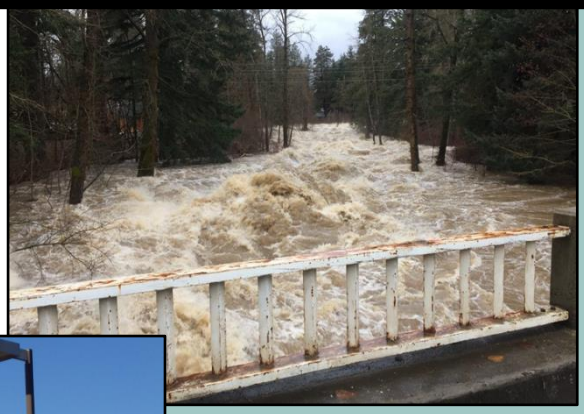
2020

Multi-Hazard Mitigation Plan

Klickitat County, Washington



Klickitat County

Department of Emergency Management

4/2/2020

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FOREWORD

Klickitat County Department of Emergency Management is dedicated to the protection of life, property, economic, environmental, and historic and cultural resources throughout the county. Seeking to inform and educate the public and reduce the vulnerability of citizens and infrastructure in Klickitat County through comprehensive disaster planning and mitigation.

"Hazard mitigation is sustained action to reduce or eliminate the long-term risk to human life and property from hazards. Multi-hazard mitigation planning is a process used by state, tribal, and local governments to engage stakeholders, identify hazards and vulnerabilities, develop a long-term strategy to reduce risk and future losses, and implement the plan, taking advantage of a wide range of resources. A state mitigation plan demonstrates commitment to reduce risks from natural hazards and serves as a guide for decision makers for reducing the effects of natural hazards as resources are committed"[1]

The **Klickitat County Multi-Hazard Mitigation Plan (MHMP)** is a new plan developed by the Klickitat County Multi-Hazard Mitigation Plan Planning Team in cooperation with Northwest Management, Inc. of Moscow, Idaho. This plan satisfies the requirements for county Multi-Hazard Mitigation Plans under 44 CFR Part 201.6.

[1] Federal Emergency Management Agency. "Local Multi-Hazard Mitigation Planning Guidance." July 1, 2008

TABLE OF CONTENTS

List of Figures

List of Tables

APPROVAL LETTER FROM FEMA

U.S. Department of Homeland Security
FEMA Region 10
130 228th Street, SW
Bothell, WA 98021-8627

FEMA

October 26, 2020

The Honorable Jim Sizemore
Chairman, Klickitat County Commission
205 S Columbus
Goldendale, Washington 98620

Dear Chairman Sizemore:

On October 26, 2020, the United States Department of Homeland Security's Federal Emergency Management Agency (FEMA) Region 10, approved the Klickitat County Hazard Mitigation Plan as a multi-jurisdictional local plan as outlined in Code of Federal Regulations Title 44 Part 201. This approval provides the below jurisdictions eligibility to apply for the Robert T. Stafford Disaster Relief and Emergency Assistance Act's, Hazard Mitigation Assistance (HMA) grants projects through October 25, 2025, through your state:

Klickitat County	City of Goldendale	Underwood Conservation District
City of Bingen	Central Klickitat Conservation District	Public Hospital District #1 of Klickitat County
City of White Salmon	Eastern Klickitat Conservation District	

FEMA individually evaluates all application requests for funding according to the specific eligibility requirements of the applicable program. Though a specific mitigation activity or project identified in the plan may meet the eligibility requirements, it may not automatically receive approval for FEMA funding under any of the aforementioned programs.

Over the next five years, we encourage your communities to follow the plan's schedule for monitoring and updating, and to develop further mitigation actions. To continue eligibility, jurisdictions must review, revise as appropriate, and resubmit the plan within five years of the original approval date.

If you have questions regarding your plan's approval or FEMA's mitigation grant programs, please contact Kevin Zerbe, State Mitigation Strategist with Washington Emergency Management Division, at (253) 512-7467, who coordinates and administers these efforts for local entities.

Sincerely,

KRISTEN C MEYERS

Digitally signed by KRISTEN C MEYERS
Date: 2020.10.27 07:50:54 -07'00'

Kristen Meyers, Director
Mitigation Division

cc: Tim Cook, Washington Emergency Management Division

ADOPTION RESOLUTIONS

KLICKITAT COUNTY

BEFORE THE BOARD OF COUNTY COMMISSIONER
Klickitat County, Washington

IN THE MATTER OF }
DECLARING THE ADOPTION }
OF THE KLICKITAT COUNTY }
MULTI-HAZARD MITIGATION PLAN }

Resolution # 11120

WHEREAS, the Board of County Commissioners, meeting in regular session, having before it the need to consider declaring the adoption of the Multi-Hazard Mitigation Plan; and

WHEREAS, the Board of County Commissioners supports the Klickitat County Multi-Hazard Mitigation Plan and;

WHEREAS, the Department of Emergency Management, on behalf of the Board of County Commissioners has facilitated the plan creation and participated with other jurisdictions and stakeholders in the development of the Klickitat County Multi-Hazard Mitigation Plan and;

WHEREAS, the Klickitat County Multi-Hazard Mitigation Plan will serve as a guide for planning as related to FEMA Pre-Disaster Mitigation and other purposes as deemed appropriate.

NOW, THEREFORE, BE IT RESOLVED, that Board of County Commissioners do hereby adopt, support, and will facilitate the Klickitat County Multi-Hazard Mitigation Plan's implementation as deemed appropriate.

Dated this 18th day of August 2020

BOARD OF COUNTY COMMISSIONERS
Klickitat County, Washington

Jim Sizemore
Chairman, Jim Sizemore

Commissioner, David M. Sauter

/s/ Rex Johnston
Commissioner, Rex Johnston

ATTEST:
Clerk of the Board

in and for the County of Klickitat
State of Washington

CITY OF GOLDENDALE

CITY OF GOLDENDALE
GOLDENDALE, WASHINGTON

RESOLUTION NO. 711

A RESOLUTION OF THE CITY OF GOLDENDALE DECLARING SUPPORT AND ADOPTION OF THE KLICKITAT COUNTY MULTI-HAZARD MITIGATION PLAN.

WHEREAS, the City of Goldendale supports the Klickitat County Multi-Hazard Mitigation Plan; and

WHEREAS, the City of Goldendale has participated in the development of the Klickitat County Multi-Hazard Mitigation Plan; and

WHEREAS, the Klickitat County Multi-Hazard Mitigation Plan will be utilized as a guide for planning as related to Federal Emergency Management Agency (FEMA) pre-disaster mitigation and other purposes as deemed appropriate.

NOW, THEREFORE, BE IT RESOLVED by the City Council as follows:

SECTION 1:
The City of Goldendale does hereby adopt, support, and will facilitate the Klickitat County Multi-Hazard Mitigation Plan's implementation as deemed appropriate.

SECTION 2:
This resolution shall be effective five (5) days after its publication, according to law.

PASSED AND ADOPTED BY THE CITY COUNCIL OF THE CITY OF GOLDENDALE, WASHINGTON, this 7th day of September 2020.

Michael Canon, Mayor

ATTEST:

Connie Byers, Clerk-Treasurer

CITY OF WHITE SALMON

RESOLUTION 2020-08-504

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF WHITE SALMON, WASHINGTON, ADOPTING AND DECLARING SUPPORT OF THE KLICKITAT COUNTY MULTI-HAZARD MITIGATION PLAN

WHEREAS, the City of White Salmon supports the Klickitat County Multi-Hazard Mitigation Plan; and

WHEREAS, the City of White Salmon has participated in the development of the Klickitat County Multi-Hazard Mitigation Plan; and

WHEREAS, the Klickitat County Multi-Hazard Mitigation Plan will be utilized as a guide for planning as related to FEMA pre-disaster mitigation and other purposes as deemed appropriate; and

NOW, THEREFORE, be it resolved by the City Council of the City of White Salmon hereby adopts, supports and will facilitate the implementation of the Klickitat County Multi-Hazard Mitigation Plan as deemed appropriate.

This resolution shall take effect after its passage by the City Council.

ADOPTED by the Council of the City of White Salmon, Washington. Dated this 19th day of August, 2020.

Marla Keethler, Mayor

ATTEST:

Jan Brending, Clerk Treasurer

APPROVED AS TO FORM:

Kenneth B. Woodrich, City Attorney

CITY OF BINGEN

RESOLUTION NO. 2020-006

A RESOLUTION OF THE CITY OF BINGEN, WASHINGTON, DECLARING SUPPORT AND ADOPTION OF THE KLICKITAT COUNTY NATURAL HAZARD MITIGATION PLAN

WHEREAS, the City Council of Bingen, Washington is in regular session this 15th day of September 2020, and all members of the City Council have had notice of the time, place, and purpose of said meeting; and

WHEREAS, the City of Bingen supports the Klickitat County Natural Hazard Mitigation Plan; and

WHEREAS, the City of Bingen has participated in the development of the Klickitat County Natural Hazard Mitigation Plan; and

WHEREAS, the Klickitat County Natural Hazard Mitigation Plan will be utilized as a guide for planning as related to FEMA pre-disaster mitigation and other purposes as deemed appropriate.

NOW THEREFORE, BE IT RESOLVED, that the City Council of the Bingen, Washington do hereby adopt, support, and will facilitate the Klickitat County Natural Hazard Mitigation Plan's Implementation as deemed appropriate.

Section 1. Effective Date. This Resolution shall take effect and be in force immediately upon its passage.

ADOPTED by the City Council of the City of Bingen, Washington, and APPROVED by its Mayor, at a regularly scheduled open public meeting thereof this 15th day of September, 2020.

Attest:

Clerk

Mayor

Approved as to Form:

Attorney

KLICKITAT VALLEY HEALTH

Klickitat Valley HEALTH

PUBLIC HOSPITAL DISTRICT NO. 1 OF KLICKITAT COUNTY
Resolution No. 2020-13

A RESOLUTION of the Board of Commissioners of Public Hospital District No. 1 of Klickitat County, Washington declaring county support and adoption of the Klickitat County Hazard Mitigation Plan.

Whereas, the Public Hospital District No. 1 of Klickitat County Board of Commissioners supports the Klickitat County Hazard Mitigation Plan, and

Whereas, the Public Hospital District No. 1 of Klickitat County Board of Commissioners has participated in the development of the Klickitat County Hazard Mitigation Plan, and

Whereas, The Klickitat County Hazard Mitigation Plan will be utilized as a guide for planning as related to FEMA Pre-Disaster Mitigation and other purposes as deemed appropriate.

Therefore be it resolved, that the Public Hospital District No. 1 of Klickitat County Board of Commissioners do hereby adopt, support, and will facilitate the Klickitat County Hazard Mitigation Plan's implementation as deemed appropriate.

RESOLVED AND APPROVED by the Commission of Public Hospital District No. 1 of Klickitat County, Washington at a regular open public meeting held this 19th day of August, 2020, the following Commissioners being present and voting in favor of this resolution.

President:

Vice-President:

Secretary: DocuSigned by:

Commissioner:

Commissioner: DocuSigned by:

CENTRAL KLICKITAT CONSERVATION DISTRICT

Central Klickitat Conservation District

Resolution No. 2020-01

Adoption of the Klickitat County Hazard Mitigation Plan

A RESOLUTION of the Board of Supervisors of Central Klickitat Conservation District, declaring CKCD's support and adoption of the Klickitat County Natural Hazard Mitigation Plan.

The Board of Supervisors of Central Klickitat Conservation District, Washington, hereby resolves as follows:

Whereas, The Central Klickitat Conservation District Board of Supervisors supports the Central Klickitat County Natural Hazard Mitigation Plan, and

Whereas, The Central Klickitat Conservation District has participated in the development of the Central Klickitat County Natural Hazard Mitigation Plan, and

Whereas, The Central Klickitat County Natural Hazard Mitigation Plan will be utilized as a guide for planning as related to FEMA Pre-Disaster Mitigation and other purposes as deemed appropriate.

Whereas, this resolution shall become effective immediately upon its adoption.

Therefore, be it resolved, that the Central Klickitat Conservation District Board of Supervisors do hereby adopt, support, and will facilitate the Klickitat County Natural Hazard Mitigation Plan's implementation as deemed appropriate.

ADOPTED BY THE BOARD OF SUPERVISORS of Central Klickitat Conservation District, Washington, at a regular open public meeting thereof, and effective this 19th day of August 2020.

8/27/2020

Terry Nickels, Board Chair Date

EASTERN KLICKITAT CONSERVATION DISTRICT

Eastern Klickitat Conservation District

Resolution No. 2020-01

Adoption of the Klickitat County Hazard Mitigation Plan

A RESOLUTION of the Board of Supervisors of Eastern Klickitat Conservation District, declaring EKCD's support and adoption of the Klickitat County Natural Hazard Mitigation Plan.

The Board of Supervisors of Eastern Klickitat Conservation District, Washington, hereby resolves as follows:

Whereas, The Eastern Klickitat Conservation District Board of Supervisors supports the Klickitat County Natural Hazard Mitigation Plan, and

Whereas, The Eastern Klickitat Conservation District has participated in the development of the Klickitat County Natural Hazard Mitigation Plan, and

Whereas, The Klickitat County Natural Hazard Mitigation Plan will be utilized as a guide for planning as related to FEMA Pre-Disaster Mitigation and other purposes as deemed appropriate.

Whereas, this resolution shall become effective immediately upon its adoption.

Therefore be it resolved, that the Eastern Klickitat Conservation District Board of Supervisors do hereby adopt, support, and will facilitate the Klickitat County Natural Hazard Mitigation Plan's implementation as deemed appropriate.

ADOPTED BY THE BOARD OF SUPERVISORS of Eastern Klickitat Conservation District, Washington, at a regular open public meeting thereof, and effective this 25th day of August 2020.

Ron Juris, Board Chair Date

UNDERWOOD CONSERVATION DISTRICT

Underwood Conservation District

Resolution No. 2020-03

Adoption of Klickitat County Multi-Hazard Mitigation Plan

A RESOLUTION of the Board of Supervisors of Underwood Conservation District, declaring the District's support and adoption of the Klickitat County Multi-Hazard Mitigation Plan.

The Board of Supervisors of Underwood Conservation District, Washington, hereby resolves as follows:

Whereas, the Underwood Conservation District ("District") supports the Klickitat County Hazard Mitigation Plan, and

Whereas, the District has participated in the development of the Klickitat County Hazard Mitigation Plan, and

Whereas, the Klickitat County Hazard Mitigation Plan will serve as a guide for planning as related to FEMA Pre-Disaster Mitigation and other purposes as deemed appropriate, and

Whereas, this resolution shall become effective immediately upon its adoption.

Therefore be it resolved that the District does hereby adopt, support and will facilitate the Klickitat County Multi-Hazard Mitigation Plan as deemed appropriate.

ADOPTED BY THE BOARD OF SUPERVISORS of Underwood Conservation District, Washington, at a regular open public meeting thereof, and effective this 18th day of August, 2020.

Paul Newell, Chair
Vice

CHAPTER 1 - INTRODUCTION

OVERVIEW OF THIS PLAN AND ITS DEVELOPMENT

In 2018, the Klickitat County Department of Emergency Management (KCDEM) contracted with Northwest Management Inc. (NMI) to conduct an in-depth risk assessment for natural hazards in Klickitat County, Washington. Hazardous natural events occur annually in Klickitat County; thus, programs and projects that mitigate the impacts of these hazards benefit the residents, property, infrastructure, and the economy.

This Multi-Hazard Mitigation Plan (MHMP) for Klickitat County, Washington, is the result of analysis, professional collaboration, and assessments of natural hazards and other factors focused on reducing threats to people, structures, infrastructure, and unique ecosystems in Klickitat County. This document assists with the identification and assessment of various potential hazards and helps maintain the County's eligibility for grants and other funding. This MHMP will include the County's Community Wildfire Protection Plan as a component within the main document.

The planning team responsible for implementing this project was led by the Klickitat County Department of Emergency Management with assistance from Northwest Management, Inc. Agencies and organizations that participated in the planning process included:

- Klickitat County Dept. of Emergency Management
- Klickitat County Building Department
- Klickitat Valley Health
- Klickitat Public Utility District
- Klickitat County Natural Resources
- Klickitat County Planning Department
- Klickitat County Sheriff's Office
- Washington State Parks
- Washington State Patrol
- Underwood Fruit Company
- City of Goldendale
- City of Goldendale Public Works
- Goldendale Fire Department
- City of White Salmon
- Bingen Public Works
- City of Bingen
- Washington Department of Natural Resources
- Central Klickitat Conservation District
- Eastern Klickitat Conservation District
- Underwood Conservation District
- U.S. Army Corps of Engineers
- Klickitat County Fire District 3
- Klickitat County Fire District 4
- Klickitat County Public Health
- Klickitat County Public Works
- White Salmon Fire Department
- Washington Gorge Action Programs
- Puget Sound Energy
- Community of Trout Lake
- Washington Gorge Action Programs

PLANNING PHILOSOPHY AND GOALS

KLICKITAT COUNTY PLANNING PHILOSOPHY

Promote awareness of natural hazards, County-Wide, and propose workable solutions to mitigate the effects of natural hazards. The MHMP is an action plan and depends upon people and partnerships to carry it forward.

MISSION STATEMENT

To make Klickitat County residents, economy, resources and ecosystems less vulnerable to the negative effects of natural and man-made hazards.

JURISDICTIONAL PLANNING AND MITIGATION GOALS

As part of the 2018-19 planning process, each participating jurisdiction in Klickitat County was asked to either develop its own set of planning and mitigation goals or adopt those of the county. Through the process of developing planning and mitigation goals, adopting jurisdictions were able to reflect on and keep track of their own planning and mitigation prioritize as well as changes in their hazard vulnerability over time. During one of the earlier planning team meetings, the group discussed several overall short-term and long-term goals as well as goals for the planning process itself. Members of the planning team were given a list of example goals statements and a blank goals worksheet to fill out and return. The goals submitted by each jurisdiction are summarized as follows:

KLICKITAT COUNTY GOALS:

Klickitat County planning and mitigation goals are recognized by the cities of Bingen, Goldendale, and White Salmon, Underwood Conservation District, Eastern, Central, and Western Klickitat Conservation Districts.

1. Prioritize the protection of people, structures, infrastructure, and unique ecosystems that contribute to our way of life and the sustainability of the local and regional economy;
2. Identify and evaluate the hazards that could impact the residents of Klickitat County;
3. Educate residents about the unique challenges and benefits of hazard preparedness in the county;
4. Improve enrollment in the National Flood Insurance Program within communities that are at risk to floods through increased outreach and education;
5. Establish and prioritize mitigation strategies in Klickitat County and the adopting jurisdictions;
6. Increase the resilience of local communities, businesses and residents to the impacts of hazards;
7. Encourage collaboration between local stakeholders, residents, organizations, first responders, and various government agencies to promote hazard preparedness through communication, planning and response and;
8. Reduce the impact of hazard events and potential losses incurred by both public and private residents and entities.

KLICKITAT VALLEY HEALTH GOALS:

1. Reduce the impact of hazard events and potential losses incurred on the KVH campus;
2. To educate employees and patients about the unique challenges of emergency preparedness in the area;
3. Consider policies to alleviate potential hazard risks and impact as it relates to future development;
4. Create mitigation priorities and mitigation strategies for the KVH campus;
5. Strategically locate and plan infrastructure and risk reduction projects that take into consideration the impacts of natural hazards and;
6. Coordinate interdepartmentally and with other agencies to ensure that the Emergency Operations Plan is successful and well understood

PLANNING MECHANISMS AND CAPABILITIES

During the development of this Multi-Hazard Mitigation Plan, existing planning and management documents, programs, and policies were reviewed in order to avoid conflicting goals and objectives and to identify those that would enhance the hazard mitigation objectives outlined in this document. For a more exhaustive list of jurisdictional capabilities refer to Appendix 6; each adopting jurisdiction filled out a Capability Assessment form (an adaptation of FEMA worksheet 4.1) in order to provide a more complete picture of the resources that are already available for the purposes of natural hazard planning and mitigation. ***It should also be noted that all adopting jurisdictions have the ability and access to resources that are necessary to expand upon and improve existing policies and programs as needed.***

Klickitat County Comprehensive Emergency Management Plan (2017):

The purpose of the Comprehensive Emergency Management Plan (CEMP) is to coordinate and facilitate resources to minimize the impacts of disasters and emergencies on people, property, the environment and the economy of Klickitat County. The CEMP establishes responsibilities for agencies within Klickitat County and the coordination with organizations inside and outside of the County for preparation for, response to, recovery from, and mitigation of the potential effects of emergencies and disasters.

The CEMP is an all hazard plan that is promulgated by Klickitat County Board of Commissioners and Mayors of the participating cities within the County and applies to all local public and private entities and organizations participating and included in the plan.

Klickitat County 10 Year Economic Development Strategic Plan (2017):

The strategic plan serves as a blueprint for attracting new industry, retaining existing business, developing the workforce, and enhancing the county's quality of place. Ultimately, the plan will help position Klickitat County as an ideal location to operate a successful business, make capital investment, find a job, raise a family, and enjoy all that life has to offer. The strategies were developed with the goal of creating new jobs in the county and significantly increasing the region's tax base.

The Economic Development Strategic Plan was incorporated into this plan by reviewing potential growth in the County.

Klickitat County Community Wildfire Protection Plan (2018):

Klickitat County's recently adopted Community Wildfire Protection Plan identifies the fire risks throughout the County through the collaboration between planning members, stakeholders, and the public to determine areas that need fuel treatments to protect life and property.

Klickitat County Critical Areas Ordinance (2013):

This ordinance was reviewed during the development of the county's MHMP. The Critical Areas Ordinance (CAO) will reference the plan at the date of the next amendment.

This plan attempted to use the landslide section (5.2 Classification and designation) of the CAO to map potential landslide impact areas. The CAO also classifies unincorporated portions of the County as frequently flooded areas when they are within the floodplain and subject to ≥ 1% chance of flooding in a year.

Klickitat County Zoning Ordinance (Amended 2015):

This ordinance is related to planning and zoning for land use and development in the unincorporated territory of Klickitat County.

This ordinance was reviewed to determine future development trends throughout the County.

Bingen Point Incident Response Plan (2016):

The Bingen Point Incident Response Plan (BPIRP) is a comprehensive, all-hazards framework enabling response to incidents that may occur in or near The Point.

Mount St. Helens - Mount Adams Volcanic Region Coordination Plan (2014):

The purpose of this plan is to identify common coordination tasks and responsibilities, which various private sector, county, state, and federal agencies in the United States will need to accomplish before, during, and after a hazardous geologic incident at either volcano. This coordination plan supports (but does not supplant) each jurisdiction's and agency's comprehensive emergency management plan or emergency procedures.

The Mount St. Helens - Mount Adams Volcanic Region Coordination Plan was incorporated into this plan by including the preparedness recommendations into the Mitigation Action Plan.

Klickitat Valley Health has several emergency preparedness/response planning mechanisms on campus:

- Emergency Preparedness Committee: meets monthly at KVH. Made up of staff and board.
- Security Committee: meets monthly at KVH. Made up of staff and board.
- Hazard Vulnerability Analysis: conducted annually to evaluate priorities for training and mitigation efforts.
- Participating in the County HMP process to improve coordination and response.

- Regional planning efforts through Region IV (based in Vancouver, WA), REDI HCC (based in Tri-Cities, WA) and ATAB-6 (based in Oregon).

Columbia River Gorge National Scenic Area (2016)

Congress called for the preparation of the Management Plan for the Columbia River Gorge National Scenic Area (Management Plan) to ensure that land in the National Scenic Area is used consistently with the purposes and standards of the National Scenic Area Act. The Gorge Commission and Forest Service must revise the management plan at least every 10 years. The Gorge Commission and Forest Service adopted the management plan in 1991 with input from Indian tribal governments, county and city governments, state and federal agencies, citizens, and non-governmental organizations. In 2004, the agencies completed the first 10-year revision. The Gorge Commission may amend the management plan between revisions if it finds that conditions in the National Scenic Area have significantly changed. The Secretary of Agriculture must concur with revisions and amendments to the management plan.

The management plan contains the land use and resource protection standards, non-regulatory programs, and actions for protecting and enhancing Columbia River Gorge resources, as well as a description of roles and relationships of governments and agencies responsible for implementation of the National Scenic Area Act. The Forest Service develops the land use regulations for federal land and land in the "special management areas." The Gorge Commission develops the land use regulations for the general management area. The management plan does not directly apply to the 13 urban areas.

Incorporation of Other Planning Mechanisms

Klickitat County

Klickitat County will incorporate this Plan into the update of the Shorelines Master Program, where appropriate, in the revision currently underway. The County's Economic Development Plan is not due to be revised until 2027 but this Plan's update will be done in 2025 and will be included then. The County has a Six Year Transportation Improvement Plan (TIP) that is updated annually. The TIP was last updated in December of 2019 and will review this MHMP ahead of the 2020 update. The County uses the Washington State Department of Ecology's Stormwater Management Manual for Eastern Washington to manage stormwater. The County is currently in the process of adding a requirement to County Code which requires developers to follow the State's Stormwater Management Manual. The County will also review this MHMP during any newly proposed (or revised) zoning ordinances or building codes that occur during the life of this plan.

Bingen

The City of Bingen will utilize the information within this plan update when creating or updating other plans. The City has recently updated multiple plans and therefore will not be updating those plans again during the lifecycle of this MHMP. The information provided in this plan is based on the best available science and technology at the time of the update and should be utilized to update all additional pertinent

City plans, Ordinances, Policies, Regulations, etc. scheduled for update within five years from adoption of this MHMP.

GOLDENDALE

The City of Goldendale will utilize the information within this plan update when creating or updating other plans. The City has recently updated multiple plans and therefore will not be updating those plans again during the lifecycle of this MHMP. The information provided in this plan is based on the best available science and technology at the time of the update and should be utilized to update all additional pertinent City plans, Ordinances, Policies, Regulations, etc. scheduled for update within five years from adoption of this MHMP.

WHITE SALMON

The City of White Salmon will utilize the information within this plan update when creating or updating other plans. The City has recently updated multiple plans and therefore will not be updating those plans again during the lifecycle of this MHMP. The information provided in this plan is based on the best available science and technology at the time of the update and should be utilized to update all additional pertinent City plans, Ordinances, Policies, Regulations, etc. scheduled for update within five years from adoption of this MHMP.

KLICKITAT VALLEY HEALTH

- KVH will incorporate and reference the finished plan into our own Emergency Operations Plan
- KVH will continue to look for opportunities to jointly drill/plan with other jurisdictions within the community
- KVH will continue to seek and execute MOUs and MOAs for sharing resources in times of need and will seek to cooperate in all future planning
- KVH will use the hazards identified in the plan to inform our annual Hazard Vulnerability Analysis on an ongoing basis

CONSERVATION DISTRICTS (EASTERN & CENTRAL)

Central and Eastern Klickitat Conservation Districts will incorporate this Plan into their annual and five-year plans. If funding is available, each District will also develop a procedure on emergency actions related to the Plan.

UNDERWOOD CONSERVATION DISTRICT

UCD will incorporate this Plan into its annual and five-year plans. If funding is available, the District will also develop a procedure on emergency actions related to the Plan.

GUIDING PRINCIPLES

Effective November 1, 2004, a Multi-Hazard Mitigation Plan approved by the Federal Emergency Management Agency (FEMA) is required for Hazard Mitigation Grant Program (HMGP) and Pre-Disaster Mitigation Program (PDM) eligibility. The HMGP and PDM programs provide funding, through state

emergency management agencies, to support local mitigation planning and projects to reduce potential disaster damages.

The new local Multi-Hazard Mitigation Plan requirements for HMGP and PDM eligibility are based on the Disaster Mitigation Act of 2000, which amended the Stafford Disaster Relief Act to promote an integrated, cost effective approach to mitigation. Local Multi-Hazard Mitigation Plans must meet the minimum requirements of the Stafford Act-Section 322, as outlined in the criteria contained in 44 CFR Part 201. The plan criteria cover the planning process, risk assessment, mitigation strategy, plan maintenance, and adoption requirements.

In order to be eligible for project funds under the Flood Mitigation Assistance (FMA) program, communities are required under 44 CFR Part 79.6(d)(1) to have a mitigation plan that addresses flood hazards. On October 31st, 2007, FEMA published amendments to the 44 CFR Part 201 at 72 Federal Reg. to incorporate mitigation planning requirements for the FMA program (44 CFR Part 201.6). The revised Local Mitigation Plan Review Crosswalk (October 2011) used by FEMA to evaluate local hazard mitigation plans is consistent with the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended by Section 322 of the Disaster Mitigation Act of 2000, the National Flood Insurance Act of 1968, as amended by the National Flood Insurance Reform Act of 2004 and 44 Code of Federal Regulations (CFR) Part 201 – Mitigation Planning, inclusive of all amendments through July 1, 2008, was used as the official guide for development of a FEMA-compatible Klickitat County, Washington Multi-Hazard Mitigation Plan.

FEMA will only review a local Multi-Hazard Mitigation Plans submitted through the appropriate State Hazard Mitigation Officer (SHMO). Draft versions of local Multi-Hazard Mitigation Plans will not be reviewed by FEMA. FEMA will review the final version of a plan prior to local adoption to determine if the plan meets the criteria, but FEMA will be unable to approve it prior to adoption.

A FEMA designed plan will be evaluated on its adherence to a variety of criteria, including:

- Adoption by local governing bodies and multi-jurisdictional plan adoption
- Multi-jurisdictional planning participation and documentation of the planning process identifying hazards and profiling hazard events
- Assessing vulnerability by identifying assets, estimating potential losses, and analyzing development trends
- Multi-jurisdictional risk assessment
- Local hazard mitigation goals and identification, analysis, and implementation of mitigation measures
- Multi-jurisdictional mitigation strategy
- Monitoring, evaluating, and updating the plan
- Implementation through existing programs
- Continued public involvement

UNITED STATES GOVERNMENT ACCOUNTABILITY OFFICE (GAO)

Since 1984, wildland fires have burned an average of more than 850 homes each year in the United States and, because more people are moving into fire-prone areas bordering wildlands, the number of homes at risk is likely to grow. The primary responsibility for ensuring that preventative steps are taken to protect homes lies with homeowners. Although losses from fires made up only 2.2 percent of all insured catastrophic losses from 1991 to 2010, fires can result in billions of dollars in damages.

GAO was asked to assess, among other issues, (1) measures that can help protect structures from wildland fires, (2) factors affecting use of protective measures, and (3) the role technology plays in improving firefighting agencies' ability to communicate during wildland fires.

The GAO supports that the two most effective measures for protecting structures from wildland fires are: (1) creating and maintaining a buffer, called defensible space, from 30 to 100 feet wide around a structure, where flammable vegetation and other objects are reduced; and (2) using fire-resistant roofs and vents. In addition to roofs and vents, other technologies – such as fire-resistant windows and building materials, surface treatments, sprinklers, and geographic information systems mapping – can help in protecting structures and communities, but they play a secondary role[2].

Although protective measures are available, many property owners have not adopted them because of the time or expense involved, competing concerns such as aesthetics or privacy, misperceptions about wildland fire risks, and lack of awareness of their shared responsibility for fire protection. Federal, state, and local governments, as well as other organizations, are attempting to increase property owners' use of protective measures through education, direct monetary assistance, and laws requiring such measures. In addition, some insurance companies have begun to direct property owners in high risk areas to take protective steps.

STATE AND FEDERAL CWPP GUIDELINES

The Community Wildfire Protection Plan included in this document is compatible with FEMA requirements for a Multi-Hazard Mitigation Plan, while also adhering to the guidelines proposed in the National Fire Plan, and the Healthy Forests Restoration Act (2003). The Community Wildfire Protection Plan has been prepared in compliance with:

- Healthy Forests Restoration Act (2003).
- The Federal Land Assistance, Management and Enhancement (FLAME) Act (2009).
- The National Fire Plan: A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment 10-Year Comprehensive Strategy Implementation Plan (December 2006).

[2] Technology Assessment: Protecting Structures and Improving Communications during Wildland Fires. United States Government Accountability Office. April 2005. https://www.govinfo.gov/content/pkg/GAOREPORTS-GAO-05-380/pdf/GAOREPORTS-GAO-05-380.pdf

- National Cohesive Wildland Fire Management Strategy (March 2011). The Cohesive Strategy is a collaborative process with active involvement of all levels of government and non-governmental organizations, as well as the public, to seek national, all-lands solutions to wildland fire management issues.
- The Federal Emergency Management Agency's Region 10 guidelines for a Local Hazard Mitigation Plan as defined in 44 CFR parts 201 and 206, and as related to a fire mitigation plan chapter of a Multi-Hazard Mitigation Plan.
- National Association of State Foresters – guidance on identification and prioritizing of treatments between communities (2003).

UPDATE AND REVIEW GUIDELINES

Deadlines and Requirements for Regular Plan Reviews and Updates: In order to apply for a FEMA PDM project grant, Tribal and local governments must have a FEMA-approved mitigation plan. Tribal and local governments must have a FEMA-approved mitigation plan in order to receive HMGP project funding for disasters declared on or after November 1, 2004. States and Tribes must have a FEMA-approved Standard or Enhanced Mitigation Plan in order to receive non-emergency Stafford Act assistance (i.e., Public Assistance Categories C-G, HMGP, and Fire Management Assistance Grants) for disasters declared on or after November 1, 2004. State mitigation plans must be reviewed and reapproved by FEMA every three years. Local Mitigation Plans must be reviewed and reapproved by FEMA every five years.

Plan updates. In addition to the timelines referenced above, the Rule includes the following paragraphs that pertain directly to the update of State and local plans:

- ✓ §201.3(b)(5) [FEMA Responsibilities] …Conduct reviews, at least once every three years, of State mitigation activities, plans, and programs to ensure that mitigation commitments are fulfilled….
- ✓ §201.4(d) Review and updates. [State] Plan must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts, and changes in priorities and resubmitted for approval…every three years.
- ✓ §201.6(d) [Local] plans must be reviewed, revised if appropriate, and resubmitted for approval within five years in order to continue to be eligible for project grant funding.

Plan updates must demonstrate that progress has been made in the past three years (for State plans), or in the past five years (for local plans), to fulfill commitments outlined in the previously approved plan. This will involve a comprehensive review and evaluation of each section of the plan and a discussion of the results of evaluation and monitoring activities detailed in the Plan Maintenance section of the previously approved plan. FEMA will leave to State discretion, consistent with this plan update guidance, the documentation of progress made. Plan updates may validate the information in the previously approved plan or may involve a major plan rewrite. In any case, a plan update is NOT an annex to the previously approved plan; it must stand on its own as a complete and current plan.

The objective of combining these complementary guidelines is to facilitate an integrated natural hazard risk assessment, identify pre-hazard mitigation activities, and prioritize activities and efforts to achieve

the protection of people, structures, the environment, and significant infrastructure in Klickitat County while facilitating new opportunities for pre-disaster mitigation funding and cooperation.

National Flood Insurance Program Compliance

Effective October 1, 2008, the Federal Emergency Management Agency (FEMA) will require jurisdictions that participate in the National Flood Insurance Program (NFIP) to link their mitigation strategy with continued compliance with the National Flood Insurance Program. As of March 2019, Klickitat County is participating in NFIP and is in good standing. Klickitat County's NFIP ID# is 530099. Table 1 provides additional information about active NFIP policies in the county (this table is also included in the Analysis of Resources at Risk section in the Flood Risk Assessment).

Table 1) National Flood Insurance Policy statistics for participating adopting jurisdictions (January 1, 1978 to September 30, 2018).

Community	Policies In-Force	Insurance In-Force	Written Premium In-Force	FIRM Effective Date	Floodplain Manager	CRS Ranking
Klickitat County (Unincorporated)	53	$13,335,700	$49,180	7/2/1981	Mo-Chi Lindblad	10
Bingen	4	$904,800	$12,007	9/24/1984	Cheyenne Wright	10
Goldendale	2	$475,000	$2,546	9/17/1981	Larry Bellamy	10
White Salmon	1	$350,000	$415	3/18/1985	Pat Munyan	10

CHAPTER 2 - PLANNING PROCESS

DOCUMENTING THE PLANNING PROCESS

Documentation of the planning process, including public involvement, is required to meet FEMA's DMA 2000 (44CFR§201.6(b) and §201.6(c)(1)) for an updated local mitigation plan. This section includes a description of the planning process used to produce this plan, including how it was prepared, who was involved in the process, and how all the involved agencies participated.

THE PLANNING TEAM

The Klickitat County Department of Emergency Management led the planning team efforts alongside the Northwest Management, Inc. team. This planning team of resource professionals included county and city staff, fire protection districts, State and Federal Agencies:

• Lynn Ward	Klickitat County Building Department
• Tim Darland	U.S. Army Corps of Engineers
• Randi Heinzen	Klickitat County Department of Emergency Management
• Scott Koehler	Klickitat County Department of Emergency Management
• Caitlin Jones	Klickitat Valley Health
• Jonathan Lewis	Klickitat Valley Health
• Brandon Johnson	Klickitat Public Utility District
• Mark Pritchard	Klickitat Public Utility District
• Jacob Anderson	Klickitat County Natural Resources
• Fred Best	Puget Sound Energy
• Ruth Juris	Puget Sound Energy
• Lem Pratt	Washington State Parks
• Nate Hovinghoff	Washington State Patrol
• Dan Richardson	Underwood Conservation District
• Wes Long	Klickitat County Fire District 3
• David McCune	Klickitat County Fire District 4
• Tom Pierson	Licensed Geologist (retired from U.S. Geological Survey)
• Carla Dionne	Klickitat County Public Health
• Bill Hunsaker	White Salmon Building Official & Fire Department
• Matt Borden	Klickitat County Public Health
• Julie Buck	Klickitat County Department of Emergency Management
• Mike Canon	City of Goldendale
• Karl Enyeart	City of Goldendale Public Works
• Julianna Outiveros	Goldendale Fire Department
• Jeff King	Klickitat County Department of Emergency Management
• Alan Lawson	Washington Department of Natural Resources
• Loren Meagher	Klickitat Conservation Districts (Eastern & Central)
• Ron Schultz	Klickitat Public Utility District
• Rachel Haymon	Professor Emerita, UC Santa Barbara
• Bruce Bolme	Washington Gorge Action Programs

- Bill Hunsaker City of White Salmon
- Kevin English City of White Salmon
- David Spratt Bingen Public Works
- Cheyenne Wright City of Bingen
- Tim Webster Community of Trout Lake
- Amanda Smeller Klickitat County Planning Department
- Bruce Bolme Washington Gorge Action Programs
- Gordie Kelsey Klickitat County Public Works
- Kevin Leis Klickitat County Public Works
- Seth Scarola Klickitat County Public Works
- Carmen Knopes Klickitat County Sheriff's Office
- Bob Songer Klickitat County Sheriff's Office

The planning team met with residents of the county during the community risk assessments and at public meetings. Additionally, the press releases encouraged interested citizens to contact their county Emergency Management Department or attend planning meetings to ensure that all issues, potential solutions, and ongoing efforts were thoroughly discussed and considered by the planning team. When the public meetings were held, several of the planning team members were in attendance and shared their support and experiences with the planning process and their interpretations of the results.

The planning philosophy employed in this project included open and free sharing of information with interested parties. Information from federal and state agencies was integrated into the database of knowledge used in this project. Meetings with the planning team were held throughout the planning process to facilitate a sharing of information between cooperators.

Description of the Planning Process

The Klickitat County MHMP was developed through a collaborative process involving all the organizations and agencies listed above. The planning effort began by organizing and convening a multijurisdictional planning team. Following the first meeting in November of 2018 the planning team identified other individuals/agencies that should be invited. The planning team consists of any and all individuals who participated in meetings. The planning process included seven distinct phases:

1. **Organization of Resources** — Klickitat County and NMI worked together to develop a comprehensive list of potential participants as well as a project timeline and work plan. The 2018-19 planning team served as the basis for identifying stakeholders; however, that list was expanded in order to provide a comprehensive review and update of the risk assessments and mitigation strategies during the update process.
2. **Collection of Data** — NMI coordinated with the planning team to gather any new data and information about the extent and periodicity of hazards in Klickitat County to ensure a robust dataset for making inferences about hazards.
3. **Field Observations and Estimations** — Members of the planning team and NMI conducted field tours to help train and validate risk analyses. The planning team and NMI developed risk models and identified problem areas in order to better understand risks, juxtaposition of structures and infrastructure to risk areas, access, and potential mitigation projects.

4. **Mapping** — NMI developed a comprehensive database and map files relevant to pre-disaster mitigation control and mitigation, structures, resource values, infrastructure, risk assessments, and other related data.
5. **Public Involvement** —Klickitat County and NMI developed a plan to involve the public from the formation of the planning team. Using news releases, public meetings, public review of the draft documents, and acknowledgement of the final updated plan by the signatory representatives.
6. **Strategies and Prioritization —** NMI and the planning team representatives worked together to review the risk analyses and develop realistic mitigation strategies. The Klickitat County Emergency Manager met individually with representatives from each jurisdiction to identify informational needs for the plan and develop a strategy for continued involvement in the planning process.
7. **Drafting of the Report—**NMI drafted a final update report and worked with members of the planning team to review each section, incorporate public comments, proceed with the state and federal review processes, and adopt the final document.

MULTI-JURISDICTIONAL PARTICIPATION

CFR requirement §201.6(a)(4) calls for multi-jurisdictional planning in the development of Hazard Mitigation Plans that impact multiple jurisdictions. To be included as an adopting jurisdiction in the Klickitat County Multi-Hazard Mitigation Plan, jurisdictions were required to participate in at least one planning advisory meeting or meet with planning team leadership individually, provide a goals statement, submit at least one mitigation strategy, and adopt the final Plan by resolution.

The following is a list of jurisdictions that have met the requirements for an adopting jurisdiction and are thereby included in the MHMP:

Klickitat County	Klickitat Valley Health
City of Goldendale	Central Klickitat Conservation District
City of White Salmon	Eastern Klickitat Conservation District
City of Bingen	Underwood Conservation District

The monthly planning team meetings were the primary venue for authenticating the planning record. However, additional input was gathered from each jurisdiction in a combination of the following ways:

- planning team leadership attended local government meetings where planning updates were given, and information was exchanged. Additionally, representatives on the planning team periodically attended city council meetings to provide municipality leadership with updates on the project and to request reviews of draft material. All the adopting jurisdictions maintained active participation in the monthly planning meetings.
- planning team leadership and the representatives of the municipalities and special districts was facilitated as needed to ensure understanding of the process, collect data and other information, and develop specific mitigation strategies.

- Public meetings were hosted by the communities of Goldendale and White Salmon. Each meeting involved representatives of KCDEM, NMI, various adopting jurisdictions, planning partners, and nearby communities.
- Written correspondence was provided at least monthly between the planning team leadership and the contractor to provide updates to the cooperators on the document's progress, making requests for information, and facilitating feedback from participating jurisdiction. Klickitat County Department of Emergency Management representatives used an email distribution list of all the stakeholders to announce meetings, distribute meeting minutes, provide draft sections for review, and request information. All the participating jurisdictions provided comments to the draft document during the data gathering phase as well as during the various planning team and public review processes.

PLANNING TEAM MEETINGS

The Klickitat County Department of Emergency Management solicited participation from each jurisdiction and State and Federal Agencies throughout the county as well as local hazard experts. With the full integration of the Community Wildfire Protection Plan and the HMP processes, local fire districts were also asked to participate in the planning team meetings (see *Meeting Sign-in Sheets* section in Appendix 3). Throughout the meetings, the planning team reviewed the updated plan, aided in the risk and vulnerability analysis, developed public outreach efforts, and determined the best mitigation strategies for each jurisdiction. The planning kickoff meeting was held in November of 2018 with periodic meetings through December 2019. With the exception of the December meeting, which was a web-meeting, planning team members were able to either attend meetings in-person or online via Zoom web-meetings.

PUBLIC INVOLVEMENT

Public involvement in this plan was made a priority from the inception of the project. There were several ways that public involvement was sought and facilitated. In some cases, this led to members of the public providing information and seeking an active role in protecting their communities, while in other cases it led to the public becoming more aware of the process without becoming directly involved in the planning.

Under the auspices of the Klickitat County Department of Emergency Management, periodic press releases were submitted to local papers and radio stations and posted on the KCDEM websites Facebook page. Additional press releases provided information regarding the public meetings and public comment period including how to find electronic versions of the draft on the KCDEM Facebook page for review and instructions on how to submit comments through the KCDEM webpage. A record of published articles regarding the HMP is included in the Appendices.

PUBLIC MEETINGS

Public meetings were held on July 10th in Goldendale and July 11th in White Salmon. Planning team leadership presented a PowerPoint overview of the purpose of the plan, risk assessments for each hazard, and mitigation activities that may benefit Klickitat County. There were map displays to help facilitate open

discussion. Overall, there were several members of the planning group at each meeting along with community members. See Appendix 3 for documentation of public meetings.

Documented Review Process

Opportunities to review and comment on this Plan were provided at multiple points during the planning process for both the planning team and the general public. A record of the document's review process has been established through email correspondence, press releases, published articles, meeting minutes, and meeting sign-in sheets.

During regularly scheduled planning team meetings in 2018-2020, the group members met to discuss findings, review mapping analysis, and provide written comments on draft sections of the document. During the public meetings attendees observed map analyses, discussed general findings from the risk assessments, and made recommendations on potential project areas.

Sections of the draft Plan were delivered to the planning team members during the regularly scheduled meetings. The completed first draft of the document was presented to the group in June for full advisory review. The planning team spent several weeks proofreading and editing sections of draft. Many jurisdictions met individually to review and revise their specific risk assessment and mitigation strategy including the prioritization of action items. Once the group's review was completed, the draft document was released for public review and comment. The public review period remained open from March 5th, 2020 to March 19th, 2020.

Plan Maintenance

Evaluating and Updating the Plan

The Klickitat County MHMP will be reviewed on an annual basis by the planning team to determine the effectiveness of mitigation programs, projects, or other related activities, and to reflect changes in land development or programs that may affect mitigation priorities and/or strategies. The plan will be updated every five years. These five-year updates will be delivered to the Washington State Hazard Mitigation Program Manager for review and forwarding to the Federal Emergency Management Agency, Region X Office.

Annual Plan Review

To facilitate the annual plan review process, the Klickitat County Hazard Mitigation planning team will remain a semi-active group following the formal adoption of this plan and shall be charged with the responsibility of conducting an annual plan review. The Director of the Klickitat County Department of Emergency Management or his/her designee will be responsible for contacting the chairperson and members of the Klickitat County MHMP planning team and organizing the annual plan review process.

The Klickitat County MHMP planning team will review the current hazard mitigation strategies to determine their relevance to changing situations within Klickitat County, integrate known changes in State or Federal policy, and ensure mitigation strategies are addressing current and expected conditions.

Following the annual plan review process, the Chairperson of the Klickitat County Hazard Mitigation planning team, in cooperation with the Klickitat County Department of Emergency Management, will prepare a written report describing: 1) the plan review process; 2) the status of any current mitigation activities or projects; and 3) any deficiencies identified as a result of the plan evaluation. This report will be saved and referenced during the next five-year plan update.

FIVE-YEAR PLAN UPDATE

Updates to the Klickitat County MHMP shall be conducted on a five-year cycle and shall commence at the direction of the Director of the Klickitat County Department of Emergency Management. Upon such direction, staff from KCDEM, in cooperation with the chairperson of the Klickitat County MHMP planning team, will begin the process of updating the plan. It is advised that during the third annual update the planning team should begin the FEMA grant process for updating the plan with the following year (fourth year) used to update the plan. The governing body of each of the participating jurisdictions shall approve the updated plan and a copy of the updated plan shall be submitted to the Washington State Hazard Mitigation Program Manager.

CONTINUED PUBLIC INVOLVEMENT

All participating entities are dedicated to the continued involvement of the public in the hazard mitigation process. The plan will be available on the KCDEM website with the understanding that questions or comments can be directed to staff at any time. Any formal meetings to discuss the plan will be "advertised" on our website so the public can attend if they wish.

Hardcopies of the Klickitat County MHMP will be kept and made available for public review at the following locations:

- Klickitat County Department of Emergency Management
- Klickitat County Services Building
- Klickitat County Pioneer Center
- Goldendale Community Library
- White Salmon Valley Community Library

The Klickitat County Department of Emergency Management shall be responsible for receiving, tracking, and filing public comments regarding the Klickitat County MHMP. Contact information for KCDEM is listed below. A public meeting will be held as a part of the review process as well as the final five-year plan update. Additional meetings may also be held as deemed necessary by the Chairperson of the Klickitat County MHMP planning team. The purpose of these meetings is to provide a public forum so that citizens can express concerns, opinions, or ideas about the Klickitat County MHMP. The Klickitat County MHMP planning team will continue to meet at least annually and be made up of representatives from the participating jurisdictions as well as entities, departments, and agencies involved or impacted by hazard events in Klickitat County.

Klickitat County Department of Emergency Management: (509) 773-0582

CHAPTER 3 - COMMUNITY PROFILES

The purpose of this chapter is to link the unique qualities, features, and characteristics of each jurisdiction to local and regional natural hazards. Each community profile includes relevant information about demographics, infrastructure, commerce, industry, natural resources, and geography and identifies any community-components that are of interest, especially as they relate to natural hazards. Following the community profile is a risk and vulnerability assessment that summarizes the probability of a given natural hazard event affecting a jurisdiction, the potential impacts that a natural hazard event could have on a jurisdiction, and which community-components are at risk.

KLICKITAT COUNTY PROFILE

DESCRIPTION OF THE REGION

Klickitat County is located on the Columbia Plateau in south-central Washington State. It is bordered on the south by the Columbia River, by Skamania County on the west, by Yakima County on the north, and by Benton County on the east. Klickitat County was inhabited by the Klickitat Tribe prior to 1855 but was formally established in 1859. Stretching 84 miles along the north side of the Columbia River, the County covers just over 1,900 square miles geographically centered on the county seat in Goldendale. Most of the land in Klickitat County, approximately 76%, is privately owned and is classified as agricultural or rangeland.

Most of the land in Klickitat County is privately owned. Just over 10% of the total area of the County is tribal land owned by the Yakama Nation. The State of Washington owns almost 8% of the land in Klickitat County while less than 5% is owned by the Federal Government (Table 2). Tribal land is located along the northern boundary of the county, Federal land is concentrated along the western edge of the county, and state land is scattered throughout the county (Figure 1).

Table 2) Land Ownership in Klickitat County, WA.

Landowner	Percent
Private	76.70%
Tribal	10.30%
Washington State	7.80%
Bureau of Land Management	1.50%
US Forest Service	1.30%
Washington Department of Fish and Wildlife	1.10%
FWS	<1%
Water	<1%
Washington State Parks	<1%
Total	100%

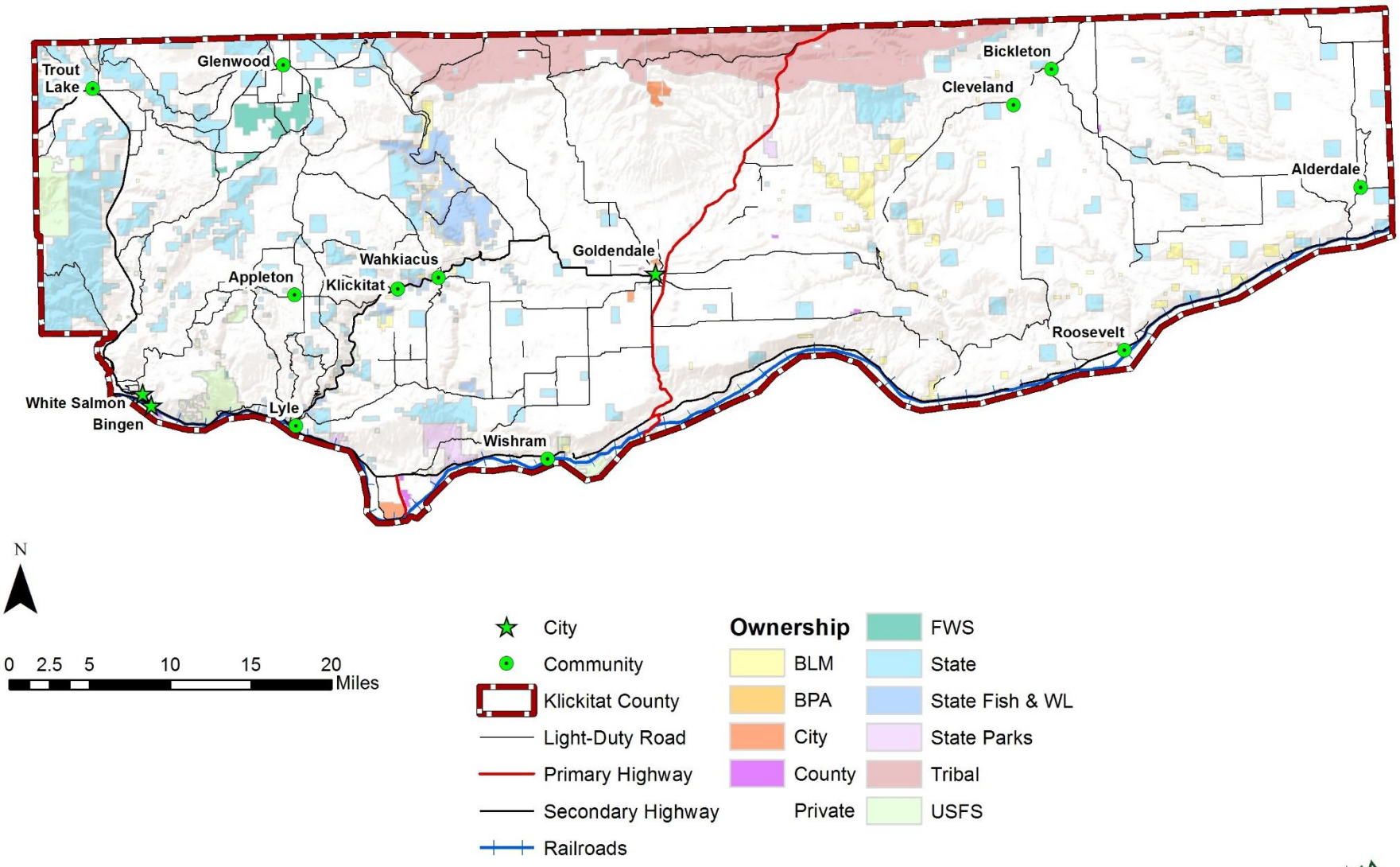

Figure 1) Land ownership in Klickitat County, WA.

Chapter 3 – Community Profiles

There are three rivers and a series of major creeks in Klickitat County. The Columbia River flows east to west along the entire southern border of the County, separating it from Oregon to the south. The White Salmon River originates on the lower west flank of Mt. Adams in Yakima County. It flows south through the west end of the County and enters the Columbia River near White Salmon. The Klickitat River originates near Gilbert Peak on the Yakama Indian Reservation in northwest Yakima County. It drains much of the western and central portions of Klickitat County and enters the Columbia River near Lyle. The eastern portion of the County drains into the Columbia via a series of major creeks that break up the basalt plateau.

TRANSPORTATION & INFRASTRUCTURE

The transportation system within the County is comprised of a significant number of roads, two public airports, a rail line and an extensive trail system. The road system is comprised of state highways, Washington State Department of Natural Resources (DNR) roads, County roads, USFS or BIA roads, and private roads. Roads are important in hazard mitigation planning because they provide a means of escape and emergency access.

Almost all the roads in the County were originally built to facilitate logging and farming activities. As such, these roads can support the emergency response equipment referenced in this document. However, many of the new roads have been built for home site access, especially for new subdivisions. In many cases, these roads are adequate to facilitate emergency response equipment as they adhere to County road standards. Nevertheless, construction of substandard access roads, particularly in subdivisions, can become a major safety issue and severely hinder the ability of emergency response personnel.

Transportation networks in the County have been challenged because several communities have only one or two access points suitable for use during an emergency. The communities of Husum and Wishram are prime examples.

Primary and secondary access routes were identified by planning team members and amended by the public during public meetings. These routes identify the primary access 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.

The Burlington Northern Santa Fe railroad parallels Highway 14 along the southern border of the County with a stop in Bingen.

There are two public airports in Klickitat County. The first is Goldendale Municipal Airport (single asphalt runway) located northwest of Goldendale; the second is the Columbia Gorge Regional Airport (two asphalt runways), also referred to as The Dalles Municipal Airport, located in Dallesport. Additionally, there are several private airfields scattered throughout the county.

Klickitat County features significant infrastructure. Of note is US 97, State Routes 14, 141, and 142, power lines, a major east-west natural gas pipeline (mostly buried), the north abutments of several major

interstate bridges, numerous power-generating wind turbines, and the Washington State portions of two large hydroelectric dams on the Columbia River.

Demographics and Socioeconomics

Table 3 shows historical changes in population in Klickitat County and among the various communities within the County.

Table 3) Historical and current population by community in Klickitat County, WA. Data is from US Census Bureau.

Jurisdiction	1970	1980	1990	2000	2010	2017 est.
Klickitat County	12,138	15,822	16,616	19,161	20,318	21,811
Goldendale	2,484	3,575	3,319	3,760	3,407	3,485
White Salmon	1,585	1,853	1,861	2,193	2,224	2,552
Bingen	671	644	645	672	712	729

The Census Bureau's Population Estimates Program indicates that in 2017, ethnicity in Klickitat County is approximately 82.2% white, 12.1% Hispanic or Latino, 3.2% American Indian or Alaska Native, 0.6% Asian, 0.3% African American, and 1.6% other. In 2010 there were 8,327 occupied housing units (85.1% of available housing units) in Klickitat County. The population in Klickitat County is 50.5% male; 4.3% of the population 5 years of age and older speak English less than very well. [3]

Development Trends

Klickitat County is largely characterized by rural, undeveloped land. Three incorporated cities and ten census-designated locations make up the urban growth areas that account for most of Klickitat County's population. The remaining population is spread across a rural landscape that serves as the natural resource base of the county's economy.

The following sections are direct excerpts from Klickitat County's 2017 10-Year Economic Development Strategic Plan outlining key findings concerning the economic environment in the County:[4]

Steady Population Growth

Klickitat County's growth rates over the past decade largely mirror national trends, with both the county and the US population increasing by roughly 8 percent since 2005. This translates to a compound annual growth rate of 0.8 percent. However, this rate of growth lags the state, which experienced an increase of 13 percent over the same period, or 1.2 percent annually. As is the case in many communities, domestic

[3] US Census Bureau. American FactFinder. Available online at https://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml. Accessed January 2019.

[4] Advancing Economic Prosperity in Klickitat County: 10-Year Economic Development Strategic Plan. Klickitat County Public Economic Development Authority. May 2017.

migration is the largest factor in determining population growth in the county (when compared with the role of natural increase or migration from outside the US).

Imbalance in age distribution

The county's age structure differs from both the state and the US in the share of the population age 65 and over. This is not a surprise, as many portions of Klickitat County are retirement destinations. The county's age structure also differs in its lower than average share of young adult workers as compared to the state and US. While the county's current experienced working age population exceeds the state and nation, portions of this age group are nearing retirement and will need to be replaced. The pool of young adult workers that will transition into this age category is smaller than average.

Net Exporter of workers

Commuting patterns data point to a mismatch between the skills of Klickitat County workers and the available jobs. In 2014, three out of five employed residents (61 percent) commuted to jobs outside the county. While healthcare, government, manufacturing, and education all represent top industry clusters in Klickitat County's employment base, they also showed the highest number of outbound workers as represented on Figure 6 Likewise, the county draws in a large share of its workforce—nearly one-half—from outside. The largest net flows of workers are in professional services and agriculture. Top "trading" partners for workers include the other Mid-Columbia region counties, as well as Portland-area counties including Clark and Multnomah.

Low levels of labor force participation

Labor force participation rates compare the portion of a region's labor force that is employed or looking for work with the population that is labor force eligible (defined here as those who are 16 years or older). These rates often reflect an area's demographics. For example, an area with an above-average share of retirees would have lower labor force participation rates since these individuals would still be considered labor force eligible. This factor may explain Klickitat County's relatively low participation rate of 51.5 percent, compared with 63.5 percent nationally. High levels of unemployment can also influence this statistic, as chronic unemployment can result in growth of the number of discouraged workers (those who are labor force eligible but have stopped actively looking for work). This factor may help further explain the county's low participation levels, as the county has historically experienced relatively high levels of unemployment relative to the state and the US.

Concentration of employment in vulnerable industry sectors

More than half of the county's job base (55.7 percent) is comprised of three industries: agriculture and forestry, local government, and manufacturing. While these broad sectors are highly desirable and include several stable, well-paying jobs, they are often heavily influenced by economic cycles and public policy fluctuations. Utilities and energy-related jobs are also vulnerable to these factors. Although they represent a relatively small share of employment, they play an important role in the local economy. A continued focus on diversifying the county's industrial base is of paramount importance.

The Development Plan also includes the following SWOT analysis further defining the strengths, weaknesses, opportunities, and threats related to development in Klickitat County.

SWOT ANALYSIS

STRENGTHS

- Available land for industrial development
- Low utility costs
- Quality of life
- Access to outdoor recreational opportunities
- Sense of community, spirit of regionalism
- Low crime; law enforcement works well with other agencies
- Low property taxes; no state income tax
- Variety of natural scenery
- Educational attainment in western portions of county
- Favorable climate for grape-growing; higher quality wine grapes than other wine-growing regions in PNW
- Growing technology sector
- Utility infrastructure
- Collaboration between economic development entities
- Increased airport activity
- Collaboration to reduce poverty in the county
- Community mindset is a healthy balance of advocating for development while being sensitive to the environment
- Diverse climate
- Proximity to I-84
- Low population density

WEAKNESSES

- Shortage of available talent and economic opportunity for workers
- Lack of affordable housing, especially in western portions of the county
- Lack of temporary and rental housing
- Lack of broadband access across county
- Shortage of entrepreneur/small business assistance/ business support network organizations
- Water rights & resources
- Lack of soft skills among job-seekers
- Lack of tourism infrastructure & capacity
- County "curb appeal" compared to communities across the river
- Resident resistance to change amidst growth & development
- Net exporter of workers outside the county

OPPORTUNITIES

- Create an inventory of buildable land
- Create a workforce training center
- Technology-related infrastructure in schools
- Apprenticeships to attract & retain graduating seniors
- Cultivate entrepreneurial spirit already in county
- Increase awareness and promotion of county-level pro-business programs
- Gorge-wide public transit system
- Craft beverages industry
- Outreach to businesses who need technical employees
- Leveraging existing entrepreneurs to build a county-wide culture and ecosystem
- Airport infrastructure
- Support development opportunities at available industrial sites
- Emerging timber technologies
- Solicitation of more municipal solid waste to the landfill
- Wine-tourism

THREATS

- Barriers to new industrial development
- Lack of high-tech jobs for spouses of employees relocating to the county
- Residents are leaving to start businesses in other counties
- Losing county identity through growth and development
- Generational poverty; increasing impoverished population
- Wind energy production tax credits going away
- Aging population

Figure 2) SWOT Analysis for Klickitat County Development.

Chapter 3 – Community Profiles

GEOGRAPHY AND CLIMATE

Topography throughout the County is variable, dominated by a major upland plateau broken up by steep river canyons. The County generally drains to the south and drops off sharply into the Columbia River. Elevation in the County ranges from around 80' above sea level near the confluence of the Klickitat and Columbia Rivers to just over 5,800' on Indian Rock in the north-central portion of the County. Average annual precipitation received in Goldendale is around 17.25 inches. The greatest amount of precipitation is received from November through January. The summer months usually see about one-third of an inch of rain on average. Average annual snowfall is around 24 inches. The average summertime high temperature in July and August is 85 degrees Fahrenheit. The average low wintertime temperature in December and January is 24 degrees Fahrenheit.[5]

The following sections are excerpted from the USDA General Technical Report *Climatology of the Interior Columbia River Basin.*[6]

Most of Klickitat County lies in Ecological Reporting Unit (ERU) 4 (Figure 1) within the Central Columbia zone of the interior Columbia River Basin. As it sits in the rain shadow of the Cascade Mountains to the west, this ERU is in the driest part of the Columbia Basin. The Columbia Plateau is, however, susceptible to marine intrusions that can relieve summer hot spells and winter cold spells. The accompanying moisture can put out summer wildfires or cause winter rain-on-snow floods. Although rain-on-snow floods are rare in this region, when they occur, they are more destructive and of much greater magnitude than spring floods.

Typical seasonal snowfall totals range from 40 to 80 centimeters (15 to 32 in). The upper plateaus (ERUs 4, 10, and 11) experience a moderate spring cycle of convective precipitation, with lightning most common in ERU 11. The convection can be caused by the northward migration of a thermal low-pressure center, especially in ERU 05, ERU 04, and the western part of ERU 10. Also, hot unstable air from the Great Salt Lake region can increase thunderstorm and lightning development over ERU 11 and eastern ERU 10. The strongest sustained winds in this region occur during summer from the west at the eastern outflow of the Columbia Gorge (ERU 05) and during winter from the south and west along ridgetops. Because of the volcanic soils and significant agricultural tilling in this zone, the wind can cause significant soil erosion and degradation in visibility. Although climate in this region is marked by few extremes, long periods of stagnation occur during winter in the central Columbia basin (ERU 05), the Snake River Valley (ERU 10), and high, isolated basins (ERUs 4, 10, and 11). The stagnation events cause this region to be the most susceptible to air pollution concerns.

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[5] U.S. climate data. Available online at https://www.usclimatedata.com/climate/goldendale/washington/united-states/uswa0514. Accessed January 2019.

[6] Ferguson, S. 1999. Climatology of the Interior Columbia River Basin. USDA PNW-GTR-445. Accessed online at https://www.fs.fed.us/pnw/pubs/pnw_gtr445.pdf

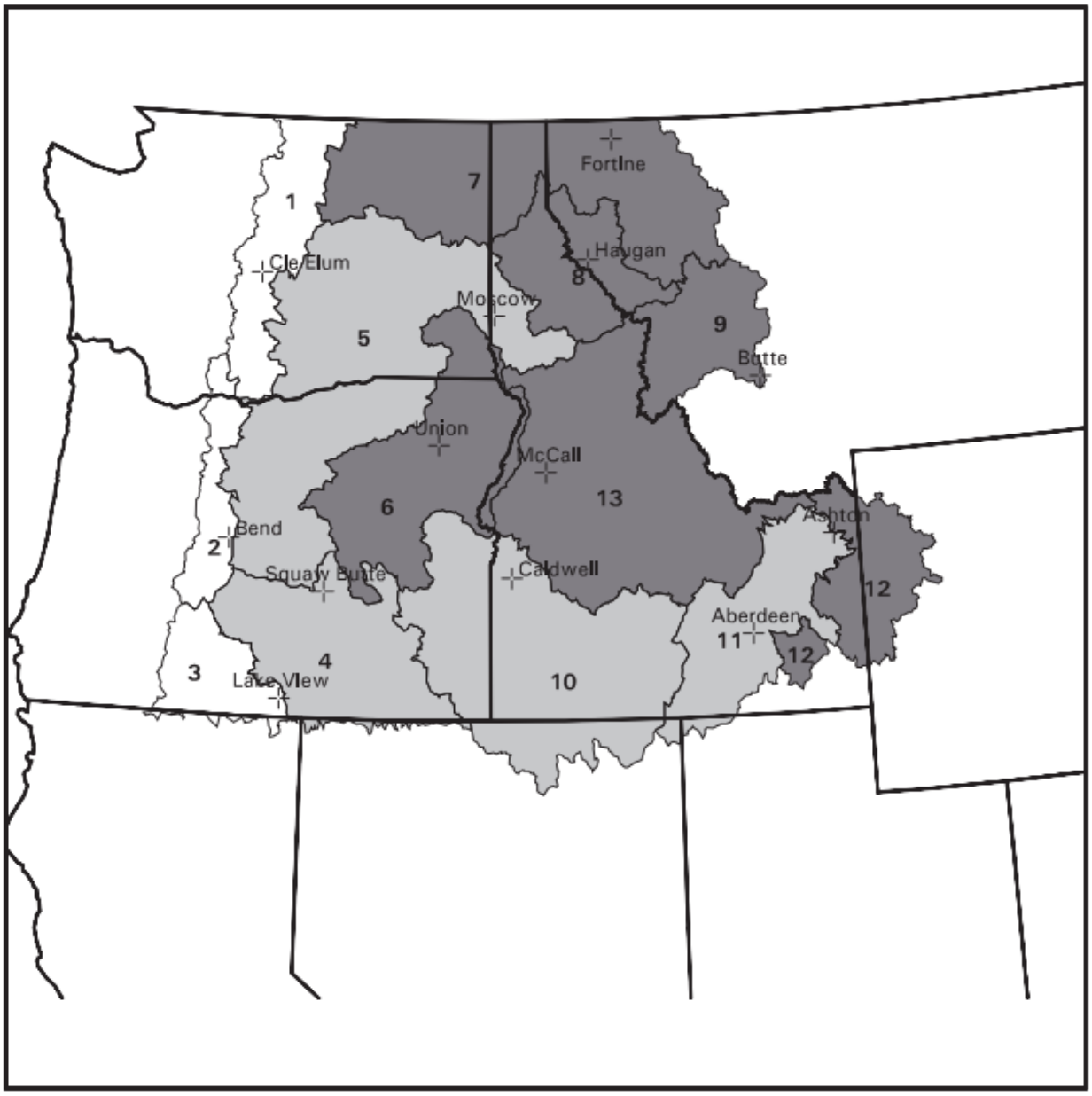

Figure 3) The interior Columbia River basin. Each ERU is numbered. The Eastern Cascasdes zone (ERUs 1-3) has no shading, the Northern Rockies zone (ERUs 6-9 and 12-13) is dark shaded, and the Central Columbia and Snake River Plateaus zone (ERUs 4, 5, 10, and 11) is lightly shaded. Stations selected to represent climate trends in each ERU are labeled[7].

[7] Ferguson, S. 1999. Climatology of the Interior Columbia River Basin. USDA PNW-GTR-445. Accessed online at https://www.fs.fed.us/pnw/pubs/pnw_gtr445.pdf

Natural Resources

Klickitat County hosts diverse ecosystems with a complex array of vegetation, wildlife, and fisheries that have developed with and adapted to natural disturbance processes. Industries based on natural resource management are integral to Klickitat County's economy. Forestry and logging, wood product manufacturing, clean energy power generation and distribution, in addition to agriculture are all important components of continued local development. Nearly a century of wildland fire suppression coupled with past land-use practices (primarily timber harvesting and agriculture) has altered plant community succession and has resulted in dramatic shifts in fire regimes, biodiversity, and species composition. As a result, some of the natural resources in Klickitat County have become more susceptible to large-scale, natural hazards posing a threat to life, property, and industries that are important to the economy and culture of Klickitat County. Increased susceptibility to natural hazards not only threatens natural resource-based industries but also increases the costs of hazard recovery and elevates safety risks to first responders and hazard management personnel throughout the County.

Fish and Wildlife

Klickitat County is home to a diverse array of fish and wildlife species, including populations that are listed as endangered or threatened under the federal Endangered Species Act. Waterways in Klickitat County provide habitat for Chinook salmon (*Oncorhynchus tshawytscha*), Steelhead (*Oncorhynchus mykiss*), Coho salmon (*Oncorhynchus kisutch*), sturgeon (Acipenseridae), walleye (*Sander vitreus*), bass (Centrarchidae), trout (Salmoninae), catfish (Siluriformes), panfish (Centrarchidae), and shad (*Alosa sapidissima*).

Forestlands and interface areas are important habitat for many species of game birds and mammals such as deer (*Odocoileus* sp.), elk (*Cervus* sp.), black bear (*Ursus americanus*), cougar (*Puma concolor*), wild turkey (*Meleagris gallopavo*), pheasant (Phasianidae), grouse (Tetraoninae), partridge (Phasianidae), chukar (*Alectoris chukar*), ducks (Anatidae), and geese (*Anser* sp.) in addition to a wide array of other North American wildlife species.

Bull trout (*Salvelinus confluentus*), the gray wolf (*Canis lupus*), and the northern spotted owl (*Strix occidentalis caurina*) are listed as endangered in Klickitat County. North American wolverine (*Gulo gulo luteus*) and the Oregon spotted frog (*Rana pretiosa*) are proposed for listing. Klickitat County is designated critical habitat for bull trout and proposed critical habitat for the Oregon spotted frog.[8]

Vegetation

Much of the terrain along the Columbia Gorge and eastern portion of Klickitat County is dominated by shrub-steppe plant communities. Oak-prairie is found across the irregular plains and in deep rugged canyons. Conifer forests that primarily consist of ponderosa pine, Douglas-fir, and grand fir dominate the

[8] USFWS 2013. Listed and Proposed Endangered and Threatened Species and Critical Habitat; Candidate Species; and Species of Concern in Klickitat County. U.S. Fish and Wildlife Service, Central Washington Field Office. Available online at https://www.fws.gov/wafwo/speciesmap/Klickitat.pdf. Accessed January 2019.

western and north central sections of the County. Riparian corridors are located intermittently across the landscape and are often characterized by hardwood species. For wildlife, these vegetation-types provide cover from predators, thermal cover from extreme temperatures, forage and nesting sites, and sources of water.

Based on an existing vegetation type analysis, coniferous cover types are the most dominant in the county accounting for almost 34% of the total acreage. Shrubland covers approximately 22% of the county and agriculture covers just over 14%. Grasslands and exotic herbaceous plant communities (non-native/invasive), collectively, cover almost 20% of Klickitat County. The rest of the county is classified as barren or sparse, developed, open water, or some variation of the cover-types listed above. Table 4 shows the percent coverage of each vegetation cover type. The orographic effect caused by the Cascades creates a moisture gradient across Klickitat County producing wetter conditions in the west and drier conditions in the east, influencing species composition, vegetative growth, and vegetative distribution. Conifer dominated forests represent the greatest coverage in the west part of the county where moisture is more abundant and grasslands or shrublands dominate the east part of the county where moisture is more limited. Figure 4 shows the distribution of existing vegetation types in Klickitat County and Figure 5 shows average annual precipitation.

Table 4) Existing Vegetation Types in Klickitat County, WA.

Existing Vegetation Type	Acres	% of Total
Conifer	411,418	33.8%
Shrubland	268,316	22%
Agricultural	172,488	14.2%
Grassland	114,368	9.4%
Exotic Herbaceous	94,922	7.8%
Developed	41,562	3.4%
Developed-Roads	22,865	1.9%
Open Water	22,365	1.8%
Riparian	21,778	1.8%
Sparsely Vegetated	18,323	1.5%
Hardwood	15,440	1.3%
Developed-Low Intensity	10,941	1.0%
Conifer-Hardwood	1,684	<1.0%
Developed-Medium Intensity	1,787	<1.0%
Developed-High Intensity	276	<1.0%
Barren	93	<1.0%
Quarries-Strip Mines-Gravel Pits	16	<1.0%
Total	**1,218,640**	**100.0%**

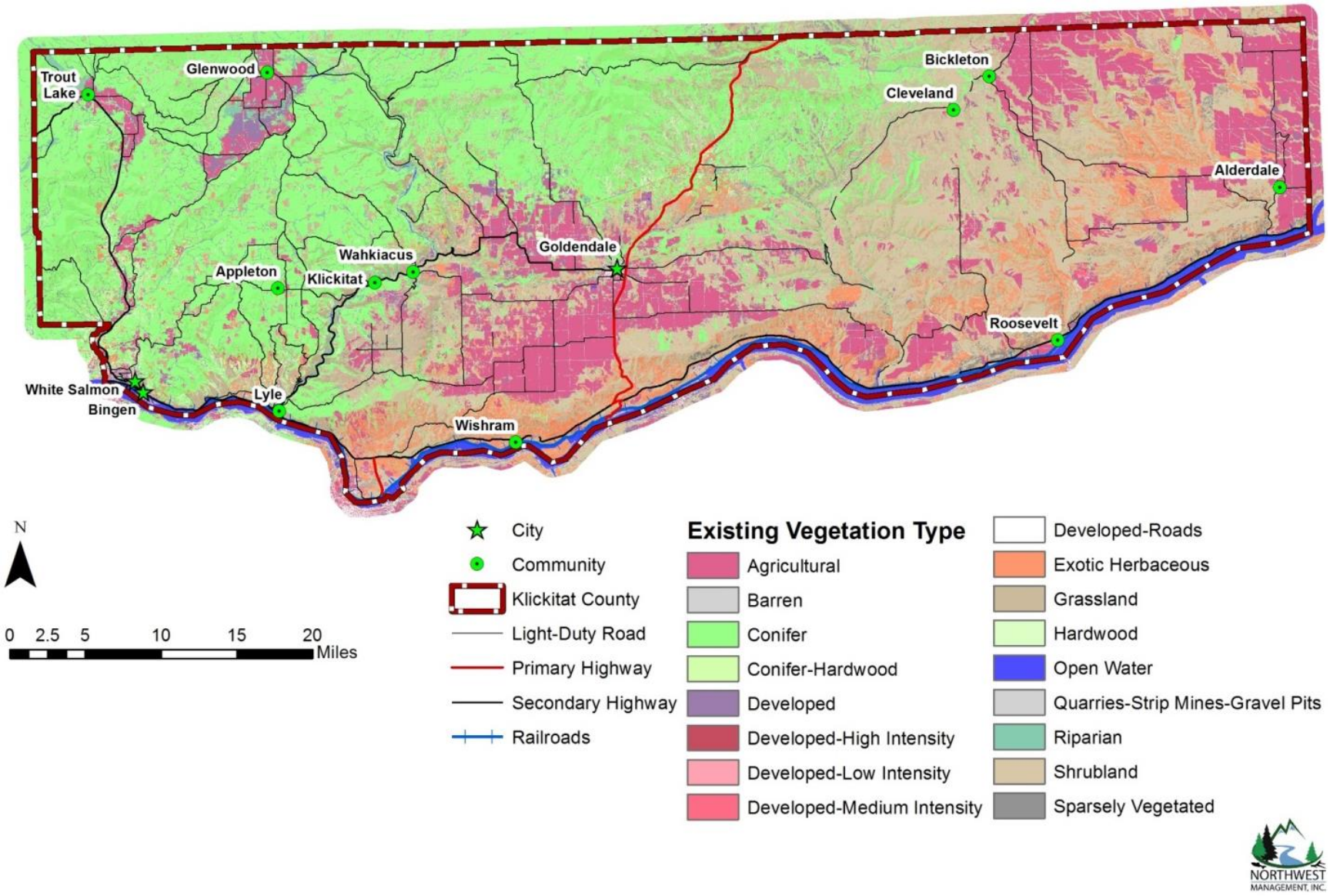

Figure 4) Existing Vegetation Types for Klickitat County, WA.

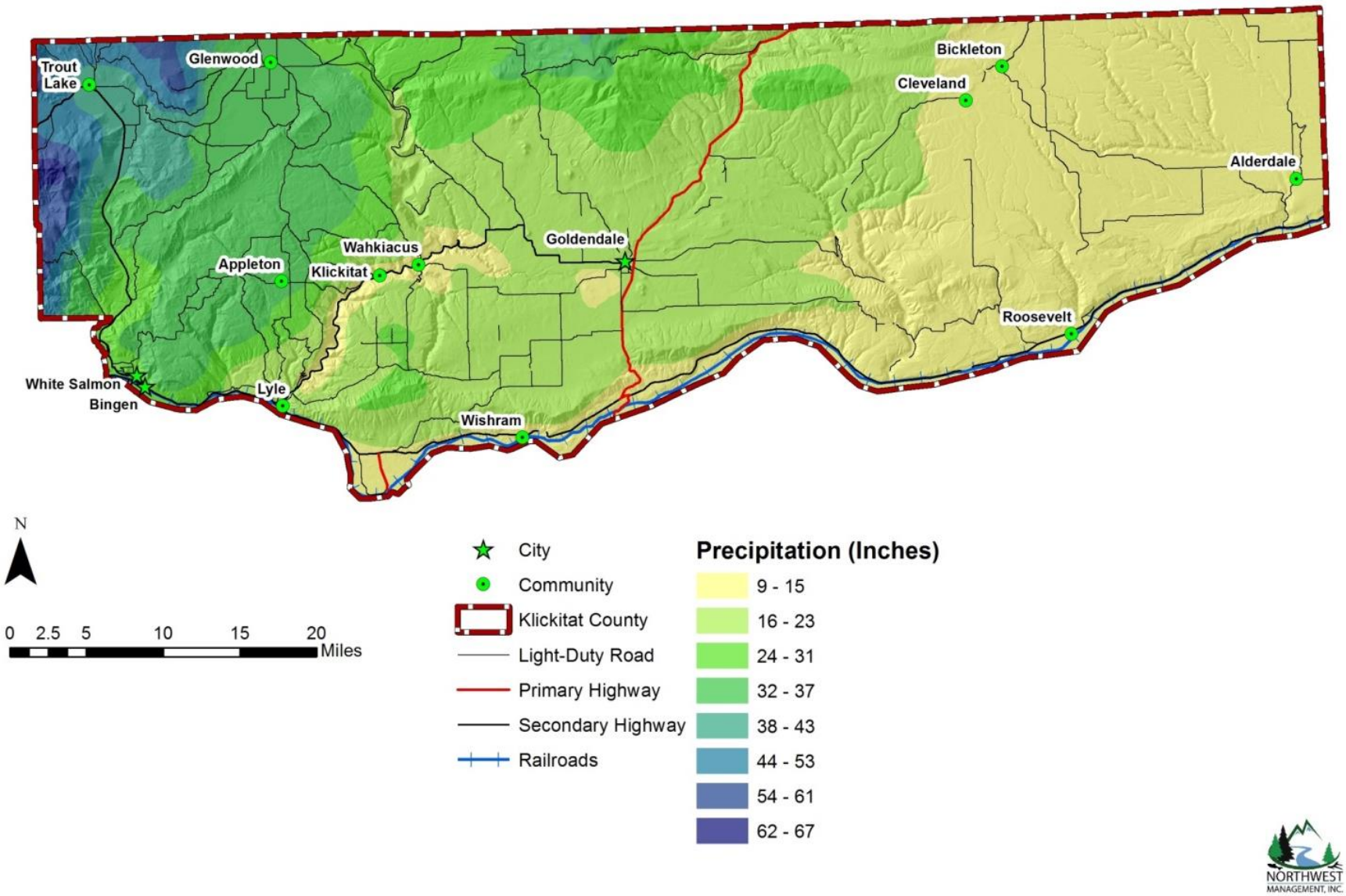

Figure 5) Average annual precipitation in Klickitat County, WA.

HYDROLOGY

The Washington Department of Ecology & Water Resources Program is charged with the development of the Washington State Water Plan. Included in the State Water Plan are the statewide water policy plan, and component basin and water body plans which cover specific geographic areas of the state (WDOE 2005). The Washington Department of Ecology has prepared General Lithologies of the Major Ground Water Flow Systems in Washington.

The state may assign or designate beneficial uses for Washington water bodies to support. These beneficial uses are identified in section WAC 173-201A-200 of the Washington Surface Water Quality Standards (WQS). These uses include:

- **Aquatic Life Support:** cold water biota, seasonal cold-water biota, and warm water biota;
- **Contact Recreation:** primary (swimming) and secondary (boating);
- **Water Supply:** domestic, agricultural, and industrial; and
- Wildlife Habitat and Aesthetics

While there may be competing beneficial uses in streams, federal law requires the protection of the most sensitive of these beneficial uses.

AIR QUALITY

The primary means by which the protection and enhancement of air quality is accomplished is through implementation of National Ambient Air Quality Standards (NAAQS). These standards address six pollutants known to harm human health including ozone, carbon monoxide, particulate matter, sulfur dioxide, lead, and nitrogen oxides.[9]

The Clean Air Act, passed in 1963 and amended in 1977, is the primary legal authority governing air resource management. The Clean Air Act provides the principal framework for national, state, and local efforts to protect air quality. Under the Clean Air Act, OAQPS (Office for Air Quality Planning and Standards) is responsible for setting standards, also known as national ambient air quality standards (NAAQS), for pollutants which are considered harmful to people and the environment. OAQPS is also responsible for ensuring these air quality standards are met, or attained (in cooperation with state, Tribal, and local governments) through national standards and strategies to control pollutant emissions from automobiles, factories, and other sources.[10]

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[9] USDA-Forest Service (United States Department of Agriculture, Forest Service). 2000. Incorporating Air Quality Effects of Wildland Fire Management into Forest Plan Revisions – A Desk Guide. April 2000. – Draft.

[10] Louks, B. 2001. Air Quality PM 10 Air Quality Monitoring Point Source Emissions; Point site locations of DEQ/EPA Air monitoring locations with Monitoring type and Pollutant. Idaho Department of Environmental Quality. Feb. 2001. As GIS Data set. Boise, Idaho.

Smoke emissions from wildfires and ash from volcanic eruptions not only affect the immediate vicinity but also the surrounding airsheds. Climatic conditions affecting air quality in Washington are governed by a combination of factors. Large-scale influences include latitude, altitude, prevailing hemispheric wind patterns, and mountain barriers. At a smaller scale, topography and vegetation cover also affect air movement patterns. Air quality in the area is generally moderate to good. However, locally adverse conditions can result from occasional wildland fires in the summer and fall, and prescribed fire and agricultural burning in the spring and fall. All major river drainages are subject to temperature inversions which trap smoke and affect dispersion, causing local air quality problems. This occurs most often during the summer and fall months and could potentially affect all communities in Klickitat County. Wintertime inversions are less frequent, but are more apt to trap smoke from heating, winter silvicultural burning, and pollution from other sources.

Washington Department of Ecology[11]

The Washington Department of Ecology Air Quality Program protects public health and the environment from pollutants caused by vehicles, outdoor and indoor burning, and industry. The DOE oversees permitting for non-forested (i.e. agriculture and rangeland) burning. Klickitat County falls under the jurisdiction of the Central Regional Office which can be reached at (509) 575-2490.

Washington State Smoke Management Plan[12]

The DNR, Department of Ecology (ECY), U.S. Forest Service (USFS), National Park Service (NPS), BLM, U.S Fish and Wildlife Service (USFWS), participating Indian nations, military installations (DOD), and small and large forest landowners have worked together to deal with the effect of outdoor burning on air.

Protection of public health and preservation of the natural attractions of the state are high priorities and can be accomplished along with a limited, but necessary, outdoor burning program. Public health, public safety, and forest health can all be served through the application of the provisions of Washington State law and this plan, and with the willingness of those who do outdoor burning on forest lands to further reduce the negative effects of their burning.

The Washington State Smoke Management Plan pertains to DNR-regulated silvicultural outdoor burning only and does not include agricultural outdoor burning or outdoor burning that occurs on improved property. Although the portion of total outdoor burning covered by this plan is less than 10 percent of the total air pollution in Washington, it remains a significant and visible source.

The purpose of the Washington State Smoke Management Plan is to coordinate and facilitate the statewide regulation of prescribed outdoor burning on lands protected by the DNR and on unimproved,

[11] Washington Department of Ecology website http://www.ecy.wa.gov/air.html Accessed January 2019.

[12] Washington State Department of Natural Resources, Smoke Management Plan 1993. http://www.dnr.wa.gov/Publications/rp_burn_smptoc.pdf Accessed January 2019.

federally managed forest lands and participating tribal lands. The plan is designed to meet the requirements of the Washington Clean Air Act.

The plan provides regulatory direction, operating procedures, and advisory information regarding the management of smoke and fuels on the forest lands of Washington State. It applies to all persons, landowners, companies, state and federal land management agencies, and others who do outdoor burning in Washington State on lands where the DNR provides fire protection, or where such burning occurs on federally-managed, unimproved forest lands and tribal lands of participating Indian nations in the state.

The Smoke Management Plan does not apply to agricultural outdoor burning and open burning as defined by Washington Administrative Code (WAC) 173-425-030 (1) and (2), nor to burning done "by rule" under WAC 332-24 or on non-forested wildlands (e.g., range lands).

Additionally, the Federal Air Rules for Indian Reservations (FARR) in Idaho, Oregon, and Washington is a set of air quality regulations established under the Clean Air Act. The FARR creates rules to manage activities that cause air pollution.

The FARR applies to all residents (both tribal members and non-tribal members) and businesses located within the exterior boundaries of reservations in Idaho, Oregon, and Washington. The ownership status of land on the reservation does not affect how the rules apply.

The Rule for Forestry and Silvicultural Burning Permits sets up a permit program for forestry and silvicultural burning on the Nez Perce Indian Reservation. People on the reservation who want to perform forestry and silvicultural burning will need to get a permit. Forestry and silvicultural burning is the burning of vegetation that comes from the growing and harvesting of trees and timber. This type of burning includes slash burning, burning for reducing fire hazards, and burning for managing the forest environment. Burning may also be performed to prevent disease, to control pests, and for forest reproduction.

Goldendale Profile

Goldendale is near the geographic center of Klickitat County and has the Little Klickitat River running through it. The city obtained its start as a watering stop on the Yakima – Okanogan wagon trail. The first plat was recorded in 1872 and the city was incorporated in 1879. Goldendale is now the largest city in Klickitat County as well as the county seat. It serves as the regional service center. The city sits on a fertile plateau roughly 100 miles east of Portland, Oregon, 70 miles south of Yakima, Washington, and 100 miles west of the Tri-Cities. The Columbia River is 13 miles south of the city. The terrain around the city is generally rolling with an elevation of 1620’ at the Goldendale Municipal Airport.[13]

[13] City of Goldendale website. Available online at www.ci.goldendale.wa.us. Accessed January 2019.

The following sections are heavily excerpted from the City of Goldendale Comprehensive Plan.[14]

Population and Demographics

The population of Goldendale has continued to grow since 1940, but at levels far below the state average. During the 1970s and early 1980s Goldendale experienced a growth "spurt" with the establishment of the aluminum plant. Since this time period, the local economy and population have reflected the success or failure of the aluminum plant. The closure of lumber mills in the county has further dampened economic vitality, reduced employment opportunities, and caused the migration of people to other regions. In recent years Goldendale has experienced a growth in the production of renewable and alternative energy sources, including a natural gas energy plant, the construction of the wind turbines in the area mostly east and south of the city, and increased production of energy from landfill gas at the landfill site out near Roosevelt. The U.S. Census report of 2010 places the population of Goldendale at 3,407 persons, representing approximately 17% of the Klickitat County population. Since 1990, the population of Goldendale has remained relatively flat, since the 1990 Census when the population stood at 3,324. The most recent population estimates report the population for Goldendale in 2017 stands at 3,485.

Economic Conditions

Goldendale's economy has historically been based on natural resource industries. Forestry, ranching, and farming have traditionally provided many marketable products. Recently, renewable energy construction and production and an emerging tourist commercial industry have contributed to greater economic prosperity in our region. Additional opportunities to expand and enhance the intersections with US Highway 97 are being explored.

Development Trends and Urban Growth

The existing corporate city limits are bordered on two sides (East and South) by land devoted primarily to agricultural uses. The western corporate boundary is next to property primarily used for industrial purposes. The northern corporate boundary abuts rocky, forested terrain which is more suitable for residential development and less suitable for high density development activities. The County Fairgrounds and Municipal Airport are located approximately 1 mile to the north west of the City. A privately-owned golf course is situated approximately 2 miles north of the city center. There are areas designated by a Corps of Engineer's study as flood hazardous areas within and adjacent to the corporate limits.

Due to a change in State Highway 97 alignment, there has been a shift in businesses from Main Street to more visible locations along the highway and major arterials into the city. This has created a tendency towards more strip development, a generally unsound method of urban development. The urban growth areas map in the City of Goldendale Comprehensive Plan shall be a guide for future developments and

[14] Goldendale Planning Commission 2014. City of Goldendale Comprehensive Plan Update.

annexations. Location and distribution were determined by evaluating current development activities, circulation systems, and access to water/sewer.

WHITE SALMON PROFILE

The City of White salmon is situated at an elevation of 550', on a bluff in the southwest corner of Klickitat County overlooking the Columbia River, Mt. Hood, and Hood River Oregon. White Salmon is approximately 60 miles east of Portland, Oregon and 45 miles west of the county seat in Goldendale. The first white settlers in White Salmon purchased their land from the Klickitat Tribe, now a part of the Yakama Confederated Nations. The city was officially incorporated in 1907.

The local forests and orchards are the backbone of industries that the area was founded upon, while new technology and fermentation industries are rapidly expanding and opening new employment and investment opportunities. In particular, the White Salmon area has developed into an unmanned aerial vehicle nexus, and its proximity to the Columbia River transportation corridor offers unique opportunities for traditional and progressive industrial development. White Salmon also has access to nearby barge, train, air transport and interstate highways – all leading to Pacific Rim ports and other major transportation arteries.[15]

The following sections are heavily excerpted from the White Salmon Comprehensive Plan.[16]

POPULATION AND DEMOGRAPHICS

The City of White Salmon has a stable population. The figures released by the US Census Bureau as a result of the 1990 Census indicated a population of 1,882. The City disagreed with that estimate and by City count, contended that there were 2,110 people within the existing City limits. At that time, because of the methodology used by the City administration in developing the estimates, the figure of 2,110 was chosen as a base for estimating future populations of the Urban Exempt Area. Some dwellings that are used as second homes may account for the difference between the City and the Census Bureau report. The Census Bureau's Population Estimates Program indicates that in 2017, the population of White Salmon was 2,552 people.

ECONOMIC CONDITIONS

For many years logging, lumber production and agriculture were the mainstays for the White Salmon economy. These sectors still play an important role in the community but the economy has become much more diversified in recent years. Recreation, tourism, and high technology are now significant sectors and are becoming increasingly important. Home-based businesses are becoming more prevalent as individuals find ways to generate income with computers and cottage industries. The economy recently has started

[15] City of White Salmon Website. Available online at www.white-salmon.net. Accessed January 2019.

[16] City of White Salmon. White Salmon Comprehensive Plan. 2012.

to attract new businesses involved in arts and crafts products. A glass blowing store recently opened, which has attracted several artists that produce glass products to be distributed here and in businesses outside of White Salmon. New home construction has been strong providing many jobs. Government services, health care, the school system and retail sales round out the economic picture for the community.

The City's largest employer is the Underwood Fruit Company; much of their employment is seasonal. The SDS Lumber Mill located in the City of Bingen established in 1946, continues as one of the main employment opportunities for White Salmon residents. Insitu is a relatively new high technology company that started at the Port of Klickitat property on Bingen Point and has spread throughout the White Salmon and Bingen communities in various buildings as they continue to expand.

Businesses with retail sales are found in the downtown central business district along Jewett Blvd. Arts, crafts, and recreation related sales have become more important in recent times. Although there are no motels, the City has a popular bed and breakfast in which includes a hostel facility. There has been considerable turnover in retail sales establishments and restaurant businesses during the past ten years.

By City Administration count, there are a total of 136 businesses currently operating within the City limits on a sustained basis, providing a host of goods and services for the community.

Development Trends and Urban Growth

The urban exempt areas outlined in the White Salmon comprehensive plan are areas outside the City of White Salmon and exempt from the Columbia River Gorge – National Scenic Area. This urban growth area consists of approximately 2,210 acres surrounding White Salmon and serves as a buffer between the urban areas of the city and the more rural areas to the north and west in Klickitat County.

The urban exempt area currently receives services from both Klickitat County and the City of White Salmon. The County maintains road systems within the urban exempt area and residents in the area use the City of White Salmon's water and sewer systems. The urban exempt area is in Fire Protection District #3 but the City of White Salmon Fire Department responds to all fire calls in the area. As of 2009, the urban exempt area is a mixture of subdivided lots ranging from one-half acre to more than 20 acres. The entire area has one-half acre minimum lot size enforced by Klickitat County.

The supply of estimated buildable land in the urban exempt area around White Salmon appears adequate to meet both the midpoint and high demand estimates for residential and commercial land needs. Additional information would be required to assess general public water and sewer feasibility in order to refine the buildable lands inventory. City, stakeholder and public input is recommended in refining urbanization strategies.

BINGEN PROFILE

Located in the heart of the Columbia River Gorge, Bingen sits in the southwest corner of Klickitat County approximately 60 miles east of Portland, Oregon and 45 miles west of the county seat in Goldendale. The town site was platted in 1892 and incorporated in 1924. Bingen is located on Washington State Route 14 with one of only two Amtrak stops between Vancouver and Pasco, Washington. The Columbia River can be accessed through the Port of Klickitat at Bingen Point. Three of Klickitat County's largest employers, SDS Lumber Company, Underwood Fruit, and Insitu, are in Bingen.[17]

POPULATION AND DEMOGRAPHICS

The population of Bingen has grown since 1940, but at levels below the state average. The U.S. Census report of 2010 placed the population of Bingen at 672 persons. The most recent population estimates report the population for Bingen in 2017 stands at 729.

ECONOMIC CONDITIONS

The closure of lumber mills in the county dampened economic vitality, reduced employment opportunities, and caused the migration of people to other regions. The resilience of SDS Lumber Company and the agricultural industries around Bingen have helped stabilize the local economy in recent decades. Insitu, a manufacturer of unmanned aircraft systems headquartered in Bingen, has provided additional economic growth.

DEVELOPMENT TRENDS AND URBAN GROWTH

The city of Bingen does not foresee any growth within the community in the foreseeable future.

KLICKITAT VALLEY HEALTH PROFILE

Klickitat Valley Health is a nonprofit care provider, operated by Public Hospital District #1 of Klickitat County, Washington and owned by the citizens of the district. An elected Board of Commissioners, comprised of five community members who serve six-year terms, governs the District. Union employees of the District are represented by SEIU, Local 1199 NW.

The KVH Campus encompasses several facilities that include Klickitat Valley Hospital, KVH Family Medicine, and Home Health & Hospice.

[17] City of Bingen website. Available online at www.bingenwashington.org. Accessed January 2019.

Population and Demographics

The city of Goldendale is the largest population center in Hospital District #1. Please refer to Goldendale's population and demographics section to gain insight for KVH. Some demographic information is contained in the development trends section below.

Economic Conditions

Last year, KVH proposed expansion of facilities, services, and opportunities through what was called Bold Vision 20/20. It was to be proposed through a $19 million tax-supported bond to be paid by residents of the hospital district over the next 25 years. It was not passed by the community.

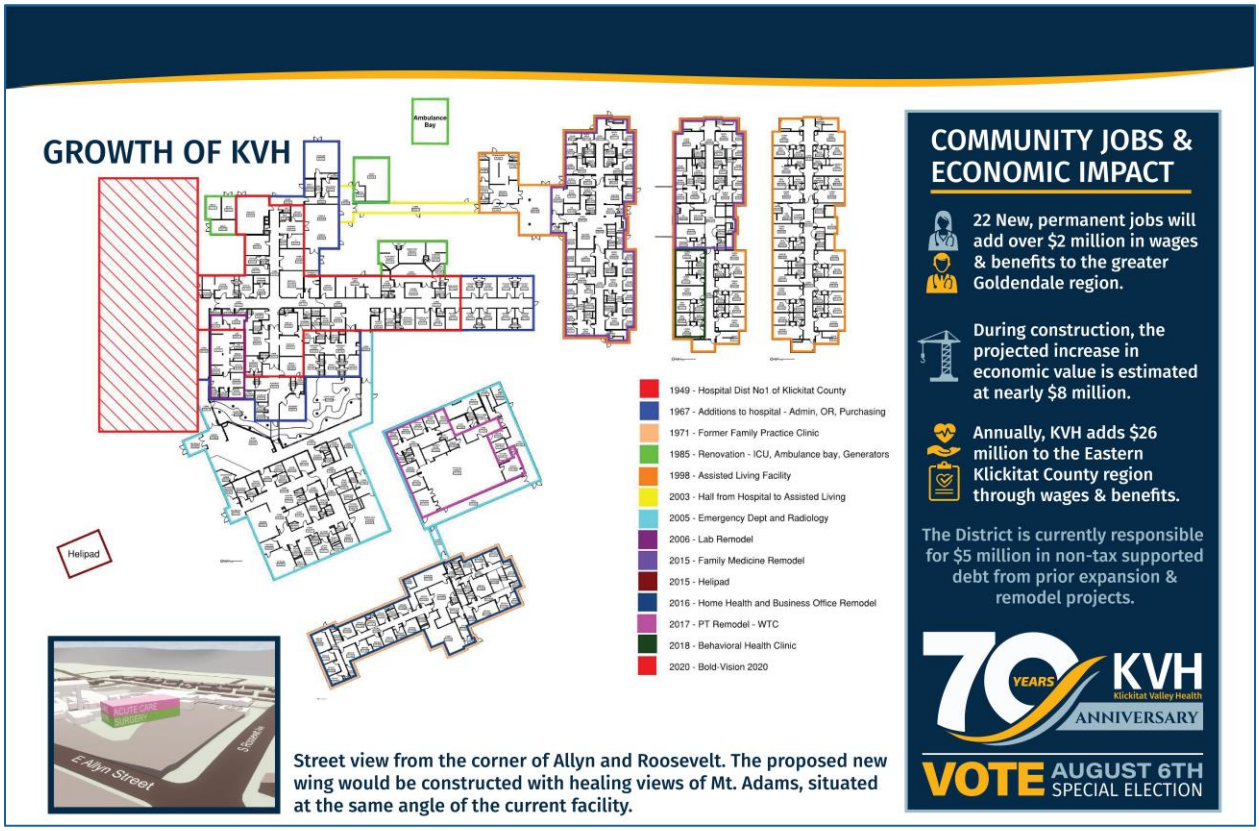


Figure 6) Klickitat Valley Health Bold Vision 20/20.

Development Trends and Urban Growth

KVH is always working to improve and expand services in order to meet the needs of the community closer to home. We recently opened a dental clinic, started a MAT (medication assisted treatment) program, and are expanding surgical services. We anticipate continuing to grow alongside the community.

Although it did not pass, KVH's Bold Vision 20/20 plan was a response to the changing demographic make-up of KVH services as well as demand for services. The following is an excerpt from the Bold Vision 20/20 plan that describes development and growth trends observed in 2019:

Bold Vision 20/20 is a plan for KVH to expand community healthcare services with increased access to core services, specialty providers and updated facilities to meet the growing need of the region's population. This is especially true of two of the fastest growing age groups: the elderly and millennials.

Nationwide, the elderly population is growing faster than any other segment of the population. At KVH, we are seeing that trend in the greater Goldendale population that we serve. A person 65 or older is four times more likely to be hospitalized than those under 65. At the same time, we see a potential influx of younger families with new commercial developments on the horizon in Eastern Klickitat County. In order to continue the legacy that began in 1949, we outlined a Master Facilities Plan in 2015 to meet these unique needs and provide services in a more comprehensive, convenient and efficient way.

Eastern & Central Conservation District Profile

The mission of the Central Klickitat CD is to improve, conserve and promote the wise use of natural resources by serving citizens within the CKCD through educational programs, public information, technical advice, and financial assistance.

Population and Demographics

The population and demographics of Eastern and Central Klickitat Conservation Districts are the same as described for Klickitat County and Goldendale. Please refer to those respective profiles for this information.

Economic Conditions

The economic conditions of Eastern and Central Klickitat Conservation Districts are the same as described for Klickitat County and Goldendale. Please refer to those respective profiles for this information.

Development Trends and Urban Growth

The development trends and urban growth of Eastern and Central Klickitat Conservation Districts are the same as described for Klickitat County and Goldendale. Please refer to those respective profiles for this information.

Underwood Conservation District Profile

Underwood Conservation District (UCD) was established in 1940 when concerned orchardists and farmers from the area around Underwood Mountain gathered to discuss irrigation needs, the decline of forest productivity, and the impacts that development was having on their land – increasing soil erosion and degrading water quality. The meeting resulted in a partnership between the Soil Conservation Service (a Federal USDA Agency, now called the Natural Resource Conservation Service) and private landowners, which created the locally run conservation district.

Since its inception in 1940, UCD has grown several times. The District's boundaries now encompass the western third of Klickitat County and all of Skamania County.

Population and Demographics

The population and demographics of UCD are the same as described for Klickitat County, White Salmon, and Bingen. Please refer to those respective profiles for this information.

Economic Conditions

The economic conditions of UCD are the same as described for Klickitat County, White Salmon, and Bingen. Please refer to those respective profiles for this information.

Development Trends and Urban Growth

Underwood CD plans to maintain the current level of staffing with the intention of expanding services as opportunities become available, specifically in the areas of noncommercial forestry on private lands, land stewardship education, and climate change mitigation. The area of the district is undergoing a growing population, with lands previously forested and/or in agricultural use seeing rural development pressure – more people, many from out of the area, buying smaller rural parcels for recreation, weekend use or retirement.

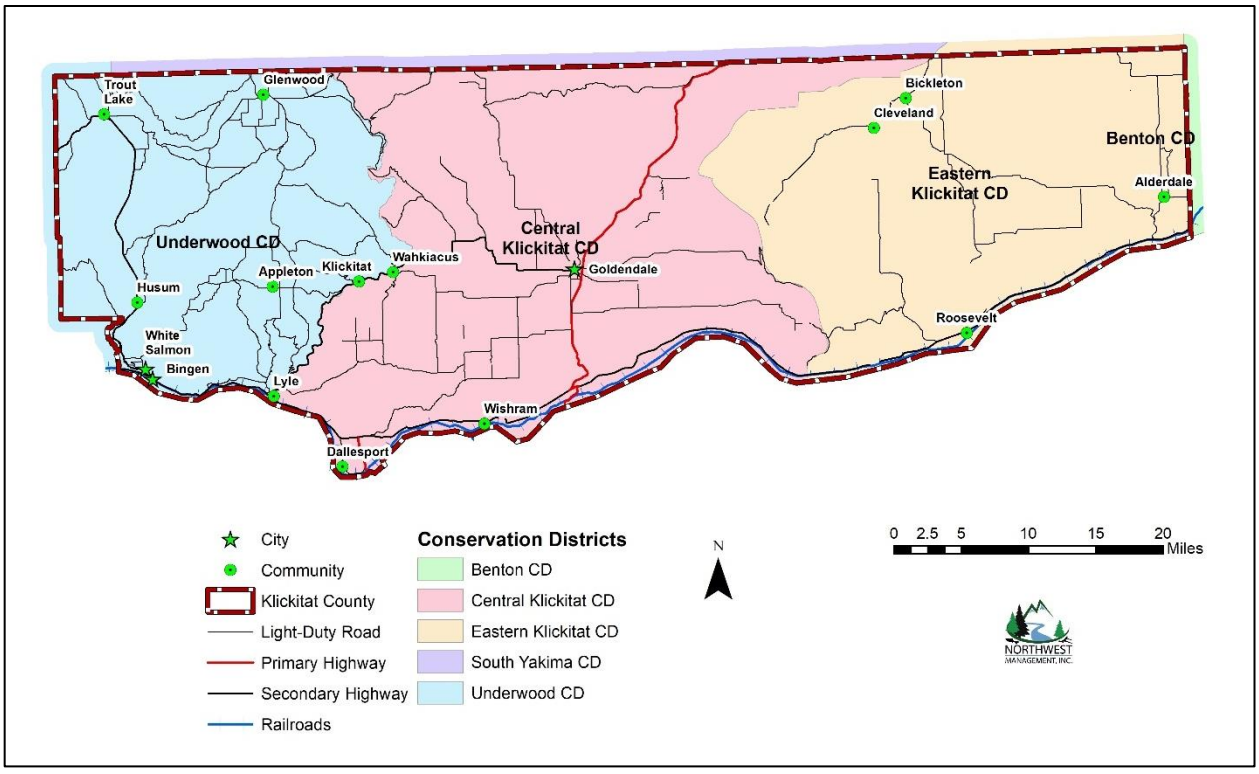


Figure 7) Conservation District boundaries in Klickitat County, WA.

CHAPTER 4 – HAZARD PROFILES & RISK ASSESSMENTS

NATURAL HAZARDS AND CLIMATE CHANGE

Natural hazard profiles historically are assessments of future hazard potential that are based largely on past behavior of natural systems. Today, however, assessments of future climate-related hazards (such as floods, droughts, wildfires, severe weather, and landslides) must include anticipated impacts of climate change on natural systems. In 1990, the U.S. Congress enacted the Global Change Research Act mandating that climate change impacts be evaluated every four years in a National Climate Assessment Report prepared by the U.S. Global Change Research Program. The most recent (fourth) National Climate Assessment Report, released in 2018[1,2], states that the average temperature in the Pacific Northwest already has warmed over 1.5° F since 1900 (Table 1)[1], and predicts a 3-5° F increase by mid-century (Table 2)[1] [see: https://science2017.globalchange.gov/chapter/6/]. These temperature changes will be accompanied by major shifts in precipitation patterns and hydrology of the Pacific Northwest[1,2] [see: https://nca2018.globalchange.gov/chapter/24/ and https://science2017.globalchange.gov/chapter/7/].

Changes are calculated by subtracting observed temperature averages for the period 1901 to 1960 from observed temperature averages for the period 1986 to 2016. [Data excerpted from Table 6.1 in Volume 1 of the Fourth National Climate Assessment Report.] (USGCRP, 2017)

Table 5) Observed increase from 1901 to 2016 in annual average temperature for the Pacific Northwest.

National Climate Assessment Region	Change in Annual Avg Temperature	Change in Annual Avg Max Temperature	Change in Annual Avg Min Temperature
Northwest	1.54°F	1.52°F	1.56°F

Changes are calculated by subtracting observed temperature averages for the 1976-2005-time interval from projected temperature averages for the 2016-2065 (mid-century) and 2071-2100 (late century) time intervals; projected estimates are derived from statistical analysis of 32 climate models. [Data excerpted from Table 6.4 in Volume 1 of the Fourth National Climate Assessment Report.] (USGCRP, 2017)

Table 6) Projected 21st Century increase in annual average temperature for the Pacific Northwest for lower scenario (RCP4.5) and higher scenario (RCP8.5).

National Climate Assessment Region	RCP4.5 Mid-Century (2036-2065)	RCP8.5 Mid-Century (2036-2065)	RCP4.5 Late-Century (2071-2100)	RCP8.5 Late-Century (2071-2100)
Northwest	3.66°F	4.67°F	4.99°F	8.51°F

In Klickitat County, warming of average temperatures is expected to cause the following consequences (USGCRP, 2018) (Hamlet, 2013):

- precipitation will increasingly fall more as rain than as snow, and as mixed rain-and-snow;
- there will be higher precipitation, runoff, soil saturation, and stream flows during cool months;
- there will be less snowpack at lower-to-middle elevations;

- snowpack will melt earlier in spring, and may melt more quickly;
- alpine glaciers will continue to shrink;
- there will be increasingly lower stream flows during warm months;
- flooding, landslides, wildfire and other secondary impacts will increase in frequency and severity and temperature and precipitation patterns change.

These changes in precipitation and hydrology significantly raise future risk for severe weather and storm-related floods and landslides in Oct-Feb, for spring riverine flooding in Mar-May, and for droughts and wildfires in July-Oct. Potential for lahars from Mount Adams also may be enhanced by future increase in frequency and intensity of rainstorms and soil saturation.

The Northwest chapter of the 2018 National Climate Assessment Report states that: "increases in the amount of precipitation falling in heavy rainfall events (including atmospheric rivers) are anticipated to magnify [flood and landslide] risks" (USGCRP, 2018). Atmospheric rivers are narrow atmospheric regions of enhanced water vapor transport northward from the tropics which produce intense "Pineapple Express" precipitation events along the U.S. west coast. In the Northwest, these are typically warm storms that can cause flooding from combination of rain runoff and snowmelt. Atmospheric rivers are expected to be more frequent and intense in the future (though variable from year-to-year) because climate models show that increasing summer warming of Pacific Ocean surface waters will transfer increasing volumes of water vapor to the atmosphere. This transported water vapor will condense and precipitate over the Pacific Northwest, starting in the fall season when cooling commences (Hamlet, 2013) (Warner, 2017). *In the Pacific Northwest, climate models predict a 9-11% increase by mid-century in the number of extreme precipitation events* (USGCRP, 2017).

The likely outcomes for Klickitat County of predicted shifts in precipitation magnitude, intensity, timing, and type (more rain, less snow) will be increased frequency of severe weather, floods, and rain-triggered landslides, and less water storage in snowpack and glaciers to support stream flow and water supplies during increasingly hot summers. Earlier spring warming and rising average summer temperatures will dry out the landscape sooner and longer, causing more timber stress, disease and mortality. This is predicted to raise the number, intensity and size of wildfires in late summer and early fall. Crops, fisheries, and wildlife are expected to suffer from more frequent extremes of heat, precipitation, and drought, and from changes in seasonal timing of available water and food sources and maximum/minimum stream flows. Outdoor recreational activities (boating, fishing, hunting, hiking, camping) are likely to be adversely affected by low summer-fall stream flows, wildfires, and extreme temperatures. Most of the consequences discussed above already have started happening during the past two decades and are predicted to ramp up as average temperatures become warmer regionally and globally[2].

In recent years there has been more extensive and persistent north and south meandering of the northern hemisphere jet stream, which has brought extremes of both warming (during northward meanders) and cooling (during southward meanders) to mid-latitudes in the U.S. and Eurasia. (Screen, 2013) The Arctic is warming at a faster rate than mid-latitudes, and some recent studies have posited that this has weakened the polar vortex wind belt, causing observed wandering of the jet stream (Vavrus, et al., 2017) (Cohen, 2016). If this hypothesis is true, then it portends more extreme and longer-lived spring-summer

heat waves and cold season frigid temperature episodes in the Pacific Northwest over the coming decades as the Arctic warms faster than mid-latitudes.

In summary, Klickitat County must prepare for heightened hazards caused by the weather and temperature extremes and shifts in precipitation patterns (volume, intensity, and seasonal timing), that climate change is expected to bring in the decades ahead. The fourth National Climate Assessment Report states that: *"Available vulnerability assessments for infrastructure show the prominent role that future extremes play. Since much of the existing infrastructure was designed and is managed for an unchanging climate, changes in the frequency and intensity of flooding, drought, wildfire, and heat waves affect the reliability of water, transportation, and energy services."* (USGCRP, 2018) Klickitat County must prepare to mitigate future impacts of predicted extreme events and precipitation patterns on human health and major economic sectors, including agriculture and vineyards, forest resource industries, fisheries, and outdoor recreation.

HAZARD SUMMARY

The purpose of this chapter is to link the unique qualities, features, and characteristics of each jurisdiction to local and regional natural hazards. Each community profile includes relevant information about any community-components that are of interest, especially as they relate to natural hazards. Each adopting jurisdiction has a risk and vulnerability assessment that summarizes the probability of a given natural hazard event affecting a jurisdiction, the potential impacts that a natural hazard event could have on a jurisdiction, and which community-components are at risk.

The MHMP is developed in accordance with the requirements of the Federal Emergency Management Agency (FEMA) and Washington State Emergency Management Division for a county level pre-disaster mitigation plan. The State of Washington State identifies twelve natural hazards and four technological hazards affecting the State. To be consistent, the planning team chose seven natural and four anthropogenic annexes from the state identified hazards that pose the highest risk for Klickitat County. The hazards addressed in this Plan are:

- Flood
- Wildfire
- Drought
- Severe Weather
- Earthquake
- Landslide
- Volcano
- Hazardous Materials
- Mass Casualty
- Radiological
- Terrorism

Additional hazard annexes may be added to this plan as funding allows. The highest priority hazards to be considered for future evaluation are:

- Avalanche
- Endemic/Pandemic
- Air Quality
- Transportation Disruption

To help document the perspectives and first-hand experiences of the planning team members, a hazard summary worksheet was distributed to the group in order to gauge hazard event frequency and the potential impact a hazard event could have on people, property, infrastructure, and the economy. Local knowledge and input are valuable as those personal experiences and accounts of small-scale impacts are often absent from state and Federal data sets. The results of the hazard summary, which were agreed upon by the group, can be found in Table 8 and Table 9.

Jurisdictional Risk and Vulnerability Rating

Given the frequency of occurrence and limited record of natural hazard events that have affected Klickitat County, it was NMI's opinion that a simple hazard rating exercise would suffice for summarizing and reporting natural hazard ratings for the county. In NMI's opinion, issues with the data, including inconsistencies in event reporting, changes in terminology, definitions, and parameters, and a limited number of datapoints for any one hazard, created limitations for data processing and interpretation (for example, large wildfires and flood events were recorded at the agency level but many smaller, more minor events are likely only on record with the local entity who responded (assuming there is a record at all). Therefore, a more complex analysis and the development of plan-specific methodology was not included in the scope of work for the 2020 Klickitat County MHMP. Alternatively, FEMA worksheet 5.1 was presented to and completed by the planning group; the planning group selected hazard ratings based on their knowledge of and experience with the location, impacts, and extent of natural hazard events in the county (it should be noted that the planning group elected to create two columns for "location"; one describes total geographic area while the other describes populated areas). Ratings were then selected for each adopting jurisdiction by representatives from that jurisdiction. The four numeric values were then added together to determine the Overall Significance Ranking. These values are reported in the Probability and Magnitude section in each Hazard Profile and Risk Assessment.

For more information about the basic requirements for reporting hazard ratings, refer to Task 5 and Worksheet 5.1 in the FEMA Local Mitigation Planning Handbook.

Table 7) FEMA Hazard Summary Worksheet (FEMA worksheet 5.1).

Location (Geographic Area Affected)	
Negligible	Less than 10% of planning area or isolated single-point occurrences
Limited	10 to 25% of the planning area or limited single-point occurrences
Significant	25 to 75% of the planning area or frequent single-point occurrences
Extensive	75 to 100% of the planning area or consistent single-point occurrences
Location (Populated Area Affected)	
Negligible	Less than 10% of planning area or isolated single-point occurrences
Limited	10 to 25% of the planning area or limited single-point occurrences
Significant	25 to 75% of the planning area or frequent single-point occurrences
Extensive	75 to 100% of the planning area or consistent single-point occurrences

Maximum Probable Impact (Magnitude/Strength based on historic events or future probability)	
Weak	Limited classification on scientific scale, moderate speed of onset or moderate duration, resulting in little to no damage
Moderate	Moderate classification on scientific scale, moderate speed of onset or moderate duration, resulting in some damage and loss of services for days
Severe	Severe classification on scientific scale, fast speed of onset or long duration, resulting in devastating damage and loss of services for weeks or months
Extreme	Extreme classification on scientific scale, immediate onset or extended duration, resulting in catastrophic damage and uninhabitable conditions
Probability of Future Events (Occurrence in the next 50 years)	
Unlikely	Less than 1% probability of occurrence in the next year or a recurrence interval of greater than every 100 years
Occasional	1 to 10% probability of occurrence in the next year or a recurrence interval of 11 to 100 years
Likely	10 to 90% probability of occurrence in the next year or a recurrence interval of 1 to 10 years
Highly Likely	90 to 100% probability of occurrence in the next year or a recurrence interval of less than 1 year
Overall Significance	
Low	Two or more criteria fall in lower classifications or the event has a minimal impact on the planning area.
Medium	The criteria fall mostly in the middle ranges of classifications and the event's impacts on the planning area are noticeable but not devastating
High	The criteria consistently fall in the high classifications and the event is likely/highly likely to occur with severe strength over a significant to extensive portion of the planning area

The worksheet (shown above) was used to classify the geographic area affected (location) and populated area affected (location), relative magnitude (max probable extent) and the probability of future events (frequency) that each hazard may have on a community. The classifications were then given a numerical value and then totaled to show the overall significance ranking for each hazard.[18] This process was conducted for each adopting jurisdiction. Table 8 summarizes the results of the Hazard Summary exercise for Klickitat County and Table 9 shows the totals (overall significance value) for each adopting jurisdiction.

Table 8) Hazard Rating Summary for Klickitat County, WA. Refer to Table 7 for definitions for the ranking values in this table.

Hazard	Location (Geographic Area Affected)	Location (Population Area Affected)	Max Probable Impact	Probability of Future Events (in the next 50 years)	Overall Significance Ranking
Flood	Limited (2)	Significant (3)	Severe (3)	Highly Likely (4)	**High (10)**
Landslide	Limited (2)	Significant (3)	Severe (3)	Occasional (3)	**Medium (9)**
Earthquake	Extensive (4)	Extensive (4)	Extreme (4)	Occasional (2)	**High (10)**

[18] Hazard Summary Worksheet. Local Mitigation Planning Handbook. 2013. Pp A-29, A-30.

Severe Weather	Extensive (4)	Extensive (4)	Severe (3)	Highly Likely (4)	**High (11)**
Wildland Fire	Significant (4)	Extensive (4)	Extreme (4)	Highly Likely (4)	**High (12)**
Drought	Extensive (4)	Limited (2)	Moderate (2)	Highly Likely (4)	**Medium (8)**
Volcano	Extensive (4)	Extensive (4)	Moderate (2)	Unlikely (1)	**Low (7)**
HazMat	Limited (2)	Significant (3)	Extreme (4)	Occasional (2)	**Medium (9)**
Radiological	Limited (2)	Significant (3)	Extreme (4)	Occasional (2)	**Medium (9)**
Mass Casualty	Negligible (1)	Limited (2)	Moderate (2)	Occasional (2)	**Low (7)**
Terrorism	Negligible (1)	Significant (3)	Moderate (2)	Unlikely (1)	**Low (7)**
Ranking Value	1 – Negligible 2 – Limited 3 – Significant 4 – Extensive	1 – Negligible 2 – Limited 3 – Significant 4 – Extensive	1 – Weak 2 – Moderate 3 – Severe 4 – Extreme	1 - Unlikely 2 – Occasional 3 – Likely 4 – Highly Likely	4 to 7 – Low 8 to 11 – Medium 12 to 16 - High

Table 9) Overall hazard significance ratings for each adopting jurisdiction featured in the 2020 Klickitat County HMP.

Hazard	Klickitat County	City of Bingen	City of Goldendale	City of White Salmon	Klickitat Valley Health	Eastern Klickitat Conservation	Central Klickitat Conservation	Underwood Conservation District
Flood	High	Medium	Medium	Low	Medium	Medium	Medium	Medium
Landslide	High	Medium	Low	Medium	Medium	Medium	Medium	Medium
Earthquake	High	High	Low	High	Medium	High	High	High
Severe Weather	High	High	High	High	Medium	High	High	High
Wildland Fire	High	High	Medium	High	High	High	High	High
Drought	Medium	Medium	Medium	Medium	High	Medium	Medium	Medium
Volcano	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
HazMat	High	Medium	Low	Medium	Medium	Medium	Medium	Medium
Radiological	High	Low	Low	Low	Medium	Medium	Medium	Medium
Mass Casualty	Low	Low	Low	Low	Low	Low	Low	Low
Terrorism	Low	Low	Low	Low	Medium	Low	Low	Low

FLOOD HAZARD PROFILE & RISK ASSESSMENT

OVERVIEW

Klickitat County is flood-vulnerable because of its location within a vast hydrologic system that pumps enormous quantities of water from the Pacific Ocean through the atmosphere to the Cascade Range and Columbia Basin, and then back to the ocean via the Columbia River (Figure 8, Figure 9). Consequently, in Klickitat County flooding occurs yearly, with severity varying from year-to-year. Climate, weather, geology, topography, and hydrology combine to create an annual cycle of seasonal flooding conditions. In late fall and early winter, storm flooding typically results from copious rainfall from atmospheric rivers onto saturated ground and early snow at higher elevations. In winter and early spring, flooding commonly arises from a combination of back-to-back Pacific storms, rapid melting of local snowpack on frozen ground, and rapid basin-wide melting of mountain snowpack. In summer, intense thunderstorms may produce local flash-flooding. Denudation of slopes by wildfires, logging and urban/suburban development can increase runoff and flood hazard. Other types of potential flooding hazards in the county include failure of man-made water-impoundment structures (such as dams, irrigation canals, levees), and failure of natural impoundments (such as those formed in stream valleys by landslides, lahars, volcanic flows, logjams, ice).

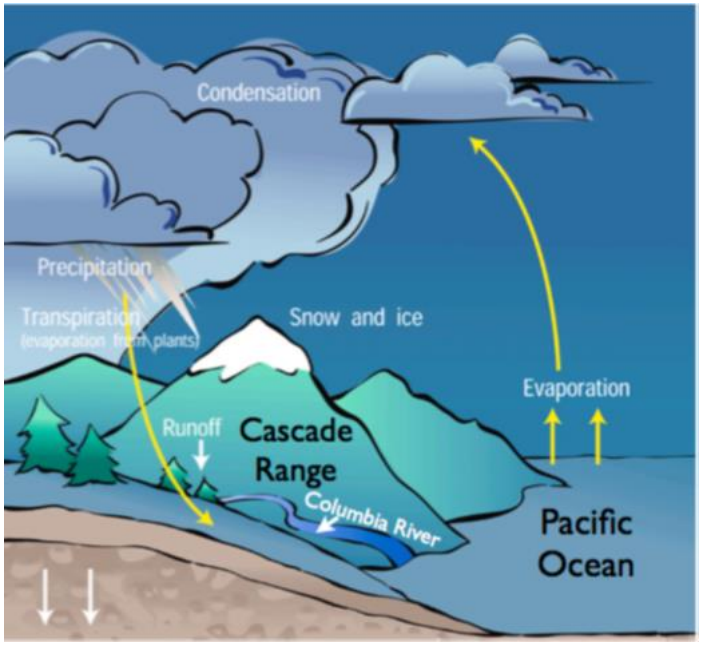


Figure 8) Hydrologic cycle of Pacific Northwest. Klickitat County straddles the Cascade Range and is bounded to the south by the Columbia River[1].

Flooding occurs when water flows outside of its usual channel onto surrounding lands. Two types of flooding primarily affect Klickitat County: riverine flooding (mainly along the Columbia River) and small-stream flooding (see definitions below). In addition, any low-lying area has the potential to flood if water accumulates faster than it can drain away. Flooding of developed areas occurs when the amount of water generated from rainfall and runoff is large enough to exceed a storm water system's (ditch or sewer) capability to remove it. Development and urban growth reduce the natural capacity of the landscape to absorb and channel water and can increase both the rate and amount of runoff until it overwhelms storm water systems, causing local flooding in small watersheds within developed areas.

Riverine flooding takes place almost every year during winter-spring along the Columbia River from melting snow plus rain throughout the very large drainage area of the Columbia Basin. A system of dams, including the John Day and The Dalles Dams located along the southern edge of Klickitat County, usually

can mitigate flood damage along the Columbia by storing water in reservoirs during periods of rapid runoff and releasing it slowly afterward. However, every few years-to-decades (and as recently as May 2018) flooding and damage to property along the Columbia River in Klickitat County has happened when there is exceptionally high runoff and dams upriver are forced to release water. The potential for property damage from Columbia River floods has increased as Klickitat County port districts have attracted significant industrial development in recent years.

Elsewhere in Klickitat County, along the White Salmon River, Klickitat River, and smaller tributary streams (see Figure 10), flooding is common during fall and winter when storms bring heavy precipitation, rapid snowmelt, or both at once during rain-on-snow events. Risk of this type of flooding is greater during years when atmospheric rivers channel excessive amounts of atmospheric water vapor from the tropical and northeast Pacific Ocean into the Pacific Northwest (Figure 9). When these warm "Pineapple Express" storms pass over the Cascade Range, extreme amounts of precipitation can fall in parts of Klickitat County, and snow can melt quickly. Under these conditions, flooding occurs in many locations throughout the county: flash flooding occurs in canyons and gullies, rivers and streams overflow or back up behind natural dams, lowlands saturate and fill with ponding water, and small-stream flooding is widespread (Figure 13, Figure 14, Figure 15, Figure 16, and Figure 17).

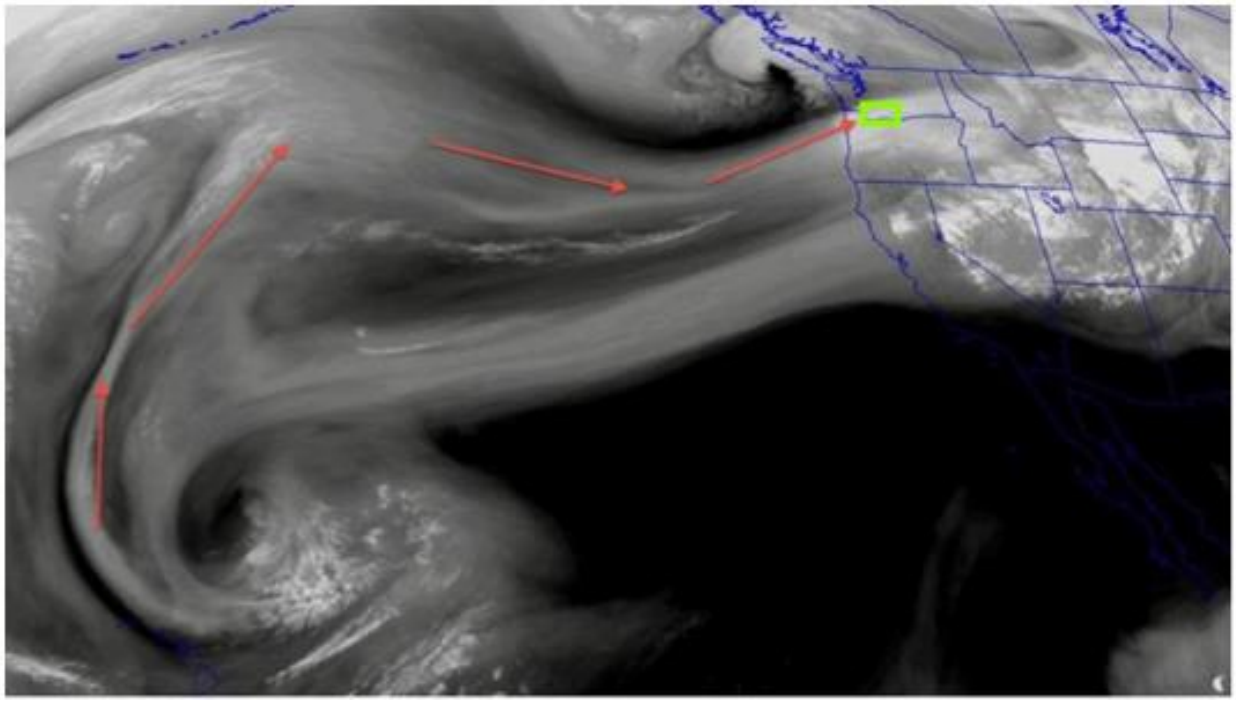


Figure 9) Satellite image captured on September 28, 2013, showing an atmospheric river bringing a deluge of precipitation to the Pacific Northwest. Green box shows location of Klickitat County[19]. Image credit: UW Madison SSEC; Posted by Stu Ostro.

[19] Ostro, 2013. Climate Central. http://www.climatecentral.org/blogs/atmospheric-river-smashes-records-in-pacific-northwest-16550

In Klickitat County, floods caused by heavy precipitation combined with snowmelt during storms in November-February are historically the largest in magnitude. Since 1964, a total of nine Federal Flood Disaster Declarations were issued for Klickitat County for storm-related floods in fall-winter (Federal declarations are included in the list of historical flood events). While spring riverine floods are typically smaller in magnitude, spring flooding can last up to four weeks, and total volumes of runoff from long-lasting spring floods sometimes can be large. Altogether, there have been twenty-five historic floods along the Columbia River, including three thus far in the 21st century.

Flood Hazard Summary

In summary, Klickitat County is subject to annual seasonal flood hazards. During fall and winter, flood hazards arise from extreme precipitation and rain-on-snow during storms, particularly when atmospheric rivers channel Pacific moisture into the Pacific Northwest. During late winter-spring, riverine flooding is caused by large volumes of snowmelt adding to rain runoff, and in summertime intense thunderstorms can cause flash-flooding (Figure 14). In future decades, climate models predict an increase in atmospheric rivers delivering precipitation to the Pacific Northwest in fall and winter (see discussion of climate change impacts at the beginning of the Chapter), and this may increase frequency and severity of floods. Looking ahead, mitigations will be needed to prevent small-stream flooding as future development replaces fields and forests with impermeable surfaces and structures, and as wildfire or human activity reduce natural capacity of the landscape to absorb precipitation. There also is a low probability that low-lying areas in the county along the Columbia River could flood if there is damage to Columbia River dams upstream caused by earthquakes, large landslides, or sabotage.

Definitions

Riverine Flooding: Riverine flooding is over-the-bank flooding of rivers and streams. The natural processes of riverine flooding add sediment and nutrients to fertile floodplain areas. Flooding in large river systems, like the Columbia River, typically results from large-scale weather systems that generate prolonged rainfall over a wide geographic area, causing flooding in hundreds of smaller streams (Figure 17), which then drain into the major rivers. Shallow area flooding is a special type of riverine flooding. FEMA defines shallow flood hazards as areas that are inundated by the 100-year flood with flood depths of only one to three feet. These areas are generally flooded by low-velocity sheet flows of water.

Small-Stream Flooding: As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb rainfall. Urbanization of a watershed changes the hydrologic systems of the basin. Heavy rainfall collects and flows faster off roofs and on impervious concrete and asphalt surfaces. The water moves from the clouds to the ground and into streams at a much faster rate in developed areas, particularly in cities, and storm drains can clog from leaves and debris washing off streets. Adding these elements to local drainages can result in floodwaters that rise very rapidly. Klickitat County's incorporated towns and cities have only moderate concentrations of impermeable surfaces that either collect water or concentrate the flow of water in man-made channels, but it can be enough to cause local flooding. During periods of small-stream flooding, streets can become inundated and impassable, and basements can flood.

Floodplain: A floodplain is a land area adjacent to a river, stream, lake, estuary, or other water body that is subject to flooding. This area, if left undisturbed, acts to store excess floodwater. The floodplain is made up of two sections: the floodway and the flood fringe.

Floodway: The floodway is one of two main sections that make up the floodplain. Floodways are defined for regulatory purposes. Unlike floodplains, floodways do not reflect a recognizable geologic feature. For National Flood Insurance Program (NFIP) purposes, floodways are defined as the channel of a river or stream, and the overbank areas adjacent to the channel. The floodway carries the bulk of the floodwater downstream and is usually the area where water velocities and forces are the greatest. NFIP regulations require that the floodway be kept open and free from development or other structures that would obstruct or divert flood flows onto other properties. The NFIP floodway definition is "the channel of a river or other watercourse and adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot." Floodways are not mapped for all rivers and streams but are generally mapped in developed areas.

Flood Fringe: The flood fringe refers to the outer portions of the floodplain, beginning at the edge of the floodway and continuing outward. This is the area where development is most likely to occur, and where precautions to protect life and property need to be taken.

Development: For floodplain ordinance purposes, development is broadly defined to mean "any manmade change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation, or drilling operations located within the area of special flood hazard." The definition of development for floodplain purposes is generally broader and includes more activities than the definition of development used in other sections of local land use ordinances.

100-Year Flood: The 100-year flooding event is the flood having a one percent chance of being equaled or exceeded in magnitude in any given year. Contrary to popular belief, it is not a flood occurring once every 100 years. The 100-year floodplain is the area adjoining a river, stream, or watercourse covered by water in the event of a 100-year flood.

Base Flood Elevation (BFE): The term "Base Flood Elevation" refers to the elevation (normally measured in feet above sea level) that the base flood is expected to reach. Base flood elevations can be set at levels other than the 100-year flood. Some communities choose to use higher frequency flood events as their base flood elevation for certain activities, while using lower frequency events for others. For example, for the purpose of storm water management, a 25-year flood event might serve as the base flood elevation, while the 500-year flood event may serve as base flood elevation for the tie down of mobile homes. The regulations of the NFIP focus on development in the 100-year floodplain.

Dam Failure Flooding: Loss of life and damage to structures, roads, utilities and crops may result from a dam failure. Economic losses can also result from a lowered tax base and lack of utility profits. These effects would certainly accompany the failure of one of the major dams affecting the Columbia, Snake, or Yakima rivers. Because dam failure can have severe consequences, FEMA requires that all dam owners develop Emergency Action Plans (EAP) for warning, evacuation, and post-flood actions. Although there

may be coordination with municipal officials in the development of the EAP, the responsibility for developing potential flood inundation maps and facilitation of emergency response is the responsibility of the dam owner.

Background Information

Effect of Development on Floods

When structures or fill are placed in the floodway or flood fringe, water is displaced and capacity to convey water downstream is reduced. Development raises the river levels by forcing the river to compensate for the space obstructed by the inserted structures and/or fill. When structures or materials are added to the floodway or flood fringe and no fill is removed to compensate, serious problems can arise. Floodwaters may be forced into areas not considered part of the floodplain for a specified flood magnitude, and existing floodplain areas may experience floodwaters that rise above historic levels.

Local governments must require engineer certification and/or restrict development through proper planning to ensure that proposed developments will not adversely affect the flood carrying capacity of the Special Flood Hazard Area (SFHA). Displacement of only a few inches of water can mean the difference between no structural damage occurring during a flood event and the inundation of many homes, businesses, and other facilities. Careful attention should be given to development that occurs within the floodplain to ensure that structures are prepared to withstand base flood events. In highly urbanized areas, increased paving can lead to an increase in volume and velocity of runoff after a rainfall event, exacerbating the potential flood hazards. Care should be taken in the development and implementation of storm water management systems to ensure that these runoff waters are dealt with effectively.

Sediment Transport and Deposition

Sediment deposited in the river channel can promote lateral erosion of banks, channel migration, and levee failure, and it reduces the channel's conveyance capacity for high flows. Large quantities of sediment can be moved over short periods during flood events. Sediment deposition occurs where the river becomes flatter or wider, reducing the energy of its flow and thus its sediment transport capacity, its ability to carry sediment downstream. Sediment transport increases and deposition decreases near channel constrictions or areas where flow velocity increases.

Effects of Levees

Levees attempt to keep floodwaters within a designated channel by confining them instead of allowing them to spill over into the floodplain. Levees provide a certain level of protection to floodplain residents; however, they can raise floodwater elevations upstream by creating a backwater effect, increase flow velocities, reduce side channel fish habitat, increase channel migration, and negate the effects of floodplain storage, leading to greater flood magnitudes downstream.

All levees and berms provide some level of flood protection. Many only protect during low-level, high-frequency floods, such as 1 to 10-year events. Small levees typically fail during significant flood events.

Despite their shortcomings during major floods, many farmers and businesses construct levees to prevent small frequent floods from causing damage by killing crops, eroding banks, and depositing unwanted silt.

There are no significant levees in Klickitat County, only private levees aimed at protecting individual buildings or property. These private levees would likely have limited local impact on riverine flooding.

Identification of Flood-Prone Areas

Flood maps and Flood Insurance Studies (FIS) are often used to identify flood-prone areas (Figure 10). The National Flood Insurance Program (NFIP) was established in 1968 as a means of providing low-cost flood insurance to the nation's flood-prone communities. The NFIP also reduces flood losses through regulations that focus on building codes and "sound floodplain management". NFIP regulations (44 Code of Federal Regulations [CFR] Chapter 1, Section 60.3) require that all new construction in floodplains must be elevated at or above base flood level. The Washington Building Code requires new construction to be elevated to one foot above the base flood elevation. Communities participating in the NFIP may adopt regulations that are more stringent than those contained in 44 CFR 60.3, but not less stringent.

Flood Insurance Rate Maps (FIRM) and Flood Insurance Studies (FIS)

Floodplain maps are the basis for implementing floodplain regulations and for delineating flood insurance purchase requirements. A Flood Insurance Rate Map (FIRM) is the official map produced by FEMA, which delineates SFHA in communities where NFIP regulations apply. FIRMs are also used by insurance agents and mortgage lenders to determine if flood insurance is required and what insurance rates should apply.

Water surface elevations are combined with topographic data to develop FIRMs. FIRMs illustrate areas that would be inundated during a 100-year flood, floodway areas, and elevations marking the 100-year-flood level. In some cases, they also include base flood elevations (BFEs) and areas located within the 500-year floodplain.

Flood Insurance Studies and FIRMs produced for the NFIP provide assessments of the probability of flooding at a given location. FEMA conducted many Flood Insurance Studies in the late 1970s and early 1980s. These studies and maps represent flood risk at the point in time when FEMA completed the studies. However, it is important to note that not all 100-year or 500-year floodplains have been mapped by FEMA.

FEMA flood maps provide a general assessment of flood risk meaning that they are not entirely accurate on a small-scale (i.e. on the scale of individual homes or properties). At a granular level, these large-scale maps do not always account for fine-scale features of topography that affect actual flood risk for individual properties. These studies and maps also represent flood risk at the point in time when FEMA completed the studies and does not incorporate planning for floodplain changes due to new development since the studies were completed. Although FEMA is considering a policy change, these maps do not currently account for any increases in flood frequency or magnitudes due to climate change. The inclusion of climate change variables is currently optional for local communities.

Flood Hazard Areas in Klickitat County Communities

Refer to Table 10, below, for definitions of the NFIP flood zones in Figure 10, Figure 11, Figure 12, Figure 18, Figure 19, and Figure 20.

A few communities in Klickitat County potentially are vulnerable to seasonal flooding along the Columbia River (Figure 10). Although White Salmon, Bingen, Lyle, Dallesport, Wishram, and Roosevelt are located along the north shore of the Columbia, only parts of Bingen, Wishram, and North Roosevelt are low enough in elevation to be impacted by large floods. The extensively developed port area of Bingen is the most vulnerable to Columbia River flooding because it is mostly situated within about 15 feet of river level. The other towns sit on benches at least 100 feet above river level.

Table 10) National Flood Insurance Policy flood zone definitions.

ZONE	DESCRIPTION
A	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas; no depths or base flood elevations are shown within these zones.
AE	The base floodplain where base flood elevations are provided. AE Zones are now used on new format FIRMs instead of A1-A30 Zones.
A1-30	These are known as numbered A Zones (e.g., A7 or A14). This is the base floodplain where the FIRM shows a BFE (old format).
AH	Areas with a 1% annual chance of shallow flooding, usually in the form of a pond, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
AO	River or stream flood hazard areas and areas with a 1% or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Average flood depths derived from detailed analyses are shown within these zones.
AR	Areas with a temporarily increased flood risk due to the building or restoration of a flood control system (such as a levee or a dam). Mandatory flood insurance purchase requirements will apply, but rates will not exceed the rates for unnumbered A zones if the structure is built or restored in compliance with Zone AR floodplain management regulations.
A99	Areas with a 1% annual chance of flooding that will be protected by a Federal flood control system where construction has reached specified legal requirements. No depths or base flood elevations are shown within these zones.
X500	Areas of moderate flood hazard from the principal source of flood in the area, determined to be within the limits of one percent and 0.2 percent annual chance floodplain.

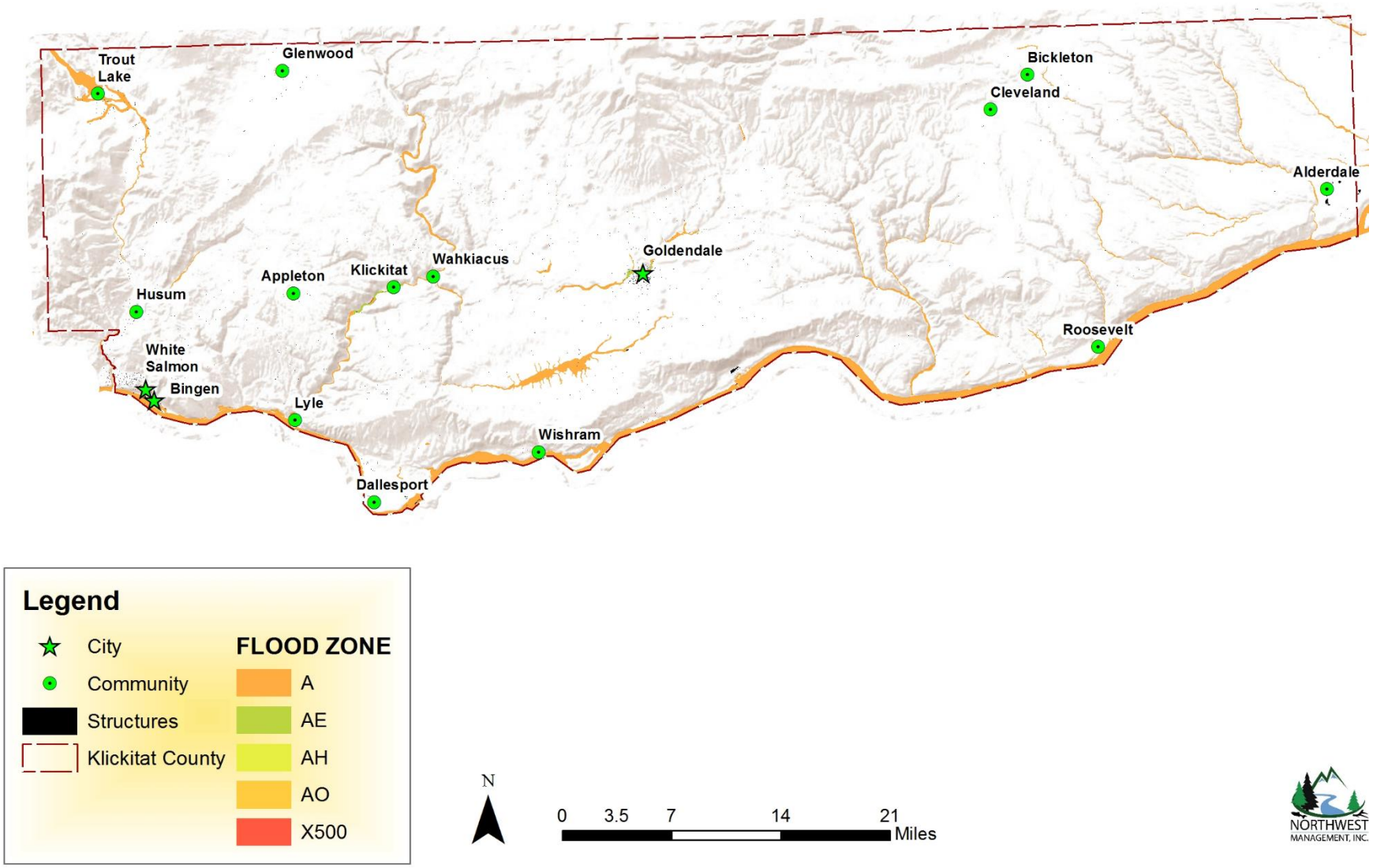


Figure 10) NFIP Flood zones for Klickitat County, WA. See Table 10 for NFIP flood zone definitions.

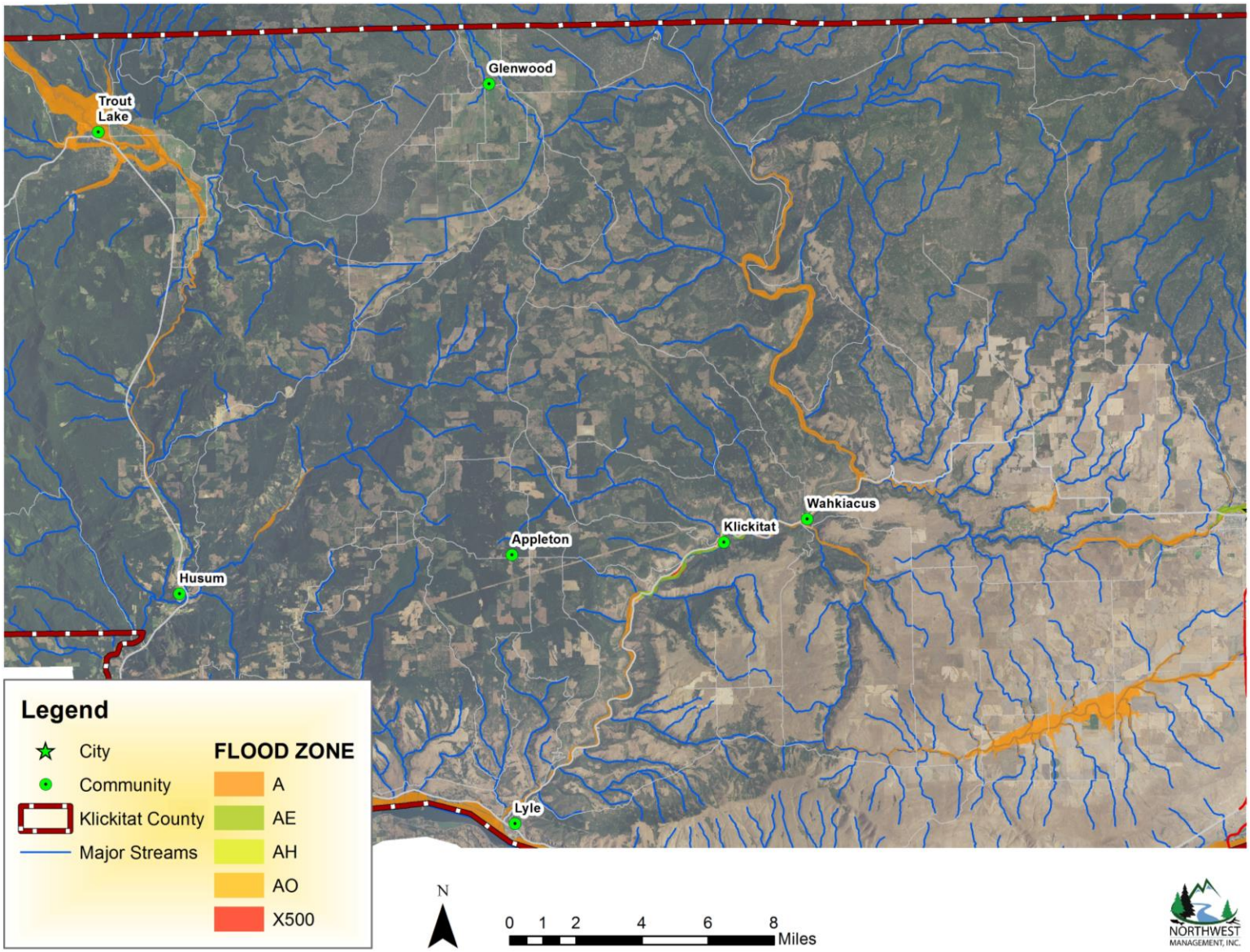
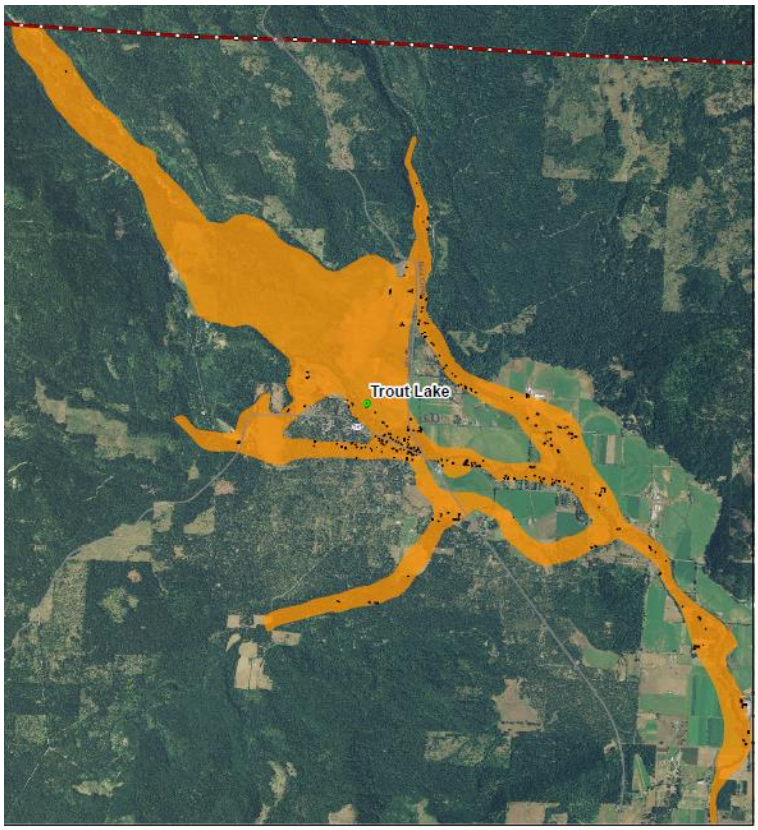
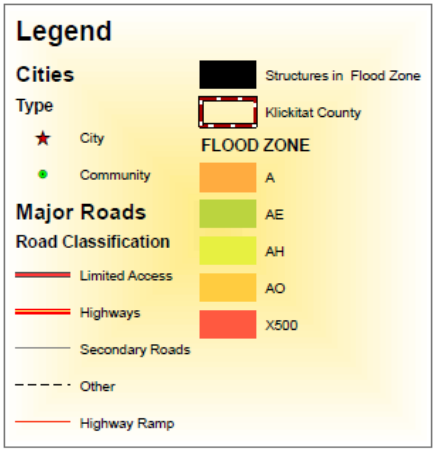
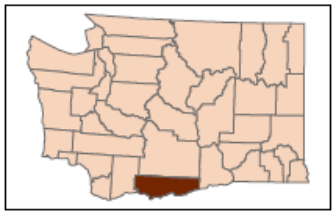


Figure 11) NFIP Flood zones in central Klickitat County, WA. See Table 10 for NFIP flood zone definitions.







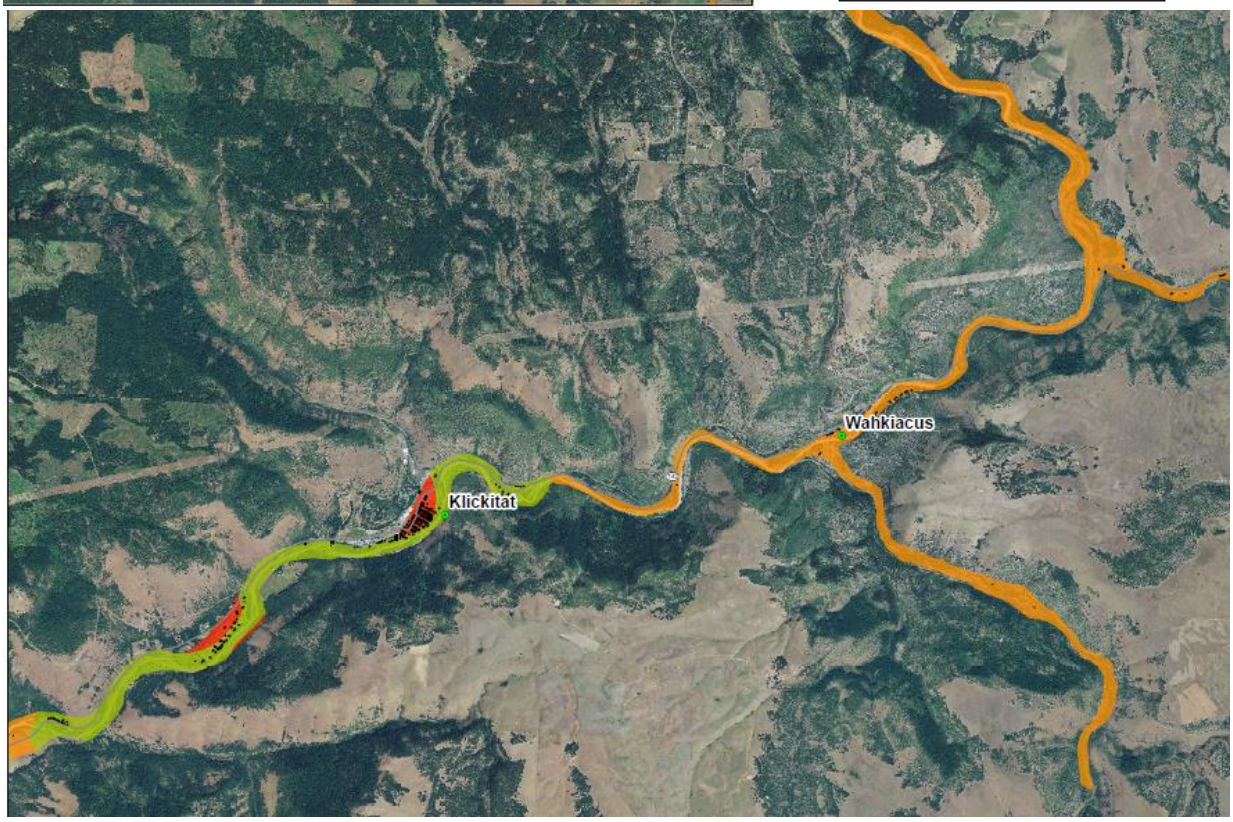


Figure 12) NFIP Flood zones in the Trout Lake Valley (top map) and Klickitat/Wahkiacus area (bottom map); Klickitat County, WA. See Table 10 for NFIP flood zone definitions.

In the northwest portion of Klickitat County near Mount Adams, the community of Trout Lake is vulnerable to flooding (Figure 10, Figure 11, and Figure 12) along the White Salmon River and its tributaries (Trout Creek and Bear Creek). The White Salmon River originates north of Trout Lake on the flanks of Mount Adams. South of Trout Lake, the White Salmon River runs through a deep gorge and does not overtop its banks and flood. However, about 6,000 and 260 years ago, lahars composed of mud, rock, and debris from Mount Adams traveled down the White Salmon River and spread out across the valley floor in the Trout Lake vicinity (see Volcano Hazard Profile below). Because these lahar deposits were emplaced not very long ago, the upper White Salmon River and its tributaries have not yet had time to erode downward and form new gorges, and thus these streams can easily overtop their banks and flood surrounding areas in the upper Trout Lake Valley.

Figure 13) Klickitat River flooding of Washington State Highway 142 near Klickitat, WA. Photo from Goldendale Sentinel newspaper (April 4, 2012). Photo credit: Andrew Christiansen.

In addition to areas adjacent to river and creek channels, other low-lying areas on the floor of the Trout Lake Valley are often subject to flooding from ponding of water in low areas with poor percolation (Figure 15). Furthermore, recent large wildfires and pest infestations have killed many trees on Mount Adams in forests within the White Salmon River watershed. During high water flow, the dead timber is being moved into and along the river channel, and where the river narrows or is crossed by bridges this woody debris can form logjams that temporarily dam the river and cause flooding (Figure 16). Another flood concern is the potential for lahars or landslides in the narrow upper reaches of the White Salmon River to form a

natural dam and impound the river upstream from Trout Lake. Catastrophic failure of such a dam could unleash a devastating flood on people living downstream in the Trout Lake area.

Elsewhere, the communities of Klickitat and Wahkiacus are subject to overbank flooding along portions of the Klickitat River, within the river's gorge along WA State Highway 142 (Figure 11 and Figure 12). A tributary to the Klickitat River, named the Little Klickitat River, flows through the county seat town of Goldendale and can be a source of flooding at times (Figure 10, Figure 17, and Figure 19).

Many areas of Klickitat County have steep terrain and deep, narrow drainages. During torrential rains, flash flooding can occur along many such ravines and drainages. The cliffs along the Columbia River are cut by many steep ravines that can flash flood across WA state Highway 14 (see Figure 14), which is a major east-west artery along the north side of the vital Columbia River transportation corridor.

The following image (Figure 14) shows a huge volume of water channeled into draws overwhelming culverts. Work crews begin repaving a section of SR14 where a basin was filled to about 50 feet deep until it overflowed the highway, damaging the guardrail and buckling the asphalt. The culvert seen at the lower right was not plugged and was scoured clean by the deluge.

Figure 14) Flash flood damage in the Columbia Gorge along WA State Highway 14. Photo and action published in the Goldendale Sentinel newspaper (July 18, 2012). photo credit: Andrew Christiansen.

HISTORICAL FLOOD EVENTS

DISASTER DECLARATION FLOODING

December 29, 1964 Heavy rains and flooding (DR-185)

"The total precipitation for December was about three times normal in the eastern part of the region (lower Columbia River basin) and in the Cascade Range and about 150 percent of normal in the lower Columbia River valley. In January the total precipitation was more than twice normal in the eastern part and about 150 percent of normal in the lower Columbia River valley[20]."

January 25, 1974 Severe storms, snowmelt, flooding (DR-414)

"Chinook weather which removed 10 inches of snow cover caused damaging floods in the Klickitat basin. Roads, five bridges and about 100 culverts were washed out and 17 homes destroyed. The water system of Klickitat was destroyed as the community was nearly isolated. The Klickitat River near Pitt, WA, crested at 17.12 feet on the 16th, exceeding the previous record of 14.34 feet set in December 1964.

Figure 15) Ponding of flood water in Trout Lake, WA. Photo published in the White Salmon Enterprise newspaper (December 17, 2015).

[20] Waananen, Harris, & Williams

Damaging flooding occurred in the portion of Klickitat and Skamania Counties of Washington drained by these streams. Loss of a 27-inch snow-cover at Glenwood, WA was reflected in the record crest of 12.85 feet on the White Salmon River near Underwood." (Climatological Data National Summary, 1950 to 1980)

Figure 16) Logjam near Trout Lake, WA that temporarily dammed the White Salmon River in December 2015. Photo credit: Linda Turner, Rachel Haymon.

December 10, 1977 Severe storms, mudslides, flooding (DR-545)

January 26, 1996 Severe storm and flooding (DR-1100)

"The February 1996 flood was one of the most widespread across the whole Pacific Northwest and Washington: 24 of 39 Washington State counties were affected. A precursor to the event was an extended period of cold temperatures that brought snow to low elevations and created river ice on the east side of the Cascades. Furthermore, the ground was frozen or saturated, so subsequent rainfall was directed mostly into runoff. During the week of February 4-10, warm air and excessive precipitation, typical Atmospheric River conditions, and the resultant snow melt caused widespread flooding that continued

into the following week. In addition to record precipitation in some of the mountainous areas, melting snowpack across the region contributed as much as half of the total runoff in some locations[21].

The heavy rain and rapid snowmelt combined to produce record and near-record flooding, mudslides, and avalanches. More than 2,600 homes were flooded, dozens of bridges were lost, an estimated $120 million in damages, and 3 fatalities occurred in Washington.

December 26, 1996 - February 10, 1997 Severe winter storms/flooding (DR-1159)

April 10, 1997 Snowmelt/flooding (DR-1182)

January 6, 2009 – January 16, 2009 Severe storm, landslides, mudslides and flooding (DR-1817)

On January 21, 2009, Governor Christine O. Gregoire requested a major disaster declaration as a result of a severe winter storm that yielded widespread and damaging effects from flooding, mudslides, landslides, avalanches, high winds, and freezing rain, during the period of January 6-16, 2009. The Governor requested a declaration for Individual Assistance for nine counties and Hazard Mitigation for all counties.

January 11, 2011-January 21, 2011 Severe winter storm, flooding, landslides, and mudslides (DR-1963)

January 14, 2012-January 23, 2012 Severe winter storm, flooding, landslides, and mudslides (DR-4056)

COLUMBIA RIVER FLOODS

In historic times (1894-2017), the Columbia River has crested above 16 feet at the Port of Vancouver twenty-five times (For a complete list of floods from 1894-2017 refer to the Public Works section of the Clark County, WA website[22]). The largest floods on record took place before construction of the dam system that now provides substantial flood protection; however, 11 floods have happened since the dams were built, including the twelfth-largest recorded flood in 1964-65 ("Christmas Flood" below).

Much of the historic information provided here is from "The Columbia River, A Photographic Journey" which can be found online[23].

1894 - The "Great Flood of 1894" was the highest flood along the Columbia on record. Rainfall was heavy during the winter of 1893-94 resulting in a heavy snowpack. A dry and warm spring resulted in massive snowmelt. Peaks reached nearly 35 feet at Umatilla, Oregon, and Longview, Washington hit a record 24.0 feet (12 feet over flood stage). A measured peak at The Dalles was 1,240,000 cubic feet per second (enough flow to cover a standard-size football field with water 1,500 feet deep in just one minute) while

[21] Service 2019

[22] https://www.clark.wa.gov/public-works/columbia-river-and-flooding

[23] http://www.columbiariverimages.com/Regions/Places/columbia_river_floods.html

flood stage on the Willamette River at Portland, Oregon was measured at 33.0 feet. The town of Cascades, located near the location of today's Bonneville Dam, was wiped out.

1948 - A warm May in the spring of 1948 resulted in rapid snowmelt in the Cascades and rising waters of the Columbia River. By May 25, 1948, both the Columbia and the Willamette Rivers were nearly at 23 feet, eight feet over flood stage. On May 30, 1948, at approximately 4:17 p.m., the railroad dike between Smith Lake and Vanport City gave way. Within moments a 10-foot-high wall of water rushed over lands north of the Columbia Slough and inundated the city of Vanport. Sixteen lives were lost, and Vanport City was forever gone. Today the area which once was Vanport City is now the location of the Portland International Raceway and the Huron Lakes Golf Course.

1964 "Christmas Flood" - In December 1964, heavy snow followed by unusually warm temperatures and torrential rain triggered what became known as the Christmas Flood of 1964, which caused $430 million in property damage and killed 47 people across a four-state region. The Columbia River [at/near Vancouver] crested at 27.7 feet on December 25, 1964.

Figure 17) 2012 Flooding near Goldendale, WA. Photo published in the Goldendale Sentinel newspaper (March 28, 2012).

1996 - "Flooding occurred along the Columbia River and other waterways. The average river level for the Columbia River is 7 to 8 feet in winter. On February 9, 1996, the river crested at 27.2 feet, more than 11 feet above its flood stage."

2011 – June 2, 2011, the Columbia River at Port of Vancouver crested at 17.43 feet, the 24th highest crest on record[24].

2017 - According to the National Weather Service's "Advanced Hydrologic Prediction Service, Historic Crests" (2018), the Columbia River's most recent flood was in 2017. On March 30th, the reading at the "Columbia River at Vancouver" showed the river crested at 17.60 feet, putting it in 22nd spot.

2018 - May 12, 2018 "Gov. Jay Inslee late yesterday proclaimed a state of emergency for Eastern Washington counties responding to [Columbia River] flood conditions. Covered by the proclamation are Adams, Asotin, Benton, Chelan, Columbia, Douglas, Ferry, Franklin, Garfield, Grant, Kittitas, Klickitat, Lincoln, Okanogan, Pend Oreille, Spokane, Stevens, Yakima, Walla Walla, and Whitman counties[25]."

Risk Assessment: Flood

The history of flooding in Klickitat County underscores the need to be well-prepared for the inevitable floods of the future that may come more often, and/or be more extreme, in the 21st century. Klickitat County is in the bullseye of a massive hydrologic system that delivers water annually from the Pacific Ocean to the Cascade Range and Columbia Basin, and circulates the water back to the ocean through the Columbia River. Warming of the atmosphere and ocean in the 21st century is expected to magnify and strengthen this cycle. Mitigation of flood hazards beforehand, proper planning and oversight of future development, and advance planning and preparation for flood recovery are the essential keys to flood resilience in Klickitat County in the decades ahead.

Probability and Magnitude

Although floods can happen at any time during the year, there are typical seasonal patterns for flooding in Washington State, based on the variety of natural processes that cause floods:

- Heavy rainfall on wet or frozen ground, before a snowpack has accumulated, typically cause fall and early winter floods.
- Rainfall combined with melting of the low elevation snowpack typically cause winter and early spring floods. Of concern is the so-called Pineapple Express, a warm and wet flow of subtropical air originating near Hawaii which can produce multi-day storms with copious rain and very high freezing levels.

[24] https://www.clark.wa.gov/public-works/columbia-river-and-flooding

[25] https://www.governor.wa.gov/news-media/inslee-proclaims-state-emergency-eastern-washington-due-flooding

- Late spring floods in Eastern Washington result primarily from melting of the snowpack.
- Thunderstorms typically cause flash floods during the summer in Eastern Washington; on rare occasions, thunderstorms embedded in winter-like rainstorms cause flash floods in Western Washington.

For the purposes of this Plan, the probability and magnitude of flood hazards in Klickitat County jurisdictions are based on the 100-year flood or 1% probability floodplains delineated on FEMA Flood Insurance Rate Maps (FIRMs), plus any provisional floodplains delineations used for in-house purposes by participating jurisdictions. FEMA has not updated the FIRM maps in Klickitat County since 2006. Table 11 summarizes the magnitude, probability, and overall risk ratings selected for each jurisdiction by the planning team. Refer to the Jurisdictional Risk and Vulnerability Ratings section at the beginning of this chapter for more information about the process used to determine hazard ratings.

Table 11) Overall Flood Significance Summary for adopting jurisdictions.

Jurisdiction	Magnitude	Probability	Overall Flood Risk
Klickitat County	**Severe**	**Highly Likely**	**High**
City of Bingen			Low
City of Goldendale			Medium
City of White Salmon			Low
Klickitat Valley Health			Low
Eastern Klickitat Conservation District			High
Central Klickitat Conservation District			High
Underwood Conservation District			High

Analysis of Resources at Risk

NFIP Participation

Participation in the NFIP is a key element of any community's local floodplain management and flood mitigation strategy. Klickitat County, Bingen, Goldendale, and White Salmon all participate in the NFIP.

Table 12) National Flood Insurance Policy statistics for participating adopting jurisdictions (January 1, 1978 to September 30, 2018).

Community	Policies In-Force	Insurance In-Force	Written Premium In-Force	FIRM Effective Date	Floodplain Manager	CRS Ranking
Klickitat County (Unincorporated)	53	$13,335,700	$49,180	7/2/1981	Mo-Chi Lindblad	10
Bingen	4	$904,800	$12,007	9/24/1984	Cheyenne Wright	10
Goldendale	2	$475,000	$2,546	9/17/1981	Larry Bellamy	10
White Salmon	1	$350,000	$415	3/18/1985	Pat Munyan	10

FEMA makes the following statement about the purpose of the National Flood Insurance Program:

The National Flood Insurance Program aims to reduce the impact of flooding on private and public structures. It does so by providing affordable insurance to property owners, renters and businesses and by encouraging communities to adopt and enforce floodplain management regulations. These efforts help mitigate the effects of flooding on new and improved structures. Overall, the program reduces the socio-economic impact of disasters by promoting the purchase and retention of general risk insurance, but also of flood insurance, specifically.

Joining the NFIP requires the adoption of a floodplain management ordinance that requires jurisdictions to follow established minimum standards set forth by FEMA and the State of Washington when developing in the floodplain. These standards require that all new buildings and substantial improvements to existing buildings will be protected from damage by the 100-year flood (1% flood), and that new floodplain development will not aggravate existing flood problems or increase damage to other properties. As a participant in the NFIP, communities benefit primarily from having access to federally backed flood insurance. Enrolled communities also benefit from having Flood Insurance Rate Maps (FIRM) that show flood hazard areas and can be used to assess flood hazard risk, regulated construction practices, and set flood insurance rates. FIRMs are also an important source of information to educate residents, government officials and the private sector about the likelihood of flooding in their community. Table 12 summarizes the NFIP status and statistics for each of the jurisdictions participating in this Program.

The county and cities that participate in NFIP for the benefit of their residents will continue to participate in the program in the future. The currently enrolled entities will also continue to educate and promote the program to residents/property owners that lay within the flood zone.

Residents in the county can refer to FEMA's website for information about reducing flood potential on private property, planning for a flood event, and preparing for flood conditions[26].

Repetitive Loss Properties

Repetitive Loss (RL) and Severe Repetitive Loss (SRL) properties are those NFIP-insured properties that have experienced multiple flood losses since 1978. FEMA tracks RL properties to identify SRL properties. RL properties demonstrate a record of repeated flooding for a certain location and are one element of the vulnerability analysis. RL properties are also important to the NFIP since structures that flood frequently put a strain on the National Flood Insurance Fund. Although there are no RL/SRL properties, there has been 22 paid claims submitted totaling $326,235.00 under this program in the unincorporated areas of Klickitat County and only one paid claim in Goldendale totaling $4,594.00 according to a report run by the Washington Department of Ecology (Table 13).

[26] https://www.fema.gov/national-flood-insurance-program

Table 13) NFIP Repetitive loss statistics for Klickitat County, WA.

Jurisdiction	Repetitive Loss Structures	Number of Paid Losses	Amount Paid
Klickitat County	0	22	$ 326,235.00
Goldendale	0	1	$ 4,594.00
Bingen	0	0	$ -
White Salmon	0	0	$ -
Total	**0**	**23**	**$ 330,829.00**

Community Rating System

The Community Rating System (CRS) is a voluntary program for NFIP participating communities. The goals of the CRS are to reduce flood damages to insurable property, strengthen and support the insurance aspects of the NFIP, and encourage a comprehensive approach to floodplain management. The CRS has been developed to provide incentives in the form of premium discounts for communities that go beyond the minimum floodplain management requirements and develop extra mitigation measures that reduce flood risk to insured properties, thus reducing the overall tax on the Program nationally.

There are 10 CRS classes; Class 1 provides the most credits and gives the greatest premium discount, Class 10 identifies a community that does not apply for the CRS discount, or that does not obtain a minimum number of credit points therefore receives no discount. Activities recognized as measures for reducing exposure to floods and worth CRS points are organized under four main categories; Public Information, Mapping and Regulation, Flood Damage Reduction, and Flood Preparedness. Currently, Klickitat County, Town of Bingen, City of Goldendale, and the Town of White Salmon have CRS ratings of 10.

Estimation of Loss

The building values were determined using the county's parcel database. According to this data set, there are 819 parcels with improvement values in the Klickitat County floodplain. Of these parcels there are approximately 779 buildings equating to a total value of $116,298,600.00 (Table 14). However, none of these parcels have been identified as repetitive loss properties in the county (Table 13). Combined, there are 114 parcels with improvements located in the Bingen and Goldendale floodplains worth $29,206,000. Collectively, these parcels feature 118 structures. There are 705 improved parcels, featuring 661 structures, located in floodplains in the unincorporated areas of the county, with a total value of $87,092,600.

Table 14) Number and value of parcels in Klickitat County that are in NFIP flood zones.

Flood Impact Zones	Total Number of Parcels	Number of Improvements	Improvement Value	Number of Structures
Unincorporated	1802	705	$87,092,600	661
Goldendale	102	79	$9,115,400	88
Bingen	55	35	$20,090,600	30
County Total	1959	819	$116,298,600.00	779

Impacts From Flooding

The National Flood Insurance Program defines flood as, "A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties (at least one of which is the policyholder's property) from:

- Overflow of inland or tidal waters; or
- Unusual and rapid accumulation or runoff of surface waters from any source; or
- Mudflow (liquid and flowing mud moving across surface); or
- Collapse or subsidence of land along the shore of a lake or similar body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels that result in a flood as defined above."

Floods cause loss of life and damage to structures, crops, land, flood control structures, transportation infrastructure (roads and bridges) and utilities. Floods also cause erosion and landslides (including mudslides or mudflows) and can transport debris and toxic products that cause secondary damage. Flood damage in Washington State exceeds damage by all other natural hazards. There have been 37 Presidential Major Disaster Declarations for floods in Washington State from 1956 through March 2019. Every county has received a Presidential Disaster Declaration for flooding. While not every flood creates enough damage to merit a declaration, most are severe enough to warrant intervention by local, state or federal authorities.

Impacts to Klickitat County

In addition to the general impacts listed above, Klickitat County could be subjected to specific impacts due to unique geological and hydrological features and distribution of populated areas and infrastructure. Refer to the "Flood Hazard Areas in Klickitat County Communities" section for a summary of impact areas in the county and summaries of historic flood events and the resulting impacts on populations, structures, and infrastructure.

Climate Change

Climate change will alter how, where, and when flooding occurs within Klickitat County. Climate change is increasing the extent and the frequency of flooding, a trend that is likely to continue into future planning cycles for the county. Heavy rain events are projected to intensify, increasing flood risk to all Cascade watersheds. In snow accumulating watersheds, winter floods will increase as the snow line recedes. Summer flows will reduce, and corresponding flooding will become less likely as our Cascade drainages change from rain-snow systems to rain-dominant ones. The flood impact areas detailed in "Flood Hazard Areas in Klickitat County Communities" section will likely flood more often, be greater in scope, and be subjected to similar impacts but at increased severity.

Development

Development in or near floodplains increases the likelihood of flood damage. As time passes, it is likely that there will be more new developments near the identified floodplains within the county. New developments can add structures and people to flood areas thereby increasing, not the extent of the flood

itself, but the impacts or damages that may be caused. New construction can also alter surface water flows by diverting water to new courses or increasing the amount of water that runs off impervious pavement and roof surfaces. This second effect diverts waters to places previously unaffected by flood issues. Unlike the weather and the landscape, this flood-contributing factor can be controlled. Development and occupation of the floodplain places individuals and property at risk. Such use can also increase the probability and severity of flood events (and consequent damage) downstream by reducing the water storage capacity of the floodplain, or by pushing the water further from the channel or in larger quantities downstream.[27] Most new development in the county is in the form of single homes in rural settings. There are some rural residential communities, as described in the Klickitat County CWPP, but these communities are located in the foothills of the mountains away from FEMA flood zones. Vulnerability to flooding in the county is increased by new residential structures located in communities located near major drainages, such as Trout Lake, Klickitat, and Wahkiacus.

Impacts to Other Adopting Jurisdictions

In addition to the general impacts listed above for the county, each adopting jurisdiction could be subjected to specific impacts as a result of location and nearby landscape features:

- **City of Bingen:** The City of Bingen has a medium probability of flooding. According to the NFIP floodplain map, impacts to the city from riverine flooding could be moderate in scope and moderate in severity (Figure 18).
    - Although it is located next to White Salmon, the City of Bingen is situated at a lower elevation and is closer to the edge of the Columbia River. Even though most impacts from flooding will be concentrated in the industrial areas along the edge of the Columbia River, flood waters could cross Highway 14 and affect structures and property in town.
    - Jewett Creek also poses a flood threat to Bingen as it runs along and through the eastern end of the city. Impacts from Jewett Creek flooding are expected to be much more limited in scope and to only occur north of Highway 14.
    - Because of the steep terrain in the Bingen area, flooding from heavy rains or excessive runoff could cause ground failures or trigger landslides in the vicinity of the city.
    - Dry Creek has an extensive history of flooding. Storm/urban flooding along Route 14 occurs when Dry Creek backs up from debris and releases at the downstream outlet. This happens frequently enough that the city has mitigation procedures in place and staff on call during storm events[28]

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[27] Planning and Flood Risk. Planning Policy Statement 15. The Planning Service, Department of Environment. January 2020. Available online at http://www.planningni.gov.uk/index/policy/policy_publications/planning_statements/pps15-flood-risk.pdf.

[28] FEMA Region X. Risk Map Discovery Interview: City of Bingen Washington. June 25, 2015. https://fortress.wa.gov/ecy/gisresources/SEA/RiskMAP/Mid_Columbia_Hood/Mid%20Columbia%20Hood%20Discovery%20Docs/bingen%20interview%20notes_6-25-15.pdf. Accessed February 2020.

- **City of Goldendale:** Goldendale has a moderate probability of flooding. According to the NFIP flood maps, flooding could be moderate in extent and cause moderate damage to communities along the Little Klickitat River (Figure 19).
    - The Little Klickitat River has a history of flooding and presents the greatest flood-threat to the Goldendale area as reflected in the NFIP flood analysis.
    - Depending on the depth of flood waters, the most significant impact would be flooded homes and structures in the northern part of the city.
    - Significant flooding could complicate and slow response from emergency personnel as the flood zone cuts across all streets and roads oriented north/south. Depending on the location of emergency responders at the time of peak flooding, mobilizing to the opposite side of the flood zone could be difficult.
- **City of White Salmon:** White Salmon has a low probability for flooding. According to the NFIP floodplain map, impacts to White Salmon from riverine flooding will be limited in scope and minimal in severity (Figure 20).
    - Because of its size and numerous control features, the Columbia River poses a low risk to White Salmon. However, the presence of multiple drainages, steep terrain, and potential for heavy runoff presents a flash flood risk.
    - Because of White Salmon's elevation and position above surrounding rivers, flooding will only be concentrated in the industrial areas along the edge of the Columbia River and in the eastern end of the city along Jewett Creek. Flooding from the Columbia River should be expected to reach the railroad tracks. Jewett Creek could overtop but impacts should be localized and only affect structures and property close to the creek.
    - Because of the steep terrain in the White Salmon area, flooding from heavy rains or excessive runoff could cause ground failures or trigger landslides in the vicinity of the city.
- **Klickitat Valley Health:** Based on the NFIP analysis for Goldendale, flood risk for the KVH facility in Goldendale is low.
    - The Klickitat Valley Health facility is located to the south of the Little Klickitat River outside of the NFIP flood zone. It is highly unlikely that the facility will be impacted by flooding.
    - Although flooding is unlikely to affect the facility directly, it could impact patient transport to the KVH campus.
- **Eastern Klickitat Conservation District**
    - Potential flood impacts to the eastern end of the county were discussed earlier in this section. NFIP flood zones have been identified in the eastern end of the county along the Columbia River and in multiple canyons.
- **Central Klickitat Conservation District**
    - Potential flood impacts to the central part of the county were discussed earlier in this section. NFIP flood zones have been identified in the central part of the county along the Columbia River, Little Klickitat River, in the Klickitat River Canyon, and in multiple smaller canyons.

- **Underwood Conservation District**
  - Potential flood impacts to the western end of the county were discussed earlier in this section. NFIP flood zones have been identified in the western end of the county along the Columbia River, the White Salmon River, in the Trout Lake Valley, and in multiple canyons.

Second-Order Hazard Events

Except for dam failure, flood events are typically caused by severe weather events such as thunderstorms or rapid spring runoff. Klickitat County has a high risk of major flood damages; however, flood events can trigger other types of hazard events that may be more damaging than the flood itself. The following chart (Table 15) outlines the interconnection between flood and other types of hazard events.

Table 15) Second-Order Hazards Related to Flood Events.

Related Causal Events	Related Effects
Severe Weather	Landslide
Dam/Culvert Failure	Dam Failure
Rapid Snowmelt	Transportation Systems
	Infectious Disease / Epidemic / Pandemic
	Crop Loss
	Power Outage
	Hazardous Materials
	Drinking Water Contamination
	Wastewater Treatment Plant Failure

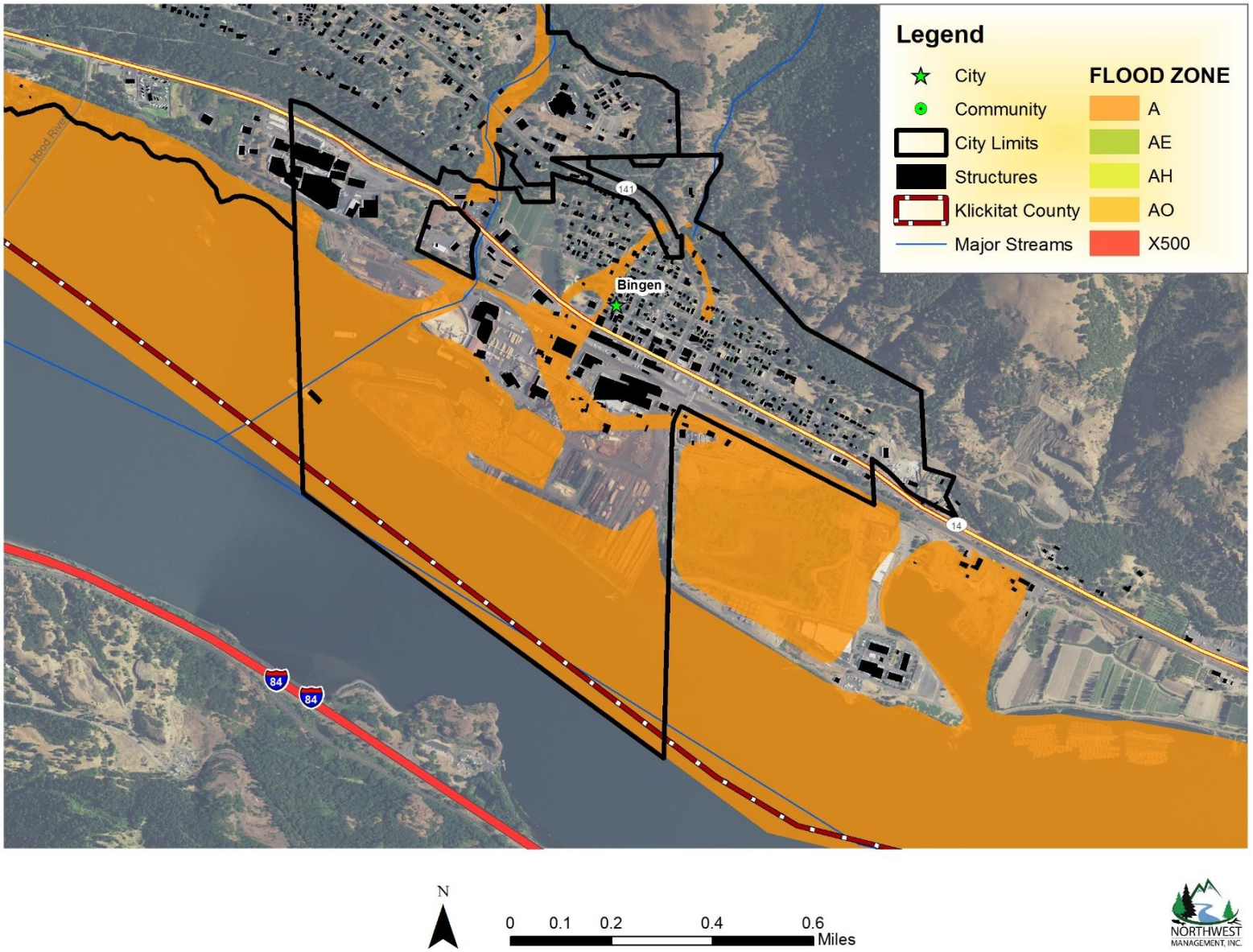

Figure 18) NFIP flood zones in Bingen, WA. See Table 10 for NFIP flood zone definitions.

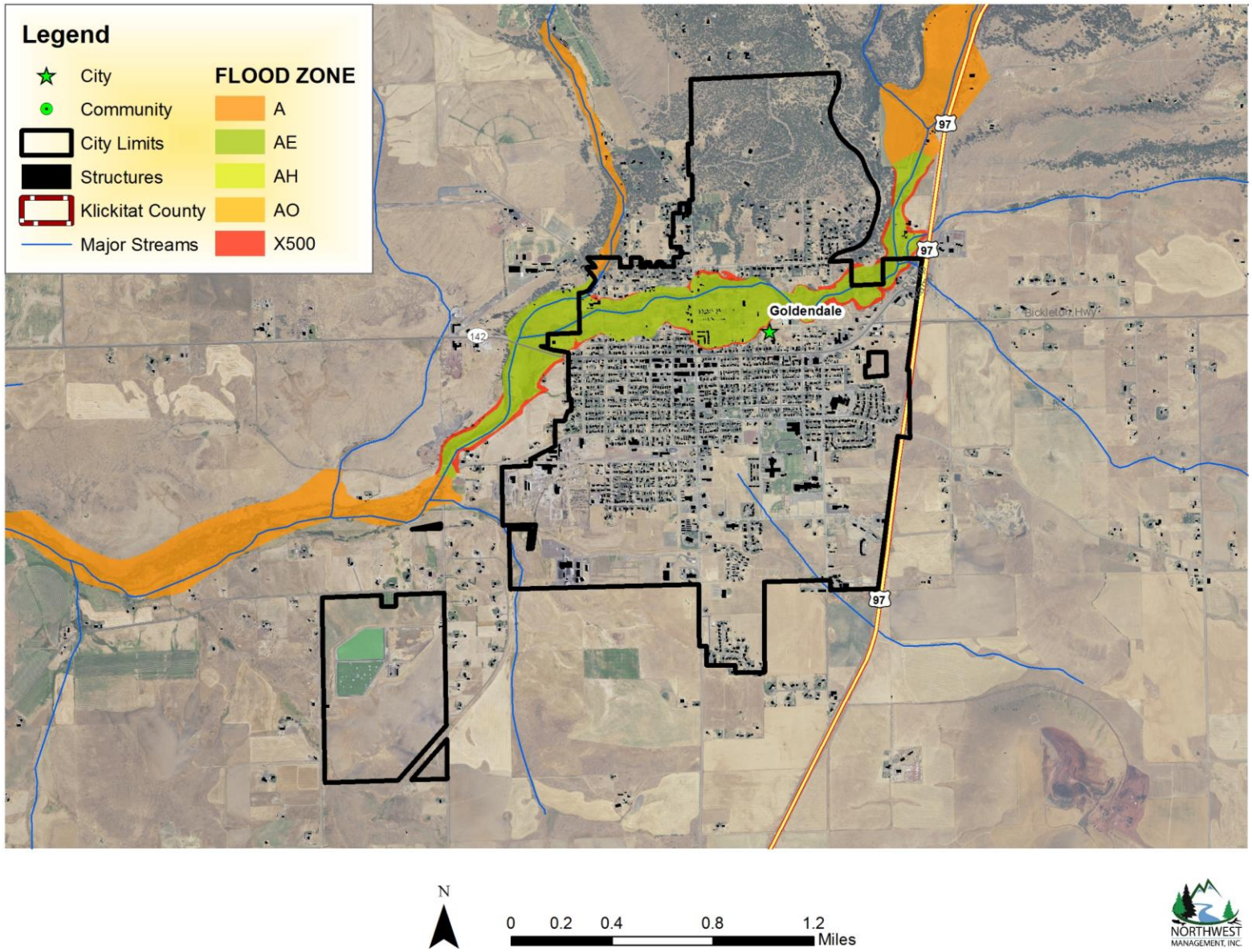

Figure 19) NFIP flood zones in Goldendale, WA. See Table 10 for NFIP flood zone definitions.

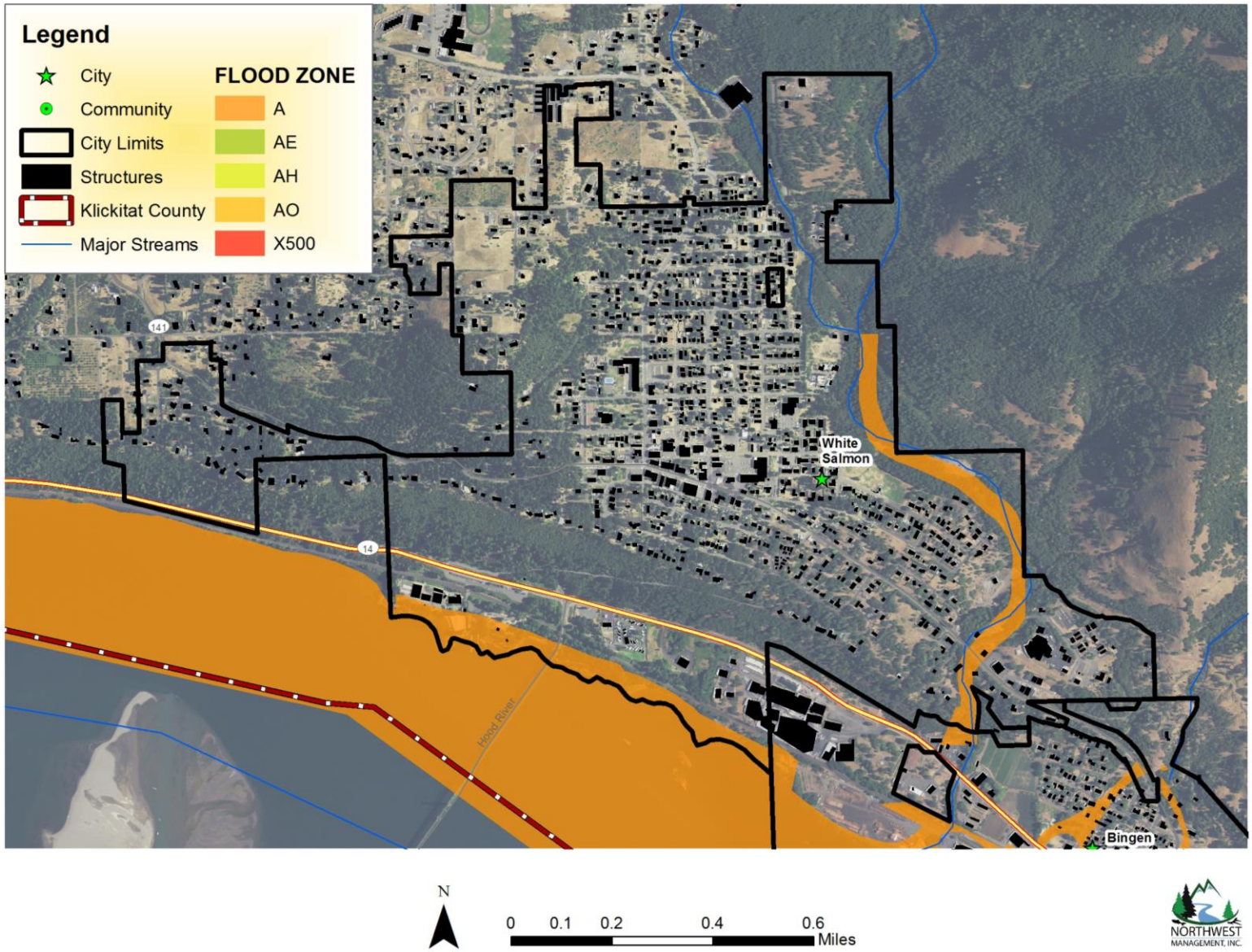

Figure 20) NFIP Flood zones in White Salmon, WA. See Table 10 for NFIP flood zone definitions.

WILDLAND FIRE HAZARD PROFILE & RISK ASSESSMENT

Most of the information in this section is a direct excerpt from the 2018 Klickitat County Community Wildfire Protection Plan (CWPP). The full Klickitat CWPP can be found online at:

https://www.klickitatcounty.org/DocumentCenter/View/5490/Klickitat-County-CWPP-DRAFT-20181105

DEFINITIONS

Structure Fire: A fire of accidental or human-caused origin that results in the uncontrolled destruction of homes, businesses, and other structures in populated, urban or suburban areas.

Wildland Fire: A fire of exposure or human-caused origin that results in the uncontrolled destruction of forests, field crops and grasslands.

Wildland-Urban Interface: A fire of natural or human-caused origin that occurs in or near forest or grassland areas where isolated homes, subdivisions, and small communities are also located.

WILDLAND FIRE BEHAVIOR & CHARACTERISTICS

In general, wildland fire behavior describes how fire reacts to available fuels, local topography, and current weather conditions. The relationships between these three components are dynamic; changing one condition can often exacerbate the affects that the other conditions have on fire behavior. As such, fire behavior is often modeled as a triangle with fuels, topography, and weather serving as the three sides (Figure 21). Understanding the relationships between the fire behavior components has important implications for not only managing an active wildfire but also mitigating wildfire risk. Since fuel is the only component that can be managed directly, management decisions regarding fuel-types and fuel loading across the landscape need to be made based on characteristics that are inherent of the region; climate and topography. Strategic fuel breaks, conservation and restoration of native species, and prescribed burns are examples of management activities that can reduce wildfire risk and simplify the process of assessing potential wildfire behavior. A brief description of each of the fire behavior elements follows in order to illustrate their effect on fire behavior.

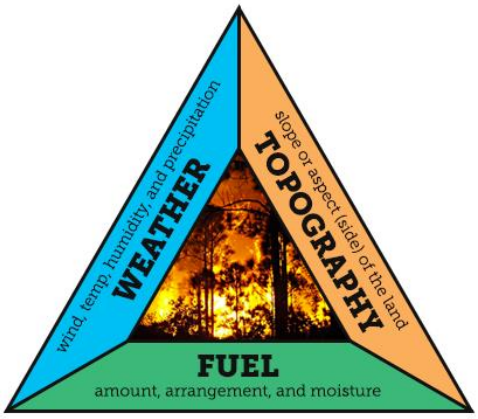

Figure 21) Fire Behavior Triangle (learn.weatherstem.com)

WEATHER

Fire behavior is largely influenced by weather conditions. Wind, moisture levels, temperature, and relative humidity are all factors that determine the rates at which fuels dry and vegetation cures. The ignition potential of fuels is also determined by these factors; weather patterns and trends can be analyzed to determine how likely or easily a certain fuel type will ignite and if a fire will be sustained. Once started, the behavior of a wildfire is further determined by atmospheric stability and local and regional weather.

As temperature, wind speed, wind direction, precipitation, storm systems, and prevailing winds all influence fire behavior, weather is the most difficult component of the fire triangle to predict and interpret. As observed in the Yarnell Hill fire in Arizona that killed 19 firefighters, a storm cell can cause a flaming front to change direction abruptly, 90 degrees in the case of the Yarnell Hill fire, and rapidly accelerate.

TOPOGRAPHY

Fires burning in similar fuel-types will burn differently under varying topographic conditions. Topography alters heat transfer and localized weather conditions, which in turn influences vegetative growth and resulting fuels. Changes in slope and aspect can have significant influences on how fires burn. In general, north slopes tend to be cooler, wetter, more productive sites. This typically results in heavy fuel accumulations, high fuel moistures, lower rates of curing for fuels, and lower rates of spread. In contrast, south and west slopes tend to receive more direct sun and therefore have the highest temperatures, lowest soil and fuel moistures, and lightest fuels. The combination of light fuels and dry sites leads to fires that typically display the highest rates of spread. These slopes also tend to be on the windward side of mountains which means they tend to be "available to burn" for a greater portion of the year. Slope also plays a significant role in the rate of spread of a fire as fuels upslope from the flaming front are subjected to preheating which means that they readily combust as the fire draws closer. The preheating process is exacerbated as slope increases which results in greater rates of spread and increased flame lengths. Therefore, steep slopes with a south–southwest aspect generally promote intense fire behavior due to dry fuels and the likelihood of predominant, westerly winds.[29]

FUELS

In the context of wildfire, fuels describe any organic material, dead or alive, found in the fire environment. Grasses, brush, branches, logs, logging slash, forest-floor litter, conifer needles, and buildings are all examples of fuel-types. The physical properties and characteristics of fuels govern how fires burn. Fuel loading, size and shape, moisture content, and continuity and arrangement all have an effect on fire behavior. In general, the smaller and finer the fuels, the faster the potential rate of fire spread. Small fuels such as grass, needle litter and other fuels less than a quarter inch in diameter are most responsible for fire spread. Fine fuels, those with high surface to volume ratios, are considered the primary carriers of surface fire. As fuel size increases, the rate of spread tends to decrease due to a decrease in the surface to volume ratio. Fires in large fuels generally burn at a slower rate but release much more energy and burn with much greater intensity. This increased energy release, or intensity, makes these fires more difficult to control.[30]

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[29] Topography's effect on Fire Behavior. Auburn University. http://www.auburn.edu/academic/forestry_wildlife/fire/topos_effect.htm. Accessed December 2016.

[30] Gorte, R. 2009. Congressional Research Service, Wildfire Fuels and Fuel Reduction.

Fuels are classified by diameter as that has important implications for fuel moisture retention. The smaller the diameter, the more quickly the moisture content of a given fuel type changes while larger diameter fuels take longer to change. In terms of fire potential on the landscape and fire suppression, the amount of time that is required for a fuel type to become volatile is critical which is why instead of referring to fuels by size, they are referred to as either one hour, ten-hour, 100 hour, or 1000 hour fuels. This method of classifying fuels describes the amount of time required for a fuel's status to change from non-combustible to combustible as a result of altered moisture levels in the surrounding environment.

WILDLAND FIRE HAZARD PROFILE

In the 1930s, wildfires burned an average of 40 to 50 million acres per year in the contiguous United States, according to US Forest Service estimates. By the 1970s, the average acreage burned had been reduced to about 5 million acres per year. Accounting for the substantial reduction in burned acreage was an increase in fire suppression efforts and development of firefighting equipment and strategy. Since 1970, about 3.5 million acres burn annually in the western U.S. The 2014 wildfire season set a record for 31 days at Preparedness Level (PL) 5 and had one of the largest wildfires in Washington History, the Carlton Complex at 256,108 acres. There was a total of 425,136 acres burned in the state of Washington.[31]

The potential volatility of a fire season can be predicted from winter snowfall, snowpack longevity, spring temperatures, and total precipitation. When winter snowfall is limited and snowpack melts early due to warm spring temperatures, conditions begin to favor fire activity as fine fuels dry out and spring storms generate lightning and high winds. Additionally, human activity increases in natural areas and recreation areas in warm weather months; typically, April through October in the Columbia River Basin. This increases the likelihood of a human-caused ignition, particularly in natural areas where fuels are abundant, that could result in a wildfire, threatening both populated areas and natural resources.

FIRE HISTORY

Historically, most plant communities in the state of Washington were fire-adapted and burned at regular intervals. Frequent, low intensity fires limited fuel accumulation across the landscape and contributed to the distribution of native, fire-adapted plant communities. In contrast to modern day conditions, fire return intervals (the amount of time between fires in a defined area) were shorter but fires burned with less intensity. Shorter return intervals between fire events often resulted in less dramatic changes in plant species composition.[32] Across the landscape, fires typically burned 1 to 50 years apart in a given area with most fire returning between 5 and 20 years.[33] With infrequent return intervals, plant communities tended

[31] http://www.nwccinfo.blogspot.com. Accessed July 2017.

[32] Johnson, C.G. 1998. Vegetation Response after Wildfires in National Forests of Northeastern Oregon. 128 pp.

[33] Barrett, J.W. 1979. Silviculture of ponderosa pine in the Pacific Northwest: the state of our knowledge. USDA Forest Service, General Technical Report PNW-97. Pacific Northwest Forest and Range Experiment Station, Portland, OR. 106 p.

to burn more severely and be replaced by vegetation communities different in composition, structure, and age.[34] Native plant communities in this region developed under the influence of fire. These adaptations to fire are evident at the species, community, and ecosystem levels.

Table 16 lists wildland fires 1,000 acres in size or larger that affected Klickitat County, WA between 1972 and 2018 (Fire History Points dataset). Fire information taken from the 2013 Washington State Enhanced Hazard Mitigation Plan list of major wildland fires are denoted with an asterisk (*).

Table 16) Historic fires greater than 1,000 acres in size that affected Klickitat County.

Year	Name of Fire	Size (acres)	Notes
1992*	Skookum	51,000	Threatened the Town of Goldendale
1998	Cleveland	18,500	
2000*	Mule Dry	76,800	Affected multiple counties
2001	Goodnoe	4,455	
2005	Wood Gulch	5,751	
2007	WoodGulch	7,666	Part of the Horse Heaven Complex
2007	Sixprong	20,395	Part of the Horse Heaven Complex
2010	Dallesport	1179	
2010	Highway 8	2,018	
2011	Monastery	3,621	Destroyed numerous structures
2011	Wishram II	8,990	
2012	Highway 141	1,636	Fire burned less than two miles from White Salmon; numerous homes and structures were threatened.
2012	Roosevelt	2,827	
2013	Dead Canyon	3,708	
2013	Mile Marker 28	26,092	
2014	Sand Ridge	2,277	
2015	Davies Pass	1,300	
2015	Horsethief Butte	6,383	
2015	Old Highway 8	33,105	Threatened the town of Roosevelt. See below for more information.
2016	Old Lady Canyon	2,800	Destroyed multiple structures. See below for more information.
2018	Mile Post 90	14,200	Threatened multiple communities and forced evacuations. See below for more information.

[34] Johnson, C.G.; Clausnitzer, R.R.; Mehringer, P.J.; Oliver, C.D. 1994. Biotic and Abiotic Processes of Eastside Ecosystems: The Effects of Management on Plant and Community Ecology, and on Stand and Landscape Vegetation Dynamics. Gen. Tech. Report PNW-GTR-322. USDA-Forest Service. PNW Research Station. Portland, Oregon. 722pp.

Since 1990, Klickitat County has had 21 significant wildfires ranging in size from approximately 1,200 to 51,000 acres. Several fires directly threatened cities and communities in Klickitat County:

- **Skookum Fire (1992):** Burned 51,000 acres and threatened the town of Goldendale.
- **Monastery Fire (2011):** Burned 3,626 acres and destroyed numerous structures.
- **Old Highway 8 fire (2015):** Burned 33,105 acres and was notable for the following points:
    - It threatened the community of Roosevelt burning right to the edges of town.
    - PUD evaporation pit liner damage. Replacement cost could potentially reach $500,000 to $750,000 (this is only an estimate and needs to be verified).
    - It was a wind driven event from the beginning. The fire nearly doubled in size after a wind shift on the third day.
- **Old Lady Canyon Fire (2016):** Burned approximately 2,800 acres but was a significant fire in Klickitat County:
    - One occupied home was lost and one ranch ceased operation due to fire related losses (fencing, corrals, feed, & range land).
    - Wind driven event from the beginning. The structures were lost on the second day when the wind direction changed and the fire size nearly doubled in size.
- **Mile Post 90 Fire (2018):** Threatened the communities of Wishram and Maryhill and forced level 2 and level 3 evacuations.

Historically, major wildfires have occurred throughout Klickitat County and are expected to continue to happen into the future. Since 1990, most major fires occurred in the eastern half of the county (Figure 22) while significant fires that burned in the western half of the county were generally located along the Columbia River. The Washington DNR created fire history maps of western and eastern Klickitat County that show historical wildfires in a greater level of detail. Refer to the Klickitat County CWPP for more information about fire history in the county.

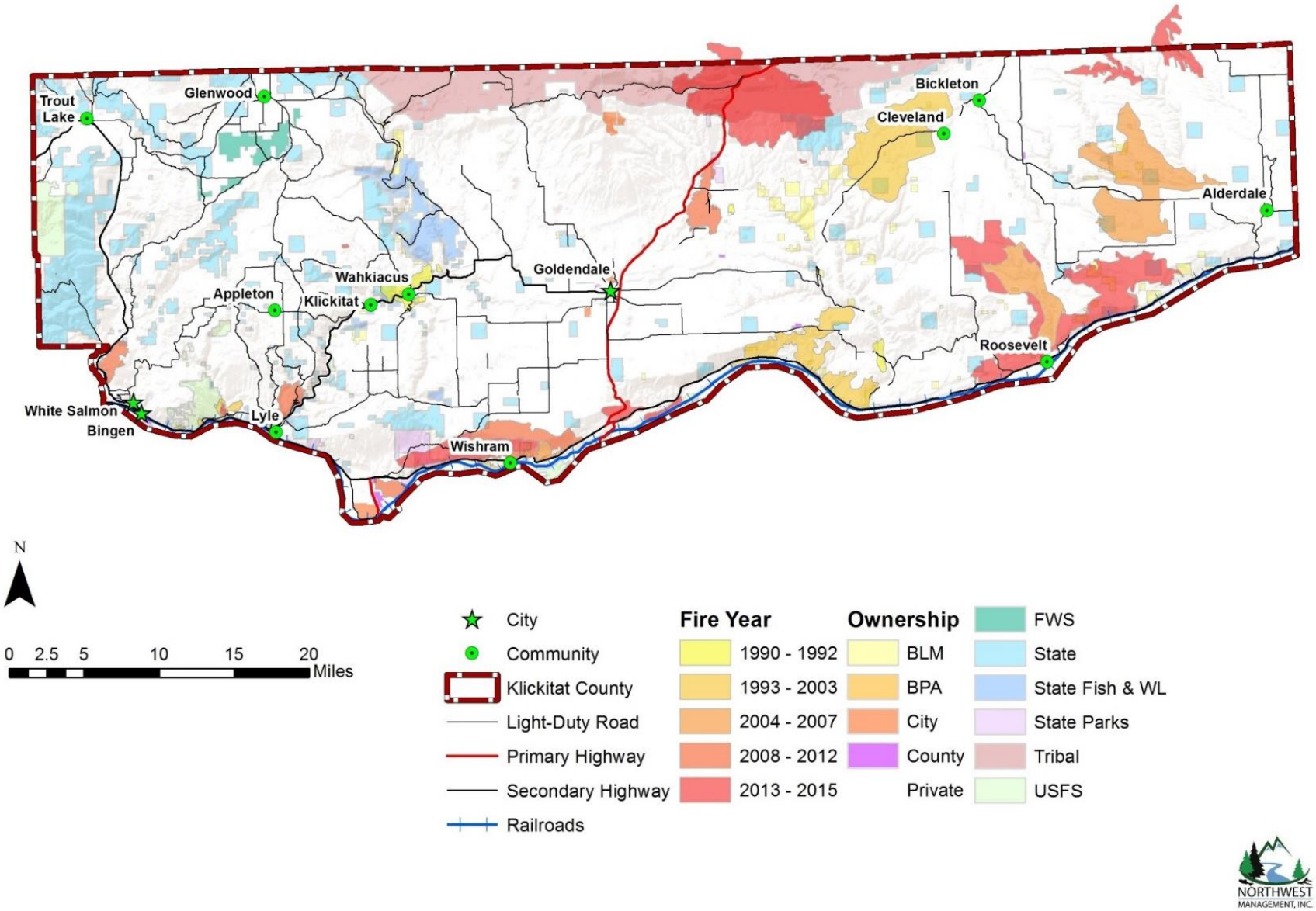

Figure 22) Wildland fires by decade occurring in Klickitat County, WA.

WILDFIRE IGNITION PROFILE

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

The Federal and State agencies database of wildfire ignitions (1972-2017) used in this analysis includes ignition and extent data within their jurisdictions. During this period, the agencies recorded an average of 52 wildfire ignitions per year resulting in an average total burn area of 1,700 acres per year. The highest number of ignitions (85) occurred in 1999. According to this dataset, most fires, approximately 71%, that occurred in Klickitat County were human caused; however, naturally ignited/unknown caused fires equal about 28% (Table 17). Of the known-cause categories, the two human-causes responsible for the most fire starts were debris burning (437 starts) and recreation (406 starts) (Figure 23). These values were comparable to the number of lighting caused fires which totaled 415 starts.

Table 17) Number and type of ignitions and acreage burned by wildfire from 1972 to 2017 in Klickitat County, WA.

Cause	Percent of Total Ignitions by Cause	Acreage	% of Total Acreage	Avg. Annual Acreage Burned
Human	80%	55,316	71%	1,203
Natural	17%	22,146	28%	481
Unknown	3%	710	1%	15
Total	100%	78,172	100%	1,700

Based on the wildfire ignition data specific to Klickitat County, the trends in both acreage burned (Figure 24) and number of fire starts (Figure 25) since 1972 match the national trends; acreage burned has increased while the number of fire starts has decreased. However, it is important to note that acreage burned is skewed by several "above average" fire seasons in the early and mid-1990's and even more so by the Mule Dry fire in 1998 and the Mile Marker 28 fire in 2013. The reasoning behind the decreasing-trend in fire starts at the national level, which is discussed in the next section, can likely be applied to Klickitat County.

The increasing trend observed in annual acreage burned by wildfire in Klickitat County (Figure 24) matches the national trend (Figure 27). One factor that likely explains the trend is the extensive grassland fuel type found throughout most of Klickitat County and the increasing component of cheat grass and other invasive species found across the landscape. Fuel loading and distribution across the landscape is largely dependent on spring precipitation. Increased fuel loads and greater fuel continuity often mean that the potential for wildfire and more severe fire behavior also increases. Cheat grass and other invasive species have almost certainly spread and become a greater component of grassland landscapes in Klickitat County since 1983. Cheat grass changes the fire regime of native plant communities by altering fire behavior and reducing fire return intervals. As cheat grass becomes a greater component of grasslands in Klickitat County, any infested areas will burn more often, and more acreage will likely burn before a fire is

suppressed. As population, vehicle traffic, and human activity increase in Klickitat County an increased number of fire-starting events should be expected.

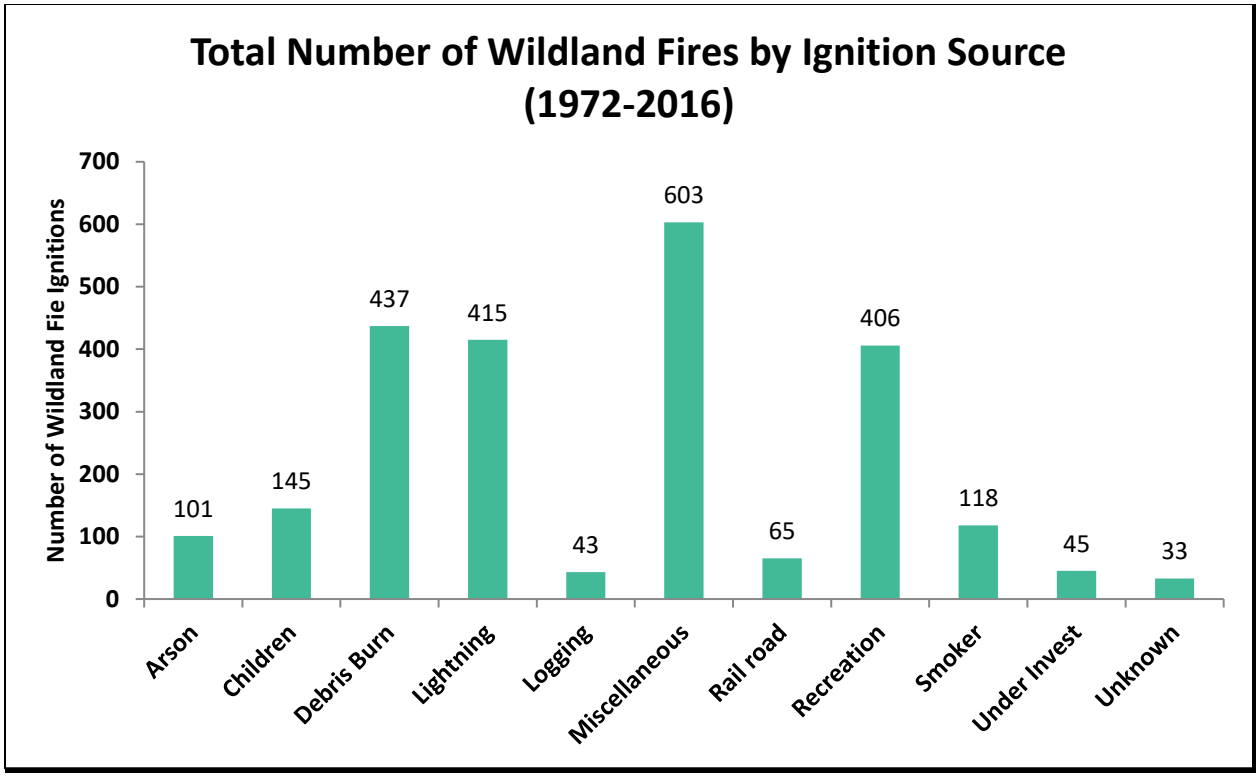

Figure 23) Number of wildfire ignitions by cause from 1972-2017 for Klickitat County, WA.

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

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

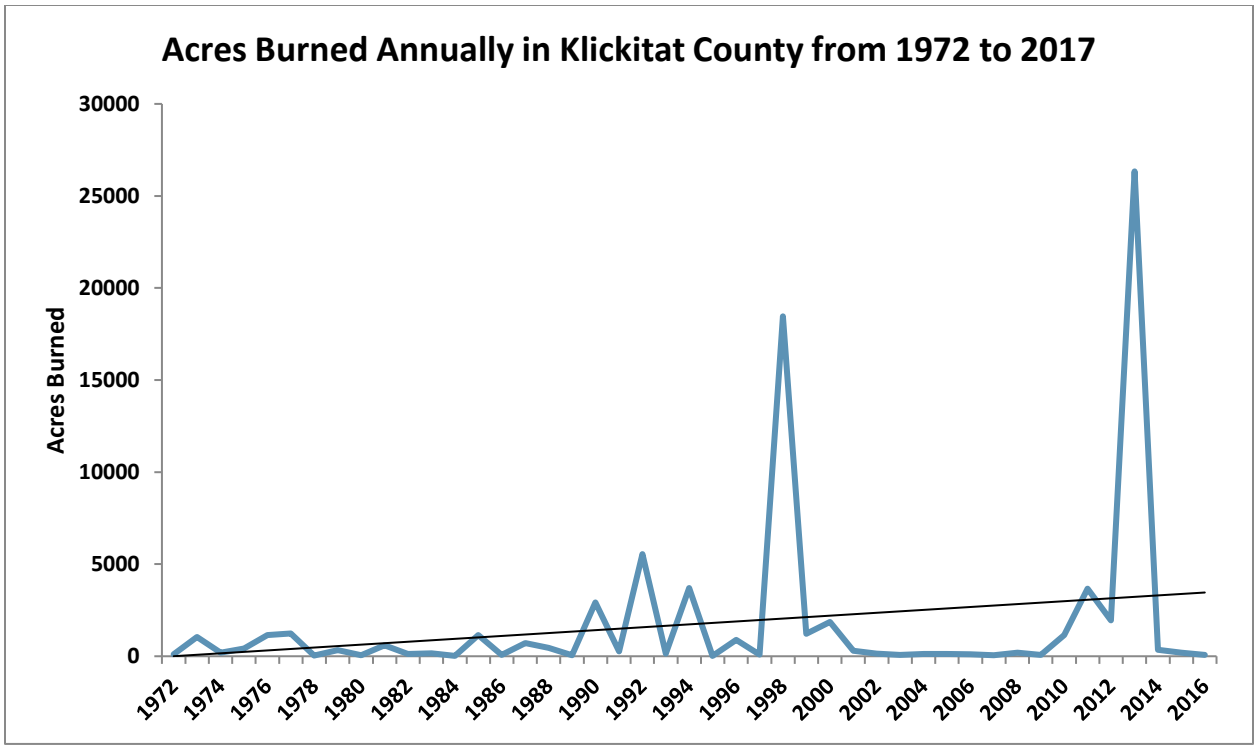

Figure 24) Acreage burned annually by wildfire in Klickitat County, WA from 1972 to 2017.

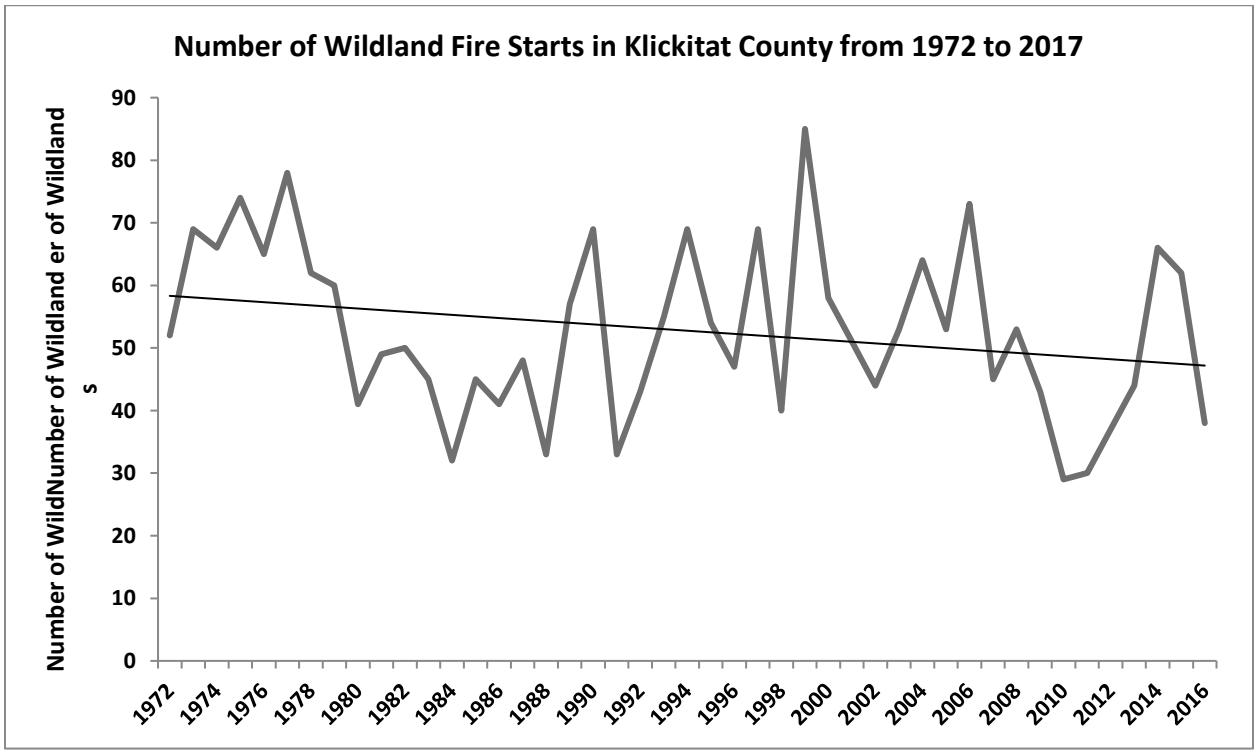

Figure 25) Annual number of wildfire ignitions in Klickitat County, WA from 1972 to 2017.

WILDFIRE EXTENT PROFILE

The National Interagency Fire Center and the National Incident Coordination Center maintains records of fire costs, extent, and related data for the entire nation. The number of wildland fire starts, total acreage burned, and annual cost to control figures were created using data from end-of-year reports compiled by all wildland fire agencies after each fire season. The agencies include the Bureau of Land Management, Bureau of Indian Affairs, National Park Service, US Fish and Wildlife Service, Forest Service, and all state agencies.

Across the west, wildfires have been increasing in extent and cost of control (Figure 26). Even though the number of fires that occur annually has decreased since 1990 (Figure 28), the total number of acres burned has increased (Figure 27). Over the last few decades summers have become warmer and drier; this trend has had significant implications for the severity of recent fire seasons, particularly in areas where decades of fire suppression have resulted in overstocked stands and heavy fuel loading. However, the inverse relationship between total number of fires and total acres burned can likely be attributed to a few other factors as well. Fire awareness programs have likely reduced the number of fire starts per season by making the public more cognizant of the impacts of wildfire and therefore more diligent when recreating or working in high risk areas. While in addition to recent climate trends, the increase in acreage burned each year can partially be attributed to changes in wildland firefighting tactics and emphasis on safety. In some situations, fire management teams are electing to intentionally burn additional acreage with back-burn operations or let the fire burn itself out or burn to a point where it can be contained with a greater level of assurance and under safer conditions.

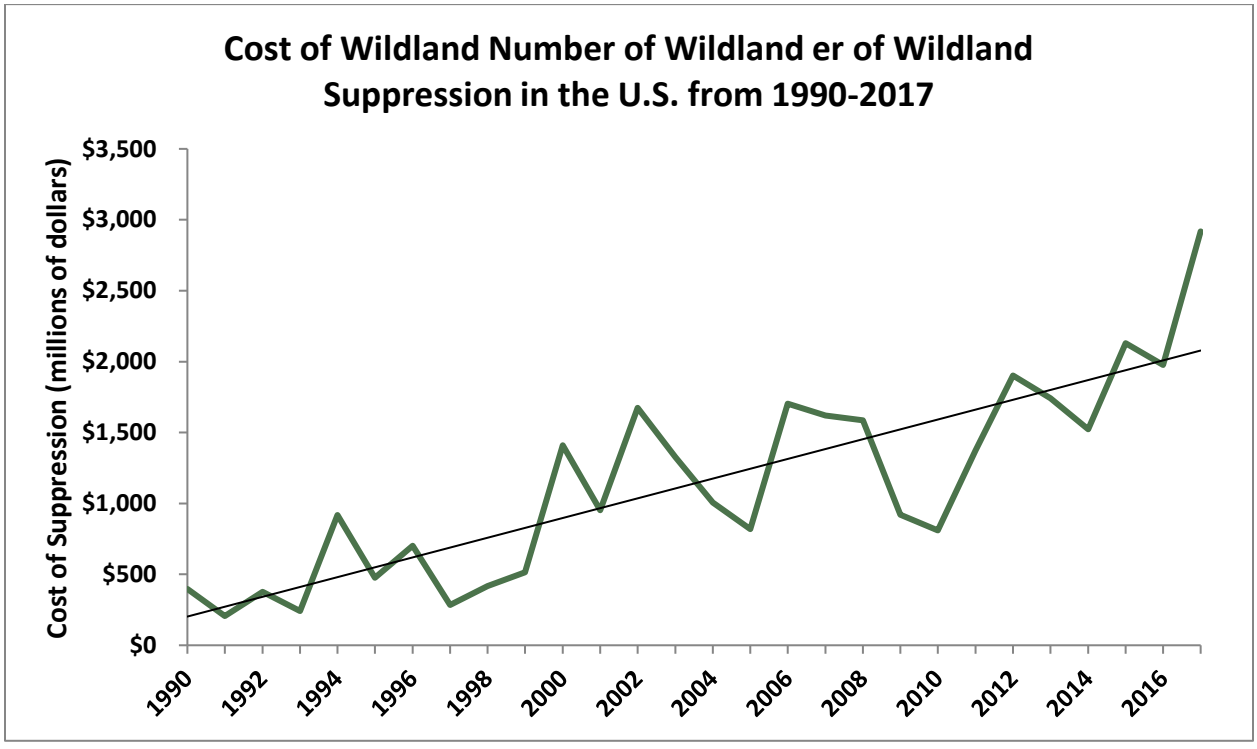

Figure 26) Annual cost of wildland fire suppression in the United States from 1990 to 2017. Values were not adjusted for inflation.

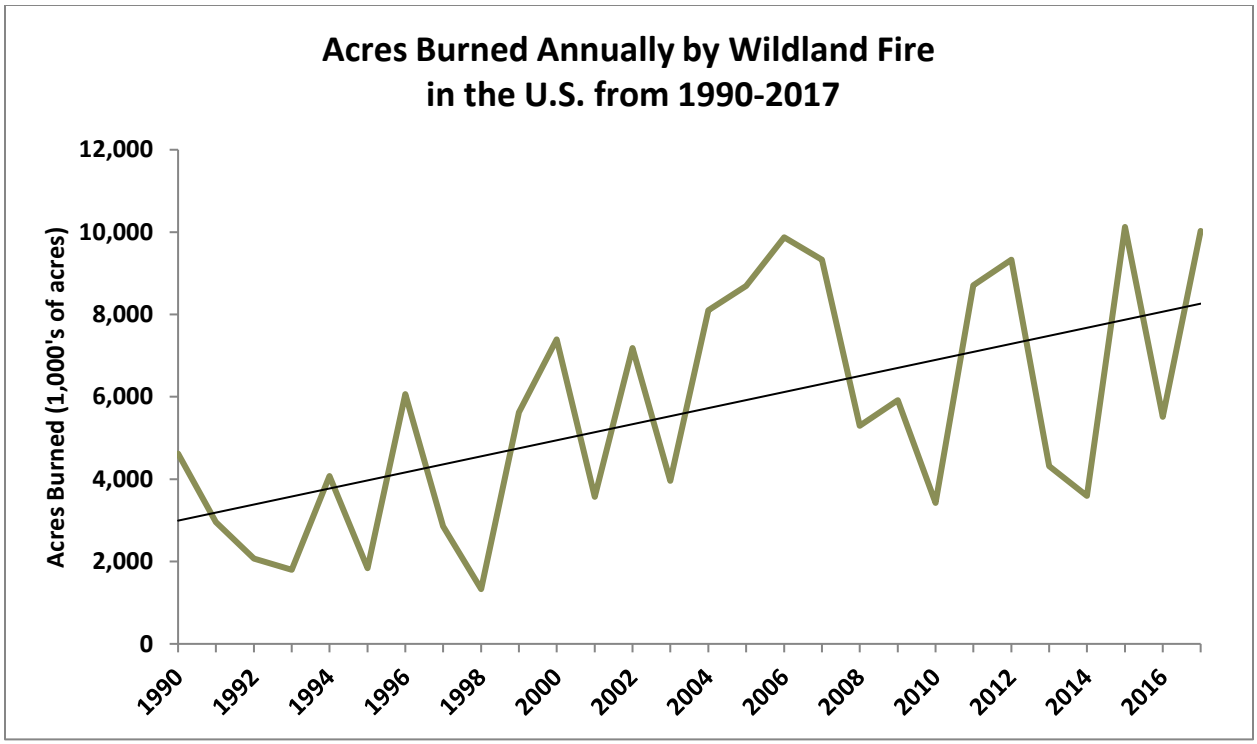

Figure 27) Annual acreage burned as a result of wildfire in the United States from 1990 to 2017.

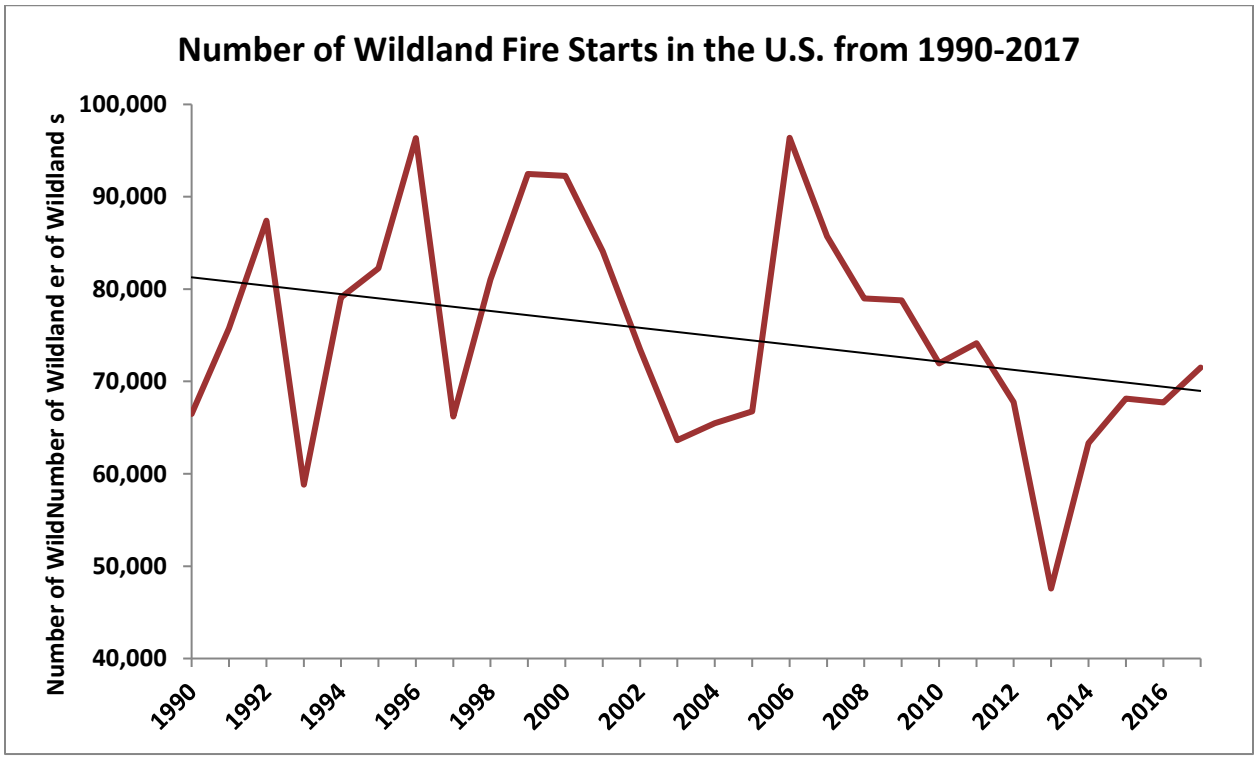

Figure 28) Annual number of wildland fire starts in the United States from 1990 to 2017.

The trends displayed in these figures are likely to continue into future fire seasons. Particularly as fire seasons extend earlier and later into the year and conditions become more volatile at the hottest and driest times of the year. As populations continue to increase and the WUI expands, more people, structures, and infrastructure will be exposed to wildfire risks which continues to increase the value of fire planning and fire mitigation work.

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

Fire Regime Groups

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

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

Many ecological assessments are enhanced by the characterization of the historical range of variability which helps managers understand: (1) how the driving ecosystem processes vary from site to site; (2) how these processes affected ecosystems in the past; and (3) how these processes might affect the ecosystems of today and the future. Historical fire regimes are a critical component for characterizing the historical range of variability in fire-adapted ecosystems. Furthermore, understanding ecosystem departures provides the necessary context for managing sustainable ecosystems. Land managers need to understand how ecosystem processes and functions have changed prior to developing strategies to maintain or restore sustainable systems. In addition, the concept of departure is a key factor for assessing risks to ecosystem components. For example, the departure from historical fire regimes may serve as a useful proxy for the potential of severe fire effects from an ecological perspective.

This model uses only the current vegetation types to determine the historic fire regime. Native Americans reportedly burned throughout the county on a regular basis. The vegetation types were much different pre-Euro-American settlement than they are today and believed to be a more grassland dominated landscape.

The Historic Fire Regime Group (FRG) model suggests that fires in Klickitat County historically burned with mixed severity and on both short and long return intervals. The orographic effect caused by the Cascades creates a moisture gradient across Klickitat County that results in wetter conditions in the west and drier conditions in the east and influences both species composition and vegetative growth. According to the analysis, approximately 60% of the county, primarily the eastern portion, are categorized as FRG III and IV. For these areas, a 35 to 200-year historical return interval and mixed severity fires capable of consuming 100% of existing vegetation should be expected. Approximately 54% of the county, mostly the western portion, is categorized as FRG I and III. Historical fire return intervals of less than 35 years to more than 200 years and low to mixed severity fires should be expected. Fire will likely consume grassy understory fuel-types while overstory trees survive. Currently, forested areas in the western half of the county are overstocked and in poor health which will likely increase the severity of fires to the level of stand replacing. Table 18 shows total acreage and percent of total acreage by FRG for Klickitat County and Figure 29 shows the distribution of FRG.

Table 18) Fire Regime Groups for Klickitat County, WA.

Designation	Description	Acres	% Total
Fire Regime Group I	<= 35 Year Fire Return Interval, Low and Mixed Severity	393,342	32.3%
Fire Regime Group II	<= 35 Year Fire Return Interval, Replacement Severity	17,778	1.5%
Fire Regime Group III	35 - 200 Year Fire Return Interval, Low and Mixed Severity	267,719	22.0%
Fire Regime Group IV	35 - 200 Year Fire Return Interval, Replacement Severity	466,723	38.3%
Fire Regime Group V	> 200 Year Fire Return Interval, Any Severity	41,394	3.4%
Water	Water	22,364	1.8%
Barren	Barren	93	<1%
Sparsely Vegetated	Sparsely Vegetated	9,147	<1%
Total		1,218,560	100%

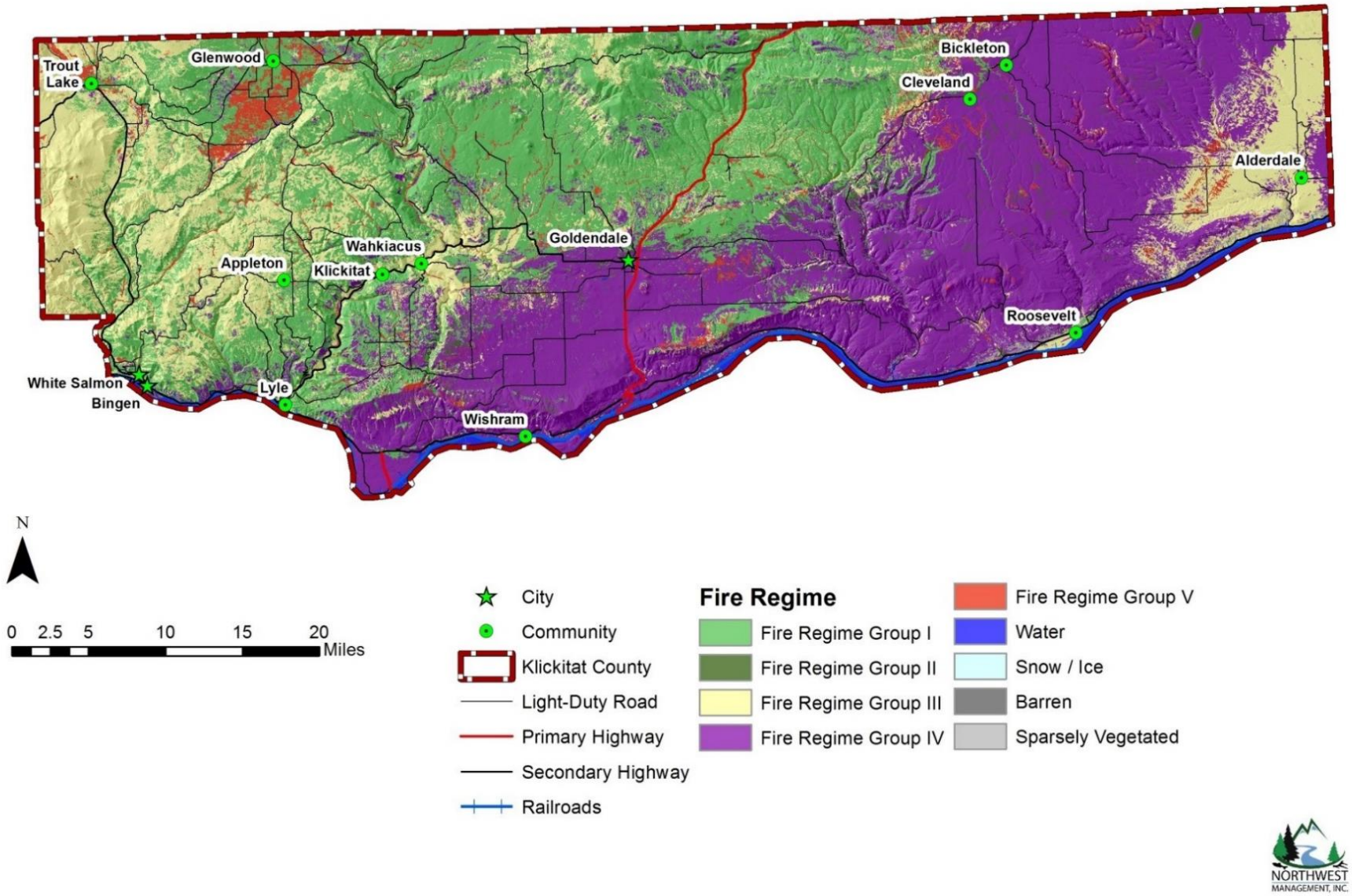

Figure 29) Fire Regime Group map for Klickitat County, WA. Map created using the Fire Regime Group dataset.

Fire Regime Condition Class

A natural fire regime is a general classification of the role fire would play across a landscape in the absence of modern human mechanical intervention, but including the influence of aboriginal burning.[35, 36] Coarse scale definitions for historic fire regimes have been developed by Hardy et al[37] and Schmidt et al[38] and interpreted for fire and fuels management by Hann and Bunnell.

A fire regime condition class (FRCC) is a classification of the amount of vegetative departure from the historic regime.[39] The three classes are based on low (FRCC 1), moderate (FRCC 2), and high (FRCC 3) departure from the central tendency of the natural (historical) regime.[40,41] The central tendency is a composite estimate of vegetation characteristics (species composition, structural stages, stand age, canopy closure, and mosaic pattern); fuel composition; fire frequency, severity, and pattern; and other associated natural disturbances. Low departure is within the natural (historical) range of variability, while moderate and high departures are outside.

An analysis of Vegetation Condition Classes in Klickitat County shows that, of all land that has not been converted to agriculture, approximately 28% of the land in the county is considered highly departed from its historic fire regime and associated vegetation and fuel characteristics (Table 19) Fire Regime Condition Classes for Klickitat County, WA.). Just over 15% has a low departure and just over 35% is considered moderately departed.

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[35] Agee, J. K. Fire Ecology of the Pacific Northwest forests. Oregon: Island Press. 1993.

[36] Brown. J. K. "Fire regimes and their relevance to ecosystem management." *Proceedings of Society of American Foresters National Convention*. Society of American Foresters. Washington, D.C. 1995. Pp 171-178.

[37] Hardy, C. C., et al. *"Spatial data for national fire planning and fuel management."* International Journal of Wildland Fire. 2001. Pp 353-372.

[38] Schmidt, K. M., et al. *"Development of coarse scale spatial data for wildland fire and fuel management."* General Technical Report, RMRS-GTR-87. U.S. Department of Agriculture, Forest Service. Rocky Mountain Research Station. Fort Collins, Colorado. 2002.

[39] Hann, W. J. and D. L. Bunnell. "Fire and land management planning and implementation across multiple scales." International Journal of Wildland Fire. 2001. Pp 389-403.

[40] Hardy, C. C., et al. *"Spatial data for national fire planning and fuel management."* International Journal of Wildland Fire. 2001. Pp 353-372.

[41] Schmidt, K. M., et al. *"Development of coarse scale spatial data for wildland fire and fuel management."* General Technical Report, RMRS-GTR-87. U.S. Department of Agriculture, Forest Service. Rocky Mountain Research Station. Fort Collins, Colorado. 2002.

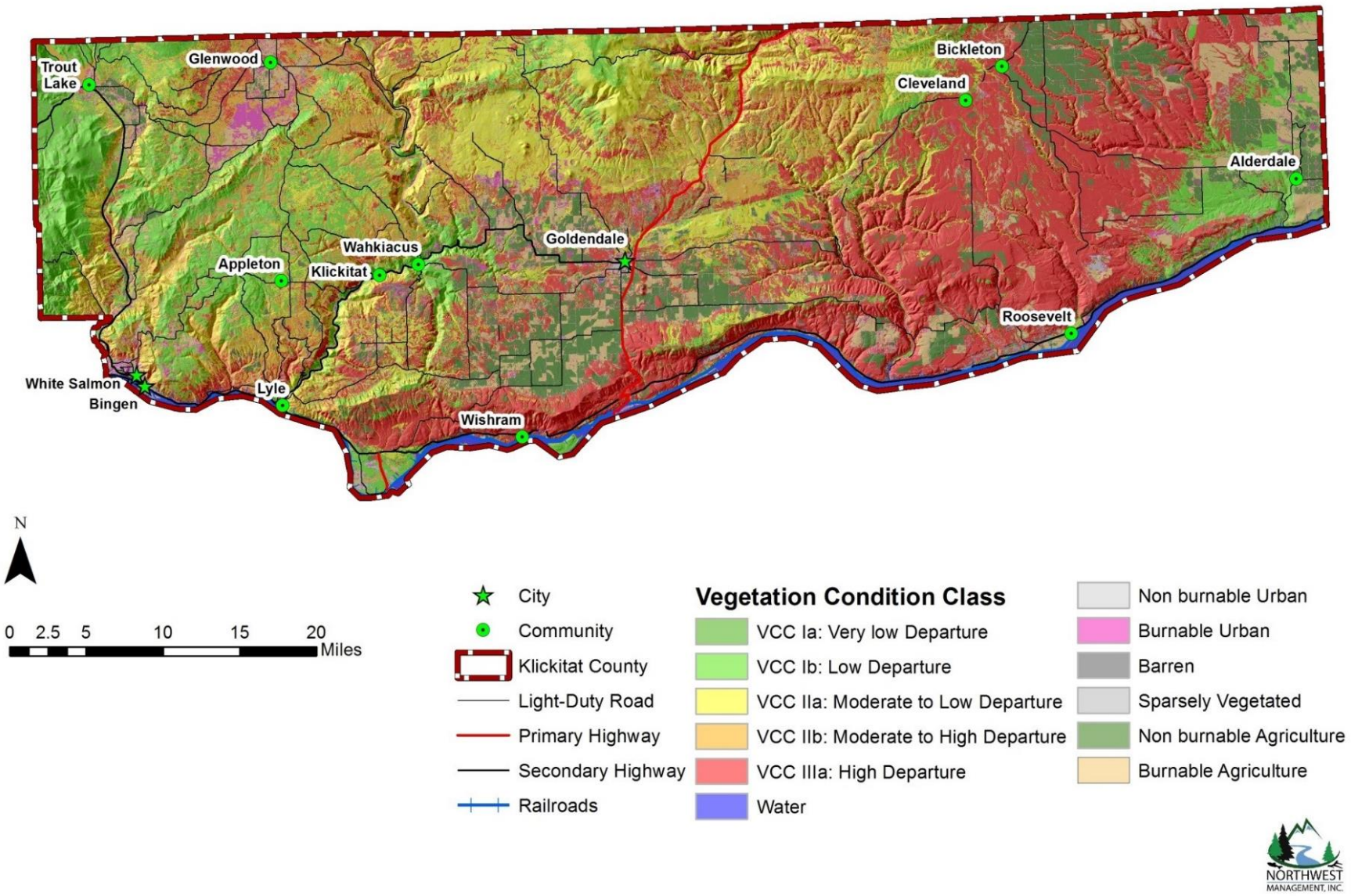


Figure 30) Fire Regime Condition Classes for Klickitat County, WA.

The current Vegetation Condition Class model shows that most of the land that is classified as High Departure is found in the eastern half of the county which is predominately grassland (Figure 30). The slopes along the Columbia River are also considered to be High Departure. The current fire severity model suggests that fires with increased severity, relative to historical fires, should be expected in highly departed areas.

Table 19) Fire Regime Condition Classes for Klickitat County, WA.

Fire Regime Condition Class	Description	Acres	Percent of Total
Fire Regime Condition Class I	Low Vegetation Departure	185,043	15.2%
Fire Regime Condition Class II	Moderate Vegetation Departure	429,890	35.3%
Fire Regime Condition Class III	High Vegetation Departure	339,464	27.9%
Water	Water	20,988	1.7%
Urban	Urban	33,674	2.8%
Burnable Urban	Burnable Urban	39,002	3.2%
Barren	Barren	87	<1%
Sparsely Vegetated	Sparsely Vegetated	8,550	<1%
Agriculture	Agriculture	94,356	7.7%
Burnable Agriculture	Burnable Agriculture	67,508	5.5%
Total		1,218,560	100%

Wildland Urban Interface

The wildland urban interface (WUI) has gained attention through efforts targeted at wildfire mitigation; however, this analysis technique is also useful when considering other hazards because the concept looks at where people and structures are concentrated in any region.

A key component in meeting the underlying need for protection of people and structures is the protection and treatment of hazards in the WUI. The WUI refers to areas where wildland vegetation meets urban developments or where forest fuels meet urban fuels such as houses. The WUI encompasses not only the interface (areas immediately adjacent to urban development), but also the surrounding vegetation and topography. Reducing the hazard in the WUI requires the efforts of federal, state, and local agencies and private individuals.[42] "The role of [most] federal agencies in the WUI includes wildland firefighting, hazard fuels reduction, cooperative prevention and education, and technical experience. Structural fire protection [during a wildfire] in the WUI is [largely] the responsibility of Tribal, state, and local

[42] Norton, P. Bear Valley National Wildlife Refuge Fire Hazard Reduction Project: Final Environmental Assessment. Fish and Wildlife Services, Bear Valley Wildlife Refuge. June 20, 2002.

governments".[43] The role of the federal agencies in Klickitat County is and will be much more limited. Property owners share a responsibility to protect their residences and businesses and minimize danger by creating defensible areas around them and taking other measures to minimize the risks to their structures.[44] With treatment, a WUI can provide firefighters a defensible area from which to suppress wildland fires or defend communities against other hazard risks. In addition, a WUI that is properly treated will be less likely to sustain a crown fire that enters or originates within it. [45]

By reducing hazardous fuel loads, ladder fuels, and tree densities, and creating new and reinforcing existing defensible space, landowners can protect the WUI, the biological resources of the management area, and adjacent property owners by:

- Minimizing the potential of high-severity ground or crown fires entering or leaving the area;
- Reducing the potential for firebrands (embers carried by the wind in front of the wildfire) impacting the WUI. Research indicates that flying sparks and embers (firebrands) from a crown fire can ignite additional wildfires as far as 1¼ miles away during periods of extreme fire weather and fire behavior;[46]
- Improving defensible space in the immediate areas for suppression efforts in the event of wildland fire.

Three WUI conditions have been identified (Federal Register 66(3), January 4, 2001) for use in wildfire control efforts. These include the Interface Condition, Intermix Condition, and Occluded Condition. Descriptions of each are as follows:

- **Interface Condition** – a situation where structures abut wildland fuels. There is a clear line of demarcation between the structures and the fuels along roads or back fences. The development density for an interface condition is usually 3+ structures per acre;
- **Intermix Condition** – a situation where structures are scattered throughout a wildland area. There is no clear line of demarcation; the wildland fuels are continuous outside of and within the developed area. The development density in the intermix ranges from structures very close together to one structure per 40 acres; and
- **Occluded Condition** – a situation, normally within a city, where structures abut an island of wildland fuels (park or open space). There is a clear line of demarcation between the structures

[43] USFS. 2001. United States Department of Agriculture, Forest Service. Wildland Urban Interface. Web page. Date accessed: 25 September 2001. Accessed at: http://www.fs.fed.us/r3/sfe/fire/urbanint.html

[44] USFS. 2001. United States Department of Agriculture, Forest Service. Wildland Urban Interface. Web page. Date accessed: 25 September 2001. Accessed at: http://www.fs.fed.us/r3/sfe/fire/urbanint.html

[45] Norton, P. Bear Valley National Wildlife Refuge Fire Hazard Reduction Project: Final Environmental Assessment. Fish and Wildlife Services, Bear Valley Wildlife Refuge. June 20, 2002.

[46] McCoy, L. K., et all. Cerro Grand Fire Behavior Narrative. 2001.

and the wildland fuels along roads and fences. The development density for an occluded condition is usually like that found in the interface condition and the occluded area is usually less than 1,000 acres in size.

In addition to these classifications detailed in the Federal Register, Klickitat County has included three additional classifications to augment these categories:

- **Rural Condition** – a situation where the scattered small clusters of structures (ranches, farms, resorts, or summer cabins) are exposed to wildland fuels. There may be miles between these clusters.
- **High Density Urban Areas** – those areas generally identified by the population density consistent with the location of incorporated cities, however, the boundary is not necessarily set by the location of city boundaries or urban growth boundaries; it is set by very high population densities (more than 7-10 structures per acre).
- **Non-WUI Condition** – a situation where the above definitions do not apply because of a lack of structures in an area or the absence of critical infrastructure. This classification is not considered part of the WUI and does not occur in Klickitat County.

In summary, the designation of areas by the Klickitat County planning team includes:

- Interface Condition: WUI
- Intermix Condition: WUI
- Occluded Condition: WUI
- Rural Condition: WUI
- High Density Urban Areas: WUI
- Non-WUI Condition: Not WUI, not present in Klickitat County

Klickitat County's WUI is primarily based on population density. Relative population density across the County was estimated using a GIS based kernel density population model that uses object locations to produce, through statistical analysis, concentric rings or areas of consistent density. To graphically identify relative population density across the county, structure locations are typically used as an estimate of population density. However, Klickitat County does not have an address or structure GIS layer so population densities are based on parcel count for this analysis. Assigning a value of one to each parcel, the resulting output displays the concentration of parcels throughout the county (Figure 31).

By evaluating structure density in this way, WUI areas can be identified on maps by using mathematical formulae and population density indexes. The resulting population density indexes create concentric circles showing high density areas, interface, and intermix condition WUI, as well as low density WUI (as defined above). This portion of the analysis allows us to "see" where the highest concentrations of structures are in reference to relatively high-risk landscapes, limiting infrastructure, and other points of concern.

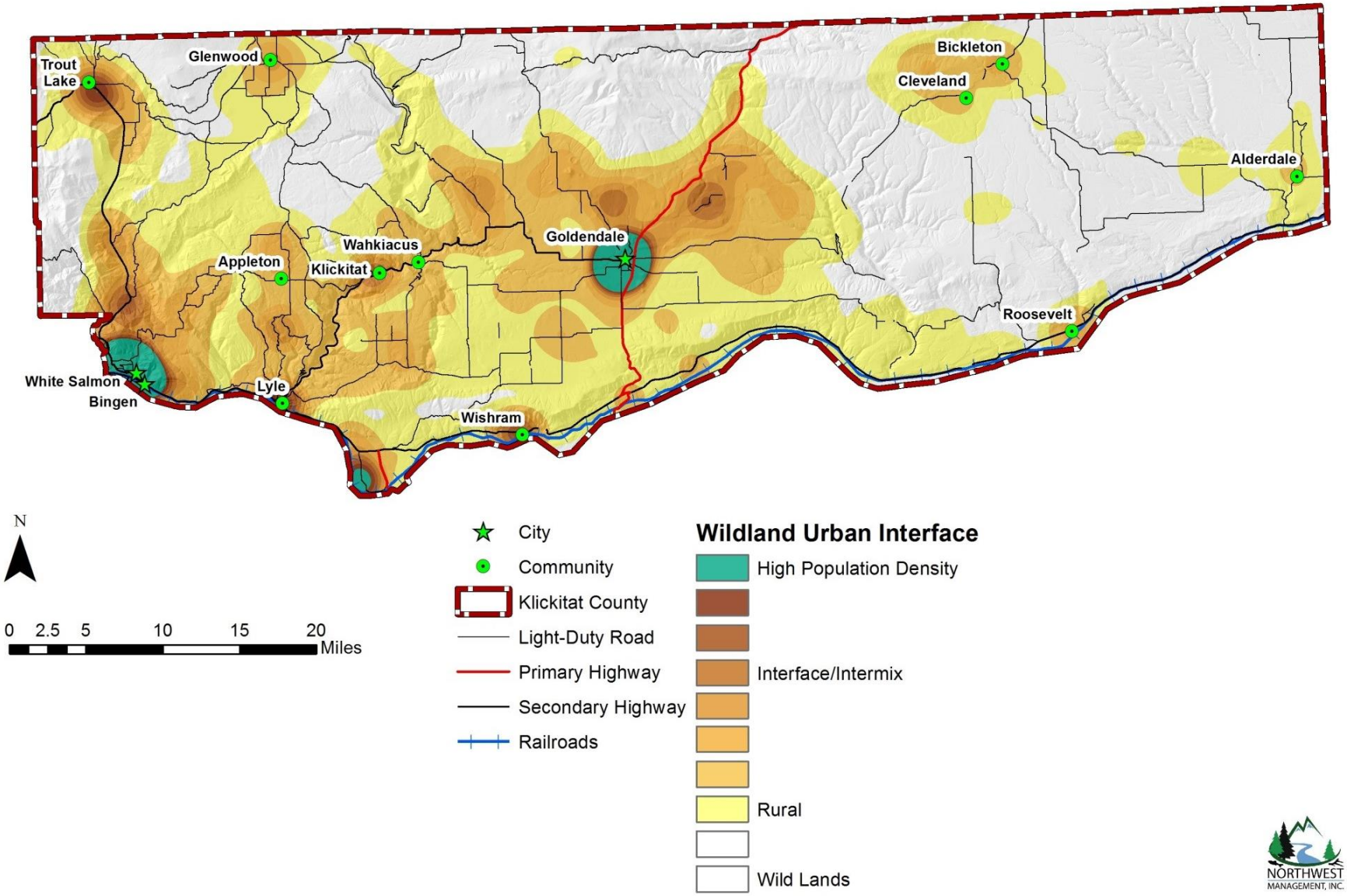


Figure 31) Wildland Urban Interface (WUI) map of Klickitat County, WA.

The WUI, as defined here, is unbiased and consistent and most importantly – it addresses all of the county, not just federally identified communities at risk. It is a planning tool showing where homes and businesses are located and the density of those structures leading to identified WUI categories. It can be determined again in the future, using the same criteria, to show how the WUI has changed in response to increasing population densities. It uses a repeatable and reliable analysis process that is unbiased.

The Healthy Forests Restoration Act makes a clear designation that the location of the WUI is at the determination of the county or reservation when a formal and adopted Community Wildfire Protection Plan is in place. It further states that the federal agencies are obligated to use this WUI designation for all Healthy Forests Restoration Act purposes. The Klickitat County Community Wildfire Protection Plan planning team evaluated a variety of different approaches to determining the WUI for the County and selected this approach and has adopted it for these purposes. In addition to a formal WUI map for use with the federal agencies, it is hoped that it will serve as a planning tool for the County, state and federal agencies, and local Fire Protection Districts.

Potential WUI Treatments

The definition and mapping of the WUI is the creation of a planning tool to identify where structures, people, and infrastructure are in reference to each other. This analysis tool does not include a component of fuels risk. There are several reasons to map and analyze these two components separately (population density vs. fire risk analysis). Primary among these reasons is the fact that population growth often occurs independent from changes in fire risk, fuel loading, and infrastructure development. Thus, making the definition of the WUI dependent on all of them would eliminate populated places with a perceived low level of fire risk today, which may in a year become an area at high risk due to forest health issues or other concerns.

By examining these two tools separately, the planner is able to evaluate these layers of information to see where the combination of population density overlays areas of high current relative fire risk and then take mitigative actions to reduce the fuels, improve readiness, directly address factors of structural ignitability, improve initial attack success, mitigate resistance to control factors, or (more often) a combination of many approaches.

It should not be assumed that just because an area is identified as being within the WUI, that it will therefore receive treatments because of this identification alone. Nor should it be implicit that all WUI treatments will be the application of the same prescription. Instead, each location targeted for treatments must be evaluated on its own merits: site ignition factors, site access, resistance from the public to forest management, population density, resources and capabilities of firefighting personnel, and other site-specific factors.

It should also not be assumed that WUI designation on national or state forest lands automatically equates to a treatment area. The Forest Service, Bureau of Land Management, and Washington Department of Natural Resources are still obligated to manage lands under their control according to the standards and guides listed in their respective forest plans (or other management plans). The adopted forest plan has

legal precedence over the WUI designation until such a time as the forest plan is revised to reflect updated priorities.

Most treatments may begin with a home evaluation, and the implicit factors of structural ignitability (roofing, siding, deck materials) and vegetation within the treatment area of the structure. However, treatments in the low population areas of rural lands (mapped as yellow) may look closely at access (two ways in and out) and communications through means other than land-based telephones. On the other hand, a subdivision with densely packed homes (mapped as brown – interface areas) surrounded by forests and dense underbrush, may receive more time and effort implementing fuels treatments beyond the immediate home site to reduce the probability of a crown fire entering the subdivision.

As effective and important as fuel treatments are to communities and residents living in the WUI there are factors that limit hazard-reduction efforts. Lack of consistent funding to agencies (specifically conservation districts) which carry out much of this work in Klickitat County on a non-regulatory, property-by-property basis is a significant limitation. The Washington DNR is very active in working with landowners in the county as it has significant funding for fuels reduction projects. The Conservation Districts are also very active in assisting landowners, but funding is limited.

AIR QUALITY

The primary means by which the protection and enhancement of air quality is accomplished is through implementation of National Ambient Air Quality Standards (NAAQS). These standards address six pollutants known to harm human health including ozone, carbon monoxide, particulate matter, sulfur dioxide, lead, and nitrogen oxides.[47]

The Clean Air Act, passed in 1963 and amended in 1977, is the primary legal authority governing air resource management. The Clean Air Act provides the principal framework for national, state, and local efforts to protect air quality. Under the Clean Air Act, OAQPS (Office for Air Quality Planning and Standards) is responsible for setting standards, also known as national ambient air quality standards (NAAQS), for pollutants which are considered harmful to people and the environment. OAQPS is also responsible for ensuring these air quality standards are met, or attained (in cooperation with state, Tribal, and local governments) through national standards and strategies to control pollutant emissions from automobiles, factories, and other sources.[48]

Smoke emissions from fires potentially affect an area and the airsheds that surround it. Climatic conditions affecting air quality in Washington are governed by a combination of factors. Large-scale influences

[47] USDA-Forest Service (United States Department of Agriculture, Forest Service). 2000. Incorporating Air Quality Effects of Wildland Fire Management into Forest Plan Revisions – A Desk Guide. April 2000. – Draft.

[48] Louks, B. 2001. Air Quality PM 10 Air Quality Monitoring Point Source Emissions; Point site locations of DEQ/EPA Air monitoring locations with Monitoring type and Pollutant. Idaho Department of Environmental Quality. Feb. 2001. As GIS Data set. Boise, Idaho.

include latitude, altitude, prevailing hemispheric wind patterns, and mountain barriers. At a smaller scale, topography and vegetation cover also affect air movement patterns. Air quality in the area is generally moderate to good. However, locally adverse conditions can result from occasional wildland fires in the summer and fall, and prescribed fire and agricultural burning in the spring and fall. All major river drainages are subject to temperature inversions which trap smoke and affect dispersion, causing local air quality problems. This occurs most often during the summer and fall months and could potentially affect all communities in Klickitat County. Wintertime inversions are less frequent, but are more apt to trap smoke from heating, winter silvicultural burning, and pollution from other sources.

Air quality standards and regulations for Klickitat County are governed by the Washington Department of Ecology in Yakima, WA. The State of Washington Department of Ecology website provides information on burn bans, local air quality, burning permits, data and research, and state and federal regulations[49].

Risk Assessment: Wildland Fire

Much of the information included in this analysis was taken from the Klickitat County Community Wildfire Protection Plan. For the CWPP, wildland fire risk in Klickitat County was analyzed using a variety of models, managed on a Geographic Information System (GIS) system. Physical features of the region including roads, streams, soils, elevation, and remotely sensed images were represented by data layers. Field visits were conducted by specialists from Northwest Management, Inc. and others. Discussions with area residents and local fire suppression professionals augmented field visits and provided insights into forest health issues and treatment options. This information was analyzed and combined to develop an objective assessment of wildland fire risk in the region.

Probability and Magnitude

Fire was once an integral function within most ecosystems in Washington. The seasonal cycling of fire across most landscapes was as regular as the July, August and September lightning storms plying across central Washington. Depending on the plant community composition, structural configuration, and buildup of plant biomass, fire resulted from ignitions with varying intensities and extent across the landscape. Shorter return intervals between fire events often resulted in less dramatic changes in the species composition of plant communities.[50] These fires burned from 1 to 47 years apart, with most at 5- to 20-year intervals.[51] With infrequent return intervals, plant communities tended to burn more severely

[49] https://ecology.wa.gov/Air-Climate/Air-quality.

[50] Johnson, C.G. 1998. Vegetation Response after Wildfires in National Forests of Northeastern Oregon. 128 pp.

[51] Barrett, J.W. 1979. Silviculture of ponderosa pine in the Pacific Northwest: the state of our knowledge. USDA Forest Service, General Technical Report PNW-97. Pacific Northwest Forest and Range Experiment Station, Portland, OR. 106 p.

and be replaced by vegetation different in composition, structure, and age.[52] Native plant communities in this region developed under the influence of fire, and adaptations to fire are evident at the species, community, and ecosystem levels.

Ideally, pre-European settlement historical fire data would be used to estimate the annual probability for fires in Klickitat County. However, current data are not adequate to make credible calculations because the data for local, state, and federal responsibility areas are not reported by the same criteria. Nevertheless, the data reviewed above provides a general picture of the level of wildland-urban interface fire risk for Klickitat County overall. Based on the historical information available, Klickitat County has a very high probability of wildland fires occurring on an annual basis. Recreational areas, major roadways, debris burning, and agricultural equipment are typically the most likely human ignition sources. Lightning is also a significant source of wildfires in Klickitat County.

Table 20 summarizes the magnitude, probability, and overall risk ratings selected for each jurisdiction by the planning team. Refer to the Jurisdictional Risk and Vulnerability Ratings section at the beginning of this chapter for more information about the process used to determine hazard ratings.

Table 20) Overall wildland fire Significance Summary for adopting jurisdictions.

Jurisdiction	Magnitude	Probability	Overall Wildfire Risk
Klickitat County	**Severe**	**Highly Likely**	**High**
City of Bingen			High
City of Goldendale			Medium
City of White Salmon			High
Klickitat Valley Health			High
Eastern Klickitat Conservation District			High
Central Klickitat Conservation District			High
Underwood Conservation District			High

Analysis of Resources at Risk

Relative Threat Level Mapping

Klickitat County recognizes that certain regions of the county have unique risk factors that increase their vulnerability to wildland fire. To demonstrate these risk factors, the planning team developed a threat level model analyzing various risk factors on a scale relative to Klickitat County specifically.

The predicted Wildland Fire Threat layer shown on the map below was produced by combining weighted data sets that relate to wildfire risk in an additive model. Datasets considered for the model included; fire

[52] Johnson, C.G.; Clausnitzer, R.R.; Mehringer, P.J.; Oliver, C.D. 1994. Biotic and Abiotic Processes of Eastside Ecosytems: the Effects of Management on Plant and Community Ecology, and on Stand and Landscape Vegetation Dynamics. Gen. Tech. Report PNW-GTR-322. USDA-Forest Service. PNW Research Station. Portland, Oregon. 722pp.

behavior fuel models, percent slope, aspect, fire protection capabilities, ignition probability, wildland fire rate of spread, wildland fire intensity, precipitation, and population. Each of these data layers was reviewed by members of the planning group who confirmed whether they fairly represented those characteristics of Klickitat County. Once the layers were compiled the planning team reviewed the final threat level map for accuracy. Table 21 provides more information about the data layers that were used to create the Klickitat County Relative Threat Level Map.

Table 21) Parameters for Threat Level Mapping Exercise.

Dataset	Source
Fuel Models	Scott and Burgen 40 Fire Behavior Fuel Model from LANDFIRE
Slope	10 Meter Digital Elevation Model (DEM)
Aspect	10 Meter Digital Elevation Model (DEM)
Ignition Probability	Density of Fire Occurrences
Wildland Fire Rate of Spread	30 Meter FlamMap Rate of Spread Raster
Wildland Fire Intensity	
Precipitation	PRISM Climate Data from Oregon State University
Population	911 Address Points

Threat Level Map Risk Categories

Based on analysis of the various modeling tools, existing historical information, and local knowledge, a preliminary assessment of potentially high wildfire risk areas was completed. This assessment prioritized areas that may be at higher risk due to non-native or high fire risk vegetation, fire history profile, high risk fuel models, and/or limited suppression capabilities. This assessment also considered areas that had a high population or other valuable assets requiring protection from the impacts of wildland fires.

High-Risk Vegetation

The eastern half and portions of central Klickitat County are characterized by light, flashy fuel-types that are continuous in coverage and pose a high risk for ignition. Areas featuring light fuel-types and higher population centers and / or greater volumes of vehicle traffic were assigned higher risk values on the threat level map.

Issues with Accessibility

Areas with either limited or no access points were assigned higher risk values on the threat level map. Wildfires burning in remote areas or areas with limited road systems either require more time for response from ground suppression resources or they require air support.

High-Value Resources at Risk

In addition to residential and municipal infrastructure, recreational resources and infrastructure are also of high value and generate revenue in the county. These areas were also assigned a higher risk level because of the potential financial impacts that a wildfire could have on recreational infrastructure and the recreation-industry.

Population Centers and Human Activity

Areas with larger populations and higher levels of human activity were assigned a higher threat level because of the increased potential for ignition, particularly in areas that feature light, flashy fuels like grasses and shrubs.

Determination of Relative Threat Level

Following the field assessments, the planning team began development of the Relative Threat Level model. Risk categories included in the final analysis were fuel models, slope, aspect, wildland fire intensity, precipitation, and population density. The various categories, or layers, were ranked by the planning team based on their significance pertaining to causal factors of high wildland fire risk conditions or protection significance. The ranked layers were then analyzed in a geographical information system to produce a cumulative effects map based on the ranking. Following is a brief explanation of the various categories used in the analysis and the general ranking scheme used for each.

- Environmental Factors – slope, aspect and precipitation all can have an enormous impact on the intensity of a wildfire. Therefore, areas with steep slopes, dry aspects, or lesser amounts of precipitation, relative to Klickitat County as a whole, were given higher threat rankings.
- Vegetation Cover Types – certain vegetation types are known to carry and produce more intense fires than other fuel-types. For Klickitat County, shrub and grass fuel models were given the higher rankings followed by short grass / agriculture, and forest types (shrub understory) fuel models.
- Fire Behavior – areas identified by fire behavior modeling as having high rate of spread potential or high fire intensity were given a higher threat level ranking.
- Populated Areas – these areas were ranked higher due to the presence of human populations, structures, and infrastructure requiring protection from fire.

Each data layer was developed, ranked, and converted to a raster format using ArcGIS 10.x. The data layers were then analyzed in ArcGIS using the Spatial Analyst extension to calculate the cumulative effects of the various threats. This process sums the ranked overlaid values geographically to produce the final map layer. The ranked values were then color coded to show areas of highest threat (red) to lowest threat (dark blue) relative to Klickitat County.

Estimation of Loss

Due to the unpredictable nature of wildfire behavior and occurrence of ignition, it is difficult to estimate potential losses in Klickitat County resulting from wildland fire. It is impossible to forecast the path a wildfire will take and what type of assets and resources, man-made and ecological, will be at risk. However, one can draw conclusions from the average costs to suppress a wildland fire. According to the National Interagency Fire Center there were 58,083 ignitions and 8,767,492 acres burned nationally in 2018. (National Interagency Fire Center, 2019) The cost to suppress these fires totaled $3,143,256,000 which averages out to approximately $54,116 per ignition. Comparatively there were 1,743 wildland fires totaling 438,834 acres in the state of Washington that federal agencies responded to in 2018. Large wildland fires can cost hundreds of thousands and even millions of dollars to suppress.

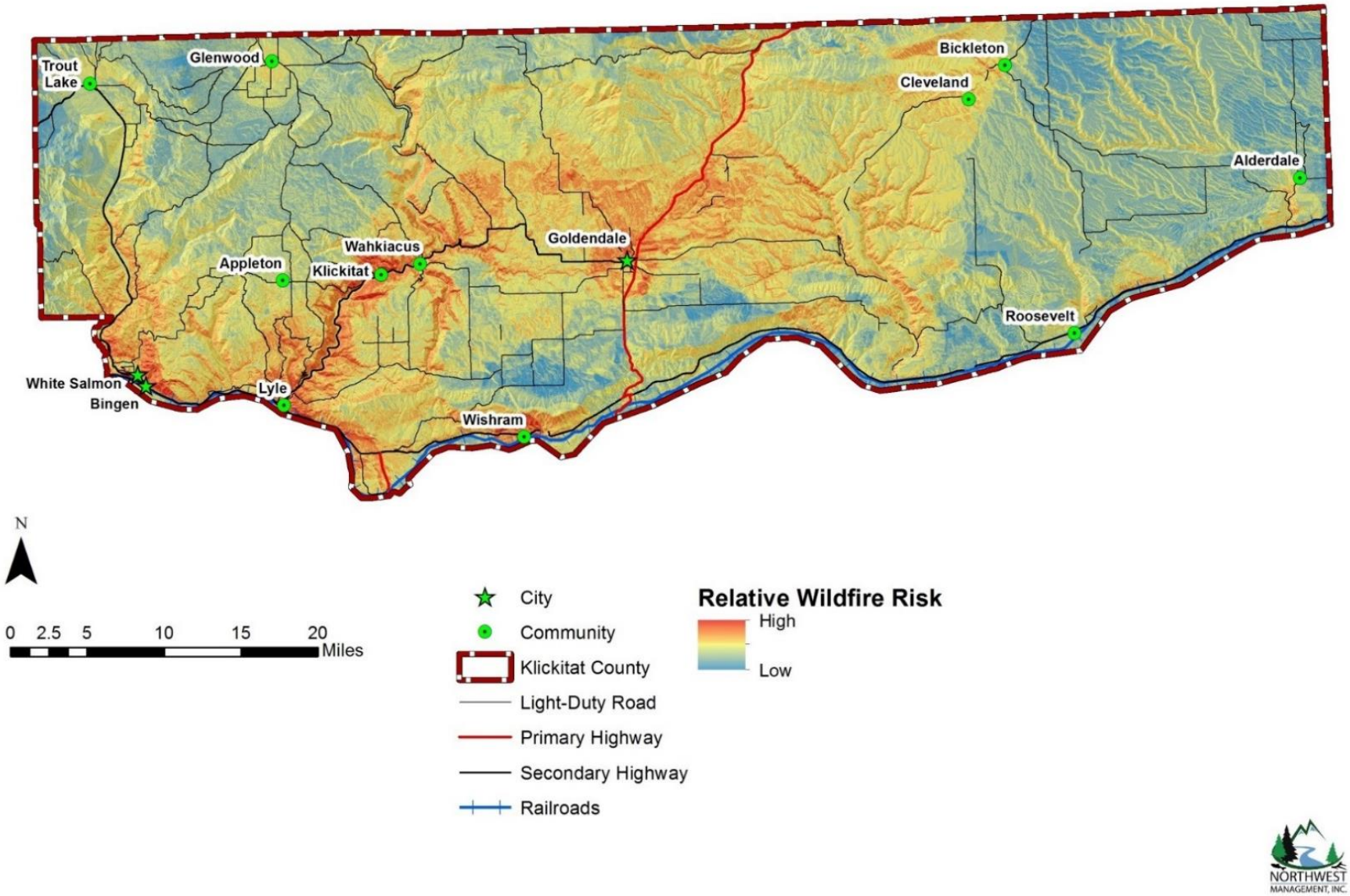


Figure 32) Relative threat level map for Klickitat County, WA.

IMPACTS OF WILDLAND FIRE

Wildland fires, big and small, are dangerous to both residents and emergency response personnel. Residents with property in the path of wildland fire will likely suffer the greatest impacts through loss of structures and/or the value of any timber or agricultural crops on their land. Many fires require an evacuation of nearby residences to ensure the safety of citizens. Evacuation procedures require the coordination of law enforcement and fire service organizations and may involve temporary sheltering in extreme cases. Risk to wildland firefighters is greatest when performing suppression activities. Suppression efforts which have a very high frequency of injuries, such as heat exhaustion and smoke inhalation, and have caused numerous deaths nationwide. Fire events typically result in a multi-department and agency response effort; thus, coordinating activities and ensuring everyone's safety is paramount.

Many communities have sensitive populations, such as elderly residents and children, who may be affected by air quality during a wildland fire. Smoke and particulates can severely degrade air quality, triggering health problems. In areas heavily impacted by smoke, people with breathing problems might need additional services from doctors or emergency rooms.

Local and regional commerce may also be interrupted by wildland fires. Transportation corridors will likely be temporarily closed or slowed due to a fire burning in the area. Heavy smoke from a wildfire several miles away could be dense enough to make travel unsafe on roadways.

The environmental impacts from a fire are dependent on the vegetation present and the intensity of the fire. Most rangeland and forest ecosystems in the Pacific Northwest are adapted to periodic fire events and benefit from occasional, low intensity burns. On the other hand, overcrowded forest conditions or over mature stands of sage brush will likely burn much more intensely than occurred historically. These types of fires tend to result in a high rate of mortality in the vegetation and often adversely impact soil conditions. High intensity fires are also much more dangerous and difficult to suppress.

Typically, structures located in forested areas without an adequate defensible space or fire-resistant landscaping have the highest risk of loss. Nevertheless, homes and other structures and infrastructure located in the grasslands or agricultural regions are not without wildfire risk. Grass fires are often the most dangerous due to high rates of spread. Fires in this fuel type are considered somewhat easier to suppress given the appropriate resources, but they can also be the most destructive.

Public Safety Power Shutoff (PSPS)

Some electric supply companies have determined that it may be necessary to turn off electricity if dry conditions or wind events are forecasted to prevent ignitions from power lines. One such company is PG&E and their website claims that strategic outages could last for several days. If conditions warrant a PSPS the power will be shutoff to all customers in that area regardless of their medical needs.

This of course would impact residents and businesses as well as emergency services. Klickitat County electric suppliers have not said they would implement this strategy however, suppliers in Oregon have committed to the PSPS. This impacts Klickitat County because they have communication sites in Oregon

that would not transmit during a PSPS. First responders would not be able to speak with dispatch during a PSPS because these sites do not currently have backup generators.

Impacts to Klickitat County

In addition to the general impacts listed above, the following is a list of infrastructural resources in Klickitat County that are could be affected and/or disrupted by wildland fire. For more information refer to the Klickitat County CWPP.

- **Water Infrastructure and Resources:**
  - For homes in unincorporated parts of the county, domestic water is primarily supplied by private wells. Homes in Goldendale, Bingen, White Salmon, Glenwood, and Klickitat are on municipal water systems.
  - The PUD operates ten municipal water systems and seven sewer systems.
  - Water resources for wildfire suppression include water tanks, hydrants, drafting ponds, and irrigation sources.
- **Power/Electricity:**
  - Major county-level power infrastructure includes sub stations, transmission lines, and windmills while most residential areas feature above-ground powerlines.
  - In the event of a wildfire, residents who are on wells will not be able to get water in their homes if they were to lose power.
- **Timber Industry Resources and Infrastructure:**
  - Equipment and infrastructure
  - Roads and improvements including culverts, gates, signs, fencing, etc.
- **Recreational Infrastructure and Resources:**
  - Recreational activities including hiking, biking, wind surfing, rafting, etc., generate millions of dollars in spending.
  - Millions of dollars in recreational assets, including fences, restrooms, parking areas, signage, trail heads, launch sites, etc., at risk in the event of a wildfire.
  - Impacts from wildfire result in millions of dollars lost in recreational spending:
    - The Dry Creek fire forced the closure of river access points which had major financial impacts on local rafting outfitters.
    - The Monastery and Mile Marker 28 fires forced the closure of Brooks Memorial State Park. Major damage was cause to the park and recovery efforts required extensive financial resources.
- **Ranching and Farming**
  - Wildfire can cause significant losses to ranch and farm operations. Fences, water tanks, buildings, vehicles, livestock, irrigation equipment, tools, etc. are all at risk during a wildfire.
- **Other Infrastructure:**
  - Critical repeater and cell sites.
  - Cell coverage is limited to nonexistent in the community of Bickleton and outside of the Highway 97 and Highway 14 corridors.

  - Large commercial buildings in and around the Cities of Goldendale and White Salmon.
  - Major highways and other roadways and roadway infrastructure.
  - The BNSF rail line.
  - A natural gas pipeline runs the entire length of Klickitat County with pumping stations east of Goldendale off Hoctor Road and north of Roosevelt off of Six Prong Road.
  - Dallesport Industrial site and Dallesport Airport.
  - The Roosevelt Landfill is located just northeast of Roosevelt just off of E Road / the Roosevelt Grade Road.
- **Air Quality:** Smoke is the most widespread impact from wildfire; cities, communities, and residents can be affected by the smoke from wildfires burning hundreds of miles away. Consequently, the residents of Klickitat County are much more likely to be indirectly affected by wildfire because of smoke than they are to be directly affected by flames. Refer to the Air Quality section in the Wildland Fire Hazard Profile for more information.
  - Smoke is a health concern for residents, especially for older or more sensitive populations.
  - Smoke can also have negative impacts on tourism. People are much less likely to go site-seeing or recreate outdoors, especially when air quality warnings are in place.

Climate Change

Climate change is likely to increase the likelihood of occurrence, scope, and/or severity of the impacts listed above. Climate change, coupled with the current high fuel and vegetation status of the forest, suggest that high intensity fires will continue to degrade the landscape unless proper management policies are implemented. Our winters are becoming shorter and wetter with less snow, while summers are becoming drier and longer. This process is resulting in the generation of flash fuels, uncharacteristically denser forests, and are stressing normal regenerative processes and increasing wildland fire risk.

Accordingly, forests in the western half of the county may become less resilient in the absence of management and the continued displacement of native grass and shrub species by invasive species in the eastern half of the county increases the risk of wildland fires county-wide.

Development

One challenge Klickitat County faces is an increase in the number of houses in the rural fringe. Since the 1970s, a segment of Washington's growing population has expanded further into traditional forest or resource lands. The “interface” between urban and suburban areas and the resource lands created by this expansion has produced a significant increase in threats to life and property from fires and has pushed existing fire protection systems beyond original or current design or capability. Currently, High Prairie and Ponderosa Park are Firewise communities and Goldendale has received the Keystone Acres HOA grant but many property owners throughout the County are still not aware of the threats they face or of the resources that are available to them. Consequently, increased development in rural areas continues to change the county’s exposure and vulnerability to wildland fire. As more homes are built in the rural fringe the impacts from fire will increase in severity and scope in the absence of fuels management.

Impacts to Other Adopting Jurisdictions

In addition to the general impacts listed above, each adopting jurisdiction could be subjected to specific impacts as a result of location and nearby landscape features:

- **City of Bingen:** Wildland fire risk for Bingen is high. Impacts from wildland fire could be extensive in scope and severity.
    - The above ratings are supported by the Relative Threat Level map in the which rated fire risk in the Bingen area as high.
    - Grasses and other light, flashy fuels are the predominant fuel-types around the City of Bingen. Fire can burn and move quickly with moderate to high intensity in these fuel-types, especially on the steep terrain on the north side of the city.
    - Highway 14 and high levels of human activity present a significant risk for fire ignition (Sparks from dragging trailer chains have served as an ignition source for past fires).
    - Although ignitions occur less frequently than they did in previous decades, railway activity has also served as an ignition source for wildland fires.
- **City of Goldendale:** Wildland fire risk for Goldendale is medium. Impacts from wildfire would likely be moderate in scope and moderate to high in severity.
    - The above ratings are supported by the Relative Threat Level map which rated fire risk in the White Salmon area as high.
    - The terrain around Goldendale is generally flat with low undulations; land around the city is primarily used for farming and ranching.
    - Flat terrain, managed farmland, irrigation, and an extensive network of roads reduces the overall fire risk for Goldendale. Agricultural fields are tilled and mowed annually, and roads can be effective fuel breaks.
- **City of White Salmon:** Wildland fire risk for White Salmon is high. Impacts from wildland fire could be extensive in scope and severity.
    - Grasses and shrubs are the predominant fuel-types around the City of White Salmon. Fire can burn and move quickly with moderate to high intensity in these fuel-types, especially on the steep terrain around the city.
    - Highway 14 and high levels of human activity present a significant risk for fire ignition (Sparks from dragging trailer chains have served as an ignition source for past fires). The steep, brushy terrain along Highway 14 poses a significant, immediate fire threat to the homes at the top of the bluff.
    - Although ignitions occur less frequently than they did in previous decades, railway activity has also served as an ignition source for wildland fires.
    - In addition to numerous homes and businesses in White Salmon, there are several large commercial buildings that could be impacted by wildfire.
- **Klickitat Valley Health:** Wildland fire risk for Klickitat Valley Health is low. Impacts to KVH from wildland fire are likely to be limited in scope and severity.
    - Given its “interior” location in Goldendale, KVH is located away from wildland fuels and significant wildland fire threats.

- Smoke is the most immediate concern to the KVH campus as the hospital houses members of populations who may be particularly sensitive to smoke.

Conservation Districts

The following content was taken from the Wildfire Potential sections in Chapter 5 of the Klickitat County Wildfire Protection Plan. Given the size of the conservation districts, the wildfire potential information was included as a direct excerpt in order to describe the potential impacts from wildland fire as completely and accurately as possible. Based on the terrain and distribution of fuels throughout Klickitat County, wildfire potential was assessed in two different sections; Eastern and South-Central Landscape Assessment and North-Central and Western Landscape Assessment, hence the combination of impact summaries for the conservation districts (see below).

Eastern and Central Klickitat Conservation Districts

Flat Plains and Irregular Prairie:

Supported by the history of large wildfires that have occurred in the eastern half of the county, the eastern and south-central region of Klickitat County have a high risk of experiencing a large wildfire. Large expanses of open rangeland or pasture provide a continuous fuel bed that could, if ignited, threaten structures and infrastructure under extreme weather conditions. Cattle grazing will often reduce fine, flashy fuels reducing a fire's rate of spread; however, high winds increase the rate of fire spread and intensity of rangeland fires. A wind-driven fire in dry, native fuel complexes on variable terrain produces a rapidly advancing, very intense fire with large flame lengths, which enables spotting ahead of the fire front.

Wildfire risk in the flat plains and irregular prairie is at its highest during summer and fall when daily temperatures are high and relative humidity is low. Fires burning in some types of unharvested fields would be expected to burn more intensely with larger flame lengths due to the greater availability of fuels. Fields enrolled in conservation programs or managed for wildlife habitat, can burn very intensely due to an increased amount of fuel build-up from previous years' growth. Fires in this fuel type are harder to extinguish completely due to the dense duff layer, which often leads to hold-over fires that may reemerge at a later date causing additional fire starts.

Breaks and Foothills:

Breaking up the prairie and agricultural fields are shallow conifer-lined canyons and several deep rugged canyons that feature various fuel-types and levels of fuel loading. The shallow canyons and adjacent prairie primarily feature ponderosa pine which is a fire adapted species capable of surviving low intensity fires. Overstory fuels are discontinuous so it is unlikely that a fire would be carried any significant distance before a natural break slows the spread. However, torching trees and high winds can cause fire to spot over longer distances in these conditions versus a fire burning in a mix of grasses and low shrubs. There are two deep rugged canyons in the eastern and south-central region of the county. Klickitat River Canyon and Rock Creek are characterized by steep canyon walls that feature prairie grasses and rock outcrops

with patches of oak and conifers growing mostly in draws or other higher-moisture sites. These deep rugged canyons pose a more serious fire threat due to the steep, complex terrain and variable fuel-types and fuel loading. Even though the oak and conifer species are more fire adapted, a wildfire could still make a significant run in the deep canyons if conditions are hot and dry enough. Klickitat Canyon likely has a higher risk of ignition due to the presence of Highway 142 which runs along the bottom of the canyon for almost 20 miles. Heavy vehicle traffic during the summer season and several small communities located along the bottom of the canyon could be potential sources of ignition. The Rock Creek drainage is at a lower risk for human-caused wildfires as there is very little public access to the canyon. However, fighting wildfire in Rock Creek could be challenging for firefighters due to limited access to the canyon.

Central and Underwood Klickitat Conservation Districts

Foothills and Low Mountain:

Although not historically as active as the eastern half of the county, the western and north central region of Klickitat County also has a moderate to high risk of experiencing a large wildfire. At lower elevations, stands of white oak are both homogenous and mixed with conifers (primarily ponderosa pine) and are extensive across irregular prairie and line canyons and draws. These stands can be classified as oak-prairie cover type due to a heavy grass/grass-shrub understory component that is frequently associated with the oak in Klickitat County. Stands of ponderosa pine and mixed-conifer stands are found at higher elevations. In areas where prairie and forest converge, the understory consists of regeneration and grasses while areas of continuous forest coverage feature brush and regeneration in the understory. At higher elevations, mixed conifer forests are primarily composed of Douglas-fir and grand fir with other species present at lower frequencies. All of these cover types have the ability to carry large fires under high risk conditions.

Fuel distribution at the landscape level is often disrupted by logging or agriculture, specifically to the east of highway 141 where logging units are numerous and variation in stocking density and horizontal and vertical structure is high. Most logging units are clear cut with wildlife trees and stream buffers left intact. The variability in fuel loading in this part of the county can potentially be an advantage in the event of a wildfire given the circumstances and site-specific terrain. In general, conditions to the west of highway 141 are similar to those to the east but forested tracts of land seem to be more continuous as logging does not appear to be as heavy. The valley bottoms, particularly around Trout Lake and Glenwood, are mostly used for agriculture. Considering the amount of precipitation that the western half of the county receives and the use of some irrigation, the potential for a large wildfire in these areas is low. In the north central part of the county, the bottom of Satus Pass is an interface of ponderosa pine and prairie. Stands of ponderosa pine often have understories that contain grasses, shrubs and regeneration. At higher elevations, forests are mixed conifer and are mostly composed of ponderosa pine and Douglas-fir at mid-elevations and grand fir becomes a larger component at higher elevations. As Satus pass doesn't receive as much precipitation as the eastern flanks of the Cascades, stocking densities appear to be lower in the north central part of the county. This is also attributed to logging operations that occur on Satus Pass. The potential for the north central part of Klickitat County to experience a large wildfire is also high.

Breaks and Foothills

The western and north central region of the county does feature one deep rugged canyon. The White Salmon drainage runs from the Cascade Range down through Trout Lake and down to the City of White Salmon. Differing from the other two deep rugged canyons in the eastern half of the county, the White Salmon drainage is in the low mountain portion of the county and features large hardwood trees and shrubs in the riparian corridor and mostly conifers on the canyon walls. Highway 141 runs along the bottom of the canyon and passes through multiple small towns/communities. Logging activity takes place on either side of the canyon as industrial timber ground is extensive in the low mountain areas of the county. In hot dry conditions or periods of drought, the level of human activity taking place in the canyon poses a fire risk in the canyon. Summer tourism and higher volumes of traffic along Highway 141 introduce new sources of ignition. The amount of mechanized logging happening in the area could also be a source of ignition but closure systems, such as the Industrial Fire Precaution Level system, help to reduce risk associated with fires. The flanks of the Cascade Mountains are also subject to summer storms that could produce lightning. Lightning is one of the leading sources for wildfire in Klickitat County often starting fires in areas that can be difficult to access.

Second-Order Hazard Events

Wildland fires can be caused naturally by lightning or by various technological sources. Wildland fire can also be a secondary effect of another type of hazard. The following chart outlines the interconnection between wildland fire and other types of hazard events. Areas with high structure density could experience vast structure to structure ignitions during a wildland fire.

Table 22) Second-order hazards related to wildland fire events.

Related Causal Events	Related Effects
Severe Weather	Structural/Urban Fire
Drought	Community Displacement
Earthquake	Landslide
Transportation Systems	Transportation Systems
Hazardous Materials	Power Outage
Structural/Urban Fire	

DROUGHT HAZARD PROFILE & RISK ASSESSMENT

The term 'drought' is applied to a period in which an unusual scarcity of rain causes a serious hydrological imbalance: water-supply reservoirs empty, wells dry up, and crop damage ensues. The severity of the drought is gauged by the degree of moisture deficiency, its duration, and the size of the area affected. If the drought is brief, it is known as a dry spell, or partial drought. A partial drought is usually defined as more than 14 days without appreciable precipitation, whereas a drought may last for years.

DEFINITIONS

Washington has a statutory definition of drought, consisting of two parts:

1. An area has to be experiencing or projected to experience a water supply that is below 75 percent of normal.
2. Water users within those areas will likely incur undue hardships as a result of the shortage.

BACKGROUND INFORMATION

Drought is a normal, recurrent feature of climate. It occurs in virtually all climate zones, but its characteristics vary significantly from one region to another. Drought is a temporary occurrence; it differs from aridity, which is restricted to low rainfall regions and is a permanent feature of climate. A drought is therefore different from a dry climate.

Droughts tend to be more severe in some areas than in others. Catastrophic droughts generally occur at latitudes of about 15°-20°, in areas bordering the permanently arid regions of the world. In North America, archaeological studies of Native Americans and statistics derived from long term agricultural records show that six or seven centuries ago whole areas of the Southwest were abandoned by the indigenous agriculturists because of repeated droughts and were never reoccupied. The statistics indicate that roughly every 22 years—with a precision of three to four years—a major drought occurs in the United States, most seriously affecting the Prairie and midwestern states. It is expected that climate change will influence both drought and precipitation patterns world-wide. Arid regions are expected to get drier and experience longer and more severe periods of drought while areas that receiver higher amounts of annual precipitation are expected to receive more moisture.

A drought directly or indirectly affects all people and all areas of the state. A drought can result in farmers not being able to plant crops or the failure of the planted crops. Table 23 shows how drought is classified by severity and which impacts/consequences can be expected at different levels of severity. This results in loss of work for farm workers and those in related food processing jobs. Other water or electricity-dependent industries commonly shut down all or a portion of their facilities, resulting in further layoffs. A drought can spell disaster for recreational companies that use water (e.g., swimming pools, water parks, and river rafting companies) and for landscape and nursery businesses because people will not invest in new plants if water is not available to sustain them. Additionally, with much of Washington's energy coming from hydroelectric plants, a drought can mean more expensive electricity from other resources than dams and probably higher electric bills.

Overall, about 75% of the total land area in the State of Washington is estimated to be at medium or higher exposure from droughts. According to the Washington State Enhanced Hazard Mitigation Plan, drought is ranked as medium-high for natural hazard risk within Klickitat County

Measuring Drought

There are two methods that are commonly used to measure, report, and predict periods of drought. The Palmer Drought Indices measure both short and long-term drought while the Standard Precipitation Index uses precipitation totals to report drought probability. The following two sections are excerpts from NOAA's website: https://www.ncdc.noaa.gov/monitoring-references/dyk/measuring-drought

The Palmer Drought Indices

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

The Palmer Drought Severity Index (PDSI) (known operationally as the *Palmer Drought Index (PDI)*) attempts to measure the duration and intensity of the long-term drought-inducing circulation patterns. Long-term drought is cumulative, so the intensity of drought during the current month is dependent on the current weather patterns plus the cumulative patterns of previous months. Since weather patterns can change almost literally overnight from a long-term drought pattern to a long-term wet pattern, the PDSI (PDI) can respond fairly rapidly.

The hydrological impacts of drought (e.g., reservoir levels, groundwater levels, etc.) take longer to develop and it takes longer to recover from them. The Palmer Hydrological Drought Index (PHDI), another long-term drought index, was developed to quantify these hydrological effects. The PHDI responds more slowly to changing conditions than the PDSI (PDI).

The Standard Precipitation Index

While Palmer's indices are water balance indices that consider water supply (precipitation), demand (evapotranspiration) and loss (runoff), the Standardized Precipitation Index (SPI) is a probability index that considers only precipitation. The SPI is an index based on the probability of recording a given amount of precipitation, and the probabilities are standardized so that an index of zero indicates the median precipitation amount (half of the historical precipitation amounts are below the median, and half are above the median). The index is negative for drought, and positive for wet conditions. As the dry or wet conditions become more severe, the index becomes more negative or positive. The SPI is computed by NCEI for several time scales, ranging from one month to 24 months, to capture the various scales of both short-term and long-term drought.

Historical Drought Events

The State's most severe drought episode occurred in 1977, when many of the current records for low precipitation, snow accumulation (e.g. snowpack), and stream flow totals were set. The more recent 2001 drought turned out to be the second-worst drought year in state-recorded history. By mid-March 2001,

most of Washington was suffering a water supply deficit. Federal, state and local officials worried that low river flows would disrupt state energy production. Dwindling water supplies put various threatened and endangered fish species at risk. The state also experienced severe economic strain on its agricultural, municipal and industrial sectors due to the drought. In 2015, 44% of Washington was initially declared a drought emergency area, including Klickitat County. By May of 2015 one fifth of the state's rivers and streams were at record lows. By August, 85% of the state was categorized as "extreme drought", also including Klickitat County.

In the last century, there have been several drought episodes in central Washington, including several that have lasted for more than a single season, such as the dry periods between 1928-32 and 1992-94. The primary effects of these droughts have been economic – affecting agriculture and the population in general due to energy curtailments. The worst national drought in 50 years affected at least 35 states during the summer of 1988. In some areas the lack of rainfall dated back to 1984. In 1988, rainfall totals over the mid-west, Northern Plains and the Rockies were 50 percent to 85 percent below normal. Crops and livestock were mortally affected, and some areas were affected by desertification. Forest fires began over the Northwest and by autumn, 4,100,000 acres had been destroyed.

Droughts in Washington state can be observed using the US Drought Monitor. This tool provides a snapshot in time of state and county specific conditions. Figure 33 shows drought severity history for the whole state of Washington from 2000 to 2019. Drought conditions during that period were highly variable. From the figure, it appears that 2001, 2005, and 2015 were the worst years for drought conditions while moderate drought conditions occurred in 2003, 2007, 2009, 2014, and 2018; refer to Table 23 for definitions of the drought severity classifications. As of August 2019, the majority of Klickitat County is under a D0 classification which indicates abnormally dry conditions.

Table 23) Drought severity index from U.S. Drought Monitor Weekly Drought Map (www.drought.gov).

Description	Possible Impacts
Abnormally Dry	Going into drought: short-term dryness slows growth of crops/pastures. Coming out of drought: some lingering water deficits; crops/pastures not fully recovered.
Moderate Drought	Some damage to crops/pastures; streams, reservoirs, or wells are low with some water shortages developing or imminent; voluntary water-use restrictions requested.
Severe Drought	Crop/pasture losses are likely; water shortages are common and water restrictions are imposed.
Extreme Drought	Major crop/pasture losses; widespread water shortages or restrictions.
Exceptional Drought	Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams, and wells creating water emergencies.

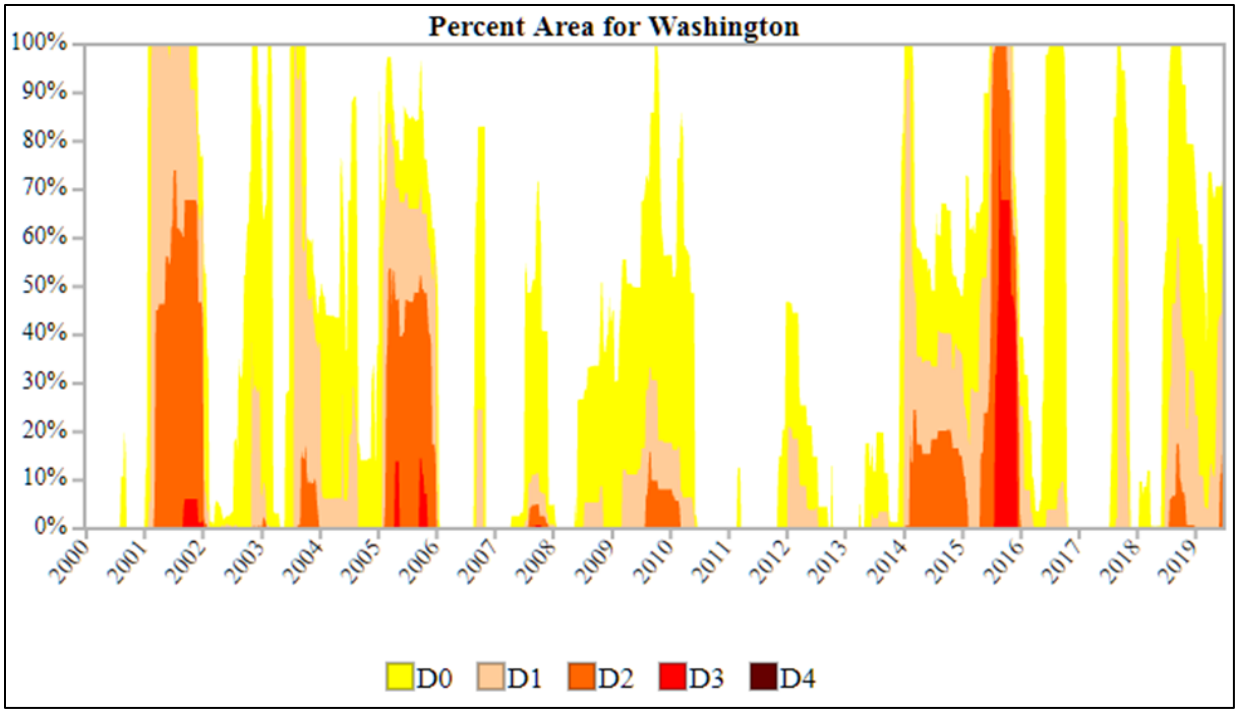


Figure 33) Annual Drought Percentage of Washington. Figure is from www.drought.gov.

Because of the number and nature of variables that contribute to drought conditions, it is difficult to find a complete list of all drought-periods or drought-related impacts reported at the county level. There are a number of resources, such as Drought.gov, that offer current "snapshots" of drought conditions at different geographic scales. However, there are very few resources beyond the FEMA disaster declaration database that can be used to build a historic profile of drought impacts, particularly at the county level. Table 24 is a list of media stories and agency press releases related to drought impacts that have, according to the National Drought Mitigation Center database, affected Klickitat County.

Table 24) Drought-related media stories and agency press releases retrieved from a "Klickitat County" search query using the National Drought Mitigation Center Drought Impact Reporter.

Date	Description
6/10/19	**Wildfire risk increasing in Washington State:** The Washington State Department of Natural Resources asked the public to be extremely cautious with fire outdoors, due to the increasing temperatures and strong winds, given that 71 percent of the state was in drought. Department of Natural Resources (Olympia, Wash.), June 10, 2019
5/10/19	**Increased fire danger rating for much of Washington State:** The WADNR increased the fire danger rating from low to moderate for most of the state, including Chelan, Foothills, Highlands, Kaniksu, Lower Basin, Lower Yakama, Methow, Upper Basin, Upper Yakama, and Valley. We have dry landscapes, it's as dry as it can typically be in mid-August, stated DNR spokesperson Janet Pearce. This is alarming, but we have our fire crews on call this weekend and ready for initial attack should any wildfires start. On top of expanded staffing levels for fire crews, the public is asked to be very careful not to spark a wildfire and to call 911 if they see smoke. iFiberOne (Ephrata, Wash.), May 10, 2019

4/4/19	**Expanded drought emergency in Washington State** Gov. Jay Inslee declared drought emergencies for 24 additional river basins in Washington as a lower than normal snowpack and a warm, dry spring depleted the snowpack. About half of the state was affected. Yakima Herald-Republic (Wash.), May 20, 2019. Washington Gov. Jay Inslee declared a drought emergency on April 4 for the Methow, Okanogan and Upper Yakima basins, due to anticipated water shortages. Water supplies in the Upper Yakima Basin were forecast at 74% of normal, one percentage point below the trigger of 75% for a drought emergency. The Methow and Okanogan basins were at 72 and 58% of normal, respectively. The Washington Department of Ecology was seeking $2 million from the state Office of Financial Management for drought response programs and requested that the Legislature update the state's drought laws. Yakima Herald-Republic (Wash.), April 4, 2019
8/8/18	**Drought-stressed trees in Washington State under beetle attack** Washington residents reported unusually high numbers of dead and dying Douglas-fir trees to the Washington State Department of Natural Resources this spring and summer as drought and bark beetles ravaged the trees. The state also experienced several hot, dry summers in a row. Bark beetle infestation is a visible manifestation of drought conditions, stressed trees, and unhealthy forestland, said Commissioner of Public Lands Hilary Franz. Unfortunately, this infestation increases the risk of wildfires in the forests that surround our communities. Department of Natural Resources (Olympia, Wash.), Aug. 8, 2018
1/1/18	**Drought a factor in Washington state's forest damage, tree deaths** In 2018, 469,000 acres of Washington state's forests were damaged or died, due to drought, an above-average fire season and insects, according to a survey performed by the Washington Department of Natural Resources, the Oregon Department of Forestry, and the Forest Service Forest Health Protection staff. Yakima Herald-Republic (Wash.), Nov. 10, 2019
7/1/17	**Drought killed seedlings, stressed Christmas trees in Washington, Oregon** The dry summer affected Christmas tree growers who had to irrigate and adapt to drier weather than is common for the area. One grower in Granite Falls had to adjust the way she usually trims trees because the trees were stressed with needles falling from the boughs. Another tree farm near Lake Stephens lost some seedlings to the dry weather. A board member of the Pacific Northwest Christmas Tree Association knew of growers mostly in Oregon, but also some in Washington, who lost more than half of their new seedlings to the dry weather. Bellingham Herald (Wash.), Sept. 30, 2017
8/18/16	**Burning prohibited on state-managed lands, no campfires in state parks in Washington** The Washington Department of Natural Resources prohibited burning on all state-managed forest lands. Washington State Parks also announced a campfire ban in all state parks through Sept. 30. Nearly all of Washington state was abnormally dry, while the southeast corner was in moderate drought. Bellingham Herald (Wash.), Aug. 18, 2016
10/2/15	**Wheat farmers in Washington, Oregon waiting for rain to plant** Dryland wheat farmers in the Inland Northwest were waiting for rain before planting their wheat. Boise State Public Radio (Idaho), Oct. 2, 2015
7/17/15	**Fishing for sturgeon prohibited on Columbia River on the Washington/Oregon border** Sturgeon fishing was temporarily prohibited on the Columbia River upstream of the Bonneville Dam to McNary Dam. Oregon and Washington fishery managers found increased drought-related sturgeon mortality in some mid-Columbia River reservoirs. The closure began on July 18. Salem Statesman-Journal (Ore.), July 17, 2015

6/1/15	**Columbia River Basin salmon devastated by drought in 2015** Low snowpack and warm temperatures devastated salmon populations on the Columbia River in 2015. Temperatures in the mainstem Columbia River were the highest on record from mid-June to mid-July, due to lower flows and higher air temperatures, resulting in a 95% loss of adult sockeye salmon between Bonneville and Lower Granite dams. Compiled by NDMC from reports.
4/1/15	**The Washington Department of Ecology seeking to lease senior water rights in the Upper Yakima River Basin** The Washington Department of Ecology was seeking irrigators willing to lease water to supplement stream flow in the Upper Yakima Basin. With the warm winter and extremely low snowpack, streams in the upper watershed, which normally benefit from snowmelt, could run dry this summer, said the state Department of Ecology in a news release. Ecology is interested in senior water rights to tributaries north of Yakima and will pay the water rights holders to not divert water this summer. An Ecology spokeswoman said the agency has $500,000 to use for this endeavor. By keeping water in the tributaries, fisheries and river flows benefit. Yakima Herald-Republic (Wash.), April 2, 2015
3/18/15	**Be prepared for dust storms, says Washington Ecology Department** The lack of snow and warmer than normal temperatures have the Washington Ecology Department warning residents of Central and Eastern Washington to carry dust masks, due to the likelihood of dust storms. Strong winds, combined with drying fields and forest beds, could cause dust storms and respiratory problems the very young and people with asthma. Spokane Spokesman-Review (Wash.), March 18, 2015
3/13/15	**Drought emergency in Washington** Washington state's drought declaration was allowed to expire at the end of 2015 as heavy rain and snow ended drought in western Washington and eased drought conditions affecting central and eastern Washington. The state spent $5.6 million in drought relief projects during 2015.Everett Herald (Wash.), Dec. 22, 2015Washington's Gov. Inslee declared a drought emergency for the entire state, smoothing the way for aid to those coping with water shortages. Record low snowpack and subsequent water shortfalls led agriculture officials to estimate a crop loss of $1.2 billion this year. The Seattle Times, May 15, 2015. The drought emergency was expanded to include 24 river basins, with 16 watersheds in western Washington and 8 watersheds in the east. The emergency area encompasses about 44% of the state. Statewide snowpack was 24% of normal. The Office of the Governor (Olympia, Wash.), April 17, 2015Gov. Inslee of Washington declared a drought emergency for the Olympic Peninsula, east side of the central Cascades including Yakima and Wenatchee, and the Walla Walla region. Precipitation has been about average in parts of the state, but came as rain rather than snow. Everett Herald (Wash.), March 13, 2015
1/7/15	**Drought-Related USDA Disaster Declarations in 2015** The U.S. Department of Agriculture began declaring counties as primary and secondary disaster areas related to drought in January, for the 2015 growing season. Farmers in affected counties have eight months from the date of the declaration to apply for low-interest emergency loans. For more information, agricultural producers should contact their Farm Service Agency office. From Farm Service Agency press releases.

1/1/15	**Drought, heat take $700 million cut out of Washington state crop production** Washington state growers lost $700 million due to the 2015 drought, significantly higher than the estimated loss of $85 million. But even the revised estimate may be too low when tallying the complete economic impact, which could be as high as $1.2 billion. Yakima Herald-Republic (Wash.), May 4, 2017. Drought cost Washington state's red raspberry industry $12 million in 2015, due to a warm spring and a hot, dry summer of drought. Bloomberg (New York), April 5, 2016. A preliminary assessment of Washington state farm drought losses found that the figure reached $336 million, according to the Washington State Department of Agriculture. The estimate will likely rise as other numbers on yields and prices become available. Approximate losses for wheat, apples, blueberries and red raspberries were used in the report, but figures on potatoes, milk and cattle will be added in later. Wheat production was down 22%, compared to the five-year average, for an estimated loss of $212.4 million. Apple production was off by 280 million pounds, for an expected loss of $86.52 million. Heat hampered blueberry production by 8 million pounds for a loss of about $12 million. Red raspberry production was down 26% for a loss of about $13.9 million. Capital Press (Salem, Ore.), Jan. 4, 2016
8/19/14	**The wheat crop in the Inland Northwest was about 30% lower than last year's yield and a little below the 10-year average** The wheat crop in the Inland Northwest was about 30% lower than last year's yield and a little below the 10-year average. Wheat was planted deeper in dry areas in the fall of 2013, and significant rainfall caused the soil to form a crust that the wheat plants could not break through. Some farmers replanted two or three times. The dry spring and summer and one hundred-degree temperatures sealed the crop's fate. The winter wheat in Lincoln County, Washington was shorter than usual, ready early and yield has been 30 to 50% lower than last year's yield. The smaller than usual crop hurts grain storage companies that will take in less revenue as farmers bring in less grain. Spokane Spokesman-Review (Wash.), Aug. 19, 2014
1/9/14	**Drought-Related USDA Disaster Declarations in 2014** The U.S. Department of Agriculture began declaring counties as primary and secondary disaster areas related to drought in January, for the 2014 growing season. Farmers in affected counties have eight months from the date of the declaration to apply for low-interest emergency loans. For more information, agricultural producers should contact their Farm Service Agency office. From Farm Service Agency press releases.
7/24/13	**Dry conditions in Washington and the approach of another lightning storm have fire officials on edge** Dry conditions in Washington and the approach of another lightning storm have fire officials on edge as two wildfires continue to burn in the state. The Colockum Tarps Fire near Wenatchee has blackened more than 25,000 acres of parched grass, brush and undergrowth and destroyed three homes since it began on July 27. The Mile Marker 28 fire has charred more than 20,000 acres of timberland and shrub in Klickitat County since it began on July 24. Both fires have required the evacuation of more than 65 homes each. Sacramento Bee (Calif.), July 30, 2013

RISK ASSESSMENT: DROUGHT

PROBABILITY AND MAGNITUDE

"Predicting future probability of a drought is difficult because of the number of variables involved in modeling the underlying climatic conditions. Whether a drought will occur (and how long it will last) depends on a huge number of factors including atmospheric and ocean circulation, soil moisture, topography, land surface processes, and interactions between the air, land and ocean which ultimately influence temperature and precipitation." (Division, 2018)

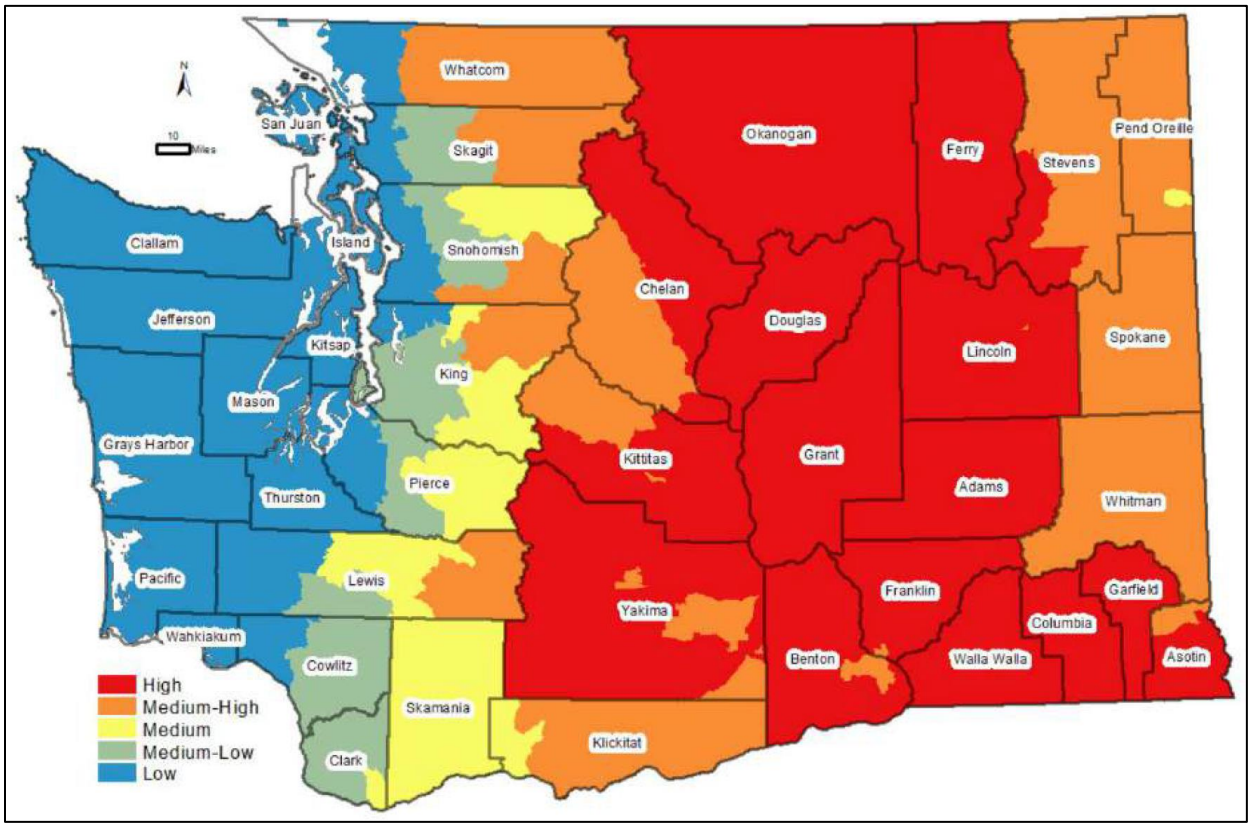


Figure 34) Drought Hazard in Washington State. Figure is from the Washington State Hazard Mitigation Plan.

Vulnerability to drought is affected by (among other things) population growth and shifts, urbanization, demographics, technology, water use trends, government policy, social behavior, environmental awareness, and economic ability to endure a drought. These factors evolve, and a community's vulnerability to drought may rise or fall in response to these changes. For example, increasing and shifting populations put greater pressure on water and other natural resources – more people need more water.

Klickitat County is within the Drought Hazard Zone as identified in the Washington State Hazard Mitigation Plan; it has a medium to medium-high drought exposure (Figure 34). The methodology used by the state included an analysis of area exposure, population exposure, and vulnerable population exposure to drought. Table 25 shows the drought-hazard ratings that planning team members selected for each adopting jurisdiction. Due to precipitation patterns in the county (Figure 5) drought appears to be a more

immediate concern in the eastern half of the county. Refer to the Jurisdictional Risk and Vulnerability Ratings section at the beginning of this chapter for more information about the process used to determine hazard ratings.

Table 25) Overall drought Significance Summary for adopting jurisdictions.

Jurisdiction	Magnitude	Probability	Overall Drought Risk
Klickitat County	**Moderate**	**Likely**	**Extensive**
City of Bingen			Limited
City of Goldendale			Moderate
City of White Salmon			Moderate
Klickitat Valley Health			Moderate
Eastern Klickitat Conservation District			Extensive
Central Klickitat Conservation District			Limited
Underwood Conservation District			Moderate

Analysis of Resources at Risk

This section is largely focused on the direct impacts of drought on agricultural and farming resources in Klickitat County. All conclusions regarding the impacts of drought on agriculture and farming are based on data from the 2017 USDA Census of Agriculture. Wildland fire is a significant threat that results from drought conditions. For information about resources at risk to wildland fire refer to the Wildland Fire Hazard Profile and Risk Assessment. Additional resources at risk, including those related to recreation and water, are also discussed without specific values due to data limitations.

USDA Census of Agriculture

There are hundreds of farm operations with livestock in Klickitat County. The USDA Census of Agriculture reports that there are more than 25,000 head of livestock (cattle, hogs, sheep, and chickens) in the county, with an average of 161 head of livestock per farm operation. With irrigation it is unlikely that water-shortages resulting from drought will have a direct impact on livestock. However, drought exacerbates fire conditions and increases the probability that farmers and ranchers will experience losses as a result of wildland fire. Table 26 shows select livestock data from the 2017 USDA Census of Agriculture for Klickitat County.

Table 26) Select livestock data from the 2017 USDA Census of Agriculture for Klickitat County, WA.

Livestock Category	Number of Operations	Livestock Inventory	Avg. Inventory / Operation
Cattle (Including Calves)	255	20,439	80
Hogs	28	233	8
Sheep (Including Lambs)	46	2,407	52
Chickens	125	2,563	21
Total		**25,642**	**161**

In total, there are 750 farm operations in Klickitat County putting more than 573,000 acres into agricultural or rangeland production. There are fewer than 25,000 irrigated agricultural acres in the county; most agricultural acreage is in dry agriculture. Wheat, including both spring and winter wheat, is the most produced crop in the county with hay and haylage production being second. Table 27 is a summary of select agricultural data from the 2017 USDA Census of Agriculture for Klickitat County. It should be noted that some census categories were excluded from the table so totals for each column were not calculated.

Table 27) Select agricultural and farming data from the 2017 USDA Census of Agriculture for Klickitat County, WA.

Census Category	Number of Operations	Acres	Production (Bushels)
Farm Operations	**750**	**573,730**	
Agricultural Land	514	229,473	
Agricultural Land - Irrigated	238	24,445	
Wheat, Spring	35	24,364	721,449
Wheat, Winter	71	31,162	1,017,262
Oats	4	4	160
Barley	13	1,278	58,626
Beans, Dry Edible (Excluding Chickpeas & Lima)	1		
Hay & Haylage	214	36,058	
Potatos	8	4	
Orchards (Bearing and Non-Bearing)	89	10,060	

Estimation of Loss

Although a total value of all agricultural and farming resources cannot be calculated from the Census of Agriculture data, totals were provided for different commodities, assets, and income values related to farming in the county. Considering that approximately 35% of farm operations in the county are only 10 to 50 acres in size, the average net income per farm is just under $34,000 per year (total income for all operations in the county exceeded $25 million in 2017). Crops and income are likely to be directly affected by drought while other resources, such as farm buildings and machinery, could be lost as a result of wildfire. Refer to Table 28 for a summary of farming and agricultural resource values in the county.

Table 28) Values of agricultural and ranching resources in Klickitat County, WA. data from the 2017 USDA Census of Agriculture.

Agriculture and Ranching Value Categories	Breakdown of Value	Value
Agricultural Operations (Including Buildings)	Value per operation	$ 1,360,462.00
Net Farm Income	Income per operation	$ 33,700.00
Farm Machinery	Total Value	$ 77,313,000.00
Crop Sales	Total Value	$ 80,720,000.00
Livestock Sales (Including Products)	Total Value	$ 18,439,000.00
Net Farm Income	Total Value	$ 25,275,000.00

In addition to agricultural losses, there are various other economic impacts that could result from drought conditions. Financial losses are incurred in the recreation and tourism industries as fewer people travel to the county for water recreation, fishing, site-seeing, and other tourism-related spending (wineries, hotels, restaurants, etc.). Select industries in the county are also affected by drought. Forest operations and access can be limited or shut down completely as a result of fire risk; logging and other aspects of the wood-products industry can experience significant economic setbacks due to drought. Other natural resources, such as drinking water, will also be very expensive to supplement in the event of a shortage. Even though it is very difficult to place a value on these losses, it seems reasonable to assume that tens of millions of dollars of economic productivity are at risk.

IMPACTS OF DROUGHT

The impacts of drought are far reaching as they affect wildlife, human health, the natural environment, communities of all sizes, and many sectors of local, national, and global economies; Klickitat county is vulnerable to drought in all of these areas.

Severe drought conditions can negatively affect air quality. During drought, there is an increased risk for wildfires and dust storms. Particulate matter suspended in the air from these events can irritate the bronchial passages and lungs. This can make chronic respiratory illnesses worse and increase the risk for respiratory infections like bronchitis and pneumonia.

The health implications of drought are numerous and far reaching. Some drought-related health effects are experienced in the short-term and can be directly observed and measured. However, the slow rise or chronic nature of drought can result in longer term, indirect health implications that are not always easy to anticipate or monitor. The possible public health implications of drought include (the bolded points are of particular concern in Klickitat County):

- **compromised quantity and quality of drinking water;**
- **increased recreational risks;**
- **effects on air quality;**
- diminished living conditions related to energy, air quality, and sanitation and hygiene;
- compromised food and nutrition; and
- increased incidence of illness and disease.

Prolonged drought, two or more winters of below normal precipitation combined with extreme summer heat, may cause reduced irrigation quotas resulting in some crop loss. Drought can affect the agricultural industry in several ways:

- It reduces crop production, sometimes for several years.
- It reduces availability of food on rangeland for grazing animals, which may result in premature withdrawal of livestock from the range with an eventual sharp increase in forage expense.
- It eliminates jobs in the field, at food processing plants and in affiliated facilities.
- It reduces availability of relatively inexpensive hydropower for farmers, processors, and storage facilities, increasing their reliance on more expensive energy sources.

- It increases shipping costs for some segments of the industry. For example, wheat growers may have to use truck and rail transport for a portion of their crop if the level of the Snake and Columbia Rivers become too low for barge traffic.

Impacts to Klickitat County

In addition to the general impacts listed above, Klickitat County could be subjected to specific impacts due to unique geological and hydrological features and distribution of populated areas and infrastructure.

Agriculture is a vital part of Klickitat County's economy. The impact of drought varies by area, by crop (some croplands in Klickitat County are irrigated), and by the status of the irrigation water right holder (junior or senior). Loss of water is far more damaging to perennial crops, such as fruit trees, grapes, hops, and asparagus, than to annual crops because it takes perennials several years to return to normal production. Reducing irrigation on annuals such as corn, peas, and other vegetables not only results in loss of a crop for a year, but it also may result in the loss of the food-processing infrastructure because of lack of product or higher costs for hydropower or other energy source.

Drought affects more than Klickitat County farms and ranches. It also can affect availability and cost of hydropower and of shipping capacity for crops dependent on water transport. The cost of hydropower is critical to food processors; from 30 to 40 percent of the cost of processing and cold storage is for energy. Higher energy costs caused by drought remove local food processors' competitive edge. Low water flow in the Columbia River can present problems for wheat growers, since more than 60 percent of their crop moves by barge. Lack of dredging combined with low river levels reduces capacity of barge transportation down river, forcing growers to use higher-cost alternatives such as trucking and rail.

Drought also places stress on potable water supplies (both surface water and wells), affecting many non-agricultural businesses and residents who are on wells. Overall, the economy in the county can be significantly affected by drought. Many sectors and industries are negatively affected by drought conditions and water shortages.

Drought conditions are also conducive to wildland fire. Historically, active fire seasons were characterized by widespread, persistent smoke that affected many communities across the Pacific Northwest. In addition to economic impacts, smoke and degraded air quality pose health risks to affected residents, particularly more sensitive populations.

Climate Change

Predicting future probability of a drought is difficult because of the number of variables involved in modeling the underlying climatic conditions. Whether a drought will occur (and how long it will last) depends on a huge number of factors including atmospheric and ocean circulation, soil moisture, topography, land surface processes and interactions between the air, land and ocean which ultimately influence temperature and precipitation. Predicting drought depends on the ability to forecast these two fundamental meteorological surface parameters, precipitation and temperature. From the historical record we know that climate is inherently variable, and that anomalies of precipitation and temperature may last from several months to several decades. But, given the number of variables involved it is difficult

to predict future drought events. Climate change is making summers warmer with correspondingly drier water course. This is increasing the likelihood of periods of drought during the summer months and flooding during spring months as snow transitions to rain earlier in the year. Reduced winter snowpack results in reduced summer water availability and a higher probability of summer drought.

Development

Development increases the county's exposure and vulnerability to drought. More people, structures, services, etc. places a greater demand on water supplies. Most new residential development is located in the rural fringe areas of the county; some of these homes may be occupied year-round while others are occupied seasonally. In addition to tourism, seasonally occupied homes temporarily increase the population of the county which places greater stress on water supplies; the county population likely peaks during the summer months when drought is most likely to be a factor. Most of these homes are on wells which could dry up during water shortages and more homes in the rural fringe increases the need of additional sources of water for wildfire fighting efforts.

Located along the Columbia River, White Salmon and Bingen have experienced increases in tourism over the last decade. More people visiting and staying in the area has resulted in the expansion of service industries which also places additional stress on water supplies. Conversely, severe drought negatively impacts tourism as smoke from wildfire and low water levels deter people from spending time and money in the county, especially if people are visiting for recreation purposes.

Impacts to Other Adopting Jurisdictions

In addition to the general impacts listed above, each adopting jurisdiction could be subjected to specific impacts as a result of location and geophysical features of the surrounding landscape:

- **City of Bingen:** Considering Bingen's location next to the Columbia River and minimal agricultural footprint, the impacts of drought will likely be limited in scope.
    - The greatest threat to Bingen resulting from drought is wildland fire. The terrain, presence of light and flashy fuels, and high levels of human activity and vehicle traffic are all conducive to rapid fire starts and spread, especially under drought conditions.
    - Nearby recreation, including rafting and fishing, could be negatively affected by low water levels, effectively impacting tourism in the area.
    - Water quality may also be degraded in nearby rivers and streams.
- **City of Goldendale:** Considering the number of agricultural operations immediately outside of Goldendale, the impacts from drought could be moderate in scope and severity.
    - Evacuations, smoke, and disruption of transportation are the most likely impacts to Goldendale resulting from drought and wildland fire.
- **City of White Salmon:** Because of the its proximity to and elevation above the Columbia River, the impacts of drought on the City of White Salmon will likely be moderate in scope and severity.
    - The greatest threat to White Salmon resulting from drought is wildland fire. The terrain, presence of light and flashy fuels, and high levels of human activity and vehicle traffic are all conducive to rapid fire starts and spread, especially under drought conditions.

  - Tourism may be negatively affected by drought as low water levels in nearby rivers and streams can impact local recreation.
  - Drought can reduce available surface water and degrade water quality in nearby rivers and streams.
  - Potable water supplies can become stressed during drought periods. The availability of surface water and ground water can be negatively affected, limiting available drinking water for residents who are on wells.
- **Klickitat Valley Health:** Given its location in the City of Goldendale and connection to the municipal water supply, impacts from drought could be moderate in both scope and severity.
  - Evacuations, smoke, and disruption of transportation are the most likely impacts to KVH resulting from drought and wildland fire.
- **Eastern Klickitat Conservation District:** Impacts from drought are likely to be extensive in scope and magnitude in the eastern half of the county as grass, sagebrush, and dry agriculture are the predominant vegetative cover-types and readily burn under drought conditions.
  - Exacerbated wildland fire conditions are likely to be the most significant impacts resulting from drought; refer to the wildland fire hazard profile and risk assessment for more information about wildland fire.
  - Homes that are on well water systems may be affected by periods of drought.
  - Conservation efforts, including plantings and restoration work, could be negatively impacted by drought; wildland fire is a significant risk to conservation work.
- **Central Klickitat Conservation District:** Impacts from drought are likely to be limited in the central part of the county.
  - Periods of drought can potentially increase levels of fire danger in the central part of the county; refer to the wildland fire hazard profile and risk assessment for more information about wildland fire.
  - Conservation efforts, including plantings and restoration work, could be negatively impacted by drought; wildland fire is a significant risk to conservation work.
  - Water shortages in the central part of the county will negatively affect fish populations and vegetation found in riparian corridors.
- **Underwood Klickitat Conservation District:** Drought impacts in the western end of the county are likely to be moderate in scope and severity.
  - Periods of drought can potentially increase levels of fire danger in the western end of the county; refer to the wildland fire hazard profile and risk assessment for more information about wildland fire.
  - Conservation efforts, including plantings and restoration work, could be negatively impacted by drought; wildland fire is a significant risk to conservation work.
  - Water shortages in the western end of the county can have significant impacts on fish habitat, recreation, and other water uses.

SECOND-ORDER HAZARD EVENTS

Drought is caused by natural processes and can last for multiple seasons or years. Drought can also be a secondary effect of another type of hazard. The following chart outlines the interconnection between drought and other types of hazard events.

Table 29) Second-Order hazards related to drought events.

Related Causal Events	Related Effects
Global Warming	Crop Loss
Severe Weather	Water Supply
	Wildland Fire
	Hydroelectric Supply
	Civil Unrest

SEVERE WEATHER HAZARD PROFILE & RISK ASSESSMENT

Severe storms are a significant hazard in the Pacific Northwest that occur in the region annually and seasonally. Due to Washington's complex landscape and influence from the Pacific Ocean, severe storms have varying degrees of impact on different portions of the state. Although Washington sees relatively few damaging storms in comparison with the rest of the nation, severe weather still poses a significant hazard to populated areas in Washington. Warmer seasonal temperatures and longer, hotter summers are expected to be more the norm in Washington State. These trends are expected to cause other weather extremes, including severe/high winds, hail, lightning, tornados, ice storms, and winter storms, to occur with greater frequency and severity.

DEFINITIONS

High Winds: Sustained wind speeds of 40 mph or greater lasting for 1 hour or longer, or winds of 58 mph or greater for any duration, not caused by thunderstorms. In Washington State, extreme sustained wind velocities can be expected to reach 50 mph at least once in two years; 60 to 70 mph once in 50 years; and 80 mph once in 100 years. The National Climatic Data Center (NCDC) has recorded 82 high or strong wind events with wind speeds greater than 30 knots since 1950. The 2014 Washington State Enhanced Hazard Mitigation Plan identified Klickitat County as being vulnerable to severe high wind events.

Severe Thunderstorm: A thunderstorm that produces a tornado, winds of at least 58 mph (50 knots), and/or hail at least 1 inch in diameter. A thunderstorm with wind equal to or greater than 40 mph (35 knots) and/or hail at least ½ inches in diameter is defined as approaching severe. Thunderstorms with lightning, heavy rain, hail, and high winds are frequent occurrences in Klickitat County and its neighboring counties from late April through September. The spring storms are generally the result of local convection. They develop quickly, dissipate rapidly, and generally cause small amounts of localized damage, if any.

Tornado: A violently rotating column of air, usually pendant to a cumulonimbus (type of cloud), with circulation reaching the ground. It nearly always starts as a funnel cloud and may be accompanied by a loud rotating noise. On a local scale, it is the most destructive of all atmospheric phenomena.

Heavy Snow: This generally means: a snowfall accumulating to 4" or more in depth in 12 hours or less or snowfall accumulating to 6" or more in depth in 24 hours or less.

Lightning: A visible electrical discharge produced by a thunderstorm. The discharge may occur within or between clouds, between the cloud and air, between a cloud and the ground or between the ground and a cloud. Lightning strikes are fairly common during summer storms and are known to start fires and damage property.

Hail: Showery precipitation in the form of irregular pellets or balls of ice more than 5 mm in diameter, falling from a cumulonimbus cloud.

Winter storm: A storm with significant snowfall, ice, and/or freezing rain; the quantity of precipitation varies by elevation. Heavy snowfall is 4 inches or more in a 12-hour period, or 6 or more inches in a 24-

hour period in non-mountainous areas; and 12 inches or more in a 12-hour period or 18 inches or more in a 24-hour period in mountainous areas.

Background Information

Severe weather events occur relatively frequently in western Washington. The NOAA Storm Events Database recognizes various seasonal weather events with the potential to achieve "storm" or "extreme" status. For Klickitat County, some of the more common weather events that attain "storm" or "extreme" status include hail, lightning, severe wind, tornados, and winter weather (refer to the severe weather definitions section above for more detailed descriptions about each severe weather hazard type). Based on event history and frequency of weather events, thunderstorms, hail, winter weather, and severe wind will be discussed in greater detail later in the Risk Assessment portion of this section.

The wide range of severe weather categories included in the NOAA severe weather history dataset for Klickitat County, WA reflects the strong four seasons that are characteristic of the region. Hot and dry summers and mountainous terrain are conducive to the formation of thunderstorms capable of producing lighting, hail, strong winds, heavy rain, and flash flooding. These same conditions can also lead to prolonged periods of drought and increase risk of catastrophic wildfires. Fall months are mild and rainy with potential for flooding and late season snowfall. The winter months can be characterized by heavy snow fall, below freezing temperatures, freezing rain and ice storms, strong winds and white-out conditions, sleet, and risks to human health that are associated with wind chill. The spring months bring warmer temperatures, snow melt, and rain which can combine to maximize flood and flash flood potential. Snow melt, rain, frozen soil, log jams, and ice jams can all become factors in spring flooding situations.

Historical Weather Events

Severe weather events are relatively common in the State of Washington. From 1953 to 2018, 147 Presidential Disaster declarations were made for the state, which is just over two declarations per year since 1953. Of those declarations, 18 were made in response to severe weather events.

Severe weather events are also common in Klickitat County. Of the 18 severe weather disaster declarations made for the state, 11 included Klickitat County (Table 30)[53]. The severe weather declarations made for the county were in response to heavy rain, flooding, snowmelt, mudslides, high winds, ice, and winter weather produced by severe weather systems that occurred during winter months (November through February). Information from the NOAA Severe Storms Database was used to provide details about some of the severe weather disaster declarations listed in Table 30. However, details could not be

[53]FEMA Data Visualization: Disaster Declarations for States and Counties. Accessed 3/06/19 https://www.fema.gov/data-visualization-disaster-declarations-states-and-counties:

provided for any declarations made before 1996 as that is when the record of severe storms begins for Klickitat County in the Severe Storms database.

Even though most severe weather events do not reach a level of severity that warrants a disaster declaration, since 1996 the NOAA National Climatic Data Center has classified 307 weather events as "severe". Most of those events were related to high wind (116) and heavy snow (100) (Table 32).

Table 30) Presidential Disaster declarations for events related to severe weather made for Klickitat County, WA between 1956 and 2018.

Disaster #	Year	Month	Incident Type	Incident Title
DR-185	1964	December	Flood	Heavy Rains and Flooding
DR-414	1974	January	Flood	Severe Storms, Snowmelt & Flooding
DR-545	1977	December	Flood	Severe Storms, Mudslides, & Flooding
DR-1100	1996	January – February	Flood	High Winds, Severe Storms and Flooding
DR-1152	1996	November – December	Severe Ice Storm	Severe Ice Storm
DR-1159	1996 – 1997	December – February	Severe Storm(s)	Severe Winter Storms, Land & Mud Slides, Flooding
DR-1682	2006	December	Severe Storm(s)	Severe Winter Storm, Landslides, and Mudslides
DR-1817	2009	January	Flood	Severe Winter Storm, Landslides, Mudslides, and Flooding
DR-1825	2009	December – January	Severe Storm(s)	Severe Winter Storm and Record and Near Record Snow
DR-1963	2011	January	Severe Storm(s)	Severe Winter Storm, Flooding, Landslides, and Mudslides
DR-4056	2012	January	Severe Storm(s)	Severe Winter Storm, Flooding, Landslides, and Mudslides

DR-1152: December 4, 1996

Fifty-one traffic accidents on ice covered highways. Interstate 82 was closed for six-hours, workers went home early, and church services were cancelled as freezing rain fell over the Tri Cities. There were about 30 accidents reported, but none with injuries.

DR-1682: December 14 & 15, 2006

A deep Pacific low-pressure system brought widespread high winds, property damage, and power outages from the evening of December 14 to the morning of December 15. Tens of thousands of utility customers lost power. Recorded wind gusts 60 to 70 mph were common. Several reports were received from the Hanford Mesonet, including a gust to 92 mph 10 miles north northwest of Richland at 215 am and a gust to 62 mph at Juniper Dunes RAWS at 440 am. ASOS at KDLS reported a gust to 63 mph at 1208 am and 58 mph at 102 am. There were also numerous reports of power outages and trees down.

DR-1817: January 6 – 16, 2009

Tight surface gradients and strong winds aloft combined to produce damaging winds across central and south-east Washington. Wind gusts in mph include Goldendale (80), Pasco (60), 10 miles north northeast of Yakima (76), Umtanum Ridge (71). Damage included power lines down near Cliffdel and Tieton, trees down near Ellensburg, and buildings damaged in Kennewick.

DR-1825: December 12, 2009 – January 5, 2010

December 15: A moist Pacific airmass combined with cold air trapped near the surface to produce heavy snowfall and freezing rain across south central Washington. Snowfall amounts in inches included 3 miles west of White Swan (4), 3 miles east of West Valley (5), 1 mile west northwest of White Salmon (6), 5 miles east northeast of West Valley (5.5), 11 miles west northwest of Goldendale (7), 4 miles west northwest of West Valley (4.2), 6 miles west of Fruitvale (6.2), 1 miles south southwest of Snowden (6), 3 miles northeast of Dallesport (4), 4 miles south southwest of Kittitas (4), Thorp (5), 6 miles east of Easton (12), 7 miles north northwest of Easton (8), 1 mile north northwest of Glenwood (12), 1 mile north of Trout Lake (12), 8 miles southeast of Cliffdell (8). Freezing rain accumulated to around 1/4 inch 1 mile southwest of Prosser and 5 miles west of Richland.

December 31: A surge of moist Pacfic air brought heavy snowfall to areas west of a line from Kittitas to Sunnyside to Roosevelt. Snowfall amounts in inches included Trout Lake (6), Snowden (6), 5 miles east northeast of West Valley (5), 3 miles east of West Valley (4), 4 miles east of Ellensburg (4), 11 miles north northwest of Ellensburg (4), White Salmon (4.5), 4 miles west northwest of West Valley (4.5), and Wishram (4).

DR-1963: January 11 – 21, 2011

January 8: An upper level low in Canada moved southeast and brought cold air and heavy snow to the East Slopes of the Cascades. Snowfall amounts reported in inches included 7 miles north northwest of Easton (8), Easton (6.5), 1 miles west of Cle Elum (8), Easton (14), and 6 miles east of Easton (16).

January 11: Moist air from the southwest overrode cold air at the surface and produced heavy snowfall. Amounts reported in inches included 3 miles northwest of Cle Elum (6), 7 miles north northwest of Easton (9), 2 miles east of Cle Elum (6), 8 miles southeast of Cliffdell (7), 2 miles northwest of Ellensburg (5), and 1 mile north of Thorp (5).

January 16: A large Pacific weather system became established in mid-January that produced copious amounts of rainfall with unseasonably warm conditions in parts of Washington. The heavy rainfall combined with snowmelt caused rapid runoff with 4 rivers and 7 different warning points reaching flood stage. Flood warnings were first issued on the morning of January 15 and the last flood warning ended on January 21st.

January 16 & 17: A frontal system combined with strong winds aloft produced high wind gusts. Klickitat PUD reported 23 power poles down. Two trees fell in the Goldendale area. On the east side of Goldendale, a strong wind gust totaled an empty semi-truck as it traveled south bound on Highway 97. Peak winds

recorded in miles per hour were 15 miles west of Benton City (83), 8 miles northwest of West Richland (96), 22 miles southeast of Sunnyside (70), 3 miles west of Sunnyside (59), 21 miles south of Vantage (77), 19 miles northwest of West Richland (62), 13 miles west northwest of Bickleton (78), and 10 miles east northeast of Goldendale (62).

DR-4056: January 14 – 23, 2012

Modified arctic air moved into the region followed by a series of moderate to strong upper level storm systems riding on a moist subtropical jet stream. The result was widespread heavy snow and local high winds. Freezing rain and sleet accumulated to between 1/4 and 1/2 inch over the lower elevations.||On January 17 and 18, snowfall amounts reported in inches included Waitsburg (6), 5 miles north northwest of Wiley City (6), 18 miles west northwest of West Richland (5), 8 miles west northwest of Connell (4), 2 miles west of Yakima (5), Toppenish (6), 1 mile southwest of Yakima (5), 5 miles north northwest of Centerville (15), 9 miles northwest of Roslyn (23), 3 miles north northeast of Ellensburg (4), Yakima (4), 7 miles northeast of Goldendale (14.5), 4 miles east northeast of White Salmon (18), 1 mile south southwest of Yakima (4), Cle Elum (7), Dayton (7.5), Ski Bluewood (18), Goldendale (12), 1 mile west northwest of White Salmon (17), Glenwood (10), 1 mile east of Walla Walla (5), 5 miles north of White Salmon (10.2), Mount Adams Ranger Station (17), Snowden (18), Easton (14), Tampico (11), 2 miles east south of West Valley (5.5), 4 miles east northeast of Yakima (4), Waitsburg (7), Richland (6), 15 miles northeast of Pasco (7.5), 10 miles east of Goldendale (13), 1 mile west of Toppenish (5), Kennewick (7.8), 3 miles northeast of College Place (4), West Richland (7), 5 miles south of Sunnyside (5), 20 miles west of Prescott (7), Selah (5), White Salmon (16), 6 miles east of White Swan (5.5), West Valley (7), Sunnyside 4.5), 10 miles north of Pasco (4), 1 mile southwest of Ellensburg (4), and 2 miles northeast of Husum (10.2).||On January 19-20, another surge of subtropical Pacific moisture moved over the cold air with a widespread mixture of precipitation. The lower elevations received freezing rain mixed at times with sleet and snow. The higher elevations received heavy snowfall. The storm caused numerous vehicle accidents with injuries, downed tree branches, power outages, and closed roads and schools. ||Ice accumulation reported in inches included Kennewick (.5), 1 mile west of Patterson (.25), Dayton (.5), Walla Walla (.5), 3 miles northeast of Dallesport (.38), 1 mile west northwest of White Salmon (.25).||Snowfall amounts reported in inches included 8 miles southeast of Cliffdell (13), 5 miles west southwest of Yakima (4.5), Yakima (4), Connell (4.5), 2 miles northwest of Ellensburg (5.8), Sunnyside (4.1), Glenwood (8), and 7 miles west of Fruitvale (7).

Risk Assessment: Severe Weather

Most of the weather-event information and data presented in this section is from the NOAA Storm Events Database for Klickitat County, WA. Although a query was run for the largest date range that can be selected (1950 through December 2019), data for Klickitat County is only available for the years 1996 through September 2019. Other event information, including fatalities, injuries, and damages reported in dollars, are also from the NOAA dataset. Values related to number of structures and potential loss values as a result of severe weather were calculated from GIS data provided by Klickitat County.

PROBABILITY AND MAGNITUDE

Severe weather in Klickitat County ranges from the commonly occurring thunderstorms to hail, tornadoes, high winds, dense fog, lightning, and winter weather (winter weather may include heavy snow fall, ice storms, cold and wind chill, and general winter weather conditions). There have been 307 weather events designated as "severe" in Klickitat County between 1996 and September 2019. Collectively, those events caused three fatalities, 43 injuries, and a little over $16.1 million in property damage (Table 31, Table 32). Figure **35** shows the frequency and distribution of those severe weather events by month (It should be noted that some hazard categories, such as "heat" and "excessive heat", were combined to simplify the dataset for the purposes of presentation).

Three of the top five most expensive hazard events in Klickitat County were windstorms or weather events that produced strong winds. The two most expensive events include a wind event in 2018 that caused $1 million in damage to property and an event in 2012 that caused over $550,000 in property damages[54].

Table 31) County of severe weather events in Klickitat County (1996-2019) (Division, 2018). Data is from the NOAA Severe Storms Database (1996-2019).

Weather Type	Count	Definition
Fog	3	
Drought	1	
Dust Storm	13	A storm of dust and debris blown by wind gusts of at least 35 mph, reducing visibility to less than ¼ of a mile.
Extreme Cold / Wind Chill	12	A wind chill factor of 30 degrees or lower on exposed skin will result in frostbite in a short period of time.
Flood	7	High flow, overflow or inundation of a normally dry area which causes or threatens damage.
Funnel Cloud	1	
Hail	10	Showery precipitation in the form of irregular pellets or balls of ice more than 5 mm in diameter, falling from a cumulonimbus cloud.
Heat	9	
Heavy Rain	2	Excessive rainfall over a defined period of time.
Heavy Snow	100	Exceptional snow accumulation.
High Wind	116	Sustained wind at greater than 40 miles per hour and/or gusts to greater than 58 miles per hour.
Ice Storm	10	
Lightning	3	An electrical discharge from a thunderstorm.
Winter Storm	20	
Total	**307**	

[54] National Oceanic and Atmospheric Administration, 2019

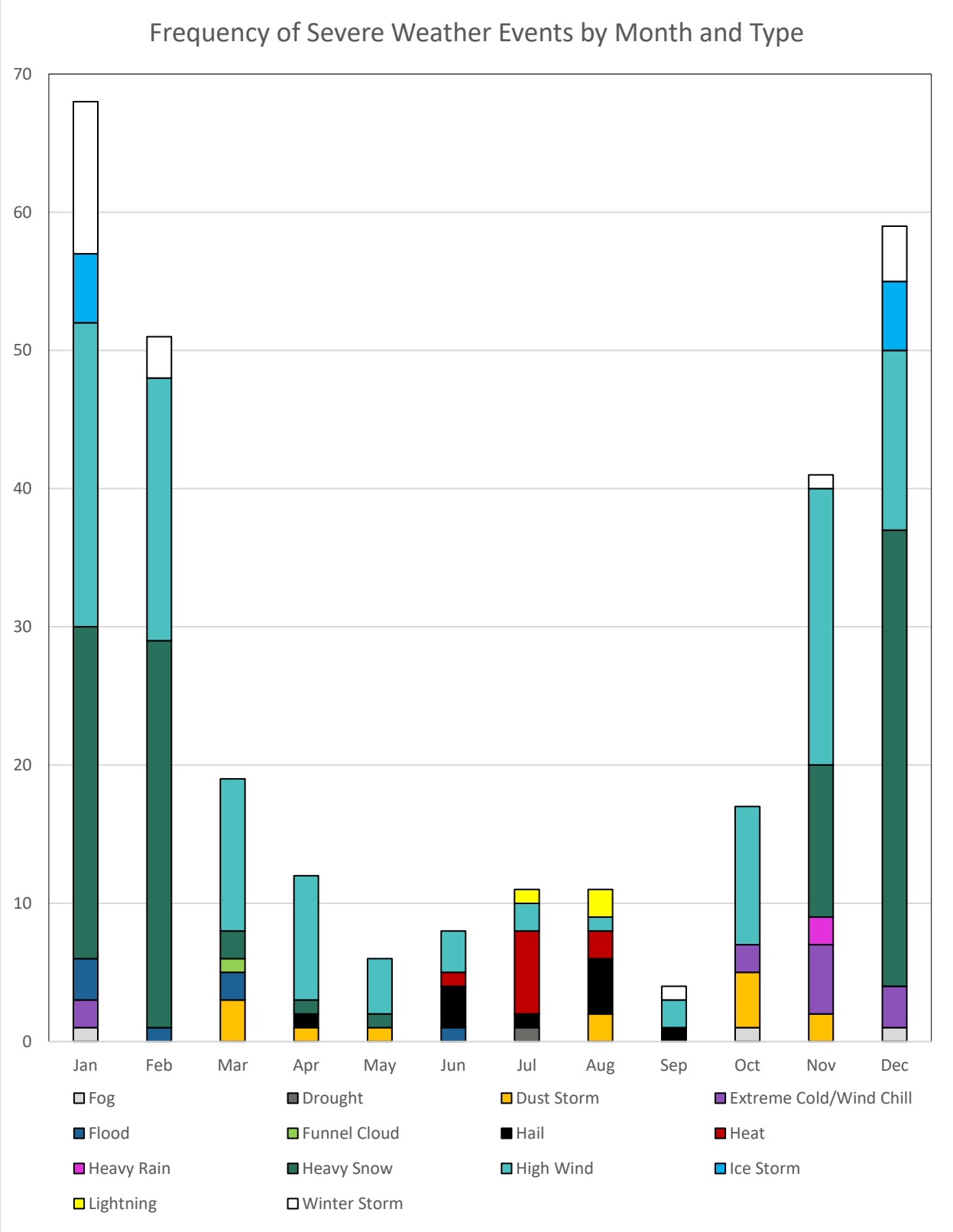


Figure 35) Historic severe weather events by event type and month for Klickitat County, WA. Data is from the NOAA Severe Storms Database (1996-2019).

Given the evidence of past weather patterns and resulting damage, the probability of Klickitat County continuing to experience severe weather events is very high. Nevertheless, residents in the area are generally aware of and have experience with the potential hazard resulting from severe weather; thus, the likelihood of major damage is moderate as communities and residents are often prepared. Of all resources and commodities in the county crops are generally the most vulnerable to severe damage and economic loss as a result of severe weather.

Table 32) Impact summary of severe weather events that affected Klickitat County, WA (1996-2017) (Division, 2018). Data is from the NOAA Severe Storms Database.

Severe Weather Impact Category	Total Value
Number of Severe Weather Events	307
Total Property Damage (in 2015 dollars)	$16,148,500
Total Number of Injuries	43
Total Number of Fatalities	3

The severe weather hazard rating map that was included in the Washington State EHMP (Figure 36) classifies the western third of the county as "medium-high" risk and the eastern two-thirds as "high" risk. Table 33 summarizes the risk ratings assigned to each adopting jurisdiction by the planning group. Overall risk associated with severe weather for the county and all cities and communities is high. It was also determined that most severe weather events are moderate in magnitude and the frequency at which they occur is occasional. Refer to the Jurisdictional Risk and Vulnerability Ratings section at the beginning of this chapter for more information about the process used to determine hazard ratings.

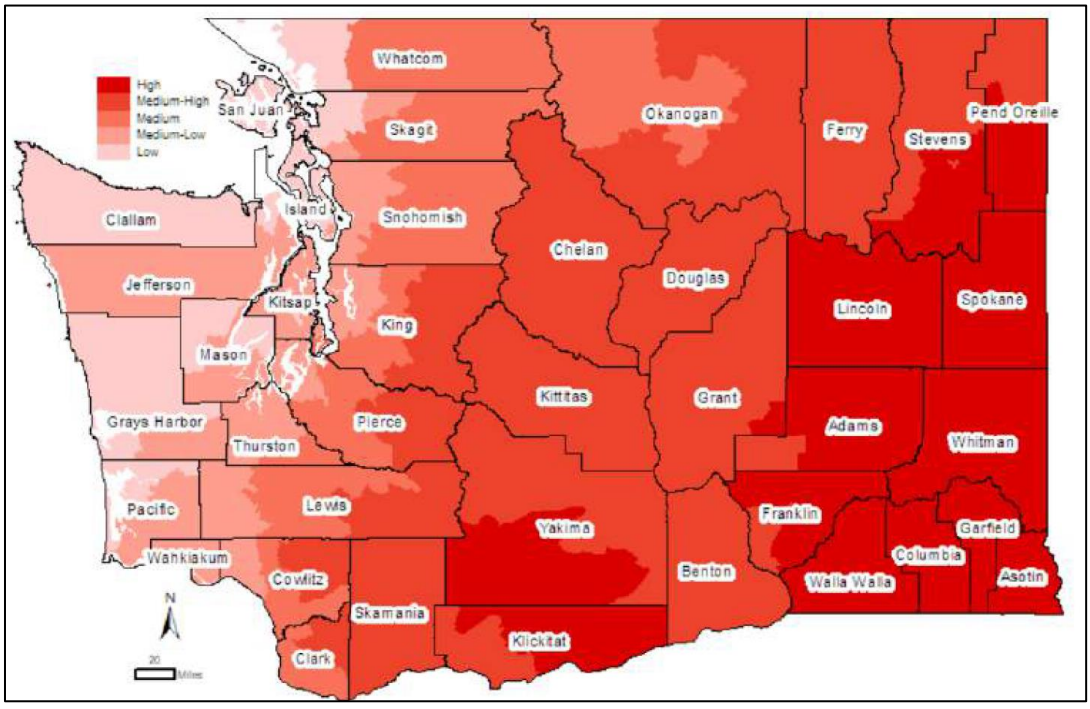


Figure 36) Washington State Severe Weather Hazard ratings. Map is from the Washington State Enhanced Hazard Mitigation Plan (Division, 2018).

Table 33) Overall severe weather Significance Summary for adopting jurisdictions.

Jurisdiction	Magnitude	Probability	Overall Severe Weather Risk
Klickitat County	Moderate	Occasional	High
City of Bingen			High
City of Goldendale			High
City of White Salmon			High
Klickitat Valley Health			Moderate
Eastern Klickitat Conservation District			High
Central Klickitat Conservation District			High
Underwood Conservation District			High

Analysis of Resources at Risk

It is difficult to summarize all resources that are at risk to severe weather in Klickitat County. Damage resulting from severe weather can vary considerably as there are multiple variables that determine the extent of the damage and the cost of repairs. Storm cell events can be localized and affect structures differently based on their age, construction style and materials, location, surrounding terrain, proximity to water, etc. Because of the unpredictable nature of severe storms, it should be assumed that all structures, infrastructure, and people are at risk during an event. Strong winds can blow over or break limbs out of trees, penny to quarter sized hail can impact any part of the county, extreme temperatures can freeze pipes and heavy snowfall can potentially damage roofs, and drought can damage crops, reduce water quality and availability, and place the entire county at high levels of risk for wildland fire. Consequently, the values of resources at risk include all structures and infrastructure in the county as a future storm cell or drought event, particularly as it relates to wildfire, could impact any part of the county.

Thunderstorms

In Washington, severe thunderstorm systems can be large enough to affect all counties in the state, but these storms are typically localized events. Their impacts are limited and do not significantly affect the communities extensively enough to warrant a disaster declaration. Flash flooding can be a concern in the county, but due to geologic uplift and other natural processes many of the waterways in Klickitat County are deeply incised limiting the effects of flash flooding. However, the loss potential from flash flooding caused by severe thunderstorms can be significant in low lying areas of Klickitat County. For example, winds in excess of 20 mph tend to blow debris into irrigation canals resulting in overtopping and damage throughout the county. In order to mitigate the risk of flooding, the irrigation district deploys vegetation clearing crews to canals when winds exceed 20 mph.

Hail

Although the financial impacts of hail can be substantial and extended, accurately quantifying these impacts is problematic. Hail typically causes direct losses to structures and other personal property as well as to the vast forestlands and extensive agricultural development in Klickitat County. The most significant losses are most clearly seen in the agriculture sectors of the county's economy. Potential losses to

agriculture can be disastrous. Impacts can also be localized; thus, individual farmers can have significant losses, but the event may not drastically affect the economy of the county. Furthermore, crop damage from hail will also be different depending on the time of year and the type of crop. Most farmers carry insurance on their crops to help mitigate the potential financial loss resulting from a localized hailstorm. Federal and state aid is available for counties with declared hail disasters resulting in significant loss to local farmers as well as the regional economy.

Homeowners in Klickitat County rarely incur severe damage to structures (roofs); however, hail damage to vehicles can happen. The damage to vehicles is difficult to estimate because the number of vehicles impacted by a specific ice storm is unknown.

Winter Storm

Damage to roofs by heavy snow accumulations depends on the moisture content of the snow and the structural characteristics of the buildings. In general, snow in this region tends to have low moisture content because of the low temperatures and arid environment. However, heavy snow fall does occur.

Frozen water pipes are the more common damage to residential and business structures. Older homes tend to be at a higher risk to frozen water pipes than newer ones.

Snow plowing in Klickitat County occurs from a variety of departments and agencies. The State of Washington maintains the state highways. Plowing of county roads is done by the Klickitat County Public Works Department and the road departments of the individual cities. Private landowners are responsible for maintaining their own driveways or other private roads.

Utility supplies are impacted during severe winter storms as power is lost on a regional basis. This has a two-fold impact on Klickitat County residents as not only is power cut to homes and businesses, but primary heating is lost for many residents. Gas furnaces and wood stoves supplement electrical heating, but with wood heating the senior population is at a disadvantage.

Emergency response to severe winter storms includes site visits by police or fire department personnel, opening of shelters, or assistance with shopping, medical attention, and communications.

Ice Storms[55]

Heavy accumulations of ice can bring down trees and topple utility poles and communication towers. Ice can disrupt communications and power for days while utility companies repair extensive damage. Even small accumulations of ice can be extremely dangerous to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces. Ice storms have caused multi-vehicle accidents in south-central Washington, resulting in both injuries and fatalities.

[55] Ice Storms. National Weather Service. January 2020. Accessed online at: https://www.weather.gov/safety/winter-ice-frost

Black Ice: Black ice is a deadly driving hazard defined as patchy ice on roadways or other transportation surfaces that cannot easily be seen. It is often clear (not white) with the black road surface visible underneath. It is most prevalent during the early morning hours, especially after snow melt on the roadways has a chance to refreeze over night when the temperature drops below freezing. Black ice can also form when roadways are slick from rain and temperatures drop below freezing overnight.

Ice Jams: Long cold spells can cause rivers and lakes to freeze. A rise in the water level or a thaw breaks the ice into large chunks which become jammed at manmade and natural obstructions. Ice jams can act as a dam, resulting in severe flooding.

Frost: Frost describes the formation of thin ice crystals on the ground or other surfaces in the form of scales, needles, feathers, or fans. Frost develops under conditions similar to dew, except the temperatures of the Earth's surface and earthbound objects fall below 32°F. As with the term "freeze," this condition is primarily significant during the growing season. If a frost period is sufficiently severe to end the growing season or delay its beginning, it is commonly referred to as a "killing frost." Because frost is primarily an event that occurs as the result of radiational cooling, it frequently occurs with a thermometer level temperature in the mid-30s.

Severe Wind

Severe wind events are a regular occurrence in the region and in the county. They can happen at any time of year and exacerbate other impacts from seasonal weather. Newer construction is less likely to be affected by severe wind than older construction; modern materials and building designs will either be up to code or will meet standards for severe winds that are characteristic of the area. Aside from property damage, it is unlikely that residents will be directly impacted as they typically anticipate annual occurrences of such events.

Natural resources can also be damaged or lost as a result of severe wind. Damage to trees and blow down are common during severe wind events, especially when winds occur with heavy or freezing rains. Trees are much more likely to blow down when soils are saturated from rain while freezing rain increases the likelihood of limb damage as ice accumulates on the tree. Down trees and falling limbs can get caught on powerlines and cause power-outages. Crops can also be damaged or lost by severe winds that occur during the growing season. Tall, slender crops like corn are particularly vulnerable to severe winds as the crop is usually lost if blown over.

Estimation of Loss

It is difficult to estimate potential losses in Klickitat County due to severe weather as there are many variables involved in determining damage. Due to time, budget, and data constraints the planning group was unable to develop methodology to estimate damages from each type of severe weather. However, there is a simple formula that can be used to estimate damage from windstorms and tornadoes; given the frequency of severe wind events that affect Klickitat County, there is utility in attempting to determine the order of magnitude of monetary damage that could be expected in the county.

It is assumed, however, that construction throughout the county has been implemented with the knowledge and understanding of wind-speed potential in the region, therefore, it is expected that most structures are capable of enduring average wind speeds and storm conditions. However, exceptional storm events producing significant wind speeds will likely cause damage to trees, power lines, and some structures in the county; older buildings that have not been updated with modern building materials will likely be the most vulnerable during such an event. Therefore, the following calculations estimate both structural damage and roof damage resulting from high winds.

We have estimated losses based on wind and tornado damage as follows:

- 3% of the parcels damaged causing 50% of value loss (loss could be from downed or damaged trees, damaged outbuildings, damaged fences/poles, damage to siding, damaged landscaping etc.)
- 5% of the parcels received damage to roof (requiring replacement of roof averaging $3,000)

Damages associated with sensitive receptors (which includes but is not limited to hospitals, schools, daycare facilities, elderly housing, and other facilities that serve or are occupied by sensitive populations) have not been estimated. We have also not estimated the potential for a large-scale wildfire event associated with high winds.

- Damages associated with sensitive receptor irritation have not been estimated. We have also not estimated the potential for a large-scale wildfire event associated with high winds.

Based on data from the US Census and the American Housing Survey, there are 10,301 total assessed homes in Klickitat County with a total value of approximately $2.43 billion. Using the criteria outlined above an estimate of the impact of high winds on in the county has been made. The potential wind and tornado damage to all buildings is estimated at approximately $38 million. The estimated damage to roofs is approximately $1.5 million (Table 34).

Table 34) Loss estimates for Klickitat County, WA resulting from severe wind events. Data is from the US Census Bureau and the American Housing Survey.

Loss Variables	Klickitat County	Bingen	Goldendale	White Salmon
Total Housing Units	10,301	284	1,603	1,396
Median Property Value	$235,900	$171,700	$124,200	$315,300
Total Value	$2,430,005,900	$48,762,800	$199,092,600	$440,158,800
Structural Damage	$36,450,089	$731,442	$2,986,389	$6,602,382
Roof Damage	$1,545,150	$42,600	$240,450	$209,400
Total Estimated Losses	**$37,995,239**	**$774,042**	**$3,226,839**	**$6,811,782**

Impacts of Severe Weather

When a strong windstorm strikes a community, it leaves behind a distinctive trail. Trees toppled over on buildings and cars, downed power lines crisscrossing the roads, and widespread power outages are a few

of the signs that a windstorm has struck. After such an event, it can take communities days, weeks, or longer to return to normal activities. In addition to costly structural damages, windstorms can cause injury or even death.

Windstorms can cause damage over 100 miles from the center of storm activity. Isolated wind phenomena in the mountainous regions have more localized effects. Winds impacting walls, doors, windows, and roofs, may cause structural components to fail. Wind pressure can create a direct and frontal assault on a structure, pushing walls, doors, and windows inward. Conversely, passing currents can create lift and suction forces that act to pull building components and surfaces outward. The effects of winds are magnified in the upper levels of multi-story structures. As positive and negative forces impact the building's protective envelope (doors, windows, and walls), the result can be roof or building component failures and considerable structural damage.

Winter storms are deceptive killers. Many of the deaths that occur are indirectly related to the actual storm, including deaths resulting from traffic accidents on icy roads, heart attacks while shoveling snow, and hypothermia from prolonged exposure to the cold. Property is at risk due to flooding and landslides resulting from heavy snow melt. Trees, power lines, telephone lines, and television and radio antennas can be impacted by ice, wind, snow, and falling trees and limbs. Saturated soil can cause trees to lose their ability to stand and fall on houses, cars, utilities, and other property. Similarly, if streets are icy, it is difficult for emergency personnel to travel and may pose a secondary threat to life if police, fire, and medical personnel cannot respond to calls. Common winter storm hazards are as follows:

- **Roads and Bridge:** Snow and ice events resulting in icy road conditions can lead to major traffic accidents. Roads blocked by fallen trees during a windstorm may have tragic consequences for people who need access to emergency services. The ability to travel after a natural hazard event is a priority issue for residents, organizations, and providers of essential services such as hospitals and utilities.
- **Power Lines:** Historically, falling trees can be a major cause of power outages resulting in interruption of services and damaged property. In addition, falling trees can bring electric power lines down, creating the possibility of lethal electric shock. Snow and ice can also damage utility lines and cause prolonged power outages. Rising population growth and new infrastructure in the city creates a higher probability for damage to occur from severe winter storms as more life and property are exposed to risk.
- **Water Lines:** The most frequent water system problem related to cold weather is a break in cast iron mainlines. Breaks frequently occur during severe freeze events, as well as during extreme cooling periods during the months of October, November, and December. Another common problem during severe freeze events is the failure of commercial and residential water lines. Inadequately insulated potable water and fire sprinkler pipes can rupture and cause extensive damage to property.

Vulnerability to severe storm hazards is a function of location, type of human activity, use, and frequency of storm events. The effects of severe storms on people and structures can be lessened by total avoidance of flood hazard areas or by restricting, prohibiting, or imposing conditions on hazard zone activity. Local

governments can reduce flooding, landslides and wind effects through land-use policies and regulations. Individuals can reduce their exposure to hazards by educating themselves on the history of a site and by making inquiries to planning and engineering departments of local governments. In addition, it is highly advised to consult the professional services of an engineering geologist, geotechnical engineer, or a civil engineer, who can properly evaluate a site, built or un-built.

Climate Change

Severe weather events are a part of the natural climatic cycle. As such, these events play an important role in maintenance and sustenance of local biodiversity. However, climate change, by its very nature, and following the basic laws of thermodynamics and the conservation of energy, is adding energy to many systems. We can think of this process as our weather having a grand volume dial, a climate directed rheostat where climate change is turning up the energy volume and all atmospheric systems are impacted. This added energy in the atmosphere has to go somewhere and that somewhere can be realizing in stronger winds, more hailstorms and greater rain intensity. As such, Klickitat County should expect changes in weather patterns over the next five-year planning cycle. This includes storm systems with greater intensities as well as seasonal changes in the timing and type of precipitation. Refer to the Natural Hazards and Climate Change section at the beginning of this chapter for more information about the influence of climate change on severe weather patterns.

Development

An increase in development will increase exposure to severe weather impacts, but vulnerability does not necessarily increase if building codes and ordinances are adequate and adhered to when designing new construction. An increase in population can result in more people being stranded or needing help during a long-term loss of services, but community outreach programs focused on sheltering in-place can help reduce the number of residents who will need immediate assistance after a severe weather event. Most new development in Klickitat County is in the rural fringe. The construction of new homes in rural areas does not have to increase community vulnerability, but residents need to have enough supplies to shelter in place for up to two weeks.

Impacts to Klickitat County

In addition to the general impacts listed above, Klickitat County could be subjected to specific impacts due to unique geological and hydrological features and distribution of populated areas and infrastructure.

The intensity and frequency of severe weather events will be similar across the whole county. Prevailing westerly winds will move air masses from the west over the Cascades where they gain energy and turn into storm systems. Storm systems then move from the west end to the east end of the county. Most impacts will be similar across the county, but there may be some differences between the eastern end and western ends because of differences in terrain and vegetation cover-types:

- Eastern Klickitat County: Because of the open, flat terrain winds could be more severe. It may be more likely that exposed structures are damaged more frequently or the damage could be more severe; coupled with winter storms, wind may create snow drifts and blowing snow may create

more hazardous driving conditions; debris may accumulate more rapidly in ditches and other drainage features which could create flood conditions; lightning may also be more hazardous because of the open, flat terrain.

- Western Klickitat County: Steep, mountainous terrain covered with dense forest may dampen winds produced by storms, but downed trees are much more common and can block roadways, damage structures, and injure or kill people; sitting closer to the Cascades, lightning strikes may occur more frequently and could start wildfires; on average, snowfall is greater and, when combined with steep and winding roads, creates dangerous driving conditions; steep terrain is also conducive to flash flooding.

Impacts to Other Adopting Jurisdictions

In addition to the general impacts listed above, each adopting jurisdiction could be subjected to specific impacts as a result of location and nearby landscape features:

- **City of Bingen:** Overall severe weather risk in Bingen is high; general impacts are moderate in scope and occur seasonally.
    - Winter weather can make steep roads in and around the city hazardous, disrupting individuals traveling to work and commerce.
    - Localized flooding may also occur along Jewett Creek during periods of heavy rainfall.
- **City of Goldendale:** Overall severe weather risk for Goldendale is high; general impacts are moderate in scope and occur annually.
    - The area in and around Goldendale is flat which limits the impacts that winter storm conditions have on roads and drivers. However, Goldendale may be more exposed to strong winds and blowing snow because the terrain is open and level.
    - During the spring, periods of heavy rainfall can contribute to the rise and potential overtopping of the Little Klickitat River. Nearby homes and structures in the northern part of the city may be affected by flood waters in extreme circumstances.
- **City of White Salmon:** Overall severe weather risk for White Salmon is high; general impacts are moderate in scope and occur seasonally.
    - Steep roads in and around White Salmon can become very dangerous for drivers and disrupt commerce during winter storm conditions.
    - Flooding along Jewett Creek may also occur during periods of heavy precipitation.
- **Klickitat Valley Health:** Overall severe weather risk for KVH is moderate; general impacts are moderate in scope and occur seasonally.
    - Although backup power is available, power-outages are a primary concern for KVH during severe weather events.
    - Transportation of patients can also be dangerous during severe winter weather when roads are covered with snow and ice making access to homes and remote areas difficult or impossible.
    - High winds are common and can affect KVH's ability to transport patients to other facilities by air.

  - Goldendale often experiences extreme heat and cold temperatures that can have a variety of negative impacts on the facility, particularly on patients.
  - Severe weather presents the biggest threat to the continuity of power and other utilities at the KVH campus. Power outages are particularly problematic as KVH has limited redundancy in many of its building systems.
- **Eastern and Central Klickitat, and Underwood Conservation Districts:** Overall severe weather risk for the conservation districts is high; general impacts are moderate in scope and occur seasonally.
  - The western half of the county can expect more precipitation and snowfall annually than the eastern half of the county.
  - The eastern and south-central parts of the county are flat and may be subjected to stronger winds throughout the year; strong winds can displace topsoil and push wildfires through light, flashy fuels at a high rate.
  - The western and north central parts of the county are heavily timbered; strong winds may produce blow down and create forest health concerns.
  - There are numerous shallow canyons that run through the eastern half of the county and several deep canyons in the western half of the county. All drainages can channel a significant amount of water during periods of heavy rainfall.
  - Wildland fire resulting from and exacerbated by severe weather is likely the greatest threat to the conservation districts.

Second-Order Hazard Events

Severe weather is often the causal factor in damages from other types of hazard incidents such as flood or wildland fire. The following chart outlines the interconnection between severe weather and other types of hazard events.

Table 35) Second-order hazards related to severe weather events.

Related Causal Events	Related Effects
Flooding	Drought
Landslides	Crop Loss
Wildland Fires (Lightning)	Tornado
	Wildland Fire
	Power Outage
	Transportation
	Flood

EARTHQUAKE HAZARD PROFILE & RISK ASSESSMENT

Significant seismic risk in Klickitat County arises from diverse geologic sources, as described in this hazard profile. The highest probability threat over the next 50 years (Figure 38) is from a large magnitude earthquake, due to tectonic plate collision, within the Cascadia Subduction Zone (CSZ; described and discussed below). The CSZ is capable of producing very strong-to-moderate intensity ground shaking throughout the county (Figure 39) from seismic events in a large zone underlying the Pacific continental margin and western Washington, including deep areas directly beneath Klickitat County. In addition, strong-to-moderate shaking within Klickitat County can be caused by movement on other potentially-active shallow crustal faults such as the Mill Creek Thrust Fault and related faults in the Toppenish Ridge Fault Zone of Yakima County, or from earthquakes in the active St. Helens Seismic Zone west-northwest of Klickitat County. There are also unknown seismic risks from faults, seismic zones, and geologic features for which insufficient information is available for adequate risk assessment, including the Olympic-Wallowa Lineament that passes through the nearby Hanford nuclear waste storage facility in southeastern Washington.

In 2018, the U.S. Geological Survey published national Seismic Hazard Maps showing estimated aggregate seismic risk in the 48 conterminous states, including Washington[56]. The models on which these maps are based include multiple possible seismic sources, and calculate peak ground acceleration (i.e., ground shaking intensity) that is expected to be exceeded within a defined time period. The 50-year map models show that there is an estimated aggregate 10% probability (1 in 10 chance) that seismic event(s) exceeding strong-to-moderate ground shaking will happen in Klickitat County over the next 50 years (Figure 38). The uncertainty range of the 10% probability estimate cannot be ascertained from the map.

Figure 39 shows model scenarios of ground-shaking intensity for specific individual earthquakes that likely pose the greatest hazard (see below) for Klickitat County. The worst-case scenario shown here is for a very large CSZ magnitude earthquake located west of Portland, OR. For this event, ground shaking intensity in Klickitat County is estimated to range from very strong in the west end of the county to strong or moderate throughout the rest of the county. Calculations of the probability for a mega-earthquake on the northern CSZ over the next 50 years range widely from 7-41% depending on the method used for calculation (Stein et al., 2017)[1]. However, it is certain that a very large CSZ earthquake will happen in the future, as it has many times in the geologic past, and that such an event can happen at any time.

Perhaps most important of all is that strong ground shaking can trigger other hazards in Klickitat County, covered in other sections of this HMP. For example, ground shaking could cause numerous landslides around the County, and a lahar (a liquefied mixture of water and rock fragments) could be triggered from Mount Adams and flow down the White Salmon River as far as the Columbia River, causing extensive

[56] United States Geological Survey. 2018 United States (Lower 48) Seismic Hazard Long-term Model. https://www.usgs.gov/natural-hazards/earthquake-hazards/science/2018-united-states-lower-48-seismic-hazard-long-term?qt-science_center_objects=0#qt-science_center_objects.

damage. Seismic shaking might cause leakage of toxic substances, or leakage of radioactive waste in storage upstream at the Hanford Site. Mass casualties are possible. Although probabilities for these linked risks are difficult to assess, planning is needed for mitigation of seismically triggered hazards.

Much of the information provided below was excerpted or derived from the Washington Military Department's Washington State Enhanced Hazard Mitigation Plan (EHMP), the Washington State Dept. of Natural Resources Interactive Geoportal website[57] and the U.S. Geological Survey Hazard Maps website[58].

More than 1,000 earthquakes occur in Washington State annually. Washington has a record of at least 20 damaging earthquakes during the past 125 years (Figure 37). Large earthquakes in 1946, 1949, and 1965 killed 15 people and caused more than $200 million (1984 dollars) in property damage. Most of these earthquakes occurred in western Washington, but several, including the 1872 Lake Chelan earthquake which is one of the largest earthquakes on record for the State of Washington, occurred east of the Cascade crest. Because of the potential for another earthquake with a magnitude like that of the Lake Chelan quake, researchers are currently attempting to map and understand the seismic potential of the fault systems in eastern and central Washington. One geologic feature that is of concern in central Washington is the Mill Creek Thrust Fault in the Toppenish Ridge Fault Zone in Yakima County, just north of Klickitat County (Figure 40). Some researchers believe that the fault could produce a shallow M7.1 magnitude earthquake which could cause substantial surface cracking, soil liquefaction, and damage to infrastructure in local communities in Yakima and Klickitat Counties (Figure 39). Other active seismic zones in proximity to Klickitat County include the St. Helens Seismic Zone, the Rainier Seismic Zone, and the Goat Rocks Seismic Zone. As recently as 1980, the St. Helens Seismic Zone in Skamania County (immediately west-northwest of Klickitat County) has produced several M4-M5 magnitude earthquakes (Figure 37).

In addition to locating and mapping fault lines in Washington, researchers are also attempting to predict when earthquakes will occur. Washington's short historical record (starting about 1833) is inadequate to sample its earthquake record. Using a branch of geology called paleoseismology to extend the historical earthquake record, geologists have found evidence in Washington of very large, prehistoric earthquakes and earthquake-triggered tsunamis. The recurrence interval of these very large prehistoric earthquakes is 100-1100 years (averaging every 400-600 years), and the most recent such event was about 320 years ago (Goldfinger et al., 2012)[2]. Therefore, another very large earthquake can happen at any time now, and most of the state may be at risk from such an event (Walsh et al., 2006)[3].

[57] https://geologyportal.dnr.wa.gov/#natural_hazards

[58] https://earthquake.usgs.gov/hazards/hazmaps/

DEFINITIONS

Amplification: increased ground shaking that occurs where earthquake waves pass from hard bedrock into softer geologic materials such as loose or poorly cemented sediments or soil. Buildings constructed on soft material will typically see more damage than buildings on hard or very firm material.

Earthquake: waves of energy moving rapidly through the earth and along the earth's surface (seismic waves), resulting in ground shaking. Earthquakes are generated by a sudden rupture and displacement of the earth's crust that typically occurs along a fault. Volcanic or magmatic activity, or other sudden stress changes in the earth's crust, can also cause earthquakes.

Fault: a crack or fracture in the earth's brittle crust where relative movement has occurred between the two sides. Movement (also called displacement) can be down on one side with respect to the other (a *normal fault*); up on one side with respect to the other (a *reverse fault*, also called a *thrust fault* when the fault plane dip angle is less than 45 degrees); or, horizontal sliding (right or left) of one side with respect to the other (a *strike-slip fault*). Normal faults typically form where the earth's crust is being extended (pulled apart); reverse and thrust faults form where the earth's crust is being compressed (pushed together); and strike-slip faults occur where the earth's crust is being horizontally pulled or pushed in opposite directions. Some faults are actually boundaries between tectonic plates (*interplate faults*); *subduction zones* are interplate thrust faults, and *transform faults* are interplate strike-slip faults. Faults contained within a single tectonic plate are called *intraplate faults*.

Ground Shaking: the motion felt on the earth's surface in response to passage of earthquake seismic waves. It is the primary cause of earthquake damage. The extent of damage depends on the duration and strength, or intensity, of ground shaking. The duration of shaking is a function earthquake magnitude and distance from the source of the earthquake. Intensity of ground-shaking depends on the magnitude of the earthquake, the type of fault, distance from the epicenter (the point on the ground surface above where the earthquake originates), and depth within the earth of the source of the earthquake waves. Ground shaking intensity generally decreases with distance from the earthquake source due to loss of wave energy during travel ("attenuation"), but shaking can be intensified locally, relative to adjacent areas, by amplification in soft substrates (see below). The Modified Mercalli Intensity (MMI) scale measures seismic ground-shaking intensity during an earthquake at a specified location; the scale ranges from 1 to 10 but is shown with Roman numerals (see legend on bottom right in Figure 39). *Moderate intensity ground shaking* (MMI = V) can stop pendulum clocks, break dishes and windows, and overturn unstable objects**.** *Strong ground shaking* (MMI = VI) can move some heavy furniture and cause plaster to fall; damage to some buildings is slight. *Very strong ground shaking* (MMI = VII) can cause considerable damage in poorly built or badly designed structures and cause some chimneys to break or collapse; damage is slight to moderate in well-built ordinary structures, and negligible in buildings of good design and construction.

Liquefaction: occurs when water-saturated sands, silts, or (less commonly) gravels are shaken so violently that the sediment grains rearrange, causing the sediment to lose strength and to essentially turn into quicksand. Buildings can tilt or sink into the ground, and lateral spreading of the ground can produce large

fissures. Liquefaction is common during earthquakes in ground built up by artificial fill (dredge spoils) adjacent to bodies of water.

Richter Magnitude Scale: The Richter magnitude scale measures the amount of energy released by an earthquake and was developed in 1935 by Charles F. Richter as a mathematical device to compare the size of earthquakes. The magnitude of an earthquake is determined from the logarithm of the amplitude of waves recorded by seismographs. Magnitude is expressed in whole numbers and decimal fractions from 0-10. For example, a magnitude 5.3 (M5.3) might be computed for a moderate earthquake, and a strong earthquake might be rated as magnitude 6.3 (M6.3). Because of the logarithmic basis of the scale, each whole number increase in magnitude represents a tenfold increase in measured amplitude; 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.

Seiche: The up and down movement of the water surface (a standing wave) in a bay or lake (like water sloshing in a bathtub) that can be caused by earthquakes, wind, tides, and changes in atmospheric pressure.

Background Information

There are numerous geologic features in the Pacific Northwest that pose as potential seismic hazards to populated areas. The following is a summary of known geologic features located either adjacent to or within the State of Washington:

Cascadia Subduction Zone (CSZ) Earthquakes: Washington is situated at a “convergent” continental margin, i.e. at the place where two tectonic plates are slowly colliding (Figure 41). A plate of oceanic lithosphere known as the Juan de Fuca Plate (a slab of oceanic crust plus some rigid deeper material) is being pushed beneath the continental North American Plate along a major boundary parallel to the coast of Washington and Oregon. The boundary, a type of massive thrust fault, is called the "Cascadia Subduction Zone" (CSZ). It lies about 50 miles offshore and extends parallel to the coast from the middle of Vancouver Island in British Columbia past Washington and Oregon to northern California. The two plates are converging at a rate of about 3-4 centimeters per year (about 2 inches per year). The collision is not head-on but is oblique-- the northward-moving Pacific Plate is pushing the Juan de Fuca Plate north, causing complex seismic strain to accumulate in the crust beneath Washington and Oregon. The descending Juan de Fuca plate lies directly beneath the western half of Washington state, including Klickitat County. Strong CSZ earthquakes occur when there is abrupt release of this slowly accumulated strain along significant lengths of the CSZ.

The interaction of these two tectonic plates, as depicted in Figure 41, produces three primary types of earthquakes in the Pacific Northwest:

- **Deep “Benioff Zone” Earthquakes:** These earthquakes occur as breaks or fractures within the Juan de Fuca Plate as it pushes downward under the overriding North American plate. Hypocenters (actual rupture locations) can occur at depths of 15 to 60 miles, although the largest events typically occur at depths of about 25 to 40 miles. Ruptures occur within a plate (intraplate

earthquakes) rather than between two different plates (interplate earthquakes) and may produce events with Richter magnitudes exceeding M9.0.

- **Subduction Zone Earthquakes:** These earthquakes release accumulated elastic strain along the interface between colliding tectonic plates, and scientists have found evidence of several great-magnitude earthquakes along the Cascadia Subduction Zone (Goldfinger et al., 2012)[2]. These earthquakes have been very powerful, with magnitudes of M8 to M9 or greater; they have occurred at intervals ranging from as short as about 100 years to as long as 1,100 years, averaging 400-600 years. Subduction zone earthquakes are particularly dangerous in that they produce strong ground motions (see Figure 39) and, in nearly all cases, damaging tsunamis.
- **Shallow Crustal Earthquakes:** These earthquakes occur in the earth's crust within the upper part of the North American Plate. Crustal earthquakes originate at shallow depths, typically within the upper 5 or 10 miles of the earth's surface, and some ruptures may reach the surface.

Olympic-Wallowa Lineament (OWL): The OWL, which can be seen from space, is an approximately 500-km-long topographic feature of the landscape oblique to the Cascadia plate boundary, extending from the northern Olympic mountains through Seattle and south-central Washington counties (including Klickitat County), and continuing through Walla Walla in southeastern Washington across the Columbia River to the Blue Mountains in northeastern Oregon (Sherrod et al., 2016)[4]. The OWL features numerous fault lines that may be able to produce earthquakes. The OWL is a consequence of large-scale tectonic plate motions (Figure 41), and thus has potential risk for large-magnitude earthquakes. Because the nature of the OWL is complex, the seismic risks associated with it are not fully known, although it is possible to assess risk associated with some of the individual geologic features encompassed by the OWL (see below).

Yakima Fold-and-Thrust Belt: Compressional forces in the earth's crust, due to clockwise rotation in response to large-scale tectonic plate motions (Figure 41), have created folds and faults that are expressed in the landscape of south-central Washington as a north-to-south series of prominent east-west trending ridges across the Columbia River basin, including Klickitat County (Figure 40 and Figure 42). Collectively, these features are called the Yakima Fold-and-Thrust Belt, and they are part of the OWL between the Blue Mountains in the east and faults in northwestern Washington. These folds are interpreted as being forced up by compression along thrust faults extending below the basalt flows of the Columbia Plateau into rigid crustal rocks beneath the basalt; these thrust and reverse faults may be significant earthquake sources (Yeats et al., 2018)[5].

Mill Creek Thrust Fault: The Mill Creek Thrust Fault is an integral feature of the Yakima Fold-and-Thrust Belt. It is located west of the cross-section depicted in Figure 40 B, and its latitude lies between Horse Heaven Hills (south) and Rattlesnake (north) faults. The Mill Creek Thrust Fault follows the northern flank of Toppenish Ridge for 65 kilometers (Figure 40). The Mill Creek fault has been active during the past 10,000 years (Lidke et al, 2016) [6], most recently about 500 years ago (Bjornstad et al., 2010)[7], and can produce earthquakes of magnitudes of M7 or higher (Figure 39).

Toppenish Ridge Fault Zone: The Mill Creek Thrust Fault is part of a network of faults known collectively as the Toppenish Ridge Fault Zone (Figure 40). Like the Mill Creek Thrust Fault, these unnamed E-W trending faults are associated with the Toppenish Ridge anticline, which is a fold within the Yakima Fold-

and-Thrust Belt. Some of these faults are known to have slipped in the Pleistocene and Holocene (Lidke et al., 2016b)[8], and are still seismically active (Bjornstad et al., 2010)[7].

Wallula Fault Zone: The Wallula Fault Zone is a NW-SE trending fault zone in southeastern Washington that is located northeast and east of Klickitat County. The Wallula Fault Zone is in the southeastern part of the Yakima-Fold-and-Thrust Belt and lies along the OWL. It includes multiple fault strands and extends ~120 km-- from Rattlesnake Mountain at the NW end, near the Hanford Site, to Milton-Freewater, OR, at the SE end. Recent work of Sherrod et al. (2016)[4] establishes that strong shaking accompanied by liquefaction took place during the Holocene on a fault strand near Kennewick, WA, and documents other evidence of recent (Holocene) fault movement on the southeastern portion of the Wallula Fault Zone within 10 km of the historic 1936 M6.1 Milton-Freewater earthquake epicenter. It is estimated that an M7.5 magnitude earthquake is possible along the Wallula Fault Zone (Sherrod et al., 2016)[4].

St. Helens, Rainier, and Goat Rocks Seismic Zones: Mount St. Helens and Mount Rainier are active Cascade volcanoes located northwest of Klickitat County. These volcanoes sit along narrow zones of recent and ongoing seismicity that trend NNW-SSE (Figure 44). Mount St. Helens exploded catastrophically in May 1980, and since then there have been smaller episodes of eruption accompanied by seismic activity along the St. Helens Seismic Zone (including earthquakes with magnitudes of M4-5; Figure 37 and Figure 44). The Rainier Seismic Zone also is active and can become more so whenever Mount Rainier volcanic activity ramps up. The Goat Rocks Seismic Zone is a third NNW-SSE zone of seismicity located SE of Mount Rainier. (Figure 44); Goat Rocks is an extinct Cascades volcano.

Historical Earthquake Events

Deep Benioff Zone Earthquakes: The Olympia quake in 1949, which had a magnitude of 7.1 (M7.1) on the Richter scale, is the largest intraplate (Benioff Zone) earthquake to be recorded historically. Other significant Benioff Zone events in Washington include the M6.8 Nisqually earthquake of 2001, the M5.8 Satsop earthquake in 1999, and the M6.5 Seattle-Tacoma earthquake in 1965. Strong shaking lasted about 20 seconds in the 1949 Olympia earthquake and about 15 to 20 seconds during the 2001 Nisqually earthquake. The Nisqually earthquake caused $2 billion dollars in property damage. Since 1900, there have been five deep Benioff Zone earthquakes in the Puget Sound basin with measured or estimated magnitude of M6.0 or larger, and one M7 event. The average recurrence rate for earthquakes like the 1965 M6.5 Seattle-Tacoma event and the 2001 M6.8 Nisqually event is once every 35 years. The average recurrence rate for earthquakes like the 1949 M7.1 Olympia earthquake is once every 110 years.

Cascadia Subduction Zone Earthquakes: The most recent CSZ earthquake to strike Washington occurred on January 26, 1700, about 320 years ago (Goldfinger et al., 2012)[2]. Ground shaking intensity for this type of earthquake has been modeled by the U.S. Geological Survey assuming a Richter magnitude of M9.3 and an epicenter depth of 21.4 km (Figure 39). The ground shaking intensity in Klickitat County for this scenario varies from very strong on the west side of the county to moderate at the east edge of the county.

Probability of a CSZ or deep Benioff Zone "megaquake" affecting Klickitat County has been calculated based on geologic evidence for the timing of such events throughout the past 10,000 years (Goldfinger et al., 2012)[2]. The mean recurrence interval for all large CSZ earthquakes that occurred during this time

interval is 530 years, with an uncertainty of ± 271 years. Some seismologists argue (though others disagree) that there have been 18 earthquake clusters separated by quiet intervals of 700-1000 years, and that during the most recent cluster the mean recurrence interval is 326 years. Using these observations and arguments, probability of another large earthquake during the next 50 years has been calculated by several methods, which are well-described in Stein et al., 2017[1]. One method divides 50 years by the mean recurrence interval (530 years) of all CSZ mega-earthquakes in the geologic record of the past 10,000 years, yielding a result of approximately 10% probability in the next 50 years (this is the probability cited in Figure 38). Another method assumes that the next earthquake will be part of the most recent cluster and divides 50 years by the mean recurrence interval for the cluster (326 years), yielding a 50-year probability of 15%. A third approach allows probability to increase with time since the most recent earthquake nearly 320 years ago, yielding a 50-year probability of about 7% when using mean recurrence interval of 530 years, and about 41% when using mean recurrence interval of 326 years. What is known for sure is that these large earthquakes will happen one day, and that one can happen at any time.

Shallow Crustal Earthquakes: Shallow intraplate crustal earthquakes occur within about 20 miles of the surface. The short distance of wave travel to the earth's surface from these earthquakes means less energy loss (attenuation), and hence stronger ground shaking intensity. Recent examples occurred near Bremerton in 1997, near Duvall in 1996, off Maury Island in 1995, near Deming in 1990, near North Bend in 1945, just north of Portland in 1962, and at Elk Lake in 1981 on the St. Helens Seismic Zone (Figure 44). These earthquakes ranged in magnitude from M5 to M5.5. Scientists believe that the state's largest shallow crustal earthquake, the 1872 quake near Lake Chelan, may be the state's most widely felt earthquake. The 1936 Milton-Freewater M6.1 quake near Walla Walla, another significant eastern Washington earthquake, was also shallow. Faults responsible for earthquakes cannot always be located, and recurrence rates for earthquakes on particular surface faults are often unknown. However, four M7.0 or greater shallow crustal events have occurred in the Pacific Northwest during the past 1,100 years, including two since 1918 on Vancouver Island.

Shallow faults can also produce multiple earthquakes in rapid succession called swarms. Residents of Spokane strongly felt a swarm of earthquakes in 2001; the largest earthquake in that swarm had a magnitude of M4.0. The Spokane earthquakes were very shallow, with most events located within a few miles of the surface. The events occurred near a suspected fault informally called 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 near Spokane.

Elsewhere in central and eastern Washington and in the Columbia Gorge, geologists recently have uncovered evidence of several surface faults; however, they have not yet determined how active the faults are, nor determined the extent of the risk these faults pose to the public. A few examples of major faults and fault systems in central and eastern Washington that could produce damaging earthquakes in the Columbia River Basin include: Toppenish Ridge (Figure 40), which appears to have been the source of two earthquakes with magnitudes of M6.5 to M7.3 in the past 10,000 years (EMD 2004)[9]; other fault zones in the Yakima Fold-and-Thrust belt found to the east of Toppenish Ridge (Figure 42 shows, from left-to-right, a south-to-north cross section of the Yakima Fold-and-Thrust belt, and the relationship between

some of the prominent ridges in the Columbia River Basin and the location of fault lines); and, the Wallula Fault Zone, discussed above. As technology evolves, geologists will continue to gain a better understanding of how central and eastern Washington fault systems work and their potential to produce damaging earthquakes.

Surface traces of faults and the epicenter locations of recent earthquakes (events greater than M1 between 1970 - 2016) in and near Klickitat County are shown in Figure 40. In Klickitat County, there were dozens of small earthquakes over the 46-year time interval of the data displayed, and all had magnitudes less than M4. However, close by in Yakima County, upon and in between Toppenish Ridge and Horse Heaven Hills, there have been many earthquakes, several with magnitudes exceeding M4, and there has been fault movement within the past 500-to-10,000 years (Figure 40b). Shallow crustal earthquakes exceeding magnitudes of M7 are thought to be possible in this area and could produce strong shaking in Klickitat County (see Figure 39, Mill Creek M7.1 shake intensity scenario, shown in upper left panel).

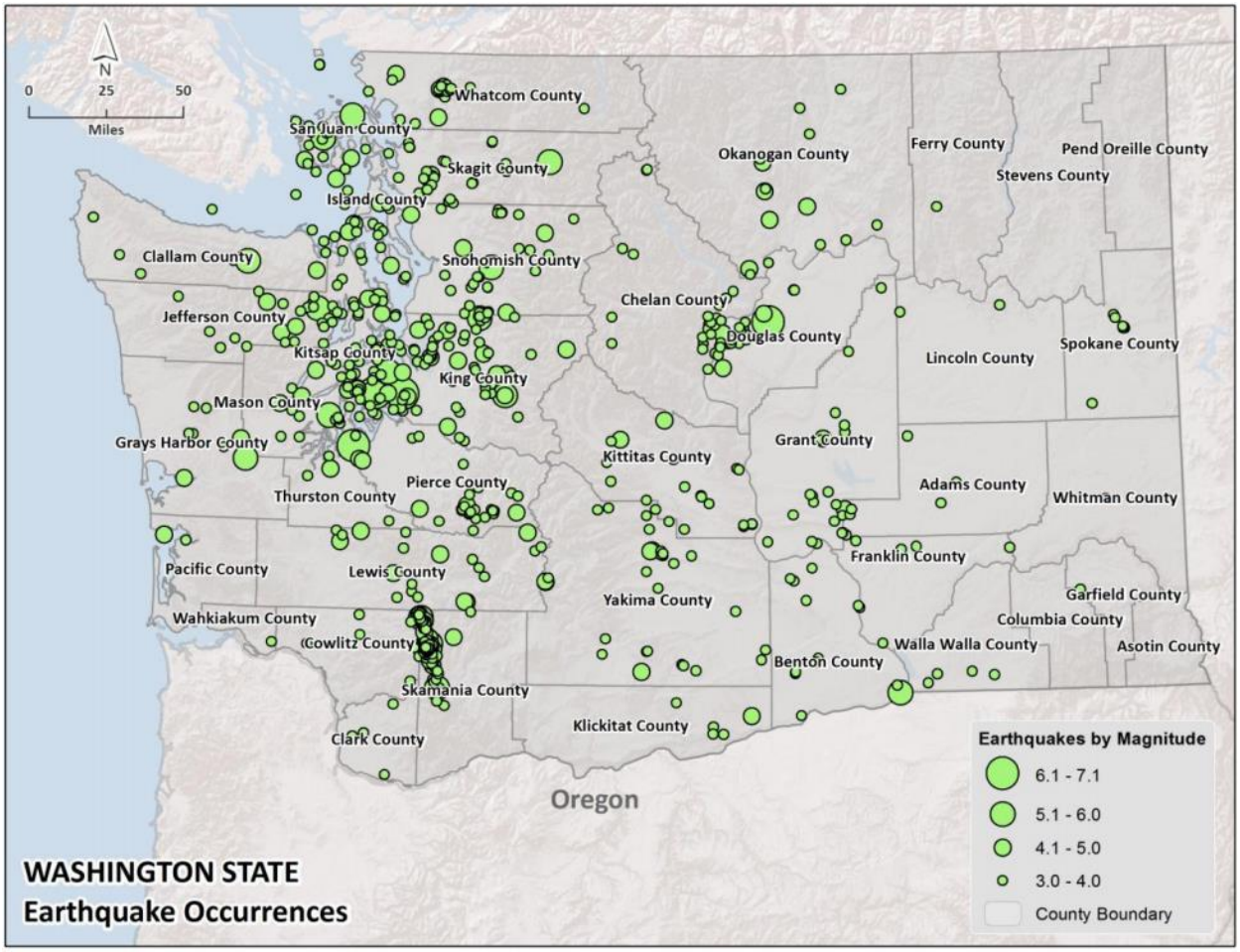
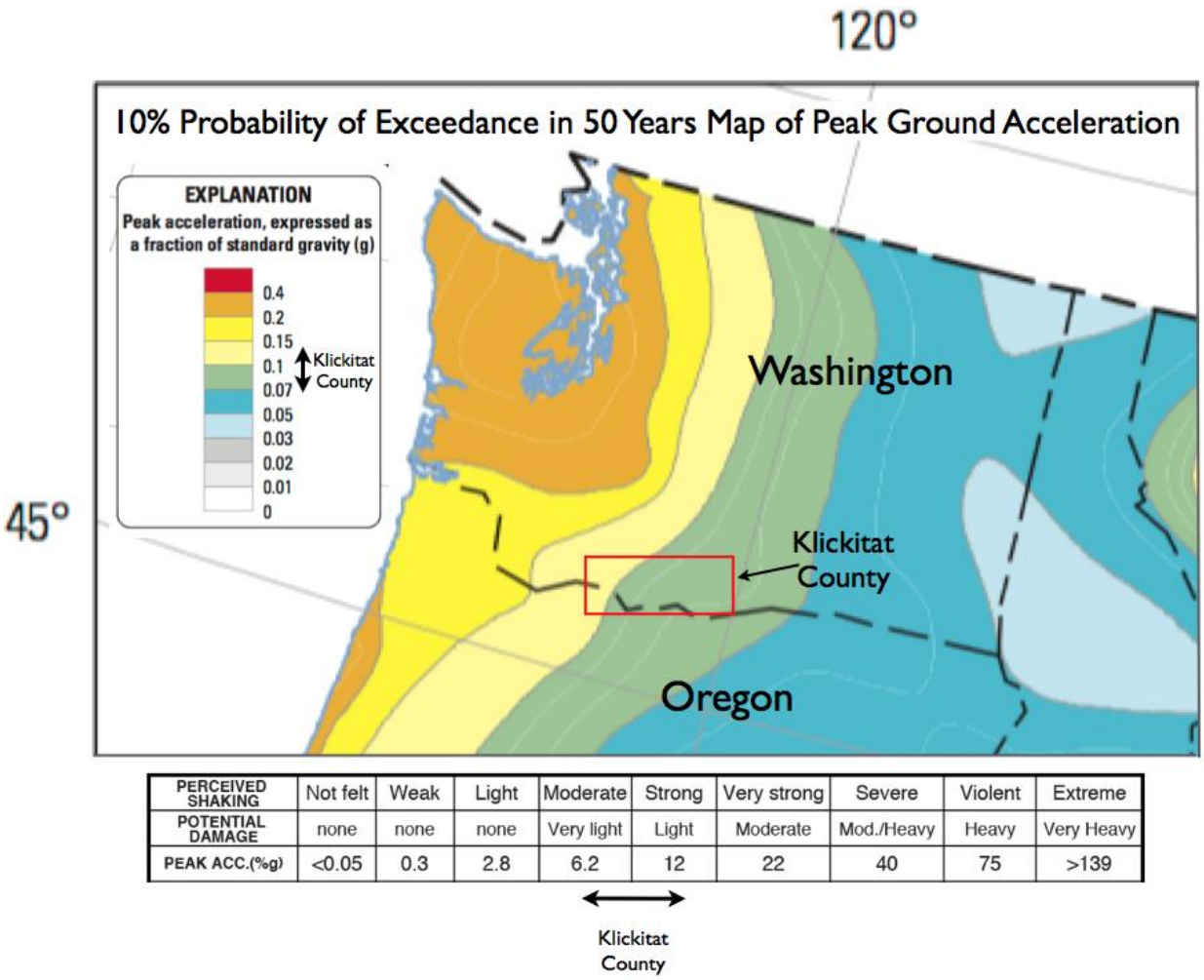


Figure 37) Historic earthquake epicenters with magnitudes of 3.0 or greater (1872-2011) (Division, 2018).

RISK ASSESSMENT: EARTHQUAKE

PROBABILITY AND MAGNITUDE

There is significant seismic hazard risk in Klickitat County from known active faults that lie outside the borders of the county, especially from the Cascadia Subduction Zone, the Mill Creek Thrust Fault and related Toppenish Ridge Faults, the Wallula Fault Zone located very near the Hanford nuclear waste storage facility (upstream along the Columbia River from Klickitat County), and the Cascade volcano seismic zones. In addition, there is unknown risk from shallow faults located both within and outside county borders.



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139

Klickitat County

Figure 38) U. S. Geological Survey National Hazard Map of the Pacific Northwest (2014).

Figure 45 is a composite shake intensity map that combines scenarios from earthquakes (stars) on the active faults listed above plus on other faults in Washington. This map illustrates that strong -to-moderate ground shaking is possible throughout Klickitat County. Figure 38 shows that the probability of exceeding strong to moderate seismic ground shaking in Klickitat County is 1 in 10 over the next 50 years, although, as discussed above, there is uncertainty in probability calculations arising from different interpretations

of the paleoseismic record as well as from unknown seismic risks. It is nevertheless quite certain that large earthquakes will happen in the future, and that they can happen at any time. Figure 39 shows that a very large magnitude earthquake located near Portland, OR on the Cascadia Subduction Zone could produce very strong ground shaking in the western portion of Klickitat County, and strong-to-moderate shaking elsewhere in the county. Klickitat County needs to be prepared for strong intensity of ground shaking, and for other dangerous hazards (landslides, lahars, infrastructure damage, floods, transportation disruptions, toxic and radioactive waste leakage, mass casualties) that can result from seismic damage within Klickitat County or along the Columbia River.

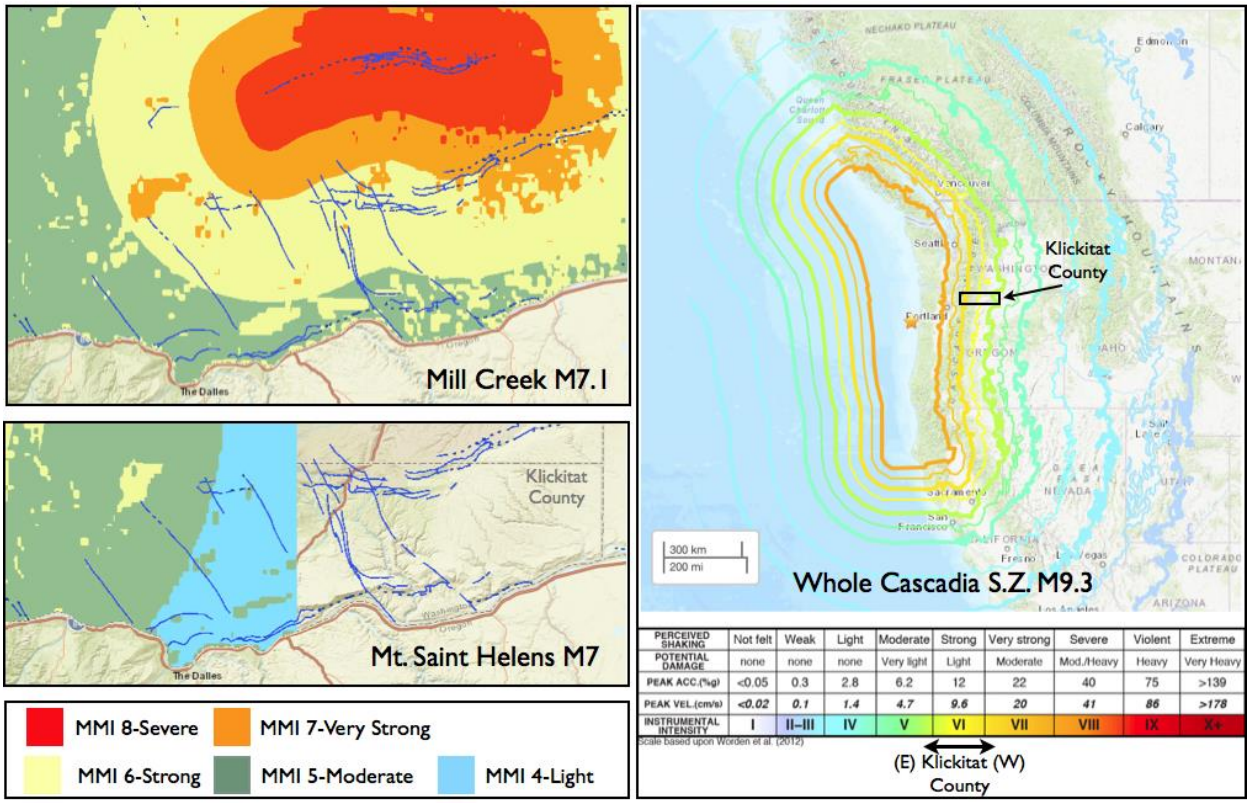


Figure 39) Shake intensity scenarios for individual earthquakes on faults posing known risk to Klickitat County, WA

Color contours show peak ground acceleration risk as a fraction of standard gravity, which is converted to a percentage value in the table below the figure. Model scenarios of potential earthquakes were used to produce this map. The map shows that there is an estimated aggregate 10% probability (1 in 10 chance) that Klickitat County will experience strong to moderate intensity ground shaking at some time(s) during the next 50 years (see text for discussion of probability calculations and uncertainties). Modified from national hazard map[59]).

[59] https://earthquake.usgs.gov/hazards/hazmaps/conterminous/

These scenarios are modeled with the Richter magnitudes (M) shown, for specified earthquake depths (not shown). The two panels on the left are from the Washington State Earthquake Hazards Scenario Catalog[60]. The panel on right is a scenario for a very large earthquake on the Cascadia Subduction Zone (CSZ) near Portland, OR, from the U.S. Geological Survey BSSC2014 Earthquake Scenario Catalog[61]. Such a large CSZ earthquake would produce ground shaking ranging from moderate intensity in the east end of Klickitat County to very strong intensity in the west end of Klickitat county. See text for discussion of past CSZ seismicity and probability of a similar event during the next 50 years.

Seismic activity occurs daily in the Pacific Northwest, with most earthquakes having magnitudes less than 3.0 and largely going unnoticed by people in affected communities. The Pacific Northwest Seismic Network (PNSN) monitors earthquake activity, and maps displaying the most recent earthquakes can be found at the PNSN website[62].

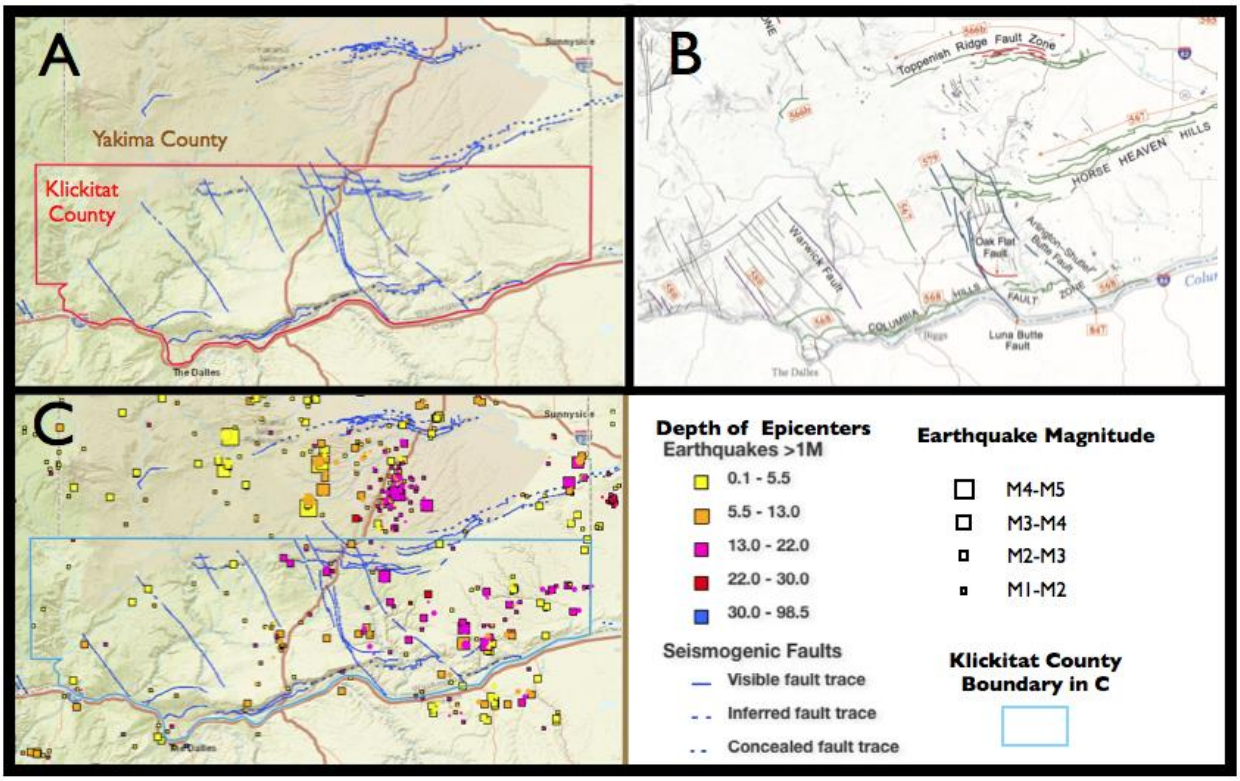


Figure 40) Local faults and seismicity in and near Klickitat County.

[60] https://geologyportal.dnr.wa.gov/#natural_hazards

[61] https://earthquake.usgs.gov/scenarios/catalog/bssc2014/

[62] https://pnsn.org/earthquakes/recent

Figure 40 is a collection of maps produced using various web-based mapping programs. The frames in the figure show: A) Fault traces (blue lines) in Klickitat County (outlined in red) and in southern Yakima County; from Washington State Department of Natural Resources (DNR) interactive Geoportal website[63]; B) Fault map for Klickitat County and southern Yakima County from Czajkowski and Bowman (2014)[64]; faults active during the Holocene are highlighted in red, faults active during the Pleistocene are in green-note that Toppenish Ridge Fault Zone includes the Mill Creek Thrust Fault; C) Fault traces (blue lines) and earthquakes (box symbols) occurring from 1970-2016 with magnitudes >1, in Klickitat County (outlined in blue) and in southern Yakima County; sizes of box symbols indicate Richter magnitudes of earthquakes, and colors of boxes indicate earthquake depths (in kilometers) as defined in key at lower right.

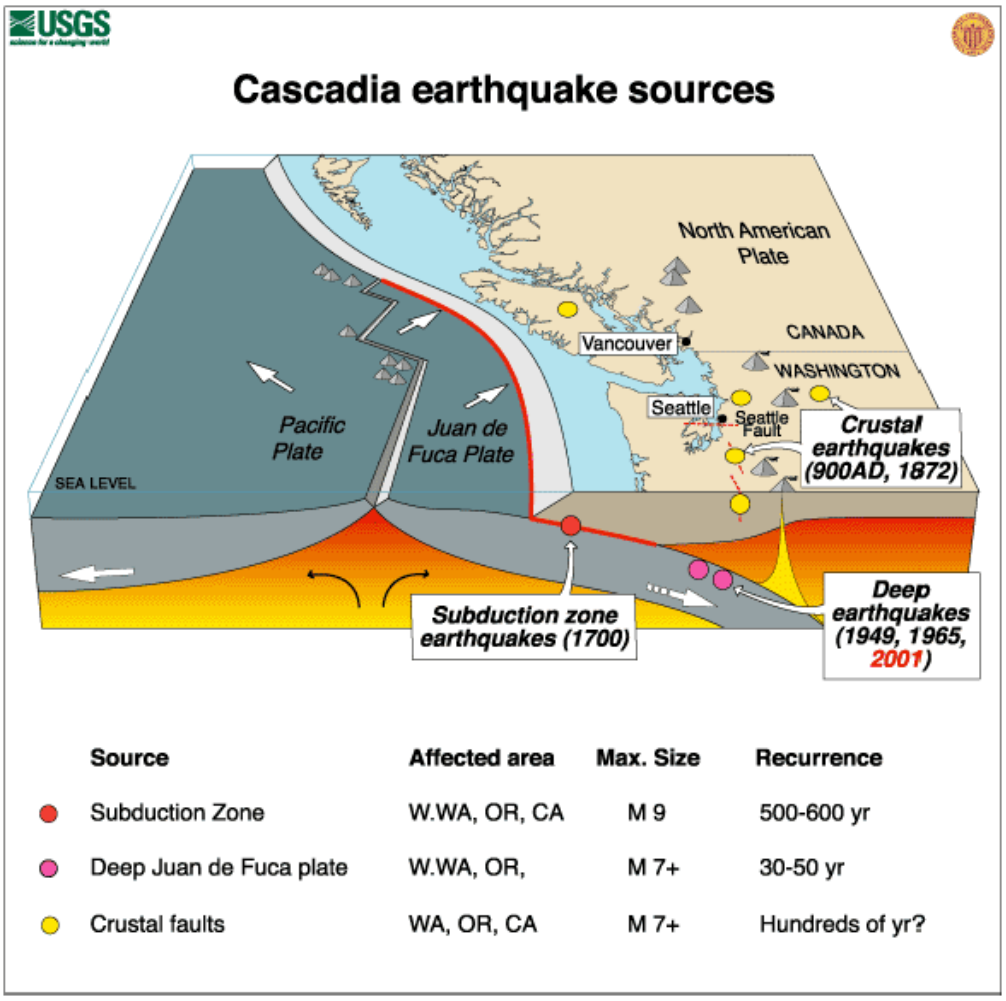


Figure 41) Diagram of tectonic plate subduction zone along the Pacific Coast.

[63] https://geologyportal.dnr.wa.gov/#natural_hazards.

[64] Czajkowski, J. L.; Bowman, J. D., 2014, Faults and earthquakes in Washington State: Washington Division of Geology and Earth Resources Open File Report 2014-05, 1 sheet, scale 1:750,000

The boundary between the Juan de Fuca Plate and North American Plate is at the Cascadia Subduction Zone (red line) where the oceanic plate sinks beneath the continental plate (Figure 41). Very large earthquakes occur along the Cascadia Subduction Zone, most recently in the year 1700. More recently, large historic earthquakes have occurred beneath the North American Plate within the descending Juan de Fuca Plate. Such earthquakes pose significant seismic risk to the state of Washington. Figure 39 shows the intensity of ground shaking estimated by a model scenario of an M9.3 Cascadia Subduction Zone earthquake centered near Portland, OR[65].

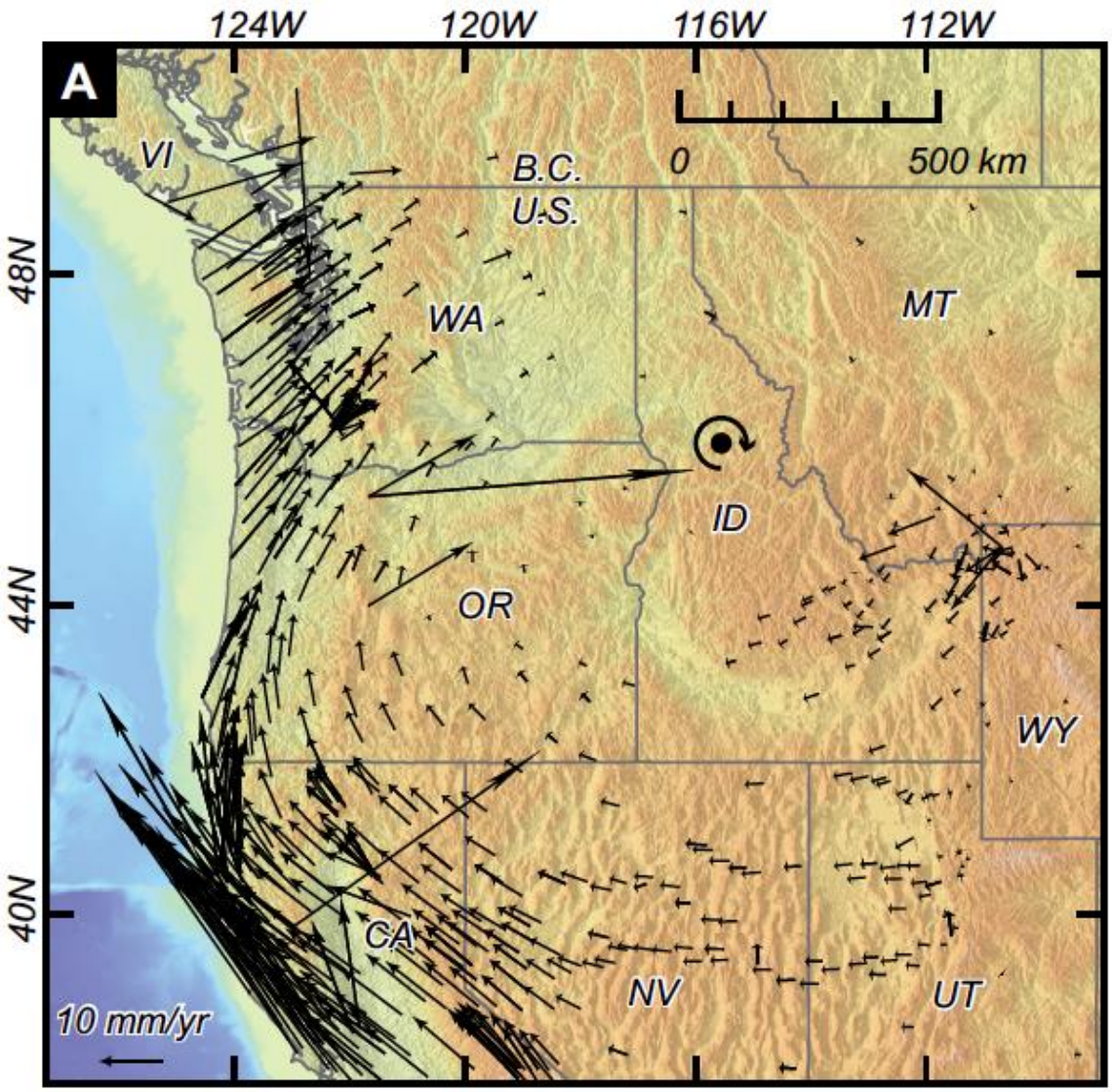


Figure 42) Global Positioning System (GPS) velocities and rotational motion of the northwestern U.S.

[65] https://pnsn.org/outreach/earthquakesources/csz

Figure 42 is a map showing global positioning system (GPS) velocities and rotational motion of the northwestern United States, from Sherrod et al. (2016)[66]. Digital elevation model (DEM) is from the CGIAR-CSI GeoPortal[67], and black arrows show crustal velocities derived from regional GPS measurements[68].

Figure 43 geologic cross section across Yakima Fold Belt, west of Hanford nuclear waste storage site (from Yeats, 2018). Part of the Yakima Fold Belt is the Mill Creek Thrust Fault located on Toppenish Ridge, which is not shown above because Toppenish Ridge is west of the cross section (at a latitude between Horse Heaven Hills and Rattlesnake faults). North-south compression of the earth's crust, due to the clockwise rotation shown in (Figure 42) arising from large-scale tectonic plate motions, has created the series of folds and thrust faults shown in (Figure 43).

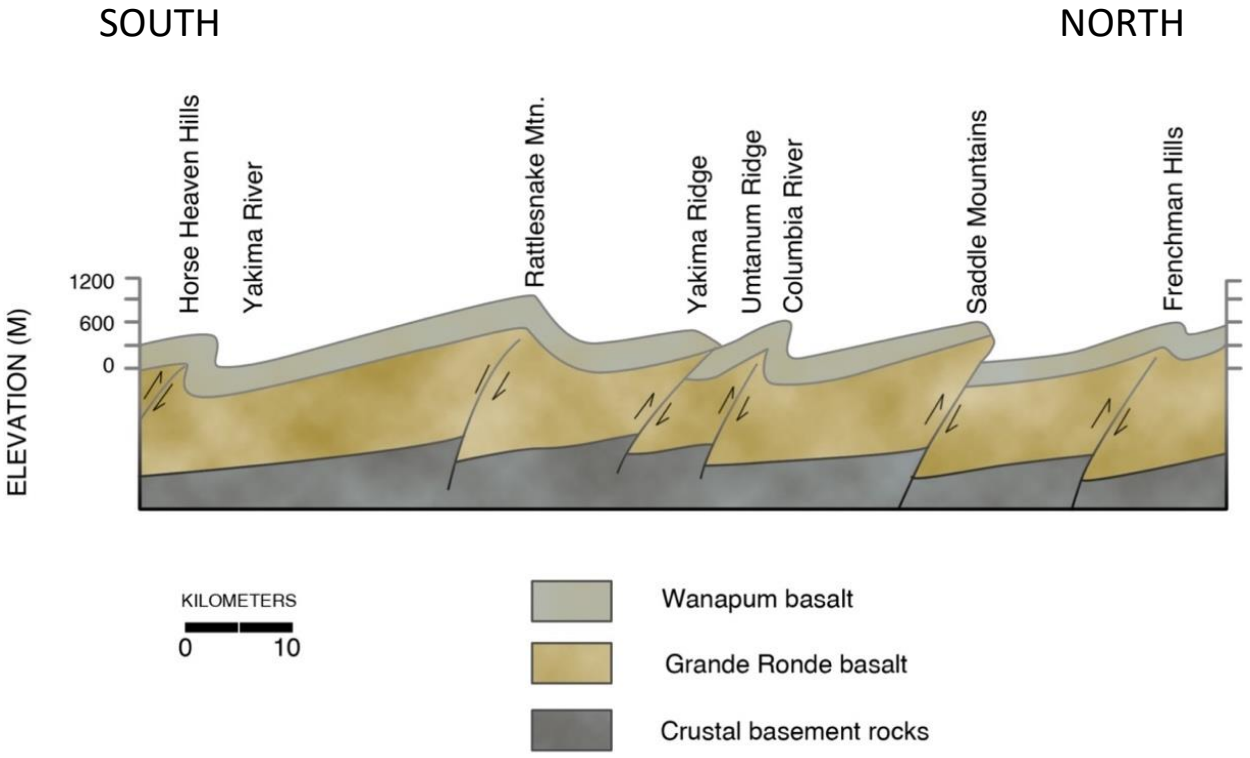


Figure 43) Geologic cross section across Yakima Fold Belt, west of Hanford Site. The cross section is oriented North/South; the left end of the figure is south, the right end of the figure is north.

[66] Sherrod, B.L.; R.J. Blakely; J.P. Lasher; A. Lamb; S.A. Mahan F.F. Foit, Jr.; E.A. Barnett, GSA Bulletin (2016) 128(11-12): 1636-1659.

[67] http://srtm.csi.cgiar.org

[68] http://www.unavco.org/data/gps-gnss/gps-gnss.html

Dashed blue lines in Figure 44 show locations of the St. Helens, Rainier, and Goat Rocks Seismic Zones. Filled circles mark epicenter locations of well-located M1-M5.5 earthquake events occurring from 1970 to 2016; depths of earthquake sources are indicated by color (see Figure 4C for key to color code).

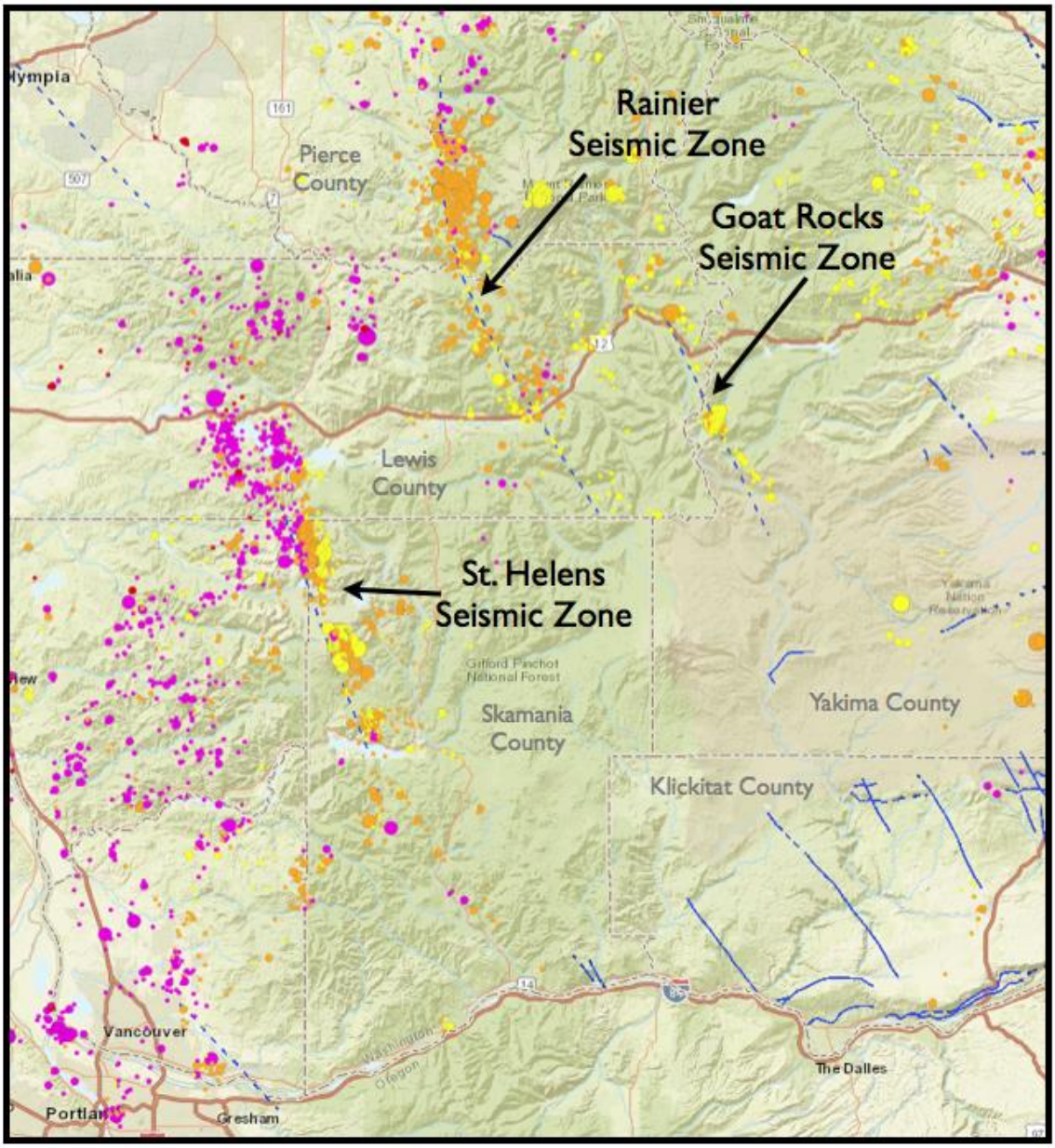


Figure 44) St. Helens, Rainier, Goat Rocks Seismic Zones.

The image shown in Figure 45 is a portion of a composite U.S. Geological Survey Earthquake Scenario Map (compiled from BSCC 2014 Scenario Catalog), illustrating estimated ground shaking intensity in Klickitat County from various earthquakes on known active faults. The map combines results of individual shake scenario models for specific earthquakes (epicenters shown as stars) along known active faults (outlined in red) and includes models of ground shaking for Cascadia Subduction Zone earthquakes that are located to the west of this zoomed-in map.

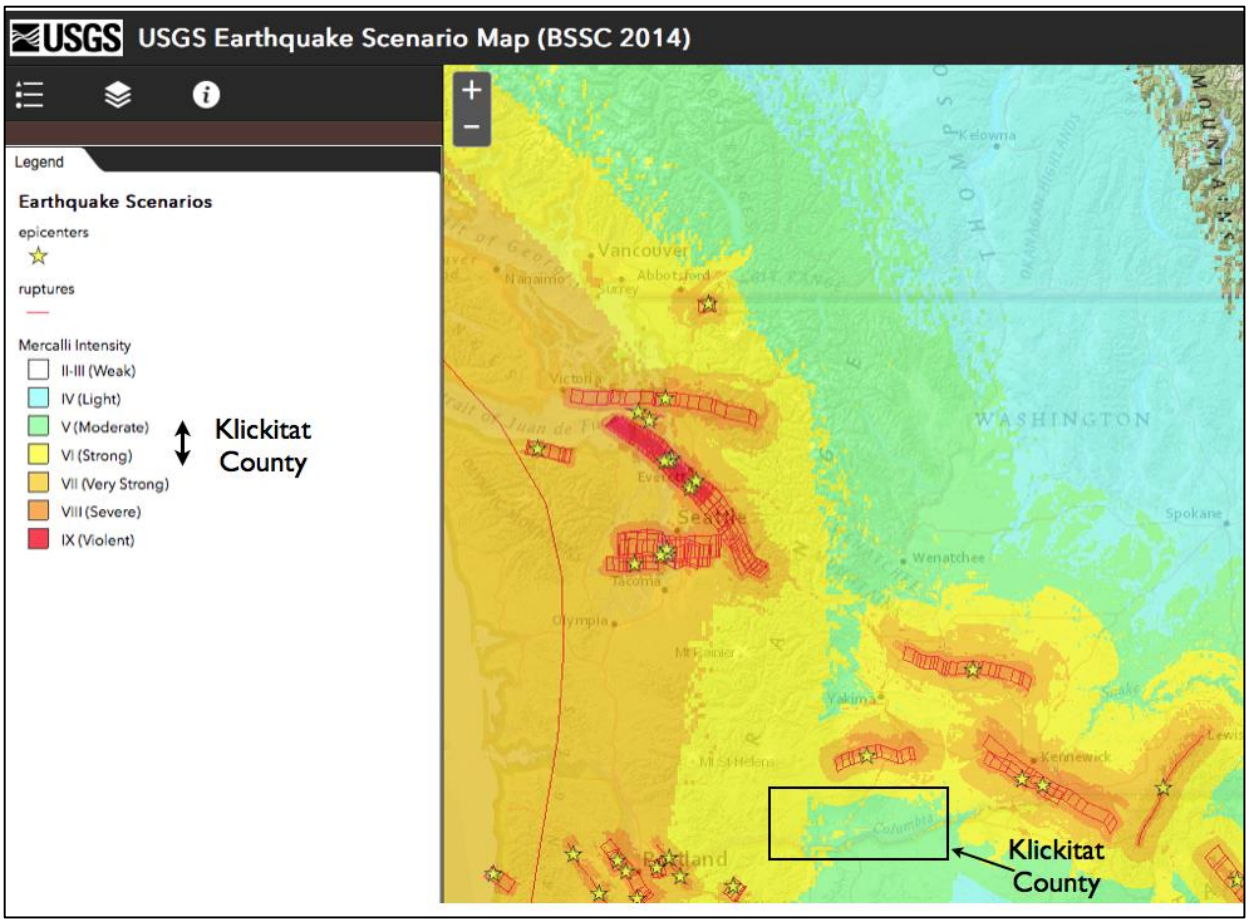


Figure 45) Estimated ground shaking intensity in Klicktat County.

Table 36 summarizes the risk ratings assigned to each adopting jurisdiction by the planning group. Overall risk associated with earthquakes for the county and all cities and communities is high. It was also determined that the impacts from an earthquake could be extreme in magnitude and the frequency at which they occur is occasional. Refer to the Jurisdictional Risk and Vulnerability Ratings section at the beginning of this chapter for more information about the process used to determine hazard ratings.

Table 36) Overall earthquake Significance Summary for adopting jurisdictions.

Jurisdiction	Magnitude	Probability	Overall Earthquake Risk
Klickitat County	**Extreme**	**Occasional**	**High**
City of Bingen			High
City of Goldendale			Low
City of White Salmon			High
Klickitat Valley Health			Moderate
Eastern Klickitat Conservation District			High
Central Klickitat Conservation District			High
Underwood Conservation District			High

Analysis of Resources at Risk

Unreinforced masonry structures and unreinforced chimneys of homes will likely be damaged during an earthquake. There are several unreinforced masonry structures in the county in addition to the numerous homes and other buildings throughout the County with unreinforced chimneys. Damaged or collapsed chimneys could result in the secondary hazard of fire. Nonstructural damage caused by falling and swinging objects may be considerable after any magnitude earthquake. Damage to some older, more fragile bridges and land failure causing minor slides along roadways may isolate some residents. Mobile homes and/or manufactured homes, particularly those not attached to a foundation, are also at higher risk.

Critical facilities include medical and health services, governmental functions (including executive, legislative, and judicial offices); protective functions (including police and fire stations), community shelters, food banks, WGAP emergency services, water supplies, wastewater treatment, and schools (including pre-school, primary, and secondary schools). Loss or damage to critical facilities would result in severe disruption in the daily functioning of Klickitat County. Incapacitation of one or more of these critical facilities could restrict emergency response and medical care, prevent children from going to school, stop normal governmental functions, contaminate water supplies, and potentially lead to chaos and looting.

Water, sewer, and irrigation infrastructure would likely suffer considerable damage in the event of an earthquake. Several communities in Klickitat County, both incorporated and unincorporated, have water storage tanks that could be damaged during an earthquake; potentially cutting off access to clean drinking water for some residents. In addition, personal well systems could also collapse or become damaged. All or part of the municipal sewer systems in the County could also be damaged causing backups and/or detriment to the surrounding ecosystem. Without further analysis of the individual components of this type of infrastructure, all these systems are exposed to potential breakage and failure because of earthquake.

No specific jurisdictions or special districts were identified as having differing issues or levels of risk associated with this hazard.

Estimation of Loss

It is difficult to estimate potential losses in Klickitat County because of the low periodicity of earthquakes and unknown building factors such as year of construction and building materials. Anecdotal evidence suggests that the potential losses would be minimal because of the high percentage of structures which are relatively new wooden frame construction. Key infrastructure buildings such as the County Courthouse, Medical Clinic, and the schools are multi-story buildings with a component of masonry used in construction. Thus, these buildings would be at an increased risk to loss during an earthquake (both in terms of financial loss and loss of life). Value-estimates of potential damage to unreinforced masonry structures in the county are provided in Table 37. The number of structures susceptible to damage were based on visual estimates during field visits in 2019.

Table 37) Estimate of unreinforced masonry buildings by jurisdiction.

Jurisdiction	Estimate of UMBs/Chimneys	Value of Buildings
Unincorporated County	30-50	unknown
Goldendale	30-50	unknown
Bingen	20-30	unknown
White Salmon	25-40	unknown

A seismic evaluation was completed for several school facilities within Klickitat County. This survey can be found on the Washington Department of Natural Resources website at:

https://www.dnr.wa.gov/school-seismic-safety

IMPACTS OF EARTHQUAKES

Earthquakes cause damage by strong ground shaking and by the secondary effects of ground failures, tsunamis, and seiches. The strength of ground shaking generally decreases with distance from the earthquake source. Shaking can be much stronger when soft soils amplify earthquake waves. West Seattle and downtown Olympia are examples where amplification repeatedly has occurred, and ground shaking was much stronger than in other nearby areas. Ground failures caused by earthquakes include fault rupture, ground cracking, lateral spreading, slumps, landslides, rock falls, liquefaction, localized uplift and subsidence. Faults often do not rupture through to the surface. Unstable or unconsolidated soil is most at risk. Any of these failures will affect structures above or below them. Large and disastrous landslides can often result from an earthquake. Soil liquefaction describes a phenomenon whereby a saturated soil substantially loses strength and stiffness in response to an applied stress like an earthquake's ground shaking, causing it to behave like a liquid. Liquefaction can cause building foundations to fail and low-density structures such as underground fuel tanks and pilings to float.

The Nisqually earthquake is included in this plan as an example because there is little to no documentation of the impacts that a high magnitude earthquake HAS HAD OR WILL HAVE on Klickitat County; the modeled earthquakes detailed at the beginning of this section have not occurred and damages to structures, infrastructure, vehicles, property, natural resources, animal populations, human populations, etc. resulting from those scenarios were not summarized.

The Nisqually Earthquake that took place on February 28, 2001 near Seattle caused extensive damage to communities along the Pacific coast. Depending on the location of the epicenter and the magnitude of an earthquake, Klickitat County may be able to expect some of the same types of damage that occurred in coastal communities after the Nisqually earthquake. A summary of the damage is as follows:

- Two studies by the University of Washington funded by the National Science Foundation estimated the quake caused $1.5 billion in damages to nearly 300,000 households and that 20% of small businesses in the region affected by the quake had a direct physical loss and 60% experienced productivity disruptions.

- Structures damaged included office buildings, residences, schools, hospitals, airport facilities and churches; many damaged structures were closed for various lengths of time following the earthquake.
- Structural damage was primarily concentrated in older, unreinforced masonry buildings built before 1950, with some damage reported to wood-frame structures and reinforced concrete structures.
- In general, new buildings and buildings that had recently been seismically upgraded typically displayed good structural performance, but many still sustained non-structural damage.
- The capital building in Olympia was severely damaged. The dome of the 74-year-old building sustained a deep crack in its limestone exterior and damage to supporting columns. There was non-structural damage which occurred throughout the building.
- Lifeline systems generally performed well during the event.
- Water utilities reported minor structural damages; at least two landowners in eastern Washington received funding from FEMA for wells that went dry.
- A gas-line leak caused a fire and explosion when two maintenance workers were resetting an earthquake valve at a correctional facility near Olympia.
- Seattle City Light reported 17,000 customer power outages, and Puget Sound Energy reported 200,000 customers without power, but power was restored to most customers within a day.
- The volume of calls placed immediately after the earthquake overloaded landline and wireless communication systems.
- Seattle-Tacoma International Airport closed immediately because its control tower was disabled. King County Airport (Boeing Field) suffered serious cracking and gaps on the runway due to soil liquefaction and lateral spreading.
- While the area's overall road network remained functional, many highways, roads, and bridges were damaged. Several state routes and local roadways closed due to slumping and pavement fractures. Two local bridges closed due to significant damage.
- The state's dams fared well during the earthquake. Dams controlled or regulated by the Federal Energy Regulatory Commission, the Bureau of Reclamation, or the U.S. Army Corps of Engineers, were not damaged.

Damage to residential structures came in a variety of forms, from severe mudslide destruction of entire homes to breakage of replaceable personal property. The study indicates that structural damage to roofs, walls and foundations accounted for nearly two-thirds of losses, followed by chimney damage, and damages to nonstructural elements and household contents.

Climate Change

NASA reports that there may be a correlation between climate change and earthquake events, particularly when considering how climate change might affect tectonic processes. Some studies support the idea that there is a correlation between changes in surface water and changes in stress loads on fault lines. However, the correlations typically occur in earthquakes with magnitudes less than zero and there is

currently insufficient evidence to support any predictions about large earthquake events with regard to climate change.[69]

Development

Earthquake risk does not rise with development, but vulnerability can increase, depending on the type of development and the building standards applied. Earthquake vulnerability can be mitigated if certain seismic provisions within building codes are followed. Many communities have not yet adopted the most current editions of building codes. Therefore, adherence to the newest seismic building standards is voluntary but is the best way to mitigate earthquake vulnerability.

Impacts to Klickitat County

In addition to the general impacts listed above, Klickitat County could be subjected to specific impacts due to unique geological and hydrological features and distribution of populated areas and infrastructure.

Past events suggest that an earthquake in the Klickitat County area would cause little to no damage. Most crustal earthquakes are in 5.0 to 5.5 magnitude range, and do not have a history of occurrence in the County. Nonetheless, severity can increase in areas that have softer soils, particularly in shoreline areas along the Columbia that are underlain by water-saturated unconsolidated sediment. Damage would be negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; and considerable in poorly built or badly designed structures.

Earthquakes can cause several secondary effects. They can cause large and sometimes disastrous landslides and rock or mud slides. River valleys are vulnerable to slope failure, often because 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.

Impacts to Other Adopting Jurisdictions

In addition to the general impacts listed above, each adopting jurisdiction could be subjected to specific impacts as a result of location and nearby landscape features:

- **City of Bingen:** Situated in the west end of the county, overall earthquake risk for Bingen is high; ground shaking could range from moderate to severe.
    - Bingen could be subjected to flooding in the event that an up-river dam on the Columbia River fails during an earthquake.

[69] Buis, Alan, "Can Climate Affect Earthquakes, Or Are The Connections Shaky," Global Climate Change, NASA, October 29, 2019, https://climate.nasa.gov/news/2926/can-climate-affect-earthquakes-or-are-the-connections-shaky/.

  - Given the steep terrain around Bingen, landslides may be triggered by an earthquake causing damage to buildings, infrastructure, and roadways.
  - Homes and other structures featuring unreinforced masonry structures could be damaged and pose a threat to occupants.
- **City of Goldendale:** Located in the middle of the county, Goldendale's overall earthquake risk is low; ground shaking is likely to be moderate.
  - Given the flat terrain in and around Goldendale the impacts from secondary hazards should be minimal.
  - Homes and other structures featuring unreinforced masonry structures could be damaged and pose a threat to occupants.
- **City of White Salmon:** Situated in the west end of the county, overall earthquake risk for White Salmon is high; ground shaking could range from moderate to severe.
  - Given the steep terrain around White Salmon, landslides may be triggered by an earthquake causing damage to buildings, infrastructure, and roadways.
  - Homes and other structures featuring unreinforced masonry structures could be damaged and pose a threat to occupants.
- **Klickitat Valley Health:** Located in the middle of the county, KVH's overall earthquake risk is high; ground shaking is likely to be moderate.
  - Loss of power and damage to equipment is likely the greatest concern for KVH as that would disrupt, limit, or prevent medical staff from supporting patients.
  - Given the flat terrain in and around Goldendale and new construction design of the KVH building, impacts from secondary earthquake hazards should be minimal.
  - The biggest threat presented by an earthquake is the damage to major transportation routes or traffic disruptions that either prevent or delay patient transport to the KVH facility.
- **Eastern and Central Klickitat, and Underwood Conservation Districts:** Overall risk for the conservation districts is high; ground shaking will likely range from moderate to severe.
  - All three districts feature steep terrain that could slide as a result of an earthquake; most landslide-susceptible areas are located along the Columbia River.
  - All three districts could experience flooding along the Columbia River.

Second-Order Hazard Events

Earthquake events can result in other types of hazard incidents. In a disaster event, the first hazard event may not be the primary cause of damages or losses within the community. Historical earthquake events have often resulted in structural fires due to broken gas lines, candles, electrical malfunctions, etc. The following table outlines the connection between earthquakes and other types of hazards.

Table 38) Second-order hazards related to earthquake events.

Related Causal Events	Related Effects
None	Dam Failure
	Structural/Urban Fire
	Wildland Fire
	Transportation System
	Hazardous Materials
	Landslide
	Power Outage
	Seiche
	Tsunami
	Volcano

LANDSLIDE HAZARD PROFILE & RISK ASSESSMENT

Landslides are downslope gravity-driven movements of rock, soil material, or artificial fill. The displaced masses of earth material may move in different ways (defined below), and movement can be slow (over months or years) or rapid (in seconds or minutes). Saturation of sloping ground by water from heavy or prolonged rainfall, rapid snowmelt, seepage from irrigation ditches/canals, or broken water/sewer lines is usually the trigger for landslides; build-up of pore pressure within slope material can reduce internal friction that holds the slope in place. But excess water is not always necessary, and other natural phenomena can also trigger landslides (see discussion below). Humans can also cause or trigger ground movement with unsafe construction practices such as excavation at the toe of a slope (for example at quarries, building sites on slopes, or road cuts), loading of slopes with fill (such as side-casting of earth in road construction), or clearcutting trees on steep, marginally stable slopes.

In Klickitat County as elsewhere, unweathered and minimally fractured bedrock is generally able to form steeper, more stable slopes (even vertical cliffs) than slopes covered with a mantle of soil material. The cliffs of flat-lying Columbia River Basalt (CRB) along the Columbia River are a good example of such strong, relatively stable rock, because the Ice Age Missoula Floods that swept down the Columbia Gorge on numerous occasions eroded away the loose unstable soil mantle and cut the slopes back to hard unweathered rock. But away from the Gorge, the 6 to 17-million-year-old CRB, which underlies much of Klickitat County, is mantled by tens of feet of loose, highly weathered, clay-rich soil, rock fragments, and weathered and weakened bedrock derived from the CRB. This material is weaker and susceptible to landslides under certain conditions.

Tectonic uplift and compressional forces have tilted the CRB rock layers in some parts of the county, so that even fresh hard basalt rock can be subject to downslope movement. This can occur where sediment layers are sandwiched between CRB or younger basalt lava flows (Figure 46 A). In addition to weak sediment layers, clay-rich weathered horizons--buried soils between lava flow units--can also act as landslide failure planes. This situation (Figure 46 B) is common farther west in the part of the Columbia Gorge in Skamania County[70].

Such tilted rock units can be unstable where exposed on slopes in the sides of creeks, draws, and small canyons. Currently most of the county is semiarid, and summer thunderstorms typically deliver rainfall that is intense but of short duration. Thus, naturally triggered landslides are rare over the drier parts of the county. Landslides here are more likely to be initiated by unsafe construction practices, quarry operations, seepage from irrigation pipes and ditches, and broken water or sewer lines. However, the west side of the county is wetter and is more subject to rain-induced landslides during more prolonged

[70] Mickelson, K. A.; Jacobacci, K. E.; Contreras, T. A.; Gallin, William; Slaughter, S. L., 2018, Landslide inventory and susceptibility of the Columbia Gorge in Clark, Skamania, and Klickitat Counties, Washington: Washington Geological Survey Report of Investigation 40, 11 p. text, with 2 accompanying ESRI file geodatabases. [https://fortress.wa.gov/dnr/geologydata/publications/ger_ri40_columbia_gorge_landslide_inventory.zip]

storms. Climate-related factors likely to have impact on future landslide risk in Klickitat County are increased tree kill by insect infestations and the increasing frequency and severity of wildfires in steep terrain. Tree roots help stabilize soil on slopes and weakened soils on denuded slopes are more likely to fail.

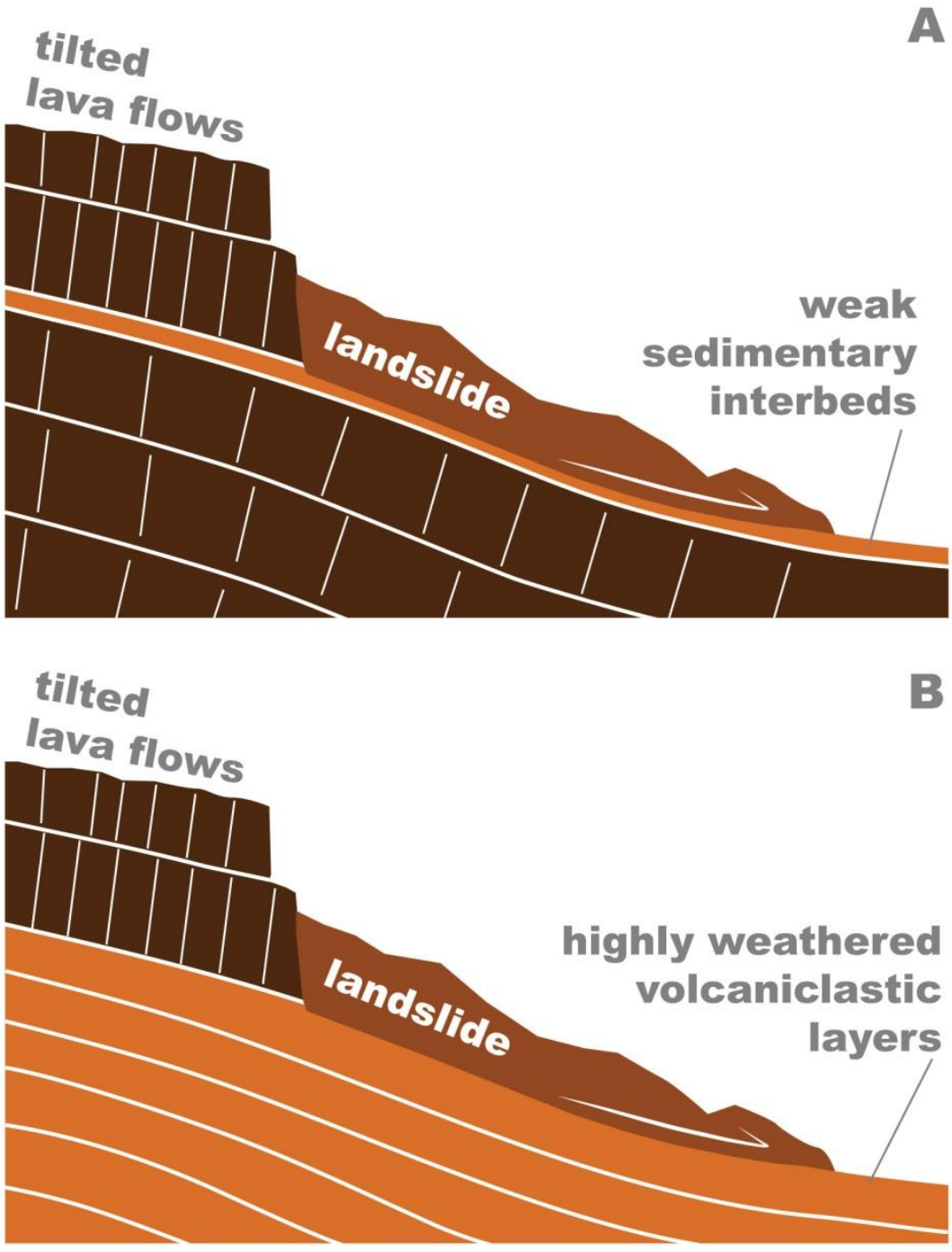


Figure 46) Diagram of tilted lava flow layers.

DEFINITIONS

The debris from a landslide can exhibit different types of motion as a result of subsurface geology, substrate texture and stratification, surface terrain, and the mechanism responsible for triggering the landslide. The most common landslide-types are *slides*, *flows*, *falls*, and *topples* (Figure 47) which can vary in size and impact. Figure 48 is a more detailed diagram of the "anatomy" of a rotational landslide with commonly used terminology.

Slide: A slide is a downslope movement of soil or rock mass occurring dominantly along a failure surface—a distinct surface of rupture or a relatively thin zone of intense shear strain. Slide failure surfaces are usually slope-parallel (typical of shallow slides) or concave (typical of deep-seated slides).

Shallow slides: Shallow landslides typically are less than 5 to 10 m thick, depending on the material on the slope, have slope-parallel or spoon-shaped failure surfaces, and involve only the uppermost layer of unconsolidated material on the slope, usually only the soil. Shallow slides can be triggered quickly during intense rainstorms, commonly when the rainfall is most intense, and their failure planes typically occur at interfaces between relatively permeable material above and relatively impermeable material below. Shallow slides of earth material typically move rapidly (meters per second) and commonly transform almost instantaneously to *debris flows*. Shallow slides generally involve relatively small volumes of material (hundreds to thousands of cubic meters).

Deep-seated slides: Deep-seated landslides commonly have failure planes that are strongly concave and involve material deeper than the surface soil layer. In these cases, the slide material generally rotates backward (into the slope) as failure occurs—a *slump*. In other cases the deep failure plane can be more or less slope-parallel—a *translational slide, block slide,* or *lateral spread*. Deep-seated slides typically move slowly (<1 m/day), although under certain conditions, movement can accelerate to meters per second. Volumes are commonly large, tens to hundreds of thousands of cubic meters. Because failure planes are deep and infiltration of rainwater is slow, deep-seated landslides rarely move in response to a single intense rainstorm. Instead, deep-seated slides more commonly move in response to the cumulative effect of many rainstorms.

Flow: Flow involves the spatially continuous downslope movement of earth material in a form resembling a highly viscous fluid. Shear within the moving mass is not confined to a thin zone of shear at the base, but rather distributed well up into the moving mass. *Earthflows* are relatively dry, deep-seated, slowly moving (meters per day) types of flows. *Debris flows* are water-saturated and rapidly moving (meters per second) types of flows. *Debris avalanches* are rapid but unsaturated flows of soil and rock debris.

Fall: A fall of rock or earth material starts with the detachment from a steep slope along a surface on which little or no shear displacement takes place. The material then descends mainly through the air by falling, bouncing, or rolling. Falls are common along steep road cuts.

Topple: Toppling is the forward or outward rotation of a mass of soil or rock away from the slope. Toppling is sometimes driven by gravity exerted by material upslope of the displaced mass and sometimes by ice formation in vertical cracks in rock slopes.

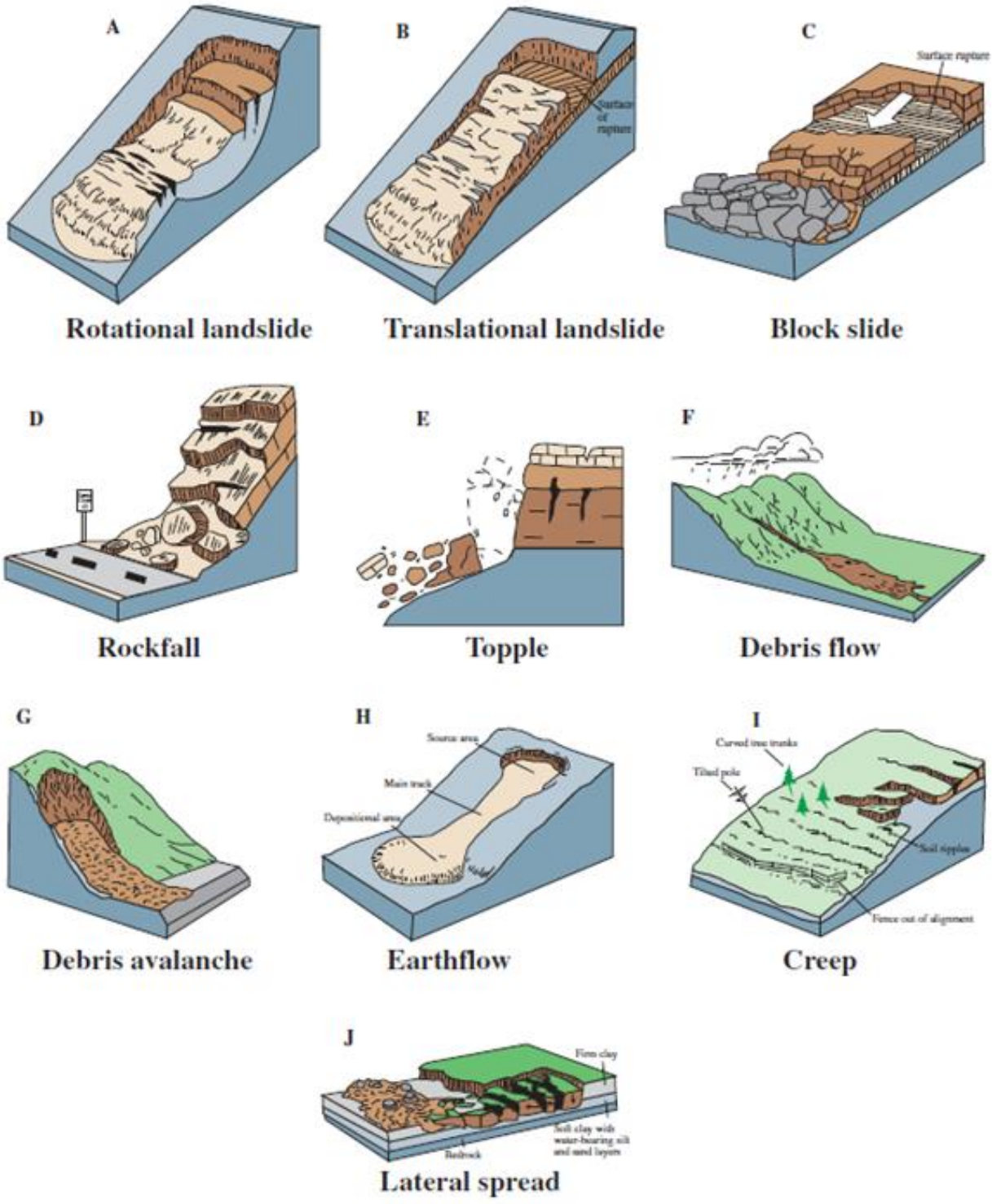


Figure 47) Classification of landslide types and processes[71]

[71] United States Geological Survey: https://pubs.usgs.gov/fs/2004/3072/fs-2004-3072.html

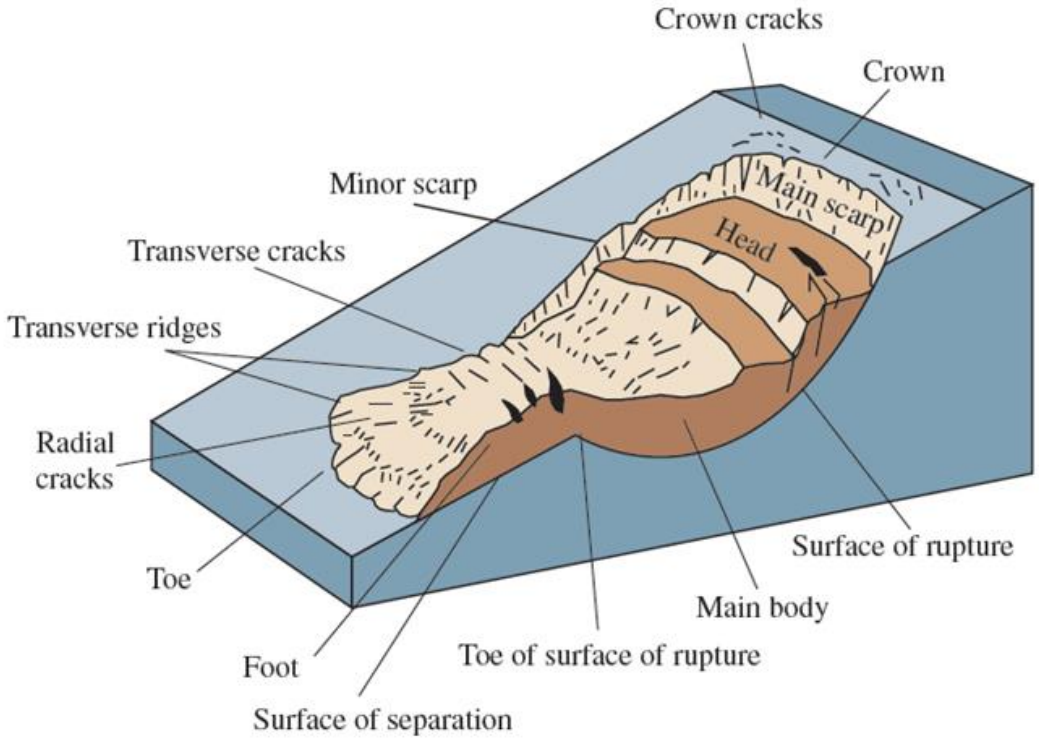


Figure 48) An idealized rotational landslide with commonly used terms for various features[72].

BACKGROUND INFORMATION

Landslides are downslope gravity-driven movements of rock, soil material, or artificial fill that can vary greatly in size, complexity, downslope extent, degree of hazard, and timing with respect to triggering events. Their occurrence, causes, and triggers, as well as strategies for mitigating risk from this hazard are varied[73].

Landslide causes are the slowly acting changes to a slope mass, or the underlying morphologic and material properties of that mass, that predispose it to eventual failure. Causes include the slow weakening of the slope material through chemical or physical weathering, inherent degree of rock fracturing, degree of consolidation (of a soil material), permeability contrasts within or beneath the mass, erosion to the toe of a slope (river bank erosion or wave action), and forest death or removal (by wildfire, drought, insect infestation, or logging). Many landslides have more than one underlying cause.

A landslide trigger is a relatively sudden event or rapid change in site conditions that destabilizes a slope, either by increasing the downslope driving force or decreasing the upslope resisting force acting on a mass

[72] United States Geological Survey: https://pubs.usgs.gov/fs/2004/3072/fs-2004-3072.html

[73] https://pubs.usgs.gov/circ/1325/pdf/C1325_508.pdf

of earth material on a slope. Gravity is the underlying downslope driving force that can be rapidly increased by slope loading or by rapid ground acceleration during an earthquake. Buttressing at the toe of a slope and friction (between grains of soil material or between rock joints or fractures) within material on a slope are the dominant resisting forces. Friction can be rapidly decreased by the buildup of hydrostatic pressure by infiltrating water. The buttressing effect can be decreased by stream or wave erosion or by excavations at the toe of a slope. Landslide triggering events for shallow landslides are most commonly a single prolonged and intense rainstorm. For deep-seated landslides, the trigger is typically a series of big storms or an exceptionally wet winter.

Washington State has six landslide provinces, each with its own characteristics; Klickitat County is primarily part of the Columbia Basin province. Landslides in this province include slope failures (1) in bedrock, with failure planes within sediment beds between CRB lava flows or along fractures within them, and (2) in unconsolidated sediments overlying the CRB units—soil formed by weathering of CRB bedrock, Missoula flood deposits, and windblown silt deposits (loess) emplaced at the end of the last Ice Age. In general, areas most susceptible to natural landslides in Klickitat County are:

1. Any canyon walls and steep valley sideslopes of incised rivers and streams, particularly the White Salmon and Klickitat Rivers and their tributaries.
2. Hilly terrain underlain by relatively young volcanic rocks and deposits on the western edge of the county, around Mount Adams, and in the Simcoe Mountains.
3. Cliffs and steep slopes adjacent to the Columbia River.

Bedrock slope failures are most likely to be in the form of very large deep-seated translational landslides or deep-seated slumps, and they can occur in terrain with only limited relief. Contemporary Columbia Basin landslides have occurred during the relocation of transportation routes required by the filling of the reservoir behind the John Day Dam and in the highly erosive and weak loess soils across southeastern Washington. Rockfalls have occurred in the over steepened rock slopes left behind by road construction or by the erosion of the catastrophic floods.

Road building or other excavation in slopes can remove the buttressing support of a slope and trigger landslides where heavy rainfall is not an issue. Agricultural irrigation practices or infiltration from irrigation ditches and canals may, under certain conditions, also add enough water to the ground to trigger landslides. Logging operations that remove slope-stabilizing vegetation and cut roads in steep terrain also can lead to landslides. In general, any land use changes that affect drainage patterns, steepen slope profiles, increase erosion on or below slopes, or increase ground-water levels within slopes can augment the potential for landslide activity.

PHYSICAL CHARACTERISTICS OF LANDSLIDE HAZARD AREAS

If no landslide inventory maps or hazard maps exist for an area, there are still ways to assess whether the ground is stable. Signs to look for include:

1) Bluff retreat caused by sloughing of bluff sediments, resulting in a vertical bluff face with little vegetation

2) Tension or ground cracks along or near the edge of the top of a bluff or on a hillside
3) Bowed or jack-sawed trees
4) Mid-slope ground water seepage from a bluff face
5) Hillside that has increased spring and (or) seep activity, or newly saturated ground, especially if it was previously dry
6) Mounds or bulges appear on the lower part of a hillslope
7) Utility lines start sagging or become taut; utility poles start leaning
8) Sticking windows or doors in buildings; new and (or) growing cracks in walls, ceilings, or foundations; separation of steps from main structure
9) Broken underground utilities (phone, power) or leaking/broken water, septic, or sewer lines
10) Changes in water well levels or water wells that suddenly run dry
11) The sound of cracking wood, knocking boulders, groaning of the ground, especially if the sounds steadily increase
12) Abrupt changes in creek water levels, sometimes with increased sediment, especially during or right after large or protracted storm events

Signs 1-5 may be found in terrain that has been unstable in the past or could be unstable soon. Signs 6-12 indicate that the ground could be moving, and a landslide is likely in progress. If this is the situation, leave the area immediately or as soon as it is safe to do so. Once safety is reached report the problem, as soon as possible, to the Klickitat County Emergency Manager by calling 9-1-1.

What Can Be Done to Minimize Landslide Risk?

1. Avoid building on or near old landslides, if possible (consult with an engineering geologist).
2. Minimize water infiltrating into the ground, and be alert for problems and any sign of ground movement:
    a. Maintain storm drains that route runoff directly to creeks.
    b. Don't let water pond on ground surface.
    c. Route runoff from roof gutters into storm drains or streams, NOT into dry wells.
    d. Quickly repair breaks in water lines, sewers, storm drains.
3. Avoid excavation that adds too much weight to a slope or removes too much the slope's support (consult with an engineering geologist).

The Washington DNR[74] and U.S. Geological Survey[75,76] have publications that offer more information about landslide hazard areas and about how to mitigate risk. Landslides are dangerous and unpredictable. Some landslides may provide clues that they are about to happen; others may happen suddenly without any of the above warning signs. Although landslides are infrequent, they can be life-threatening. People

[74] https://www.dnr.wa.gov/publications/ger_fs_landslide_hazards.pdf?o0nqho

[75] https://pubs.usgs.gov/circ/1325/pdf/C1325_508.pdf

[76] https://doi.org/10.3133/fs20043072

purchasing real estate or existing landowners should not expect realtors or government entities to warn them of landslide risk, and most homeowners' insurance policies do not cover losses due to landslides. Become informed and consult with experts when planning construction projects on sloping ground to avoid future landslide problems.

HISTORICAL LANDSLIDE EVENTS

Significant landslide events (those resulting in disasters) are rare, but several have been recorded in the State, including the 2014 Oso landslide that killed 43 people and destroyed 49 homes or other structures. Major landslide events had a significant impact on transportation, communities, and natural resources in 1977, 1979, 1986, 1989, 1997, 1998, 2006 (x2), 2007 (x2), 2009, and 2014. Greater detail on each landslide event can be found in the Washington Military Department's Washington State Enhanced Hazard Mitigation Plan.

Existing old landslides, ancient ones as well as historic occurrences, are key in helping identify areas susceptible to future landslides, particularly deep-seated ones. This is because some landslides can move intermittently over years or centuries, and terrain that has been mapped on landslide inventory maps as an old landslide is likely to reactivate before surrounding slopes that have not previously moved. It should be remembered that many (if not most) natural slopes have formed at the threshold between instability and stability.

The draw of natural beauty and recreation opportunities in the Columbia Gorge has led to increasing population and home construction within the federally designated Columbia River Gorge National Scenic Area (CRGNSA). The Washington Geological Survey, Washington Dept. of Natural Resources (WGS) reports that landslides are of concern here as landowners continue to develop on or below the characteristic steep slopes, ancient landslides, and cliffs of the Columbia Gorge. People living on or adjacent to existing landslides in the CRGNSA, or elsewhere in Klickitat County, may not be aware of the hazard and the potential consequences of landslide activation or reactivation. Identification of potential landslide hazard areas is the first step toward increasing awareness and reducing the impacts of landslides on property, infrastructure, and human life. To increase awareness, the WGS completed a landslide inventory/susceptibility map in 2018 that includes part of western Klickitat County, based on the type of slope material, slope steepness, and history of past landslides[77]. Map extent has been dependent on availability of *lidar* ground-imaging data, which is currently limited to areas west of the Klickitat River and south of Trout Lake. Within the mapped areas, analysis has revealed numerous old deep-seated landslides, many of these located on the downhill side of ridge crests. The WGS map also provides a landslide susceptibility analysis for both shallow and deep-seated landslides (Figure 49).

[77] https://fortress.wa.gov/dnr/geologydata/publications/ger_ri40_columbia_gorge_landslide_inventory.zip

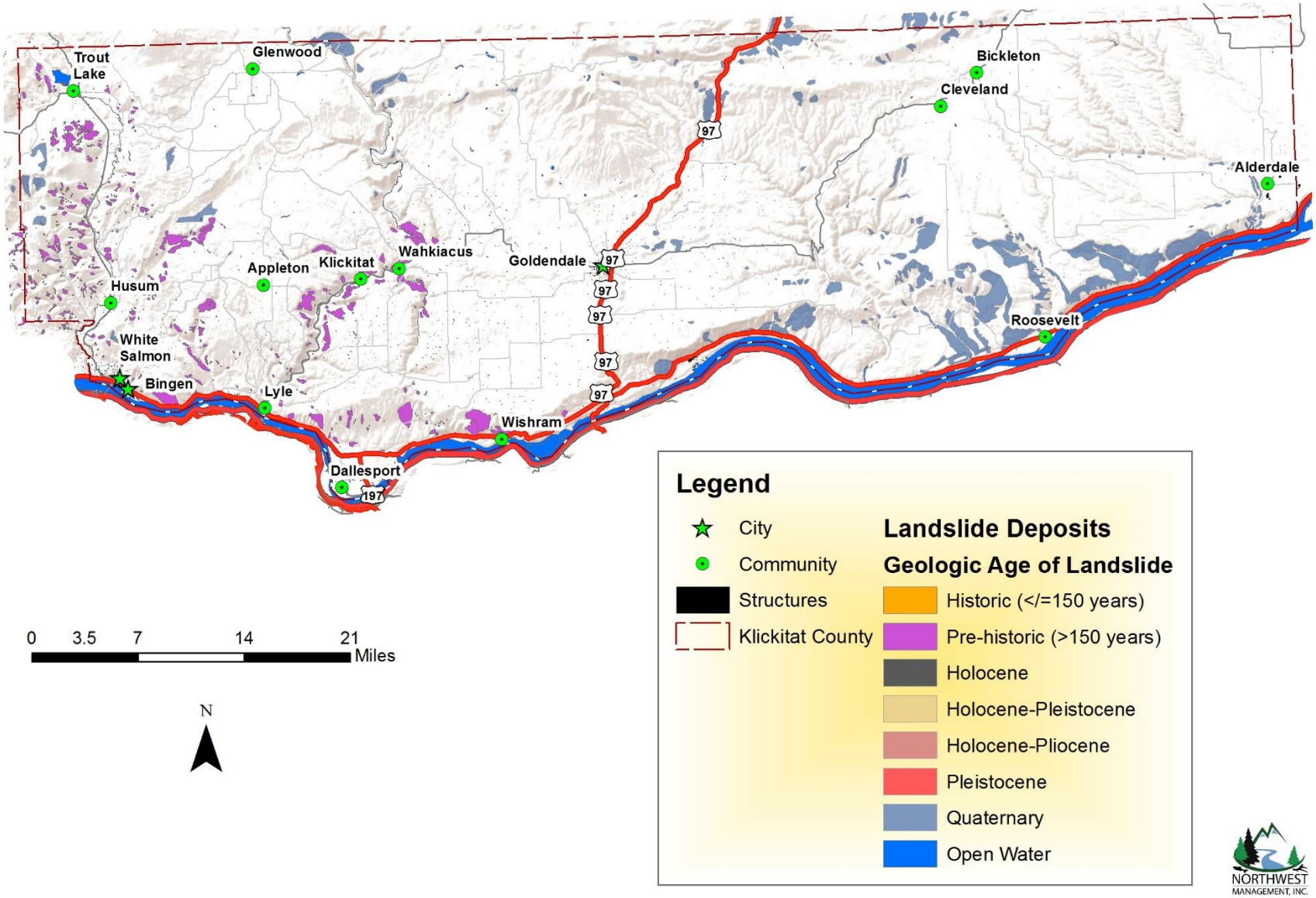


Figure 49) Historic landslides in Klickitat County, WA.

Earth movements affecting Klickitat County in the past have been both large and small, but even small events can be life-threatening. One of the largest landslides in Klickitat County in this inventory is located upslope of the town of Bingen (Figure 50), which has reactivated in recent years (as recently as 2009) by gravel quarry operations. The owner of the quarry has implemented a long-range plan to stabilize the slide. Outside the inventory map area, Google Earth imagery shows several large old landslide complexes near Roosevelt, adjacent to the Columbia River. Smaller events include rockfalls onto SR 14, as recently as 2014 near Lyle and Bingen.

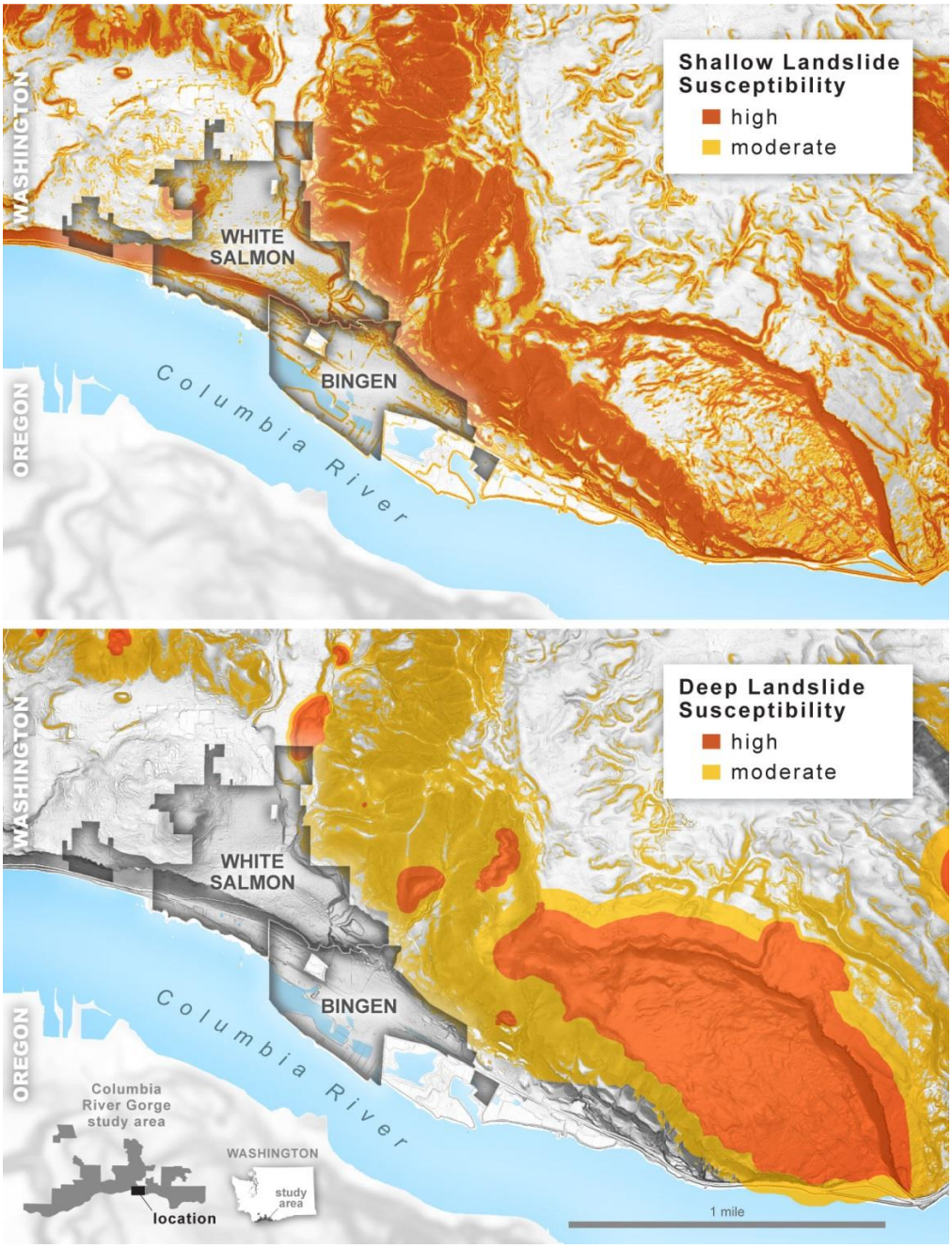


Figure 50) Example of mapped landslide susceptibility near the cities of Bingen and White Salmon, WA. This map is a portion of the 2018 WGS inventory and susceptibility map.

This recent WGS landslide inventory and susceptibility analysis increases awareness of where landslides can occur in parts of Klickitat County, but the usefulness of this awareness depends on the application of this knowledge by planners, emergency managers, public works departments, and those who live and work where landslides could occur. Such regional hazard maps can only provide an overview of potential landslide hazard if a potential landslide trigger is provided (such as heavy rain). For a detailed assessment of landslide hazard on a particular site, it is highly recommended that a professional consulting engineering geologist be retained to provide a site-specific assessment.

Figure 50 is an example of mapped shallow (top) and deep-seated (bottom) landslide susceptibility around White Salmon and Bingen, WA, from the 2018 WGS landslide inventory map. The deep-seated slide susceptibility includes the mapped landslides from the detailed inventory[78].

Risk Assessment: Landslide

Probability and Magnitude

Klickitat County is vulnerable to landslide hazards under the proper conditions, especially areas characterized by steeper slopes (red areas on deep-seated landslide hazard area maps; Figure 51 and Figure 52; and green areas on shallow landslide hazard area maps; Figure 53 and Figure 54). In order to create a deep-seated landslide hazard area "footprint" for the county, two different datasets are displayed in Figure 51 and Figure 52. The orange and red polygons are from a Washington Geological Survey (WGS) study that used lidar to detect deep-seated landslide hazard areas while the green-gray polygons are mapped historic deep landslide areas (Washington Division of Geology and Earth Resources). The WGS study area only includes the western third of the county, approximately. The shallow landslide hazard area maps (Figure 53 and Figure 54) were also created using data from the WGS study.

Several factors, such as rainfall levels, vegetation cover, soil depth and geology, affect the stability of slopes which, in general, become potentially less stable as slope-steepness increases. This is becoming more of a concern as it relates to new construction in the county. In response to market conditions, competition among competing land uses, and as higher income households target view lots on slopes and ridges, new residential developments in Klickitat County are increasingly occupying the more geologically complex terrain. These are the areas that present problems associated with slope instability and erosion, especially those in excess of 40 percent slope as identified by The Klickitat County Critical Areas Ordinance.

[78] Source: Mickelson, K. A.; Jacobacci, K. E.; Contreras, T. A.; Gallin, William; Slaughter, S. L., 2018, Landslide inventory and susceptibility of the Columbia Gorge in Clark, Skamania, and Klickitat Counties, Washington: Washington Geological Survey Report of Investigation 40, 11 p. text, with 2 accompanying ESRI file geodatabases. [https://fortress.wa.gov/dnr/geologydata/publications/ger_ri40_columbia_gorge_landslide_inventory.zip]

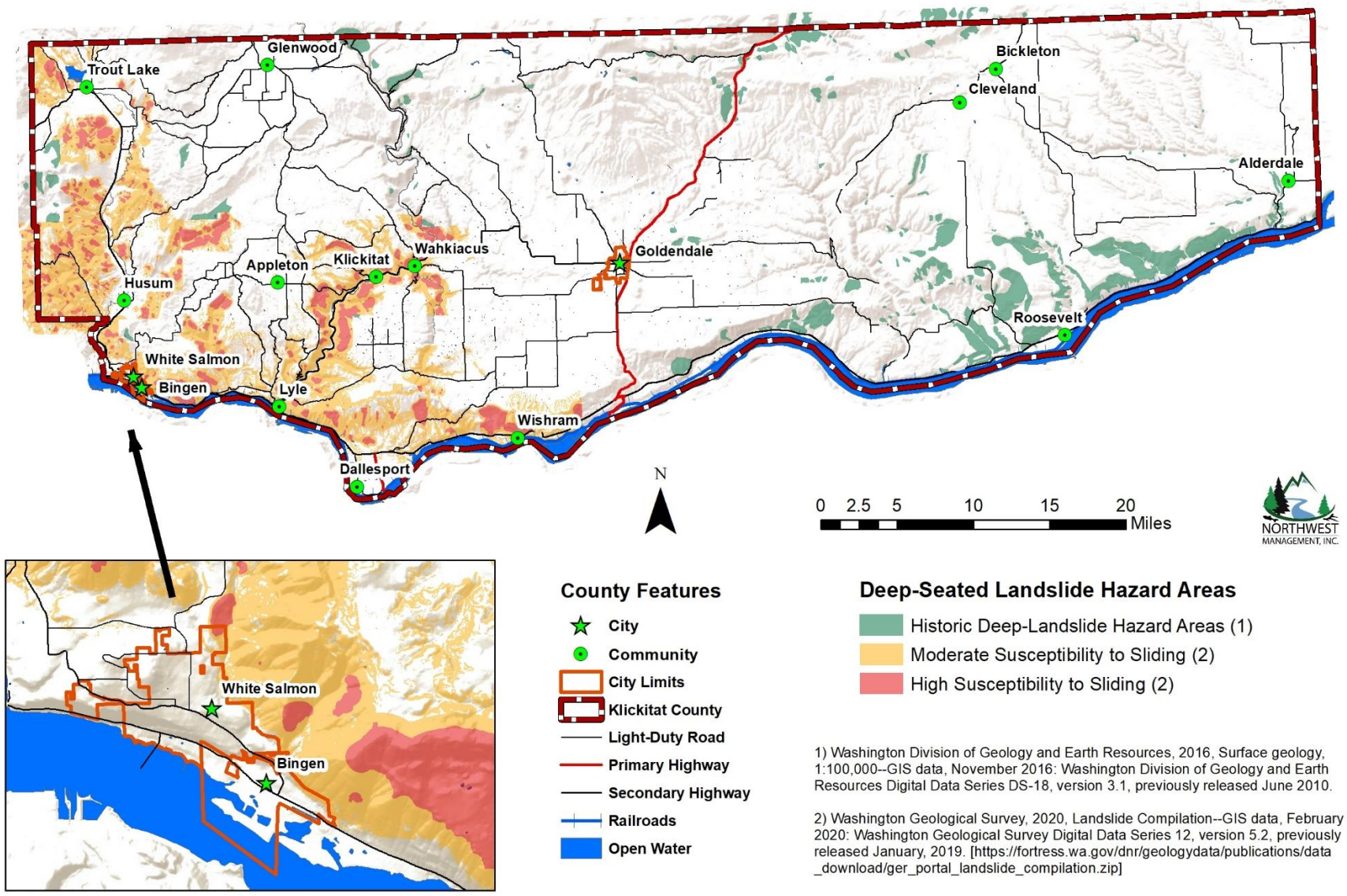


Figure 51) Deep-seated landslide hazard areas in Klickitat County, WA. Due to data limitations, two different data sets were combined to create this map; the intent is to display the total "footprint" of all areas in the county that are associated with deep-seated landslide hazards.

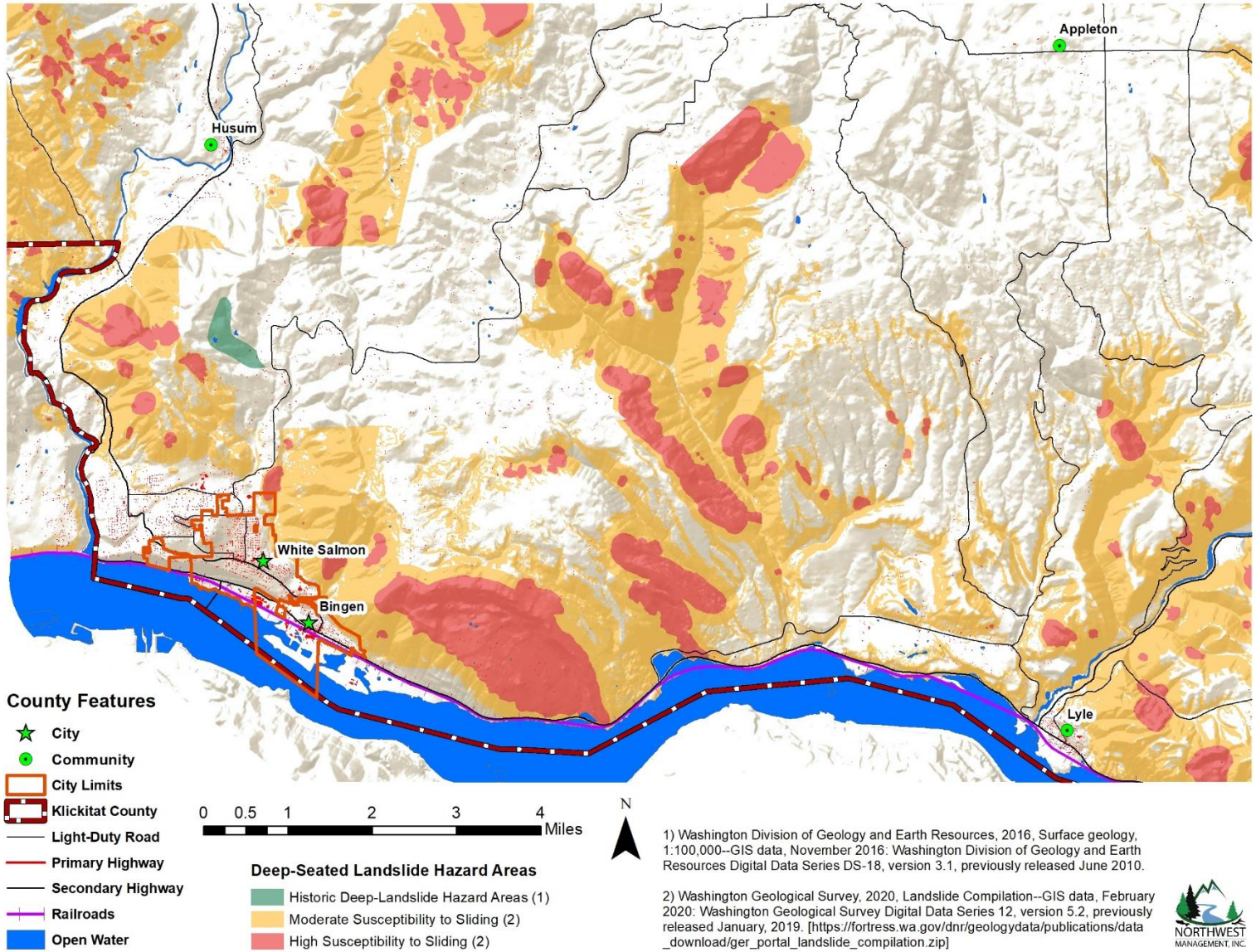


Figure 52) Deep landslide hazard areas in and around Bingen and White Salmon, WA. Due to data limitations, two different data sets were combined to create this map; the intent is to display the total "footprint" of all areas in and around the cities that are associated with deep-seated landslide hazards.

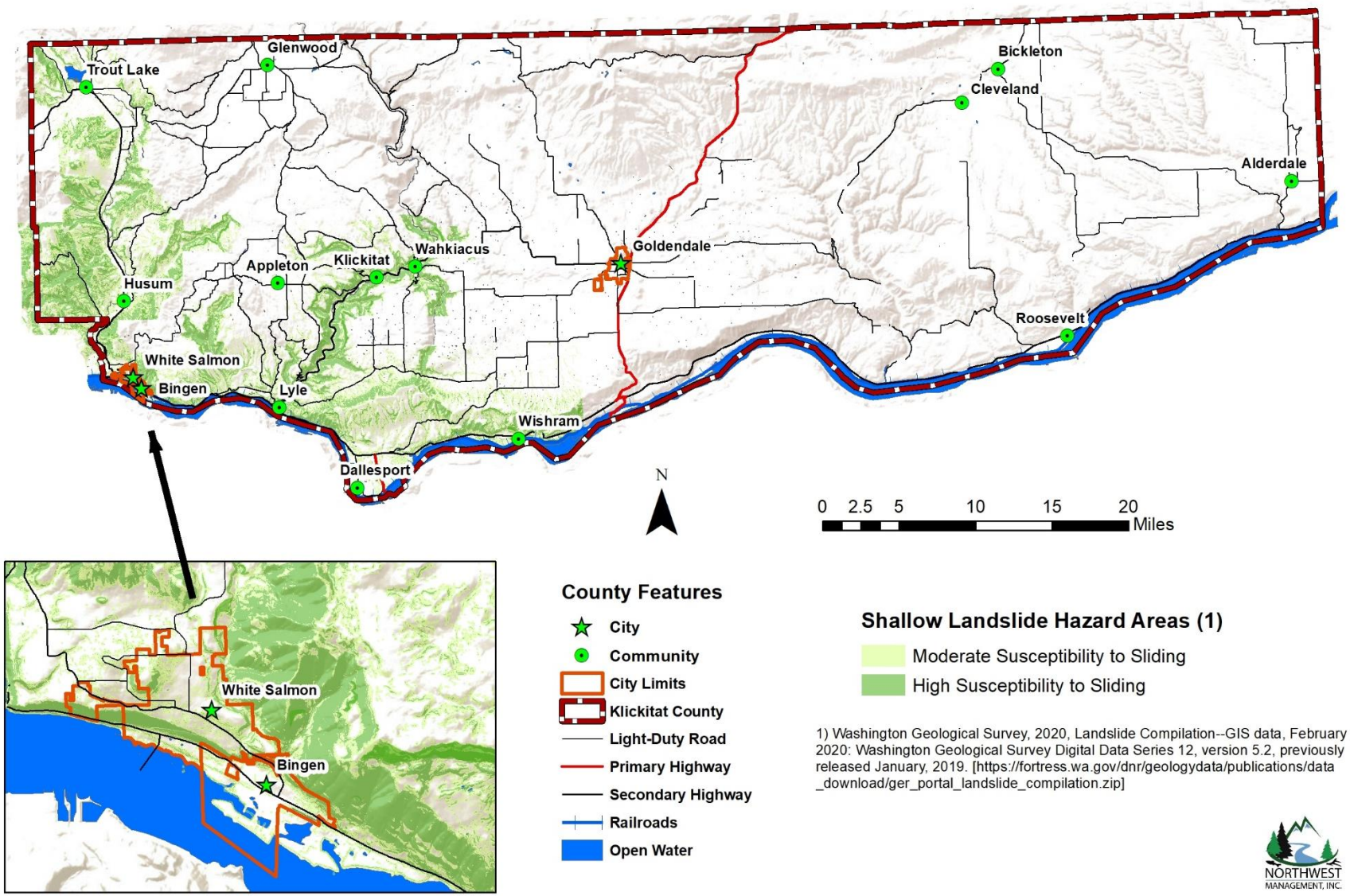


Figure 53) Shallow landslide hazard areas in Klickitat County, WA. It is important to note that only about one-third of the county has been assessed for shallow landslide susceptibility. In general, the WGS study area includes areas in the county that are to the west of the Klickitat River.

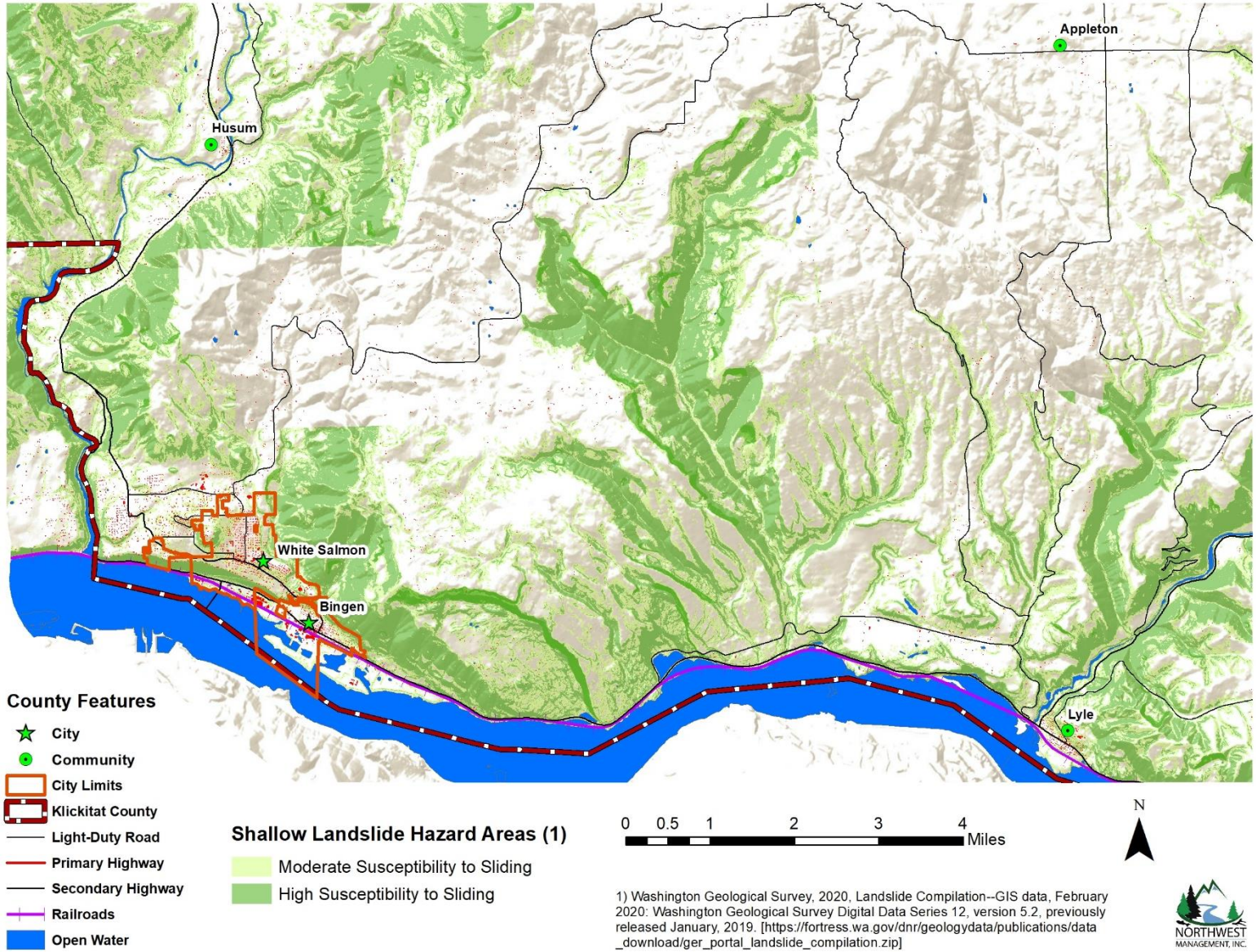


Figure 54) Shallow landslide hazard areas in and around Bingen and White Salmon, WA. Data is from the Washing ton Geological Survey lidar study.

Table 39 summarizes the risk ratings assigned to each adopting jurisdiction by the planning group. Overall risk associated with landslides for the county and all cities and communities is moderate. It was also determined that even though the impacts from a landslide would be localized, they could be severe. It was also decided that the frequency at which landslides occur is occasional. Refer to the Jurisdictional Risk and Vulnerability Ratings section at the beginning of this chapter for more information about the process used to determine hazard ratings.

Table 39) Overall landslide Significance Summary for adopting jurisdictions.

Jurisdiction	Magnitude	Probability	Overall Landslide Risk
Klickitat County	Severe	Likely	Moderate
City of Bingen			Moderate
City of Goldendale			Low
City of White Salmon			Moderate
Klickitat Valley Health			Moderate
Eastern Klickitat Conservation District			Moderate
Central Klickitat Conservation District			Moderate
Underwood Conservation District			Moderate

Analysis of Resources at Risk

Although individual homes and sections of roadways or powerlines could be heavily impacted or destroyed during a landslide, no county, municipality or special districts participating in the development of this plan own or maintain facilities or other assets that are currently located within the landslide impact zones.

Estimation of Loss

The cost of cleanup and repairs of roadways is difficult to estimate due to the variable circumstances with each incident including size of the slide, proximity to a State or County shop, and whether the slide occurred on the cut slope or the fill slope. Other factors that could affect the cost of the damage may include culverts, streams, and removal of debris. This type of information is impossible to anticipate; thus, no repair costs for damaged roadways have been estimated.

Impacts of Landslides

According to the Washington State Enhanced Hazard Mitigation Plan (2018) Klickitat County has experienced two significant landslide events between 1960 and 2016. These landslides resulted in no injuries or deaths and totaled $69,241 in damages. That same resource states that over 70% of the land area in Klickitat County is exposed to landslides and of the 322 critical infrastructure facilities, 207 of them are in landslide exposure areas.

Climate Change

Changes to the climate could lead to an increased number of landslides because of changes in precipitation patterns, erosion risk due to wildfires, and temperature changes. A more comprehensive

examination of how landslides in Klickitat County could be affected by climate change is needed to make any predictions for planning purposes.

Development

Smart development is required to minimize exposure of buildings and infrastructure to landslides. Adherence to current building codes and potentially the implementation of new building codes might be required to mitigate hazard vulnerability. Increases in population in a given area may increase the vitality of given road system. If said road system is at risk to damage or closure because of a landslide event, that sector of the population will be more dramatically affected, especially if anyone is reliant on the road system for medical supplies, economic purposes, or in the event of an emergency. These factors should be considered when planning development of road systems as well as buildings.

Impacts to Klickitat County

The analysis of the terrain and soil types of Klickitat County concludes that risks to both types of landslide events (deep-seated and shallow-rapid) are greatest on the western side of the county and along the southern county line near the Columbia River. Landsides could potentially impact communities located in highly susceptible areas in the south and west ends of the county. Transportation could be highly impacted by landslide events throughout the county, especially along Highway 14, Highway 141, and Highway 142; important routes for business, commuting, emergency response, and general travel between communities and recreation areas.

Impacts to Other Adopting Jurisdictions

In addition to the general impacts listed above, each adopting jurisdiction could be subjected to specific impacts as a result of location and nearby landscape features:

- **City of Bingen:**
  - Terrain and soil types in the vicinity of Bingen pose both shallow-rapid and deep-seated slide risk.
  - The terrain along the northeastern edge of the city poses a moderate risk for deep-seated landslides and a high risk for shallow-rapid slides.
  - In addition to threatening homes and structures located along the northeastern edge of the city, the landslide risk area continues to the east and extends along Highway 14.
- **City of Goldendale:**
  - Terrain and soil types in the immediate vicinity of Goldendale pose very little to no risk for any type of landslide.
- **City of White Salmon:**
  - Terrain and soil types in the vicinity of White Salmon pose both shallow-rapid and deep-seated slide risk.
  - The terrain along the eastern edge of the city poses a moderate risk for deep-seated landslides and a high risk for shallow-rapid slides.
  - In addition to threatening homes and structures located along the eastern edge of the city, the landslide risk area runs north of Bingen and continues along Highway 14.

  - The bluffs located along the river at the south end of town also pose a landslide risk to homes and traffic positioned at the bottom of the bluff.
  - Because the slide area is a near vertical rock outcrop, it poses a high risk for shallow-rapid slides, likely consisting of loose rock and surface debris mobilized by heavy rainfall, freeze-thaw cycles, or heavy precipitation.
- **Klickitat Valley Health:**
  - Located in Goldendale, KVH does not face any significant threats to landslide events.
- **Eastern Klickitat Conservation District:**
  - In the eastern part of Klickitat County, there is some very low landslide risk in the south as the terrain slopes down to the Columbia River.
  - Overall this part of the county has very little susceptibility to landslide events.
- **Central Klickitat Conservation District:**
  - Isolated areas of moderate and high susceptibility to deep-seated landslides do exist in the south along the Columbia River, especially near Wishram.
  - Areas of moderate and high susceptibility to shallow-rapid landslides are spread across the southern part where terrain begins to slope downward toward the river.
- **Underwood Conservation District:**
  - Terrain and soil types along the Columbia River pose a risk for both deep-seated and shallow-rapid landslides, and in some places the susceptibility is high, especially east of Bingen.
  - In the drainages and more mountainous parts of west Klickitat County, the terrain and soils pose moderate to high risk for both types of landslides, especially around communities and along roadways.
  - West of Highway 141 the terrain and soils susceptible to both deep-seated landslides and shallow-rapid landslides are widespread.

Second-Order Hazard Events

Landslide events are often caused by other types of hazard events, but the costs of cleaning up after a landslide including road and other infrastructure repairs can often dwarf the damages of the initial hazard. The following chart outlines the interconnection between landslides and other types of hazard events.

Table 40) Second-order hazards related to landslide events.

Related Causal Events	Related Effects
Flood	Transportation System
Earthquakes	Power Outage
Volcano	
Wildland Fire	

VOLCANO HAZARD PROFILE & RISK ASSESSMENT

Washington State has five major volcanoes (composite volcanoes) that are active and hundreds of smaller non-active volcanoes. Most of the smaller ones erupted only once or several times and have shut down. All are in the Cascade Range. The five major active systems are, from north to south, Mount Baker, Glacier Peak, Mount Rainier, Mount Adams, and Mount St. Helens. Both Mount St. Helens and Mount Adams can produce serious but different hazards that could impact Klickitat County, even though only Mount Adams is located within the county. Mount St. Helens is a highly active and typically explosive system that commonly produces significant amounts of volcanic ash during eruptions. Ash is carried by wind, and part of the time wind directions could transport erupting ash over Klickitat County, where fallout of that ash could impose a widespread significant hazard. Mount Adams and the smaller volcanoes around it, on the other hand, have never erupted much ash. Instead its eruptions typically extrude slow-moving lava flows that seldom extend more than about 5 miles from their source vent. However, the farthest-reaching potential hazard from Mount Adams is a lahar (see definition below) that could flow tens of miles down the White Salmon or Klickitat River valleys.

DEFINITIONS

Volcano: A vent in the earth's crust through which magma, rock fragments, and gases are ejected from the earth's interior. Over time, accumulation of the erupted solid products on the earth's surface commonly creates a cone-shaped volcanic mountain.

Magma: Molten rock produced miles to tens of miles beneath Earth's surface. The name for molten rock changes from *magma* to *lava* after it has erupted.

Composite Volcano: A steep-sided, often symmetrical cone constructed of alternating layers of lava flows, ash, and other volcanic debris, typically over the course of hundreds of eruptions and over hundreds of thousands of years. Composite volcanoes can erupt explosively but do not always do so.

Active Volcano: A volcano that has erupted within the past 10,000 years and is considered to have the potential to erupt again. Active volcanoes may be erupting, restless (about to erupt soon), or dormant (unlikely to erupt soon).

Volcanic Hazard: A natural geologic or hydrologic process associated with a volcano, which has the potential to inflict harm to people or property. Volcanic hazards commonly occur during eruptions, but some may occur when the volcano is quiet.

Volcanic Ash: Small fragments (sand-size or finer) of solidified lava, typically rich in sharp broken shards of volcanic glass and pumice. It is produced by the forceful, high-velocity ejection of gas-rich magma through a volcanic vent.

Lahar: A viscous, high-density "flash flood" of water, mud, and rock fragments that can flow down the sides of volcanoes during eruptions or at other times. Lahars typically resemble soupy wet concrete, flow

rapidly (up to about 80 mph), and can travel long distances down river valleys (more than 100 miles). Lahars can be triggered by various causes or events.

BACKGROUND INFORMATION

Figure 55) Boulder of chemically altered and weakened rock from Mount Adams, suspended in a lahar deposit in upper Trout Lake valley (Sunnyside Road). The source area of the collapse that produced the lahar is the scalloped depression (landslide scar) on the left of the summit—a depression now occupied by the White Salmon and Avalanche Glaciers (Photo courtesy of Darryl Lloyd, used with permission).

Mount St. Helens is the most active volcano in the Cascades, and it commonly erupts explosively, producing ash clouds that can distribute a blanket of ash over thousands of square miles. Since Europeans settled in America, Mount St. Helens has been in a state of unrest or eruption more than half of the time, with the latest eruption ending in 2008. Seismic rumbling beneath the volcano suggests it's not about to shut down any time soon. Mount Adams, on the other hand, is now seismically the quietest volcano in Washington, with its last eruption occurring probably about 1,000 years ago. Yet, Mount Adams is still a very dangerous volcano because much of the rock beneath the summit, two miles above the valleys below and exposed in the steep upper flanks on the southwest and east sides, is "rotten". The rock has been

chemically altered by acidic volcanic gases and fluids over the millennia, reducing the rock strength—what holds it in place—by 80 to 90 percent. Massive rock avalanches, which turned into lahars, occurred about 6000 years ago and about 260 years ago. Both lahars reached now-populated parts of the White Salmon River valley. The older one inundated the broad valley floor near Trout Lake, left massive boulders (Figure 55), dammed Trout Lake Creek to form Trout Lake (now largely infilled with sediment), and flowed south down the valley at least as far as Husum. Neither of these two lahars is known to have occurred during an eruption. Large volumes of weakened rock remain on the upper flanks and pose an ongoing lahar threat to downstream communities.

ASHFALL HAZARD

Areas likely to be affected by the fall of volcanic ash (*ashfall*) are determined by wind direction (at various altitudes) during and following the time that ash is being ejected from the source volcanic vent. Because Mount St. Helens is the volcano most likely to impact Klickitat County with volcanic ash in the future, the county would be affected only during northwesterly wind conditions. Early U.S. Geological Survey (USGS) tephra hazard zone maps estimate that the annual probability of Klickitat County receiving 10 cm or more of ashfall (about 4 inches) would be between 0.02 and 0.2 percent[79], with a greater probability in the western part of the county than the eastern part. In the event of a "large" eruption, presumably the size of the May 18, 1980 Mount St. Helens eruption or larger, the chances of the county receiving 10 cm of ash or more would increase to between 2 percent and 20 percent, increasing in probability from east to west[80].

Preliminary findings from recent computer modeling by the USGS further predict the likelihood of *significant* ashfall (thickness of accumulated ash layer equaling or exceeding 0.1 mm) to be between about 5 and 35 percent, given an explosive eruption having a magnitude between VEI 3 and VEI 5. The model combines the probability distribution of wind directions in southwest Washington with the probability distribution of different eruption sizes between VEI 3 and 5. The most likely size of the next St. Helens eruption was considered to be VEI 3, where VEI (Volcano Explosivity Index) classifies eruption size on the basis of erupted bulk volume. A VEI 3 eruption would be about 100 times smaller than the VEI 5 May 18, 1980 eruption of Mount St. Helens. A VEI 5 might be considered the maximum probable size of eruption, though not the maximum possible size. This preliminary modeling also predicts that there is nearly a 50/50 chance of getting significant ashfall (0.1 mm or more) at Goldendale in the next explosive eruption of Mount St. Helens. That probability increases to a greater than 50/50 chance if the next eruption of Mount St. Helens is assumed to be the size of the May 18, 1980 eruption.

Heavy ashfall (accumulations over about 4 inches or 10 cm) can be life-threatening; the weight can cause roofs to collapse. However, current modeling suggests that so much ash would not fall on the county under the assumed eruption scenarios. Significant light ashfall, on the other hand, is not a threat to

[79] United States Geological Survey: https://pubs.er.usgs.gov/publication/ofr95499

[80] United States Geological Survey: http://pubs.er.usgs.gov/publication/ofr95497

buildings, but it can lead to extremely hazardous driving conditions and can threaten aircraft operations. Furthermore, inhalation of the fine abrasive particles is particularly hazardous for people with asthma and other lung diseases. Besides the abrasiveness of ash, tiny droplets of acid commonly adhere to ash particles, making the ash corrosive, highly damaging to crops, and sometimes toxic to livestock and to fish and wildlife.

LAHAR HAZARD

Imagine a flash flood of soupy wet concrete—the equivalent of three concrete mixer loads dumped into a river every second—surging toward you at about 25 mph. This is what one lahar was like that snuck up on two young people who were swept away by it on the morning of May 18, 1980, where they were camped along the South Fork Toutle River, 26 miles west of Mount St. Helens. Unknown to them, the volcano had just erupted and unleashed multiple torrents of dense rocky slurries down its flanks. Their incredible story of survival is recounted in a book, *In the Path of Destruction*, by Richard Waitt, 2014: Washington State University Press. A lahar from Mount Adams could easily be ten times larger than this and could travel much faster.

Most people don't consider lahars when they think of volcanic hazards. After all, volcanoes are known to spew hot lava and volcanic ash, and lahars are wet and often cold. Yet lahars kill more people at distances greater than about 15 miles from a volcano than any other volcano hazard. They typically occur without warning and are enormously destructive. "Sheltering in place" is not a viable option if you are in the path of an oncoming lahar. Lahars move faster than people can run; exert stupendous forces on buildings, trees, and bridges; and can threaten lives and property more than 100 miles downstream of source volcanoes. See USGS Fact Sheet 2018–3024 to learn how lahars behave and can be generated[81].

Since 1980, more than 23,000 people have been killed by lahars worldwide, and lahars continue to be a significant threat to the safety, economic well-being, and resources of communities downstream of volcanoes all over the world, including several communities in the U.S. Strategies to lower risk to communities in potential lahar pathways involve two intertwined approaches, namely: (1) physical strategies to help keep lahars away from people and people away from lahars, and (2) educational strategies to encourage risk-reducing decisions and behavior—on both the parts of populations at risk and the public officials who set policy. Refer to *Reducing risk from lahar hazards: concepts, case studies, and roles for scientists* for more detailed discussion on mitigating lahar hazards[82].

Physical strategies that have been developed by experts around the world to mitigate the risk from lahars fall into four basic categories (Figure 56): (1) avoidance of lahars through land-use planning and by keeping development out of hazard zones; (2) engineered structures to protect assets by diverting, redirecting, or halting lahars; (3) lahar detection and warning systems to alert populations and enable evacuations to

[81] United States Geological Survey: https://doi.org/10.3133/fs20183024

[82] Pierson, T.C., Wood, N.J., and Driedger, C.L., 2014, *Reducing risk from lahar hazards: concepts, case studies, and roles for scientists*: Journal of Applied Volcanology 3:16, <http://www.appliedvolc.com/content/3/1/16>

higher ground; and (4) response and recovery plans to facilitate search and rescue, protect critical infrastructure, and speed recovery after lahars occur. Successful application of any of these strategies requires an accurate assessment of the hazard at the location, an understanding of their applicability and limitations at that location, and thorough planning.

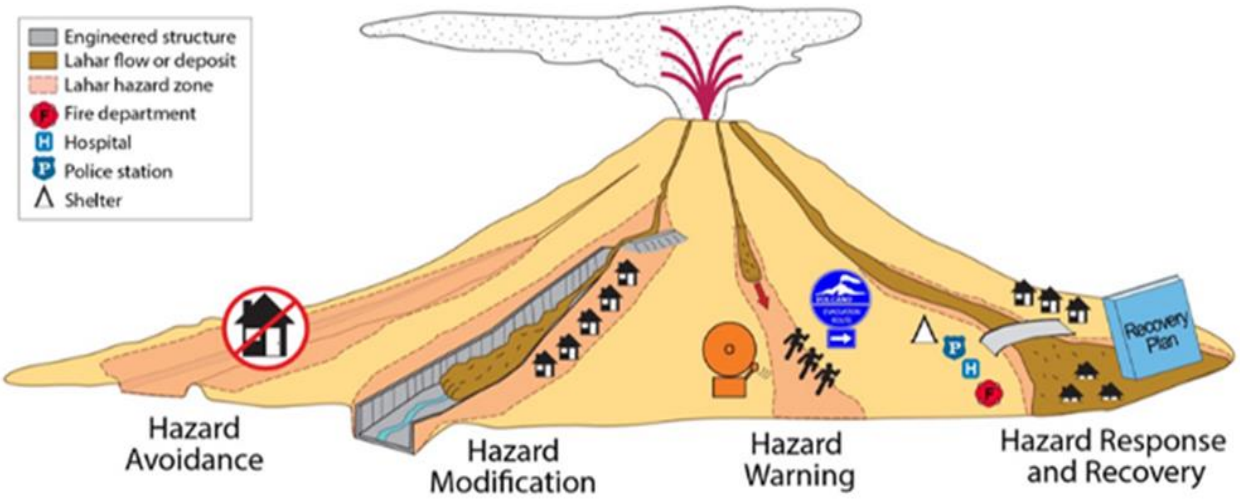


Figure 56) This schematic representation describes the four physical strategies to reduce risk from lahars, where lahar hazard zones are known: (1) lahar avoidance with land-use planning and zonation; (2) lahar protection with engineered structures (bypass channel and deflection berm); (3) lahar detection and warning to allow for timely evacuation; and (4) response and recovery planning to minimize loss of life and speed recovery after a lahar has occurred.

In Klickitat County, past lahars from Mount Adams have come from the southwest sector of the mountain via the White Salmon River drainage[83]. However, remote sensing of rock properties in the summit area of Mount Adams[84] has shown that future lahars could descend either the White Salmon River or Klickitat River valleys (Figure 57). Lahars are most commonly triggered by eruptions, but they can happen at other times, possibly triggered by other natural events. Results of the latest computer modeling to show where lahars of different magnitudes could reach in the White Salmon River valley can be found online[85].

[83] United States Geological Survey. *Helicopter magnetic and electromagnetic surveys at Mounts Adams, Baker and Rainier, Washington: implications for debris flow hazards and volcano hydrology*: https://doi.org/10.3133/b2161

[84] United States Geological Survey. *Helicopter magnetic and electromagnetic surveys at Mounts Adams, Baker and Rainier, Washington: implications for debris flow hazards and volcano hydrology*: https://doi.org/10.3133/b2161

[85] United States Geological Survey. *Modeled inundation limits of potential lahars from Mount Adams in the White Salmon River Valley, Washington*: https://pubs.er.usgs.gov/publication/ofr20181013

Figure 57 is a simplified hazards map for Mount Adams, Washington and surrounding volcanic fields. This map shows where the potential impact areas for ground-based volcanic hazards (lahars and lava flows) are located.

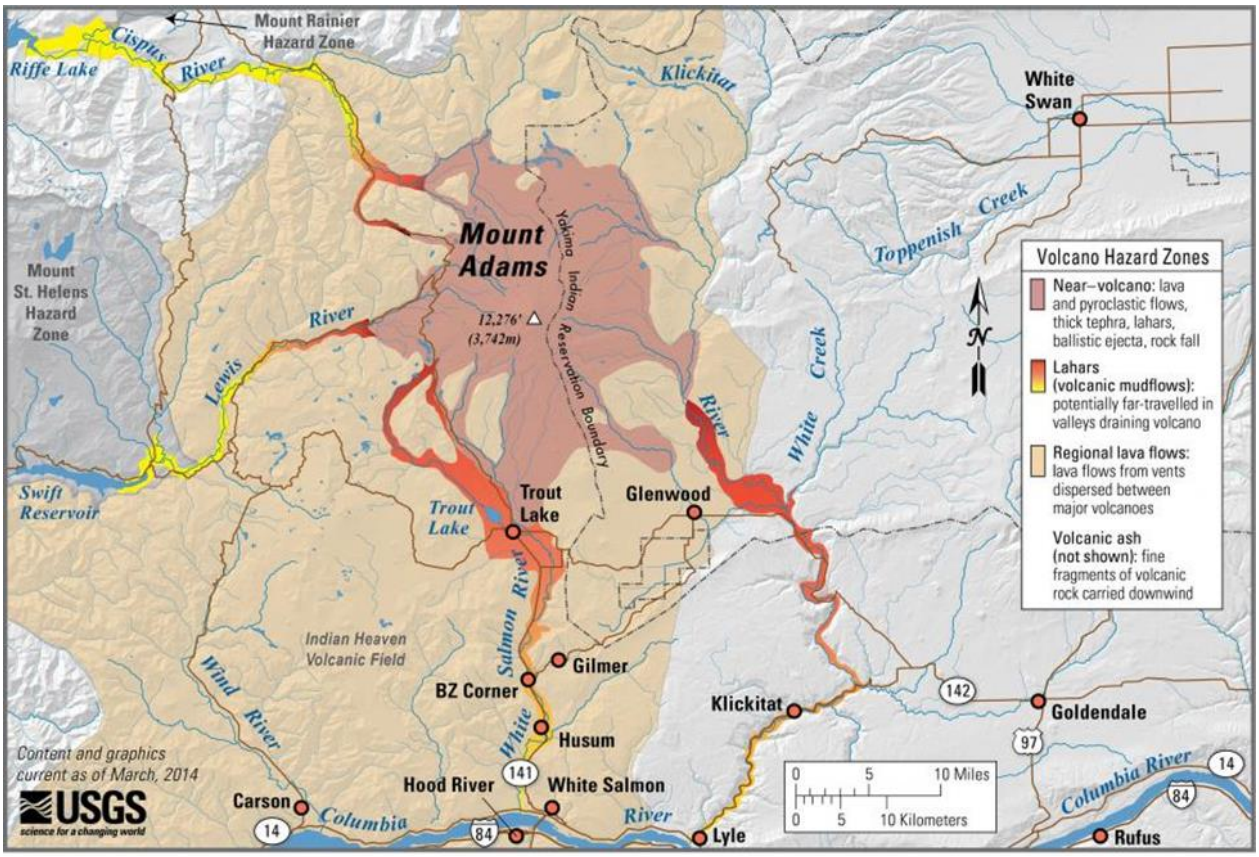


Figure 57) Simplified Volcano Hazards Map for Mount Adams, WA.

Currently there is no lahar warning system in place at Mount Adams, as there is at Mount Rainier, which would detect an approaching lahar and notify the populace with a warning message. The USGS-designed Mount Rainier system has a built-in lag time of about 30 minutes to allow for human verification, which makes it impractical for utilization at Mount Adams. Lahars large enough to reach populated areas in the White Salmon River valley could arrive in less than 30 minutes. Currently, university researchers associated with the University of California, Santa Barbara are attempting to develop a new method of rapid lahar detection for the White Salmon River valley. More work will be needed to improve this method and integrate it with other methods to yield a reliable early detection system. Meanwhile, residents in the White Salmon River and Klickitat River valleys must rely on "self-detection" of an approaching lahar and should learn to recognize several possible indications of an approaching lahar:

- A distant low booming sound (and possible dark dust cloud if the summit area is visible) caused by a large mass of collapsing, avalanching rock.
- A persistent low-frequency rumbling sound that slowly gets progressively louder (like an approaching freight train).

- The sudden change of clear water in the river to very muddy water, particularly if the water appears to be thickening with mud, changing its viscosity, and starting to roll boulders in the flow.
- A sudden dramatic decrease in the river flow, which could be caused by a lahar damming the river farther upstream. If the river is dammed, an outbreak flood could send a flash flood or lahar downstream hours or days later.
- Sharp cracks of breaking trees or the sight of trees being violently shaken or knocked down a relatively short distance upstream.
- A strong earthquake, a volcanic explosion (if the volcano is in a state of unrest), or exceptionally prolonged and intense rainfall; any of these, if the conditions are right, could trigger a lahar.

If any of these signs are seen or heard, people should get to high ground (at least 100 ft above the valley floor) as quickly as possible.

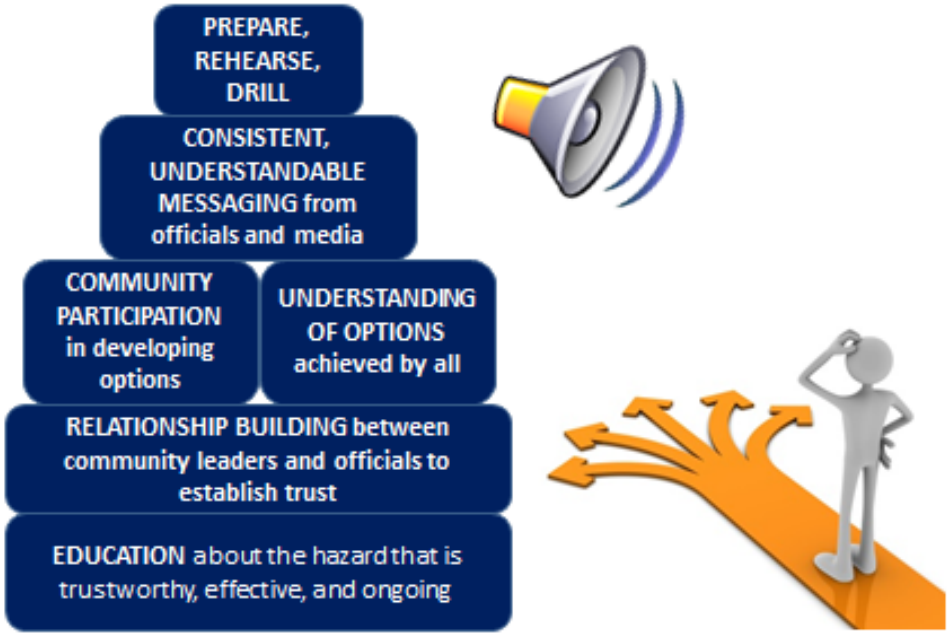


Figure 58) Lahar Educational Strategies; What will the person facing imminent risk from an oncoming lahar do? All these educational building blocks are essential for preparing at-risk populations to act decisively and wisely during a crisis.

Educational strategies have both human and institutional components (Figure 58), and those two components must be coordinated and work in tandem when combined with physical strategies to achieve effective risk reduction. Working together, humans and institutions must work to ensure engagement of all stakeholders in hazard education; good communication of hazard and risk information among scientists, emergency managers, elected officials, and the at-risk public during crisis and non-crisis periods; sustained response training; and adequate funding for risk-reduction efforts.

Lava Flow Hazard

Volcanic vents on Mount Adams itself or in the Mount Adams and Indian Heaven Volcanic Fields could potentially erupt lava flows, although the likelihood is extremely low. The extent of these volcanic fields is shown in Figure 57. The types of lava likely to erupt from these systems are basalt and basaltic andesite, which erupt at about 2,000°F. Flow fronts of these lava types can advance through forest in this type of terrain at speeds up to about 5-10 mph. Once lava channels are established, it can flow faster. Lava flows always run downhill and can destroy and bury everything in their paths, including houses, roads and utilities. At such high temperatures, ignition of wildfires is a virtual certainty.

The only realistic strategy to mitigate the risk from lava flows is to evacuate from their flow paths. Deflection of lava flows by engineered barriers is theoretically possible but difficult and extremely expensive. If Mount Adams or a satellite vent were building up to an eruption, adequate warning by the U.S. Geological Survey's Cascades Volcano Observatory would be given to local officials, and instructions to residents in lava flow hazard zones would be provided.

Historical Volcano Events

Mount St. Helens has been, by far, the most active volcano in the Cascades over the past 4,000 years (Figure 59). Its last ash-producing explosive eruptive events were in 1980 (six between May and October), although it erupted lava to build lava domes between late 1980 and 1986 and again between 2004 and 2008. It also erupted intermittently between 1800 and 1857 and between 1479 and about 1720. The volcano's symmetrical summit was built during the latter part of this earlier eruptive period, but two massive explosive eruptions—both considerably larger than the May 18, 1980 eruption—heralded the onset of this activity in 1479 and 1482. Seismic data from the USGS suggests that fresh new magma, potentially gas-rich and explosive, may have been slowly accumulating beneath the volcano since 2008—an indication that Mount St. Helens will likely erupt again, although the timing is uncertain.

Mount Adams, by contrast, is a sleepy giant that has never produced large explosive eruptions. Its last eruptive activity was about 1,000 years ago, and it is seismically quiet currently. However, catastrophic lahars were initiated by landslides off the southwest summit area of Mount Adams about 6,000 and 260 years ago, and additional large volumes of weakened, potentially unstable rock have been detected in this same area and on the eastern flank. Therefore, future large lahars down the White Salmon and Klickitat Rivers are possible. The next major volcanoes nearest to Klickitat County, Mount Rainier and Mount Hood, have both had eruptions within the last 300 years, but neither of these volcanoes has been a major producer of volcanic ash, and therefore they pose no threat to Klickitat County. One other major ash-producing volcano in the northern Cascades is Glacier Peak. However, it has not been as active as Mount St. Helens, and if it were to erupt a large ash cloud, its position directly north of Klickitat County means that northerly winds would be required to deliver ash to the county, and these are rare. If Mount St. Helens or any of these other volcanoes were threatening to erupt again, precursory signals would be

detected by the USGS monitoring systems, and alerts would be given to officials and the public at least weeks to months in advance of future eruptions[86].

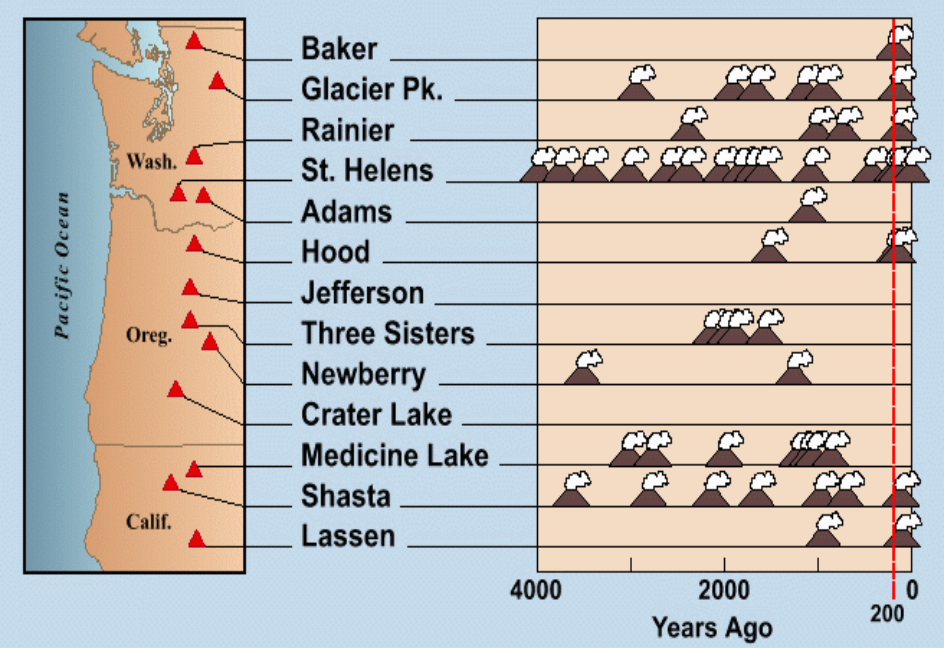


Figure 59) History of relatively recent volcanic activity in the Pacific Northwest in the last 4,000 years. Figure is from the USGS.

Risk Assessment: Volcano

Probability and Magnitude

The Pacific Ring of Fire, whose perimeter includes the Cascades, has produced 22 of the 25 largest volcanic eruptions over the last roughly 11,000 years. The USGS studies and monitors many of the active volcanos in Washington State. Studies have shown that Glacier Peak has erupted an estimated five times in the last 13,000 years; likewise Mount St. Helens last eruption on May 18, 1980 demonstrated that the Volcanoes within the Cascade Mountain Range are still active and they will erupt again. While not a common occurrence, there are, on average, two eruptions in the Cascade Mountain Range every 100 years. Figure 60 indicates that there is a 1 in 1,000 to 1 in 10,000 chance every year that either some or all jurisdictions in Klickitat County will receive 10 centimeters (approximately 4 inches) of ash fall from a volcanic eruption. The annual probability that Klickitat County will receive any ash fall during an eruption is much higher. It should be noted that probabilities of occurrence are influenced by size and duration of an eruption, the point of eruption, prevailing wind direction and wind speed, and other weather factors.

[86] Mount St. Helens—Mount Adams Volcanic Region Coordination Plan-- https://volcanoes.usgs.gov/vsc/file_mngr/file-132/mount-st.-helens---mount-adams-volcanic-region-coordination-plan-october-2014.pdf.

Table 41) Overall Volcano Significance Summary for adopting jurisdictions.

Jurisdiction	Magnitude	Probability	Overall Volcano Risk
Klickitat County	Extreme	Unlikely	Moderate
City of Bingen			Moderate
City of Goldendale			Moderate
City of White Salmon			Moderate
Klickitat Valley Health			Moderate
Eastern Klickitat Conservation District			Moderate
Central Klickitat Conservation District			Moderate
Underwood Conservation District			Moderate

Another explosive eruption from Mount St. Helens within the next 50 years is possible, based on current geophysical evidence that magma has been ascending beneath the volcano since 2008. However, if an eruption does occur, prevailing winds are most likely to take volcanic ash north of Klickitat County, so the overall probability of significant ashfall in the County is low. The likelihood of a lahar from Mount Adams in the next 50 years is also low, but the impact of a lahar would be catastrophic to residents of the White Salmon or Klickitat River valleys if those valleys were inundated. A lahar warning system, when developed for Mount Adams and implemented, would greatly reduce lahar risk to residents. The likelihood of lava flows occurring in the next 50 years and affecting populated areas in the County is exceedingly low. Table 41 summarizes the hazard ratings that the planning team assigned to each adopting jurisdiction. Refer to the Jurisdictional Risk and Vulnerability Ratings section at the beginning of this chapter for more information about the process used to determine hazard ratings.

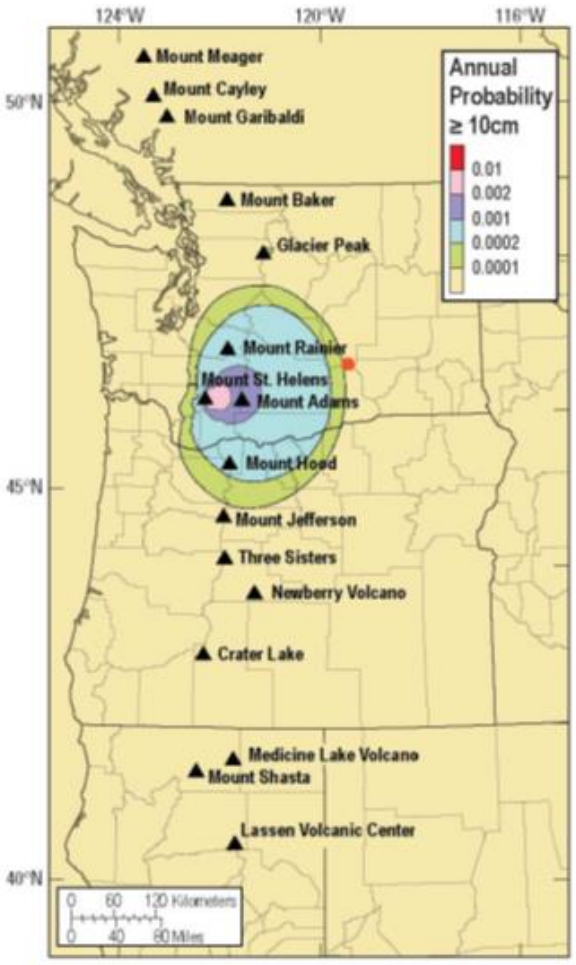


Figure 60) Probability map of at least 10.0 cm of ash accumulating as a result of a Mount St. Helens eruption.

Analysis of Resources at Risk

Resources at risk from ashfall in Klickitat County include hay and grain crops, livestock (as risk from ingesting ash), water-treatment facilities, sensitive air-cooled electronic and communications equipment, and continuity of road and rail transportation Resources at risk from lahars include buildings, roads, and other fixed infrastructure in the White Salmon and Klickitat River valleys.

It is estimated that 18% of Klickitat County's land base and 30% of Klickitat County's population would potentially be exposed to volcanic hazard if an event were to occur. (Division, 2018). Approximately 50% of the County's general building stock is in a lahar hazard zone. (Division, 2018) There are 61 (19%) critical infrastructure facilities in the County that are in the volcano hazard exposure area and will be directly impacted. (Division, 2018) The degree to which the population, building, and critical facility is impacted is largely dependent upon several factors such as proximity to event, building/facility physical details, size of eruption, and size of lahar.

Estimation of Loss

It is difficult to estimate the value of resources at risk from volcanic hazards. Costs associated with ash-related damage would likely depend on the duration of exposure, thickness of ash layer, and size of ash particles during and following ash fallout. Ash can collapse the roofs of buildings, impact water resources and infrastructure, clog vehicle engines, ground or damage airplanes, harm or kill livestock, crops, and other vegetation, and have adverse impacts on human and animal health. Lahars and lava flows can have devastating effects on the impacted areas down valley from the source.

In addition to any kind of damage to infrastructure, there will be, depending on the volume of ash fall and occurrence/severity of other impacts related to volcanic activity, high costs associated with clean-up efforts, the need for additional medical supplies, food and water, temporary shelter and transportation needs, and any other emergency supplies needed for both emergency responders and the general public.

Impacts of Volcanic Events

Ashfall can have a wide range of effects on communities, as outlined below. Severity of impact is affected by variables such as fineness of the ash, whether it falls wet (mixed with rain) or dry, and whether post-ashfall winds keep it stirred up. The following points are summarized from the USGS website, *Volcanic Ash Impacts & Mitigation*. Please visit that site for more detailed information[87].

- **Buildings—** Ash can clog air filters on HVAC systems; easily brought inside by wind, clothing, footwear; it is damaging to computers, electronics, and electric motors; it can corrode metal roofs; it plugs gutters and downspouts.
- **Transportation—** Ashfall may severely disrupt transportation systems over extremely large areas for hours to days. Roads and cars, airports and aircraft, railways, and marine craft are vulnerable.
    - Aviation: Ash can cause severe impacts to aircraft, and the presence of ash can result in the temporary shutdown of airports and flights.
    - Roads, Vehicles, and Railways: Ashfalls of 1 mm (1/32 in) or more can seriously reduce visibility on highways and railways, make roads and tracks slippery for cars and trains, strand travelers and damage vehicles.
    - Marine Transportation: Ash can clog air filters and water intakes and can reduce visibility for marine craft, affecting operations.

[87] https://volcanoes.usgs.gov/volcanic_ash/

- **Power Supply—** Ashfall can quickly lead to widespread power outages, impacting communities, businesses, and critical life-support services. The generation, transmission, distribution, and substation components of a modern power system are vulnerable to different ash-induced impacts, depending on the equipment at each phase of power delivery. The most commonly reported problems are:
    - Supply outages from insulator flashover caused by wet ash on insulators.
    - Disruption of generation facilities.
    - Controlled outages during ash cleaning.
    - Abrasion and corrosion of exposed equipment.
    - Line (conductor) breakage due to ash loading.
- **Human Health—** Exposure to ashfall rarely endangers human life directly, except where very thick falls cause structural damage to buildings (e.g. roof collapse) or indirect casualties such as those sustained during ash clean-up operations or in traffic accidents. Short-term effects commonly include irritation of the eyes and upper airways and exacerbation of pre-existing respiratory disease such as asthma; serious health problems are rare. In addition, affected communities may experience increased levels of psychological distress. This is particularly the case when eruptions cause social and economic disruption. The International Volcanic Health Hazards Network (IVHHN) is an umbrella organization for all research and information on volcanic health hazards. IVHHN has produced guidelines and databases on volcanic health issues[88].
    - People should avoid unnecessary exposure to ash and wear an effective face mask when outside to reduce inhalation of ash particles. People with existing respiratory problems should take special care to avoid exposure to airborne ash and should carry their medication with them.
    - Medical services can expect an increased number of patients with respiratory and eye symptoms during and after ashfall. People will generally be very concerned about the effects of ash, and questions commonly arise about the characteristics of the ash and the implications for their health.
- **Agriculture: Crops and Livestock—** Ashfall can have serious detrimental effects on agricultural crops and livestock depending mainly on ash thickness, the type and growing condition of a crop, the presence of soluble fluoride on the ash, timing and intensity of subsequent rainfall, condition of pasture and animals prior to ashfall, and availability of uncontaminated feed and water. Fluorine poisoning and death can occur in livestock that graze on ash-covered grass if fluoride is present in high concentrations; it may be advisable to sample and analyze ash or ash-coated vegetation to determine whether this potential hazard exists for livestock in areas covered with ash, even as thin as 1 mm. Livestock eating pasture that is contaminated with ash can suffer and

[88] *New IVHHN guidelines on Protection from Breathing Ash*, *Guidelines on Preparedness Before, During and After an Ashfall*, and *Health Hazards of Volcanic Ash-A Guide for the Public* may be downloaded from the IVHHN website: http://www.ivhhn.org/.

die from gastrointestinal blockages. Shortages of uncontaminated feed and water after an ashfall can also lead to starvation.

  - Survival of agricultural crops and pasture is often severely limited when ash thickness is greater than 100-150 mm (4-6 in). Predicting the potential crop losses from ashfall, however, is difficult and usually exaggerated because of the great variety of environmental and plant conditions that exist in tropical and temperate areas during and after ashfalls of varying thicknesses.
  - The abrasiveness of ash can damage farm machinery and equipment, but increased maintenance and a few precautionary actions can significantly reduce the cost of keeping the machinery in working condition.

- **Water and Wastewater—** Following an eruption, it is very common for the public to hold fears about chemical contamination of water supplies. However, in general, the physical impacts of an ashfall will tend to overwhelm problems caused by the release of chemical contaminants from fresh volcanic ash. Impacts vary according to the type of treatment system.
  - It is very difficult to exclude ash from the sewage and storm-water collection networks. Systems with combined stormwater/sewer lines are most at risk. Ash will enter sewer lines where there is inflow by stormwater (e.g., cross connections, around manhole covers, or through holes and cracks in sewer pipes).
  - Ash-laden sewage entering a treatment plant is likely to cause failure of mechanical prescreening equipment such as step screens or rotating screens. Ash that penetrates further into the system will settle and reduce the capacity of biological reactors, as well as increasing the volume of sludge and changing its composition.

Climate Change

Volcanic activity can cause changes to climate patterns and more significant volcano events do have a global impact on weather and climate. An eruption that emitted enough particles and gases into the atmosphere could actually trigger a temporary period of global cooling.[89] The stress that a local volcanic eruption could have on the local environment might exacerbate conditions that are already strained due to drought, wildfire, or other climate-related issues.

Development

Increases in population could result in significant development in parts of the county. If the vulnerable population also increases this could lead to more risk factors during a volcanic eruption. Emergency responders and their resources might be stretched thin and they are unable to attend to individuals with special needs, especially among those in rural parts of the county.

[89] https://climate.nasa.gov/faq/42/what-do-volcanoes-have-to-do-with-climate-change/

Impacts to Klickitat County

In addition to the general impacts listed above, Klickitat County could be subjected to specific impacts due to unique geological and hydrological features and distribution of populated areas and infrastructure. The following points are discussed in much greater detail in Background Information:

- **Ash Fall:** Ashfall will be the most wide-spread impact from a volcanic eruption. Refer to the list of potential impacts from ashfall at the beginning of Impacts from Volcanic Events section for more information.
- **Lahars:** Communities and infrastructure along the White Salmon and Klickitat Rivers could be directly impacted by lahars; in the event of an eruption, lahars are expected to flow all the way to the Columbia River.
- **Lava Flows:** Given the proximity of the county to Mount Adams, the west end of the county could be affected by regional lava flows. Lava flows are also expected to follow the White Salmon and Klickitat Rivers.

Impacts to Other Adopting Jurisdictions

In addition to the general impacts listed above, each adopting jurisdiction could be subjected to specific impacts as a result of location and nearby landscape features:

- **City of Bingen:**
  - Ashfall will be the most significant impact to Bingen. The impacts described for the county in the previous section will be the same for the city.
  - Access to homes and travel on city and county roadways could be increasingly difficult as ash accumulates. Steep roadways in and around the city will be covered with ash, resulting in additional challenges for emergency responders.
- **City of Goldendale:**
  - Given Goldendale's location in the middle of the county, away from waterways and steep terrain, ashfall is likely to be the most significant impact to the City of Goldendale.
- **City of White Salmon:**
  - Ashfall will be the most significant impact to White Salmon. The impacts described for the county will be the same for the city.
  - Access to homes and travel on city and county roadways could be increasingly difficult as ash accumulates. Steep roadways in and around the city will be covered with ash, resulting in additional challenges for emergency responders.
- **Klickitat Valley Health:**
  - Ashfall will be the most significant impact to KVH. Ash can compromise the functionality of equipment and damage generators that may be needed to provide backup power. Ambulances and other emergency response vehicles could be damaged by ash and roadways may be difficult to navigate because of ash accumulation.
- **Eastern Klickitat Conservation District:**
  - The most significant impact to the eastern half of the county is likely to be ashfall. Ashfall can have a variety of negative impacts on wildlife, livestock, vegetation, and agriculture.

- **Central Klickitat Conservation District:**
  - The most significant impact to the central portion of the county is likely to be ashfall. Ashfall can have a variety of negative impacts on wildlife, livestock, vegetation, and agriculture.
  - A lahar may also be channeled along the Klickitat River drainage which would have devastating impacts on wildlife and plant life along the river.
- **Underwood Conservation District:**
  - Ashfall would have a significant impact on the western half of the county. Ashfall can have a variety of negative impacts on wildlife, livestock, vegetation, and agriculture.
  - Lahars may also be channeled along the White Salmon and Klickitat River drainages which would have devastating impacts on wildlife and plant life along the river.
  - Regional lava flows may affect the western end of the county as well. Natural resource damage from lava flows would be devastating.

Second-Order Hazard Events

Volcanic events can result in other types of hazard incidents as well. In a disaster event, the first hazard event may not be the primary cause of damages or losses within the community. Historical volcanic events have often resulted in flash flooding, landslides, wildfires, etc. The following chart outlines the interconnection between volcanic hazards and other types of hazard events.

Table 42) Second-order hazards related to volcanic events

Related Causal Events	Related Effects
	Transportation System
	Power Outage
	Wildland Fire
	Flash Flooding/Flooding
	Lahar
	Earthquake
	Avalanche
	Landslide

HAZARDOUS MATERIALS HAZARD PROFILE & RISK ASSESSMENT

Much of the information below was excerpted or derived from the Washington Military Department's Washington State Enhanced Hazard Mitigation Plan (EHMP).

Hazardous materials are substances that are considered severely harmful to human and environmental health. Many hazardous materials are commonly used substances, which may be harmless in their intended uses, but are quite dangerous if released into the environment. Misuse or release of hazardous materials can cause death, serious injury, long-lasting adverse health effects, structure and property damage, as well as environmental degradation.

Washington State considers hazardous materials as three categories:

1. Spills either at fixed facilities or on transportation routes which include water, land and pipeline;
2. Methamphetamine labs; and
3. Washington cleanup sites for leaking underground storage tanks, brownfields, and superfund sites.

DEFINITIONS

Hazardous material (HazMat), as defined by the US Department of Transportation (DOT), as a substance or material that is capable of posing an unreasonable risk to health safety, and property when transported in commerce, and has been designated as hazardous under the federal hazardous materials transportation law (49 U.S.C. 5103).

There are however, various definitions and descriptive names used to further classify the term "hazardous material", depending on the nature of the problem being addressed. There lacks a comprehensive list of definitions that covers everything, as Federal, state, and local governments have diverse circumstances and purposes for regulating hazardous materials.

Environmental Protection Agency Definitions

Hazardous Substance: any material which when discharged into or upon the navigable water of the United States or adjoining shorelines may be harmful to the public health or welfare of the United States, including, but not limited to fish, shellfish, wildlife, and public or private property, shorelines and beaches. EPA uses the term hazardous substance for chemicals which, if released into the environment above a certain amount, must be reported and, depending on the threat to the environment, federal involvement in handling the incident can be authorized. A list of the hazardous substances is published in 40 CFR § 302, Table 302.4.

Hazardous Waste: any material that may pose an unreasonable risk to health, safety or property when transported in commerce for the purposes of treatment, storage or disposal as waste. EPA uses the term hazardous wastes for chemicals that are regulated under the Resource, Conservation and Recovery Act (40 CFR § 261.33). Hazardous wastes in transportation are regulated by DOT (49 CFR § 171-177).

Extremely Hazardous Substances: the chemicals which must be reported to the appropriate authorities if released above the threshold reporting quantity. Each substance has a threshold reporting quantity. The list of extremely hazardous substances is identified in Title III of Superfund Amendments and Reauthorization Act (SARA) of 1986 (40 CFR § 355). Extremely hazardous substances, while also generally toxic materials, represent acute health hazards that, when released, are immediately dangerous to the lives of humans and animals and cause serious damage to the environment. When facilities have these materials in quantities at or above the threshold planning quantity (TPQ), they must submit "Tier II" information to appropriate State and/or local agencies to facilitate emergency planning.

Toxic Chemicals: chemicals whose total emissions or releases must be reported annually by owners and operators of certain facilities that manufacture, process, or otherwise use a listed toxic chemical. The list of toxic chemicals is identified in Title III of SARA.

Occupational Safety and Health Administration (OSHA) Definitions

Hazardous Chemical: any chemical that would be a risk to employees if exposed in the work place. Hazardous chemicals cover a broader group of chemicals than the other chemical lists.

Hazardous Substances: OSHA uses the term hazardous substance in 29 CFR § 1910.120, which resulted from Title I of SARA and covers emergency response. OSHA uses the term differently than EPA. Hazardous substances, as used by OSHA, cover every chemical regulated by both DOT and EPA.

When a substance meets the DOT definition of a hazardous material, it must be transported in accordance with safety regulations providing for appropriate packaging, communication of hazards, and proper shipping controls.

In addition to EPA and DOT regulations, the National Fire Protection Association (NFPA) develops codes and standards for the safe storage and use of hazardous materials. These codes and standards are generally adopted locally and include the use of the NFPA 704 standard for communication of chemical hazards in terms of health, fire, instability (previously called "reactivity"), and other special hazards (such as water reactivity and oxidizer characteristics). Diamond-shaped NFPA 704 signs ranking the health, fire and instability hazards on a numerical scale from zero (least) to four (greatest) along with any special hazards, are usually required to be posted on chemical storage buildings, tanks, and other facilities. Similar NFPA 704 labels may also be required for individual containers stored and/or used inside facilities.

While it is defined somewhat differently by various organizations, the term "hazardous material" may be generally understood to encompass substances that have the capability to harm humans and other living organisms, property, and/or the environment. No universally accepted, objective definition of the term "hazardous material release incident" has been developed either. A useful working definition, however, might be framed as: any actual or threatened uncontrolled release of a hazardous material, its hazardous reaction products, or the energy released by its reactions that poses a significant risk to human life and health, property and/or the environment.

BACKGROUND INFORMATION

Klickitat County has the most exposure to hazardous materials transport than any other county in the state. However, relative to Western Washington counties, Klickitat County is at lower risk of a hazardous material incident due to less dense industrial and urban development as well as distance from particularly fragile ecosystems found near coastal waterways. Existing pipelines, rail systems, highways, and barge transport routes along the Columbia River present the potential for hazardous material incidents, however the above-mentioned qualities of Klickitat County serve to minimize hazard exposure to residents, businesses, travelers, and the environment.

Pipelines in Klickitat County includes hazardous liquid and high-pressure natural gas above 250 psi. The Northwest Pipeline consists of roughly 102 miles within Klickitat County, and transports natural gas longitudinally across the entire county, with diversions crossing county boundaries to the south at both White Salmon and Dallesport and north to Goldendale. Pipeline incidents often occur due to problems such as corrosion. Corrosion is the deterioration of metal that results from a reaction with the environment which changes the iron contained in pipe to iron oxide (rust). Corrosion can occur on the external and internal portions of the pipe and can result in the gradual reduction of the wall thickness and a resulting loss of pipe strength. This loss of pipe strength can then result in leakage or rupture of the pipeline due to internal pressure stresses unless the corrosion is repaired, the affected pipeline section is replaced, or the operating pressure of the pipeline is reduced. Pipeline corrosion creates weakness at points in the pipe, which in turn makes the pipe more susceptible to other risks such as third-party damage, overpressure events, natural disasters, etc. Events such as flooding and earthquakes can increase the likelihood of a pipeline incident.

Transportation of crude oil by rail occurs along the railroad route that parallels the county's southern border along the Columbia River. In the first quarter of 2017, the total number of barrels of crude oil transported in the state of Washington was 12,142,580, of which 94 percent originated in North Dakota.

The Columbia River, which creates the southern border of Klickitat County, is utilized by ships and barges for transportation of various industrial material. This utilization presents the potential for large quantities of hazardous material to spill directly into the river should an incident occur.

Hazardous materials incidents can occur naturally and during the manufacture, transportation, storage and use of hazardous materials. These incidents are brought about by human error, natural hazards, deliberate deed, or breakdown in equipment monitoring systems. The magnitude of incidents is dependent upon hazardous material quantities, physical properties, as well as environmental factors upon release.

In 1986 Congress enacted the Emergency Planning and Community Right to Know Act (EPCRA) as part of the Superfund Amendments and Reauthorization Act (SARA) due to public concern regarding the environmental and safety hazards posed by the storage and handling of toxic chemicals. This act, known as SARA Title III, established requirements for federal, state, tribal and local governments as well as industry regarding emergency response planning and the public's right to know about hazardous chemicals stored and released in their community. These provisions helped increase the public's

knowledge and access to information on chemicals at individual facilities, their uses and releases into the environment. In 1987, Washington adopted the Federal SARA Title III regulations in Chapter 118-40 of the Washington Administrative Code and established the Washington State Emergency Response Commission (SERC) to oversee implementation of requirements imposed by SARA Title III, including the creation of planning districts, designation of the Local Emergency Planning Committees (LEPC), and the development of a statewide master plan for hazardous materials incident response. The Washington SERC is comprised of a broad-based membership including representatives from private industry, state, tribal and local governments. In addition, the Washington State Patrol, the Washington State Military Department's Emergency Management Division and the Department of Ecology have specific responsibilities under the state regulation. The LEPC's representation consists of state and local elected officials, law enforcement, emergency management, firefighting, health professionals, hospital, transportation, environmental, media, community groups and owners and operators of facilities subject to the requirements of Section 302(b) of EPCRA. LEPCs are required to develop a local hazardous materials emergency plan for their district and to collect EPCRA information submitted by industry. Each local committee shall establish procedures for receiving and processing requests from the general public for information under Section 324 (including Tier II information under Section 312) EPCRA. Such procedures shall include the designation of an official to serve as committee coordinator for all information requests. According to the Department of Ecology and Washington Emergency Management Division, in 2018 Washington has 42 LEPCs, one for each of Washington's 39 counties as well as for the Emergency Services Coordinating Agency, the Southwest Snohomish Emergency Services Coordinating Agency and the Fort Lewis military installation/reservation.

Historical Hazardous Material Events

Washington reported 2,581 separate hazardous material incidents in 2017. More than 20 billion gallons of oil and hazardous chemicals are transported by ship, barge, pipeline, rail and road each year. From 2000-2007, a total of 152 spills were reported to the Washington State Department of Ecology for Klickitat County (Figure 61) (Division, 2018). Clandestine drug labs and dump sites reported to the Washington State Department of Ecology from 1999-2011 totaled 27 (Division, 2018).

Klickitat County has experienced both transportation and fixed facility hazardous materials accidents, most involving petroleum products or agricultural products such as anhydrous ammonia. Two notable spills of greater than 10,000 gallons have been reported and recorded (Figure 62). In 1978 a vessel spill occurred on the Columbia River, releasing approximately 100,000 gallons of diesel fuel. In 1996, the Wind River Train Derailment incident resulted in a spill of roughly 65,000 gallons of diesel fuel.

The Washington State Department of Ecology lists 75 cleanup sites within Klickitat County, many of which have been remediated and require no further action.[90] Two EPA National Priorities List (NPL) sites are

[90] "Cleanup Site Search." *Washington Department of Ecology*, fortress.wa.gov/ecy/gsp/SiteSearchPage.aspx, accessed March 18, 2019

located across the Columbia River in The Dalles; the Union Pacific Railroad Co. Tie-Treating Plant (active NPL site) and the Martin-Marietta Aluminum Co. (removed from the NPL in 1996). These sites continue to pose a risk to the environmental quality of Klickitat County through hydraulic connectivity.

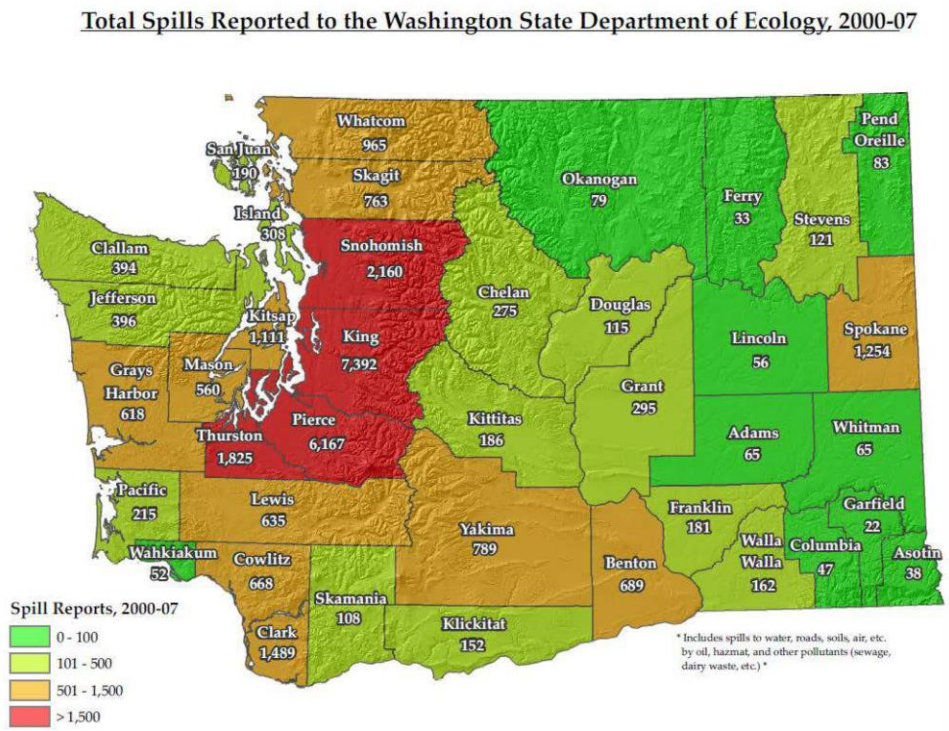


Figure 61) Total HazMat spills reported to the Washington State Department of Ecology (2000-2007).

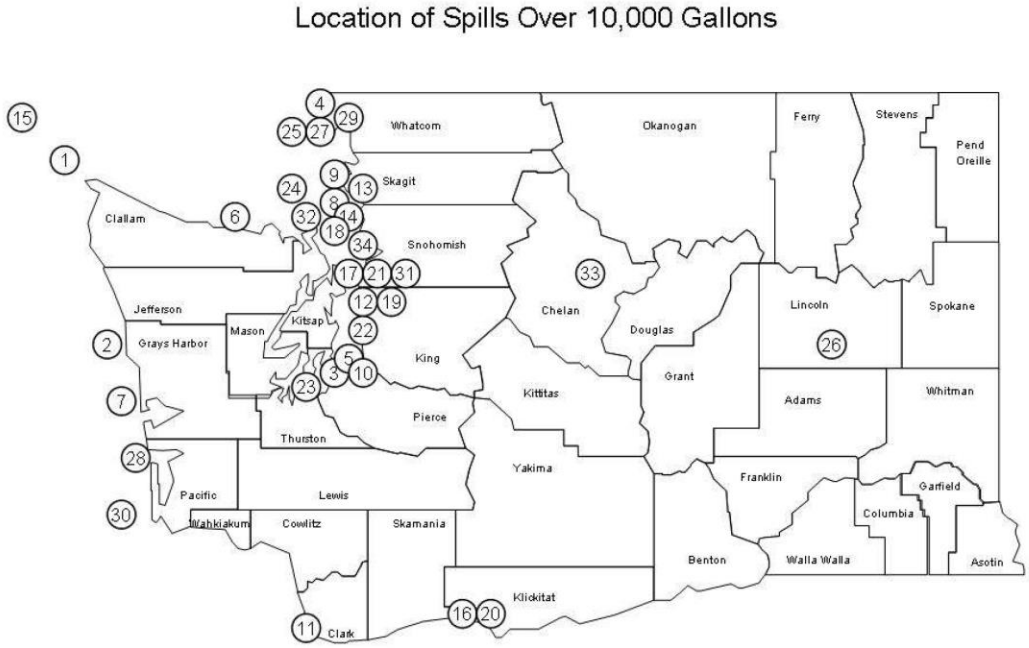


Figure 62) Location of spills over 10,000 gallons in Washington State.

Risk Assessment: Hazardous Materials

Table 43 provides a summary of hazardous materials that are commonly associated with certain types of business and industries. The list is not specific to Klickitat County, but it demonstrates the danger to emergency responders who may be entering a facility containing hazardous materials. For example, firefighters are at high risk of exposure to hazardous materials when responding to fire or other emergency at a facility where hazardous materials are stored.

Table 43) Hazardous Materials Present by Business Type (Idaho, 2019)

Type of Business	Types of Chemicals Used
Airport and marine fuel depots	gasolines and fuel oils
Breweries and distilleries	alcohols
Chemical manufacturers	acids/bases, cyanide wastes, heavy metals/inorganics, ignitable wastes, reactives, solvents
Cleaning agents and cosmetics	acids/bases, heavy metals/inorganics, ignitable wastes, reactives, solvents, pesticides
Compressed gas suppliers	medical and industrial gases
Dry cleaners and laundries	cleaning solvents, perchloroethylene, dry cleaning filtration residues, solvents
Educational and vocational shops	acids/bases, ignitable wastes, pesticides, reactives, solvents
Electronic circuit makers	acids/bases
Embalming supply houses and funeral services	formaldehyde, solvents
Equipment repair	acids/bases, ignitable wastes, solvents
Farm/garden supply shows, lawn fertilizer companies, pesticide end users and application services	pesticides, fertilizers, herbicides, heavy metal/inorganics, solvents
Fireworks manufacturers	explosives, pyrotechnics
Food stores or warehouses	ammonia (in refrigeration systems), combustible dusts
Foundries	resins, other chemicals
Formulators	acids/bases, cyanide wastes, heavy metals/inorganics, ignitable wastes, reactives, pesticides, solvents
Fuel oil companies	fuel oils
Furniture/wood manufacturing and refinishing	solvents, ignitable wastes
Gasoline stations	various fuels
Gun and ammo shops	ammunition, explosives
Hazardous waste disposal facilities	virtually anything
Hospitals	compressed gases, medicines, radioactive materials, etiologic agents
Laboratories, research, chemical and biological	acids/bases, cyanide wastes, heavy metals/inorganics, ignitable wastes, reactives, solvents, various chemical and etiologic agents
Leather tanners	various chemicals
LP-gas or propane suppliers	liquefied/flammable gases
Metal manufacturing	acids/bases, cyanide wastes, heavy metals/inorganics, ignitable wastes, reactives, solvents, spent plating wastes
Motor freight terminals and railroad transportation	acids/bases, heavy metals/inorganics, ignitable wastes, lead-acid batteries, solvents, fuels
Paint, varnish, and lacquer makers and wholesalers	resins, solvents, chemical pigments and additives
pest control companies	pesticides, poisons
Plastic and rubber makers	solvents, additives, bulk chemicals
Plating shops	acids/bases, cyanides
Printing and allied industries	acids/bases, heavy metals/inorganics, ink sludges, spent plating wastes, solvents

Pulp and paper mills	bleaches, caustics, acids, sulfur compounds, and others
School and university chemical laboratories	various chemicals
Swimming pools and supply houses	liquefied chlorine, oxidizers, acids/bases, algaecides
Steel mills	acids, degreasers
Textile and fiber manufacturers	solvents, dyes, resins, various other bulk chemicals
Vehicle maintenance	acids/bases, heavy metals/inorganics, ignitable wastes, lead-acid batteries, solvents, compressed gases, paints
Water treatment facilities	liquefied chlorine, acids
Welding shops and supply shops	compressed gases
Wood preserving	preserving agents

Probability and Magnitude

"Determining the probability of future hazardous materials incidents is difficult because so many factors can contribute and there are so many different types of incidents" (Division, 2018), however the Planning Team determined that there was a 1 to 10% probability of occurrence in the next year. According to the Washington State Enhanced Hazard Mitigation Plan (2018) hazardous material releases happen each year in Washington State. While every 1 to 10 years in Washington a significant pipeline incident occurs. It bares noting here that Bakken Crude oil is also transported by rail across the southern boundary of the County paralleling the Columbia River where landslides and flooding commonly occur that could potentially impact rail lines.

Table 44 summarizes the hazard ratings that the planning team assigned to each adopting jurisdiction for hazardous materials. Since large quantities of hazardous materials are moved through transportation corridors in Klickitat County regularly on both the railroad and highways, the group assigned a rating of "severe" for magnitude and "occasional" for probability.

Table 44) Overall HazMat Significance Summary.

Jurisdiction	Magnitude	Probability	Overall HazMat Risk
Klickitat County	Severe	Occasional	Moderate
City of Bingen			Moderate
City of Goldendale			Low
City of White Salmon			Moderate
Klickitat Valley Health			Moderate
Eastern Klickitat Conservation District			Moderate
Central Klickitat Conservation District			Moderate
Underwood Conservation District			Moderate

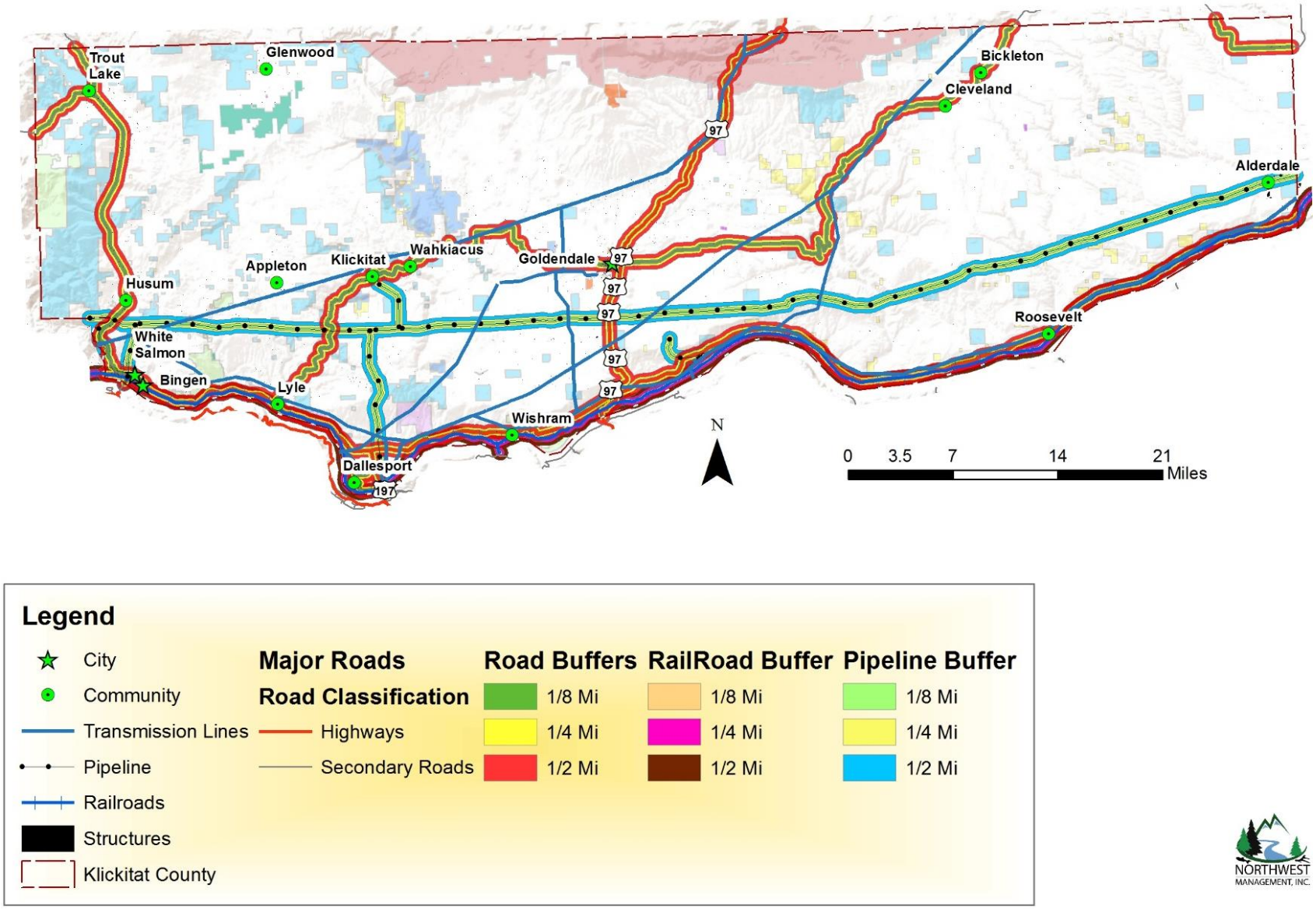


Figure 63) Hazardous materials spill impact zones in Klickitat County, WA

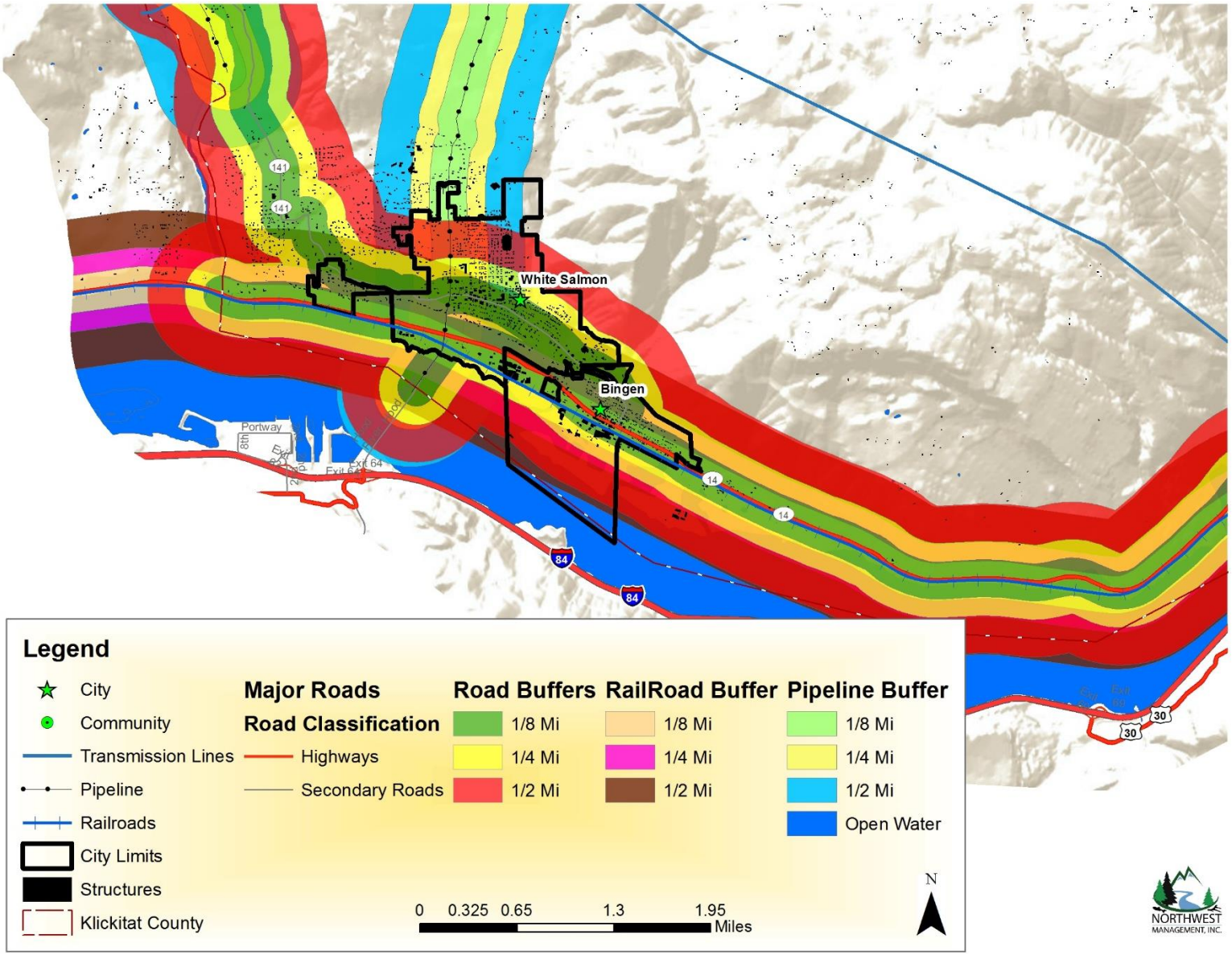


Figure 64) Hazardous spill impact zones for White Salmon/Bingen in Klickitat County, WA.

Analysis of Resources at Risk

According to Klickitat County Emergency Management Klickitat County has the most exposure to hazardous materials transport than any other county in the state. The transportation routes (rail and river) primarily pass through unincorporated portions of the County. The western portion of the county (see Figure 64) is where much of the concern would lie if a spill were to occur along these routes. The figure shows a map of the communities of Bingen and White Salmon with a series of distances from the various types of transportation routes (pipeline, rail, and road). Based on events that have occurred in the past, most of the materials transported through this area would remain relatively localized due to the physical properties of these materials and the quick response of operators and first responders. If materials being transported were gaseous or radiological in nature, then they would begin impacting residents downwind from the spill site.

The rich fisheries resource of the lower (downstream of Klickitat County) Columbia River could be impacted if a hazardous material were to enter the major waterway. The impacts would of course be dependent on the size of the spill and the substance released.

Estimation of Loss

It is difficult to estimate the damages that could occur with a hazardous materials release because it depends on multiple factors (type of material, physical property, and location of release). If a spill were to occur in the rural parts of the county it would only likely temporarily close roads. If a spill were to occur closer to Bingen, White Salmon, or Dallesport there could be evacuations, residents becoming ill from exposure, and minor impacts to the economy (road/business closures). Some of the County's largest employers are in this area and effects could be more widespread than can be assessed in this plan alone. This region of the County relies heavily on tourism to support the local economy throughout the year. Therefore, a reductions in tourism to the area could impact businesses depending on the time of year of a potential hazmat release. Many of these impacts would likely be short lived, however cleanup could last for days or weeks. One important note is that some of the railroad underpasses that residents utilize to access portions of White Salmon and Bingen could become very dangerous if the physical property of a hazmat spill is gaseous. These underpasses are lower than the surrounding area and heavy gases could accumulate in those locations.

Impacts of Hazardous Materials

Impacts to Klickitat County

In addition to the general impacts listed above, Klickitat County could be subjected to specific impacts due to unique geological and hydrological features and distribution of populated areas and infrastructure.

Many of the County roadways provide a travel corridor for several different types of hazmat, particularly Highways 97 and 14. The main natural gas pipeline crosses the County from west to east. The pipeline comes into the County just north of White Salmon in the west and travels east passing south of Goldendale and leaves the County near Alderdale. The rail line follows the southern boundary of the County and

parallels the Columbia River for much of its journey through the County. The primary hazardous material that the rail transports is different types of oil.

Impacts to Other Adopting Jurisdictions

In addition to the general impacts listed above, each adopting jurisdiction could be subjected to specific impacts as a result of location and nearby landscape features:

- **City of Bingen:**
  - Much of the residents and businesses in Bingen occur within proximity to all three types of hazardous materials travel corridors (pipeline, Hwy 14, and rail).
  - The risk to residents and businesses in Bingen occur from leakage/spillage, fire, upwind gas release.
- **City of Goldendale:**
  - Much of the residents and businesses in Goldendale occur within proximity to hazardous materials transported along Highway 97 and 142.
  - The risk to residents and businesses in Goldendale occur from leakage/spillage, fire, upwind gas release.
- **City of White Salmon:**
  - Much of the residents and businesses in White Salmon occur within close proximity to all three types of hazardous materials travel corridors (pipeline, Hwy 14, and rail).
  - The risk to residents and businesses in White Salmon occur from leakage/spillage, fire, upwind gas release.
- **Klickitat Valley Health:**
  - Located in Goldendale, KVH would likely only be affected if a gas were released upwind of the hospital.
  - Hazardous materials may be stored or delivered to the hospital thus could create a risk onsite.
- **Eastern Klickitat Conservation District:**
  - Much of this part of the county is sparsely inhabited, thus creating a low risk of hazardous materials to residents and businesses in this area.
  - Small losses to agriculture could occur in this area if a spill were to occur.
- **Central Klickitat Conservation District:**
  - This part of the county is more populated than the eastern third, however this is considered a low risk area for hazardous materials.
  - The extent of a hazmat event would depend on the location and type of spill.
  - Small losses to agriculture could occur in this area if a spill were to occur.
- **Underwood Conservation District:**
  - Many of the hazmat transportation corridors converge in this portion of the County
  - Impacts to residents, businesses, and the environment would be relatively high in this area compared to the rest of the County given the population density, natural resources, and amount of travel corridors through the area.

Second-Order Hazard Events

Hazardous materials spills are most commonly the result of human error, but they can be caused by natural disasters such as earthquake or flooding. Hazardous materials spills can result in other types of hazard incidents as well. Historical spills have often resulted in transportation disruption, power outages, wildland fires, water contamination, etc. The following chart outlines the interconnection between hazmat hazards and other types of hazard events.

Table 45) Second-order hazards related to hazardous materials spill events.

Related Causal Events	Related Effects
Earthquake	Transportation System
Flooding	Power Outage
Volcano	Wildland Fire
Wildfire	Contaminated Water

MASS CASUALTY HAZARD PROFILE & RISK ASSESSMENT

Much of the information below was excerpted or derived from the Washington Military Department's Washington State EHMP, the Klickitat County Comprehensive Emergency Management Plan (CEMP), and the 2012 Mass Casualty Incident Plan Initial Response Guide for Washington State Southwest Regional EMS which is currently being updated.

A mass casualty incident (MCI) can occur at any time in any place. Typically, property damage associated with an MCI is low, but injury and loss of life has the potential to be very high. MCIs can occur at any time from any number of different events, including transportation accidents (air, rail, or highway), major fires, natural disasters, terrorism, and others.

DEFINITIONS

Mass Casualty Incident: A medical incident that overwhelms the ability of the emergency responders and/or medical facilities to provide normal levels of care to sick & injured victims.

International Terrorism: the unlawful use of force or violence committed by a group or individual, who has some connection to a foreign power or whose activities transcend national boundaries, against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives.

Homegrown Violent Extremism: is a person of any citizenship who has lived and/or operated primarily in the U.S. who advocates, is engaged in, or is preparing to engage in ideologically motivated terrorist activities (including support to terrorism) in the furtherance of political or social objectives promoted by a foreign terrorist organization (FTO), but is acting independently of direction by the FTO.

Domestic Terrorism: acts of terrorism perpetrated by individuals and/or groups inspired by or associated with primarily designated U.S.-based movements or organizations that espouse extremist ideologies of a political, religious, social, racial or environmental nature.

Domestic Violent Extremism: is encouraging, supporting or committing a violent act to achieve political, ideological, religious, social, or economic goals, but is not associated with a designated foreign or domestic terrorist organization. Includes extremism ideologies based on religious supremacy, racial/ethnic supremacy, environmental/animal rights, political extremism and single-issue extremism (e.g., anti-abortion, law enforcement, homosexuality, immigration).

Targeted Violence: "an intentional act committed by an individual or group for the purpose of (or resulting in) psychologically and/or physically affecting an organization or person associated with an organization, whereby the attacker selects a particular target prior to their violent attack." This includes hate crimes, workplace violence, rampage shootings, [non-terrorism] suicide attacks or cases of violence caused by mental instability.

Cyberterrorism: is the convergence of cyberspace and terrorism. It refers to unlawful attacks and threats of attack against computers, networks and the information stored therein when done to intimidate or

coerce a government or its people in furtherance of political or social objectives. A cyberterrorism attack may result in violence against persons or property, or at least cause enough harm to generate fear.

Response Level: the pre-planned responses of ambulances, rescues, helicopters, and other equipment needed to deliver adequate immediate care in the event of an MCI.

Background Information

MCIs generally occur without warning. These events are characterized by an overall decrease in public safety in other areas of fire and law enforcement, as emergency responder resources are dedicated to reacting to the MCI. Since an MCI may occur at any time in any place, planning and preparation are vital in coping with an MCI. Regional hospitals have agreed that when a MCI is declared from the field, that the hospital that is servicing the ambulance response area of the MCI will be considered the "Local Resource Hospital". Should that hospital be unable to act as the resource facility, those duties by mutual agreement may be handed off to another area hospital. For Klickitat County, the local resource hospital will be either Klickitat Valley Hospital or Skyline Hospital depending on the location of the incident and the current capacity of each hospital. Mid-Columbia Medical Center acts as the medical control hospital for the region.

Table 46 shows the number of patients required for different response levels from emergency personnel. Depending on the number of patients, emergency responders will bring a specified number of ambulances to the scene. Table 47 details which EMS service responds to designated response zones in Klickitat County. Klickitat County EMS District #1 covers the greatest number of zones; representatives from the EMS district do not feel as though the current number and location of EMS stations is sufficient to cover that area and be able to respond to an incident in a timely manner. Refer to the Klickitat County Mitigation Action Item Annex for information about the EMS station expansion project.

Table 46) Criteria for MCI Alarm Selection.

Response Level	Number of Patients	Ambulances Needed
1st Alarm	1-5	1-3
2nd Alarm	6-15	3-5
3rd Alarm	16-25	5-8
4th Alarm	>25	Special call for additional resources

Table 47) Klickitat County Ambulance Response Areas.

County Zone	Jurisdiction
Zone 4	Klickitat County EMS District #1
Zone 5	Klickitat County EMS District #1
Zone 6	Klickitat County EMS District #1
Zone 7	Klickitat County EMS District #1
Zone 8	Prosser, Paterson & Sunnyside EMS

Available MCI Incident Supply Trailers in Klickitat County and other neighboring counties:

- Klickitat County EMS District #1 (insufficiently supplied and does not have a vehicle to tow the trailer)
- Mid-Columbia Fire & Rescue
- Hood River Fire Chiefs
- Skamania County Ambulance
- Cascade Locks Fire & EMS
- Fire District #2 and #10 EMS service out of Benton County

HISTORICAL MASS CASUALTY EVENTS

Mass casualty incidents have occurred within and around Klickitat County. On average, first responders have dealt with one MCI per year in Klickitat County. While Klickitat County is considered lower risk for a MCI, critical infrastructure sites and public events in non-densely populated regions have been the targets of previously-foiled terror plots. Intelligence reporting indicated terrorists' interests in targeting infrastructure such as dams, food supplies, or cyber infrastructures, the assets of which are not centralized to one specific locale. The difficulty in being able to forecast an MCI, like one would for a forest fire or flood, requires that response planning consider the wide variety of factors that are unique to MCIs, and develop responses that are malleable, efficient, and scalable.

Washington's EHMP has an extensive list of MCIs and terrorism-related attacks over the last decade further highlighting the unique nature of each incident. Currently, the FBI is the lead agency in the U.S. for all matters concerning terrorism and violent extremism.

RISK ASSESSMENT: MASS CASUALTY

PROBABILITY AND MAGNITUDE

MCI occurrence is extremely difficult to predict; however, it is known that the frequency of terror-related MCIs is increasing over the last decade. Based on recent, successful terrorist and violent extremist events:

- The *most likely tactics* include active shooter(s), vehicle attacks, stabbing/cutting, bombings, and cyberattacks.
- The *least likely tactics* include chemical, biological, radiological and nuclear bombing, hijacking/skyjacking, and maritime attacks.
- The *most likely targets* include human targets (military, government and law enforcement in particular), government facilities, commercial facilities (including public assembly, retail, and entertainment and sports venues), and transportation.
- The *least likely targets* include amusement parks, bridges, museums, national monuments or icons, and vessels.

Table 48 summarizes the hazard ratings that the planning team assigned to each adopting jurisdiction for hazardous materials. The group assigned a rating of "moderate" for magnitude and "occasional" for probability for the county. Each adopting jurisdiction determined that a Mass Casualty incident is low risk, overall.

Table 48) Overall MCI Significance Summary as identified by the HMP planning team.

Jurisdiction	Magnitude	Probability	Overall Mass Casualty Risk
Klickitat County	Moderate	Occasional	Low
City of Bingen			Low
City of Goldendale			Low
City of White Salmon			Low
Klickitat Valley Health			Low
Eastern Klickitat Conservation District			Low
Central Klickitat Conservation District			Low
Underwood Conservation District			Low

Analysis of Resources at Risk

Victims involved in a mass casualty incident are the primary 'resource' at risk. Overwhelmed medical facilities may not have the resources to properly treat every victim. Victims would likely be transported to area medical facilities to alleviate the strain.

Impacts of Mass Casualty Incidents

Mass Casualty is not a hazard in and of itself, but rather the result of some type of natural disaster or other man-made event. Even a traffic accident with multiple victims (as few as 2-3) can overwhelm medical resources and first responders in some of the more rural communities.

Impacts to Klickitat County

In addition to the general impacts listed above, Klickitat County could be subjected to specific impacts due to unique geological and hydrological features and distribution of populated areas and infrastructure.

Many parts of Klickitat County are isolated with limited travel corridors due to terrain or remoteness causing ingress/egress issues. Emergency response is limited because of a lack of strategically placed resources throughout the County. The MCI response resources that the County does have are poorly stocked and maintained.

Impacts to Other Adopting Jurisdictions

In addition to the general impacts listed above, each adopting jurisdiction could be subjected to specific impacts as a result of location and nearby landscape features:

An MCI event in any adopting jurisdiction would likely exhaust emergency response resources in the area. Emergency response from outside of the county would be critical during an MCI. Depending on the location of the event, it could disrupt travel through the County. Hospital resources could be exhausted if a MCI event occurred in the County.

- **Klickitat Valley Health:**
    - *Mass Casualty:* As a Critical Access Hospital, we would need to transfer patients fairly quickly if there were a large number were received simultaneously. Klickitat Valley Health

is a 14-bed hospital which limits the facilities ability to handle large numbers of patients arriving at one time.

- Infectious Disease: The rapid spread of disease, even with limited casualties, could impact the facility because of limited staffing pool--access to back up staff is limited due to the size of the community and the distance from other larger communities with more available staffing resources.

Second-Order Hazard Events

Mass casualty events result from many other types of hazard events. The following chart outlines the interconnection between mass casualty hazards and other types of hazard events.

Table 49) Second-order hazards related to mass casualty events.

Related Causal Events	Related Effects
Earthquake	None
Flooding	
Volcano	
Landslide	
Severe Weather	
Radiological Release	
Hazardous Materials Spill	
Volcano	
Anthropogenic	
Wildfire	

RADIOLOGICAL HAZARD PROFILE & RISK ASSESSMENT

Much of the information below was excerpted or derived from the Washington Military Department's Washington State EHMP, and the Klickitat County Comprehensive Emergency Management Plan (CEMP).

No emergencies involving the release of radiation have occurred in Klickitat County. In the past, emergencies have occurred at facilities containing radioactive materials in Benton County, but none have resulted in significant radiation release. A radiological emergency can arise from a number of facilities in the region, including research laboratories, waste storage, and decommissioned nuclear reactors at the U.S. Department of Energy's Hanford Site; the Columbia Generating Station (CGS) nuclear power plant; Siemens' nuclear fuel fabrication facility, as well as private research and development laboratories near the Hanford Site. Radiological materials are transported by road, rail, and barge in and around Klickitat County.

DEFINITIONS

Non-Ionizing Radiation: Electromagnetic radiation that lack sufficient energy to ionize atoms or molecules. The danger posed by non-ionizing radiation sources (e.g. lasers, microwave or UV producing machines, and linear accelerators) are injury to the eyes or skin. This type of source can be made inert by shutting off the machine causing the production of non-ionizing radiation will cease. Emergencies involving nonionizing radiation are typically confined to the industrial or medical building location of the equipment itself and rarely pose any risk to the general public.

Ionizing Radiation: Ionizing radiation is energetic waves or particles that have sufficient energy to ionize other atoms (break electron bonds). This results in the biological breakdown of DNA and cellular molecules in all living organisms exposed to radioactivity. Soft tissue damage resulting from exposure to ionizing radiation can vary significantly depending on the duration and intensity of exposure. Mild skin erythema can result from low-level radiation exposure while radiation sickness (nausea, vomiting, diarrhea) and death can result from moderate to high levels of exposure. Ionizing radiation comes from particles (Alpha, Beta, and Neutrons) as well as electromagnetic radiation (x-Rays, Gamma-Rays).

Exposure: Exposure to ionizing radiation signifies an individual has been exposed to the energy from the radioactive particles or waves. Once that individual moves away from that source or places sufficient shielding material between them and the source, they are no longer being exposed to the radioactivity. The biological damage done by radioactive exposure does not continue, once the exposure has discontinued.

Contamination: the uncontrolled deposition of radioactive substances (solids, liquids, or gases) onto people, equipment, or the environment. Contamination signifies the individual is continually being exposed to ionizing radiation until it has been removed; either by various decontamination processes, or when the body flushes it from their system. Ingestion, inhalation, and injection of radioactive particles into the body can result in a permanent dose to that individual if the body fails to excrete it through natural processes.

Natural Background Radioactivity: Natural radioactivity originates from cosmogonic sources as well as from radioactive elements in the earth's crust. About 340 nuclides have been found in nature, of which about 70 are radioactive and are found mainly among the heavy elements. All elements having an atomic number greater than 80 possess radioactive isotopes, and all isotopes of elements heavier than number 83 (Bismuth) are radioactive (Eisenbud 1997).

Man-Made Sources: A small fraction of background radiation comes from human activities. Trace amounts of radioactive elements have dispersed in the environment from nuclear weapons tests and accidents like the one at the Chernobyl nuclear power plant in Ukraine. Nuclear reactors emit small amounts of radioactive elements. Radioactive materials used in industry and even in some consumer products are also a source of small amounts of background radiation.

Technologically Enhanced Naturally Occurring Radioactive Material: Radioactive elements, generally thorium and uranium, occurring naturally underground may become mobilized during various industrial processes (e.g. oil and gas extraction) and pose a radiological risk to humans. Incidents with these materials have a high probability of occurrence, but a low probability of major impact due to their concentrations.

Technologically Produced Radioactive Material: generated by nuclear reactors or high energy particle accelerators, or relatively high levels of ionizing electromagnetic radiation. Nearly all industrial sources are licensed through the U.S. Nuclear Regulatory Commission. Technologically produced sources are used extensively in medical and industrial applications and have the highest probability of being involved in a radiological incident due to their high levels of use.

Background Information

Exposure to sources of radiation may be known and recognized or clandestine. Large radiation exposures would result from a nuclear bomb detonation or catastrophic damage to a nuclear power station or storage facility. The most common radiological incidents occur due to loss, theft, or mismanagement of relatively minor or low-level radioactive sources or technologically enhanced, naturally occurring radioactive material.

As seen in the 2011 Fukushima Daiichi nuclear disaster, natural hazards and severe weather have the potential to impact nuclear or radiological facilities. The Washington State Enhanced Hazard Mitigation Plan (2018) states that Klickitat is within the 50-mile Ingestion Planning Zone for the Columbia Generating Station or the Hanford Reservation, making Klickitat County one of eight counties in Washington at the greatest risk.

The U.S. Centers for Disease Control and Prevention (CDC) developed the Radiation Hazard Scale (RHS) as a standardized tool for communication in the event of a radiological emergency. The RHS provides a framework of reference for relative hazards of radiation applicable to short-term exposure durations.

Table 50. Description of the Radiation Hazard Scale Categories[91]

Category	Description
5	**Category 5:** High doses of radiation can cause massive damage to organs of the body and kill the person. The exposed person loses white blood cells and the ability to fight infections. Diarrhea and vomiting are likely. Medical treatment can help, but the condition may still be fatal in spite of treatment. At extremely high doses of radiation, the person may lose consciousness and die within hours. For more information, go to https://www.remm.nlm.gov/ars_summary.htm
4	**Category 4:** Radiation doses are dangerously high and can make people seriously ill. Radiation doses are not high enough to cause death, but one or more symptoms of radiation sickness may appear. Radiation sickness, also known as Acute Radiation Syndrome (ARS), is caused by a high dose of radiation. The severity of illness depends on the amount (or dose) of radiation. The earliest symptoms may include nausea, fatigue, vomiting, and diarrhea. Symptoms such as hair loss or skin burns may appear in weeks. For more information about the health effects of radiation, go to http://emergency.cdc.gov/radiation/healtheffects.asp For more information about medical treatment of radiation exposure, go to http://emergency.cdc.gov/radiation/countermeasures.asp
3	**Category 3:** Radiation doses are becoming high enough where we may expect increased risk of cancer in the years ahead for people who are exposed. Leukemia and thyroid cancers can appear in as few as 5 years after exposure. Other types of cancer can take decades to develop. Studies have shown that radiation exposure can increase the risk of people developing cancer. This increased risk of cancer is typically a fraction of one percent. The lifetime risk of cancer for the population due to natural causes is approximately 40%. The increase in risk of cancer from radiation depends on the amount (or dose) of radiation, and it becomes vanishingly small and near zero at low doses of radiation. For more information, go to http://emergency.cdc.gov/radiation/cancer.asp
2	**Category 2:** Radiation levels in the environment are higher than the natural background radiation for that geographic area. However, these radiation levels are still too low to observe any health effects. When radiation levels are higher than what we normally have in our natural environment, it does not necessarily mean that it will cause us harm. For more information about health effects of radiation, go to https://www.cdc.gov/nceh/radiation/health.html
1	**Category 1:** Radiation levels in the environment are within the range of natural background radiation for that geographic area. Low amounts of radioactive materials exist naturally in our environment, food, air, water, and consequently in our bodies. We are also exposed to radiation from space that reaches the surface of the Earth. These conditions are natural, and this radiation is called the natural background radiation. For more information about radiation and radioactivity in everyday life and how it can vary by location, see https://www.cdc.gov/nceh/radiation/sources.html

[91] https://emergency.cdc.gov/radiation/radiationhazardscale.asp, Accessed March 20, 2019.

Historical Radiological Events

Much of the region's radiological history is centered on the decommissioned Hanford Site, an EPA Superfund site. Currently being stored at the Hanford Site is 56 million gallons of radioactive waste from cold war era nuclear weapons production. Still in progress is a multi-billion-dollar effort to clean-up all radioactive material at The Hanford Site. This includes dismantling and disposing building materials that were exposed to radioactive material and the disposal of radioactive material itself. Considering the quantity of nuclear waste still present at the Hanford Site and that the clean-up effort is a multi-decadal project, prolonged exposure to potential earthquakes is a concern. Additionally, most of the original structures on the Hanford Site, including the underground storage tanks that currently hold liquid nuclear waste, were constructed during World War II before earthquakes were a significant hazard in Central Washington. Considering new research about faults in central Washington, the Hanford Sitewide Probabilistic Seismic Hazard Analysis, prepared by Pacific Northwest National Laboratory, was conducted from 2012 to 2014 to summarize earthquake hazards at the Hanford Site.

According to the 2018 Washington State Enhanced Hazard Mitigation Plan, there has not been a significant release of radiological material in Washington in the last 50 years.

Risk Assessment: Radiological

Probability and Magnitude

The Hanford Site contains approximately 53 million gallons of high level radioactive hazardous wastes leftover from the Manhattan Project. The waste is stored in 177 underground tanks, 149 of which are prone to leaking. It is estimated that one million gallons of highly toxic contaminants have leaked into the ground and are moving towards the Columbia River via groundwater. It has been estimated that these toxins could reach the Columbia River in 1 to 50 years. (Division, 2018)

Table 51 summarizes the hazard ratings that the planning team assigned to each adopting jurisdiction for a radiological event. The overall risk for the county is low to moderate; impacts from an event could be extreme and an event could happen on occasion.

Table 51) Overall Radiological Significance Summary as identified by the HMP planning team.

Jurisdiction	Magnitude	Probability	Overall Radiological Risk
Klickitat County	Extreme	Occasional	Moderate
City of Bingen			Low
City of Goldendale			Low
City of White Salmon			Low
Klickitat Valley Health			Moderate
Eastern Klickitat Conservation District			Moderate
Central Klickitat Conservation District			Moderate
Underwood Conservation District			Moderate

Analysis of Resources at Risk

Values of resources at risk to radiologic release are difficult to assess. The impacts to Klickitat County will likely primarily be associated with a leakage from the Hanford Site. The leakage is expected to seep into the Columbia River ecosystem and could have significant impact on the system and Klickitat residents who rely on the waterway for a living (tourism, fishing, transportation, irrigation, etc.). The other type of radiological release is airborne and due to typical prevailing winds would not likely have an impact on Klickitat County residents or businesses but could pose an indirect short-term disruption to the economy.

Impacts of Radiological Event

While the direct economic impact from a radiological release would be isolated to the areas exposed to the radioactive isotopes, the greater impact is the cascading effects to the agricultural community. A release would result in the establishment of a Food Control Area and potential embargoes. Public fear would likely lead to consumers no longer buying agricultural products from the State of Washington. (Division, 2018)

Impacts to Klickitat County

In addition to the general impacts listed above, Klickitat County could be subjected to specific impacts due to unique geological and hydrological features and distribution of populated areas and infrastructure.

A radiological event would primarily occur outside of the County. The typical prevailing winds would prevent any type of fallout from occurring in the County. The most likely impact would occur along the Columbia River. The extent of the damages from this type of event is difficult to estimate however we can infer that irrigated crops, fisheries, tourism, local economy, and the environment would all be negatively impacted. The crops, businesses and residents located along the Columbia River would be the most severely impacted.

Impacts to Other Adopting Jurisdictions

In addition to the general impacts listed above, each adopting jurisdiction could be subjected to specific impacts as a result of location and nearby landscape features:

- **City of Bingen:**
    - Many residents and businesses in Bingen rely on the Columbia River for a variety of reasons; radiological waste in the river would disrupt all activities and operations occurring on the Columbia River.
    - Tourism in the area would decrease and select recreation areas and services will either close or become restricted.
    - The environment and wildlife would be negatively impacted.
    - Crops relying on irrigation could be impacted due to contaminated water.
    - Fisheries in the region would be negatively impacted.
    - Many residents commute to neighboring cities for work. A radiological event, such as the release of radiological waste from the Handford Site into the Columbia River, could disrupt the flow of traffic between cities; particularly on the Hood River bridge.

- **City of Goldendale:**
  - Goldendale would likely not be directly impacted by a radiological event, but the impacts would still be felt in the economy and by some residents.
- **City of White Salmon:**
  - Many residents and businesses in White Salmon rely on the Columbia River for a variety of reasons; radiological waste in the river would disrupt all activities and operations occurring on the Columbia River.
  - Tourism in the area would decrease. and select recreation areas and services will either close or become restricted.
  - The environment and wildlife would be negatively impacted.
  - Crops relying on irrigation could be impacted due to contaminated water.
  - Fisheries in the region would be negatively impacted.
  - Many residents commute to neighboring cities for work. A radiological event, such as the release of radiological waste from the Handford Site into the Columbia River, could disrupt the flow of traffic between cities; particularly on the Hood River bridge.
- **Klickitat Valley Health:**
  - KVH would likely not be directly impacted by a radiological event.
- **Eastern Klickitat, Central Klickitat, and Underwood Klickitat Conservation Districts:**
  - The Conservation Districts would likely be most impacted along the Columbia River.
  - The natural environment would be impacted along the Columbia River.
  - Farms and orchards that rely on irrigation would be impacted.

Second-Order Hazard Events

Radiological release can be caused by earthquakes but more commonly are the result of human error. Radiological release events can result in other types of hazard incidents. In a disaster event, the first hazard event may not be the primary cause of damages or losses within the community. Historical radiological events have often resulted in contaminated water, damaged ecosystems, permanent abandonment of the immediate vicinity, etc. The following chart outlines the interconnection between radiologic hazards and other types of hazard events.

Table 52) Second-order hazards related to radiological release events

Related Causal Events	Related Effects
Earthquake	Transportation System
Anthropogenic	Power Outage
	Contaminated Water

CHAPTER 5 - MITIGATION STRATEGIES

Mitigation Action Items (MAIs) are central to the overall purpose of the Multi-Hazard Mitigation Plan (MHMP). As these MAIs are developed, implemented, and reviewed, Klickitat County will build disaster resistance into everyday operations and become more protected from potential losses. For the purposes of this document, mitigation action items are defined as activities designed to reduce or eliminate losses resulting from natural hazards. Losses can include life, physical property, and monetary value.

DEVELOPMENT OF MITIGATION ACTION ITEMS

All MAIs included in this chapter are new for the 2020 MHMP. The MAIs were prepared by representatives from each adopting jurisdiction with the objective of reducing impacts from the natural hazards addressed in this plan: flood, wildland fire, drought, severe weather, earthquake, landslide, and volcano; some items, most of which were response-oriented, were considered to be "multi-hazard". Each member of the planning team served as a representative for their jurisdiction (or entity/department if their action items fall under the county annex) and was responsible for collecting the information required for a complete action item. Each item was then entered into a table where they were organized by the primary hazard for which they were created. A unique ID was then assigned to each action item in order to simplify future communication between entities within the county.

In addition to the basic statement explaining the mitigation action item, the template required additional information regarding the timeline on which the item will be implemented, potential funding source(s), approximate cost, the agency responsible for the project, and mitigation goals that the project addresses.

ACTION ITEM CRITERIA

This section provides a brief overview of how the different fields in the MAI table were populated and the criteria used to assign ratings and values.

DESCRIPTION OF THE PROBLEM

This part of each MAI provides information about what the current issue is, who is affected and why? What is causing the problem or creating concern? If it hasn't become a problem yet, why is it an issue and why does it need to be addressed?

MITIGATION PROJECT SUMMARY

An overview of a proposed solution to the problem is included under this heading. Now that we know what the problem is, what initiative can be taken to solve the problem or, at the very least, reduce risk associated with that problem?

PRIORITY

As part of the preparation process, all action items were prioritized by representatives from the different adopting jurisdictions who were directly involved with the development of the action item; most

departments selected items based on jurisdictional goals, project feasibility, cost, and urgency of implementation.

To help assign a rating/value to each project, the STAPLEE method was used to score each action item based on **S**ocial, **T**echnical, **A**dministrative, **P**olitical, **L**egal, **E**conomic, and **E**nvironmental considerations (Refer to Appendix 5 for more information about the STAPLEE method). Each of these categories is further broken out into additional criteria that are used to score an action item; these other criteria can be seen in Handout 16-7: STAPLEE Criteria Worksheet (Appendix 5). To complete the exercise for an action item, the scoring entity assigned one of the following ratings to each criterion:

- **Plus (+):** This is a favorable aspect of the project. For example, replacing a one-lane bridge with a two-lane bridge in the county would likely be favorable as it relates to community acceptance.
- **Minus (-):** This is an unfavorable aspect of the project. For example, creating a fuel break on a forested parcel of state land may be unfavorable as it relates to community acceptance and public support because of the impact the project will have on aesthetics.
- **Not Applicable (N/A):** This indicates that an aspect or component of a project does not apply. For example, "contributes to economic goals" may not apply to the bridge modification example that was described in the first bullet point.

To calculate a score, the pluses and minuses were changed to either +1 or -1 and added together. The total was then divided by the number of applicable categories (all categories that received a +/- ranking) and multiplied by 100. The idea behind the calculation is that the added score did not account for the total number of positive and negative aspects to a project. For example:

- Project 1: A project with one positive aspect (and the remaining aspects are non-applicable) would have a score of 1.
- Project 2: A project with 12 positive aspects and 11 negative aspects (there are 23 total criteria by which a project is either scored a +1, -1, or NA using the STAPLEE method) also has a total score of 1.
- The argument can be made that, even though both projects have a total score of 1, the first project is a greater priority because it doesn't have any negative aspects (all but one are N/A) while the second project has 11 negative aspects (even though it has 12 positive aspects).
- Therefore, when the scores are divided by the total number of applicable categories (ranging from one to 23) and multiplied by 100, the number of negative aspects is accounted for. So, project 1 has a final score of 100 (A score of 1 divided 1 applicable category, multiplied by 100) while project 2 has a final score of 4.3 (A score of 1 divided by 23 applicable categories, multiplied by 100).

For the purpose of keeping the rating process simple and to help reduce bias, each mitigation action item was ranked relative to the other projects included in that annex; ***the mitigation action items were not ranked across adopting jurisdictions.*** Because it was not uncommon for projects to generate the same STAPLEE score, it was possible for multiple projects to "tie" and have the same STAPLEE score and intra-annex ranking. Excel was the used to rate a jurisdiction's MAIs relative to one another; ratings were derived from the STAPLEE scores.

Lead Agency

The agencies listed in the table may not have developed the action item, but they are responsible for the implementation, status update, and close-out of the respective action item.

Timeline

This is the anticipated amount of time required to complete a mitigation project once it is started.

An estimation was made for either the date of completion or the number of years required to fully implement and complete each project. For those projects that report the anticipated number of years until a project is completed, the number of years reflects the amount of time a project will require to complete once it is started (project start dates are unknown as they are dependent on the availability of funding and other resources).

Funding Sources

This is a short list of grants, agencies, local entities, etc. that could potentially fund the respective mitigation action item. Although not exhaustive, these sources are the most likely to provide funding.

Cost

The value in the cost field in each table is an estimate of what each project will cost. Some estimates are rough and are, therefore, reported as a range while other costs are much more accurate. For projects with much more variable cost projections, a LOW, MEDIUM, HIGH rating was assigned:

- Low: $0 to $25,000
- Medium: $25,000 to $100,000
- High: $100,000 or more

Planning and Mitigation Goals

Mitigation goals are defined as general guidelines that explain what a community wants to achieve in terms of hazard and loss prevention. Goal statements are typically long-range, policy-oriented statements representing community-wide visions.

The following are the mitigation goals that were listed at the beginning of this plan in Chapter 1. They are included here for reference as the mitigation action items were developed for the purpose of addressing or achieving each goal.

Klickitat County Goals:

1. Prioritize the protection of people, structures, infrastructure, and unique ecosystems that contribute to our way of life and the sustainability of the local and regional economy;
2. Identify and evaluate the hazards that could impact the residents of Klickitat County;
3. Educate residents about the unique challenges and benefits of hazard preparedness in the county;

4. Improve enrollment in the National Flood Insurance Program within communities that are at risk to floods through increased outreach and education;
5. Establish and prioritize mitigation strategies in Klickitat County and the adopting jurisdictions;
6. Increase the resilience of local communities, businesses and residents to the impacts of hazards;
7. Encourage collaboration between local stakeholders, residents, organizations, first responders, and various government agencies to promote hazard preparedness through communication, planning and response and;
8. Reduce the impact of hazard events and potential losses incurred by both public and private residents and entities.

KLICKITAT VALLEY HEALTH GOALS:

1. Reduce the impact of hazard events and potential losses incurred on the KVH campus;
2. To educate employees and patients about the unique challenges of emergency preparedness in the area;
3. Consider policies to alleviate potential hazard risks and impact as it relates to future development;
4. Create mitigation priorities and mitigation strategies for the KVH campus;
5. Strategically locate and plan infrastructure and risk reduction projects that take into consideration the impacts of natural hazards and;
6. Coordinate interdepartmentally and with other agencies to ensure that the Emergency Operations Plan is successful and well understood.

FUNDING SOURCES

All the action items listed in the following tables will require some kind of funding, whether it be the donation of a person's time or an expensive improvement project. Different types of projects will apply for funding from a variety of sources that cater specifically to accomplishing the goals of the action item. For example, a culvert replacement project may be eligible for funding from the Natural Resource Conservation Service and the Washington Department of Ecology.

Natural Hazard Mitigation Project Fund-Source Matrix

Common Eligible Projects / Mitigation Programs	Points of Contact Federal / State	Fuels Reduction	Defensible Space	Property Acquisition or Demolition	Property Elevation	Utility Undergrounding	Critical Facility Generator	Vertical Evacuation Structure	Structural Retrofit	Non-Structural Retrofit	Other Infrastructure Retrofit[1]	Water Source Protection or Aquifer Recharge	Slope or Bank Stabilization	Feasibility Study, Mapping, and Design	Planning (Hazard Mitigation or Other)	Flood Risk Reduction Project	Other
BUILD Grants *Description:* Grants support investments in surface transportation infrastructure and are to be awarded on a competitive basis for projects that will have a significant local/regional impact.	U.S. Department of Transportation (USDOT)								✓		✓					✓	Stormwater Reduction
Building Blocks for Sustainable Communities *Description*: This EPA program provides targeted, technical assistance to communities to develop resilience plans, development plans, sustainability strategies, etc.	U.S. Environmental Protection Agency (EPA)													✓	✓		
Community Development Block Grants *Description:* CDBG funds comprehensive plans, limited infrastructure planning/construction, feasibility studies, community action plans. Income and population restrictions apply.	U.S. HUD / WA Department of Commerce								✓		✓			✓	✓		Low-Income Housing
Community Economic Revitalization Board *Description:* CERB provides loan funding to local jurisdictions for public infrastructure to support private business growth and expansion.	WA Department of Commerce								✓		✓						Public-Private Partnerships
Cooperating Technical Partnership Program *Description*: The program creates partnerships between FEMA and qualified local and state partners to create, maintain, and publicize up-to-date flood and other hazard maps and data.	Federal Emergency Management Agency (FEMA)													✓	✓		Outreach Data Collection and Analysis
Drinking Water State Revolving Fund *Description:* The Drinking Water State Revolving Fund (DWSRF) provides loans to drinking water systems to pay for infrastructure improvements. In some cases, partial loan forgiveness is offered.	WA Department of Health / WA Department of Commerce										✓	✓		✓			Drinking Water System Improvements
Emergency Watershed Protection Program *Description:* Emergency recovery measures for runoff retardation and erosion prevention to relieve imminent hazards created by a natural disaster.	Natural Resource Conservation Service (NRCS)										✓	✓	✓			✓	Erosion Prevention and Restoration
Estuary and Salmon Restoration Program *Description:* ESRP provides funding restoration and protection efforts in Puget Sound, including projects such as flood storage, erosion control, and climate resilience measures.	Department of Fish and Wildlife (WA DFW)			✓									✓			✓	Salmon Recovery Ecosystem Restoration
Firewise Fuel Mitigation Grant Program *Description:* The Fuel Mitigation Grant provides a cost share for communities engaged in defensible space and fuels reduction projects.	WA Department of Natural Resources	✓	✓														
Floodplains by Design *Description*: Floodplains by Design is the primary grant program for projects that reduce flood hazards while restoring the natural functions that Washington rivers and floodplains provide.	WA Department of Ecology			✓							✓	✓	✓	✓	✓	✓	

[1] Other Infrastructure Retrofit includes many projects, such as water system seismic upgrades, bridge retrofits, and roadway retrofits.

Washington State Emergency Management – Hazard Mitigation Section – Updated: June 1, 2018

Natural Hazard Mitigation Project Fund-Source Matrix

Flood Mitigation Assistance Grant Program *Description:* FMA provides funding to local jurisdictions and states for projects and planning that reduces or eliminates long-term risk of flood damage to structures insured under the NFIP.	FEMA / WA Emergency Management			✓	✓				✓	✓	✓		✓	Advanced Assistance Only	✓	✓	
Hazard Mitigation Grant Program *Description:* HMGP is authorized statewide after a disaster declaration and is the most flexible of FEMA's three mitigation programs. Jurisdictions must have an approved hazard mitigation plan and projects must be cost effective.	FEMA / WA Emergency Management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	5% Initiative Only	✓	✓	✓	✓	Miscellaneous
Combined Water Quality Funding Program *Description:* Fund sources for projects associated with publicly-owned wastewater and stormwater facilities. The integrated program also funds nonpoint source pollution control activities.	U.S. EPA / WA Department of Ecology										✓	✓		✓			Drinking Water and Wastewater System Improvements
Pre-Disaster Mitigation Grant Program *Description*: Annual program for cost-effective mitigation projects and plans. Jurisdiction must have a current mitigation plan to be eligible.	FEMA / WA Emergency Management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	Miscellaneous
Public Works Board *Description*: Low-interest loans for pre-construction or new construction for replacement/repair of infrastructure for stormwater, solid waste, road, or bridge projects. Emergency loans are available for public projects made necessary by a disaster or imminent threat to public health and safety.	WA Department of Commerce					✓			✓		✓	✓		✓			
Rural Community Assistance Corporation *Description:* Water, wastewater, stormwater, and solid waste planning; environmental work; to assist in developing an application for infrastructure improvements for small, rural communities.	Rural Community Assistance Corporation													✓	✓		
Rural Water Revolving Loan Fund *Description:* The RWLF provides low-cost loans for short-term repair costs, small capital projects, or pre-development costs associated with larger projects to small, rural communities.	National Rural Water Association										✓	✓					Drinking Water and Wastewater System Improvements
USDA Rural Development Grants *Description:* Pre-construction planning, design, construction associated with building, repairing, or improving drinking water, solid waste facilities and wastewater facilities in rural communities.	U.S. Department of Agriculture										✓	✓		✓			
Source Water Protection Grant Program *Description:* Projects and studies to identify solutions to source water protection problems, implement protection plans, or update data that directly benefits source water protection.	WA Department of Health / WA Department of Commerce										✓	✓		✓			
Washington Transportation Improvement Board *Description:* TIB makes and manages street construction and maintenance grants to 320 cities and urban counties.	Transportation Improvement Board										✓					✓	
Urban and Community Forest Program *Description:* Program provides technical, financial, research and educational services to local jurisdictions and organizations for the preservation, protection, and restoration of forestlands.	U.S. Department of Agriculture / WA Department of Natural Resources														✓		Natural Resource Protection Public Information and Education

Washington State Emergency Management – Hazard Mitigation Section – Updated: June 1, 2018

MECHANISMS TO INCORPORATE MITIGATION STRATEGIES

For information on each adopting jurisdiction's planning mechanisms refer to page 6 in Chapter 1 and Appendix 6 for completed capability assessment forms for each adopting jurisdictions. Additional resources that are available to the county are also described in the Funding Sources box in each mitigation action item table.

Klickitat County promotes disaster awareness and preparedness in communities and actively builds resiliency in everyday operations. One strategy that Klickitat County and other adopting jurisdictions will consider and initiate where possible is the implementation of plan activities through existing programs and resources. By using existing resources, the cost of mitigation should be reduced, and the likelihood of project initiation and completion should also be greater since more people and resources required to complete the action are already in place.

Through their resolution of adoption as well as their participation in the planning process, each jurisdiction is aware of and committed to incorporating the risk assessments and mitigation strategies contained herein. It is anticipated that the research, local knowledge, and documentation of hazard conditions coalesced in this document will serve as a tool for decision-makers as new policies, plans, and projects are evaluated.

There are several planning processes and mechanisms in Klickitat County that will either use the risk assessment information presented in this document to inform decisions or will integrate the mitigation strategy directly into capital improvement, infrastructure enhancement, and training projects; prevention campaigns; and land use and development plans. Although not inclusive, the following is a list of mechanisms available to each jurisdiction for incorporating the mitigation requirements:

Conservation Districts

The Conservation Districts will incorporate this plan into their annual and five-year plans (the Underwood Conservation District, for example, has a 5-year long range plan). Funding for mitigation projects may be possible through capital improvements project funding and fees charged to private landowners for services and various types of work.

Klickitat Valley Health

KVH can address emergency planning and preparedness through the KVH Emergency preparedness Committee and the leadership of the Emergency Preparedness Coordinator. Mitigation Action Items will be identified through the Capital Improvements Plan and funding opportunities will be available through capital improvements project funding.

Cities

The cities have various plans into which the HMP will be incorporated and through which mitigation projects will be identified. Mutual aid agreements between the cities and resources through the county can be used to implement mitigation strategies and expand response capabilities. The cities can fund

portions of mitigation projects internally, but most funding would need to come from the various grants listed in the Funding Sources sections.

County

The county will incorporate information from the HMP into various plans, prevention programs, training programs, and mutual aid agreements. Mitigation projects will be identified through the capabilities listed previously and incorporated into the HMP during the annual reviews and 5-year update.

The Klickitat County Emergency Manager is responsible for educating the Board of Commissioners and other County departments as well as city planners on the contents and incorporation requirements of the Multi-Hazard Mitigation Plan. County Emergency Management and other planning Team partners should be aware of the risk assessments and mitigation strategies respective to their jurisdictions and include them in the planning processes and discussions for other types of projects as they come up. The Klickitat County Department of Emergency Management is responsible for ensuring that each participating jurisdiction as well as other partners has a copy of the Multi-Hazard Mitigation Plan readily available for reference purposes. Furthermore, as previously mentioned, the Department of Emergency Management is responsible for annual and 5-year evaluations of the Multi-Hazard Mitigation Plan. The annual meetings will serve a dual purpose of updating the document and refreshing each jurisdiction's memory of the contents and mitigation requirements of Multi-Hazard Mitigation Plan. Members of the planning Team are also responsible for educating decision-makers in their own jurisdictions on the use and incorporation of mitigation requirements of this document into other planning mechanisms such as those listed above.

MITIGATION ACTION ITEMS

KLICKITAT COUNTY ANNEX

KC 1 – Multi-Hazard				
Description of the Problem: The 3 current EMS Stations are not sufficiently covering the County				
Mitigation Project Summary: Establish another two stations that are strategically placed (Glenwood and Wishram areas) to provide proper coverage throughout the County.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 38.5 Rank: 22	EMS District #1	3 to 5 years	Community Development Block Grants	$1.25 to $1.5 million each

KC 2 – Multi-Hazard				
Description of the Problem: Most of Klickitat County Fire and EMS Stations are not currently equipped with appropriate ventilation systems for removing toxic vehicle / apparatus emissions.				
Mitigation Project Summary: Install appropriate ventilation systems in each fire, EMS, and police station in Klickitat County.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 71.4 Rank: 9	Klickitat FD's/EMS District #1	1-3 Years	Individual Fire Districts, EMS Dist. #1, City Police Departments, FEMA pre-disaster mitigation grants	$7,600 each plus installation

KC 3 – Multi-Hazard				
Description of the Problem: Most Klickitat County fire, EMS, and police stations do not have backup power sources.				
Mitigation Project Summary: Install fixed backup generators capable of powering all building critical infrastructure at all existing fire, EMS, and police stations that are not already equipped. Provide the buildings electrical modifications and a permanently installed emergency generator.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 57.1 Rank: 23	Klickitat FD's/EMS District #1	2-3 Years	Individual Fire Districts, EMS Dist. #1, City Police Departments, FEMA pre-disaster mitigation grants	$10K to $15K ea. for approx. $270K total

KC 4 – Multi-Hazard				
Description of the Problem: The Mass Casualty Incident (MCI) trailer is not properly stocked and the EMS district does not have a vehicle sufficiently powered to pull a fully stocked trailer.				
Mitigation Project Summary: Purchase the equipment and supplies necessary to have a properly operating MCI trailer. Purchase and outfit a second MCI trailer for proper coverage of the region. Research and purchase an adequate rig to pull the MCI trailer.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 71.4 Rank: 9	EMS District #1	1 year to stock trailer and 1 to 2 years to purchase a rig	EMS District #1, PDM Grants	$40k to $50k for a tow rig, $80,000 for a new and outfitted MCI trailer.

KC 5 – Multi-Hazard				
Description of the Problem: The EMS District does not have the equipment, PPE, or training to properly assist in the various types of services commonly needed throughout the County. One example is when the District is asked to assist County SAR with rope rescues, they do not have the necessary training or equipment to help.				
Mitigation Project Summary: Identify the equipment and training needed then purchase equipment and provide training to District staff.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 69.2 Rank: 12	EMS District #1	1 to 2 years	EMS Dist. #1, PDM grants	$25k to $50k

KC 6 – Multi-Hazard				
Description of the Problem: The EMS District has two existing stations that are located on hospital property and one has single ingress/egress to the station.				
Mitigation Project Summary: Move the two stations to County owned property in the same areas that they are currently located.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 33.3 Rank: 25	EMS District #1	2 to 4 years	EMS Dist. #1, PDM grants, Community Development Block Grants	$1.25 to $1.5 million for new stations and approx. $50k (ea.) for the land

KC 7 – Multi-Hazard				
Description of the Problem: Fire District 13 occupies 3 buildings, which were initially constructed by volunteers and primarily built for the purpose of keeping apparatus out of the weather. In no way were these buildings constructed or designed in preparation for a seismic event. These buildings may or may not survive an earthquake. If the buildings were made unsafe or unusable due to a serious seismic event, essential fire and EMS services would be difficult or impossible to provide. Remodel and retrofit current facilities to seismic standards.				
Mitigation Project Summary: Provide a buildings seismic evaluation, and appropriate structural modifications				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 38.5 Rank: 22	Klickitat Fire Dist. 13	3-5 Years	KCFD #13, WA State Legislature Capital Projects Appropriations, grants	$40k to $50k for each building

KC 8 – Multi-Hazard				
Description of the Problem: Nonexistent / inadequate water supply system -2 Fire Stations				
Mitigation Project Summary: 2 of 3 Stations are without a reliable water source and the appropriate water delivery system(s) to maintain the station and for fire use. This impacts the ability to properly wash and remove toxins and hazmat from PPE and response personnel, and to safely and fully utilize the facilities' as an emergency assembly point for the public emergency personnel. District fire apparatus are currently getting water for fire suppression use from individual private water sources (wells) as needed, with no municipal water sources nearby or available, as District 13 is located in a very rural part of Klickitat County. Develop reliable water source and water supply system for 2 Fire Stations				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 53.8 Rank: 13	Klickitat Fire Dist. 13	3-5 Years	KCFD #13, WA State Legislature Capital Projects Appropriations, grants	$40k to $50k for each building

KC 9 – Multi-Hazard				
Description of the Problem: Washington Gorge Action Program (WGAP) operates several programs out of their headquarters building in Bingen, including: Programs for Peaceful Living (domestic violence and sexual assault support services); Second Hand Rose (community resource store); administrative office; and food bank hub with a large walk-in cooler and large walk-in freezer. If the building was not usable, it would be difficult to provide those services, which would be especially needed in an emergency. If the food bank was without power for more than a day, there would be a very large amount of spoiled food to be discarded.				
Mitigation Project Summary: Provide the building electrical modifications and a permanently installed emergency generator for the headquarters building, including the large cooler and freezer used by the hub food bank.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 78.9 Rank: 3	WGAP	1-2- years	Klickitat County pre-disaster mitigation program	$9,000

KC 10 – Multi-Hazard				
Description of the Problem: When the next natural or other disaster strikes, WGAP employees will be overworked at their jobs and assisting other WGAP workers helping members of our community. With this training, WGAP employees will have the specific skills needed to assist their friends, neighbors and clients immediately following any type of tragedy.				
Mitigation Project Summary: Provide Emotional First Aid training (part of the Trauma Intervention Program, TIP) to all WGAP employees and others at Goldendale, White Salmon, and Stevenson locations. Contract for the 8-hour seminar at three locations, in collaboration with county and local governments and other human resources agencies.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 52.9 Rank: 14	WGAP	6 months	WGAP's CSBG funding for WGAP employees	$4,000

KC 11 – Earthquake				
Description of the Problem: WGAP occupies a two-story building constructed shortly after World War II. In some ways the building is well prepared for a seismic event. The lower story is concrete, partially embedded in the earth, and the roof has a robust truss structure. The upper story is a wood frame structure. It may or may not survive an earthquake without damage, and the connection of the upper story to the lower story is unknown. If the building was not usable, many WGAP essential services would be difficult or impossible to provide.				
Mitigation Project Summary: Provide a building seismic evaluation, and structural modifications to the headquarters building as indicated by the evaluation.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 44.4 Rank: 18	WGAP	2-3 years	Klickitat County pre-disaster mitigation program	$18,000

KC 12 – Volcano/Landslide				
Description of the Problem: Residents along the White Salmon River are currently exposed to a life-threatening hazard from a lahar (a rapid flow of mud and debris) from Mount Adams. An early detection / warning system is in place at Mount Rainier for a similar hazard, and one is needed at Mount Adams. A warning system for the White Salmon River valley is now being designed and planned, in partnership with the USGS Cascade Volcano Observatory and with the University of California. A detection system pilot project is currently underway. Following detection system deployment, Klickitat County will be responsible for implementing an early warning system (mainly via reverse 9-1-1) and for educating the public about the hazard and the emergency response plans.				
Mitigation Project Summary: Facilitate a lahar detection and warning system for Trout Lake and the White Salmon River valley and educate the public about lahars and emergency response plans.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 36.8 Rank: 24	Emergency Management, Sheriff, Public Works	3-5 years	(1) U.S.G.S., UC at Santa Barbara; WAEMD; U of WA--also Klickitat PUD; Williams Pipeline Co.; WSDOT; U.S.F.S.; (2) the above entities plus FEMA, Washington State	Est. $500,000 for installation and public education, plus annual maintenance and operation costs.

KC 13 – Flood				
Description of the Problem: Hazards resulting from the downstream movement of down woody debris (dead timber produced by recent large wildfires around Mount Adams) on the White Salmon River. The accumulation of woody debris at abutments can potentially turn bridges into water impoundment structures causing flooding, which is what happened in 2016, and may cause more extensive property damage and human casualties.				
Mitigation Project Summary: Evaluate hazards created on the upper White Salmon River by dead timber from large recent burns on Mount Adams making their way downstream and have potential to turn bridges into water impoundment structures.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 41.2 Rank: 20	Public Works	1-2 years	(1) U.S. Forest Service (identifying wood debris sources); (2) FEMA, Washington State	Est. $10,000 - $15,000 for inspection costs and for preparation of a mitigation plan

KC 14 – Volcano				
Description of the Problem: Mount St. Helens is being "reloaded" with new magma at depth now, making another explosive eruption from that volcano a hazard that the county should be prepared to handle. We don't know exactly how long it will be until ash is erupted, or where the winds will be blowing when it happens, but it will happen, and we need to be ready for it.				
Mitigation Project Summary: Obtain air filtration systems for critical facilities housing communications and IT equipment, to protect the equipment from damage due to fine volcanic ash in the air.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 42.9 Rank: 19	Klickitat County and City Public Works	2-3 years	(1) Cities of Bingen, White Salmon, and Goldendale; (2) Grants	Est. $120,000 for equipment and installation costs

KC 15 – Earthquake

Description of the Problem: Public buildings and public safety infra-structure has never been assessed for seismic resilience and structural stability secondary to a major earthquake. The Seismic Hazard Profile projects the possibility of "severe ground shaking" (Modified Mercalli Intensity Scale) during the next major earthquake to affect Klickitat County. Professional structural engineering assessment is needed to determine which critical facilities and infrastructure might need seismic retrofitting to ensure that they do not fail or collapse due to the age and type of building, the substrate they are built upon, and their likelihood of surviving severe shaking during an earthquake.

Mitigation Project Summary: Hire a structural engineering firm to: a) conduct seismic evaluations of public buildings and critical public safety infrastructure to determine the likely resilience of these facilities post-major earthquake b) develop a plan for risk mitigation that includes a prioritized list of retrofit projects with cost and timeline estimates.

Critical facilities would include but are not limited to:

a. Klickitat County Department of Emergency Management - EOC/9-1-1/Dispatch Center
b. Klickitat County Courthouse - Sheriff's Office and Jail
c. Klickitat County Pioneer Center – Sheriff's West End Office, Public Health Dept.
d. Klickitat County Annex Buildings
e. All County Fire/EMS stations
f. Klickitat Valley Health and Skyline Hospitals
g. Goldendale and White Salmon Police Departments
h. City Halls (3)
i. Schools, Community Centers

Priority	Lead Agency	Timeline	Funding Sources	Cost
STAPLEE: 56.5 Rank: 11	KCDEM KC Public Works Cities (3)	2-3 years	Individual entities, Klickitat County, FEMA pre-disaster mitigation grants	$200,000

KC 16 – Volcano

Description of the Problem: River drainages off Mt. Adams have never been assessed to determine the amount of debris that would become part of the mud flow from a lahar or volcanic event.

Mitigation Project Summary: Conduct a survey of debris in river drainages that could become part of a Mt. Adams volcanic or lahar event.

Priority	Lead Agency	Timeline	Funding Sources	Cost
STAPLEE: 4.3 Rank: 34		3-5 years	County, USGS, USFS, grants	$60,000

KC 17 – Multi-Hazard				
Description of the Problem: Klickitat County lacks a backup Emergency Operations Center and backup 9-1-1/Dispatch Center.				
Mitigation Project Summary: Develop a collocated backup EOC & 9-1-1/Dispatch Center in a location separate from the primary EOC & 9-1-1/Dispatch facilities in the Goldendale area.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 39.1 Rank: 21	KCDEM, KC Public Works	3-5 years	County, Cities (3), WA State Legislature Capital Projects appropriation, grants	$1 million

KC 18 – Multi-Hazard				
Description of the Problem: Less than half of the County's residents have signed-up for the Electronic Emergency Notification System to receive public alerts and warnings in the event of emergencies and disasters.				
Mitigation Project Summary: Develop reader boards and or audio public address systems in Goldendale, White Salmon & Bingen that can provide public alert & warning information and emergency alerts to residents and visitors.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 21.7 Rank: 31	KCDEM	2-4 years	County, Cities (3), Wa. State Legislature Capital Projects appropriation, grants	$300,000

KC 19 – Multi-Hazard				
Description of the Problem: Less than half of the County's residents have signed-up for the Electronic Emergency Notification System to receive public alerts and warnings in the event of emergencies and disasters.				
Mitigation Project Summary: Develop local AM or FM radio transmit capabilities in existing Public Safety Radio Sites across Klickitat County that can provide public alert & warning information and emergency alerts to residents and visitors.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 21.7 Rank: 31	KCDEM	2-5 years	County, Cities (3), Wa. State Legislature Capital Projects appropriation, grants	$300,000

KC 20 – Multi-Hazard				
Description of the Problem: The capacity of publicly owned culverts has never been studied, county-wide, to identify potential problem areas during periods of peak drainage or for proactive improvement to avoid potential flooding of houses, public property, roads and vital infrastructure.				
Mitigation Project Summary: Conduct a comprehensive study of publicly owned culverts in the Klickitat County road system.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 30.4 Rank: 27	Klickitat County & City (3) Public Works	2-4 years	Klickitat County, WA State Legislature Capital Projects appropriation, grants	$50,000

KC 21 – Wildland Fire				
Description of the Problem: Many residents in Klickitat County live in areas with only one means of road access. In a wildfire event, the lack of a second means of ingress and egress is problematic and can be life threatening for emergency responders and civilians.				
Mitigation Project Summary: Conduct a survey of roads to determine those residents and locations that have limited access and determine if any road improvements can be made to provide additional egress and ingress and/or better protect access routes by mitigating fuel buildup and other hazards.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 21.7 Rank: 31	KCDEM, KC Public Works	2-4 years	PDM, Firewise Fuel Mitigation Grant Program	$60,000

KC 22 – Multi-Hazard				
Description of the Problem: Limited local funding for all Klickitat County public safety agencies and a lack of paid staff in volunteer fire organizations, makes development and delivery of a comprehensive public awareness/public education program difficult. This results in a lack of information about disasters, disaster preparedness, and appropriate citizen response.				
Mitigation Project Summary: Develop a comprehensive public awareness/public education program that focuses on the hazards that exist or are likely to occur in Klickitat County and provide information on disaster preparedness for residents via an ongoing supply of information through in-person public events and the use of various media. Such programs could emphasize the need to be 2 weeks ready for floods, winter storms, earthquake events etc., wildfire fuels reduction, construction of pre-incident fire lines, etc.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 30.4 Rank: 27	KCDEM	2-5 years	KCDEM, Fire, law enforcement and EMS agencies, grants	$100,000

KC 23 – Multi-Hazard				
Description of the Problem: Limited local funding for all Klickitat County public safety agencies (3 Law, 18 Fire, 1 EMS, 1 Search & Rescue) negatively impact those agencies' ability to provide appropriate equipment (structural and wildfire PPE, foam trailer, Mass Casualty trailer, etc.) and training (fire, EMS, hazardous materials, etc.) for more efficiently dealing with emergency incidents.				
Mitigation Project Summary: Provide equipment and training to public safety agencies through any funding source possible (direct funds, matching grants, contract fees, etc.).				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 56.5 Rank: 11	KCDEM	2-5 years	Individual agencies, grants	$750,000

KC 24 – Multi-Hazard				
Description of the Problem: Klickitat County Public Safety Radio sites (11 separate facilities) are in remote, high elevation locations with difficult access and limited security features to protect vital equipment. Functionality of the sites is essential for to the safety of the public and responders.				
Mitigation Project Summary: Provide security cameras at each location with the ability to transmit video from the remote sites to the Klickitat County Dispatch Center for round the clock monitoring, with recording capabilities to capture evidence when vandalism or theft occurs.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 30.4 Rank: 27	KCDEM	2-3 years	Klickitat County, grants	$200,000

KC 25 – Wildland Fire

Description of the Problem: Most of Klickitat County is sparsely populated, which allows wildfires to grow, without detection, until they are large and present significant control issues to responding personnel.

Mitigation Project Summary: Install wildfire detection video camera systems at some or all 11 Klickitat County Public Safety Radio sites, located in high elevation, remote locations that are ideal for wildfire detection. Creating a wildfire video camera detection system for Klickitat County like the Calfire video camera system (alertwildfire.org).

Priority	Lead Agency	Timeline	Funding Sources	Cost
STAPLEE: 73.9 Rank: 4	Klickitat County Department of Emergency Management	1-2 years	U.S.F.S; BIA, FEMA, Washington State, Klickitat County, local fire districts.	$200,000

KC 26 – Multi-Hazard

Description of the Problem: Klickitat County experiences regular interruption of telephone, internet, and cell phone service provided by utility companies. Some lasting for extended periods of time (multiple days). These outages negatively impact the public's ability to contact emergency service providers and make communication and coordination between the 9-1-1 Dispatch centers in the Upper Columbia River Gorge Region of both Washington and Oregon extremely difficult or non-existent (Klickitat, Skamania, Hood River & Wasco County, Frontier Regional and Columbia River Inter-Tribal fisheries Enforcement). The resiliency of these six Columbia Gorge area 9-1-1 Dispatch Centers is negatively affected by their reliance on the commercial telephone, internet and cellular service providers.

Mitigation Project Summary: Install equipment in existing Public Safety radio sites to create a communication network (that is not public utility reliant) to allow communication/coordination between Klickitat County 9-1-1 and the five other Columbia Gorge area 9-1-1 Dispatch Centers of Hood River County, Skamania County, Wasco County, Frontier Regional 9-1-1 Center, and the Columbia River Inter-tribal Fisheries Enforcement group. The goal is to leverage existing public safety radio systems, microwave networks and IP connectivity at sites of all six entities in order to continuously interconnect all six Upper Columbia River Gorge 9-1-1 Dispatch Centers together using Voice Over IP (VOIP) technology that is much more resilient than current communication services.

Priority	Lead Agency	Timeline	Funding Sources	Cost
STAPLEE: 65.2 Rank: 8	KCDEM	1-3 years	Individual entities listed, Washington State 9-1-1, grants.	$350,000

KC 27 – Wildland Fire				
Description of the Problem: Many areas of Klickitat County have limited and primitive road access. In wildfire events, the lack of improved roads that wildfire apparatus can travel on safely or at all for proper ingress and egress is problematic and can be life threatening for Firefighters and inhibits or delays fire suppression.				
Mitigation Project Summary: Conduct a survey of primitive roads and two track trails in wildfire prone areas to determine those locations that have limited access and determine if any road improvements can be made to provide additional egress and ingress for improved wildfire suppression capabilities. Conduct improvements as recommended by survey.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 76.5 Rank: 2	Klickitat County Public Works	2-4 years	Klickitat County, Firewise Fuel Mitigation Grant Program other grants	$60,000

KC 28 – Wildland Fire				
Description of the Problem: Many grass and pasture land areas along major roadways in Klickitat County are susceptible to wildfires on a regular basis. The lack of fire breaks or trails along these roadways leads to easier ignition and spread of wildfires in many cases.				
Mitigation Project Summary: Conduct a survey of areas along major roadways in Klickitat County that are historically proven to be prone to wildfires to determine the feasibility of creating firebreaks or trails in those locations. Conduct fire break and trailing activities as determined by survey results.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 73.3 Rank: 4	KCDEM	1-3 years	Klickitat County, Firewise Fuel Mitigation Grant Program, other grants	$150,000

KC 29 – Hazardous Materials				
Description of the Problem: Need to Evaluate Specialized Firefighting and Oil-Spill-Containment Capabilities in Klickitat County for Readiness in the Event of Oil-Train Derailment				
Mitigation Project Summary: Expert consultants in this field would assess the (1) equipment available at Klickitat County fire stations near the BNSF rail line on the north side of the Columbia River, (2) assess the training level of firefighting personnel to deal with a fire and oil spill that could arise from a derailment, and (3) assess the likely response times to such an incident (4) provide a report outlining recommended mitigation action items. In addition, they would evaluate the readiness of BNSF emergency crews to deal with such an incident and evaluate interagency (BNSF-county-state-federal) coordination strategy for responding to a major incident.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 50.0 Rank: 32	KCDEM	1-3 years	Klickitat County, relevant KCFD's, USDOT, BNSF, grants	$60,000

KC 30 – Multi-Hazard				
Description of the Problem: Lack of backup power generation solutions for buildings/facilities used for emergency sheltering across Klickitat County.				
Mitigation Project Summary: Outfit buildings with electrical modifications for mobile emergency generator use or a permanently installed emergency generator capable of powering all critical facilities infrastructure at emergency shelter locations that not already equipped with appropriate backup power.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 57.1 Rank: 22	KCDEM	2-3 years	Klickitat County, individual facility owners, Red Cross, Wa. State Legislature Capitol Projects appropriations, FEMA pre-disaster mitigation grant.	$180,000

CITY OF GOLDENDALE

GD 1 – Multi-Hazard				
Description of the Problem: Goldendale airport does not have a fuel system to fuel/refuel aircraft that are responding to emergency situations.				
Mitigation Project Summary: Purchase and install fuel system at municipal airport. The addition of fuel will enable aircrafts from various agencies to respond to a variety of hazards.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 47.4 Rank: 7	Goldendale	1 year	Community Development Block Grants, other grants	$1 Million

GD 2 – Multi-Hazard				
Description of the Problem: The runway at the Goldendale airport is small and in disrepair.				
Mitigation Project Summary: Extend the municipal airport runway. An extended runway will accommodate larger aircrafts and a higher volume of traffic, both of which will facilitate emergency response during natural hazard situations.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 55.6 Rank: 5	Goldendale	1-2 years	Community Development Block Grants, PDM grants	$1.5 Million

GD 3 – Multi-Hazard				
Description of the Problem: The Goldendale Municipal Airport does not feature a helipad				
Mitigation Project Summary: Design and construct a helicopter landing pad at the municipal airport. The addition of this landing area will accommodate helicopters from various agencies that are responding to emergency situations related to natural hazards.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 55.6 Rank: 5	Goldendale	1 year	Community Development Block Grants, PDM grants	$1 Million

GD 4 – Multi-Hazard				
Description of the Problem: Emergency response staging areas in and around Goldendale need to be re-examined and improved.				
Mitigation Project Summary: Design spaces and purchase necessary equipment to outfit FEMA staging areas at hospital, airport, high school, strategic parking lots, and other suitable indoor spaces.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 76.5 Rank: 4	Goldendale	1 year	FEMA grants / funding	$1 Million

GD 5 – Multi-Hazard				
Description of the Problem: The City of Goldendale's public water source, backup wells, water processing/testing facilities, and wastewater treatment plan lack adequate security and, in some cases, functionality, to ward off manmade threats to these systems or otherwise continue to function in the event of a natural catastrophic event that might impact these systems. The ability to protect and maintain the potability and accessibility of water, as well as the ability to process effluent, is critical in the event of various hazards.				
Mitigation Project Summary: Enhance security and functionality of water springs, backup wells, water processing/testing facilities and wastewater treatment plant.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 80.0 Rank: 1	Goldendale	1-3 years	Public Works Board, Rural Community Assistance Corporation, others	$1 Million

GD 6 – Multi-Hazard				
Description of the Problem: The City of Goldendale is currently undertaking a periodic update to its Critical Area Ordinances, as mandated by the Growth Management Act. To better protect critical areas and achieve regulatory consistency with land use decisions pertaining to its critical areas, the City of Goldendale requires accurate mapping of its environmentally sensitive areas. These maps will ensure that development plans adequately account for and mitigate potential hazards associated with such critical areas.				
Mitigation Project Summary: Obtain professional mapping of environmental critical areas to assist city administration in determining and performing critical areas review.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 80.0 Rank: 1	Goldendale	1 year	Community Development Block Grants	$250,000

GD 7 – Wildland Fire				
Description of the Problem: The volunteer fire department only has two fire trucks; a third truck is greatly needed. The City lacks a full-time fire chief, which limits the department's ability to effectively recruit and retain volunteers. The department also lacks proper training and equipment needed to combat both structural and wildland fires.				
Mitigation Project Summary: Obtain equipment and training for fire department. The department needs to obtain funding for a new fire truck, to support the salary of a fulltime Chief, and to purchase equipment/training so volunteers can combat fires safely and effectively/				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 80.0 Rank: 1	KCDEM	1 years	Pre-Disaster Mitigation Grant Program	$1 Million

CITY OF WHITE SALMON

WS 1 – Earthquake				
Description of the Problem: Failing Water Mainline. City of White Salmon's water system is a regional system that provides water to Skamania County, Klickitat County, White Salmon, Bingen and the Port of Klickitat. If the mainline fails, the City of White Salmon will not be able to provide water for drinking or fire protection to the area.				
Mitigation Project Summary: Design and replace water mainline to withstand seismic activity; and provide uninterrupted water service and maintain water quality.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 81.0 Rank: 1	City of White Salmon	3 to 5 years	Any water-related grants under Funding Sources	$10 million

WS 2 – Multi-Hazard				
Description of the Problem: White Salmon River Slow Sand Filter Plant. Provide a redundant water source to reduce dependency on Buck Creek in case of drought, flood or seismic activity.				
Mitigation Project Summary: Design and construct a slow sand water treatment plant on the White Salmon River for redundancy during emergencies. City of White Salmon's water system is a regional system that provides water to Skamania County, Klickitat County, White Salmon, Bingen and Port District. Without redundancy the City of White Salmon cannot provide adequate water service in our current plant and/or well field fail to operate because storm events and/or mechanical failures.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 54.5 Rank: 2	City of White Salmon	Current to 10 years	Any water-related grants under Funding Sources	$11 million

WS 3 – Severe Weather				
Description of the Problem: Storm Water Master Plan				
Mitigation Project Summary: Develop a Stormwater Master Plan that evaluates shed conditions and utilizes information to implement improvement plans to capture, control, treat and discharge storm water in a responsible manner that protects stream tributaries water quality for fish habitat. Information will also be utilized to create a stormwater district.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 73.9 Rank: 3	City of White Salmon	2 to 6 years.	Water and planning-related grants under Funding Sources	$500,000

WS 4 – Multi-Hazard				
Description of the Problem: Wastewater Collection improvement. The City of White Salmon's wastewater collection system needs to be updated to better protect it from seismic and flood damage.				
Mitigation Project Summary: Replace failing and /or outdated infrastructure with current construction practices and materials that withstand seismic activity. Currently most of the City of White Salmon sewer collection system is constructed of concrete which will easily fail during seismic activity or landslides. In addition, these improvements will also eliminate I and I.				
Priority 4	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 72.7 Rank: 4	City of White Salmon	2 to 25 year	Any wastewater-related grants under Funding Sources	$12 million

WS 5 – Multi-Hazard				
Description of the Problem: Dock Grade Street Stabilization Reconstruction Project. Egress from White Salmon needs to be improved for evacuation and emergency response in the event of a natural disaster.				
Mitigation Project Summary: Dock Grade is one of the main entry points to the City of White Salmon. The project would stabilize the cut and fill portions of the road base as well as widen for two-way traffic and pedestrian use. The road is currently subject to annual rock and land slide and is often shutdown in adverse weather conditions. During these events, emergency response takes approximately 10 minutes longer to respond from the upper to lower White Salmon. The White Salmon fire department currently responds through Bingen to emergencies in lower White Salmon.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 56.5 Rank: 5	City of White Salmon	2 to 10 years	Build Grants, Community Development Block Grants, Community Economic Revitalization Board	$6 million

WS 6 – Multi-Hazard				
Description of the Problem: Los Altos reservoir pump station does not have a backup generator. Drinking water and water for fire protection will be lost in case of a power outage due to flood, seismic activity, wildfire and storms.				
Mitigation Project Summary: Obtain generator to power pumps at Los Altos reservoir to pump water to Strawberry mountain reservoirs. The Strawberry mountain reservoirs supply water to the Strawberry mountain area and the area north of White Salmon (including Columbia High School, Henkle Middle School, Head Start and others. If power is out for an extended period the water will drain from the reservoirs.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 47.8 Rank: 6	City of White Salmon	1 to 5 years	Water and planning-related grants under Funding Sources	$50,000

KLICKITAT VALLEY HEALTH

KVH 1 – Multi-Hazard				
Description of the Problem: Active Shooter/Bomb Threat possible on KVH campus.				
Mitigation Project Summary: To increase security on the KVH campus for the safety of employees and the public, an assessment and system design needs to be completed by a Security Consultant. The system should include lock down buttons for Emergency Dept., a new reception desk with additional security features, and Lock down buttons and control for FM doors.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 64.7 Rank: 5	KVH	2-3 years	Nonprofit Security Grant Program	Approx. $157,000

KVH 2 – Severe Weather				
Description of the Problem: Loss of power resulting from severe weather (particularly extreme heat and cold). A power loss could endanger staff and patients, or negatively impact the facility's ability to provide services to the public.				
Mitigation Project Summary: Power loss is one of the biggest risks to KVH during extreme cold weather events. Installation of a campus microgrid with electrical service upgrade and new NG generators is the best way to mitigate this risk.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 45.5 Rank: 12	KVH	2 years	Pre-Disaster Mitigation Grant Program	$5.8 million (based on assessment by Apollo)

KVH 3 – Severe Weather				
Description of the Problem: Ice storm/Extreme Cold/Snowfall/Blizzard could potentially damage the roof of the facility.				
Mitigation Project Summary: Increase the resilience of the campuses roofing to withstand various extreme weather events. Complete re-roofing project with flashing designed to withstand ice, additional insulation in roof members, proper scuppers and drain system repair.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 52.9 Rank: 10	KVH	1 month	Community Development Block Grant, PDM Grants, Kresge Foundation Grants	$1.6 million (based on estimate from Tempco Roofing in 2017)

KVH 4 – Severe Weather				
Description of the Problem: Ice storm/Extreme Cold/Snowfall/Blizzard present hazards to employees commuting to and from the facility.				
Mitigation Project Summary: Increase employee safety by leveling the front parking lot to mitigate slip hazards and improve conditions for vehicle traffic.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 66.7 Rank: 4	KVH	1 month	Community Development Block Grant, PDM Grants, Kresge Foundation Grants	$750,000 (estimate from Pioneer engineering)

KVH 5 – Severe Weather				
Description of the Problem: Ice storm/Extreme Cold/Snowfall/Blizzard conditions present challenges related to snow removal on campus.				
Mitigation Project Summary: Purchase Bobcat snow removal equipment to speed up snow removal and get piles of snow out of parking spaces. Efficient snow removal will increase accessibility during extreme winter weather for both staff and the public, increase safety in getting to and from the KVH campus, and minimize staff time spent on snow removal.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 75.0 Rank: 1	KVH	Immediate once purchased	Community Development Block Grant, PDM Grants, Kresge Foundation Grants	$25,000

KVH 6 – Severe Weather				
Description of the Problem: Extreme wind conditions have blown open the front doors of the building.				
Mitigation Project Summary: The front doors into registration and the Emergency Dept cannot withstand extreme winds and have blown open during windstorms and come off their hinges. Upgrading the doors will increase the safety of staff and patients and mitigate the risk of injury.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 62.5 Rank: 6	KVH	1 month	Community Development Block Grant, PDM Grants, Kresge Foundation Grants	$32,000

KVH 7 – Severe Weather				
Description of the Problem: Ice storm/Extreme Cold/Snowfall/Blizzard increase risk related to helicopter landing and departure at the facility.				
Mitigation Project Summary: Increase the ability for helicopters to safely land on the KVH helipad. The helipad is falling apart due to ice and a bad reaction with the paint & concrete. It needs a hydronic loop from our boiler system to keep it ice free during extreme weather events. The pad lights have also been broken off during snow and ice removal - these need to be embedded into the concrete and flush.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 68.4 Rank: 3	KVH	1 month	Community Development Block Grant, PDM Grants, Kresge Foundation Grants	$22,000

KVH 8 – Severe Weather				
Description of the Problem: Extreme Weather could cause an HVAC failure at the facility.				
Mitigation Project Summary: HVAC Heating and Cooling systems at the facility are inefficient and lack redundancy. A backup system would mitigate the risk of patient death if an HVAC failure coincided with an extreme weather event and decrease the cost to KVH by increasing efficiency in the system.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 45.5 Rank: 12	KVH	2 years	Community Development Block Grant, PDM Grants, Kresge Foundation Grants	$5 million (based on estimate by Apollo)

KVH 9 – Multi-Hazard				
Description of the Problem: The facility lacks adequate backup communication systems.				
Mitigation Project Summary: To have a backup system for communications if phone, internet, radios were not working; redundant internet connection via satellite.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 62.5 Rank: 6	KVH	1 to 2 months	Nonprofit Security Grant Program	$26,000

KVH 10 – Multi-Hazard				
Description of the Problem: Communications and data storage/access can be interrupted by a loss of power.				
Mitigation Project Summary: Communication systems and data storage are often affected by natural disasters, resulting in downtime. The campus wide microgrid project with a central, solar supported UPS is the best way to mitigate this down time.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 45.5 Rank: 12	KVH	2 years	PDM Grants	$540,000 (for solar supported UPS only)

KVH 11 – Multi-Hazard				
Description of the Problem: Wildfire/Forest Fire/Extreme Heat can cause or increase risk associated with power outages at the facility.				
Mitigation Project Summary: Power loss is one of the biggest risks to KVH during fire events. A campus microgrid with electrical service upgrade and new NG generators is the best way to mitigate this risk and reduce the possibility of power loss during a fire event.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 45.5 Rank: 12	KVH	2 years	PDM Grants	See cost above in MAI No. 2

KVH 12 – Wildland Fire				
Description of the Problem: Wildfire/Forest Fire produce smoke that affects air quality inside of the facility, potentially harming sensitive occupations.				
Mitigation Project Summary: Increase DDC control and filtration on outdoor air intake system to keep smoke out of the building. This measure will reduce the possibility of smoke inhalation by staff and patients inside the KVH campus buildings during a fire event.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 62.5 Rank:6	KVH	1 month	PDM Grants	$120,000

KVH 13 – Multi-Hazard				
Description of the Problem: Supply chain shortage/failure (as a result of a Natural Disaster), specifically the loss of food and other refrigerated items as a result of a power outage.				
Mitigation Project Summary: Currently the Dietary Dept has no back up power and we would lose everything in the walk-in coolers. This can most effectively be addressed by the campus microgrid project which would help reduce loss of food and maintain food supplies for staff and patients during an emergency event/power outage.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 45.5 Rank: 12	KVH	2 years	PDM Grants	See cost above in MAI No. 2

KVH 14 – Multi-Hazard				
Description of the Problem: Supply chain shortage/failure (as a result of a Natural Disaster), specifically the ability to store materials, supplies, and resources on-campus.				
Mitigation Project Summary: Add additional onsite storage facility in order to be able to store materials, supplies and resources on-site, increasing efficiency and reducing dependency on shipments during hazard events.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 62.5 Rank: 6	KVH	1 month	Community Development Block Grant, PDM Grants, Kresge Foundation Grants	$85,000

KVH 15 – Multi-Hazard				
Description of the Problem: There are staffing insufficiencies at KVH related to emergency planning.				
Mitigation Project Summary: Hire a full-time Emergency Preparedness Coordinator To increase emergency planning and preparedness capabilities for the KVH campus (currently this is a 10 hr/week position with no outside funding).				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 52.9 Rank: 10	KVH	ongoing	Internal, grants that fund paid positions	$60,000

KVH 16 – Multi-Hazard				
Description of the Problem: Staff training to help increase the preparedness of the KVH campus.				
Mitigation Project Summary: Trainings and training equipment for staff - Hazmat suits, POD, De-escalation etc. – would improve preparedness of the entire KVH campus and staff.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 41.2 Rank: 18	KVH	Ongoing	Department of Labor training grants	Approx. $20,000

KVH 17 – Multi-Hazard				
Description of the Problem: Heating and cooling could be lost as the result of a regional catastrophe such as Cascadia Rising.				
Mitigation Project Summary: To create a unique and self-supporting heating/cooling system that could be utilized in the event of a regional catastrophe. A district heating/cooling and microgrid system will support KVH, Middle School, High School and Elementary Schools so that all facilities can work together to offer support during regional disaster scenarios like Cascadia Rising.				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 45.5 Rank: 12	KVH	3-5 years	Community Development Block Grants, PDM Grants	Approx. $30 million

KVH 18 – Multi-Hazard				
Description of the Problem: The current fire alarm system often malfunctions, and it is a difficult system to troubleshoot.				
Mitigation Project Summary: Fire alarm system replacement/upgrade				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 70.0 Rank: 2	KVH	1 year	PDM Grants	$150,000

UNDERWOOD CONSERVATION DISTRICT

UCD 1 – Wildland Fire				
Description of the Problem: There are several communities and many individual homes in the wildland urban interface (WUI) in Klickitat County. Many homeowners are aware of the importance of treating fuels and creating defensible space around their homes, but some do not know, and others may need help maintaining their defensible space. There is a need for homeowner/landowner assistance in the county as it relates to wildfire and defensible space.				
Mitigation Project Summary: Defensible space and wildfire community resilience (aka, "Firewise" program)				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 53.8 Rank: 2	UCD	Depending on funding, 2020 through 2025?	Partnerships: Wa-DNR, homeowner associations / local communities Potential funding source: Wa-DNR	$30,000 - $60,000 / year

UCD 2 – Drought				
Description of the Problem: Predictable outcomes of prolonged drought include lowering of localized and regional water tables and decreases in surface streamflow. Similar outcomes are expected from the ongoing reduction in the areas and volumes of glaciers and snowpacks on Mount Adams due to global warming, at least for communities in the White Salmon and Klickitat River watersheds. The U.S. Geological Survey Water Resources office in Tacoma, WA, recently completed a detailed regional study of water availability in the Columbia Basin, at present and under future climate scenarios. They could be engaged by the county to do a more specific evaluation for Klickitat County, based on their regional assessment and projected population growth, with forecasts of how soon County water supplies could be seriously affected.				
Mitigation Project Summary: Evaluate Municipal Water Supplies and Select Private Water Sources for Vulnerability to Prolonged Drought				
Priority	**Lead Agency**	**Timeline**	**Funding Sources**	**Cost**
STAPLEE: 64.7 Rank: 1	UCD	1 to 2 years; 2022?	Partnerships: County agencies, Wa-Dept. of Ecology, local communities Potential funding source: uncertain	$100,000

CURRENT WILDFIRE MITIGATION ACTIVITIES

The county's fire departments and agencies are actively working on public education and homeowner responsibility by visiting neighborhoods and schools to explain fire hazards to citizens. Often, they hand deliver informative brochures and encourage homeowners to have their driveways clearly marked with their addresses to ensure more rapid and accurate response to calls and better access.

PUBLIC EDUCATION PROGRAMS

Many of the county's fire departments and agencies are actively working on public education and homeowner responsibility by visiting neighborhoods and schools to explain fire hazards to citizens. Often, they hand deliver informative brochures and encourage homeowners to have their driveways clearly marked with their addresses to ensure more rapid and accurate response to calls and better access.

MUTUAL AID AGREEMENTS

Currently the cities, towns, fire protection districts, and wildland fire agencies within Klickitat County have extensive mutual aid agreements that serve to increase the protection and effectiveness of all Klickitat County fire response jurisdictions. Municipal and county fire departments fully provide mutual aid for each other to the extent possible. These agreements significantly improve the capabilities and effectiveness of any and all individual fire departments as well as aid the state and federal wildland fire teams. Not only does this improve the safety of Klickitat County residents, structures, infrastructure, and lands, but it also facilitates good interdepartmental working relationships.

WASHINGTON DNR WILDLAND FIRE PROTECTION STRATEGIC PLANNING

Washington's record fire seasons in 2014 and 2015 were devastating: the loss of life, homes, and structures; damage to fish and wildlife habitat and other natural and cultural resources; local communities suffering from a loss of visitors and revenue, and poor air quality. The state spent millions of dollars in direct suppression costs, and millions more were spent mitigating the social, cultural, and economic impacts from these fires. These seasons—and this year's fire season across the west—represent a trend of large, uncharacteristic wildfires that is expected to continue with no end in sight.

The state's future Wildland Fire Protection Strategic Plan will provide a blueprint for effective wildland fire protection in Washington and inform associated policy and resource decisions. The plan is the next phase in an overall strategy to fundamentally change the future trajectory of wildland fire in Washington. It follows the recent roll-out of the state's 20-Year Forest Health Strategic Plan, which establishes a framework to systematically treat broad forest landscapes to improve forest health and reduce the risk of uncharacteristic wildfires. The plan is also anchored in the National Cohesive Wildland Fire Management Strategy and shares its focus on resilient landscapes, fire-adapted communities, and safe, effective wildfire response. Additionally, the plan will focus on wildfire prevention and reducing human-caused ignitions.

WASHINGTON DNR LANDOWNER ASSISTANCE PROGRAM

The Following information was taken from the Washington DNR Forest Highlights Brief 2018 and was written for private landowners.

If you own forest land in eastern Washington, the odds are that your property is in a less-than-healthy condition and at increased risk of damage from threats like wildfire and bark beetles.

The Eastern Washington Forest Landowner Cost-Share Program can provide you with professional forestry advice and financial assistance to help you significantly improve the health of your forest and substantially reduce the threat of future damage and loss.

- How does the program work?
    - The program can reimburse approved applicants for up to 50% of their cost
    - Eligible practices include:
        - Thinning
        - Pruning
        - Slash (forest debris) Disposal
        - Preparation of a Forest Stewardship Plan by a private consulting forester.
- Contact your landowner assistance forester or apply online to get the process started.
    - In Klickitat County DNR offices are located in Goldendale and Husum.
        - Husum: 509-493-3218
        - Goldendale: 509-773-5588

WASHINGTON DEPARTMENT OF ECOLOGY

The Washington Department of Ecology Air Quality Program protects public health and the environment from pollutants caused by vehicles, outdoor and indoor burning, and industry. The DOE oversees permitting for non-forested (i.e. agriculture and rangeland) burning. Klickitat County falls under the jurisdiction of the Central Regional Office (CRO).

The CRO can be reached at: 509-575-2490.

WASHINGTON STATE SMOKE MANAGEMENT PLAN

The Department of Natural Resources (DNR), Department of Ecology (DOE), U.S. Forest Service (USDA), National Park Service (NPS), Bureau of Land Management (BLM), U.S Fish and Wildlife Service (USFWS), participating Indian nations, military installations (DOD), and small and large forest landowners have worked together to deal with the effect of outdoor burning on air.

Protection of public health and preservation of the natural attractions of the state are high priorities and can be accomplished along with a limited, but necessary, outdoor burning program. Public health, public safety, and forest health can all be served through the application of the provisions of Washington State law and this plan, and with the willingness of those who do outdoor burning on forest lands to further reduce the negative effects of their burning.

The Washington State Smoke Management Plan pertains to DNR-regulated silvicultural outdoor burning only and does not include agricultural outdoor burning or outdoor burning that occurs on improved property. Although the portion of total outdoor burning covered by this plan is less than 10 percent of the total air pollution in Washington, it remains a significant and visible source.

The purpose of the Washington State Smoke Management Plan is to coordinate and facilitate the statewide regulation of prescribed outdoor burning on lands protected by the DNR and on unimproved, federally managed forest lands and participating tribal lands. The plan is designed to meet the requirements of the Washington Clean Air Act.

The plan provides regulatory direction, operating procedures, and advisory information regarding the management of smoke and fuels on the forest lands of Washington State. It applies to all persons, landowners, companies, state and federal land management agencies, and others who do outdoor burning in Washington State on lands where the DNR provides fire protection, or where such burning occurs on federally-managed, unimproved forest lands and tribal lands of participating Indian nations in the state.

The plan does not apply to agricultural outdoor burning and open burning as defined by Washington Administrative Code (WAC) 173-425-030 (1) and (2), nor to burning done "by rule" under WAC 332-24 or on non-forested wildlands (e.g., range lands). All future reference to burning in this plan will refer only to silvicultural burning unless otherwise indicated.

APPENDICES

APPENDIX 1: FIRE PROTECTION SYSTEM

OVERVIEW

The Department of Interior (DOI), United States Forest Service, State, Tribes, Counties, and local governments maintain operational wildland fire organizations. These are supplemented by volunteer organizations such as volunteer fire departments and rangeland protection associations. In DOI, the operational fire organizations reside in Bureau of Land Management, National Park Service, U.S. Fish and Wildlife Service, and Bureau of Indian Affairs. Other organizations such as US Fire Administration and U.S. Geological Survey have fire expertise that supports and partners with the operational fire organizations. The Office of Wildland Fire at DOI provides budget and policy coordination, leadership, and oversight for the operational programs within DOI. Several chartered interagency groups exist to provide coordination and consistency among wildland fire organizations to ensure policy and operational consistency and interoperability.

LOCAL FIRE DEPARTMENT AND DISTRICT SUMMARIES

The firefighting resources and capabilities information provided in this section is a summary of information provided by the fire chiefs or representatives of the wildland firefighting agencies listed. Each organization completed a survey with written responses. Their answers to a variety of questions are summarized here. These synopses indicate their perceptions and information summaries. Also included in this section is a map of Klickitat County fire districts and their boundaries (Figure 65).

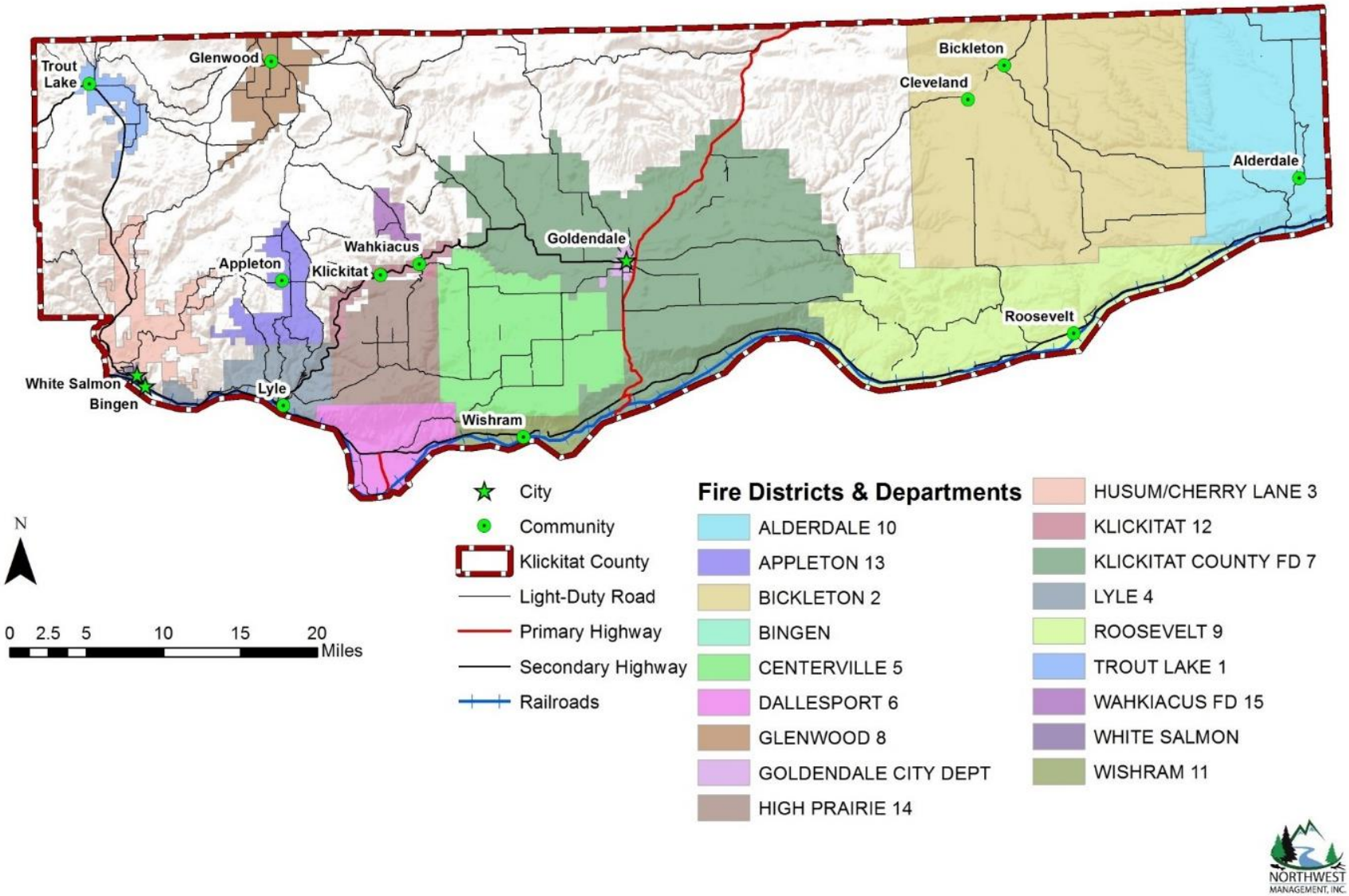


Figure 65) Klickitat County Fire Districts map.

Bingen Fire Department

District Summary: The Bingen Fire Department covers 0.8 square miles within the city of Bingen. This district is staffed by 14 volunteer firefighters and has access to the vehicles listed in Table 53.

Table 53) Available firefighting resources for Bingen Fire Department.

Equipment	Year	Make	Tank Size (Gallons)	Type	Pump GPM	License #	VIN #	Other Info
Engine 33	2004	E-One Typhoon	1000	S1	1500	19139D	4EN6AAA8441009091	Class A Foam
Engine 34	1976	American R200HD	1000	S1	1250	09753D	3574121875	Class B Foam
Engine 35	1969	Ford F-600 Western States	750	S2	700	D8534	F80FUE16072	Class A, B Foam
Tender 36	1977	Ford Cabover	3000	T2	300	19100D	X90JVL72543	
Brush 37	1979	Chev K2500 4x4	200	B6	250	13802D	CKL249J154964	

Goldendale Fire Department

District Summary: The City of Goldendale Volunteer Fire Department is a volunteer organization; it is not staffed with any full-time fire fighters. The department typically maintains between 20 and 30 members but can have as many as 36 members. The Goldendale Volunteer Fire Department covers approximately 2.9 square miles.

Table 54) Available firefighting resources for Goldendale Fire Department.

Equipment Number	Year	Make	Tank Size (Gallons)	Type	Pump (GPM)	License Number	Vin Number	Other	Available for Mobilization
E 61-11	2004	HME	780	S1	1500	32118D	44KFT42845WZ20627	Class A Foam	Yes
E 61-12	1998	Pierce	500	S1	1250	19114D	P1CT0202WA000795		Yes
61-15		FIRE STATION	N/A	N/A	N/A	N/A	N/A		N/A
B 61-21	1994	GMC 3/4 Ton 4x4	275	B6	50			Class A Foam	Yes
S 61-23	1999	Ford F350	TRAUMA VERIFIED BLS AID UNIT			19190D	1FDWE30FOX4A87536		No

S 61-24	1986	Chevrolet G-30 1 Ton	BREATHING AIR SUPPORT			32157D	2GDHG3E1M3E4530230	Set up for Rehab Cascade air supply	Yes
T 61-31	2002	TENDER	3000	T3	60				Yes
B 61-51	1969	Jeep M3521, 1 1/4 Ton 4x4	200	B6	60	1282D	35966	Class A Foam	Yes
B 61-52	2014	Ford F-450 Ext. Cab 4x4	500	B3	150	32155D	2FTJW36G3JCA09472	Class A Foam	Yes
B 61-53	1994	Chevrolet G-20 3/4 Ton 4x4	200	B6	60	19107D	1GGK263294	Class A Foam	Yes
E 61-64	1972	Seagrave	500	S1	1500	01281D	PB25068	UL Rated	No

White Salmon Fire Department

District Summary: The White Salmon Fire Department covers 1.25 square miles. The department encompasses the city of White Salmon, which lies along the Columbia River in the western portion of Klickitat County.

Klickitat County Fire District 1 (Trout Lake)

District Summary: KCFD #1 covers slightly more than 13 square miles. The land consists mostly of hay and pasture ground, with some agriculture and timber interspersed.

Klickitat County Fire District 2 (Bickleton)

District Summary: KCFD #2 protects 290 square miles consisting of farm ground, shrublands and minor amounts of timber. Paging is handled by the Klickitat Department of Emergency Management.

Klickitat County Fire District 3 (Husum)

District Summary: KCFD #3 consists of a mix of timber and agriculture. It covers 38 square miles. The department consists of 30 volunteer firefighters and one paid fire chief. This district covers almost 40 square miles and is in the southwestern portion of Klickitat County, with its majority to the north of the city of White Salmon. Table 55 lists available resources for KCFD #3.

Table 55) Available firefighting resources for Klickitat County Fire District #3.

Equipment Number	Year	Make	Tank Size (Gallons)	Type	Pump (GPM)	License Number	Vin Number	Other	Available for Mobilization
				Type-1 Engine					
				Type-1 Engine					
				Type-1 Tender					
				Type-1 Tender					
				Type-3 Brush/Engine					
				Type 6 Brush					
				Reserve Engine					
				Utility Vehicle					
				Utility Vehicle					
				Passenger School Bus					

KLICKITAT COUNTY FIRE DISTRICT 4 (LYLE)

District Summary: KCFD #4 consists of 30 volunteer firefighters and covers 32 square miles along the Columbia River and the encompasses the hills north and west of the city of Lyle. The land consists mostly of shrubland, with some timber. As with any volunteer-based department, the largest need in the District is more volunteers, while there are plenty of volunteers that are trained and willing to respond many have jobs that require travel outside of the District making them unavailable for response. Table 56 lists available resources for KCFPD #4.

Table 56) Available firefighting resources for Klickitat County Fire District #4.

Equipment Number	Year	Make	Tank Size (Gallons)	Type	Pump (GPM)	License Number	Vin Number	Other	Available for Mobilization
C400	2000	Ford 4x4	N/A					Command	
E401	2003	Freightliner	1000	S1	1250			Structure w/ foam	
E404	1991	International	500	S3	1000			Structure w/ foam	
T405	1984	Kenworth	3000	T2	300			Tender w/ pump	
A406	1996	Ford 4x4	N/A		N/A			Aid/Rescue truck	
B408	1993	International	750	B3	200			Brush w/foam	

B409	1991	International	750	B3	200	Brush w/foam
B411	1996	GMC 4x4	450	B4	200	Brush w/foam
B411	1991	Ford F-450	200	B6	100	Brush w/foam

Klickitat County Fire District 5 (Centerville)

District Summary: KCFD #5 currently has 25 volunteers serving a population of approximately 700 residents spread over 102 square miles. The fire station is located in the town of Centerville with 3 trucks stationed remotely during fire season. The primary land use in this area is dryland agriculture, and much of the district is shrubland. The south, east, and western regions of the district have channeled scablands. The district also protects 24 sections of state and federal land.

Klickitat County Fire District 6 (Dallesport)

District Summary: KCFD #6 encompasses 38 square miles and serves a population of approximately 2,000. There are 18 volunteer firefighters serving Dallesport District. Presently, all of the district's communication equipment is capable of narrow banding.

Klickitat County Fire District 7 Fire & Rescue (Goldendale)

District Summary: KCFD #7 is staffed by 24 part-time firefighters. It is 272 square miles and surrounds the city of Goldendale. The primary land cover in the district is agriculture, with scrubland interspersed, as well as timber. The city of Goldendale has its own fire department.

Klickitat County Fire District 8 (Glenwood)

District Summary: KCFD #8 is located in the northwestern portion of Klickitat County, Washington. It consists of 26 square miles and is staffed by 13 volunteer firefighters. The primary land use is hay and pasture.

KLICKITAT COUNTY FIRE DISTRICT 9 (ROOSEVELT)

District Summary: KCFD #9 covers 145 square miles. It is located in the eastern portion of the County and the Columbia River borders it on the south. The land consists mostly of shrubland with some agriculture. Table 57 lists available resources for KCFD #9.

Table 57) Available firefighting resources for Klickitat County Fire District #9.

Equipment Number	Year	Make	Tank Size (Gallons)	Type	Pump (GPM)	License Number	Vin Number	Other	Available for Mobilization
902	2003	Ford F250	30	Type-7 Command	CAFS				
903	1970	American	1000	Type-4	61				
904	1985	Am Gen	1000	Type-4	140				
906	1982	Am Gen	1000	Type-5	140				
907	1998	Ford F350	N/A	Aid Car-BLS	N/A				
909	2001	Ford F350	300	Type-6	100				
910	1963	Peterbilt	4500	Tender-1	850				
911	1999	E One Pumper	750	Type-1	1000				
912	2002	Ford F350	300	Type-6	140				
914	2008	LMTV	750	Type-4	250				
915	1977	GMC	1500	Tac Tender-1	140				
916	1977	GMC	1500	Tac Tender-1	140				
918	2004	Freightliner F70	625	Type-4	850				
920	2010	Freightliner M916A1	3100	Tac Tender-1	850				
926	2008	Ford F550	300	Type-6	140				

KLICKITAT COUNTY FIRE DISTRICT 10 (ALDERDALE)

District Summary: Covering roughly 128 square miles KCFD #10 services the eastern portion of the County, where the fuels consist of agriculture and sagebrush/grass understory. KCFD #10 typically response to 10-20 fires per season, with half of responses as aid to neighboring districts. The District relies on volunteers, and is currently staffed by 25 volunteers. Table 58 lists available resources for KCFD #10.

Table 58) Available firefighting resources for Klickitat County Fire District #10.

Equipment Number	Year	Make	Tank Size (Gallons)	Type	Pump (GPM)	License Number	Vin Number	Other	Available for Mobilization
1051		Chevrolet	N/A	N/A	N/A				
1004	1992	Ford	N/A	N/A	N/A				
Fire Buggy		Polaris	100	Type 7	50				
1011	1984	GMC	300	Type 6	150				
1012	1987	Chevrolet	300	Type 6	150				
1013	1992	Ford	300	Type 6	150/Foam				
1014	1984	Chevrolet	500	Type 6	150/Foam				
1015	1983	Jeep/Kaiser	1000	Type 4	150				
1016	1977	Jeep/Kaiser	1000	Type 4	150				
1017	1984	Jeep/Kaiser	1000	Type 4	150				
1018		Jeep/Kaiser	1000	Type 4	150				
1019	2004	Stewart and Stevenson	500	Type 6	150				
1020		Freightliner	5000	Type 2	300				
1021			1500	Type 3	150/300				
1031	1964	Ford	1000		1000				
1051	1979	Ford	750		1000				

KLICKITAT COUNTY FIRE DISTRICT 11 (WISHRAM)

District Summary: KCFD #11 covers almost 17 square miles. The district encompasses the town of Wishram, and the land cover is primarily shrubland and herbaceous cover. Table 59 lists available resources for KCFD #11.

Table 59) Available firefighting resources for Klickitat County Fire District #11.

Equipment Number	Year	Make	Tank Size (Gallons)	Type	Pump (GPM)	License Number	Vin Number	Other	Available for Mobilization
C1100	1997	Ford Exp		Command		902088	1FMFU18L4VLB14832	Command	Yes
A1101	1989	Ford Econoline		Aid		65123C	1FDHS34M1KHC39147	Aid Vehicle	
T1102	1966	White Diesel	4000	T2	500	33725C	671337	2.5" Monitor	County
B1103	1966	Jeep 1 1/4 Ton 4x4	250	B6	150	C41980	11630		County
B1104	1994	Ford F350 4x4	250	B6	150	31920C	2FTHF36RCA500088	Medical Supplies	Yes
E1105	1996	Hend	750	S1	1500	B2792C	44KFT4284TWZ18180	Structure	County
T1106	2005	International	3000	T2	1000	65162C	1HTWYAHT25J036820	2.5" Monitor, Foam	Yes
B1107	1973	Ford F250 4x4	250	B6	150	74581C	F28YRR83643		Yes
R11	1985	International 1800 4x4	125	Rescue	35	33743C	1HTLFHXN5FHA40005	Rescue Truck	County
B1108	1999	Ford F450 4x4	300	B6	150	96767C	1FDXF47FXXEB00615		County

Klickitat County Fire District 12 (Klickitat)

District Summary: KCFD #12 consists of 15 volunteer firefighters and covers 11 square miles along the Klickitat River. The land consists mostly of shrubland, with some timber. The district encompasses the town of Klickitat. Table 60 lists available resources for KCFD #12.

Table 60) Available firefighting resources for Klickitat County Fire District #12.

Equipment Number	Year	Make	Tank Size (Gallons)	Type	Pump (GPM)	License Number	Vin Number	Other	Available for Mobilization
	1993	Ford		Brush Truck					
	1990	Chevy		Command					
	1995	Ford		Ambulance					
	1990	FMC Ford		Tender					
	1985	GMC		Pumper tanker					

Klickitat County Fire District 13 (Appleton)

District Summary: KCFD #13 is a small district with 25 square miles and only 598 residents. It contains large areas of evergreen forest as well as herbaceous land cover. This district borders the shrublands of the east and the Cascades to the west. Table 61 lists available resources for KCFD #13.

Table 61) Available firefighting resources for Klickitat County Fire District #13.

Equipment Number	Year	Make	Tank Size (Gallons)	Type	Pump (GPM)	License Number	Vin Number	Other (Crew)	Available for Mobilization
1302	200?	Freightliner	3000		450				
1303	1984	Hurricane	500		1500				
1304	1996	Ford							
1305	1992	Freightliner	3200		450				
1306	2000	Ford	300		250				
1307	2000	Ford	500		250				
1308	1990	Ford	1200		450				

1309	1989	Ford	1000	1250
1310	1997	Ford	300	250
1311	1994			450
	2001	Ford		

KLICKITAT COUNTY FIRE DISTRICT 14 (HIGH PRAIRIE)

District Summary: KCFD #14 covers approximately 49 square miles and consists primarily of shrubland with nearly equal parts of agriculture and timber cover. The department consists of 10 volunteer firefighters. Table 62 lists available resources for KCFD #14.

Table 62) Available firefighting resources for Klickitat County Fire District #14.

Equipment Number	Year	Make	Tank Size (Gallons)	Type	Pump (GPM)	License Number	Vin Number	Other (Crew)	Available for Mobilization
C1400	2003	Ford	N/A	Command	N/A			2	
T1415	1977	Oshkosh M911	4000	Type-2 Tender	400			2	
E1411	2002	International	750	Type-2 Pumper	750			5	
B1412	2007	Ford F550	300	Type-6 Brush	120			5	
E1421	N/A	N/A	750	Type-1 Pumper	1250			3 (+2)	
B1422	1983	GMC	500	Type-3 Brush	350			3 (+2)	
1424	1967	Ford FW004	1000	Type-5 Tender	120			2	
1425	1988	international	2000	Type-2 Tender	500			2	
Aid 14	1989	Ford		Aid Unit	N/A			2 (+1)	

KLICKITAT COUNTY FIRE DISTRICT 15 (WAHKIACUS)

District Summary: KCFD #15 consists of 16 volunteer firefighters and covers 7 square miles. The land consists of nearly equal parts of timber and shrubland and lies west of the Klickitat River. Table 63 lists available resources for KCFD #15.

Table 63) Available firefighting resources for Klickitat County Fire District #15.

Equipment Number	Year	Make	Tank Size (Gallons)	Type	Pump (GPM)	License Number	Vin Number	Other	Available for Mobilization
			300	Type-6 Brush	150				
				Type-6 Brush	150				
			1000	Type-6 Brush	150				
			1000	Type-6 Brush	150				
			3000	Type-1 Tactical Tender	750				
			3000	Type-1 Tactical Tender	750				
			10000	Storage Tank					

Additional Entities with Wildland Firefighting Resources

USFS Columbia River Gorge National Scenic Area

- Available Personnel:
  - 1 Permanent Full Time Fire Management Officer (ICT3, DIVS, TFLD, AOBD, RXB2)
  - 1 Permanent Full Time Assistant FMO – suppression (ICT3, DIVS, TFLD, RXB2)
  - 1 Permanent Full Time Assistant FMO – Fuels/Planner (ICT3, OPS2, DIVS, TFLD, RXB2)
  - 1 Permanent Seasonal Prevention Tech. (ENGB, FFT1)
  - 1 Permanent Full Time Engine Captain (ICT3, DIVS, ENGB, RXB2)
  - 1 Permanent Full Time Engine Captain (ICT4, ENGB, TFLD)
  - 1 Permanent Full Time Crew Captain (ICT4, DIVS, TFLD, CRWB, ENGB, RXB2)
- Seasonal Resources:
  - During Fire season (May through October) 2 type 6 Engines and a 10 person Handcrew are fully staffed. The Engines are 7-day effective and the Handcrew works 5 days per week.
- Additional Vehicle Resources:
  - 2 Type 6 Engines (Captains are full time but the crew are seasonal and temp employees) – Available with full staff between May and mid-October.
  - 1 additional Type 6 Engine (used as back up engine if mechanical issues arise with primary engines; but can also staff up for a third staffed Engine).
  - 1 Type 7 patrol truck (Prevention tech has water with pump in bed of pick-up truck).
- Additional Personnel Resources:
  - In addition to our regular fire personnel we roster other resource area employees with red cards for extra help. These employees are typically just FFT2 qualified and can assist on the engines or handcrew. We also keep a list of AD employees for various needs. We have many EMTF, EMPF, ENGB, FFT1, HECM, and a few finance section ADs that help us.

USFS Mt. Adams Ranger District / Gifford Pinchot National Forest

USFS Mt. Adams Ranger District / Gifford Pinchot National Forest Washington State Parks currently have the following vehicles and staff for wildfire suppression:

- 2 type 6 engines, both are fully staffed with 5 personnel
- Both engines are capable of 7 day coverage

Bureau of Land Management

District Summary: The BLM owns and manages over 18,000 acres in Klickitat County; all of which could potentially receive hazardous fuels reduction treatments in the future. However, in addition to being identified by the community as a priority, those projects will be planned, implemented, and prioritized in accordance with Agency directives and goals.

WASHINGTON DNR RESOURCES

District Summary: The Washington Department of Natural Resources (DNR) is the largest on-call fire department in the State with 1,200 permanent and temporary employees that fight fire on more than 12 million acres of private and state-owned forest lands. The DNR's fire protection and safety equipment requirements help local Fire Protection Districts respond to wildfires. The DNR also works with the National Weather Service to provide the fire weather forecasts and fire precaution levels that firefighters, landowners, forest industry rely on.

The Washington DNR maintains a statewide fire support system of which the Southeast Region of the DNR supports Klickitat County with resources to educate the public on fire risks and resources to suppress fires on private and state lands that are under various "patrol assessment" structures.

Cooperative Agreements in Klickitat County: There are formal agreements between all rural fire districts and city fire departments in Klickitat County and the Washington DNR and the US Forest Service.

NOTE: Washington DNR does not respond to structure fires

Firefighting Resources: The Washington State Department of Natural Resources has multiple workcenters within Klickitat County with a variety of firefighting resources and personnel. The following is the list of resources available within Klickitat County as of 2018 as well as a summary of the fires that DNR resources were dispatched to in Klickitat County in 2018.

- Goldendale Workcenter:
  - 4 Type 5 Engines (Ford F-550, 420 gal, crew cabs, staffed w/4)
  - 1 Type 6 Engine (Ford F-450, 240 gal, single cab, staffed w/3)
  - 1 UTV (utility terrain vehicle, side by side)
  - 1 Type 3 Cache Truck (Support local type 3 incidents)
  - 4 OH (Fire Unit Manager, Assistant Fire Unit Manager, Fire Technician, and Land owner assistant Forester)
- Husum Workcenter:
  - 3 Type 5 Engines (Ford F-550, 420 gal, crew cab, staffed w/4)
  - 1 Cooperator Firefighter position from CRGNSA (FFT2)
  - IA Dozer (D5 Cat, w/operator, transport w/operator)
  - 3 OH (Assistant Fire Unit Manager, LOA Coordinator, RMAPs Forester)
  - 2 Support functions (Type 3 Logistics, Type 3 Plans, Type 2/3 Finance)
- Glenwood Workcenter:
  - 1 Type 6 Engine (Not Staffed/Spare Engine)
- Seasonal Staffing:
  - 8 ENGL (5 of 8 ENGB qualified) April 1st– October 31st
  - 21 Firefighters (May 1st– October 31st)
  - End of Season (5 Type 5 Engines w/ 14 seasonal employees)
- Aviation Assets – Dallesport SEAT Base (Staffed June through September):

  - 1 Air Attack platform (Contracted)
  - 2 C508 w/pontoon (Contracted Fire Bosses); Added a third early August
  - 0-2 Bell 205++ Type 2 Helicopter; staffed with Helitack Crew (Hit and miss with seeing a ship in Dallesport this season)
  - Still discussion about having a CWN Type 1 Helicopter in Dallesport in the future?
- Preparedness Resources (Hosted in Klickitat Unit 2018); There has been an increase over the last few seasons in Severity staffing:
  - 3 STEN (OR, NW, SPS)
  - 5 ENGB (OR, MN, FL)
  - 3 ENGB (t) (MN, FL)
  - 1 TFLD (Spokane FD)
  - 2 DIVS (NC, North Bend FD)
  - 3 Dozers (Viper Contracts Local: Krepps, Holtmann, Estey) 6+ weeks hired
  - 3 HEQB (MS, PC, Mt Vernon FD)
  - 3 INVF (AK, PC)
  - 8 Boost Engines (PC and OLY)
- Washington DNR Fire Stats for 2018:
  - 48 classified fires (>400 acres); 1 Type 3 Fire for 230 acres
  - 16 other agency assist (>14, 807 acres)
  - 64 Total Fire responses in the Klickitat Unit
  - 94% Human Caused/Unknown
  - 6% Lightning
  - 90% of fires <10 Acres

WASHINGTON STATE PARKS

The Goldendale Area Parks Management includes:

Brooks Memorial	Maryhill
Goldendale Observatory	Doug's Beach
Ft. Simcoe	Columbia Hills
Spring Creek	

Washington State Parks currently they have four Red Carded Employees that take the fire refresher and pack test annually:

- 2 Type-1 firefighters
- 2 Type-2 firefighters

The following vehicles and equipment are available to assist with fire suppression:

- 1 Type 4 Engine
- 1 one-ton truck with a slip-on tank
- 2 smaller pickups with 50-gallon slip-on takes

Mt. Adams Resource Stewards (MARS)

Mt. Adams Resource Stewards (MARS) formed in 2004 to address issues surrounding forest health and the well-being of Mt. Adams communities. Programs include the Mt. Adams Community Forest Project – 400 acres of working forestlands managed for sustainable forestry, public access and fire protection; participation in the Washington Fire Adapted Communities Learning Network; management agreements with Conboy Lake National Wildlife Refuge to provide support services in implementation of forest restoration, wildlife habitat and prescribed burning projects that have led to approximately 500 acres of successfully completed burns over the past three years; stewardship agreements with the Gifford Pinchot National Forest and work with the S. Gifford Pinchot Collaborative to secure $375K in state funding to prepare prescribed burned units on the south slopes of Mt. Adams; development of a local stewardship crew with wildland and prescribed fire training/capacity; and efforts to incubate businesses that will expand local markets for small diameter logs and byproducts of fuels management work in the region. MARS also authored the Glenwood Community Wildfire Protection Plan.

Roosevelt Landfill

Republic Services at Roosevelt is able to assist with wildfire that is within proximity to the landfill (within 10 to 15 miles of the landfill). Personnel availability for fire is dependent on the day and the number of people working at the landfill at that time; several employees are district firefighters and EMTs. The following is a list of all available resources:

Resource	Quantity	Description
D10 Dozers	4	Would not be able to transport off site
D6 Dozers	3	Available to move with lowboy
Graders	2	
Hydro-seeder	1	4,000 gallon capacity, equipped with monitor and 200 feet of hose
Tender	1	9,000 gallon capacity off-road Caterpillar truck with monitor
Type 6 Engine	1	200 gallon brush truck with 200 feet of hose on reel
Dump Trucks	3	ADT's off-road trucks
Loaders	2	
Excavators	2	
Backhoes	2	
AEDs	4	Located on-site at Landfill

SDS Lumber Company

SDS will respond within our capability to all fires occurring on lands managed by SDS and any uncontrolled fires, which may threaten our ownership. Our response should be immediate, within reason, and with utmost concern for the safety of everyone involved. SDS employees will take the immediate action necessary to contact appropriate fire control agencies once a fire is identified. SDS employees will not place themselves or contractors at unreasonable risk during any response to a fire or during the course of fighting a fire. Safety is our first priority. SDS employees and contractors should work to contain and

extinguish fires until fire is taken over by state or federal fire protection agency or some other responsible party. SDS will cooperate with, and follow the direction of the state fire protection agencies or local fire protection associations responsible for fire protection on SDS lands. SDS will obey Industrial Fire Precaution Levels (IFPL's). Additionally, SDS Managers can consider the use of other factors that may influence shutdown on lands managed by SDS. These factors could include: relative humidity, temperature, wind direction and speed, overall fire season trends, and availability of resources. See the *SDS Lumber Company: 2018 Fire Plan* for more information including contact information, fire policy, prevention procedures, etc.

The following is a list of equipment required to be carried with or readily available during day to day operations on SDS grounds. Minimum Equipment Requirements that satisfy WA and OR rules:

- Pickups and trucks:
    - Fire extinguisher, 5 pounds 2A:10BC, inspect monthly/maintain annually
    - Round pointed shovel
    - Ax or pulaski
- Power saws:
    - Fire extinguisher, 8 oz., immediately available
    - Round pointed shovel
    - Firewatch (in Washington)
- Equipment Operations
    - Each mobile machine:
        - Fire extinguisher, 5 pounds 2A:10BC, inspect monthly/maintain annually
        - Round pointed shovel appropriately mounted
    - Operation requirements:
        - 2, 5-gallon pump cans
        - Hand tools: 1 per person: even mix of Pulaskis, axes, shovels, Hazel hoes • Portable water supply, 300 gallon minimum; at least 250 feet of hose and nozzle connected and ready to go, and enough hose to reach all parts of operation where equipment working that day (OR). Additional water capacity may be required. **Check and run pump daily**
        - Communications to outside within 15 minutes
    - Additional requirements for cable logging:
        - 5-gallon pump can and round-pointed shovel at each block
        - Hand tool cache and portable water supply on the rigging (for WA, >1,200 feet span): 3 axes/Pulaskis, 6 shovels, 6 Hazel hoes, 300 gallons water

OTHER WILDLAND FIREFIGHTING COOPERATORS

- Yakama Nation Fire Management / Bureau of Indian Affairs (BIA):
    - Our Mission is to protect lives, property, and resources while restoring and maintaining healthy ecosystems through cost-effective fire management –YNFM
- Bureau of Land Management (BLM):

- The BLM has holdings in Klickitat County and firefighting resources in the Spokane area.

- United States Fish and Wildlife Service (USFWS):
  - The USFWS has holdings in Klickitat County and firefighting resources outside of the county.

APPENDIX 2: FIRE PROTECTION ISSUES

The following sections provide a brief overview of the many difficult issues currently challenging Klickitat County in providing wildland fire safety to citizens. These issues were discussed at length both during the planning team process and at several of the public meetings. In most cases, the planning team developed action items that are intended to begin the process of effectively mitigating these issues.

WILDLAND URBAN INTERFACE EXPANSION

One challenge Klickitat County faces is an increase in the number of houses in the rural fringe. Since the 1970s, a segment of Washington's growing population has expanded further into traditional forest or resource lands. The “interface” between urban and suburban areas and the resource lands created by this expansion has produced a significant increase in threats to life and property from fires and has pushed existing fire protection systems beyond original or current design or capability. Currently, High Prairie and Ponderosa Park are Firewise communities and Goldendale has received the Keystone Acres HOA grant but many property owners throughout the County are still not aware of the threats they face or of the resources that are available to them.

Most fire districts have similar concerns regarding the WUI: adequate landowner education about fire protection programs, landowner initiative to create defensible space around homes and clear driveways, and that the response potential of fire resources adequately covers the number of residents and structures within a given jurisdiction. In addition to issues with defensible space in residential areas, most of the fire districts within Klickitat County are concerned about human activity, such as recreation, campfires, and brush burning, in proximity to fire-sensitive areas. This includes activity in community green spaces, such as Lyle Point where light, flashy fuels are abundant, and recreation in proximity to heavily wooded areas; for example, Washington Department of Fish and Wildlife land near Highway 97 and the ground owned and managed by industrial timber companies as many logging units in the county feature dense conifer regeneration and stands of sub merchantable trees that are yet to be pre-commercially thinned. Other districts have also identified the need to address fuel concerns around city structures and municipal property.

RURAL FIRE PROTECTION

People moving from mainland urban areas to the more rural parts of Klickitat County, frequently have high expectations for structural fire protection services. Often, new residents do not realize that the services provided are not the same as in an urban area. The diversity and amount of equipment and the number of personnel can be substantially limited in rural areas. Fire protection may rely more on the landowner’s personal initiative to take measures to protect his or her property. Furthermore, subdivisions on steep slopes and the greater number of homes exceeding 3,000 square feet are also factors challenging fire service organizations. In the future, public education and awareness may play a greater role in rural or interface areas. Great improvements in fire protection techniques are being made to adapt to large, rapidly spreading fires that threaten large numbers of homes in interface areas.

Fire districts within Klickitat County have reported various concerns and needs in regards to staffing and equipment. Few districts feel as though they are both sufficiently staffed and have all equipment necessary to service their respective jurisdictions, particularly in scenarios where prolonged action is required. Most districts are challenged by either personnel recruitment or retention or by outdated equipment and/or equipment limitations.

Fire Works

Fireworks are becoming increasingly available to the public in Klickitat County. Even with the existing fireworks ban during periods of high wildland fire risk, the use of fireworks, particularly in recreational areas is high. Both the CWPP planning team and residents have noted fireworks as a high-risk factor for wildfire ignitions. In June of 2018, the Klickitat County Sherriff Office issued a cease and desists to fireworks retailers within Klickitat County.

Pre-planning in High Risk Areas

Although conducting home, community, and road defensible space projects is a very effective way to reduce the fire risk to communities in Klickitat County, recommended projects cannot all occur immediately, and many will take several years to complete. Thus, developing pre-planning guidelines specifying which and how local fire agencies and departments will respond to specific areas is very beneficial. These response plans should include assessments of the structures, topography, fuels, available evacuation routes, available resources, response times, communications, water resource availability, and any other factors specific to an area. All these plans should be available to the local fire departments as well as dispatch personnel.

All fire districts identified the need for fuel treatments in high risk areas on their respective districts. A few districts have developed plans for or intend to address fuels in high risk areas, but most districts reported that they either need to perform mitigation work or do not currently have plans in place for any mitigation projects.

Accessibility

Fire chiefs throughout the County have identified home accessibility issues as a primary concern in some parts of Klickitat County. Many existing housing developments and private driveways have been constructed without regard to access requirements of large emergency vehicles. Additionally, many of these roads are several miles long and dead end with no warning or plans for future connections to other access roads. The lack of road connectivity and general accessibility in some areas restricts engagement by fire suppression resources. Continued enforcement of Klickitat County's current standards regarding road and driveway construction regulations for fire apparatus would prevent accessibility issues in new developments. Wildfire risk can be lessened, and firefighter safety can be improved by keeping vegetation including tall grass, brush, and trees a safe distance from the road right-of-way. This will not only improve accessibility but will also allow the road to serve as a control point for suppression activities.

A few districts reported that road width/clearance is adequate for emergency vehicles and that fuel breaks have been created and maintained, but most districts recognize the need to widen roads in order to accommodate two-way traffic during emergency situations and that more fuel breaks need to be created. These fuel treatment projects are especially important in areas where access is limited to only one road, a concern expressed by some districts.

Additionally, the fire districts have identified several unimproved and unmaintained county roads that could serve as strategic access points for fire suppression activities if they were maintained periodically for this purpose. In some cases, these roads are partially maintained, but are limited by inadequate or nonexistent bridge crossings.

Protection of Natural Resources

Protection of native plant communities, especially those containing perennial native grasses and forbs essential to ecosystem integrity and diversity, is important to provide ecosystem services that sustain wildlife, such as the greater sage-grouse and native pollinators. One of the primary challenges to restoring the health of rangeland ecosystems is achieving effective long-term restoration and post-fire recovery. Arid rangelands face many environmental and site conditions stresses exacerbated by drought, climate change, and spread of invasive species, leading to more frequent and catastrophic fires. While restoration can be successful at the small scale, achieving a landscape approach to effective and sustainable restoration of the sagebrush-steppe can be difficult. There is a need for natural resource advisors and fire managers, at all levels, to improve communication and continue to coordinate and work collaboratively to identify priority habitats before and throughout the wildfire season to improve fire response and protection of priority habitats. Where priority habitat exists, pre-position of firefighting assets to improve preparedness and suppression capability in the initial stages of a wildfire increases the chances of keeping fires small and limits loss of habitat.

Fire-Resistant Construction Materials

Due to the multitude of highly publicized wildland-urban interface fires occurring in the western states, there has been an increased level of research, development, and marketing of more fire-resistant construction materials. Information on high risk materials as well as fire-resistant alternatives can be readily found online or through local fire departments.

Conservation Reserve Program Fields

Since the introduction of the CRP by the federal government, many formerly crop producing fields have been allowed to return to native grasses. CRP fields are creating a new fire concern all over the west. As thick grasses can grow naturally year after year, dense mats of dead plant material begin to buildup. Due to the availability of a continuous fuel bed, fires in CRP fields tend to burn very intensely with large flame lengths that often jump roads or other barriers, particularly under the influence of wind. Many landowners and fire personnel are researching allowable management techniques to deal with this increasing problem.

Volunteer Firefighter Recruitment and Retention

The rural fire departments in Klickitat County are predominantly dependent on volunteer firefighters. The trend for several years, in many volunteer fire departments, is that membership has continued to decrease. This can be attributed to several reasons including the need for two wage earners in a house hold to support their family, lack of desire from today's generation, and the tremendous amount of time spent in training to satisfy the ever-increasing regulations from state and federal agencies. Whether it be job and family commitments combined with hobbies or competition with other volunteer organizations, it comes down to the fact there is very little time left for being a volunteer firefighter. This is exacerbated by the added stress of emergencies and inherent dangers of the job, not to mention that our society is generally less appreciative of the commitment and sacrifices made by volunteer firefighters.

Today's fire departments, career and volunteer, find themselves in a position where there is an increased demand for their services, but are confronted with increasing operational costs and overall less revenue. In the rural setting where revenue is limited and volunteers are limited, this can add up to a fire service that is stretched very thin. In particular, many departments have difficulty maintaining volunteers available during regular work day hours (8am to 5pm).

Each district spends a considerable amount of time and resources training and equipping each volunteer, with the hope that they will continue to volunteer their services to the department for at least several years. One problem that all volunteer-based departments encounter is the diminishing number of new recruits. As populations continue to rise and more and more people build homes in high fire risk areas, the number of capable volunteers has gone down.

Several fire districts stated that recruiting volunteer fire fighters is a challenge and that they are currently in need of more volunteers. As time has passed, unsuccessful recruitment and low rates of retention have caused the average age of fire personnel to increase on some districts. As a result, pressure to recruit younger firefighters has increased and the impacts of a limited volunteer-pool have been exacerbated as current members of volunteer fire departments retire or become unavailable due to lifestyle changes.

Communication

The public safety radio system in Klickitat County was upgraded with two new towers in 2014, improving communications between first responders and central dispatch. There are still areas throughout the county that have poor cellphone reception, specifically the remote and isolated areas around Glenwood and Bickleton. Communication in the county will be further improved with the purchase of new radios for White Salmon and the construction of a cell tower in the Appleton area.

Water Resources

Developing water supply resources such as cisterns, dry hydrants, drafting sites, and/or dipping locations ahead of an incident is considered a force multiplier and can be critical for successful suppression of fires. Pre-developed water resources can be strategically located to cut refilling turnaround times in half or more, which saves valuable time for both structural and wildland fire suppression efforts.

Several districts reported concerns regarding water availability, FD2, FD3, and FD13 specifically, in the event of a wildfire while others felt that they would be better prepared if their current resources were supplemented with additional hydrants, etc. Several of the districts that reported having adequate water supplies stated that some of the tanks that they can fill from are also open to public use which may be an issue during a wildfire.

Invasive Species

Cheatgrass (*Bromus tectorum*) contributes to the size and frequency of fires and directly threatens the habitat of the greater sage-grouse and other sagebrush-steppe dependent wildlife. Fire behavior and fire regimes have been altered due to the proliferation of cheatgrass and other invasive species. Cheatgrass invades disturbed open sites and can dominate an area. Cheatgrass ripens and cures much earlier in the season when compared with native species, thus extending the fire season.[92] According to some statistical analysis, cheatgrass dominated ranges are about 500 times more likely to burn than a native species dominated range.[93] Fire return intervals in steppe and shrub-steppe fuel-types, pre-European settlement was typically between 32 and 70 years.[94] In certain Great Basin rangelands, the fire return interval is now less than 5 years on rangelands dominated by cheatgrass.[95]

Vegetation management at this scale is complex and requires aggressive and targeted application of both proven techniques and implementation of new practices to control cheatgrass and mitigate habitat impacts from unwanted rangeland fire. Land managers need tools to reduce cheatgrass while simultaneously restoring resilient sagebrush-steppe ecosystems that can withstand fire and resist re-invasion of cheatgrass or other invasive species. Effective strategies developed for early detection and rapid response and implemented in collaboration with a wide range of stakeholders, can help check the rapid expansion of invasive non-native species.

Hazardous Materials

Hazardous materials that are stored throughout the county are a concern for fire fighters. Pesticides and fertilizers used in the agriculture industry can present significant hazards should a location storing such

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[92] Pellant, Mike. 1996. Cheatgrass: The Invader That Won the West. Idaho State Office: Bureau of Land Management. 23p.

[93] Platt, K.; Jackman, E.R. 1946. The cheatgrass problem in Oregon. Extension Bull. 668. Corvallis, OR: Oregon State College. 48 p.

[94] Wright, H.A.; Neuenschwander, L.F.; Britton, C.M. 1979. The role and use of fire in sagebrush and pinyon juniper plant communities: a state-of-the-art review. Gen. Tech. Rep. INT-58. Ogden UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 48 p.

[95] Pellant, Mike. 1990. Unpublished data on file at: U.S. Department of Interior, Bureau of Land Management, Idaho State Office, Boise, ID.

materials burn. Any facility in Washington that stores over a certain amount (reporting threshold) of a hazardous material must submit a Tier Two report by March 1st each year. These reports are sent to the Washington State Emergency Response Commission, local emergency planning committees, and local fire departments. Tier Two reports will be on file for larger facilities, such as those in the Dallesport area. Many private residences and farms will have smaller quantities of hazardous materials that may be unreported. The distribution of unreported hazardous materials across the county poses a threat to unsuspecting first responders.

Public Wildfire Awareness

As the potential fire risk in the wildland-urban interface continues to increase, it is clear that fire service organizations cannot be solely responsible for protection of lives, structures, infrastructure, ecosystems, and all of the intrinsic values that go along with living in rural areas. Public awareness of the wildland fire risks as well as homeowner accountability for the risk on their own property is paramount to protection of all the resources in the wildland-urban interface.

Firewise Communities Program encourages local solutions for safety by involving homeowners in taking individual responsibility for preparing their homes from the risk of wildfire

Fire Adapted Communities incorporates people, buildings, business, infrastructure, cultural resources and natural areas into the effort to prepare for the effects of wildland fire.

Wildfire Community Preparedness Day is an excellent opportunity for neighborhoods and fire agencies to work together to make communities a safer place to live. Efforts raise wildfire awareness and help protect homes, neighborhoods, and entire communities, while increasing safety of wildland firefighter or could lessen current post-fire impacts.

The national **Ready Set Go! Program**, managed by the International Association of Fire Chiefs (IAFC), works to develop and improve dialogue about wildland fire awareness and action between local fire departments and the residents they serve. It is designed to be complimentary and collaborative with Firewise and other wildland fire public education efforts.

NFPA Fire Prevention Week offers information and tools to help public educators teach all audiences about important fire and life safety issues.

FEMA's America's PrepareAthon! Is an opportunity for individuals, organizations, and communities to prepare for specific hazards, including wildfire, through drills, group discussions, and exercises.

The continued development of mechanisms and partnerships to increase public awareness regarding wildfire risks and promoting "do it yourself" mitigation actions is a primary goal of the planning team as well as many of the individual organizations participating in the group.

Protection of Watersheds

Catastrophic wildfires often burn all surface vegetation and soil organic material which can result in flooding, mudslides, and debris flows. Additionally, catastrophic wildfires also affect surface water quality due to increased sediment loading. Large quantities of post-fire sediment can harm wildlife by inundating sensitive aquatic habitats as well as impact drinking water systems by filling or damaging a water source, such as a reservoir, or by overwhelming and clogging water treatment systems that remove suspended particulate. Residents in Klickitat County that get their drinking water from reservoirs or water treatment facilities could face water shortages if a catastrophic wildfire burned within one of the local watersheds.

Protection of watersheds is a concern of the different agencies and governing bodies in Klickitat County. There are several watershed projects for 2019 and 2020 that are in the development stages that aim to reduce the risk of catastrophic wildfire and protect surface water quality. Descriptions of these projects can be found in Chapter 6 – Community Fuels Reduction Projects, of the Community Wildfire Protection Plan

Post Fire Recovery

Both local government officials and citizens of Klickitat County should be aware of post fire recovery resources that are available through federal and state agencies. Post fire recovery resources offer some guidance to government officials but focus on private landowners who may not be aware of the hazards present on the portions of their property that burned or who to contact if they need assistance. The NRCS, for example, provides information on personal and public safety, managing risk and protecting property, protection of soils and erosion mitigation practices, insect infestation protection, reseeding, site rehabilitation and restoration, and financial and technical assistance. More information and specific resources can be found in Appendix 1.

Response Drills/Planning

Currently, there are a limited number of designated locations where ICP can be set up in the event of a fire. Identifying additional locations where ICP can be set up may decrease response times and allow ICP to become operational sooner and be in a more strategic location.

Most fire districts do not conduct response drills. Response drills can increase emergency preparedness and decrease response times in the event of a wildfire.

Special Areas of Concern

The following pieces of critical infrastructure have been identified as special areas of concern:

- Utility lines, including power transmission, water, phone, internet, and natural gas lines
- Goldendale Generating Station. Puget Sound Energy natural gas-fired power plant in Goldendale
- Wind power turbines and facilities
- Municipal watershed infrastructure and facilities
- Natural gas service lines and pumping stations
- Cell and 911 communication towers.
- Millions of dollars in recreational infrastructure and spending are at risk during a wildfire.
- Ranching and farming equipment, protection of fence posts and other infrastructure during a wildfire.

APPENDIX 3: MEETING SIGN-IN SHEETS

NOVEMBER 26,2018

MEETING SIGN-IN SHEET

Project: Klickitat County Hazard Mitigation Plan
Facilitator: Northwest Management Inc.
Date: November 26, 2018 1:30-3:00
Place: KCDEM EOC

Name	Title	Company	Phone	Email	Hours To-Date	Hourly Rate	Miles To-Date
Tera R. King		Northwest Management	208-818-3411	King@northwestmanagement.com	NA		
Lynn Ward	Building Official	KC Building Dept.	509-773-3706	lynnw@klickitatcounty.org			
TIM DARLAND	Natural Resource Manager	U.S. Army Corps Engineers	541-739-1040	TIMOTHY.J.DARLAND@USACE.ARMY.MIL			
Randi Heinzen	Admin Asst KCDEM	KCDEM	509-773-0582	randih@klickitatcounty.org			
Caitlin Jones	KVH Emergency Prep	KVH	206 949 7174	cjones@kvhealth.net			
Jonathan Lewis	KVH Director of Services	KVH	509-261-1004	jlewis@kvhealth.net	Doodle Poll		
Brandon Johnson	Eng. Tech	KPUD	509 773 6715	BJohnson@klickpud.com	Meeting room		
MARK PRITCHARD	OPS Manager	KPUD	509-773-7629	MPritch@klickpud.com			
Jacob Anderson	Proj coordinator	Klickitat County	509-250-4828 / 509 388 7804	jacoba@klickitatcounty.org			
FRED BEST	O&M Supervisor	Puget Sound Energy		FRED.BEST@PSE.com			
Lem Pratt	Area Manager	WA. ST. Parks	425-327-8852	Lem.Pratt@parks.wa.gov			
NATE HOVINGHOFF	SGT	WSP	360 903 3965	NATHAN.HOVINGHOFF@WSP.WA.GOV			
Vaiden Block	Land of	NMI	208 874 2740	block@nmi2.com			

Page 1 of 2

Name	Title	Company	Phone	Email	Hours To-Date	Hourly Rate	Miles To-Date
Dan Richardson		Underwood Fruit Co.	Zoom	dan@ucdwa.org zoom conference			
Wes Long			Zoom				
Tom Pierson Pierson			Zoom	tpierson@usgs.gov			
Carla Dionne			Zoom	carlad@klickitatcounty.org			
~~At~~ Bill Hunsaker			Zoom				
Matt Borden		Klickitat county	zoom	mattb@klickitatcounty.org			
Julie Buck	Chief of Operations	Klickitat County	509 773 0582	julieb@klickitatcounty.org			
Mike Canon	Mayor	City of Goldendale	509-250 0431	mcanon@ci.goldendale.wa.us			
Karl Enyeart	Public Works Director	City of Goldendale	509 773 3771	kenyeart@ci.goldendale.wa.us			
Jeff King	~~KCDEM~~ Director	KCDEM	509-773 -0582	jeffk@Klickitatcounty.org	N/A		
ALAN LAWSON	FUELS COORDINATOR SE REGION	WA. DNR	509 859 2641	alan.lawson@dnr.wa.gov	0		
Loren Meagher	Managing Engineer	central & eastern Klickitat Conservation Districts	509 773-5803 ext 111	LM@ckcd.org			
Ron Schultz	Eng Manager	KRUD	509 773 7631	RSCHULTZ@klickPUD.com			
Brad P Rachel Haymon				Zoom haymon@geol.ucsb.edu			

MEETING SIGN-IN SHEET

Project: Klickitat County Hazard Mitigation Plan

Date: 1/16/2019

Facilitator: Northwest Management Inc.

Place: Klickitat PUD

Name	Title	Company	Phone	Email	Hours To-Date	Hourly Rate	Miles To-Date
Brad Tucker	Planner Northwest Mgmt →		208-310-0320	tucker@northwestmanagement.com			
Wes Long		KCFD 3		Zoom			
Matt Borden							
Tim Webster	civil engineer	Trout Lake Mayor					
Jacob Anderson		KC Natural Resources					
Thomas Pierson	Geologic Hazards Specialist	U.S. Geological Survey (retired)	360-910-8215	piersontc@gmail.com	4 hr		60
FRED BEST	OEM supervisor	Puget Sound Energy	509 773 7902	FRED.BEST@PSE.COM	1 HR		
NATE HOVINGHOFF	SERGEANT	WASHINGTON STATE PATROL	360 903-3965	NATHAN.HOVINGHOFF@WSP.WA.GOV	1.5		6
Caitlin Jones	Emergency Preparedness Coordinator	Klickitat Valley Health	206 949 7174	cjones@kvihealth.net	2.5		5
Lynn Ward	Building Official/ Director	Klickitat Co. Building Dept.	509-773-3706	lynnw@klickitatcounty.org			
Amanda Smeller	Senior Planner	Klickitat Co Planning Dept	509773	amandas@klickitatcounty.org			
Dan Richardson	Watershed Resource Technician	Underwood Conservation Dist.	509.493.1936	dan@ucdwa.org	4		60
RON SCHULTZ	ENGINEERING MANAGER	KlickitatPUD	509 773 7631	rschultz@klickpud.com	3		2

MEETING SIGN-IN SHEET

Project: Klickitat County Hazard Mitigation Plan	**Date:**
Facilitator: Northwest Management Inc.	**Place:**

Name	Title	Company	Phone	Email	Hours To-Date	Hourly Rate	Miles To-Date
Brandon Johnson	Engineering Tech	KPUD	509 773 7615	BJOHNSON@klickpud.com	3		2
Bruce Bolme	Board President	WGAP	541-806-3256	bbolme@gorge.net	4		30
Randi Heinzen	KC DEM Admin Asst	KCDEM	509-773-0582	randih@klickitatcounty.org	5.5 Not sure		
Jeff King	Director	KCDEM	509-773-0582	jeffk@klickitatcounty.org			
Gordie Kelsey	PW DIRECTOR	Klickitat County Public Works	509-773-4666	gordonk@Klickitatcounty.org			

MEETING SIGN-IN SHEET

Project: Klickitat County Hazard Mitigation Plan | **Date:** 3/7/19

Facilitator: Northwest Management Inc. | **Place:** Klickitat PUD, Goldendale

Name	Title	Company	Phone	Email	Hours To-Date	Hourly Rate	Miles To-Date
FRED BEGS	O&M supervisor	PSE	5097737902	Fred.Begs@PSE.com	2.5		2
Ruth Juris	ENV. Scientist	PSE	509-773-7919	Ruth.juris@PSE.com	0		2
Jeff King	Director KCDEM	KCDEM	773-0582		3		
SCOTT KOEHLER	EMER MGNT PROG COORD	KCDEM	360.989.7586	SCOTT KOEHLER 97123@GMAIL.Com	2		1
Amanda Sueller	Senior Planner	KC	509 773 5703	amandas@klickitatcounty.ag	2		
Matt Borden	EHS II Emergency Coor.	KCHD	509-773-2484	mattb@klickitat-county.org	2D		1
Bruce Bolme	Pres Board of Dir	WGAP	541-806-3256	bbolme@gorge.net	2		90
Tom P.			call in				
Rachel H.			call in				
Bill Huntsaker			call in				
D. Richardson			call in				
Loren Maeger							

MEETING SIGN-IN SHEET

Project: Klickitat County Hazard Mitigation Plan

Date: 4/10/19

Facilitator: Northwest Management Inc.

Place: Klickitat Co PUD, Goldendale

Name	Title	Company	Phone	Email	Hours To-Date	Hourly Rate	Miles To-Date
Jeff King	~~EE~~ Director	KCDEM	509-773-0582	jeffK@Klickitatcounty.org			
Matt Rowden	LEPC	Health dept.	508-773-2994	mattb @ kl			
Lynn Ward	Director	Bldg.	773-3706	lynnw@klickitatcounty.org			
Amanda Smeller	Planner	Planning	7735703	amandas@klickitatcounty.org			
Bruce Bolme	Board Member	WGAP	541-806-3256	bbolme@gorge.net			
Kevin English	City of WhiteSalmon →		509.493.1133	kevine@ci.white-salmon			
Alan Lawson	IMT / FIRE-FUELS Coordinator	WADNR	(509) 8592641	alan.lawson@dnr.wa.gov			
Bill Hunsaker (Zoom)							
Scott Koehler (Zoom)							
Loren Meager		Central + Eastern Klickitat Conservation District					
Brad Tucker		NMI					
Eric Nelson		NMI					

MEETING SIGN-IN SHEET

Project: Klickitat County Hazard Mitigation Plan

Date: 5/14/19

Facilitator: Northwest Management Inc.

Place: Goldendale PUD

Name	Title	Company	Phone	Email	Hours To-Date	Hourly Rate	Miles To-Date
Jacob Anderson	zoom						
Rachel Haymon	zoom						
Tim Webster	zoom						
David Spratt	zoom						
Bill Hunsaker	Building official White Salmon	White Salmon	509-493-1133	billh@ci.White-Salmon-wa.us			120
Tom Pierson	USGS Hydrologist (retired)		360-910-8215	piersontc@gmail.com	17 (Apr-May)		210
Caitlin Jones	Emergency Prep Coordinator	Klickitat Valley Health	509 773 4022 x2906	cjones@kvhealth.net	6		5
Kevin L Leis	Design Engineer	Klickitat County Public Works	509-773-4616	kevinl@klickitatcounty.org			
SETH SCAROLA	CIVIL ENGINEER	KLICKITAT COUNTY PUBLIC WORKS	509 773-4616	SETHS@KLICKITATCOUNTY.ORG			
Bruce Bolme	Board. President	WG AP	541-806-3256	bbolme@gorge.net	7		

MEETING SIGN-IN SHEET

Project: Klickitat County Hazard Mitigation Plan | **Date:** July 10, 2019 | **Time Began:** 1:30pm

Facilitator: Northwest Management Inc. | **Place:** KPUD | **Time Ended:**

Name	Title	Company	Phone	Email	Hrs outside meeting	Hourly Rate	Miles To-~~Date~~ Day
Jeff King	Director	KCDEM	773-0582		6		2
Scott Koehler	EM Prog Coord	KCDEM	360 989-7586	scott koehler 97123@gmail.com			2
Nate Houinghoff	Sgt.	WSP	360 903-3965	nathan.houinghoff@wsp.wa.gov			
Seth Scarcola	Civil Engineer	Klickitat County	773-2370	sethS@klickitatcounty.org			
Tom Pierson	Scientist Emeritus	USGS	360-910-8215	piersontc@gmail.com	4.5 hr since last mtg		70 ~~35~~
Jonathan Lewis	Director of Support Services	KVH	509-261-1004	jlewis@kvhealth.net	10	$56	6
Rachel Haymon	Profession Emerita	UCSB	509-345-2566 805-895-8954	haymonr@gold.ucsb.edu	8		130 ~~65~~
Brandon Johnson	Engineering Tech	KPUD	509 773 7615	BJOHNSON@klickpud.com			∅
TIM					1		
DAN					3		

MEETING SIGN-IN SHEET

Project: Klickitat County Hazard Mitigation Plan	**Date:** AUGUST 8, 2019 Time Began:
Facilitator: Northwest Management Inc.	**Place:** Time Ended:

Name	Title	Company	Phone	Email	Hrs outside meeting	Hourly Rate	Miles To-Date
Jeff King	Director	KCDEM			8		~~0~~
Jonathan Lewis		KVH			14		
Rachel Haymon					14		
MARK PRITCHARD	OPS MANAGER	KPUD			2		~~0~~
Brandon Johnson	Eng. Tech	KPUD			1		0

MEETING SIGN-IN SHEET

Project: Klickitat County Hazard Mitigation Plan | **Date:** 10/17/2019

Facilitator: Northwest Management Inc. | **Place:** Goldendale KPUD

Name	Title	Company	Phone	Email	Hours To-Date	Hourly Rate	Miles To-Date
RACHAEL HAYMON *							
BILL HUNSAKER *	Building Official	White Salmon	509-493-1133				
Caitlin Jones	Emergency Prep Coordinator	KVH	206 949 7174	Cjones@kvhealth.net	10		
WES [redacted] LONG *		FD#3					
BRAD TUCKER	Planning Team/ [redacted]	NMI					
ERIC NELSON	Planning Team/ [redacted]	NMI					
TOM PIERSON *	Geologic Hazards Specialist	USGS (Retired)					

 * PARTICIPATED VIA ZOOM

MEETING SIGN-IN SHEET

Project: Klickitat County Hazard Mitigation Plan | **Date:** 12/5/19 | **Time Began:** 13:30

Facilitator: Northwest Management Inc. | **Place:** KC Dept. Energy Mgt. | **Time Ended:** 16:00

Name	Title	Company	Phone	Email	Hrs outside meeting	Hourly Rate	Miles To-Date
Jeff King	Director	KCDEM			6		~~0~~
Bruce Bolme	Board	WAGAP					
Carmen Thropes	Chief	KCSO					1
Bob Songer	Sheriff	KCSO					
Alan Lawson	Fuels WADNR	WADNR					
Cheyenne Wright	Clerk	City of Bingen					
David Sprecht	Public Works	City of Bingen					
Caitlin Jones	emergency prep coordinator	KVH			2		
Jonathan Lewis	Director of Support Services	KVH			2		
Bill Hunsaker	Fire Chief Building official	White Salmon			4		120
Julianna Ontiveros	GFD Lieutenant	GFD					
SCOTT KOEHLER	EM PROG COORD	KCDEM					~~0~~
Zoom Participants –							
David McCune							
Nathene							
Tom Pierson							
			Rachel Haymon				

APPENDIX 4: MEETING MINUTES

NOVEMBER 26, 2018

Klickitat County Multi-Hazard Mitigation Plan

Minutes for Kickoff Meeting

November 26, 2018

- Jeff King: Opening comments and introductions.
- Brad Tucker/Tera King: Kickoff presentation and explanation of meeting documentation requirements for FEMA and grant match.
    - All counties must have an HMP to be eligible for FEMA funding.
    - What are natural hazard-related problems and concerns in the county and how can we address/resolve them?
    - HMP meetings are important for getting all vulnerable parties together to discuss hazards.
    - Each adopting jurisdiction will get its own profile and will be able to apply for grant money and perform mitigation work without the county.
    - Adopting jurisdictions must have a representative at each meeting.
    - A jurisdiction should adopt if they have any specific mitigation needs.
    - Tera explains the different hazards that will be included in the plan and why the man-made hazards will be treated in a limited capacity.
    - The wildfire portion of the plan will come from the CWPP.
    - The Klickitat County CWPP and HMP will be updated one year apart.
    - Maps will be developed using GIS data, the floodplain map will come from the Washington State Department of Ecology.
    - The grant deadline for the HMP is September 30th.
    - Where will plan data/documents be kept so planning team members can access them at any time? Drop Box will not work for some planning team members.
    - Any sensitive information will be handled/addressed in the plan accordingly by Jeff and others. Select information can be kept vague/generic for the purposes of confidentiality.
    - Who else should be invited to the meetings or included on the mailing list?
    - Public involvement: can we host a public outreach event during another community event?
- Brad Tucker: Explain hazard ranking exercise and discuss flooding in the county:
    - Flash flooding is problematic at the east end of the county.
    - Drainages in the county tend to be deep and allow for large volumes of water to flow. However, drainages can flood under the right conditions.
    - The 1997 flood was significant.
    - 2006 atmospheric flood events; this type of flooding is typically caused by rain events.
    - There are concerns about more severe flooding in unincorporated areas.
    - Interacting disasters; burn scars are sources of flooding, these events can carry debris that cause waterway blockages.

- Brad Tucker and Jeff King closing remarks
    - E-mail attachments should be kept below 5 megabytes
    - Doodle polls will be sent out to decide meeting times: Mondays and Wednesdays will likely be the days that are selected for future meetings.

JANUARY 16, 2019

Agenda Item #1 Old Business

After introductions, Brad passed around a sign-in sheet and reminded everyone to keep track of their time for use in the County's In-Kind match of grant funds. This can be done monthly on the sign-in sheets.

Brad let the group know that he had received several hazard summaries to date and that we will discuss this topic later in the meeting.

Brad asked the group if everyone was able to access the dropbox file. The consensus was that this method of file sharing was useful and acceptable for the duration of the project. If anyone does not have the link to access dropbox let Brad know and he will send the link.

Agenda Item #2 Plan Outline

Eric Nelson reviewed the tentative outline of the plan with the group. Eric explained that the information and sections in the outline are required but that the order of the information is open for debate. The group decided that the outline is acceptable and agreed to allow NMI to move forward with writing the plan.

Agenda Item #3 Press Release

Brad passed around a draft of the Press Release announcing to residents that the County has embarked on this project to develop a Hazard Mitigation Plan. It also briefly informs the public that they will have opportunities to participate in the process. Brad asked the group if it was okay to have himself as the contact in the event any residents have questions regarding the project…it was determined that having Brad as primary contact was the most beneficial. Jeff King asked that NMI provide the final draft to his Department to send out to their media list. It was also recommended that NMI include the KC Department of Emergency Management website as a place where residents can go to find information regarding the project.
The group decided to set January 23rd as the last day to submit comments on the draft press release. Have comments to Brad by Close of Business that day.

Agenda Item #4 Hazards Summary Exercise

Brad passed around the averaged rankings of the hazard summary for the County. Brad explained that he had received several worksheets from various individuals and that he had averaged the scores (rankings) for the various categories. Rachel and Thomas provided a very detailed hazard summary and a document explaining their methods. Rachel and Thomas suggested adding a category of "Location (Populated Area Affected)" and Klickitat County DEM agreed. All the hazard summaries will be on the dropbox file for anyone to review. Brad stated that he would accept more hazard summary submissions if people still would like to submit them.

The following table shows the outcome of the hazard summary exercise.

Klickitat County

Hazard	Location (Geographinc Area Affected)	Location (Populated Area Affected)	Max Probable Extent (Magnitude/Strength)	Probability of Future Events	Overall Significance Ranking
Flood	2.1	3.0	2.1	3.2	10.4
Landslide	1.9	3.0	2.8	2.7	10.4
Earthquake	3.5	4.0	3.8	1.8	13.1
Severe Weather	3.9	4.0	2.4	3.3	13.6
Wildland Fire	3.1	4.0	2.9	3.7	13.7
Drought	3.6	2.0	2.1	2.7	10.4
Volcano	2.6	4.0	3.6	1.2	11.4
HazMat	1.3	3.0	2.9	1.9	9.1
Radiological	2.8	3.0	3.6	1.6	11.0
Mass Casualty	1.1	2.0	2.0	1.8	6.9
Terrorism	1.4	3.0	2.2	1.5	8.1

Agenda Item #5 Goals Statements

The group reviewed some Mission and Goals statements that NMI brought as examples. Many thought the shorter Mission examples were the best option, but no one was prepared to have a significant discussion on this topic. It was decided to table the topic until our meeting in February.

Agenda Item #6 Community Capability Assessments

NMI passed around a FEMA worksheet to the adopting jurisdictions. Brad explained that each adopting jurisdiction will need to fill out this worksheet to the best of their ability. He also explained that the worksheet is designed more for local government entities but the nongovernment entities that are adopting jurisdictions (Conservation Districts, Hospitals, NGOs).

The Community Capability Assessments need to be completed and turned in to NMI by our meeting in March.

Agenda Item #7 Review Draft

NMI provided the group with a draft of 2.5 chapters of the document. Brad explained that the information within these chapters was basic information regarding the planning process, an overview of the plan and Jurisdiction profiles. The group spent some time going through each section briefly and Brad pointed out information that was still being worked on.

The group was asked by NMI to review the chapters and provide feedback at the next meeting or sooner.

Agenda Item #8 Timeline

The next meeting will be on February 13th at 1:30 pm located at the Klickitat PUD facility in Goldendale.

Agenda Item #9 Homework

Adopting jurisdictions need to complete the Capability Assessments. Anyone that still wants to submit a hazard summary please do so prior to our next meeting. Everyone needs to review the draft chapters and goals statements provided and be prepared to discuss any revisions at our next meeting.

MARCH 7, 2019

Agenda Item #1 Old Business

After introductions, Brad passed around a sign-in sheet and reminded everyone to keep track of their time for use in the County's In-Kind match of grant funds. This can be done monthly on the sign-in sheets.

Brad asked the group if there were any comments on the sections of the draft that were provided at the January meeting. It was suggested that we look at the Mount St. Helens Response Plan and the County's Emergency Management Plan to add to the "Incorporated Plans" portion of the draft.

Brad reminded the group that we are still missing some of the adopting jurisdictions' Hazard Summaries and Capability Assessments. If you need assistance contact Brad.

Agenda Item #2 Map Discussion

The group reviewed several draft maps developed by Northwest Management primarily using Washington DNR data. Tom will send NMI better lahar map from the USGS. Recommend providing a zoomed in flood map of the Glenwood and south area. Need to make sure NMI adds narrative discussion to hazards (flood, landslide, lahar etc.) that could have compounding effects eg. lahar causing floods. Also show communities of Husum and Dallesport on maps

The current landslide map only shows slopes that are a risk to slippage. They should show surrounding areas that could be impacted if a landslide were to occur on the slopes above. Should also zoom in on the community of Lyle. Focus on White Salmon and Goldendale watersheds being impacted by landslides as well. Look into what would happen if a landslide blocked the Columbia. Hwys 14 and 141 frequently closed due to landslides.

The earthquake map shows a .7 magnitude earthquake scenario of the Mill Creek Fault north of the county. There was a fair bit of discussion of whether this scenario was appropriate. If an earthquake occurred within the county it would obviously have a larger impact on residents. NMI explained that the scenario was run using the Washington DNR's map portal and they had a limited number of scenario options in the region. Rachel recommended using a shake map that she will send to NMI. NMI will bring the map to the next meeting. The Cascadia Rising scenario was brought up and determined that the Klickitat County HMP should describe being a staging area for response efforts and how to handle the displaced population.

Some critical infrastructure from PSE are pumping stations near Goldendale and Roosevelt and a valve station near Snowden.

Jeff may be able to provide dam failure maps from the Army Corp of Engineers. Some of the information may be sensitive so he will find out what he can share for this project.

Agenda Item #3 Goals Statements

The group then discussed the Mission and Goals Statements. It was decided that we would use a modified version of the County's recently updated Community Wildfire Protection Plan's Mission statement. It would read "To make Klickitat County residents, economy, resources and ecosystems less vulnerable to the negative effects of natural and man-made hazards."
Key items identified for goals statements are as follows:

- Collaboration
- Identify Hazards
- Evaluate Hazards
- Develop an action plan with a prioritized list of projects
- Make the County and its residents more resilient to the impacts of natural disasters
- Education

It was suggested that we investigate having plan goals as well as hazard specific goals, NMI might have some options but needed to table this discussion until the next meeting.

Agenda Item #4 Event History

Brad explained that he has posted some databases showing natural disasters in the County/region on dropbox. We did not have time to review these events at the meeting, but he encouraged everyone to take a look and let him know if anything is missing.

As NMI develops the history of events they ask the group for any information to make it personal to the County (eg. pictures, newspaper articles, specific events).

Agenda Item #5 Hazard Profiles

Brad also asked the group to review the latest draft section Hazard Profiles. This section is posted on Dropbox but if you want Brad to email it to you let him know.

Agenda Item #6 Timeline

The next meeting will be on April 10th at 1:30 pm located at the Klickitat PUD facility in Goldendale.

Agenda Item #7 Homework

Adopting jurisdictions need to complete the Capability Assessments. Anyone that still wants to submit a hazard summary please do so prior to our next meeting. Everyone needs to review the draft chapters and goals statements provided and be prepared to discuss any revisions at our next meeting.

APRIL 4, 2019

Agenda Item #1 Old Business

After introductions, Brad passed around a sign-in sheet and reminded everyone to keep track of their time for use in the County's In-Kind match of grant funds. This can be done monthly on the sign-in sheets.

Brad asked the group if there were any comments on the sections of the draft that were provided at the March meeting.

Brad reminded the group that we are still missing some of the adopting jurisdictions' Hazard Summaries and Capability Assessments. If you need assistance contact Brad.

Agenda Item #2 Map Discussion

The group reviewed a few new draft maps developed by Northwest Management. NMI utilizing DNR data for geologic events unless other sources are provided. The earthquake shake hazard map was created using information provided by Rachel Haymon, the group seemed more comfortable with this updated version.

Agenda Item #3 Goals Statements

NMI provided a draft of the mission and goals statements for the County. Jeff King asked to include two more goals from the examples that were provided in the March meeting. NMI will add those and then bring the latest draft to the next meeting.

Brad informed the group that each adopting jurisdiction needs to have their own set of goals statements. He asked if they could bring those statements to the May meeting.

Agenda Item #4 Event History

NMI passed around two sets of data, from different sources, showing disasters/events that have occurred in Klickitat County. One set of data came from NOAA and shows events that have occurred in Klickitat County specifically from 1996 thru 2017. The other set is from FEMA which shows all of the disaster declarations in the state of Washington from 1956 thru 2018.

Brad asked for the group to review for any major discrepancies with their knowledge of events that have occurred in the region. One thing that came up upon immediate review was some missing fires. It was recommended that NMI refer to the recently approved Community Wildfire Protection Plan for the most up to date history of wildfire events in the County.

As NMI develops the history of events they ask the group for any information to make it personal to the County (eg. pictures, newspaper articles, specific events).

Agenda Item #5 Hazard Profiles

NMI passed out the latest version of the Hazard Profile Chapter of the plan. This current version has additional hazards that were not included in the version that NMI provided last month. The group reviewed a few of the specific hazards and Brad explained that all the sections were similar in format, except for wildfire. Brad asked the group if they thought that it would be better to cut some information out of the wildfire section to make it like the other sections. The consensus was that wildfire was one of the more prominent hazards affecting Klickitat County, therefore they like having the additional information. NMI also explained that Tom Pierson and Rachel Haymon were working on the flood and geologic hazard profiles to make them more robust.

Brad also asked the group to review the latest draft section Hazard Profiles.

Agenda Item #6 Timeline

The next meeting will be on May 15th at 1:30 pm located at the Klickitat PUD facility in Goldendale.

Agenda Item #7 Homework

Adopting jurisdictions need to complete the Capability Assessments. Anyone that still wants to submit a hazard summary please do so prior to our next meeting. Everyone needs to review the draft chapters and goals statements provided and be prepared to discuss any revisions at our next meeting.

MAY 15, 2019

Agenda Item #1 Old Business

After introductions, Brad passed around a sign-in sheet and reminded everyone to keep track of their time for use in the County's In-Kind match of grant funds. This can be done monthly on the sign-in sheets.

Brad asked the group if there were any comments on the sections of the draft that were provided at the April meeting and the storm event data.

Brad reminded the group that we are still missing some of the adopting jurisdictions' Hazard Summaries and Capability Assessments. If you need assistance contact Brad.

Agenda Item #2 Map Discussion

Brad did not have any "new" maps to show the group, however he asked if anyone present wanted to see the maps. Nobody took Brad up on the offer so we moved on to the next agenda item.

Agenda Item #3 Goals Statements

NMI provided the final draft of the mission and goals statements for the County. NMI added the two additional goals that Jeff King asked to include the April meeting. Brad informed the group that each adopting jurisdiction needs to have their own set of goals statements. He asked if they could send those statements to him before the June meeting.

Agenda Item #4 Hazard Profiles

NMI passed out the revised version of the Volcano, Earthquake, and Landslide Hazard Profiles. This current version has additional hazards that were not included in the version that NMI provided last month. The group reviewed a bit of these revisions and Brad explained that all the sections were available on Dropbox. Tom asked the group if they thought that it would be better to cut some information out of the wildfire section to make it like the other sections. Brad explained that the group discussed that very topic at the previous meeting and the consensus was that wildfire was one of the more prominent hazards affecting Klickitat County, therefore they like having the additional information.

Agenda Item #5 Public Meetings

Although Jeff King was not present, the group discussed having the public meetings sometime in June. The locations were discussed, and everyone agreed that having one in Goldendale and one in White Salmon would be sufficient to allow residents to attend. NMI would discuss dates with Klickitat County Emergency Management and let the group know when they would occur.

Agenda Item #6 Timeline

The next meeting has not been scheduled as we will plan it for one of the days that we have the public meetings. NMI will inform the group as soon as something is scheduled.

Agenda Item #7 Homework

Adopting jurisdictions need to complete the Capability Assessments, hazard summaries and now goals statement.

JULY 10, 2019

Agenda Item #1 Old Business

After introductions, Jeff passed around a sign-in sheet and reminded everyone to keep track of their time for use in the County's In-Kind match of grant funds. This can be done monthly on the sign-in sheets.

Eric asked the group if there were any comments on the sections of the draft that were provided at last meeting.

Eric reminded the group that we are still missing some of the adopting jurisdictions' Hazard Summaries, Capability Assessments, and Goals Statements. Jeff asked that some of the county information be applied to Bingen, Goldendale, and White Salmon. Jeff will continue to ask the three cities for completed Capabilities Assessments.

Agenda Item #2 Risk Assessments

Risk Assessments for Klickitat County, Bingen, and White Salmon were competed prior to the meeting and were presented to the group. After discussing the completed content and the overall layout of the plan, the group decided to restructure the plan in the interest of reducing redundancy. The plan will instead by organized by hazard, with the jurisdictions included as secondary headings under each hazard.

Agenda Item #3 Action Items

Mitigation Action Items were introduced to the group and examples from other counties were distributed to those in attendance. The group discussed the required information for each action item and decided that group members would enter projects into Excel spreadsheets in Dropbox. The final layout/format of the action items will be decided at a later date.

Agenda Item #4 Public Meetings

Eric reminded the group of the times and locations of the upcoming public meetings. The first was held in Goldendale at the KPUD building on July 10th from 6:00 to 8:00 pm and the second meeting was held in White Salmon on July 11th from 6:00 to 8:00 pm.

Agenda Item #5 Timeline

The group also discussed the timeline of the project and the late October completion date; the process needs to keep moving as time is limited. The next planning group meeting was scheduled for August 8th.

Agenda Item #6 Homework

For the next meeting, the planning group is to develop a list of mitigation action items while Eric and Brad restructure the plan so it is organized by hazard instead of jurisdiction.

AUGUST 8, 2019

Agenda Item #1 Old Business
NMI briefly summarized the public meetings that occurred in July. There was good turnout of both planning team members and residents at both meetings. Most of the discussions centered around disaster preparation.

Agenda Item #2 Natural Hazard Risk Assessments
The risk assessments presented at the July meeting sparked a discussion of redundancies in the plan and the need for a new layout. NMI revised the sections according to team recommendations and presented the new risk assessments to the group at the August meeting. There were some general comments about the content and formatting, but the group approved of the new layout. NMI asked the group to provide comments on these sections before August 23rd.

Agenda Item #3 Non-natural Hazard Risk Assessments
NMI shared these hazards with the group and explained that these hazards were laid out the same way that the natural hazards are now laid out. NMI asked the group to provide comments on these sections before August 23rd.

Agenda Item #4 Action Items
NMI reminded the group that they need projects from each jurisdiction. Some members present at the meeting forwarded their list to NMI during the meeting. NMI asked for planning team members to provide a list of projects before August 23rd.

Agenda Item #5 Timeline

The group also discussed the timeline of the project and the late October completion date; the process needs to keep moving as time is limited. The next planning group meeting was scheduled for September 5th.

OCTOBER 17, 2019

Agenda Item #1 Old Business

The project has been extended through March of 2020. This new deadline includes the review phase which can take three to four months to complete. Therefore, we need to have the final draft ready for review by the planning team by January 2020 to begin that review phase.

The main item still missing from the plan is the Action Plan (projects) that we need the planning team and adopting jurisdictions assistance with completing.

Comments received regarding the hazard risk assessment are still being incorporated into the plan.

Agenda Item #2 Mitigation Action Items

NMI presented the short list of Action Items (projects) that have been received to date. KVH says they sent a list of projects that were not included and NMI will have to look back through the files. NMI asked the group to develop more projects. Each adopting jurisdiction is encouraged to have their own projects. NMI was asked to send out the current list along with blank sheet for people to fill in.

Agenda Item #3 Critical Facilities Exercise

The group present worked through an exercise to identify the critical facilities located within the county. This will need to be done for each adopting jurisdiction and NMI will provide the worksheet. Once the facilities are identified each facility needs to be given a vulnerability rating (utilizing the vulnerability rating sheet).

Agenda Item #4 Terrorism & Civil Unrest

NMI has a portion of the TCU section ready for the Group to look at. It was explained that the TCU section will be a stand-alone chapter of the plan so that the County can keep track of who is looking at that section of the plan if they choose to. The risk assessment portion of this chapter is still under construction and we will need the critical facilities checklist from each jurisdiction to complete this section. NMI will provide the worksheets for each jurisdiction to complete.

Agenda Item #5 Homework

List of projects

Critical facilities

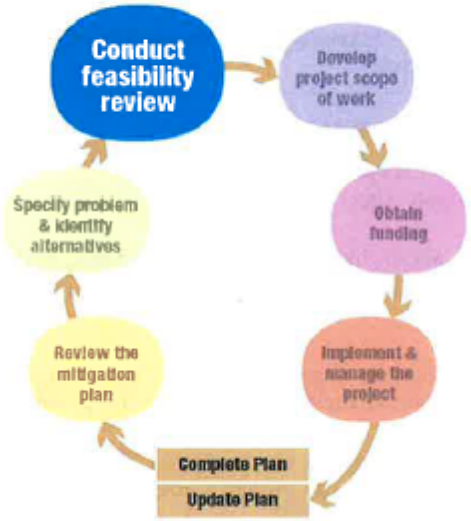
In addition to these items there is specific information that we still need from each adopting jurisdiction. NMI will email out a list of things needed from each adopting jurisdiction.

Agenda Item #6 Timeline

The next meeting is scheduled for November 21st.

APPENDIX 5: STAPLEE SCORING SYSTEM

Step 3: Conduct a Feasibility Review to Evaluate Alternatives



Begin to examine the feasibility of a proposed mitigation project alternative, by asking questions such as:

- Will this alternative present a long-term solution to a specific problem?
- Is this alternative consistent with future development plans, government priorities, environmental and historic preservation goals, and with the local hazard mitigation plan?

If an alternative presents only a short-term or temporary solution, consider a mitigation action that is longer term or eliminates the risk entirely. If an alternative is not consistent with existing plans, priorities, or goals, consider a different solution to the problem that is supported by existing plans.

Mitigation Plan Update Tip: If a suggested alternative seems to be an excellent solution to a problem but is not consistent with the current hazard mitigation plan, the plan may need to be revised and updated to include more accurate data.

As recommended in How-to Guides #3 and #5 (FEMA 386-3 and 386-5), a planning process known as STAPLEE may be used to prioritize mitigation actions in the plan. STAPLEE can also be used to conduct a systematic feasibility review of alternatives that appear to provide a long-term solution to the problem and are consistent with the hazard mitigation plan. STAPLEE is discussed in detail below.

STAPLEE

STAPLEE is an acronym for the seven criteria used to conduct a feasibility review. These criteria are: **S**ocial, **T**echnical, **A**dministrative, **P**olitical, **L**egal, **E**conomic, and **E**nvironmental feasibility.

How-To Guide 9: Using the Hazard Mitigation Plan to Prepare Successful Mitigation Projects
15

Step 3: Conduct a Feasibility Review to Evaluate Alternatives

Table 2 suggests questions to pose for each alternative under review and offers comments that may be helpful in identifying the positive and negative consequences associated with an action for each of the STAPLEE criteria.

Table 2: Using the STAPLEE Criteria to Assess the Feasibility of an Alternative

Feasibility Criteria	Questions to Answer and Comments
Social	▪ Is the mitigation action socially acceptable? ▪ Will the action adversely affect any one segment of the population? ▪ What effects will the action have on the social, historic, and cultural environment of the community? Comments: If some of the population may be negatively affected by a proposed mitigation project, it may not be the best solution to the problem. Unless detrimental effects of a project on the disruption of community life can be minimized, the project under consideration may not be a good fit for the community.
Technical	▪ Is the proposed action technically feasible and does it provide the appropriate level of protection? ▪ What types of technical/professional expertise will be required to plan and implement the project? ▪ Will the action create more problems than it solves? ▪ How long will it take to complete the project? Is this a reasonable timeframe? Comments: In developing a mitigation project, the community must ensure that the project will actually mitigate the risk posed by a particular hazard. A project to protect one community asset at the expense of another or a project that will protect a structure from one hazard while making it more vulnerable to another hazard may not benefit the community. Alternatives for flood mitigation projects are presented in *Selecting Appropriate Mitigation Measures for Floodprone Structures*, FEMA 551, which is available through the FEMA online library (http://www.fema.gov/library/index.jsp). The FEMA Technical Assistance Helpline (1-866-222-3580) is available to provide assistance regarding grant requirements, engineering feasibility, cost effectiveness, and environmental/historic preservation compliance. Additional information is available online at: http://www.fema.gov/government/grant/resources/index.shtm#5

Step 3: Conduct a Feasibility Review to Evaluate Alternatives

Feasibility Criteria	Questions to Answer and Comments
Administrative	▪ Does the community have the capability (staff, expertise, time, funding) to implement the action? ▪ Can the community provide the necessary maintenance of the project? Comments: A complicated project that will demand a great deal of attention from already busy municipal staff will be difficult to implement successfully. If the administrative costs associated with a project are too great, the community can consider hiring additional staff, providing additional training for existing staff, implementing a less complicated project, or implementing a complex project in phases.
Political	▪ Is the mitigation action politically acceptable? ▪ Will the general public support or oppose this project? Comments: A highly visible project that is costly and does not have broad public support will be very difficult to implement. When committing to a controversial project, the community should prepare for the time and expense required to work through the controversy.
Legal	▪ Does the community have the authority to implement the proposed action? ▪ Will the action comply with local, State, and Federal environmental regulations? ▪ Do homeowner association bylaws apply to the project site? ▪ Is the action likely to be challenged by stakeholders whose interests may be adversely affected? Comments: Examine the project relative to Federal, State, Tribal, and local laws to determine whether there is potential for violating a law. If a project has the potential to violate a law, it may not be the best alternative. Model deed restrictions resources that may be helpful for mitigation projects involving voluntary acquisition of real property are available online at: http://www.fema.gov/government/grant/resources/pre-award.shtm.

Step 3: Conduct a Feasibility Review to Evaluate Alternatives

Feasibility Criteria	Questions to Answer and Comments
Economic	▪ Do the costs of the action seem reasonable for the size of the problem and the likely benefits? ▪ What burden will be placed on the local economy to implement and maintain the action? ▪ Will the action generate additional jobs locally? Comments: When evaluating capabilities, the community should estimate the long-term annual cost of maintaining the project, such as the costs of mowing grass when property is acquired as part of a buyout project and used as a park (see Figure 7). FEMA will not pay for project maintenance. A project that will endanger public health or reduce employment opportunities is not likely to be widely supported. An action cannot be implemented without sufficient funding. Examine various avenues for funding a mitigation project; a costly mitigation project could be financially feasible if the community applies for and receives grant funds to supplement available community resources.
Environmental	▪ Is the proposed action in a floodplain or wetland or will it indirectly impact the natural and beneficial functions of a floodplain or wetland? ▪ How will the action affect the natural environment? ▪ How will the action affect utility and transportation systems? Comment: Unless detrimental effects of a project on the natural environment can be minimized, the project under consideration may not be a good fit for the community.

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APPENDIX 6: CAPABILITY ASSESSMENTS

KLICKITAT COUNTY

CAPABILITY ASSESSMENT: Klickitat County		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
Planning and Regulatory	Comprehensive or Master Plan	None
	Capital Improvements Plan	None
	Economic Development Plan	Yes, 10-year plan (2017)
	Local Emergency Operations Plan	Comprehensive Emergency Management Plan (CEMP) (2017)
	Continuity of Operations Plan	Included in the CEMP
	Transportation Plan	None
	Stormwater Management Plan	None
	Community Wildfire Protection Plan	Yes, 2018
	Other	Shorelines Master Plan Update (2019)
Administrative	Maintenance programs (tree trimming, drain clearing, etc.)	Unknown
	Mutual aid agreements	Master Mutual Aid Agreement between Wasco, Hood River and Sherman Fire Defense Districts and Klickitat And Skamania County Fire Protection Agencies (2013)
	Memorandums of understanding	Unknown
	Other	

CAPABILITY ASSESSMENT: Klickitat County		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
Technical	Warning systems/services	Klickitat County DEM operates an emergency alert notification system and A.R.E.S.
	Hazard data and information	Yes
	GIS capabilities	Yes
	Grant Writing	Limited
	Flood Plain Manager	Yes
	Other	
Codes and Ordinances	Building code	
	Zoning ordinance	Ordinance No 62678 Enacted 1979, amended 2015
	Subdivision ordinance	Yes, amended 2015
	Floodplain ordinance	Ordinance No 0110788-1 (1981)
	Natural hazard specific ordinance	
	Flood insurance rate maps	Yes
	Other	
Project Funding Sources	Capital improvements project funding	Yes potentially
	Community Development Block Grant	Unknown
	Other federal funding program	Yes potentially

CAPABILITY ASSESSMENT: Klickitat County		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
	State funding programs	Yes potentially
	Other	
Education and Outreach	Ongoing public education or information programs	Yes, various
	Firewise Communities certification	No
	StormReady certification	Yes, information flyers
	Other	
Other Comments:		

GOLDENDALE

CAPABILITY ASSESSMENT: Goldendale		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
Planning and Regulatory	Comprehensive or Master Plan	Yes, it addresses growth concerns in Goldendale proper and within designated urban growth areas (2014)
	Capital Improvements Plan	Some capital facilities goals are included in the Comprehensive Plan.
	Economic Development Plan	Yes, along with a City Marketing Brochure
	Local Emergency Operations Plan	Some emergency response goals and capabilities are included in the Comprehensive Plan.
	Continuity of Operations Plan	No
	Transportation Plan	Some transportation goals are included in the Comprehensive Plan.
	Stormwater Management Plan	
	Community Wildfire Protection Plan	Yes, updated in 2018.
	Other	2005 Goldendale Community Action Plan (details a 20-year vision for the city)
Administrative	Maintenance programs (tree trimming, drain clearing, etc.)	Possibly with county
	Mutual aid agreements	Possibly with county
	Memorandums of understanding	Possibly with county
	Other	City Administrator
Technical	Warning systems/services	Through county
	Hazard data and information	Through county

CAPABILITY ASSESSMENT: Goldendale		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
	GIS capabilities	Through county
	Grant Writing	Limited
	Flood Plain Manager	
	Other	Gorge Tech Alliance (supports and develops the tech community in the Columbia River Gorge
Codes and Ordinances	Building code	State Building Code, 2006 International Building Code. Building / Code Enforcement
	Zoning ordinance	Yes
	Subdivision ordinance	Yes
	Floodplain ordinance	Yes
	Natural hazard specific ordinance	Yes, critical flood areas
	Flood insurance rate maps	Yes
	Other	
Project Funding Sources	Capital improvements project funding	Possibly through county
	Community Development Block Grant	Possibly through county
	Other federal funding program	Possibly through county
	State funding programs	Possibly through county
	Other	

CAPABILITY ASSESSMENT: Goldendale		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
Education and Outreach	Ongoing public education or information programs	Implemented as needed
	Firewise Communities certification	N/A
	StormReady certification	No
	Other	
Other Comments:		

White Salmon

CAPABILITY ASSESSMENT: White Salmon		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
Planning and Regulatory	Comprehensive or Master Plan	Yes, the 2012 version is currently being updated to chart a path for future development and public investment (2020)
	Capital Improvements Plan	No, capital improvements are included in the Comprehensive Plan
	Economic Development Plan	No, however an urbanization study was conducted in 2009 to analyze future land needs within White Salmon and its potential expansion area.
	Local Emergency Operations Plan	Some emergency response goals and capabilities are included in the Comprehensive Plan.
	Continuity of Operations Plan	No
	Transportation Plan	Some transportation goals are included in the Comprehensive Plan.
	Stormwater Management Plan	No, stormwater is discussed in the Comprehensive Plan. Public Works Department has water and sewer design standards established (2018)
	Community Wildfire Protection Plan	Yes, updated in 2018
	Other	Shoreline Master Plan (2018)
Administrative	Maintenance programs (tree trimming, drain clearing, etc.)	The city is committed to maintaining the visual aesthetics and safe vehicular and pedestrian access of the city
	Mutual aid agreements	An Inter-local Agreement was signed between White Salmon, Bingen and Husum that allows responders from all three jurisdicttions to be toned and respond to fires called into 911 emergency services in all three areas. There is an Inter-local Agreement between White Salmon and Bingen for police protection.
	Memorandums of understanding	
	Other	

CAPABILITY ASSESSMENT: White Salmon		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
Technical	Warning systems/services	Through county
	Hazard data and information	Through county
	GIS capabilities	Through county
	Grant Writing	Limited
	Flood Plain Manager	Unknown
	Other	
Codes and Ordinances	Building code	Ordinance 2016-08-989 amending WSMC 15.04 Building Code by adopting most recent International Building Code by reference
	Zoning ordinance	Numerous
	Subdivision ordinance	None specifically
	Floodplain ordinance	None found
	Natural hazard specific ordinance	None found
	Flood insurance rate maps	Effective March 18, 1985
	Other	
Project Funding Sources	Capital improvements project funding	unknown
	Community Development Block Grant	unknown
	Other federal funding program	unknown

CAPABILITY ASSESSMENT: White Salmon		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
	State funding programs	unknown
	Other	
Education and Outreach	Ongoing public education or information programs	unknown
	Firewise Communities certification	unknown
	StormReady certification	unknown
	Other	
Other Comments:		

BINGEN

CAPABILITY ASSESSMENT: Bingen		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
Planning and Regulatory	Comprehensive or Master Plan	None
	Capital Improvements Plan	None
	Economic Development Plan	None locally, Klickitat County 10-year economic development strategic plan (2017)
	Local Emergency Operations Plan	Unknown
	Continuity of Operations Plan	None
	Transportation Plan	None
	Stormwater Management Plan	Unknown
	Community Wildfire Protection Plan	Yes, updated in 2018
	Other	Shoreline Master Plan (2017)
Administrative	Maintenance programs (tree trimming, drain clearing, etc.)	
	Mutual aid agreements	An Inter-local Agreement was signed between White Salmon, Bingen and Husum that allows responders from all three jurisdictictions to be toned and respond to fires called into 911 emergency services in all three areas. There is an Inter-local Agreement between White Salmon and Bingen for police protection.
	Memorandums of understanding	
	Other	

CAPABILITY ASSESSMENT: Bingen		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
Technical	Warning systems/services	Through county
	Hazard data and information	Through county
	GIS capabilities	Through county
	Grant Writing	Limited
	Flood Plain Manager	Unknown
	Other	
Codes and Ordinances	Building code	Ordinance No 2016-07-663 amending Bingen Municipal Code 15.04 building code by adopting most recent International Building Code by reference
	Zoning ordinance	Municipal Code Chapter 17 Zoning
	Subdivision ordinance	Municipal Code Chapter 17 Zoning
	Floodplain ordinance	Municipal Code Chapter 15.16 flood hazard protection
	Natural hazard specific ordinance	Ordinance No 2015-06-646 Critical Area, 17.66 Slope hazard overlay zone, and 17.67 wetlands and wetland buffers. Ordinance No 2015-03-643 adopting Municipal Code Chapter 13.07 water shortage emergency procedures.
	Flood insurance rate maps	Amended in 2006
	Other	

CAPABILITY ASSESSMENT: Bingen		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
Project Funding Sources	Capital improvements project funding	unknown
	Community Development Block Grant	unknown
	Other federal funding program	unknown
	State funding programs	unknown
	Other	
Education and Outreach	Ongoing public education or information programs	unknown
	Firewise Communities certification	unknown
	StormReady certification	unknown
	Other	
Other Comments:		

KLICKITAT VALLEY HEALTH

CAPABILITY ASSESSMENT: Klickitat Valley Health		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
Planning and Regulatory	Comprehensive or Master Plan	NA
	Capital Improvements Plan	Yes 2019. The plan is based on the annual HVA, projects are identified to include the mitigation strategy, with further funding the plan can be used to implement mitigation actions.
	Economic Development Plan	NA. KVH is part of the County/City Economic Development Plan but does not maintain it's own
	Local Emergency Operations Plan	Yes 2019. Emergency Operations Plan with supporting policies from all departments
	Continuity of Operations Plan	Yes 2019. As part of Emergency Operations Plan.
	Transportation Plan	Yes 2019. As part of Emergency Operations Plan
	Stormwater Management Plan	NA
	Community Wildfire Protection Plan	NA
	Other	
Administrative	Maintenance programs (tree trimming, drain clearing, etc.)	NA
	Mutual aid agreements	Yes. In Emergency Operations Plan: Region IV, Regional Emergency and Disaster Health Care Coalition, Region 6 Area Trauma Advisory Board
	Memorandums of understanding	NA
	Other	KVH does have planning capabilities through the Emergency Preparedness Committee (under oversight of Hospital District Board)

CAPABILITY ASSESSMENT: Klickitat Valley Health		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
Technical	Warning systems/services	
	Hazard data and information	
	GIS capabilities	No
	Grant Writing	Yes. Various positions are responsible for writing grants.
	Flood Plain Manager	NA
	Building Official	Plant manager/Safety Officer is responsible for workplace safety, utilities, water treatment plan, and security. Coordinates with all KVH staff effectively through Emergency Preparedness Coordinator, ongoing training and skill-building
	Emergency Planner	Emergency Preparedness Coordinator, responsible for EOP/HVA and exercises/drills as required by CMS regulations
Codes and Ordinances	Building code	Yes. We follow the standards adopted by the Department of Health Construction Review Services, including NFPA (2012) regulations
	Zoning ordinance	NA
	Subdivision ordinance	NA
	Floodplain ordinance	NA
	Natural hazard specific ordinance	NA
	Flood insurance rate maps	NA
	Other	Site plan review requirements: Construction Review Services and City of Goldendale reviews all planning documents, our hospital license is dependent on passing an 18-month survey (building codes)

CAPABILITY ASSESSMENT: Klickitat Valley Health		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
Project Funding Sources	Capital improvements project funding	Yes. Capital improvements are included in the annual budget and funded by KVH income. Secured USDA grant to finish Wellness and Therapy Center. Applied for Local Community Project Funding through the State Legislature in the past (funds were granted) and currently (pending).
	Community Development Block Grant	NA
	Other federal funding program	Unknown
	State funding programs	Unknown
	Other	As a Public Hospital District. Main KVH buildings were built with bond monies. Planning to levy a bond for a new patient wing in 2020.
Education and Outreach	Ongoing public education or information programs	Working on integrating with local media and the new KVH website to notify the public of relevant disaster-related issues
	Staff education programs	Emergency Preparedness Committee meets monthly--staff and board member participation. Staff education through posts on intranet system and AllStaff emails and a series of Emergency Preparedness exercises/events/drills throughout the year.
	StormReady certification	NA
	Other	
Other Comments:		

Central Klickitat County Conservation District

CAPABILITY ASSESSMENT: Central Klickitat County Conservation District		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
Planning and Regulatory	Comprehensive or Master Plan	NA
	Capital Improvements Plan	NA
	Economic Development Plan	NA
	Local Emergency Operations Plan	NA
	Continuity of Operations Plan	NA
	Transportation Plan	NA
	Stormwater Management Plan	NA
	Community Wildfire Protection Plan	NA
	Other	NA
Administrative	Maintenance programs (tree trimming, drain clearing, etc.)	NA
	Mutual aid agreements	NA
	Memorandums of understanding	NA
	Other	NA
Technical	Warning systems/services	NA
	Hazard data and information	NA

CAPABILITY ASSESSMENT: Central Klickitat County Conservation District		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
	GIS capabilities	NA
	Grant Writing	NA
	Flood Plain Manager	NA
	Other	NA
Codes and Ordinances	Building code	NA
	Zoning ordinance	NA
	Subdivision ordinance	NA
	Floodplain ordinance	NA
	Natural hazard specific ordinance	NA
	Flood insurance rate maps	NA
	Other	NA
Project Funding Sources	Capital improvements project funding	Eastern Klickitat CD has capability to apply for, receive and implement capital improvement projects example would be manmade fish barrier replacements.
	Community Development Block Grant	NA
	Other federal funding program	NA
	State funding programs	NA
	Other	Conservation Districts have RCW authority to work with county commissioners to assess a rates and charges fee to private land through for programs to protect and improve natural resources

CAPABILITY ASSESSMENT: Central Klickitat County Conservation District		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
Education and Outreach	Ongoing public education or information programs	One of the main functions of the district is public education to both adult and youth on natural resource cycles and how man impacts. This can be focused on prevention and recovery of natural disasters and how land management can reduce severity and occurrence we have focused on flooding and wildfire for many years.
	Firewise Communities certification	Can provide assistance to help communities to become certified
	StormReady certification	
	Other	
Other Comments:		

Eastern Klickitat County Conservation District

CAPABILITY ASSESSMENT: Eastern Klickitat County Conservation District		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
Planning and Regulatory	Comprehensive or Master Plan	NA
	Capital Improvements Plan	NA
	Economic Development Plan	NA
	Local Emergency Operations Plan	NA
	Continuity of Operations Plan	NA
	Transportation Plan	NA
	Stormwater Management Plan	NA
	Community Wildfire Protection Plan	NA
	Other	NA
Administrative	Maintenance programs (tree trimming, drain clearing, etc.)	NA
	Mutual aid agreements	NA
	Memorandums of understanding	NA
	Other	NA
Technical	Warning systems/services	NA
	Hazard data and information	NA

CAPABILITY ASSESSMENT: Eastern Klickitat County Conservation District		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
	GIS capabilities	NA
	Grant Writing	NA
	Flood Plain Manager	NA
	Other	NA
Codes and Ordinances	Building code	NA
	Zoning ordinance	NA
	Subdivision ordinance	NA
	Floodplain ordinance	NA
	Natural hazard specific ordinance	NA
	Flood insurance rate maps	NA
	Other	NA
Project Funding Sources	Capital improvements project funding	Eastern Klickitat CD has capability to apply for, receive and implement capital improvement projects example would be manmade fish barrier replacements
	Community Development Block Grant	NA
	Other federal funding program	NA
	State funding programs	NA
	Other	Conservation Districts have RCW authority to work with county commissioners to assess a rates and charges fee to private land through for programs to protect and improve natural resources

CAPABILITY ASSESSMENT: Eastern Klickitat County Conservation District		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
Education and Outreach	Ongoing public education or information programs	One of the main functions of the district is public education to both adult and youth on natural resource cycles and how man impacts. This can be focused on prevention and recovery of natural disasters and how land management can reduce severity and occurrence we have focused on flooding and wildfire for many years.
	Firewise Communities certification	Can provide assistance to help communities to become certified
	StormReady certification	NA
	Other	
Other Comments:		

Underwood Conservation District

CAPABILITY ASSESSMENT: Underwood Conservation District		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
Planning and Regulatory	Comprehensive or Master Plan	UCD's Long-Range (5-year) Plan, 2017, which lists forest health, wildfire and climate impacts as key issues.
	Capital Improvements Plan	NA
	Economic Development Plan	NA
	Local Emergency Operations Plan	NA
	Continuity of Operations Plan	NA
	Transportation Plan	NA
	Stormwater Management Plan	NA
	Community Wildfire Protection Plan	UCD has been involved with several CWPPs, including assisting with Klickitat County's (2018-19), and carries out allied wildfire hazard-reduction projects.
	Other	UCD is starting to consider appropriate climate change adaptation strategies and programs for Klickitat County. The District is currently writing a plan to be completed this year.
Administrative	Maintenance programs (tree trimming, drain clearing, etc.)	UCD, when appropriate funding is available, carries out wildfire hazard-reduction work on both the individual and small-community scale. Similarly, the District has administered projects to alleviate ice-storm damage and remove beetle-killed trees next to houses during a beetle outbreak.
	Mutual aid agreements	
	Memorandums of understanding	
	Other	UCD has "Firewise" wildfire hazard-reduction personnel on staff who are experienced in working with landowners, contractors and other agencies.

CAPABILITY ASSESSMENT: Underwood Conservation District		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
Technical	Warning systems/services	
	Hazard data and information	Wildfire hazards to individual sites, a function UCD staff carry out with both homeowners and small communities (e.g., cabin associations).
	GIS capabilities	
	Grant Writing	
	Flood Plain Manager	
	Other	
Codes and Ordinances	Building code	
	Zoning ordinance	
	Subdivision ordinance	
	Floodplain ordinance	
	Natural hazard specific ordinance	As a non-regulatory natural resource agency, UCD does not write ordinances, but staff does work with landowners / homeowners and local governments in writing plans and carrying out projects, such as stream/floodplain and wildfire hazard-reduction.
	Flood insurance rate maps	
	Other	UCD is considering acquiring land for open space and public recreation uses.
Project Funding Sources	Capital improvements project funding	
	Community Development Block Grant	
	Other federal funding program	Yes

CAPABILITY ASSESSMENT: Underwood Conservation District		
Category	**Planning Tool/Capability**	**Yes/No; Year; Comments**
	State funding programs	UCD has obtained state and local grants. Most of our project funding consists of grants. The District has used grants for a number of natural resource-improvement and hazard-reduction projects.
	Other	
Education and Outreach	Ongoing public education or information programs	UCD regularly conducts educational workshops on natural resource issues, including wildfire, fire ecology and other related topics.
	Firewise Communities certification	UCD has been involved in Firewise Communities in Klickitat County, including the county-wide plan recently completed.
	StormReady certification	
	Other	UCD focuses on working with landowners / homeowners and local communities on a range of natural resource issues.

Expansion of Planning and Regulatory Capabilities: UCD's capability to work with local governments and landowners to assess natural resources and hazards – e.g., planning and zoning on forested areas adjacent to towns – depends primarily on individual grants. So, a consistent but modest level of funding over a 2-to-5 year horizon would be most useful.

Expansion of Administrative and Technical Capabilities: Capacity to implement hazard-reduction/-mitigation projects, such as wildfire hazard-reduction, and related noncommercial forest health work, will be contingent on funding -- either consistent programmatic funds or programmatic "block grants." Even on the scale of just 2-5 years, a modest but consistent effort would be very helpful in identifying, prioritizing and implementing wildfire hazard-reduction projects in populated, rural, wildfire-prone areas of Klickitat County.

Expansion of Financial Capabilities: Consistent, if modest, funding (on a 2-5 year horizon) would greatly expand our agency's capabilities.
Secondly, a hazard-reduction grant for landowners that focuses on metrics of people or properties assisted - instead of acreage treated - would foster actionable risk-reduction.

Expansion of Education and Outreach Capabilities: There are several ways these existing capabilities could be expanded:
A) identification of key realistic hazards that individual and communities can feasibly address: e.g., drought, wildfire and climate impacts;
B) fund UCD with a consistent, modest level to carry out specific hazard-reduction efforts;
C) make the required match as small as possible, to focus on results.

Plan Reference

For more information about the 2020 Klickitat County Multi-Hazard Mitigation Plan, please contact:

Klickitat County Department of Emergency Management:

Phone: (509) 773-0582

Website: http://www.klickitatcounty.org/249/Emergency-Management

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