

Clackamas County Multi-Jurisdictional Hazard Mitigation Plan

Clackamas County and the Jurisdictions of:
Canby, Estacada, Gladstone, Happy Valley, Johnson City, Lake Oswego,
Milwaukie, Molalla, Oregon City, Sandy, West Linn, Wilsonville and
Clackamas Fire District #1



Photo Credit: Gary Halvorson, Oregon State Archives

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Volume I: Basic Plan

Prepared for:

Clackamas County Emergency Management

Prepared by:

University of Oregon
Institute for Policy Research and Engagement
Oregon Partnership for Disaster Resilience



UNIVERSITY OF OREGON

PPPM

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Special thanks to Jay Wilson, Clackamas County Resilience Coordinator for his vision, passion, and positive outlook throughout the plan update process.

Hazard Mitigation Advisory Committee

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Geographic Information Systems (GIS) Maps:

The Clackamas County GIS department updated the vulnerability analysis tables; this table was a vital component to the committee's review and update of the hazard analysis. The contributions from this department were essential in illustrating the extent and potential losses associated with the natural hazards affecting the community

- Kelly Neumeier, Clackamas County Geographic Information Systems

Additional Thanks:

To the Department of Geology and Mineral Industries for assistance with hazard data; the Department of Land Conservation and Development staff in the hazards for flood data, mapping and process support; to the Oregon Military Department Office of Emergency Management for grant administration and process support.

About the Institute for Policy Research and Engagement

The Institute for Policy Research and Engagement (IPRE), a research center affiliated with the School of Planning, Public Policy and Management at the University of Oregon, is an interdisciplinary organization that assists Oregon communities by providing planning and technical assistance to help solve local issues and improve the quality of life for Oregon residents. The role of the IPRE is to link the skills, expertise and innovation of higher education with the transportation, economic development and environmental needs of communities and regions in the State of Oregon, thereby providing service to Oregon and learning opportunities to the students involved.

About the Oregon Partnership for Disaster Resilience

The Oregon Partnership for Disaster Resilience (OPDR) is a coalition of public, private and professional organizations working collectively toward the mission of creating a disaster-resilient and sustainable state. Developed and coordinated by the Institute for Policy Research and Engagement at the University of Oregon, the OPDR employs a service-learning model to increase community capacity and enhance disaster safety and resilience statewide.

Plan Template Disclaimer

This Hazard Mitigation Plan is based in part on a plan template developed by the Oregon Partnership for Disaster Resilience. The template is structured to address the requirements contained in 44 CFR 201.6; where language is applicable to communities throughout Oregon, OPDR encourages the use of standardized language. As part of this regional planning initiative, OPDR provided copies of the plan templates to communities for use in developing or updating their hazards mitigation plans. OPDR hereby authorizes the use of all content and language provided to Clackamas County in the plan template.

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PLAN SUMMARY

Clackamas County updated this Multi-Jurisdictional Natural Hazards Mitigation Plan (MJNHMP, NHMP, or Plan) to prepare for the long-term effects resulting from hazards. It is impossible to predict exactly when these hazards will occur, or the extent to which they will affect the community. However, with careful planning and collaboration among public agencies, private sector organizations and citizens within the community, it is possible to create a resilient community that will benefit from long-term recovery planning efforts.

The Federal Emergency Management Agency (FEMA) defines mitigation as “. . . the effort to reduce loss of life and property by lessening the impact of disasters . . . through risk analysis, which results in information that provides a foundation for mitigation activities that reduce risk.” Said another way, hazard mitigation is a method of permanently reducing or alleviating the losses of life, property and injuries resulting from hazards through long and short-term strategies. Example strategies include policy changes, such as updated ordinances, projects, such as seismic retrofits to critical facilities; and education and outreach to targeted audiences, such as non-English speaking residents or the elderly. Hazard mitigation is the responsibility of the “Whole Community.” FEMA defines Whole Community as, “private and nonprofit sectors, including businesses, faith-based and disability organizations and the public, in conjunction with the participation of local, tribal, state, territorial and Federal governmental partners.”

44 CFR 201.6 – The local mitigation plan is the representation of the jurisdiction’s commitment to reduce risks from natural hazards, serving as a guide for decision makers as they commit resources to reducing the effects of natural hazards. . . .

Why Develop this Mitigation Plan?

The Disaster Mitigation Act of 2000 (DMA2K) and the regulations contained in 44 CFR 201 require that jurisdictions maintain an approved Natural Hazard Mitigation Plan (NHMP) in order to receive FEMA Hazard Mitigation Assistance funds for mitigation projects. To that end, Clackamas County is involved in a broad range of hazard and emergency management planning activities. Local and federal approval of this Plan ensures that the County and listed jurisdictions will (1) remain eligible for pre- and post-disaster mitigation project grants and (2) promote local mechanisms to accomplish risk reduction strategies.

44 CFR 201.6(a)(1) – A local government must have a mitigation plan approved pursuant to this section in order to receive HMGP project grants . . .

What is Mitigation?

“Any sustained action taken to reduce or eliminate long-term risk to life and property from a hazard event.”

- U.S. Federal Emergency Management Agency

Who Participated in Developing the Plan?

The Clackamas County NHMP is the result of a collaborative effort between the County, cities, special districts, citizens, public agencies, non-profit organizations, the private sector and regional organizations. County and City Hazard Mitigation Advisory Committees guided the Plan development process.

For a list of individual County Hazard Mitigation Advisory Committee participants, refer to the acknowledgements section above. The update process included representatives from the following jurisdictions and agencies:

- Clackamas County Application Services
- Clackamas County Disaster Management
- Clackamas County Planning
- Clackamas County Public Health
- Clackamas County Public Works
- City of Canby
- City of Estacada
- City of Gladstone
- City of Happy Valley
- City of Johnson City
- City of Milwaukie
- City of Molalla
- City of Lake Oswego
- City of Oregon City
- City of Sandy
- City of West Linn
- City of Wilsonville
- Clackamas Soil and Water Conservation District
- Clackamas River Water Providers
- Clackamas Fire District #1
- Oregon Department of Geology and Mineral Industries
- Oregon Department of Land Conservation and Development
- Oregon Emergency Management
- United States Army Corps of Engineers

44 CFR 201.6(c)(1) – Documentation of the planning process used to develop the plan, including how it was prepared, who was involved in the process and how the public was involved.

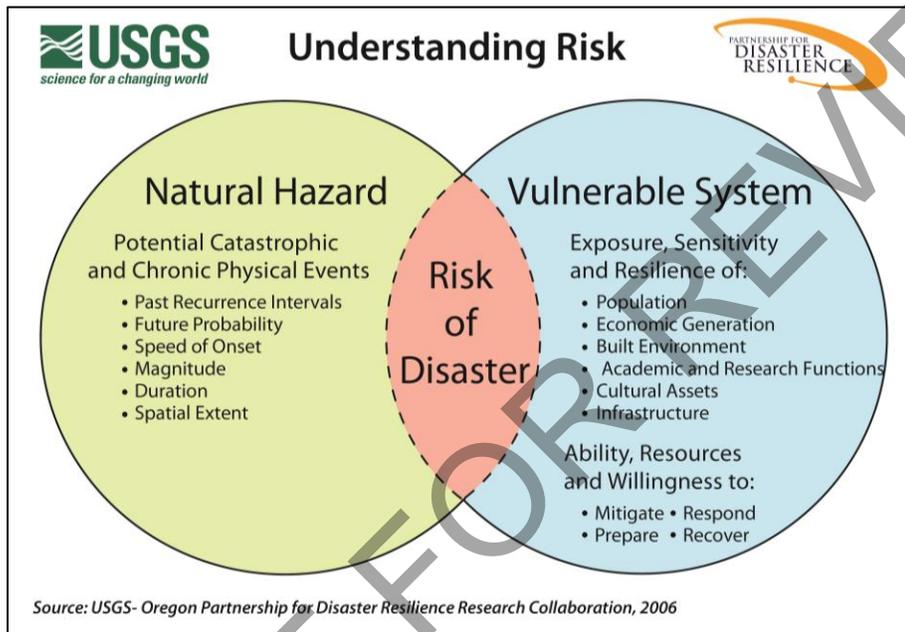
The Clackamas County Resilience Coordinator convened the planning process and will take the lead in implementing, maintaining and updating the County Plan. Each of the participating cities have also named a local convener who is responsible for implementing, maintaining and updating the city addenda (see addenda for specific names and positions). Clackamas County is dedicated to directly involving the public in the continual review and update of the Natural Hazards Mitigation Plan. The County achieves this through systematic engagement of a wide variety of active groups, organizations or committees, public and private infrastructure partners, watershed and neighborhood groups and numerous others. Although members of the Hazard Mitigation Advisory Committee represent the public to some extent, the public will also have the opportunity to continue to provide feedback about the Plan throughout the implementation and maintenance period.

How Does this Mitigation Plan Reduce Risk?

The NHMP is intended to assist Clackamas County reduce the risk from hazards by identifying resources, information and strategies for risk reduction. It is also intended to guide and coordinate mitigation activities throughout the County. A risk assessment consists of three phases: hazard identification, vulnerability assessment and risk analysis, as illustrated in the following graphic.

44 CFR 201.6(c)(2) – A Risk Assessment that provides the factual basis for activities proposed in the strategy

Figure PS-I Understanding Risk



Source: Oregon Partnership for Disaster Resilience.

By identifying and understanding the relationship between hazards, vulnerable systems and existing capacity, Clackamas County is better equipped to identify and implement actions aimed at reducing the overall risk to hazards. Notably, Clackamas County took the unique step of directly engaging representatives in four critical lifeline sectors: Communication, Energy, Transportation, and Water. Because these four lifeline sectors are critical to virtually all other activity in the county, this approach was used to better understand each sector's unique vulnerabilities, threats and hazards. The County will utilize the information collected to inform action items updates that are specific and aimed at reducing risks across each of the four lifeline sectors.

Note: The sector specific risk assessment is still in development. It will be provided as an appendix when it is complete.

What is Clackamas County’s Overall Risk to Hazards?

Clackamas County reviewed and updated the risk assessment to evaluate the probability of each hazard as well as the vulnerability of the community to that hazard. Table PS-1 below summarizes hazard probability and vulnerability as determined by the County Hazard Mitigation Advisory Committee (for more information see Volume I, Section 2).

Table PS-1 Hazard and Vulnerability Assessment Summary

Hazard	Maximum				Total Threat Score	Hazard Rank	Hazard Tiers
	History	Vulnerability	Threat	Probability			
Earthquake - Cascadia	4	45	100	49	198	#1	Top Tier
Earthquake - Crustal	6	50	100	21	177	#2	
Wildfire	12	25	70	56	163	#3	
Winter Storm	10	30	70	49	159	#4	
Drought	10	15	50	56	131	#5	Middle Tier
Flood	16	20	30	56	122	#6	
Windstorm	14	15	50	42	121	#7	
Landslide	14	15	20	63	112	#8	Bottom Tier
Volcanic Eruption	2	35	50	14	101	#9	
Extreme Heat	2	20	40	14	76	#10	

Source: Clackamas County NHMP Hazard Mitigation Advisory Committee, 2018

What is the Plan’s Mission?

The mission of the Clackamas County NHMP is to:

Promote sound public policy designed to protect citizens, critical facilities, infrastructure, private property, and the environment from natural hazards.

This can be achieved by increasing public awareness, documenting the resources for risk reduction and loss-prevention, and identifying activities to guide the county towards building a safer, more sustainable community.

What are the Plan Goals?

The plan goals describe the overall direction that the participating jurisdiction’s agencies, organizations and citizens can take toward mitigating risk from all-hazards. The goals of the Clackamas County Natural Hazards Mitigation Plan are organized under several broad categories. The goals are:

44 CFR 201.6(c)(3)(i) – A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

PROTECT LIFE AND PROPERTY

- Implement activities that assist in protecting lives by making homes, businesses, infrastructure, critical facilities, and other property more resistant to natural hazards.

- Reduce losses and repetitive damages for chronic hazard events while promoting insurance coverage for catastrophic hazards.
- Improve hazard assessment information to make recommendations for discouraging new development and encouraging preventative measures for existing development in areas vulnerable to natural hazards.

ENHANCE NATURAL SYSTEMS

- Balance watershed planning, natural resource management, and land use planning with natural hazards mitigation to protect life, property, and the environment.
- Preserve, rehabilitate, and enhance natural systems to serve natural hazard mitigation functions.

AUGMENT EMERGENCY SERVICES

- Establish policy to ensure mitigation projects for critical facilities, services, and infrastructure.
- Strengthen emergency operations by increasing collaboration and coordination among public agencies, non-profit organizations, and business, and industry.
- Coordinate and integrate natural hazards mitigation activities, where appropriate, with emergency operations plans and procedures.

ENCOURAGE PARTNERSHIPS FOR IMPLEMENTATION

- Strengthen communication and coordinate participation among and within public agencies, citizens, non-profit organizations, business, and industry to gain a vested interest in implementation.
- Encourage leadership within public and private sector organizations to prioritize and implement local, county, and regional hazard mitigation activities.

PROMOTE PUBLIC AWARENESS

- Develop and implement education and outreach programs to increase public awareness of the risks associated with natural hazards.
- Provide information on tools, partnership opportunities, and funding resources to assist in implementing mitigation activities.

How are the Action Items Organized?

The action items are organized within an action matrix included within Section 3, Mitigation Strategy.

Data collection, research and the public participation process resulted in the development of the action items. The Action Item Matrix portrays the plan framework and identifies linkages between the plan goals and actions. The matrix documents the title of each action along with, the coordinating organization, timeline and the Plan goals addressed. City specific action items are included in Volume II, City Addenda.

44 CFR 201.6(c)(3)(ii) – A section that identifies and analyzes a comprehensive range of specific mitigation actions . . .

Comprehensive Action Plan

Action items are detailed recommendations for activities that local departments, citizens, and others could engage in to reduce risk. The Hazard Mitigation Advisory Committee will prioritize the following actions to focus their attention, and resource availability, upon an achievable set of high leverage activities over the next five-years.

In addition to the actions listed below **Wildfire #1** (see Appendix A) is considered high priority. See the [Clackamas Community Wildfire Protection Plan](#) for detailed information.

EDUCATION AND OUTREACH

- **Multi-Hazard (MH) #4.** Identify, improve, and sustain collaborative programs focusing on the real estate and insurance industries, public and private sector organizations, and individuals to avoid activity that increases risk to natural hazards
- **Multi-Hazard (MH) #7.** Strengthen emergency services preparedness and response by linking emergency services with natural hazard mitigation programs, and enhancing and implementing public education programs on a regional scale
- **Flood (FL) #1.** Identify opportunities to educate people within Clackamas County's public and private flood prone properties and identify feasible mitigation options
- **Flood (FL) #8.** Encourage purchase of flood insurance
- **Landslide (LS) #3.** Continue to limit activities in identified potential and historical landslide areas through regulation and public outreach
- **Wildfire (WF) #2.** Encourage private landowners to create and maintain defensible space around homes and other buildings.

GIS/MAPPING

- No action within this category was identified as a priority.

MAINTENANCE/PLANNING

- **Multi-Hazard (MH) #1.** Integrate the goals and action items from the Clackamas County Natural Hazard Mitigation Plan into existing regulatory documents and programs, where appropriate.
- **Multi-Hazard (MH) #2.** Identify and pursue funding opportunities to develop and implement local and county mitigation activities.
- **Severe Weather (SW) #3.** Monitor and implement programs to keep trees from threatening lives, property, and public infrastructure during windstorm events

CRITICAL INFRASTRUCTURE/ESSENTIAL FACILITIES

- **Multi-Hazard (MH) #6.** Update and Maintain inventories of at-risk buildings and infrastructure and prioritize mitigation projects
- **Multi-Hazard (MH) #10.** Perform pre-disaster assessments on County owned and/or operated buildings and facilities, potential shelter sites, and essential facilities.
- **Earthquake (EQ) #3.** Encourage seismic strength evaluations for existing critical facilities in the County to identify vulnerabilities for mitigation of schools and universities, public infrastructure, and critical facilities to meet current seismic standards

LAND USE/DEVELOPMENT

- **Multi-Hazard (MH) #9.** Enhance strategies for debris management.
- **Landslide (LS) #4.** Recommend construction and subdivision design that can be applied to steep slopes to reduce the potential adverse impacts from development.

How will the Plan be implemented?

The implementation and maintenance section (Section 4) details the formal process that will ensure that the Clackamas County NHMP remains an active and relevant document. The Clackamas County Resilience Coordinator is the designated convener (Plan Convener) and is responsible for overseeing the review and implementation processes (see city addenda for city conveners). The NHMP maintenance process includes a schedule for monitoring and evaluating the NHMP semi-annually and producing a revision every five years. This section also describes how the communities will integrate public participation throughout the implementation and maintenance process.

44 CFR 201.6(c)(3)(iii) – An action plan describing how the actions . . . will be prioritized, implemented and administered . . .

44 CFR 201.6(c)(4) – A plan maintenance process . . .

Plan Adoption

Once the NHMP is locally reviewed and deemed complete the Plan Convener (or their designee) submits it to the State Hazard Mitigation Officer at the Oregon Military Department – Office of Emergency Management (OEM). OEM reviews the Plan and submits it to the Federal Emergency Management Agency (FEMA – Region X) for review. This review will address the federal criteria outlined in FEMA Interim Final Rule 44 CFR Part 201.6. Once the NHMP is pre-approved by FEMA, the County and cities formally adopt it via resolution. The Clackamas County Plan Convener will be responsible for ensuring local adoption of the NHMP and providing the support necessary to ensure NHMP implementation. Once the resolution is executed at the local level and documentation is provided to FEMA, the NHMP is formally acknowledged by FEMA and the County (and participating cities) will maintain eligibility for the Pre-Disaster Mitigation Grant Program, the Hazard Mitigation Grant Program funds and the Flood Mitigation Assistance program funds.

44 CFR 201.6(c)(5) – Documentation that the plan has been formally adopted by the governing body of the jurisdiction . . .

44 CFR 201.6(d) – Plan review [process] . . .

The accomplishment of the NHMP goals and actions depends upon regular Hazard Mitigation Advisory Committee participation and adequate support from County and City leadership. Comprehensive familiarity with this NHMP will result in the efficient and effective implementation of appropriate mitigation activities and a reduction in the risk and the potential for loss from future natural hazard events.

The Hazard Mitigation Advisory Committees for Clackamas County and participating cities each met to review the Plan update process and their governing bodies adopted the NHMP as shown below:

Clackamas County adopted the NHMP on [DATE], 2019

The City of Canby adopted their addendum to the NHMP on [DATE], 2019

The City of Estacada adopted their addendum to the NHMP on [DATE], 2019

The City of Gladstone adopted their addendum to the NHP on [DATE], 2019

The City of Happy Valley adopted their addendum to the NHMP on [DATE], 2019

The City of Johnson City adopted their addendum to the NHMP on [DATE], 2019

The City of Lake Oswego adopted their addendum to the NHMP on [DATE], 2019

The City of Milwaukie adopted their addendum to the NHMP on [DATE], 2019

The City of Molalla adopted their addendum to the NHMP on [DATE], 2019

The City of Oregon City adopted their addendum to the NHMP on [DATE], 2019

The City of Sandy adopted their addendum to the NHMP on [DATE], 2019

The City of West Linn adopted their addendum to the NHMP on [DATE], 2019

The City of Wilsonville adopted their addendum to the NHMP on [DATE], 2019

The Clackamas Fire District #1 adopted their addendum to the NHMP on [DATE], 2019

FEMA Region X approved the Clackamas County NHMP on [DATE], 2019. With approval of this Plan, the entities listed above are now eligible to apply for the Robert T. Stafford Disaster Relief and Emergency Assistance Act's hazard mitigation project grants through [DATE], 2024.

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SECTION I: INTRODUCTION

This section provides a general introduction to natural hazard mitigation planning in Clackamas County. In addition, it addresses the planning process requirements contained in 44 CFR 201.6(b) thereby meeting the planning process documentation requirement contained in 44 CFR 201.6(c)(1). The section concludes with a general description of how the NHMP is organized.

What is Natural Hazard Mitigation?

The Federal Emergency Management Agency (FEMA) defines mitigation as “. . . the effort to reduce loss of life and property by lessening the impact of disasters . . . through risk analysis, which results in information that provides a foundation for mitigation activities that reduce risk.”¹ Said another way, natural hazard mitigation is a method of permanently reducing or alleviating the losses of life, property and injuries resulting from natural hazards through long and short-term strategies. Example strategies include policy changes, such as updated ordinances, projects, seismic retrofits to critical facilities and education and outreach to targeted audiences, such as Spanish speaking residents or the elderly. Natural hazard mitigation is the responsibility of the “Whole Community”; individuals, private businesses and industries, state and local governments and the federal government.

Engaging in mitigation activities provides jurisdictions (counties, cities, special districts, etc.) with many benefits, including reduced loss of life, property, essential services, critical facilities and economic hardship; reduced short-term and long-term recovery and reconstruction costs; increased cooperation and communication within the community through the planning process; and increased potential for state and federal funding for recovery and reconstruction projects.

Why Develop a Mitigation Plan?

Clackamas County updated this Multi-Jurisdictional Natural Hazard Mitigation Plan (MNHMP, NHMP) to reduce future loss of life and damage to property resulting from natural hazards. It is impossible to predict exactly when natural hazard events will occur, or the extent to which they will affect community assets. However, with careful planning and collaboration among public agencies, private sector organizations and citizens within the community, it is possible to minimize the losses that can result from natural hazards.

In addition to establishing a comprehensive community-level mitigation strategy, the Disaster Mitigation Act of 2000 (DMA2K) and the regulations contained in 44 CFR 201, require that jurisdictions maintain an approved NHMP to receive federal funds for mitigation projects. Local adoption and federal approval of this NHMP ensures that the County and listed cities will remain eligible for pre- and post-disaster mitigation project grants.

¹ FEMA, *What is Mitigation?* <http://www.fema.gov/what-mitigation>

What Federal Requirements Does This NHMP Address?

DMA2K is the latest federal legislation addressing mitigation planning. It reinforces the importance of mitigation planning and emphasizes planning for natural hazards before they occur. As such, this Act established the Pre-Disaster Mitigation (PDM) grant program and new requirements for the national post-disaster Hazard Mitigation Grant Program (HMGP). Section 322 of the Act specifically addresses mitigation planning at the state and local levels. State and local jurisdictions must have approved mitigation plans in place in order to qualify to receive post-disaster HMGP funds. Mitigation plans must demonstrate that State and local jurisdictions' proposed mitigation measures are based on a sound planning process that accounts for the risk to the individual and State and local jurisdictions' capabilities.

Chapter 44 Code of Federal Regulations (CFR), section 201.6, also requires a local government to have an approved mitigation plan in order to receive HMGP project grants.² Pursuant of Chapter 44 CFR, the Natural Hazard Mitigation Plan planning processes shall include opportunity for the public to comment on the NHMP during review and the updated NHMP shall include documentation of the public planning process used to develop the NHMP.³ The Natural Hazard Mitigation Plan update must also contain a risk assessment, mitigation strategy and a NHMP maintenance process that has been formally adopted by the governing body of the jurisdiction.⁴ Lastly, the Natural Hazard Mitigation Plan must be submitted to Oregon Military Department – Office of Emergency Management (OEM) for initial review and then sent to FEMA for federal approval.⁵ Additionally, a recent change in the way OEM administers the Emergency Management Performance Grant (EMPG), which helps fund local emergency management programs, also requires a FEMA-approved NHMP.

What is the Policy Framework for Natural Hazards Planning in Oregon?

Planning for natural hazards is an integral element of Oregon's statewide land use planning program, which began in 1973. All Oregon cities and counties have comprehensive plans (Comprehensive Plans) and implementing ordinances that are required to comply with the statewide planning goals. The challenge faced by state and local governments is to keep this network of local plans coordinated in response to the changing conditions and needs of Oregon communities.

Statewide land use planning Goal 7: Areas Subject to Natural Hazards calls for local plans to include inventories, policies and ordinances to guide development in or away from hazard areas. Goal 7, along with other land use planning goals, has helped to reduce losses from natural hazards. Through risk identification and the recommendation of risk-reduction actions, this NHMP aligns with the goals of the jurisdiction's Comprehensive Plan and helps each jurisdiction meet the requirements of statewide land use planning Goal 7.

The primary responsibility for the development and implementation of risk reduction strategies and policies lies with local jurisdictions. However, additional resources exist at the state and federal levels. Some of the key agencies in this area include Oregon Military

² Code of Federal Regulations, Chapter 44. Section 201.6, subsection (a), 2015

³ *ibid*, subsection (b). 2015

⁴ *ibid*, subsection (c). 2015

⁵ *ibid*, subsection (d). 2015

Department – Office of Emergency Management (OEM), Oregon Building Codes Division (BCD), Oregon Department of Forestry (ODF), Oregon Department of Geology and Mineral Industries (DOGAMI) and the Department of Land Conservation and Development (DLCD).

How was the NHMP Developed?

The NHMP was developed by the Clackamas County Natural Hazard Mitigation Plan Hazard Mitigation Advisory Committee and the Hazard Mitigation Advisory Committees for the Cities of Canby, Estacada, Gladstone, Happy Valley, Johnson City, Lake Oswego, Milwaukie, Molalla, Oregon City, Sandy, West Linn, Wilsonville. The Clackamas County Hazard Mitigation Advisory Committee formally convened on two occasions to discuss and revise the NHMP. Each of the participating city Hazard Mitigation Advisory Committees met at least once formally. Hazard Mitigation Advisory Committee members contributed data and maps, reviewed and updated the community profile, risk assessment, action items and implementation and maintenance plan.

An open public involvement process is essential to the development of an effective NHMP. To develop a comprehensive approach to reducing the effects of natural disasters, the planning process shall include opportunity for the public, neighboring communities, local and regional agencies, as well as, private and non-profit entities to comment on the NHMP during review.⁶ Clackamas County provided an accessible project website for the public to provide feedback on the draft NHMP: <https://www.clackamas.us/dm/naturalhazard.html>. In addition, Clackamas County provided a press release on their website to encourage the public to offer feedback on the NHMP update. The County and city websites continue to be a focal point for distribution natural hazard information using hazard viewers, emergency alerts, hazard preparation and annual natural hazard progress reports. In addition, the County administered a survey (see Appendix H, to be provided later) that was used to inform the prioritization of action items.

How is the NHMP Organized?

Each volume of the NHMP provides specific information and resources to assist readers in understanding the hazard-specific issues facing county and city residents, businesses and the environment. Combined, the sections work in synergy to create a mitigation plan that furthers the community's mission to reduce or eliminate long-term risk to people and their property from hazards and their effects. This NHMP structure enables stakeholders to use the section(s) of interest to them.

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Plan Summary

The NHMP summary provides an overview of the FEMA requirements, planning process and highlights the key elements of the risk assessment, mitigation strategy and implementation and maintenance strategy.

⁶ Code of Federal Regulations, Title 44. Section 201.6, subsection (b). 2015

Section 1: Introduction

The Introduction briefly describes the countywide mitigation planning efforts and the methodology used to develop the NHMP.

Section 2: Hazard Identification and Risk Assessment

This section provides the factual basis for the mitigation strategies contained in Volume I, Section 3. (Additional information is included within Volume III, Appendix C, which contains an overall description of Clackamas County and the incorporated cities.) This section includes a brief description of community sensitivities and vulnerabilities. The Risk Assessment allows readers to gain an understanding of each jurisdiction's vulnerability and resilience to natural hazards.

A hazard summary is provided for each of the hazards addressed in the NHMP. The summary includes hazard history, location, extent, vulnerability, impacts and probability. This NHMP addresses the following hazards:

- Drought
- Earthquake
- Flood
- Landslide
- Volcanic Eruption
- Wildfire
- Severe Weather
 - Extreme Heat
 - Windstorm
 - Winter Storm

Additionally, this section provides information on each jurisdictions' participation in the National Flood Insurance Program (NFIP).

Section 3: Mitigation Strategy

This section documents the NHMP vision, mission, goals and actions (mitigation strategy) and describes the components that guide implementation of the identified actions. Actions are based on community sensitivity and resilience factors and the risk assessments in Volume I, Section 2 and Volume II.

Section 4: Plan Implementation and Maintenance

This section provides information on the implementation and maintenance of the NHMP. It describes the process for prioritizing projects and includes a suggested list of tasks for updating the NHMP, to be completed at the semi-annual and five-year review meetings.

Volume II: Jurisdictional Addenda

Volume II of the plan is reserved for any city or special district addendums developed through this multi-jurisdictional planning process. Each of the cities with a FEMA approved addendum went through an update to coincide with the county's update. As such, the five-year update cycle will be the same for all of the cities and the county.

The plan includes city addenda updates for the following cities:

- Canby;
- Estacada;
- Gladstone;
- Happy Valley;
- Johnson City;
- Lake Oswego;
- Milwaukie;
- Molalla;
- Oregon City;
- Sandy;
- West Linn; and
- Wilsonville.

In addition, the Clackamas Fire District #1 created an addendum during this update period.

Note 1: The City of Damascus disincorporated in 2016, as such there is not update for the City and the applicable information has been incorporated into the County portion of this plan.

Note 2: Additional special districts may opt to develop an addendum during future versions of the NHMP. See acknowledgements for a list of special districts that participated in the development of this NHMP.

Volume III: Appendices

The appendices are designed to provide the users of the Clackamas County NHMP with additional information to assist them in understanding the contents of the NHMP and provide them with potential resources to assist with NHMP implementation.

Appendix A: Action Items

This appendix contains the detailed action item forms for each of the mitigation strategies identified in this plan.

Appendix B: Planning and Public Process

This appendix includes documentation of all the countywide public processes utilized to develop the NHMP. It includes invitation lists, agendas, sign-in sheets and summaries of Hazard Mitigation Advisory Committee meetings as well as any other public involvement methods.

Appendix C: Community Profile

The community profile describes the County and participating cities from a number of perspectives in order to help define and understand the region's sensitivity and resilience to natural hazards. The information in this section represents a snapshot in time of the current sensitivity and resilience factors in the region when the plan was updated.

Appendix D: Natural Hazard and Base Maps

This appendix includes base and natural hazard maps that are cited throughout the plan, particularly within Volume I, Section 2 and Volume III, Appendix C.

Appendix E: Economic Analysis of Natural Hazard Mitigation Projects

This appendix describes the Federal Emergency Management Agency's (FEMA) requirements for benefit cost analysis in natural hazards mitigation, as well as various approaches for conducting economic analysis of proposed mitigation activities.

Appendix F: Grant Programs and Resources

This appendix lists state and federal resources and programs by hazard.

Appendix G: Lifeline Sector Risk Assessment (to be provided)

The Lifeline Sector Risk Assessment provides more detailed accounts of adaptive capacity and sensitivities to natural hazards that affect the Communication, Drinking Water, Transportation, and Electric sectors.

Appendix H: Community Survey (to be provided)

This appendix includes the survey instrument and results from the community survey administered by Clackamas County.

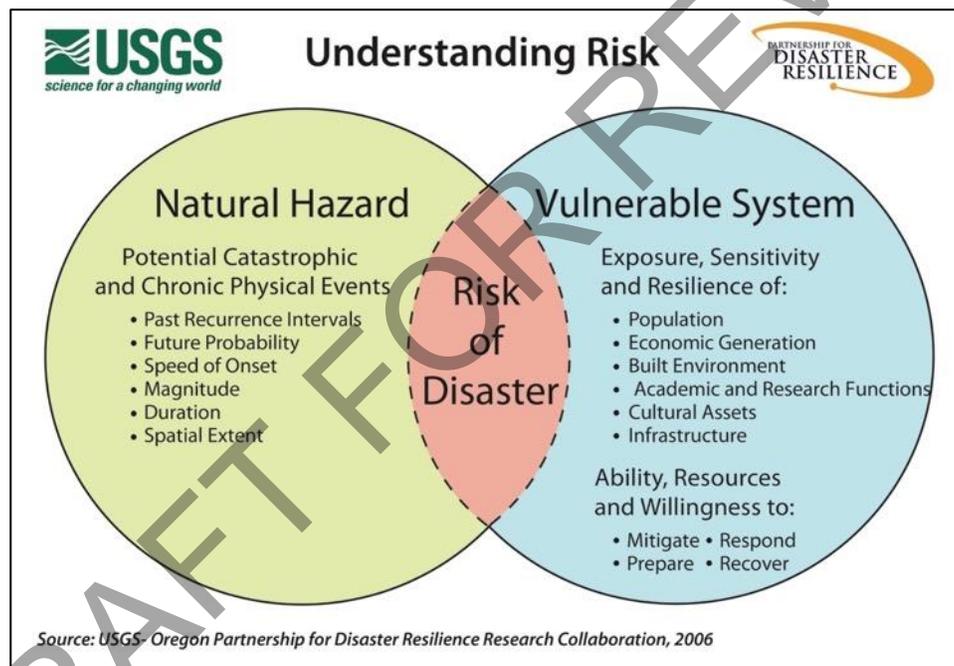
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SECTION 2: HAZARD IDENTIFICATION AND RISK ASSESSMENT

This section of the NHMP addresses 44 CFR 201.6(b)(2) - Risk Assessment. The Risk Assessment applies to Clackamas County and the city addenda included in the NHMP. We address city specific information where relevant. In addition, this chapter can assist with addressing Oregon Statewide Planning Goal 7 – Areas Subject to Natural Hazards.

We use the information presented in this section, along with community characteristics presented in Volume III, Appendix C to inform the risk reduction actions identified Volume I, Section 3. Figure 2-1 shows how we conceptualize risk in this NHMP. Ultimately, the goal of hazard mitigation is to reduce the area where hazards and vulnerable systems overlap.

Figure 2-1 Understanding Risk



Source: Oregon Partnership for Disaster Resilience.

What is a Risk Assessment?

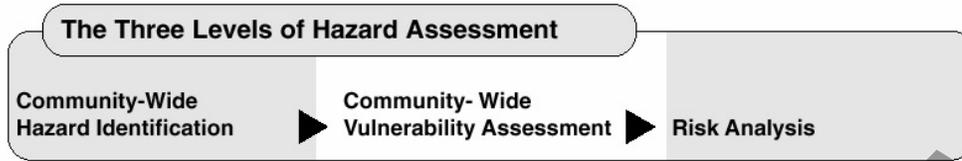
A risk assessment consists of three phases: hazard identification, vulnerability assessment and risk analysis.

- **Phase 1:** Identify hazards that can affect the jurisdiction. This includes an evaluation of potential hazard impacts – type, location, extent, etc.
- **Phase 2:** Identify important community assets and system vulnerabilities. Example vulnerabilities include people, businesses, homes, roads, historic places and drinking water sources.

- **Phase 3:** Evaluate the extent to which the identified hazards overlap with, or have an impact on, the important assets identified by the community.

The following figure illustrates the three-phase risk assessment process:

Figure 2-2 Three Phases of a Risk Assessment



Source: Planning for Natural Hazards: Oregon Technical Resource Guide, 1998

This three-phase approach to developing a risk assessment should be conducted sequentially because each phase builds upon data from prior phases. However, gathering data for a risk assessment need not occur sequentially.

Hazard Identification

Clackamas County identifies nine natural hazards that could have an impact on the County and participating cities. Table 2-1 lists the hazards identified in the County in comparison to the hazards identified in the Oregon NHMP for the Northern Willamette Valley/Portland Metro (Region 2), which includes Clackamas County.

Table 2-1 Clackamas County Hazard Identification

Clackamas County	State of Oregon NHMP Region 2: Northern Willamette Valley/ Portland Metro
Drought	Drought
Earthquake	Earthquake
Extreme Heat	N/A
Flood	Flood
Landslide	Landslide
Volcanic Eruption	Volcano
Wildfire	Wildfire
Windstorm	Windstorm
Winter Storm	Winter Storm

Source: Clackamas County NHMP Hazard Mitigation Advisory Committee (2018) and State of Oregon NHMP, Region 2: Northern Willamette Valley/Portland Metro (2015)

Probability and Vulnerability Summary

Table 2-2 presents the probability scores for each of the natural hazards present in Clackamas County for which descriptions are provided herein. Probability assesses the likelihood that a hazard event will take place in the future. Vulnerability assesses the extent to which people are susceptible to injury or other impacts resulting from a hazard as well as the exposure of the built environment or other community assets (social, environmental, economic, etc.) to hazards. The exposure of community assets to hazards is critical in the

assessment of the degree of risk a community has to each hazard. Identifying the populations, facilities and infrastructure at risk from various hazards can assist the County in prioritizing resources for mitigation and can assist in directing damage assessment efforts after a hazard event has occurred. The exposure of County assets to each hazard and potential implications are explained in each hazard section.

Vulnerability includes the percentage of population and property likely to be affected under an “average” occurrence of the hazard. Clackamas County evaluated the best available vulnerability data to develop the vulnerability scores presented below.

Table 2-2 Probability and Vulnerability Assessment Summary

Hazard	Probability	Vulnerability
Drought	High	Low
Earthquake - Cascadia	Moderate	High
Earthquake - Crustal	Low	High
Extreme Heat	Low	Moderate
Flood	High	Moderate
Landslide	High	Low
Volcanic Eruption	Low	Moderate
Wildfire	High	Moderate
Windstorm	Moderate	Low
Winter Storm	Moderate	Moderate

Source: Clackamas County Hazard Mitigation Advisory Committees 2018.

Community vulnerabilities are an important component of the NHMP risk assessment. Changes to population, economy, built environment, critical facilities, and infrastructure have not significantly influenced vulnerability. New development has complied with the standards of the Oregon Building Code and the county’s development code including their floodplain ordinance. For more in-depth information regarding specific community vulnerabilities see Volume III, Appendix C.

Hazard Analysis Matrix and Methodology

For local governments, conducting the hazard analysis is a useful step in planning for hazard mitigation, response and recovery. The method provides the jurisdiction with a sense of hazard priorities but does not predict the occurrence of a hazard.

For the purposes of this NHMP, the County and cities utilized the Oregon Military Department – Office of Emergency Management (OEM) Hazard Analysis methodology. The hazard analysis methodology in Oregon was first developed by FEMA circa 1983 and gradually refined by the Oregon Military Department’s Office of Emergency Management over the years.

The methodology produces scores that range from 24 (lowest possible) to 240 (highest possible). Vulnerability and probability are the two key components of the methodology. Vulnerability examines both typical and maximum credible events and probability endeavors to reflect how physical changes in the jurisdiction and scientific research modify the historical record for each hazard. Vulnerability accounts for approximately 60% of the total score and probability approximately 40%. We include the hazard analysis summary here to ensure consistency between the EOP and NHMP.

The Oregon method provides the jurisdiction with a sense of hazard priorities, or relative risk. It doesn't predict the occurrence of a hazard, but it does "quantify" the risk of one hazard compared with another. By doing this analysis, planning can first be focused where the risk is greatest.

In this analysis, severity ratings and weight factors, are applied to the four categories of history, vulnerability, maximum threat (worst-case scenario) and probability.

The hazard analysis matrix involves estimating the damage, injuries and costs likely to be incurred in a geographic area over time. Risk has two measurable components: (1) the magnitude of the harm that may result, defined through the vulnerability assessment (assessed in the previous sections) and (2) the likelihood or probability of the harm occurring.

Table 2-3 presents the updated hazard analysis matrix for Clackamas County. The hazards are listed in rank order from high to low. The table shows that hazard scores are influenced by each of the four categories combined. With considerations for past historical events, the probability or likelihood of a hazard event occurring, the vulnerability to the community and the maximum threat or worst-case scenario, the Cascadia Subduction Zone earthquake, crustal earthquakes, wildfires, and winter storms rank as the top hazard threats to the County (top tier). Droughts, floods, and windstorm events rank in the middle (middle tier). Landslides, volcanic eruptions, and extreme heat events comprise the lowest ranked hazards in the county (bottom tier).

Table 2-3 Hazard Analysis Matrix – Clackamas County

Hazard	Maximum				Total Threat Score	Hazard Rank	Hazard Tiers
	History	Vulnerability	Threat	Probability			
Earthquake - Cascadia	4	45	100	49	198	#1	Top Tier
Earthquake - Crustal	6	50	100	21	177	#2	
Wildfire	12	25	70	56	163	#3	
Winter Storm	10	30	70	49	159	#4	
Drought	10	15	50	56	131	#5	Middle Tier
Flood	16	20	30	56	122	#6	
Windstorm	14	15	50	42	121	#7	
Landslide	14	15	20	63	112	#8	Bottom Tier
Volcanic Eruption	2	35	50	14	101	#9	
Extreme Heat	2	20	40	14	76	#10	

Source: Clackamas County Hazard Mitigation Advisory Committee (2018)

City Specific Risk Assessment

Each participating jurisdiction (cities and special districts) in Clackamas County completed a jurisdiction specific hazard analysis that assessed each jurisdiction's risks where they vary from the risks facing the entire planning area. The multi-jurisdictional risk assessment information is located within the addenda of Volume II.

Federal Disaster and Emergency Declarations

Reviewing past events can provide a general sense of the hazards that have caused significant damage in the county. Where trends emerge, disaster declarations can help inform hazard mitigation project priorities.

President Dwight D. Eisenhower approved the first federal disaster declaration in May 1953 following a tornado in Georgia. Since then, federally declared disasters have been approved within every state because of natural hazard related events. As of June 2018, FEMA has approved a total of 33 major disaster declarations, 70 fire management assistance declarations and two (2) emergency declarations in Oregon.¹ When governors ask for presidential declarations of major disaster or emergency, they stipulate which counties in their state they want included in the declaration. Table 2-4 summarizes the major disasters declared in Oregon that affected Clackamas County, since 1955. The table shows that there have been nine (9) major disaster declarations for the County (one since 2013). Most of which were related to weather events resulting primarily in flooding, snow and landslide related damage. There has been one disaster declaration for earthquake (1993 Scott Mills).

Table 2-4 FEMA Major Disaster (DR) for Clackamas County

Declaration Number	Declaration Date	Incident Period		Incident	Individual Assistance	Public Assistance Categories
		From	To			
DR-184	12/24/1964	12/24/1964	12/24/1964	Heavy rains and flooding	Yes	A, B, C, D, E, F, G
DR-319	1/21/1972	1/21/1972	1/21/1972	Severe storms, Flooding	Yes	A, B, C, D, E, F, G
DR-413	1/25/1974	1/25/1974	1/25/1974	Severe Storms, Snowmelt, Flooding	Yes	A, B, C, D, E, F, G
DR-985	4/26/1993	3/25/1993	3/25/1993	Earthquake	None	A, B, C, D, E, F, G
DR-1099	1/23/1997	12/25/1996	1/6/1997	Severe Winter Storms/Flooding	Yes	A, B, C, D, E, F, G
DR-1510	2/19/2004	12/26/2003	1/14/2004	Severe winter storms	None	A, B, C, D, E, F, G
DR-1632	2/9/1996	2/4/1996	2/21/1996	Severe storms, Flooding	None	A, B, C, D, E, F, G
DR-1824	3/2/2009	12/13/2008	12/26/2008	Severe Winter Storm, Record and Near Record Snow, Landslides, and Mudslides	None	A, B, C, D, E, F, G
DR-1956	2/17/2011	1/13/2011	1/21/2011	Severe Winter Storm, Flooding, Mudslides, Landslides, And Debris Flows	None	A, B, C, D, E, F, G
DR-4258	2/17/2016	12/6/2015	12/23/2015	Oregon Severe Winter Storms, Straight-line Winds, Flooding, Landslides, and Mudslides	None	A, B, C, D, E, F, G

Source: FEMA, Oregon Disaster History. Major Disaster Declarations.

Table 2-5 summarizes fire management assistance and emergency declarations. Fire Management Assistance may be provided after a State submits a request for assistance to the FEMA Regional Director at the time a "threat of major disaster" for a fire emergency exists. There are two (2) fire management assistance declarations on record for the county.

¹ FEMA, *Declared Disasters by Year or State*, http://www.fema.gov/news/disaster_totals_annual.fema#markS. Accessed July 10, 2018.

An Emergency Declaration is more limited in scope and without the long-term federal recovery programs of a Major Disaster Declaration. Generally, federal assistance and funding are provided to meet a specific emergency need or to help prevent a major disaster from occurring. Clackamas County has two recorded Emergency Declarations related to the 1977 Drought and 2005 Hurricane Katrina evacuation.

Table 2-5 FEMA Fire Management (FM) and Emergency Declarations (EM) for Clackamas County

Declaration Number	Declaration Date	Incident Period		Incident	Individual Assistance	Public Assistance Categories
		From	To			
FM-2043	9/15/81	9/5/81	-	Peavine Peak Fire	None	-
FM-5080	9/16/14	9/15/14	9/26/14	36 Pit Fire	None	-
EM-3039	4/29/77	4/29/77	4/29/77	Drought	None	A, B
EM-3228	9/7/05	8/29/05	10/1/05	Hurricane Katrina Evacuation	None	B

Source: FEMA, Oregon Disaster History. Major Disaster Declarations.

Hazard Profiles

The following subsections briefly describe relevant information for each hazard. For additional background on the hazards, vulnerabilities and general risk assessment information for hazards in Clackamas County, refer to the [Risk Assessment for Region 2, Northern Willamette Valley/Portland Metro, of the Oregon NHMP \(2015\)](#).

In addition, the Oregon Department of Geology and Mineral Industries (DOGAMI) conducted a multi-hazard risk assessment (Risk Report) for portions of unincorporated Clackamas County within the Lower Columbia-Sandy Watershed, including the unincorporated communities of Government Camp and The Villages at Mt. Hood. The study was funded through the FEMA Risk MAP program and was completed in 2018. The Risk Report provides a quantitative risk assessment that informs communities of their risks related to the following natural hazards: channel migration, earthquake, flood, lahar (volcanic event), landslide, and wildfire. The County hereby incorporates the Risk Report into this NHMP by reference to provide greater detail to hazard sensitivity and exposure ([DOGAMI, IMS-59](#)).

Drought.....	7
Earthquake	11
Flood	24
Floodplain Management Plan (Activity 510)	33
Landslide.....	46
Severe Weather	53
Extreme Heat	54
Windstorm.....	56
Winter Storm	59
Volcanic Eruption.....	63
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Drought

Significant Changes since Previous NHMP:

One (1) significant drought event has occurred since the previous NHMP.

Characteristics

A drought is a period of drier than normal conditions. Drought occurs in virtually every climatic zone, but its characteristics vary significantly from one region to another. Drought is a temporary condition; it differs from aridity, which is restricted to low rainfall regions and is a permanent feature of climate. The extent of drought events depends upon the degree of moisture deficiency and the duration and size of the affected area. Typically, droughts occur as regional events and often affect more than one city and county.

Location and Extent

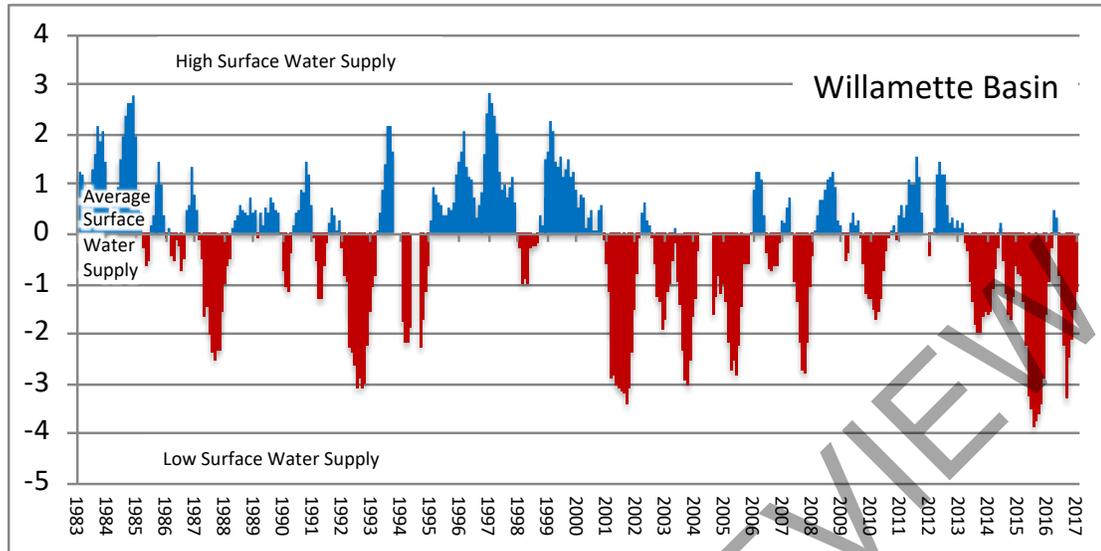
Droughts occur in every climate zone and can vary from region to region. Drought may occur throughout Clackamas County and may have profound effects on the economy, particularly the agricultural and hydro-power sectors. The extent of drought depends upon the degree of moisture deficiency, and the duration and size of the affected area. Typically, droughts occur as regional events and often affect more than one county. In severe droughts, environmental and economic consequences can be significant. Volume III, Appendix D includes maps detailing average precipitation (Map 2) and river sub-basins (Map 4).

History

Clackamas County experiences annual dry conditions typically during the summer months from July through September. Drought is typically measured in terms of water availability in a defined geographical area. It is common to express drought with a numerical index that ranks severity. Most federal agencies use the Palmer Method which incorporates precipitation, runoff, evaporation and soil moisture. However, the Palmer Method does not incorporate snowpack as a variable. Therefore, it is not believed to provide a very accurate indication of drought conditions in Oregon and the Pacific Northwest.

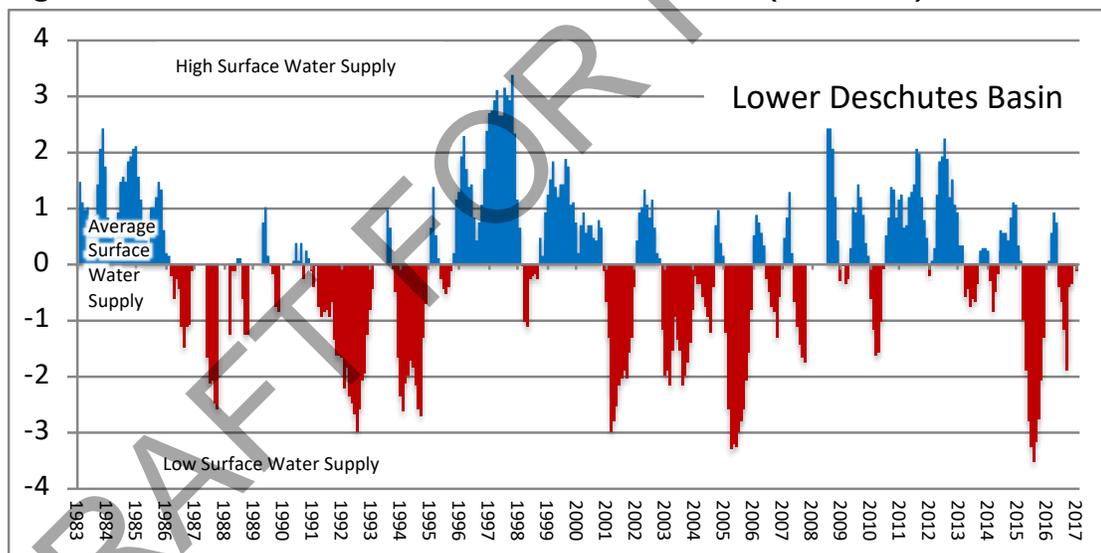
The Surface Water Supply Index (SWSI) from the Natural Resources Conservation Service is an index of current water conditions throughout the state. The index utilizes parameters derived from snow, precipitation, reservoir and stream flow data. NRCS collects data each month from key stations in each basin. The lowest SWSI value, -4.2, indicates extreme drought conditions (Low Surface Water Supply ranges from -1.6 to -4.2). The highest SWSI value, +4.2, indicates extreme wet conditions (High Surface Water Supply ranges from +1.6 to +4.2). The mid-point is 0.0, which indicates an average water supply (Average Water Supply ranges from +1.5 to -1.5). The figures below show the monthly history of SWSI values from 1983 to 2017 for the Willamette Basin (Figure 2-3, includes all portions of the County that are outside of the Lower Columbia-Sandy Watershed) and Lower Deschutes Basin (Figure 2-4, includes northeast portion of the County within the Lower Columbia-Sandy Watershed).

Figure 2-3 SWSI Values for the Willamette Basin (1983-2017)



Source: Department of Agriculture-Natural Resources Conservation Service, "Surface Water Supply Index, Willamette Basin" www.or.nrcs.usda.gov. Accessed January 2018.

Figure 2-4 SWSI Values for the Lower Deschutes Basin (1983-2017)



Source: Department of Agriculture-Natural Resources Conservation Service, "Surface Water Supply Index, Lower Deschutes Basin" www.or.nrcs.usda.gov. Accessed January 2018.

Research shows that the periods of drought have fluctuated; recent drought periods occurred (SWSI < -3.0 for four or more months) in 1991-1992, 2001 and 2015. In addition, two (2) executive orders declaring drought emergencies have occurred in 1991 and 2015; the 2015 drought was also federally declared.² Other historically significant regional drought events that affected Clackamas County include 1928 to 1941 and 1976 to 1981.

² Oregon Water Resources Department Public Declaration Status Report, http://apps.wrd.state.or.us/apps/wr/wr_drought/declaration_status_report.aspx, accessed January, 2018.

El Niño/La Niña

El Niño Southern Oscillation (ENSO) weather patterns can increase the frequency and severity of drought. During El Niño periods, alterations in atmospheric pressure in equatorial regions yield an increase in the surface temperature off the west coast of North America. This gradual warming sets off a chain reaction affecting major air and water currents throughout the Pacific Ocean; La Niña periods are the reverse with sustained cooling of these same areas. In the North Pacific, the Jet Stream is pushed north, carrying moisture laden air up and away from its normal landfall along the Pacific Northwest coast. In Oregon, this shift results in reduced precipitation and warmer temperatures, normally experienced several months after the initial onset of the El Niño. These periods tend to last nine to twelve months, after which surface temperatures begin to trend back towards the long-term average. El Niño periods tend to develop between March and June, and peak from December to April. ENSO generally follows a two to seven-year cycle, with El Niño or La Niña periods occurring every three to five years. However, the cycle is highly irregular, and no set pattern exists. The last major El Niño was during 1997-1998, and in 2015-2016 Oregon experience a “super” El Niño (the strongest in 15 years, the two previous events occurred in 1982-1983 and 1997-1998) that included record rainfall and snowpack in areas of the state.³

Future Climate Variability⁴

Climate models for Oregon suggest, future regional climate changes include increases in temperature around 0.2-1°F per decade in the 21st Century, along with warmer and drier summers, and some evidence that extreme precipitation will increase in the future. Increased droughts may occur in the Willamette Valley under various climate change scenarios because of various factors, including reduced snowpack, rising temperatures, and likely reductions in summer precipitation. Climate models suggest that as the region warms, winter snow precipitation will likely shift to higher elevations and snowpack will be diminished as more precipitation falls as rain altering surface flows.

Probability Assessment

Based on the available data and research the Hazard Mitigation Advisory Committee assessed the **probability of experiencing a locally severe drought as “High,”** meaning one incident is likely within the next 10 to 35 years. *This rating has increased since the previous NHMP.*

Droughts are not uncommon in the State of Oregon, nor are they just an “east of the mountains” phenomenon. They occur in all parts of the state, in both summer and winter. Oregon’s drought history reveals many short-term and a few long-term events. The average recurrence interval for severe droughts in Oregon is somewhere between 8 and 12 years. According to SWSI analysis there have been three (3) droughts between 1983 and 2017 (see Figure 2-3 and Figure 2-4).

³ Cho, Renne. “El Nino and global warming – what’s the connection.” Phys.org, February 3, 2016. <https://phys.org/news/2016-02-el-nino-global-warmingwhat.html>

⁴ Oregon Climate Change Research Institute (OCCRI), Oregon Climate Assessment Report (2010) and Northwest Climate Assessment Report (2013). <http://occri.net/reports>

Vulnerability Assessment

The Hazard Mitigation Advisory Committee rated the County as having a **“low” vulnerability to drought hazards**, meaning it is expected that less than 1% of the unincorporated County’s population or assets would be affected by a major drought emergency or disaster. *This rating has not changed since the previous NHMP.*

The environmental and economic consequences can be significant, especially for the agricultural sector. Drought also increases the probability of wildfires – a major natural hazard concern for Clackamas County. Drought can affect all segments of Clackamas County’s population, particularly those employed in water-dependent activities (e.g., agriculture, hydroelectric generation, recreation, etc.). Also, domestic water-users may be subject to stringent conservation measures (e.g., rationing) as per the County’s water management plan.

All parts of Clackamas County are susceptible to drought; however, the following areas and issues are of concern:

- Drinking water systems
- Power and water enterprises
- Residential and community wells in rural areas
- Fire response capabilities
- Fish and wildlife

Potential impacts to county water supplies and the agriculture industry are the greatest threats. Additionally, long-term drought periods of more than a year can impact forest conditions and set the stage for potentially destructive wildfires.

More information on this hazard can be found in the [Risk Assessment for Region 2, Northern Willamette Valley/Portland Metro, of the Oregon NHMP \(2015\)](#).

Earthquake

Significant Changes since Previous NHMP:

The Oregon Resilience Plan (2013), Earthquake Regional Impact Analysis for Clackamas, Multnomah, and Washington Counties, and the Lower Columbia-Sandy Watershed Multi-Hazard Risk Report have been cited and incorporated where applicable.

Characteristics

The Pacific Northwest in general is susceptible to earthquakes from four sources: 1) the offshore Cascadia Subduction Zone, 2) deep intraplate events within the subducting Juan de Fuca Plate, 3) shallow crustal events within the North American Plate, and 4) earthquakes associated with volcanic activity.

Crustal Fault Earthquakes

Crustal fault earthquakes are the most common earthquakes and occur at relatively shallow depths of 6-12 miles below the surface.⁵ While most crustal fault earthquakes are smaller than magnitude 4 and generally create little or no damage, they can produce earthquakes of magnitudes up to 7, which cause extensive damage. Clackamas County has seven documented crustal faults that could cause serious damage to buildings and infrastructure. These include: Portland Hills, Sandy River, Bolton, Mount Angel, Grant Butte, Clackamas Creek, and Mount Hood. These faults could generate earthquakes 6.5 or larger. *Note: The hazards associated with the Portland Hills and Mount Hood faults area discussed in more detail within this profile.*

Deep Intraplate Earthquakes

Occurring at depths from 25 to 40 miles below the earth's surface in the subducting oceanic crust, deep intraplate earthquakes can reach up to magnitude 7.5.⁶ The February 28, 2001 earthquake in Washington State was a deep intraplate earthquake. It produced a rolling motion that was felt from Vancouver, British Columbia to Coos Bay, Oregon and east to Salt Lake City, Utah. A 1965 magnitude 6.5 intraplate earthquake centered south of Seattle-Tacoma International Airport caused seven deaths.⁷

Subduction Zone Earthquakes

The Pacific Northwest is located at a convergent plate boundary, where the Juan de Fuca and North American tectonic plates meet. The two plates are converging at a rate of about 1-2 inches per year. This boundary is called the Cascadia Subduction Zone (CSZ). It extends from British Columbia to northern California. Subduction zone earthquakes are caused by the abrupt release of slowly accumulated stress.⁸

⁵ Madin, Ian P. and Zhenming Wang. Relative Earthquake Hazard Maps Report. (1999) DOGAMI.

⁶ Planning for Natural Hazards: The Oregon Technical Resource Guide, Department of Land Conservation and Development (July 2000), Ch. 8, pp. 8.

⁷ The Oregonian. "A region at risk." March 4, 2001.

⁸ Questions and Answers on Earthquakes in Washington and Oregon (February 2001) www.geophys.washington.edu/seis/pnsn/info_general/faq.html.

Subduction zones like the CSZ have produced earthquakes with magnitudes of 8 or larger. Historic subduction zone earthquakes include the 1960 Chile (magnitude 9.5) and 1964 southern Alaska (magnitude 9.2) earthquakes⁹ with more recent events being the 2004 Indian Ocean (magnitude 9.1) and 2011 Japan (magnitude 9).

Volcanic Earthquakes

Volcanic earthquakes are usually smaller than magnitude 2.5, roughly the threshold for shaking felt by observers close to the event. Swarms of small earthquakes may persist for weeks to months before eruptions, but little or no earthquake damage would occur to buildings in surrounding communities. Some volcanic related swarms may include earthquakes as large as about magnitude 5.

While all four types of earthquakes have the potential to cause major damage, local crustal faults are expected to be more damaging primarily because of their proximity to densely populated areas.¹⁰

Location and Extent

The seismic hazard for Clackamas County arises predominantly from major earthquakes on the Cascadia Subduction Zone. Large (M6.8-7.0M), crustal earthquakes in or near Clackamas County could be more damaging than a CSZ earthquake but the likelihood of these events is considerably less. Additional fault zones throughout the county and region may produce localized crustal earthquakes up to 6.0. Table 2-6 presents a list of the different Class A and B fault lines throughout the county. In addition, the Mount Hood Fault (Class C) is located near Mount Hood and runs approximately 55 kilometers north from Clear Lake to the Columbia River.¹¹ A local earthquake of M 6.0 or a regional M 9.0 earthquake is likely to cause substantial structural damage to bridges, buildings, utilities, and communications systems, as well as the following impacts to infrastructures and the environment:

- Floods and landslides
- Fires, explosions, and hazardous materials incidents
- Disruption of vital services such as water, sewer, power, gas, and transportation routes
- Disruption of emergency response systems and services
- Displaced Households
- Economic losses for buildings
- Economic loss to highways, airports, communications
- Generated debris
- Illness, injury, and death
- Significant damage to critical and essential facilities, including schools, hospitals, fire stations, police departments, city hall

⁹ The Oregonian. "A region at risk." March 4, 2001.

¹⁰ Bauer, John, William Burns, and Ian Madin. Earthquake Regional Impact Analysis for Clackamas, Multnomah, and Washington Counties, Oregon. (2018). DOGAMI

¹¹ Scott, W.E., and Gardner, C.A., 2017, [Field trip guide to Mount Hood, Oregon, highlighting eruptive history and hazards](#). U.S. Geological Survey Scientific Investigations Report 2017-5022-G.

Table 2-6 Class A and B Faults Located in or near Clackamas County

Name	Class	Fault ID	Primary County, State	Length (km)	Time of Most Recent Deformation	Slip-Rate Category
Canby-Molalla Fault	A	716	Clackamas County	50km	Latest Quaternary (<15ka)	Less than 0.2 mm/yr
Clackamas River Fault Zone	A	864	Marion County	29km	Quaternary (<1.6 Ma)	Less than 0.2 mm/yr
Bull Run Thrust	B	868	Clackamas County	9km	Quaternary (<1.6 Ma)	Less than 0.2 mm/yr
Mount Angel Fault	A	873	Marion County	30km	Latest Quaternary (<15ka)	Less than 0.2 mm/yr
Bolton Fault	B	874	Clackamas County	9km	Quaternary (<1.6 Ma)	Less than 0.2 mm/yr
Oatfield Fault	A	875	Washington County	29km	Quaternary (<1.6 Ma)	Less than 0.2 mm/yr
East Bank Fault	A	876	Multnomah County	29km	Latest Quaternary (<15ka)	Less than 0.2 mm/yr
Portland Hills Fault	A	877	Columbia County	49km	Quaternary (<1.6 Ma)	Less than 0.2 mm/yr
Damascus-Tickle Creek Fault Zone	A	879	Multnomah County	17km	Middle and Late Quaternary (<750ka)	Less than 0.2 mm/yr

Source: Source: US Geological Survey (USGS), Quaternary Fault and Fold Database

For more information on Class A and B faults located in Clackamas County see the US Geological Survey, Quaternary Fault and Fold Database:

<https://earthquake.usgs.gov/hazards/qfaults/>.

Figure 2-5 shows a generalized geologic map of Clackamas County and includes the areas for potential low and moderate liquefaction. Volume III, Appendix D includes additional maps detailing soil liquefaction (Map 8), soil amplification (Map 9), and relative earthquake hazard (Map 10). Most of the earthquakes shown in the figure below are low-impact events below M 3.0, although several events are shown with M 2 to 5.

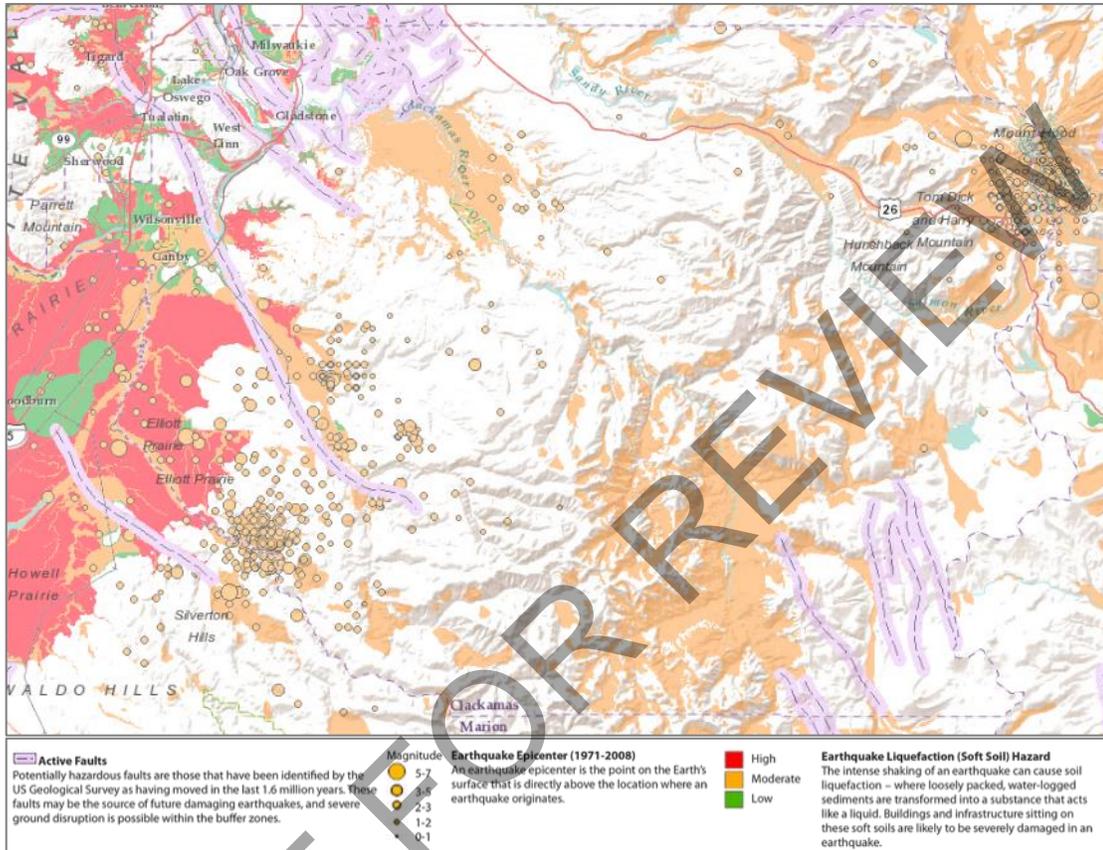
Liquefaction

Liquefaction occurs when ground shaking causes wet granular soils to change from a solid state to a liquid state. This results in the loss of soil strength and the soil's ability to support weight. Buildings and their occupants are at risk when the ground can no longer support these buildings and structures.

To develop a regional liquefaction hazard map (Volume II, Appendix D, Map 8) for Clackamas County, DOGAMI started by collecting the best available geologic information. Hazard groupings were primarily based on lithologies and checked with individual data points. With the available information compiled, DOGAMI assigned liquefaction susceptibility classes based on the dominant lithologies for each geologic unit in the study area, checked source data boundaries, and simplified the GIS outputs into four relative hazard classes: None/Very Low, Low, Moderate, and High. Areas with Moderate to High liquefaction susceptibilities are concentrated along the rivers and flood plains in the Willamette Valley, Cascade Range tributaries, and major stream valleys within the Cascade Range. Older river terrace and Missoula Flood deposits in the Willamette Valley were assigned a lower liquefaction hazard

yet are still considered susceptible to liquefaction in larger earthquakes. It is important to note that the quality and scale of the available base maps precluded identification of all liquefaction hazard areas, particularly in the eastern portion of the county.

Figure 2-5 Earthquake Active Faults, Epicenters (1971-2008), and Soft Soils



Source: [Oregon HazVu: Statewide Geohazards Viewer](#) – To view map in more detail click hyperlink to left.

Amplification

Soils and soft sedimentary rocks near the earth's surface can modify ground shaking caused by earthquakes. One of these modifications is amplification. Amplification increases the magnitude of the seismic waves generated by the earthquake. The amount of amplification is influenced by the thickness of geologic materials and their physical properties. The degree of amplification greatly affects the performance of infrastructure in earthquake. Buildings and structures built on soft and unconsolidated soils, for example, face greater risk. Amplification can also occur in areas with deep sediment filled basins and on ridge tops.

DOGAMI developed the ground shaking amplification map (Volume III, Appendix D, Map 9) based generally on the NEHRP 1997 method of categorizing relative hazards, and simplified the GIS outputs into relative hazard classes – Low, Moderate, and High. The resulting map is not intended to be used in place of site-specific studies. The high hazard soils are located along and adjacent to streams and rivers in Clackamas County. The eastern portion of the county is varied, with competent bedrock areas mapped as Low hazard, dense soil areas

mapped as Moderate hazard, and younger landslide and alluvial deposit areas mapped as High hazard for ground shaking amplification.¹²

DOGAMI and Clackamas County GIS worked together to combine the ground shaking, amplification, and liquefaction data to develop a composite Relative Earthquake Hazard Map (Volume III, Appendix D, Map 10). This map represents the overall earthquake hazards in Clackamas County.

Due to the expected pattern of damage resulting from a CSZ event, the Oregon Resilience Plan divides the State into four distinct zones and places Clackamas County predominately within the "Valley Zone" (Valley Zone, from the summit of the Coast Range to the summit of the Cascades).

The Oregon Department of Geology and Mineral Industries (DOGAMI), in partnership with other state and federal agencies, has undertaken a rigorous program in Oregon to identify seismic hazards, including active fault identification, bedrock shaking, tsunami inundation zones, ground motion amplification, liquefaction and earthquake induced landslides. DOGAMI has published a number of seismic hazard maps that are available for communities to use. The maps show liquefaction, ground motion amplification, landslide susceptibility and relative earthquake hazards. OPDR used the DOGAMI Statewide Geohazards Viewer to present a visual map of recent earthquake activity, active faults and liquefaction; ground shaking is generally expected to be higher in the areas marked by soft soils in the map above. The severity of an earthquake is dependent upon a number of factors including: 1) the distance from the earthquake's source (or epicenter); 2) the ability of the soil and rock to conduct the earthquake's seismic energy; 3) the degree (i.e., angle) of slope materials; 4) the composition of slope materials; 5) the magnitude of the earthquake; and 6) the type of earthquake.

For more information, see the following reports:

- Multi-Hazard Risk Report for the Lower Columbia-Sandy Watershed, Oregon: Including the cities of Gresham, Sandy, and Troutdale and Unincorporated Communities of Government Camp and The Villages at Mt Hood (2018, [IMS-59](#)).
- Earthquake regional impact analysis for Clackamas, Multnomah, and Washington Counties, Oregon (2018, [O-18-02](#)).
- Statewide Cascadia earthquake hazard data (2013, [O-13-06](#))
- Cascadia Subduction Zone earthquakes: A magnitude 9.0 earthquake scenario, (2012, [O-12-22](#))
- Multi-Hazard and Risk Study for the Mount Hood Region (2011, [O-11-16](#)). *Portions of the earthquake section superseded by the Multi-Hazard Risk Report for the Lower Columbia-Sandy Watershed.*
- Statewide seismic needs assessment: Implementation of Oregon 2005 Senate Bill 2 relating to public safety, earthquakes, and seismic rehabilitation of public buildings, (2007, [O-07-02](#)).
- Map of selected earthquakes for Oregon: 1841-2002 (2003, [O-03-02](#)).

¹² Hofmeister, Hasenberg, Madin, Wang, 2003. "Earthquake and Landslide Hazard Maps and Future Earthquake Damage Estimates for Clackamas County, Oregon: Oregon Department of Geology and Mineral Industries Open-File Report 0-03-10."

- Interpretive Map Series: IMS-9 - Relative earthquake hazard maps for selected urban areas in western Oregon (2000, [IMS-9](#)).

Additional reports are available via DOGAMI's Publications Search website:
<http://www.oregongeology.org/pubs/search.php>

Other agency/ consultant reports:

[Oregon Resilience Plan \(2013\)](#)

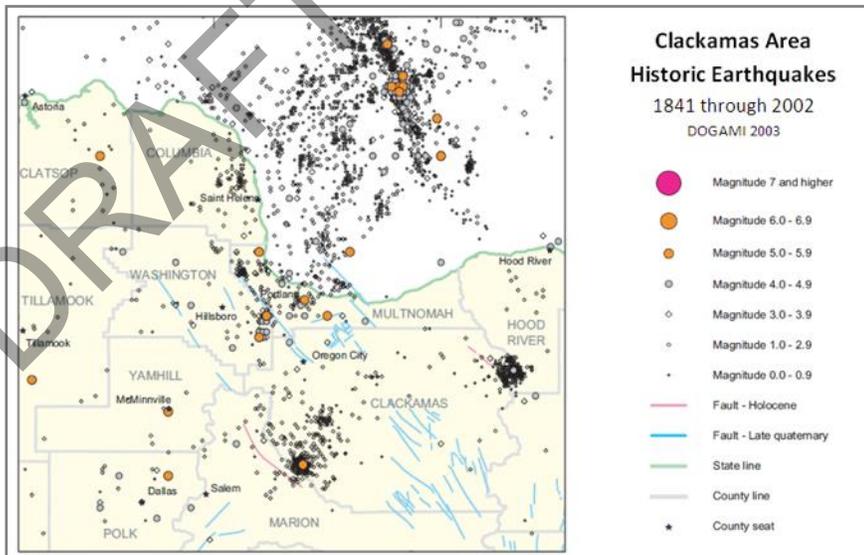
[The Mount Hood Fault Zone – Late Quaternary and Holocene fault features newly mapped with high-resolution lidar Imagery \(p. 100-109\).](#)

History

Dating back to 1841, there have been more than 6,000-recorded earthquakes in Oregon, most with a magnitude below three (Figure 2-5 and Figure 2-6). Portland and its surrounding region is potentially the most seismically active area within Oregon. The Portland metropolitan region has encountered seventeen earthquakes of an estimated magnitude of four and greater, with major earthquakes in 1877 (magnitude 5.3), 1962 (magnitude 5.2), and 1993 (magnitude 5.6). Although seismograph stations were established as early as 1906 in Seattle and 1944 in Corvallis, improved seismograph coverage of the Portland region did not begin until 1980, when the University of Washington expanded its regional network into northwestern Oregon.

Geologic evidence shows that the Cascadia Subduction Zone has generated great earthquakes, most recently about 300 years ago. It is generally accepted to have been magnitude 9 or greater. The average recurrence interval of these great Cascadia earthquakes is approximately 500 years, with gaps between events as small as 200 years and as large as 1,000 years.

Figure 2-6 Regional Earthquake History (1841-2001)



Source: DOGAMI, Map of Selected Earthquakes for Oregon, 1841 through 2002 ([O-03-02](#))

Probability Assessment

Based on the available data and research the Hazard Mitigation Advisory Committee determined the **probability of experiencing a Cascadia Subduction Zone (CSZ) is “moderate”**, meaning one incident may occur within the next 35 to 75 years. The Hazard Mitigation Advisory Committee determined the **probability of experiencing a crustal earthquake is “low”**, meaning one incident may occur within the next 75 to 100 years. *The previous NHMP rated the CSZ earthquake probability as “moderate” and the crustal earthquake probability also as moderate.*

Clackamas County is susceptible to deep intraplate events within the Cascadia Subduction Zone (CSZ), where the Juan de Fuca Plate is diving beneath the North American Plate and shallow crustal events within the North American Plate.

According to the Oregon NHMP, the return period for the largest of the CSZ earthquakes (Magnitude 9.0+) is 530 years with the last CSZ event occurring 314 years ago in January of 1700. The probability of a 9.0+ CSZ event occurring in the next 50 years ranges from 7 - 12%. Notably, 10 - 20 “smaller” Magnitude 8.3 - 8.5 earthquakes occurred over the past 10,000 years that primarily affected the southern half of Oregon and northern California. The average return period for these events is roughly 240 years. The combined probability of any CSZ earthquake occurring in the next 50 years is 37 - 43%.¹³

Establishing a probability for crustal earthquakes is difficult given the small number of historic events in the region. However, both of the faults used to inform this report (Portland Hills and Mount Hood) have a low probability of rupture. Earthquakes generated by volcanic activity in Oregon’s Cascade Range are possible, but likewise unpredictable. For more information, see the DOGAMI reports cited previously.

Vulnerability Assessment

The Hazard Mitigation Advisory Committee rated the County as having a **“high” vulnerability to the Cascadia Subduction Zone (CSZ) earthquake hazard** meaning that more than 10% of the unincorporated County’s population or assets would be affected by a major CSZ event. The Hazard Mitigation Advisory Committee rated the County as having a **“high” vulnerability to a crustal earthquake hazard**, meaning that more than 10% of the unincorporated County’s population or assets would be affected by a major crustal earthquake event. *These ratings have not changed since the previous NHMP.*

The local crustal faults, the county’s proximity to the Cascadia Subduction Zone, potential slope instability and the prevalence of certain soils subject to liquefaction and amplification combine to give the county a high-risk profile.

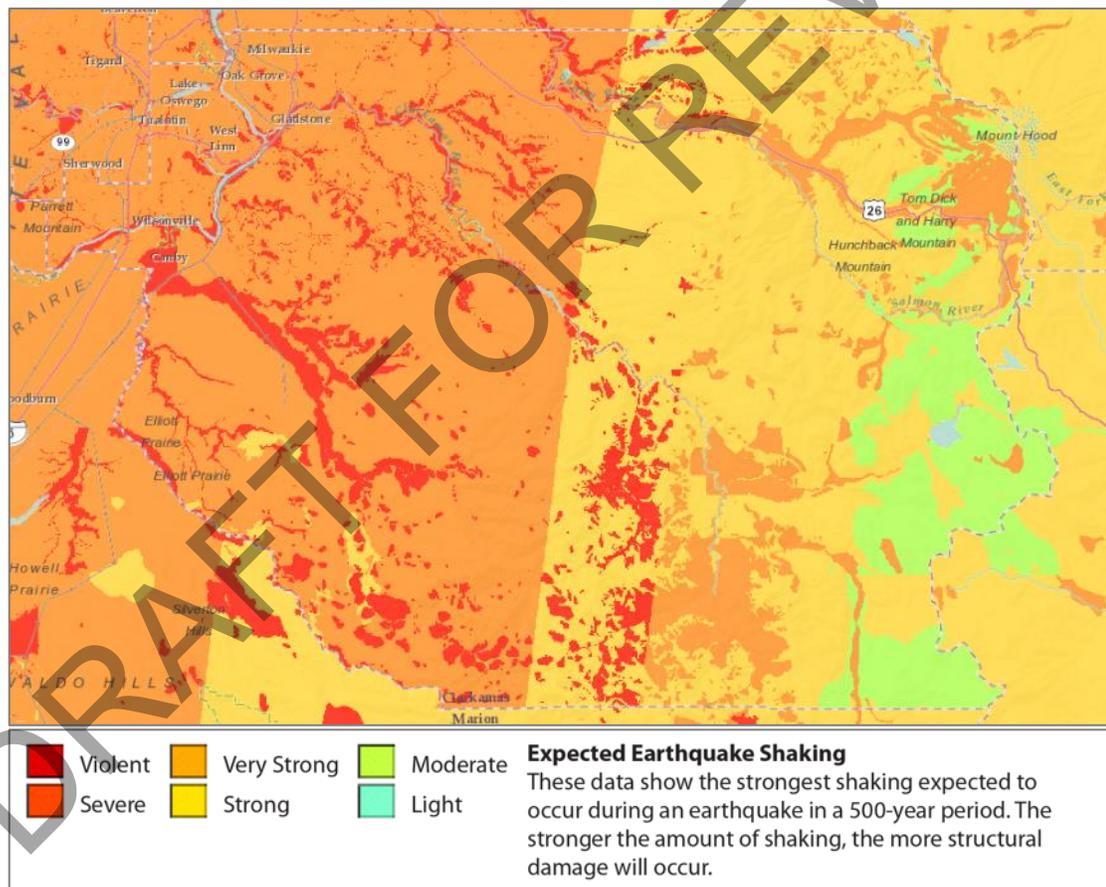
Factors included in an assessment of earthquake risk include population and property distribution in the hazard area, the frequency of earthquake events, landslide susceptibility, buildings, infrastructure and disaster preparedness of the region. This type of analysis can generate estimates of the damages to the county due to an earthquake event in a specific location.

¹³ DLCD, Oregon Natural Hazards Mitigation Plan (2015).

Seismic activity can cause great loss to businesses, either a large-scale corporation or a small retail shop. Losses not only result in rebuilding cost, but fragile inventory and equipment can be destroyed. When a company is forced to stop production for just a day, business loss can be tremendous. Residents, businesses and industry all suffer temporary loss of income when their source of finances is damaged or disrupted.

Figure 2-7 shows the expected shaking/damage potential for Clackamas County as a result of a Cascadia Subduction Zone (CSZ) earthquake event. The figure shows that the county will experience “moderate” to “severe” shaking that will last two to four minutes. The strong shaking will be extremely damaging to lifeline transportation routes including I-5. For more information on expected losses due to a CSZ event see the [Oregon Resilience Plan](#) and the Risk Report information provided below. Analysis of the Relative Earthquake Hazard Map (Volume III, Appendix D, Map 10) shows that about 45% of the total county land area is in moderate to high hazard zones. In addition, 19% of total tax parcels are within the high relative earthquake hazard area (Table 2-7).

Figure 2-7 Cascadia Subduction Zone Expected Shaking



Source: [Oregon HazVu: Statewide Geohazards Viewer](#) – To view map in more detail click hyperlink to left.

Clackamas County considers two main earthquake related vulnerability categories: Life and Property and Critical Facilities and Infrastructure. Both categories are discussed in further detail below.

The amount of property in the relative earthquake high hazard area, as well as the type and value of structures on those properties, is calculated to provide a working estimate for potential losses. Table 2-7 shows potentially impacted parcels, critical and critical facilities, vulnerable populations, and infrastructure within Clackamas County.

Table 2-7 Relative Earthquake Hazard Vulnerability Assessment

Hazard	Potentially Impacted Parcels		Potentially Impacted Locations			Infrastructure				
	Number of Parcels	Percent of Total Parcels	Critical Facilities	Essential Facilities	Vulnerable Populations	Miles of Road	Miles of Sewer Lines	Bridges	Cell Towers	Dams
County Total	158,226	Not Applicable	235	55	576	4911	340	597	17	69
Relative Earthquake Hazard										
High	30,098	19%	26	7	58	636	56	153	3	22

Source: Clackamas County Geographic Information Systems (2018)

Note: Percentage of property in High Relative Earthquake Hazard area may include property in tax lots that intersect the area, including property that does not physically reside in the area itself.

Earthquake Regional Impact Analysis

In 2018 DOGAMI completed a regional impact analysis for earthquakes originating from the Cascadia Subduction Zone and Portland Hills faults ([O-18-02](#)). Their study focused on damage to buildings, and the people that occupy them, and to two key infrastructure sectors: electric power transmission and emergency transportation routes. Each earthquake was studied with wet and dry soil conditions and for events that occur during the daytime (2 PM) and night time (2 AM). Impacts to buildings and people were tabulated at the county, jurisdictional, and neighborhood unit level. Estimated damaged varied widely across the study area depending on local geology, soil moisture conditions, type of building, and distance from the studied faults. In general, damage from the Cascadia Subduction Zone scenario was greater in the western portion of the study area, however, damage could still be significant in some areas east of the Willamette River. The report found that damage to high-value commercial and industrial buildings was high since many of these facilities are in areas of high to very high liquefaction hazard (Figure 2-5). Casualties were higher during the daytime scenario (generally double) since more people would be at work and occupying non-wood structures that fare worse in an earthquake. The Portland Hills fault scenario created greater damages than the Cascade Subduction Zone scenario due primarily to its placement relative to population centers and regional assets; however, at distances 15 or more miles from the Portland Hills fault the damages from the Cascadia Subduction Zone scenario generally were higher. In both the Cascadia Subduction Zone and Portland Hills Fault scenarios it is forecasted that emergency transportation routes will be fragmented, affecting the distribution of goods and services, conditions are worse under the Portland Hills Fault scenario. Portions of the electric distribution system are also expected to be impacted under both scenarios, however, the impact is considerably less than it is to the transportation routes. Additional, capacity or redundancy within the electric distribution network may be beneficial in select areas that are likely to have greater impacts.

Table 2-8 shows the buildings that are in regions that are susceptible to liquefaction and landslides, it does not predict that damage will occur in specific areas due to either liquefaction or landslide. The table shows that a small percentage of buildings are located within the area susceptible to liquefaction (4% high and very high) or landslides (2% high to very high).

Table 2-8 Building statistics by Hazus-based liquefaction susceptibility rating and earthquake-induced landslide susceptibility rating

	Number of Buildings	Building Percent	Building Value (\$ Million)	Building Value Percent
Liquefaction Susceptibility				
None to low	113,010	63%	36,392	58%
Moderate	58,905	33%	23,738	38%
High	746	0%	276	0%
Very High	6,503	4%	1,984	3%
Landslide Susceptibility				
Low	161,505	90%	56,485	91%
Moderate	14,582	8%	4,890	8%
High to Very High	3,077	2%	1,015	2%
Total	179,164	100%	62,390	100%

Source: DOGAMI, Earthquake regional impact analysis for Clackamas, Multnomah, and Washington Counties, Oregon (2018, O-18-02), Tables 10-5 and 10-6.

Table 2-9 shows building damage expected under the Cascadia Subduction Zone scenario, about 13% of all buildings are expected to be damaged in the “dry” scenario and 15% in the “wet” scenario. Of those, it is expected that 158 buildings will collapse in the “dry” scenario, while 313 are expected to collapse in the “wet” scenario.¹⁴ The unincorporated portions of Clackamas County are expected to have a 5% building loss ratio with a repair cost of \$1.5 billion under the CSZ “dry” scenario, and a 7% building loss ratio with a repair cost of \$2.18 billion under the CSZ “wet” scenario.¹⁵

Table 2-9 Number of buildings per damage state for CSZ earthquake and soil moisture scenario

Building Damage State	"Dry" Soil	Building Percent	"Wet" Saturated Soil	Building Percent
None	121,428	68%	119,150	67%
Slight	34,145	19%	33,133	18%
Moderate	15,936	9%	15,386	9%
Extensive	5,390	3%	5,228	3%
Complete	2,265	1%	6,267	3%
Total	179,164	100%	179,164	100%

Source: DOGAMI, Earthquake regional impact analysis for Clackamas, Multnomah, and Washington Counties, Oregon (2018, O-18-02), Table 12-1

Table 2-10 shows building damage expected under the Portland Hills Fault scenario, about 46% of all buildings are expected to be damaged in the “dry” scenario and 49% in the “wet” scenario. Of those, it is expected that 666 buildings will collapse in the “dry” scenario, while 1,066 are expected to collapse in the “wet” scenario.¹⁶ The unincorporated portions of Clackamas County are expected to have a 20% building loss ratio with a repair cost of \$5.9

¹⁴ DOGAMI, Earthquake regional impact analysis for Clackamas, Multnomah, and Washington Counties, Oregon (2018, O-18-02), Table 12-3.

¹⁵ Ibid, Tables 12-8 and 12-9.

¹⁶ Ibid, Tables 12-8 and 12-9.

billion under the CSZ “dry” scenario, and a 26% building loss ratio with a repair cost of \$7.6 billion under the CSZ “wet” scenario.¹⁷

Table 2-10 Number of buildings per damage state for Portland Hills Fault earthquake and soil moisture scenario

Building Damage State	"Dry" Soil	Building Percent	"Wet" Saturated Soil	Building Percent
None	50,466	28%	47,990	27%
Slight	46,152	26%	42,988	24%
Moderate	47,122	26%	43,417	24%
Extensive	22,526	13%	20,761	12%
Complete	12,898	7%	24,008	13%
Total	179,164	100%	179,164	100%

Source: DOGAMI, Earthquake regional impact analysis for Clackamas, Multnomah, and Washington Counties, Oregon (2018, O-18-02), Table 12-1

Table 2-11 shows the permanent resident population that lives within buildings that are exposed to different expected levels of building damage. More population is exposed to higher degrees of expected damage under the Portland Hills Fault “wet” scenario than in any other scenario. The unincorporated portions of Clackamas County are expected to have around 778 daytime or 216 nighttime casualties during the CSZ “dry” scenario and 1,058 daytime or 508 nighttime casualties during the CSZ “wet” scenario. In addition, it is expected that there will be a long-term displaced population of around 1,006 for the CSZ “dry” scenario and 4,652 for the CSZ “wet” scenario.¹⁸

The long-term displaced population and casualties are greatly increased for all the Portland Hills Fault scenarios. The unincorporated portions of Clackamas County are expected to have around 3,582 daytime or 1,500 nighttime casualties during the Portland Hills Fault “dry” scenario and 4,555 daytime or 2,462 nighttime casualties during the Portland Hills Fault “wet” scenario. In addition, it is expected that there will be a long-term displaced population of around 12,036 for the Portland Hills Fault “dry” scenario and 24,307 for the Portland Hills Fault “wet” scenario.¹⁹

Table 2-11 Permanent residents displaced by building damage state and by earthquake and soil moisture conditions scenario.

Building Damage State	Cascadia Subduction Zone (M9.0)		Portland Hills Fault (M6.8)	
	"Dry" Soil	"Wet" Saturated Soil	"Dry" Soil	"Wet" Saturated Soil
Slight	75,828	73,670	101,881	94,448
Moderate	31,559	30,471	105,523	96,722
Extensive	6,644	6,580	47,996	44,065
Complete	1,931	10,093	25,152	50,802

Source: DOGAMI, Earthquake regional impact analysis for Clackamas, Multnomah, and Washington Counties, Oregon (2018, O-18-02), Table 12-3.

Note: Numbers for permanent residents occupying buildings in the “None” damage state are not included.

¹⁷ Ibid, Tables 12-10 and 12-11

¹⁸ Ibid, Tables 12-8 and 12-9.

¹⁹ Ibid, Tables 12-10 and 12-11.

Recommendations from the report included topics within Planning, Recovery, Resiliency: Buildings, Resiliency: Infrastructure Improvements, Resiliency: Essential and Critical Facilities, Enhanced Emergency Management Tools, Database Improvements, Public Awareness, and Future Reports. The recommendations of this study are largely incorporated within this NHMPs mitigation strategies (Volume I, Section 3). For more detailed information on the report, the damage estimates, and the recommendations see: *Earthquake regional impact analysis for Clackamas, Multnomah, and Washington Counties, Oregon* (2018, [O-18-02](#)).

Natural Hazard Risk Report for Lower Columbia-Sandy Watershed

The **Risk Report** ([DOGAMI, IMS-59](#)) provides hazard analysis summary tables that identify populations and property within the Lower Columbia-Sandy River Watershed Study Area that are vulnerable to the Cascadia subduction zone earthquake and a local crustal earthquake event associated with the Mount Hood fault. The Risk Report provides distinct profiles for (1) unincorporated Clackamas County within the study area, (2) the unincorporated community of Government Camp, and (3) the unincorporated community of The Villages at Mount. Hood (including Brightwood, Rhododendron, Welches, Wimpe, and Zig Zag).

According to the Risk Report the following populations and property within the study area may be impacted by the profiled events:

Unincorporated Clackamas County within the Study Area²⁰

Cascadia Subduction Zone event (M9.0 Deterministic): 143 buildings are expected to be damaged (0 critical facilities) for a total potential loss of \$37,084,000 (a loss ratio of 4%). In addition, 119 residents may be displaced (about 3% of the population).

Crustal event (Mt Hood M6.9 Probabilistic): 81 buildings are expected to be damaged (0 critical facilities) for a total potential loss of \$22,080,000 (a loss ratio of 3%). In addition, 70 residents may be displaced (about 2% of the population).

Government Camp²¹

Cascadia Subduction Zone event (M9.0 Deterministic): 14 buildings are expected to be damaged (0 critical facilities) for a total potential loss of \$3,533,000 (a loss ratio of 2%). In addition, 6 residents may be displaced (about 1% of the population).

Crustal event (Mt Hood M6.9 Probabilistic): 348 buildings are expected to be damaged (1 critical facility; Hoodland RFPD #74) for a total potential loss of \$67,142,000 (a loss ratio of 46%). In addition, 100 residents may be displaced (about 30% of the population).

The Villages at Mt. Hood²²

Cascadia Subduction Zone event (M9.0 Deterministic): 304 buildings are expected to be damaged (1 critical facility) for a total potential loss of \$56,005,000 (a loss ratio of 7%). In addition, 408 residents may be displaced (about 6% of the population).

²⁰ DOGAMI, *Lower Columbia-Sandy Watershed Natural Hazard Risk Report* (March 2018 Draft), Table 10.1.

²¹ *Ibid.*, Table 10.5.

²² *Ibid.*, Table 10.7.

Crustal event (Mt Hood M6.9 Probabilistic): 923 buildings are expected to be damaged (2 critical facilities) for a total potential loss of \$177,327,000 (a loss ratio of 22%). In addition, 993 residents may be displaced (about 16% of the population).

2007 Rapid Visual Survey

As noted in the community profile approximately 76% of residential buildings were built prior to 1990 (74% are either pre-code or low code according to DOGAMI²³), which increases the county's vulnerability to the earthquake hazard.

In 2007, DOGAMI completed a rapid visual screening (RVS) of educational and emergency facilities in communities across Oregon, as directed by the Oregon Legislature in Senate Bill 2 (2005). RVS is a technique used by the Federal Emergency Management Agency (FEMA), known as FEMA 154, to identify, inventory and rank buildings that are potentially vulnerable to seismic events. DOGAMI ranked each building surveyed with a 'low,' 'moderate,' 'high,' or 'very high' potential for collapse in the event of an earthquake. It is important to note that these rankings represent a probability of collapse based on limited observed and analytical data and are therefore approximate rankings. To fully assess a buildings potential for collapse, a more detailed engineering study completed by a qualified professional is required, but the RVS study can help to prioritize which buildings to survey.

DOGAMI's Rapid Visual Screening for Clackamas County listed 179 facilities in the unincorporated County and incorporated cities. Information on specific public buildings' (schools and public safety) estimated seismic resistance is available on DOGAMI's website: <http://www.oregongeology.org/rvs/default.htm>

Mitigation Successes

Seismic retrofit grant awards per the [Seismic Rehabilitation Grant Program](#)²⁴ have been funded to retrofit Clackamas Fire District Fire Station #12 (Logan), (2013-2014 grant award, \$94,552); Clackamas Fire District Fire Station #13 (Clarks), (2013-2014 grant award, \$71,582); Molalla Fire District Station 82, (Phase Two of 2015-2017 grant award, \$1,189,967); Sunnyside Elementary (Community of Clackamas), North Clackamas School District, (Phase Two of 2015-2017 grant award, \$1,500,000); and Whitcomb Elementary, North Clackamas School District (Phase Two of 2015-2017 grant award, \$1,500,000).

See city addenda for mitigation successes within each city.

For more information, see: [Open-File-Report: O-2007-02 - Statewide seismic needs assessment: Implementation of Oregon 2005 Senate Bill 2 relating to public safety, earthquakes and seismic rehabilitation of public buildings, 2007](#)

More information on this hazard can be found in the [Risk Assessment for Region 2, Northern Willamette Valley/Portland Metro, of the Oregon NHMP \(2015\)](#).

²³ DOGAMI, Earthquake regional impact analysis for Clackamas, Multnomah, and Washington Counties, Oregon (2018, O-18-02), Tables 10-2 and 10-3.

²⁴ The Seismic Rehabilitation Grant Program (SRGP) is a state of Oregon competitive grant program that provides funding for the seismic rehabilitation of critical public buildings, particularly public schools and emergency services facilities.

Flood

Significant Changes since Previous NHMP:

This section has updated data from the Lower Columbia-Sandy Watershed Multi-Hazard Risk Report, and the National Flood Insurance Program. Additional information is provided from reports detailing channel migration issues along the Sandy River.

Characteristics

Flooding results when rain and snowmelt create water flow that exceeds the carrying capacity of rivers, streams, channels, ditches and other watercourses. In Oregon, flooding is most common from October through April when storms from the Pacific Ocean bring intense rainfall. Most of Oregon's destructive natural disasters have been floods.²⁵

The flood events in Clackamas County usually occur when storms move in from the Pacific, dropping heavy precipitation into the Willamette valley; flooding is most significant during rain-on-snow events. Flooding in the valley becomes a problem when human activities infringe on the natural floodplain.

Two types of flooding primarily affect Clackamas County: riverine flooding and urban flooding. Channel migration and bank erosion also occurs along the Sandy River. In addition, any low-lying area has the potential to flood. The flooding of developed areas may occur when the amount of water generated from rainfall and runoff exceeds a storm water system's (ditch or sewer) capability to remove it.

Riverine Flooding

Riverine flooding is the overbank flooding of rivers and streams. The natural processes of riverine flooding add sediment and nutrients to fertile floodplain areas. Flooding in large river systems typically results from large-scale weather systems that generate prolonged rainfall over a wide geographic area, causing flooding in hundreds of smaller streams, which then drain into the major rivers. Figure 2-8 shows the various river basins in Clackamas County.

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.

Urban 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 on impervious concrete and asphalt surfaces. The water moves from the clouds, to the ground, and into streams at a much faster rate in urban areas. Adding these elements to the hydrological systems can result in floodwaters that rise very rapidly and peak with violent force.

²⁵ Taylor, George H. and Chris Hannan. *The Oregon Weather Book*. Grants Pass, OR: Oregon State University Press. 1999

Almost one-eighth of the area in Clackamas County is incorporated and has a high concentration of impermeable surfaces that either collect water or concentrate the flow of water in unnatural channels. During periods of urban flooding, streets can become swift moving rivers and basements can fill with water. Storm drains often back up with vegetative debris causing additional, localized flooding.

Channel migration and bank erosion

Following the 2011 flood on the Sandy River, County staff began to emphasize the different nature of the flood hazard in the upper reaches of the river, as that of bank erosion due to channel migration. The upper Sandy may not have to reach flood stage to achieve a level of flow capable of mobilizing sediments and impounding gravel and woody debris in the channel. These impoundments can redirect the main channel into the bank and cause failures that exacerbate further erosion downstream. The Oregon Department of Geology and Mineral Industries (DOGAMI) has extensively mapped the channel migration zone (see reports cited at the end of this section for more information).



Location and Extent

Because Clackamas County spans a wide range of climatic and geologic regions, there is considerable variation in precipitation, with elevation being the largest factor in precipitation totals.

Moving east from Oregon City at 55 feet above sea level to Mt Hood at 11,235 feet above sea level, annual precipitation averages range from 47 inches to over 125 inches, respectively. This change in elevation causes a significant increase in precipitation, in the form of both rain and snow. Although the majority of the county enjoys a fairly mild winter, with less than 5-10 inches of snow per year, the higher elevations surrounding Mt. Hood are covered with snow for the majority of the winter months. This is of primary concern when dealing with potential flood events. Mt. Hood's snowmelt provides a continuous water source throughout the year and can be a major contributor to high waters.

Flooding is most common from October through April, when storms from the Pacific Ocean, 60 miles away, bring intense rainfall to the area.²⁶ During the rainy season, monthly rainfall totals average far higher than other months of the year. This results in high water, particularly in December and January. The larger floods are the result of heavy rains of two-day to five-day durations augmented by snowmelt at a time when the soil is near saturation from previous rains. Frozen topsoil also contributes to the frequency of floods.²⁷

A large portion of Clackamas County's area lies in the lower Willamette River basin. The broad floodplain of the valley can be easily inundated by floodwaters. The surface material

**Sandy River Channel Migration Damage
January 16, 2011**

Source: Oregonian

²⁶ Interagency Hazard Mitigation Team, *State Hazard Mitigation Plan* (2000) Oregon Emergency Management.

²⁷ Taylor, George H., Hannan, Chris, *The Climate of Oregon* (1999). Oregon State University Press. Corvallis, Oregon.

includes poorly drained, unconsolidated, fine-grained deposits of Willamette silt, sand, and gravel. Torrential flood events can introduce large deposits of sand and gravel that assist in the drainage of the otherwise poorly drained soils.²⁸

After the January 2009 flood event on South Creek Road along Abernethy Creek, Clackamas County sponsored an inquiry to FEMA into mapping errors for transitioning the 1978 FIRM into DFIRM and argued that the original FIRM Approximate A Zone polygon was incorrectly registered that at least two properties in the Approximate A Zone were now outside of the flood zone, even Abernethy Creek itself. Following the 2009 flood event, the County petitioned FEMA for reconsideration and eventually submitted an inquiry through Senator Wyden’s office to the Mitigation Directorate at FEMA Headquarters, but the request was denied. Table 2-12 lists the locations of known chronic flooding problems in Clackamas County.



Sandy River Flooding – January 16, 2011
Source: Clackamas County Disaster Management

Table 2-12 Locations of Identified Chronic Flooding Problems

Location	River	Description
Tranquility Lane	Clackamas River	Road
Paradise Park	Clackamas River	Open Space
Welches	Salmon River	Unincorporated community
Lolo Pass	Sandy River	Road
Timberline Rim	Sandy River	Housing development
Dickie Prairie Road	Molalla River	Road
Feyrer Park/Shady Dell	Molalla River	Open space and housing development
Alder Creek Area	Alder Creek	Open space
Canby	Pudding River	City
Dogwood Drive/Rivergrove	Tualatin River	City
Oregon City	Confluence of Willamette River and Clackamas River	City
Johnson Creek Basin	Johnson Creek	Basin
Abernethy Creek Basin	Abernethy Creek	Basin

Source: Clackamas County Disaster Management

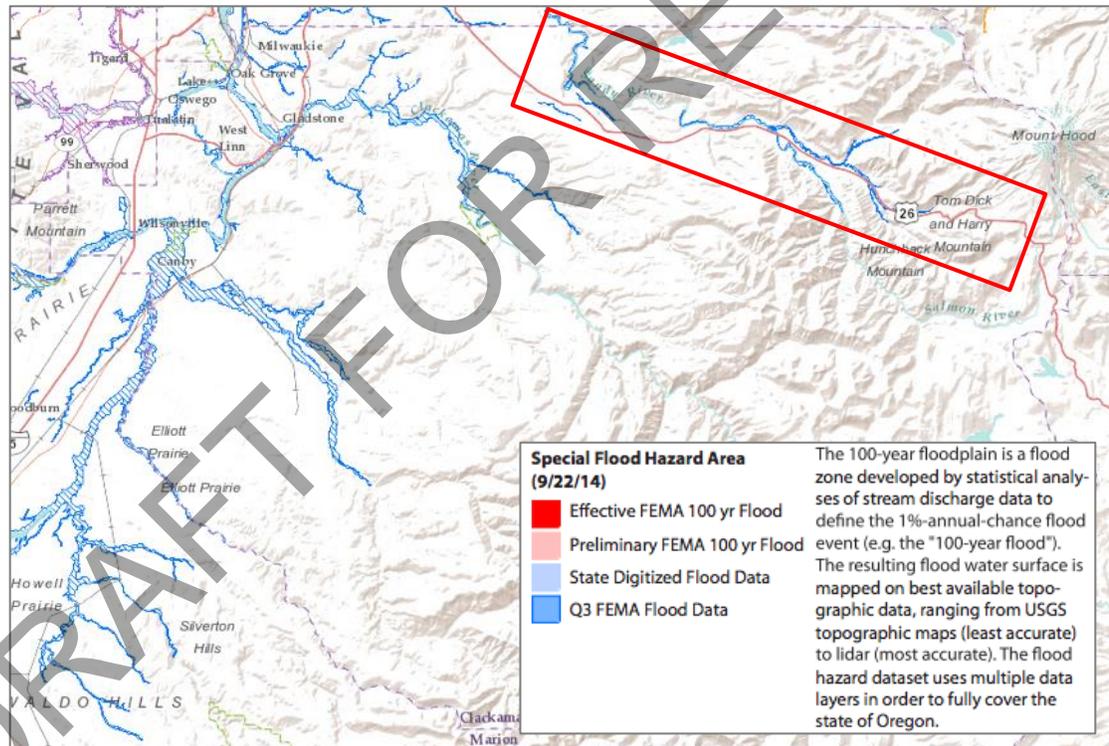
Floods are described in terms of their extent (including the horizontal area affected and the vertical depth of floodwaters) and the related probability of occurrence. Flood studies often use historical records, such as streamflow gages, to determine the probability of occurrence

²⁸ Geologic Hazards of the Bull Run Watershed Multnomah and Clackamas Counties, Oregon. DOGAMI. Bulletin 82. 1974

for floods of different magnitudes. The probability of occurrence is expressed in percentages as the chance of a flood of a specific extent occurring in any given year.

The magnitude of flood used as the standard for floodplain management in the United States is a flood having a one percent probability of occurrence in any given year. This flood is also known as the 100-year flood or base flood. The most readily available source of information regarding the 100-year flood is the system of Flood Insurance Rate Maps (FIRMs) prepared by FEMA. These maps are used to support the National Flood Insurance Program (NFIP). The FIRMs show 100-year floodplain boundaries for identified flood hazards. These areas are also referred to as Special Flood Hazard Areas (SFHAs) and are the basis for flood insurance and floodplain management requirements. In 2008 FEMA undertook an update of all FIRMs in Clackamas County as part of a recalibration of the datum for measuring elevation into the Digital FIRM (DFIRM) format. Figure 2-8 provides an overview of the flood zones in Clackamas County and Volume III, Appendix D includes maps showing average precipitation (Map 2), FEMA floodplains (Map 3), and river sub-basins (Map 4).

Figure 2-8 Special Flood Hazard Area and preliminary FIRMs study area



Source: [Oregon HazVu: Statewide Geohazards Viewer](#) – To view map in more detail click hyperlink to left.

For detailed information, refer to the following Flood Insurance Study (FIS) and associated Flood Insurance Rate Maps (FIRMs):

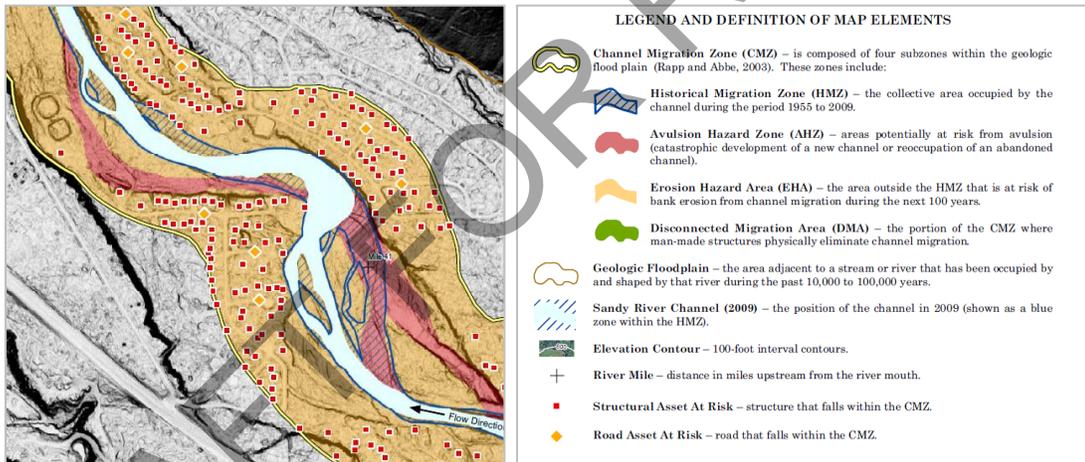
- [Clackamas County FIS \(2008\) - Volume 1 of 3](#)
- [Clackamas County FIS \(2008\) - Volume 2 of 3](#)
- [Clackamas County FIS \(2008\) - Volume 3 of 3](#)

FEMA flood hazard mapping for updating the FIRMs is underway for the Sandy River (area shown in Figure 2-8 red bordered box), preliminary maps were released in March 28, 2016 (effective maps are expected by January 18, 2019). Preliminary FIRMs and revised flood profiles and floodway data can be downloaded and viewed via FEMA’s Flood Map Service Center: <https://msc.fema.gov/portal/advanceSearch>.

Conventional FIRMs (flood hazard maps) show existing floodplain information. However, in some areas bank erosion causes river channels to migrate, sometimes even in the absence of a flood event.

To address this concern the Oregon Department of Geology and Mineral Industries (DOGAMI) has contributed a Channel Migration Zone mapping study for the Sandy River and generated LiDAR-based maps for the Sandy Basin and other flood-prone areas of the County. Figure 2-9 provides an example map and legend from the report. More information on the report is found below in the vulnerability section. The resulting channel migration zone and subzones represents the likely hazard area over the next 100 years. According to DOGAMI, “[t]he channel migration hazard map should be used as a guide for local governments, land owners, and infrastructure managers to identify assets potentially at risk and to develop effective mitigation measures”.²⁹

Figure 2-9 Channel Migration Hazard Map for Timberline Rim Area



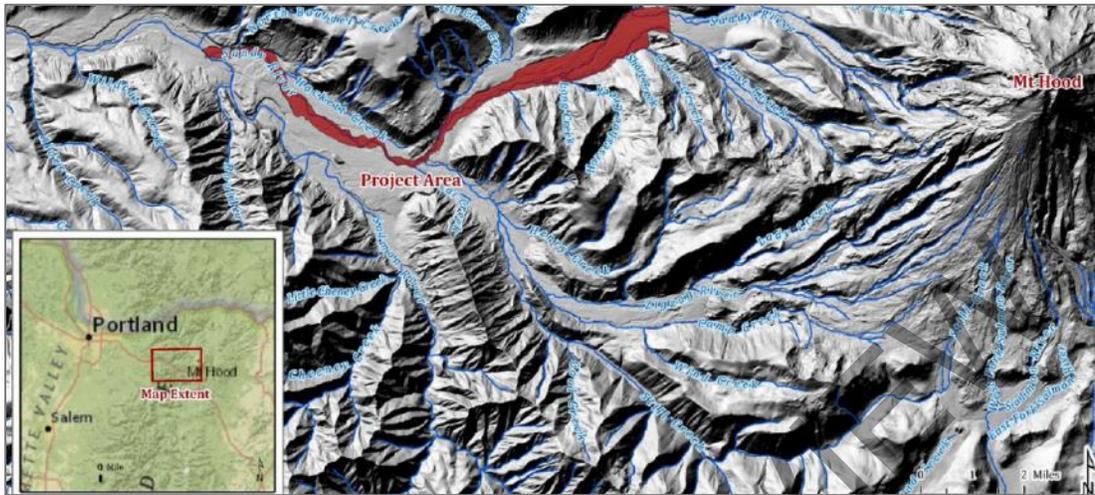
Source: DOGAMI, Open-File Report O-11-13, Plate 10 (superseded by O-13-10).

To refine the data provided by DOGAMI Clackamas County contracted with Natural Systems Design to conduct a Flood Erosion Hazard Mitigation Evaluation for the Upper Sandy River (NSD evaluation). The NSD evaluation was completed in 2015 and was funded through the Hazard Mitigation Grant Program for DR-1956.³⁰ The NSD evaluation project area (Figure 2-10) is limited to a 10-mile reach of the Sandy River extending from River Mile 37.4 (just above the Salmon River confluence) to River Mile 47.5 (just above the Lost Creek confluence).

²⁹ DOGAMI, Open-File Report O-13-10, *Channel migration hazard data and maps for the Sandy River, Multnomah and Clackamas Counties, Oregon*. John T. English, Daniel E. Coe, and Robert D. Chappell.

³⁰ Natural Systems Design, [Flood Erosion Hazard Mitigation Evaluation: Upper Sandy River](#), March 25, 2015.

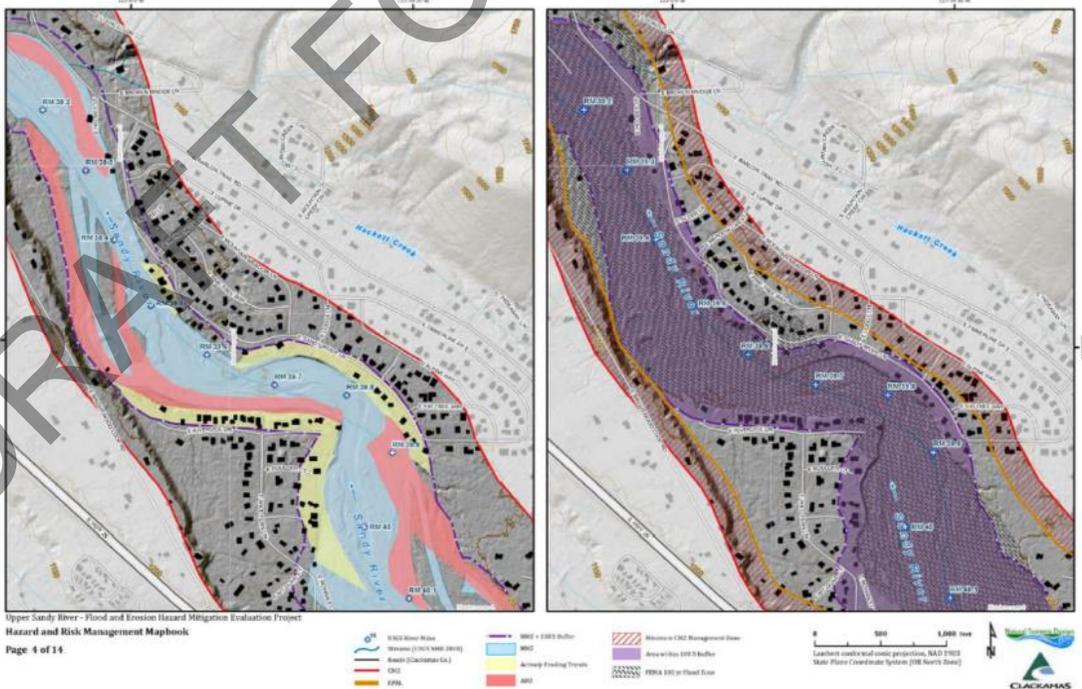
Figure 2-10 Upper Sandy River Project Area (RM 37-47)



Source: Natural Systems Design, Flood Erosion Hazard Mitigation Evaluation: Upper Sandy River, March 25, 2015.

The NSD evaluation’s map update recommendations include: (1) expanding the historic migration zone (HMZ) to account for a broader corridor of channel occupancy over the historical record, (2) adding additional avulsion pathways to the avulsion hazard zone (AHZ), (3) increasing the setback from the AHZ to limit future erosion hazards, and (4) removing some areas noted as disconnected migration areas (DMA) which may be at risk to erosion (e.g., areas blocked by roads). The NSD evaluation created an adjusted channel migration zone (CMZ) that averages 2,000 feet wide throughout the project area (Figure 2-11).

Figure 2-11 NSD Hazard and Risk Maps



Source: Natural Systems Design, Flood Erosion Hazard Mitigation Evaluation: Upper Sandy River, March 25, 2015. Maps show side-by-side hazard (left) and risk (right) maps for the 10-mile reach of the river affected in 2011. These maps characterize the CMZ exposure for the first time and will become the basis for flood mitigation along the Sandy. See [Channel Migration Zone Hazard Maps](#) (Risk Hazard Mapbook) for high resolution risk maps.

The NSD evaluation promotes the use of restorative erosion protection measures which take advantage of natural processes to decrease erosive forces while also benefitting fish and wildlife. Restorative measures must: (1) provide the river with sufficient space within an established River Management Corridor (RMC), (2) dissipate the river's energy as it approaches the margins of the RMC by splitting the main channel into smaller side channels, and (3) establish a line of defense at the RMC through the use of restorative bank protection measures (rough and complex) that dissipate energy, protect the bank, and enhance fish habitat.³¹ A list of high risk erosion hazard sites is provided in NSD evaluation Table 5 that may be used as a resource when evaluating which sites to prioritize in future mitigation efforts along the Sandy River. An example bank projection strategy is provided in Figure 2-12. For more information review the NSD evaluation:

<https://dochub.clackamas.us/documents/drupal/e5a6ebef-f7be-4bcd-8f0f-48d33d537afd>.

Figure 2-12 Example Bank Protection Strategy



Source: Natural Systems Design, *Flood Erosion Hazard Mitigation Evaluation: Upper Sandy River*, March 25, 2015.

More information on restorative flood protection measures can be found in the FEMA publication: [Engineering with Nature: Alternative Techniques to Riprap Bank Stabilization](#).

Additional reports are available via FEMA's Flood Map Service Center website:

<https://msc.fema.gov/portal>

Refer to the following DOGAMI reports for additional information:

- Multi-Hazard Risk Report for the Lower Columbia-Sandy Watershed, Oregon: Including the cities of Gresham, Sandy, and Troutdale and Unincorporated Communities of Government Camp and The Villages at Mt Hood (2018, [IMS-59](#)).
- Statewide subbasin-level channel migration screening (2017, [IMS-56](#)).
- Channel migration zone study of Sandy River (2013, [O-13-10](#)). *Portions superseded by the Multi-Hazard Risk Report for the Lower Columbia-Sandy Watershed.*

³¹ Ibid. pp. 62-65.

- Multi-Hazard and Risk Study for the Mount Hood Region (Earthquake, Flood and Channel Migration, Landslide, Volcano) (2011, [O-11-16](#)). *Portions of the flood and channel migration section superseded by the Multi-Hazard Risk Report for the Lower Columbia-Sandy Watershed.*
- Channel migration hazard maps for the Sandy River, Multnomah and Clackamas counties, Oregon (2011, [O-11-12](#)). Superseded by O-13-10.

Additional reports are available via DOGAMI's Publications Search website:

<http://www.oregongeology.org/pubs/search.php>

Other agency/ consultant reports:

- Natural Systems Design, [Flood Erosion Hazard Mitigation Evaluation: Upper Sandy River](#), March 25, 2015.
 - Channel Migration Zone Hazard Maps ([Risk Hazard Mapbook](#))
- Mathie, A.M., and Wood, N., 2013, Residential and service-population exposure to multiple natural hazards in the Mount Hood region of Clackamas County, Oregon: U.S. Geological Survey Open-File Report 2013-1073, available at <http://pubs.usgs.gov/of/2013/1073/>.

History

Clackamas County has many rivers and small tributaries in both unincorporated and incorporated areas that are susceptible to flooding. Major floods have affected the citizens of the county since as early as 1861, when it was reported that the streets of Oregon City were inundated with about four feet of Willamette overbank flow. Although the 1996 floods were devastating to the entire region, the floods of 1861, 1890, and 1964 were larger. All four floods have been estimated to exceed the 100-year or base flood. Since the previous version of the plan there have no presidentially declared flood disaster events in Clackamas County, however, there have been four flood events: 2012, 2014, 2015, and 2016-2017.

Probability Assessment

Based on the available data and research the Hazard Mitigation Advisory Committee determined the **probability of experiencing a flood is "high"**, meaning one incident is likely within the next 10 to 35-year period *This rating has not changed since the previous NHMP.*

Flooding can occur every year depending on rainfall, snowmelt or how runoff from development impacts streams and rivers. The Federal Emergency Management Agency (FEMA) has mapped the 100 and 500-year floodplains in portions of Clackamas County (see referenced 2008 FIS for more information; preliminary maps are available for the Sandy River, 2018). This corresponds to a 1% and 0.2% chance of a certain magnitude flood in any given year. The 100-year flood is the benchmark upon which the National Flood Insurance Program (NFIP) is based.

Climate change will likely be an influencing factor for future flood probabilities. Long-term modeling suggests increases in annual average temperatures may translate in the Pacific Northwest to less total accumulated snow pack and faster storm runoff. This could mean flashier flood events for upper watersheds and the need for greater attention to storm water management in floodplains.

Vulnerability Assessment

The Hazard Mitigation Advisory Committee rated the county as having a **“moderate” vulnerability to flood hazards**, meaning that between 1-10% of the unincorporated County’s population or assets would be affected by a major flood event. *This rating has not changed since the previous NHMP.*

A floodplain vulnerability assessment combines the floodplain boundary, generated through hazard identification, with an inventory of the property within the floodplain. Understanding the population and property exposed to natural hazards will assist in reducing risk and preventing loss from future events.

The amount of property in the floodplain, as well as the type and value of structures on those properties, is calculated to provide a working estimate for potential flood losses. Table 2-13 shows potentially impacted parcels, critical and critical facilities, vulnerable populations, and infrastructure within Clackamas County’s 100-year floodplain.

Table 2-13 Flood Hazard Vulnerability Assessment

Hazard	Potentially Impacted Parcels		Potentially Impacted Locations			Infrastructure				
	Number of Parcels	Percent of Total Parcels	Critical Facilities	Essential Facilities	Vulnerable Populations	Miles of Road	Miles of Sewer Lines	Bridges	Cell Towers	Dams
County Total	158,226	Not Applicable	235	55	576	4911	340	597	17	69
Flooding										
100 year Floodplain	9,921	6%	2	1	4	78	34	140	0	6

Source: Clackamas County Geographic Information Systems (2018)

Note: Percentage of property in the 100-year floodplain may include property in tax lots that intersect the floodplain, including property that does not physically reside in the floodplain itself.

Clackamas County development regulations restrict, but do not prohibit, new development in areas identified as floodplain. This reduces the impact of flooding on future buildings. As new land has been brought into the regional Urban Growth Boundary, the applicable development codes have been applied to prevent the siting of new structures in flood prone areas.

For mitigation planning purposes, it is important to recognize that flood risk for a community is not limited only to areas of mapped floodplains. Other portions of the county outside of the mapped floodplains may also be at relatively high risk from over bank flooding from streams too small to be mapped by FEMA, from channel migration, or from local storm water drainage.

Lower Columbia-Sandy Watershed Natural Hazard Risk Report

The **Risk Report** ([DOGAMI, IMS-59](#)) provides hazard analysis summary tables that identify populations and property within the Lower Columbia-Sandy River Watershed Study Area that are vulnerable to the profiled natural hazards. The Risk Report provides distinct profiles for (1) unincorporated Clackamas County within the study area, (2) the unincorporated community of Government Camp, and (3) the unincorporated community of The Villages at Mt. Hood (including Brightwood, Rhododendron, Welches, Wimpe, and Zig Zag).

According to the Risk Report the following populations and property are vulnerable:

Unincorporated Clackamas County within the Study Area³²

Flood event (100-Year Flood): 74 buildings are expected to be damaged (0 critical facilities) for a total potential loss of \$2,989,000 (a loss ratio of < 1%). In addition, 138 residents may be displaced (about 3% of the population).

Channel migration:* 145 buildings are exposed (0 critical facilities) for a total potential loss of \$33,781,000 (an exposure ratio of 4%). In addition, 178 residents may be displaced (about 4% of the population).

Government Camp³³

Flood event (100-Year Flood): 12 buildings are expected to be damaged (0 critical facilities) for a total potential loss of \$182,000 (a loss ratio of < 1%). In addition, 4 residents may be displaced (about 2% of the population).

Channel migration:* No potential risk to Government Camp.

The Villages at Mt. Hood³⁴

Flood event (100-Year Flood): 161 buildings are expected to be damaged (0 critical facilities) for a total potential loss of \$2,628,000 (a loss ratio of < 1%). In addition, 285 residents may be displaced (about 1% of the population).

Channel migration:* 1,307 buildings are exposed (0 critical facilities) for a total potential loss of \$233,667,000 (an exposure ratio of 29%). In addition, 1,855 residents may be displaced (about 36% of the population).

*Note: * - The channel migration hazard may be under reported in the DOGAMI Risk Report which does not utilize the Natural Systems Design [Flood Erosion Mitigation Evaluation: Upper Sandy River](#) (NSD evaluation) to determine the width of the channel migration zone. Please review the NSD evaluation for more information on the hazard.*

Floodplain Management Plan (Activity 510)

The Natural Hazard Mitigation Plan functions as, among other things, the County's Floodplain Management plan so that the County receives credit for, and maintains compliance with, its membership within the National Flood Insurance Program (NFIP) Community Rating System (CRS), which recognizes jurisdictions for participating in floodplain management practices that exceed NFIP minimum requirements. The County was admitted into the CRS program in April 2004 and received a rating of Class 5, becoming the highest rated jurisdiction in Oregon and one of only 23 nationally. Currently, the County's participation in the CRS is rescinded and the County does not receive a discount in flood insurance premiums for residents of unincorporated Clackamas County in a special flood hazard zone.

Below are several CRS related activities that the 2018 NHMP documents for credit under the Activity 510 – Floodplain Management Plan:

³² DOGAMI, *Lower Columbia-Sandy Watershed Natural Hazard Risk Report* (March 2018 Draft), Table 10.1.

³³ Ibid., Table 10.5.

³⁴ Ibid., Table 10.7.

National Flood Insurance Program (NFIP)

FEMA updated the Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRMs) in 2008 (effective June 17, 2008). Preliminary maps for portions of the County within the Lower Columbia-Sandy River Watershed were released March 28, 2016 (expected to be effective January 18, 2019). Clackamas County has an open Community Assistance Visit (CAV) that was initiated January 11, 2017. The NFIP's Community Rating System (CRS) recognizes jurisdictions for participating in floodplain management practices that exceed NFIP minimum requirements.

Table 2-14 shows that the majority of flood insurance policies are for residential structures, primarily single-family homes. There are 1,311 National Flood Insurance Program (NFIP) policies in force within the unincorporated portion of the County. Of those, 754 are for properties that were developed before development of the initial FIRMs.

Flood insurance covers only the improved land, or the actual building structure. There have been 385 paid claims paid as of July 2018 (294 pre-FIRM and 58 substantial damage) in the unincorporated County totaling just under \$10.7 million.

Table 2-14 Flood Insurance Detail

	Clackamas County	Unincorporated Clackamas County
Effective FIRM and FIS	6/17/2008	6/17/2008
Initial FIRM Date	-	3/1/1978
Total Policies	1,957	1,311
Pre-FIRM Policies	1,086	754
Policies by Building Type		
Single Family	1,761	1,231
2 to 4 Family	30	14
Other Residential	58	5
Non-Residential	9	7
Minus Rated A Zone	123	81
Insurance in Force	\$541,833,400	\$349,852,800
Total Paid Claims	590	385
Pre-FIRM Claims Paid	450	294
Substantial Damage Claims	83	58
Total Paid Amount	\$20,830,662	\$10,664,411
Repetitive Loss Structures	51	40
Severe Repetitive Loss Properties	4	3
CRS Class Rating	-	10
Last Community Assistance Visit	-	1/11/2017*

Source: Department of Land Conservation and Development, July 2018. The portion of the cities of Portland and Tualatin that are within Clackamas County are not included in this table.

Note: * - The most CAV has been open since 1/11/2017

Risk Analysis - Repetitive Loss Properties:

Clackamas County works to mitigate problems regarding flood issues when they arise. Some areas in the county are more susceptible to flooding issues and have incurred repetitive losses. A repetitive loss property (RL) is defined as a National Flood Insurance Program

(NFIP)-insured building that has had at least two paid flood losses of more than \$1,000 each in any 10-year period since 1978. A severe repetitive loss property (SRL) is defined as a building that is covered under an NFIP flood insurance policy and has had at least four paid flood losses of more than \$5,000 each or for which at least two separate building claims payments with the cumulative amount exceeding the market value of the building. RL and SRL properties are troublesome because they continue to expose lives and valuable property to the flooding hazard. Local governments as well as federal agencies such as FEMA attempt to address losses through floodplain insurance and attempts to remove the risk from repetitive loss of properties through projects such as acquiring land and improvements, relocating homes or elevating structures. Continued repetitive loss claims from flood events lead to an increased amount of damage caused by floods, higher insurance rates, and contribute to the rising cost of taxpayer funded disaster relief for flood victims.

Table 2-15 and Figure 2-13 provide information on the identified RL and SRL properties. The NFIP record identifies 39 RL properties in unincorporated Clackamas County. There have been 112 paid RL claims totaling \$3,556,703. Of these properties, three (3) are considered SRL (total paid losses amount to \$209,132). Fifteen (15) of the RL/SRL properties are not insured as of July 2018. Most repetitive loss properties are located outside of city limits.

Table 2-15 Repetitive Loss and Severe Repetitive Loss Properties Detail

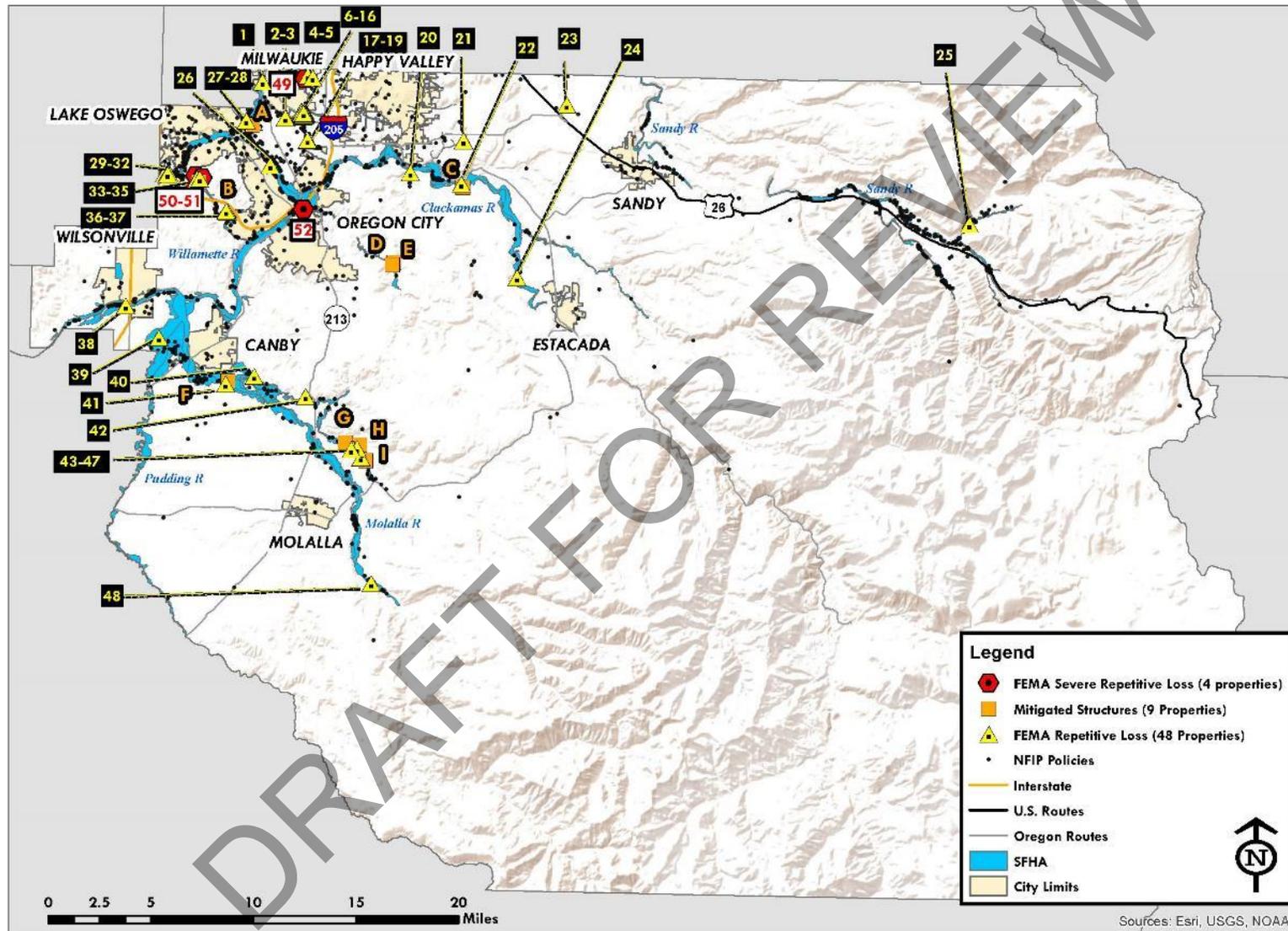
RL or SRL Property	Location	Currently Insured?	Flood Zone	Occupancy	Historic Building	Total Paid Claims	Total Paid Amount
RL	Property 2	YES	AE	Single Family	No	3	\$37,585
RL	Property 4	NO	A	Single Family	No	2	\$3,719
RL	Property 6	YES	AE	Single Family	No	2	\$141,105
RL	Property 7	YES	AE	Single Family	No	2	\$117,381
RL	Property 8	YES	AE	Single Family	No	2	\$29,624
RL	Property 9	YES	A02	2-4 Family	No	2	\$131,249
RL	Property 10	YES	A02	2-4 Family	No	2	\$216,191
RL	Property 11	YES	C	2-4 Family	No	2	\$229,582
RL	Property 12	YES	C	2-4 Family	No	2	\$224,271
RL	Property 13	YES	C	Other residential	No	2	\$262,315
RL	Property 17	NO	X	Single Family	No	2	\$15,123
RL	Property 18	YES	A02	Single Family	No	3	\$46,901
RL	Property 19	YES	A02	Single Family	No	2	\$11,832
RL	Property 20	YES	A07	Single Family	No	2	\$14,220
RL	Property 21	NO	X	Single Family	No	2	\$30,066
RL	Property 22	YES	A	Single Family	No	2	\$11,961
RL	Property 23	NO	X	Single Family	No	2	\$17,338
RL	Property 24	YES	X	Single Family	No	3	\$63,409
RL	Property 25	YES	A05	Single Family	No	2	\$123,375
RL	Property 27	YES	A19	Single Family	No	2	\$28,933
RL	Property 28	NO	A19	Single Family	No	2	\$125,288
RL	Property 33	YES	C	Single Family	No	2	\$84,648
RL	Property 34	YES	A	Single Family	No	2	\$42,719
RL	Property 35	YES	A	Single Family	No	2	\$74,014
RL	Property 36	YES	B	Single Family	No	2	\$80,721
RL	Property 37	NO	X	Single Family	No	2	\$18,418
RL	Property 38	YES	C	Single Family	No	2	\$84,976
RL	Property 39	NO	AE	Single Family	No	2	\$8,949
RL	Property 40	NO	AE	Single Family	No	2	\$7,072
RL	Property 41	YES	A05	Single Family	No	3	\$77,410
RL	Property 42	YES	A04	Single Family	No	2	\$17,494
RL	Property 43	YES	AE	Single Family	No	2	\$11,501
RL	Property 44	NO	B	Single Family	No	3	\$52,708
RL	Property 45	NO	A	Single Family	No	2	\$46,637
RL	Property 46	YES	A04	Single Family	No	2	\$8,058
RL	Property 47	YES	B	Single Family	No	2	\$39,933
RL	Property 48	NO	C	Single Family	No	2	\$16,732
SRL	Property 49	NO	X	Single Family	No	6	\$123,952
SRL	Property 50	SDF	A	Single Family	No	2	\$41,201
SRL	Property 51	SDF	A	Single Family	No	2	\$43,978
Total						89	\$2,762,591

Source: Department of Land Conservation and Development, July 2018.

Notes: RL – Repetitive Loss Property, SRL – Severe Repetitive Loss Property

For location details see Figure 2-13

Figure 2-13 NFIP Policies, Repetitive Loss, and Severe Repetitive Loss Properties



Source: Department of Land Conservation and Development, July 2018 (data from July 2017).

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Implementing Flood Hazard Mitigation

Clackamas County works closely with Oregon Emergency Management and FEMA to reduce flood losses and seeks to best utilize federal mitigation grant funds to minimize future flood risk. With that said, Clackamas County has demonstrated in the two most recent disaster their investment in flood mitigation actions through prioritizing substantially damaged properties and repetitive loss properties when applying for flood acquisition projects. The County considers these buyouts of flood prone properties to be the most cost effective approach to reduce future flood losses for property owners, minimize future disaster-related expenses to the community and provide savings to federal tax payers on a permanent reduction in flood exposed properties.

Table 2-16 and Figure 2-13 provide information on repetitive loss properties that have been mitigated through FEMA HMA grant programs. The record indicates that nine (9) properties in unincorporated Clackamas County have received some form of flood mitigation (buy out, elevation, relocation, etc.). There have been 112 paid repetitive loss claims totaling \$3,556,703.

Table 2-16 Mitigated Flood Properties

Location	Currently Insured?	Flood Zone	Occupancy	Historic Building	Total Paid Claims	Total Paid Amount
Property A	YES	X	Single Family	No	2	\$90,040
Property B	YES	A	Single Family	No	2	\$94,465
Property C	YES	A07	Single Family	No	3	\$132,435
Property D	YES	A	Single Family	No	3	\$275,678
Property E	NO	C	Single Family	No	3	\$60,499
Property F	NO	AE	Single Family	No	3	\$36,618
Property G	YES	A	Single Family	No	2	\$27,038
Property H	YES	A04	Single Family	No	2	\$19,704
Property I	NO	A04	Single Family	No	3	\$57,635
Total					23	\$794,112

Source: Department of Land Conservation and Development, July 2018.
For location details see Figure 2-13

One of the best investments for implementing hazard mitigation is not only through projects but to affect policy, such as land use planning and even long-term recovery planning. Following the 2011 flood disaster, Clackamas County convened a standing group to address sustainable flood recovery on the upper Sandy River. This group has begun addressing the interdepartmental roles and responsibilities in transitioning from response activities to recovery phase.

Since the previous plan was adopted ongoing discussions have occurred on how the expected updated DFIRMS (preliminary in March 28, 2016, expected to be effective January 18, 2019) for the Sandy River will influence the DOGAMI Channel Migration Zone study and possible implications for long-term land use decisions on replacing damaged infrastructure and recovery for private property owners. DOGAMI completed their Channel Migration Study in 2013 ([Open-File Report O-13-10](#)). County staff is working with the Sandy River Basin Watershed Council's "restorative flood response" outreach to homeowners and associations on providing education about benefits from combining multiple goals of enriching habitat,

cost-effectiveness, elevated bank protection and equitable performance towards neighboring properties.

The County is also reviewing the level of flood insured properties in the upper Sandy Basin and investing in public outreach to encourage more Preferred Risk policies for residences outside of the Special Flood Hazard Zone and that by having flood insurance, homeowners can also take advantage of the Flood Mitigation Assistance Program for projects like acquisitions that do not require a disaster declaration.

Public outreach was employed several times since the January 2011 flood event to address public concerns, present flood response and recovery operations status, discuss flood threat issues to property owners and promote the purchase of flood insurance.

Urban Area Flood Mitigation

50th Anniversary recognition of the 1964 Christmas flood – Clackamas/Willamette Rivers Confluence

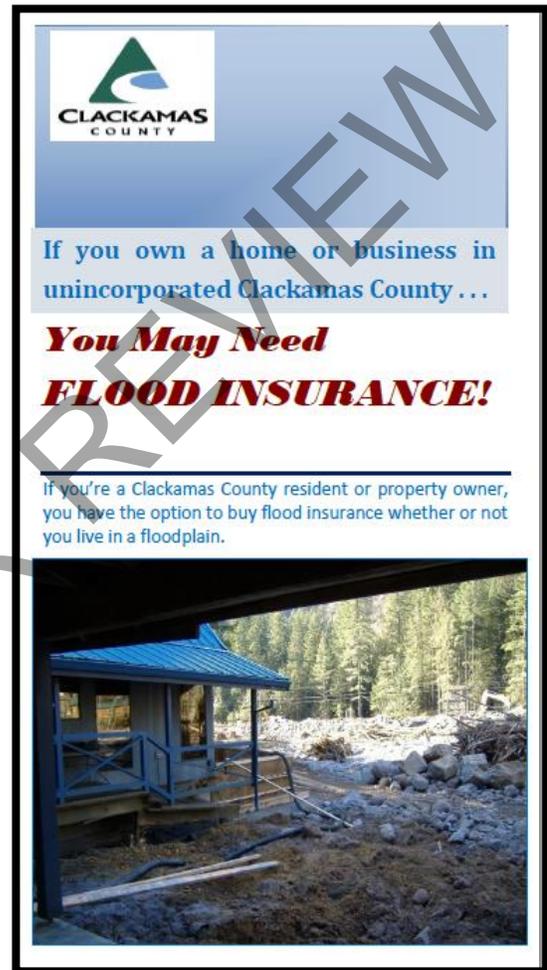
In anticipation of the 2014 holiday season, Clackamas County began collecting images and interviews from residents who directly experienced the 1964 Christmas flood. By focusing on personal photos and accounts, the County used stories rather than agency reports to document how this flood event affected people, neighborhoods and Clackamas history.

Post Flood Actions – December 2015

Clackamas County held a September 2016 community meeting for owners and tenants of flooded homes to review the nature of the flood event, mitigation options with HMGP funds and information resources from federal, state and county agencies and the North Clackamas Urban Watersheds Council.

An NFIP Repetitive Loss residential property along SE Rusk Road that flooded in 1996, 2009, and 2015 is participating in the 2016 Flood Mitigation Assistance (FMA) program. At the time of the NHMP update, the property is under consideration for a relocation/elevation on the current parcel but may end up accepting a voluntary flood acquisition if the house's structure can't be raised.

In October 2015 and November 2016, the County organized two "Flood of Information" community education events for urban flood hazards and winter weather safety. Participants included the North Clackamas Urban Watersheds Council, the Greater Oregon City Watershed Council, the Oregon NFIP Coordinator, the US Geological Survey's Portland



Water Resources Office, the Cascades Region of the American Red Cross and staff from multiple County departments.

Surface Water Management – Water Environment Services (WES)

WES administers sanitary sewer, surface water management, and erosion control programs in urban areas of Clackamas County.

Since 2012, WES has completed several in-stream restoration projects, repaired many drainage issues, rehabilitated some stormwater ponds, conducted monitoring, and other storm system-related maintenance. These restoration projects have been done to improve physical habitat and water quality, as well as to correct drainage/flow issues.

- Mt Scott Creek in North Clackamas Park: In-stream restoration and invasive control/native vegetation enhancement, construction of an overlook deck. Completed in partnership w/NCPRD, partial funding from Metro Nature in Neighborhoods Capital Grant program and WES ratepayer fees.
- Happy Valley Park stream stabilization: Replaced a culvert with a bridge, repaired a headcut, improved in-stream habitat in partnership w/City of Happy Valley. Funding by and WES ratepayer fees.
- Cedar Way stream stabilization: Repaired a headcut and stabilized a stream along a walking path in partnership w/City of Happy Valley. Funding from and WES ratepayer fees.
- Rock Creek Confluence project: in-stream restoration, invasive control/native vegetation enhancement, construction of a shelter for use by environmental education program. Partnered with Clackamas River Basin Council, partial funding from Metro Nature in Neighborhoods Capital Grant program, The Nature Conservancy, OWEB, and WES ratepayer fees.
- Carli Creek constructed wetland and stream restoration: currently in construction. In-stream portion completed. Constructed wetland will treat currently untreated stormwater runoff from industrial properties and gradually release treated water back to Carli Creek. Partial funding from PGE's Clackamas Habitat Fund and WES ratepayer fees.

Kellogg Creek Stream Gauge Installation – Water Environment Services (WES)

WES installed satellite communications at its lower Kellogg Creek flow monitoring station near Milwaukie and partnered with NOAA to host the real-time data on its Advanced Hydrologic Prediction Service website. This will not only serve for flood monitoring, but also provide needed stream flow data for watershed planning.

<https://water.weather.gov/ahps2/hydrograph.php?wfo=PQR&gage=kcmo3>

RiverHealth Stewardship Program – Water Environment Services (WES)

The RiverHealth Stewardship Program grants support a variety of watershed activities with the purpose of enhancing water quality, restoring fish habitat, managing invasive species, organizing volunteer events, and removing trash from waterways.

Since 2013, their RiverHealth Stewardship Program grants have funded over \$1 million dollars to support community groups, businesses, and property owners who want to improve the health of watersheds within the surface water areas served by WES. The current 2018-19 funding cycle supports 14 projects with \$270,000 in grants.

Benefiting watersheds include Rock Creek, Kellogg Creek, Mt Scott Creek, Phillips Creek, Johnson Creek, and the Clackamas River. The grants will also support the continued stewardship of previously restored project sites, protecting District investments made in recent years.

Rural Area Flood Mitigation

Channel Migration Zone Hazards – Upper Sandy River

In January of 2011, Clackamas County experience a 25-year flood on the upper Sandy River with destruction to three houses, severe damage to roads and bridges, and multiple properties that lost tens of feet of streamside land – all to bank erosion. Since 2011, the County has worked to address an emerging understanding of the basis for the hazard and risk as primarily channel migration on a steep mountain river system and not traditional over-bank flooding. No hydrologic studies had been conducted in the Upper Sandy basin and there was no scientifically based research to use for managing erosion and property losses. Bank armoring using rip rap (rock armoring), permitted and unpermitted, was the normal approach for property by property protection. This historical treatment demonstrated clear evidence of many examples of unintended consequences of erosion along exposed neighboring and downstream properties, often creating escalated armoring and negative impacts to habitat and stream function.

US Army Corps of Engineers (USACE) Public Involvement Pilot Project

In 2013-14 the County was included in a dozen selected communities across the nation as pilot projects for Public Involvement and conflict resolution around flood risk management. The County convened a workgroup of representatives from upper Sandy River communities to consider options for short-term flood recovery and future mitigation.

50th Anniversary recognition of the 1964 Christmas flood – Upper Sandy River Basin

During the 1964 Christmas floods, Clackamas County was the hardest hit area in Oregon and the upper Sandy River communities were the hardest hit on the County, mostly from channel migration damage. 155 homes were destroyed with miles of washed out roads and the loss of numerous bridges. The County used this historic anniversary to emphasize that 50 years later channel migration hazard is still a threat and must be addressed in future policy decisions in planning for flood recovery and community development (Figure 2-11).

Three flood acquisitions due to CMZ damage

Clackamas County acquired three flood erosion-damaged residential properties following the 2011 upper Sandy River disaster declaration using HMGP funds (DR-1956-OR). Channel migration during the high-water event eroded approximately 40 feet of property at each location and undermined the foundations making the residences uninhabitable. All three properties were acquired and transferred to County ownership as open space.

Other flood mitigation assistance

Two repetitive loss properties along South Creek Road have received mitigation assistance against future flood losses. Following the flood of January 2009 along Abernethy Creek, one used HMGP funds to elevate at least eight feet above grade and three feet above the flood of record. The second property was an HMGP flood acquisition along Abernethy Creek that is returning the property to permanent open space in the floodplain. Clackamas County

completed an additional two flood elevations: one along the upper Sandy River in February 2008 using a Flood Mitigation Assistance Grant, and the other along Abernethy Creek in March 2010 using the Hazard Mitigation Grant Program (HMGP).

As of September 2018, the County is using 2016 FMA funds to mitigate a RL residential dwelling along SE Rusk Rd.



Mitigation Success - Abernethy Creek elevation completed in March 2010 and successfully tested on January 19, 2012.
Source: Clackamas County

HMGP 5% Flood Warning System installation, but continuing technical problems.

Following the 2011 flood event, the County sought a means to monitor the stream flows of the three rivers in the upper Sandy Basin to better help provide status and warnings for communities at risk. Improving on the existing three NWS staff gauges, we used HMGP 5% funds to install five new sonar-based, solar powered sensors with radio communication on County-owned bridges (2 on the Sandy, 2 on the Salmon, and 1 on the Zig Zag Rivers). Unfortunately, due to mountainous terrain, extensive tree cover, and harsh winter weather conditions, these five stations have never performed to their expected design capabilities. We are currently exploring additional options for enhancing or replacing them.

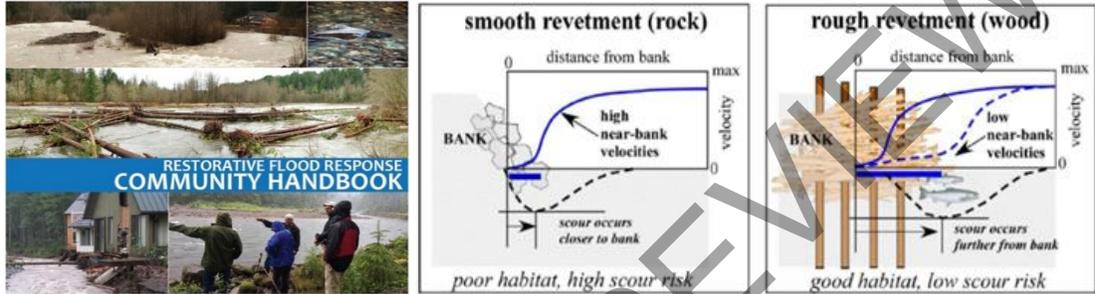
OPDR Channel Migration Zone hazard and risk public opinion survey

During the summer of 2016, the Oregon Partnership for Disaster Resilience (OPDR) used RiskMap outreach funds from the FIRM update of the Sandy River Basin to design and conduct a public option survey to capture valuable data on community attitudes towards flood risk tolerance and avoidance, preferences on flood mitigation, and the role of government on flood risk management. Out of 3,000 surveys sent, we received

approximately 300 responses, with mixed opinions on flood risk management. Generally, the community has more support for maintaining existing levels of exposure but is willing to have government place more restrictions on future development.

Sandy River Basin Watershed Council (SRBWC) – Restorative Flood Response Community Handbook

The SRBWC has become a vital partner in flood mitigation in the upper Sandy River Basin, due to their work on what they call, “Restorative Flood Response.” This approach leverages bank stabilization, with advanced bio engineering practices tailored for the Sandy River, to improve habitat, stream function, and reduces flood risk.



SRBWC Community Handbook – This 2016 handbook is based on the County’s 2015 CMZ study and is co-authored by the SRBWC and NSD. The SRBWC is very effective in engaging the public on reach-based stream restoration projects through their non-regulatory role and hands-on volunteer opportunities.

Floodplain Reconnection Project – Columbia Land Trust and SRBWC



Engineered Log Jam (ELJ) – Construction of 3 ELJs, removal of 300 feet of post-1964 flood levees and reconnection of 2,900 feet of side channel to provide refuge for salmonids, absorb flood velocities, and redistribute storm flows across a broader floodplain. Photo: SRBWC.

RiskMap Resilience Meeting for the Upper Sandy River Basin

As a concluding activity for the FIRM update in the Upper Sandy River basin, the County sponsored FEMA's Resilience Meeting in October 2017 to review mitigation opportunities. This meeting was attended by federal, state and local government officials as well as a panel of five community representatives to highlight CMZ issues and express concerns related to homeowners, community planning, or realtors. The County reviewed policy issues that emerged following the 2011 flood and emphasized the strategies of the two following actions underway in 2018:

- **US Army Corps Silver Jackets Project – Upper Sandy River Flood Risk Management Plan**
The County worked with the Corps' Silver Jackets group to receive a two-year (FFY 2018-19) project for flood risk management planning and community engagement. His effort building on the 2013-14 Public Involvement Pilot and the recommendations from the 2015 Natural Systems Design erosion study.
- **Oregon Solutions assistance with State policy for CMZ regulation**
The County has been working with Oregon Solutions since 2015 on a project assessment around CMZ polices and is currently supporting Oregon Solutions and the Governor's Resilience Policy Advisor on a statewide examination of the need for CMZ polices and regulations for both property and habitat.

Clackamas County CRS Program Review

In 2009-10 the County requested the University of Oregon's Partnership for Disaster Resilience to lead a project to assess the feasibility and benefits of a more efficient, streamlined and integrated approach to flood mitigation and flood plain management in the county. A 2011 report found that programmatic improvements are expected to reduce the risk of damage to property and life resulting from flood; establish better coordination of mitigation actions and activities across public, private and not-for-profit entities; enhance and restore natural and constructed flood control functionality; and maximize the use of limited resources.³⁵

More information on this hazard can be found in the [Risk Assessment for Region 2, Northern Willamette Valley/Portland Metro, of the Oregon NHMP \(2015\)](#).

³⁵ OPDR, 2011, *Clackamas County Community Rating System Program Review*.

Landslide

Significant Changes since Previous NHMP:

New landslide susceptibility information based on updated Lidar data provided by DOGAMI (O-16-02) has also been included. Analysis from the Lower Columbia-Sandy Watershed Natural Hazard Risk Report is also included.

Characteristics

A landslide is any detached mass of soil, rock, or debris that falls, slides or flows down a slope or a stream channel. Landslides are classified according to the type and rate of movement and the type of materials that are transported. In a landslide, two forces are at work: 1) the driving forces that cause the material to move down slope, and 2) the friction forces and strength of materials that act to retard the movement and stabilize the slope. When the driving forces exceed the resisting forces, a landslide occurs.

Clackamas County is subject to landslides or debris flows (mudslides), especially in the Cascade Range in the eastern portion of the county, which may affect buildings, roads and utilities.

Additionally, landslides often occur together with other natural hazards, thereby exacerbating conditions, as described below:

- Shaking due to earthquakes can trigger events ranging from rockfalls and topples to massive slides.
- Intense or prolonged precipitation that causes flooding can also saturate slopes and cause failures leading to landslides.
- Landslides into a reservoir can indirectly compromise dam safety and a landslide can even affect the dam itself.
- Wildfires can remove vegetation from hillsides, significantly increasing runoff and landslide potential.

Location and Extent

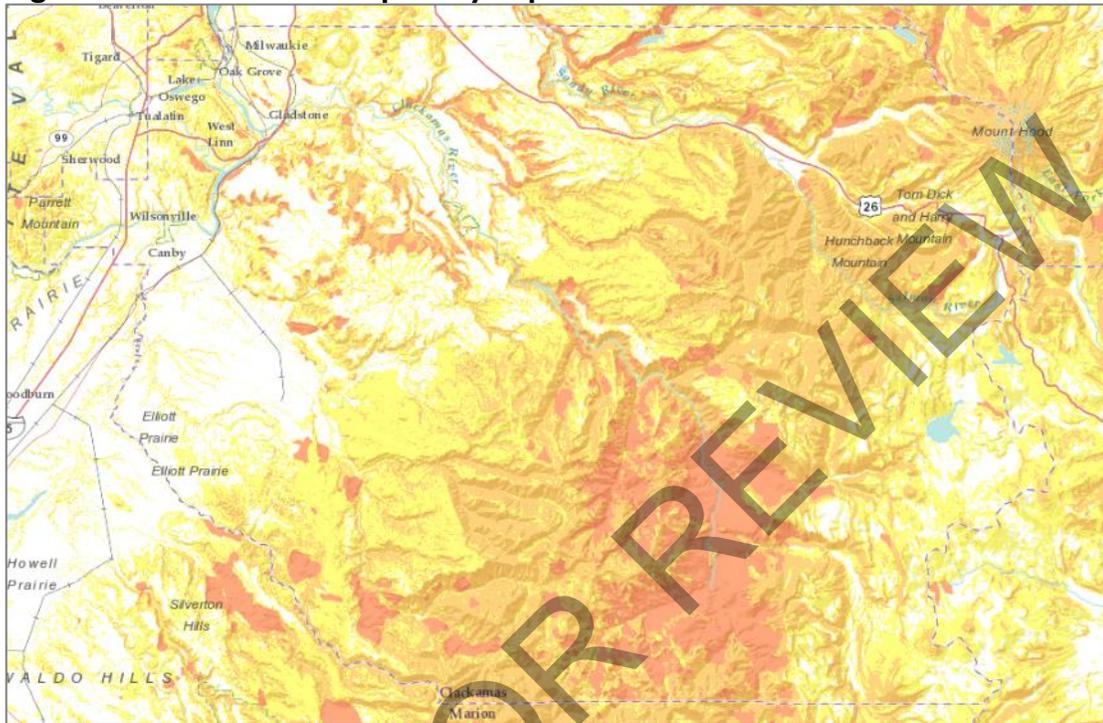
In many parts of Clackamas County, weathering and the decomposition of geologic materials produces conditions conducive to landslides. Human activity has further exacerbated the landslide problem in many parts of the county. A study conducted by Dr. Scott Burns at Portland State University found that changes to the slope through cutting or filling increased the risk of landslides in 76% of the 701 inventoried landslides in the Metro region. The study documented 48 landslides that occurred in Oregon City in February 1996 and found that only about half the slides were considered natural.³⁶

For Clackamas County, many high landslide potential areas are in hilly-forested areas (Figure 2-14). Landslides in these areas may damage or destroy some timber and impact logging roads. Many of the major highways in Clackamas County are at risk for landslides at one or

³⁶ Burns, Burns, James, and Hinchke. Landslides in Portland, Oregon Metropolitan Area (resulting from Storm of 1996: Inventory, Map Data, and Evaluation.)

more locations with a high potential for road closures and damage to utility lines. Especially in the central-eastern portions of the County, with a limited redundancy of road network, such road closures may isolate communities. Additional maps can be found in Volume III, Appendix D: slope stability (Map 5), historic landslides (Map 6), and debris flows (Map 7).

Figure 2-14 Landslide Susceptibility Exposure



Low	Landsliding unlikely. Areas classified as Landslide Density = Low (less than 7%) and areas classified as Slopes Prone to Landsliding = Low.
Moderate	Landsliding possible. Areas classified as Landslide Density = Low to Moderate (less than 17%) and areas classified as Slopes Prone to Landsliding = Moderate OR areas classified as Landslide Density = Moderate (7%-17%) and areas classified as Slopes Prone to Landsliding = Low.
High	Landsliding likely. Areas classified as Landslide Density = High (greater than 17%) and areas classified as Slopes Prone to Landsliding = Low and Moderate OR areas classified as Landslide Density = Low and Moderate (less than 17%) and areas classified as Slopes Prone to Landsliding = High.
Very High	Existing landslides Landslide Density and Slopes Prone to Landsliding data were not considered in this category. Note: the quality of landslide inventory (existing landslides) mapping varies across the state.

Source: [Oregon HazVu: Statewide Geohazards Viewer](#) – To view map in more detail click hyperlink to left.

More detailed landslide hazard assessment at specific locations requires a site-specific analysis of the slope, soil/rock and groundwater characteristics at a specific site. Such assessments are often conducted prior to major development projects in areas with moderate to high landslide potential, to evaluate the specific hazard at the development site.

Table 2-17 shows landslide susceptibility exposure for Clackamas County and the incorporated cities. Approximately 45% of the county has high or very high landslide susceptibility exposure. These are concentrated in areas of high slopes, and close to river valleys (Figure 2-14). In general cities within the County have a lower landslide susceptibility

exposure than does the unincorporated area of the County (see Volume II for more information on each city's exposure). Note that even if a County or city has a high percentage of area in a high or very high landslide exposure susceptibility zone, this does not mean there is a high risk, because risk is the intersection of hazard and assets.

The severity or extent of landslides is typically a function of geology and the landslide triggering mechanism. Rainfall initiated landslides tend to be smaller and earthquake induced landslides may be very large. Even small slides can cause property damage, result in injuries or take lives.

Table 2-17 Landslide Susceptibility Exposure

Jurisdiction	Area, ft ²	Low	Moderate	High	Very High
Clackamas County	52,482,820,515	23.5%	31.1%	34.5%	10.9%
Canby	121,922,939	89.2%	9.0%	1.8%	0.0%
Estacada	62,896,341	59.8%	14.6%	22.9%	2.6%
Gladstone	69,974,152	70.8%	22.2%	4.6%	2.4%
Happy Valley	255,471,143	36.0%	48.6%	15.3%	0.2%
Johnson City	1,896,509	73.9%	23.2%	2.9%	0.0%
Lake Oswego	317,377,635	42.0%	43.6%	12.9%	1.5%
Milwaukie	137,561,959	64.5%	31.2%	4.3%	0.0%
Molalla	65,771,550	95.7%	4.2%	0.1%	0.0%
Oregon City	278,148,504	1.9%	16.1%	8.2%	3.7%
Sandy	93,736,907	52.2%	29.5%	15.0%	3.2%
West Linn	223,398,149	35.3%	44.0%	15.7%	5.0%
Wilsonville	207,231,898	74.0%	20.5%	5.5%	0.1%

Source: DOGAMI [Open-File Report, O-16-02](#), Landslide Susceptibility Overview Map of Oregon (2016)

For more information, refer to the following report and maps provided by DOGAMI:

- Multi-Hazard Risk Report for the Lower Columbia-Sandy Watershed, Oregon: Including the cities of Gresham, Sandy, and Troutdale and Unincorporated Communities of Government Camp and The Villages at Mt Hood (2018, [IMS-59](#)).
- Statewide Landslide Susceptibility (2016, [O-16-02](#)).
- Landslide inventory and susceptibility for northwest Clackamas County (2013, [O-13-08](#)).
- Surficial geology for greater Portland area (2012, [O-12-02](#)).
- Multi-Hazard and Risk Study for the Mount Hood Region (2011, [O-11-16](#)). *Portions of the landslide section superseded by the Multi-Hazard Risk Report for the Lower Columbia-Sandy Watershed.*
- Landslide Inventory Maps for the Canby (2009, [IMS-32](#)), Damascus (2012, [IMS-49](#)), Estacada (2012, [IMS-52](#)), Gladstone (2012, [IMS-48](#)), Lake Oswego (2010, [IMS-32](#)), Oregon City (2010, [IMS-30](#)), Redland (2012, [IMS-51](#)), Sandy (2012, [IMS-38](#)), Sherwood (2012, [IMS-50](#)) quadrangles.
- Slope failures in Oregon: GIS inventory for three 1996/97 storm events (2000, [Special Paper 34](#)).

Additional reports are available via DOGAMI's Publications Search website:

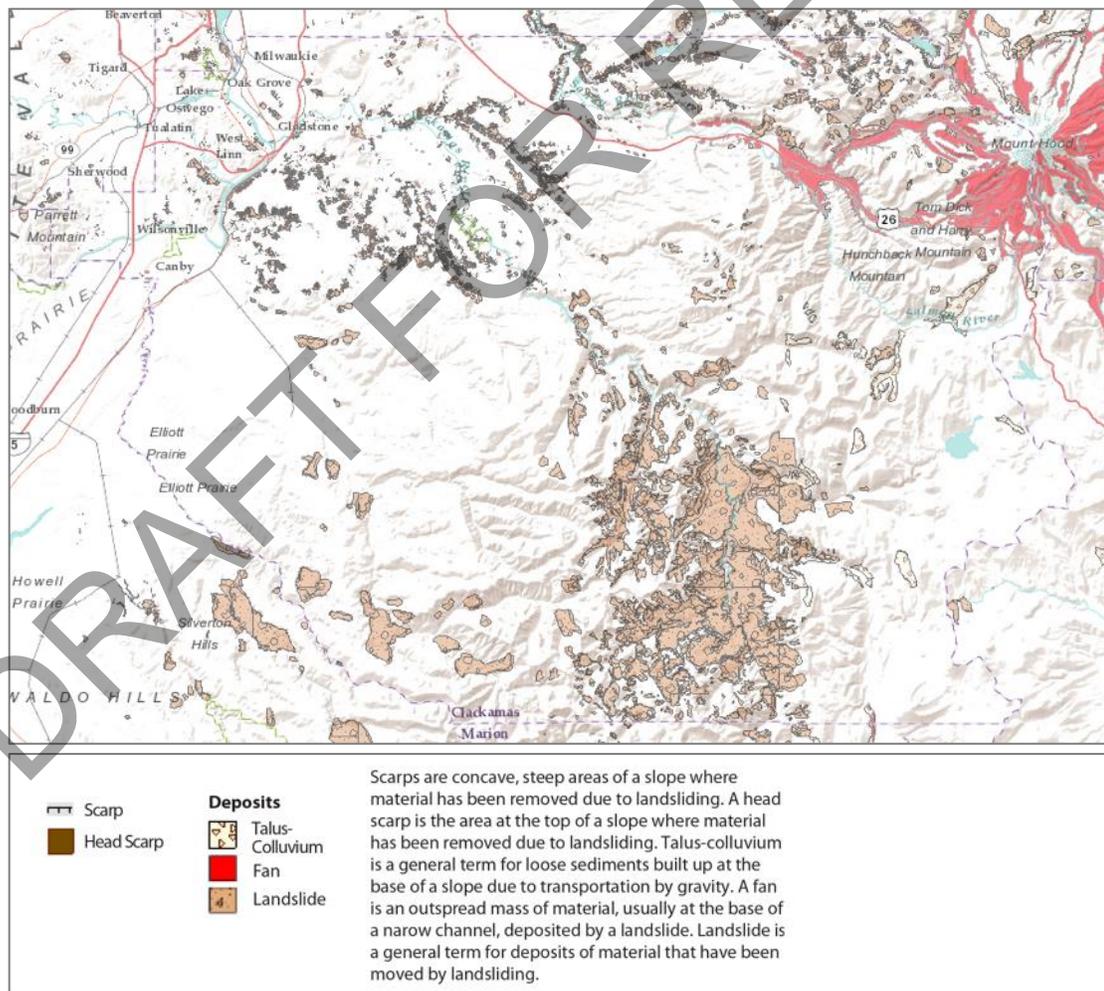
<http://www.oregongeology.org/pubs/search.php>

History

Landslides may happen at any time of the year. In addition to landslides triggered by a combination of slope stability and water content, earthquakes may also trigger landslides. Areas prone to seismically triggered landslides are generally the same as those prone to ordinary (i.e., non-seismic) landslides. As with ordinary landslides, seismically triggered landslides are more likely for earthquakes that occur when soils are saturated with water.

Debris flows and landslides are a very common occurrence in hilly areas of Oregon, including portions of Clackamas County. Many landslides occur in undeveloped areas and thus may go unnoticed or unreported. For example, DOGAMI conducted a statewide survey of landslides from four winter storms in 1996 and 1997 and found 9,582 documented landslides, with the actual number of landslides estimated to be many times the documented number. For the most part, landslides become a problem only when they impact developed areas and have the potential to damage buildings, roads or utilities. Figure 2-15 shows the landslide inventory for Clackamas County, for additional information see the historic landslides map in Volume III, Appendix D (Map 6) and the [Statewide Landslide Information Database for Oregon](#).

Figure 2-15 Landslide Inventory



Source: [Oregon HazVu: Statewide Geohazards Viewer](#) – To view map in more detail click hyperlink to left.

Landslides in Clackamas County are not a localized problem. For example, sediment generated by the slides can affect regional water quality. During the winter of 1972, a relatively small landslide on the north fork of the Bull Run River in the western Cascades introduced a large volume of silt and clay into Portland's main water supply reservoir. Consequently, the city's water supply was discolored for several weeks.³⁷

Many landslides are difficult to mitigate, particularly in areas of large historic movement with weak underlying geologic materials. As communities continue to modify the terrain and influence natural processes, it is important to be aware of the physical properties of the underlying bedrock as it, along with climate, dictates hazardous terrain. Without proper planning, landslides will continue to threaten the safety of people, property, and infrastructure.

Development coupled with natural processes such as heavy rainfall or rapid snowmelt can cause landslides or re-activate historical landslide sites. The County has received three Presidential Disaster Declarations since 2002, three of which included major landslide damage to county roads and infrastructure. Although not included within the disaster declaration the County also experienced landslides associated with storm events in 2012, 2014, 2015, and 2016-2017.

Probability Assessment

Based on the available data and research the Hazard Mitigation Advisory Committee determined the **probability of experiencing a landslide or debris flow is "high"**, meaning at least one incident is likely within the next 10 to 35-year period. *This rating has not changed since the previous NHMP.*

Landslides are a common hazard in and around Oregon. In fact, a prominent theme of the 1996 flood disaster was that a significant amount of building damage affected structures outside of identified flood hazard areas. Many of the 5,000 Clackamas County applicants eligible for FEMA housing assistance grants were not floodplain cases but were landslide and erosion losses.³⁸

The probability of rapidly moving landslide occurring depends on a number of factors, including steepness of slope, slope materials, local geology, vegetative cover, human activity and water. There is a strong correlation between intensive winter rainstorms and the occurrence of rapidly moving landslides (debris flows). Consequently, the National Weather Service tracks storms during the rainy season, monitors rain gauges and snow melt and issues warnings as conditions warrant. Given the correlation between precipitation, snowmelt and rapidly moving landslides, it would be feasible to construct a probability curve. The installation of slope indicators or the use of more advanced measuring techniques could provide information on slower moving slides.

³⁷ Schlicker, Ht., and Finlayson Ct. (1979) Geologic and Geohazards of NW Clackamas County. Bulletin 99. DOGAMI, OR.)

³⁸ Interagency Hazard Mitigation Team, State Hazard Mitigation Plan (2000) Oregon Emergency Management.

Geo-engineers with the Oregon Department of Geology and Mineral Industries (DOGAMI) estimate widespread landslides about every 20 years; landslides at a local level can be expected every two or three years.³⁹

Vulnerability Assessment

The Hazard Mitigation Advisory Committee rated the County as having a **“low” vulnerability to landslide hazards**, meaning that less than 1% of the unincorporated County’s population or assets would be affected by a major disaster. *This rating has not changed since the previous NHMP.*

To a large degree, landslides are very difficult to predict. Vulnerability assessments assist in predicting how different types of property and population groups will be affected by a hazard.⁴⁰ The optimum method for doing this analysis at the city or county level is to use parcel-specific assessment data on land use and structures.⁴¹ Data that includes specific landslide-prone and debris flow locations in the county can be used to assess the population and total value of property at risk from future landslide occurrences.

Landslides can impact major transportation arteries, blocking residents from essential services and businesses. Many aspects of the county are vulnerable to landslides. This includes land use and development patterns, the economy, population segments, ecosystem services and cultural assets.

A quantitative landslide hazard assessment requires overlay of landslide hazards (frequency and severity of landslides) with the inventory exposed to the hazard (value and vulnerability) by considering:

- Extent of landslide susceptible areas;
- Inventory of buildings and infrastructure in landslide susceptible areas;
- Severity of earthquakes or winter storm event (inches of rainfall in 24 hours);
- Percentage of landslide susceptible areas that will move and the range of movements (displacements) likely; and
- Vulnerability (amount of damage for various ranges of movement).

The amount of property in the high landslide area, as well as the type and value of structures on those properties, is calculated to provide a working estimate for potential landslide losses. Table 2-18 shows potentially impacted parcels, critical and critical facilities, vulnerable populations, and infrastructure within Clackamas County’s high landslide susceptibility areas.

Table 2-18 Landslide Hazard Vulnerability Assessment

Hazard	Potentially Impacted Parcels		Potentially Impacted Locations			Infrastructure				
	Number of Parcels	Percent of Total Parcels	Critical Facilities	Essential Facilities	Vulnerable Populations	Miles of Road	Miles of Sewer Lines	Bridges	Cell Towers	Dams
County Total	158,226	Not Applicable	235	55	576	4911	340	597	17	69
Landslide Hazard										
High	13,603	9%	7	0	6	532	27	54	0	7

Source: Clackamas County Geographic Information Systems (2018)

³⁹Mills, K. 2002. Oregon’s Debris Flow Warning System. Cordilleran Section–98th Annual Meeting. Corvallis.

⁴⁰ Burby, R., ed. 1998. Cooperating with Nature. Washington D.C.: Joseph Henry Press.

⁴¹ Burby, R., ed. 1998. Cooperating with Nature. Washington D.C.: Joseph Henry Press.

Note: Percentage of property in the high landslide susceptibility area may include property in tax lots that intersect the area, including property that does not physically reside in the area itself.

Roads and Bridges

Large losses incurred from landslide hazards in Clackamas County have been associated with roads. The Clackamas County Roads Division is responsible for responding to slides that inhibit the flow of traffic or are damaging a road or a bridge. The roads department does its best to communicate with residents impacted by landslides, but can usually only repair the road itself, as well as the areas adjacent to the slide where the county has the right of way.

It is not cost effective to mitigate all slides because of limited funds and the fact that some historical slides are likely to become active again even with mitigation measures. The County Roads Division alleviates problem areas by grading slides, and by installing new drainage systems on the slopes to divert water from the landslides. This type of response activity is often the most cost-effective in the short-term but is only temporary. Unfortunately, many property owners are unaware of slides and the dangers associated with them.

Lower Columbia-Sandy Watershed Natural Hazard Risk Report

The **Risk Report** ([DOGAMI, IMS-59](#)) provides hazard analysis summary tables that identify populations and property within the Lower Columbia-Sandy River Watershed Study Area that are vulnerable to the profiled natural hazards. The Risk Report provides distinct profiles for (1) unincorporated Clackamas County within the study area, (2) the unincorporated community of Government Camp, and (3) the unincorporated community of The Villages at Mt. Hood (including Brightwood, Rhododendron, Welches, Wimpe, and Zig Zag).

According to the Risk Report the following populations and property are vulnerable:

Unincorporated Clackamas County within the Study Area⁴²

Landslide event (High and Very High Susceptibility): 311 buildings are exposed (0 critical facilities) for a total potential loss of \$91,139,000 (an exposure ratio of 10%). In addition, 380 residents may be displaced (about 8% of the population).

Government Camp⁴³

Landslide event (High and Very High Susceptibility): 27 buildings are exposed (0 critical facilities) for a total potential loss of \$2,295,000 (an exposure ratio of 16%). In addition, 8 residents may be displaced (about 3% of the population).

The Villages at Mt. Hood⁴⁴

Landslide event (High and Very High Susceptibility): 420 buildings are exposed (0 critical facilities) for a total potential loss of \$88,719,000 (an exposure ratio of 11%). In addition, 524 residents may be displaced (about 10% of the population).

More information on this hazard can be found in the [Risk Assessment for Region 2, Northern Willamette Valley/Portland Metro, of the Oregon NHMP \(2015\)](#).

⁴² DOGAMI, *Lower Columbia-Sandy Watershed Natural Hazard Risk Report* (March 2018 Draft), Table 10.1.

⁴³ Ibid., Table 10.5.

⁴⁴ Ibid., Table 10.7.

Severe Weather

Clackamas County experiences a range of weather-related hazards on an annual basis, such as severe heat, winter storms and wind storms. This section combines the above hazard sections from the previous two Mitigation Plans into a single Severe Weather section.

Severe weather events occur throughout Oregon at all times of the year. Often originating in the Pacific Ocean, westerly winds pummel the coast, slowing as they cross the Coastal mountain range and head into the inland valleys.⁴⁵ Similarly, severe winter storms consisting of rain, freezing rain, ice, snow, cold temperatures, and wind originate from troughs of low pressure offshore in the Gulf of Alaska or in the central Pacific Ocean that ride along the jet stream during fall, winter, and early spring months.⁴⁶ In summer, the most common wind directions are from the west or northwest; in winter, they are from the south and east. Local topography, however, plays a major role in affecting wind direction. For example, the north-south orientation of the Willamette Valley channels the wind most of the time, causing predominately north and south winds.

Climate Change Factors

Oregon and the Pacific Northwest experience a variety of extreme weather incidents ranging from severe winter storms and floods to drought and dust storms, often resulting in morbidity and mortality among people living in the impacted regions. According to the Oregon Climate Change Research Institute, climate change is expected to increase the frequency and intensity of some weather incidents.⁴⁷

Climate change poses risks for increased injuries, illnesses and deaths from both direct and indirect effects. Incidents of extreme weather (such as floods, droughts, severe storms, heat waves and fires) can directly affect human health as well as cause serious environmental and economic impacts. Indirect impacts can occur when climate change alters or disrupts natural systems.

Future Climate Variability⁴⁸

Climate models for Oregon suggest, future regional climate changes include increases in temperature around 0.2-1°F per decade in the 21st Century, along with warmer and drier summers, and some evidence that extreme precipitation will increase in the future. Increased droughts may occur in the Willamette Valley under various climate change scenarios because of various factors, including reduced snowpack, rising temperatures, and likely reductions in summer precipitation. Climate models suggest that as the region warms, winter snow precipitation will likely shift to higher elevations and snowpack will be diminished as more precipitation falls as rain altering surface flows.

⁴⁵ US Department of Agriculture. <http://www.fsa.usda.gov/or/Notice/Flp104.pdf>

⁴⁶ Interagency Hazard Mitigation Team. 2000. State Hazard Mitigation Plan. Salem, OR: Oregon State Police – Office of Emergency Management

⁴⁷ Oregon Climate Change Research Institute <http://occri.net/wp-content/uploads/2011/04/chapter9ocar.pdf> Page 412

⁴⁸ Oregon Climate Change Research Institute (OCCRI), Oregon Climate Assessment Report (2010) and Northwest Climate Assessment Report (2013). <http://occri.net/reports>

Extreme Heat

Significant Changes since Previous NHMP:

There have been no significant changes to this section since the previous NHMP.

Characteristics

Between 1979 and 2003, heat waves killed at least 8,015 Americans, according to the Centers for Disease Control and Prevention. That's more than hurricanes, lightning, tornadoes, floods and earthquakes combined. And it's largely an urban problem—the bulk of those deaths occur in cities.⁴⁹

Location and Extent

Cities are more vulnerable to heat waves because that's where more people are concentrated but also because there is less vegetation to permit evaporation, cars and factories give off heat, and the proximity of asphalt roads and buildings store and radiate heat. On a hot summer day, urban areas can be 5°F to 18°F hotter than surrounding rural areas which is enough to turn a heat wave into a serious health crisis.⁵⁰

Mitigation Actions to reduce the urban heat island effect include:

1. Planting appropriate trees to provide shade and passive cooling of buildings and to provide local cooling through evaporation.
2. Improving the reflective surfaces of urban roof tops to bounce light (heat) rather than absorbing it. Ideally, solar panel arrays could absorb sunlight and shade the roof tops from storing heat, while also providing a source of energy for the internal powering of fans, or air conditioning and diminish the draw on local and regional power demands at peak use periods.

History

A severe heat episode or "heat wave" occurs about every two to three years and typically lasting two to three days but can last as many as five days. A severe heat episode can be defined as consecutive days of upper 90s to around 100. Severe heat hazard in the Portland metro region can be described as the average number of days we have temperatures greater than or equal to 90F and 100F. On average the region experiences 13.6 days with temperatures above 90-degrees Fahrenheit and 1.4 days above 100-degrees Fahrenheit, based on new 30-year climate averages (1981-2010) from the National Weather Service – Portland Weather Forecast Office.

The region's last severe heat episode was an event in 2016 when cooling centers were opened in the County. Before that a five-day event in July 2009 delivered three consecutive days in excess of 100F and two days over 90F; high temperatures on July 28-29 of 2009 were recorded at 106F each day. Another event occurred in July 2006.

⁴⁹ U.S. Centers for Disease Control and Prevention
http://www.bt.cdc.gov/disasters/extremeheat/heat_guide.asp

⁵⁰ Study: Many U.S. Cities Unprepared for Future Heat Waves (*Washington Post: Ezra Klein's Wonk Blog*)

Probability Assessment

Based on the available data and research the Hazard Mitigation Advisory Committee determined the **probability of experiencing a long lasting extreme heat event is “low”**, meaning one incident is likely within the next 75 to 100-year period. *This rating has not changed since the previous NHMP.*

Extreme heat events occur every few years within the region, however, they are generally not long lasting. Climate models for Oregon suggest, future regional climate changes include increases in temperature around 0.2-1°F per decade in the 21st Century, along with warmer and drier summers.

Vulnerability Assessment

The Hazard Mitigation Advisory Committee rated the county as having a **“high” vulnerability to extreme heat**, meaning that more than 10% of the unincorporated County’s population or assets would be affected by an extreme heat event. *This rating has increased since the previous NHMP.*

Very high temperatures can create serious health problems. Pets are also affected by the higher temperatures. “Prevention is the best defense,” said Mel Kohn, M.D., M.P.H., director of Oregon Public Health. “Drinking plenty of water, staying out of the sun during the hottest part of the day, knowing the warning signs of heat-related illness and taking precautions when swimming are a few important steps people can take.” Kohn added: “We have had hot weather in the past, but with the climate change we are likely to have more high temperature days in Oregon.”⁵¹

A significant percentage of the population does not have air conditioning, so once temperatures get into the 90s, it is quite uncomfortable. If a hot weather pattern persists for a few days, the situation gets worse because of the number of days in sequence. Reports show that heat-health related problems really increase once you get multiple days in a row of very hot weather. Oregon Public Health officials remind people to take precautions to avoid getting sick from extreme heat and be careful when swimming in Oregon’s lakes, streams and the ocean.

The first symptoms of health problems from the heat can include headache, dizziness and weakness. In extreme cases heat-related illness can cause convulsions and sudden loss of consciousness and can be fatal. Those at greatest risk for heat-related illness include infants and children up to 4 years of age, people 65 and older, people who are overweight, and people who are ill or on certain medications, as well as those who work outdoors.

Climate Change Factor

Predicted average increases in summer temperatures will make heat waves a greater likelihood. Without mitigation, increased numbers of extreme heat events will likely result in additional heat-related morbidity and mortality, especially among vulnerable populations, such as the elderly, low income populations, pregnant women and those who work in outdoor occupations.⁵²

⁵¹ Oregon Health Authority <http://cms.oregon.gov/DHS/news/2010news/2010-0813.pdf>

⁵² Oregon Climate Change Research Institute <http://occri.net/wp-content/uploads/2011/04/chapter9ocar.pdf>
Page 408.

Windstorm

Significant Changes since Previous NHMP:

The windstorm hazard section has been edited to reference new history since the previous NHMP.

Characteristics

A windstorm is generally a short duration event involving straight-line winds and/or gusts in excess of 50 mph. Although windstorms can affect the entirety of Clackamas County, they are especially dangerous near developed areas with large trees or tree stands. The extent of any particular windstorm is determined by its track, intensity and local terrain.⁵³ In the southwest Oregon, wind speed is typically 60 mph for 25-year storm events, 70 mph for 50-year storm events and 80 mph for 100-year storm events. Clackamas County has experienced multiple 25-, 50- and 100-year windstorm events over the past century with impacts often occurring countywide. A windstorm will frequently knock down trees and power lines, damage homes, businesses, public facilities and create tons of storm related debris. Windstorms are a common, chronic hazard in Clackamas County.

Location and Extent

The most common type of wind pattern affecting Clackamas County is straight-line winds, which originate as a downdraft of rain-cooled air and reach the ground and spread out rapidly. Straight-line winds can produce gusts of 100 mph or greater. Records of major Pacific windstorms are documented by state agencies and weather stations throughout Oregon, including several official weather stations in Clackamas County's lower valleys.

Typically, mountainous terrain slows down wind movement, which is why Oregon's sheltered valley areas have the slowest wind speed in the state. However, in the foothills, the wind speeds may increase due to down-sloping winds from the mountains. Although windstorms can affect the entirety of the county, they are especially dangerous in developed areas with significant tree stands and major infrastructure, especially above ground utility lines. A windstorm will frequently knock down trees and power lines, damage homes, businesses, public facilities and create tons of storm related debris.

History

The most destructive windstorm ever recorded in Oregon, in terms of loss of life and property damage, was the Columbus Day storm of 1962. Damage was most severe in the Willamette Valley. The storm killed thirty-eight people and did upwards of \$200 million in damage (over \$1.7 billion in today's dollars). Hundreds of thousands of homes were without power for short periods of time, while others were without power for two to three weeks. More than 50,000 homes were seriously damaged, and nearly 100 were completely destroyed. The storm destroyed fruit and nut orchards and killed scores of livestock. Intense wind speeds were recorded in the metropolitan areas with gusts of 116 mph on Portland's Morrison Bridge.

⁵³ State of Oregon Natural Hazard Mitigation Plan (2015)

More recently, Clackamas County experienced several high wind events during the past five years since the October 2007 Hazard Mitigation Plan Update. A regional storm in early December 2007 that required a federal disaster declaration along the Oregon Coast brought high winds and heavy rain to the County.

On March 13, 2011, 50 mph winds with 70 mph gusts brought trees down in numerous areas of the County and left power out for tens of thousands of residents. Damages were concentrated in the eastern half of the County along in communities like Molalla and Estacada in the Cascade foothills.

Since 2007 the National Weather Service reports three tornadoes that have touched down in or near Clackamas County: On January 10, 2008 an EF1 tornado touched down in Vancouver, Washington causing considerable damage; October 26, 2009 an EF0 tornado touched down near Oregon City causing damage to many houses; and on December 14, 2010 a damaging EF2 tornado struck in the City of Aumsville in Marion County not far from the southern border of Clackamas County. On October 12, 2017 another EF0 tornado touched down near Canby at the Aurora State Airport impacting airplanes and buildings.



Windstorm damage – March 13, 2011

Source: Clackamas County Emergency Management

Windstorms were also part of winter storms that occurred each year between 2014 and 2017.

Several additional, small windstorm events have occurred since the previous NHMP, see the [Storm Events Database](#) provided by the National Oceanic and Atmospheric Administration for more information. According to historical records, there have been an estimated six major windstorm events in the past 100 years, which is about one every 16-17 years.

Probability Assessment

Based on the available data and research the Hazard Mitigation Advisory Committee determined the **probability of experiencing a windstorm is “moderate”**, meaning one severe incident is likely within the next 35 to 75-year period. *This rating has not changed since the previous NHMP.*

Windstorms in the county usually occur in the winter from October to March and their extent is determined by their track, intensity (the air pressure gradient they generate) and local terrain. Summer thunderstorms may also bring high winds along with heavy rain and/or hail. The National Weather Service uses weather forecast models to predict oncoming windstorms, while monitoring storms with weather stations in protected valley locations throughout Oregon.

Table 2-19 shows the wind speed probability intervals that structures 33 feet above the ground would expect to be exposed to within a 25, 50 and 100-year period. The table shows that structures in Region 2, which includes Clackamas County, can expect to be exposed to 65 mph winds in a 25-year recurrence interval (4% annual probability).

Table 2-19 Probability of Severe Wind Events (Region 2)

	25-Year Event (4% annual probability)	50-Year Event (2% annual probability)	100-Year Event (1% annual probability)
Region 2:			
North Willamette Valley	65 mph	72 mph	80 mph

Source: Oregon State Natural Hazard Mitigation Plan, 2012

Vulnerability Assessment

The Hazard Mitigation Advisory Committee rated the county as having a **“low” vulnerability to windstorm hazards**, meaning that less than 1% of the unincorporated County’s population or assets would be affected by a major disaster. *This rating has not changed since the previous NHMP.*

Many buildings, utilities and transportation systems within Clackamas County are vulnerable to wind damage. This is especially true in open areas, such as natural grasslands or farmlands. It is also true in forested areas, along tree-lined roads and electrical transmission lines and on residential parcels where trees have been planted or left for aesthetic purposes. Structures most vulnerable to high winds include insufficiently anchored manufactured homes and older buildings in need of roof repair.

Fallen trees are especially troublesome. They can block roads and rails for long periods of time, impacting emergency operations. In addition, up-rooted or shattered trees can down power and/or utility lines and effectively bring local economic activity and other critical facilities to a standstill. Much of the problem may be attributed to a shallow or weakened root system in saturated ground. In Clackamas County, trees are more likely to blow over during the winter (wet season).

More information on this hazard can be found in the [Risk Assessment for Region 2, Northern Willamette Valley/Portland Metro, of the Oregon NHMP \(2015\)](#).

Winter Storm

Significant Changes since Previous NHMP:

The winter storm hazard section has been edited to reference new history since the previous NHMP.

Characteristics

Winter storms affecting Clackamas County are generally characterized by a combination of heavy rains and high winds throughout the county, sometimes with snowfall, especially at higher elevations in the eastern portion of the County. Heavy rains can result in localized or widespread flooding, as well as debris slides and landslides. High winds commonly result in tree falls which primarily affect the electric power system, but which may also affect roads, buildings and vehicles. This chapter deals primarily with the snow and ice effects of winter storms.

The winter storms that affect Clackamas County typically are not local events affecting only small geographic areas. Rather, winter storms are usually large cyclonic low-pressure systems that move in from the Pacific Ocean and affect large areas of Oregon and/or the whole Pacific Northwest. These storms are most common from October through March.

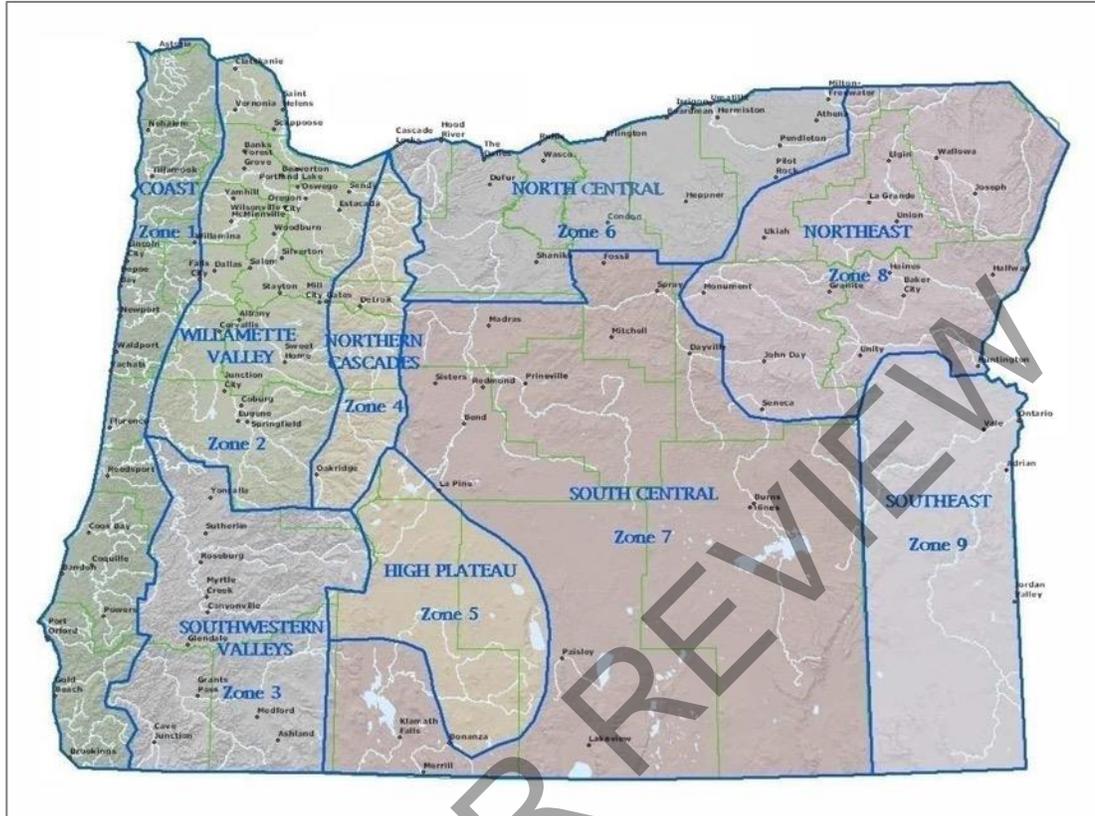
Ice storms are comprised of cold temperatures and moisture, but subtle changes can result in varying types of ice formation which may include freezing rain, sleet and hail. Of these, freezing rain can be the most damaging of ice formations.

Outside of mountainous areas, significant snow accumulations are much less likely in western Oregon than on the east side of the Cascades. However, if a cold air mass moves northwest through the Columbia Gorge and collides with a wet Pacific storm, then a larger than average snow fall may result.

Location and Extent

The National Climatic Data Center has established climate zones in the United States for areas that have similar temperature and precipitation characteristics. Oregon's latitude, topography and proximity to the Pacific Ocean give the state diversified climates. Figure 2-16 shows that Clackamas County is located within Zone 2: Willamette Valley and Zone 4: Northern Cascades.

Figure 2-16 Oregon Climate Divisions



Source: Oregon Climate Service,

The principal types of winter storms that occur include:

- **Snowstorms:** require three ingredients: cold air, moisture and air disturbance. The result is snow, small ice particles that fall from the sky. In Oregon, the further inland and north one moves, the more snowfall can be expected. Blizzards are included in this category.
- **Ice storms:** are a type of winter storm that forms when a layer of warm air is sandwiched by two layers of cold air. Frozen precipitation melts when it hits the warm layer and refreezes when hitting the cold layer below the inversion. Ice storms can include sleet (when the rain refreezes before hitting the ground) or freezing rain (when the rain freezes once hitting the ground).
- **Extreme Cold:** Dangerously low temperatures accompany many winter storms. This is particularly dangerous because snow and ice storms can cause power outages, leaving many people without adequate heating.

Unlike most other hazards, it is not simple to systematically map winter storm hazard zones. The entire County is susceptible to damaging severe weather. Winter storms that bring snow and ice can impact infrastructure, business and individuals. Those resources that exist at higher elevations will experience more risk of snow and ice, but the entire County can face damage from winter storms and, for example, the hail or life threateningly cold temperatures that winter storms bring.

History

Winter storms occur yearly; more destructive storms occur once or twice per decade, most recently in 2011.⁵⁴ More recent winter storm events occurred in 2012, 2014, 2015, 2016, and 2017, however, these winter storm events did not lead to a disaster declaration within the County.

The County received a FEMA Disaster Declaration for an extended severe winter weather event from December 22 through December 28, 2008, when Clackamas County (and Oregon in general) experienced heavy snow accumulations, ice, and sustained freezing temperatures that caused extensive property damage. Transportation networks were significantly affected, as major freeways, railways, and the Portland International Airport were periodically closed.

Downed trees disrupted power to several portions of the county, leaving many residents without heat or water for several days. Residential care facilities, home-bound ill personnel requiring daily treatment, hospital patients, and anyone requiring emergency assistance was affected by this winter storm because obstructed roadways prevented emergency vehicle movement. The damage to fire stations, equipment, roads, and other infrastructure affected the ability to effectively respond, as well as reducing the operating budgets of these facilities.



Car covered in ice, 2004

Source: Clackamas County
Emergency Management

Probability Assessment

Based on the available data and research the Hazard Mitigation Advisory Committee determined the **probability of experiencing a winter storm is “moderate”**, meaning one incident is likely within the next 35 to 75-year period. *This rating has decreased since the previous NHMP.*

The recurrence interval for a moderate to severe winter storm is about once every year; however, there can be many localized storms between these periods. Severe winter storms occur in western Oregon regularly from November through February. Clackamas County experiences moderate winter storms every year to every other year, more damaging winter storms happen less often. According to historical records, there have been an estimated 16 severe winter storm events in the past 100 years, which is about one every six years.

Vulnerability Assessment

The Hazard Mitigation Advisory Committee rated the County as having a **“moderate” vulnerability to winter storm hazards**, meaning that between 1 and 10% of the

⁵⁴ <https://www.ncdc.noaa.gov/stormevents/listevents>

unincorporated County's population or assets would be affected by a major disaster. *This rating has not changed since the previous NHMP.*

Given current available data, no quantitative assessment of the risk of winter storm was possible at the time of this NHMP update. However, assessing the risk to the County from winter storms should remain an ongoing process determined by community characteristics and physical vulnerabilities. Weather forecasting can give County resources (emergency vehicles, warming shelters) time to prepare for an impending storm, but the changing character of the County population and resources will determine the impact of winter storms on life and property in Clackamas County.

The most likely impact of snow and ice events on Clackamas County are road closures limiting access/egress to/from some areas, especially roads to higher elevations. Winter storms with heavy wet snow or high winds and ice storms may also result in power outages from downed transmission lines and/or poles.

Winter storms which bring snow, ice and high winds can cause significant impacts on life and property. Many severe winter storm deaths occur as a result of traffic accidents on icy roads, heart attacks may occur from exertion while shoveling snow and hypothermia from prolonged exposure to the cold. The temporary loss of home heating can be particularly hard on the elderly, young children and other vulnerable individuals.

Property is at risk due to flooding and landslides that may result if there is a heavy snowmelt. Additionally, ice, wind and snow can affect the stability of trees, power and telephone lines and TV and radio antennas. Downed trees and limbs can become major hazards for houses, cars, utilities and other property. Such damage in turn can become major obstacles to providing critical emergency response, police, fire and other disaster recovery services.

Severe winter weather also can cause the temporary closure of key roads and highways, air and train operations, businesses, schools, government offices and other important community services. Below freezing temperatures can also lead to breaks in un-insulated water lines serving schools, businesses, industries and individual homes. All of these effects, if lasting more than several days, can create significant economic impacts for the affected communities and the surrounding region. In the rural areas of the county severe winter storms can isolate small communities, farms, and ranches.

At the time of this update, sufficient data was not available to determine winter storm vulnerability in terms of explicit types and numbers of existing and future buildings, infrastructure or critical infrastructure.

More information on this hazard can be found in the [Risk Assessment for Region 2, Northern Willamette Valley/Portland Metro, of the Oregon NHMP \(2015\)](#).

Volcanic Eruption

Significant Changes since Previous NHMP:

Updated vulnerability information from Clackamas County GIS and analysis from the Lower Columbia-Sandy Watershed Natural Hazard Risk Report is included.

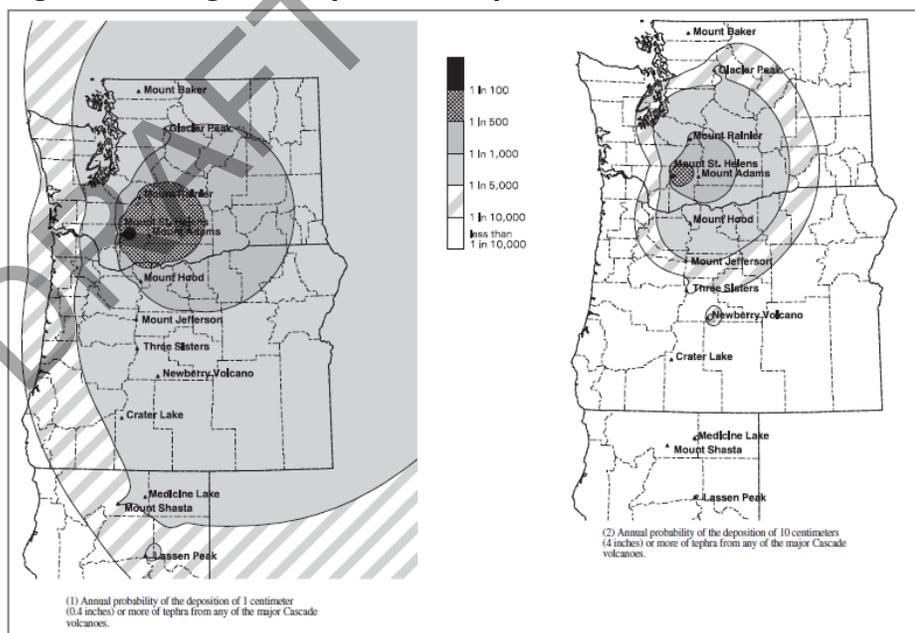
Characteristics

The Pacific Northwest, lies within the “ring of fire,” an area of very active volcanic activity surrounding the Pacific Basin. Volcanic eruptions occur regularly along the ring of fire, in part because of the movement of the Earth’s tectonic plates. The Earth’s outermost shell, the lithosphere, is broken into a series of slabs known as tectonic plates. These plates are rigid, but they float on a hotter, softer layer in the Earth’s mantle. As the plates move about on the layer beneath them, they spread apart, collide, or slide past each other. Volcanoes occur most frequently at the boundaries of these plates and volcanic eruptions occur when molten material, or magma, rises to the surface.

Location and Extent

Scientists use wind direction to predict areas that might be affected by volcanic ash; during an eruption that emits ash, the ash fall deposition is controlled by the prevailing wind direction. The predominant wind pattern over the Cascades originates from the west and previous eruptions seen in the geologic record have resulted in most ash fall drifting to the east of the volcanoes. Regional tephra fall shows the annual probability of ten centimeters or more of ash accumulation from Pacific Northwest volcanoes. Figure 2-17 depicts the potential and geographical extent of volcanic ash fall in excess of ten centimeters from a large eruption of Mt. St. Helens.

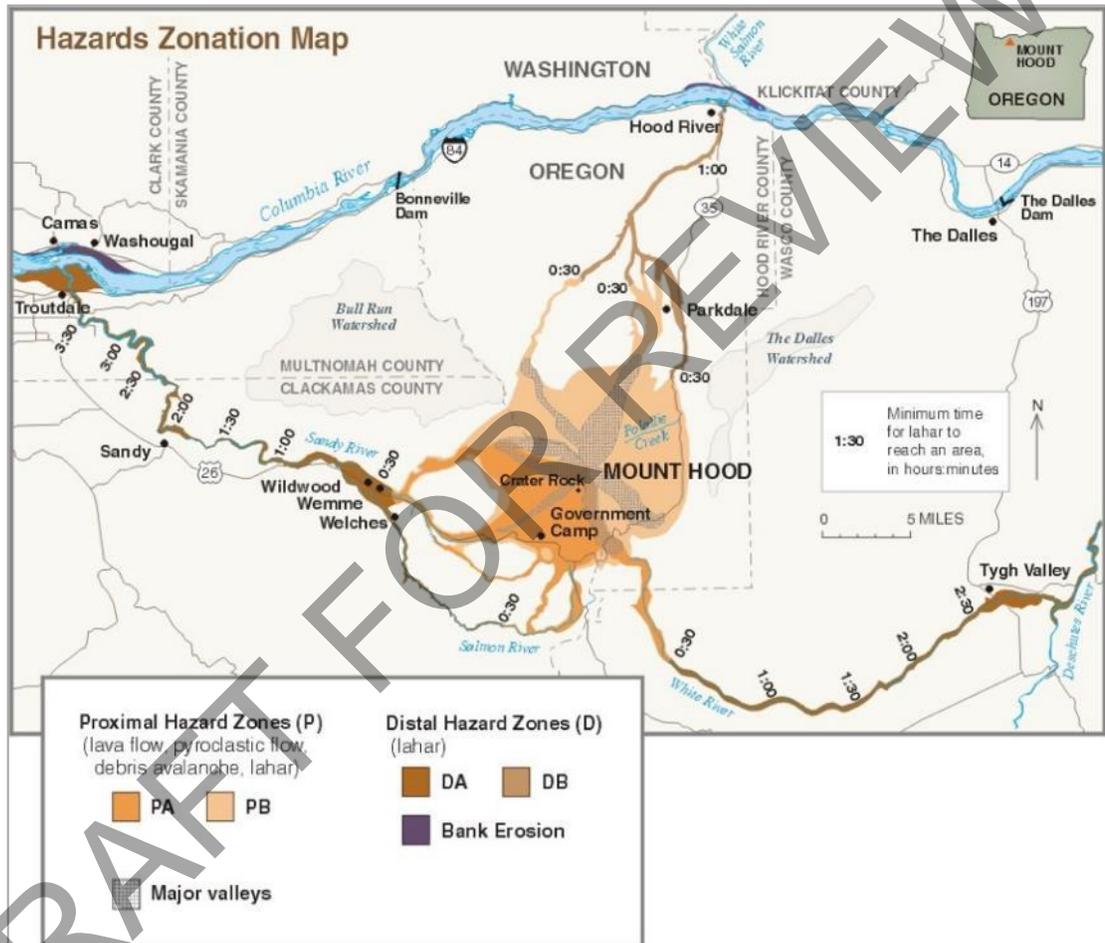
Figure 2-17 Regional Tephra-fall Maps



Source: USGS “Volcano Hazards in the Mount Jefferson Region, Oregon”

The USGS/Cascades Volcano Observatory (CVO) produced a volcanic hazard zonation report for Mount Hood in 1997 and 2000. The report includes a description of potential hazards that may occur to immediate communities. The hazard zones illustrated on Map (USGS 060-00) were determined based on the distance from the volcano, vent location, and type of hazardous events. The two Proximal zones show two potential eruptive scenarios. The zone shown in peach indicates failure of the vents on the north, east, or western flanks. The proximal hazard zone shown in orange is the more likely scenario, which is a failure of the lava dome, Crater Rock, and primarily would affect the drainages in the Sandy River basin in Clackamas County.

Figure 2-18 Hazards Zonation Map



Source: [USGS, Cascades Volcano Observatory, Volcano Hazards Program](https://www.usgs.gov/cascades-volcano-observatory/volcano-hazards-program)

Geologic hazard maps have been created for most of the volcanoes in the Cascade Range by the USGS Volcano Program at the Cascade Volcano Observatory in Vancouver, WA and are available at http://vulcan.wr.usgs.gov/Publications/hazards_reports.html.

Refer to the following DOGAMI reports for additional information:

- Multi-Hazard Risk Report for the Lower Columbia-Sandy Watershed, Oregon: Including the cities of Gresham, Sandy, and Troutdale and Unincorporated Communities of Government Camp and The Villages at Mt Hood (2018, [IMS-59](#)).

- Multi-Hazard and Risk Study for the Mount Hood Region (2011, [O-11-16](#)). *Portions of the volcano section superseded by the Multi-Hazard Risk Report for the Lower Columbia-Sandy Watershed*. See also, [Mount Hood Hazards and Assets Viewer](#).

Additional reports are available via DOGAMI's Publications Search website:

<http://www.oregongeology.org/pubs/search.php>

Other agency/ consultant reports:

- Mathie, A.M., and Wood, N., 2013, Residential and service-population exposure to multiple natural hazards in the Mount Hood region of Clackamas County, Oregon: U.S. Geological Survey Open-File Report 2013–1073, available at <http://pubs.usgs.gov/of/2013/1073/>.
- Ewert, J.W., Diefenbach, A.K., and Ramsey, D.W., 2018, 2018 update to the U.S. Geological Survey national volcanic threat assessment: U.S. Geological Survey Scientific Investigations Report 2018–5140, 40 p., <https://doi.org/10.3133/sir20185140>.

History

Mount Hood and Mount St. Helens are two active volcanoes near Clackamas County. Mount Hood is several hundred miles north of the county and is more than 500,000 years old. It has had two significant eruptive periods, one about 1,500 years ago and another about 200 years ago. Mount St. Helens is in southern Washington State and has been active throughout its 50,000-year lifetime. In the past 200 years, seven of the Cascade volcanoes have erupted, including (from north to south): Mt. Baker, Glacier Peak, Mt. Rainier, Mount St. Helens (Washington), Mt. Hood (Oregon), Mt. Shasta and Mt. Lassen (California).

There has been no recent volcanic activity near the county associated with Mount Hood. The 1980 explosion of Mount St. Helens in southern Washington State is the latest on record; both Mount St. Helens and Mount Hood remain listed as active volcanoes.

Probability Assessment

Based on the available data and research the Hazard Mitigation Advisory Committee determined the **probability of experiencing volcanic activity is "low"**, meaning one incident is likely within the next 75 to 100-year period. *This rating has not changed since the previous NHMP.*

The Sandy River drainage is within proximal hazard Zone PA and has a return period of 5000 to 1,000 years (0.1% to 0.2% annual chance of occurrence).⁵⁵

The United States Geological Survey-Cascades Volcano Observatory (CVO) produced volcanic hazard zonation reports for Mount St. Helens and Mount Hood in 1995 and 1997. The reports include a description of potential hazards that may occur to immediate communities. The CVO created an updated annual probability of tephra (ash) fall map for the Cascade region in 2001, which could be a rough guide for Clackamas County in

⁵⁵ DOGAMI, 2011. *Multi-Hazard and Risk Study for the Mount Hood Region, Multnomah, Clackamas, and Hood River Counties, Oregon*, Open File Report [O-11-13](#).

forecasting potential tephra hazard problems (Figure 2-17). The map identifies the location and extent of the hazard.

The CVO Volcanic tephra fall map is based on the combined likelihood of tephra-producing eruptions occurring at Cascade volcanoes. Probability zones extend farther east of the range because winds blow from westerly directions most of the time. The map shows annual probabilities for a fall of one centimeter (about 0.4 inch). The patterns on the map show the dominating influence of Mount St. Helens as a tephra producer. Because small eruptions are more numerous than large eruptions, the probability of a thick tephra fall at a given locality is lower than that of a thin tephra fall. The annual probability of a fall of one centimeter or more of tephra is about 1 in 10,000 for Clackamas County. This is small when compared to other risks faced by the County.

Vulnerability Assessment

The Hazard Mitigation Advisory Committee rated the county as having a **“moderate” vulnerability to volcanic activity**, meaning that between 1-10% of the unincorporated County’s population or assets would be affected by a major disaster (volcanic ash/lahar). *This rating has not changed since the previous NHMP.*

The U.S. Geological Survey (USGS) lists the threat potential of volcanoes. According to the USGS there are nine volcanoes with Very High or High threat potentials in Oregon and Washington (listed here in order of threat potential): Mount St. Helens, Mount Rainier, Mount Hood, Three Sisters, Newberry, Mount Baker, Glacier Peak, Crater Lake, and Mount Adams (High).⁵⁶

The primary threat to lives and property from active volcanoes is from violent eruptions that unleash tremendous blast forces, generate mud and debris flows (lahars), or produce flying debris and ash clouds. Volcano hazards are divided into proximal (near the volcano) and distal (far from the volcano). Mount Hood poses the greatest threat to the population of Clackamas County. Proximal hazard zones for Mount Hood are about 15 miles from the summit and are subject to several hazards including rapidly moving landslides, pyroclastic surges, and debris avalanches. The Sandy Watershed is located within proximal hazard Zone PA (Figure 2-19).

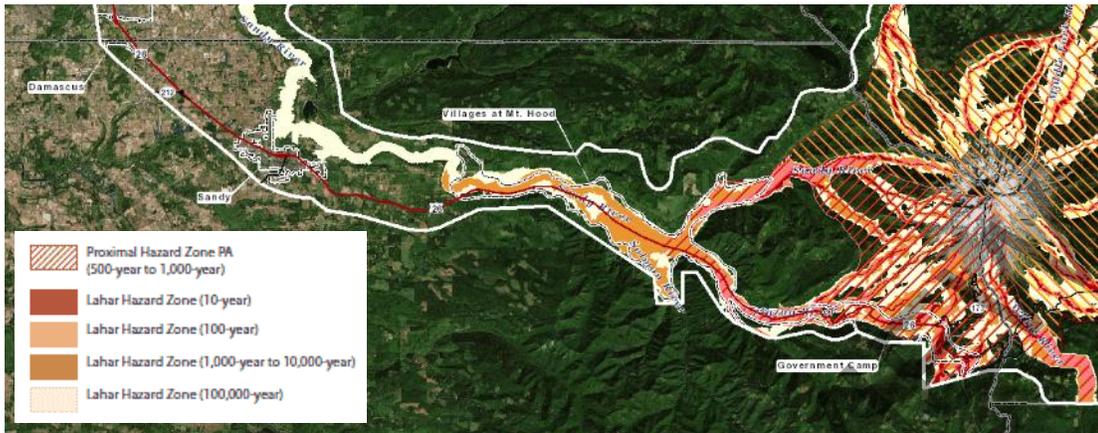
The most severed, widespread, and hazardous consequence of a Mount Hood eruption would include lahars sweeping down the length of the Sandy River valley impacting Government Camp, The Villages at Mount Hood, and the City of Sandy. A Mount Hood eruption could impact up to 68 percent of homes, 60 percent of residents, 73 percent of businesses and 87 percent of employees in the Hoodland Area (including parts of Clackamas and Hood River counties). A mega-eruption scenario would increase population exposure, but the increase is not substantial—typically 10 percent or less of an increase in population exposed.

Population exposure to volcano hazards is largest in the proximal hazard zone, including 65 percent of the local workforce, 80 percent of educational facilities, 82 to 100 percent of

⁵⁶ Ewert, J.W., Diefenbach, A.K., and Ramsey, D.W., 2018, 2018 update to the U.S. Geological Survey national volcanic threat assessment: U.S. Geological Survey Scientific Investigations Report 2018–5140, 40 p., <https://doi.org/10.3133/sir20185140>.

daytime visitors to recreation sites (summer and winter month averages, respectively), and approximately two thirds of overnight visitors.

Figure 2-19 Proximal and Distal Volcano Hazard Zones



Source: DOGAMI, [Mount Hood Hazards and Assets Viewer](#)

According to County GIS about 8% of total county acres are exposed to volcano hazards. These areas are centralized around potential failure areas in the proximal zone, as well as the Sandy River valley in the distal zones. Only 5% of total county parcels are exposed, as the volcanic landscape generally does not lend itself well to development (Table 2-20).

Volcanic activity from ash clouds that drift downwind to the county from near or distant eruptions is possible from Mount Saint Helens, Three Sisters, Mount Bachelor and the Newberry Crater areas. Because the distance to these potentially active volcanic areas is so great, the only adverse effect that would impact areas of Clackamas County is ash fallout, with perhaps some impact on water supplies. The area affected by ash fallout depends upon the height attained by the eruption column and the atmospheric conditions at the time of the eruption. Volcanic ash can contaminate water supplies, cause electrical storms, create health problems and collapse roofs.

The amount of property exposed to the volcanic eruption hazard area, as well as the type and value of structures on those properties, is calculated to provide a working estimate for potential volcanic eruption losses. Table 2-20 shows potentially impacted parcels, critical and critical facilities, vulnerable populations, and infrastructure within Clackamas County's volcanic eruption area.

Table 2-20 Volcanic Eruption Hazard Vulnerability Assessment

Hazard	Potentially Impacted Parcels		Potentially Impacted Locations			Infrastructure				
	Number of Parcels	Percent of Total Parcels	Critical Facilities	Essential Facilities	Vulnerable Populations	Miles of Road	Miles of Sewer Lines	Bridges	Cell Towers	Dams
County Total	158,226	Not Applicable	235	55	576	4911	340	597	17	69
Volcano										
Exposed	7,778	5%	7	1	2	271	21	59	1	1

Source: Clackamas County Geographic Information Systems (2018)

Note: Percentage of property exposed to the volcanic eruption area may include property in tax lots that intersect the area, including property that does not physically reside in the area itself.

Risk to Life & Property: High

Proximal Hazard Zones 1 and 2 are areas subject to rapidly moving debris avalanches, pyroclastic flows, and lahars that can reach the hazard boundary in less than 30 minutes, as

well as slow-moving lava flows. Areas within proximal hazard zones should be evacuated before an eruption begins because there is little time to get people out of harm's way once an eruption starts. Most pyroclastic flows, lava flows, and debris avalanches will stop within the proximal hazard zone, but lahars can travel much farther. Evacuation may prove problematic, as volcanoes are difficult to predict, and there is only one primary route (Hwy 26) off the mountain. In addition, Mount Hood is a prime destination for visitors during all seasons. For these reasons, the threat to life is quite high.

Risk to Critical Facilities and Infrastructure: High

Distal Hazard Zone 3 includes areas adjacent to rivers that are pathways for lahars. Estimated travel time for lahars to reach these zones is more than 30 minutes, which may allow individuals time to move to higher ground and greater safety if given notice. Lahars could affect transportation corridors by damaging or destroying roads and can damage Bull Run pipelines that cross the Sandy River. Although only one critical facility is exposed to the volcano hazard, the effect of lahars and pyroclastic flows and ashfall on equipment and infrastructure will be devastating.

Lower Columbia-Sandy Watershed Natural Hazard Risk Report

The **Risk Report** ([DOGAMI, IMS-59](#)) provides hazard analysis summary tables that identify populations and property within the Lower Columbia-Sandy River Watershed Study Area that are vulnerable to the profiled natural hazards. The Risk Report provides distinct profiles for (1) unincorporated Clackamas County within the study area, (2) the unincorporated community of Government Camp, and (3) the unincorporated community of The Villages at Mt. Hood (including Brightwood, Rhododendron, Welches, Wimpe, and Zig Zag).

According to the Risk Report the following populations and property are vulnerable:

Unincorporated Clackamas County within the Study Area⁵⁷

Volcanic event (lahar, medium – 1% annual chance): Risk was not calculated for other unincorporated regions of the County.

Government Camp⁵⁸

Volcanic event (lahar, medium – 1% annual chance): 611 buildings are exposed (1 critical facility; Hoodland RFPD #74) for a total potential loss of \$92,477,000 (an exposure ratio of 63%). In addition, 163 residents may be displaced (about 64% of the population).

The Villages at Mt. Hood⁵⁹

Volcanic event (lahar, medium – 1% annual chance): 342 buildings are exposed (0 critical facilities) for a total potential loss of \$51,338,000 (an exposure ratio of 9%). In addition, 218 residents may be displaced (about 4% of the population).

More information on this hazard can be found in the [Risk Assessment for Region 2, Northern Willamette Valley/Portland Metro, of the Oregon NHMP \(2015\)](#).

⁵⁷ DOGAMI, *Lower Columbia-Sandy Watershed Natural Hazard Risk Report* (March 2018 Draft), Table 10.1.

⁵⁸ Ibid., Table 10.5.

⁵⁹ Ibid., Table 10.7.

Wildfire

Significant Changes since Previous NHMP:

The wildfire hazard has been edited to reference the recently updated Clackamas Community Wildfire Protection Plan and analysis from the Lower Columbia-Sandy Watershed Natural Hazard Risk Report.

Recent fires in Oregon and across the western United States have increased public awareness of the potential losses to life, property, and natural and cultural resources. In June of 2004, the Board of Clackamas County Commissioners (BCC) directed the County Departments to work with state and federal agencies, fire protection districts, and community organizations throughout the County to develop an integrated wildfire plan. The BCC initiated this effort to reduce wildfire risk to citizens, the environment, and quality of life within Clackamas County.

The [2017 Clackamas Community Wildfire Protection Plan \(CCWPP\)](#) was completed in May 2018. The CCWPP is hereby incorporated into this NHMP by reference and it will serve as the wildfire chapter. The following presents a brief summary of key information; refer to the full CCWPP for a complete description and evaluation of the wildfire hazard.

Characteristics

Wildfires occur in areas with large amounts of flammable vegetation that require a suppression response due to uncontrolled burning. Fire is an essential part of Oregon's ecosystem, but can also pose a serious threat to life and property particularly in the state's growing rural communities. Wildfire can be divided into three categories: interface, wildland and firestorms. The increase in residential development in interface areas has resulted in greater wildfire risk. Fire has historically been a natural wildland element and can sweep through vegetation that is adjacent to a combustible home. New residents in remote locations are often surprised to learn that in moving away from built-up urban areas, they have also left behind readily available fire services providing structural protection. Recent fires in Oregon and across the western United States have increased public awareness over the potential losses to life, property and natural and cultural resources that fire can pose.

The following three factors contribute significantly to wildfire behavior and can be used to identify wildfire hazard areas.

Topography: As slope increases, the rate of wildfire spread increases. South-facing slopes are also subject to more solar radiation, making them drier and thereby intensifying wildfire behavior. However, ridgetops may mark the end of wildfire spread, since fire spreads more slowly or may even be unable to spread downhill.

Fuel: The type and condition of vegetation plays a significant role in the occurrence and spread of wildfires. Certain types of plants are more susceptible to burning or will burn with greater intensity. Dense or overgrown vegetation increases the amount of combustible material available to fuel the fire (referred to as the "fuel load"). The ratio of living to dead plant matter is also important. The risk of fire is increased significantly during periods of prolonged drought as the moisture content of both living and dead plant matter decreases. The fuel's continuity, both horizontally and vertically, is also an important factor.

Weather: The most variable factor affecting wildfire behavior is weather. Temperature, humidity, wind and lightning can affect chances for ignition and spread of fire. Extreme weather, such as high temperatures and low humidity, can lead to extreme wildfire activity. By contrast, cooling and higher humidity often signals reduced Wildfire occurrence and easier containment.

The frequency and severity of wildfires is also dependent upon other hazards, such as lightning, drought, equipment use, railroads, recreation use, arson and infestations. If not promptly controlled, wildfires may grow into an emergency or disaster. Even small fires can threaten lives and resources and destroy improved properties. In addition to affecting people, wildfires may severely affect livestock and pets. Such events may require emergency watering/feeding, evacuation and shelter.

The indirect effects of wildfires can be catastrophic. In addition to stripping the land of vegetation and destroying forest resources, large, intense fires can harm the soil, waterways and the land itself. Soil exposed to intense heat may lose its capability to absorb moisture and support life. Exposed soils erode quickly and enhance siltation of rivers and streams, thereby enhancing flood potential, harming aquatic life and degrading water quality. Lands stripped of vegetation are also subject to increased debris flow hazards, as described above.

Location and Extent

Wildfire hazard areas are commonly identified in regions as the Wildland Urban Interface (WUI). The interface is the urban-rural fringe where homes and other structures are built into a densely forested or natural landscape. If left unchecked, it is likely that fires in these areas will threaten lives and property. One challenge Clackamas County faces is from the increasing number of houses being built in the urban/rural fringe. The “interface” between urban or suburban areas and the resource lands has significantly increased the threat to life and property from fires. Responding to fires in the expanding Wildland Urban Interface area may tax existing fire protection systems beyond original design or current capability.

The ease of fire ignition further determines ranges of the wildfire hazard due to natural or human conditions and the difficulty of fire suppression. The wildfire hazard is also magnified by several factors related to fire suppression/control, such as the surrounding fuel load, weather, topography and property characteristics.

Fire susceptibility throughout the county dramatically increases in late summer and early autumn as summer thunderstorms with lightning strikes increases and vegetation dries out, decreasing plant moisture content and increasing the ratio of dead fuel to living fuel. However, various other factors, including humidity, wind speed and direction, fuel load and fuel type and topography can contribute to the intensity and spread of wildland. In addition, common causes of wildfires include arson and negligence from industrial and recreational activities.

The CCWPP addresses wildfires countywide and defined each local fire district or department as individual Community at Risk. Communities that are particularly vulnerable to wildfires are shown in Map #2 and Table 4-1 of the CCWPP.⁶⁰

The 2018 CCWPP continues to take a more localized approach to wildfire planning by creating individual CWPP's for each fire agency. [Chapter 10: Clackamas County Fire Agencies](#)

⁶⁰ Clackamas Community Wildfire Protection Plan (2018)

has been expanded to include a brief description of wildfire hazards, emergency operations, structural ignitability, community outreach and education and fuels reduction priorities for each local fire agency. Local Communities at Risk were also identified. Each Fire Agency CWPP is complete with action plans to address wildfire issues specific to the local area.

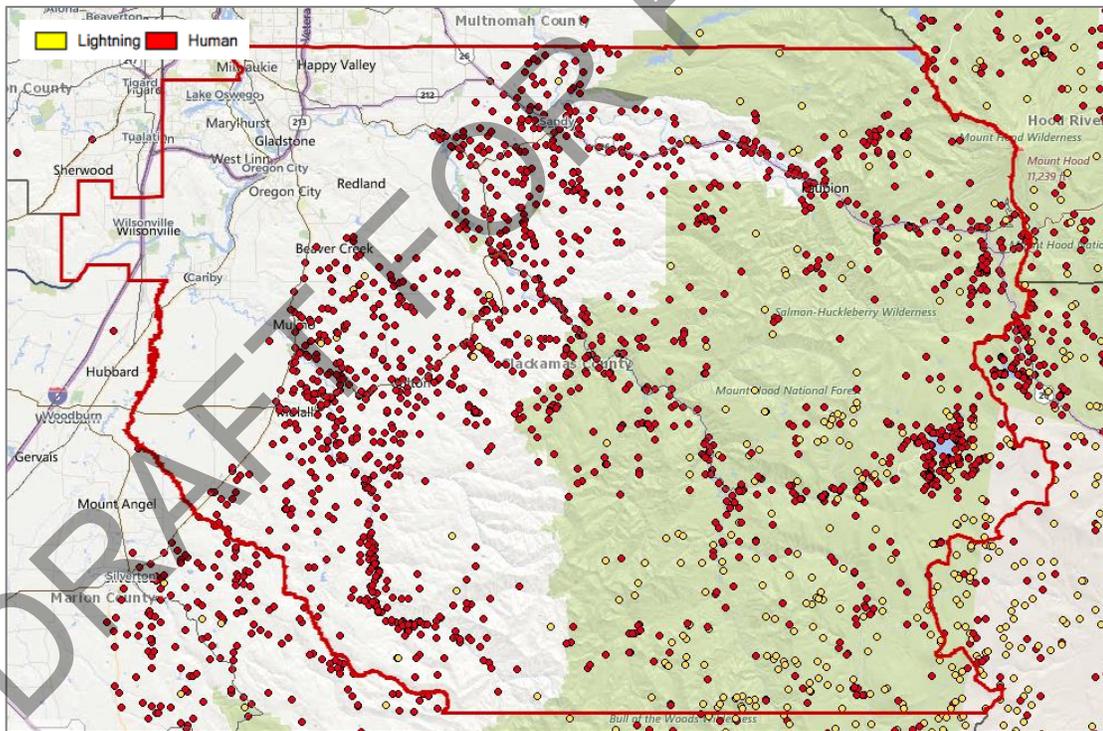
Other agency/ consultant reports:

- Mathie, A.M., and Wood, N., 2013, Residential and service-population exposure to multiple natural hazards in the Mount Hood region of Clackamas County, Oregon: U.S. Geological Survey Open-File Report 2013–1073, available at <http://pubs.usgs.gov/of/2013/1073/>.

History

In the last 10 years there have been 723 fires that have burned 6,752 acres.⁶¹ Figure 2-20 shows fire starts from 1992-2017, fires ignited by humans are shown in red, lightning caused fires are shown in yellow. In the past 10 years 16% of all fires were caused by lightning and 84% of fires were caused by human activity (ranging from arson and debris burning to equipment use and fires caused along powerlines). In general, the human caused wildfires are in populated areas and within river and stream corridors near transportation routes, while lightning caused wildfires are often in more remote locations.

Figure 2-20 Local Fire Starts (1992-2017)

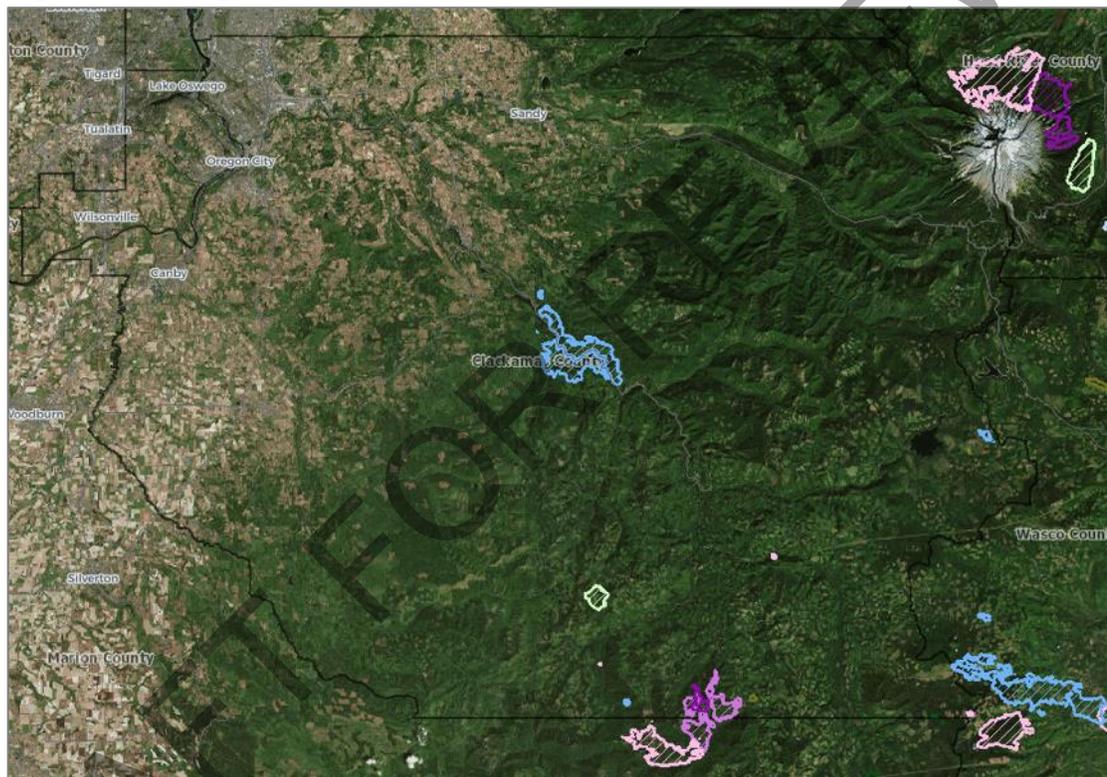


Source: [Oregon Wildfire Risk Explorer](http://OregonWildfireRiskExplorer.com)

⁶¹ Oregon Wildfire Risk Explorer, Area of Interest Report, Clackamas County, accessed July 9, 2018. http://oe.oregonexplorer.info/ExternalContent/wildfire_reports/WildfireRisk_AreaofInterestReport_clackamas_county.pdf

While the majority of fire ignitions occurred along travel corridors and the edges of major urban areas, the fires that escape initial suppression efforts tend to be in more remote areas and are more likely to occur in some portions of the landscape than others (see Figure 2-21). The figure includes the 36 Pit Fire (2014) in the center Blister Fire (2006) just to the south. On the southern edge of the county are the View Lake Fire Complex (2010) and the Bull of the Woods Fire (2010). Several other wildfire have threatened the county as shown just outside the southeast boundary of the county: Logging Unit Complex (2014) and High Cascades Complex (2011) and around Mt. Hood in the northeast: Dollar Lake Fire (2011), Gnarl Ridge Fire (2008), and Mt. Hood Complex (2006). The Eagle Creek Fire (2017), just outside the figure to the north, threatened the Bull Run Watershed that provides water to 950,000 customers in the Portland metropolitan region.

Figure 2-21 Large Fire Perimeters



Source: [Oregon Wildfire Risk Explorer](#)

Probability Assessment

Based on the available data and research the Hazard Mitigation Advisory Committee determined the **probability of experiencing a Wildfire is “high”**, meaning one incident is likely within the next 10 to 35-year period. *This rating has increased since the previous NHMP.*

Certain conditions must be present for significant interface fires to occur. The most common are hot, dry and windy weather; the inability of fire protection forces to contain or suppress the fire; the occurrence of multiple fires that overwhelm committed resources; and a large fuel load (dense vegetation). Once a fire has started, several conditions influence its behavior, including fuel, topography, weather, drought and development. Many of these

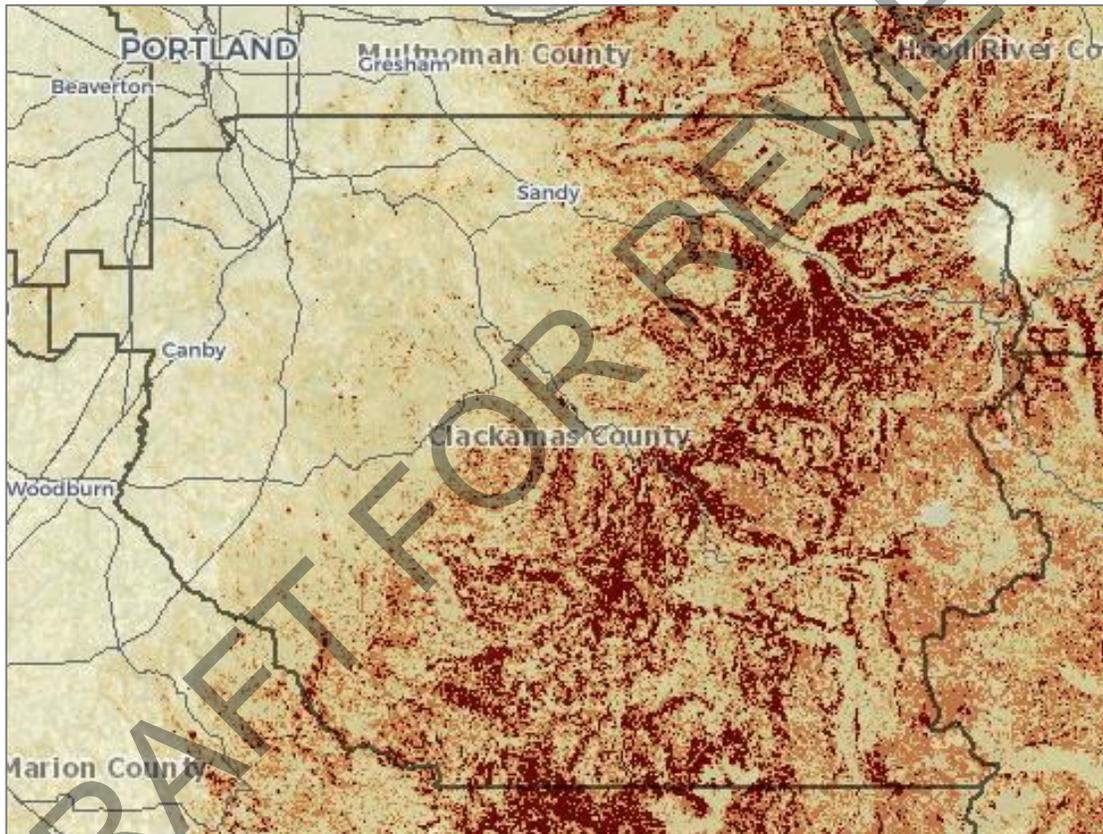
conditions are demonstrated across large areas within Clackamas County, creating a significant collective risk.

Vulnerability Assessment

The Hazard Mitigation Advisory Committee rated the county as having a **“moderate” vulnerability to wildfire hazards**, meaning that between 1-10% of the County’s population or assets would be affected by a major disaster. *This rating has not changed since the previous NHMP.*

Potential impact to structure from wildfire is shown in Figure 2-22, darker areas have higher risk to structures if fire ignites nearby. The areas of greater risk are generally located in more rural parts of the county, that are hillier, and more heavily vegetated and forested.

Figure 2-22 Oregon Wildfire Risk Explorer – Potential Impact to Structure



Source: [Oregon Wildfire Risk Explorer](http://oregonexplorer.info)

Additional wildfire hazard information for Clackamas County and cities is available via Oregon Explorer’s Wildfire Risk Explorer: <http://oregonexplorer.info/topics/wildfire-risk?topic=62>

The amount of property exposed to the wildfire risk hazard area, as well as the type and value of structures on those properties, is calculated to provide a working estimate for potential wildfire losses. Table 2-21 shows potentially impacted parcels, critical and critical facilities, vulnerable populations, and infrastructure within Clackamas County’s wildfire risk hazard area.

Table 2-21 Wildfire Hazard Vulnerability Assessment

Hazard	Potentially Impacted Parcels		Potentially Impacted Locations			Infrastructure				
	Number of Parcels	Percent of Total Parcels	Critical Facilities	Essential Facilities	Vulnerable Populations	Miles of Road	Miles of Sewer Lines	Bridges	Cell Towers	Dams
County Total	158,226	Not Applicable	235	55	576	4911	340	597	17	69
Overall Wildfire Risk										
High	1,650	1%	0	0	2	349	4	21	7	5

Source: Clackamas County Geographic Information Systems (2018)

Note: Percentage of property exposed to wildfire risk may include property in tax lots that intersect the area, including property that does not physically reside in the area itself.

Lower Columbia-Sandy Watershed Natural Hazard Risk Report

The **Risk Report** ([DOGAMI, IMS-59](#)) provides hazard analysis summary tables that identify populations and property within the Lower Columbia-Sandy River Watershed Study Area that are vulnerable to the profiled natural hazards. The Risk Report provides distinct profiles for (1) unincorporated Clackamas County within the study area, (2) the unincorporated community of Government Camp, and (3) the unincorporated community of The Villages at Mt. Hood (including Brightwood, Rhododendron, Welches, Wimpe, and Zig Zag).

According to the Risk Report the following populations and property are vulnerable:

Unincorporated Clackamas County within the Study Area⁶²

Wildfire event (High Risk): 31 buildings are exposed (0 critical facilities) for a total potential loss of \$9,036,000 (an exposure ratio of 1%). In addition, 44 residents may be displaced (< 1% of the population).

Government Camp⁶³

Wildfire event (High Risk): 2 buildings are exposed (0 critical facilities) for a total potential loss of \$534,000 (an exposure ratio of < 1%). In addition, 1 resident may be displaced (< 1% of the population).

The Villages at Mt. Hood⁶⁴

Wildfire event (High Risk): 47 buildings are exposed (0 critical facilities) for a total potential loss of \$9,855,000 (an exposure ratio of 12%). In addition, 53 residents may be displaced (about 1% of the population).

Refer to the following DOGAMI reports for additional information:

- Multi-Hazard Risk Report for the Lower Columbia-Sandy Watershed, Oregon: Including the cities of Gresham, Sandy, and Troutdale and Unincorporated Communities of Government Camp and The Villages at Mt Hood (2018, [IMS-59](#)).

More information on this hazard can be found in the [Clackamas Community Wildfire Protection Plan \(2018\)](#) and the [Risk Assessment for Region 2, Northern Willamette Valley/Portland Metro, of the Oregon NHMP \(2015\)](#).

⁶² DOGAMI, *Lower Columbia-Sandy Watershed Natural Hazard Risk Report* (March 2018 Draft), Table 10.1.

⁶³ Ibid., Table 10.5.

⁶⁴ Ibid., Table 10.7.

SECTION 3: MITIGATION STRATEGY

This section outlines Clackamas County's strategy to reduce or avoid long-term vulnerabilities to the identified hazards. Specifically, this section presents a mission and specific goals and actions thereby addressing the mitigation strategy requirements contained in 44 CFR 201.6(c). The NHMP Hazard Mitigation Advisory Committee reviewed and updated the mission, goals and action items documented in this NHMP. Additional planning process documentation is in Volume III, Appendix B.

Mitigation Plan Mission

The NHMP mission states the purpose and defines the primary functions of Clackamas County's NHMP. It is intended to be adaptable to any future changes made to the NHMP and need not change unless the community's environment or priorities change.

The mission of the Clackamas County NHMP is to:

Promote sound public policy designed to protect citizens, critical facilities, infrastructure, private property, and the environment from natural hazards.

This can be achieved by increasing public awareness, documenting the resources for risk reduction and loss-prevention, and identifying activities to guide the county towards building a safer, more sustainable community.

Note: The 2018 NHMP Hazard Mitigation Advisory Committee reviewed the previous NHMP's mission statement and agreed to retain it without modifications.

Mitigation Plan Goals

Mitigation plan goals are more specific statements of direction that Clackamas County citizens and public and private partners can take while working to reduce the County's risk from natural hazards. These statements of direction form a bridge between the broad mission statement and action items. The goals listed here serve as checkpoints as agencies and organizations begin implementing mitigation action items.

Meetings with the Hazard Mitigation Advisory Committee, previous hazard event reports, and the previous county Natural Hazards Mitigation Plans served as methods to obtain input and identify priorities in developing goals for reducing risk and preventing loss from natural hazards in Clackamas County.

The 2018 Clackamas County NHMP Hazard Mitigation Advisory Committee reviewed the previous NHMP goals in comparison to the State Natural Hazard Mitigation Plan (2015) goals and determined that they would retain their original goals without modifications.

All the NHMP goals are important and are listed below in no order of priority. Establishing community priorities within action items neither negates nor eliminates any goals, but it

establishes which action items to consider implementing first, should funding become available.

PROTECT LIFE AND PROPERTY

- Implement activities that assist in protecting lives by making homes, businesses, infrastructure, critical facilities, and other property more resistant to natural hazards.
- Reduce losses and repetitive damages for chronic hazard events while promoting insurance coverage for catastrophic hazards.
- Improve hazard assessment information to make recommendations for discouraging new development and encouraging preventative measures for existing development in areas vulnerable to natural hazards.

ENHANCE NATURAL SYSTEMS

- Balance watershed planning, natural resource management, and land use planning with natural hazards mitigation to protect life, property, and the environment.
- Preserve, rehabilitate, and enhance natural systems to serve natural hazard mitigation functions.

AUGMENT EMERGENCY SERVICES

- Establish policy to ensure mitigation projects for critical facilities, services, and infrastructure.
- Strengthen emergency operations by increasing collaboration and coordination among public agencies, non-profit organizations, and business, and industry.
- Coordinate and integrate natural hazards mitigation activities, where appropriate, with emergency operations plans and procedures.

ENCOURAGE PARTNERSHIPS FOR IMPLEMENTATION

- Strengthen communication and coordinate participation among and within public agencies, citizens, non-profit organizations, business, and industry to gain a vested interest in implementation.
- Encourage leadership within public and private sector organizations to prioritize and implement local, county, and regional hazard mitigation activities.

PROMOTE PUBLIC AWARENESS

- Develop and implement education and outreach programs to increase public awareness of the risks associated with natural hazards.
- Provide information on tools, partnership opportunities, and funding resources to assist in implementing mitigation activities.

Action Item Development Process

Action items identified through the planning process are an important part of the mitigation plan. Action items are detailed recommendations for activities that local departments, citizens, and others could engage in to reduce risk. Development of action items was a multi-step, iterative process that involved brainstorming, discussion, review and revisions.

Action items can be developed through many sources. Figure 3-1 illustrates some of these sources.

Figure 3-1 Development of Action Items



Most of the action items were first created during the previous NHMP planning processes. During these processes, Hazard Mitigation Advisory Committee (HMCA) developed maps of local vulnerable populations, facilities and infrastructure in respect to each identified hazard. Review of these maps generated discussion around potential actions to mitigate impacts to the vulnerable areas. The Oregon Partnership for Disaster Resilience (OPDR) provided guidance in the development of action items by presenting and discussing actions that were used in other communities. OPDR also took note of ideas that came up in HMCA meetings and drafted specific actions that met the intent of the HMCA. All actions were then reviewed by the HMCA, discussed at length and revised as necessary before becoming a part of this document.

Action Item Matrix

The action item matrix (Table 3-1) portrays the overall action plan framework and identifies linkages between the plan goals, partnerships (coordination and partner organizations), and actions. The matrix documents a brief description of the action, coordinating and partner (internal) organizations, timeline (ongoing, short term, long term), priority (low, medium, high), and plan goals addressed. Refer to Volume II, Appendix A for detailed information for each action.

Action Item Categories

The HMCA categorized action items within the following categories:

EDUCATION AND OUTREACH

Enhancing individual jurisdictional responsibility and accountability is a low-cost, high-benefit way to increase resilience throughout the county. Education and outreach programs already exist. The actions in this category are intended in some cases for the general public, but are predominantly aimed at better educating and informing local officials about actions they can take to make their communities more disaster resilient.

GIS/MAPPING

The actions in this category address mapping needs that are essential to the plans risk assessment of each hazard. The ability to utilize data gathered by the county's GIS department and other local and state organizations allows the risk assessment to continually be updated and reviewed.

MAINTENANCE/PLANNING

Actions in this category stress the importance of maintaining elements of this Clackamas County NHMP, the date that supports the Clackamas County NHMP, and also promote the development of plans and reports that support the goals of the Clackamas County NHMP.

CRITICAL INFRASTRUCTURE/ESSENTIAL FACILITIES

The actions within this category address critical infrastructure and public facilities that are essential to the basic functioning of society, and fundamentally necessary for effective emergency response, as well as recovery and redevelopment efforts following a disaster event.

LAND USE/DEVELOPMENT

Actions within this category seek to utilize laws, regulations, and other tools regarding the use and development of land as methods of protecting lives and property.

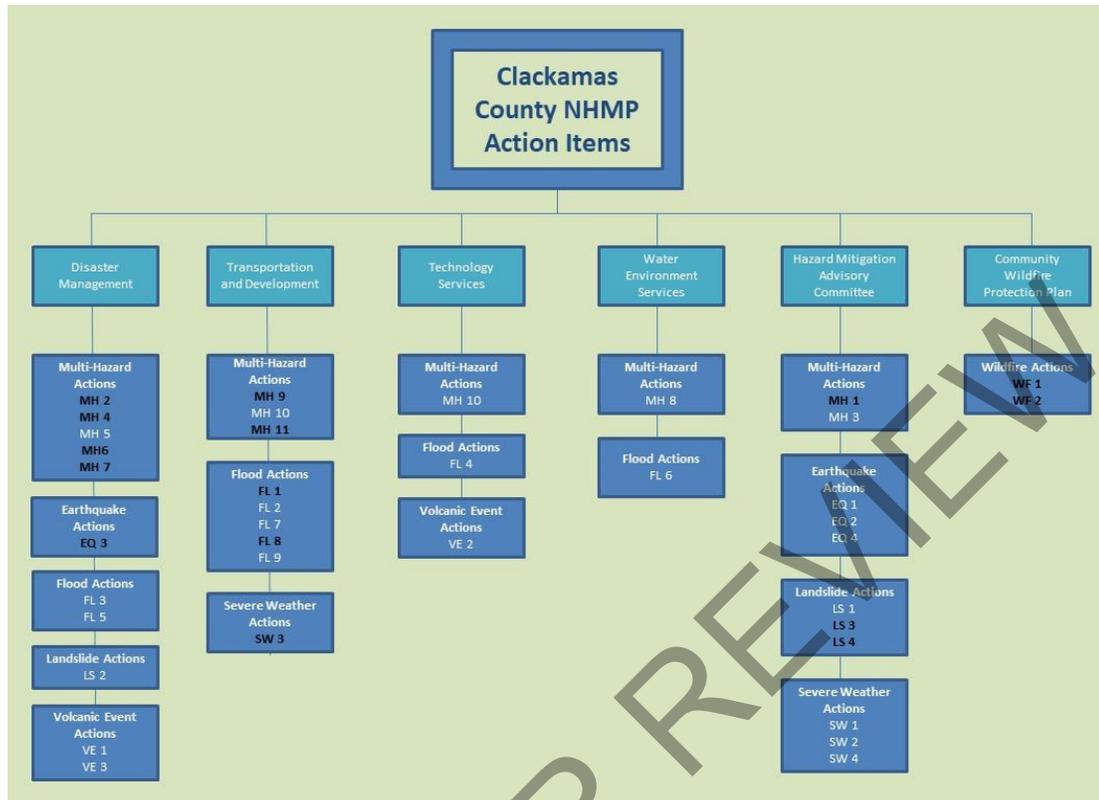
Action Item Framework

Many of the Clackamas County multi-jurisdictional Natural Hazards Mitigation Plan's recommendations are consistent with the goals and objectives of the County's existing plans and policies. Where possible, Clackamas County will implement the NHMP's recommended actions through existing plans and policies. Plans and policies already in existence have support from residents, businesses, and policy makers. Many land-use, comprehensive, and strategic plans get updated regularly, and can adapt easily to changing conditions and needs. Implementing the Natural Hazard Mitigation Plan's action items through such plans and policies increases their likelihood of being supported and implemented.

Figure 3-2 outlines which county department or committee is the lead responsible for implementing and documenting progress on each action item.

See Volume II for the Priority Actions for each participating city.

Figure 3-2 Action Item Framework



Source: Hazard Mitigation Advisory Committee

Note: High Priority Actions are noted in **bold black text**.

Action Item Prioritization

The Hazard Mitigation Advisory Committee decided to modify the prioritization of action items in this update. Because all action items are important to the mitigation plan, the group prioritized the action items with tiered priorities (low, medium, high). Each functional category contains a set of specific action items. High priority actions are shown in bold text and highlighted in yellow within Table 3-1.

During the February 28, 2018 meeting the HMAc agreed to maintain the existing categorization of the action items, to revise some existing actions to make them more specific, to remove one action that no longer applies, and to add one action (see Volume III, Appendix A for an updated list of action items and Appendix B for information on changes).

The Hazard Mitigation Advisory Committee will prioritize the following actions to focus their attention, and resource availability, upon an achievable set of high leverage activities over the next five-years.

In addition to the actions listed below **Wildfire #1** (see Appendix A) is considered high priority. See the [Clackamas Community Wildfire Protection Plan](#) for detailed information.

EDUCATION AND OUTREACH

- **Multi-Hazard (MH) #4.** Identify, improve, and sustain collaborative programs focusing on the real estate and insurance industries, public and private sector organizations, and individuals to avoid activity that increases risk to natural hazards
- **Multi-Hazard (MH) #7.** Strengthen emergency services preparedness and response by linking emergency services with natural hazard mitigation programs, and enhancing and implementing public education programs on a regional scale
- **Flood (FL) #1.** Identify opportunities to educate people within Clackamas County's public and private flood prone properties and identify feasible mitigation options
- **Flood (FL) #8.** Encourage purchase of flood insurance
- **Landslide (LS) #3.** Continue to limit activities in identified potential and historical landslide areas through regulation and public outreach
- **Wildfire (WF) #2.** Encourage private landowners to create and maintain defensible space around homes and other buildings.

GIS/MAPPING

- No action within this category was identified as a priority.

MAINTENANCE/PLANNING

- **Multi-Hazard (MH) #1.** Integrate the goals and action items from the Clackamas County Natural Hazard Mitigation Plan into existing regulatory documents and programs, where appropriate.
- **Multi-Hazard (MH) #2.** Identify and pursue funding opportunities to develop and implement local and county mitigation activities.
- **Severe Weather (SW) #3.** Monitor and implement programs to keep trees from threatening lives, property, and public infrastructure during windstorm events

CRITICAL INFRASTRUCTURE/ESSENTIAL FACILITIES

- **Multi-Hazard (MH) #6.** Update and Maintain inventories of at-risk buildings and infrastructure and prioritize mitigation projects
- **Multi-Hazard (MH) #10.** Perform pre-disaster assessments on County owned and/or operated buildings and facilities, potential shelter sites, and essential facilities.
- **Earthquake (EQ) #3.** Encourage seismic strength evaluations for existing critical facilities in the County to identify vulnerabilities for mitigation of schools and universities, public infrastructure, and critical facilities to meet current seismic standards

LAND USE/DEVELOPMENT

- **Multi-Hazard (MH) #9.** Enhance strategies for debris management.
- **Landslide (LS) #4.** Recommend construction and subdivision design that can be applied to steep slopes to reduce the potential adverse impacts from development.

Although this methodology provides a guide for the HMAC in terms of implementation, the HMAC has the option to implement any of the action items at any time. This option to consider all action items for implementation allows the committee to consider mitigation strategies as new opportunities arise, such as capitalizing on funding sources that could pertain to an action item that is not the highest priority.

Table 3-1 Clackamas County Action Items

Natural Hazard Action ID	Action Item	Coordinating Organization (Lead)	Internal Partners	Priority	Timing	Plan Goals Addressed				
						Goal 1	Goal 2	Goal 3	Goal 4	Goal 5
Education and Outreach										
Multi-Hazard #4	Identify, improve, and sustain collaborative programs focusing on the real estate and insurance industries, public and private sector organizations, and individuals to avoid activity that increases risk to natural hazards	Disaster Management	PGA BCS	High	Ongoing	✓		✓	✓	
Multi-Hazard #7	Strengthen emergency services preparedness and response by linking emergency services with natural hazard mitigation programs and enhancing and implementing public education programs on a regional scale.	Disaster Management	DTD PGA TS H3S	High	Ongoing	✓	✓		✓	
Flood #1	Identify opportunities to educate people within Clackamas County's public and private flood prone properties and identify feasible mitigation options	Transportation and Development	DM HMAC	High	Ongoing	✓		✓		
Flood #3	Develop better flood warning systems	Disaster Management	TS DTD	Medium	Ongoing	✓	✓			
Flood #8	Encourage purchase of flood insurance	Transportation and Development	HMAC DM	High	Ongoing	✓			✓	
Landslide #1	Continue to improve knowledge of landslide hazard areas and understanding of vulnerability and risk to life and property in hazard-prone areas	Hazard Mitigation Advisory Committee	DTD TS	Medium	Short Term	✓			✓	
Landslide #3	Continue to limit activities in identified potential and historical landslide areas through regulation and public outreach	Hazard Mitigation Advisory Committee	TS DTD	High	Ongoing	✓			✓	✓

Natural Hazard Action ID	Action Item	Coordinating Organization (Lead)	Internal Partners	Priority	Timing	Plan Goals Addressed				
						Goal 1	Goal 2	Goal 3	Goal 4	Goal 5
Severe Weather #2	Continue to educate the public on severe weather mitigation activities.	Hazard Mitigation Advisory Committee	PGA	Medium	Ongoing	✓			✓	
Earthquake #2	Encourage purchase of earthquake hazard insurance	Hazard Mitigation Advisory Committee	DM	Low	Ongoing	✓			✓	
Earthquake #4	Encourage reduction of nonstructural and structural earthquake hazards in homes, schools, businesses, and government offices through public education	Hazard Mitigation Advisory Committee	DM	Medium	Ongoing	✓	✓		✓	
Volcanic Eruption #3	Strengthen response and recovery programs, and work with the USGS-CVO to enhance public education programs for volcanic eruption hazards.	Disaster Management	-	Low	Long Term	✓	✓		✓	
Wildfire #2	Encourage private landowners to create and maintain defensible space around homes and other buildings.	Disaster Management	DTD	High	Ongoing	✓			✓	✓
GIS/Mapping										
Multi-Hazard #10	<i>This is a repeated action. See description under "Maintenance/Planning"</i>	Technology Services	DTD DM	Medium	Long Term	✓		✓		
Flood #4	Maintain data and mapping for floodplain information within the county and identify and map flood-prone areas outside of designated floodplains	Technology Services	DTD DM	Medium	Ongoing	✓				
Volcanic Eruption #2	Utilize existing risk assessments and collaborate with USGS-CVO and related agencies to develop ash fall models that are specific to Clackamas County	Technology Services	DM	Low	Long Term	✓		✓	✓	

Natural Hazard Action ID	Action Item	Coordinating Organization (Lead)	Internal Partners	Priority	Timing	Plan Goals Addressed				
						Goal 1	Goal 2	Goal 3	Goal 4	Goal 5
Maintenance/Planning										
Multi-Hazard #1	Integrate the goals and action items from the Clackamas County Natural Hazard Mitigation Plan into existing regulatory documents and programs, where appropriate.	Hazard Mitigation Advisory Committee	DM Finance DTD	High	Ongoing			✓		
Multi-Hazard #2	Identify and pursue funding opportunities to develop and implement local and county mitigation activities.	Disaster Management	DTD	High	Ongoing			✓		
Multi-Hazard #3	Establish a formal role for the Clackamas County Natural Hazards Mitigation Committee to develop a sustainable process for implementing, monitoring, and evaluating countywide mitigation activities	Hazard Mitigation Advisory Committee	DM, DTD, TS, CA	Medium	Ongoing			✓		
Multi-Hazard #5	Develop public and private partnerships to foster natural hazard mitigation program coordination and collaboration in Clackamas County	Disaster Management	DTD, PGA, BCS	Medium	Ongoing			✓		
Multi-Hazard #10	Update County Comprehensive Plan to integrate most current natural hazard mapping data for Clackamas County and make available to county GIS to improve technical analysis of earthquake hazards.	Transportation and Development	TS DM	Medium	Long Term	✓		✓		
Flood #7	Establish a framework to compile and coordinate surface water management plans and data throughout the county.	Transportation and Development	WES TS	Medium	Short Term	✓		✓		
Flood #9	Develop a floodplain management plan as a standalone for the CRS program	Transportation and Development	DM WES CA	Medium	Short Term			✓		
Landslide #2	Identify public education tools and opportunities in high-risk debris flow and landslide areas.	Disaster Management	DTD	Medium	Short Term	✓	✓			

Natural Hazard Action ID	Action Item	Coordinating Organization (Lead)	Internal Partners	Priority	Timing	Plan Goals Addressed				
						Goal 1	Goal 2	Goal 3	Goal 4	Goal 5
Severe Weather #1	Develop and implement programs to coordinate maintenance and mitigation activities to reduce risk to public infrastructure from severe weather	Hazard Mitigation Advisory Committee	DTD	Medium	Ongoing		✓	✓		
Severe Weather #3	Monitor and implement programs to keep trees from threatening lives, property, and public infrastructure during windstorm events	Transportation and Development	BCS	High	Ongoing		✓	✓		
Volcanic Eruption #1	Work with the state and other impacted jurisdictions to update and exercise the Mount Hood Inter-Agency Volcano Coordination Plan	Disaster Management	DTD TCA	Medium	Long Term		✓	✓	✓	
Critical Infrastructure/Essential Facilities										
Multi-Hazard #6	Update and Maintain inventories of at-risk buildings and infrastructure and prioritize mitigation projects	Disaster Management	DTD Finance TS	High	Ongoing	✓		✓		
Multi-Hazard #11	Perform pre-disaster assessments on County owned and/or operated buildings and facilities, potential shelter sites, and essential facilities.	Transportation and Development	DM	High	Short Term	✓		✓		
Flood #6	Identify and address surface water drainage problematic sites for all parts of unincorporated Clackamas County	Water Environment Services	DTD TS	Medium	Ongoing	✓				
Earthquake #1	Pursue funding opportunities for structural and nonstructural retrofitting of homes, schools, businesses, and government offices that are identified as seismically vulnerable	Hazard Mitigation Advisory Committee	DM CA	Medium	Ongoing			✓	✓	

Natural Hazard Action ID	Action Item	Coordinating Organization (Lead)	Internal Partners	Priority	Timing	Plan Goals Addressed				
						Goal 1	Goal 2	Goal 3	Goal 4	Goal 5
Earthquake #3	Encourage seismic strength evaluations for existing critical facilities in the County to identify vulnerabilities for mitigation of schools and universities, public infrastructure, and critical facilities to meet current seismic standards	Disaster Management	DTD HMAC	High	Ongoing	✓	✓			
Land Use/Development										
Multi-Hazard #8	Use technical knowledge of natural ecosystems and events to link natural resources management and land use organizations to mitigation activities and technical assistance.	Water Environment Services	DTD	Medium	Ongoing					✓
Multi-Hazard #9	Enhance strategies for debris management	Transportation and Development	DM	High	Short Term/ Ongoing		✓	✓		✓
Flood #2	Recommend revisions to requirements for development within the floodplain, where appropriate	Transportation and Development	DM, TS WES	Low	Long Term	✓				
Flood #5	Encourage development of acquisition and management strategies to preserve open space for flood mitigation, fish habitat, and water quality in the floodplain and reduce risk to flood prone properties as well as preserve space for open space property.	Disaster Management	WES DTD	Medium	Ongoing	✓				✓
Landslide #4	Recommend construction and subdivision design that can be applied to steep slopes to reduce the potential adverse impacts from development.	Hazard Mitigation Advisory Committee	DTD	High	Short Term	✓			✓	✓
Severe Weather #4	Support/encourage electrical utilities to use underground construction methods where possible to reduce power outages from windstorms.	Transportation and Development	DM	Medium	Ongoing			✓		✓

Source Clackamas County NHMP Hazard Mitigation Advisory Committee, updated 2018

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SECTION 4:

PLAN IMPLEMENTATION AND MAINTENANCE

This section details the formal process that will ensure that the NHMP remains an active and relevant document. The plan implementation and maintenance process includes a schedule for monitoring and evaluating the NHMP semi-annually, as well as producing an updated plan every five years. Finally, this section describes how the County will integrate public participation throughout the NHMP maintenance and implementation process.

Implementing the NHMP

The success of the Clackamas County NHMP depends on how well the outlined action items are implemented. In an effort to ensure that the activities identified are implemented, the following steps will be taken: 1) the NHMP will be formally adopted, 2) a Hazard Mitigation Advisory Committee (HMAC) will be assigned, 3) a convener shall be designated, 4) semi-annual meetings will be held (flood group meets semi-monthly), 5) the identified activities will be prioritized and evaluated, and 6) the NHMP will be implemented through existing plans, programs and policies.

NHMP Adoption

The Clackamas County NHMP was developed and will be implemented through a collaborative process. After the NHMP is locally reviewed and deemed complete, the Clackamas County Resilience Coordinator, or their designee, shall submit it to the State Hazard Mitigation Officer (SHMO) at the Oregon Military Department – Office of Emergency Management (OEM). OEM submits the NHMP to FEMA-Region X for review. This review addresses the federal criteria outlined in the FEMA Interim Final Rule 44 CFR Part 201. Upon acceptance by FEMA, the County will adopt the NHMP via resolution. At that point, the County will gain eligibility for the Pre-Disaster Mitigation Grant Program, the Hazard Mitigation Grant Program and Flood Mitigation Assistance program funds. Following adoption by the County, the participating jurisdictions should convene local decision makers and adopt the Clackamas County Multijurisdictional NHMP.

Convener

The Board of County Commissioners (BCC) will adopt the Clackamas County Natural Hazards Mitigation Plan, and the HMAC will take responsibility for plan implementation. The County Administrator or designee will serve as the plan convener to facilitate the HMAC meetings and will assign tasks such as updating and presenting the Plan to the members of the committee.

- Coordinate HMAC meeting dates, times, locations, agendas and member notification;
- Document the discussions and outcomes of committee meetings;
- Serve as a communication conduit between the HMAC and the public/stakeholders;
- Identify emergency management-related funding sources for natural hazard mitigation projects; and

- Utilize the Risk Assessment as a tool for prioritizing proposed natural hazard risk reduction projects.

Plan implementation and evaluation will be a shared responsibility among all HMAc members.

Hazard Mitigation Advisory Committee

The HMAc serves as the coordinating body for the mitigation plan and is responsible for coordinating implementation of Plan action items and undertaking the formal review process. The BCC will assign representatives from county agencies, including, but not limited to, the current HMAc members.

Roles and responsibilities of the HMAc include:

- Attending future meetings;
- Prioritizing projects and recommending funding for natural hazard risk reduction projects;
- Participation in the plan update process;
- Documenting successes and lessons learned;
- Evaluating and updating the Natural Hazards Mitigation Plan following a disaster;
- Evaluating and updating the Natural Hazards Mitigation Plan in accordance with the prescribed maintenance schedule; and
- Development and coordination of ad hoc and/or standing subcommittees as needed.

HMAc Members

The following jurisdictions, agencies and/or organizations were represented and served on the HMAc during the development of the Clackamas County NHMP and may be represented during implementation and maintenance phase (for a list of individuals see *Acknowledgements*):

- | | |
|---|--|
| <ul style="list-style-type: none"> • Clackamas County Application Services • Clackamas County Disaster Management • Clackamas County Planning • Clackamas County Public Health • Clackamas County Public Works • City of Canby • City of Estacada • City of Gladstone • City of Happy Valley • City of Johnson City • City of Milwaukie • City of Molalla • City of Lake Oswego • City of Oregon City | <ul style="list-style-type: none"> • City of Sandy • City of West Linn • City of Wilsonville • Clackamas Soil and Water Conservation District • Clackamas River Water Providers • Clackamas County Fire District #1 • Oregon Department of Geology and Mineral Industries • Oregon Department of Land Conservation and Development • Oregon Emergency Management • United States Army Corps of Engineers |
|---|--|

To make the coordination and review of the Clackamas County NHMP as broad and useful as possible, the HMAAC will engage additional stakeholders and other relevant hazard mitigation organizations and agencies to implement the identified action items. Specific organizations have been identified as partners in the action item matrices.

Implementation through existing programs

The NHMP includes a range of action items that, when implemented, will reduce loss from hazard events in the county. Within the NHMP, FEMA requires the identification of existing programs that might be used to implement these action items. Clackamas County and the participating cities currently address statewide planning goals and legislative requirements through their comprehensive land use plans, capital improvement plans, mandated standards and building codes. To the extent possible, Clackamas County and participating cities will work to incorporate the recommended mitigation action items into existing programs and procedures.

Many of the recommendations contained in the NHMP are consistent with the goals and objectives of the participating City and County's existing plans and policies. Where possible, Clackamas County and participating cities should implement the recommended actions contained in the NHMP through existing plans and policies. Plans and policies already in existence often have support from residents, businesses and policy makers. Many land-use, comprehensive and strategic plans get updated regularly and can adapt easily to changing conditions and needs. Implementing the action items contained in the NHMP through such plans and policies increases their likelihood of being supported and implemented.

Examples of plans, programs or agencies that may be used to implement mitigation activities include:

- City and County Budgets
- Community Wildfire Protection Plans
- Comprehensive Land Use Plans
- Economic Development Action Plans
- Zoning Ordinances and Building Codes

For additional examples of plans, programs or agencies that may be used to implement mitigation activities refer to list of plans in Volume I, Section 2.

NHMP Maintenance

NHMP maintenance is a critical component of the NHMP. Proper maintenance of the NHMP ensures that it will maximize the County and participating Cities' efforts to reduce the risks posed by natural hazards. This section was developed by OPDR and includes a process to ensure that a regular review and update of the NHMP occurs. The HMAAC and local staff are responsible for implementing this process, in addition to maintaining and updating the NHMP through a series of meetings outlined in the maintenance schedule below.

Meetings

The HMAAC will meet on a **semi-annual basis** to complete the following tasks (the County flood group meets semi-monthly). During the first meeting the HMAAC will:

- Review existing action items to determine appropriateness for funding;
- Educate and train new members on the NHMP and mitigation in general;
- Identify issues that may not have been identified when the NHMP was developed; and
- Prioritize potential mitigation projects using the methodology described below.

During the second meeting, the HMAC will:

- Review existing and new risk assessment data;
- Discuss methods for continued public involvement; and
- Document successes and lessons learned during the year.

The county's Hazard Mitigation Coordinator will host a meeting once a year with the city leads for participating jurisdictions. This meeting is an opportunity for the cities to report back to the county on progress that has been made towards their Natural Hazard Mitigation Plan Addenda. This meeting will also serve as a means for the Hazard Mitigation Coordinator to provide information regarding potential funding sources for mitigation projects, as well as provide additional support for the cities steering committees.

The convener will be responsible for documenting the outcome of the semi-annual meetings in Appendix B: Planning and Public Process. The process the coordinating body will use to prioritize mitigation projects is detailed in the section below. The plan's format allows the county and participating jurisdictions to review and update sections when new data becomes available. New data can be easily incorporated, resulting in a natural hazards mitigation plan that remains current and relevant to the participating jurisdictions.

Project Prioritization Process

Chapter 3 describes the process the HMAC used to establish the current prioritization of action items. Understanding that priorities may change over time depending on new events or resource availability, the Disaster Mitigation Act of 2000 requires that jurisdictions identify a process for future action item prioritization. Potential mitigation activities often come from a variety of sources; therefore, the project prioritization process needs to be flexible. Committee members, local government staff, other planning documents or the risk assessment may be the source to identify projects. Figure 4-1 illustrates the project development and prioritization process that the HMAC can use in the future.

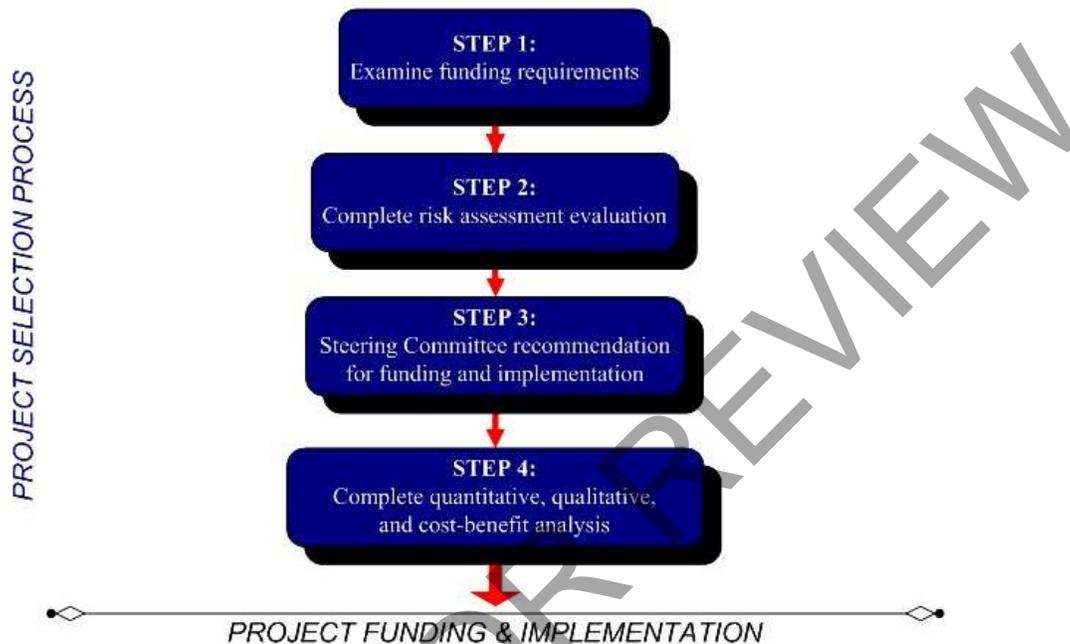
Step 1: Examine funding requirements

The first step in prioritizing the NHMP's action items is to determine which funding sources are open for application. Several funding sources may be appropriate for the County's proposed mitigation projects. Examples of mitigation funding sources include but are not limited to: FEMA's Pre-Disaster Mitigation competitive grant program (PDM), Flood Mitigation Assistance (FMA) program, Hazard Mitigation Grant Program (HMGP), National Fire Plan (NFP), Community Development Block Grants (CDBG), local general funds and private foundations, among others. Please see Volume II, Appendix E for a more comprehensive list of potential grant programs.

Because grant programs open and close on differing schedules, the HMAC will examine upcoming funding streams' requirements to determine which mitigation activities would be eligible. The HMAC may consult with the funding entity, Oregon Military Department –

Office of Emergency Management (OEM), or other appropriate state or regional organizations about project eligibility requirements. This examination of funding sources and requirements will happen during the HMAC's semi-annual NHMP maintenance meetings.

Figure 4-1 Action Item and Project Review Process



Source: Oregon Partnership for Disaster Resilience, 2008.

Step 2: Complete risk assessment evaluation

The second step in prioritizing the NHMP's action items is to examine which hazards the selected actions are associated with and where these hazards rank in terms of community risk. The HMAC will determine whether the NHMP's risk assessment supports the implementation of eligible mitigation activities. This determination will be based on the location of the potential activities, their proximity to known hazard areas and whether community assets are at risk. The HMAC will additionally consider whether the selected actions mitigate hazards that are likely to occur in the future or are likely to result in severe/catastrophic damages.

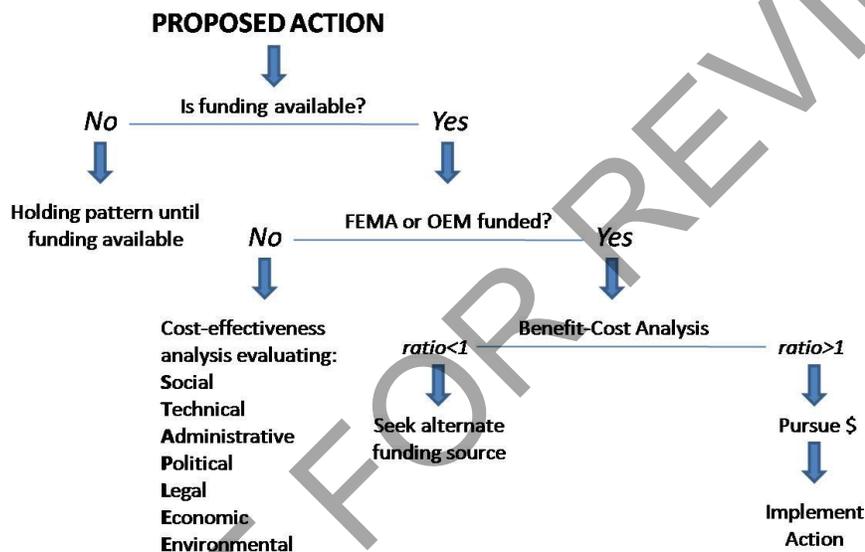
Step 3: Hazard Mitigation Advisory Committee Recommendation

Based on the steps above, the HMAC will recommend which mitigation activities should be moved forward. If the HMAC decides to move forward with an action, the coordinating organization designated in the matrix will be responsible for taking further action and, if applicable, documenting success upon project completion. The HMAC will convene a meeting to review the issues surrounding grant applications and to share knowledge and/or resources. This process will afford greater coordination and less competition for limited funds.

Step 4: Complete quantitative and qualitative assessment and economic analysis

The fourth step is to identify the costs and benefits associated with the selected natural hazard mitigation strategies, measures or projects. Two categories of analysis that are used in this step are: (1) cost-benefit analysis and (2) cost-effectiveness analysis. Conducting cost-benefit analysis for a mitigation activity assists in determining whether a project is worth undertaking now, in order to avoid disaster-related damages later. Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. Determining the economic feasibility of mitigating natural hazards provides decision makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects. Figure 4-2 shows decision criteria for selecting the appropriate method of analysis.

Figure 4-2 Benefit Cost Decision Criteria



Source: Oregon Partnership for Disaster Resilience, 2010.

If the activity requires federal funding for a structural project, the HMAC will use a FEMA-approved cost-benefit analysis tool to evaluate the appropriateness of the activity. A project must have a cost-benefit ratio of greater than one in order to be eligible for FEMA grant funding.

For non-federally funded or nonstructural projects, a qualitative assessment will be completed to determine the project's cost effectiveness. The HMAC will use a multivariable assessment technique called STAPLE/E to prioritize these actions. STAPLE/E stands for Social, Technical, Administrative, Political, Legal, Economic and Environmental. Assessing projects based upon these seven variables can help define a project's qualitative cost effectiveness. OPDR at the University of Oregon's Community Service Center has tailored the STAPLE/E technique for use in natural hazard action item prioritization.

Continued Public Involvement and Participation

The participating jurisdictions are dedicated to involving the public directly in the continual reshaping and updating of the Clackamas County NHMP. Although members of the HMAc represent the public to some extent, the public will also have the opportunity to continue to provide feedback about the NHMP.

To ensure that these opportunities will continue, the County and participating jurisdictions will:

- Post copies of their plan on corresponding websites;
- Place articles in the local newspaper directing the public where to view and provide feedback; and
- Use existing newsletters such as schools and utility bills to inform the public where to view and provide feedback.
- Continue to host a booth at the Clackamas County Fair on an annual basis and will present information about hazard mitigation. For example, on August 29, 2012, Clackamas County Disaster Management (CCDM) set up a looped PowerPoint presentation regarding the plan update process at the fair booth. In addition, CCDM staffed the booth and were available to answer questions and engage interested members of the public directly. The county will continue to employ direct outreach strategies such as this at future county wide events.
- Clackamas County Disaster Management will continue to utilize their social media platforms to involve the public. For example, during the plan update process, the county made posts to Facebook encouraging the public to follow the link provided by the Oregon Partnership for Disaster Resilience and provide comments and feedback on the draft NHMP. The county will continue to employ social media platforms to engage the public about hazard mitigation.

In addition to the involvement activities listed above, Clackamas County will ensure continued public involvement by posting the Clackamas County NHMP on the county's website (<https://www.clackamas.us/dm>). The NHMP will also be archived and posted on the University of Oregon Libraries' Scholar's Bank Digital Archive (<https://scholarsbank.uoregon.edu>).

Five-Year Review of NHMP

This NHMP will be updated every five years in accordance with the update schedule outlined in the Disaster Mitigation Act of 2000. **The Clackamas County MNHMP is due to be updated by [date] 2024.** The Convener will be responsible for organizing the HMAc to address NHMP update needs. The HMAc will be responsible for updating any deficiencies found in the NHMP and for ultimately meeting the Disaster Mitigation Act of 2000's NHMP update requirements.

The following 'toolkit' can assist the Convener in determining which NHMP update activities can be discussed during regularly-scheduled NHMP maintenance meetings and which activities require additional meeting time and/or the formation of sub-committees.

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Table 4-1 Natural Hazard Mitigation Plan Update Toolkit

Question	Yes	No	Plan Update Action
Is the planning process description still relevant?			Modify this section to include a description of the plan update process. Document how the planning team reviewed and analyzed each section of the plan, and whether each section was revised as part of the update process. (This toolkit will help you do that).
Do you have a public involvement strategy for the plan update process?			Decide how the public will be involved in the plan update process. Allow the public an opportunity to comment on the plan process and prior to plan approval.
Have public involvement activities taken place since the plan was adopted?			Document activities in the "planning process" section of the plan update
Are there new hazards that should be addressed?			Add new hazards to the risk assessment section
Have there been hazard events in the community since the plan was adopted?			Document hazard history in the risk assessment section
Have new studies or previous events identified changes in any hazard's location or extent?			Document changes in location and extent in the risk assessment section
Has vulnerability to any hazard changed?			Document changes in vulnerability in the risk assessment section
Have development patterns changed? Is there more development in hazard prone areas?			Document changes in vulnerability in the risk assessment section
Do future annexations include hazard prone areas?			Document changes in vulnerability in the risk assessment section
Are there new high risk populations?			Document changes in vulnerability in the risk assessment section
Are there completed mitigation actions that have decreased overall vulnerability?			Document changes in vulnerability in the risk assessment section
Did the plan document and/or address National Flood Insurance Program repetitive flood loss properties?			Document any changes to flood loss property status

Source: Oregon Partnership for Disaster Resilience, 2010.

Table 4-1 Natural Hazard Mitigation Plan Update Toolkit (continued)

Question	Yes	No	Plan Update Action
Did the plan identify the number and type of existing and future buildings, infrastructure, and critical facilities in hazards areas?			1) Update existing data in risk assessment section, or 2) determine whether adequate data exists. If so, add information to plan. If not, describe why this could not be done at the time of the plan update
Did the plan identify data limitations?			If yes, the plan update must address them: either state how deficiencies were overcome or why they couldn't be addressed
Did the plan identify potential dollar losses for vulnerable structures?			1) Update existing data in risk assessment section, or 2) determine whether adequate data exists. If so, add information to plan. If not, describe why this could not be done at the time of the plan update
Are the plan goals still relevant?			Document any updates in the plan goal section
What is the status of each mitigation action?			Document whether each action is completed or pending. For those that remain pending explain why. For completed actions, provide a 'success' story.
Are there new actions that should be added?			Add new actions to the plan. Make sure that the mitigation plan includes actions that reduce the effects of hazards on both new and existing buildings.
Is there an action dealing with continued compliance with the National Flood Insurance Program?			If not, add this action to meet minimum NFIP planning requirements
Are changes to the action item prioritization, implementation, and/or administration processes needed?			Document these changes in the plan implementation and maintenance section
Do you need to make any changes to the plan maintenance schedule?			Document these changes in the plan implementation and maintenance section
Is mitigation being implemented through existing planning mechanisms (such as comprehensive plans, or capital improvement plans)?			If the community has not made progress on process of implementing mitigation into existing mechanisms, further refine the process and document in the plan.

Source: Oregon Partnership for Disaster Resilience, 2010.

Volume II: Jurisdictional Addenda

In development. To be provided when complete.

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**Volume III:
Appendices**

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APPENDIX A: ACTION ITEM FORMS

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* - Priority Action Item

Table A-I Internal and External Partners and Acronyms

HMAC – Hazard Mitigation Advisory Committee Lead and Supporting Agencies

Internal to Clackamas County

CA - County Administration	PGA - Public and Government Affairs
BCS – Business and Community Services	TS – Technology Services
DM – Disaster Management	TCA - Tourism and Cultural Affairs
Finance	DTD - Transportation and Development
H3S – Health, Housing, and Human Services	WES - Water Environment Services

External to County

Local and Regional

Chambers of Commerce	RDPO – Regional Disaster Preparedness Organization
CFDB - Clackamas Fire Defense Board	School Districts
CWEC - Clackamas Wildfire Executive Committee	SWCD - Soil and Water Conservation Districts
Community Planning Organizations	TVF&R – Tualatin Valley Fire and Rescue
Metro	Universities and Colleges
Mutual Aid Partners	UASI – Urban Area Security Initiative
Neighborhood Associations	Utility Providers
Property Owners	Water districts
	WC - Watershed Councils

State

DLCD – Department of Land Conservation and Development	ODF - Oregon Department of Forestry
DOGAMI – Oregon Department of Geology and Mineral Industries	OSSPAC – Oregon Seismic Safety Policy Advisory Commission
IFA – Infrastructure Finance Authority	OWEB – Oregon Watershed Enhancement Board
OMD-OEM – Oregon Military Department - Office of Emergency Management	Oregon Solutions

Federal

ASFPM - Association of State Floodplain Managers	USACE – U.S. Army Corps of Engineers
BLM – Bureau of Land Management	USFS – U.S. Forest Service
CVO – David A Johnston Cascade Volcano Observatory, USGS Volcano Hazards Program	NRCS – Natural Resources Conservation Service
FEMA – Federal Emergency Management Agency	NWS – National Weather Service
	USGS – United States Geological Survey

Private/Non-Profit

Community Foundations
Insurance Providers
Realtors

Action Item Forms

Each action item has a corresponding action item worksheet describing the activity, identifying the rationale for the project, identifying potential ideas for implementation, and assigning coordinating and partner organizations. The action item worksheets can assist the community in pre-packaging potential projects for grant funding. The worksheet components are described below.

ALIGNMENT WITH EXISTING PLANS/POLICIES

The Clackamas County multi-jurisdictional Natural Hazard Mitigation Plan includes a range of action items that, when implemented, will reduce loss from hazard events in the County. Within the plan, FEMA requires the identification of existing programs that might be used to implement these action items. Clackamas County currently addresses statewide planning goals and legislative requirements through its comprehensive land use plan, capital improvements plan, mandated standards and building codes. To the extent possible, Clackamas County will work to incorporate the recommended mitigation action items into existing programs and procedures. Each action item identifies related existing plans and policies.

STATUS/RATIONALE FOR PROPOSED ACTION ITEM

Action items should be fact-based and tied directly to issues or needs identified throughout the planning process. Action items can be developed at any time during the planning process and can come from a number of sources, including participants in the planning process, noted deficiencies in local capability, or issues identified through the risk assessment. The rationale for proposed action items is based on the information documented in Section 2. The worksheet provides information on the activities that have occurred since the previous plan for each action item.

IDEAS FOR IMPLEMENTATION

The ideas for implementation offer a transition from theory to practice and serve as a starting point for this plan. This component of the action item is dynamic, since some ideas may prove to not be feasible, and new ideas may be added during the plan maintenance process. Ideas for implementation include such things as collaboration with relevant organizations, grant programs, tax incentives, human resources, education and outreach, research, and physical manipulation of buildings and infrastructure.

COORDINATING (LEAD) ORGANIZATION:

The coordinating organization is the public agency with the regulatory responsibility to address natural hazards, or that is willing and able to organize resources, find appropriate funding, or oversee activity implementation, monitoring and evaluation.

INTERNAL AND EXTERNAL PARTNERS:

The internal and external partner organizations listed in the Action Item Worksheets are potential partners recommended by the project HMAAC but not necessarily contacted during the development of the plan. The coordinating organization should contact the identified partner organizations to see if they are capable of and interested in participation. This initial

contact is also to gain a commitment of time and/or resources toward completion of the action items.

Internal partner organizations are departments within the County or other participating jurisdiction that may be able to assist in the implementation of action items by providing relevant resources to the coordinating organization.

External partner organizations can assist the coordinating organization in implementing the action items in various functions and may include local, regional, state, or federal agencies, as well as local and regional public and private sector organizations.

PLAN GOALS ADDRESSED:

The plan goals addressed by each action item are identified as a means for monitoring and evaluating how well the mitigation plan is achieving its goals, following implementation.

TIMELINE:

All broad scale action items have been determined to be ongoing, as opposed to short-term (0 to 2 years) or long-term (3 or more years). This is because the action items are broad ideas, and although actions may be implemented to address the broad ideas, the efforts should be ongoing. For example, although Flood Action Item #3: *“Develop better flood warning systems”* has been addressed by working with the National Weather Service to install flood staff gauges around troublesome areas, the HMAC will continue this effort of mitigating flood loss.

POTENTIAL FUNDING SOURCE

Where possible potential funding sources have been identified. Example funding sources may include: Federal Hazard Mitigation Assistance programs, state funding sources such as the Oregon Seismic Rehabilitation Grant Program, or local funding sources such as capital improvement or general funds. An action item may include several potential funding sources.

ESTIMATED COST

A rough estimate of the cost for implementing each action item is included. Costs are shown in general categories showing low, medium, or high cost. The estimated cost for each category is outlined below:

Low - Less than \$50,000

Medium - \$50,000 – \$100,000

High - More than \$100,000

Multi-Hazard #1*

Proposed Action Item		Alignment with Plan Goals:	
Integrate the goals and action items from the Clackamas County Natural Hazard Mitigation Plan into existing regulatory documents and programs, where appropriate.		Encourage Partnerships & Implementation	
Alignment with Existing Plans/Policies:			
Capital Improvement Plan; Comprehensive Plan			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> The HMAC continues to work with the county on integrating action items for the NHMP into regulatory documents and programs. The DTD Long-Range Planning Work Program may include a project to consolidate and streamline County regulations and plans that pertain to sensitive, hazardous, and environmental zones and overlays that would be contained in one all-encompassing Critical & Hazardous Overlay Zone (CHAOZ). The timeframe for initiating this project has not been precisely determined. No updates to the seismic building codes are expected at the moment. The state could, however, decide in the future to incorporate the updated DOGAMI earthquake information into the applicable codes, at which point the County would be required to adopt it, but nothing is currently expected or on the radar. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> Use the mitigation plan to update the county's Comprehensive Land Use Plan State Land Use Planning Goal 7, designed to protect life and property from natural disasters and hazards through planning strategies that restrict development in areas of known hazards; Integrate the county's mitigation plan into current capital improvement plans; and Partner with other organizations and agencies with similar goals to promote building codes that are more disaster resistant at the state level. 			
Coordinating Organization:		Hazard Mitigation Advisory Committee	
Internal Partners:		External Partners:	
Disaster Management; Finance; Transportation and Development		U.S. Forest Service	
Potential Funding Sources:		Estimated cost:	Timeline:
General Fund		Low	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing action item		
Priority:	High		

* - High Priority Action Item

Multi-Hazard #2*

Proposed Action Item		Alignment with Plan Goals:	
Identify and pursue funding opportunities to develop and implement local and county mitigation activities.		Encourage Partnerships & Implementation	
Alignment with Existing Plans/Policies:			
Capital Improvement Plan			
2018 Status/Rationale for Proposed Action Item:			
<p>The following are different funding opportunities used to develop and implement local and county mitigation activities during the last NHMP cycle:</p> <ul style="list-style-type: none"> • 1 FMA FY16 grant award for mitigating a Repetitive Loss property • 1 HMGP 5% award for a flood warning system (DR-1956) • 1 HMGP awards for flood acquisitions (DR-1956) • 1 PDM FY16 award for NHMP update planning grant • 1 Title III award for updating the Clackamas Community Wildfire Protection Plan • \$2.36 million in wildfire mitigation grants for wildfire mitigation and fuels reduction activities by ODF and CCFD1 			
Ideas for Implementation:			
<ul style="list-style-type: none"> • Develop incentives for local governments, citizens, and businesses to pursue hazard mitigation projects; • Allocate county resources and assistance to mitigation projects when possible; and • Partner with other organizations and agencies in Clackamas County to identify grant programs and foundations that may support mitigation activities. 			
Coordinating Organization:		Disaster Management	
Internal Partners:		External Partners:	
Transportation and Development		Oregon Emergency Management; Federal Emergency Management Agency; Oregon Department of Forestry; Community Foundations, etc.	
Potential Funding Sources:		Estimated cost:	Timeline:
Capital Funds; FEMA PDM, HMGP and FMA Grants; Forest Service Grants; Other grant sources		Low to High: Calculated on a project by project basis	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing action item		
Priority:	High		

* - High Priority Action Item

Multi-Hazard #3

Proposed Action Item:		Alignment with Plan Goals:	
Establish a formal role for the Clackamas County Natural Hazards Mitigation Committee to develop a sustainable process for implementing, monitoring, and evaluating countywide mitigation activities.		Encourage Partnerships & Implementation	
Alignment with Existing Plans/Policies:			
N/A			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> The Hazard Mitigation Advisory Committee continues to meet annually. The following are the dates of past HMAAC meetings prior to the 2018 NHMP update process: <ul style="list-style-type: none"> June 11, 2013 and November 11, 2013 April 23, 2014 and June 25, 2014 April 2, 2015 and June 17, 2015 March 30, 2016 and June 23, 2016 May 25, 2017 and November 7, 2017 (began NHMP update) February 28, 2018 NHMP update The Sandy Sustainable Flood Recovery Group, which includes many of the County members of the HMAAC, has continued to meet twice a month since March 2011 to discuss long-term mitigation activities. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> Establish clear roles for participants, meeting regularly to pursue and evaluate implementation of mitigation strategies; Oversee implementation of the mitigation plan; Establish measurable standards to evaluate mitigation policies and programs and provide a mechanism to update and revise the mitigation plan; Monitor hazard mitigation implementation by jurisdictions and participating organizations through surveys and other reporting methods; Develop updates for the Natural Hazards Mitigation Action Plan based on new information; Conduct a full review of the Natural Hazards Mitigation Action Plan every 5 years by evaluating mitigation successes, failures, and areas that were not addressed; and Provide training for Committee members to remain current on developing issues in the natural hazard loss reduction field. 			
Coordinating Organization:		Hazard Mitigation Advisory Committee	
Internal Partners:		External Partners:	
Disaster Management; Transportation and Development, Technology Services, County Administration			
Potential Funding Sources:		Estimated cost:	Timeline:
General Fund		Low	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	Medium		

Multi-Hazard #4*

Proposed Action Item		Alignment with Plan Goals:	
Identify, improve, and sustain collaborative programs focusing on the real estate and insurance industries, public and private sector organizations, and individuals to avoid activity that increases risk to natural hazards.		Encourage Partnerships & Implementation; Promote Public Awareness; Protect Life and Property	
Alignment with Existing Plans/Policies:			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> • In October 2013, Clackamas County co-sponsored with the Portland Area Realtors Association a realtor workshop on flood insurance. • Clackamas County was selected in 2014 by the USACE for a Public Involvement Pilot Project for the upper Sandy Basin communities, which involved holding facilitated community meetings to discuss flood risk management, with participation by a local realtor. • A Sandy River area realtor participated as a local stakeholder at the Clackamas County Risk Map Resilience Meeting in Oct. 2017. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> • Distribute information about flood, fire, earthquake, and other forms of natural hazards insurance to property owners in areas identified to be at risk through hazard mapping; • Develop a one-page handout on types of insurance and deliver through county utility or service agencies; • Educate individuals and businesses on the benefit of engaging in mitigation activities such as developing impact analyses; • Pinpoint areas of high risk and transfer the cost of risk to property owners through insurance (rather than to the public); • Encourage the development of unifying organizations to ensure communication and dissemination of natural hazard mitigation information; • Identify activities for private sector and citizen involvement such as nonstructural seismic daycare retrofits; and • 			
Coordinating Organization:		Disaster Management	
Internal Partners:		External Partners:	
Public and Government Affairs; Business and Community Services		Realtors; Utility Providers; Property Owners	
Potential Funding Sources:		Estimated cost:	Timeline:
General Fund		Low to Medium	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing action item		
Priority:	High		

* - High Priority Action Item

Multi-Hazard #5

Proposed Action Item:		Alignment with Plan Goals:	
Develop public and private partnerships to foster natural hazard mitigation program coordination and collaboration in Clackamas County.		Encourage Partnerships & Implementation	
Alignment with Existing Plans/Policies:			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> • Since 2013 there has been one county-wide, Presidential Disaster Declaration. As a result, there has been outreach to affected residents regarding SBA loans. • There has also been some outreach and partnering with the Oregon City Chamber of Commerce. (Cascadia Rising, 2015 Floods and the Vice President joined County DM staff to take the National Disaster Recovery Framework training at EMI in 2017.) 			
Ideas for Implementation:			
<ul style="list-style-type: none"> • Work with city governments to develop local Natural Hazards Mitigation Plans that are consistent with the goals and framework of the County Plan; • Identify all organizations within Clackamas County that have programs or interests in natural hazards mitigation; • Involve private businesses throughout the county in mitigation planning; • Improve communication between ODOT and county road departments, and work together to prioritize and identify strategies to deal with road problems; and • Establish protocol for communication electric providers and the Department of Transportation and Development to assure rapid restoration of transportation capabilities. 			
Coordinating Organization:		Disaster Management	
Internal Partners:		External Partners:	
Transportation and Development; Business and Community Services; Public and Government Affairs		Chambers of Commerce	
Potential Funding Sources:		Estimated cost:	Timeline:
General Fund; Business Partnerships		Low	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing action item		
Priority:	Medium		

Multi-Hazard #6*

Proposed Action Item		Alignment with Plan Goals:	
Update and Maintain inventories of at-risk buildings and infrastructure and prioritize mitigation projects.		Protect Life and Property; Encourage Partnerships & Implementation	
Alignment with Existing Plans/Policies:			
Comprehensive Plan			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> • The County is implementing a Building Safety Evaluation Program (BSEP) as a process for identifying vulnerable buildings and conducting post-disaster safety inspections. • The Facilities Maintenance Department continues to work with Disaster Management to develop and maintain a list/inventory of the County's at-risk buildings and infrastructure. Disaster Management maintains the prioritized list. • The County also utilizes the, Statewide Seismic Needs Assessment Using Rapid Visual Screening (RVS), DOGAMI Open-File Report O-07-02. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> • Identify critical facilities at risk from natural hazards events; • Develop strategies to mitigate risk to these facilities, or to utilize alternative facilities should natural hazards events cause damages to the facilities in question; • Incorporate the building inventory developed by the Department of Geology and Mineral Industries (Dec. 2002) into the hazard assessment; and • Identify bridges at risk from flood or earthquake hazards, identify enhancements, and implement projects needed to reduce the risks. 			
Coordinating Organization:		Disaster Management	
Internal Partners:		External Partners:	
Technology Services; Finance; Transportation and Development		Department of Geology and Mineral Industries	
Potential Funding Sources:		Estimated cost:	Timeline:
Capital Funds		Medium to High	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	High		

* - High Priority Action Item

Multi-Hazard #7*

Proposed Action Item		Alignment with Plan Goals:	
Strengthen emergency services preparedness and response by linking emergency services with natural hazard mitigation programs and enhancing and implementing public education programs on a regional scale.		Augment Emergency Services	
Alignment with Existing Plans/Policies:			
Emergency Operations Plan			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> • Clackamas County continues to participate in safety fairs throughout the county. • Each city sponsors workshops in conjunction with the Disaster Management Department. • The county's Resilience Coordinator continues to present at local and regional workshops, conferences, and fairs. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> • Develop a program to encourage private property owners to upgrade their bridges to support weight of fire trucks and emergency vehicles; • Encourage individual and family preparedness through public education projects such as safety fairs; • Identify opportunities for partnering with citizens, private contractors, and other jurisdictions to increase availability of equipment and manpower for efficiency of response efforts; • Work with Community Planning Organizations (CPO's) and other neighborhood groups to establish community response teams; and • Familiarize public officials of requirements regarding public assistance for disaster response. 			
Coordinating Organization:		Disaster Management	
Internal Partners:		External Partners:	
Transportation and Development; Public and Government Affairs; Technology Services; Health, Housing, and Human Services		Community Planning Organizations; Neighborhood Associations	
Potential Funding Sources:		Estimated cost:	Timeline:
Disaster Management Grant Program; General Fund		Low to Medium	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	High		

* - High Priority Action Item

Multi-Hazard #8

Proposed Action Item:		Alignment with Plan Goals:	
Use technical knowledge of natural ecosystems and events to link natural resources management and land use organizations to mitigation activities and technical assistance.		Enhance Natural Systems	
Alignment with Existing Plans/Policies:			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> • Clackamas County Department of Transportation and Develop is working with Water Environment Services and the Sandy River Watershed Council to use the best available data to accurately redefine the erosion zone and not just the flood zone. WES is working with LiDAR studies, and is working to map the migration zones to include all public infrastructure. • Mapping erosional hazards and channel migration is a component of WES's collection system and wastewater treatment facility for Hoodland master plans. • WES partnered with the Wetlands Conservancy on projects to educate property owners in the upper Kellogg Creek basin about floodplain functions and flooding, to hold community workshops to discuss living next to the creek, and to identify project sites on private property for future flood mitigation projects. Additional engagement and coordination has occurred with watershed groups: <ul style="list-style-type: none"> ○ North Clackamas Urban Watershed Council (NCUWC) ○ Greater Oregon City Watershed Council (GOCWC) 			
Ideas for Implementation:			
<ul style="list-style-type: none"> • Review ordinances that protect natural systems and resources to mitigate for natural hazards for possible enhancements; • Pursue vegetation and restoration practices that assist in enhancing and restoring the natural and beneficial functions of the watershed; and • Develop education and outreach programs that focus on protecting natural systems as a mitigation activity. 			
Coordinating Organization:		Water Environment Services	
Internal Partners:		External Partners:	
Transportation and Development		Watershed Councils; Soil and Water Conservation Districts; Oregon Watershed Enhancement Board	
Potential Funding Sources:		Estimated cost:	Timeline:
Oregon Watershed Enhancement Board; General Fund		Low to Medium	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	Medium		

Multi-Hazard #9*

Proposed Action Item		Alignment with Plan Goals:	
Enhance strategies for debris management.		Encourage Partnerships and Implementation; Augment Emergency Services; Enhance Natural Systems	
Alignment with Existing Plans/Policies:			
Emergency Operations Plan			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> The Clackamas County Sustainability & Solid Waste program has one member attending the regional workgroup, and several key staff have attended the FEMA Debris Management training at the NETC in Maryland in September 2016. County staff have developed a Preliminary Debris Management Plan which is slated for submittal to FEMA for first review in 2018. They have been training internally to address disaster-related debris management and have engaged city partners in the development of an action plan that will inform and allow the County to refine its Debris Management Plan with broader community needs in mind. Dan Johnson, DTD Director; Scott Caufield, Building Codes Administrator; Eben Polk, Sustainability Manager et al, are creating the Disaster Debris Management Plan and are coordinating internally as needs arise. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> Work with Metro to complete a regional debris management plan; and Identify local resources available to implement debris management plan. 			
Coordinating Organization:		Transportation and Development	
Internal Partners:		External Partners:	
Disaster Management		Metro; Regional Disaster Preparedness Organization	
Potential Funding Sources:		Estimated cost:	Timeline:
General Fund		Low to Medium	<input checked="" type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	High		

* - High Priority Action Item

Multi-Hazard #10

Proposed Action Item:		Alignment with Plan Goals:	
Update County Comprehensive Plan to integrate most current natural hazard mapping data for Clackamas County and make available to county GIS to improve technical analysis of earthquake hazards.		Protect Life and Property; Encourage Partnerships & Implementation	
Alignment with Existing Plans/Policies:			
Clackamas County Comprehensive Plan; Statewide Planning Goal 7			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> The Clackamas County Comprehensive Plan and Zoning & Development Ordinance (ZDO) have not yet adopted earthquake hazard mapping or associated implementing ordinances. Again, the aforementioned development of CHAOZ and a countywide Surface Water Management Master Plan could lead to adoption and implementation of earthquake hazard mapping and associated development standards. Under the Clackamas County Strategic Plan, Performance Clackamas, the County has developed a strategic goal to adopt a master plan for countywide surface water management. This plan conceivably might include the development of CHAOZ that could operate as a key component of the surface water management plan. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> Utilize LIDAR technology to enhance earthquake mapping efforts. 			
Coordinating Organization:		Transportation and Development and Technology Services	
Internal Partners:		External Partners:	
Disaster Management		Metro; Department of Geology and Mineral Industries; U.S. Geological Survey	
Potential Funding Sources:		Estimated cost:	Timeline:
General Fund; Grants		Low to Medium	<input type="checkbox"/> Short Term (0-2 years) <input checked="" type="checkbox"/> Long Term (2-4+ years) <input type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	Medium		

Multi-Hazard #11*

Proposed Action Item		Alignment with Plan Goals:	
Perform pre-disaster assessments on County owned and/or operated buildings and facilities, potential shelter sites, and essential facilities.		Protect Life and Property; Encourage Partnerships & Implementation	
Alignment with Existing Plans/Policies:			
Clackamas County Comprehensive Plan; Statewide Planning Goal 7			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> The Building Codes Division is developing a plan to perform pre-disaster assessments on County owned and/or operated buildings and facilities, potential shelter sites, and essential facilities. The plan will outline and prioritize these facilities to be evaluated pre-disaster to determine potential hazards that could be mitigated over time to ensure better performance should a disaster occur. The plan and pre-assessments will include evaluations for hazards such as unreinforced masonry construction (URM), year built and relative condition, type of construction, and suitability for the proposed use as component of the Division's Education & Outreach efforts. The anticipated time line for completion of the work in June 30, 2020. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> Utilize the pre-assessments to inform prioritization and retrofitting of County owned and/or operated buildings and facilities, potential shelter sites, and essential facilities. 			
Coordinating Organization:		Transportation and Development	
Internal Partners:		External Partners:	
Disaster Management		Department of Geology and Mineral Industries; U.S. Geological Survey	
Potential Funding Sources:		Estimated cost:	Timeline:
General Fund; Grants		Medium to High	<input checked="" type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input type="checkbox"/> Ongoing
Form Submitted by:	New Action Item (2018)		
Priority:	High		

* - High Priority Action Item

Earthquake #1

Proposed Action Item:		Alignment with Plan Goals:	
Pursue funding opportunities for structural and nonstructural retrofitting of homes, schools, businesses, and government offices that are identified as seismically vulnerable.		Protect Life and Property; Augment Emergency Services; Encourage Partnerships & Implementation	
Alignment with Existing Plans/Policies:			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> Funding source of limited implementation is the Oregon Seismic Rehabilitation Grant Program (SRGP) that depends on the State Treasurer to obligate bond capacity and the ability of the Infrastructure Finance Authority to incur bond debt into their operating budget. Projects that have been funded through the SRGP program are listed in Volume I, Section 2 and within the city addenda. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> Provide information for property owners, small businesses, and organizations on sources of funds (loans, grants, etc.); and Work with owners of buildings included in the DOGAMI seismic survey to ensure that they are aware of potential grant opportunities. Current Needs: <ul style="list-style-type: none"> Rivergrove Water has completed seismic analysis on reservoirs and needs funding for seismic bracing. Milwaukie Community Center (owned by Milwaukie, maintained and operated by Clackamas County North Parks Recreation District) needs seismic upgrade. No engineering studies have been completed. Colton Fire has an engineering report and needs seismic upgrades 			
Coordinating Organization:		Hazard Mitigation Advisory Committee	
Internal Partners:		External Partners:	
Disaster Management; County Administration		Office of Emergency Management; Federal Emergency Management Agency	
Potential Funding Sources:		Estimated cost:	Timeline:
FEMA HMA; IFA Seismic Rehabilitation Grant Program; Capital Funds; Local bonds		High	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	Medium		

Earthquake #2

Proposed Action Item:		Alignment with Plan Goals:	
Encourage purchase of earthquake hazard insurance.		Protect Life and Property; Promote Public Awareness	
Alignment with Existing Plans/Policies:			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> CCDM continues to encourage the purchase of earthquake hazard insurance at annual preparedness fairs all over the county. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> Provide earthquake insurance information to Clackamas County residents; and Coordinate with insurance companies and organizations such as the Insurance Information Service of Oregon and Idaho to produce and distribute earthquake insurance information. 			
Coordinating Organization:		Hazard Mitigation Advisory Committee	
Internal Partners:		External Partners:	
Disaster Management		Insurance Providers, Office of Emergency Management; Oregon Seismic Safety Policy Advisory Commission	
Potential Funding Sources:		Estimated cost:	Timeline:
General fund		Low	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	Low		

Earthquake #3*

Proposed Action Item		Alignment with Plan Goals:	
Encourage seismic strength evaluations for existing critical facilities in the County to identify vulnerabilities for mitigation of schools and universities, public infrastructure, and critical facilities to meet current seismic standards.		Protect Life and Property; Augment Emergency Services	
Alignment with Existing Plans/Policies:			
Emergency Operations Plan			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> • Currently, all new facilities must comply with and meet seismic standards. If someone moves into an old building, they must upgrade to current standards. • DOGAMI did a windshield survey of schools, fire stations, police, and city halls (2007 RVS). The focus was on action of existing buildings and information was shared with participants. • Seismic resiliency is a component of WES's collection system and wastewater treatment facility master plans. Upgrades are constructing as opportunity and funding allows. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> • Encourage owners of non-retrofitted reservoirs to upgrade them to meet seismic standards; • Encourage all water providers to replace all old cast iron pipes with more ductile iron, and identify partnership opportunities with other agencies for pipe replacement; and • Perform FEMA 154 seismic evaluations on all buildings not included in the recent DOGAMI inventory. 			
Coordinating Organization:		Disaster Management	
Internal Partners:		External Partners:	
Transportation and Development, Hazard Mitigation Advisory Committee		Infrastructure Finance Authority, School districts, universities and colleges, utilities, water districts	
Potential Funding Sources:		Estimated cost:	Timeline:
SRGP, HMA (PDM, HMGP)		High	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	High		

* - High Priority Action Item

Earthquake #4

Proposed Action Item:		Alignment with Plan Goals:	
Encourage reduction of nonstructural and structural earthquake hazards in homes, schools, businesses, and government offices through public education.		Protect Life and Property; Promote Public Awareness	
Alignment with Existing Plans/Policies:			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> • Voluntary programs are ongoing. • County building inspectors provide earthquake safety brochures. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> • Provide information to government building and school facility managers and teachers on nonstructural mitigation techniques including: securing bookcases, filing cabinets, light fixtures, and other objects that can cause injuries and block exits; <ul style="list-style-type: none"> ○ Encourage facility managers, business owners, and teachers to refer to FEMA’s practical guidebook: Reducing the Risks of Nonstructural Earthquake Damage; ○ Encourage homeowners and renters to use Is Your Home Protected from Earthquake Disaster? A Homeowner’s Guide to Earthquake Retrofit (IBHS) for economic and efficient mitigation techniques; • Use the FEMA 154 seismic evaluations generated by DOGAMI to prioritize critical and essential buildings for upgrades; • Explore partnerships to provide retrofitting classes for homeowners, renters, building professionals, and contractors; and • Target development located in potential fault zones or in unstable soils for intensive education and retrofitting resources. 			
Coordinating Organization:		Hazard Mitigation Advisory Committee	
Internal Partners:		External Partners:	
Disaster Management		Federal Emergency Management Agency, Office of Emergency Management, Department of Land Conservation and Development	
Potential Funding Sources:		Estimated cost:	Timeline:
General fund		Low	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	Medium		

Flood #1*

Proposed Action Item		Alignment with Plan Goals:	
Identify opportunities to educate people within Clackamas County's public and private flood prone properties and identify feasible mitigation options.		Protect Life and Property; Encourage Partnerships & Implementation	
Alignment with Existing Plans/Policies:			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> • The CRS is on hold at a Class 10 until the County has a dedicated agency and staff to fully implement and support the program. The requisite staff and resources necessary to reconstitute and implement the CRS could be acquired through the aforementioned development of CHAOZ and a countywide Surface Water Management Master Plan. • The Sandy Sustainable Flood Recovery Group continues education and outreach in the upper Sandy River Basin and in the Kellogg Creek Watershed. • WES partnered with the Wetlands Conservancy on projects to educate property owners in the upper Kellogg Creek basin about floodplain functions and flooding, to hold community workshops to discuss living next to the creek, and to identify project sites on private property for future flood mitigation projects. • Clackamas County adopted a strategic goal of having a CRS score of 6 by 2020 http://www.clackamas.us/performance/documents/performanceclackamas.pdf 			
Ideas for Implementation:			
<ul style="list-style-type: none"> • Identify appropriate and feasible mitigation activities for identified repetitive flood properties. Funding may be available through FEMA's Hazard Mitigation Grant and Flood Mitigation Assistance Programs and the Pre-disaster Mitigation Program; • Contact repetitive loss property owners to discuss mitigation opportunities, and determine interest should future project opportunities arise; • Explore options for incentives to encourage property owners to engage in mitigation; • Determine mitigation strategies to reduce undermining of Anderson road by Pudding River; and • Encourage and support the relocation of the Clackamas County Roads Department out of the floodplain. 			
Coordinating Organization:		Transportation and Development	
Internal Partners:		External Partners:	
Disaster Management; Hazard Mitigation Advisory Committee		Department of Land Conservation and Development; Office of Emergency Management	
Potential Funding Sources:		Estimated cost:	Timeline:
General Fund; HMA; FEMA Risk MAP		Medium	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	High		

* - High Priority Action Item

Flood #2

Proposed Action Item:		Alignment with Plan Goals:	
Recommend revisions to requirements for development within the floodplain, where appropriate		Protect Life and Property	
Alignment with Existing Plans/Policies:			
Flood Ordinance; Zoning Code			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> • Clackamas County Planning is working on trying to get residents more involved. • The county dropped to a 10 in the CRS. At this point the cost of implementing the program is higher than the actual benefits to NFIP policy holders, so the county is working on ways to resolve this. • WES is beginning a project to update its Regulations and Standards for new development, which pertain solely to storm systems, erosion control, water quality buffers, and wastewater systems. Water quality and flow control requirements for development may change. • WES applies its Standards for new development to properties whether in the floodplain or not. • Clackamas County is working with Oregon Solutions to examine the need for a state-scale channel migration zone policy for new and existing development. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> • Explore raising the base elevation requirement for new residential construction to three or more feet above base flood elevation, or greater. An increased elevation standard is one activity the county can engage in to receive credit from the NFIP Community Rating System Program; and • Consider adopting regulations specific to migrating streams such as the Sandy and Molalla Rivers. 			
Coordinating Organization:		Transportation and Development	
Internal Partners:		External Partners:	
Disaster Management; Water Environment Services; Technology Services		Department of Land Conservation and Development; Association of State Floodplain Managers; Oregon Solutions	
Potential Funding Sources:		Estimated cost:	Timeline:
General Fund		Low	<input type="checkbox"/> Short Term (0-2 years) <input checked="" type="checkbox"/> Long Term (2-4+ years) <input type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	Low		

Flood #3

Proposed Action Item:		Alignment with Plan Goals:	
Develop better flood warning systems.		Protect Life and Property; Augment Emergency Services	
Alignment with Existing Plans/Policies:			
Emergency Operations Plan			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> Clackamas County Disaster Management used DR-1956-OR HMGP 5% project to install five electronic river gauges in the upper Sandy Basin on five County-owned bridges. Technical and communication problems have prevented the full implementation of this project. The County is currently seeking technical and funding support to enhance the performance and reliability. WES installed satellite communications at its lower Kellogg Creek flow monitoring station near Milwaukie, and partnered with NOAA to host the real-time data on its Advanced Hydrologic Prediction Service website https://water.weather.gov/ahps2/hydrograph.php?wfo=PQR&gage=kcmo3 			
Ideas for Implementation:			
<ul style="list-style-type: none"> Coordinate with appropriate organizations to evaluate the need for more stream gauges; and Distribute information regarding flooding to the general public efficiently. 			
Coordinating Organization:		Disaster Management	
Internal Partners:		External Partners:	
Technology Services; Transportation and Development		Northwest Weather Service; Federal Emergency Management Agency; Oregon Emergency Management; US Army Corps of Engineers	
Potential Funding Sources:		Estimated cost:	Timeline:
General Fund; NWS; FEMA		Low to Medium	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	Medium		

Flood #4

Proposed Action Item:		Alignment with Plan Goals:	
Maintain data and mapping for floodplain information within the county and identify and map flood-prone areas outside of designated floodplains.		Protect Life and Property; Promote Public Awareness	
Alignment with Existing Plans/Policies:			
Flood Ordinance			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> Updated FIRMS for the Sandy River Basin are completed in the County's adoption process. These maps do not address erosion hazards. The 2015 Channel Migration Zone (CMZ) Study for the upper Sandy River delineates 10 miles of erosion hazard and risk with an Erosion Protection Action Line to help plan for mitigation measures. The GIS department has also coordinated with CCDM to map CMZ property exposure and estimate losses. DOGAMI has released a 2017 report mapping CMZ sub-basins in Oregon. Silver Jackets CMZ project in progress to develop a flood risk management plan for the upper Sandy River Communities. movement of river channel. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> Apply for FEMA's cooperative technical partnership using the 2-foot contour interval floodplain mapping data acquired by Clackamas County GIS; Use WES inventory and mapping data to update the flood-loss estimates for Clackamas County; and Identify opportunities to upgrade Federal Insurance Rate Maps, and arrange for Cooperative Technical Partnership mapping upgrades for select areas. 			
Coordinating Organization:		Technology Services	
Internal Partners:		External Partners:	
Transportation and Development; Disaster Management		Department of Geology and Mineral Industries; Federal Emergency Management Agency; Department of Land Conservation and Development	
Potential Funding Sources:		Estimated cost:	Timeline:
RiskMap; General Fund; FEMA		Medium	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	Medium		

Flood #5

Proposed Action Item:		Alignment with Plan Goals:	
Encourage development of acquisition and management strategies to preserve open space for flood mitigation, fish habitat, and water quality in the floodplain and reduce risk to flood prone properties as well as preserve space for open space property.		Protect Life and Property; Enhance Natural Systems	
Alignment with Existing Plans/Policies:			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> County used DR-1956 HMGP funds to acquire three damaged properties along the upper Sandy River following the 2011 flood and is currently using FMA16 funds to acquire a repetitive loss property along Mt. Scott Creek. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> Develop a comprehensive strategy for acquiring and managing floodplain open space in Clackamas County; Explore funding for property acquisition from federal (e.g., FEMA Hazard Mitigation Grant Program), state, regional, and local governments, as well as private and non-profit organizations, trails programs, fish programs; Develop a regional partnership among flood mitigation, fish habitat, and water quality enhancement organizations/programs to improve educational programs; Identify sites where environmental restoration work can benefit flood mitigation, fish habitat, and water quality; Work with landowners to develop flood management practices that provide healthy fish habitat; and Identify existing watershed education programs and determine which programs would support a flood education component. 			
Coordinating Organization:		Disaster Management	
Internal Partners:		External Partners:	
Water Environment Services; Transportation and Development		Metro; Federal Emergency Management Agency	
Potential Funding Sources:		Estimated cost:	Timeline:
Capital Funds; General Fund; FEMA HMA; OWEB		Medium	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	Medium		

Flood #6

Proposed Action Item:		Alignment with Plan Goals:	
Identify and address surface water drainage problematic sites for all parts of unincorporated Clackamas County.		Protect Life and Property; Enhance Natural Systems	
Alignment with Existing Plans/Policies:			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> • DTD is replacing culverts throughout the county (ongoing project). • In the urban area and portions of the Tualatin River watershed, WES identifies capacity-limited storm infrastructure for replacement or repair. Currently WES is evaluating 6 capacity-limited storm systems and is budgeting for repairs in FY 2018-19. Additional sites may follow in future FYs, pending available funding. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> • Map culverts in unincorporated areas of the county; • Prepare an inventory of culverts that historically create flooding problems and target them for retrofitting; and • Prepare an inventory (<i>in-progress</i>) of major urban drainage problems and identify causes and potential mitigation actions for urban drainage problem areas (e.g. reduce standing water on Telford Road along Johnson Creek by upgrading the 20-inch culvert on Spring Water Trail to drain more efficiently with the County 60-inch culvert in that area.). 			
Coordinating Organization:		Water Environment Services	
Internal Partners:		External Partners:	
Transportation and Development; Technology Services		Soil and Water Conservation Districts; Watershed Councils	
Potential Funding Sources:		Estimated cost:	Timeline:
Capital Funds		Medium to High	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	Medium		

Flood #7

Proposed Action Item:		Alignment with Plan Goals:	
Establish a framework to compile and coordinate surface water management plans and data throughout the county.		Protect Life and Property; Encourage Partnerships & Implementation	
Alignment with Existing Plans/Policies:			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> The development of CHAOZ and a countywide Surface Water Management Master Plan could lead to the establishment of a framework to compile and coordinate surface water management plans and data on a countywide basis. Clackamas County adopted a strategic goal of by 2020 adopting a master plan for surface water management that will enhance the quality of surface water. WES is taking a lead role in this planning effort, along with DTD and Disaster Management input. The plan could include floodplain management as an action to improve surface water quality. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> Develop surface water management plans for areas that are not currently within surface water management plan boundaries. 			
Coordinating Organization:		Transportation and Development	
Internal Partners:		External Partners:	
Water Environment Services; Technology Services			
Potential Funding Sources:		Estimated cost:	Timeline:
Unidentified		Medium	<input checked="" type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	Medium		

Flood #8*

Proposed Action Item		Alignment with Plan Goals:	
Encourage purchase of flood insurance.		Protect Life and Property; Encourage Partnerships & Implementation; Promote Public Awareness	
Alignment with Existing Plans/Policies:			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> The Clackamas County Planning Division routinely encourages property owners and prospective buyers, at all levels of development review and provision of property information, to purchase flood insurance if they are within proximity to a perennial water body, especially anywhere within the Sandy River Basin, even if they are not located in a FEMA floodplain. The Division also informs prospective buyers about FEMA's mandatory purchase of flood insurance for structures in the floodplain that are financed through federally backed mortgages. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> Develop an outreach program that addresses communities located in or near the 100 and 500-year floodplain and provides them with valuable information on the NFIP. 			
Coordinating Organization:		Transportation and Development	
Internal Partners:		External Partners:	
Disaster Management; Hazard Mitigation Advisory Committee		Department of Land Conservation and Development; Insurance Providers	
Potential Funding Sources:		Estimated cost:	Timeline:
Unknown		Unknown	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item (HMAC, 2012)		
Priority:	High		

* - High Priority Action Item

Flood #9

Proposed Action Item:		Alignment with Plan Goals:	
Develop a floodplain management plan as a standalone for the CRS program.		Encourage Partnerships & Implementation	
Alignment with Existing Plans/Policies:			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> The CRS could be reconstituted and implemented through the development of CHAOZ and a countywide Surface Water Management Master Plan, in turn leading to the development of a standalone floodplain management plan that fully meets CRS criteria. Nothing has occurred since 2012. Countywide surface water district under consideration in 2018. Clackamas County adopted a strategic goal of by 2020 adopting a master plan for surface water management that will enhance the quality of surface water. WES is taking a lead role in this planning effort, along with DTD and Disaster Management input. The plan could include floodplain management as an action to improve surface water quality. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> Create a floodplain management plan that can be used for the CRS program. This new plan will give the CRS program new weight and can help improve the county's current CRS rating score. 			
Coordinating Organization:		Transportation and Development	
Internal Partners:		External Partners:	
Disaster Management; Water Environment Services; County Administration			
Potential Funding Sources:		Estimated cost:	Timeline:
General Fund		High	<input checked="" type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item (HMAC, 2012)		
Priority:	Medium		

Landslide #1

Proposed Action Item:		Alignment with Plan Goals:	
Continue to improve knowledge of landslide hazard areas and understanding of vulnerability and risk to life and property in hazard-prone areas.		Protect Life and Property; Promote Public Awareness	
Alignment with Existing Plans/Policies:			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> In late 2013 DOGAMI completed a landslide hazard and susceptibility analysis for most of the County, (9 quadrangles covering the northwestern and central communities with most of the County's populations). These maps have not yet been adopted or integrated into the County's planning process. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> Adopt and integrate the 2013 DOGAMI landslide hazard and susceptibility maps into the county's planning process. Develop public information to emphasize economic risk when building on potential or historical landslide areas; Identify funding sources to enhance site-specific geohazard mapping the Urban Growth Boundary; Partner with PSU to develop a descriptive landslide inventory along all Clackamas County roadways, including appropriate mitigation strategies; and Identify existing mechanisms for public outreach (e.g., SWCD, NRCS, watershed councils, etc.). 			
Coordinating Organization:		Hazard Mitigation Advisory Committee	
Internal Partners:		External Partners:	
Transportation and Development; Technology Services		Department of Geology and Mineral Industries	
Potential Funding Sources:		Estimated cost:	Timeline:
General Fund		Medium to High	<input checked="" type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	Medium		

Landslide #2

Proposed Action Item:		Alignment with Plan Goals:	
Identify public education tools and opportunities in high-risk debris flow and landslide areas.		Protect Life and Property; Augment Emergency Services; Promote Public Awareness	
Alignment with Existing Plans/Policies:			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> • There is currently a USGS report in review that examines concentrations of residents, employees and visitors in the Hoodland area with seasonal variability to serve as a tool for evacuation planning. • DOGAMI MH study for Mt. Hood contains exposure analysis for landslide and debris flow hazards in the Sandy River Basin. http://www.oregongeology.org/pubs/ofr/p-O-11-16.htm 			
Ideas for Implementation:			
<ul style="list-style-type: none"> • Identify potential debris removal resources; • Increase participation in regional committee planning for emergency transportation routes; • Identify and publicize information regarding emergency transportation routes; and • Work with County Evacuation Planning Committee to develop and exercise evacuation plans. 			
Coordinating Organization:		Disaster Management	
Internal Partners:		External Partners:	
Transportation and Development		Department of Geology and Mineral Industries	
Potential Funding Sources:		Estimated cost:	Timeline:
General Fund		Low to Medium	<input checked="" type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	Medium		

Landslide #3*

Proposed Action Item		Alignment with Plan Goals:	
Continue to limit activities in identified potential and historical landslide areas through regulation and public outreach.		Protect Life and Property; Promote Public Awareness; Enhance Natural Systems	
Alignment with Existing Plans/Policies:			
Comprehensive Plan; Development Code			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> • DOGAMI continues to map out landslide hazard areas and get the word out. • There haven't been any changes in the Comprehensive Plan or land use ordinances, however land use mapping tools pick up new information automatically because the GIS Division updates new mapping data when received from DOGAMI. • Steep slope land use maps continue to refer to hazardous areas. • Changes in land use ordinances to routinely adopt the most current landslide hazard data from DOGAMI could be realized through the aforementioned development of CHAOZ and a countywide Surface Water Management Master Plan. In the meantime, the County obtains the most recent landslide hazard data from DOGAMI and coordinates among the Planning, Engineering, Building and Septic & Onsite Wastewater Systems (SOWS) divisions to utilize the data, steer development away from hazardous areas to the extent feasible, and apply requirements for geotechnical reports during the course of development review. • Customers are also routinely notified when properties are located in a mass movement / landslide hazard area. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> • Analyze and recommend improvements to existing regulations regarding development in landslide prone areas. Consider using the City of Salem Landslide Ordinance as an example of effective regulation for development; • Incorporate the data from the historic and potential debris flow and landslides hazard map (DOGAMI, 2003) into the County's Comprehensive Land Use Plan to assist in meeting State Land Use Planning Goal 7, designed to protect life and property from natural disasters and hazards through the implementation of planning strategies that restrict development in areas of known hazards; • Examine logging regulations on private property to ensure accountability of cumulative downslope effects; and • Identify existing mechanisms for public outreach (e.g., SWCD, NRCS, watershed councils, etc.). 			
Coordinating Organization:		Hazard Mitigation Advisory Committee	
Internal Partners:		External Partners:	
Transportation and Development, Technology Services		Department of Geology and Mineral Industries; Department of Land Conservation and Development	
Potential Funding Sources:		Estimated cost:	Timeline:
DLCD Technical Assistance		Low to Medium	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	High		

* - High Priority Action Item

Landslide #4*

Proposed Action Item		Alignment with Plan Goals:	
Recommend construction and subdivision design that can be applied to steep slopes to reduce the potential adverse impacts from development.		Protect Life and Property; Promote Public Awareness	
Alignment with Existing Plans/Policies:			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> • Landslides and steep slopes are already considerations in the approval of land divisions and residential developments on legal lots of record) as required by Clackamas County Zoning and Development Ordinance Sections 1001, 1002, and 1003. • Additionally, the state-wide adopted Building Codes in Oregon address foundation design and slope stability for both commercial and residential construction. • Finally, the County's adopted Grading and Excavation Ordinance (CC Title 9.03) also establishes requirements for earthwork in hazardous areas. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> • Analyze and recommend improvements to existing regulations regarding development in landslide prone areas. Consider using the City of Salem Landslide Ordinance as an example of effective regulation for development; • Incorporate the data from the historic and potential debris flow and landslides hazard map (DOGAMI, 2003) into the County's Comprehensive Land Use Plan to assist in meeting State Land Use Planning Goal 7, designed to protect life and property from natural disasters and hazards through the implementation of planning strategies that restrict development in areas of known hazards; • Examine logging regulations on private property to ensure accountability of cumulative downslope effects; and • Identify existing mechanisms for public outreach (e.g., SWCD, NRCS, watershed councils, etc.). 			
Coordinating Organization:		Hazard Mitigation Advisory Committee	
Internal Partners:		External Partners:	
Transportation and Development		Department of Geology and Mineral Industries Department of Land Conservation and Development; Soil and Water Conservation Districts, Natural Resources Conservation Services, Watershed Councils	
Potential Funding Sources:		Estimated cost:	Timeline:
General Fund		Low	<input checked="" type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item (HMAC, 2012)		
Priority:	High		

* - High Priority Action Item

Severe Weather #1

Proposed Action Item:		Alignment with Plan Goals:	
Develop and implement programs to coordinate maintenance and mitigation activities to reduce risk to public infrastructure from severe weather.		Augment Emergency Services; Encourage Partnerships & Implementation	
Alignment with Existing Plans/Policies:			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> WES and DTD, along with Happy Valley and Rivergrove, will partner to implement a joint stormwater management plan that includes routine inspection and maintenance of storm system inlets, conveyances, and treatment BMPs, to ensure proper condition and function, thereby improving operational resiliency in severe weather events like intense rainfall. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> Partner with responsible agencies and organizations to design and implement programs that reduce risk to life, property, and utility systems; Develop partnerships between utility providers and county and local public works agencies to document known hazard areas; Reduce icy conditions or other hazards at public access public service buildings and ensure public safety by prioritizing critical facilities' parking lots to be cleared before other roads. <ul style="list-style-type: none"> Improve traffic management Track progress of road crews. Provide public/staff with info. regarding road closures, sanding and plowing routes, time the roads were plowed, and a safety rating via cable access and website; and Enhance County plowing capability <ul style="list-style-type: none"> Purchase a residential snow plow and a deicer machine 			
Coordinating Organization:		Hazard Mitigation Advisory Committee	
Internal Partners:		External Partners:	
Transportation and Development		Mutual Aid Partners	
Potential Funding Sources:		Estimated cost:	Timeline:
Capital Funds		Low to High	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	Medium		

Severe Weather #2

Proposed Action Item:		Alignment with Plan Goals:	
Continue to educate the public on severe weather mitigation activities.		Protect Life and Property; Promote Public Awareness	
Alignment with Existing Plans/Policies:			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> Ongoing effort of County Disaster Management (see below of implementation measures). 			
Ideas for Implementation:			
<ul style="list-style-type: none"> Distribute educational materials to Clackamas residents and public and private sector organizations regarding evacuation routes during road closures; Target the vulnerable populace for disseminating preparedness information; and Reduce freezing pipes and resultant damage by encouraging water providers to put a flyer in November water bills to advise of preventions measures available. Calendar discontinued 			
Coordinating Organization:		Hazard Mitigation Advisory Committee	
Internal Partners:		External Partners:	
Public and Government Affairs			
Potential Funding Sources:		Estimated cost:	Timeline:
General Fund		Low	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	Medium		

Severe Weather #3*

Proposed Action Item		Alignment with Plan Goals:	
Monitor and implement programs to keep trees from threatening lives, property, and public infrastructure during windstorm events.		Augment Emergency Services; Encourage Partnerships & Implementation	
Alignment with Existing Plans/Policies:			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> • Efforts to monitor and implement programs to keep trees from threatening lives, property, and public infrastructure during windstorm events is ongoing. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> • Partner with responsible agencies and organizations to design and disseminate education information to property owners to reduce risk from tree failure to life, property, and utility systems; • Develop partnerships between utility providers and county and local public works agencies to document known hazard areas; and • Identify potentially hazardous trees in urban areas. 			
Coordinating Organization:		Transportation and Development	
Internal Partners:		External Partners:	
Business and Community Services		Utility Providers	
Potential Funding Sources:		Estimated cost:	Timeline:
General Fund		Medium	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	High		

* - High Priority Action Item

Severe Weather #4

Proposed Action Item:		Alignment with Plan Goals:	
Support/encourage electrical utilities to use underground construction methods where possible to reduce power outages from windstorms.		Encourage Partnerships & Implementation; Enhance Natural Systems	
Alignment with Existing Plans/Policies:			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> All new county electrical utilities (non-transmission) are required to be constructed underground. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> Increase the use of underground utilities where possible. 			
Coordinating Organization:		Transportation and Development	
Internal Partners:		External Partners:	
Disaster Management		Utility Providers	
Potential Funding Sources:		Estimated cost:	Timeline:
Permit fees		Low	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	Medium		

Volcanic Eruption #1

Proposed Action Item:		Alignment with Plan Goals:	
Work with the state and other impacted jurisdictions to update and exercise the Mount Hood Inter-Agency Volcano Coordination Plan.		Augment Emergency Services; Encourage Partnerships & Implementation; Promote Public Awareness	
Alignment with Existing Plans/Policies:			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> Clackamas County Disaster Management has initiated a multi-hazard evacuation planning process for the Hoodland area for volcano, wildfire and flood hazards. Many of the jurisdictions involved in the Mt. Hood Inter-Agency Volcano Coordination Plan are participating. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> Coordinate with local and regional groups to conduct exercises, plan evaluation and revisions. 			
Coordinating Organization:		Disaster Management	
Internal Partners:		External Partners:	
Tourism and Cultural Affairs; Transportation and Development		Department of Geology and Mineral Industries; U.S. Geological Survey; Office of Emergency Management; Metro; Cascades Volcano Observatory; Tualatin Valley Fire and Rescue	
Potential Funding Sources:		Estimated cost:	Timeline:
General Fund		Low	<input type="checkbox"/> Short Term (0-2 years) <input checked="" type="checkbox"/> Long Term (2-4+ years) <input type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	Medium		

Volcanic Eruption #2

Proposed Action Item:		Alignment with Plan Goals:	
Utilize existing risk assessments and collaborate with USGS-CVO and related agencies to develop ash fall models that are specific to Clackamas County.		Protect Life and Property; Augment Emergency Services; Encourage Partnerships & Implementation; Promote Public Awareness	
Alignment with Existing Plans/Policies:			
Emergency Operations Plan			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> USGS funded DOGAMI Multi-Hazard study of proximal and distal land-based exposure to volcano hazards for Sandy River and Hood River valleys. This may provide the basis for vulnerability assessments for near-field ash hazard assessments. http://www.oregongeology.org/pubs/ofr/p-O-11-16.htm Clackamas County collaborated with the USGS on a population exposure analysis for the Hoodland area in the eastern County for volcano, wildfire and flood hazards. https://pubs.er.usgs.gov/publication/ofr20131073 From the GIS standpoint, no one has done or has access to any ash fall models or maps at this time. GIS is a tool that could model some of this if the base data was available. Once the DOGAMI Mt Hood study becomes available, it may provide the county with initial debris flow and possibly ash fall models. 			
Ideas for Implementation:			
<ul style="list-style-type: none"> Determine critical activities that must be implemented for varying degrees of ash fall; and Work with the National Early Volcano Warning System collaborative group to better assess ash fall modeling and warning systems in Clackamas County. 			
Coordinating Organization:		Technology Services	
Internal Partners:		External Partners:	
Disaster Management		Department of Geology and Mineral Industries; U.S. Geological Survey	
Potential Funding Sources:		Estimated cost:	Timeline:
USGS		Low to Medium	<input type="checkbox"/> Short Term (0-2 years) <input checked="" type="checkbox"/> Long Term (2-4+ years) <input type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	Low		

Volcanic Eruption #3

Proposed Action Item:		Alignment with Plan Goals:	
Strengthen response and recovery programs, and work with the USGS-CVO to enhance public education programs for volcanic eruption hazards.		Protect Life and Property; Augment Emergency Services; Encourage Partnerships & Implementation; Promote Public Awareness	
Alignment with Existing Plans/Policies:			
2018 Status/Rationale for Proposed Action Item:			
<ul style="list-style-type: none"> • CCDM participated in CVO and UW regional volcano risk workshop, May 2017. • Cooperated with USGS for the release of OFR 2013-1073 multi-hazard vulnerability study for the Hoodland area, with an emphasis on assessing volcanic risk. • DOGAMI Natural Hazard Risk Report (expected July 2018) 			
Ideas for Implementation:			
<ul style="list-style-type: none"> • Develop basic public education materials that describe volcanic eruption hazards (pyroclastic surges, pyroclastic flows, lahars, mudflows, landslides, ash fall), potential impacts, and appropriate response and mitigation activities; • Coordinate with the media for volcanic hazard education programs to reduce conveyance of misinformation; • Participate with the USGS-CVO to develop a public education program for volcano hazards specific to Clackamas County; and • Work with active citizen groups to sustain volcanic hazards education programs. 			
Coordinating Organization:		Disaster Management	
Internal Partners:		External Partners:	
		U.S. Geological Survey	
Potential Funding Sources:		Estimated cost:	Timeline:
USGS		Low	<input type="checkbox"/> Short Term (0-2 years) <input checked="" type="checkbox"/> Long Term (2-4+ years) <input type="checkbox"/> Ongoing
Form Submitted by:	Existing Action Item		
Priority:	Low		

Wildfire #1*

Proposed Action Item:		Alignment with Plan Goals:	
Coordinate wildfire mitigation action items through the Clackamas Community Wildfire Protection Plan .		Protect Life and Property; Augment Emergency Services; Encourage Partnerships & Implementation; Promote Public Awareness; Enhance Natural Systems	
Alignment with Existing Plans/Policies:			
Clackamas Community Wildfire Protection Plan (2018)			
2018 Status/Rationale for Proposed Action Item:			
The wildfire mitigation action items provide direction on specific activities that organizations and residents in Clackamas can take to reduce wildfire hazards.			
Ideas for Implementation: CCWPP Identified Focus Areas and Priority Actions			
<u>Wildfire Risk Assessment (Ch. 4):</u>			
<ol style="list-style-type: none"> 1. Maintain and update the Fuels Reduction (FR) and Communities at Risk (CAR) maps and databases. 2. Continue to track structure vulnerability data throughout the County through structural triage assessments. 3. Update the Overall Wildfire Risk Assessment as new data becomes available. 			
<u>Hazardous Fuels Reduction and Biomass Utilization (Ch. 5):</u>			
<ol style="list-style-type: none"> 1. Develop and maintain an inventory of potential and successful FR projects by meeting with parks and natural lands managers quarterly. 2. Continue securing funding to implement projects/hire seasonal ODF staff. 			
<u>Emergency Operations (Ch. 6):</u>			
<ol style="list-style-type: none"> 1. Develop and FDB Communications Works Group. 2. Conduct a Conflagration Exercise. 			
<u>Education and Community Outreach (Ch. 7):</u>			
<ol style="list-style-type: none"> 1. Develop Firewise toolkit for CAR's. 2. Create incentives for fuels reduction. 3. Update and distribute the Burn Permitting and Fire Restrictions Brochure. 4. Continue to improve address signage throughout the County. 			
<u>Structural Ignitability Policies and Programs (Ch. 8):</u>			
<ol style="list-style-type: none"> 1. Identify a DTD representative for the WFEP. 2. Improve coordination with Rural Fire Agencies. 3. Integrate WU into Plan Map and include a public outreach strategy. 			
Coordinating Organization:		Clackamas Wildfire Executive Committee	
Internal Partners:		External Partners:	
Clackamas Fire Defense Board, Disaster Management public land management agencies		Oregon Department of Forestry, U.S. Forest Service, U.S. Bureau of Land Management	
Potential Funding Sources:		Estimated cost:	Timeline:
ODF, operating budgets		Low to High	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	New Action Item/ Wildfire Planning Executive Committee (2018)		
Priority:	High (CCWPP identified priority actions listed above)		

* - High Priority Action Item

Wildfire #2*

Proposed Action Item:		Alignment with Plan Goals:	
Encourage private landowners to create and maintain defensible space around homes and other buildings.		Protect Life and Property; Encourage Partnerships & Implementation; Promote Public Awareness	
Alignment with Existing Plans/Policies:			
Clackamas Community Wildfire Protection Plan (2018)			
2018 Status/Rationale for Proposed Action Item:			
<p>Along with a home's structural characteristics, a home's surroundings are the other most important factor in determining home ignitability in wildland-urban interface areas. Defensible space is the most effective way to reduce the risk of structural loss from wildfires that spread into residential areas. Proper implementation and maintenance of defensible space could significantly decrease risk to residential development.</p>			
Ideas for Implementation: CCWPP Identified Focus Areas and Priority Actions			
<ul style="list-style-type: none"> • Develop basic public education materials that describe wildfire hazards and the benefits of creating defensible space around homes and other buildings. • Coordinate with the media for wildfire hazard education programs to reduce conveyance of misinformation; • Work with active citizen groups (Firewise Communities, etc.) to sustain volcanic hazards education programs. • Wildfire education and outreach materials may be found on the National Fire Protection Association's website: https://www.nfpa.org/Public-Education. 			
Coordinating Organization:		Disaster Management	
Internal Partners:		External Partners:	
		Oregon Department of Forestry, U.S. Forest Service, U.S. Bureau of Land Management, Clackamas Fire Defense Board, Clackamas Wildfire Executive Committee, public land management agencies	
Potential Funding Sources:		Estimated cost:	Timeline:
ODF, operating budgets		Low to High	<input type="checkbox"/> Short Term (0-2 years) <input type="checkbox"/> Long Term (2-4+ years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	New Action Item		
Priority:	High		

* - High Priority Action Item

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DRAFT FOR REVIEW

APPENDIX B: PLANNING AND PUBLIC PROCESS

NHMP Update Changes

This memo describes the changes made to the 2013 Clackamas County Natural Hazard Mitigation Plan (MNHMP) during the 2018 NHMP update process.

Project Background

Clackamas County and the cities of Canby, Estacada, Gladstone, Happy Valley, Johnson City, Lake Oswego, Milwaukie, Molalla, Oregon City, Sandy, West Linn, and Wilsonville and Clackamas Fire District #1 partnered with the Oregon Partnership for Disaster Resilience (OPDR) to update the multi-jurisdictional 2013 Clackamas County NHMP. The Disaster Mitigation Act of 2000 requires communities to update their mitigation plans every five years to remain eligible for Pre-Disaster Mitigation (PDM) program funding, Flood Mitigation Assistance (FMA) program funding, and Hazard Grant Mitigation Program (HMGP) funding. A Federal Disaster Management Pre-Disaster Mitigation grant funded the CSC work with non-federal match provided by Clackamas County.

OPDR and the committees made several changes to the previous NHMP to consolidate and streamline the plan. The Clackamas Fire District #1 and Clackamas River Water Providers had addenda added to this version of the plan. The community of Damascus disincorporated in 2016, as such their addendum was removed in this version of the plan.

Major changes are documented and summarized in this memo.

2018 NHMP Update Changes

The sections below only discuss *major* changes made to the NHMPs during the 2018 NHMP update process. Major changes include the replacement or deletion of large portions of text, changes to the NHMP's organization, new mitigation action items, the deletion of the Damascus addendum, and the addition of the Clackamas Fire District to the NHMP. If a section is not addressed in this memo, then it can be assumed that no significant changes occurred.

The NHMP's format and organization have been altered to fit within OPDR's NHMP templates. Table B-1 lists the 2013 Clackamas County NHMP section names and the corresponding 2018 section names, as updated (major Volumes are highlighted). This memo will use the 2018 NHMP update section names to reference any changes, additions, or deletions within the NHMP.

Table B-I Changes to MNHMP Organization

2013 Clackamas County MNHMP	2018 Clackamas County MNHMP
Acknowledgements	Acknowledgements
Table of Contents	Table of Contents
-	Approval Letters and Resolutions
-	FEMA Review Tool
Volume I: Basic Plan	Volume I: Basic Plan
Executive Summary	Plan Summary
Section 1: Introduction	Section 1: Introduction
Section 2: Risk Assessment	Section 2: Hazard Identification and Risk Assessment
Section 3 Mission, Goals, and Action Items	Section 3: Mitigation Strategy
Section 4: Plan Implementation and Maintenance	Section 4: Plan Implementation and Maintenance
Volume II: Hazard Annexes	
Drought	Incorporated into Volume I, Section 2
Earthquake	
Flood	
Landslide	
Severe Storm	
Volcanic Eruption	
Wildfire	
Volume III: City Addenda	Volume II: Jurisdictional Addenda
Canby	Canby
Damascus	-
Estacada	Estacada
Gladstone	Gladstone (participation to be determined)
Happy Valley	Happy Valley
Johnson City	Johnson City
Lake Oswego	Lake Oswego
Milwaukie	Milwaukie
Molalla	Molalla
Oregon City	Oregon City
Sandy	Sandy
West Linn	West Linn
Wilsonville	Wilsonville
-	Clackamas Fire District #1
Volume IV: Appendices	Volume III: Appendices
Appendix A: Action Items	Appendix A: Action Item Forms
Appendix B: Planning and Public Process	Appendix B: Planning and Public Process
Appendix C: Community Profile	Appendix C: Community Profile
Appendix D: Economic Analysis	Appendix E: Economic Analysis of Natural Hazard Mitigation Projects
Appendix E: Regional Hazard Mitigation Public Opinion Survey	Appendix H: Community Survey
Appendix F: Vulnerability Analysis Table	<i>Not included</i>
Appendix G: Grant Programs	Appendix F: Grant Programs and Resources
Appendix H: Clackamas Community Wildfire Protection Plan	<i>Incorporated by reference in Volume I, Section 2</i>
-	Appendix D: Natural Hazard and Base Maps
-	Appendix G: Lifeline Sectors Risk Assessment

As the table indicates the structure of the NHMP has changed significantly including the addition of several additional addenda. Content and changes are described below.

Front Pages

1. The NHMP's cover has been updated.
2. Acknowledgements have been updated to include the 2018 project partners and planning participants.
3. The FEMA approval letter, review tool, and county and city resolutions of adoption are included.

Volume I: Basic Plan

Volume I provides the overall NHMP framework for the 2017 Multi-jurisdictional NHMP update. Volume I includes the following sections:

Plan Summary

The 2018 NHMP includes an updated NHMP summary that provides information about the purpose of Natural Hazard Mitigation planning and describes how the NHMP will be implemented.

Section 1: Introduction

Section 1 introduces the concept of Natural Hazard Mitigation planning and answers the question, "Why develop a mitigation plan?" Additionally, Section 1 summarizes the 2018 NHMP update process, and provides an overview of how the NHMP is organized. Major changes to Section 1 include the following:

- Most of Section 1 includes new information that replaces out of date text found in the 2013 NHMP. The new text describes the federal requirements that the NHMP addresses and gives examples of the policy framework for natural hazards planning in Oregon.
- Section 1 of the 2018 update, outlines the entire layout of the NHMP update, which has been altered as described above.

Section 2: Hazard Identification and Risk Assessment

This section consists of three phases: hazard identification, vulnerability assessment, and risk analysis. Hazard identification involves the identification of hazard geographic extent, its intensity, and probability of occurrence. The second phase, attempts to predict how different types of property and population groups will be affected by the hazard. The third phase involves estimating the damage, injuries, and costs likely to be incurred in a geographic area over a period of time. Changes include:

- The hazard information of the previous NHMP have been integrated into this section and within Volume III, Appendix C.
- Hazard identification, characteristics, history, probability, vulnerability, and hazard specific mitigation activities were updated. Outdated and extraneous information was removed and links to technical reports were added as a replacement. With this update the Oregon NHMP is cited heavily as a reference to the more technical hazard material.
- The recently completed a multi-hazard risk assessment (Risk Report, DOGAMI) for the Lower Columbia-Sandy Watershed including unincorporated communities, The

Villages at Mount Hood and Government Camps and the City of Sandy is incorporated into this section and within applicable city addenda.

- Updated vulnerability information is included, with special emphasis placed upon the hazards profiled in the Risk Report cited above, recent earthquake reports specifically the Cascadia Subduction Zone, Portland Hills Fault, and Mount Hood Fault), and volcanic hazards associated with Mount Hood.
- Links to specific hazard studies and data are embedded directly into the NHMP where relevant and available.
- NFIP information was updated.
- The hazard vulnerability analysis has been updated for the county and cities (city information is included with more detail within Volume II).

Section 3: Mitigation Strategy

This section provides the basis and justification for the mission, goals, and mitigation actions identified in the NHMP. The 2013 mission and goals were evaluated by the HMAC and no changes were made. The activities and status of mitigation strategies (actions) are noted on each Action Item Form within Volume III, Appendix A. Major changes to the mitigation strategies (actions) include the following:

- **Severe Weather Action #4 (2013)** *“Map and publicize locations around the county that have the highest incidence of extreme windstorms”* was deleted as an action item. Extreme windstorms are possible throughout the County and defined locations are currently available. At this time this action is considered unnecessary.
- **Severe Weather Action #5 (2013)** was renumbered to Severe Weather Action #4 (2018), see Volume III, Appendix A for more information.
- **Multi-Hazard Action #11 (2018)** *“Perform pre-disaster assessments on County owned and/or operated buildings and facilities, potential shelter sites, and essential facilities”* was added to the list of mitigation actions in 2018.

Section 4: Plan Implementation and Maintenance

Clackamas County Disaster Management will continue to convene and coordinate the County Hazard Mitigation Advisory Committee (documentation for the City Hazard Mitigation Advisory Committees is contained within the City addenda in Volume II).

Volume II: Jurisdictional Addenda

The cities of Canby, Estacada, Gladstone, Happy Valley, Johnson City, Lake Oswego, Milwaukie, Molalla, Oregon City, Sandy, West Linn, and Wilsonville opted to participate and update their 2013 city addenda. The 2013 version of the city addenda was provided as a changes memo for each participating city, in this update the city addenda have been rewritten as final addenda without a changes memo. Clackamas Fire District #1 was included with an addendum in this version of the NHMP.

Where appropriate, information has been consolidated and a reference is provided within the addenda to the appropriate NHMP section. New data and hazard information was included for the participating cities and actions were reviewed, revised and prioritized as described in the addenda. The City of Damascus disincorporated in 2016, as such they do not have an addendum in this version of the plan, where appropriate hazard information and mitigation actions were incorporated into the County plan.

Volume III: Appendices

Below is a summary of the changes to the appendices included in the 2018 NHMP:

Appendix A: Action Item Forms

Action items were updated including the status as noted in Volume I, Section 3 changes section above.

Appendix B: Planning and Public Process

This planning and public process appendix reflects changes made to the Clackamas County MNHMP and documents the 2018 planning and public process.

Appendix C: Community Profile

The community profile has been updated to conform to the OPDR template and consolidates information for Clackamas County and census designated places. City and special district profiles are incorporated into their addenda within Volume II.

Appendix D: Clackamas County Natural Hazard and Base Maps

Appendix D includes maps of natural hazards. These maps have not changed since the previous version of the plan.

Appendix E: Economic Analysis of Natural Hazard Mitigation Projects

Updates are provided for the economic analysis of natural hazard mitigation projects.

Appendix F: Grant Programs and Resources

Some of the previously provided resources were deemed unnecessary since this material is covered within the Oregon NHMP. Updates were made to the remaining grant programs and resources.

Appendix G: Lifeline Sector Risk Assessment

The Lifeline Sector Risk Assessment is a new appendix and provides more detailed accounts of adaptive capacity and sensitivities to natural hazards that affect the Communication, Drinking Water, Transportation, and Electric sectors.

Appendix H: Community Survey

This survey was conducted with the 2018 update of the NHMP and was utilized to inform the development of mitigation strategies and identification of community vulnerabilities. It is provided herein as documentation and to serve as a resource for future planning efforts.

City Addenda Changes

This space reserved for additional information on major changes to each city addenda.

DRAFT FOR REVIEW

2018 NHMP PUBLIC PARTICIPATION PROCESS

2018 NHMP Update

Clackamas County is dedicated to directly involving the public in the review and update of the natural hazard mitigation plan. Although members of the Hazard Mitigation Advisory Committee represent the public to some extent, the residents of Clackamas County and participating cities were also given the opportunity to provide feedback about the NHMP. The NHMP will undergo review by the County NHMP Hazard Mitigation Advisory Committee on a semiannual basis and by the City Hazard Mitigation Advisory Committees on an annual basis.

Clackamas County made the NHMP available via their website (<https://www.clackamas.us/dm/naturalhazard.html>) throughout the update process and the updated NHMP was made available for public review and comment through the FEMA review period.

Public Involvement Summary

A survey was provided to the public during the early stages of the update cycle (Volume III, Appendix H, to be provided). Information from this survey was used by the Hazard Mitigation Advisory Committee to help inform their risk assessment and mitigation strategies.

During the public review period (see next page) there were (XX) commentsto be provided following public review.

Members of the Hazard Mitigation Advisory Committee provided edits and updates to the NHMP prior to the public review period as reflected in the final document.

Work Sessions: Clackamas County Board of County Commissioners

On [DATE] Clackamas County staff briefed the Clackamas County Board of County Commissioners on the updates to the Multi-Jurisdictional Clackamas County Natural Hazard Mitigation Plan.

Press Release

Clackamas County Press Release to be included.

DRAFT FOR REVIEW

Clackamas County Hazard Mitigation Advisory Committee

Hazard Mitigation Advisory Committee members possessed familiarity with the Clackamas County community and how it's affected by natural hazard events. The Hazard Mitigation Advisory Committee guided the update process through several steps including goal confirmation and prioritization, action item review and development and information sharing to update the NHMP and to make the NHMP as comprehensive as possible. The Hazard Mitigation Advisory Committee met formally on the following dates:

Meeting #0: Risk MAP Resilience Workshop, October 30, 2017

Some members of the County and City Hazard Mitigation Advisory Committees participated in the Lower Columbia-Sandy Watershed Resilience Workshop and discussed resources to support efforts to combat the flood hazard associated with the channel migration of the Sandy River in the unincorporated area of the County particularly at The Villages at Mount Hood.

Meeting #1: Kickoff, November 7, 2017

During this meeting, the Hazard Mitigation Advisory Committee reviewed the previous NHMP, and were provided updates on hazard mitigation planning, the NHMP update process, and project timeline. They also provided updates on the history of hazard events in the county and cities, reviewed and revised the NHMP's mission and goals, and discussed progress made toward the previous NHMP's action items.

Meeting #2: Risk Assessment, Mitigation Strategy, and Implementation and Maintenance, February 28, 2018

During this meeting, the Hazard Mitigation Advisory Committee reviewed the existing risk assessment including community vulnerabilities and hazard information. Information attained during this meeting was used to inform the update of the hazard analysis. The HMAC also reviewed their existing mitigation strategy (actions), provided status updates, recommended the deletion of one action, and the addition of one action. The previous NHMP's implementation and maintenance program was reviewed and any changes that were necessary were made as indicated in this appendix and Volume I, Section 4.

Jurisdictional Addenda Meetings:

The participating cities and special district held at least one formal Hazard Mitigation Advisory Committee meeting with OPDR staff in attendance. During these meetings, the Hazard Mitigation Advisory Committees for each jurisdiction provided comments on draft updates, revised and prioritized their actions, and reviewed the plan implementation and maintenance schedule. Jurisdictional addenda meetings were held: July 24, August 1, September 12, October 10, October 23, and October 24.

In addition to the meetings listed above, there were numerous informal meetings and email exchanges between Hazard Mitigation Advisory Committee members, OPDR, the County, and other state agencies.

The following pages includes copies of meeting agendas and sign-in sheets.

Clackamas County NHMP Update Kick-Off



Agenda

Meeting: Clackamas County NHMP Update - Kickoff
Date: November 7, 2017
Time: 9:00 am – 12:00 PM (3.0 hours)
Location: County EOC room at 2200 Kaen Rd, Oregon City, 97045

- | | |
|---|-------------------|
| I. Welcome and Background | 10 minutes |
| a. Introductions | |
| b. Project context | |
| II. Natural Hazard Mitigation Planning | 15 minutes |
| a. Emergency Management Overview | |
| b. Natural Hazard Mitigation Plans (NHMP) Overview | |
| c. Project Timeline | |
| III. Existing NHMP Overview and Review | 20 minutes |
| IV. Community Profile Update | 15 minutes |
| a. Changes in development since previous plan | |
| b. Critical facilities | |
| V. Hazard History | 15 minutes |
| a. Hazard history since previous plan | |
| What are the critical hazard concerns for your community? | |
| Any changes since the previous plan? | |
| BREAK | 10 minutes |
| VI. Mission and Goals review | 60 minutes |
| a. Visioning Exercise | |
| VII. Mitigation Actions Review | 15 minutes |
| a. Review previous action categories | |
| b. Feedback and broad new action ideas | |
| VIII. Public Outreach Strategy | 15 minutes |
| a. Examples of outreach | |
| b. Document your outreach! | |
| IX. Wrap Up and Next Steps | 5 minutes |
| a. Next Steps/Questions? | |

OREGON PARTNERSHIP FOR DISASTER RESILIENCE | COMMUNITY SERVICE CENTER
1209 University of Oregon | Eugene, Oregon 97403 | T: 541.346.3889 | F: 541.346.2040 <http://csc.uoregon.edu/opdr>

Meeting Sign-In

Clackamas NHMP Update:

Meeting #1: Kickoff November 7, 2017



Name	Email	Representing
Ryan Keresey	ryank@happyvalley.gov	CITY OF Happy Valley
LANE CAUVERT	lcauert@washi.maryland.gov	CITY OF WEST LINN
Bouvié Hvshberger -	bhvshberger@ci.oswego.or.us	Lake Oswego.
Martin Montelvo	mmontelvo@oreilly.org	Oregon City
Nancy Bush	nbush@clackamas.us	CCDM
CLAIR KLOCK	cklock@conservationdistrict.org	Clack SWCD
Melanie Wagner	Wagner@cityofestacada.org	City of Estacada

Name	Email	Representing
Jed Roberts	jed.roberts@oregon.gov	Dept. of Geology + Mineral Industries (DOGAMI)
PHILIP MASON	PMASON@CLACKAMAS.WA	CLACKAMAS CO. PUBLIC HEALTH
Kim Swan	Kims@clackamasproviders.org	CRWP
GREGG RAMIREZ	gregg.ramirez@clackamasfire.com	CFDA
ERIC BOHARD	ericbo@clackamas.wa	TS/GIS
DAVID KENTNER	david.kentner@state.or.us	Org. Dept of Land Conservation + Dev.
Bor Blessing	blessing@clackamas.wa	DDO - Planning

Clackamas County NHMP Update Meeting #2



Agenda

Meeting: Clackamas County NHMP Update – Meeting #2
Date: February 28, 2018
Time: 1:00 pm – 4:00 PM (3.0 hours)
Location: Development Services Building - Rm 401, 150 Beaver Creek Rd, Oregon City

- | | |
|--|-------------------|
| I. Welcome and Meeting Goals | 10 minutes |
| a. Committee Introductions | |
| b. Project Updates | |
| II. Public Outreach Strategy Updates | 10 minutes |
| a. Next steps | |
| III. Hazard Vulnerability Assessment | 20 minutes |
| a. Clackamas review and update | |
| b. Lifeline sectors update and next steps | |
| IV. Critical Facilities Update and Review | 15 minutes |
| a. Overview of Critical Facilities inventory | |
| b. Additional facilities? | |
| V. Action Item Update and Review | 90 minutes |
| a. Present changes | |
| b. Discuss new actions | |
| c. Prioritize actions | |
| VI. Plan Implementation and Maintenance | 20 minutes |
| a. Recommended updates | |
| b. Discuss committee membership | |
| c. Discuss meeting schedule | |
| VII. Questions and Discussion | 10 minutes |
| VIII. Wrap Up and Next Steps | 5 minutes |
| a. Next Steps | |

Meeting Sign-In

Clackamas NHMP Update:
Meeting #2: February 28, 2018



Name	Email	Representing
GREGG RAMIREZ	gregg.ramirez@clackamas.gov.com	CLACKAMAS FIRE DISTRICT #2
Bonnie Hrushberger	bhrushberger@lakeoswego.city	Lake Oswego
Philip Mason - Joyner	PMason@clackamas.us	Clackamas Co. Public Health
Anna Menon	amenon@clackamas.us	CCPH
Jack Nottall	jnottall@clackamas.us	CCPHD
Kim Swan	Kim@clackamasproviders.org	CRWP
Jay Wilson	jwilson@clackamas.us	CCDM

Name	Email	Representing
NICOLA MEHRLING	nicola.mehrling@hoopco.ood-oreg.or.us	HOOD RIVER COUNTY
Nancy Bush	nbush@clackamas.us	Clackamas Disaster Management
Scott Canfield	scottc@clackamas.us	Clack County Bldg Codes
Paul Salafoni	paul.salafoni@usace.army.mil	USACE
Anjie Lane, SHMO	anjie.lane@state.or.us	OEM
ERIC BEHARD	eric.bh@clackamas.us	TS/GIS
DAVID BENTZNER	david.bentzner@state.or.us	DLCD
Clair Klock	cklock@conservationdistrict.org	Slack SWCD

Name	Email	Representing
Jed Roberts	jed.roberts@oregon.gov	DOGAMI
DEORA KERBER	kerber@ci.wilsonville.or.us	city of Wilsonville
Melanie Wagner	Wagner@cityofestacada.org	City of Estacada

Clackamas County NHMP Update: Jurisdiction Addenda Meeting #1: Lake Oswego



Agenda

Meeting: Clackamas County NHMP Update: Lake Oswego Addendum
Date: June 24, 2018
Time: 1:00 – 3:00 PM
Location: 380 A Street, City Manager's Conference Room (3rd Floor), Lake Oswego, OR

- I. Welcome and Introductions**
 - a. Overview of NHMP process
- II. Hazard Identification**
 - a. Review County Hazard Identification
 - b. Complete Jurisdiction Specific Hazard Inventories
- III. Review Existing Vulnerability Information**
 - a. Review County Identified Vulnerabilities
 - b. Identify Jurisdiction Specific Assets and Vulnerabilities
- IV. Jurisdiction Specific Risk Assessment**
 - a. Review/ Revise Jurisdiction Specific Hazard Vulnerability Assessment (HVA)
- V. Jurisdiction Specific Mitigation Strategy**
 - a. Review Process and County Strategy
 - b. Review, Update, and Develop Jurisdiction Specific Actions
 - c. Prioritize Actions
- VI. Overview of Implementation and Maintenance**
- VII. Next Steps**
 - a. Prepare final draft of the NHMP for City Review
 - b. Provide the OMD-Office of Emergency Management a Review Opportunity
 - c. Submit updated plan to FEMA for review

Meeting Sign-In

Clackamas NHMP Update:
 Lake Oswego Addendum Meeting: July 24, 2018



Name	Email	Representing
DARYL WIRISLEY	Dwirisley@ci.oswego.or.us	LO Police
Bonnie Hirschberger.	bhirschberger@ci.oswego.or.us	
Rob D. Amisberry	ramsberry@ci.oswego.or.us	L.O. Engineering
Megan Phelan	mphan@lakeoswego.city	City Manager's Office
Leslie Hamilton	lhamilton@lakeoswego.city	Planning
Jim Bateman	jbateman@lakeoswego.city	P.W
Gert Zoutendijk	GZoutendijk@ci.oswego.or.us	Fire

Clackamas County NHMP Update: Jurisdiction Addenda Meeting #2: Estacada and Sandy



Agenda

Meeting: Clackamas County NHMP Update: City Addenda Meeting
Date: August 1, 2018
Time: 9:00 – 11:00 AM
Location: 475 SE Main St, Estacada City Hall (Council Chambers), Estacada, OR

- I. Welcome and Introductions**
 - a. Overview of NHMP process
- II. Hazard Identification**
 - a. Complete Jurisdiction Specific Hazard Inventories
- III. Review Existing Vulnerability Information**
 - a. Identify Jurisdiction Specific Assets and Vulnerabilities
- IV. Jurisdiction Specific Risk Assessment**
 - a. Review/ Revise Jurisdiction Specific Hazard Vulnerability Assessment (HVA)
- V. Jurisdiction Specific Mitigation Strategy**
 - a. Review, Update, and Develop Jurisdiction Specific Actions
 - b. Prioritize Actions
- VI. Overview of Implementation and Maintenance**
- VII. Next Steps**
 - a. Prepare final draft of the NHMP addenda for City Review
 - b. Provide the OMD-Office of Emergency Management a Review Opportunity
 - c. Submit updated plan to FEMA for review

Meeting Sign-In

Clackamas NHMP Update:
City Addenda Meeting (9:00 am): August 1, 2018



Name	Email	Representing
Andi Howell	ahowell@ci.sandy.or.us	Sandy
Kim YAMASHITA	KYAMASHITA@CI.SANDY.OREGON.US	SANDY
Scott Crosby	crosbys@cuaccess.net	Reliance Connects
Tom Seal	Seal@cityofestacada.org City of Estacada	City of Estacada
Ernie Roberts	eroberts@ci.sandy.or.us	city of Sandy
Jason Crowe	jcrowe@estacadafire.org	Estacada Fire
Denise Carey	carey@cityofestacada.org	City of Estacada

Melanie Wagner
Wagner@cityofestacada.org City of Estacada

Clackamas County NHMP Update: Jurisdiction Addenda Meeting #3: Wilsonville and Oregon City



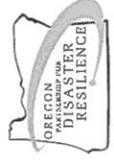
Agenda

Meeting: Clackamas County NHMP Update: City Addenda Meeting
Date: August 1, 2018
Time: 1:30 – 3:30 PM
Location: 29799 Town Center Loop E, City Hall (Large Conference Room), Wilsonville, OR

- I. Welcome and Introductions**
 - a. Overview of NHMP process
- II. Hazard Identification**
 - a. Complete Jurisdiction Specific Hazard Inventories
- III. Review Existing Vulnerability Information**
 - a. Identify Jurisdiction Specific Assets and Vulnerabilities
- IV. Jurisdiction Specific Risk Assessment**
 - a. Review/ Revise Jurisdiction Specific Hazard Vulnerability Assessment (HVA)
- V. Jurisdiction Specific Mitigation Strategy**
 - a. Review, Update, and Develop Jurisdiction Specific Actions
 - b. Prioritize Actions
- VI. Overview of Implementation and Maintenance**
- VII. Next Steps**
 - a. Prepare final draft of the NHMP addenda for City Review
 - b. Provide the OMD-Office of Emergency Management a Review Opportunity
 - c. Submit updated plan to FEMA for review

Meeting Sign-In

Clackamas NHMP Update:
City Addenda Meeting (1:30 pm): August 1, 2018



Name	Email	Representing
Tim Woodley	woodleyt@w.wilsonville.or.us	West Linn Wilsonville School District
Delora Kerber	kerber@c1.wilsonville.or.us	city of Wilsonville
DAN SIMPK	DSIMP@	"
Kelley Reid	kreid@orecity.org	Oregon City
Joha Lewis	julewis@orecity.org	Oregon City Public Works
Martin Montalvo	mmontalvo@orecity.org	" "
Jeff Rubin	jeff.rubinctbk.com	TUFR

Name	Email	Representing
Dan Carlson	Carlson@ci.wilsonville.or.us	Wilsonville
Kerry Rappold	rappold@ci.wilsonville.or.us	Wilsonville
Dan Pauly	pauly@ "	Wilsonville

Clackamas County NHMP Update: Jurisdiction Addenda Meeting #4: Happy Valley and Clackamas Fire District #1



Agenda

Meeting: Clackamas County NHMP Update: Addenda Meeting (Happy Valley/CFD #1)
Date: September 12, 2018
Time: 2:00 – 4:00 PM
Location: 16000 SE Misty Drive, Happy Valley Oregon

- I. Welcome and Introductions**
 - a. Overview of NHMP process
- II. Hazard Identification**
 - a. Complete Jurisdiction Specific Hazard Inventories
- III. Review Existing Vulnerability Information**
 - a. Identify Jurisdiction Specific Assets and Vulnerabilities
- IV. Jurisdiction Specific Risk Assessment**
 - a. Review/ Revise Jurisdiction Specific Hazard Vulnerability Assessment (HVA)
- V. Jurisdiction Specific Mitigation Strategy**
 - a. Review, Update, and Develop Jurisdiction Specific Actions
 - b. Prioritize Actions
- VI. Overview of Implementation and Maintenance**
- VII. Next Steps**
 - a. Prepare final draft of the NHMP addenda for City/CFD Review
 - b. Provide the OMD-Office of Emergency Management a Review Opportunity
 - c. Submit updated plan to FEMA for review



Meeting Sign-In

Clackamas NHMP Update:
 Addenda Meeting (2:00 pm): September 12, 2018



Name	Email	Representing
Stephanie Walker	stephanie.walker@clackamasfire.com	CFDI
Gregg Ramirez	gregg.ramirez@clackamasfire.com	CFDI
Chris Ramirez	chris@happyvalley.or.gov	City of Happy Valley Public Works
RYAN KERSEY	ryan.k@happyvalley.or.gov	City of Happy Valley
Steve Campbell	SteveC@happyvalley.or.gov	HV

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Clackamas County NHMP Update: Jurisdiction Addenda Meeting #5: West Linn



Agenda

Meeting: Clackamas County NHMP Update: Happy Valley Addendum Meeting
Date: October 10, 2018
Time: 10:30 – 12:00 PM
Location: West Linn City Hall, Bolton Room, 22500 Salamo Road

- I. Welcome and Introductions**
 - a. Overview of NHMP process
- II. Hazard Identification**
 - a. Complete Jurisdiction Specific Hazard Inventories
- III. Review Existing Vulnerability Information**
 - a. Identify Jurisdiction Specific Assets and Vulnerabilities
- IV. Jurisdiction Specific Risk Assessment**
 - a. Review/ Revise Jurisdiction Specific Hazard Vulnerability Assessment (HVA)
- V. Jurisdiction Specific Mitigation Strategy**
 - a. Review, Update, and Develop Jurisdiction Specific Actions
 - b. Prioritize Actions
- VI. Overview of Implementation and Maintenance**
- VII. Next Steps**
 - a. Prepare final draft of the NHMP addenda for City Review
 - b. Provide the OMD-Office of Emergency Management a Review Opportunity
 - c. Submit updated plan to FEMA for review

Space reserved for West Linn Sign-In

DRAFT FOR REVIEW

Clackamas County NHMP Update: Jurisdiction Addenda Meeting #6: Johnson City, Molalla, and Canby



Agenda

Meeting: Clackamas County NHMP Update: Johnson City Addendum Meeting
Date: October 23, 2018
Time: 2:30 – 4:30 PM
Location: City Hall, 16121 SE 81st Avenue, Johnson City.

- I. Welcome and Introductions**
 - a. Overview of NHMP process
- II. Hazard Identification**
 - a. Complete Jurisdiction Specific Hazard Inventories
- III. Review Existing Vulnerability Information**
 - a. Identify Jurisdiction Specific Assets and Vulnerabilities
- IV. Jurisdiction Specific Risk Assessment**
 - a. Review/ Revise Jurisdiction Specific Hazard Vulnerability Assessment (HVA)
- V. Jurisdiction Specific Mitigation Strategy**
 - a. Review, Update, and Develop Jurisdiction Specific Actions
 - b. Prioritize Actions
- VI. Overview of Implementation and Maintenance**
- VII. Next Steps**
 - a. Prepare final draft of the NHMP addendum for City Review
 - b. Provide the OMD-Office of Emergency Management a Review Opportunity
 - c. Submit updated plan to FEMA for review



Meeting Sign-In

Clackamas NHMP Update: Johnson City
City Addenda Meeting (2:30 pm): October 23, 2018



Name	Email	Representing
judy davis	johnson.city@hotmail.com	Johnson City
Elizabeth Collins	LIZZ1717@msn.com	Johnson City
BRIAN JOHNSON		Johnson City
Vincent Ballard	vballard.365@gmail.com	Johnson City
Dan Zinder	dzinder@cityofmolalla.com	Molalla
Jennifer Cline	CLINES@CANSY.OREGON.GOV	CITY OF CANBY

Clackamas County NHMP Update: Jurisdiction Addenda Meeting #7: Milwaukie



Agenda

Meeting: Clackamas County NHMP Update: Milwaukie Addendum Meeting
Date: October 24, 2018
Time: 9:00 – 11:00 AM
Location: Police Department, 3200 SE Harrison St, Milwaukie

- I. Welcome and Introductions**
 - a. Overview of NHMP process
- II. Hazard Identification**
 - a. Complete Jurisdiction Specific Hazard Inventories
- III. Review Existing Vulnerability Information**
 - a. Identify Jurisdiction Specific Assets and Vulnerabilities
- IV. Jurisdiction Specific Risk Assessment**
 - a. Review/ Revise Jurisdiction Specific Hazard Vulnerability Assessment (HVA)
- V. Jurisdiction Specific Mitigation Strategy**
 - a. Review, Update, and Develop Jurisdiction Specific Actions
 - b. Prioritize Actions
- VI. Overview of Implementation and Maintenance**
- VII. Next Steps**
 - a. Prepare final draft of the NHMP addendum for City Review
 - b. Provide the OMD-Office of Emergency Management a Review Opportunity
 - c. Submit updated plan to FEMA for review



Meeting Sign-In

Clackamas NHMP Update: Milwaukie
 City Addendum Meeting (9:00 am): October 24 2018



Name	Email	Representing
Jaimantha Vandagaitff	vandagaitffs@milwaukieoregon.gov	Building
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Space reserved for Gladstone Agenda/Sign-In

DRAFT FOR REVIEW

APPENDIX C: COMMUNITY PROFILE

The following section describes the county from a number of perspectives in order to help define and understand the county’s sensitivity and resilience to natural hazards. Sensitivity and resilience indicators are identified through the examination of community capitals which include natural environment, social/demographic capacity, economic, physical infrastructure, community connectivity, and political capital. These community capitals can be defined as resources or assets that represent all aspects of community life. When paired together, community capitals can influence the decision-making process to ensure that the needs of the community are being met.¹

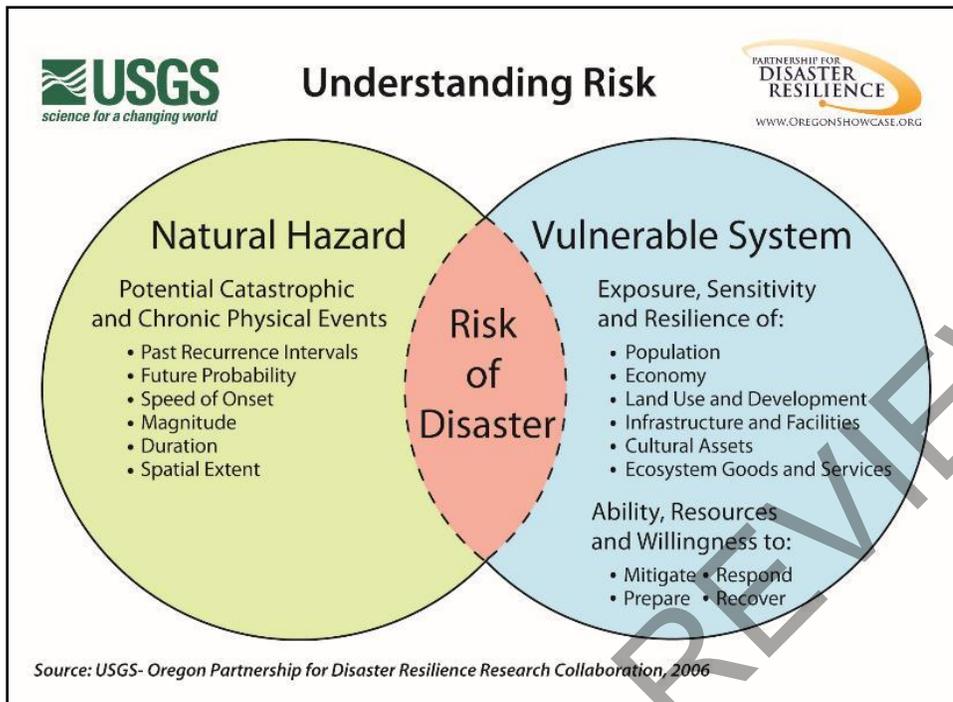
Sensitivity factors can be defined as those community assets and characteristics that may be impacted by natural hazards, (e.g., special populations, economic factors, and historic and cultural resources). Community resilience factors can be defined as the community’s ability to manage risk and adapt to hazard event impacts (e.g., governmental structure, agency missions and directives, and plans, policies, and programs).

Natural Environment Capacity	3
Social/Demographic Capacity	10
Economic Capacity	25
Physical Infrastructure Capacity	36
Community Connectivity Capacity	47
Political Capacity	52

The Community Profile describes the sensitivity and resilience to natural hazards of Clackamas County, and its incorporated cities, as they relate to each capacity. It provides a snapshot in time when the plan was developed and will assist in preparation for a more resilient county. The information in this section, along with the hazard assessments located in Volume I, Section 2 should be used as the local level rationale for the risk reduction actions identified in Volume I, Section 3. The identification of actions that reduce the county’s sensitivity and increase its resiliency assist in reducing overall risk of disaster, the area of overlap in Figure C-1.

¹ Mary Emery and others, “Using Community Capitals to Develop Assets for Positive Community Change,” *CD Practice* 13 (2006): 2

Figure C-1 Understanding Risk



Oregon Partnership for Disaster Resilience

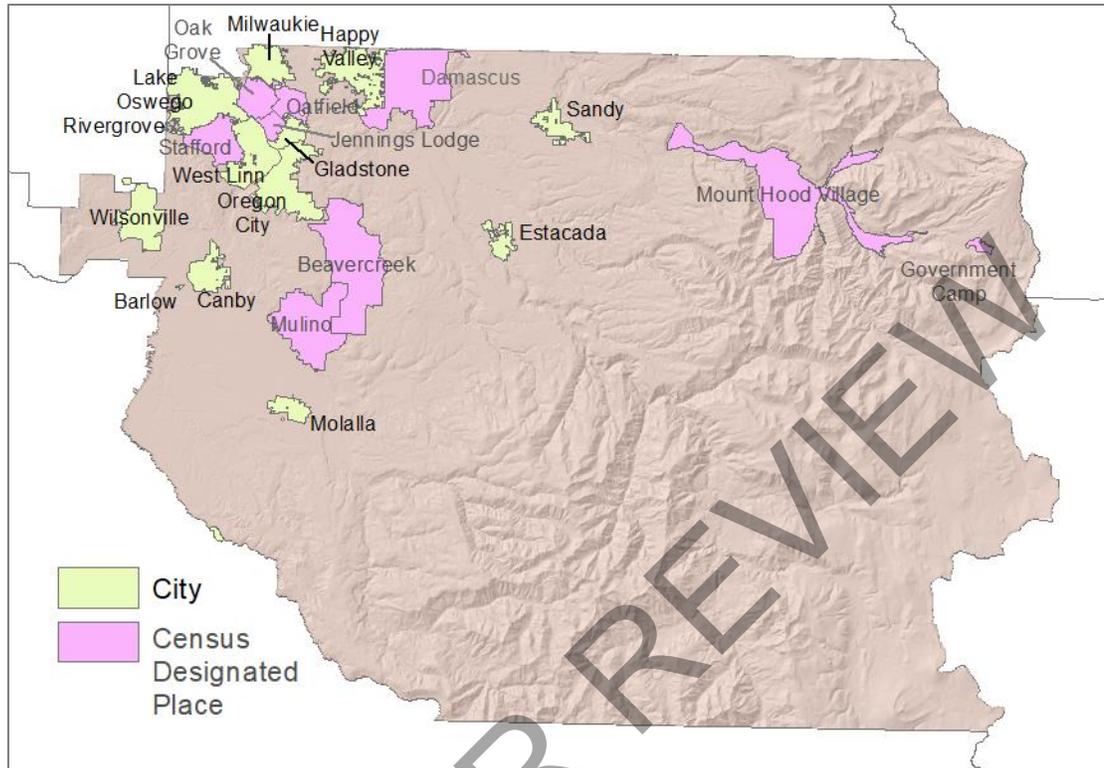
The U.S. Census delineates areas of settled population concentrations that are identifiable by name but are not legally incorporated as Census Designated Places (CDPs). There are nine CDPs in Clackamas County as shown in Table C-1 and Figure C-2.

Table C-1 Clackamas County Cities and Census Designated Places

Incorporated Cities		Unincorporated Census Designated Places
Barlow	Molalla	Beavercreek
Canby	Oregon City	Damascus
Estacada	Portland (part)*	Government Camp
Gladstone	Rivergrove (part)	Jennings Lodge
Happy Valley	Sandy	Mount Hood Village**
Johnson City	Tualatin (part)*	Mulino
Lake Oswego (part)	West Linn	Oak Grove
Milwaukie	Wilsonville (part)	Oatfield
		Stafford

Source: Portland State University Population Research Center, U.S. Census Bureau Tiger Lines Files
 Notes: * - The majority of the Portland and Tualatin populations are outside of Clackamas County and are not profiled in this plan. ** - Mount Hood Village CDP is noted elsewhere in this report as The Villages at Mt. Hood.

Figure C-2 Clackamas County Cities and Census Designated Places



Source: OPDR, 2018, U.S. Census Bureau Tiger Lines Files

The remainder of this appendix will provide detailed information for the unincorporated communities and summarized data for the incorporated cities. Detailed information for each incorporated city participating in this NHMP is provided within each city's addendum (Volume II).

Natural Environment Capacity

Natural environment capacity is recognized as the geography, climate, and land cover of the area such as, urban, water and forested lands that maintain clean water, air and a stable climate.² Natural resources such as wetlands and forested hill slopes play significant roles in protecting communities and the environment from weather-related hazards, such as flooding and landslides. However, natural systems are often impacted or depleted by human activities adversely affecting community resilience.

Geography

Clackamas County has an area of 1,879 square miles and is located along the Willamette River in Northwestern Oregon. About one-eighth of the land area in Clackamas County is incorporated, while a majority is unincorporated. More than three-fourths of the county's area lies within the lower Willamette River basin. The Clackamas, Molalla, Pudding, and Tualatin rivers are major tributaries which flow into the Willamette. The remaining one-

² Mayunga, J. 2007. Understanding and Applying the Concept of Community Disaster Resilience: A capital-based approach. Summer Academy for Social Vulnerability and Resilience Building.

fourth of the county is within the Lower-Columbia-Sandy River basin, a tributary of the Columbia River.

Elevations in the county range from a high of 11,235-feet at the peak of Mount Hood (the highest point in the state) to a low of 55-feet in Oregon City located along the shores of the Willamette River. There are a variety of complex eco-regions, including high-altitude forests, foothills, lowlands and valleys, prairie terraces, and riparian forest. Clackamas County has two major physiographic regions that should be considered in planning for natural hazards: the Willamette River Valley, and the Cascade Range Mountains. The Willamette Valley, in western Clackamas County, is the most heavily populated portion and is characterized by flat or gently hilly topography. The Cascade Range, in eastern and southern Clackamas County has a relatively small population and is characterized by heavily forested slopes.

Clackamas County has a long growing season and mild temperatures, which lead to a wide range of agricultural activities. Seasonal flooding, high ground water levels, and soil erosion cause most of the non-urban drainage problems in the county. When maintained in their natural state, Clackamas County's wetlands control runoff and decrease soil erosion and water pollution while reducing potential damage from flooding and helping to recharge water supplies.

Cascade Mountains

As Oregon's tallest peak, Mount Hood borders the eastern edge of Clackamas County and rises to 11,235 feet. Nearby volcanic neighbors along the Cascade Range include Mount St. Helens, Mount Adams, and Mount Jefferson. Mount Hood has had at least four major eruptive periods in the past 15,000 years, with the most recent one taking place around 1805, shortly before the arrivals of Lewis and Clark. These eruptions produced deposits that were primarily distributed along the Sandy and Zigzag rivers in Clackamas County. As one of the major volcanoes in the Cascade Range, it contributes to valuable water, scenic, and recreational resources which help to sustain agricultural and tourist segments throughout the region. When Mount Hood erupts again, volcanic ash is expected to fall and severely affect areas on its flanks as well as downstream in the major river valleys that lie in the path of the volcano.³

Willamette River

The Willamette River Basin covers 11,500 square miles, encompassing 16,000 miles of streams and is ranked 12th among US rivers in volume.⁴ The river is about 187 miles long and is unique because it flows from the south to the north, originating in the mountains of west central Oregon, passing through Oregon City and over Willamette Falls, passing through the City of Portland and then emptying out into the Columbia River.⁵ The Willamette River is a vital, multi-purpose waterway that touches the lives of millions of people along its banks throughout the Pacific Northwest. The Willamette River has generated economic growth and promoted quality of life for the past 150 years. It is a source of power, irrigation, forestry, agriculture, and recreation. However, to achieve these benefits, the structure and

³ U.S. Geological Survey, The Cascade Range, "Description: Mount Hood Volcano". Accessed 19 December 2011. http://vulcan.wr.usgs.gov/Volcanoes/Hood/description_hood.html.

⁴ Portland Bureau of Environmental Services. "Willamette Watershed." Accessed 19 December 2011. <http://www.portlandonline.com/bes/index.cfm?a=231466&c=30938>.

⁵ Willamette River Water Coalition. "About the Willamette River." Accessed 19 December 2011. <http://www.willametteriver.org/willamette.php>.

integrity of the river have been compromised with increased population growth and development.

Clackamas River

Located west of the Cascade Range, the Clackamas River flows through a steep-walled canyon lined with dense forest and basalt crags as it heads towards its confluence with the Willamette River near Gladstone and Oregon City.⁶ This river was added to the Federal Wild and Scenic River System in 1988, and qualifies as “outstandingly remarkable” in five different resource categories—recreation, fish, wildlife, historic, and vegetation.⁷

The Clackamas River Basin is largely forested but has large areas of pasture used for grazing. More than 400,000 people depend on the Clackamas River for their drinking water. Parts of three streams/ivers within the watershed are listed as “water-quality limited” on the state’s 303(d) list, mostly for high water temperatures in the summer. These include the: lower Clackamas River (river mouth to River Mill Dam), Fish Creek (mouth to headwaters), and Eagle Creek (mouth to wilderness boundary). Occurrences of taste and odor problems in drinking water from the river have increased in recent years, apparently due to blue-green algae blooms. Upon request of a local consortium of drinking water providers, a proposal was developed to examine nutrient, algae, and water quality conditions basin wide.⁸

The Clackamas River and its tributaries provide numerous spawning and rearing areas for steelhead, as well as Coho and Chinook salmon. However, the Endangered Species Act listed the river’s steelhead as “threatened” on March 13th, 1998. The watershed is home to two wilderness areas: the Salmon-Huckleberry Wilderness and the Bull of the Woods Wilderness. More than 72 percent of land in the watershed is publicly owned, predominantly by the U.S. Forest Service.⁹

Sandy River

The Sandy River originates high on the slopes of Mount Hood, located about 50 miles east of Portland. The headwaters are beneath Reid and Sandy Glaciers at 6,000 feet in elevation. From there the river flows due west through the Hoodland Corridor. It cascades past the communities of Welches, Brightwood, and Sandy, then turns north to enter the Columbia River near Troutdale, which is 10 miles east of Portland, Oregon. Two separate sections of the Sandy River have been designated Federal Wild and Scenic Waterways. Riverside trails offer spectacular scenery, easily observed geologic features, unique plant communities, and other wilderness experiences. Just outside Portland, the lower Sandy flows through a deep, winding, forested gorge known for its anadromous fish runs, botanical diversity, recreational boating, and beautiful parks.¹⁰

⁶ Oregon Rivers. Accessed 19 December 2011. http://www.oregon.com/oregon_rivers.

⁷ Ibid.

⁸ U.S. Geological Survey, Oregon Water Science Center, “Clackamas River Basin Water Quality Assessment”. Accessed 1 December 2011. <http://or.water.usgs.gov/clackamas/or176.html>.

⁹ Ibid.

¹⁰ Oregon Rivers. Accessed 19 December 2011. http://www.oregon.com/oregon_rivers.

Climate

Situated in the northern portion of the Willamette Valley, Clackamas County experiences a relatively mild climate with cool, wet winters and warm, dry summers. Temperatures in the valley may exceed 90°F in the summer or drop below 30°F in the winter but are generally more moderate than temperatures at higher elevations. Average temperatures in the summer range from the low 80s down to the low 50s, while average temperatures in the winter range from the mid 40s to the low 30s. Because of these mild temperatures, the average growing season in Clackamas County generally lasts for 150-180 days in the lower valley and for 110-130 days in the foothills (i.e. roughly above 800–feet in elevation).¹¹

The most important determinant of precipitation is elevation. Because Clackamas County widely spans from the valley floor of Oregon City at 55 feet to the top of Mount Hood at 11,235 feet, it is no surprise that there is considerable variation of precipitation totals in the form of rain and snow, throughout the county. Map 2 in Volume III, Appendix D shows the annual average precipitation throughout the county.

The monthly and annual averages of snowfall show that the valley floor experiences a mild winter with annual averages of 1-10 inches of snow per year, while the communities in the lower Cascades surrounding Mount Hood, such as Government Camp, are covered with snow for a majority of the winter months (annual average of 250 inches).¹²

Total precipitation in the Pacific Northwest region may remain similar to historic levels but climate projections indicate the likelihood of increased winter precipitation and decreased summer precipitation.

Increasing temperatures affects hydrology in the region. Spring snowpack has substantially decreased throughout the western part of the United States, particularly in areas with milder winter temperatures, such as the Cascade Mountains. In other areas of the West, such as east of the Cascades Mountains, snowfall is affected less by the increasing temperature because the temperatures are already cold and more by precipitation patterns.¹³

Hazard Severity

Situated in the Willamette Valley with the Cascades just off to the east, the county is susceptible to a variety of storms that can affect residents and damage property. Typical hazards to affect the county include floods, landslides, wildfires, severe winter storms, windstorms, earthquakes, and volcanic eruptions. While the entire county is susceptible to all these types of natural hazards, the hamlets and villages located around the Mount Hood vicinity seem to be most affected by seasonal floods that are characterized by periods of heavy rains in a short amount of time, as well as a hard snowfall and ice storm immediately followed by warm temperatures causing that fresh snow to melt at a faster rate. With the amount of volcanic sediment that has settled in the streams and valleys over the years since Mount Hood's last eruption, the houses located in this vicinity are vulnerable to landslides and floods as the water permeates in the soil more easily; another factor to consider is the

¹¹ Loy, W. G., ed. 2001. Atlas of Oregon, 2nd Edition. Eugene, OR: University of Oregon Press.

¹² Ibid.

¹³ Mote, Philip W., et. al., "Variability and trends in Mountain Snowpack in Western North America," <http://cses.Clackamas.edu/db/pdf/moteetalvarandtrends436.pdf>

erosive behavior of the Sandy River's migrating channel. As this part of the county is mostly forested, wildfires also affect this area.

Ownership and Land Cover

More than half of the land in Clackamas County is federally owned by either the BLM (6%) or the US Forest Service (45%). Another 46% is privately owned, while 1% is owned by the state.¹⁴

The eastern portion of the county is mostly rural and is where most of the US Forest Service owns their land. On the contrary, the western portion of the county is more urbanized with a higher percentage of privately owned land. The western portion also includes zoning for agriculture, forest, rural exception, and the urban growth boundary; a vast majority of this portion of the county is either included in the Urban Growth Boundary or is designated as rural reserve.¹⁵

According to the *Willamette Valley Land Use/Land Cover Map Informational Report*, a majority of the land cover that includes farmland used for production of tree fruits, vineyards, berries, Christmas trees, and nursery stock can be found in Clackamas County.¹⁶ The report goes on to discuss that the valley portion of the county can be characterized by row crops in the bottomland along the Willamette, Pudding, and Molalla Rivers, with its upland areas characterized by a combination of all the agricultural cover types.¹⁷ Because this area is interlaced with all types and sizes of creeks and swales, the land drains better here, than the rest of the Willamette Valley.¹⁸ The foothill areas leading into the Cascade Range can be characterized by rural non-farm small parcels that are agriculture lands with little or no management, as well as large parcels that are being, or have been, broken to make smaller ranches for single-family dwellings.¹⁹ The foothill area in the Cascade Range has also seen a conversion from all types of forested areas to Christmas tree plantations and solid Douglas Fir Forest.²⁰

Minerals and Soils

The characteristics of the minerals and soils present in Clackamas County indicate the potential types of hazards that may occur. Rock hardness and soil characteristics can determine whether or not an area will be prone to geologic hazards such as earthquakes and landslides. Some of Oregon's richest soils are located in areas surrounding Canby, Sandy, Molalla, and Wilsonville. In fact, 87% of non-urban soil is classified as productive, agricultural land. These deep alluvial soils are rich in minerals and are great for agriculture, but serve to amplify the effects of earthquakes. Steep slopes toward the Cascade Range increase the potential for landslides. The four mineral and soil types in Clackamas County

¹⁴ Loy, W. G., ed. 2001. *Atlas of Oregon*, 2nd Edition. Eugene, OR: University of Oregon Press.

¹⁵ Loy, W. G., ed. 2001. *Atlas of Oregon*, 2nd Edition. Eugene, OR: University of Oregon Press.

¹⁶ "Willamette Valley Land Use/Land Cover Map Informational Report," Pg. 25. Accessed 19 December 2011. <http://nwhi.org/inc/data/gisdata/docs/willamette/wvveg24k.pdf>.

¹⁷ Ibid.

¹⁸ Ibid.

¹⁹ Ibid.

²⁰ Ibid.

are valley fill and semi-consolidated sedimentary rocks, basaltic lavas, marine sedimentary rocks, and Eocene-age volcanic and sedimentary rocks.²¹

The surface material includes unconsolidated, fine-grained deposits of Willamette silt, sand, gravel, and recent floodplain deposits. Torrential flood events can introduce large deposits of sand and gravel. Sandy silt and silt containing clay are moderately dense and firm, and are primarily considered to be prone to liquefaction, an earthquake related hazard. Basaltic lava consists mainly of weathered and non-weathered, dense, fine-grained basalt. Though the characteristics of this lava may offer solid foundation support, landslides are common in many of these areas where weathered residual soil overlies the basalt. Understanding the geologic characteristics of Clackamas County is an important step in mitigation and avoiding at-risk development.²²

Other Significant Geologic Features

Clackamas County, like most of the Pacific Northwest, lies over the area of Cascadia Subduction Zone where the North American crustal plate overrides the Juan de Fuca plate underneath the earth's crust. The fault along these two plates creates a structural sag at the Willamette River Valley. Volcanoes are present along this structural sag, and the activity on these mountains is caused by the buoyant melted rock of the Juan de Fuca plate, as it rises to the surface.

Synthesis

This natural environment capacity section is composed of elements known as natural capital. Natural capital is essential in sustaining all forms of life including human life and plays an often under represented role in community resiliency to natural hazards. The growing population and increased development in Clackamas County increases its risk from natural hazard events by threatening loss of life, property, and long-term economic disruption.

With mild temperatures and diverse terrain, the most typical natural hazards that affect Clackamas County are widespread heavy rain events followed by major flood events, as well as the occasional wildfire. With eminent hazard events such as these, it is important that the county is able to react in the event that the county's water supply, supplied by several of the major rivers flowing throughout, is heavily impacted by disaster.

Oregon City experiences an annual mean temperature of 55°F, and the average of the annual amount of precipitation for parts of the county range from an average of 89 feet per year in Government Camp down to an average of 43 feet per year at the North Willamette Experiment Station near Canby. Contrastingly, snowfall rates are drastically different with Government Camp seeing an annual average of 253 feet of snow, while the North Willamette Experiment Station will only see an average of two feet of snow.

Highlighting natural capitals such as key river systems, as well as temperature and precipitation patterns, will allow the county to identify key hazard areas that need to be better prepared for and mitigated, to increase the resiliency of each community.

²¹ Schlicker, Herbert G. and Deacon, Robert J., Engineering geology of the Tualatin Valley Region, Oregon (1967), (Bulletin 60). Oregon: Department of Geology and Mineral Industries.

²² Ibid.

Table C-2 indicates where natural environment and related infrastructure vulnerabilities exist in relation to each of the natural hazards profiled in Volume I, Section 2.

Table C-2 Clackamas County Natural Environment Vulnerabilities

Clackamas County Asset	Drought	Earthquake	Extreme Heat	Flood	Landslide	Volcanic Event	Wildfire	Windstorm	Winter Storm
Forest/woodland areas							X		
Streams/riparian zones (property damage, bridges/culverts)	X			X					
County/City parks				X			X	X	X
General groundwater issues	X			X		X	X		
Groundwater and surface water contamination from industrial area disruption		X		X	X				

Source: Clackamas County HMAC

Social/Demographic Capacity

Social/demographic capacity is a significant indicator of community hazard resilience. The characteristics and qualities of the community population such as language, race and ethnicity, age, income, educational attainment, and health are significant factors that can influence the community's ability to cope, adapt to and recover from natural disasters. Population vulnerabilities can be reduced or eliminated with proper outreach and community mitigation planning.

Population

Clackamas County is part of the tri-county metro area comprised of Multnomah, Clackamas, and Clackamas Counties. The tri-county metro area experienced population growth between 2010 and 2016 (Table C-4). Clackamas County's population grew 7.5% from 2010 to 2016 and is the third most populous Oregon county.

The tri-county metro area accounts for roughly 44% of Oregon's population. Clackamas County accounts for just under one-quarter of the tri-county metro area's population. Lake Oswego and Oregon City are the county's largest cities at roughly 35,000 each, while Milwaukie is the third largest city with about two-thirds the population of the two larger cities (20,510).

The unincorporated area of the county accounts for about 48% of the overall population (194,008) and is growing slower than the incorporated cities (1.1% AAGR).

Oak Grove (16,848), Oatfield (13,592), and Damascus²³ (10,625) are the largest unincorporated communities (CDPs) in Clackamas County.

Since 2014, Portland State University's Population Research Center has created coordinated population forecasts for counties and cities across the state (Table C-3). According to the most recent forecast (2017), Clackamas County's population is expected to increase to over 516,000, a 28% increase from the 2016 estimate.²⁴

Table C-3 Population Forecast for Tri-County Metro Area

Jurisdiction	2016		2035		Change		
	Number	Percent	Number	Percent	Number	Percent	AAGR
3-County Area	1,779,245	100%	2,226,974	100%	447,729	25%	1.2%
Clackamas County	404,980	23%	516,744	23%	111,764	28%	1.3%
Multnomah County	790,670	44%	944,785	42%	154,115	19%	0.9%
Washington County	583,595	33%	765,445	34%	181,850	31%	1.4%

Source: Portland State University, Population Research Center, "Annual Population Estimates", 2016; Portland State University, Population Research Center, "Population Forecasts", 2017.

²³ Damascus (along with the community of Carver) incorporated in 2004 and disincorporated in 2016.

²⁴ Office of Economic Analysis. Long Term County Population Forecast, 2010-2050 (2013 release).

Table C-4 Population Estimates and Change (2010 and 2016)

Jurisdiction	2010		2016		Change (2010-2016)		AAGR
	Number	Percent	Number	Percent	Number	Percent	
Oregon	3,837,300	100%	4,076,350	100%	239,050	6%	1.0%
3-County Area	1,644,635	43%	1,779,245	44%	134,610	8%	1.3%
Clackamas County	376,780	23%	404,980	23%	28,200	7%	1.2%
Multnomah County	736,785	45%	790,670	44%	53,885	7%	1.2%
Washington County	531,070	32%	583,595	33%	52,525	10%	1.6%
Unincorporated^	181,402	48%	194,008	48%	12,606	7%	1.1%
Beavercreek	4,443	1%	4,034	1%	-409	-9%	-1.6%
Damascus**	10,540	3%	10,625	3%	85	1%	0.1%
Government Camp	56	<1%	121	<1%	65	116%	13.7%
Jennings Lodge	7,799	2%	7,727	2%	-72	-1%	-0.2%
Mount Hood Village	4,598	1%	5,231	1%	633	14%	2.2%
Mulino	2,183	1%	2,797	1%	614	28%	4.2%
Oak Grove	16,931	4%	16,848	4%	-83	<-1%	-0.1%
Oatfield	13,619	4%	13,592	3%	-27	<-1%	0.0%
Stafford	1,765	<1%	1,945	<1%	180	10%	1.6%
Not Within a CDP^^	119,468	32%	131,088	32%	11,620	10%	1.6%
Incorporated	195,378	52%	210,972	52%	15,594	8%	1.3%
Barlow	135	<1%	135	<1%	0	0%	0.0%
Canby	15,830	4%	16,420	4%	590	4%	0.6%
Estacada	2,730	1%	3,155	1%	425	16%	2.4%
Gladstone	11,495	3%	11,660	3%	165	1%	0.2%
Happy Valley	14,100	4%	18,680	5%	4,580	32%	4.8%
Johnson City	565	<1%	565	<1%	0	0%	0.0%
Lake Oswego (part)*	34,067	9%	34,855	9%	788	2%	0.4%
Milwaukie	20,290	5%	20,510	5%	220	1%	0.2%
Molalla	8,110	2%	9,085	2%	975	12%	1.9%
Oregon City	31,995	8%	34,240	8%	2,245	7%	1.1%
Portland (part)*	744	<1%	766	<1%	22	3%	0.5%
Rivergrove (part)*	258	<1%	459	<1%	201	78%	10.1%
Sandy	9,655	3%	10,655	3%	1,000	10%	1.7%
Tualatin (part)*	2,869	1%	2,911	1%	42	1%	0.2%
West Linn	25,150	7%	25,615	6%	465	2%	0.3%
Wilsonville (part)*	17,385	5%	21,260	5%	3,875	22%	3.4%

Source: Portland State University, Population Research Center, "Annual Population Estimates", 2016. Social Explorer, Table T1, U.S. Census Bureau, 2012-2016 American Community Survey Estimates and 2006-2010 American Community Survey Estimates. Jurisdictions in **bold** are participating in this plan.

Notes:

* - Most of the Portland and Tualatin populations are outside of Clackamas County and are not profiled in this plan.

** - Damascus incorporated in 2004 and unincorporated in 2016, its population is shown as unincorporated for 2010 & 2016.

^ - Population information is from the American Community Survey 5-Year Estimates

^^ - Population information is derived using PSU Annual Population Estimates and American Community Survey 5-Year Estimates

Tourists

Tourists are not counted in population statistics; and are therefore considered separately in this analysis. The table below shows the estimated number of person nights in private homes, hotels and motels, and other types of accommodations. The table shows that, between 2014-2016, approximately 71% of all visitors to Clackamas County lodged in private homes, with 20% staying in hotels/motels, the remaining visitors stay on other accommodations (vacation homes/campgrounds). Tourists' lodging in private homes suggests these visitors are staying with family and friends. For hazard preparedness and mitigation purposes, outreach to residents in Clackamas County will likely be transferred to these visitors in some capacity. Visitors staying at hotel/motels are less likely to benefit from local preparedness outreach efforts aimed at residents.

Table C-5 Annual Visitor Estimates in Person Nights

	2014		2015		2016p	
	Person-Nights (1,000's)	Percent	Person-Nights (1,000's)	Percent	Person-Nights (1,000's)	Percent
All Overnight	7,012	100%	7,209	100%	7,392	100%
Hotel/Motel	1,340	19%	1,413	20%	1,496	20%
Private Home	5,069	72%	5,183	72%	5,275	71%
Other	603	9%	613	9%	621	8%

Source: Oregon Tourism Commission, Oregon Travel Impacts: 1991-2016p, Dean Runyan Associates

Tourists are specifically vulnerable due to the difficulty of locating or accounting for travelers within the region. Tourists are often at greater risk during a natural disaster because of unfamiliarity with evacuation routes, communication outlets, or even the type of hazard that may occur. Knowing whether the region's visitors are staying in friends/relative's homes in hotels/motels, or elsewhere can be instructive when developing outreach efforts.²⁵

Vulnerable Populations

Vulnerable populations, including seniors, disabled citizens, women, and children, as well as those people living in poverty, often experience the impacts of natural hazards and disasters more acutely. Hazard mitigation that targets the specific needs of these groups has the potential to greatly reduce their vulnerability. Examining the reach of hazard mitigation policies to special needs populations may assist in increasing access to services and programs. FEMA's Office of Equal Rights addresses this need by suggesting that agencies and organizations planning for natural hazards identify special needs populations, make recovery centers more accessible, and review practices and procedures to remedy any discrimination in relief application or assistance.

Population size itself is not an indicator of vulnerability. More important is the location, composition, and capacity of the population within the community. Research by social scientists demonstrates that human capital indices such as language, race, age, income,

25 MDC Consultants (n.d.). When Disaster Strikes – Promising Practices. Retrieved March 18, 2014, from <http://www.mdcinc.org/sites/default/files/resources/When%20Disaster%20Strikes%20-%20Promising%20Practices%20-%20Tourists.pdf>

education and health can affect the integrity of a community. Therefore, these human capitals can impact community resilience to natural hazards.

Additional information on vulnerable populations is available via Clackamas County Public Health’s [Community Health Assessment](#) and [Blueprint for a Healthy Clackamas County](#).

Language

Special consideration should be given to populations who do not speak English as their primary language. Language barriers can be a challenge when disseminating hazard planning and mitigation resources to the general public, and it is less likely they will be prepared if special attention is not given to language and culturally appropriate outreach techniques.

There are various languages spoken across Clackamas County; the primary language is English. Approximately 12% of the Clackamas County population speaks a language other than English, Spanish is the second most widely spoken language with about 6% of the population 5 years and over speaking Spanish (11% of Stafford’s, and 10% of Mulino’s, and 9% of Jennings Lodge’s populations speak Spanish at home).²⁶ Overall, about 4% of the Clackamas County population is not proficient in English (Table C-6). Jennings Lodge (6%) and Mulino (5%) have the highest percentage of residents who have limited or no English language proficiency. Outreach materials used to communicate with, plan for, and respond to non-English speaking populations should take into consideration the language needs of these populations.

Table C-6 Clackamas County Language Barriers

Jurisdiction	Population 5 years and over	English Only		Multiple Languages		Limited or No English	
		Number	Percent	Number	Percent	Number	Percent
Clackamas County	373,421	328,068	88%	45,353	12%	16,613	4%
Beavercreek	3,809	3,631	95%	178	5%	52	1%
Damascus	10,457	9,486	91%	971	9%	309	3%
Government Camp	121	121	100%	0	0%	0	0%
Jennings Lodge	7,204	6,226	86%	978	14%	462	6%
Mount Hood Village	5,131	4,680	91%	451	9%	44	1%
Mulino	2,689	2,265	84%	424	16%	141	5%
Oak Grove	15,890	14,397	91%	1,493	9%	467	3%
Oatfield	13,072	12,246	94%	826	6%	236	2%
Stafford	1,835	1,539	84%	296	16%	75	4%
Incorporated*	199,191	174,070	87%	25,121	13%	8,899	4%

Source: Social Explorer, U.S. Census Bureau, 2012-2016 American Community Survey Estimates, Table 16002.

Note: * - Includes portions of Lake Oswego, Rivergrove, and Wilsonville that are outside Clackamas County; does not include portions of Portland and Tualatin that are inside Clackamas County.

²⁶ Social Explorer, U.S. Census Bureau, 2012-2016 American Community Survey Estimates, Table 16001

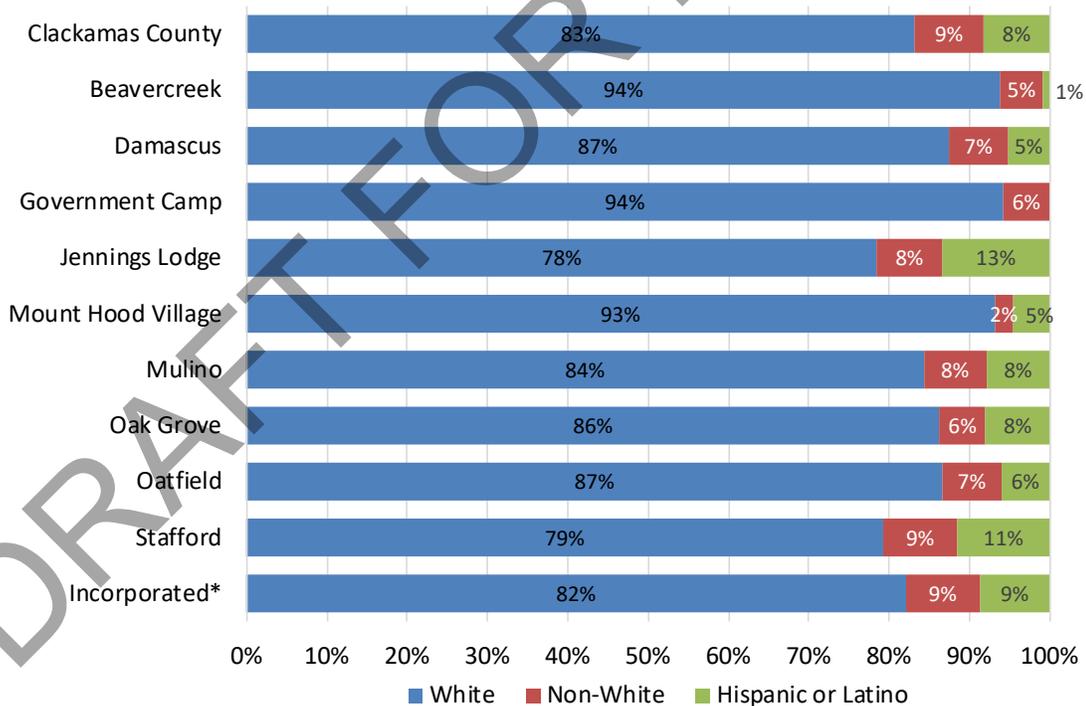
Race and Ethnicity

The impact in terms of loss and the ability to recover may also vary among minority population groups following a disaster. Studies have shown that racial and ethnic minorities can be more vulnerable to natural disaster events. This is not reflective of individual characteristics; instead, historic patterns of inequality along racial or ethnic divides have often resulted in minority communities that are more likely to have inferior building stock, degraded infrastructure, or less access to public services. The table below describes Clackamas County’s population by race and ethnicity.

The majority of the population in Clackamas County is racially white (83%); Stafford, and the incorporated areas of the County have the largest percentages of non-white population. About 13% of Jennings Lodge, and 11% of Stafford are Hispanic or Latino.

It is important to identify specific ways to support all portions of the community through hazard mitigation, preparedness, and response. Culturally appropriate, and effective outreach can include both methods and messaging targeted to diverse audiences. For example, connecting to historically disenfranchised populations through already trusted sources or providing preparedness handouts and presentations in the languages spoken by the population will go a long way to increasing overall community resilience.

Figure C-3 White, Non-White, and Hispanic or Latino



Source: Social Explorer, Table T14, U.S. Census Bureau, 2012-2016 American Community Survey Estimates.

Note: * - Includes portions of Lake Oswego, Rivergrove, and Wilsonville that are outside Clackamas County; does not include portions of Portland and Tualatin that are inside Clackamas County.

Gender

Clackamas County has slightly more females than males (Female 51%, Male: 49%).²⁷ Government Camp, (64%), Stafford (57%), and Mount Hood Village (56%) have the highest male to female ratios comprising their populations.²⁸ It is important to recognize that women tend to have more institutionalized obstacles than men during recovery due to sector-specific employment, lower wages, and family care responsibilities.

Age

Of the factors influencing socio demographic capacity, the most significant indicator in Clackamas County may be age of the population. Depicted in Table C-7 as of 2016, 16% of the county population is over the age of 64, a percentage that is projected to rise to 22% by 2035. The Clackamas County age dependency ratio²⁹ is 52.0 (Oatfield has the largest age dependency ration at 60.6). The age dependency ratio indicates a higher percentage of dependent aged people to that of working age. The age dependency ratio for Clackamas County is expected to rise to 66.1 in 2035, largely because of the rise in the older age cohorts (population 65+, 22% in 2035). With a higher age-dependency ratio there will be fewer people of working age who can support mitigation and recovery from a natural disaster. In addition, as the population ages, the County may need to consider different mitigation and preparedness actions to address the specific needs of this group.

Table C-7 Population by Vulnerable Age Groups

Jurisdiction	Total	< 15 Years Old		> 64 Years Old		15 to 64 Years Old	Age Dependency Ratio
		Number	Percent	Number	Percent		
Clackamas County	394,967	71,291	18%	63,787	16%	259,889	52.0
Beavercreek	4,034	611	15%	832	21%	2,591	55.7
Damascus	10,842	1,660	15%	1,697	16%	7,485	44.8
Government Camp	121	16	13%	27	22%	78	55.1
Jennings Lodge	7,727	1,520	20%	1,170	15%	5,037	53.4
Mount Hood Village	5,231	670	13%	1,219	23%	3,342	56.5
Mulino	2,797	637	23%	382	14%	1,778	57.3
Oak Grove	16,848	2,739	16%	3,411	20%	10,698	57.5
Oatfield	13,592	1,943	14%	3,184	23%	8,465	60.6
Stafford	1,945	370	19%	256	13%	1,319	47.5
Incorporated*	211,806	41,249	19%	30,696	14%	139,861	51.4
2035							
Oregon		865,889	17%	1,082,781	22%	3,046,530	64.0
Clackamas County		92,126	18%	113,495	22%	311,123	66.1

Source: Social Explorer, Table 17, U.S. Census Bureau, 2012-2016 American Community Survey Estimates, Office of Economic Analysis, Long-Term County Population Forecast, 2010-2050 (2013 release). Portland State University, Population Research Center, "Population Forecasts", 2017.

Note: * - Includes portions of Lake Oswego, Rivergrove, and Wilsonville that are outside Clackamas County; does not include portions of Portland and Tualatin that are inside Clackamas County.

²⁷ Social Explorer, Table 4, U.S. Census Bureau, 2012-2016 American Community Survey Estimates

²⁸ Ibid.

²⁹ The age dependency ratio is derived by dividing the combined under 15 and 65-and-over populations by the 15-to-64 population and multiplying by 100. A number close to 50 indicates about twice as many people are of working age than non-working age. A number that is closer to 100 implies an equal number of working age population as non-working age population. A higher number indicates greater sensitivity.

The age profile of an area has a direct impact both on what actions are prioritized for mitigation and how response to hazard incidents is carried out. School age children rarely make decisions about emergency management. Therefore, a larger youth population in an area will increase the importance of outreach to schools and parents on effective ways to teach children about fire safety, earthquake response, and evacuation plans. Furthermore, children are more vulnerable to the heat and cold, have few transportation options and require assistance to access medical facilities. Older populations may also have special needs prior to, during and after a natural disaster. Older populations may require assistance in evacuation due to limited mobility or health issues. Additionally, older populations may require special medical equipment or medications, and can lack the social and economic resources needed for post-disaster recovery.³⁰

Families and Living Arrangements

Two ways the census defines households are by type of living arrangement and family structure. A householder may live in a “family household” (a group related to one another by birth, marriage or adoption living together); in a “nonfamily household” (a group of unrelated people living together); or alone. Table C-8 shows that Clackamas County is predominately comprised of family households (69%). Of all households, 24% are one-person non-family households (householder living alone). Countywide about 10% of householders live alone and are age 65 or older (about 16% and 18% of all households in Jennings Lodge and Oak Grove respectively).

Table C-8 Household by Type, Including Living Alone

Jurisdiction	Total Households		Family Households		Householder Living Alone		Householder Living Alone (age 65+)	
	Estimate	Percent	Estimate	Percent	Estimate	Percent	Estimate	Percent
Clackamas County	151,150		103,760	69%	36,824	24%	15,621	10%
Beavercreek	1,453		1,178	81%	226	16%	134	9%
Damascus	3,723		3,100	83%	484	13%	269	7%
Government Camp	53		37	70%	0	0%	0	0%
Jennings Lodge	3,139		1,740	55%	1,086	35%	496	16%
Mount Hood Village	2,215		1,458	66%	597	27%	211	10%
Mulino	838		669	80%	131	16%	78	9%
Oak Grove	7,038		4,097	58%	2,367	34%	1,239	18%
Oatfield	5,201		3,857	74%	1,158	22%	609	12%
Stafford	718		595	83%	115	16%	22	3%
Incorporated*	81,742		55,133	67%	20,944	26%	8,563	10%

Source: Social Explorer, Table 165, U.S. Census Bureau, 2012-2016 American Community Survey Estimates.

Note: * - Includes portions of Lake Oswego, Rivergrove, and Wilsonville that are outside Clackamas County; does not include portions of Portland and Tualatin that are inside Clackamas County.

Table C-9 shows household structures for families with children. Nearly 22% of all households within the county are married family households that have children. Jennings Lodge (12%) and Oak Grove (9%) have the highest percentage of single-parent households.

³⁰ Wood, Nathan. Variations in City Exposure and Sensitivity to Tsunami Hazards in Oregon. U.S. Geological Survey, Reston, VA, 2007.

These populations will likely require additional support during a disaster and will inflict strain on the system if improperly managed.

Table C-9 Married-Couple and Single Parent Families with Children

Jurisdiction	Total Households Estimate	Married-Couple with Children		Single Parent with Children	
		Estimate	Percent	Estimate	Percent
Clackamas County	151,150	33,797	22%	13,366	9%
Beavercreek	1,453	400	28%	18	1%
Damascus	3,723	1,070	29%	256	7%
Government Camp	53	9	17%	0	0%
Jennings Lodge	3,139	483	15%	388	12%
Mount Hood Village	2,215	323	15%	109	5%
Mulino	838	271	32%	48	6%
Oak Grove	7,038	1,107	16%	614	9%
Oatfield	5,201	973	19%	355	7%
Stafford	718	204	28%	5	1%
Incorporated*	81,742	19,719	24%	8,133	10%

Source: U.S. Census Bureau, 2012-2016 American Community Survey Estimates, Table DP02.

Note: * - Includes portions of Lake Oswego, Rivergrove, and Wilsonville that are outside Clackamas County; does not include portions of Portland and Tualatin that are inside Clackamas County.

Income

Household income and poverty status are indicators of socio demographic capacity and the stability of the local economy. Household income can be used to compare economic areas as a whole but does not reflect how the income is divided among the area residents. Table C-10 shows the distribution of household income for 2010 and 2016.

Table C-10 Household Income

Household Income	2010 [^]		2016		Change in Share	
	Households	Percent	Households	Percent	Households	Percent
Less than \$15,000	11,022	8%	11,215	7%	193	-0.3%
\$15,000-\$29,999	16,378	11%	17,613	12%	1,235	0.2%
\$30,000-\$44,999	17,335	12%	18,635	12%	1,300	0.2%
\$45,000-\$59,999	17,610	12%	18,256	12%	646	-0.2%
\$60,000-\$74,999	15,375	11%	16,344	11%	969	0.1%
\$75,000-\$99,999	20,563	14%	21,764	14%	1,201	0.1%
\$100,000-\$199,999	34,698	24%	36,308	24%	1,610	-0.2%
\$200,000 or more	10,379	7%	11,015	7%	636	0.0%

Source: Social Explorer, Table 56, U.S. Census Bureau, 2012-2016 American Community Survey and 2006-2010 American Community Survey.

Note: [^] - 2010 dollars adjusted for 2016 via Social Explorer's Inflation Calculator

Countywide, between 2010 and 2016 all income cohorts increased in households, however, the share of households making more than \$100,000 increased more than other income cohorts. For the same period the share of total households remained relatively stable for all income cohorts.

The 2016 median household income across Clackamas County is \$68,915; this is about the same as the inflation adjusted 2010 figure, representing a 1% increase in real incomes (Table C-11). Stafford has the highest median household income (and had the greatest gain), Jennings Lodge has the lowest median household income. The table below shows decreases, or modest gains, in real incomes across most of Clackamas County, except for Stafford which increased by 37%.

Table C-11 Median Household Income

Jurisdiction	Median Household Income		Percent Change
	2010 [^]	2016	
Clackamas County	\$68,281	\$68,915	1%
Beavercreek	\$85,726	\$83,550	-3%
Damascus	\$90,107	\$82,830	-8%
Government Camp	na	na	na
Jennings Lodge	\$56,651	\$53,101	-6%
Mount Hood	\$65,185	\$60,572	-7%
Mulino	\$78,786	\$72,813	-8%
Oak Grove	\$57,573	\$59,545	3%
Oatfield	\$72,686	\$74,663	3%
Stafford	\$91,422	\$125,556	37%
Incorporated*	\$69,258	\$69,473	<1%

Source: Social Explorer, Table 57, U.S. Census Bureau, 2012-2016 American Community Survey Estimates and 2006-2010 American Community Survey Estimates.

Note: ^ - 2010 dollars adjusted for 2016 via Social Explorer's Inflation Calculator

Table C-12 identifies the percentage of individuals and cohort groups that are below the poverty level in 2016. It is estimated that about 9% of individuals, 11% of children under 18, and 7% of seniors live below the poverty level across the county. Jennings Lodge, Mulino, and Government Camp have the highest poverty rates. Jennings Lodge also has the highest poverty rate for children under 18 and for adults age 65 and older. Overall, 4% of Clackamas County residents live in "deep poverty" (having incomes below half the federal poverty level), the percent is greatest in Jennings Lodge at 9%.³¹

Cutter's research suggests that lack of wealth contributes to social vulnerability because individual and community resources are not as readily available. Affluent communities are more likely to have both the collective and individual capacity to more quickly rebound from a hazard event, while impoverished communities and individuals may not have this capacity –leading to increased vulnerability. Wealth can help those affected by hazard incidents to

³¹ Social Explorer Tables 117, U.S. Census Bureau, 2012-2016 American Community Survey Estimates

absorb the impacts of a disaster more easily. Conversely, poverty, at both an individual and community level, can drastically alter recovery time and quality.³²

Table C-12 Poverty Rates

	Total Population in Poverty		Children Under 18 in Poverty		18 to 64 in Poverty		65 or over in Poverty	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Clackamas County	36,160	9%	9,464	11%	22,544	9%	4,152	7%
Beavercreek	217	5%	50	6%	123	5%	44	5%
Damascus	819	8%	232	10%	545	8%	42	3%
Government Camp	16	13%	0	0%	16	21%	0	0%
Jennings Lodge	1,119	15%	309	19%	583	12%	227	19%
Mount Hood Village	383	7%	18	2%	273	9%	92	8%
Mulino	382	14%	93	12%	268	17%	21	6%
Oak Grove	1,552	9%	368	12%	973	10%	211	6%
Oatfield	1,091	8%	143	6%	664	8%	284	9%
Stafford	161	8%	0	0%	161	13%	0	0%
Incorporated*	19,021	9%	5,496	11%	11,674	9%	1,851	6%

Source: Social Explorer Tables 114, 115, 116, U.S. Census Bureau, 2012-2016 American Community Survey Estimates.

Note: * - Includes portions of Lake Oswego, Rivergrove, and Wilsonville that are outside Clackamas County; does not include portions of Portland and Tualatin that are inside Clackamas County.

Federal assistance programs such as food stamps are another indicator of poverty or lack of resource access. Statewide social assistance programs like the Supplemental Nutritional Assistance Program (SNAP) and Temporary Assistance for Needy Families (TANF) aid individuals and families. In Clackamas County, TANF reaches approximately 1,083 families per month and SNAP helps to feed about 22,059 people per month.³³ Those reliant on state and federal assistance are more vulnerable in the wake of disaster because of a lack of personal financial resources and reliance on government support.

Education

Educational attainment of community residents is also identified as an influencing factor in socio demographic capacity. Educational attainment often reflects higher income and therefore higher self-reliance. Widespread educational attainment is also beneficial for the regional economy and employment sectors as there are potential employees for professional, service and manual labor workforces. An oversaturation of either highly educated residents or low educational attainment can have negative effects on the resiliency of the community.

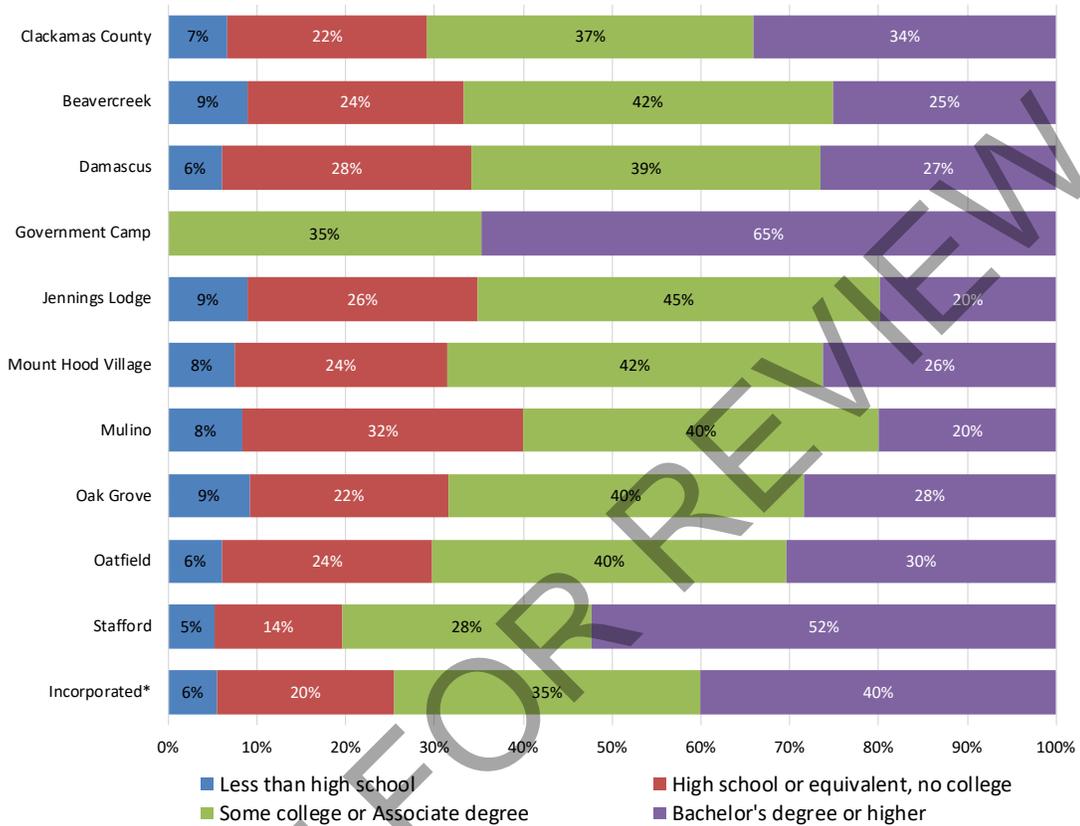
Approximately 7% of the Clackamas County population over 25 years does not have a high school degree or equivalent, while 22% have a high school degree or equivalent but do not have college experience. An additional 37% have some college or an Associate degree and

³² Statewide Supplemental Nutrition Assistance Program Activity - Nov. 2014 (SSP, APD, and AAA combined); P. 3 of report. Temporary Assistance for Needy Families One and two Parent Families Combined; P. 3 of report. <http://www.oregon.gov/dhs/assistance/Pages/data/main.aspx>

³³ Sabatino, J. (2016). Oregon TANF Caseload FLASH, "One and Two Parent Families Combined", District 15; February 2018 data, and Sabatino, J. (2018). Oregon SNAP Program Activity, "SSP, APD and AAA Combined", District 15; February 2018 data. Retrieved from State of Oregon Office of Business Intelligence website: <http://www.oregon.gov/DHS/ASSISTANCE/Pages/Data.aspx>, accessed March 21, 2018.

34% have earned a Bachelor’s degree or higher (Figure C-4). Beavercreek, Jennings Lodge, and Oak Grove have the lowest percentages of high school graduates. Government Camp and Stafford have the highest percentages of people with a Bachelor’s degree or higher.

Figure C-4 Educational Attainment



Source: Social Explorer, Table 25, U.S. Census Bureau, 2012-2016 American Community Survey Estimates
 Note: * - Includes portions of Lake Oswego, Rivergrove, and Wilsonville that are outside Clackamas County; does not include portions of Portland and Tualatin that are inside Clackamas County.

Health

Individual and community health play an integral role in community resiliency, as indicators such as health insurance, people with disabilities, dependencies, homelessness and crime rate paint an overall picture of a community’s well-being. These factors translate to a community’s ability to prepare, respond to, and cope with the impacts of a disaster.

The Resilience Capacity Index recognizes those who lack health insurance or are impaired with sensory, mental or physical disabilities, have higher vulnerability to hazards and will likely require additional community support and resources. Clackamas County has 8% of its population without health insurance; Jennings Lodge (13%) and Mount Hood Village (12%) have the highest percentages. The percentage of uninsured changes with age, the highest rates of uninsured are within the 18 to 64-year cohort; Jennings Lodge and Mount Hood

Village have about 20% of this age cohort that is uninsured. The ability to provide services to the uninsured populations may burden local providers following a natural disaster.

Table C-13 Health Insurance Coverage

Jurisdiction	Total Population	Without Health Insurance							
		Total		Under 18 years		18 to 64 years		65+	
		Number	Percent	Number	Percent	Number	Percent	Number	Percent
Clackamas County	393,403	31,774	8%	3,427	4%	28,107	12%	240	<1%
Beavercreek	4,034	211	5%	0	0%	211	9%	0	0%
Damascus	10,832	409	4%	71	3%	338	5%	0	0%
Government Camp	121	0	0%	0	0%	0	0%	0	0%
Jennings Lodge	7,727	977	13%	64	4%	913	19%	0	0%
Mount Hood Village	5,217	633	12%	44	5%	589	19%	0	0%
Mulino	2,797	206	7%	29	4%	177	11%	0	0%
Oak Grove	16,786	1,397	8%	0	0%	1,388	14%	9	<1%
Oatfield	13,564	1,092	8%	56	2%	1,036	13%	0	0%
Stafford	1,945	13	1%	0	0%	13	1%	0	0%
Incorporated*	209,214	15,184	7%	1,720	3%	13,315	10%	149	<1%

Source: Social Explorer, Table 146, U.S. Census Bureau, 2012-2016 American Community Survey Estimates.

Note: * - Includes portions of Lake Oswego, Rivergrove, and Wilsonville that are outside Clackamas County; does not include portions of Portland and Tualatin that are inside Clackamas County.

The table below describes disability status of the population. Approximately 12% of the Clackamas County civilian non-institutionalized population identifies with one or more disabilities. Government Camp has the highest percentage of its total population with a disability (36%), as well as individuals under 18 and 65 years and older with a disability (hearing and/or cognitive).

Table C-14 Disability Status by Age Group

Jurisdiction	Population Estimate [^]	With a disability		Under 18 years with a disability		65 years and over with a disability	
		Estimate	Percent	Estimate	Percent**	Estimate	Percent**
Clackamas County	393,403	46,829	12%	3,409	4%	21,261	34%
Beavercreek	4,034	465	12%	23	3%	247	30%
Damascus	10,832	1,499	14%	152	7%	457	27%
Government Camp	121	43	36%	16	100%	27	100%
Jennings Lodge	7,727	1,034	13%	57	3%	426	36%
Mount Hood Village	5,217	1,084	21%	65	8%	339	28%
Mulino	2,797	291	10%	35	4%	157	41%
Oak Grove	16,786	2,848	17%	98	3%	1,430	43%
Oatfield	13,564	1,430	11%	126	5%	860	27%
Stafford	1,945	322	17%	20	4%	88	34%
Incorporated*	209,214	22,045	11%	1,733	3%	10,123	34%

Source: Social Explorer, U.S. Census Bureau, 2012-2016 American Community Survey Estimates, Table B18101.

Notes: [^] Non-institutionalized civilian population, * Includes portions of Lake Oswego, Rivergrove, and Wilsonville that are outside Clackamas County; does not include portions of Portland and Tualatin that are inside Clackamas County, ** Percent of age group

Table C-15 displays disability status of the population by type and age. Older populations tend to have more disabilities than younger populations in Clackamas County.

Approximately 19% of the population 65 and over has an ambulatory disability, 17% have a hearing disability, and 13% have an independent living disability. Among unincorporated

communities 30% of Government Camp’s population has a hearing disability, 10% of Jennings Lodge and Oak Grove populations 65 and over have a vision disability, 44% of Government Camps population under 18 has a cognitive disability, approximately one-quarter of Jennings Lodge, Mulino, and Oak Grove populations 65 and over population have an ambulatory disability, and 13% of Jennings Lodge’s population 65 and over has an independent living disability.³⁴ Depending on the type of disability outreach, mitigation, and response efforts may need to be adjusted.

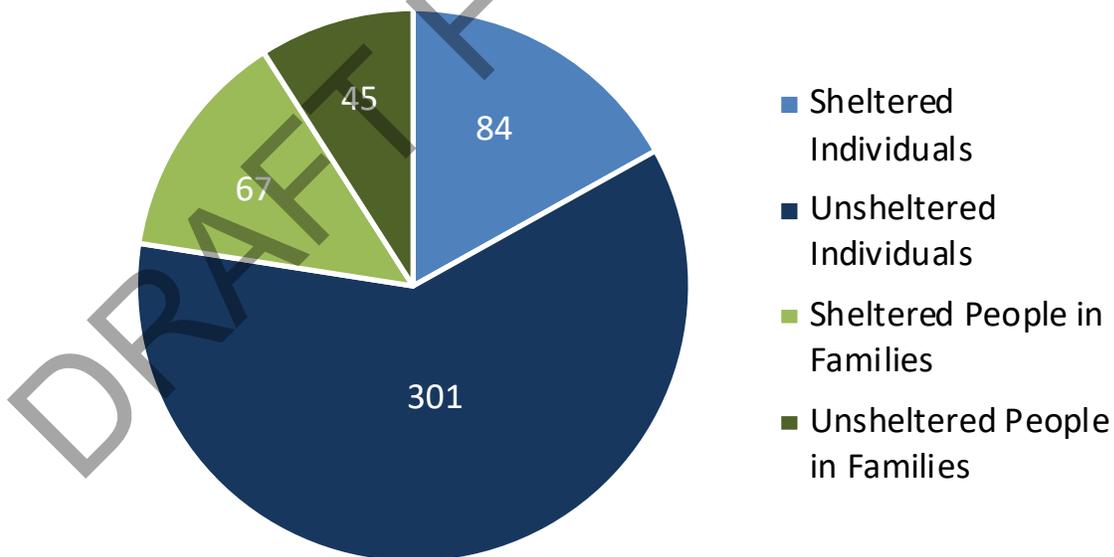
Table C-15 Disability Type by Age Group – Clackamas County

	Hearing Disability	Vision Disability	Cognitive Disability	Ambulatory Disability	Self-Care Disability	Independent Living Disability
Total Population [^]	4%	2%	5%	6%	2%	5%
Under 18 [*]	1%	< 1%	4%	< 1%	1%	-
18 to 64 [*]	2%	1%	4%	4%	2%	3%
65 and over [*]	17%	5%	9%	19%	7%	13%

Source: Social Explorer, U.S. Census Bureau, 2012-2016 American Community Survey Estimates, Tables B18102 through B18106.

Notes: [^] Non-institutionalized civilian population, ^{*} Percent of age group

In 2017, Oregon Housing and Community Services (OHCS) conducted a point-in-time homeless count to identify the number of homeless, their age and their family type. The OHCS study found that 497 individuals and persons in families in Clackamas County identify as homeless; 30%, 151 people, were sheltered (84 individuals and 67 persons in families), and 70%, 346 people, were unsheltered (301 individuals and 45 persons in families).



Source: Oregon Housing and Community Services, 2017 Point-in-Time Homeless Count

³⁴ Social Explorer, U.S. Census Bureau, 2012-2016 American Community Survey Estimates, Tables B18102 through B18106

The homeless have little resources to rely on, especially during an emergency. It will likely be the responsibility of the county, cities, and local non-profit entities to provide services such as shelter, food and medical assistance. Therefore, it is critical to foster collaborative relationships with agencies that will provide additional relief such as the American Red Cross and homeless shelters. It will also be important to identify how to communicate with these populations, since traditional means of communication may not be appropriate or available.

Household Characteristics – Vehicles Available

Countywide 5% of all occupied households, and 14% of renter-occupied households, have no vehicle available (Table C-16). The percentage of all households without a vehicle available is greatest in Jennings Lodge (13%) and Oak Grove (13%); for renter occupied households the percentage is greatest in Oak Grove (27%), Oatfield (26%), and Jennings Lodge (23%). Household access to a vehicle is key to evacuating quickly and safely. Households that have no access to a vehicle or limited vehicles available may face delays, or need assistance, to evacuate.

Table C-16 Vehicles Available (All Households and Renter Occupied)

Jurisdiction	Occupied Housing			Renter Occupied Housing		
	Housing Units	No Vehicle (Percent)	One Vehicle (Percent)	Housing Units	No Vehicle (Percent)	One Vehicle (Percent)
Clackamas County	151,150	5%	28%	47,026	14%	43%
Beavercreek	1,453	3%	11%	105	17%	19%
Damascus	3,723	2%	13%	388	4%	25%
Government Camp	53	0%	17%	0	-	-
Jennings Lodge	3,139	13%	34%	1,497	23%	40%
Mount Hood Village	2,215	5%	28%	543	12%	36%
Mulino	838	0%	13%	133	0%	0%
Oak Grove	7,038	13%	30%	2,756	27%	39%
Oatfield	5,201	6%	24%	1,025	26%	26%
Stafford	718	0%	24%	162	0%	48%
Incorporated*	81,742	5%	31%	28,061	13%	46%

Source: Social Explorer, Tables 182 and 199, U.S. Census Bureau, 2012-2016 American Community Survey Estimates

Note: * - Includes portions of Lake Oswego, Rivergrove, and Wilsonville that are outside Clackamas County; does not include portions of Portland and Tualatin that are inside Clackamas County.

Synthesis

Socio demographic capacity is a significant indicator of county hazard resiliency. Clackamas County is the third largest county in the state of Oregon, in terms of population. With 404,980 residents, resiliency and hazard mitigation efforts can be a lot harder to manage. The characteristics and qualities of the community population such as age, race, education, income, and health and safety are significant factors that can influence the county's ability to cope, adapt to, and recover from natural disasters. The current status of socio demographic capacity indicators can have long term impacts on the economy and stability ultimately affecting future resiliency of Clackamas County.

One important thing to consider is that there are a high number of residents who are not proficient in English. Four-percent (about 16,600) residents are not proficient in English.

Language barriers will often make it difficult to reach populations of residents who don't speak English. Resiliency efforts need to focus on targeting these populations as they will be most vulnerable and may have trouble knowing what to do in the event of a disaster. It is also important to think about the county's population in terms of its age groups; it is important to cater information towards each of these populations individually, as it is necessary to be able to reach out to all age groups. In 2016, the percentage of residents age 65 and older was 16%; by 2035, that percentage is expected to increase to 22%. While disasters don't affect certain age groups more than others, information can be dispersed and catered depending on who may be the most vulnerable.

Clackamas County socio-economic factors to consider include:

- With 1% growth from 2010 to 2016, the median household income across the county has increased to \$68,915. "Real" median household incomes are decreasing in all rural communities except Oak Grove, Oatfield, and Stafford.
- 9% of the population is considered in poverty; the rates are highest in Government Camp, Jennings Lodge, and Mulino.
- Children in poverty is greatest in Jennings Lodge, Mulino, Oak Grove, and Damascus, while those 65 or over in poverty is greatest in Jennings Lodge.
- 12% of the population has a disability, 34% of this population is 65 years or older

Highlighting the above socio-economic factors and looking at the Socio Demographic Capacity of the county is important as it affects the resiliency of the county and helps determine target areas and potential vulnerable populations for increased notification on mitigation and resiliency efforts.

Table C-17 indicates where population related physical infrastructure vulnerabilities exist in relation to each of the natural hazards profiled in Volume I, Section 2.

Table C-17 Clackamas County Population related Infrastructure Vulnerabilities

Clackamas County Asset	Drought	Earthquake	Extreme Heat	Flood	Landslide	Volcanic Event	Wildfire	Windstorm	Winter Storm
Schools (particularly those identified in the 2007 Rapid Visual Survey)		X							
Childcare Facilities		X	X	X		X	X		
Adult Care Homes/ Assisted Living Facilities		X	X	X			X		
Homeowners in the Wildfire Urban Interface							X		
Hospitals		X		X			X	X	X
Mass Transit		X		X				X	X
Clackamas County Jail		X							

Source: Clackamas County HMCAC

Economic Capacity

Economic capacity refers to the financial resources present and revenue generated in the community to achieve a higher quality of life. Income equality, housing affordability, economic diversification, employment and industry are measures of economic capacity. However, economic resilience to natural disasters is far more complex than merely restoring employment or income in the local community. Building a resilient economy requires an understanding of how the component parts of employment sectors, workforce, resources and infrastructure are interconnected in the existing economic picture. Once any inherent strengths or systematic vulnerabilities become apparent, both the public and private sectors can act to increase the resilience of the local economy.

Regional Affordability

The evaluation of regional affordability supplements the identification of Social/demographic capacity indicators, i.e. median income, and is a critical analysis tool to understanding the economic status of a community. This information can capture the likelihood of individuals' ability to prepare for hazards, through retrofitting homes or purchasing insurance. If the community reflects high-income inequality or housing cost burden, the potential for home-owners and renters to implement mitigation can be drastically reduced. Therefore, regional affordability is a mechanism for generalizing the abilities of community residents to get back on their feet without Federal, State or local assistance.

Income Equality

Income equality is a measure of the distribution of economic resources, as measured by income, across a population. It is a statistic defining the degree to which all persons have a similar income. The table below illustrates the county and cities level of income inequality. The Gini index is a measure of income inequality. The index varies from zero to one. A value of one indicates perfect inequality (only one household has any income). A value of zero indicates perfect equality (all households have the same income).³⁵

Table C-18 shows that the countywide income inequality coefficient is 0.44. The areas of greatest income inequality are Jennings Lodge (0.46) and Stafford (0.44). The areas of greatest income equality are Government Camp (0.31), Oatfield (0.37), and Mulino (0.38). Based on social science research, the region's cohesive response to a hazard event may be affected by the distribution of wealth in communities that have less income equality³⁶.

³⁵University of California Berkeley. Building Resilient Regions, Resilience Capacity Index. <http://brr.berkeley.edu/rci/>.

³⁶Susan Cutter, Christopher G. Burton, and Christopher T. Emrich. 2010. "Disaster Resilience Indicators for Benchmarking Baseline Conditions," *Journal of Homeland Security and Emergency Management* 7, no.1: 1-22

Table C-18 Regional Income Inequality

Jurisdiction	Income Inequality Coefficient
Clackamas County	0.44
Beavercreek	0.41
Damascus	0.40
Government Camp	0.31
Jennings Lodge	0.46
Mount Hood	0.41
Mulino	0.38
Oak Grove	0.41
Oatfield	0.37
Stafford	0.44
Incorporated*	na

Source: Social Explorer, Table 157, U.S. Census Bureau, 2012-2016 American Community Survey Estimates

Note: * - Includes portions of Lake Oswego, Rivergrove, and Wilsonville that are outside Clackamas County; does not include portions of Portland and Tualatin that are inside Clackamas County.

Housing Affordability

Housing affordability is a measure of economic security gauged by the percentage of an area's households paying less than 30% of their income on housing.³⁷ Households spending more than 30% are considered housing cost burdened. Table C-19 displays the percentage of homeowners and renters reflecting housing cost burden across the region.

Countywide roughly 45% of homeowners with a mortgage have a housing cost burden, compared to over 47% of renters. The communities of Mount Hood Village, Mulino, Government Camp, Beavercreek, and Stafford have more than 50% of owners (with or without a mortgage) with a housing cost burden. Amongst renters, Oak Grove, Oatfield, Jennings Lodge, and Mount Hood Village have more than 50% with a housing cost burden. In general, the population that spends more of their income on housing has proportionally fewer resources and less flexibility for alternative investments in times of crisis.³⁸ This disparity imposes challenges for a community recovering from a disaster as housing costs may exceed the ability of local residents to repair or move to a new location. These populations may live paycheck to paycheck and are extremely dependent on their employer, in the event their employer is also impacted it will further the detriment experienced by these individuals and families.

³⁷ University of California Berkeley. Building Resilient Regions, Resilience Capacity Index. <http://brr.berkeley.edu/rci/>.

³⁸ Ibid.

Table C-19 Households Spending > 30% of Income on Housing

Jurisdiction	Owners		Renters
	With Mortgage	Without Mortgage	
Clackamas County	45%	22%	47%
Beavercreek	58%	26%	15%
Damascus	49%	33%	40%
Government Camp	0%	64%	-
Jennings Lodge	41%	21%	54%
Mount Hood Village	52%	32%	51%
Mulino	64%	26%	32%
Oak Grove	43%	31%	61%
Oatfield	36%	16%	58%
Stafford	51%	36%	12%
Incorporated*	43%	21%	48%

Source: Social Explorer, Tables 103 and 109, U.S. Census Bureau, 2012-2016 American Community Survey Estimates.

Note: * - Includes portions of Lake Oswego, Rivergrove, and Wilsonville that are outside Clackamas County; does not include portions of Portland and Tualatin that are inside Clackamas County.

Economic Diversity

Economic diversity is a general indicator of an area's fitness for weathering difficult financial times. Business activity in the Willamette Valley region is fairly homogeneous and consists mostly of small businesses.

Economic diversity is a general indicator of an area's fitness for weathering difficult financial times. One method for measuring economic diversity is through use of the Herfindahl Index, a formula that compares the composition of county and regional economies with those of states or the nation as a whole. Using the Herfindahl Index, a diversity ranking of 1 indicates the county with the most diverse economic activity compared to the state as a whole, while a ranking of 36 corresponds with the least diverse county economy. The table below describes the Herfindahl Index Scores for counties in the region.

Table C-20 shows that Clackamas County has an economic diversity rank of 1 as of 2016, this is on a scale between all 36 counties in the state where 1 is the most diverse economic county in Oregon and 36 is the least diverse. The county's ranking has stayed constant since 2013.

Table C-20 Regional Herfindahl Index Scores

County	2013			2016		
	Employment	Number of Industries	State Rank	Employment	Number of Industries	State Rank
Clackamas	127,242	267	1	140,827	274	1
Multnomah	381,347	281	2	416,693	285	4
Washington	235,258	261	16	260,196	261	18

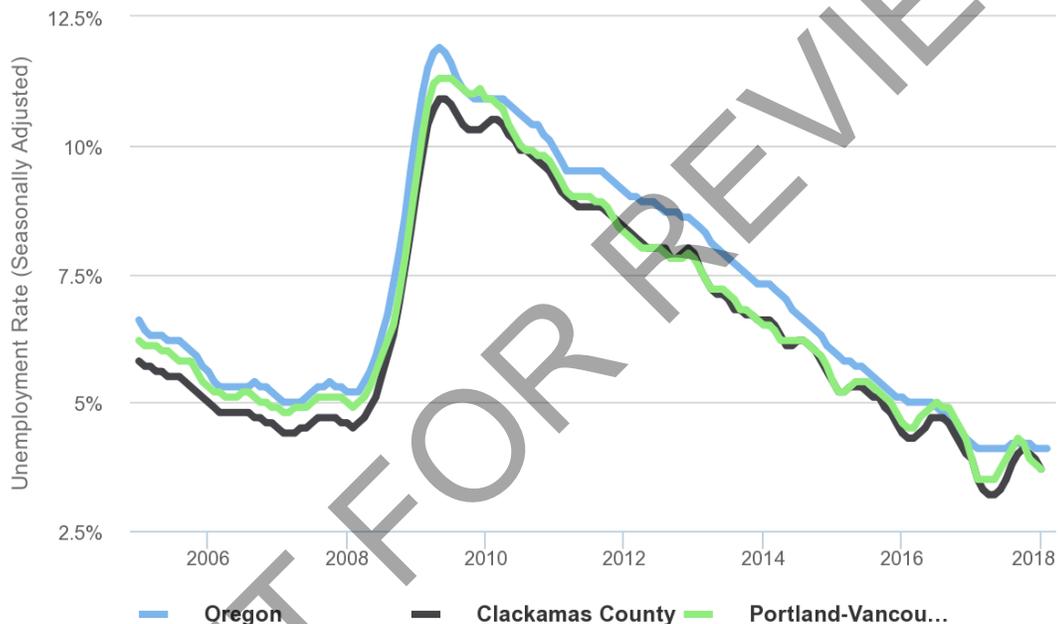
Source: Oregon Employment Department

While illustrative, economic diversity is not a guarantor of economic vitality or resilience. Clackamas County, as of December 2017, is not listed as an economically distressed community as prescribed by Oregon Law. The economic distress measure is based on indicators of decreasing new jobs, average wages and income, and is associated with an increase of unemployment.³⁹

Employment and Wages

According to the Oregon Employment Department (Figure C-6), unemployment has declined since 2009 (10.9%) and remains at a rate similar to the State of Oregon and other counties in the region (3.8%).

Figure C-6 Unemployment Rate



Source: Oregon Employment Department Qualityinfo.org

Source: Oregon Employment Department, "Local Area Employment Statistics", Qualityinfo.org .

Labor and Commute Shed

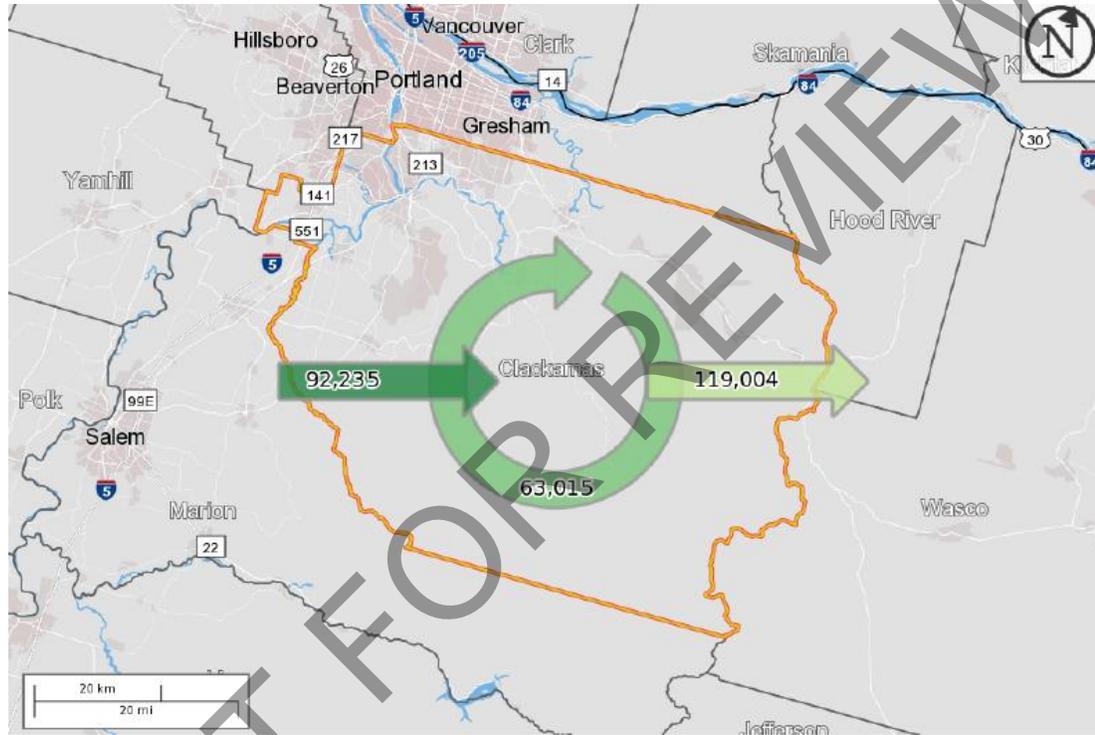
Most hazards can happen at any time during the day or night. It may be possible to give advance warning to residents and first responders who can take immediate preparedness and protection measures, but the variability of hazards is one part of why they can have such varied impact. A snow storm during the work day will have different impacts than one that comes during the night. During the day, a hazard has the potential to segregate the population by age or type of employment (e.g., school children at school, office workers in downtown areas). This may complicate some aspects of initial response such as transportation or the identification of wounded or missing. Conversely, a hazard at midnight may occur when most people are asleep and unable to receive an advance warning through typical communication channels. The following labor shed and commute shed analysis is

³⁹ Business Oregon – Oregon Economic Data "Distressed Communities List", <http://www.oregon4biz.com/Publications/Distressed-List/>

intended to document where county residents work and where people who work in Clackamas County reside.

Clackamas County employers draw in more than 59% (92,235) of their workers from outside the county. The Clackamas County economy is a cornerstone of regional economic vitality. Figure C-7 shows the county's laborshed; the map shows that about 41% of workers live and work in the county (63,015), 59% of workers come from outside the county (92,235), and about 65% of residents work outside of the county (119,004).

Figure C-7 Clackamas County Laborshed



Source: U.S. Bureau of the Census, [On The Map](#).

Table C-21 shows where workers commute to, who reside in Clackamas County. Approximately two-thirds of Clackamas County employed residents work outside of the County; 36.3% work in Multnomah County. Almost 55% of commuters outside of the County work in the Portland Metro Area (including 1.5% who commute over the Columbia River to Clark County, WA) and another 4.2% work in neighboring Marion County. Approximately 6% of workers are employed in other regions.

Table C-21 Commute Shed (Where Workers are Employed who Live in Clackamas County), 2015

Jurisdiction	Number of Jobs	Share
All Jurisdictions	182,019	100%
Metro Area	162,589	89.3%
Multnomah County	65,986	36.3%
Clackamas County	63,015	34.6%
Washington County	30,844	16.9%
Clark County (WA)	2,744	1.5%
Marion County	7,632	4.2%
Yamhill County	1,528	0.8%
Lane County	1,554	0.9%
King County (WA)	804	0.4%
Deschutes County	733	0.4%
Linn County	706	0.4%
All other Locations	6,473	3.6%

Source: U.S. Bureau of the Census, [On The Map](#).

Table C-22 shows where workers live who work in Clackamas County. Approximately 60% of Clackamas County workers live outside of the County; 24.3% live in Multnomah County. Almost 44% of commuters into the County live elsewhere in the Portland Metro Area (including 4.2% who commute over the Columbia River from Clark County, WA) and another 5.2% work in neighboring Marion County. Approximately 11% of workers live in other regions.

Table C-22 Labor Shed (Where Workers Live who are Employed in Clackamas County), 2015

Jurisdiction	Number of Jobs	Share
All Jurisdictions	155,250	100%
Metro Area	129,944	83.7%
Clackamas County	63,015	40.6%
Multnomah County	37,751	24.3%
Washington County	22,682	14.6%
Clark County (WA)	6,496	4.2%
Marion County	8,137	5.2%
Yamhill County	2,519	1.6%
Lane County	1,870	1.2%
Deschutes County	1,226	0.8%
Columbia County	1,117	0.7%
Polk County	1,079	0.7%
All other Locations	9,358	6.0%

Source: U.S. Bureau of the Census, [On The Map](#).

Workers can be impacted during a disaster to varying levels based upon their means of transportation to work. Commuters who use motorized vehicles and public transportation that rely upon maintained roads, bridges, and other infrastructure may be delayed or unable

to travel if infrastructure is impacted during an event (for example, earthquakes or heavy winter storms). Table C-23 shows that 86% of Clackamas County commuters utilized motorized vehicles (cars, trucks, vans, or motorcycles) and an additional 3% use public transportation. Three-percent of commuters bike or walk to work, and 7% work from home. Stafford (17%), Beavercreek (15%), and Damascus (10%) have the highest percentage of workers who work from home.

Table C-23 Means of Transportation to Work

Jurisdiction	Workers (16 and older)	Motorized Vehicle [^] (Percent)	Public Transportation (Percent)	Bike/Walked (Percent)	Other (Percent)	Worked at Home (Percent)
Clackamas County	188,117	86%	3%	3%	1%	7%
Beavercreek	1,851	82%	0%	1%	2%	15%
Damascus	4,934	87%	1%	1%	< 1%	10%
Government Camp	34	100%	0%	0%	0%	0%
Jennings Lodge	3,604	87%	4%	4%	0%	5%
Mount Hood Village	2,182	84%	3%	5%	0%	7%
Mulino	1,082	91%	2%	2%	0%	5%
Oak Grove	7,872	86%	5%	4%	1%	4%
Oatfield	6,448	84%	5%	3%	0%	8%
Stafford	804	77%	1%	3%	2%	17%
Incorporated*	101,029	86%	3%	3%	1%	7%

Source: Social Explorer, Table 128, U.S. Census Bureau, 2012-2016 American Community Survey Estimates

Notes: ^ - includes car, truck, van, or motorcycle, * Includes portions of Lake Oswego, Rivergrove, and Wilsonville that are outside Clackamas County; does not include portions of Portland and Tualatin that are inside Clackamas County.

Mitigation activities are needed at the business level to ensure the health and safety of workers and limit damage to industrial infrastructure. Employees are highly mobile, commuting from all over the surrounding area to industrial and business centers. As daily transit rises, there is an increased risk that a natural hazard event will disrupt the travel plans of residents across the region and seriously hinder the ability of the economy to meet the needs of Clackamas County residents and businesses.

Industry

Key industries are those that represent major employers and are significant revenue generators. Different industries face distinct vulnerabilities to natural hazards, as illustrated by the industry specific discussions below. Identifying key industries in the region enables communities to target mitigation activities towards those industries' specific sensitivities. It is important to recognize that the impact that a natural hazard event has on one industry can reverberate throughout the regional economy.

This is of specific concern when the businesses belong to the basic sector industry. Basic sector industries are those that are dependent on sales outside of the local community; they bring money into a local community via employment. The farm and ranch, information, and wholesale trade industries are all examples of basic industries. Non-basic sector industries are those that are dependent on local sales for their business, such as retail trade, construction, and health services.

Employment by Industry

Economic resilience to natural disasters is particularly important for the major employment industries in the region. If these industries are negatively impacted by a natural hazard, such that employment is affected, the impact will be felt throughout the regional economy. Thus, understanding and addressing the sensitivities of these industries is a strategic way to increase the resiliency of the entire regional economy.

Table C-24 identifies Employment by industry. The industry sectors in Clackamas County with the highest percentage of the workforce are Education and Health Services (14.0%), Professional and Business Services (12.5%), Retail Trade (11.9%), Manufacturing (11.0%), Government (10.8%; 8.4% local government), and Leisure and Hospitality (10.0%).

Table C-24 Total Non-Farm Employment by Industry 2016, Expected Growth 2024

Employment Sector	2016				Percent Change in Employment (2012-2016)	Employment Forecast* (2014-2024)
	Firms	Employees	Percent Workforce	Average Wage		
Total Payroll Employment	14,258	157,738	100%	\$49,501	13.0%	15%
Total Private	13,936	140,773	89.2%	\$49,640	14.0%	17%
Natural Resources and Mining	328	4,172	2.6%	\$32,747	2.2%	-1%
Construction	1,736	11,104	7.0%	\$54,189	30.1%	24%
Manufacturing	612	17,419	11.0%	\$63,342	5.8%	9%
Trade, Transportation & Utilities	2,592	33,819	21.4%	\$44,845	9.5%	13%
Wholesale Trade	1,148	10,955	6.9%	\$67,255	9.0%	12%
Retail Trade	1,154	18,780	11.9%	\$31,186	11.7%	13%
Information	256	2,069	1.3%	\$80,149	0.7%	8%
Financial Activities	1,369	7,425	4.7%	\$72,440	2.6%	10%
Professional and Business Services	2,372	19,662	12.5%	\$64,319	24.1%	25%
Education and Health Services	1,375	22,038	14.0%	\$52,128	16.4%	23%
Leisure and Hospitality	1,044	15,799	10.0%	\$19,072	17.6%	22%
Other Services	2,177	7,225	4.6%	\$28,886	22.4%	12%
Private Non-Classified	74	41	0.0%	\$60,873	-32.8%	-
Government	322	16,965	10.8%	\$48,349	4.7%	3%
Federal	52	1,079	0.7%	\$65,241	-13.9%	-6%
State	35	2,640	1.7%	\$36,131	15.3%	5%
Local	234	13,246	8.4%	\$49,408	4.6%	3%

Source: Oregon Employment Department, "2012 and 2016 Covered Employment and Wages Summary Reports" and "Regional Employment Projections by Industry & Occupation 2014-2024". <http://www.qualityinfo.org>.

Basic industries encourage growth in non-basic industries and bring wealth into communities from outside markets. However, a high dependence on basic industries can lead to severe difficulties when recovering from a natural disaster if vital infrastructure or primary resource concentrations have been greatly damaged. While Clackamas County has some basic industries, such as Manufacturing five out of the six largest industrial sectors are of the non-basic nature and thus they rely on local sales and services. Trending towards basic industries can lead to higher community resilience.

High Revenue Sectors

Table C-25 shows the revenue generated by each reported economic sector (not all sectors are reported). In 2012, the three sectors with the highest revenue, each with revenues over

\$5 billion, were Wholesale Trade, Manufacturing, and Retail Trade. All of the reported sectors combined generated more than \$21.77 billion in revenue for the county in 2012.

Table C-25 Revenue of Top Sectors in Clackamas County 2007 and 2012

Sector Meaning (NAICS code)	Firms		Sector Revenue		Percent Change in Revenue (2007 to 2012)
	2007	2012	2007^ (\$1,000)	2012 (\$1,000)	
Wholesale trade	598	563	\$5,858,741	\$5,388,581	-8%
Manufacturing	619	553	\$6,274,736	\$5,371,545	-14.4%
Retail trade	1,269	1,188	\$5,641,022	\$5,125,309	-9.1%
Health care and social assistance	963	1,136	\$1,884,376	\$2,424,207	28.6%
Professional, scientific, and technical services	1,238	1,231	\$0	\$1,215,906	-
Accommodation and food services	775	777	\$672,441	\$637,512	-5.2%
Administrative and support and waste management and remediation services	644	616	\$530,543	\$522,126	-1.6%
Transportation and warehousing(104)	-	276	-	\$491,387	-
Real estate and rental and leasing	693	564	\$623,345	\$451,887	-27.5%
Arts, entertainment, and recreation	147	150	\$120,817	\$104,327	-13.6%
Educational services	81	100	\$73,487	\$39,646	-46.1%
Utilities	-	16	-	Q	-
Information	167	165	\$0	N	-
Finance and insurance	-	700	-	N	-
Other services (except public administration)	660	677	\$348,086	D	-
Total	7,854	8,712	\$22,027,594	\$21,772,433	-1.2%

Source: U.S. Census Bureau, 2007 and 2012 Economic Census, Table EC1200A1.

D = Withheld to avoid disclosing data for individual companies; data are included in higher level totals

N = Not available or not comparable

Q= Revenue not collected at this level of detail for multi-establishment firms

^ 2007 dollars are adjusted for 2012 using the Social Explorer Inflation Calculator.

Clackamas County relies on both basic and non-basic sector industries and it is important to consider the effects each may have on the economy following a disaster. Basic sector businesses have a multiplier effect on a local economy that can spur the creation of new jobs, some of which may be non-basic. The presence of basic sector jobs can help speed the local recovery; however, if basic sector production is hampered by a natural hazard event, the multiplier effect could be experienced in reverse. In this case, a decrease in basic sector purchasing power results in lower profits and potential job losses for the non-basic businesses that are dependent on them.

The *Wholesale trade* sector of Clackamas County brought in the most revenue during 2012, generating more than \$5.39 billion. Wholesale trade sector is highly reliant upon transportation network for distribution of merchandise. This sector is reliant upon retail trade and manufacturing to purchase their merchandise. Depending on the type and scale, a disaster could affect all segments of the sector.

The *Manufacturing* sector of Clackamas County brought in the second most revenue during 2012, generating more than \$5.37 billion. As revenue is dependent on how fast a product can be made and distributed to consumers, this sector is highly dependent on its facility. It is highly dependent upon the transportation network in order to access supplies and send finished products to outside markets. As a base industry, manufacturers are not dependent on local markets for sales, which contribute to the economic resilience of this sector. It is important to note that depending on the severity of a natural disaster and the pace of recovery, revenue generated from this sector could be greatly impacted during a natural hazard event.

The *Retail Trade* sector of Clackamas County brought in the third highest revenue in 2012, generating almost \$5.13 billion. The *Retail Trade* sector typically relies on local residents and tourists and their discretionary spending ability. Residents' discretionary spending diminishes after a natural disaster when they must pay to repair their homes and properties. In this situation, residents will likely concentrate their spending on essential items that would benefit some types of retail (e.g., grocery) but hurt others (e.g., gift shops). The potential income from tourists also diminishes after a natural disaster as people are deterred from visiting the impacted area. Retail trade is also largely dependent on wholesale trade and the transportation network for the delivery of good for sale. Disruption of the transportation system could have severe consequences for retail businesses. In summary, depending on the type and scale, a disaster could affect specific segments of retail trade, or all segments.

In the event that any of these primary sectors are impacted by a disaster, Clackamas County may experience a significant disruption of economic productivity.

Future Employment in Industry

Table C-24 shows that between 2012 and 2016, the sectors that experienced the largest percent growth were Construction (30.1%), Professional and Business Services (24.1%), Other Services (22.4%), Leisure and Hospitality (17.6%), and Education and Health Services (16.4%). Some of these sectors often require more training and education, while others require less education and have lower wages.

Sectors that are anticipated to be major employers in the future also warrant special attention in the hazard mitigation planning process. Table C-24 shows that, between 2014 and 2024, the largest employment growth in the region is anticipated within Professional and Business Services (25%), Construction (24%), Education and Health Services (23%), and Leisure and Hospitality (22%). Mitigation activities that respond to the needs of these sectors may help to ensure the resilience of the economy and help the community stay open for business following a disaster.

Synthesis

Regional economic capacity refers to the present financial resources and revenue generated in the community to achieve a higher quality of life. Forms of economic capital include income equality, housing affordability, economic diversifications, employment, and industry. The current and anticipated financial conditions of a community are strong determinants of community resilience, as a strong and diverse economic base increases the ability of individuals, families, and the county to absorb disaster impacts for a quick recovery.

The current and anticipated financial conditions of a community are strong determinants of community resilience, as a strong and diverse economic base increases the ability of individuals, families and the community to absorb disaster impacts for a quick recovery. Because Local Government, Education and Health Services, and Manufacturing are key to post-disaster recovery efforts, the region is bolstered by its diverse and strong employment sectors. The county's economy is expected to grow by 2024. It is important to consider what might happen to the county economy if the largest revenue generators and employers are impacted by a disaster. Strategies and actions to reduce vulnerability from an economic

focus are imperative and should focus on risk management for the county’s dominant industries.

With an above average income equality, Clackamas County has a greater median household income than the state and Nation, as well as an unemployment rate of 3.8% that is about equal with that of the state. And although the county is ranked number 1 as having the most diverse economy throughout all of Oregon, more Clackamas County residents are paying greater than 35% of their income on housing, than the State as a whole.

Several industries, including Construction, Professional and Business Services, and Other Services, saw significant increases in employment from 2012 to 2016. While relying heavily on its top revenue-producing industries, wholesale trade, manufacturing, and retail, it is important for the county to consider the economic impacts that affect its residents in the event of a disaster. Strategies and actions to reduce vulnerability from an economic focus are imperative and should focus on risk management for the county’s dominant industries.

Table C-26 indicates where economy related physical infrastructure vulnerabilities exist in relation to each of the natural hazards profiled in Volume I, Section 2.

Table C-26 Clackamas County Economy Related Infrastructure Vulnerabilities

Clackamas County Asset	Drought	Earthquake	Extreme Heat	Flood	Landslide	Volcanic Event	Wildfire	Windstorm	Winter Storm
Clackamas Town Center		X							
Precision Cast Parts		X							
Fred Meyer Distribution Center		X							
Agriculture (feed procurement, seasonal worker procurement, harvest delivery, refrigeration, etc.)	X		X				X	X	X
Forestry							X	X	X
Tourism (Hotels and Restaurants)		X		X			X	X	X
County/City water supplies	X	X		X	X				
Transportation Corridors/Bridges		X			X				

Source: Clackamas County HMAP

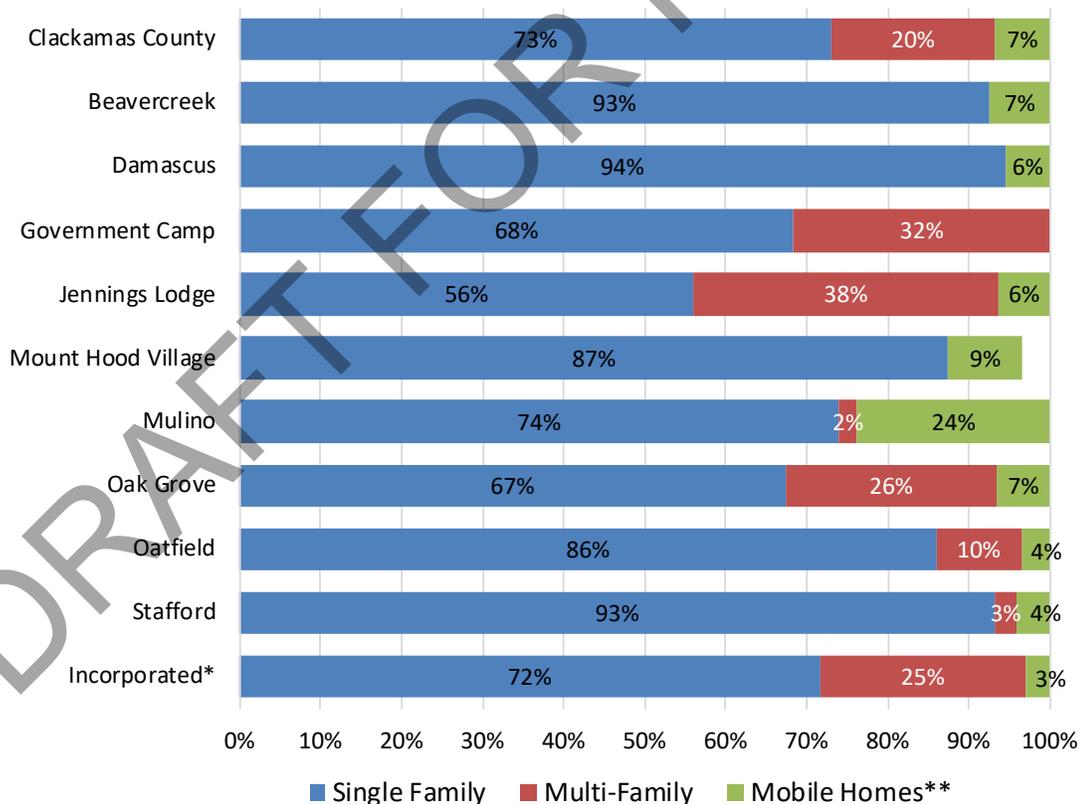
Physical Infrastructure Capacity

Physical infrastructure capacity refers to the built environment and infrastructure that supports the community. The various forms, quantity, and quality of built capital mentioned above contribute significantly to community resilience. Physical infrastructures, including utility and transportation lifelines, are critical during a disaster and are essential for proper functioning and response. The lack or poor condition of infrastructure can negatively affect a community's ability to cope, respond and recover from a natural disaster.

Housing

The table below identifies the types of housing most common throughout the county. Of particular interest are mobile homes, which account for about 7% of the housing in countywide; 24% in Mulino (Figure C-8). Mobile homes are particularly vulnerable to certain natural hazards, such as windstorms, and special attention should be given to securing the structures, because they are more prone to wind damage than wood-frame construction. In other natural hazard events, such as earthquakes and floods, moveable structures like mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants.

Figure C-8 Housing Profile



Source: Social Explorer, Table 97, U.S. Census Bureau, 2012-2016 American Community Survey

Note: * - Includes portions of Lake Oswego, Rivergrove, and Wilsonville that are outside Clackamas County; does not include portions of Portland and Tualatin that are inside Clackamas County, ** Also includes boats, RVs, vans, etc. that are used as a residence.

Aside from location and type of housing, the year structures were built has implications. In the 1970's, FEMA began assisting communities with floodplain mapping as a response to administer the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Upon receipt of floodplain maps, communities started to develop floodplain management ordinances to protect people and property from flood loss and damage. Housing within the floodplain is generally less vulnerable to flood if it was built after the implementation of floodplain development ordinances.

The National Flood Insurance Program's (NFIP's) Flood Insurance Rate Maps (FIRMs) delineate flood-prone areas. They are used to assess flood insurance premiums and to regulate construction so that in the event of a flood, damage minimized. The initial FIRMs for the county were created as early as 1977 (2008 for Johnson City) while the current FIRMs effective date for Clackamas County and cities is June 17, 2008 (preliminary maps were released for areas within the Lower Columbia-Sandy Watershed in March 2016, effective maps are expected January 18, 2019). For more information about the flood hazard, NFIP, and FIRMs, please refer to Flood Hazard section of the Risk Assessment.

Seismic building standards were codified in Oregon building code starting in 1974; more rigorous building code standards were passed in 1993 that accounted for the Cascadia earthquake fault.⁴⁰ Therefore, homes built before 1993 are more vulnerable to seismic events. DOGAMI's interpretation of state building code histories and evolution as described by Judson (2012), Oregon Building Codes Division (2002, 2010) and Business Oregon (2015) is shown in Table C-27.

Table C-27 Oregon's Seismic Design Level Benchmark Years

Building Type	Year Built	Design Level	Basis
Single Family Dwelling (including Duplexes)	prior to 1976	Pre Code	Interpretation of Judson (2012)
	1976-1991	Low Code	
	1992-2003	Moderate Code	
	2004-present	High Code	
Manufactured Housing	prior to 2003	Pre Code	Interpretation of Oregon Manufactured Dwelling Special Codes (Oregon Building Codes Division, 2002)
	2003-2010	Low Code	
	2011-present	Moderate Code	Interpretation of Oregon Manufactured Dwelling Special Codes Update (Oregon Building Codes Division, 2010)
All other buildings	prior to 1976	Pre Code	Interpretation of Oregon Benefit-Costs Analysis Tool (Business Oregon, 2015, p. 24)
	1976-190	Low Code	
	1991-present	Moderate Code	

Source: DOGAMI, Lower Columbia-Sandy Watershed Natural Hazard Risk Report (March 2018 Draft), Table 10.1.

The Oregon Department of Geology and Mineral Industries (DOGAMI) conducted a multi-hazard risk assessment ([DOGAMI, IMS-59](#)) for portions of unincorporated Clackamas County within the Lower Columbia-Sandy Watershed, including the unincorporated communities of Government Camp and The Villages at Mt. Hood. The study was funded through the FEMA Risk MAP program and was completed in 2018. The Risk Report provides a quantitative risk

⁴⁰ State of Oregon Building Codes Division. *Earthquake Design History: A summary of Requirements in the State of Oregon*, February 7, 2012. http://www.oregon.gov/OMD/OEM/ospac/docs/history_seismic_codes_or.pdf

assessment that informs communities of their risks related to the following natural hazards: channel migration, earthquake, flood, lahar (volcanic event), landslide, and wildfire.

Within the Risk Report DOGAMI assigned a seismic design level to each building within the County, summarized the number of buildings and building value as shown in Table C-28. Fifty-percent of buildings, representing 40% of total building value, within the County were built prior to seismic codes.

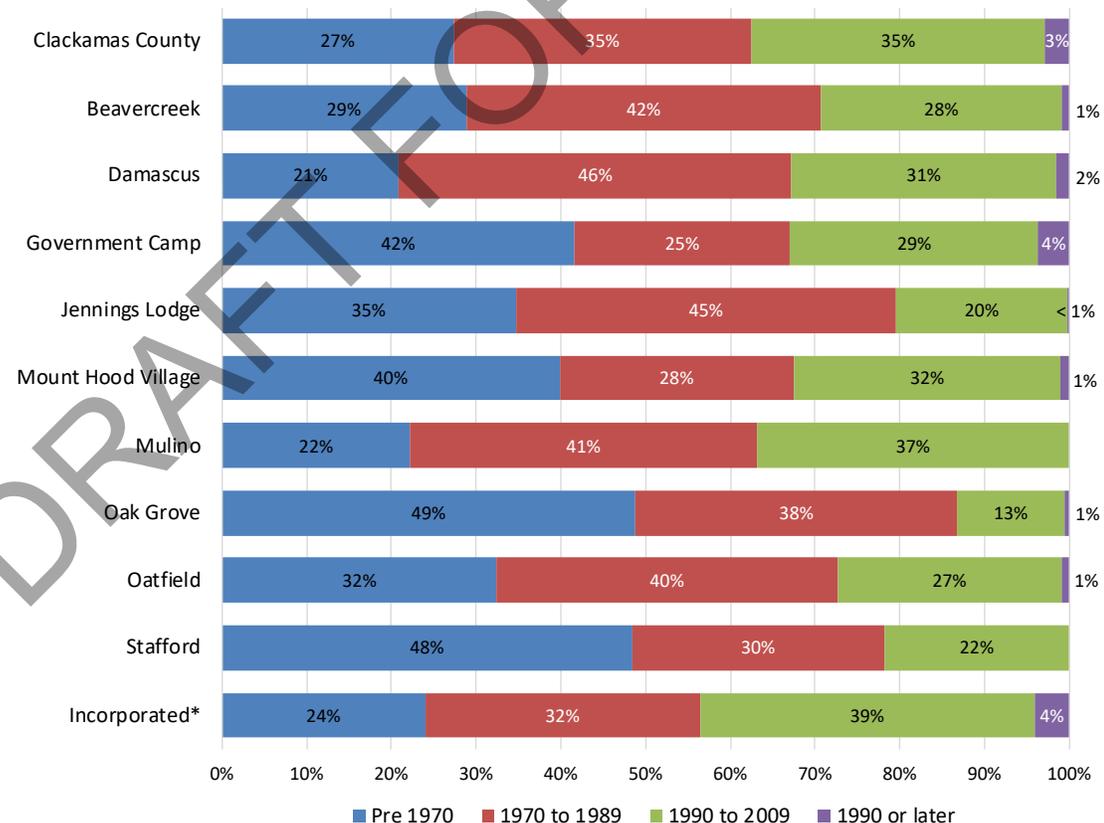
Table C-28 Building Statistics by Seismic Design Level

Seismic Design Level	Number of Buildings	Building Percent	Building Value (\$ Million)	Building Value Percent
Pre Code	89,647	50%	24,922	40%
Low Code	43,530	24%	19,523	31%
Moderate Code	30,638	17%	11,550	19%
High Code	15,349	9%	6,394	10%
Total	179,164	100%	62,389	100%

DOGAMI, Lower Columbia-Sandy Watershed Natural Hazard Risk Report (March 2018 Draft), Table 10.2.

Figure C-9 shows that, countywide, 27% of the housing stock was built prior to 1970, before the implementation of floodplain management ordinances; Oak Grove and Stafford have about one-half of their housing units built prior to 1970.

Figure C-9 Year Structure Built



Source: U.S. Census Bureau, 2012-2016 American Community Survey Estimates, Table B25034

Note: * - Includes portions of Lake Oswego, Rivergrove, and Wilsonville that are outside Clackamas County; does not include portions of Portland and Tualatin that are inside Clackamas County.

Countywide, 62% of the housing stock was built before 1990 and the codification of stricter seismic building standards (Table C-27). Government Camp (4%) and the incorporated cities (4%) have had the largest percent growth since 2010.

Infrastructure Profile

Physical infrastructure such as dams, roads, bridges, railways, and airports support Clackamas County communities and economies. Critical facilities are those facilities that are vital in government response and recovery activities and are important to consider as there can be serious secondary impacts to such facilities when disrupted. Critical facilities and infrastructure can be a wide range of things depending on the social, environmental, economic, and physical makeup of the area under consideration. Such facilities can include emergency services, communication services, transportation systems, government facilities, healthcare and public health facilities, information technology, water services, and energy generation and transmission. Due to the fundamental role that infrastructure plays both pre- and post-disaster, special attention in the context of creating more resilient communities is important. The information provided in this section will outline important infrastructures throughout the county which will help provide a basis for informed decisions about how to reduce the county's infrastructural vulnerabilities to natural hazards.

Dams

These critical infrastructure pieces not only protect water resources that are used for drinking, agriculture, and recreation, but they protect downstream development from inundation. Dams may also be multifunction, serving two or more of these purposes.

The National Inventory of Dams, NID, which is maintained by the United States Army Corps of Engineers, is a database of approximately 76,000 dams in the United States. The NID does not include all dams in the United States. Rather, the NID includes dams that are deemed to have a high or significant hazard potential and dams deemed to pose a low hazard if they meet inclusion criteria based on dam height and storage volume.

This NID potential hazard classification is solely a measure of the probable impacts if a dam fails. Thus, a dam classified as High Potential Hazard does not mean that the dam is unsafe or likely to fail. The level of risk (probability of failure) of a given dam is not even considered in this classification scheme. Rather, the High Potential Hazard classification simply means that there are people at risk downstream from the dam in the inundation area, if the dam were to fail.

Dams assigned to the significant hazard potential classification are those where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental damage, or disruption of lifeline facilities. Significant hazard potential dams are often located in predominantly rural or agricultural areas.

Dams assigned to the high hazard potential classification are those where failure or mis-operation will probably cause loss of human life. Failure of dams in the high classification will generally also result in economic, environmental or lifeline losses, but the classification is based solely on probable loss of life.

The Oregon Water and Resources Department maintains an inventory of all dams located in Oregon. There are a total of 69 dams located throughout Clackamas County (Table C-29). Three dams are categorized as high hazard in Clackamas County Bull Run Dam 1, Bull Run

Dam 2, and North Fork Dam. There are also 19 dams categorized as significant hazard and 42 low hazard dams.

Table C-29 Clackamas County Dam Inventory

Threat Potential	Number of Dams	Dam Name (storage over 9,500 cu.ft.)
High	8	<i>Bull Run Dam 1 (Upper, 33,760)</i> , Bull Run Dam 2 (Lower, 21,000), North Fork Dam (21,000)
Significant	19	-
Low	42	Timothy Lake (81,000), River Mill Dam (12,200), Lake Oswego Dam (9,800)
Total	69	

Source: Oregon Water Resources Department, "Dam Inventory Query"

Dam failures can occur at any time in a dam’s life; however, failures are most common when water storage for the dam is at or near design capacity. At high water levels, the water force on the dam is higher and several of the most common failure modes are more likely to occur. Correspondingly, for any dam, the probability of failure is much lower when water levels are substantially below the design capacity for the reservoir.

Dam failures can occur rapidly and with little warning. Fortunately, most failures result in minor damage and pose little or no risk to life safety. However, the potential for severe damage still exists.

Railroads

Railroads are major providers of regional and national cargo and trade flows. Railroads run through the Northern Willamette region provide vital transportation links from the pacific to the rest of the country. The Portland & Western (PNWR), the Union Pacific Railroad (UP), and the Oregon Pacific (OPR) are the three major railroads that run through Clackamas County. All three travel through the western portion of the county moving along north to south.

Rails are sensitive to icing from the winter storms that can occur in the Northern Willamette region. For industries in the region that utilize rail transport, these disruptions in service can result in economic losses. The potential for rail accidents caused by natural hazards can also have serious implications for the local communities if hazardous materials are involved.

Airports

Clackamas County has no commercial service airports, however Portland International Airport (PDX) which is the busiest airport in the state is located in neighboring Multnomah County. Clackamas County has 24 private airports and 4 heliports. Two heliports service hospitals, Providence Willamette Falls Medical Center and Meridian Park Hospital. Flights face potential for closure from a number of natural hazards that are common in Clackamas County, including windstorms and winter storms.

Roads

The county’s major expressway is Interstate 205. It runs North/South through Clackamas County and is one of the main passages for automobiles, buses, and trucks traveling through

the state up to Clackamas via I-5 or along the Columbia via I-84. Other highways that service Clackamas County include:

- Interstate 5: runs north to South along the western portion of the county through Wilsonville eventually branching out to create Interstate 205.
- US Route 26: connects major Clackamas County cities, such as Sandy, to Portland via the Mount Hood Scenic Byway
- Oregon Route 211: runs south and west from Portland out to Sandy when it connects with US Route 26. It also runs concurrently for part of the way with OR 224 in Estacada and Eagle Creek, and intersects with OR 213 in Molalla.
- Oregon Route 212: runs east to west running from Clackamas and connecting the cities of Boring and Damascus.
- Oregon Route 213: connects with cities and other highways in different parts of the county including Molalla and Estacada with the OR 211, Oregon City with Interstate 205, Clackamas, Estacada, Mount Hood, and Johnson City with Oregon Route 212/Oregon Route 224, and Milwaukie and Clackamas with OR 224.
- Oregon Route 224: runs north to south throughout the county through the cities of Milwaukie, Clackamas, Eagle Creek, and Estacada.

Daily transportation infrastructure capacity throughout Clackamas County is stressed by maintenance, congestion, and oversized loads. Natural hazards can further disrupt automobile traffic and create gridlock, and will make evacuations difficult.

Bridges

Because of earthquake risk, the seismic vulnerability of the county's bridges is an important issue. Non-functional bridges can disrupt emergency operations, sever lifelines, and disrupt local and freight traffic. These disruptions may exacerbate local economic losses if industries are unable to transport goods. The county's bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or that are part of regional and local systems that are maintained by the region's counties and cities.

The bridges in Clackamas County require ongoing management and maintenance due to the age and types of bridges. Modern bridges, which require minimum maintenance and are designed to withstand earthquakes, consist of pre-stressed reinforced concrete structures set on deep steel piling foundations.

Table C-30 shows the structural condition of bridges in the region. A distressed bridge is a condition rating used by the Oregon Department of Transportation (ODOT) indicating that a bridge has been identified as having a structural or other deficiency, while a deficient bridge is a federal performance measure used for non-ODOT bridges; the ratings do not imply that a bridge is unsafe.⁴¹ The table shows that overall 20% of the county owned bridges are distressed, compared to 29% of the city owned bridges and 19% of State Owned (ODOT) bridges. There are 16 historic bridges in the County; 9 state-owned and 7 county-owned.

⁴¹ Oregon. Bridge Engineering Section (2012). 2012 Bridge Condition Report. Salem, Oregon: Bridge Section, Oregon Department. of Transportation.

Table C-30 Bridge Inventory

Bridge Owner	Number	Distressed	Percent Distressed	Historic
State	114	22	19%	9
County	180	36	20%	7
City	17	5	29%	N/A
Total	311	63	20%	16

Source: Oregon Department of Transportation, 2014; Oregon Department of Transportation (2013), Oregon's Historic Bridge Field Guide

Note: ODOT bridge classifications overlap and suC-total is not used to calculate percent distressed, calculation for ODOT distressed bridges accounts for this overlap.

Utility Lifelines

Utility lifelines are the resources that the public relies on daily such as, electricity, fuel and communication lines. If these lines fail or are disrupted, the essential functions of the community can become severely impaired. Utility lifelines are closely related to physical infrastructures, like dams and power plants, as they transmit the power generated from these facilities.

The network of electricity transmission lines running throughout Clackamas County is operated by Portland General Electric.⁴² With the Williams Gas Pipeline in the Northwest operating approximately 3,900 miles of pipe beginning in northern Washington, making its way down through Portland, Oregon and then ending in the Rogue Valley, most residents in Clackamas County have their natural gas operated by Northwest Natural Gas.⁴³ These lines may be vulnerable as infrequent natural hazards, like earthquakes, could disrupt service to natural gas consumers across the region.

Seismic lifeline

Seismic lifeline routes help maintain transportation facilities for public safety and resilience in the case of natural disasters. Following a major earthquake, it is important for response and recovery agencies to know which roadways are most prepared for a major seismic event. The Oregon Department of Transportation has identified lifeline routes to provide a secure lifeline network of streets, highways, and bridges to facilitate emergency services response after a disaster.⁴⁴

System connectivity and key geographical features were used to identify a three-tiered seismic lifeline system. Routes identified as Tier 1 are considered the most significant and necessary to ensure a functioning statewide transportation network. The Tier 2 system provides additional connectivity to the Tier 1 system, it allows for direct access to more locations and increased traffic volume capacity. The Tier 3 lifeline routes provide additional connectivity to the systems provided by Tiers 1 and 2.

⁴² Allan, Stuart et. al., Atlas of Oregon. Pg. 102.

⁴³ Williams, Gas Pipeline, Natural Gas Transportation & Storage. Accessed 3 January 2011.

http://www.williams.com/gas_pipeline/.

⁴⁴ CH2MHILL, Prepared for Oregon Department of Transportation. Oregon Seismic Lifeline Routes Identification Project, *Lifeline Selection Summary Report*, May 15 2012.

The Lifeline Routes in the Portland Metro Geographic Zone (which includes Clackamas County) consist of the following:

- Tier I: I-5 (except those identified in Tier II), I-205, OR 99W (from I-5 to OR217)
- Tier II: I-84, I-5 (between the northern and southern I-405 interchanges)
- Tier III: OR 217, US 26 (from I-5 to I-205), OR 43

Critical Facilities

Critical facilities are those facilities that are essential to government response and recovery activities (e.g., polices and fire stations, public hospitals, public schools). It is important that these facilities are the most resilient to natural hazards as interruption or destruction of these facilities could restrict response efforts and time needed to assist those in danger. Table C-31 identifies the types and numbers the critical facilities located throughout Clackamas County.

Clackamas County is served by the Clackamas County Sheriff's office, as well as individual city law enforcement teams. The county Sheriff's office provides services to unincorporated parts of the county as well as contracts police services to the incorporated cities of Wilsonville, Estacada, Happy Valley, and Damascus, while the rest of the incorporated cities have their own law enforcement agency that provides services within the city limits.⁴⁵ There are 13 structural fire agencies and two (2) wildland fire agencies for a total of 15. Clackamas Fire District #1 is one of the largest fire protection districts in Oregon, serving over 220,000 residents across the region.⁴⁶ Aside from just extinguishing fires, each fire district and department provides essential public services in the communities they serve, including emergency medical services, search and rescue, and fire prevention education.⁴⁷

Table C-31 Critical Facilities in Clackamas County

Type of Facility	County Total
Hospitals (# of beds)	3 (408)
Police Stations	11
Fire & Rescue Stations	17
Dams	69 (8 High Threat)
Bridges	285
State	114 (22 distressed)
County	154 (36 distressed)
City	17 (5 distressed)
School Districts & Institutes of Higher Education	10 School Districts, 1 Community College, 1 University
Airports - General Aviation	4

Source: State of Oregon Natural Hazards Mitigation Plan, Region 2: Northern Willamette Valley/Portland Metro Regional Profile, 2012. Updated 2018.

⁴⁵ Clackamas County Website, Clackamas County Sheriff's Office. Accessed 30 December 2011. <http://www.clackamas.us/sheriff/info.jsp?name=contractcities.htm>.

⁴⁶ Clackamas County Wildfire Protection Plan.

⁴⁷ Ibid.

The county Courthouse is located in Oregon City and primarily houses state and court-related offices, the rest of the county departments are also located in Oregon City in either the Public Services Building or Development Services Building located in what is known as the Red Soils Campus.⁴⁸ The Clackamas County Department of Communications (C-COM) provides 9-1-1 emergency and non-emergency call taking service for all residents throughout the county except for residents within the city limits of Lake Oswego, West Linn and Milwaukie whose 9-1-1 calls are answered by Lake Oswego 9-1-1 (LOCOM). The county's Emergency Management Office is also located within the C-COM building.⁴⁹

Dependent Facilities

In addition to the critical facilities mentioned in Table C-31, there are other facilities vital to the continued delivery of health services and may significantly impact the public's ability to recover from emergencies. Facilities which have patients that are dependent on continued support and care include assisted living centers, nursing homes, residential mental health facilities, and psychiatric hospitals. In the event of a disaster, these facilities may also act as secondary medical facilities as they are equipped with nurses, medical supplies, and beds. Distributed across the county, Clackamas has 15 adult day care facilities, 30 assisted living facilities, 15 registered nursing homes, 30 residential care facilities, 19 supportive living facilities, and 1 mental health residential program that will assist those in need.⁵⁰

Correctional Facilities

Correctional facilities are incorporated into physical infrastructure as they play an important role in everyday society by maintaining safe separation from the public. There are two correctional facilities located in Clackamas County. The Clackamas County Jail and the Clackamas County Juvenile Department are both located in Oregon City. While correctional facilities are built to code to resist structural failure, they typically have backup power to sustain regulation of inmates following the immediate event of an emergency. It is when the impacts of the event continue over a long duration, that logistical planning of these facilities becomes a challenge.

Synthesis

Built capacity refers to the built environment and infrastructure that support a community. The various forms of built capital mentioned above will play significant roles in the event of a disaster. Physical infrastructures, along with utility and transportation lifelines are critical during a disaster and are essential for proper functioning and response. Community resilience is directly affected by the quality and quantity of built capital and lack of, or poor condition of, infrastructure can negatively affect a community's ability to cope, respond, and recover from a natural disaster. Initially following a disaster, communities may experience isolation from surrounding cities and counties due to infrastructure failure. These conditions will force communities to rely on local and immediate resources, so it is important to identify critical infrastructures throughout the county as they may play crucial roles in the mitigation and recovery stages of a disaster.

⁴⁸ Clackamas County Website. Accessed 30 December 2011. <http://www.clackamas.us/about.htm>.

⁴⁹ Clackamas County Website, Clackamas County Communications. Accessed 30 December 2011. <http://clackamas911.org/>.

⁵⁰ Clackamas County Website. Clackamas County Social Services Resource Guide. <https://www.clackamas.us/socialservices/housingresources.html#assisted>

- 73% of the housing stock in Clackamas County is single-family units, another 27% is comprised of Mobile Homes and Multi-Family buildings, which are particularly prone to the effects of natural hazards and disasters.
- 74% of the total housing units throughout the county were built before building codes enforced a stricter policy for seismic building standards (pre-code or low code).
- 29% of the housing stock is renter-occupied.

It is important for the county to consider these numbers when producing mitigation and educational outreach materials as it is important to reach all populations, especially the ones who face a higher risk of damage. There are eight (8) dams throughout the county classified with a high threat potential. There are a variety of critical facilities located throughout county limits that in the event of a disaster can make communication efforts challenging. Several major highways run throughout the county, giving residents a number of alternative routes that may provide service access, or serve as evacuation routes, yet if these roads are destroyed it can isolate communities and make rescue efforts more challenging.

Table C-32 indicates where built infrastructure related vulnerabilities exist in relation to each of the natural hazards profiled in Volume I, Section 2.

Table C-32 Clackamas County Built Infrastructure Related Vulnerabilities

Clackamas County Asset	Drought	Earthquake	Extreme Heat	Flood	Landslide	Volcanic Event	Wildfire	Windstorm	Winter Storm
Homeowners in Forest Edge Apartments		X			X				
Carver Mobile Home Ranch				X					X
Development on established floodplains, historic and pre-historic debris flow plains		X		X	X	X			
Decentralized water and sewage systems	X	X		X	X				
Increased development in the wildland-urban interface							X	X	X

Source: Clackamas County HMAP

Table C-33 indicates where critical infrastructure and services related vulnerabilities exist in relation to each of the natural hazards profiled in Volume I, Section 2.

Table C-33 Clackamas County Critical Infrastructure and Services Related Vulnerabilities

Clackamas County Asset	Drought	Earthquake	Extreme Heat	Flood	Landslide	Volcanic Event	Wildfire	Windstorm	Winter Storm
Electric grid		X	X	X	X			X	X
All highways and bridges		X		X	X			X	X
County and City buildings		X							
Cellular communications infrastructure		X						X	X
Fiber optic lines		X						X	X
Water intake facilities		X		X	X				
Emergency Services (fire departments, police departments, hospitals, EOCs)		X		X	X		X	X	X
Water treatment plants/sewer		X		X					

Source: Clackamas County HMCAC

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Community Connectivity Capacity

Community connectivity capacity places strong emphasis on social structure, trust, norms, and cultural resources within a community. In terms of community resilience, these emerging elements of social and cultural capital will be drawn upon to stabilize the recovery of the community. Social and cultural capitals are present in all communities; however, it may be dramatically different from one city to the next as these capitals reflect the specific needs and composition of the community residents.

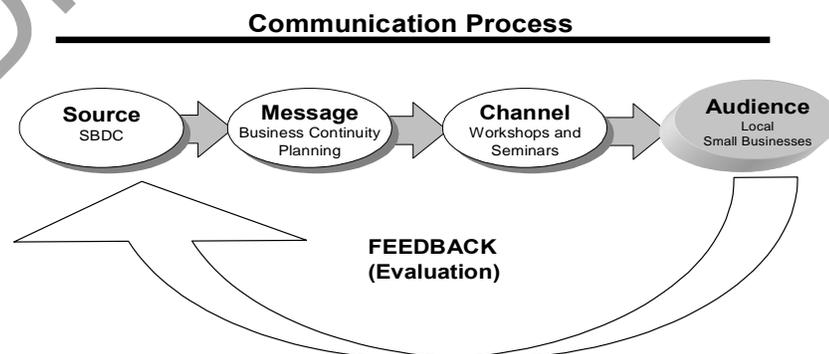
Social Systems and Service Providers

Social systems include community organizations and programs that provide social and community-based services, such as employment, health, senior and disabled services, professional associations and veterans' affairs for the public. In planning for natural hazard mitigation, it is important to know what social systems exist within the community because of their existing connections to the public. Often, actions identified by the plan involve communicating with the public or specific subgroups within the population (e.g. elderly, children, low income, etc.). The county can use existing social systems as resources for implementing such communication-related activities because these service providers already work directly with the public on a number of issues, one of which could be natural hazard preparedness and mitigation. The presence of these services is more predominantly located in urbanized areas of the county, this is synonymous with the general urbanizing trend of local residents.

The following is a brief explanation of how the communication process works and how the community's existing social service providers could be used to provide natural hazard related messages to their clients.

- There are five essential elements for communicating effectively to a target audience:
- The source of the message must be credible,
- The message must be appropriately designed,
- The channel for communicating the message must be carefully selected,
- The audience must be clearly defined, and
- The recommended action must be clearly stated and a feedback channel established for questions, comments and suggestions.

Figure C-10 Communication Process



②
each program

The following table provides a list of existing social systems within Clackamas County. The table provides information on each organization or program's service area, types of services offered, populations served, and how the organization or program could be involved in natural hazard mitigation. The three involvement methods identified in the table are defined below:

- Education and outreach – organization could partner with the community to educate the public or provide outreach assistance on natural hazard preparedness and mitigation.
- Information dissemination – organization could partner with the community to provide hazard related information to target audiences.
- Plan/project implementation – organization may have plans and/or policies that may be used to implement mitigation activities or the organization could serve as the coordinating or partner organization to implement mitigation actions.

The information provided in the table can also be used to complete action item worksheets by identifying potential coordinating agencies and internal and external partners.

Civic Engagement

Civic engagement and involvement in local, state and national politics are important indicators of community connectivity. Those who are more invested in their community may have a higher tendency to vote in political elections. The 2016 Presidential General Election resulted in 82% voter turnout in the county.⁵¹ These results are relatively equal to voter participation reported across the State (81%).⁵² Other indicators such as volunteerism, participation in formal community networks and community charitable contributions are examples of other civic engagement that may increase community connectivity.

Cultural Resources and Historic Places

The cultural and historic heritage of a community is more than just tourist charm. For families that have lived in the county for generations and new resident alike, it is the unique places, stories, and annual events that make Clackamas County an appealing place to live. The cultural and historic assets in the county are both intangible benefits and obvious quality-of-life-enhancing amenities. Mitigation actions to protect these assets span many of the other systems already discussed. Some examples of that overlap could be seismic retrofit (preserving historic buildings and ensuring safety) or expanding protection of wetlands (protect water resources and beautify the county).

The National Register of Historic Places lists all types of facilities and infrastructure that help define a community. Whether it is first schoolhouse in town or even just the home of a resident who played a vital role in the success of the community, the *Register* lists all types of historic features that characterize the area. Table 2.38 categorizes the 83 different National Historic Sites located throughout Clackamas County by their distinction and function.

These places provide current residents, youth, and visitors with a sense of community. Because of the history behind these sites, and their role in defining a community, it is

⁵¹ Oregon Blue Book, Voter Participation, <http://sos.oregon.gov/elections/Documents/statistics/participation-stats-11-2016.pdf>

⁵² Ibid.

important to protect these *historic sites* from the impacts natural disasters might have on them.

Table C-34 List of National Register of Historic Sites in Clackamas County

Type of Structure	Number of Structures
Bridges and Locks	2
Cabins, Estates, Farms, Houses, Huts, Lodges, Log Cabins	60
Mills	2
Ranger and Guard Stations	3
Roads	3
Churches	4
Schools	1
Historic Districts	2
Miscellaneous Buildings	6
Total	83

Source: National Register of Historic Places.

Libraries and Museums

Libraries and Museums are other facilities which a community will use to stay connected. Clackamas County has a Library District in which all but one city, Johnson City, is a participant.⁵³ The purpose of *The District* is to provide residents with one single library computer system which make it easy for residents to borrow materials from any or all of the libraries throughout the county. Residents can even request to have materials delivered via library courier to their neighborhood library for easy pick-up.⁵⁴ There are 2 county libraries, 11 city run libraries, and 3 college/university libraries.

Because all but one city within the county operates a public library, these facilities should be considered a common place for the community to gather during a disaster, as well as and serve a critical function in maintaining a sense of community.

Museums can also function in maintaining a sense of community as they provide residents and visitors with the opportunity to explore the past and develop cultural capacity. Throughout Clackamas County there are a number of museums that provide information on topics that range from historical, technology, science, and art. As a preservation of history, it is important to also consider museums in the mitigation process for community resilience, as these structures should be protected in critical times, especially disasters.

⁵³ Clackamas County Website, Library District. Accessed 6 December 2011.
<http://www.clackamas.us/librarydistrict/>.

⁵⁴ Libraries in Clackamas County. Accessed 6 December 2011.
<http://www.lincc.org/uhtbin/cgiirsi/?ps=sonPjuH8pE/NT/199190208/1/520/X#>.

Community Stability

Community stability is a measure of rootedness in place. It is hypothesized that resilience to a disaster stems in part from familiarity with place, not only for navigating the community during a crisis, but also accessing services and other supports for economic or social challenges.⁵⁵

Residential Geographic Stability

The table below estimates residential stability across the region. It is calculated by the number of people who have lived in the same house and those who have moved within the same county a year ago, compared to the percentage of people who have migrated into the region. Clackamas County overall has a geographic stability rating of about 92% (i.e., 92% of the population lived in the same house or moved within the county). Government Camp has the highest geographic stability (100%) while Jennings Lodge has the lowest (90%).

Table C-35 Regional Residential Stability

Jurisdiction	Population	Geographic Stability	Same House	Moved Within Same County
Clackamas County	391,057	92%	84%	8%
Beavercreek	4,003	98%	86%	12%
Damascus	10,788	93%	86%	7%
Government Camp	121	100%	100%	0%
Jennings Lodge	7,594	90%	83%	8%
Mount Hood Village	5,199	94%	88%	6%
Mulino	2,797	91%	88%	3%
Oak Grove	16,690	92%	82%	10%
Oatfield	13,494	94%	90%	4%
Stafford	1,931	100%	99%	2%
Incorporated*	209,289	92%	83%	9%

Source: Social Explorer, Table 130, U.S. Census Bureau, 2012-2016 American Community Survey Estimates

Homeownership

Housing tenure describes whether residents rent or own the housing units they occupy. Homeowners are typically more financially stable but are at risk of greater property loss in a post-disaster situation. People may rent because they choose not to own, they do not have the financial resources for home ownership, or they are transient.

Collectively, about 64.3% of the occupied housing units in Clackamas County are owner-occupied; about 35.7% are renter occupied. Falls City (82.9%) has the highest rate of owner-occupied units. Monmouth (51.7%) and Independence (45.1%) have the highest rate of renter-occupied households. Falls City (9.2%) and Independence (8.4%) have the highest

⁵⁵ Cutter, Susan, Christopher Burton, Christopher Emrich. "Disaster Resilience Indicators for Benchmarking Baseline Conditions". Journal of Homeland Security and Emergency Management.

vacancy rates within the county. In addition, seasonal or recreational housing accounts for approximately 11% of the county's vacant housing stock.⁵⁶

Table C-36 Housing Tenure and Vacancy

Jurisdiction	Housing Units	Owner-occupied		Renter-occupied		Seasonal [^]		Vacant ^{^^}	
		Estimate	Percent	Estimate	Percent	Estimate	Percent	Estimate	Percent
Clackamas County	161,005	104,124	65%	47,026	29%	2,917	2%	6,938	4%
Beavercreek	1,490	1,348	90%	105	7%	10	1%	27	2%
Damascus	3,996	3,335	83%	388	10%	8	0%	265	7%
Government Camp	683	53	8%	0	0%	582	85%	48	7%
Jennings Lodge	3,218	1,642	51%	1,497	47%	0	0%	79	2%
Mount Hood Village	3,972	1,672	42%	543	14%	1,483	37%	274	7%
Mulino	913	705	77%	133	15%	0	0%	75	8%
Oak Grove	7,579	4,282	56%	2,756	36%	41	1%	500	7%
Oatfield	5,405	4,176	77%	1,025	19%	0	0%	204	4%
Stafford	787	556	71%	162	21%	32	4%	37	5%
Incorporated*	85,401	53,681	63%	28,061	33%	440	1%	3,219	4%

Source: Social Explorer, Tables 94, and 95, U.S. Census Bureau, 2012-2016 American Community Survey Estimates, Table B25004

[^] = Seasonal, recreational, or occasional housing units.

^{^^} = Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.

According to Cutter, wealth increases resiliency and recovery from disasters. Renters often do not have personal financial resources or insurance to assist them post-disaster. On the other hand, renters tend to be more mobile and have fewer assets at risk of natural hazards.⁵⁷ In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or unaffordable post-disaster.

Synthesis

Clackamas County has distinct social and cultural resources that work in favor to increase community connectivity and resilience. Sustaining social and cultural resources, such as social services and cultural events, may be essential to preserving community cohesion and a sense of place. The presence of larger communities makes additional resources and services available for the public. However, it is important to consider that these amenities may not be equally distributed to the rural portions of the county and may produce implications for recovery in the event of a disaster.

In the long-term, it may be of specific interest to the county to evaluate community stability. A community experiencing instability and low homeownership may hinder the effectiveness of social and cultural resources, distressing community coping and response mechanisms.

⁵⁶ U.S. Census Bureau, 2012-2016 American Community Survey Estimates, Table B25004.

⁵⁷ Cutter, S. L. (2003). Social Vulnerability to Environmental Hazards. *Social Science Quarterly*.

Political Capacity

Political capacity is recognized as the government and planning structures established within the community. In terms of hazard resilience, it is essential for political capital to encompass diverse government and non-government entities in collaboration; as disaster losses stem from a predictable result of interactions between the physical environment, social and demographic characteristics and the built environment.⁵⁸ Resilient political capital seeks to involve various stakeholders in hazard planning and works towards integrating the Natural Hazard Mitigation Plan with other community plans, so that all planning approaches are consistent.

Government Structure

Clackamas County is governed by a five-member Board of Commissioners. The Commissioners are elected to four-year terms and serve as the governing body which directs the general administration of county government. The county encompasses all or part of 16 cities, and four county urban renewal districts which include Clackamas Industrial Area, Clackamas Town Center, Government Camp and the North Clackamas Revitalization Area. The Commissioners set policies, enact ordinances, and establish and manage budgets to perform the services that state law and citizens of the county requires.

Beyond the valuable function of Emergency Management, all departments within the county governance structure have some degree of responsibility in building overall community resilience. Each department plays a critical role in ensuring that county functions and normal operations resume after an incident, and that the needs of the population are met.

Some divisions and departments of Clackamas County government that have a role in hazard mitigation are:

- **Department of Disaster Management:** Develops, coordinates and implements a comprehensive all-hazards countywide program to minimize the impact of incidents or disasters which can potentially threaten the safety and welfare of citizens. Aside from being the first county in the country to have a FEMA-approved hazard mitigation plan, the Emergency Management Department also oversees emergency operations, damage assessment, disaster exercises, training, public education and outreach, a city liaison program, and is an active participant in the Portland Urban Area Security Initiative (UASI).
- **Department of Transportation and Development:** Among other things, the DTD is responsible for a broad range of county services involving land use planning and permitting, building permits, county code enforcement, sustainability, and road construction and maintenance.
 - **Building Codes:** Can collaborate to do outreach with owners of structures that were not built up to modern, resilient code. Professionals from this department could even be called on to help survey buildings after an incident.
 - **Planning and Zoning:** Conducts both short and long-range plans that determine much of the built, physical community. Through the county Comprehensive Plan

⁵⁸ Mileti, D. 1999. *Disaster by Design: a Reassessment of Natural Hazards in the United States*. D.C.: Joseph Henry Press.

and subsequent polices, this department guides decisions about growth, development, and conservation of natural resources. The Planning Department can be partners in mitigation by developing, implementing, and monitoring polices such as ensuring homes, businesses, and other buildings are built to current seismic code and out of the flood zones.

- **Transportation Maintenance:** Is responsible for maintaining the integrity and safety of over 1,407 miles of county roads, 180 bridges, 1,400 miles of road striping, 2,398 miles of rock shoulder, 26,453 road signs and operates the Canby Ferry for more than 85,000 vehicles a year.⁵⁹ As transportation and infrastructure is a critical component of mobility, this department should be considered in hazard mitigation principles to ensure that residents and safety personnel are able to safely move about in the event of a disaster.
- **Department of Health, Housing and Human Services:** The mission of the Health, Housing and Human Services Department is to promote and assist individuals, families and communities to be safe, healthy and thrive.⁶⁰
 - **Commission for Children and Families:** Plans, advocates, and engages the community around issues on behalf of families and children, often thought of as vulnerable populations due to increased sensitivity to the impacts of hazard incidents. Because this department is in frequent contact with a vulnerable population, it would be a natural partner in mitigation actions for outreach efforts and to build the county's awareness of the needs of children and families.
 - **Public Health:** Provides community-wide health promotion and disease prevention services to assure the physical and mental well-being of county residents.⁶¹ As an inherently mitigation focused department, Public Health can be an ally in preparing the community for natural hazards. Public Health likely has a distribution network established for information and supplies and these connection to the community will be to encourage personal preparedness and also during incident response.
- **Technology Services:** focuses on providing high quality, innovative, cost-effective technology for citizens, county departments, and county commissioners to conduct daily business.⁶² Without this critical component, the county could not effectively serve the residents. Mitigation efforts from this department would not likely involve citizens at all, but would go a long way to ensuring uninterrupted services during hazard incidents.
- **Geographic Information Systems:** Develops and maintains a Geographic Information System (GIS) for Clackamas County and has the ability to assist in the decision making process by providing an additional tool to analyze and compare numerous geographic data layers along with traditional databases.⁶³ The GIS is composed of computer maps and associated databases. Examples of the maps include soils, flood hazard areas, and streams. In all phases of the disaster cycle, information is key. Building robust data that catalogues not only the county's risk and vulnerability, but also resources and response capability can ensure that efficient and effective mitigation activities.

⁵⁹ Clackamas County Website. Transportation Maintenance. <https://www.clackamas.us/roads>.

⁶⁰ Clackamas County Website. Department of Health, Housing and Human Services. <https://www.clackamas.us/h3s>

⁶¹ Clackamas County Website. Public Health. <https://www.clackamas.us/publichealth>.

⁶² Clackamas County Website. Technology Services. <http://www.clackamas.us/ts/>.

⁶³ Clackamas County Website. Geographic Information Systems. <https://www.clackamas.us/gis>.

- **Sheriff's Office:** The mission of the Clackamas County Sheriff's Office is to provide a number of services such as patrol, investigation, civil process corrections services and jail operations in a professional, ethical, and fiscally responsible manner. Life safety is the first goal of mitigation and response. Public Safety interacts with the vulnerable aspects of the community on a day-to-day basis and can help identify areas for focused mitigation.⁶⁴

Regulatory Context: Oregon Statewide Planning Goal 7

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of that program is a set of 19 statewide planning goals that express the state's policies on land use and on related topics, such as citizen involvement, land use planning, and natural resources.

Most of the goals are accompanied by "guidelines," which are suggestions about how a goal may be applied. Oregon's statewide goals are achieved through local comprehensive planning. State law requires each city and county to adopt a comprehensive plan and the zoning and land-division ordinances needed to put the plan into effect. The local comprehensive plans must be consistent with the statewide planning goals. Plans are reviewed for such consistency by the state's Land Conservation and Development Commission (LCDC). When LCDC officially approves a local government's plan, the plan is said to be "acknowledged." It then becomes the controlling document for land use in the area covered by that plan.

Statewide Planning Goal 7

Goal 7: Areas Subject to Natural Disasters and Hazards has the overriding purpose to "protect people and property from natural hazards." Goal 7 requires local governments to adopt comprehensive plans (inventories, policies and implementing measures) to reduce risk to people and property from natural hazards. Natural hazards include floods, landslides, earthquakes, tsunamis, coastal erosion, and wildfires.

To comply with Goal 7, local governments are required to respond to new hazard inventory information from federal or state agencies. The local government must evaluate the hazard risk and assess the:

- frequency, severity, and location of the hazard;
- effects of the hazard on existing and future development;
- potential for development in the hazard area to increase the frequency and severity of the hazard; and
- types and intensities of land uses to be allowed in the hazard area.

Local governments must adopt or amend comprehensive plan policies and implementing measures to avoid development in hazard areas where the risk cannot be mitigated. In addition, the siting of essential facilities, major structures, hazardous facilities and special occupancy structures should be prohibited in hazard areas where the risk to public safety cannot be mitigated. The state recognizes compliance with

⁶⁴ Clackamas County Website. Sheriff. <https://www.clackamas.us/sheriff>.

Goal 7 for coastal and riverine flood hazards by adopting and implementing local floodplain regulations that meet the minimum National Flood Insurance Program (NFIP) requirements.

Goal 7 Planning Guidelines

- In adopting plan policies and implementing measures for protection from natural hazards, local governments should consider:
 - the benefits of maintaining natural hazard areas as open space, recreation, and other low density uses;
 - the beneficial effects that natural hazards can have on natural resources and the environment; and
 - the effects of development and mitigation measures in identified hazard areas on the management of natural resources.
- Local governments should coordinate their land use plans and decisions with emergency preparedness, response, recovery and mitigation programs.

Goal 7 Implementation Guidelines

Goal 7 guides local governments to give special attention to emergency access when considering development in identified hazard areas.

- Consider programs to manage stormwater runoff to address flood and landslide hazards.
- Consider non-regulatory approaches to help implement the goal.
- When reviewing development requests in high-hazard areas, require site-specific reports, appropriate for the level and type of hazard. Reports should evaluate the risk to the site, as well as the risk the proposed development may pose to other properties.
- Consider measures exceeding the National Flood Insurance Program.

Existing Plans and Policies

Communities often have existing plans and policies that guide and influence land use, land development, and population growth. Such existing plans and policies can include comprehensive plans, zoning ordinances, and technical reports or studies. Plans and policies already in existence have support from local residents, businesses and policy makers. Many land-use, comprehensive, and strategic plans get updated regularly, and can adapt easily to changing conditions and needs.⁶⁵

The Clackamas County MNHMP includes a range of recommended action items that, when implemented, will reduce the county's vulnerability to natural hazards. Many of these recommendations are consistent with the goals and objectives of the county's existing plans and policies. Linking existing plans and policies to the NHMP helps identify what resources already exist that can be used to implement the action items identified in the plan. Implementing the natural hazards mitigation plan's action items through existing plans and policies increases their likelihood of being supported and getting updated, and maximizes the county's resources.

⁶⁵ Burby, Raymond J., ed. 1998. Cooperating with Nature: Confronting Natural Hazards with Land-Use Planning for Sustainable Communities.

In addition to the plans listed below the county and incorporated cities also have zoning ordinances (including floodplain development regulations) and building regulations.

Existing plans that can incorporate mitigation actions include (for more information on these plans see the county [website](#)):

The following is a list of plans and policies already in place in Clackamas County:

- [Clackamas County Comprehensive Plan](#)
- [Clackamas County Community Wildfire Protection Plan](#)
- [Clackamas County Transportation System Plan](#)
- [Clackamas County Emergency Operations Plan](#)
- [Mt. Hood Coordination Plan](#)
- Housing and Community Development Plan
- [Capital Improvement Plan](#)
- [Clackamas County Strategic Plan](#)
- [Clackamas County Community Health Assessment](#)
- [Clackamas County Blueprint for Health \(Community Health Improvement Plan\)](#)

Synthesis

Recognized as the government and planning structures established within the community, Political Capital is an essential component of hazard resilience. Allowing the county to collaborate with several different county departments as well as outside entities makes the hazard mitigation plan more diverse. Because the Plan is composed with input from government and non-government parties, it seeks to ensure that all parties that might be involved in a disaster have a way to become more resilient. It is important that the Plan reaches out to as many entities as possible as disasters have no boundaries and can affect everyone and anyone. Being aware of hazard mitigation ahead of time will allow all parties to prepare and become more resilient.

Clackamas County works with several departments to include them during the Hazard Mitigation planning process which allows the plan to be diverse and include input from a variety of entities. Likewise, other planning documents and policies throughout the county refer to the Hazard Mitigation Plan as there is some overlap and balance in how the county deals with mitigation-related issues.

Appendix D: Natural Hazard and Base Maps

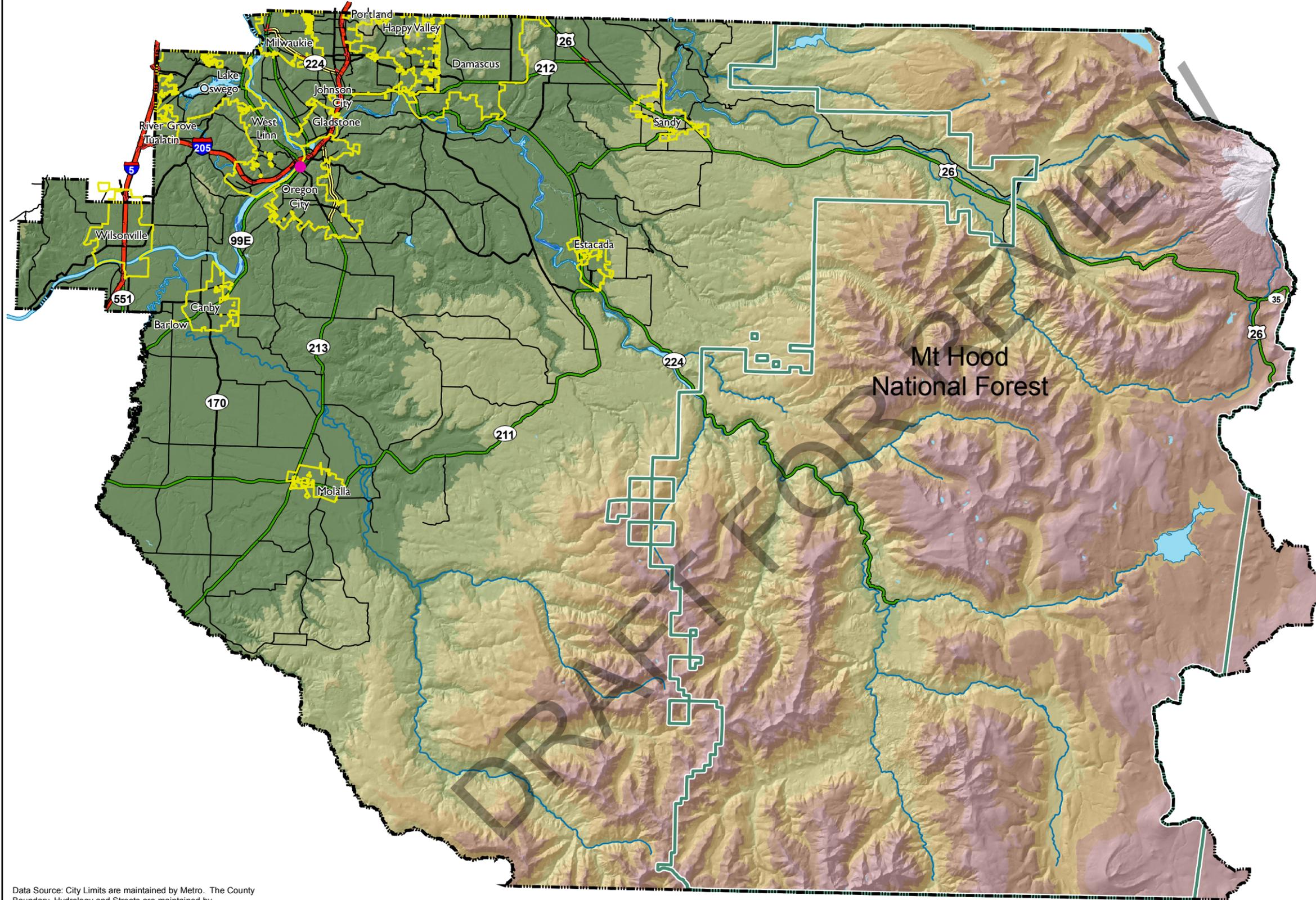
DRAFT FOR REVIEW

Note: The maps provided in this appendix are unchanged since the previous version of this NHMP.

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DRAFT FOR REVIEW

Map 1 Clackamas County



County Features

- County Seat
- Cities
- County Boundary
- Mt Hood National Forest

Water Features

- Major Rivers and Lakes
- ~ Rivers, Creeks and Streams

Streets

- Freeway
- Expressway / State Highway
- Major Arterial / State Highway
- Major Arterial
- Minor Arterial



**CLACKAMAS
COUNTY**

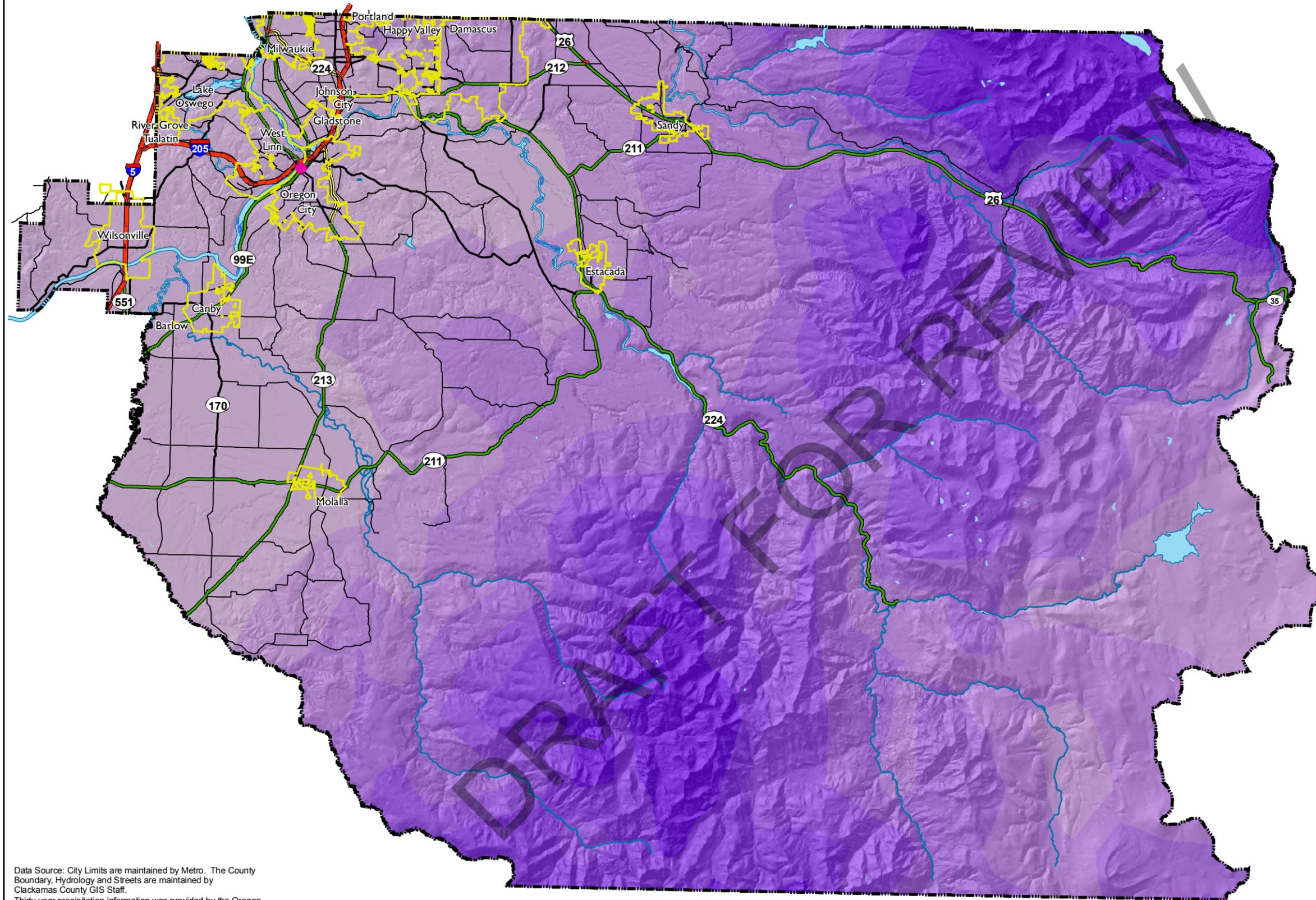
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Data Source: City Limits are maintained by Metro. The County Boundary, Hydrology and Streets are maintained by Clackamas County GIS Staff.

Map 2 Clackamas County Average Precipitation



County Features

- County Seat
- Cities
- County Boundary

Streets

- Freeway
- Expressway / State Highway
- Major Arterial / State Highway
- Major Arterial
- Minor Arterial

30 Year Average Rainfall

- 40 - 50 inches
- 51 - 60 inches
- 61 - 70 inches
- 71 - 80 inches
- 81 - 90 inches
- 91 - 100 inches
- 101+ inches



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COUNTY**

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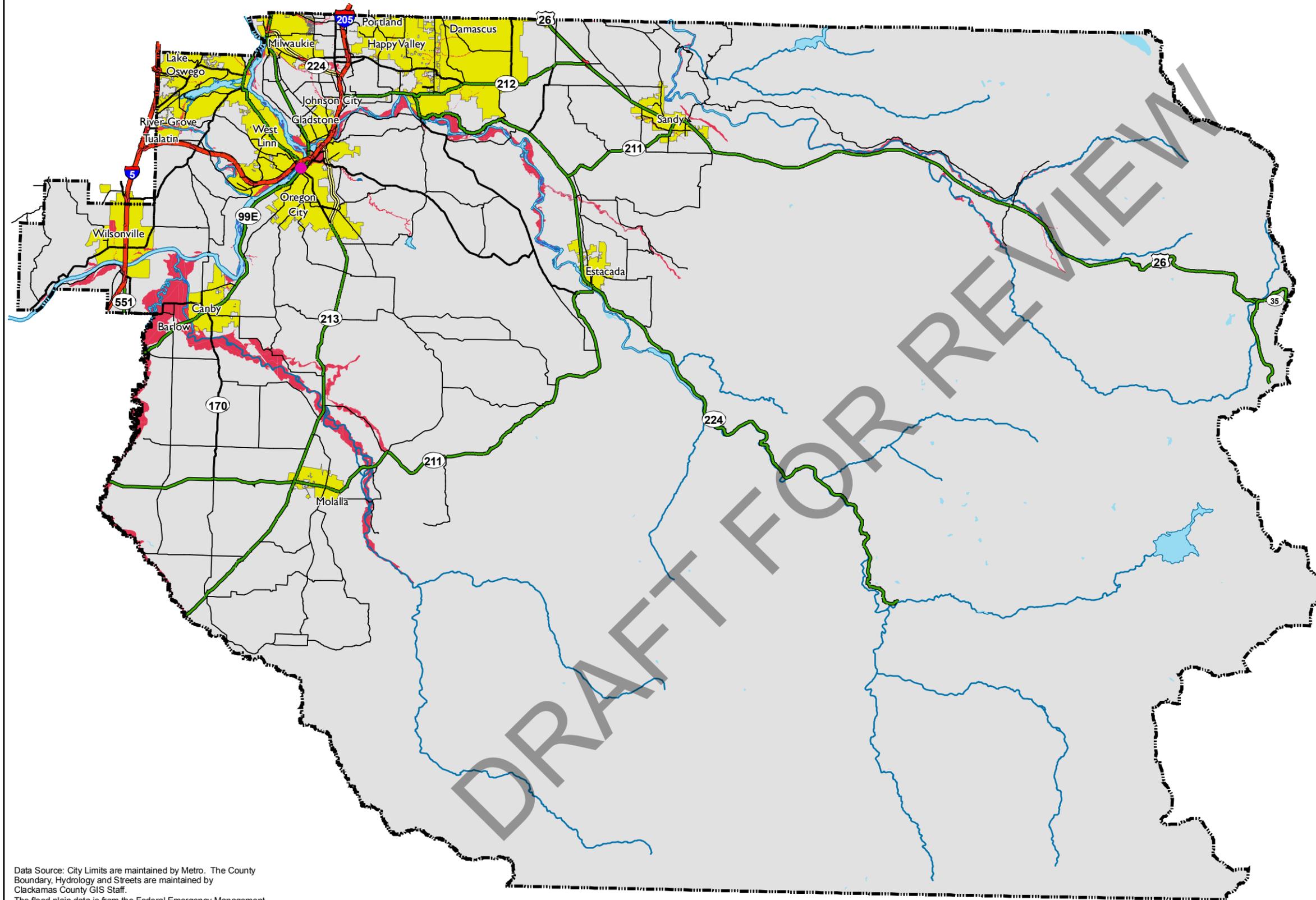
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Clackamas County - GIS - Eric Laufer - PrecipMap_Map2.mxd - February 13th, 2012

Data Source: City Limits are maintained by Metro. The County Boundary, Hydrology and Streets are maintained by Clackamas County GIS Staff. Thirty year precipitation information was provided by the Oregon State Climate Center.

Map 3 Clackamas County FEMA Firm 100 Year Flood Plain



County Features

- County Seat
- + Cities
- County Boundary

Streets

- Freeway
- Expressway / State Highway
- Major Arterial / State Highway
- Major Arterial
- Minor Arterial

Water Features

- FEMA 100 Year Flood Plain
- Major Rivers and Lakes
- Rivers, Creeks and Streams



**CLACKAMAS
COUNTY**

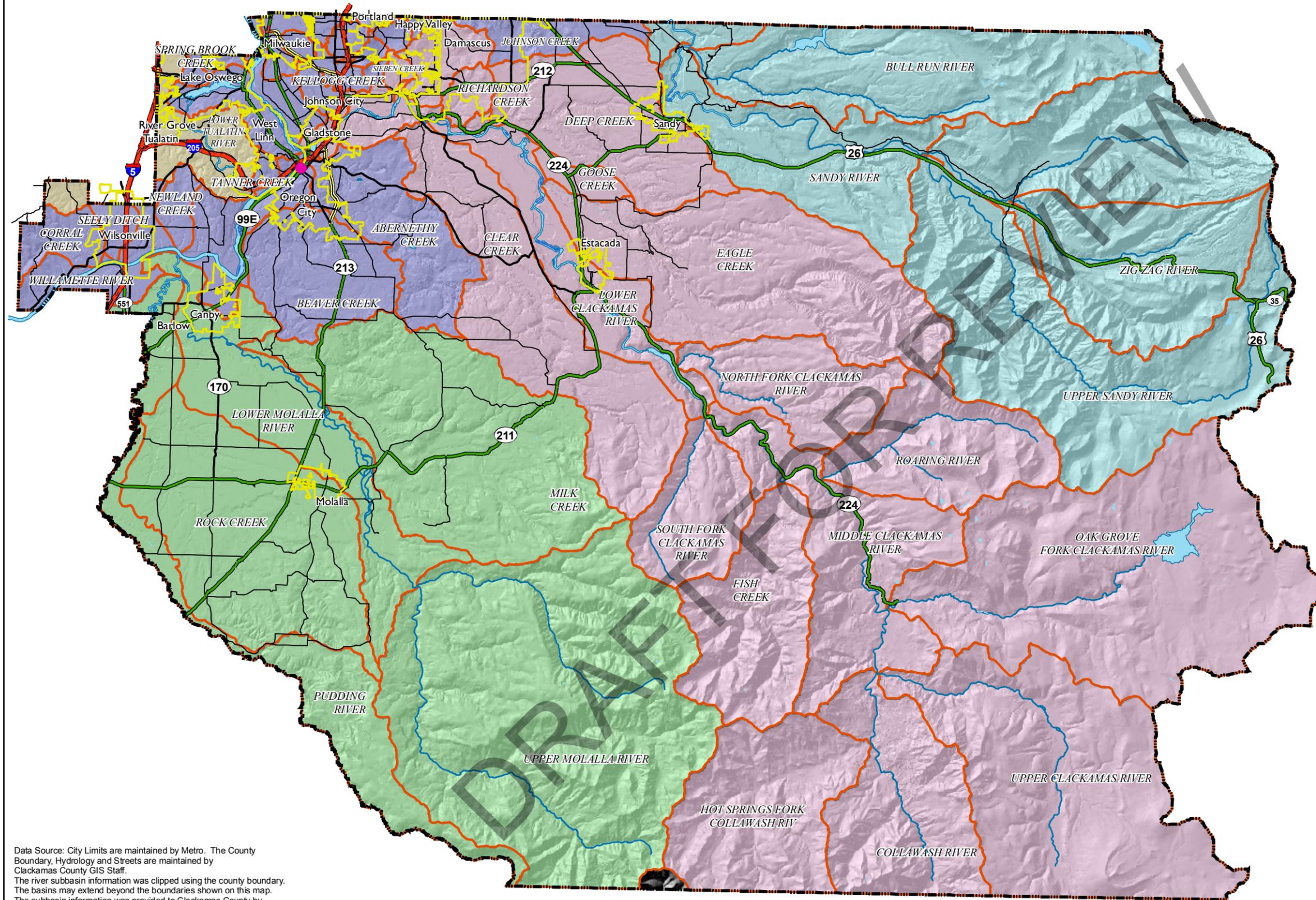
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Data Source: City Limits are maintained by Metro. The County Boundary, Hydrology and Streets are maintained by Clackamas County GIS Staff. The flood plain data is from the Federal Emergency Management Agency. The data is from 2008.

Map 4 Clackamas County River SubBasins



County Features

- County Seat
- Cities
- County Boundary

Water Features

- Major Rivers and Lakes
- Rivers, Creeks and Streams

Streets

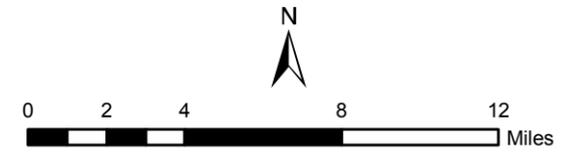
- Freeway
- Expressway / State Highway
- Major Arterial / State Highway
- Major Arterial
- Minor Arterial

Basin Names

- Clackamas River
- Molalla River
- Sandy River
- Tualatin River
- Willamette River

SubBasins

- Boundary



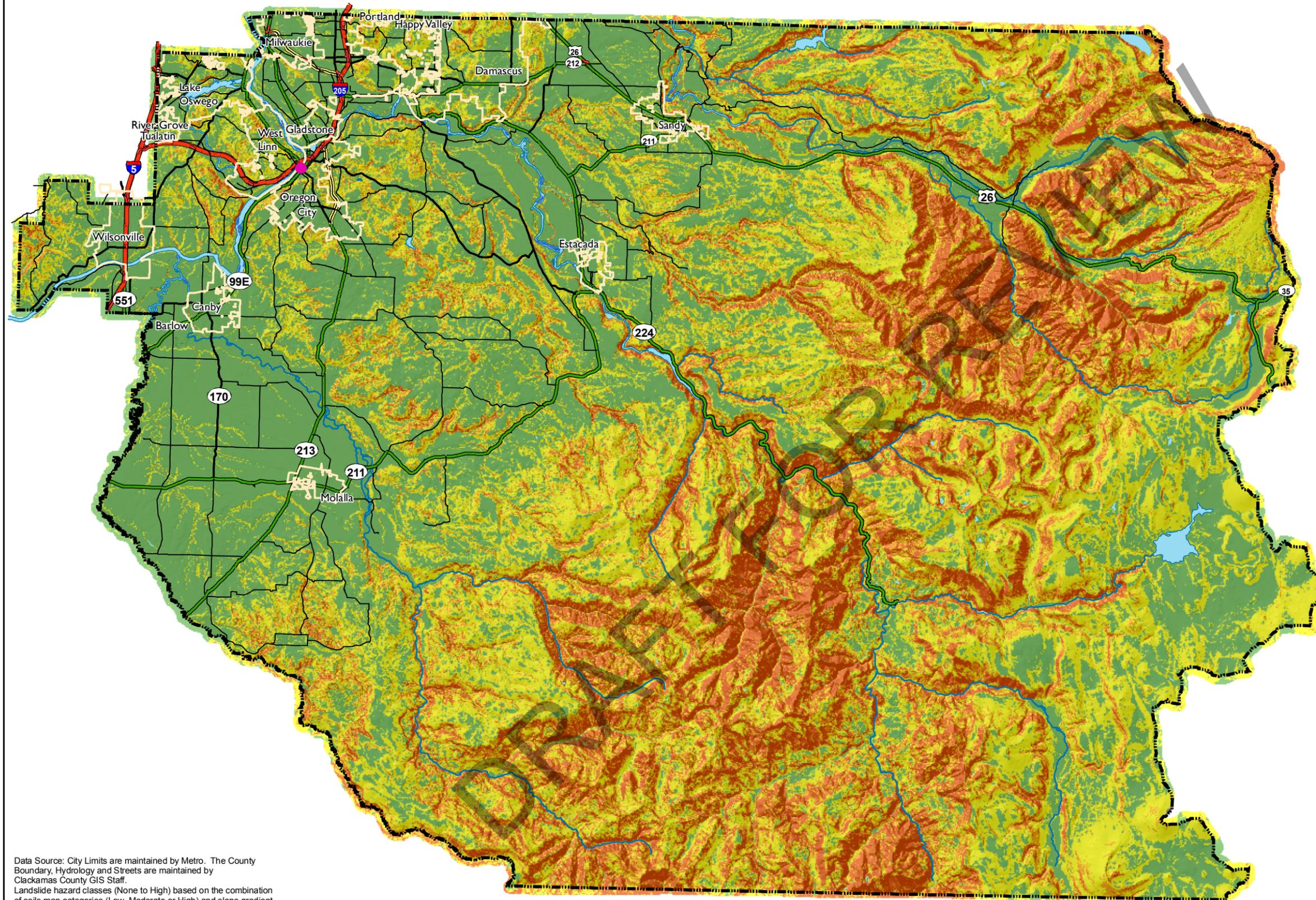
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Data Source: City Limits are maintained by Metro. The County Boundary, Hydrology and Streets are maintained by Clackamas County GIS Staff. The river subbasin information was clipped using the county boundary. The basins may extend beyond the boundaries shown on this map. The subbasin information was provided to Clackamas County by Water Environmental Services.

Map 5 Clackamas County Slope Stability



County Features

- County Seat
- Cities
- County Boundary

Water Features

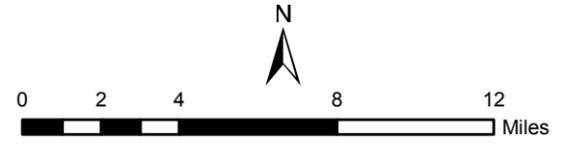
- ~ Major Rivers and Lakes
- ~ Rivers, Creeks and Streams

Streets

- Freeway
- Expressway / State Highway
- Major Arterial / State Highway
- Major Arterial
- Minor Arterial

Slope Stability

- Slope Stability only in unusual localized conditions
- Slopes between 15 percent (8.5deg) and 30 percent (16.7deg)
- Slopes between 30 percent and 45 percent (24.2deg)
- Slopes greater than 45 percent (24.2deg) and existing landslides



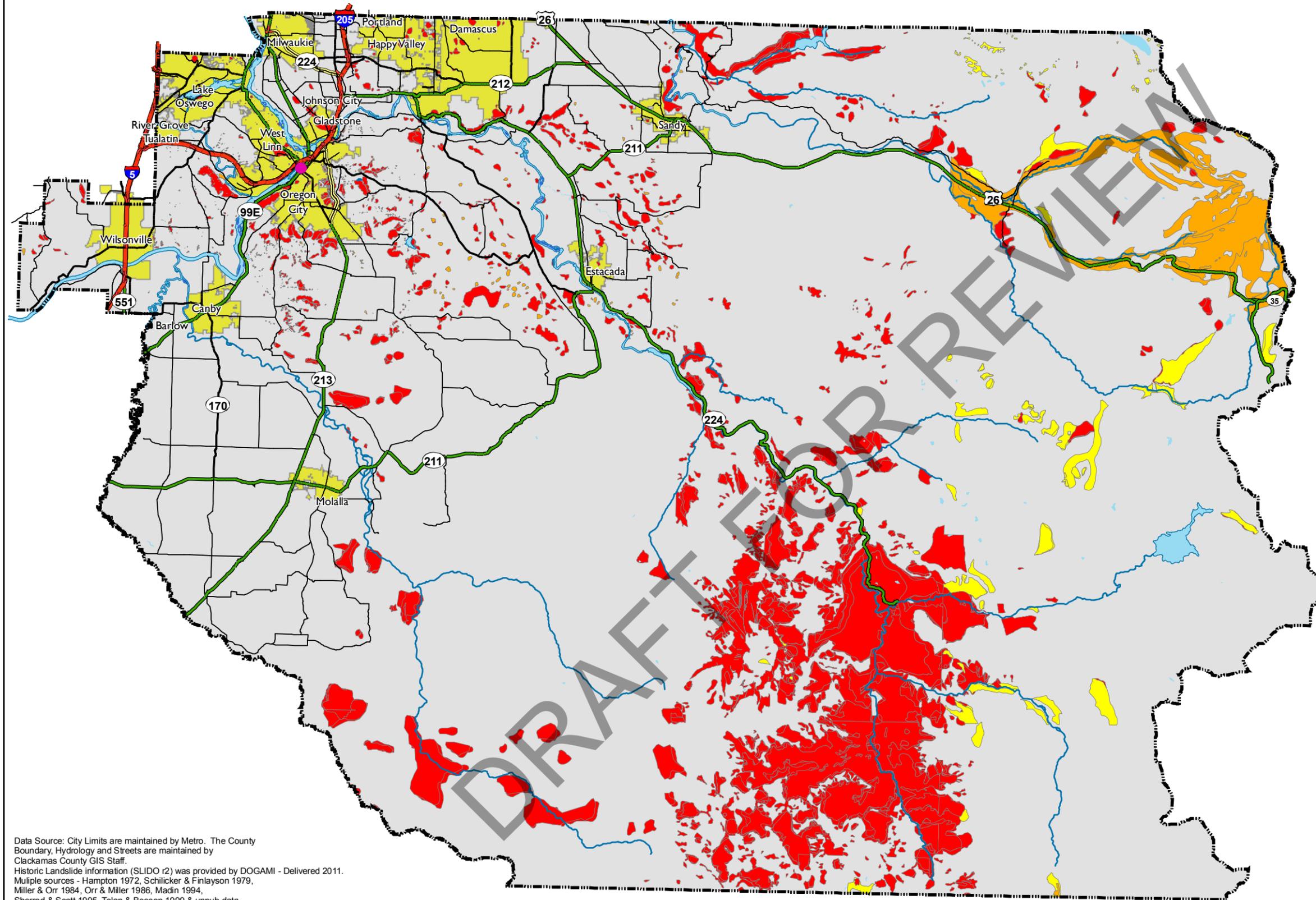
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Data Source: City Limits are maintained by Metro. The County Boundary, Hydrology and Streets are maintained by Clackamas County GIS Staff.
Landslide hazard classes (None to High) based on the combination of soils map categories (Low, Moderate or High) and slope gradient values in degrees. Data received from DOGAMI, 2003.

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Map 6 Clackamas County Historic Landslides



County Features

- County Seat
- + Cities
- County Boundary

Hazard

- Landslide
- Fan
- Talus-Colluvium

Water Features

- Major Rivers and Lakes
- ~ Rivers, Creeks and Streams

Streets

- Freeway
- Expressway / State Highway
- Major Arterial / State Highway
- Major Arterial
- Minor Arterial



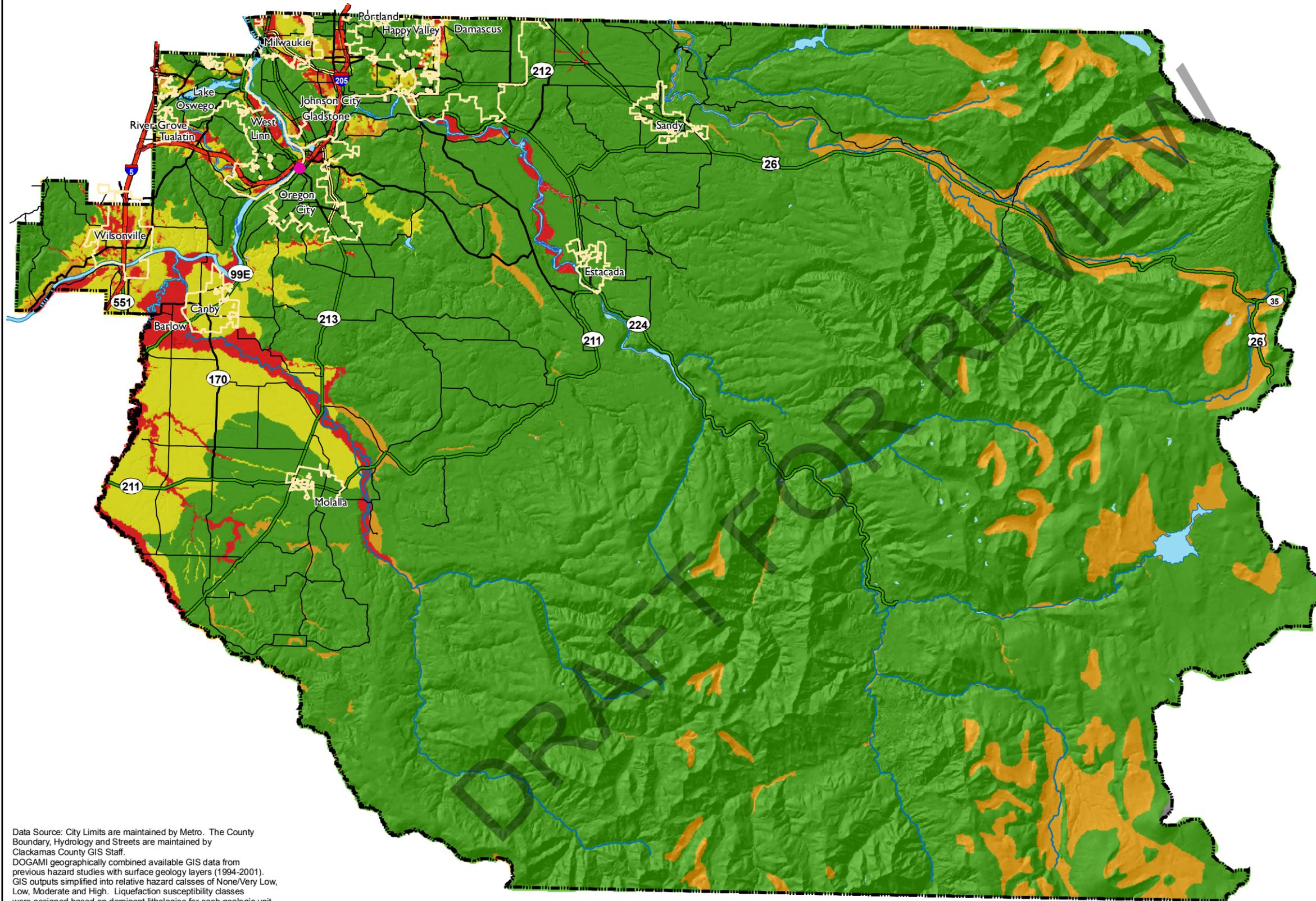
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Data Source: City Limits are maintained by Metro. The County Boundary, Hydrology and Streets are maintained by Clackamas County GIS Staff.
Historic Landslide information (SLIDO r2) was provided by DOGAMI - Delivered 2011.
Multiple sources - Hampton 1972, Schilicker & Finlayson 1979, Miller & Orr 1984, Orr & Miller 1986, Madin 1994, Sherrrod & Scott 1995, Tolan & Beeson 1999 & unpub data from Leonard Orzolat USGS & the Mt Hood National Forest data layers.

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Map 8 Clackamas County Soil Liquefaction



County Features

- County Seat
- Cities
- County Boundary

Liquefaction Hazard

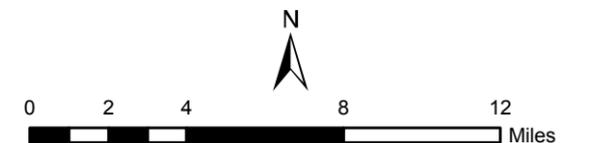
- HIGH - Areas with a thickness of liquefiable material > 30 ft where water table is 15 - 30 ft deep or areas with liq material where the water table is < 15 ft.
- MODERATE - Areas with a thickness of liquefiable material less than 20 ft where the water table is 15-30 ft.
- LOW - Area with materials that are liquefiable when they are intermittently saturated.
- NONE/VERY LOW - Areas not liquefiable or liquefiable only due to unusual local conditions

Water Features

- Major Rivers and Lakes
- ~ Rivers, Creeks and Streams

Streets

- Freeway
- Expressway / State Highway
- Major Arterial / State Highway
- Major Arterial



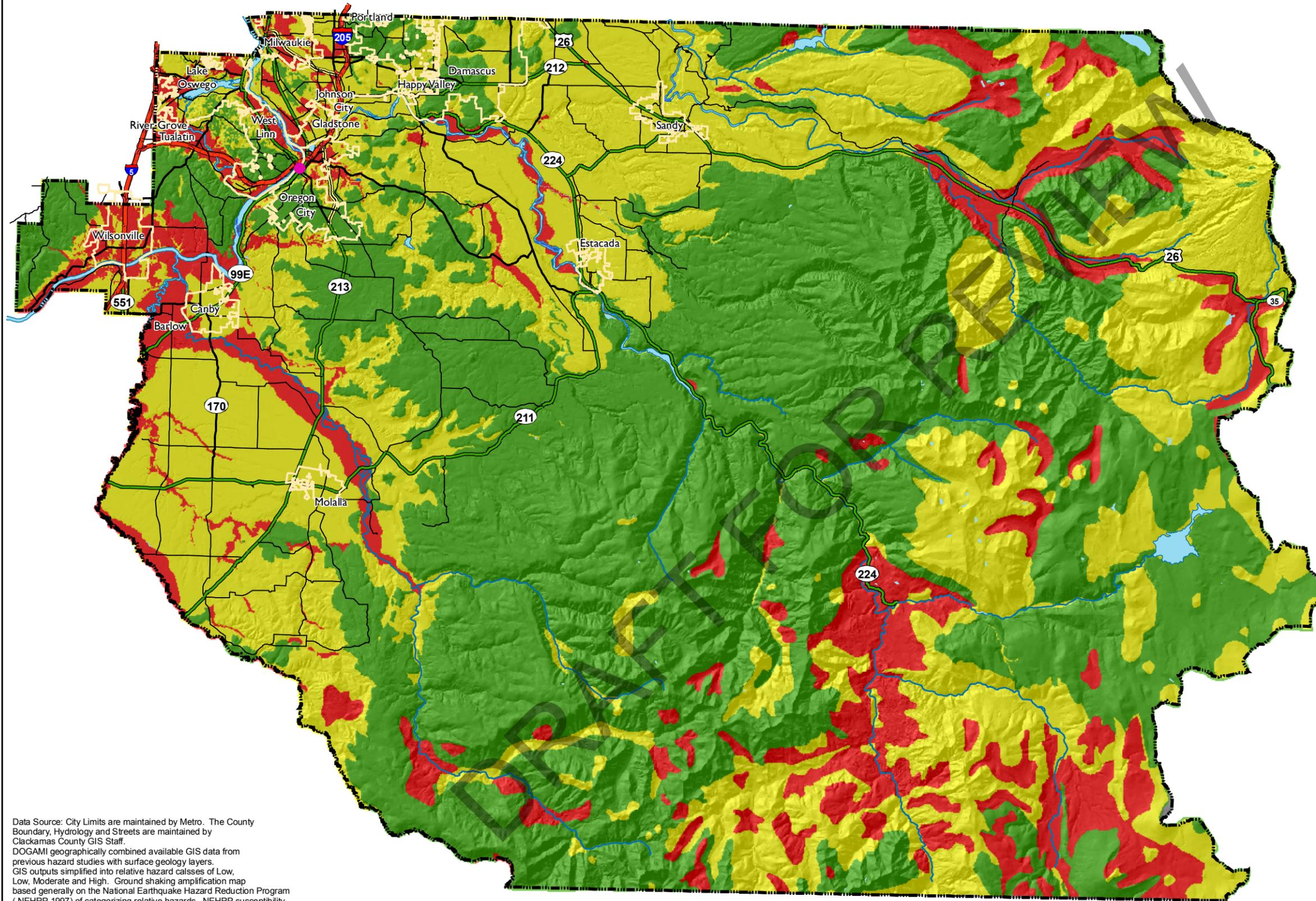
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Data Source: City Limits are maintained by Metro. The County Boundary, Hydrology and Streets are maintained by Clackamas County GIS Staff. DOGAMI geographically combined available GIS data from previous hazard studies with surface geology layers (1994-2001). GIS outputs simplified into relative hazard classes of None/Very Low, Low, Moderate and High. Liquefaction susceptibility classes were assigned based on dominant lithologies for each geologic unit. (Youd and Perkins 1978 classification system).

Map 9 Clackamas County Soil Amplification



County Features

- County Seat
- Cities
- County Boundary

Soil Amplification Hazard

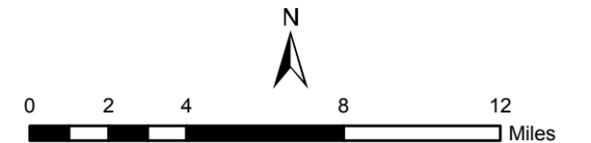
- HIGH - Areas with amplification greater than 1.50.
- MODERATE - Areas with amplification between 1.25 and 1.50.
- LOW - Areas with amplification less than 1.25

Water Features

- Major Rivers and Lakes
- ~ Rivers, Creeks and Streams

Streets

- Freeway
- Expressway / State Highway
- Major Arterial / State Highway
- Major Arterial
- Minor Arterial



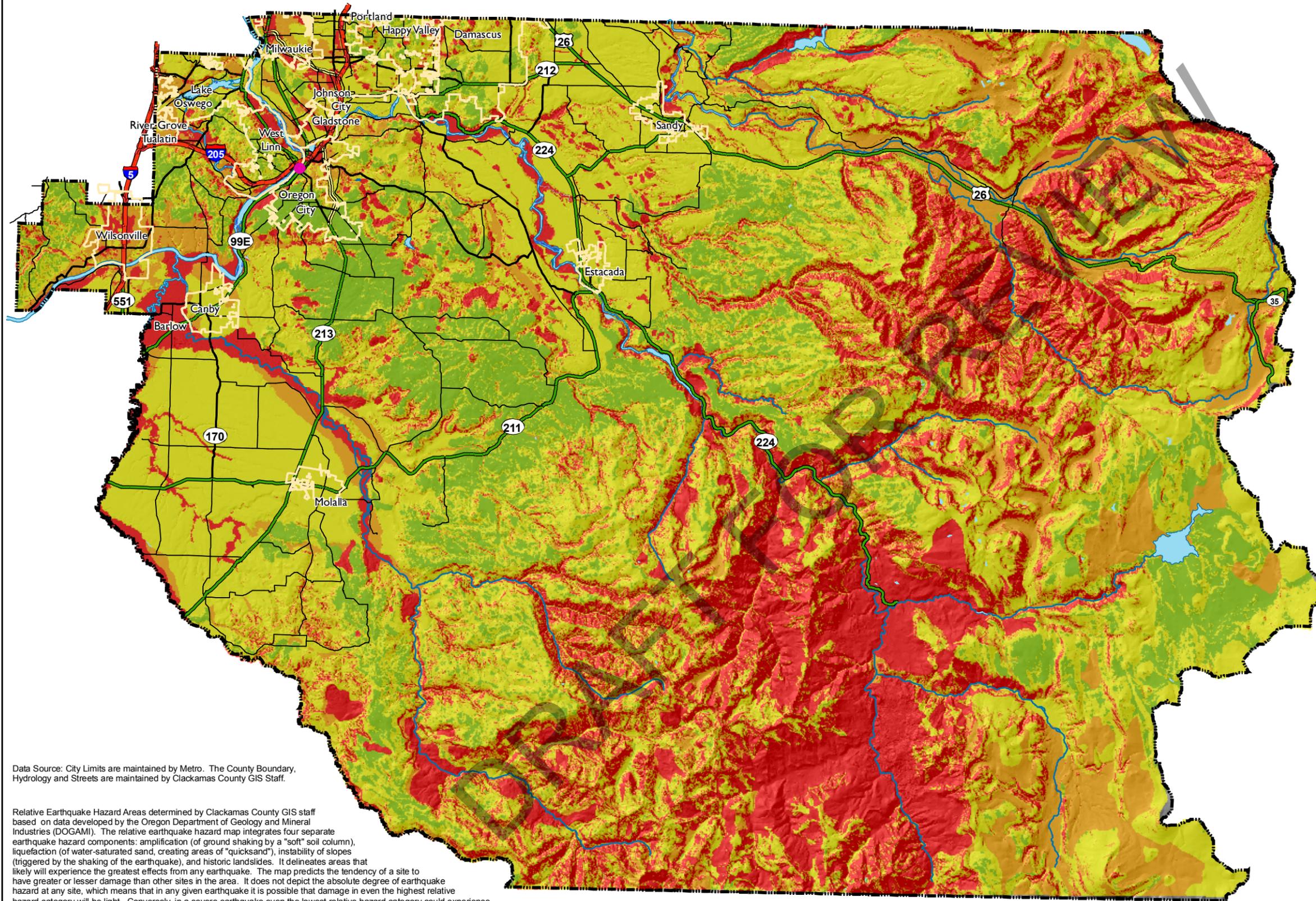
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Data Source: City Limits are maintained by Metro. The County Boundary, Hydrology and Streets are maintained by Clackamas County GIS Staff.
DOGAMI geographically combined available GIS data from previous hazard studies with surface geology layers.
GIS outputs simplified into relative hazard classes of Low, Low, Moderate and High. Ground shaking amplification map based generally on the National Earthquake Hazard Reduction Program (NEHRP 1997) of categorizing relative hazards. NEHRP susceptibility classes based on dominant lithologies for each geologic unit.

Map 10 Clackamas County Earthquake Hazard



County Features

- County Seat
- Cities
- County Boundary

Relative Earthquake Hazard

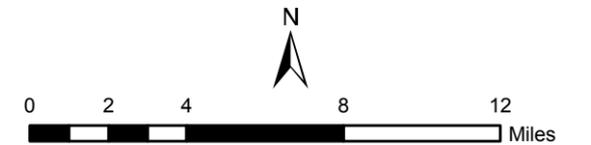
- HIGH
- MODERATE
- LOW
- NONE/VERY LOW

Water Features

- Major Rivers and Lakes
- ~ Rivers, Creeks and Streams

Streets

- Freeway
- Expressway / State Highway
- Major Arterial / State Highway
- Major Arterial
- Minor Arterial



Data Source: City Limits are maintained by Metro. The County Boundary, Hydrology and Streets are maintained by Clackamas County GIS Staff.

Relative Earthquake Hazard Areas determined by Clackamas County GIS staff based on data developed by the Oregon Department of Geology and Mineral Industries (DOGAMI). The relative earthquake hazard map integrates four separate earthquake hazard components: amplification (of ground shaking by a "soft" soil column), liquefaction (of water-saturated sand, creating areas of "quicksand"), instability of slopes (triggered by the shaking of the earthquake), and historic landslides. It delineates areas that likely will experience the greatest effects from any earthquake. The map predicts the tendency of a site to have greater or lesser damage than other sites in the area. It does not depict the absolute degree of earthquake hazard at any site, which means that in any given earthquake it is possible that damage in even the highest relative hazard category will be light. Conversely, in a severe earthquake even the lowest relative hazard category could experience severe damage. The areas depicted should not be used as the sole basis for any type of restrictive or exclusionary policy.



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Appendix E: Economic Analysis of Natural Hazard Mitigation Projects

This appendix was developed by the Oregon Partnership for Disaster Resilience at the University of Oregon's Institute for Policy Research and Engagement (IPRE). It has been reviewed and accepted by the Federal Emergency Management Agency as a means of documenting how the prioritization of actions shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.

The appendix outlines three approaches for conducting economic analyses of natural hazard mitigation projects. It describes the importance of implementing mitigation activities, different approaches to economic analysis of mitigation strategies, and methods to calculate costs and benefits associated with mitigation strategies. Information in this section is derived in part from: The Interagency Hazards Mitigation Team, *State Hazard Mitigation Plan*, (Oregon Military Department – Office of Emergency Management, 2000), and Federal Emergency Management Agency Publication 331, *Report on Costs and Benefits of Natural Hazard Mitigation*. This section is not intended to provide a comprehensive description of benefit/cost analysis, nor is it intended to evaluate local projects. It is intended to (1) raise benefit/cost analysis as an important issue, and (2) provide some background on how an economic analysis can be used to evaluate mitigation projects.

Why Evaluate Mitigation Strategies?

Mitigation activities reduce the cost of disasters by minimizing property damage, injuries, and the potential for loss of life, and by reducing emergency response costs, which would otherwise be incurred. Evaluating possible natural hazard mitigation activities provides decision-makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects.

Evaluating mitigation projects is a complex and difficult undertaking, which is influenced by many variables. First, natural disasters affect all segments of the communities they strike, including individuals, businesses, and public services such as fire, law enforcement, utilities, and schools. Second, while some of the direct and indirect costs of disaster damages are measurable, some of the costs are non-financial and difficult to quantify in dollars. Third, many of the impacts of such events produce “ripple-effects” throughout the community, greatly increasing the disaster's social and economic consequences.

While not easily accomplished, there is value from a public policy perspective, in assessing the positive and negative impacts from mitigation activities, and obtaining an instructive benefit/cost comparison. Otherwise, the decision to pursue or not pursue various mitigation options would not be based on an objective understanding of the net benefit or loss associated with these actions.

Mitigation Strategy Economic Analyses Approaches

The approaches used to identify the costs and benefits associated with natural hazard mitigation strategies, measures, or projects fall into three general categories: benefit/cost analysis, cost-effectiveness analysis and the STAPLE/E approach. The distinction between the three methods is outlined below:

Benefit/Cost Analysis

Benefit/cost analysis is a key mechanism used by the state Oregon Military Department – Office of Emergency Management (OEM), the Federal Emergency Management Agency, and other state and federal agencies in evaluating hazard mitigation projects, and is required by the Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 93-288, as amended.

Benefit/cost analysis is used in natural hazards mitigation to show if the benefits to life and property protected through mitigation efforts exceed the cost of the mitigation activity. Conducting benefit/cost analysis for a mitigation activity can assist communities in determining whether a project is worth undertaking now, in order to avoid disaster-related damages later. Benefit/cost analysis is based on calculating the frequency and severity of a hazard, avoiding future damages, and risk. In benefit/cost analysis, all costs and benefits are evaluated in terms of dollars, and a net benefit/cost ratio is computed to determine whether a project should be implemented. A project must have a benefit/cost ratio greater than 1 (i.e., the net benefits will exceed the net costs) to be eligible for FEMA funding. Unless an alternate approach is approved by FEMA, jurisdictions must use the latest available approved FEMA benefit/cost analysis (BCA) toolkit. Alternate approaches should be used with consultation from the State Hazard Mitigation Officer. See <https://www.fema.gov/benefit-cost-analysis> for more information.

Cost-Effectiveness Analysis

Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. This type of analysis, however, does not necessarily measure costs and benefits in terms of dollars. Determining the economic feasibility of mitigating natural hazards can also be organized according to the perspective of those with an economic interest in the outcome. Hence, economic analysis approaches are covered for both public and private sectors as follows.

Investing in Public Sector Mitigation Activities

Evaluating mitigation strategies in the public sector is complicated because it involves estimating all of the economic benefits and costs regardless of who realizes them, and potentially to a large number of people and economic entities. Some benefits cannot be evaluated monetarily, but still affect the public in profound ways. Economists have developed methods to evaluate the economic feasibility of public decisions which involve a diverse set of beneficiaries and non-market benefits.

Investing in Private Sector Mitigation Activities

Private sector mitigation projects may occur on the basis of one or two approaches: it may be mandated by a regulation or standard, or it may be economically justified on its own merits. A

building or landowner, whether a private entity or a public agency, required to conform to a mandated standard may consider the following options:

1. Request cost sharing from public agencies;
2. Dispose of the building or land either by sale or demolition;
3. Change the designated use of the building or land and change the hazard mitigation compliance requirement; or
4. Evaluate the most feasible alternatives and initiate the most cost effective hazard mitigation alternative.

The sale of a building or land triggers another set of concerns. For example, real estate disclosure laws can be developed which require sellers of real property to disclose known defects and deficiencies in the property, including earthquake weaknesses and hazards to prospective purchases. Correcting deficiencies can be expensive and time consuming, but their existence can prevent the sale of the building. Conditions of a sale regarding the deficiencies and the price of the building can be negotiated between a buyer and seller.

STAPLE/E Approach

Considering detailed benefit/cost or cost-effectiveness analysis for every possible mitigation activity could be very time consuming and may not be practical. There are some alternate approaches for conducting a quick evaluation of the proposed mitigation activities which could be used to identify those mitigation activities that merit more detailed assessment. One of those methods is the STAPLE/E approach.

Using STAPLE/E criteria, mitigation activities can be evaluated quickly by steering committees in a synthetic fashion. This set of criteria requires the Steering Committee to assess the mitigation activities based on the Social, Technical, Administrative, Political, Legal, Economic and Environmental (STAPLE/E) constraints and opportunities of implementing the particular mitigation item in your community. The second chapter in FEMA's How-To Guide "Developing the Mitigation Plan – Identifying Mitigation Actions and Implementation Strategies" as well as the "State of Oregon's Local Natural Hazard Mitigation Plan: An Evaluation Process" outline some specific considerations in analyzing each aspect. The following are suggestions for how to examine each aspect of the STAPLE/E approach from the "State of Oregon's Local Natural Hazard Mitigation Plan: An Evaluation Process."

Social: Community development staff, local non-profit organizations, or a local planning board can help answer these questions.

- Is the proposed action socially acceptable to the community?
- Are there equity issues involved that would mean that one segment of the community is treated unfairly?
- Will the action cause social disruption?

Technical: The city or county public works staff, and building department staff can help answer these questions.

- Will the proposed action work?

- Will it create more problems than it solves?
- Does it solve a problem or only a symptom?
- Is it the most useful action in light of other community goals?

Administrative: Elected officials or the city or county administrator, can help answer these questions.

- Can the community implement the action?
- Is there someone to coordinate and lead the effort?
- Is there sufficient funding, staff, and technical support available?
- Are there ongoing administrative requirements that need to be met?

Political: Consult the mayor, city council or city board of commissioners, city or county administrator, and local planning commissions to help answer these questions.

- Is the action politically acceptable?
- Is there public support both to implement and to maintain the project?

Legal: Include legal counsel, land use planners, risk managers, and city council or county planning commission members, among others, in this discussion.

- Is the community authorized to implement the proposed action? Is there a clear legal basis or precedent for this activity?
- Are there legal side effects? Could the activity be construed as a taking?
- Is the proposed action allowed by the comprehensive plan, or must the comprehensive plan be amended to allow the proposed action?
- Will the community be liable for action or lack of action?
- Will the activity be challenged?

Economic: Community economic development staff, civil engineers, building department staff, and the assessor's office can help answer these questions.

- What are the costs and benefits of this action?
- Do the benefits exceed the costs?
- Are initial, maintenance, and administrative costs taken into account?
- Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private?)
- How will this action affect the fiscal capability of the community?
- What burden will this action place on the tax base or local economy?
- What are the budget and revenue effects of this activity?

- Does the action contribute to other community goals, such as capital improvements or economic development?
- What benefits will the action provide? (This can include dollar amount of damages prevented, number of homes protected, credit under the CRS, potential for funding under the HMGP or the FMA program, etc.)

Environmental: Watershed councils, environmental groups, land use planners and natural resource managers can help answer these questions.

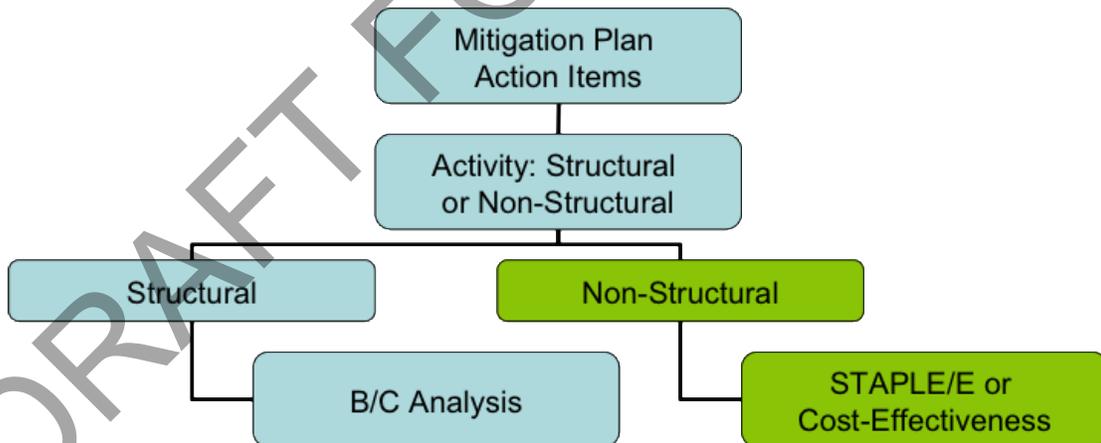
- How will the action impact the environment?
- Will the action need environmental regulatory approvals?
- Will it meet local and state regulatory requirements?
- Are endangered or threatened species likely to be affected?

The STAPLE/E approach is helpful for doing a quick analysis of mitigation projects. Most projects that seek federal funding and others often require more detailed benefit/cost analyses.

When to use the Various Approaches

It is important to realize that various funding sources require different types of economic analyses. The following figure is to serve as a guideline for when to use the various approaches.

Figure E-1 Economic Analysis Flowchart



Source: Oregon Partnership for Disaster Resilience. 2005.

Implementing the Approaches

Benefit/cost analysis, cost-effectiveness analysis, and the STAPLE/E are important tools in evaluating whether or not to implement a mitigation activity. A framework for evaluating

mitigation activities is outlined below. This framework should be used in further analyzing the feasibility of prioritized mitigation activities.

1. Identify the Activities

Activities for reducing risk from natural hazards can include structural projects to enhance disaster resistance, education and outreach, and acquisition or demolition of exposed properties, among others. Different mitigation projects can assist in minimizing risk to natural hazards, but do so at varying economic costs.

2. Calculate the Costs and Benefits

Choosing economic criteria is essential to systematically calculating costs and benefits of mitigation projects and selecting the most appropriate activities. Potential economic criteria to evaluate alternatives include:

- **Determine the project cost.** This may include initial project development costs, and repair and operating costs of maintaining projects over time.
- **Estimate the benefits.** Projecting the benefits, or cash flow resulting from a project can be difficult. Expected future returns from the mitigation effort depend on the correct specification of the risk and the effectiveness of the project, which may not be well known. Expected future costs depend on the physical durability and potential economic obsolescence of the investment. This is difficult to project. These considerations will also provide guidance in selecting an appropriate salvage value. Future tax structures and rates must be projected. Financing alternatives must be researched, and they may include retained earnings, bond and stock issues, and commercial loans.
- **Consider costs and benefits to society and the environment.** These are not easily measured, but can be assessed through a variety of economic tools including existence value or contingent value theories. These theories provide quantitative data on the value people attribute to physical or social environments. Even without hard data, however, impacts of structural projects to the physical environment or to society should be considered when implementing mitigation projects.
- **Determine the correct discount rate.** Determination of the discount rate can just be the risk-free cost of capital, but it may include the decision maker's time preference and also a risk premium. Including inflation should also be considered.

3. Analyze and Rank the Activities

Once costs and benefits have been quantified, economic analysis tools can rank the possible mitigation activities. Two methods for determining the best activities given varying costs and benefits include net present value and internal rate of return.

- **Net present value.** Net present value is the value of the expected future returns of an investment minus the value of the expected future cost expressed in today's dollars. If the net present value is greater than the projected costs, the project may be determined feasible for implementation. Selecting the discount rate, and

identifying the present and future costs and benefits of the project calculates the net present value of projects.

- **Internal rate of return.** Using the internal rate of return method to evaluate mitigation projects provides the interest rate equivalent to the dollar returns expected from the project. Once the rate has been calculated, it can be compared to rates earned by investing in alternative projects. Projects may be feasible to implement when the internal rate of return is greater than the total costs of the project. Once the mitigation projects are ranked on the basis of economic criteria, decision-makers can consider other factors, such as risk, project effectiveness, and economic, environmental, and social returns in choosing the appropriate project for implementation.

Economic Returns of Natural Hazard Mitigation

The estimation of economic returns, which accrue to building or land owners as a result of natural hazard mitigation, is difficult. Owners evaluating the economic feasibility of mitigation should consider reductions in physical damages and financial losses. A partial list follows:

- Building damages avoided
- Content damages avoided
- Inventory damages avoided
- Rental income losses avoided
- Relocation and disruption expenses avoided
- Proprietor's income losses avoided

These parameters can be estimated using observed prices, costs, and engineering data. The difficult part is to correctly determine the effectiveness of the hazard mitigation project and the resulting reduction in damages and losses. Equally as difficult is assessing the probability that an event will occur. The damages and losses should only include those that will be borne by the owner. The salvage value of the investment can be important in determining economic feasibility. Salvage value becomes more important as the time horizon of the owner declines. This is important because most businesses depreciate assets over a period of time.

Additional Costs from Natural Hazards

Property owners should also assess changes in a broader set of factors that can change as a result of a large natural disaster. These are usually termed "indirect" effects, but they can have a very direct effect on the economic value of the owner's building or land. They can be positive or negative, and include changes in the following:

- Commodity and resource prices
- Availability of resource supplies
- Commodity and resource demand changes
- Building and land values
- Capital availability and interest rates
- Availability of labor
- Economic structure
- Infrastructure

- Regional exports and imports
- Local, state, and national regulations and policies
- Insurance availability and rates

Changes in the resources and industries listed above are more difficult to estimate and require models that are structured to estimate total economic impacts. Total economic impacts are the sum of direct and indirect economic impacts. Total economic impact models are usually not combined with economic feasibility models. Many models exist to estimate total economic impacts of changes in an economy. Decision makers should understand the total economic impacts of natural disasters in order to calculate the benefits of a mitigation activity. This suggests that understanding the local economy is an important first step in being able to understand the potential impacts of a disaster, and the benefits of mitigation activities.

Additional Considerations

Conducting an economic analysis for potential mitigation activities can assist decision-makers in choosing the most appropriate strategy for their community to reduce risk and prevent loss from natural hazards. Economic analysis can also save time and resources from being spent on inappropriate or unfeasible projects. Several resources and models are listed on the following page that can assist in conducting an economic analysis for natural hazard mitigation activities.

Benefit/cost analysis is complicated, and the numbers may divert attention from other important issues. It is important to consider the qualitative factors of a project associated with mitigation that cannot be evaluated economically. There are alternative approaches to implementing mitigation projects. With this in mind, opportunity rises to develop strategies that integrate natural hazard mitigation with projects related to watersheds, environmental planning, community economic development, small business development, critical infrastructure, and transportation projects among others. Incorporating natural hazard mitigation with other community projects can increase the viability of project implementation.

Resources

CUREe Kajima Project, *Methodologies for Evaluating the Socio-Economic Consequences of Large Earthquakes*, Task 7.2 Economic Impact Analysis, Prepared by University of California, Berkeley Team, Robert A. Olson, VSP Associates, Team Leader; John M. Eiding, G&E Engineering Systems; Kenneth A. Goettel, Goettel and Associates, Inc.; and Gerald L. Horner, Hazard Mitigation Economics Inc., 1997

Federal Emergency Management Agency, *Benefit/Cost Analysis of Hazard Mitigation Projects*, Riverine Flood, Version 1.05, Hazard Mitigation Economics, Inc., 1996

Federal Emergency Management Agency, [Report on the Costs and Benefits of Natural Hazard Mitigation](#). Publication 331, 1996.

Goettel & Horner Inc., *Earthquake Risk Analysis Volume III: The Economic Feasibility of Seismic Rehabilitation of Buildings in the City of Portland*, Submitted to the Bureau of Buildings, City of Portland, August 30, 1995.

Goettel & Horner Inc., *Benefit/Cost Analysis of Hazard Mitigation Projects Volume V, Earthquakes*, Prepared for FEMA's Hazard Mitigation Branch, October 25, 1995.

Horner, Gerald, *Benefit/Cost Methodologies for Use in Evaluating the Cost Effectiveness of Proposed Hazard Mitigation Measures*, Robert Olsen Associates, Prepared for Oregon Military Department – Office of Emergency Management, July 1999.

Interagency Hazards Mitigation Team, *State Hazard Mitigation Plan*, (Oregon State Police – Office of Emergency Management, 2000.)

Risk Management Solutions, Inc., *Development of a Standardized Earthquake Loss Estimation Methodology*, National Institute of Building Sciences, Volume I and II, 1994.

VSP Associates, Inc., *A Benefit/Cost Model for the Seismic Rehabilitation of Buildings*, Volumes 1 & 2, Federal Emergency management Agency, FEMA Publication Numbers 227 and 228, 1991.

VSP Associates, Inc., *Benefit/Cost Analysis of Hazard Mitigation Projects: Section 404 Hazard Mitigation Program and Section 406 Public Assistance Program, Volume 3: Seismic Hazard Mitigation Projects*, 1993.

VSP Associates, Inc., *Seismic Rehabilitation of Federal Buildings: A Benefit/Cost Model*, Volume 1, Federal Emergency Management Agency, FEMA Publication Number 255, 1994.

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APPENDIX F: GRANT PROGRAMS AND RESOURCES

Introduction

There are numerous local, state and federal funding sources available to support natural hazard mitigation projects and planning. The following section includes an abbreviated list of the most common funding sources utilized by local jurisdictions in Oregon. Because grant programs often change, it is important to periodically review available funding sources for current guidelines and program descriptions.

Post-Disaster Federal Programs

Hazard Mitigation Grant Program

The Hazard Mitigation Grant Program (HMGP) provides grants to states and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. The HMGP is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act. The HMGP involves a paper application which is first offered to the counties with declared disasters within the past year, then becomes available statewide if funding is still available.

<http://www.fema.gov/hazard-mitigation-grant-program>

Physical Disaster Loan Program

When physical disaster loans are made to homeowners and businesses following disaster declarations by the U.S. Small Business Administration (SBA), up to 20% of the loan amount can go towards specific measures taken to protect against recurring damage in similar future disasters. <http://www.sba.gov/category/navigation-structure/loans-grants/small-business-loans/disaster-loans>

Pre-Disaster Federal Programs

Pre-Disaster Mitigation Grant Program

The Pre-Disaster Mitigation (PDM) program provides funds to states, territories, Indian tribal governments, communities, and universities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. Funding these plans and projects reduces overall risks to the population and structures, while also reducing reliance on funding from actual disaster declarations. PDM grants are to be awarded on a competitive basis and without reference to state allocations, quotas, or other formula-based allocation of funds. The PDM grant program is offered annually; applications are submitted online. Applicants need a user profile approved by the State Hazard Mitigation Officer, which should be garnered well before the application period opens.

<http://www.fema.gov/pre-disaster-mitigation-grant-program>

Flood Mitigation Assistance Program

The overall goal of the Flood Mitigation Assistance (FMA) Program is to fund cost-effective measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other National Flood Insurance Program (NFIP) insurable structures. This specifically includes:

- Reducing the number of repetitively or substantially damaged structures and the associated flood insurance claims;
- Encouraging long-term, comprehensive hazard mitigation planning;
- Responding to the needs of communities participating in the NFIP to expand their mitigation activities beyond floodplain development activities; and
- Complementing other federal and state mitigation programs with similar, long-term mitigation goals.

<http://www.fema.gov/flood-mitigation-assistance-program>

Detailed program and application information for federal post-disaster and pre-disaster programs can be found in the FY15 Hazard Mitigation Assistance Unified Guidance, available at: <https://www.fema.gov/media-library/assets/documents/103279>. Note that guidance regularly changes. Verify that you have the most recent edition. Flood mitigation assistance is usually offered annually; applications are submitted online. Applicants need a user profile approved by the State Hazard Mitigation Officer, which should be garnered well before the application period opens.

For Oregon Military Department, Office of Emergency Management (OEM) grant guidance on Federal Hazard Mitigation Assistance, visit:

<https://www.oregon.gov/OEM/emresources/Grants/Pages/HMA.aspx>

Contact: Angie Lane, angie.lane@state.or.us

State Programs

Seismic Rehabilitation Grant Program

The Seismic Rehabilitation Grant Program (SRGP) provides state funds to strengthen public schools and emergency services buildings so they will be less damaged during an earthquake. Reducing property damage, injuries, and casualties caused by earthquakes is the goal of the SRGP. <http://www.orinfrastructure.org/Infrastructure-Programs/Seismic-Rehab/>

Community Development Block Grant Program

The Community Development Block Grant Program promotes viable communities by providing: 1) decent housing; 2) quality living environments; and 3) economic opportunities, especially for low and moderate income persons. Eligible activities most relevant to natural hazards mitigation include: acquisition of property for public purposes; construction/reconstruction of public infrastructure; community planning activities. Under special circumstances, CDBG funds also can be used to meet urgent community development needs arising in the last 18 months which pose immediate threats to health and welfare.

http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/programs

Oregon Watershed Enhancement Board

While OWEB's primary responsibilities are implementing projects addressing coastal salmon restoration and improving water quality statewide, these projects can sometimes also benefit efforts to reduce flood and landslide hazards. In addition, OWEB conducts watershed workshops for landowners, watershed councils, educators, and others, and conducts a biennial conference highlighting watershed efforts statewide. Funding for OWEB programs comes from the general fund, state lottery, timber tax revenues, license plate revenues, angling license fees, and other sources. OWEB awards approximately \$20 million in funding annually. More information at: <http://www.oregon.gov/OWEB/Pages/index.aspx>

Federal Mitigation Programs, Activities & Initiatives

Basic & Applied Research/Development

National Earthquake Hazard Reduction Program (NEHRP), National Science Foundation.

Through broad based participation, the NEHRP attempts to mitigate the effects of earthquakes. Member agencies in NEHRP are the US Geological Survey (USGS), the National Science Foundation (NSF), the Federal Emergency Management Agency (FEMA), and the National Institute for Standards and Technology (NIST). The agencies focus on research and development in areas such as the science of earthquakes, earthquake performance of buildings and other structures, societal impacts, and emergency response and recovery. <http://www.nehrp.gov/>

Decision, Risk, and Management Science Program, National Science Foundation.

Supports scientific research directed at increasing the understanding and effectiveness of decision making by individuals, groups, organizations, and society. Disciplinary and interdisciplinary research, doctoral dissertation research, and workshops are funded in the areas of judgment and decision making; decision analysis and decision aids; risk analysis, perception, and communication; societal and public policy decision making; management science and organizational design. The program also supports small grants for exploratory research of a time-critical or high-risk, potentially transformative nature. http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5423

Hazard ID and Mapping

National Flood Insurance Program: Flood Mapping; FEMA

Flood insurance rate maps and flood plain management maps for all NFIP communities. <http://www.fema.gov/national-flood-insurance-program-flood-hazard-mapping>

National Map: Orthoimagery, DOI – USGS

Develops topographic quadrangles for use in mapping of flood and other hazards. <https://nationalmap.gov/ortho.html>

Mapping Standards Support, DOI-USGS

Expertise in mapping and digital data standards to support the National Flood Insurance Program. <http://ncgmp.usgs.gov/standards.html>

Soil Survey, USDA-NRCS

Maintains soil surveys of counties or other areas to assist with farming, conservation, mitigation or related purposes. http://soils.usda.gov/survey/printed_surveys/

Project Support

Coastal Zone Management Program, NOAA.

Provides grants for planning and implementation of non-structural coastal flood and hurricane hazard mitigation projects and coastal wetlands restoration.

<http://coastalmanagement.noaa.gov/>

Community Development Block Grant Entitlement Communities Program, US Department of Housing and Urban Development

Provides grants to entitled cities and urban counties to develop viable communities (e.g., decent housing, a suitable living environment, expanded economic opportunities), principally for low- and moderate- income persons.

http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/programs/entitlement

National Fire Plan (DOI – USDA)

The NFP provides technical, financial, and resource guidance and support for wildland fire management across the United States. This plan addresses five key points: firefighting, rehabilitation, hazardous fuels reduction, community assistance, and accountability.

<http://www.forestsandrangelands.gov/>

Assistance to Firefighters Grant Program, FEMA

FEMA AFGM grants are awarded to fire departments to enhance their ability to protect the public and fire service personnel from fire and related hazards. Three types of grants are available: Assistance to Firefighters Grant (AFG), Fire Prevention and Safety (FP&S), and Staffing for Adequate Fire and Emergency Response (SAFER).

<http://www.fema.gov/welcome-assistance-firefighters-grant-program>

Emergency Watershed Protection Program, USDA-NRCS

Provides technical and financial assistance for relief from imminent hazards in small watersheds, and to reduce vulnerability of life and property in small watershed areas damaged by severe natural hazard events.

<http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp>

Rural Development Assistance – Utilities, USDA

Direct and guaranteed rural economic loans and business enterprise grants to address utility issues and development needs.

http://www.rurdev.usda.gov/Utilities_Programs_Grants.html

Rural Development Assistance – Housing, USDA.

The RDA program provides grants, loans, and technical assistance in addressing rehabilitation, health and safety needs in primarily low-income rural areas. Declaration of major disaster necessary. <http://www.rurdev.usda.gov/HAD-HCFPGrants.html>

Public Assistance Grant Program, FEMA.

The objective of the Federal Emergency Management Agency's (FEMA) Public Assistance (PA) Grant Program is to provide assistance to State, Tribal and local governments, and certain types of Private Nonprofit organizations so that communities can quickly respond to and recover from major disasters or emergencies declared by the President. <http://www.fema.gov/public-assistance-local-state-tribal-and-non-profit>

National Flood Insurance Program, FEMA

The NFIP makes available flood insurance to residents of communities that adopt and enforce minimum floodplain management requirements. <http://www.fema.gov/national-flood-insurance-program>

HOME Investments Partnerships Program, HUD

The HOME IPP provides grants to states, local government and consortia for permanent and transitional housing (including support for property acquisition and rehabilitation) for low-income persons. <http://www.hud.gov/offices/cpd/affordablehousing/programs/home/>

Disaster Recovery Initiative, HUD

The DRI provides grants to fund gaps in available recovery assistance after disasters (including mitigation). http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/programs/dri

Emergency Management Performance Grants, FEMA

EMPG grants help state and local governments to sustain and enhance their all-hazards emergency management programs. <http://www.fema.gov/fy-2012-emergency-management-performance-grants-program>

Partners for Fish and Wildlife, DOI – FWS

The PFW program provides financial and technical assistance to private landowners interested in pursuing restoration projects affecting wetlands and riparian habitats. <http://www.fws.gov/partners/>

North American Wetland Conservation Fund, DOI-FWS

NAWC fund provides cost-share grants to stimulate public/private partnerships for the protection, restoration, and management of wetland habitats. <http://www.fws.gov/birdhabitat/Grants/index.shtm>

Federal Land Transfer / Federal Land to Parks Program, DOI-NPS

Identifies, assesses, and transfers available federal real property for acquisition for State and local parks and recreation, such as open space.

<http://www.nps.gov/ncrc/programs/flp/index.htm>

Wetlands Reserve program, USDA-NCRS

The WR program provides financial and technical assistance to protect and restore wetlands through easements and restoration agreements.

<http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/wetlands>

Secure Rural Schools and Community Self-Determination Act of 2000, US Forest Service.

Reauthorized for FY2012, it was originally enacted in 2000 to provide five years of transitional assistance to rural counties affected by the decline in revenue from timber harvests on federal lands. Funds have been used for improvements to public schools, roads, and stewardship projects. Money is also available for maintaining infrastructure, improving the health of watersheds and ecosystems, protecting communities, and strengthening local economies. <http://www.fs.usda.gov/pts/>

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Appendix G

Lifeline Sector Risk Assessment

In development. To be provided when complete.

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Appendix H Community Survey

In development. To be provided when complete.

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