless, rolling landscape of Spokane County leaves the environment, particularly animals, exposed to a tephra fall from a volcanic eruption. Spokane County, however, does not serve as a major habitat for any protected species, so it is unlikely for any animal populations to be adversely affected. Tephra runoff can also potentially damage stream habitats, although this was not observed in Spokane County after the Mount St. Helens eruption in 1980. The sulfuric acid contained in volcanic ash could be very damaging to area vegetation, waters, wildlife and air quality. Ash could also be distributed by wind. Clean-up of the ash could cause high water usage, which would be problematic during summer months when water tables are low.

10.6 FUTURE TRENDS IN DEVELOPMENT

All future development within the planning area will be susceptible to the potential impacts from volcanic eruptions within the region. While this potential impact on the built environment is not considered to be significant, the economic impact on industries that rely on machinery and equipment such as agriculture or civil engineering projects could be significant. Since the extent and location of this hazard is difficult to gauge because it is dependent upon many variables, the ability to institute land use recommendations based on potential impacts of this hazard is limited. While the impacts of volcanic hazards are sufficient to warrant risk assessment for emergency management purposes, the impacts are not considered to be sufficient to dictate land use decisions.

10.7 ISSUES

Presently, volcanic eruptions are not a major hazard issue in Spokane County. There are proper warning time and awareness mechanisms in place. The major issues that would come about, as with other disaster events, are clean-up costs.

Since volcanic episodes have been fairly predictable in the recent past, there is not much concern about loss of life, but there is concern about loss of property and infrastructure and severe environmental impacts.

10.8 CONSEQUENCE ANALYSIS

Any eruption of Washington's five Cascade Range volcanoes would likely produce significant amounts of ash fall that could impact the planning area. This impact is dependent upon the prevailing wind direction

[27] https://www.nass.usda.gov/Publications/AgCensus/2012/Online_Resources/County_Profiles/Washington/cp53063.pdf Accessed 8 July 2019.

during and after the event. No one in the planning area would likely be injured or killed from these events, but businesses and non-essential government would be closed until the cloud passes. People and animals without shelter would be affected. Structures would most likely be safe due to the existing load capacities in place for both wind and snow, which would be similar in nature to that needed for ash accumulation, but public and private property left out in the open, such as equipment, vehicles, HAVC systems, etc., might be damaged by the fine ash dust. Clean-up from such an event could be costly, depending upon the magnitude of the event. Depending on the density of the ash, vehicle travel may be limited, including for first responders. Table 5-1 identifies the Consequence Analysis for the Volcano hazard.

Table 10-3.
Consequence Analysis

	L	ML	M	MH	H	VH
Likelihood / Probability	X					
Geographic Boundary					X	
Population	X					
Vulnerable Population				X		
Built Environment	X					
Critical Infrastructure		X				
Facilities	X					
First Responders			X			
Economic Consequences				X		
Environmental Impact						X
Government's Ability to Continue Operations						X

L=Low; ML=Medium-Low; M=Medium; MH=Medium-High; H=High; VH=Very High

10.9 RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from a volcanic eruption throughout the area is low based on historic events. The impact is also limited in nature, but is dependent on prevailing winds and the magnitude of the eruption. Based on the potential impact, the Planning Team determined the CPRI score to be 1.75, with overall vulnerability determined to be a low level.

CHAPTER 11.
WILDFIRE

11.1 GENERAL BACKGROUND

A wildfire is any uncontrolled fire on undeveloped land that requires fire suppression. Wildfires can be ignited by lightning or by human activity such as smoking, campfires, equipment use and arson. Wildfires occur when all of the necessary elements of a fire come together in a wooded or grassy area: an ignition source is brought into contact with a combustible material such as vegetation that is subjected to sufficient heat and has an adequate supply of oxygen from the ambient air.

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

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

DEFINITIONS

Brush fire—A fast-moving fire that ignites grass, shrubs, bushes, scrub oak, chaparral, marsh grass (cattails), and grain fields. This is the type of wildfire most likely to affect Whitman County.

Conflagration—A fire that grows beyond its original source area to engulf adjoining regions. Wind, extremely dry or hazardous weather conditions, excessive fuel buildup and explosions are usually the elements behind a wildfire conflagration.

Firestorm—A fire that expands to cover a large area, often more than a square mile, when many individual fires grow together. Temperatures may exceed 1000°C. Superheated air and hot gases of combustion rise over the fire zone, drawing surface winds in from all sides, often at velocities approaching 50 miles per hour. Although firestorms seldom spread because of the inward direction of the winds, once started there is no known way of stopping them. Lethal concentrations of carbon monoxide, combined with the intense heat, poses a serious life threat to responding fire forces. In very large events, the rising column of heated air carries enough particulate matter into the upper atmosphere to cause cloud nucleation, creating a thunderstorm and the hazard of lightning strikes.

Interface Area—An area where vegetation susceptible to wildfires and urban or suburban development occur together.

Wildfire—Fires that result in uncontrolled destruction of forests, brush, field crops, grasslands, and real and personal property in non-urban areas. Because of their distance from firefighting resources, they can be difficult to contain and can cause a great deal of destruction.

11.1.1 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. Spokane County does have identified 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 several communities within Spokane County at high-risk within the vicinity of Federal lands.[28]

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, Spokane County has some areas considered to be at high risk as identified in Figure 11-1.

[28] 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

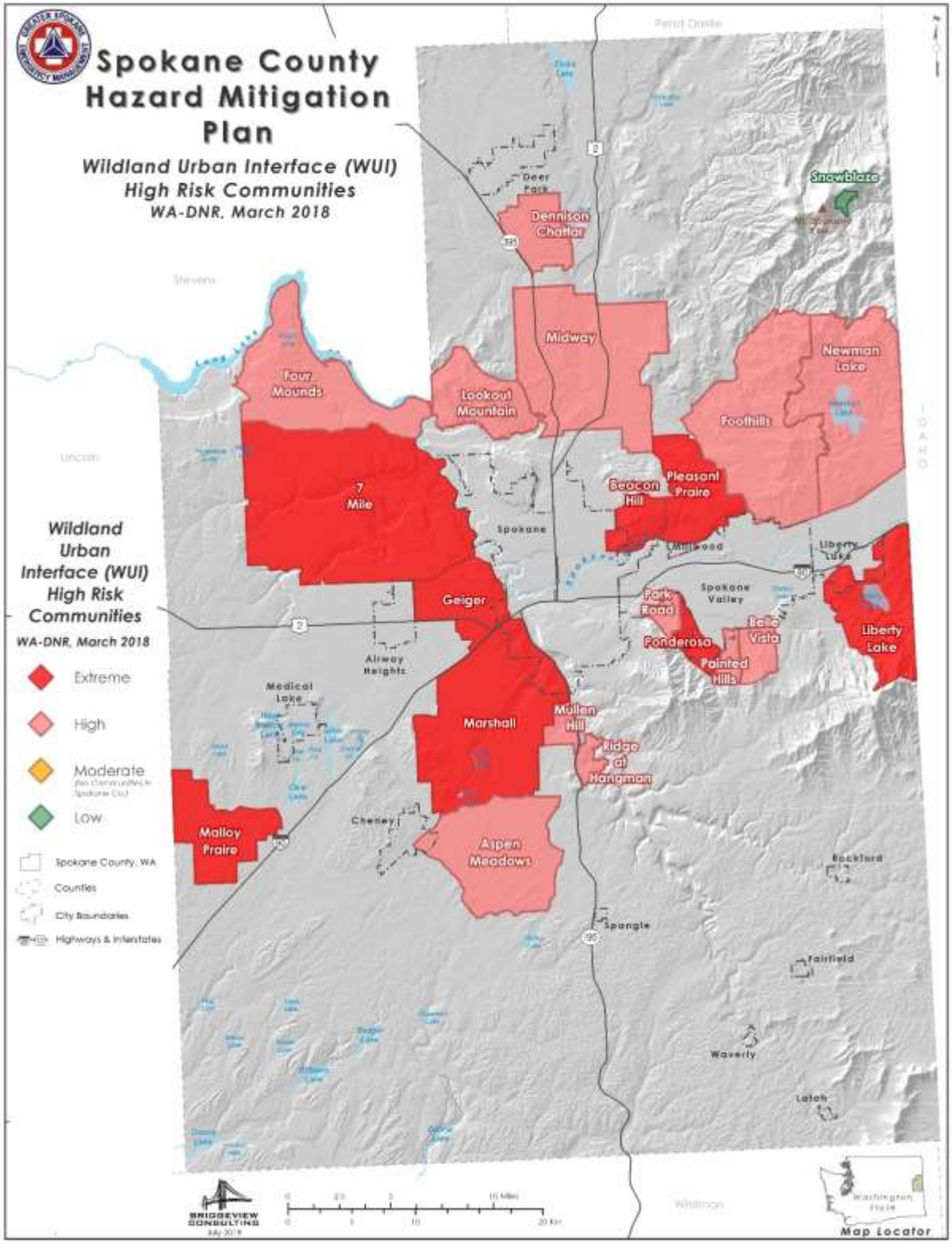


Figure 11-1. Wildland Urban Interface and Level of Risk (DNR, 2018)

11.1.2 Wildfire Types

Wildfires generally can be characterized by their fuels as follows:

- **Ground fires** are fed by subterranean roots, duff and other buried organic matter. This fuel type is especially susceptible to ignition due to spotting. Ground fires typically burn by smoldering, and can burn slowly for days to months.

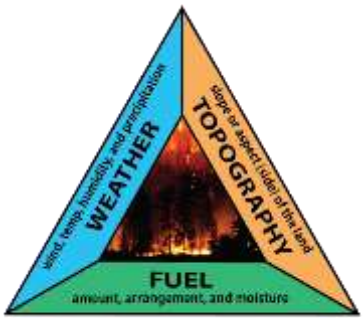
- **Crawling** or **surface fires** are fueled by low-lying vegetation such as leaf and timber litter, debris, grass, and low-lying shrubbery.

- **Ladder** fires consume material between low-level vegetation and tree canopies, such as small trees, downed logs and vines. Invasive plants that scale trees may encourage ladder fires.

- **Crown, canopy** or **aerial fires** burn suspended material at the canopy level, such as tall trees, vines and mosses. The ignition of a crown fire, termed *crowning*, is dependent on the density of the suspended material, canopy height, canopy continuity, and sufficient surface and ladder fires to reach the tree crowns.

11.1.3 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 are most useful in assessing risk in the area:



Fire Behavior Triangle

Topography

Topography can have a powerful influence on wildfire behavior. The movement of air over the terrain tends to direct a fire's course. Gulches and canyons can funnel air and act as a chimney, intensifying fire behavior and inducing faster rates of spread. Saddles on ridge tops offer lower resistance to the passage of air and will draw fires. Solar heating of drier, south-facing slopes produces upslope thermal winds that can complicate behavior.

Slope is an important factor. If the percentage of uphill slope doubles, the rate of spread of wildfire will likely double. On steep slopes, fuels on the uphill side of the fire are closer physically to the source of heat. Radiation preheats and dries the fuel, thus intensifying fire behavior. Fire travels downslope much more slowly than it does upslope, and ridge tops often mark the end of wildfire's rapid spread.

Fuels

Fuels are classified by weight or volume (fuel loading) and by type. Fuel loading, often expressed in tons per acre, can be used to describe the amount of vegetative material available. If fuel loading doubles, the energy released also can be expected to double. Each fuel type is given a burn index, which is an estimate of the amount of potential energy that may be released, the effort required to contain a fire in a given fuel, and the expected flame length. Different fuels have different burn qualities. Some fuels burn more easily or release more energy than others. Grass, for instance, releases relatively little energy, but can sustain very high rates of spread.

Continuity of fuels is expressed in terms of horizontal and vertical dimensions. Horizontal continuity is what can be seen from an aerial photograph and represents the distribution of fuels over the landscape. Vertical continuity links fuels at the ground surface with tree crowns via ladder fuels.

Another essential factor is fuel moisture. Fuel moisture is expressed as a percentage of total saturation and varies with antecedent weather. Low fuel moistures indicate the probability of severe fires. Given the same weather conditions, moisture in fuels of different diameters changes at different rates. A 1,000-hour fuel, which has a 3- to 8-inch diameter, changes more slowly than a 1- or 10-hour fuel.

Weather

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

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

11.1.4 Historical Fire Regime and Current Condition Classification

Land managers need to understand historical fire regimes (that is, fire frequency and fire severity prior to significant human settlement) to be able to define ecologically appropriate goals and objectives for an area. This understanding must include knowledge of how historical fire regimes vary across the landscape. Five historical fire regimes are classified based on average number of years between fires (fire frequency) and the severity of the fire (amount of replacement) on the dominant overstory vegetation:

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

Understanding ecosystem departures (how ecosystems have changed over time) provides a context for managing sustainable ecosystems. Broad-scale alterations of historical fire regimes and vegetation conditions have occurred in many landscapes in the U.S. through the combined influence of land management practices, fire prevention, livestock grazing, insect and disease outbreaks, climate change, and invasion of non-native plant species. These departures result in changes to one or more of the following ecological components:

- Vegetation characteristics (species composition, structural stages, stand age, canopy closure and mosaic pattern)
- Fuel composition
- Fire frequency, severity, and pattern
- Associated disturbances (e.g. insect and disease mortality, grazing, and drought).

Characteristic vegetation and fuel conditions are those that occurred within the historical fire regime. *Uncharacteristic* conditions are those that did not occur within the historical fire regime, such as invasive species (e.g. weeds, insects, and diseases), "high graded" forest composition and structure (e.g. large trees removed in a frequent surface fire regime), or repeated annual grazing that reduces grassy fuels across relatively large areas to levels that will not carry a surface fire.

The fire regime condition class (FRCC) is a classification of a given area's amount of departure from the historical fire regime. The classifications categorize wildland vegetation and fuel conditions into one of the three condition classes, based on the degree of departure. The three classes indicate low (FRCC 1), moderate (FRCC 2) and high (FRCC 3) departure from the historical fire regime. Low departure is considered to be within the historical range of variability, while moderate and high departures are outside. Determination of the amount of departure is based on comparison of a composite measure of fire regime attributes to the central tendency of the historical fire regime. The amount of departure is then classified to determine the fire regime condition class. Table 11-1 presents a simplified description of the fire regime condition classes and associated potential risks.

Table 11-1.
Fire Regime Condition Class Definitions

Description	Potential Risks
Fire Regime Condition Class 1	
Within the historical range of variability.	• Fire behavior, effects and other associated disturbances are similar to those that occurred prior to fire exclusion (suppression) and other types of management that do not mimic the natural fire regime and associated vegetation and fuel characteristics. • Composition and structure of vegetation and fuels are similar to the natural (historical) regime. • Risk of loss of key ecosystem components (e.g. native species, large trees and soil) is low.
Fire Regime Condition Class 2	
Moderate departure from the historical regime of variability.	• Fire behavior, effects, and other associated disturbances are moderately departed (more or less severe). • Composition and structure of vegetation and fuel are moderately altered. • Uncharacteristic conditions range from low to moderate. • Risk of loss of key ecosystem components is moderate.
Fire Regime Condition Class 3	
High departure from the historical regime of variability.	• Fire behavior, effects, and other associated disturbances are highly departed (more or less severe). • Composition and structure of vegetation and fuel are highly altered. • Uncharacteristic conditions range from moderate to high. • Risk of loss of key ecosystem components is high.

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. The following list identifies the Firewise Communities throughout Spokane County. This list is continually updated, and readers should review the cite referenced for updated information.[29]

- Bridlewood HOA, Spokane
- Flowery Trail, Spokane
- Four Mound Community, Spokane
- Glenrose, Spokane
- Latah Bluff Natural Area, Spokane
- Little Spokane River Estates, Colbert
- Manito Place, Spokane
- Mullen Hill Terrace Mobile Home Park, Spokane
- Pine Bluff, Nine Mile Falls, Spokane County
- Ridge at Hangman HOA, Spokane
- Ridge Park Estates, Cheney
- River Bluff Ranch, Spokane
- Wilderness Lake HOA, Spokane

11.2 HAZARD PROFILE

Spokane County's fire history is a mixture of events of varying size, severity and frequency. In the dry ponderosa pine forests dominant in the lower elevations, on south aspect slopes, and along the Spokane River, fire regimes have changed from frequent, low-severity fires to less frequent, high severity or stand replacing fires. In the more mixed conifer forests (Douglas fir, grand fir, ponderosa and lodgepole pine, larch, cedar, hemlock) typical of the higher elevations, on north slopes, and dominating much of the northeastern portion of Spokane County, fires were historically less frequent, but much larger. Fire severity in these landscapes was varied with infrequent stand replacing fires.

Population growth rates have been steadily increasing throughout the County and the region. The growing appreciation for seclusion has led to significant development in the most accessible forestland areas, particularly along the river and around several of the lakes. Frequently, this development is in the dry ponderosa/Douglas-fir forest types where grass, needle and brush surface litter create forest fuel conditions that are at a high propensity for fire occurrence. Human use is strongly correlated with fire frequency, with increasing numbers of fires as use increases. Discarded cigarettes, tire fires and hot catalytic converters increase the potential for fire starts along roadways. Careless and unsupervised use of fireworks also contributes to unwanted and unexpected wildland fires. Further contributing to ignition sources are the debris burners (burn barrels) and "sport burners" who use fire to rid ditches of weeds and other burnable materials. Farming and logging equipment have also been a source of accidental ignitions. The increased

[29] NFPA State Listing of Participants. Accessed 4 July 2019. Available online at: http://www.firewise.org/usa-recognition-program/state-listing-of-partcipants.aspx

potential for fire starts and the fire- prone landscapes in which homes have been constructed greatly increases the potential for fires in interface areas.

11.2.1 Extent and Location

Three types of mapping to identify the location of the wildfire hazard are produced by the U.S. Forest Service and LANDFIRE (a shared program between the wildland fire management programs of the U.S. Forest Service and the U.S. Department of the Interior, under the direction of the Wildland Fire Leadership Council): fire regime mapping, burn probability mapping and vegetation/flame length mapping.

Fire Behavior Fuel Model Classifications

Thirteen standard fire behavior fuel models (FBFM), referred to as Anderson 13, serve as input to a mathematical model of surface fire behavior and spread. The fire behavior fuel model layer (FBFM13) represents the distribution of fuel loading among live and dead surface fuel components, size classes, and fuel types. The fuel models are described by the most common fire-carrying fuel type (grass, brush, timber litter, or slash), loading and surface area-to-volume ratio by size class and component, fuel bed depth, and moisture of extinction. The FBFM13 layer was produced by fire and fuels specialists based on vegetation type, cover and height. The 13 classes, shown on Figure 11-2, are defined as follows:

- FBFM 1—Surface fires that burn fine herbaceous fuels, cured and curing fuels, little shrub or timber present, primarily grasslands and savanna.
- FBFM 2—Burns fine, herbaceous fuels, stand is curing or dead, may produce fire brands on oak or pine stands.
- FBFM 3—Most intense fire of grass group, spreads quickly with wind, one third of stand dead or cured, stands average 3 feet tall.
- FBFM 4—Fast spreading fire, continuous overstory, flammable foliage and dead woody material, deep litter layer can inhibit suppression.
- FBFM 5—Low intensity fires, young, green shrubs with little dead material, fuels consist of litter from understory.
- FBFM 6—Broad range of shrubs, fire requires moderate winds to maintain flame at shrub height, or will drop to the ground with low winds.
- FBFM 7—Foliage highly flammable, allowing fire to reach shrub strata levels, shrubs generally 2 to 6 feet high.
- FBFM 8—Slow, ground burning fires, closed canopy stands with short needle conifers or hardwoods, litter consisting mainly of needles and leaves, with little undergrowth, occasional flares with concentrated fuels.
- FBFM 9—Longer flames, quicker surface fires, closed canopy stands of long-needles or hardwoods, rolling leaves in fall can cause spotting, dead-down material can cause occasional crowning.
- FBFM 10—Surface and ground fire more intense, dead-down fuels more abundant, frequent crowning and spotting causing fire control to be more difficult.

- FBFM 11—Fairly active fire, fuels consist of slash and herbaceous materials, slash originates from light partial cuts or thinning projects, fire is limited by spacing of fuel load and shade from overstory.

- FBFM 12—Rapid spreading and high intensity fires, dominated by slash resulting from heavy thinning projects and clear-cuts, slash is mostly 3 inches or less.

- FBFM 13—Fire spreads quickly through smaller material and intensity builds slowly as large material ignites, continuous layer of slash larger than 3 inches in diameter predominates, resulting from clear-cuts and heavy partial cuts, active flames sustained for long periods of time, fire is susceptible to spotting and weather conditions.

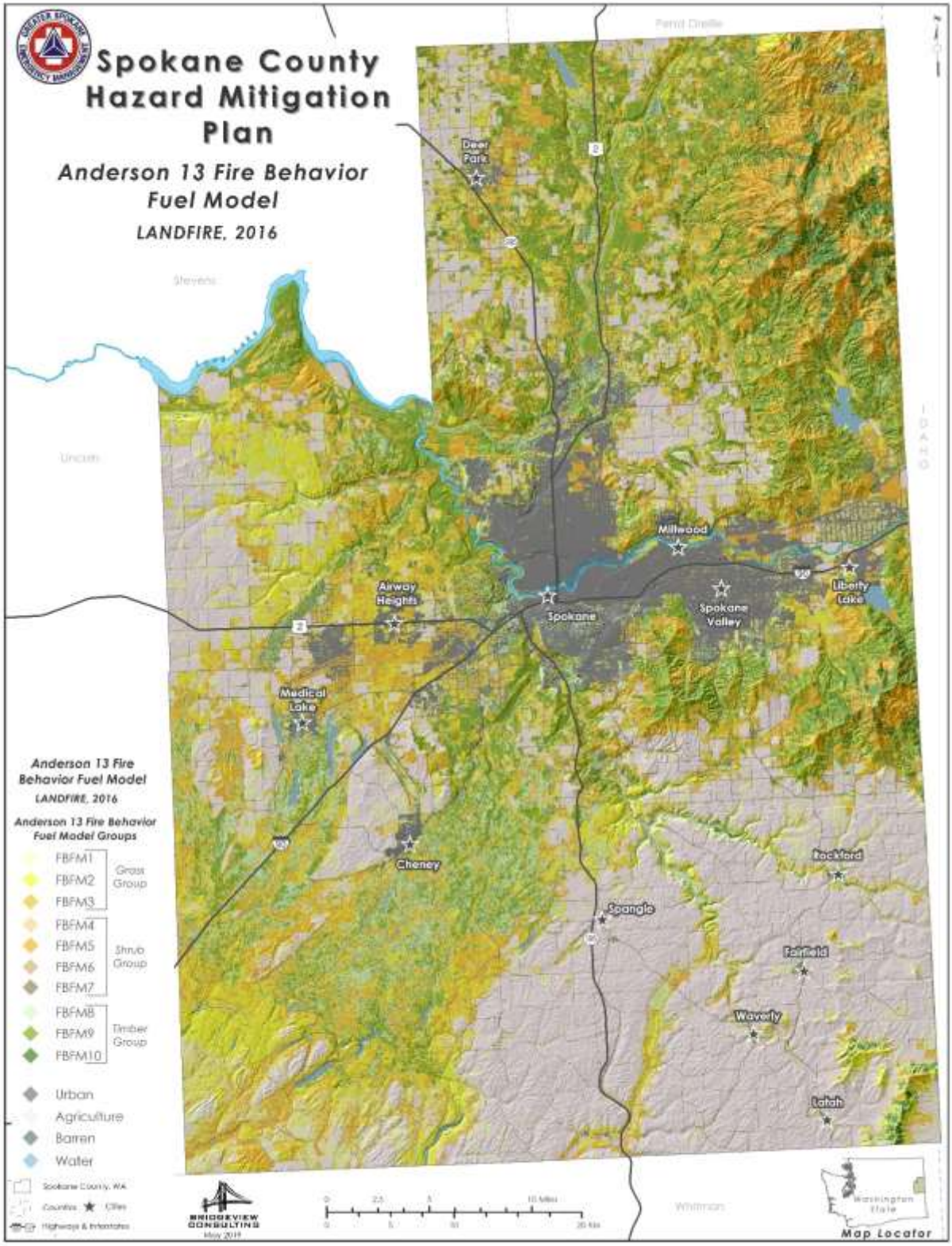


Figure 11-2. LANDFIRE Fire Behavior Fuel Model - Anderson 13 Fuel Classes

11.2.2 Previous Occurrence

The Washington Department of Natural Resources (DNR) database used in this analysis includes ignition and extent data from 2008 through June 2019 for wildfires occurring on DNR-protected lands. An analysis of the DNR-reported wildfire ignitions in Spokane County reveals that during this period approximately 36,256.49 acres burned as a result of 1,685 wildfire ignitions. The Miscellaneous ignition source category resulted in the highest number of ignitions, but the Recreation category resulted in the most acres burned for the period analyzed. Comparatively, the Children and Lightning categories contributed to a significant number of ignitions, but account for a fairly low percentage of the total acres burned. An average of 153 fires per year was recorded during this period. Fire statistics for the period from 2008 to (June) 2019 are shown in Table 11-2 as provided by the Washington State DNR database. Location of previous wildfires and landownership are identified in Figure 11-3.

Table 11-2.
Summary of Ignitions in Spokane County 2008-2019

Cause	Acres Burned	Percent	Number of Ignitions	Percent
Arson	235.70	0.7	95	5.64%
Children	92.86	0.26	133	7.89%
Debris Burning	306.45	0.85	232	13.77%
Lightning	293.06	0.81	192	11.39%
Logging	0.63	0.00	5	0.30%
Miscellaneous	33,316.59	91.89	578	34.30%
Railroad	32.50	0.09	17	1.01%
Recreation	1141.44	3.15	198	11.75%
Smoking	43.52	0.12	41	2.43%
Under Investigation	181.29	0.50	39	2.31%
Undetermined	612.45	1.69	155	9.20%
Total	36,256.49	100.00	1,685	100.00%

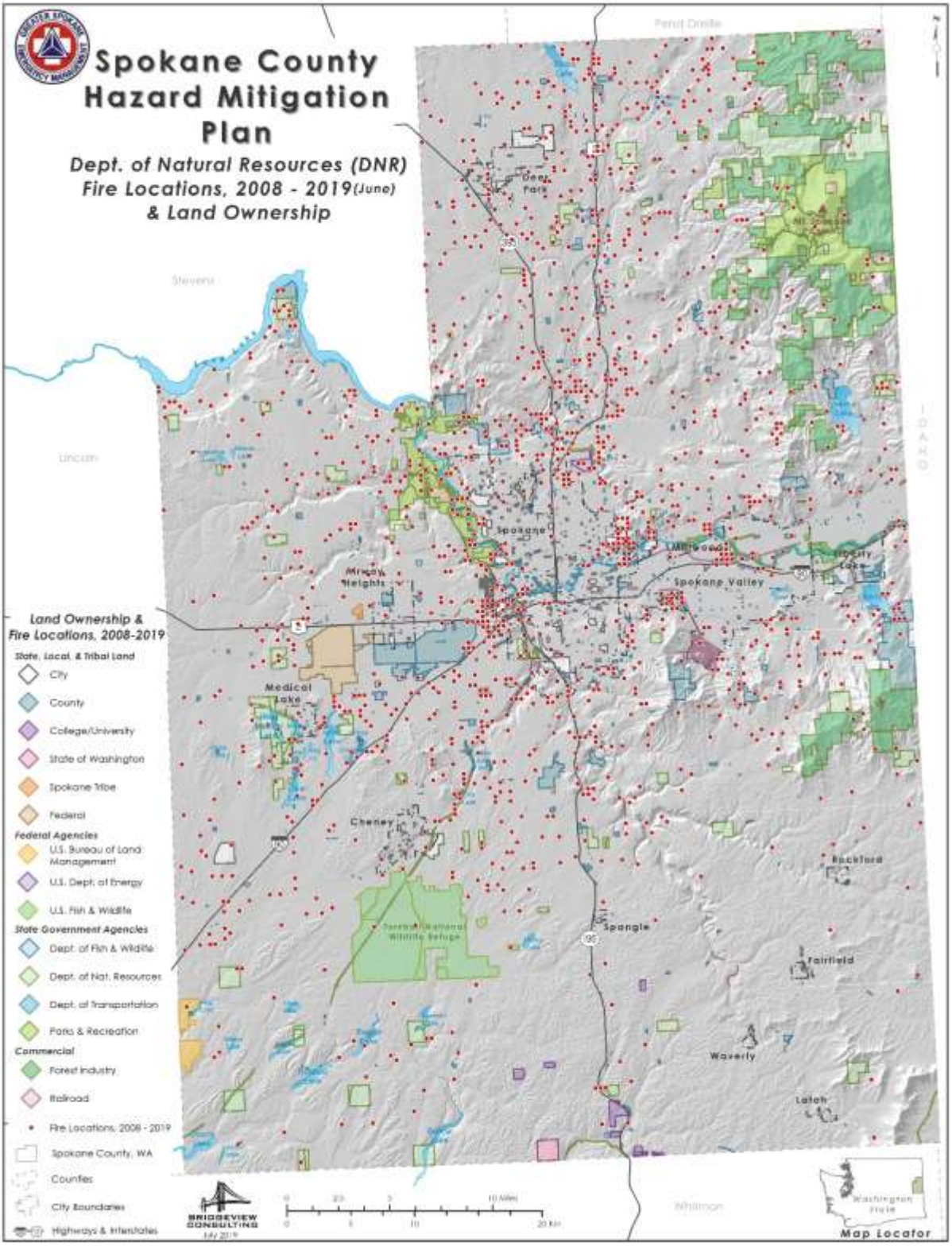


Figure 11-3. Historic Wildland Fires 2008-2019 and Land Ownership

11.2.3 Frequency

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

Natural fire rotation is defined as the number of years necessary for fires to burn over an area equal to that of the study area. Natural fire rotation is calculated from the historical record of fires by dividing the length of the record period in years by the percentage of total area burned during that period. It represents the average period between fires under a presumed historical fire regime.

Figure 11-4 shows the Fire Regimes for the planning area. Since 2008, Spokane County has seen an average of 153 wildfires per year, totaling 36,256 acres burned.

Figure 11-5 identifies the Vegetation Condition Class (VCC). VCC represents a simple categorization of the associated Vegetation Departure 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 through type of fuel, and the frequency at which such vegetation burns.

Vegetative Associations

Vegetative structure and composition in Spokane County are closely related to elevation, aspect, and precipitation. Relatively mild and dry environments characterize the undulating topography of the region which transitions from the forestland in the northern region to agricultural in the middle and eastern regions to scablands left over from the Missoula floods in the southwestern region. The higher elevation forest ecosystems in the north and northeast regions typically contain higher fuel accumulations that have the potential to burn at moderate to high intensities. The highly variable topography coupled with limited access is likely to make suppression difficult. The patchy forests occurring along the Spokane River and many of its tributaries as well as in the scabland areas are very different. These forests are much less productive due to the lack of soil. Scattered, lower density stands of primarily ponderosa pine and a minor component of Douglas fir are found in many of the sheltered drainages or where there are accumulations of loess due to

topographic features. Under natural conditions, this type of forestland would burn at frequent intervals keeping brush and other ladder fuels to a minimum.

At higher elevation mountainous regions (Mt. Spokane being the highest point in the area at just over 5,000 feet), moisture becomes less limiting due to a combination of higher precipitation and reduced solar radiation. Therefore, vegetative patterns shift based on the elevation of the area and creates specific conditions which impact fuels and fire speed. In some instances, forested conditions possess a greater quantity of both dead and down fuels as well as live fuels. Rates of fire spread tend to be lower than those in the grasslands; however, intensities can escalate dramatically, especially under the effect of slope and wind. These conditions can lead to control problems and potentially threaten lives, structures and other valued resources.

As elevation and aspect increase available moisture, forest composition transitions to moister habitat types. Increases in moisture keep forest fuels unavailable to burn for longer periods during the summer. This increases the time between fire events, resulting in varying degrees of fuel accumulation. When these fuels do become available to burn, they typically burn in a mosaic pattern at mid elevations, where accumulations of forest fuels result in either single or group tree torching, and in some instances, short crown fire runs. At the highest elevations, fire events are typically stand replacing as years of accumulation fuel large, intense wildfires.

Insects and disease can cause widespread mortality of forest stands in a very short amount of time. Pine bark beetle populations have continued to increase at epidemic levels throughout Eastern Washington State; however, mortality increases are most pronounced in eastern Washington. Ponderosa pine and lodgepole pine seem to be the most affected species at all elevations in Spokane County. In general bark beetle are not causing widespread mortality of forest stands, but are generally causing pockets of mortality. The pine bark beetle is currently at an endemic level in Spokane county. The occurrence of *Ips Pini* , western pine beetle, Douglas-fir beetle, Douglas-fir tussock moth, and root disease have also been recorded in eastern Washington (Washington Department of Natural Resources 2006). All of these disease and insects are currently in Spokane County. Insects and disease often focus and cause the most mortality in forest stands that are overcrowded or otherwise stressed by drought, recent fires, or other factors. Large areas of dead trees are a significant fire hazard. Often, dry, dead needles hang on the killed trees for several years making them prime for a potential ignition and subsequent crown fire. Thinning overcrowded stands can help reduce stress on individual trees allowing them to better withstand insect attacks. Planting of appropriate species for the site and continual management can also help ward off future outbreaks.

Many lower elevation forested areas throughout Spokane County are highly valued for their scenic qualities as well as for their proximity to travel corridors and city services. These attributes have led to increased recreational home development and residential home construction in and around forest fuel complexes. The combination of highly flammable forest types and rapid home development will continue to challenge the ability to manage wildland fires in the wildland-urban interface.

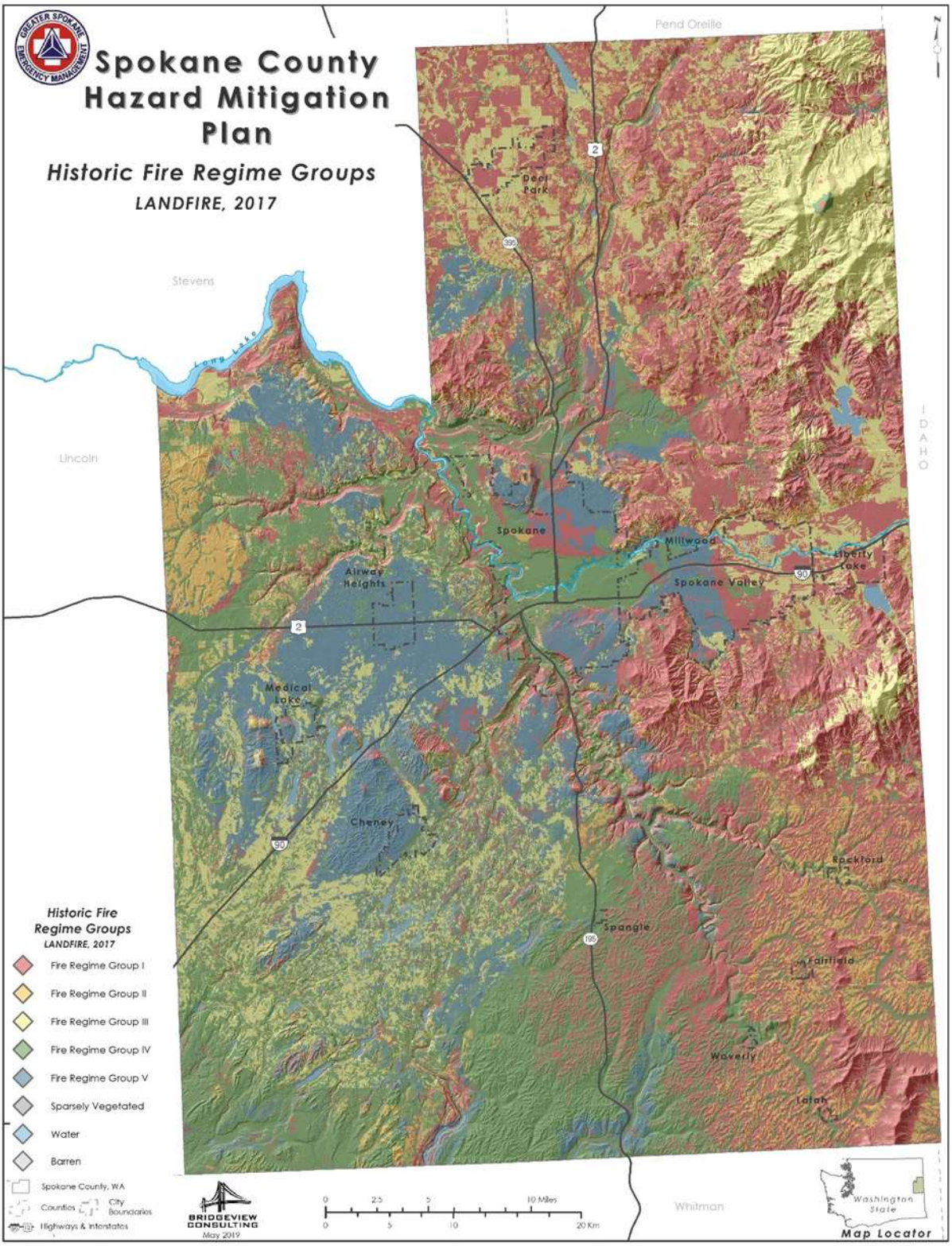


Figure 11-4. LandFire Fire Regime Groups (2017)

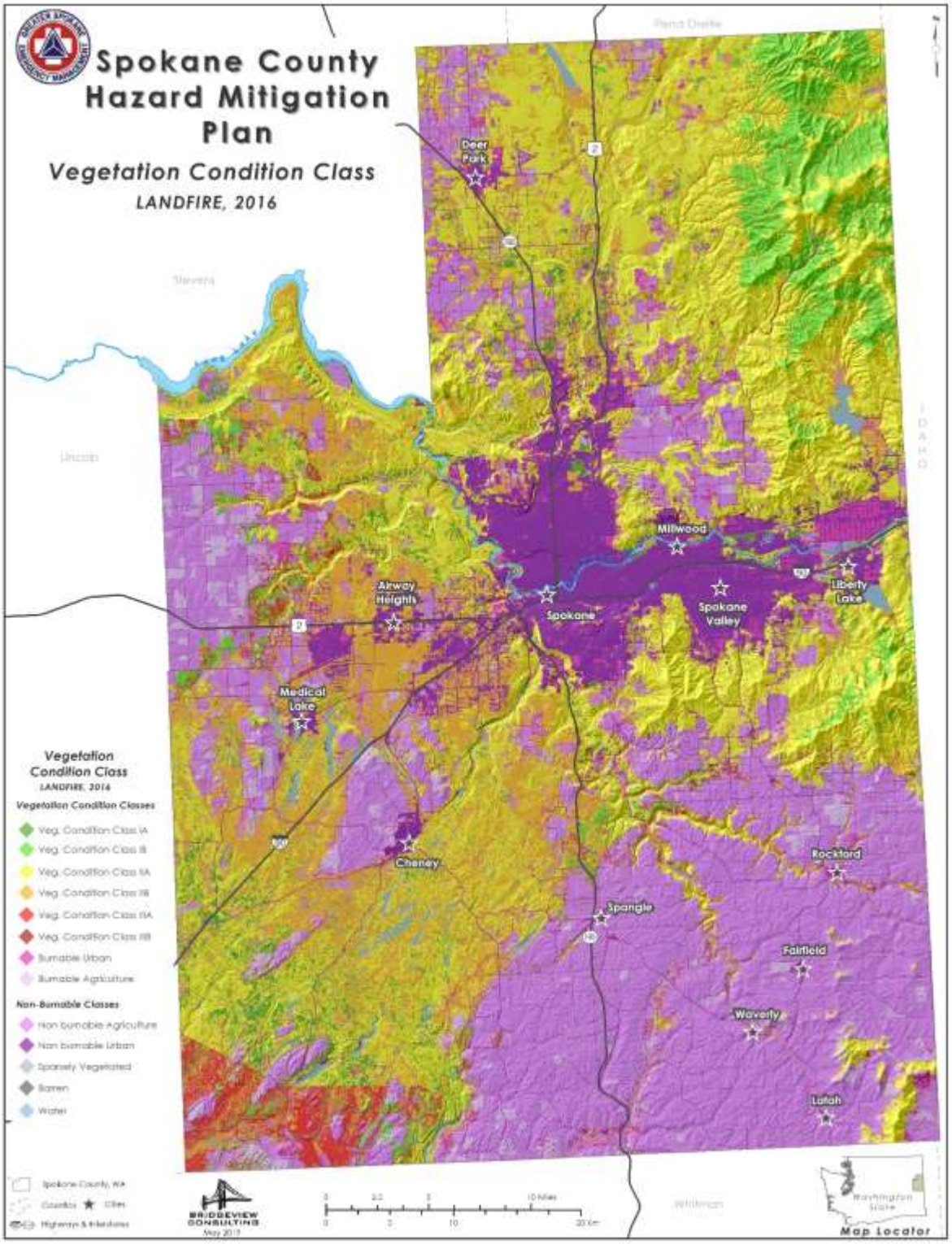


Figure 11-5 Vegetation Class

11.2.4 Severity

The severity of a fire season can usually be determined in the spring by how much precipitation is received, which in turn, determines how much fine fuel growth there is and how long it takes this growth to cure out. These factors, combined with annual wind events in late summer, drastically increase the chance a fire start will grow and resist suppression activities. Furthermore, harvest is also occurring at this time. Occasionally, harvesting equipment causes an ignition that can spread into populated areas and timberlands.

Wildfires in Spokane County tend to be small and usually confined to remote areas. There is no record of property or infrastructure being damaged by wildfires in the County. More than 99 percent of the fires recorded during a 10-year period covered 1 acre or less.

Given the fast response times to fires, the likelihood of injuries and casualties is minimal. Smoke and air pollution from wildfires can be a health hazard, especially for sensitive populations including children, the elderly and those with respiratory and cardiovascular diseases. Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke. In addition, wildfire can lead to ancillary impacts such as landslides in steep ravine areas and flooding due to the impacts of silt in local watersheds.

11.2.5 Warning Time

Wildfires are often caused by humans, intentionally or accidentally. There is no way to predict when one might break out. Since fireworks often cause brush fires, extra diligence is warranted around the Fourth of July when the use of fireworks is highest. Dry seasons and droughts are factors that greatly increase fire likelihood. Dry lightning may trigger wildfires. Severe weather can be predicted, so special attention can be paid during weather events that may include lightning. Reliable National Weather Service lightning warnings are available on average 24 to 48 hours prior to a significant electrical storm. If a fire does break out and spread rapidly, residents may need to evacuate within days or hours. Once a fire has started, fire alerting is reasonably rapid in most cases. The spread of cellular and two-way radio communications has contributed to a significant improvement in warning time.

11.3 SECONDARY HAZARDS

Wildfires can generate a range of secondary effects, which in some cases may cause more widespread and prolonged damage than the fire itself. Fires can cause direct economic losses in the reduction of harvestable timber and indirect economic losses in reduced tourism. Wildfires cause the contamination of reservoirs, destroy transmission lines and contribute to flooding. They strip slopes of vegetation, exposing them to greater amounts of runoff. This in turn can weaken soils and cause failures on slopes. Major landslides can occur several years after a wildfire. Most wildfires burn hot and for long durations that can bake soils, especially those high in clay content, thus increasing the imperviousness of the ground. This increases the runoff generated by storm events, thus increasing the chance of flooding.

11.4 CLIMATE CHANGE IMPACTS

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

Historically, drought patterns in the West are related to large-scale climate patterns in the Pacific and Atlantic oceans. The El Niño–Southern Oscillation in the Pacific varies on a 5- to 7-year cycle, the Pacific Decadal Oscillation varies on a 20- to 30-year cycle, and the Atlantic Multidecadal Oscillation varies on a 65- to 80-year cycle. As these large-scale ocean climate patterns vary in relation to each other, drought conditions in the U.S. shift from region to region. El Niño years bring drier conditions to the Pacific Northwest and more fires.

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

11.5 VULNERABILITY ASSESSMENT

11.5.1 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 2.43 persons per household for Spokane County.

11.5.2 Impact on Life, Health, and Safety

Smoke and air pollution from wildfires can be a severe health hazard, especially for sensitive populations, including children, the elderly and those with respiratory and cardiovascular diseases. Smoke generated by wildfire consists of visible and invisible emissions that contain particulate matter (soot, tar, water vapor, and minerals), gases (carbon monoxide, carbon dioxide, nitrogen oxides), and toxics (formaldehyde, benzene). Emissions from wildfires depend on the type of fuel, the moisture content of the fuel, the efficiency (or temperature) of combustion, and the weather. Public health impacts associated with wildfire include difficulty in breathing, odor, and reduction in visibility.

Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke.

Population impact could not be examined directly by wildfire regime zones because census blocks do not coincide with the zones. However, population was estimated using the residential building count in each of the Fire Regimes applying the 2017 census value of 2.43 persons per household for Spokane County. The results are shown in Table 11-3.

Table 11-3.
Population Estimates Within Fire Regimes

	Fire Regime I		Fire Regime II		Fire Regime III		Fire Regime IV		Fire Regime V	
Jurisdiction	Residential Buildings	Population	Residential Buildings	Population	Residential Buildings	Population	Residential Buildings	Population	Residential Buildings	Population
Airway Heights	0	0	0	0	2	5	94	243	1,106	3,273
Cheney	9	22	0	0	93	377	191	1,351	1,736	6,233
Deer Park	1,051	4,892	13	126	518	4,206	1	2	0	0
Fairfield	91	323	65	165	0	0	46	119	0	0
Latah	27	66	33	80	0	0	23	56	0	0
Liberty Lake	2,461	6,444	127	391	493	1,358	12	29	0	0
Medical Lake	8	18	0	0	428	1,373	353	940	626	1,801
Millwood	11	27	0	0	0	0	511	1,392	161	420
Rockford	9	22	123	316	0	0	53	129	0	0
Spangle	14	34	6	15	0	0	92	238	0	0
Spokane	15,486	43,572	719	1,798	782	2,700	28,729	93,042	21,388	58,624
Spokane Valley	10,335	30,598	84	204	4,626	13,528	3,673	11,300	8,683	27,112
Waverly	2	5	2	5	0	0	49	119	0	0
Unincorporated	16,270	41,932	2,804	6,978	7,158	19,265	10,783	30,295	9,742	27,199
Total	**45,774**	**127,955**	**3,976**	**10,078**	**14,100**	**42,812**	**44,610**	**139,256**	**43,442**	**124,661**

** Single family residences at 2.43 persons per house; 2-4 plexes were 9.72 (2.43 * 4) persons per 2-4 plex, 5+ units were 12.15 (5*2.43) persons per 5+ unit and condominiums were 24.3 (10*2.43) persons per condominium unit*

11.5.3 Impact on Property

Loss estimations for the wildfire hazard are not based on damage functions, because no such damage functions have been generated. Property damage from wildfires can be severe and can significantly alter entire communities. The number and value of homes exposed in the various Fire Regimes within the planning area are summarized in Table 11-3 (above). Density and the age of building stock in Spokane 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.

Cultural Resources

Mitigation activities in and around cultural sites has the potential to affect historic places. In all cases, the mitigation work will be intended to reduce the potential of damaging the site. Areas where ground disturbance will occur will need to be inventoried depending on the location. Ground-disturbing actions may include, but are not limited to, constructed fire lines (hand line, mechanical line, etc.), new roads to creeks to fill water tankers, mechanical treatments, etc. Traditional Cultural Properties (TCPs) will also need to be identified. Potential impact to TCPs will depend on what values make the property important and will be assessed on an individual basis.

National Register of Historic Places

The National Park Service maintains the National Register of Historical Places as a repository of information on significant cultural locale. These may be buildings, roads or trails, places where historical events took place, or other noteworthy sites. As of 2019, there are 149 properties and districts listed

throughout the planning region. A total of 126 of those properties are located within the City of Spokane, while the remaining 23 properties and districts are located elsewhere in the County. In addition, there are also other cultural resources in Spokane County that are not currently listed on the National Register of Historic Places, such as the Spokane House Interpretive Center and the Indian Painted Rocks, both in the Nine Mile area.[30]

Table 11-4.
Planning Area Structures Exposed-FIRE REGIME 1

Jurisdiction	Buildings Exposed	Assessed Value			% of AV
		Structure	Contents	**Total**	
Airway Heights	0	$0	$0	$0	0.00%
Cheney	11	$3,627,350	$1,813,675	$5,441,025	0.03%
Deer Park	1,209	$235,987,300	$117,993,650	$353,980,950	1.64%
Fairfield	139	$16,792,590	$8,396,295	$25,188,885	0.12%
Latah	51	$3,976,640	$1,988,320	$5,964,960	0.03%
Liberty Lake	2,582	$1,118,117,670	$559,058,835	$1,677,176,505	7.75%
Medical Lake	11	$11,842,170	$5,921,085	$17,763,255	0.08%
Millwood	12	$3,526,020	$1,763,010	$5,289,030	0.02%
Rockford	14	$1,870,430	$935,215	$2,805,645	0.01%
Spangle	20	$2,000,040	$1,000,020	$3,000,060	0.01%
Spokane	16,310	$3,736,907,620	$1,868,453,810	$5,605,361,430	25.90%
Spokane Valley	11,115	$3,490,971,010	$1,745,485,505	$5,236,456,515	24.19%
Waverly	6	$237,590	$118,795	$356,385	0.00%
Unincorporated	20,595	$5,804,939,461	$2,902,469,731	$8,707,409,192	40.23%
Total	**52,075**	**$14,430,795,891**	**$7,215,397,946**	**$21,646,193,837**	**100%**

Table 11-5.
Planning Area Structures Exposed-FIRE REGIME 2

Jurisdiction	Buildings Exposed	Assessed Value			% of AV
		Structure	Contents	**Total**	
Airway Heights	0	$0	$0	$0	0.00%
Cheney	0	$0	$0	$0	0.00%
Deer Park	13	$1,385,260	$692,630	$2,077,890	0.15%
Fairfield	65	$9,810,600	$4,905,300	$14,715,900	1.10%
Latah	33	$2,973,876	$1,486,938	$4,460,814	0.33%
Liberty Lake	127	$33,226,750	$16,613,375	$49,840,125	3.72%
Medical Lake	0	$0	$0	$0	0.00%

[30] "National Register of Historic Places: Weekly List Actions". National Park Service, United States Department of the Interior. Retrieved on July 8, 2019.

Table 11-5.
Planning Area Structures Exposed-FIRE REGIME 2

Jurisdiction	Buildings Exposed	Assessed Value			% of AV
		Structure	Contents	**Total**	
Millwood	0	$0	$0	$0	0.00%
Rockford	23	$13,789,200	$6,894,600	$20,683,800	1.54%
Spangle	6	$691,930	$345,965	$1,037,895	0.08%
Spokane	719	$126,236,251	$63,118,126	$189,354,377	14.12%
Spokane Valley	84	$15,170,600	$7,585,300	$22,755,900	1.70%
Waverly	2	$77,600	$38,800	$116,400	0.01%
Unincorporated	2,804	$690,625,687	$345,312,844	$1,035,938,531	77.25%
Total	**3,876**	**$893,987,754**	**$446,993,877**	**$1,340,981,631**	**100%**

Table 11-6.
Planning Area Structures Exposed-FIRE REGIME 3

Jurisdiction	Buildings Exposed	Assessed Value			% of AV
		Structure	Contents	**Total**	
Airway Heights	2	$166,600	$83,300	$249,900	0.01%
Cheney	93	$39,196,540	$19,598,270	$58,794,810	1.34%
Deer Park	518	$65,109,748	$32,554,874	$97,664,622	2.23%
Fairfield	0	$0	$0	$0	0.00%
Latah	0	$0	$0	$0	0.00%
Liberty Lake	493	$186,879,360	$93,439,680	$280,319,040	6.41%
Medical Lake	428	$62,867,874	$31,433,937	$94,301,811	2.15%
Millwood	0	$0	$0	$0	0.00%
Rockford	0	$0	$0	$0	0.00%
Spangle	0	$0	$0	$0	0.00%
Spokane	782	$185,669,434	$92,834,717	$278,504,151	6.36%
Spokane Valley	4,626	$858,414,411	$429,207,206	$1,287,621,617	29.42%
Waverly	0	$0	$0	$0	0.00%
Unincorporated	7,158	$1,519,123,756	$759,561,878	$2,278,685,634	52.07%
Total	**14,100**	**$2,917,427,723**	**$1,458,713,862**	**$4,376,141,585**	**100%**

Table 11-7.
Planning Area Structures Exposed-FIRE REGIME 4

Jurisdiction	Buildings Exposed	Assessed Value			% of AV
		Structure	Contents	**Total**	
Airway Heights	94	$16,577,300	$8,288,650	$24,865,950	0.21%
Cheney	191	$37,030,660	$18,515,330	$55,545,990	0.47%
Deer Park	1	$37,220	$18,610	$55,830	0.00%
Fairfield	46	$5,115,300	$2,557,650	$7,672,950	0.06%
Latah	23	$1,606,180	$803,090	$2,409,270	0.02%
Liberty Lake	12	$4,324,600	$2,162,300	$6,486,900	0.05%
Medical Lake	353	$55,614,315	$27,807,158	$83,421,473	0.71%
Millwood	511	$73,031,162	$36,515,581	$109,546,743	0.93%
Rockford	53	$5,763,310	$2,881,655	$8,644,965	0.07%
Spangle	92	$7,085,637	$3,542,819	$10,628,456	0.09%
Spokane	28,729	$4,638,465,037	$2,319,232,519	$6,957,697,556	58.83%
Spokane Valley	3,673	$561,516,405	$280,758,203	$842,274,608	7.12%
Waverly	49	$4,469,750	$2,234,875	$6,704,625	0.06%
Unincorporated	10,783	$2,474,386,519	$1,237,193,260	$3,711,579,779	31.38%
Total	**44,610**	**$7,885,023,395**	**$3,942,511,698**	**$11,827,535,093**	**100%**

Table 11-8.
Planning Area Structures Exposed-FIRE REGIME 5

Jurisdiction	Buildings Exposed	Assessed Value			% of AV
		Structure	Contents	**Total**	
Airway Heights	1,106	$158,835,395	$79,417,698	$238,253,093	2.05%
Cheney	1,736	$365,567,372	$182,783,686	$548,351,058	4.71%
Deer Park	0	$0	$0	$0	0.00%
Fairfield	0	$0	$0	$0	0.00%
Latah	0	$0	$0	$0	0.00%
Liberty Lake	0	$0	$0	$0	0.00%
Medical Lake	626	$94,810,194	$47,405,097	$142,215,291	1.22%
Millwood	161	$20,245,419	$10,122,710	$30,368,129	0.26%
Rockford	0	$0	$0	$0	0.00%
Spangle	0	$0	$0	$0	0.00%
Spokane	21,388	$3,848,395,604	$1,924,197,802	$5,772,593,406	49.61%
Spokane Valley	8,683	$1,314,810,658	$657,405,329	$1,972,215,987	16.95%
Waverly	0	$0	$0	$0	0.00%
Unincorporated	9,742	$1,954,457,618	$977,228,809	$2,931,686,427	25.20%

Table 11-8.
Planning Area Structures Exposed-FIRE REGIME 5

Jurisdiction	Buildings Exposed	Assessed Value			% of AV
		Structure	Contents	**Total**	
Total	**43,442**	**$7,757,122,260**	**$3,878,561,130**	**$11,635,683,390**	**100%**

11.5.4 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. Power lines are the most at risk from wildfire because most poles are made of wood and susceptible to burning. Fires can create conditions that block or prevent access and can isolate residents and emergency service providers. Wildfire typically does not have a major direct impact on bridges, but it can create conditions in which bridges are obstructed. Many bridges in areas of high to moderate fire risk are important because they provide the only ingress and egress to large areas and in some cases to isolated neighborhoods.

Table 11-9 identifies critical facilities exposed to the wildfire hazard in the county. During a wildfire event, these materials could rupture due to excessive heat and act as fuel for the fire, causing rapid spreading and escalating the fire to unmanageable levels. In the event of wildfire, there would likely be little damage to the majority of infrastructure. Most road and railroads would be without damage except in the worst scenarios. Power lines are the most at risk to wildfire because most are made of wood and susceptible to burning. In the event of a wildfire, pipelines could provide a source of fuel and lead to a catastrophic explosion. Combined, there are approximately 900 critical facilities exposed to the wildfire hazard.

Table 11-9.
Critical Facilities Exposed to Wildfire Regimes

	Regime 1	Regime 2	Regime 3	Regime 4	Regime 5	Barren	Water*
Medical and Health Services	1	0	0	6	2	0	0
Government Function	0	0	0	1	1	0	0
Schools	50	5	13	64	62	1	0
Protective Function	23	6	16	38	33	0	0
Hazmat	67	5	22	126	77	0	0
Potable Water	1	0	0	0	0	0	0
Wastewater	1	3	1	1	1	0	0
Power	1	0	0	2	1	0	0
Communications	11	4	15	4	3	0	0
Transportation**	87	15	42	228	31	0	4
Other***	8	1	5	16	2	0	9
Total	**250**	**39**	**114**	**486**	**213**	**1**	**13**

Table 11-9.
Critical Facilities Exposed to Wildfire Regimes

	Regime 1	Regime 2	Regime 3	Regime 4	Regime 5	Barren	Water*

**Facilities and Infrastructure located over water such as a structure or pier (i.e. ports or marinas)*
*** Includes bridges*
****Other Critical Facility types include Dams and Natural Gas Facilities*

Transportation & Infrastructure

The transportation system within the County is comprised of a significant number of roads, several airports, a rail line and an extensive trail system. Access is an important component in hazard mitigation planning.

Interstate 90 runs through the heart of Spokane County traveling through the major population and economic hubs of Spokane and Spokane Valley. Additionally, U.S. Highways 2, 195, and 395 and State Highways 27, 278, 290, 291, 902, and 904 provide paved linkages to many of the more rural communities throughout the County. There are also numerous county and city maintained routes accessing much of the unincorporated areas of the County. These routes are generally paved as well.

Primary and secondary access routes were identified by committee members and amended by the public during meetings. These routes identify the primary access routes into and out of the county that are relied on during emergencies. As such, they often receive prioritized treatment when allocating resources for hazard abatement. There are approximately 123 miles of interstate highway and 239 miles of state highways in Spokane County.

The Spokane International Airport is located between Highway 2 and I-90 just west of the City of Spokane. The Spokane Airport supports 10 passenger carrier airlines as well as four air cargo carriers. There are also numerous municipal airports serving many of the smaller communities in rural Spokane County.

Burlington Northern Santa Fe and Union Pacific maintain several active railroad lines in Spokane County. These lines form a hub in Spokane with tracks running north along Highway 395, east towards Coeur d'Alene, Idaho, south along Highway 27, and southwest paralleling Highway 395. AmTrack also offers passenger services on their Chicago, St. Paul, Portland/Seattle route.

Communication Sites

A list of names and locations of communication sites throughout Spokane and neighboring counties is available in the Spokane County Field Operations Guide.

Hazardous Materials Sites

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.

11.5.5 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.

11.5.6 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.

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

11.6 FUTURE TRENDS IN DEVELOPMENT

The highly urbanized portions of the planning area have little or no wildfire risk exposure. Urbanization tends to alter the natural fire regime, and can create the potential for the expansion of urbanized areas into wildland areas. The expansion of the wildland urban interface can be managed with strong land use and building codes. The planning area is well equipped with these tools, and this planning process has asked each planning partner to assess its capabilities with regards to the tools. The update of the Spokane County Community Wildfire Protection Plan has significantly enhanced the capability of the planning area to deal with future development as it interfaces with wildfire risk areas.

11.7 ISSUES

The major issues for wildfire are the following:

- There is a need for better hazard mapping within the planning area. Mapping assessments such as the National Fire Protection Administration 299 risk assessment program would be a significant enhancement to the wildfire risk assessment for the County.

- Public education and outreach to people living in or near fire hazard zones should include information about and assistance with mitigation activities such as defensible space and advance identification of evacuation routes and safe zones.
- Wildfires could cause landslides as a secondary natural hazard.
- Climate change could affect the wildfire hazard.
- Future growth into interface areas should continue to be managed.
- Area fire districts need to continue to train on wildland-urban interface events.
- Vegetation management activities should include enhancement through expansion of the target areas as well as additional resources.
- Regionally consistent higher building code standards are needed, such as residential sprinkler requirements and prohibitive combustible roof standards.
- Fire department water supply must be maintained in high-risk wildfire areas.
- Certifications and qualifications for fire department personnel should be expanded. All firefighters should be trained in basic wildfire behavior and basic fire weather, and all company officers and chief level officers should be trained to the wildland command and strike team leader level.

11.8 CONSEQUENCE ANALYSIS

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

A wildfire in Spokane County can occur at any time, but would most likely occur during the spring/summer months, when it is hot and dry, perhaps during a period of prolonged drought. There could be numerous causes: people playing with fireworks, sparks from machinery, such as farm equipment or automobiles, or a lightning strike during a summer thunderstorm. Whatever the cause, a small local brush fire, fanned by heavy winds, could disperse embers, triggering more fires that could eventually merge into one or many large fires that don’t burn out on their own. These brush fires could eventually reach scattered homes and farms, or even spread to some of the small communities in the area, such as Latah or Rockford. These fires could overwhelm emergency responders and resources and could lead to the evacuation of towns and possibly to some structures being destroyed.

To further complicate the problem, heavy rains could follow, causing flooding and landslides and releasing tons of sediment into rivers, permanently changing floodplains and damaging sensitive habitat and riparian areas. Such a fire followed by rain could release millions of cubic yards of sediment into streams for years, creating new floodplains and changing existing ones. With the forests removed from the watershed, stream flows could easily double. Floods that could be expected every 50 years may occur every couple of years. With the streambeds unable to carry the increased discharge because of increased sediment, the floodplains and floodplain elevations would increase.

Table 11-10 identifies the Consequence Analysis for the Wildfire hazard.

Table 11-10. Consequence Analysis						
	L	ML	M	MH	H	VH
Likelihood / Probability						X
Geographic Boundary					X	
Population					X	
Vulnerable Population				X		
Built Environment				X		
Critical Infrastructure			X			
Facilities			X			
First Responders						X
Economic Consequences				`	X	
Environmental Impact					X	
Government's Ability to Continue Operations						X
L=Low; ML=Medium-Low; M=Medium; MH=Medium-High; H=High; VH=Very High						

11.9 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 highly likely. The area experiences a significant number of wildfires annually. While for the most part the acreage burned has, thankfully, been more limited in nature due in large part to response activities, wildfires can spread quickly. With the increased number of fires throughout not only the planning area, but the state as a whole, resources may become more limited in nature if an active wild season were to again occur, such as those within the last few years. That, when coupled with the existing drought situations occurring statewide, and the continued impact from climate change, it is anticipated that the wildfire risk will only continue to increase with time.

Over the life cycle of this plan, there are two new housing areas which have been identified within the unincorporated areas of the County below the City of Cheney for potential development. While currently not identified as a WUI area by State DNR, once those developments occur, they will undoubtedly be identified as such when the County updates its existing CWPP. While the full aspect of the land use development is still being determined and under review, one area of concern with respect to emergency management is the potential impact to citizens with respect to first responders being able to gain access to those areas.

Major rail lines travel through the area, delivering and picking up grain on a daily basis. The trains pull a significant number of cars. As the trains travel along the tracks, they regularly stop traffic along the major arterials, sometimes for extended periods of time. Should a wildfire occur within the intended areas of development, the potential exists for ingress and egress to be limited while rail cars pass. Likewise, the grain elevators or train cars themselves, which carry fertilizers and oil, are also of concern for combustion, and potential toxic smoke plumes.

Limitations along the roadways could not only restrict first responders from gaining access to those areas, but also impact evacuation of the area by the citizens. While the County is currently attempting to work with developers to identify potential solutions to this issue, for risk planning purposes, this has caused the Planning Team to elevate wildfire rank to #1 (along with Severe Weather). Based on the potential impact, the Planning Team determined the CPRI score to be 3.30, with overall vulnerability determined to be a high level.

CHAPTER 12.
HAZARD RANKING

12.1 CALCULATED PRIORITY RISK INDEX

In ranking the hazards, the Planning Team utilized the Calculated Priority Risk Index (CPRI) to complete the Risk Ranking Workbook for each hazard identified, enabling the scoring of the hazards based on impact criteria (see Chapter 4, Figures 4-1 and 4-2 for samples).

The CPRI examines five criteria for each hazard as discussed in detail in Chapter 4 (probability, magnitude/severity, extent/location, warning time, and duration), defines a risk value for each according to four levels (e.g., 1-4), and then applies a weighting factor based on the significance of the criteria. The result is a score that has been used to rank the hazards equitably countywide.

In order to complete this process, the Planning Team is provided the hazard profiles, a loss matrix for the various hazards which identify impact to people, property, economy and environment at the local level, and the critical facilities list which was developed by the Planning Partners, and which identifies impact to each facility for each hazard of concern.

All planning partners 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 impacting Spokane County. Table 12-2 is a summary of the hazard ranking results for the planning partners. Each jurisdictional annex contains the individual scores established.

Table 12-1.
County Calculated Priority Risk Index Ranking Scores

Hazard	Probability	Magnitude and/or Severity	Extent and Location	Warning Time	Duration	Calculated Priority Risk Index Score
Drought	4	2	2	1	4	2.75
Earthquake	3	3	2	4	1	2.85
Flood	4	2	3	2	2	3.0
Landslide	4	2	2	4	2	3.1
Severe Weather	4	3	4	2	2	3.4
Volcano	1	2	3	1	4	1.75
Wildfire	4	3	2	4	2	3.30

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.
Countywide Combined Calculated Priority Risk Index Score

Entity	Drought	Earthquake	Flood/ Dam	Landslide	Severe Weather	Volcano	Wildfire
County	2.75	2.85	3.0	3.1	3.4	1.75	3.3
Airway Heights	2.4	2.25	0	0	2.55	2.20	2.3
Cheney	2.75	2.85	2.45	1.45	3.6	1.75	3.55
Deer Park	1.95	2.45	2.7	1.05	3.25	1.15	2.95
Fairfield	2.35	2.6	2.45	1.85	3.45	2	2.3
Liberty Lake	1.95	2.85	1.2	2.7	3.4	1.55	2.3
Medical Lake	2.75	2.65	3.2	2.10	3.4	1.55	3.55
Spokane Valley	2.8	2.7	3.2	2.7	3.4	1.6	3.6
Spokane County Conservation District	2.75	2.85	2.1	1.65	3.15	2.05	3.65
Spokane Valley Fire	2.75	2.85	3	3.1	3.4	1.75	3.3
Spokane County FD 3	2.95	2.85	3.05	2.05	3.4	2.15	4
Spokane County FD 4	2.55	2.85	2.45	1.65	3.5	1.55	2.9
Spokane County FD 5	2.35	2.45	2.6	2.7	3.4	1.75	3.3
Spokane County FD 8	2.55	2.65	2.4	2.7	3.4	1.7	3.35
Spokane County FD 9	2.75	2.55	2.65	2.6	3.25	3.0	3.55
Spokane County FD 10	3.15	2.85	3.0	2.7	3.4	1.75	3.7
Newman Lake Flood Control Zone District	1.90	2.25	2.4	1.65	2.4	1.75	2.9

12.2 RISK RANKING

Once the CPRI calculations were determined, the Planning Team then prioritized the hazards of concern based on a numeric value. During this risk ranking process, Planning Team members were asked to consider their experience and knowledge in identifying items which are relevant, but not necessarily captured in other areas of the hazard profiles such as local capabilities, or gaps that may exist within their communities.

During the ranking process, in some cases, the hazards ranked equally even though their CPRI scores were different based on the application of subjectivity on the part of the team members. This provided an opportunity for the inclusion of information and detail that otherwise may not be included in the risk assessment. Each Planning Team Member identified those variations in their respective annex. The results of the analysis are contained in Table 12-3.

Table 12-3.
Countywide Hazard Ranking

Entity	Drought	Earthquake	Flood/ Dam	Landslide	Severe Weather	Volcano	Wildfire
County	4	3	2	2	1	5	1
Airway Heights*	2	3	NH	NH	1	4	3
Cheney*	5	4	7	9	1	8	2
Deer Park	5	4	3	8	1	7	2
Fairfield	4	3	2	7	1	6	5
Liberty Lake	5	2	7	3	1	6	4
Medical Lake	4	5	3	6	2	7	1
Spokane Valley	4	3	2	2	1	5	1
Spokane County Conservation District*	6	3	4	5	1	8	2
Spokane Valley Fire	6	5	4	3	1	7	2
Spokane County FD 3*	4	5	3	9	2	8	1
Spokane County FD 4	4	3	5	6	1	7	2
Spokane County FD 5	4	3	2	2	1	5	1
Spokane County FD 8	5	4	6	3	1	7	2
Spokane County FD 9	4	7	5	6	2	3	1
Spokane County FD 10*	4	3	2	2	1	5	1
Newman Lake Flood Control Zone District	5	4	2	7	3	6	1

NR = Not Ranked / NH= No Hazard /
*Included Additional Hazards Identified within Jurisdictional Annex which impact ranking

The hazards ranked as being of highest concern countywide are severe weather and wildfire. Hazards ranked as being of medium concern are landslide, flood, earthquake and drought. The hazard ranked as being of lowest concern is volcano.

The final step in the process provided for the application of a qualitative rating based on a priority of high, medium or low, etc. to allow for ease in application in identifying and prioritizing not only the hazards, but also when considering strategies. The Planning Team felt this summary was particularly beneficial when discussing the hazards of concern with the public, as it provided a manner in which to define the risk associated with the hazards in simple terminology.

The Planning Team established the following descriptors for application:

- 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.

The end result of the process is illustrated in Table 12-4. This information was presented at various public outreach efforts to help identify risk countywide. Utilizing a process such as this is beneficial when discussing risk with the public and while attempting to gain their perspective of risk as it provides a means for the planning team to describe risk in a manner which is easily applied and understood, while also providing a mechanism of determining how citizens view risk to help validate the information established throughout the planning process from the view of the citizens, further validated by the surveys completed, which utilize a high/medium/low priority.

Table 12-4.
Countywide Risk Summary

Jurisdiction	Drought	Earthquake	Flood	Landslide	Severe Weather	Volcano	Wildfire
County	Medium	Medium	Medium	Medium	High	Low	High
Airway Heights	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Cheney	Medium	Medium	Low	Ex Low	High	Low	High
Deer Park	Low	Medium	Medium	Ex Low	High	Ex Low	High
Fairfield	Medium	Medium	Medium	Low	High	Med/Low	Medium
Liberty Lake	Low	Medium	Low	Medium	High	Low	Medium
Medical Lake	Medium	Medium	High	Medium-Low	High	Low	High
Spokane Valley	Medium	Medium	High	Medium	High	Low	High
Spokane County Conservation District	Medium	Low	High	Low	High	Low	High
Spokane Valley Fire	Medium	Medium	Medium	Medium	High	Low	High
Spokane County FD 3	Medium	Medium	Medium	Low	High	Low	High
Spokane County FD 4	Medium	High	Medium	Medium	High	Medium	High
Spokane County FD 5	Medium	Medium	Medium	Medium	High	Low	Ex. High
Spokane County FD 8	Medium	Medium	Medium	Medium	High	Low	High
Spokane County FD 9	Medium	Medium	Medium	Medium	High	High	High
Spokane County FD 10	Medium	Medium	Medium	Medium	High	Low	High
Newman Lake Flood Control Zone District	Low	Medium	High	Low	Medium	Low	High

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 Spokane 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.

The CRS program credits NFIP communities points for setting goals which help reduce the impact of flooding and other known natural hazards; identifying mitigation projects that include activities for prevention, property protection, natural resource protection, emergency services, structural control projects, and public information. Establishing goals in such a manner was a primary focus of the Planning Team.

13.1 HAZARD MITIGATION GOALS AND OBJECTIVES

During the kick-off meeting, the Planning Team reviewed the 2015 existing goals and objectives. The planning team felt the 2015 goals and objectives as stated support the countywide effort of enhanced capabilities which supports resilience through protection of life, property, the economy and the environment, and confirmed the goals and objectives for use in the 2020 update. The goals as written accurately describe the overall direction that Spokane 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 Guiding Principle, Goals and Objectives

Guiding Principle

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

> *Utilizing community partnerships and planning, reduce the vulnerability to natural hazards in order to protect the health, safety, welfare, environment and economy of the greater Spokane area within Spokane County.*

Goals

The planning partnership again confirmed the goals for the plan update:

1. Ensure effective and efficient emergency response and recovery capabilities to reduce the loss of life and property during and after a disaster through mitigation.

2. Protect property including critical public facilities and infrastructure from possible damage due to hazards.

3. Protect the continuity of local government to ensure no significant disruption of services during or due to a natural disaster.

4. Build and support local capacity to enable the whole community to prepare, respond, mitigate and recover from the impact of natural hazards.

5. Encourage the development and implementation of sustainable, cost-effective and environmentally sound mitigation projects.

6. Improve communication and information sharing within the community to support the planning for, response to, mitigation of and recovering from, the impacts of disasters.

Objectives

The following objectives were identified that meet multiple goals, acting as a bridge between the mitigation goals and actions and helping to establish priorities:

Objective Number	Objective Statement	Applicable Goals
O-1	Sustain continuity of local emergency and government operations, including the operation of identified critical facilities, during and after a disaster.	1, 2, 3, 4, 6
O-2	Reduce natural hazard-related risks to potentially isolated/vulnerable populations within the planning area.	1, 3, 4, 5, 6
O-3	Improve/protect systems that provide warning and emergency communications.	2, 3, 4, 6
O-4	Utilizing the best available data and science, continually share updated information on hazards, risk and ways to reduce risk with all stakeholders within the planning area.	1, 2, 3, 4, 6
O-5	Strengthen codes, land use planning and their enforcement, so that new construction can avoid or withstand the impacts of natural hazards.	All
O-6	Provide/improve flood protection with flood mitigation measures and drainage system maintenance plans.	1, 2, 5
O-7	Provide/improve fire protection thru proactive fuels management programs.	1, 2, 5
O-8	Assure coordination between participating [jurisdictions] and adjoining communities.	1, 4, 6
O-9	Work to lower emergency service response times, including through improvement to transportation facilities.	1, 3, 4, 6
O-10	Retrofit, purchase or relocate structures based on one or more of the following criteria: level of exposure, repetitive loss history, and previous damage from natural hazards.	1, 2, 3, 4, 5
O-11	Seek mitigation projects that minimize environmental impacts, improve the environment's ability to absorb the impact of natural disasters, or seek ways to mitigate their impacts on the environment.	All
O-12	Encourage mitigation of private property through programs such as the Community Rating System, Firewise and Storm Ready programs.	2, 4, 6

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 to provide ideas and concepts of possible action items. 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 2020 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 13-1 lists the recommended countywide initiatives. Many of these initiatives are also identified by other planning partners who support the effort. Table 13-2 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 (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 13-1.
Countywide Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency*	Estimated Cost	Funding Sources	Timeline	If in Previous Plan, # Identified	Initiative Type	Who Benefits?
CW-1 Continue data gathering such as with LiDAR as well as additional facility information to continue to improve the risk assessment countywide, and to help support Hazus modeling used to develop plan updates.									
New/ Existing	All	1, 4, 10	EM, All planning partners	Low	HLS/EMPG, PDM, HMGP, HUD, General Funds	Ongoing	Yes (2015 #CW-5)	Structural Projects, Property Protection	Regional

Table 13-1.
Countywide Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency*	Estimated Cost	Funding Sources	Timeline	If in Previous Plan, # Identified	Initiative Type	Who Benefits?
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. Establish a countywide hazardous materials incident response team.									
New	Hazardous Materials	1, 3, 4, 8, 9, 10	PH, Fire, EM, PW, WSDOT, WDOE	High	General Funds, HLS (EMPG), CDC grants	Long-Term	No	Prevention, Public Information and Education, Natural Resource Protection, Emergency Services/ Response	Regional
CW-3 Work on identifying points of distribution in areas of potential isolation.									
New	All	1, 2, 3, 4, 6, 7, 8, 11, 12	PH, EM, PW, Local EMs	Low	EMPG, HUD	Short-Term	No	Public Information and Education, Emergency Services / Response, Recovery	Regional
CW-4 Work with other county departments and local planning partners to capture historic hazard information utilized for future risk assessments, planning, grant and mitigation actions, including high water marks, extent and location of hazard, loss information.									
New	All	1, 2, 3, 4, 5, 6, 8, 10, 11	PH, EM, HS	Low	Health and Human Service Grants, HUD, HMGP	Long-Term	Yes (2015 #s CW-4 and 6)	Public Information and Education, Emergency Services / Response, Recovery	Community Level
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	1, 4, 5, 6, 10, 11	Assessor's Office; GIS; PW, EM; CD	Medium	General Fund, HMGP	Short-Term	Yes – (2015 #CW-5	Structural Projects, Property Protection, Recovery	County and Local

Table 13-1.
Countywide Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency*	Estimated Cost	Funding Sources	Timeline	If in Previous Plan, # Identified	Initiative Type	Who Benefits?
CW-6 Coordinate among all jurisdictions to seek out and apply for grants for site hardening of facilities. This includes back-up power at critical facilities and resource locations.									
New/ Existing	E, EQ, F, LS, SW	1, 4, 5, 6, 7, 8, 9, 10, 11	EM	Medium	Earthquake and Tsunami Program, HMGP, PDM, HUD, DOT, EPA	Long-Term	Partial	Structural Projects, Property Protection, Natural Resource Protection	Facility Specific
CW-7 Maintain and regularly update fire hydrant layer countywide.									
New/ Existing	WF	7, 8	EM, GIS, Fire	Low	HMGP, HUD, SAFER	Long-Term	No	Property Protection, Emergency Services/ Response	Countywide
CW-8 Continue implementation of public information program within Spokane County to inform citizens about the hazards faced and the appropriate preparedness and response measures, including, but not limited to, Severe Weather, Wildfire/Fire Wise, NFIP, Earthquake and landslide information, insurance information, and structural projects which homeowners can undertake, such as affixing chimneys, foundations, fire-proof roofing materials, etc. This outreach program includes maintaining a Hazard Mitigation Plan website where the final plan and risk maps are presented.									
New/ Existing	All	All	EM and Local EM, Local and County Land Use Planning, Spokane County Engineering & Roads, private industry.	Low	EMPG, General Fund	Ongoing	Yes (CW-1 and 3, SC-11)	Prevention, Public Information and Education	County and Community
CW-9 Continue to expand CERT training, involving local teams in exercises and training with first responders.									
New/ Existing	All	1, 2, 3, 4, 7, 8, 12	EM, Local EM, County Citizen Corps Groups,	Low	EMPG	Ongoing	Yes	Prevention, Public Information and Education, Emergency Services, Response, Recovery	County and Community

Table 13-1.
Countywide Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency*	Estimated Cost	Funding Sources	Timeline	If in Previous Plan, # Identified	Initiative Type	Who Benefits?
CW-10 Identify and designate emergency shelter structural and utility readiness for occupancy after a significant incident.									
New/ Existing	All	All	EM	Medium	PDM, HMGP, General Funds	Short-Term	Yes	Prevention, Public Information Emergency Services/ Response	Regional
CW-11 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	7, 11, 12	EM, Local EM, Fire	Low	Fire Grants, PDM, HMGP	Ongoing	No	Property Protection, Natural Resource Protection, Prevention	Local
CW-12 Work with local jurisdiction and planning partners to develop various emergency planning efforts to help ensure continuity of business and resiliency, and to develop mechanisms to ensure recovery efforts exist. This includes pre-identifying solid waste staging areas which can be utilized during disaster incidents.									
New/ Existing	All	1, 3, 4, 7, 8, 9, 11, 12	EM, Local EM, ED, Chamber	Medium	EMPG Funds, General Funds	Long-Term	Partial	Recovery	County, Local
CW-13 Continue to promote and establish a countywide emergency management actions, projects, and programs, working with the cities 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	1, 3, 4, 8, 9, 11	EM, Local EM, Fire, Hospitals	Medium	General Funds, Grant Opportunities as they arise	Long-Term	No	Prevention, Public Information/ Education, Emergency Services/ Response, Recovery	County and Local
CW-14 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	1, 3, 4, 5, 6, 8, 10, 11	EM and Local EMs	Medium	General Funds	Long-Term	No	Emergency Services/ Response, Recovery	County and Local

Table 13-1.
Countywide Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency*	Estimated Cost	Funding Sources	Timeline	If in Previous Plan, # Identified	Initiative Type	Who Benefits?
CW-15 Continue to enhance local emergency planning committee (LEPC) involvement with private industry and local jurisdictions throughout the County with the goal of monthly meetings.									
Existing	WF	1, 2, 3, 8,	EM, Local EM, Fire, Private Industry	Low	General Funds	Ongoing	No	Prevention, Emergency Services/ Response, Recovery	County and Local
CW-16 Seek grant funding to develop a countywide mass care and evacuation exercise, which includes all fire and police departments, Hospitals, 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	8, 9, 10, 11	EM, Local EM, 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-17 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, E. EQ, LS, SW	4, 5, 6, 7	EM, PW	Low	FEMA	Short-Term	Yes	Prevention, Emergency Services, Planning, Response, Recovery	Local and County
CW-18 Continue to develop and maintain countywide mutual aid agreements with both public and private agencies in support of preparedness and response activities.									
New	All	1, 3, 8, 9	EM	Medium	General Funds	Ongoing	No	Emergency Services/ Response, Recovery	County and Local
CW-19 Work with local school districts to study and retrofit school facilities to better withstand damage from earthquake, flood, severe weather, erosion and landslide events.									
New/ Existing	All	All	DEM, Local DEM, School Districts	High	HLS/EMPG, PDM, HMGP, Dept. of Education, Earthquake/ Tsunami Program	Ongoing	No	Structural, Property Projection, Emergency Services/ Response, Recovery	Facility, County, and Local

* CD=Community Development; ED=Economic Development; EM= Emergency Management; Fire=Districts and Depts.; HS=Human Services; LE=Law Enforcement; PH=Public Health; PW=Public Works; 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 13-2.
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?
SC-1 Seek out and apply for grant funding for an EOC facility outside of the flood zone and away from the railway tracks which carry hazardous materials, and also delay response activities due to long chain of rail cars blocking ingress and egress to facility.									
Existing	All	1, 2, 3, 4 5, 7, 8, 9	Emergency Management, Facilities, County Officials	High	HLS/EMPG, PDM, HMGP, HUD,	Short-Term	No	Structural Projects, Property Protection	Regional
SC-2 Reorganize the Roads Department, adding additional satellite shops to reduce response times during severe weather.									
New/ Existing	SW	1, 2, 8, 9	Spokane County, Engineering & Roads	High	Local/Grant	Long-Term	Yes (SC-1)	Property Protection, Structural Projects, Natural Resource Protection	County
SC-3 Consider participation in the Community Rating System.									
New and Existing	F, SW	2, 4 5, 6, 8, 12,	Spokane County, Engineering & Roads	Low	Local	Short-Term	Yes (SC-4)	Property Protection, Structural Projects, Natural Resource Protection	County
SC-4. Seek grant funding for acquisition of properties in high-hazard areas, with special attention to repetitive or severe loss properties.									
Existing	All	2, 10, 11	Spokane County, Engineering & Roads, and Emergency Management	High	PDM, HMGP, FMA	Long-Term	Yes	Property Protection, Structural Projects, Natural Resource Protection	Facility and County
SC-5. Support and implement as appropriate wildfire mitigation recommendations identified in the Spokane County CWPP.									
New/ Existing	WF	*1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12*	Emergency Management	Medium	Local, Fire Grants, FEMA Hazard Mitigation Grants	Ongoing	Yes (SC-17)	Protection, Response, Recovery, Natural Resource Protection	Local and County

Table 13-2.
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?
SC-6. Develop an inventory of culverts that includes identification of existing conditions such as: fish passage, vegetation status, evidence of scour, physical condition (i.e. rusted, crushed, split), etc. Further analysis to include identifying which can convey the 100-year flood, and which are not. And, with this information, develop a culvert ranking system that results in a culvert replacement priority list for future planning.									
Existing /New	F, LS, SW, WF,	2, 4, 5, 8, 11	Spokane County, Engineering & Roads; GIS	Medium	General Fund, DOE, WSDOT, PDM, HMGP, FMA	Long-Term	Yes (SC-10)	Prevention, Response, Recovery, Natural Resource Protection	County and Local
SC-7 Study bridges within floodplain areas to identify which are capable of conveying the100-year flood, and determine what can be done to mitigate those that are not. Develop a bridge ranking and priority replacement list / process / program.									
New/ Existing	F, SW	2, 4, 5, 8, 11	Spokane County, Engineering & Roads	Medium	General Fund	Long-Term	Yes (SC-9)	Prevention, Mitigation	County
SC-8 Continue to design and build facilities to meet or exceed seismic and code standards, including redundant essential equipment. Apply current seismic and wind load standards to all renovation or replacement of existing facilities, and/or equipment.									
New/ Existing	EQ, LS, SW	1, 2, 3, 4, 5, 6, 7, 8, 9	Planning, PW	High	LOCAL Possible Grants	Ongoing	Partial	Structural Projects, Property Protection	County
SC-9 *Study floodplain areas that currently do not have detailed studies, using more current models, resulting in more accurate mapping for planning and design of future County Capital Projects, as well as private development.*									
New and Existing	F, SW	2, 4, 5 , 8, 11	*Spokane County, Engineering & Roads*	Medium	General Fund, various grants.	Long Term	Yes (SC-8)	Structural Projects, Public Information and Education, Natural Resource Protection	County, Facility, Local
SC-10 Provide scour protection for approximately 25 “scour critical” bridges in Spokane County.									
Existing	F/SW	1, 2, 6, 10, 11	Spokane County, Engineering & Roads	High	General Funds, Grants	Short-Term	Yes (SC-7)	Prevention, Property Protection, Emergency Services	Regional

Table 13-2.
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?
SC-11 Update the Spokane Regional Stormwater Manual for compliance with the recently updated 2019 Washington State Department of Ecology Stormwater Management Manual for Eastern Washington. Ensuring that regional design thresholds and guidance are current with respect to State adopted regulations means that development is more consistent, structures and the environment have a higher degree of protection from flooding.									
New/	F, LS, SW,	2, 4, 5, 6, 8, 11	Spokane County Public Works	Low	Local / Ecology (or other) Grant Funding	Short Term	No	Structural Projects, Property Protection, Natural Resource Protection	County
SC-12 Assess the segment of the Country Homes Drainage between the Price and Wall Regional Stormwater Facility, through and beyond Whitworth University, for updated floodplain and floodway mapping boundaries; anticipate the need for both a CLOMR and LOMR to complete the mapping revisions. Once completed, seek grant funding to replace two weight-restricted bridges at Jay Avenue and Holland Avenue, which will require redesign and construction to incorporate large squash-pipe culverts to pass the appropriate 100-year flood flow.									
New/ Existing	All	All	Spokane County Public Works	Medium	Local / Ecology/ WSDOT / Grant Funding	Short-Term	No	Structural Projects, Property Protection, Response, Recovery	County
SC-13 Assess the "Shady Slope Road floodplain area." This area includes a confluence of three waterways – Little Spokane River, Deadman Creek, and Little Deep Creek, and is a very challenging area to predict flood boundaries and determining flood-related impacts due to the many unknowns in this vicinity.									
New/ Existing	EQ, F, LS, SW	2, 4, 5 , 6, 11	Spokane County Public Works	Medium	Local / Ecology (or other) Grant Program, PDM, HMGP	Short-Term	No	Property Protection, Structural Projects, Natural Resource Protection	County
SC-14 Formulate a plan to research and identify those areas of Spokane County that are located within the rural/urban corridor where there is a high potential for flood debris flow during a flash flood after wildfire scarring. Once identified, consider a pro-active plan for both pre-development (i.e. locate away from hazard-prone debris flow areas) and post-development (structures that are already existing within flow path) mitigation.									
New/ Existing	F, LS, SW, WF	1, 2, 3, 4, 5, 6, 7, 8, 9 10, 11	Spokane County Public Works, Emergency Management, Spokane County Conservation District	High	Local / Ecology, PDM, HMGP, Fire Grants	Long-Term	No	Property Protection, Structural Project, Natural Resource Protection, Response, Recovery	County

Table 13-2.
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?
SC-15 Replace the following undersized culverts (under the forenamed roads) where repeated flooding occurs; where in one case, is the only access to 10-15 residential properties, and in all cases, would cause significant inconvenience (time, terrain, road surface conditions, etc.) to traverse the detour route to reach their homes: Burroughs Road, Ballard Road (four culverts), Crosscut Road, Antler Road, Parker Road, Herman Road, and Bernhill Road.									
New	All	All	Spokane County Public Works, Emergency Management	Medium	Ecology, HMGP, EMPG and General Funds	Long Term	No	Property Protection, Response, Recovery, Natural Resource Protection	County
SC-16 An emphasis will be placed on pre-project identification of natural drainage systems relative to the preservation of same systems during the process of updating County-wide watershed plans, reviewing private and commercial development projects/plans, and the design of new, or the repair/replacement of, County roads/bridges/culverts.									
New/ Existing	F, LS, SW	2, 4, 5, 6, 11	Spokane County Public Works	Low	Ecology, Grant Funding	Long - Term	No	Structural, Response, Recovery, Natural Resource Protection	County
SC-17 Replace Valley Chapel Road Bridge #3301 over Latah Creek. Reanalyze hydraulics for 100-year flood flow; design and install suitable engineered scour repair to address scour at Pier 3, with goal to protect foundation and exposed piling.									
Existing	EQ, F, SW	2, 6, 9, 10	Spokane County Public Works	High	PDM, HMGP, WSDOT	Short-Term	No	Structural, Emergency Services, Response	County
SC-18 Replace Cheney Plaza Road Bridge #2101 over Bonnie Creek. Reanalyze hydraulics, dredge and/or replace to adequately convey 100-year flood flows, as roadway and bridge are frequently overtopped due to silt buildup and potential under-sizing of bridge.									
New/ Existing	EQ, F, SW	2, 4, 9, 10	Spokane County Public Works	High	PDM, HMGP, WSDOT	Short-Term	No	Structural, Emergency Services, Response, Recovery	County
SC-19 Replace Valley Chapel Road Bridge #3308 over California Creek. Remove aggregated material in front of Abutment 2 and repair scour at Abutment 1. Bridge is assumed to not have been sized to convey the 00-year flood flow, and will be re-analyzed as part of the replacement process.									
Existing	EQ, F, SW	2,6, 9, 10	Spokane County Public Works	High	PDM, HMGP, WSDOT	Short-Term	No	Structural, Emergency Services, Response and Recovery	County

13.5 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 13-3 lists the priority of each countywide initiative. Table 13-4 lists the priority for each county-specific initiative. A qualitative benefit-cost review as described above was performed for each of these initiatives.

Table 13-3.
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	3	H	L	Y	Y	Y	H
2	6	H	H	Y	Y	Y	H
3	9	H	L	Y	Y	Y	H
4	9	H	L	Y	Y	Y	H
5	6	H	M	Y	N	Y	M
6	9	H	M	Y	N	Y	M
7	2	M	L	Y	N	Y	M

Table 13-3.
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)
8	12	H	L	Y	Y	Y	H
9	7	H	L	Y	Y	Y	H
10	12	H	M	Y	Y	Y	H
11	3	M	L	Y	Y	N	L
12	8	M	M	Y	Y	Y	M
13	6	M	M	Y	Y	N	M
14	8	H	M	Y	N	N	M
15	4	H	L	Y	Y	N	H
16	4	M	L	Y	N	Y	M
17	4	H	H	Y	Y	N	M
18	4	L	M	N	Y	N	L
19	12	H	M	Y	N	Y	M

Table 13-4.
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	8	H	H	Y	Y	N	H
2	4	M	H	Y	Y	PARTIAL	H
3	6	H	L	Y	N	Y	H
4	3	H	H	Y	Y	N	H
5	11	H	M	Y	Y	PARTIAL	H
6	5	H	M	Y	Y	PARTIAL	H
7	5	H	M	Y	N	PARTIAL	H
8	9	H	H	Y	SOME	PARTIAL	H
9	5	H	M	Y	N	Y	H
10	5	H	H	Y	SOME	PARTIAL	H
11	6	M	L	Y	SOME	Y	M
12	12	M	M	Y	SOME	PARTIAL	M
13	5	H	M	Y	SOME	PARTIAL	H
14	11	H	H	Y	SOME	PARTIAL	M
15	12	H	M	Y	Y	PARTIAL	H
16	5	H	L	Y	Y	N	H
17	4	H	H	Y	N	Y	H

Table 13-4.
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)
18	4	H	H	Y	N	Y	H
19	4	H	H	Y	N	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 2015 ACTION PLAN STATUS

A comprehensive review of the 2015 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. On review, the County identified that six of the seven previous strategies were such in nature that they would be carried forward as indicated in Table 13-5. The one exception was for CW-7, relating to continuity of operation planning, which was completed. All the remaining items have been incorporated and indicated as a carry-over.

With respect to the 2015 County-specific mitigation strategies (previously contained in the Unincorporated Annex portion of the plan), their current status is identified in Table 13.6. Each Planning Team member's respective annex update contains information concerning their previous strategies.

Table 13-5.
Action Plan—Countywide Mitigation Initiatives

Hazards Addressed	Lead Agency	Possible Funding Sources or Resources	Time Line[a]	Objectives	2020 Status
CW-1—Maintain a Hazard Mitigation Plan website where this final plan will be housed and planning partners as well as members of the public will be able to monitor plan implementation.					**On-going, carried over**
All Hazards	DEM	DEM General Fund	Ongoing	4,8	**Now CW-8**
CW-2—Continue to support the use, development and enhancement of County-wide citizen notification system					**On-going, carried over**
All Hazards	DEM	General Fund, Department of Homeland Security/Emergency Management Performance Grants	Ongoing	1,2,3,8	**Combined with CW-8**
CW-3—Continue to leverage ongoing, regional public education and awareness programs as a method to educate the public on risk and community resilience.					**On-going**
All Hazards	All Planning Partners	Existing program funds	Ongoing	4,8	**Now CW-8**
CW-4—Strive to capture 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.					**Carried over**
All Hazards	All Planning Partners	Existing Program funds, FEMA post disaster (PA) funding	Short Term	4, 8	**Now CW-4**
CW-5—Continue the use and maintenance of the HAZUS-MH model that was developed to support this plan update. Maintenance includes periodic updates of inventory, and hazard data. Use of this tool will be available to all planning partners.					**On-going, carried over**
Flood, Earthquake, Dam Failure	DEM	DEM General Fund	Short term	4,8	**Now CW-1 and CW-5**
CW-6—Utilize DEM as a repository for historic information on hazard events. This information can be utilized by the planning partners to support future risk assessments, planning and mitigation actions within the planning area. On-going Now CW-4					**On-going, carried over**
All Hazards	DEM	DEM general Fund	Short-term	4,8	**Now CW-4**
CW-7—Support the development and maintenance of continuity of operation planning with a consistent guidance package that will promote regional consistency within the planning area.					**Completed**
All Hazards	All Planning Partners	Existing program funds, Grant funding	Long term	1,3,4,8	

Table 13-6.
2020 Status of Spokane County-Specific 2015 Hazard Mitigation Strategies

Applies to new or existing assets	*Hazards Mitigated*	*Objectives Met*	*Lead Agency*	*Estimated Cost*	*Sources of Funding*	*Timeline*	*Included in Previous Plan?*	***2020 Status****
Initiative #SC-1—Reorganize the Roads Department, adding additional satellite shops to reduce response times during severe weather.								
New and Existing	*Severe Weather*	*1, 2, 8, 9*	*Spokane County, Engineering & Roads*	*$1,000,000 High*	*Local/Grant*	*Long Term*	*No*	***Carry Over Now SC-2***
***2020 Update**: The Rockford, WA. satellite shop (with new crew room) still needs to be constructed; target goal for construction is anticipated to be within the life-cycle of this plan update.*								
Initiative #SC-2—Rebuild Bruce Road Bridge. Bridge floods and is structurally unsound.								
Existing	*Flood, Seismic*	*2, 6, 10*	*Spokane County, Engineering & Roads*	*$980,000 High*	*Local/Federal Grant*	*Short Term*	*Yes F-4*	***Completed***
***2020 Update**: Bruce Road Bridge was constructed in 2014.*								
Initiative #SC-3—Replace Elliot Road Culvert. Culvert passes Deadman Creek and is undersized; it will be sized to pass 100-year flood and fish passage.								
New and Existing	*Flood*	*2, 6, 10*	*Spokane County, Engineering & Roads*	*$1,000,000 High*	*Local*	*Short Term*	*No*	***Completed***
***2020 Update**: Elliot Road Bridge Culvert was replaced/constructed in 2016.*								
Initiative #SC-4—Consider participation in the Community Rating System program								
New and existing	*Flood*	*2, 4, 5, 6, 8, 12*	*Spokane County, Engineering & Roads*	*$25,000 Low*	*Local*	*Short Term*	*Yes*	***Carry Over Now SC-3***
***2020 Update**: Spokane County would like to participate in the CRS Program, but due to lack of staff and available resources, we have been unable to implement. Once in the CRS Program, we would need designated staff to maintain the status – which is a very intense record-keeping endeavor. We would like to keep this in the Plan, and work toward it during this next cycle.*								
Initiative #SC-5—Rehabilitate and maintain Country Homes Blvd. storm drain system.								
Existing	*Flood/Severe Weather*	*2, 6, 11*	*Spokane County, Engineering & Roads*	*$750,000 High*	*Local/Grant*	*Short Term*	*No*	***Completed***
***2020 Update**: Country Homes Boulevard Restoration Project was complete (Phase I) in 2014, and (Phase II) in 2016. Long-term maintenance of these large regional stormwater facilities is tasked to Spokane County Stormwater Utility.*								

Table 13-6.
2020 Status of Spokane County-Specific 2015 Hazard Mitigation Strategies

Applies to new or existing assets	*Hazards Mitigated*	*Objectives Met*	*Lead Agency*	*Estimated Cost*	*Sources of Funding*	*Timeline*	*Included in Previous Plan?*	***2020 Status****
Initiative #SC-6—Develop LID manual for stormwater disposal.								
Existing New	*Flood/Severe Weather*	*1, 4, 6, 8, 11, 12*	*Spokane County, Stormwater Utility*	*$100,000 Medium*	*Local/Grant*	*Long Term*	*No*	***Completed***
***2020 Update**: The Eastern Washington LID Guidance Manual was finalized in 2013. This Manual no longer exists as a separate manual, as it has been incorporated into the updated Stormwater Management Manual for Eastern Washington in spring 2019.*								
Initiative #SC-7—Provide scour protection for approximately 25 "scour critical" bridges in Spokane County.								
Existing	*Flood/Severe Weather*	*1, 2, 6, 10, 11*	*Spokane County, Engineering & Roads*	*$250,000 High*	*Local/Grant*	*Short Term*	*No*	***On-Going Now SC-10***
***2020 Update**: Spokane has provided scour protection for approximately 20% of the 25 identified as "scour critical."*								
Initiative #SC-8— Study floodplain areas that are of concern for future development. Use more current models to determine flood levels.								
New and Existing	*Flood*	*2, 4, 5, 8, 11*	*Spokane County, Engineering & Roads*	*$20,000, Medium*	*Local/Grant*	*Long Term*	*No*	***Carried forward but modified. Now SC-9***
2020 Update: Carried forward, but reworded for 2020 update.								
Initiative #SC-9—Study floodplain areas that have bridges and culverts that were never sized to pass the 100-year flood. Identify which structures are sized appropriately and determine what can be done to mitigate those that are not.								
Existing New	*Flood/Severe Weather*	*2, 4, 5, 8, 11*	*Spokane County, Engineering & Roads*	*$75,000, Medium*	*Local/Grant*	*Long Term*	*No*	***Carried forward but modified. Now SC-7***
2020 Update: Carried forward, but reworded for 2020 update.								
Initiative #SC-10—. Develop inventory of culverts, which would include fish barrier culverts and floodplain culverts. Inventory would include condition and sizing requirements. Develop a culvert replacement priority.								
Existing/ New	*Flood*	*2, 4, 5, 8, 11*	*Spokane County, Engineering & Roads*	*$30,000, Medium*	*Local/Grant*	*Long Term*	*No*	***On-Going Now SC-6***
2020 Update: Carried forward, but reworded for 2020 update.								

Table 13-6.
2020 Status of Spokane County-Specific 2015 Hazard Mitigation Strategies

Applies to new or existing assets	*Hazards Mitigated*	*Objectives Met*	*Lead Agency*	*Estimated Cost*	*Sources of Funding*	*Timeline*	*Included in Previous Plan?*	***2020 Status****
Initiative #SC-11—Continue work on website development for severe weather alerts. Notifications of roadway hazards, snow removal, road closures, and other natural hazards that may affect the traveling public.								
Existing *New*	*Severe Weather*	*1, 3, 8*	*Spokane County, Engineering & Roads*	*$20,000, Low*	*Local/Grant*	*Long Term*	*No*	***On-Going Now CW-8***
2020 Update: Spokane County continues to try and find new and improved ways to provide fast and reliable information via County website to alert the traveling public. [This initiative was combined with all-hazards public service/public information initiative for 2020 update.]								
Initiative #SC-12—Continue to maintain compliance and good standing under the National Flood Insurance Program. This will be accomplished through the implementation of floodplain management programs that, at a minimum, will meet the minimum requirements of the NFIP, which include the following: • Enforcement of the adopted Spokane County Flood Damage Code (ordinance) • Participating in floodplain identification and mapping updates • Providing public assistance/information on floodplain requirements and impacts.								
New and Existing	*Flood*	*2, 4, 5, 6, 8, 12*	*Engineering and Roads*	*Low*	*Local*	*Ongoing*	*No*	***Remove***
***2020 Update**: The County continues to address the standards and regulations of the NFIP under normal operations; as such, this has been removed as a strategy because it functions in a normal course of operations.*								
Initiative #SC-13—Continue to support the countywide initiatives identified in this plan.								
New and Existing	*All Hazards*	*1, 3, 4, 8*	*DEM*	*Low*	*Local*	*Ongoing*	*No*	***Remove***
***2020 Update**: Removed. The planning team determined that this was not an actionable strategy as phrased, and elected to remove the initiative.*								
Initiative #SC-14—Actively participate in the plan maintenance strategy identified in this plan.								
New and Existing	*All Hazards*	*1, 4, 8*	*DEM*	*Low*	*Local*	*Short term*	*No*	***Remove***
***2020 Update**: The planning team elected to remove this as a strategy as this is the focus of the plan maintenance section of the 2020 HMP, and is redundant in efforts.*								
Initiative #SC-15—Where appropriate, support retrofitting, purchase, or relocation of structures located in hazard-prone areas to protect structures from future damage, with properties that are exposed to repetitive losses as a priority.								
Existing	*All Hazards*	*2, 10, 11*	*Spokane County, Engineering & Roads*	*High*	*FEMA Grant funding/ Local contributions*	*Long term*	*No*	***On-Going Now SC-4 (Reworded)***
***2020 Update:** The County will continue to maintain this initiative moving forward.*								
Initiative #SC-16—Integrate the Hazard Mitigation Plan into other plans, ordinances or programs to dictate land uses within the jurisdiction.								

Table 13-6.
2020 Status of Spokane County-Specific 2015 Hazard Mitigation Strategies

Applies to new or existing assets	*Hazards Mitigated*	*Objectives Met*	*Lead Agency*	*Estimated Cost*	*Sources of Funding*	*Timeline*	*Included in Previous Plan?*	***2020 Status****
New and Existing	*All Hazards*	*2, 3, 4, 5, 11*	*Spokane County Planning*	*Low*	*Local*	*Short term*	*No*	***On-Going Now CW-17***
2020 Update: *The HMP was utilized in the County's update to its COMP plan, as well as undergoing a SEPA review prior to last adoption. Incorporating the HMP into other planning efforts will be an on-going effort, as integration of planning efforts is a primary focus of mitigation planning to help reduce the impacts of disasters.*								
Initiative #SC-17—Implement wildfire mitigation recommendations identified in the Spokane County CWPP.								
New and Existing	*Wildfire*	*1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12*	*Spokane Conservation District, all County Fire Districts*	*Medium*	*Local, Fire Grants, FEMA Hazard Mitigation Grants*	*Short term*	*No*	***Completed; carried forward. Now SC-5.***
2020 Update*: Several initiatives were completed since the 2015 was adopted. The County will continue to assist those entities' efforts to implement the mitigation recommendations identified annually by the CWPP development team.*								
**2020 Status:* *CO= Carried over to 2020 HMP – still a valid project but not completed* *R=Removed, no longer relevant* *C=Completed* *OG= On-going in nature, carried over*								

13.9 ADDITIONAL MITIGATION ACTIVITIES

In addition to the mitigation action items previously identified, the County and its planning partners also undertook additional initiatives which provided assistance in reducing the potential impact of disaster events on the planning area, as follows:

1) As a result of a culvert enhancement project (shore-up), Deer Park conducted enhanced outreach efforts concerning potential flooding, issuing a letter to the community, which resulted in a significant increase in registering for ALERT Spokane emergency notifications, as well as increasing flood-awareness and safety.
2) Public-private partners came together when Avista Utilities, a primary utility provider in the county, conducted a dam exercise in 2018 to test policies and procedures in place, as well as response capabilities. Planning partners from many different industries took part in the exercise.
3) The County acquired an updated Mass Notification system in 2016 which has enhanced capabilities for alert and warning, including the use of the Federal IPAWS (integrated Public Alert & Warning System).
4) The County, working with all of the municipal planning partners, is working to further develop and expand the critical facilities list currently in place. That list, when completed, will be utilized for future hazard mitigation plan updates, as well as in conjunction with other exercise, training and planning activities.

13.10 FUNDING OPPORTUNITIES

Although a number of the mitigation projects listed may not be eligible for FEMA funding, Spokane 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.

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—** The U.S. Fish & Wildlife Service (USF&W) provides Rural Fire Assistance grants to fire departments to enhance local wildfire protection, purchase equipment, and train volunteer firefighters. USF&W staff also assist with community projects. These efforts reduce the risk to human life and better permit US F&W firefighters to interact 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	☑	☑
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 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	Y
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	Y
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 is available at: 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, as are the County's capabilities. In addition, Section 2.9.1 further identifies plans in place which support Hazard Mitigation Planning and risk reduction. Each planning partner has also individually reviewed existing local plans, studies, reports, and technical information as referenced and identified in their 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 certain species listed 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 saltwater.

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. Spokane County and its cities and towns participate in the NFIP and have adopted regulations that meet the NFIP requirements. Existing flood maps are dated. 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. There is not generally a specific dollar threshold that must be met. 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 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 saltwater.

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 previously been funded for $4 million per biennium, with additional

amounts provided after severe flooding events; however, those amounts can be modified by the state Legislature.

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.

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).

Spokane County's last completed an update to its Comprehensive Land Use Plan as required under the GMA was made in 2019. 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 implementing development regulations in their entirety and revise them if needed. Opportunities for public participation in this process will be provided (see RCW 36.70A.035).

Critical Areas Ordinance

Washington's Growth Management Act requires local governments to protect five types of critical areas: important fish and wildlife habitat areas, wetlands, critical aquifer recharge areas, frequently flooded areas, and geologically hazardous areas, such as bluffs. Spokane County's critical areas regulations are a response to that law; they regulate how development and redevelopment can safely occur on lands that contain critical

areas. Chapter 11 of the Spokane County Code identifies the Critical Areas Ordinance (CAO) of Spokane County.[31]

Within the 2018 update of Spokane County's CAO, Chapter 11.20.080 provides incentives for landowners to maintain certain land classifications through property and income tax advantages, as well as making the transfer of development rights available for landowners wish to preserve, among others, wetlands.

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.

Building Codes

The Spokane County Building Division has adopted and enforces, as mandated by the State of Washington, the current editions of the International Code Council's Building, Residential, Fire, Mechanical, Fuel Gas and Existing Building codes the Washington State Energy Code and the Uniform Plumbing Code with State and local amendments.

Spokane County has adopted the 2015 International and Uniform Building Codes. Title 3 (and others) of the Spokane County Code includes the 2015 editions of the International Building, Residential, Mechanical, Fire, Existing Building and Fuel Gas codes and the 2015 editions of the Uniform Plumbing Code and Washington State Energy Code.

Washington State Farmland Preservation

Washington State, through the Department of Revenue, provides tax incentives for open space enrollment of designated as farmlands. The program is one tool for making farmland more affordable, thus keeping it out of development.

Current use classification lowers the taxable value of farm and agricultural lands and other resource lands relative to other land uses. Land that would be assessed at $10,000 an acre for its "highest and best use" might be valued at perhaps $3,000 an acre as farmland. The effect of this lower valuation is to lower the tax assessed on lands classified as "current use," thereby making the land more affordable to keep in farm production.

Regulatory, Technical, Community Organizations, Programs and Social Systems

Regulatory capabilities currently available are summarized in Table 14-1. In addition, the County also maintains administrative and technical capabilities, as identified in Table 14-2. These various programs and capabilities support the efforts of not only the County, but also many of the local municipalities and special purpose districts.

[31] https://www.spokanecounty.org/DocumentCenter/View/20132/CAO-2018-final?bidId=

In addition, 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 7 – 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.
Spokane County Legal and Regulatory Capability

	Local Authority	Other Jurisdictional Authority	State Mandated	Comments
Codes, Ordinances & Requirements				
Building Code	Yes	Yes	Yes	SCC, Title 3 adopts 2015 International Building Code
Zoning Ordinance	Yes		Yes	SCC, Title 4 - Updated as required under GMA. Last review/update occurred 2019.
Subdivision Ordinance	Yes		Yes	SCC, Title 12 (1996) - Updated regularly through Comprehensive Land Use Plan.
Floodplain Ordinance	Yes	Yes	Yes	FEMA Requirements – Spokane County CAO & Flood Damage Protection Ordinance available at: https://www.spokanecounty.org/616/Shoreline-Master-Program
Transfer of Development Rights	Yes	No	No	Section 11.20.080 of the Spokane County Critical Areas Ordinance (2018)
Stormwater Management	Yes	No	Yes	SCC, Title 3, Chapter 3.10, 2004
Real Estate Disclosure	No	No	Yes	Statewide
Growth Management	Yes		Yes	Updated 2016; partial update 2019.
Critical Areas Ordinance	Yes		Yes	Spokane County Code – Title 11 Critical Areas identified and regulatory authority established. https://www.spokanecounty.org/726/Critical-Areas-Ordinance
Site Plan Review	Yes	No	Yes	SCC, Title 12, Chapter 12.05, 1996
Public Health and Safety	Yes	Yes	Yes	SCC, Title 8, 1996
Climate Change Adaptation				

Table 14-1.
Spokane County Legal and Regulatory Capability

	Local Authority	Other Jurisdictional Authority	State Mandated	Comments
Shoreline Master Program / Shoreline Management Plan	Yes			Adopted within Comp Plan. Available at: https://www.spokanecounty.org/616/Shoreline-Master-Program
Natural Hazard Specific Ordinance (stormwater, steep slope, wildfire, etc.)	Yes		Yes	Reviewed and/or updated annually as needed.
Environmental Protection	Yes	Yes	Yes	SCC, Title 11, 1996. Administered through various departments and with other entities.
Planning Documents				
General or Comprehensive Plan	Yes	No	Yes	
Is the plan equipped to provide linkage to this mitigation plan? Yes				
Floodplain or Basin Plan	Yes		Yes	Various plans in place maintained by several departments throughout county including channel migration zone maps/plans, meander belts, etc..
Stormwater Plan	Yes	Yes	No	Various plans are in place
Capital Improvement Plan	Yes	Yes	Yes	Includes Roads, Stormwater, Facilities, and Sheriff's departments. Updated annually.
Habitat Conservation Plan	Yes			Critical Areas Ordinance and Shoreline Master Plans.
Community Wildfire Protection Plan	Yes		Yes	2015 Currently in update process. Components of this plan will be utilized to support the CWPP.
Transportation Plan	Yes		Yes	2019 Update with Comprehensive Plan
Response/Recovery Planning				
Comprehensive Emergency Management Plan	Yes		Yes	2019 Update In-progress concurrent with HMP development.
Threat and Hazard Identification and Risk Assessment	Yes		Yes	Spokane County DEM and Regional Plan
Terrorism Plan	Yes			Law enforcement maintains
Post-Disaster Recovery Plan	Yes		No	
Continuity of Operations Plan	Yes			Various departments identified as COG-supporting or with essential services maintain COOP plans.
Public Health Plans	Yes			Various public health plans are in place both through the Health Department and through the hospitals.

Table 14-1.
Spokane County Legal and Regulatory Capability

	Local Authority	Other Jurisdictional Authority	State Mandated	Comments
Administration, Boards and Commission				
Planning Commission	Yes		Yes	
Mitigation Planning Committee	Yes		No	Planning Team established for plan development and annual maintenance.
Maintenance programs to reduce risk (e.g., tree trimming, clearing drainage systems, chipping, etc.)	Yes		Yes	Various programs in place, including tree trimming, drainage systems, etc.

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 & Community Services
Professionals trained in building or infrastructure construction practices (building officials, fire inspectors, etc.)	Y	Planning & Community Services; Public Works
Engineers specializing in construction practices?	Y	
Planners or engineers with an understanding of natural hazards	Y	Floodplain Manager
Staff with training in benefit/cost analysis	Y	
Surveyors	Y	
Personnel skilled or trained in GIS applications	Y	
Personnel skilled or trained in Hazus use	N	Available under contract basis.
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 Department with trained personnel and volunteers.
Grant writers	Y	Various County departments have internal personnel who write grants; county staff monitors grants.
Warning Systems/Services (Reverse 9-1-1, outdoor warning signs or signals, flood or fire warning program, etc.?)	Y	ALERT Spokane, powered by CodeRED Mass Notification Software. IPAWS also utilized. All Emergency Management Staff are trained on using CodeRED and IPAWS.

Table 14-2. Administrative and Technical Capability		
Staff/Personnel Resources	Available?	Department/Agency/Position
Hazard data and information available to public	Y	GIS maintains data for various departments which have knowledge of and responsibility for specific types of hazards, such as flood, landslide and other hazards of concern.
Maintain Elevation Certificates	Y	

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 Spokane 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 – organizations could partner with the community to educate the public or provide outreach assistance on natural hazard preparedness and mitigation.
- Information dissemination – organizations could partner with the community to provide hazard-related information to target audiences.
- Plan/project implementation – organizations 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 14-3 identifies 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	Spokane County Conservation District
Organization focused on individuals with access and functional needs populations	Y	The County works closely with local advocacy groups, Access 4 All, and the Accessible Community Advisory Committee (ACAC)

Table 14-3.
Education and Outreach

Program/Organization	Available?	Department/Agency/Position and Brief Description
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.
Other		

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 the Public Protection Classification for Spokane County.

Table 14-4.
Countywide Public Protection Classification

Community	Protection Class Grade
Airway Heights	4
Cheney	5
Deer Park	4
Fairfield	6
Latah	7
Liberty Lake	2
Medical Lake	6
Millwood	2
Rockford	6
Spangle	6
Spokane	3
Spokane County	N/A
Spokane County F.P.D. 1	3
Spokane County F.P.D. 10	5
Spokane County F.P.D. 11	6
Spokane County F.P.D. 12	7
Spokane County F.P.D. 13	6
Spokane County F.P.D. 2	7
Spokane County F.P.D. 3	5
Spokane County F.P.D. 4	5
Spokane County F.P.D. 5	8
Spokane County F.P.D. 8	4
Spokane County F.P.D. 9	4
Spokane Valley	2
Waverly	7

Data effective as of April 2019

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.
Countywide Building Code Effectiveness Grading

Community	Commercial	Dwelling
Airway Heights	5	5
Cheney	3	3
Deer Park	4	4
Fairfield	2	3
Latah	Not Ranked	Not Ranked
Liberty Lake	3	4
Medical Lake	4	4
Millwood	2	3
Rockford	2	3
Spangle	2	3
Spokane	3	4
Spokane County	2	3
Spokane County F.P.D. 1	2	3
Spokane County F.P.D. 10	2	3
Spokane County F.P.D. 11	2	3
Spokane County F.P.D. 12	2	3
Spokane County F.P.D. 13	2	3
Spokane County F.P.D. 2	2	3
Spokane County F.P.D. 3	2	3
Spokane County F.P.D. 4	2	3
Spokane County F.P.D. 5	2	3
Spokane County F.P.D. 8	2	3
Spokane County F.P.D. 9	2	3
Spokane Valley	3	3
Waverly	5	5

Data effective as of April 2019

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. Spokane County Department of Emergency Management (DEM) has the mission to assess and plan for all hazards and emergencies, and works with other public safety and local government agencies to ensure public welfare for all of its citizens.

Spokane County Fire Departments and Districts

Spokane County's fire departments and districts serve its citizens, in addition to the local municipalities' fire departments. Within these fire districts and departments, there are a total of [redacted] fire stations which protect the county during emergency situations. The purpose of Spokane County Fire Districts is the provision of fire prevention services, fire suppression services, emergency medical services, and for the protection of life and property. Fire prevention in Spokane County is all-encompassing, including rural and wildland areas. The Firewise Community Program is administered in coordination with the WA DNR and USFS (among others). Public outreach efforts have also occurred throughout the County, including partnerships with the various school districts, where Firewise information and mitigation-related projects are presented.

Spokane County is a StormReady® County

Spokane County is also a recognized StormReady® County under the National Weather Service Program. 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 events. The 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.

Response Plans

Spokane County and its jurisdictions have developed various response plans to be utilized during incident-specific events. Such plans provide guidance to first responders and community members in what actions need to be taken during such event. These plans go through a training and exercise phase to help ensure quick response when the plans are activated.

CHAPTER 15.
PLAN MAINTENANCE

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

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

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

15.1.1 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 team and the steering committee have established goals and objectives and have prioritized mitigation actions that will be implemented through existing plans, policies and programs.

Spokane County Emergency Management will have 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).

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 Spokane 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 completely 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.

15.1.2 Annual Review

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 Deputy 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 C). The Emergency Management Program Specialist will then prepare a formal annual report on the progress of the plan. This report should be used as follows:

- Posted on the Spokane 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.

15.1.3 Future Plan Updates

In addition to the annual review, three years after adoption of the hazard mitigation plan, the Deputy Director may decide to apply for a planning grant through FEMA to start the 2025 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 2020 hazard mitigation plan update.

The Deputy 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 local jurisdiction councils, 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.

15.1.4 Implementation through Existing Programs

Spokane 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 its jurisdictional partners, through adoption of comprehensive plans and zoning ordinances, have planned for the impact of natural hazards. The plan development process provided the County and its cities 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 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 potentially 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
- 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.

15.1.5 Continued Public Involvement

Spokane 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 county's website and the annual progress reports that will be provided to the media.

All planning partners have agreed to provide links to the Hazard Mitigation Plan website on their websites to increase avenues of public access to the plan. The Spokane Department 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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Spokane County
Hazard Mitigation Plan

APPENDIX A.
ACRONYMS AND DEFINITIONS

APPENDIX A.
ACRONYMS AND DEFINITIONS

ACRONYMS

ASHRAE—American Society of Heating, Refrigerating, and Air-Conditioning Engineers
CFR—Code of Federal Regulations
cfs—cubic feet per second
CIP—Capital Improvement Plan
CRS—Community Rating System
CWPP—Community Wildfire Protection Plan
DEM—Spokane Department of Emergency Management
DFIRM—Digital Flood Insurance Rate Maps
DMA —Disaster Mitigation Act
DNA—Washington Department of Natural Resources
DSO—Dam Safety Office
EPA—U.S. Environmental Protection Agency
ESA—Endangered Species Act
FBFM—Fire Behavior Fuel Model
FCAAP—Flood Control Assistance Account Program
FEMA—Federal Emergency Management Agency
FERC—Federal Energy Regulatory Commission
FIRM—Flood Insurance Rate Map
FRCC—Fire regime condition class
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
NOAA—National Oceanic and Atmospheric Administration
NWS—National Weather Service
PDM—Pre-Disaster Mitigation Grant Program
PGA—Peak Ground Acceleration
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
THIRA— Threat and hazard identification and risk assessment
UBC—Uniform Building Code
USGS—U.S. Geological Survey
WAC—Washington Administrative Code
WRIA—Water Resource Inventory Area

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.

Acre-Foot: An acre-foot is the amount of water it takes to cover 1 acre to a depth of 1 foot. This measure is used to describe the quantity of storage in a water reservoir. An acre-foot is a unit of volume. One acre foot equals 7,758 barrels; 325,829 gallons; or 43,560 cubic feet. An average household of four will use approximately 1 acre-foot of water per year.

Asset: An asset is any man-made or natural feature that has value, including, but not limited to, people; buildings; infrastructure, such as bridges, roads, sewers, and water systems; lifelines, such as electricity and communication resources; and environmental, cultural, or recreational features such as parks, wetlands, and landmarks.

Base Flood: The flood having a 1% chance of being equaled or exceeded in any given year, also known as the "100-year" or "1% chance" flood. The base flood is a statistical concept used to ensure that all properties subject to the National Flood Insurance Program 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 National Flood Insurance Program that rewards participating communities (provides incentives) for exceeding the minimum requirements of the National Flood Insurance Program 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: Common measurement for stream discharge or river flow. 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 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: Flood Insurance Rate Maps are the official maps on which the Federal Emergency Management Agency (FEMA) has delineated the Special Flood Hazard Area.

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 Flood Insurance Rate Map. In most cases, a community Flood Insurance Rate Map 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.

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: Authorized under Section 202 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, the program 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 National Flood Insurance Program-insured property that, since 1978 and regardless of any changes of ownership during that period, has experienced:

- Four or more paid flood losses in excess of $1000.00; or
- Two paid flood losses in excess of $1000.00 within any 10-year period since 1978 or
- Three or more paid losses that equal or exceed the current value of the insured property.

Return Period (or Mean Return Period): This term refers to the average period of time in years between occurrences of a particular hazard (equal to the inverse of the annual frequency of occurrence).

Riverine: Of or produced by a river. Riverine floodplains have readily identifiable channels. Floodway maps can only be prepared for riverine floodplains.

Risk: Risk is the estimated impact that a hazard would have on people, services, facilities and structures in a community. Risk measures the likelihood of a hazard occurring and resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate or low likelihood of sustaining damage above a particular threshold due to occurrence of a specific type of hazard. Risk also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Risk Assessment: Risk assessment is the process of measuring potential loss of life, personal injury, economic injury, and property damage resulting from hazards. This process assesses the vulnerability of people, buildings and infrastructure to hazards and focuses on (1) hazard identification; (2) impacts of hazards on physical, social and economic assets; (3) vulnerability identification; and (4) estimates of the cost of damage or costs that could be avoided through mitigation.

Risk Ranking: This ranking serves two purposes, first to describe the probability that a hazard will occur, and second to describe the impact a hazard will have on people, property and the economy. Risk estimates

for the City are based on the methodology that the City used to prepare the risk assessment for this plan. The following equation shows the risk ranking calculation:

Risk Ranking = Probability + Impact (people + property + economy)

Robert T. Stafford Act: The Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 100-107, was signed into law on November 23, 1988. This law amended the Disaster Relief Act of 1974, Public Law 93-288. The Stafford Act is the statutory authority for most federal disaster response activities, especially as they pertain to FEMA and its programs.

Sinkhole: A collapse depression in the ground with no visible outlet. Its drainage is subterranean. It is commonly vertical-sided or funnel-shaped.

Special Flood Hazard Area: The base floodplain delineated on a Flood Insurance Rate Map. The special flood hazard area is mapped as a Zone A in riverine situations and zone V in coastal situations. The special flood hazard area 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 and contents and the economic value of its functions. Like indirect

damages, the vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power. Flooding of an electric substation would affect not only the substation itself but businesses as well. Often, indirect effects can be much more widespread and damaging than direct effects.

Watershed: A watershed is an area that drains downgradient from areas of higher land to areas of lower land to the lowest point, a common drainage basin.

Wildfire: These terms refer to any uncontrolled fire occurring on undeveloped land that requires fire suppression. The potential for wildfire is influenced by three factors: the presence of fuel, topography and air mass. Fuel can include living and dead vegetation on the ground, along the surface as brush and small trees, and in the air such as tree canopies. Topography includes both slope and elevation. Air mass includes temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount, duration, and the stability of the atmosphere at the time of the fire. Wildfires can be ignited by lightning and, most frequently, by human activity including smoking, campfires, equipment use and arson.

Windstorm: Windstorms are generally short-duration events involving straight-line winds or gusts exceeding 50 mph. These gusts can produce winds of sufficient strength to cause property damage. Windstorms are especially dangerous in areas with significant tree stands, exposed property, poorly constructed buildings, mobile homes (manufactured housing units), major infrastructure, and aboveground utility lines. A windstorm can topple trees and power lines; cause damage to residential, commercial, critical facilities; and leave tons of debris in its wake.

Zoning Ordinance: The zoning ordinance designates allowable land use and intensities for a local jurisdiction. Zoning ordinances consist of two components: a zoning text and a zoning map.

APPENDIX B.
STATUS UPDATE OF 2015 SPOKANE COUNTY ACTION ITEMS
ALL-HAZARD MITIGATION PLAN

APPENDIX B.
PUBLIC OUTREACH MATERIALS AND RESULTS

Published as a separate document due to size.

Spokane County
Hazard Mitigation Plan

APPENDIX C.
ANNUAL PROGRESS REPORTS

APPENDIX C.
ANNUAL PROGRESS REPORTS

Spokane County
Hazard Mitigation Plan
Annual Progress Report

Reporting Period: (Insert reporting period)

Background: Spokane County and participating cities and special purpose districts in the county developed a hazard mitigation plan to reduce risk from all hazards by identifying resources, information, and strategies for risk reduction. The federal Disaster Mitigation Act of 2000 requires state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. To prepare the plan, the participating partners organized resources, assessed risks from natural hazards within the county, developed planning goals and objectives, reviewed mitigation alternatives, and developed an action plan to address probable impacts from natural hazards. By completing this process, these jurisdictions maintained compliance with the Disaster Mitigation Act, achieving eligibility for mitigation grant funding opportunities afforded under the Robert T. Stafford Act. The plan can be viewed on-line at:

http://www.spokanecounty.org/emergencymgmt/content.aspx?c=2238

Summary Overview of the Plan's Progress: The performance period for the Hazard Mitigation Plan became effective on February 27, 2015, 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 _____ 2025. As of this reporting period, the performance period for this plan is considered to be __% complete. The Hazard Mitigation Plan has targeted _____ hazard mitigation initiatives to be pursued during the 5-year performance period. As of the reporting period, the following overall progress can be reported:

- __ initiatives (__%) reported ongoing action toward completion.
- __ initiatives (__%) were reported as being complete.
- __ 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 Spokane 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 Spokane 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 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 _____, 202_. It was determined through the plan's development process that a steering committee would remain in service to oversee maintenance of the plan. At a minimum, the steering committee will provide technical review and oversight on the development of the annual progress report. It is anticipated that there will be turnover in the membership annually, which will be documented in the progress reports. For this reporting period, the steering committee membership is as indicated in Table 1.

TABLE 1.
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]				

TABLE 2.
ACTION PLAN MATRIX

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O,✓)
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Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				

Completion status legend:
- ✓= Project Completed
- O = Action ongoing toward completion
- X = No progress at this time

Changes That May Impact Implementation of the Plan: *(Insert brief overview of any significant changes in the planning area that would have a profound impact on the implementation of the plan. Specify any changes in technical, regulatory and financial capabilities identified during the plan's development)*

Recommendations for Changes or Enhancements: Based on the review of this report by the Hazard Mitigation Plan Steering Committee, the following recommendations will be noted for future updates or revisions to the plan:

- _____
- _____
- _____
- _____
- _____
- _____

Public review notice: *The contents of this report are considered to be public knowledge and have been prepared for total public disclosure. Copies of the report have been provided to the governing boards of all planning partners and to local media outlets and the report is posted on the Spokane County Hazard Mitigation Plan website. Any questions or comments regarding the contents of this report should be directed to:*

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APPENDIX D.
ADOPTION RESOLUTIONS FROM PLANNING PARTNERS

APPENDIX D
PLAN ADOPTION RESOLUTIONS

To Be Provided With Final Release