

Lincoln County Multi-Jurisdictional Natural Hazard Mitigation Plan

Lincoln County, Cities, and Special Districts of:
Depoe Bay, Lincoln City, Newport, Siletz, Toledo, Waldport, Yachats,
Central Lincoln PUD, Lincoln County School District, and
Seal Rock Water District



Photo Credit: Gary Halvorson, Oregon State Archives

Effective:

December 29, 2020 through December 28, 2025

Prepared for:

Lincoln County
Planning and Development and Emergency Management

Prepared by:

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



This Natural Hazard Mitigation Plan was prepared by:



UNIVERSITY OF
OREGON

School of Planning, Public
Policy and Management

Institute for Policy
Research and Engagement

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Additional Support Provided by:



DLCD

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FEMA

January 8, 2021

The Honorable Kaety Jacobson
Chair Jacobson, Lincoln County Commissioners
225 West Olive Street, Room 110
Newport, Oregon 97365

Dear Chair Jacobson:

On December 29, 2020, the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) Region 10, approved the Lincoln County Hazard Mitigation Plan as a multi-jurisdictional local plan as outlined in Code of Federal Regulations Title 44 Part 201. This approval provides the below jurisdictions eligibility to apply for the Robert T. Stafford Disaster Relief and Emergency Assistance Act's, Hazard Mitigation Assistance (HMA) grants projects through December 29, 2025, through your state:

City of Newport | Lincoln County | Lincoln County School District | City of Siletz

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

Approved mitigation plans may be eligible for points under the National Flood Insurance Program's Community Rating System (CRS). For additional information regarding the CRS, please visit: www.fema.gov/national-flood-insurance-program-community-rating-system or contact your local floodplain manager. Over the next five years, we encourage your communities to follow the plan's schedule for monitoring and updating, and to develop further mitigation actions. To continue eligibility, jurisdictions must review, revise as appropriate, and resubmit the plan within five years of the original approval date.

If you have questions regarding your plan's approval or FEMA's mitigation grant programs, please contact Joseph Murray, Planner with Oregon Office of Emergency Management, at (503) 378-2911, who locally coordinates and administers these efforts.

Sincerely,

Kristen Meyers, Director
Mitigation Division

Enclosure

cc: Amie Bashant, Oregon Office of Emergency Management

EG:vl



FEMA

March 1, 2021

The Honorable Kaety Jacobson
Chair Jacobson, Lincoln County Commissioners
225 West Olive Street, Room 110
Newport, Oregon 97365

Dear Ms. Jacobson:

On December 29, 2020, the United States Department of Homeland Security's Federal Emergency Management Agency (FEMA) Region 10, approved the Lincoln County Natural Hazards Mitigation Plan as a Multi-jurisdictional Plan as outlined in Code of Federal Regulations Title 44 Part 201. This approval provides the below jurisdictions eligibility to apply for the Robert T. Stafford Disaster Relief and Emergency Assistance Act's, Hazard Mitigation Assistance grants through December 29, 2025, through your state.

City of Toledo	City of Waldport	City of Depoe Bay
Lincoln City	City of Yachats	Seal Rock Water District
Central Lincoln People's Utility District		

The updated list of approved jurisdictions includes the City of Toledo, City of Depoe Bay, City of Yachats, City of Waldport, Lincoln City, Seal Rock Water District, and Central Lincoln People's Utility District that recently adopted the Addendum to the Lincoln County Multi-Jurisdictional Natural Hazards Mitigation Plan. To continue eligibility, jurisdictions must review, revise as appropriate, and resubmit the plan within five years of the original approval date.

If you have questions regarding your plan's approval or FEMA's mitigation grant programs, please contact Joseph Murray, Planner with Oregon Office of Emergency Management, at 503-378-2911, who coordinates and administers these efforts for local entities.

Sincerely,

Kristen Meyers, Director
Mitigation Division

cc: Amie Bashant, Oregon Office of Emergency Management

Enclosure

EG:vl

**BEFORE THE BOARD OF COMMISSIONERS
FOR LINCOLN COUNTY, OREGON**

In the Matter of)
)
Adopting Updates to the Lincoln County)
Multi-Jurisdictional Natural Hazards) **RESOLUTION # 20-21-12D**
Mitigation Plan)

WHEREAS, Lincoln County recognizes the threat that natural hazards pose to people, property and infrastructure within our community; and

WHEREAS, undertaking hazard mitigation actions will reduce the potential for harm to people, property and infrastructure from future hazard occurrences; and

WHEREAS, an adopted Natural Hazards Mitigation Plan (NHMP) is required as a condition of future funding for mitigation projects under multiple FEMA pre- and post-disaster mitigation grant programs; and

WHEREAS, the *Lincoln County Multi-Jurisdictional Natural Hazard Mitigation Plan* (NHMP) was adopted by the Lincoln County Board of Commissioners with Resolution #15-02-09 on September 2, 2015; and

WHEREAS, Lincoln County fully participated in the FEMA prescribed mitigation planning process to prepare this Natural Hazards Mitigation Plan; and

WHEREAS, the Oregon Office of Emergency Management and Federal Emergency Management Agency, Region X officials have reviewed the *Lincoln County Multi-Jurisdictional Natural Hazard Mitigation Plan* and pre-approved it (dated, December 9, 2020) contingent upon this official adoption of the participating governments and entities;

WHEREAS, the NHMP is comprised of three volumes: Volume I: Basic Plan, Volume II: Jurisdictional Addenda, and Volume III: Appendices, collectively referred to herein as the NHMP; and

WHEREAS, the NHMP is in an ongoing cycle of development and revision to improve its effectiveness; and

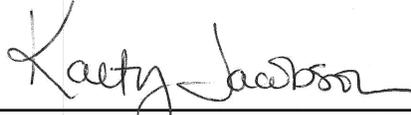
WHEREAS, Lincoln County adopts the NHMP and directs the Board of Commissioners to develop, approve, and implement the mitigation strategies and any administrative changes to the NHMP.

NOW, THEREFORE, IT IS HEREBY RESOLVED AND ORDERED AS FOLLOWS:

1. That Lincoln County adopts *the Lincoln County Multi-Jurisdictional Natural Hazards Mitigation Plan* as an official plan. The Plan is incorporated herein by this reference as if fully set forth.
2. That a copy of this Adoption Resolution be submitted to the Oregon Office of Emergency Management and Federal Emergency Management Agency, Region X officials to enable final approval of the *Lincoln County Multi-Jurisdictional Natural Hazards Mitigation Plan*.
3. That copies of this Adoption Resolution be provided to Onno Husing, Planning and Development Director for distribution to other participating government entities; Virginia Demaris, Emergency Manager and Wayne Belmont, County Counsel.

DATED this 21st day of December, 2020

LINCOLN COUNTY BOARD OF COMMISSIONERS



Kaety Jacobson, *Chair*



Doug Hunt, *Commissioner*



Claire Hall, *Commissioner*

SPECIAL THANKS & ACKNOWLEDGEMENTS

Lincoln County developed this Multi-Jurisdictional Natural Hazards Mitigation Plan (NHMP) through a regional partnership funded by the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP) Grant No. HMGP-DR-4328-OR-5-P. This updated NHMP is a collaboration between Lincoln County and the Cities of Depoe Bay, Lincoln City, Newport, Siletz, Toledo, Waldport, and Yachats and the special districts of Central Lincoln PUD, Lincoln County School District, and Seal Rock Water District. Planning process, plan templates, and plan development support provided by the Oregon Partnership for Disaster Resilience (OPDR) at the University of Oregon's Institute for Policy Research and Engagement (IPRE).

Special thanks to Jen Demaris, Lincoln County Emergency Manager and John O'Leary, Associate Planner, for their vision, passion, and positive outlook throughout the plan update process.

Steering Committee

- *Convener*, Jen Demaris, Emergency Manager, Lincoln County
- *Convener*, Onno Husing, Planning Director, Lincoln County
- Steve Hodge, County Engineer, Lincoln County
- Roy Kinion, Public Works Director, Lincoln County
- John O'Leary, Associate Planner, Lincoln County
- Rachel Cotton, Planner, Newport
- Adam Denlinger, General Manager, Seal Rock Water District
- Dave Eshleman, Public Works Administrator, Siletz
- Sue Graves, Safety Coordinator, Lincoln County School District
- Jerry Kemp, City Manager, Waldport
- Larry Lewis, Planner (contract), Depoe Bay/Waldport
- Gail Malcolm, Project Manager, Central Lincoln PUD
- Regina Martinez, EM Coordinator, Newport
- Ken Murphy, Emergency Manager, Lincoln City
- Justin Peterson, Planner (contract), Toledo, Waldport, Yachats
- Lindsey Sehmel, Planning Director, Lincoln City
- Derrick Tokos, Planning Director, Newport
- Brad Wynn, Operations Lead, Seal Rock Water District

Guests

- Meghan Dalton, Oregon Climate Change Research Institute
- Ryan Fish, Planning/Emergency Management, USCG-North Bend
- Alan Freudenthal, Oregon State Parks
- Laura Gabel, Coastal Field Geologist, DOGAMI

- Eli Grove, Emergency Preparedness Coordinator Trainee, Confederated Tribes of Siletz Indians
- Lisa Phipps, North Coast Regional Representative, DLCD
- Meg Reed, Coastal Shores Specialist, DLCD
- Hui Rodomsky, South Coast Regional Representative, DLCD
- Katherine Stanton, Applied Anthropology, OSU
- Jenna Tilt, Assistant Professor (Sr. Research), OSU
- Matt Williams, Geohazards Analyst, DOGAMI

Institute for Policy Research and Engagement Team

- Michael Howard, OPDR Director
- Emerson Hoagland, Research Assistant
- Curtis Thomas, Research Assistant
- Conrad Hock, Resource Assistance for Rural Environments

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 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.

NHMP Template Disclaimer

This NHMP 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 Lincoln County in the plan template.

TABLE OF CONTENTS

Volume I: Basic Plan

Plan Summaryi-1
Section 1: IntroductionI-1
Section 2: Hazard Identification and Risk Assessment2-1
Section 3: Mitigation Strategy.....3-1
Section 4: Plan Implementation and Maintenance4-1

Volume II: Jurisdictional Addenda

Depoe Bay DA-1
Lincoln City LA-1
Newport MA-1
Siletz NA-1
Toledo SA-1
Waldport WA-1
Yachats YA-1
Central Lincoln PUD PUD-1
Lincoln County School District LCSD-1
Seal Rock Water District SRWD-1

Volume III: Appendices

Appendix A: Action Item Forms A-1
Appendix B: Planning and Public ProcessB-1
Appendix C: Community ProfileC-1
Appendix D: Economic Analysis of Natural Hazard Mitigation Projects D-1
Appendix E: Grant Programs and Resources.....E-1
Appendix F: Community Survey F-1
Appendix G: Future Climate Projects: Lincoln County G-1

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PLAN SUMMARY

Lincoln County updated this Multi-Jurisdictional Natural Hazards Mitigation Plan (NHMP) 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.

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 NHMP in order to receive FEMA Hazard Mitigation Assistance (HMA) funds for mitigation projects. To that end, Lincoln County is involved in a broad range of hazard and emergency management planning activities. Local and federal approval of this NHMP 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 Lincoln 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, city, and special district Steering Committees guided the NHMP development process.

For a list of specific County steering committee participants, refer to the acknowledgements section above. The update process included representatives from the following jurisdictions and agencies: Lincoln County, Depoe Bay, Lincoln City, Newport, Siletz, Toledo, Waldport, Yachats, Central Lincoln PUD, Lincoln County School District, Seal Rock Water District, Department of Land Conservation and Development, Department of Geology and Mineral Industries, U.S. Coast Guard – Newport Station, Confederated Tribes of Siletz Indians, Oregon Climate Change Research Institute, and Oregon State University.

The Lincoln County Emergency Manager and Planning and Development Director convened the planning process and will take the lead in implementing, maintaining and updating the plan. Each of the participating cities and special districts have also named a local convener

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.

who is responsible for implementing, maintaining and updating their Jurisdictional Addendum (see addenda for specific names and positions). Lincoln County is dedicated to directly involving the public in the continual review and update of the NHMP. 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 steering committee represent the public to some extent, the public will continue to provide feedback about the NHMP throughout the implementation and maintenance period.

How Does this NHMP Reduce Risk?

The NHMP is a tool for Lincoln County to use to mitigate the impacts of natural 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 Figure PS-1.

By identifying and understanding the relationship between hazards, vulnerable systems and existing capacity,

Figure PS-1 Understanding Risk



Lincoln County is better equipped to identify and implement actions aimed at reducing the overall risk to hazards.

What is Lincoln County’s Overall Risk to Hazards?

Lincoln 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 summarizes hazard probability and vulnerability as determined by the County steering committee (for more information see Volume I, Section 2).

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

Table PS-1 Hazard Analysis Matrix – Lincoln County

Hazard	Maximum		Total Threat Score	Hazard Rank	Hazard Tiers
	History	Vulnerability			
Windstorm	20	50	100	70	Top Tier
Winter Storm (Snow/Ice)	18	35	90	70	
Landslide	20	40	80	70	
Earthquake (Cascadia)	10	50	100	49	
Wildfire	20	25	90	70	
Tsunami (Local)	2	40	100	49	
Flood (Riverine)	20	30	60	70	Middle Tier
Flood (Coastal)	20	30	40	70	
Drought	20	25	40	70	
Coastal Erosion	20	15	30	70	
Tornado	8	10	30	56	Bottom Tier
Tsunami (Distant)	10	15	40	35	
Earthquake (Crustal)	10	20	40	21	
Volcanic Event	2	5	40	7	

Source: Lincoln County NHMP Steering Committee (2020)

What is the NHMP’s Mission?

The NHMP mission states the purpose and defines the primary functions of the 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.

To promote public policy and mitigation activities which will enhance the safety to life and property from natural hazards.

The 2020 NHMP update Steering Committee reviewed the 2015 plan mission statement and agreed it accurately describes the overall purpose and intent of this plan. This is the exact wording that was present in the 2009 and 2015 plan. The Steering Committee believes the concise nature of the mission statement allows for a comprehensive approach to mitigation planning.

What are the NHMP Goals?

Mitigation plan goals are more specific statements of direction that Lincoln County residents, and public and private partners can use to plan their work to reduce the risk from natural hazards and to identify if it is successful. These statements of direction form a bridge between the broad mission statement and particular action items. The goals listed here serve as checkpoints as agencies and organizations begin implementing mitigation action items.

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

Public participation was a key aspect in developing the plan goals. Meetings with the project steering committee, stakeholder interviews and public workshops all served as methods to obtain input and priorities in developing goals for reducing risk and preventing loss for natural hazards in Lincoln County.

All the plan 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. Below is a list of the re-confirmed plan goals:

Goal 1: Protect life and reduce injuries resulting from natural hazards.

Goal 2: Minimize public and private property damages and the disruption of essential infrastructure and services from natural hazards.

Goal 3: Implement strategies to mitigate the effects of natural hazards and increase the quality of life and resilience of economies in Lincoln County.

Goal 4: Minimize the impact of natural hazards while protecting, restoring, and sustaining environmental processes.

Goal 5: Enhance and maintain local capability to implement a comprehensive hazard loss reduction strategy.

Goal 6: Document and evaluate progress in achieving hazard mitigation strategies and action items.

Goal 7: Motivate the public, private sector, and government agencies to mitigate the effects of natural hazards through information and education.

Goal 8: Apply development standards that mitigate or eliminate the potential impacts of natural hazards.

Goal 9: Mitigate damage to historic and cultural resources from natural hazards.

Goal 10: Increase communication, collaboration, and coordination among agencies at all levels of government and the private sector to mitigate natural hazards.

Goal 11: Integrate local NHMPs with comprehensive plans and implementing measures.

(Note: although numbered the goals are not prioritized.)

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 NHMP goals addressed. City and special district specific action items are included in Volume II, Jurisdictional 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 Steering 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.

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 . . .

- **Multi-Hazard #6:** Integrate the NHMP into County and City comprehensive plans.
- **Multi-Hazard #7:** Prepare long-term catastrophic recovery plan.
- **Multi-Hazard #8:** Review recommended mitigation strategies identified in DOGAMI reports (including O-19-06, O-20-03, O-20-11) and make recommendations to BOC for consideration as long-term mitigation strategies.
- **Coastal Erosion #2:** Evaluate revising existing county coastal hazard area regulations based on the DOGAMI risk zone mapping.
- **Earthquake #1:** Integrate new earthquake hazard mapping data for Lincoln County and improve technical analysis of earthquake hazards.
- **Earthquake #2:** Identify, inventory, and retrofit critical facilities for seismic and tsunami rehabilitation (consider both structural and non-structural retrofit options).
- **Earthquake #3:** Stay apprised of new earthquake and landslide data and perform mitigation of infrastructure where possible to increase resilience of critical transportation links to the valley and along the coast during earthquake events.
- **Tsunami #1:** Relocate county controlled critical/essential facilities and key resources, and encourage the relocation of other critical facilities and key resources that house vulnerable populations (e.g., hospitals, nursing homes, etc.) that are within the tsunami inundation zone and likely to be impacted by tsunami.
- **Landslide #3:** Collaborate with the Oregon Department of Geology and Mineral Industries to work on landslide risk reduction.
- **Severe Weather #2:** Continue and enhance severe weather (windstorm, tornado, winter storm) resistant construction methods where possible to reduce damage to utilities and critical facilities from windstorms and winter storms (snow/ice). In part, this may be accomplished by encouraging electric utility providers to convert existing overhead lines to underground lines.

- **Wildfire #1:** Implement actions identified within the Lincoln County Community Wildfire Protection Plan (CWPP) and continue to participate with ongoing maintenance and updates.

The implementation and maintenance section (Section 4) details the formal process that will ensure that the Lincoln County NHMP remains an active and relevant document. The Lincoln County Emergency Manager and Planning and Community Development Director are the designated conveners (NHMP Conveners) and are responsible for overseeing the review and implementation processes (see jurisdictional addenda for city and special district conveners). The NHMP maintenance process includes a schedule for monitoring and evaluating the NHMP semi-annually and revising the NHMP every five years. This section also describes how the communities will integrate public participation throughout the implementation and maintenance process.

The accomplishment of the NHMP goals and actions depends upon regular steering committee participation and adequate support from County, city, and special district 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.

NHMP Adoption

Once the NHMP is locally reviewed and deemed complete the NHMP Convener (or their designee) submits it to the State Hazard Mitigation Officer at the Oregon Office of Emergency Management (OEM). OEM reviews the NHMP and submits it to FEMA Region X for pre-approval. This review will address the federal criteria outlined in [44 CFR Part 201.6](#).

Once pre-approved by FEMA, the County, cities, and special districts may formally adopt it via resolution.

The Lincoln County NHMP 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 will be formally approved by FEMA and the County, participating cities, and special districts will regain eligibility for Hazard Mitigation Assistance (HMA) grant programs

The steering committees for Lincoln County and participating cities and special districts each met to review the NHMP update process and their governing bodies adopted the NHMP as shown below and in Volume II.

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] . . .

County Date of Adoption and Approval

Lincoln County adopted the NHMP on **December 21, 2020**. FEMA Region X approved the Lincoln County NHMP on **December 29, 2020**. With approval of this NHMP, the County is now eligible to apply for the Robert T. Stafford Disaster Relief and Emergency Assistance Act’s hazard mitigation project grants through **December 28, 2025**.

For the date of adoption for each participating city or special district see Volume II.

Volume I: Basic Plan

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SECTION I: INTRODUCTION

This section provides a general introduction to natural hazard mitigation planning in Lincoln 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?

Lincoln County updated this Multi-Jurisdictional Natural Hazard Mitigation Plan (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 people, local jurisdictions, and the State.

Chapter 44 Code of Federal Regulations (CFR), section 201.6, also requires a local government to have an approved NHMP in order to receive HMGP project grants.² Pursuant of Chapter 44 CFR, the NHMP 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 NHMP 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 NHMP must be submitted to the Oregon 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 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 OEM, Oregon Building Codes Division (BCD), Oregon Department of Forestry (ODF), Oregon Department of

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

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 Lincoln County NHMP Steering Committee and the Steering Committees for the participating jurisdictions (cities and special districts). The Lincoln County Steering Committee formally convened on two occasions to discuss and revise the NHMP. Each of the participating city and special district steering committees participated in the County NHMP update process. Steering 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 Lincoln County provided an accessible project website for the public to provide feedback on the draft NHMP: <https://www.co.lincoln.or.us/planning/page/natural-hazards-mitigation-plan>

In addition, Lincoln County provided a press release on their website to encourage the public to offer feedback on the NHMP update. The County, city, and special district 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 F) that was used to inform the content of, and 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.

Volume I: Basic Plan

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 I: 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 Lincoln 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:

- Coastal Erosion
- Drought
- Earthquake
- Tsunami
- Flood
- Landslide
- Severe Weather
 - Windstorm (& Tornado)
 - Winter Storm (snow/ice)
- Volcanic Event
- Wildfire

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 NHMP is reserved for any city or special district addenda 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 the participating cities, special districts, and the county.

The NHMP includes addenda for the following cities and special districts:

- Depoe Bay
- Lincoln City
- Toledo
- Waldport

- Newport
- Siletz
- Yachats
- Central Lincoln PUD
- Lincoln County School District
- Seal Rock Water District

Volume III: Appendices

The appendices are designed to provide the users of the Lincoln 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 Item Forms

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

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 and sign-in sheets of Steering Committee meetings as well as any other public involvement methods.

Appendix C: Community Profile

The community profile describes the County from several perspectives 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 NHMP was updated.

Appendix D: Economic Analysis of Natural Hazard Mitigation Projects

This appendix describes the FEMA requirements for benefit cost analysis in natural hazards mitigation, as well as various approaches for conducting economic analysis of proposed mitigation activities.

Appendix E: Grant Programs and Resources

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

Appendix F: Community Survey

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

Appendix G: Future Climate Projects: Lincoln County

This appendix includes a report produced by the Oregon Climate Change Research Institute (OCCRI). The reports provides important information regarding the influence and impacts of climate change on existing natural hazards events such as coastal erosion and flooding, river flooding, ocean temperature and chemistry, loss of coastal wetland ecosystems, drought, heat waves, cold waves, wildfire, and air quality.

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SECTION 2: HAZARD IDENTIFICATION AND RISK ASSESSMENT

This section of the NHMP addresses 44 CFR 201.6(c)(2) - Risk Assessment. The Risk Assessment applies to Lincoln County and the city addenda included in the NHMP. We address city specific information where relevant. In addition, this section 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?

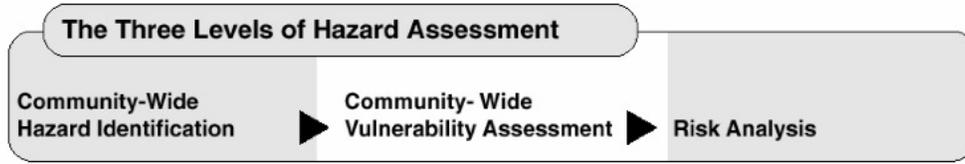
A risk assessment consists of three phases: hazard identification, vulnerability assessment and risk analysis.

- **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

Lincoln County identifies eight natural hazards that could have an impact on the County and participating cities and special districts. Table 2-1 lists the hazards identified in the County in comparison to the hazards identified in the [Risk Assessment for Region 1, Oregon Coast, Oregon SNHMP \(2020\)](#) which includes Lincoln County.

Table 2-1 Lincoln County Hazard Identification

Lincoln County	Oregon NHMP Region 1: Oregon Coast
Coastal Erosion	Coastal Hazards*
-	Dam Safety
Drought	Drought
-	Extreme Heat
Earthquake (Cascadia/ Crustal)	Earthquake (Cascadia/ Crustal)
Flood (Riverine/ Coastal)	Flood (Riverine/ Coastal)
Landslide	Landslide
Tornado	-
Tsunami (Local/ Distant)	Tsunami (Local/ Distant)
Volcanic Events	Volcano
Wildfire	Wildfire
Windstorm	Windstorm
Winter Storm	Winter Storm

Source: Lincoln County NHMP Steering Committee (2019) and State of Oregon NHMP, Region 1: Oregon Coast (2020)

* - Coastal Hazards include coastal erosion and flooding

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, cities, and special districts utilized the Oregon 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 OEM 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.

Probability and Vulnerability Summary

Table 2-2 presents the probability scores for each of the natural hazards present in Lincoln 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 the average occurrence of 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.

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 within the unincorporated County. 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 II and Volume III, Appendix C.

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.

Jurisdiction Specific Risk Assessment

Each participating jurisdiction (cities and special districts) in Lincoln 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 each jurisdiction’s addendum in Volume II.

Table 2-2 Probability and Vulnerability Assessment Summary

Hazard	Probability	Vulnerability
Coastal Erosion	High	Low
Drought	High	Moderate
Earthquake (Cascadia)	Moderate	High
Earthquake (Crustal)	Low	Moderate
Flood (Coastal)	High	Moderate
Flood (Riverine)	High	Moderate
Landslide	High	High
Tornado	High	Low
Tsunami (Distant)	Moderate	Low
Tsunami (Local)	Moderate	High
Volcanic Events	Low	Low
Wildfire	High	Moderate
Windstorm	High	High
Winter Storm (Snow/Ice)	High	Moderate

Source: Lincoln County Steering Committee, 2020

Table 2-3 presents the updated hazard analysis matrix for Lincoln 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, windstorm, winter storm, landslide, the Cascadia Subduction Zone earthquake, wildfire, and local tsunami rank as the top hazard threats to the County (top tier). Flood (riverine and coastal), drought, and coastal erosion rank in the are the next highest ranked hazards (middle tier). Tornado, distant tsunami, crustal earthquake, and volcanic event (ashfall, tephra) comprise the lowest ranked hazards in the county (bottom tier).

Table 2-3 Hazard Analysis Matrix – Lincoln County

Hazard	Maximum				Total Threat Score	Hazard Rank	Hazard Tiers
	History	Vulnerability	Threat	Probability			
Windstorm	20	50	100	70	240	#1	Top Tier
Winter Storm (Snow/Ice)	18	35	90	70	213	#2	
Landslide	20	40	80	70	210	#3	
Earthquake (Cascadia)	10	50	100	49	209	#4	
Wildfire	20	25	90	70	205	#5	
Tsunami (Local)	2	40	100	49	191	#6	
Flood (Riverine)	20	30	60	70	180	#7	Middle Tier
Flood (Coastal)	20	30	40	70	160	#8	
Drought	20	25	40	70	155	#9	
Coastal Erosion	20	15	30	70	135	#10	
Tornado	8	10	30	56	104	#11	Bottom Tier
Tsunami (Distant)	10	15	40	35	100	#12	
Earthquake (Crustal)	10	20	40	21	91	#13	
Volcanic Event	2	5	40	7	54	#14	

Source: Lincoln County Steering Committee, 2020

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 September 17, 2020 FEMA has approved a total of 38 major disaster declarations, 56 fire management assistance declarations, 36 fire suppression authorizations, and four (4) 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 fire management assistance, fire suppression authorizations, 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 is one fire management assistance declaration or fire suppression authorizations on record for the county related to the 2020 Echo Mountain Fire Complex.

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. Lincoln County has two recorded Emergency Declarations related to the 2005 Hurricane Katrina evacuation, the 2020 COVID-19 Pandemic, and the 2020 Oregon wildfires.

Table 2-4 FEMA Fire Management (FM) and Emergency Declarations (EM) for Lincoln County

Declaration Number	Declaration Date	Incident Period		Incident	Individual Assistance	Public Assistance Categories
		From	To			
FM-5362	9/9/2020	9/8/2020	-	Echo Mountain Fire Complex	None	-
EM-3228	9/7/2005	8/29/2005	10/1/2005	Hurricane Katrina Evacuation	None	B
EM-3429	3/13/2020	1/20/2020	-	COVID-19 Pandemic	None	B
EM-3542	9/10/2020	9/8/2020	-	Oregon Wildfires	None	-

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

Note: Oregon was granted an Emergency Declaration to support the Hurricane Katrina Evacuation. The Oregon National Guard deployed over 2,100 soldiers and their equipment to New Orleans in less than three days.

Table 2-5 summarizes the major disasters declared in Oregon that affected Lincoln County, since 1955. The table shows that there have been 17 major disaster declarations for Lincoln County. Most of which were related to weather events resulting primarily in flooding, landslide, winter storm (snow, ice), wildfire and related damage. There has been one disaster declaration for tsunami and for the 2020 COVID-19 Pandemic.

¹ FEMA, *Declared Disasters by Year or State*, <https://www.fema.gov/disasters/#>. Accessed July 1, 2020.

Table 2-5 FEMA Major Disaster (DR) for Lincoln 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-1099	2/9/1996	2/4/1996	2/21/1996	Severe Storms, Flooding	Yes	A, B, C, D, E, F, G
DR-1107	3/19/1997	12/10/1996	12/12/1996	Severe Storms, High Winds	None	A, B, C, D, E, F, G
DR-1510	2/19/2004	12/26/2003	1/14/2004	Severe Winter Storm	None	A, B, C, D, E, F, G
DR-1632	3/20/2006	12/18/2005	1/21/2006	Severe Storms, Flooding, Landslides, Mudslides	None	A, B, C, D, E, F, G
DR-1672	12/29/2006	11/5/2006	11/8/2006	Severe Storms, Flooding, Landslides, and Mudslides	None	A, B, C, D, E, F, G
DR-1683	2/22/2007	12/14/2006	12/15/2006	Severe Winter Storm and Flooding	None	A, B, C, D, E, F, G
DR-1733	12/8/2007	12/1/2007	12/17/2007	Severe Storms, Flooding, 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-1964	3/25/2011	3/11/2011	3/11/2011	Tsunami Wave Surge	None	A, B, C, D, E, F, G
DR-4055	3/2/2012	1/17/2012	1/21/2012	Severe Winter Storm, Flooding, Landslides, and Mudslides	None	A, B, C, D, E, F, G
DR-4169	4/4/2014	2/6/2014	2/10/2014	Severe Winter Storm	None	A, B, C, D, E, F, G
DR-4258	2/17/2016	12/6/2015	12/23/2015	Severe Winter Storms, Straight-line Winds, Flooding, Landslides, and Mudslides	None	A, B, C, D, E, F, G
DR-4499	3/28/2020	1/20/2020	-	COVID-19 Pandemic	None	A, B
DR-4562	6/7/2020	continuing	9/15/2020	Wildfires, Straight-line Winds	Yes	B

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

Future Climate Variability²

Temperatures have increased across Oregon by 2.2 °F in the period 1895–2015 (the observed record). In that same timeframe, Cascade Mountain snowpacks have declined, and higher temperatures are causing earlier spring snowmelt and spring peak streamflows. In

² Oregon Climate Change Research Institute (OCCRI), 4th Oregon Climate Assessment Report (2019) and Northwest Climate Assessment Report (2013). <http://www.occri.net/publications-and-reports/publications/>

Oregon’s forested areas, large areas have been impacted by disturbances that include wildfire in recent years, and climate change is probably one major factor.³

Climate models for Oregon suggest 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. By the 2050s Oregon is expected to see temperature increases between 3.6°F and 5.0°F depending on global emissions.

The Department of Land Conservation and Development (DLCD) contracted with the Oregon Climate Change Research Initiative (OCCRI) to provide an analysis of climate change influences on natural hazards (Appendix G). OCCRI’s *Future Climate Projections: Lincoln County* provides important information regarding the influence and impacts of climate change on existing natural hazards events such as heavy rains, river flooding, drought, heat waves, cold waves, wildfire, air quality, coastal erosion and flooding, and ocean temperature and chemistry (Appendix G).

The basis of the research prepared by OCCRI uses future climate projections that are derived from 10–20 global climate models and have been “downscaled”—made locally relevant. Several climate metrics that relate to natural hazards are being calculated for historical and mid-21st century periods under two future emissions scenarios that result in varying future temperature increases for the State of Oregon.

The report describes county-specific projected changes in climate metrics related to the selected natural hazards. The reports present future climate projections for the 2020s (2010-2039 average) and the 2050s (2040-2069 average) compared to the 1971-2000 average historical baseline. Each hazard in the report has a box highlighting “key messages” that call out the main points of the research and analysis for that hazard.

Figure 2-3 provides an overview of expected climate change impacts for Lincoln County. The table shows the direction of change (increasing, decreasing, unchanging) and indicates the level of confidence in direction of change (high, medium, low). According to the OCCRI reports there is very high confidence that heat waves will increase and that cold waves will decrease. The table also shows that there is high confidence that heavy rains, river flooding, wildfire, loss of wetland ecosystems, ocean temperature and chemistry changes, and coastal hazards will increase. The overview describes results for the natural hazards using climate metrics in summary and as a comparison. For more information see the OCCRI report in Appendix G.

³ Ibid.

Figure 2-3 Summary of projected direction of change along with the level of confidence in climate change related risk of natural hazard occurrence.

	Low Confidence	Medium Confidence	High Confidence	Very High Confidence
Risk Increasing 	 Poor Air Quality	 Drought  Increased Invasive Species Risk	 Heavy Rains Flooding  Wildfire  Loss of Wetland Ecosystems  Ocean Temp & Chemistry Changes  Coastal Hazards 	 Heat Waves
Risk Unchanging = 	 Windstorms			
Risk Decreasing 				 Cold Waves

Source: OCCRI. 2020. Future Climate Projections Lincoln County (see Appendix G).

Very high confidence means all models agree on the direction of change and there is strong evidence in the published literature. High confidence means most models agree on the direction of change and there is strong to medium evidence in the published literature. Medium confidence means that there is medium evidence and consensus on the direction of change with some caveats. Low confidence means the direction of change is small compared to the range of model responses or there is limited evidence in the published literature.

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 Lincoln County, refer to the [Risk Assessment for Region 1, Oregon Coast, Oregon SNHMP \(2020\)](#).

In addition, the Oregon Department of Geology and Mineral Industries (DOGAMI) conducted a multi-hazard risk assessment (Risk Report) for Lincoln County, including the cities of Lincoln City, Depoe Bay, Siletz, Newport, Toledo, Waldport, and Yachats, and the Confederated Tribes of Siletz Indians, and the unincorporated communities of Otis-Rose Lodge, Salishan-Lincoln Beach, Otter Rock, Seal Rock-Bayshore, and Wakonda Beach. The study was funded through the FEMA Risk MAP program and was published in 2020. The Risk Report provides a quantitative risk assessment that informs communities of their risk related to the following natural hazards: coastal erosion, Cascadia Subduction Zone earthquake and tsunami, flood, landslide, and wildfire (summarized herein). The County hereby incorporates the Risk Report into this NHMP by reference ([DOGAMI, Open-file Report O-20-11](#)).

Coastal Erosion.....	10
Drought	14
Earthquake.....	17
Tsunami	31
Flood	47
Landslide.....	58
Severe Weather (Windstorm, Tornado, and Winter Storm)	67
Windstorm & Tornado.....	68
Winter Storm.....	70
Volcanic Event.....	74
Wildfire.....	77

Coastal Erosion

Significant Changes since Previous NHMP:

New data is included from the Risk Report, OCCRI “Future Climate Projections”, and other technical reports.

Characteristics

Coastal erosion is a natural process that continually affects the entire coast. Erosion becomes a hazard when human development, life and safety are threatened. Waves, currents, tides and storms resulting in episodic and recurrent erosion constantly affect beaches, sand spits, dunes and bluffs. Shoreline retreat may be gradual over a season or many years, or it can be drastic, with the loss of substantial upland area during a single storm event.

Various combinations of large waves, storm surges, rip cell embayments, high winds, rain, runoff, flooding, or increased water levels and ocean conditions caused by periodic El Niño events cause Ocean erosion. Coastal bluffs comprised of uplifted marine terrace deposits and especially coastal dunes are vulnerable to both chronic erosion hazards.

Coastal erosion hazard poses a threat to structures and other development through the retreat of the shoreline from periodic high rates of beach, dune and bluff erosion and from mass wasting of sea cliffs in the form of landslides and slumps due to wave attack and geologic instability.

Coastal erosion is considered a chronic hazard, meaning it is usually local in nature, and the threats to human life and property that arise from it are generally less severe than those associated with catastrophic hazards. However, the wide distribution and frequent occurrence of chronic hazards such as coastal erosion makes them more of an immediate concern.

The damage caused by coastal erosion is usually gradual and cumulative. However, storms that produce large winter waves, heavy rainfall and/or high winds may result in very rapid erosion or other damage that can affect properties and infrastructure in a matter of hours. The regional, oceanic and climatic environments that result in intense winter storms determine the severity of chronic erosion hazards along the Oregon coast.

Location and Extent

Coastal erosion is a chronic hazard affecting the entire Lincoln County Coast. There are a variety of identifiable factors which affect shoreline stability. Dune-backed shorelines, which are most susceptible to wave attack, make up only a small portion of the Lincoln County coast. Processes of wave attack, including undercutting and wave overtopping, are the primary processes affecting shoreline stability in these areas. Bluff-backed shorelines, while less susceptible to rapid shoreline retreat from wave attack, are nonetheless impacted over time by coastal erosion, particularly during large storm events which result in the formation of rip cell embayments.

Coastal recession rates for Lincoln County were estimated and mapped in the Environmental Hazard Inventory of Coastal Lincoln County, RNKR Associates, 1978.

For more information, see the following DOGAMI reports:

- Coastal flood hazard study, Lincoln County, Oregon (2018, [O-15-06](#))
- Evaluation of erosion hazard zones along the Alsea Bay shoreline between the Alsea Bay Bridge and the Port of Alsea, Lincoln County, Oregon (2013, [O-13-20](#))
- Evaluation of Coastal Erosion Hazard Zones along Dune and Bluff-Backed Shorelines for southern Lincoln County: Seal Rock to Cape Perpetua (Open File Report [O-07-03](#))
- Evaluation of coastal erosion hazard zones along dune and bluff backed shorelines in Lincoln County Oregon: Cascade Head to Seal Rock - Technical report to Lincoln County (Open File Report [O-04-09](#))

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

<https://www.oregongeology.org/pubs/pubsearch.htm>

History

Chronic coastal erosion has impacted development along the Lincoln County coast for decades. Examples include the Jump Off Joe area in Newport, where a landslide, undermined by ocean wave attack, accelerated during the mid-1940s, carrying roads, drain pipes, and 15 houses seaward to their destruction.⁴ Other examples include the severe erosion which took place on the Salishan Spit in the early 1970s, resulting in the destruction of one home under construction. Only a massive effort to armor the shoreline saved the remaining development on the spit. In similar episodes, development on the Bayshore Spit at the mouth of Alsea Bay was threatened by rapid erosion, first in the 1985 El Nino, and again in similar conditions in the winter of 1998. Emergency shore front hardening was employed to save several homes in the Gleneden Beach area that were threatened by bluff face failure.

Probability Assessment

Based on the available data and research the Steering Committee (Steering Committee) assessed the **probability of experiencing coastal erosion is "high,"** meaning at least one incident is likely within the next 35 years.

Coastal erosion can, and does, occur along the entire Lincoln County coastline. The probability of a coastal erosion event happening is based in part on probabilistic (waves) and deterministic (water levels) values. The active hazard zone for Lincoln County includes coastal bluff and dunes that are undergoing erosion whether by waves, near-shore sediment transport, or mass wasting processes. The active-hazard zone for dune-backed shorelines reflects the area of historic transformation and for bluff-backed shorelines the active-hazard zone includes the beach, bluff toe, and escarpment. DOGAMI has completed coastal erosion hazard maps for Lincoln County that depict the following hazard zones:⁵

- Active-Hazard Zone: Area of active, ongoing erosion.
- High-Hazard Zone: High likelihood that the area could be affected by active erosion in the next 60 years.

⁴ DOGAMI. Geologic Hazards on the Oregon Coast: Coastal Landslides.
<http://www.oregongeology.com/sub/earthquakes/Coastal/CoastalLandslides.htm>

⁵ DOGAMI. 2007. Evaluation of Coastal Erosion Hazard Zones Along Dune and Bluff Backed Shorelines In Southern Lincoln County, Oregon: Seal Rock to Cape Perpetua. Open-File Report O-07-03.

- Moderate-Hazard Zone: Moderate likelihood that the area could be affected by active erosion in the next 60 to 100 years.
- Low-Hazard Zone: Low but significant likelihood that the area could be affected by active erosion in the next 60 to 100 years.

Within Lincoln County the active-hazard zone varies in width from a few meters on cliffy headlands to hundreds of meters on low sloping beaches. Along dune-backed beaches the active-hazard zone experiences near constant change due to movement of dunes, while on bluff-backed shorelines the active-hazard zone includes large areas of active, or potentially, active landslides. For more information see Appendix A “Erosion Hazard Maps” of Open-File Report [O-04-09](#) and Plate 1 of Open-File Report [O-07-03](#).

Future Climate Projection:

According to OCCRI report “*Future Climate Projections: Lincoln County*” (Appendix G) the risk of coastal erosion is expected to increase due to sea level rise and changing wave dynamics.

Vulnerability Assessment

The Steering Committee rated the County as having a “**low**” vulnerability to the coastal erosion hazard; meaning less than 1% of the region’s population or property could be affected by a major emergency or disaster.

Buildings, parks and various infrastructure located along the ocean shore are vulnerable to coastal erosion. This is most obvious in low-lying, dune backed shoreline areas adjacent to bays or the ocean; it is also the case in areas of bluff backed beaches where buildings and infrastructure have been located on readily erodible materials (e.g., consolidated sand, weakly cemented sandstone, siltstone, etc.). The problem is historic.

There are numerous examples of buildings and infrastructure threatened or damaged by wave attack/erosion (e.g. Salishan Spit, Bayshore Spit).

The Oregon SNHMP’s Risk Assessment⁶ considers Lincoln County to be the second most vulnerable county to coastal hazards (erosion). Particularly susceptible are the areas listed below:

- Yachats to Alsea Spit (erosion)
- Waldport (erosion and flooding)
- Alsea Spit (erosion; replaced by recent sand inundation)
- Seal Rock (erosion and landsliding)
- Ona Beach to South Beach (erosion and landsliding)
- Newport (landsliding)
- Beverly Beach (erosion and landsliding)
- Gleneden Beach to Siletz (erosion, landsliding, and flooding)
- Lincoln City (erosion and landsliding)

Highway 101 is the major infrastructure component vulnerable to coastal erosion. In Lincoln County, much of the problem is linked to the local geology. Bedrock conditions can and do change abruptly within very short distances. This results in an inconsistent highway

⁶ DLCD. *Oregon Natural Hazards Mitigation Plan*. 2020.

foundation; some sections are more susceptible to erosion than others and require continuous maintenance. There is no practical solution outside of relocation of the highway; in most cases, this option is not financially feasible now.

Natural Hazard Risk Report for Lincoln County

The **Risk Report** ([DOGAMI, O-20-11](#)) provides hazard analysis summary tables that identify populations and property within Lincoln County that are vulnerable to coastal erosion. The Risk Report provides distinct profiles for (1) unincorporated Lincoln County, and (2) the unincorporated communities of Otis-Rose Lodge, Salishan-Lincoln Beach, Otter Rock, Seal Rock-Bayshore, and Wakonda Beach.

The Risk Report provides an analysis of dune-backed beaches and bluff-backed shorelines to identify the general level of susceptibility due to storm-induced erosion, sea level rise, and subsidence due to CSZ earthquake event. The Risk Report performed an analysis of buildings, including critical facilities, to determine exposure for each community. According to the Risk Report the following resident population and property (public and private) within the study area may be impacted by the profiled coastal erosion scenario.

Population Vulnerability (Residents)

Approximately one percent of unincorporated Lincoln County’s population (186 people) may be displaced by coastal erosion within Lincoln County. These people are expected to have mobility or access issues and/or may have their residences impacted by coastal erosion. It is important to note that impact from coastal erosion may vary depending on areas that are impacted during an event. Seal Rock-Bayshore has the most population at risk (105), however, no area has more than five percent of its population impacted by coastal erosion.

Table 2-6 Potentially Displaced Residents, Coastal Erosion

	Resident Population	Potentially Displaced Residents	
		Number	Percent
"Rural" Lincoln County	10,293	0	0%
Otis-Rose Lodge	1,926	0	0%
Otter Rock	489	26	5%
Salishan-Lincoln Beach	2,093	39	2%
Seal Rock-Bayshore	2,766	105	4%
Wakonda Beach	1,326	16	1%
Total Unincorporated	18,893	186	1%

Source: IPRE. Data adapted from DOGAMI, Open-File Report O-20-11, Lincoln County Natural Hazard Risk Report. Tables A-1 through A-11; “Rural” Lincoln County includes all unincorporated areas that are not otherwise identified in this table. Note: City population based on the 2010 Census population.

Property Vulnerability

Properties that are most vulnerable to the coastal erosion hazard are those that are developed in an area of steep dunes or cliffs. Just under two percent (358 buildings) of unincorporated Lincoln County buildings are exposed to the high coastal erosion hazard zone. The percent of exposed buildings is greatest in the Otter Rock (8.7%), however,

Salishan-Lincoln Beach and Seal Rock-Bayshore have more total building value at risk (about \$25 million is at risk in each community). The value of exposed buildings is \$63.8 million.⁷

Table 2-7 Exposed Buildings, Coastal Erosion, by Unincorporated Area

	Total Buildings	Exposed Buildings		Value of Loss	
		Number	Percent	Loss Estimate (\$)	Loss Ratio
"Rural" Lincoln County	12,637	2	0.0%	\$197,000	< 1%
Otis-Rose Lodge	1,747	0	0.0%	\$0	0.0%
Otter Rock	634	55	8.7%	\$6,469,000	7.9%
Salishan-Lincoln Beach	2,847	102	3.6%	\$26,168,000	6.7%
Seal Rock-Bayshore	3,345	155	4.6%	\$25,329,000	7.3%
Wakonda Beach	1,614	44	2.7%	\$5,629,000	4.6%
Total Unincorporated	22,824	358	1.6%	\$63,792,000	3.5%

Source: IPRE. Data adapted from DOGAMI, Open-File Report O-20-11, Lincoln County Natural Hazard Risk Report, Tables A-1 through A-11; "Rural" Lincoln County includes all unincorporated areas that are not otherwise identified in this table.

Critical Facility Vulnerability

There are no critical facilities exposed to the high coastal erosion zone.

Risk Report Identified Areas of Vulnerability⁸

- Almost every building built adjacent to the shoreline in Lincoln County has some exposure to coastal erosion. During times of high tide occurring along with powerful storms, the rate of erosion can greatly increase.
- Coastal erosion risk is particularly high for the communities of Newport and Otter Rock.

More information on this hazard can be found in the [Risk Assessment for Region 1, Oregon Coast, Oregon SNHMP \(2020\)](#).

⁷ DOGAMI, Open-File Report O-20-11, Lincoln County Natural Hazard Risk Report, Tables A-1 through A-11.

⁸ Ibid. Page 31.

Drought

Significant Changes since Previous NHMP:

New data is included from the OCCRI “Future Climate Projections” report and other technical reports.

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.

There are four types of drought: meteorological, agricultural, hydrological and socioeconomic. *Meteorological drought* is based on the degree of dryness. *Agricultural drought* focuses the amount of soil moisture versus the needs of the crops. *Hydrological drought* is associated with shortfalls of surface and subsurface water supply. *Socioeconomic drought* refers to physical water shortages and its human effect and occurs when the need for water exceeds the supply resulting in a shortfall.

Location and Extent

Droughts occur in every climate zone and can vary from region to region. Drought may occur throughout Lincoln 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. The extent of the hazard is shown in Figure 2-4.

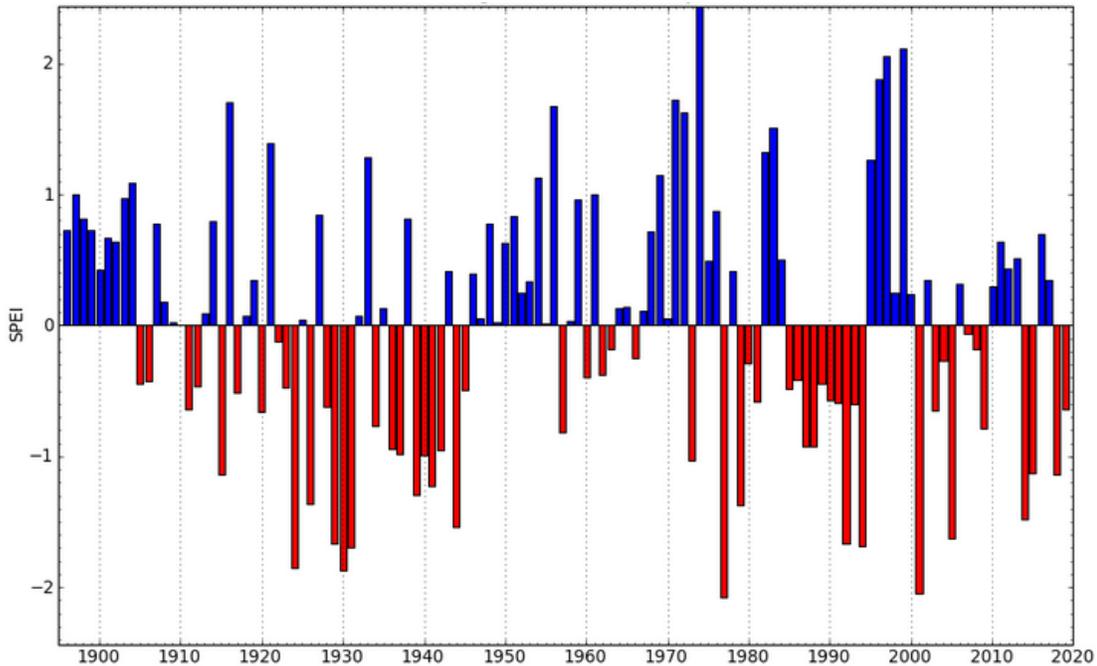
History

Lincoln 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 Standardized Precipitation-Evapotranspiration Index (SPEI) is an index of water conditions throughout the state. The index is designed to account for precipitation and evapotranspiration to determine drought. The lowest SPEI values, below -2.0, indicate extreme drought conditions. Severe drought occurs at SPEI values between -2.0 and -1.5, and moderate drought occurs between -1.5 and -1.0.

Figure 2-4 shows the water year (October 1 – September 30) history of SPEI from 1895 to 2019 for Lincoln County. The SPEI record indicates that Lincoln County has experienced two periods of extreme drought (water years 1977 and 2001), eight periods of severe drought (water years 1924, 1929, 1930, 1931, 1944, 1992, 1994, and 2005), and nine periods of moderate drought (1915, 1926, 1939, 1941, 1973, 1979, 2014, 2015, and 2018). Two (2) executive orders declaring drought emergencies by the Governor occurred in 1992 and 2018 and a federally declared drought occurred in 2015.⁹

Figure 2-4 Standardized Precipitation-Evapotranspiration Index, 12-Months Ending in September, Lincoln County, OR (1896-2019)



Source: Western Regional Climate Center. West Wide Drought Tracker. <https://wrcc.dri.edu/wwdt/time/>. Created July 6, 2020.

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

⁹ Oregon Water Resources Department Public Declaration Status Report, http://apps.wrd.state.or.us/apps/wr/wr_drought/declaration_status_report.aspx, accessed July 6, 2020.

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.¹⁰

Probability Assessment

Based on the available data and research the Steering Committee (Steering Committee) assessed the **probability of experiencing a locally severe drought as “high”** meaning at least one incident is likely within the next 35 years.

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. Droughts are particularly a concern in parts of Lincoln County that rely on surface water.

Future Climate Projection:

According to OCCRI report “*Future Climate Projections: Lincoln County*” (Appendix G) the probability of future drought conditions (low summer soil moisture, low spring snowpack, low summer runoff, low summer precipitation, and high summer evaporation) is expected to be more frequent by the 2050s.

Vulnerability Assessment

The Steering Committee rated the County as having a **“moderate” vulnerability to drought hazards**, meaning it is expected that between 1% and 10% of the unincorporated County’s population or property could be affected by a major drought emergency or disaster.

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 Lincoln County. Drought can affect all segments of Lincoln 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 Lincoln County are susceptible to drought. 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. The following issues are also of concern: drinking water sources and systems, power and water enterprises, residential and community wells in rural areas, fire response capabilities, and fish and wildlife.

More information on this hazard can be found in the [Risk Assessment for Region 1, Oregon Coast, Oregon SNHMP \(2020\)](#).

¹⁰ 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>

Earthquake

Significant Changes since Previous NHMP:

New data is included from the Risk Report and other technical reports.

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, and 3) shallow crustal events within the North American Plate.

Crustal Fault Earthquakes

Crustal fault earthquakes are the most common earthquakes and occur at relatively shallow depths of 6-12 miles below the surface.¹¹ 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.

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 7.5.¹² 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.¹³

Subduction Zone Earthquakes

The Pacific Northwest is located at a convergent plate boundary, where the Juan de Fuca and North American tectonic plates meet (Figure 2-5). 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.¹⁴

Subduction zones like the CSZ have produced earthquakes with Magnitudes (M) of 8 or larger. Historic subduction zone earthquakes include the 1960 Chile (M 9.5) and 1964 southern Alaska (M 9.2) earthquakes¹⁵ with more recent events being the 2004 Indian Ocean (M 9.1) and 2011 Japan (M 9).

¹¹ Madin, Ian P. and Zhenming Wang. Relative Earthquake Hazard Maps Report. (1999) DOGAMI.

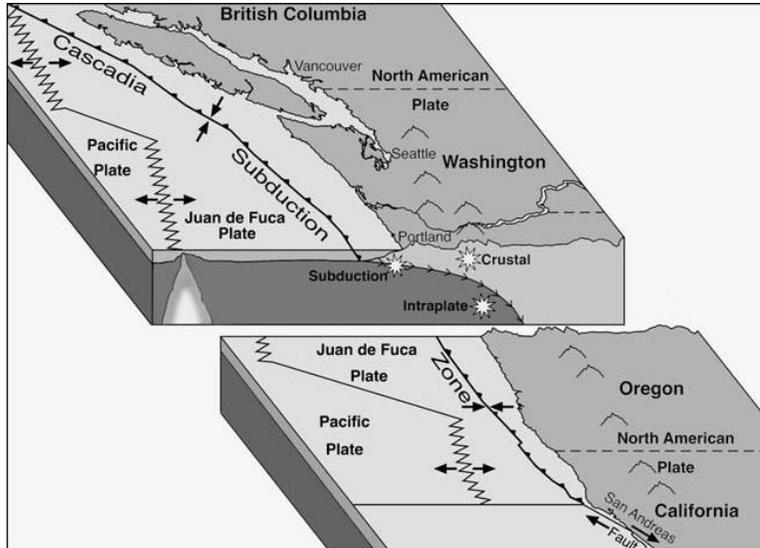
¹² Planning for Natural Hazards: The Oregon Technical Resource Guide, Department of Land Conservation and Development (July 2000), Ch. 8, pp. 8.

¹³ The Oregonian. "A region at risk." March 4, 2001.

¹⁴ Questions and Answers on Earthquakes in Washington and Oregon (February 2001) www.geophys.washington.edu/seis/pnsn/info_general/faq.html.

¹⁵ The Oregonian. "A region at risk." March 4, 2001.

Figure 2-5 Cascadia Subduction Zone



Source: Shoreland Solutions. Chronic Coastal Natural Hazards Model Overlay Zone. Salem, OR: Oregon Department of Land Conservation and Development (1998) Technical Guide-3.

The specific hazards associated with earthquakes are explained below:

Ground Shaking

Ground shaking is the motion felt on the earth's surface caused by seismic waves generated by the earthquake. Ground shaking is the primary cause of earthquake damage. The strength of ground shaking depends on the magnitude of the earthquake, the type of fault that is slipping, and distance from the epicenter (where the earthquake originates). Buildings on poorly consolidated and thick soils will typically see more damage than buildings on consolidated soils and bedrock.

Ground Shaking Amplification

Ground shaking amplification refers to the soils and soft sedimentary rocks near the surface that can modify ground shaking from an earthquake. Such factors can increase or decrease the amplification (i.e., strength) as well as the frequency of the shaking. The thickness of the geologic materials and their physical properties determine how much amplification will occur. Ground motion amplification increases the risk for buildings and structures built on soft and unconsolidated soils.

Surface Faulting

Surface faulting are planes or surfaces in Earth materials along which failure occurs. Such faults can be found deep within the earth or on the surface. Earthquakes occurring from deep lying faults usually create only ground shaking.

Liquefaction and Subsidence

Liquefaction occurs when ground shaking causes wet, granular soils to change from a solid state into a liquid state. This results in the loss of soil strength and the soil's ability to

support weight. When the ground can no longer support buildings and structures (subsidence), buildings and their occupants are at risk.

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.

Earthquake-Induced Landslides and Rockfalls

Earthquake-induced landslides are secondary hazards that occur from ground shaking and can destroy roads, buildings, utilities and critical facilities necessary to recovery efforts after an earthquake. Some Lincoln County communities are built in areas with steep slopes. These areas often have a higher risk of landslides and rockfalls triggered by earthquakes. Landslide hazard is addressed in detail in a separate section.

Tsunamis

Tsunamis are another secondary earthquake hazard created by events occurring under the ocean. A tsunami often incorrectly referred to a "tidal wave," is a series of gravity-induced waves that can travel great distances from the earthquake's origin and can cause serious flooding and damage to coastal communities. Tsunami hazard is addressed in detail in a separate section.

Location and Extent

The seismic hazard for Lincoln County arises predominantly from major earthquakes on the Cascadia Subduction Zone. Additional fault zones throughout the county and region may produce localized crustal earthquakes up to M6.0 and will be less damaging than a CSZ earthquake event which will impact the entire western portion of Oregon. Table 2-8 presents a list of the different Class A faults in, and offshore, of the county that are shown in Figure 2-7. For more information on Class A faults located in Lincoln County see the US Geological Survey, Quaternary Fault and Fold Database:

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

A local earthquake of M 6.0 or a regional M 9.0 earthquake is likely to cause substantial structural damage to bridges, buildings (residential, commercial, industrial), utilities, and communications systems, as well as the following impacts to infrastructure 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

Table 2-8 Class A Faults Located in or near Lincoln County

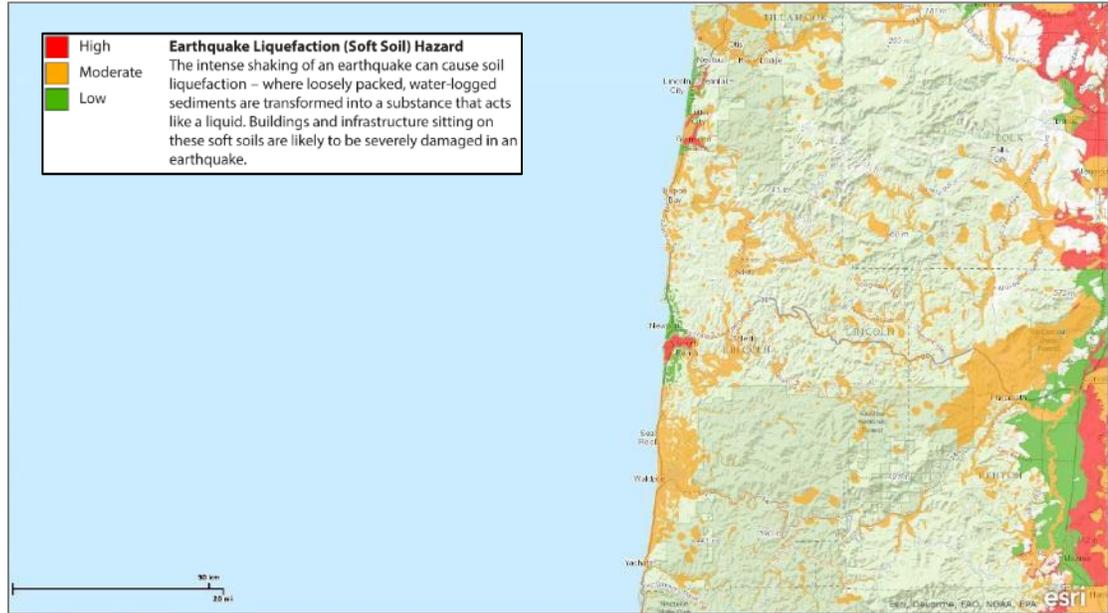
Name	Class	Fault ID	Primary County, State	Length (km)	Time of Most Recent Deformation	Slip-Rate Category
Cascadia Megathrust	A	781	Offshore	754km	Latest Quaternary	Greater than 5.0 mm/yr
Cascadia Fold and Fault Bed	A	784	Offshore	484km	Latest Quaternary	Between 1.0 & 5.0 mm/yr
unnamed offshore faults	A	785	Offshore	280km	Latest Quaternary	Between 1.0 & 5.0 mm/yr
Stonewall Anticline	A	786	Offshore	49km	Quaternary (<1.6 Ma)	Less than 0.2 mm/yr
Siletz Bay Faults	A	883	Offshore	10km	Late Quaternary	Less than 0.2 mm/yr
Cape Foulweather Fault	A	884	Lincoln County	10km	Late Quaternary	Less than 0.2 mm/yr
Yaquina Faults	A	885	Lincoln County	13km	Late Quaternary	Between 0.2 & 1.0 mm/yr
Waldport Faults	A	886	Lincoln County	14km	Late Quaternary	Less than 0.2 mm/yr

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

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 several seismic hazard maps that are available for Oregon communities to use. The maps show liquefaction, ground motion amplification, landslide susceptibility, and relative earthquake hazards.

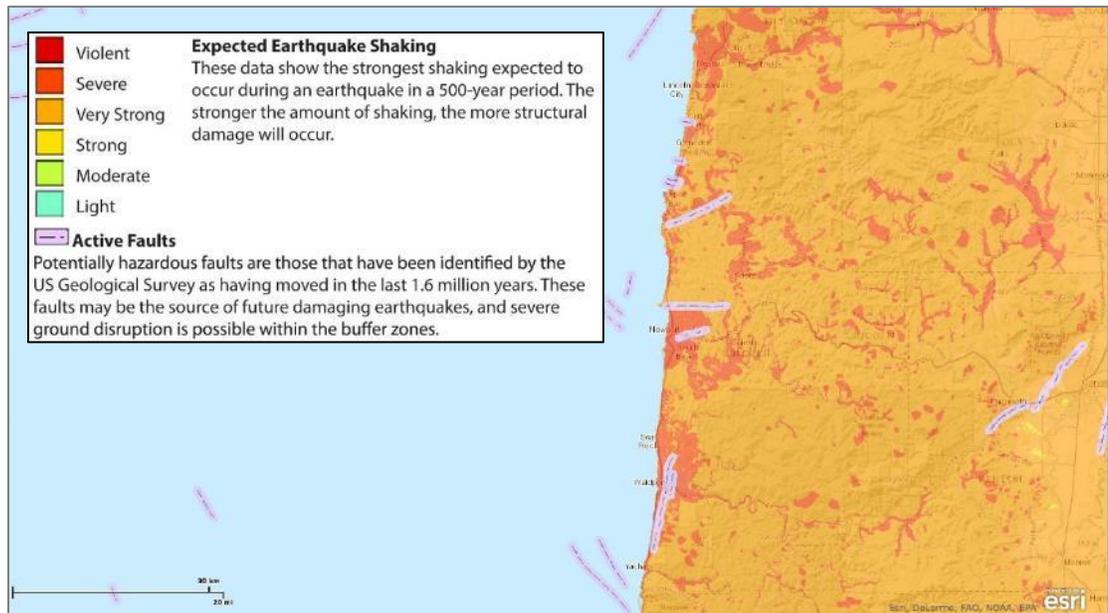
The extent of the earthquake hazard is measured in magnitude. Figure 2-6 shows areas for liquefaction hazards and Figure 2-7 shows active faults. Figure 2-9 shows recent earthquakes have registered as Magnitude 5 or less (earthquakes at this magnitude are often felt but cause no damage, or only minor damage). Lincoln County can expect similar crustal earthquake magnitudes to occur in the future. The Cascadia Subduction Zone earthquake has the capacity to cause a magnitude 8.5 or greater earthquake. Due to the proximity of the fault zone the damage locally is expected to be significant.

Figure 2-6 Earthquake Liquefaction (Soft Soil) Hazard



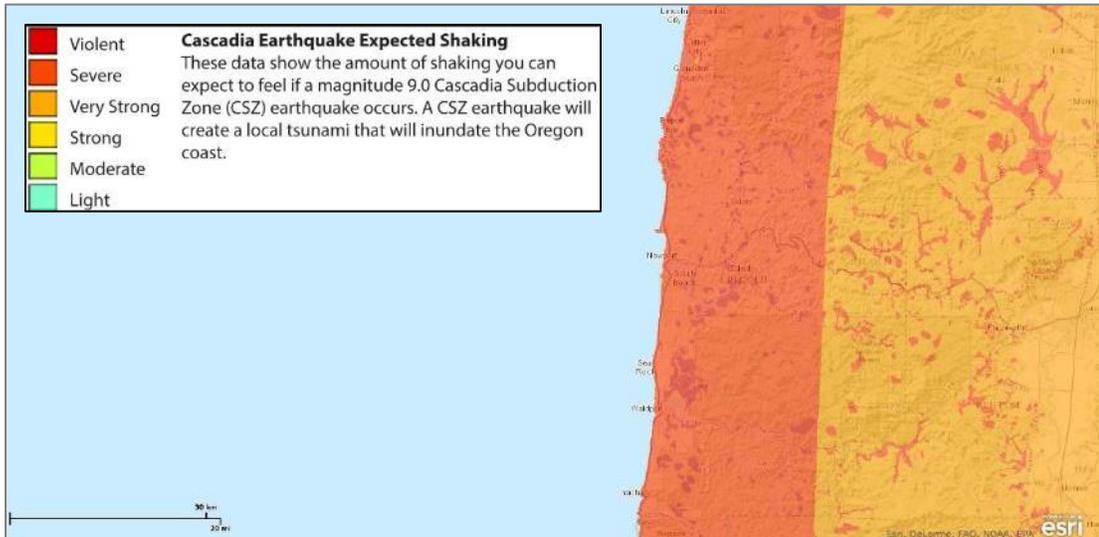
Source: [Oregon HazVu: Statewide Geohazards Viewer](#) – To explore and view map detail click hyperlink to left.

Figure 2-7 Combined Earthquake Events Expected Shaking and Active Faults



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

Figure 2-8 Cascadia Earthquake Expected Shaking



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

For more information, see the following DOGAMI reports:

- Earthquake and tsunami impact analysis for coastal Lincoln County, Oregon (2021, [O-21-02](#)) *Note: this analysis was published after the 2020 NHMP update developed.*
- Oregon Coastal Hospital Resilience Project (2020, [O-20-02](#))
- Analysis of earthquake and tsunami impacts for people and structures inside the tsunami zone for five Oregon coastal communities: Gearhart, Rockaway Beach, Lincoln City, Newport, and Port Orford (2020, [O-20-03](#))
- Resilience guidance for Oregon hospitals (2019, [O-19-02](#))
- Oregon coastal hospitals preparing for Cascadia (2018, [O-18-03](#))
- Oregon Hospital and Water System Earthquake Risk Evaluation Pilot Study (2017, [O-17-01](#))
- Statewide Cascadia earthquake hazard data (2013, [O-13-06](#))
- Cascadia Subduction Zone earthquakes: A magnitude 9.0 earthquake scenario, (2012, [O-12-22](#))
- 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](#)).I
- Relative earthquake hazard maps for selected coastal communities in Oregon: Astoria-Warrenton, Brookings, Coquille, Florence-Dunes City, Lincoln City, Newport, Reedsport-Winchester Bay, Seaside-Gearhart-Cannon Beach, Tillamook (1999, [IMS-10](#))
- Earthquake damage in Oregon: Preliminary estimate for future earthquake losses (1999, [SP-29](#))

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

<https://www.oregongeology.org/pubs/pubsearch.htm>

Other agency/ consultant reports:

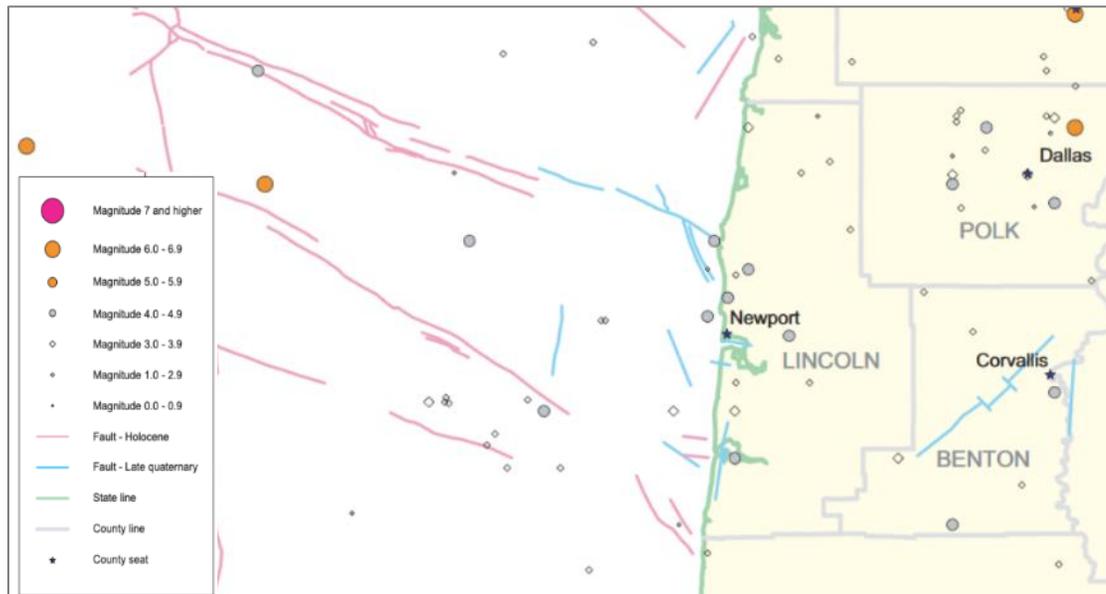
[Oregon Resilience Plan \(2013\)](#)

History

Lincoln County routinely has small earthquake events. The earthquakes shown in Figure 2-9 are relatively insignificant. They were felt by several people but little to no structural/property damage resulted. The map shows clusters of earthquakes occurring off the shoreline of Lincoln County. There is no historic record of significant crustal earthquakes centered in the region in the past 150 years, although Oregon has experienced crustal earthquakes that originated outside the region. The geologic record shows that movement has occurred along numerous offshore faults as well as some onshore faults. The faulting has occurred over the past 20,000 years.

More recently there have been several earthquakes off the Lincoln County coast. In 2003 there was a magnitude 6.3 earthquake along the Blanco Fracture Zone, one of several seismically active transform faults off the coast of Oregon. In July of 2004 there was a magnitude 4.9 earthquake located 19 miles west of Yachats. Within a three-week period in April of 2008, there were more than 600 tremors, three of which were magnitude 5 or higher.¹⁶

Figure 2-9 Regional Earthquake History (1841-2002)

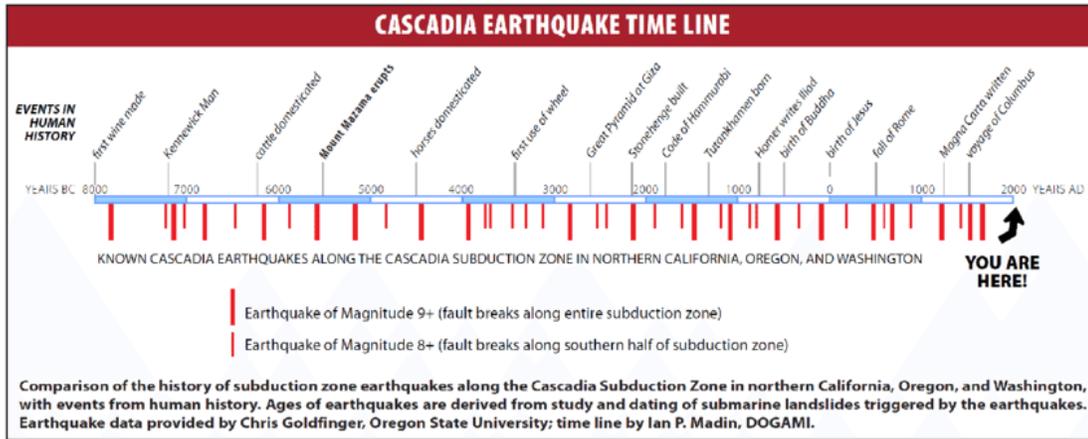


Source: DOGAMI, Snippet of Map of Selected Earthquakes for Oregon, 1841 through 2002 ([O-03-02](#))

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. The last known great earthquake to hit the Lincoln County area was in January of 1700. This CSZ event also produced a tsunami, which is discussed in the Tsunami chapter.

¹⁶ Milstein, Michael, The Oregonian, Earthquakes continue off Oregon Coast: April 14, 2008. http://blog.oregonlive.com/breakingnews/2008/04/quakes_continue_off_oregon_coa.html

Figure 2-10 Cascadia Earthquake Timeline



Source: OSSPAC, [The Oregon Resilience Plan](#) (2013)

Probability Assessment

Based on the available data and research the Steering 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 Steering Committee determined the **probability of experiencing a crustal earthquake is “low”**, meaning one incident may occur within the next 75 to 100-year period.

Lincoln 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 (Figure 2-10). 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%.¹⁷

Establishing a probability for crustal earthquakes is difficult given the small number of historic events in the region. However, the crustal faults used to inform this report are considered to have a low probability of rupture.

Vulnerability Assessment

The Steering 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 property could be affected by a major CSZ event. The Steering Committee rated the County as having a **“moderate” vulnerability to a crustal earthquake hazard**, meaning that between 1% and 10% of the unincorporated County’s population or property could be affected by a major crustal earthquake event.

¹⁷ DLCD. *Oregon Natural Hazards Mitigation Plan*. 2020.

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.

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 2-8 (above) shows the expected shaking/damage potential for Lincoln 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](#).

Natural Hazard Risk Report for Lincoln County

See Earthquake and tsunami impact analysis for coastal Lincoln County, Oregon (2021, [O-21-02](#)) for additional information. *Note: DOGAMI published this report after approval of the 2020 NHMP. A future update of this NHMP will examine the contents of this report in more detail.*

The **Risk Report** ([DOGAMI, O-20-11](#)) provides hazard analysis summary tables that identify populations and property within Lincoln County that are vulnerable to the Cascadia subduction zone earthquake. The Risk Report provides distinct profiles for (1) unincorporated Lincoln County, and (2) the unincorporated communities of Otis-Rose Lodge, Salishan-Lincoln Beach, Otter Rock, Seal Rock-Bayshore, and Wakonda Beach.

According to the Risk Report the following resident population and property (public and private) within the study area may be impacted by the profiled earthquake scenarios. *Note: Due to the simultaneous nature of a CSZ earthquake and tsunami, loss estimates have been separated in the following tables to avoid double counting. Building losses within the tsunami zone are considered total. See the tsunami section for additional information.*¹⁸

Population Vulnerability (Residents)

Approximately 30% of unincorporated Lincoln County's population (5,653 people) may be displaced by a magnitude 9.0 CSZ earthquake and tsunami event. Of those, approximately 20% will be impacted by the accompanying tsunami. The communities of Otis-Rose Lodge and Wakonda Beach have the highest percent of potentially displaced residents. *Note: The data does not include potentially impacted visitor populations that may be lodging or at a public venue during a CSZ earthquake and tsunami event.*

¹⁸ DOGAMI, Open-File Report O-20-11, Lincoln County Natural Hazard Risk Report, Tables A-1 through A-11.

Table 2-9 Potentially Displaced Residents, CSZ M9.0 Earthquake and Tsunami by Unincorporated Area

	CSZ M9.0 Earthquake		Tsunami	Combined Total	
	Resident Population	Potentially Displaced Residents	Potentially Displaced Residents	Number	Percent
"Rural" Lincoln County	10,293	2,374	459	2,833	28%
Otis-Rose Lodge	1,926	746	0	746	39%
Otter Rock	489	76	5	81	17%
Salishan-Lincoln Beach	2,093	465	118	583	28%
Seal Rock-Bayshore	2,766	546	289	835	30%
Wakonda Beach	1,326	307	268	575	43%
Total Unincorporated	18,893	4,514	1,139	5,653	30%

Source: IPRE. Data adapted from DOGAMI, Open-File Report O-20-11, Lincoln County Natural Hazard Risk Report. Tables A-1 through A-11; "Rural" Lincoln County includes all unincorporated areas that are not otherwise identified in this table. Note: City population based on the 2010 Census population.

Property Vulnerability

Earthquakes will impact every building in Lincoln County, to some degree, by a CSZ magnitude 9.0 earthquake and tsunami. Building damage (loss) estimates are reported for buildings expected to be damaged by the earthquake outside of the tsunami inundation zone (medium-sized). Additional exposure information is provided for buildings within the tsunami inundation zone to obtain the combined total damage (loss) estimate. Buildings reported as "damaged" in the area *outside* the tsunami zone include yellow tagged (extensive, limited habitability) and red tagged (complete, uninhabitable) buildings, while 100% of buildings exposed *inside* the tsunami inundation area are considered "damaged" (complete, uninhabitable). The communities of Wakonda Beach (57%) and Otis-Rose Lodge (50%) are expected to see the highest percent of their buildings damaged by a CSZ earthquake and tsunami event. Salishan-Lincoln Beach (1,093 buildings), Seal Rock-Bayshore (1,418 buildings), and "Rural" Lincoln County (5,194 buildings) have the highest number of buildings expected to be damaged. The combined (earthquake and tsunami) value of building damage losses is \$677 million (\$402.5 million from earthquake alone).¹⁹

¹⁹ Ibid.

Table 2-10 Damaged and Exposed Buildings, CSZ M9.0 Earthquake and Tsunami by Unincorporated Area

	CSZ M9.0 Earthquake		Tsunami	Combined Total	
	Total Buildings	Damaged Buildings	Exposed Buildings	Number	Percent
"Rural" Lincoln County	12,637	4,386	808	5,194	41%
Otis-Rose Lodge	1,747	871	0	871	50%
Otter Rock	634	202	22	224	35%
Salishan-Lincoln Beach	2,847	866	227	1,093	38%
Seal Rock-Bayshore	3,345	968	450	1,418	42%
Wakonda Beach	1,614	414	506	920	57%
Total Unincorporated	22,824	7,707	2,013	9,720	43%

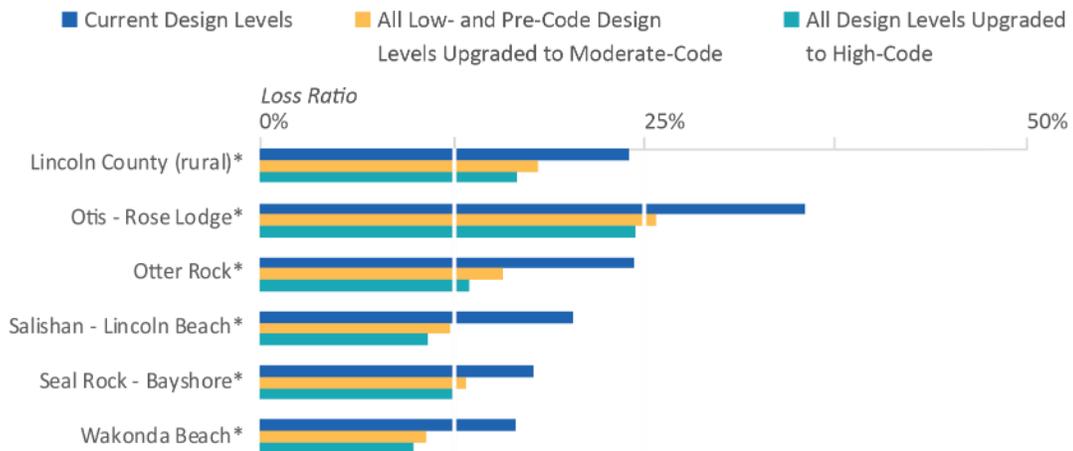
Source: IPRE. Data adapted from DOGAMI, Open-File Report O-20-11, Lincoln County Natural Hazard Risk Report. Tables A-1 through A-11; "Rural" Lincoln County includes all unincorporated areas that are not otherwise identified in this table.

As discussed in the Risk Report seismic building codes were implemented in Oregon in the 1970s, however, stricter standards did not take effect until 1991 and the early 2000s. As noted in the Community Profile (Appendix C), about 65% of residential buildings were built prior to 1990, which increases the county's vulnerability to the earthquake hazard. The Risk Report indicates that approximately 53% of unincorporated Lincoln County buildings were built prior to modern seismic building code enforcement (pre-code); 72% are either pre-code or low code.²⁰

The age of the building stock is therefore a primary indicator of vulnerability and communities with older building stocks are expected to experience more damage from an earthquake event. If buildings were retrofitted to moderate or high-code standards (see Appendix C) the impact of the CSZ event would be reduced. Figure 2-11 shows the reduction in loss estimates from a magnitude 9.0 CSZ earthquake event via two scenarios where all buildings have been retrofitted to moderate-code or high-code design standards. Communities that have a high percent of buildings within the tsunami inundation zone would benefit the least from seismic retrofits and would need additional tsunami retrofits to reduce risk.

²⁰ Ibid. Table D-2.

Figure 2-11 Reduction in Damage with simulated seismic building code upgrades, CSZ M9.0 Earthquake



Source: Figure modified from DOGAMI. 2020. Lincoln County Natural Hazard Risk Report. Figure 3-3. Note: * - Unincorporated community. "Rural" Lincoln County includes all unincorporated areas that are not otherwise identified in this figure.

Critical Facility Vulnerability

Vulnerable critical facilities include those that were considered non-functioning if the Risk Report analysis determined that the building (or complex) had a greater than 50-percent change of beings at least moderately damaged (not including areas within the tsunami inundation zone (medium sized). Critical facilities determined to be non-functioning following a CSZ earthquake include:

- Central Oregon Coast Fire Station 7300 (*Tidewater, Central Oregon Coast Fire & Rescue District*)
- Depoe Bay Fire Station 2400 (*Otter Rock, Depoe Bay Fire District*)
- Eddyville Charter School (*Charter School, Lincoln County School District*)
- North Lincoln Fire Station 1200 (*Rose Lodge, North Lincoln Fire & Rescue District*)
- North Lincoln Fire Station 1300 (*Otis, North Lincoln Fire & Rescue District*)
- North Lincoln Fire Station 1700 (*Kernville, North Lincoln Fire & Rescue District*)
- Seal Rock Fire Station (*Seal Rock, Seal Rock Rural Fire Protection District*)
- Siletz Bay Airport (*Gleneden Beach*)
- Toledo High School (*Toledo area, Lincoln County School District*)
- Toledo State Airport (*Toledo area*); also exposed to Tsunami (medium-sized)
- Wakonda Beach Airport (*Wakonda Beach*)
- Waldport Water Treatment Plant (*Waldport Area, City of Waldport*)
- Yachats Fire Station (*outside Waldport, Yachats Rural Fire Protection District*)

The following vulnerable critical facilities were identified by the County but not included in the Risk Report analysis:

- Depoe Bay RFPD Fire Station 2200 (*Gleneden Beach*)

Risk Report Identified Areas of Vulnerability²¹

- Although every building in Lincoln County will experience shaking from a CSZ earthquake, many of the buildings within the communities of Lincoln City, Salishan-Lincoln Beach, Newport, Seal Beach-Bayshore, and Waldport are located on soils with a high liquefaction potential, which increases the likelihood of substantial ground deformation and building damage. Especially for areas close to the several estuaries within the study area.
- Many of the buildings in the communities of Newport, Siletz, Toledo, and Otis-Rose Lodge are older, less likely to meet modern building design standards, and are more vulnerable to catastrophic damage during an earthquake.
- Because of the liquefaction and landslides, these communities will likely be “islands” disconnected from other communities by severed transportation routes. With losses up to 44%, it is very important for the community to be able to respond to emergencies within its own community.
- Fifty-two (56 when including areas of tsunami inundation) of the 72 critical facilities in the study area are estimated to be non-functioning due to a CSZ earthquake.

2007 Rapid Visual Survey

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 FEMA ([FEMA P-154](#)) to identify, inventory and rank buildings that are potentially vulnerable to seismic events. DOGAMI’s Rapid Visual Screening for Lincoln County lists 43 facilities, 12 are in the unincorporated County.

DOGAMI rated each building surveyed with a ‘low,’ ‘moderate,’ ‘high,’ or ‘very high’ potential for collapse in the event of an earthquake (Table 2- 11; each “X” represents one building within that category). It is important to note that these ratings represent a probability of collapse based on limited observed and analytical data and are therefore approximate. Of the facilities evaluated by DOGAMI, that have not been retrofitted, using their Rapid Visual Survey (RVS), one building has very high (100% chance) collapse potential and two (2) school buildings have a high (greater than 10% chance) collapse potential.

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. 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>

²¹ Ibid. Page 24.

Table 2- I I Rapid Visual Survey Scores, Unincorporated County

Facility	Site ID*	Level of Collapse Potential			
		Low (<1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Schools					
Toledo High** (1800 NE Sturdevant Rd)	Linc_sch11			SRGP 2014: \$1,500,000 (Gym)	
Eddyville Charter** (57 Eddyville School Rd)	Linc_sch15	X		X	X
Public Safety					
Lincoln Co. Communications (815 SW Lee St, Newport)	Linc_eoc01		X		
Lincoln Co. Sheriff's Office** (225 W Olive St, Newport)	Linc_pol02	X	X		
No. Lincoln F&R – Station 1300** (381 Old Scenic Hwy, Otis)	Linc_fir02	X			
No. Lincoln F&R – Station 1200** (5284 Salmon River Hwy, Rose Lodge)	Linc_fir03			SRGP 2015-17 Phase II: \$808,022	
Seal Rock RFPD (10333 NW Rand St, Seal Rock)	Linc_fir09	X			
No. Lincoln F&R – Station 1700** (37625 Siletz River Hwy)	Linc_fir14	X			
Depoe Bay RFPD – Gleneden Beach (6445 Gleneden Beach Lp)	Linc_fir17	X			
Seal Rock RFPD – Bayshore** (2009 NW Hilton Rd, Seal Rock)	Linc_fir20	X			
Yachats RFPD** (1395 SW Corona Ct)	Linc_fir21	X			
Siletz RFPD** (7751 Logsden Rd)	Linc_fir24	X			

Source: [DOGAMI 2007. Open File Report 0-07-02. Statewide Seismic Needs Assessment Using Rapid Visual Assessment.](#) Notes: “*” – Site ID is referenced on the [RVS Lincoln County Map](#); “**” – Facility determined to be vulnerable to CSZ earthquake and should expect moderate to complete damage (> 50% probability). DOGAMI Risk Report (2020). See jurisdictional addenda (Volume II) for additional facilities.

Mitigation Successes

Seismic retrofit grant awards per the [Seismic Rehabilitation Grant Program](#)²² have been funded to retrofit Toledo High School (near Toledo), (2014 grant award, \$1,500,000) and North Lincoln Fire and Rescue Station 1200 (Rose Lodge), (2015-2017 Phase II grant award, \$808,022). *See city addenda for mitigation successes within each city.*

More information on this hazard can be found in the [Risk Assessment for Region 1, Oregon Coast, Oregon SNHMP \(2020\)](#).

²² 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.

Tsunami

Significant Changes since the 2015 Plan

New data is included from the Risk Report and other technical reports. HB 3309 (2019) is referenced which repealed prohibitions of the SB 379 (1995) “tsunami inundation line”.

Characteristics

A tsunami generally begins as a single wave but quickly evolves into a series of ocean waves, generated by disturbances from earthquakes, underwater volcanic eruptions, or landslides (includes landslides that start below the water surface and landslides that enter a deep body of water from above the water surface). In these cases, the initial tsunami wave mimics the shape and size of the sea floor deformation that causes it.

The wavelength of a tsunami generated by sea floor deformation may be 100 miles or more in the deep ocean, with a wave height of only a few feet or less. These waves may reach speeds of up to 500 m.p.h. As tsunamis approach land where the water depth decreases, the forward speed of the tsunami will slow, but wave heights increase to as much as 100 feet. For simplicity, tsunamis can be divided geographically into two categories: those of distant origin and those generated locally. The distant tsunami is one that is usually generated by a subduction zone earthquake elsewhere in the Pacific and would take up to 24 hours to reach the Oregon coastline. A local tsunami is generated by a subduction earthquake off the Oregon Coast and would take minutes to reach the Oregon coastline. The Oregon Coast has experienced both types.²³

A tsunami from a local source will probably be stronger, higher and travel farther inland (overland and upriver) than a distant tsunami. The tsunami wave may be traveling at 30 mph when it hits the coastline and have heights of 20 to 60 feet, potentially higher depending on the coastal bathymetry (water depths) and geometry (shoreline features). The tsunami wave from a nearby earthquake will break up into a series of waves that will continue to strike the coast over an 8 to 10-hour period. Tsunami activity can continue even longer for a major Pacific-wide tsunami. The first wave is not always the most destructive; for example, some computer simulations for the Central Oregon Coast, show that waves arriving in the second or third hour may be as big or bigger than the initial wave. The deep ocean trenches off the coasts of Alaska, Japan, and South America are known for their underwater subduction zone earthquakes and are the source of many tsunamis.

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. It extends from British Columbia to northern California. Subduction zone earthquakes are caused by the abrupt release of slowly accumulated stress. Subduction zones like the Cascadia Subduction Zone 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) earthquakes. These types of earthquakes have been known to produce tsunamis.

²³ State of Oregon Emergency Management Plan. Natural Hazards Mitigation Plan: Tsunami. 2002

Tsunami destruction can come from both the tsunami wave and from the rapid retreat of the water from the coastline. Tsunami waves tend to be fast moving rising surges of water. As a tsunami wave enters coastal bays and rivers, it may move as a high velocity current or a breaking wave that travels up an estuary as a bore (wall of turbulent water like the waves at the coast after they break). This inland surge of water can often cause most or all the damage from a distant tsunami. For example, in Seaside the damage from the 1964 Alaskan tsunami occurred along the Necanicum River and Neawanna Creek, well inland from the coast. In addition, storm waves ride on top of the tsunami waves and may cause even more destruction.²⁴

Location and Extent

Tsunami inundation modeling attempts to identify areas affected by tsunamis, and the water depths, current strengths, wave heights, and wave arrival times associated with an event. Generally, this analysis is conducted for “worst case” scenarios, but it can also be used to look at damages from tsunamis of lesser magnitude. Areas along the coast, low-lying areas along bays or inlets that connect to the ocean should be designated as hazard zones. Areas along rivers that connect to the ocean should also be designated as tsunami hazard areas for at least three kilometers inland and as far as ten kilometers inland for large, flat coastal rivers.²⁵ In the event of an 8.8 magnitude earthquake, 60-200 miles off the coast, and during high tide, the inundation elevations would be: Siletz Bay, 40 feet; Depoe Bay, 31 feet; Newport, 31 feet; Yaquina Joe Point (Waldport), 26 feet; and Yachats, 27 feet.²⁶

DOGAMI has conducted analysis resulting in extensive mapping along the Oregon Coast. The maps depict the expected inundation for tsunamis produced by a magnitude 8.8 to 8.9 undersea earthquake. The tsunami hazard maps were produced to help implement Senate Bill 379 (SB 379), which was passed by the 1995 regular session of the Oregon Legislature. SB 379, implemented as Oregon Revised Statutes (ORS) 455.446 and 455.447, and Oregon Administrative Rules (OAR) 632-005 limits construction of new essential facilities and special occupancy structures in tsunami flooding zones. In this analysis they have considered topography, bathymetry data, and information about potential regional tsunami sources. It should be noted that these maps were produced in 1995. Since then DOGAMI and other agencies have conducted many tsunami inundation studies. An update of these maps was completed in 2013, as described below. Note: HB 3309 (2019) effective January 1, 2020 repealed the ban on building “new essential facilities, hazardous facilities, major structures, and special occupancy structures” inside the tsunami inundation zone (SB 379 line):²⁷

Tsunami inundation maps were created by the Department of Geology and Mineral Industries (DOGAMI) to be used for emergency response planning for coastal communities.²⁸ There are 30 tsunami inundation map panels for Lincoln County (15 for the local source tsunami scenarios and 15 for the distant source tsunami scenarios).

The local source tsunami inundation maps display the output of computer modeling showing five tsunami event scenarios shown as “T-shirt” sizes S, M, L, XL, and XXL. The

²⁴ State of Oregon Emergency Management Plan: Natural Hazards Mitigation Plan: Tsunami, March 2002

²⁵ Geohazards International. Preparing Your Community for Tsunamis: A Guidebook for Local Advocates. 2007

²⁶ Lincoln County Emergency Services, June 2007. Lincoln County Hazard Analysis

²⁷ Oregon Legislature. HB 3309 (2019).

<https://olis.leg.state.or.us/liz/2019R1/Downloads/MeasureDocument/HB3309>

²⁸ DOGAMI website and Open-File Report O-20-11, Lincoln County Natural Hazard Risk Report.

transition line between the wet and dry zones is termed the Wet/ Dry Zone, only the XXL Wet/ Dry Zone is shown on the map. The distant source tsunami inundation maps show the affects of tsunamis generated by earthquakes along the “Ring of Fire” (the Circum-Pacific belt, the zone of earthquake activity surrounding the Pacific Ocean). The distant tsunami inundation maps model the 1964 Prince William Sound event (Alaska M9.2) and a hypothetical Alaska Maximum event scenario; only the Alaska Maximum Wet/ Dry Zone is shown on the map. Both the local and distant source tsunami inundation maps show simulated wave heights and inundation extents for the various scenarios.

For more information on the regulatory and non-regulatory maps visit the Oregon Tsunami Clearinghouse resource library:

Regulatory (SB 379) - <http://www.oregongeology.org/tsuclearinghouse/pubs-regmaps.htm>
(Note: HB 3309, effective January 1, 2020, repealed ban on building essential facilities within the tsunami inundation zone, SB 379 line.)

Non-Regulatory Tsunami-Inundation Maps:

<http://www.oregongeology.org/tsuclearinghouse/pubs-inumaps.htm>

Evacuation maps (brochures) are available for the populated areas of Lincoln County. The Department of Geology and Mineral Industries (DOGAMI) developed the evacuation zones in consultation with local officials; local officials developed the routes that were reviewed by the Oregon Department of Emergency Management (OEM). The maps show the worst case scenario for a local source and distant source tsunami event and are not intended for land-use planning or engineering purposes. There are twelve (12) evacuation brochures created for Lincoln County covering the following communities: Lincoln City North, Lincoln City South, Gleneden Beach/ Salishan Spit, Lincoln Beach, Depoe Bay, Newport North, Newport South, Toledo, Seal Rock, Waldport, Yachats North (San Marine), and Yachats.

For more information on the evacuation brochures visit the Oregon Tsunami Clearinghouse resource library:

<http://www.oregongeology.org/tsuclearinghouse/pubs-evacbro.htm>

A free application is also available that displays the evacuation routes in coastal areas of Oregon: http://www.nanoos.org/mobile/tsunami_evac_app.php

For more information, see the following DOGAMI reports:

- Analysis of earthquake and tsunami impacts for people and structures inside the tsunami zone for five Oregon coastal communities: Gearhart, Rockaway Beach, Lincoln City, Newport, and Port Orford (2020, [O-20-03](#))
- Oregon Coastal Hospital Resilience Project (2020, [O-20-02](#))
- Tsunami evacuation analysis of Lincoln City and unincorporated Lincoln County: Building community resilience on the Oregon coast (2019, [O-19-06](#))
- Comparison of Oregon tsunami hazard scenarios to a probabilistic tsunami hazard analysis (PTHA) (2019, [O-19-04](#))
- Resilience guidance for Oregon hospitals (2019, [O-19-02](#))
- Coastal flood hazard study, Lincoln County, Oregon (2018, [O-15-06](#))

History

The Pacific Northwest experienced a subduction zone earthquake estimated at magnitude 9 on January 26, 1700. The earthquake generated a tsunami that caused damage as far away as Japan. Cascadia subduction zone earthquakes and associated tsunamis have occurred on average every 500 years over the last 3,500 years in the Pacific Northwest (Figure 2-10). The time between events has been as short as 100 to 200 years and as long as 1,000 years. The geologic record indicates that over the last 10,000 years approximately 42 tsunamis have been generated off the Oregon Coast in connection to ruptures of the CSZ (19 of the events were full-margin ruptures and arrived approximately 15-20 minutes after the earthquake).²⁹ Numerous distant tsunami events have also occurred in the past, including 28 documented by Oregon wave gauges since 1854, notable events are listed below.

In March 2011, a 9.0 magnitude earthquake generated tsunami originating from Japan caused approximately \$7.1 million worth of damages along the Oregon Coast. Particularly, there was extensive damage to the Port of Brookings (Curry County; \$6.7 million), as well as the Port of Depoe Bay (Lincoln County; \$182,000), and Charleston Harbor (Coos County; \$200,000); Salmon Harbor on Winchester Bay (Douglas County) and the South Beach Marina in Newport (Lincoln County) were also affected. On March 15, 2011 Governor Kitzhaber declared a State of Emergency was declared by Executive Order in Curry County. Approximately 40% of all docks at the Port of Brookings were destroyed or rendered unusable (including a dock leased by the U.S. Coast Guard) compromising commercial fishing and U.S. Coast Guard operations. Along the Oregon Coast local official activated the Emergency Alert System and sirens, implemented “reverse 9-1-1” and conducted door-to-door notices in order to evacuate people from the tsunami inundation zone. Local governments activate their Emergency Operations Centers and the state activated its Emergency Coordination Center.

In March 1964, a tsunami struck southeastern Alaska following an earthquake beneath Prince William Sound and arrived along the Alaska coastline between 20 and 30 minutes after the quake, devastating villages. Damages were estimated to be over \$100 million. Approximately 120 people drowned. The tsunami spread across the Pacific Ocean and caused damage and fatalities in other coastal areas. Four children drowned at Beverly Beach and significant property damaged was incurred, including \$5,000 in Depoe Bay. Along the entire Oregon Coast damage was estimated to be between \$750,000 and \$1 million. Tsunamis of lesser magnitude occurred along the Oregon Coast in 1946, 1960, and 1968. Tsunami wave heights reached 10-11.5 feet at Depoe Bay and 11.5 feet at Newport.³⁰

Probability Assessment

Lincoln County’s Natural Hazards Mitigation Steering Committee believes that the County’s **probability of experiencing a local or distance source tsunami event is “moderate”**, meaning one incident of either type is likely within the next 35 to 75-year period.

It is difficult to predict when the next tsunami will occur. With respect to distant sources, Oregon has experienced 25 tsunamis in the last 145 years with only three causing measurable damage. Thus, the average recurrence interval for tsunamis on the Oregon

²⁹ DLCD. *Oregon Natural Hazards Mitigation Plan*. 2020.

³⁰ DOGAMI Distant Tsunami Inundation Map (2013)

coast from distant sources is about six (6) years. However, the time interval between events has been as little as one year and as much as 73 years. Since only a few tsunamis caused measurable damage, a recurrence interval for distant tsunamis does not have much meaning for this region.

A tsunami originating from a Cascadia Subduction Zone earthquake could be exceedingly destructive and thus is of greater concern than distant tsunamis. The average recurrence interval for a CSZ event is between 500 and 600 years. There have been seven CSZ events in the last 3,500 years with time between individual events varying from 150 to 1,000 years. The last CSZ event occurred approximately 300 years ago. 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 (Figure 2-10). 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%.³¹

Vulnerability Assessment

The Lincoln County Natural Hazards Steering Committee rated the County as having a **“high” vulnerability to the local source tsunami event**, meaning that more than 10% of the county’s population or property could be affected by a major emergency or disaster; the committee rated the County as having a **“low” vulnerability to the distant source tsunami event**, meaning that less than 1% of the county’s population or property could be affected by a major emergency or disaster.

The Oregon coast is at risk from tsunamis that originate from local and distant sources. Lincoln County has six communities in the tsunami inundation zone (from north to south): Lincoln City, Depoe Bay, Newport, Toledo, Waldport, and Yachats. Figure 2-12, shows the amount and percentage of developed land within the SB 379 tsunami-inundation zone as of 2007; the data shows that Waldport and Yachats have the most developed land within the tsunami inundation zone; Lincoln City, Newport, and unincorporated areas also have significant percentages in the inundation zone.

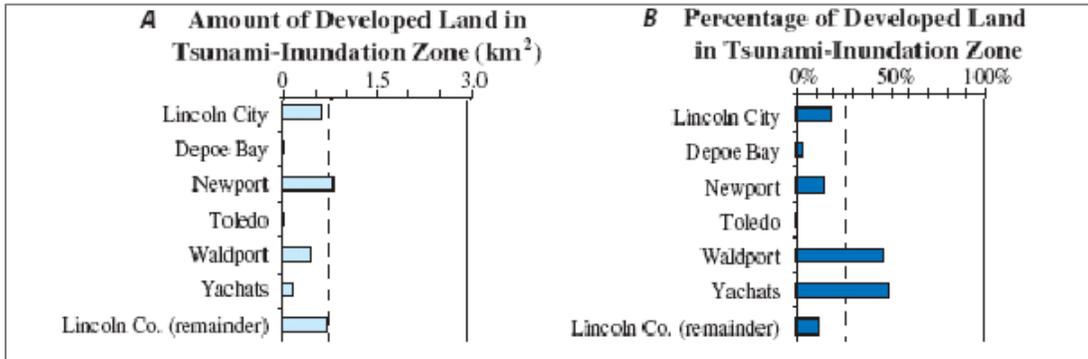
Severe damage could occur to low-lying areas of the county in a local source tsunami event, including roads, bridges, communication systems, and infrastructure. Some damage is also expected in a large distant source tsunami event (such as the 2011 Tohoku tsunami).

There are about 2,500 manufactured housing units (mobile homes) in unincorporated Lincoln County.³² Manufactured homes built prior to 2003 are subject to slipping off their foundations potentially compromising the occupants’ ability to exit. The compromised egress may hinder timely evacuation from a tsunami event.

³¹ DLCD. *Oregon Natural Hazards Mitigation Plan*. 2020.

³² Social Explorer, Table A10032, U.S. Census Bureau, 2013-2017 American Community Survey Estimates.

Figure 2-12 Developed Land in Tsunami-Inundation Zone



Source: Wood N (2007) Variations in City Exposure and Sensitivity to Tsunami Hazards in Oregon. USGS. <http://pubs.usgs.gov/sir/2007/5283/sir2007-5283.pdf>

In 2019, DOGAMI published a tsunami evacuation analysis using the XXL inundation zone which covers the largest CSZ event likely to occur based on the historical record.³³ Safety is reached when evacuees have reached “high ground”, or 20 feet beyond the limit of tsunami inundation. An analysis was conducted for cities and unincorporated areas of the county including: (1) the Siletz Bay area, and (2) the South County area.

Siletz Bay Area

The Siletz Bay area is divided into two distinct zones. The first includes Siletz Spit, Salishan, and Siletz Keys which are low-lying communities adjacent to the Siletz Bay that are susceptible to significant tsunami inundation and high liquefaction susceptibility. The second area includes Gleneden Beach, Lincoln Beach, and Fogarty Creek which are bluff backed open coast areas that have limited inundation potential and low liquefaction susceptibility. According to the model the first waves arrive along the open coast 20 minutes after the start of earthquake shaking with most of the Study Area inundated about 8 minutes later. Siletz Spit, Siletz Keys, and much of the remaining areas are expected to be completely inundated under the XXL tsunami inundation scenario. High ground is generally accessible at a slow walking speed of 2 feet per second (fps) or 1.4 mph to a walking speed of 4 fps or 2.7 mph in the communities of Gleneden Beach, Lincoln Beach, Fogarty Creek, and Salishan (parts of Salishan may need faster walking speeds up to 2.7-4.1 mph).

Evacuees in Siletz Keys (see Figure 2-13) and Siletz Spit (see Figure 2-14) will need to move faster in order to beat the wave and make it to high ground. Prompt evacuation, knowledge of the route, signage, and alternative route designation due landslide activity is necessary to improve evacuation speeds.

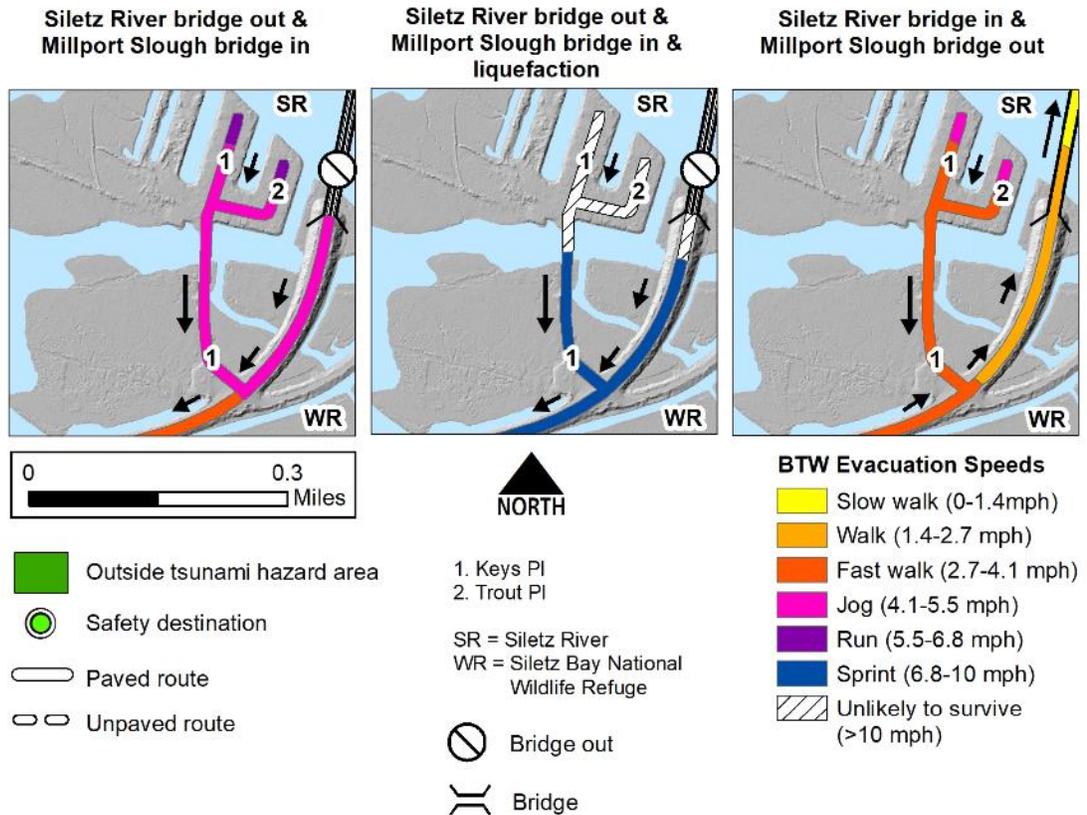
Evacuation speeds in Siletz Spit will need to be a maximum of a sprint (15 fps or 10 mph) and those north of Salishan Loop are unlikely to survive (require sprinting speeds above 10 mph). Mitigation strategies may include developing a shortcut across South Lagoon (including a footbridge) to decrease distances needed for evacuation to the hills near Dune Point Drive during a L tsunami inundation.

Near Siletz Keys it is expected that the Millport Slough Bridge will survive, however, the Siletz River Bridge is likely to fail separating the area from high ground to the north. As such,

³³ DOGAMI, Open-File Report O-19-06.

evacuation south over the Millport Slough Bridge will be necessary (although it is about 0.4 further than potential evacuation to the north over the Siletz River Bridge). Evacuation speeds to the south (to Salishan Lodge) from Siletz Keys will need to be a maximum of a sprint (15 fps or 10 mph) with a small area unlikely to survive (require sprinting speeds above 10 mph). Retrofitting the Siletz River Bridge could decrease distances and travel speed.

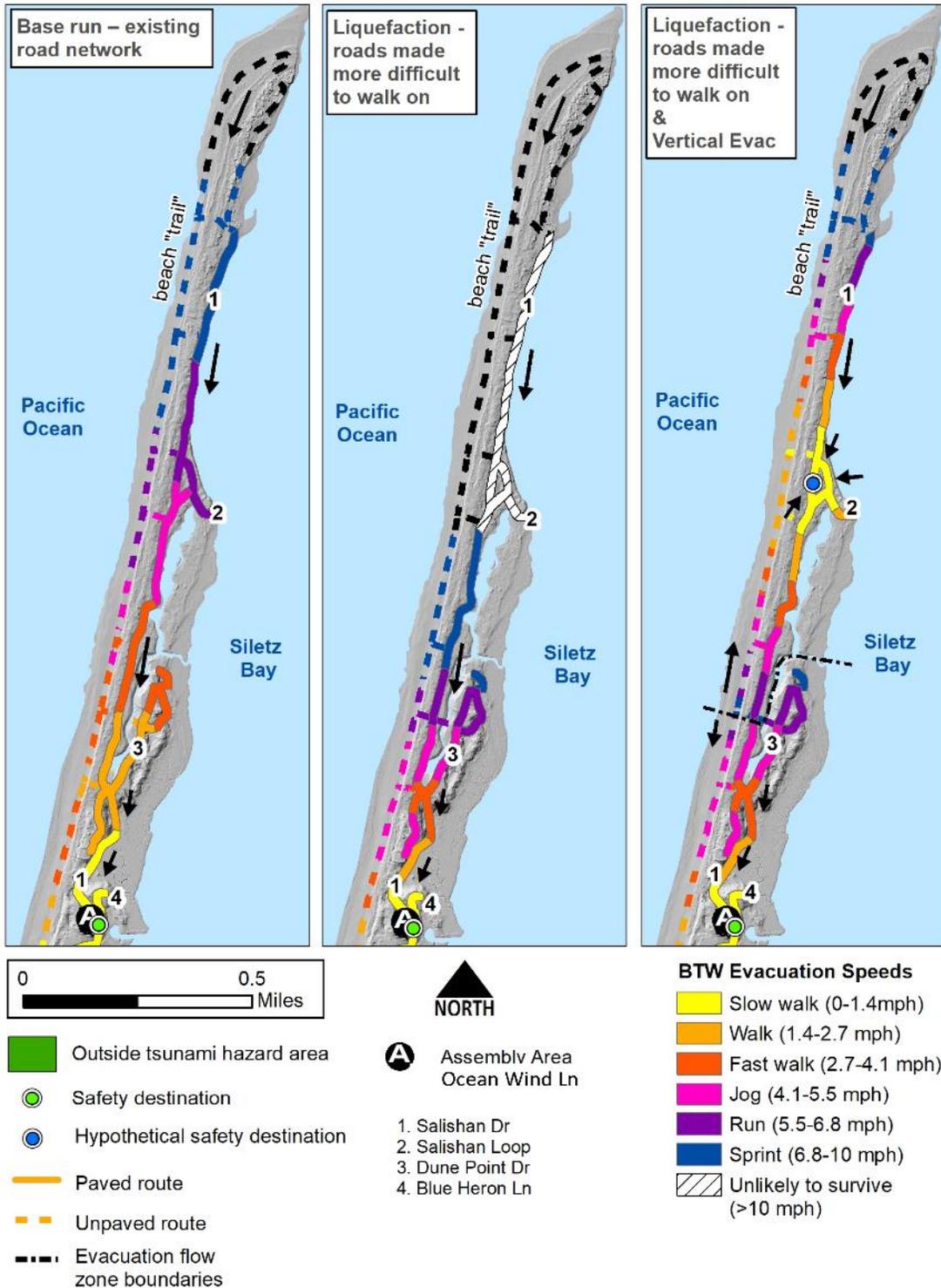
Figure 2-13 Beat the Wave modeling in Siletz Keys (CSZ earthquake XXL inundation zone)



Source: DOGAMI, Open-File Report O-19-06.

Note: Beat the Wave modeling in Siletz Keys for base scenario assuming the Siletz River Bridge fails and Millport Slough bridge survives (left), with liquefaction (middle), and with the hypothetical retrofitted of the Siletz River Bridge surviving and Millport Slough bridge failing (right).

Figure 2-14 Beat the Wave modeling in Siletz Spit (CSZ earthquake XXL inundation zone)



Source: DOGAMI, Open-File Report O-19-06.

Note: Beat the Wave modeling in Siletz Spit for base scenario/existing conditions (left), with liquefaction (middle), and hypothetical vertical evacuation structure (right).

South County Area

The South County area is also divided into two distinct zones. The first includes the low-lying communities adjacent to the Alsea Bay that are susceptible to significant tsunami inundation and high liquefaction susceptibility. The second area includes the open coast areas that have limited inundation potential, low liquefaction susceptibility, and higher elevations. According to the model the first waves arrive along the open coast 26 minutes after the start of earthquake shaking with most of the Study Area inundated about 5 to 10 minutes later. The southern half of the Alsea Spit, Beaver Creek, Tillicum Beach, and Yachats north are expected to be completely inundated under the XXL tsunami inundation scenario. High ground is generally accessible for most of this area at walking speed of 4 feet per second (fps) or 2.7 mph. The most challenging unincorporated area is south Alsea Spit where faster walking speeds may be needed.

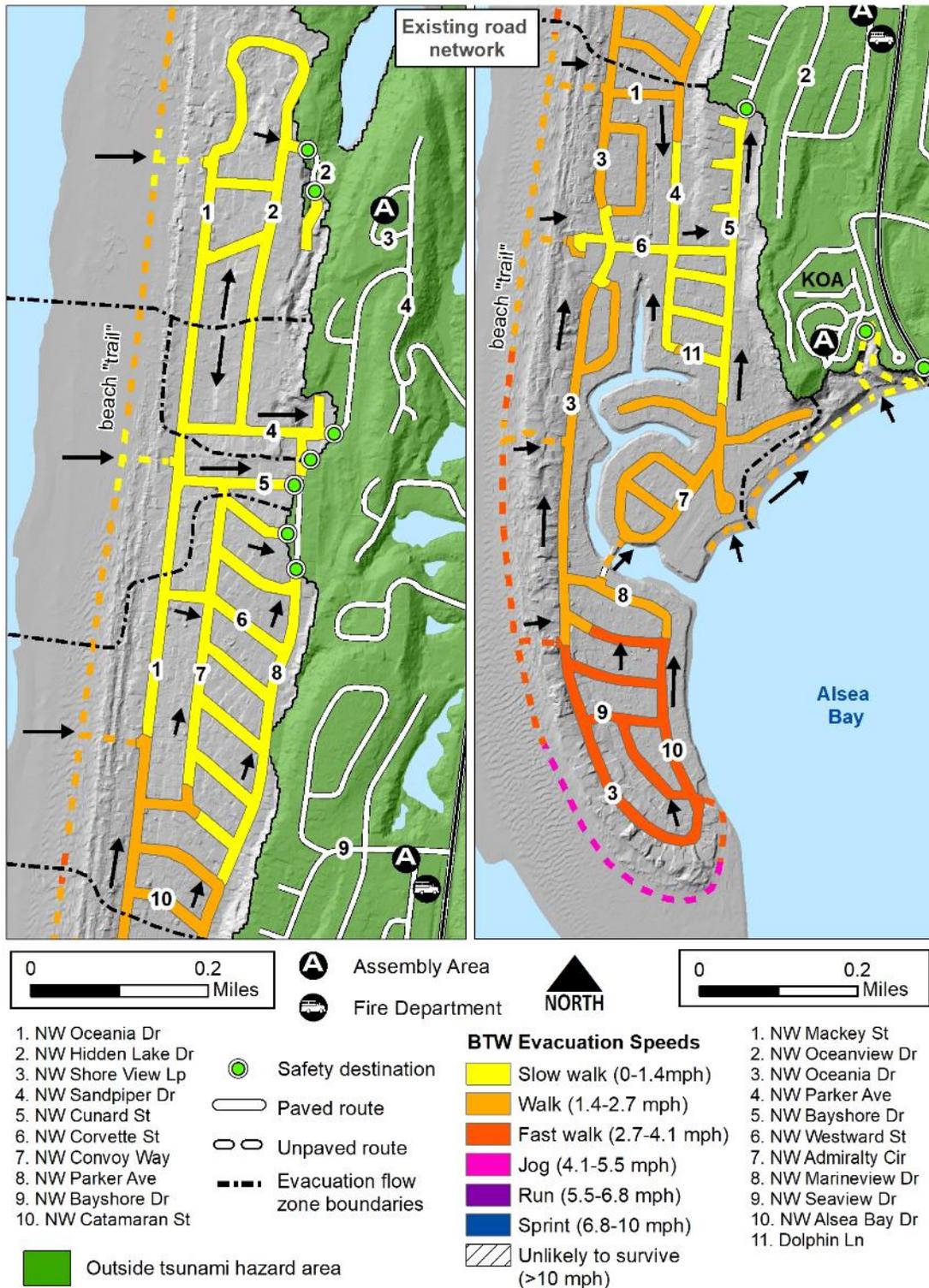
Most evacuees in the Alsea Spit (aka Bayshore) can make it to high ground at slow walk or walk speeds (see Figure 2-15). However, those in the southern end of Alsea Spit that is expected to be overtopped by an XXL tsunami will need to move faster in order to beat the wave and make it to high ground approximately one mile north. Evacuation speeds to the north from the southernmost portions of Alsea Spit will need to be a minimum of a fast walk (6 fps or 4.1 mph); following liquefaction the minimum speeds increase to a run (10 fps or 6.8 mph). Prompt evacuation, knowledge of the route, signage, and alternative route designation due landslide activity is necessary to improve evacuation speeds. If the private road off NW Bayshore Drive near NW Admiralty Circle becomes sanctioned and signed route, it would reduce travel distance and minimum speeds, to reach a secondary safety destination at the Waldport/Newport Kampground of America. The most significant change at this area would decrease minimum speeds from a fast walk to a walk.

The following is a summary of expected inundation, wave arrival time, and minimum expected evacuation speed for each profiled area:

- Beaver Creek (expected full inundation, 40-minutes until first wave, slow walk to walk speed required for safe evacuation),
- Seal Rock (mostly out of inundation, 26-minutes until first wave, slow walk speed required for safe evacuation),
- Waldport East (Hwy 234 area in inundation area, 34 minutes until first wave, slow walk to walk speed required for safe evacuation),
- Governor Patterson and Beachside recreation areas (Hwy 101, Yachats RFPD Station, and residential area west of Hwy 101 is in inundation area, 26 minutes until first wave, slow walk to walk speed required for safe evacuation),
- Tillicum Beach (expected full inundation, 26 minutes until first wave, walk to fast walk speed required for safe evacuation), and
- Yachats north (expected full inundation, 26 minutes until first wave, walk speed required for safe evacuation).

For detailed information see *Tsunami evacuation analysis of Lincoln City and unincorporated Lincoln County: Building community resilience on the Oregon coast* (DOGAMI, 2019, [O-19-06](#)).

Figure 2-15 Beat the Wave modeling in Alesia Spit (CSZ earthquake XXL inundation zone)



Source: DOGAMI, Open-File Report O-19-06.

Note: For additional Beat the Wave scenario maps for liquefaction and hypothetical trail to KOA see report.

Natural Hazard Risk Report for Lincoln County

See Earthquake and tsunami impact analysis for coastal Lincoln County, Oregon (2021, [O-21-02](#)) for additional information. *Note: DOGAMI published this report after approval of the 2020 NHMP. A future update of this NHMP will examine the contents of this report in more detail.*

The **Risk Report** ([DOGAMI, O-20-11](#)) provides hazard analysis summary tables that identify populations and property within Lincoln County that are vulnerable to the Cascadia subduction zone earthquake. The Risk Report provides distinct profiles for (1) unincorporated Lincoln County, and (2) the unincorporated communities of Otis-Rose Lodge, Salishan-Lincoln Beach, Otter Rock, Seal Rock-Bayshore, and Wakonda Beach.

According to the Risk Report the following resident population and property (public and private) within the study area may be impacted by the profiled tsunami scenarios.

Population Vulnerability (Residents)

Approximately six percent of unincorporated Lincoln County’s population (1,139 people) may be displaced by a magnitude 9.0 CSZ tsunami event (note there are additional people that will be displaced by the earthquake). This is slightly fewer people than those exposed within the Senate Bill 379 line (1,303 people). The communities of Wakonda Beach (20%) and Seal Rock-Bayshore (10%) have the highest percent of potentially displaced residents. However, the dispersed “rural” Lincoln County has the highest number (459). *Note: The data does not include potentially impacted visitor populations that may be lodging or at a public venue during a CSZ earthquake and tsunami event.*

Table 2-12 Potentially Displaced Residents, CSZ M9.0 Tsunami, by Unincorporated Area

	Resident Population	Potentially Displaced Residents			
		CSZ M9.0 (Medium)		SB 379	
		Number	Percent	Number	Percent
"Rural" Lincoln County	10,293	459	4%	466	5%
Otis-Rose Lodge	1,926	0	0%	0	0%
Otter Rock	489	5	1%	6	1%
Salishan-Lincoln Beach	2,093	118	6%	172	8%
Seal Rock-Bayshore	2,766	289	10%	309	11%
Wakonda Beach	1,326	268	20%	350	26%
Total Unincorporated	18,893	1,139	6%	1,303	7%

Source: IPRE. Data adapted from DOGAMI, Open-File Report O-20-11, Lincoln County Natural Hazard Risk Report. Tables A-1 through A-11; “Rural” Lincoln County includes all unincorporated areas that are not otherwise identified in this table. Note: City population based on the 2010 Census population.

Property Vulnerability

A tsunami will impact every building in Lincoln County within the CSZ M9.0 “Medium” zone (note, this is slightly fewer buildings than are predicted to be impacted under the SB 379 event scenario). Building damage (loss) estimates are reported for buildings expected to be damaged by the tsunami inundation zone (medium-sized and SB 379). All buildings exposed *inside* the tsunami inundation area are considered “damaged” (complete, uninhabitable). The communities of Wakonda Beach (31%) and Seal Rock-Bayshore (13%) are expected to

see the highest percent of their buildings damaged by a tsunami event. “Rural” Lincoln County (808 buildings), Wakonda Beach (506 buildings), and Seal Rock-Bayshore (450 buildings) have the highest number of buildings expected to be damaged under the SCA M9.0 tsunami scenario. The value of building damage losses due to the tsunami is \$274.6 million (another \$402.5 million will be attributed to the related earthquake).³⁴

Table 2-13 Damaged and Exposed Buildings, CSZ M9.0 Tsunami, by Unincorporated Area

	Total Buildings	Exposed Buildings			
		CSZ M9.0 (Medium)		SB 379	
		Number	Percent	Number	Percent
"Rural" Lincoln County	12,637	808	6%	864	7%
Otis-Rose Lodge	1,747	0	0%	0	0%
Otter Rock	634	22	3%	5	1%
Salishan-Lincoln Beach	2,847	227	8%	367	13%
Seal Rock-Bayshore	3,345	450	13%	476	14%
Wakonda Beach	1,614	506	31%	497	31%
Total Unincorporated	22,824	2,013	9%	2,013	9%

Source: IPRE. Data adapted from DOGAMI, Open-File Report O-20-11, Lincoln County Natural Hazard Risk Report. Tables A-1 through A-11; “Rural” Lincoln County includes all unincorporated areas that are not otherwise identified in this table.

Critical Facility Vulnerability³⁵

Critical facilities determined to be non-functioning following a CSZ tsunami include (additional critical facilities will be impacted by the related earthquake):

- Toledo State Airport (*Toledo area*)

The following vulnerable critical facilities were identified by the County but not included in the Risk Report analysis:

- Depoe Bay RFPD Fire Station 2200 (Gleneden Beach)

Risk Report Identified Areas of Vulnerability³⁶

- Residential areas built on the “Salishan Spit” in Salishan-Lincoln Beach are extremely vulnerable to tsunami hazard.
- Low-laying coastal areas and estuarine zones in Yachats, Wakonda Beach, Newport, and Lincoln City are exposed to tsunami hazard.

³⁴ Nathan J. Wood, Jeanne Jones, Seth Spielman, and Mathew C. Schmidlein. “Community clusters of tsunami vulnerability in the US Pacific Northwest”, PNAS 2015 112 (17) 5354-5359.

³⁵ DOGAMI, Open-File Report O-20-11, Lincoln County Natural Hazard Risk Report, Table A-2.

³⁶ Ibid. Page 26.

Community Clusters of Tsunami Vulnerability

Nate Wood, et al. (USGS) performed a cluster analysis of the data for coastal communities in the Pacific Northwest to identify the most vulnerable communities in the region.³⁷ The tables below provide community specific information and identify the most vulnerable communities based upon the cluster analysis. Wood, et al. conducted a comprehensive analysis to derive overall community clusters based on (1) the number of people and businesses in the tsunami hazard zone, (2) the demographic characteristics of residents in the zone, and (3) the number of people and businesses that may have insufficient time to evacuate based on slow and fast walking speeds.³⁸ The study placed all communities within Lincoln County within the following cluster category: “Relatively low numbers of residents, employees, or customer-heavy businesses in the tsunami hazard zones that will likely have sufficient time to reach high ground before tsunami wave arrival”.³⁹ Lincoln City and Toledo were noted to have slightly higher percentages of their population in the over age 65 category which may benefit from specific age related mitigation measures. The report suggests that education efforts that recognize demographic differences may be the best evacuation related mitigation measure for the Lincoln County communities.⁴⁰

Table 2-14 provides exposure analysis for the total number of residents, employees, public venues, dependent care facilities, and community businesses that are located within the “Large” local tsunami-hazard zone. The table shows that the unincorporated county (2,222) and Lincoln City (1,257) have the largest number of residents in the “Large” local tsunami-hazard zone; while Newport (1,445) and Lincoln City (584) have the largest number of employees located in the zone. The cities of Lincoln City (23) and Newport (10) have the largest number of public venues in the “Large” local tsunami-hazard zone; while Waldport (10) has the largest number of dependent care facilities in the zone and Newport (53) has the largest number of community businesses in the zone. Based upon the cluster analysis all the communities within Lincoln County are categorized within the least vulnerable group with regard to people or facilities in tsunami-hazard zones; although the report notes that Newport does have a high number of employees exposed to the tsunami-hazard zone.⁴¹

³⁷ Nathan J. Wood, Jeanne Jones, Seth Spielman, and Mathew C. Schmidlein. “Community clusters of tsunami vulnerability in the US Pacific Northwest”, PNAS 2015 112 (17) 5354-5359.

³⁸ Ibid.

³⁹ Ibid.

⁴⁰ Ibid.

⁴¹ Ibid.

Table 2-14 Total Number in Tsunami-hazard Zones

Community	Total number in tsunami-hazard zones				
	Residents	Employees	Public Venues	Dependent Care Facilities	Community Businesses
Lincoln City	1,257	584	23	1	27
Depoe Bay	27	0	0	0	0
Newport	578	1,445	10	1	53
Toledo	104	44	0	1	0
Waldport	552	283	6	10	32
Yachats	289	10	0	0	3
Unincorporated	2,222	341	8	0	17

Source: Nate Wood, "Community clusters of tsunami vulnerability in the US Pacific Northwest" (2015).

The sensitivity of communities within Lincoln County is also related to demographic characteristics of the population. Table 2-15 shows the results of an analysis of commonly used demographic variables associated with block level data in the 2010 US Census.⁴² The data shows that Yachats (42%), Waldport (27%), and Lincoln City (16%) have the highest percentage of their populations within the tsunami-hazard zone. In addition, the table shows that Depoe Bay (40%), Yachats (33%), Waldport (28%), and the unincorporated county (29%) have a relatively high percentage of their population greater than 65 years of age. In addition, the table shows that Waldport (60%) has a high percentage of renter-occupied households. The cluster analysis (Wood et al) suggests that Lincoln County communities have relatively minor variability in racial composition, housing tenure, and age compared to other communities in the study.⁴³ The study does suggest that mitigation efforts may want to focus on the needs of older residents within Depoe Bay, Newport, Waldport, Yachats, and unincorporated Lincoln County; while the needs of renters and Hispanic or Latino populations may be more important in Lincoln City and Toledo.

Table 2-15 Characteristics of Residents in Tsunami-hazard Zones

Community	Total Residents in Hazard Zone	Hispanic or Latino	American Indian or Alaska Native	Under 5 years in age	Single-mother households	More than 65 years in age	Living in group quarters	Renter-occupied households
Lincoln City	16%	6%	5%	4%	6%	21%	1%	46%
Depoe Bay	2%	2%	1%	1%	1%	40%	0%	37%
Newport	6%	4%	2%	5%	6%	24%	1%	39%
Toledo	3%	7%	12%	4%	8%	12%	0%	48%
Waldport	27%	3%	4%	2%	6%	28%	0%	60%
Yachats	42%	6%	3%	2%	3%	33%	0%	41%
Unincorporated	10%	3%	4%	3%	4%	29%	3%	25%

Source: Nate Wood, "Community clusters of tsunami vulnerability in the US Pacific Northwest" (2015).

The ability to reach higher ground before tsunami wave arrival is a critical aspect of population vulnerability to local tsunami hazards in Lincoln County. Table 2-16 shows the total number of residents and employees that may not have sufficient time to evacuate,

⁴² Ibid.

⁴³ Ibid.

assuming a slow walk (1.1 m/s), a local tsunami event; the table also shows the number of public venues, dependent care facilities, and community businesses that have significant customer presence in places where travel times out of hazards zones are greater than the predicated wave arrival times.⁴⁴ The table shows that few individuals would have difficulty evacuating; Lincoln City has the largest number of residents and employees that may have difficulty evacuating.

Table 2-16 Total Number That May Not Have Sufficient Time to Evacuate, Assuming a Slow Walk

Community	Residents	Employees	Public Venues	Dependent	
				Care Facilities	Community Businesses
Lincoln City	233	16	1	0	0
Depoe Bay	0	0	0	0	0
Newport	0	0	0	0	0
Toledo	0	0	0	0	0
Waldport	2	0	0	0	0
Yachats	0	0	0	0	0
Unincorporated	42	0	0	0	0

Source: Nate Wood, "Community clusters of tsunami vulnerability in the US Pacific Northwest" (2015).

An individual's ability to move faster during evacuation is another element of short-term resilience to tsunamis. Table 2-17 shows the number of individuals that may not be able to evacuate a local tsunami assuming a faster walk speed (1.52 m/s). Similar to the slow walk evacuation (above) there are few individuals that would have difficulty evacuating within Lincoln County.

Table 2-17 Total Number That May Not Have Sufficient Time to Evacuate, Assuming a Fast Walk

Community	Residents	Employees	Public Venues	Dependent	
				Care Facilities	Community Businesses
Lincoln City	15	0	0	0	0
Depoe Bay	0	0	0	0	0
Newport	0	0	0	0	0
Toledo	0	0	0	0	0
Waldport	0	0	0	0	0
Yachats	0	0	0	0	0
Unincorporated	26	0	0	0	0

Source: Nate Wood, "Community clusters of tsunami vulnerability in the US Pacific Northwest" (2015).

More information on this hazard can be found in the [Risk Assessment for Region 1, Oregon Coast, Oregon SNHMP \(2020\)](#).

⁴⁴ Ibid.

Flood

Significant Changes since Previous NHMP:

New data is included from the NFIP (including RL/SRL), Risk Report, OCCRI “Future Climate Projections”, and other technical reports.

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.⁴⁵

Three types of flooding affect Lincoln County: (1) riverine flooding, caused mostly by prolonged, high intensity rainfall events, (2) ocean/coastal flooding from high tides and large, wind-driven waves, and (3) urban flooding.

Riverine Flooding

Riverine floods occur when water levels in rivers and streams overflow their banks. In Lincoln County, riverine flooding occurs primarily on lands in the five major river valleys (Asea, Salmon, Siletz, Yachats, and Yaquina rivers) and along the larger tributaries. Most communities located along such water bodies have the potential to experience this type of flooding after spring rains, heavy thunderstorms or rapid runoff from snow melt. Riverine floods can be slow or fast rising, but usually develop over a period of days.

The danger of riverine flooding occurs mainly during the winter months, with the onset of persistent, heavy rainfall, and during the spring, with melting of snow in the Cascade and Coast Ranges.

Coastal Flooding

Coastal flooding occurs in low-lying coastal areas and is caused by heavy rain, storms, large waves, and even tsunamis produced by underwater seismic events. Areas exposed to this intensive wave action are termed by FEMA as high velocity zone, or “V-zones”. Special regulations are usually applied in these areas.

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.

⁴⁵ Taylor, George H. and Chris Hannan. *The Oregon Weather Book*. Grants Pass, OR: Oregon State University Press. 1999

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.

Location and Extent

Lincoln County located along the central Oregon Coast. Its western edge is the Pacific Ocean and its eastern edge lies in the Coast Range. Weather patterns generally move west to east where air masses from the Pacific Ocean rise over the Coast Range, cool, and become saturated.

The principal flood sources for the unincorporated area of Lincoln County include the: Salmon River, Siletz River, Yaquina River, Alsea River, Little Elk Creek, and the Pacific Ocean. The incorporated areas of the county are affected by many of the same rivers and also the following: Alsea Bay, Big Creek, Depoe Bay, Depoe Creek/ Slough, Devils Lake, Drift Creek, Olalla Creek/ Slough, Red River, Schooner Creek, Siletz Bay, Yachats River, and Yaquina Bay.⁴⁶ *See the City addenda for a listing of main flood sources for each community.*

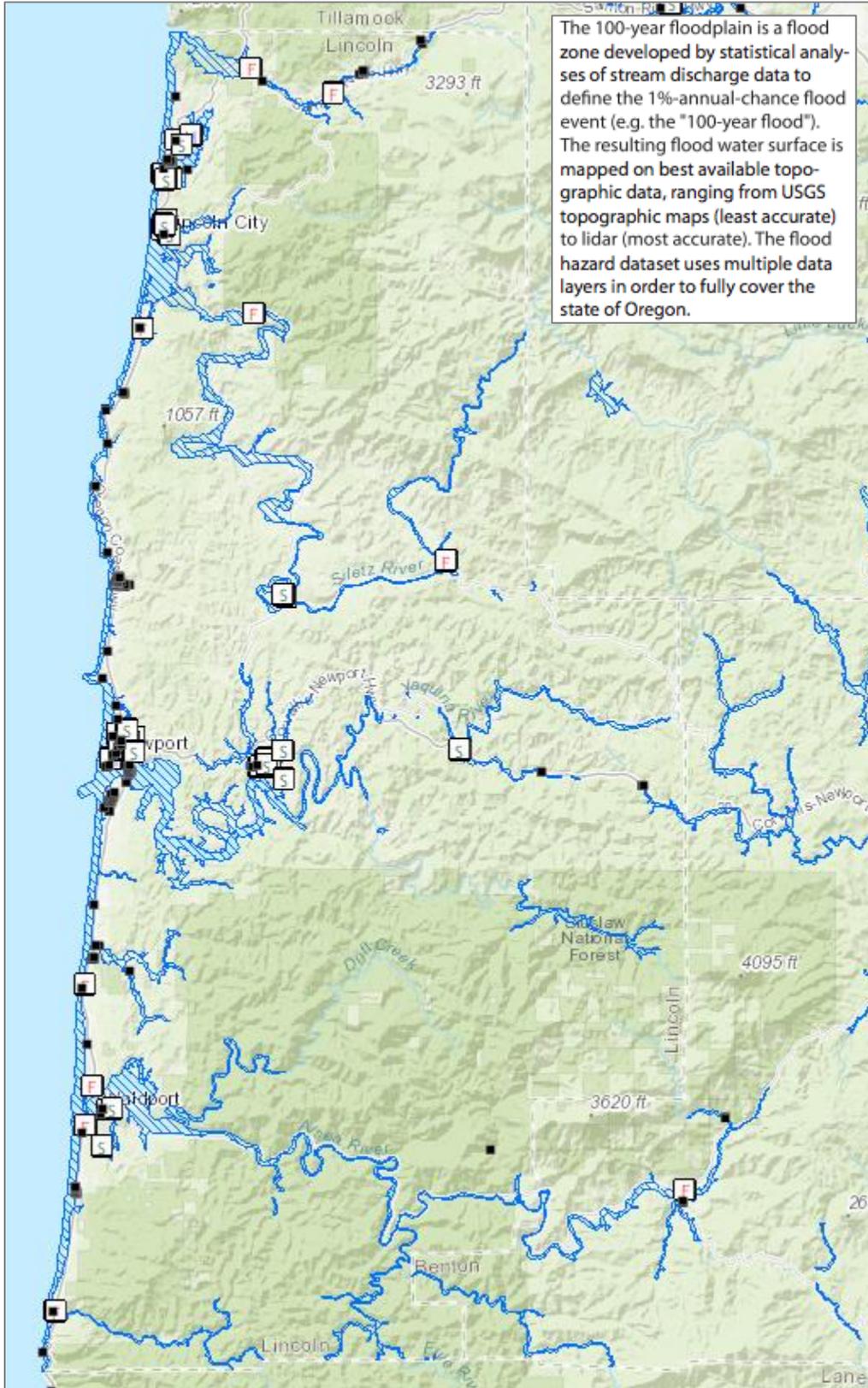
Flooding is most common from October through April, when storms from the Pacific Ocean bring intense rainfall to the area. During the rainy season, monthly rainfall totals average far higher than other months of the year. This results in high water, particularly in December and January. The larger floods 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.

Floods can result in loss of life and property, with the extent of the damage dependent on the depth and velocity of the floodwaters. 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 gauges, to determine the probability of occurrence for floods of different magnitudes.

FEMA has mapped most of the flood-prone streams in Oregon for 100- and 500-year flood events. A 100-year flood (a flood with a one-percent (1%) probability of occurring within any given year) is used as the standard for floodplain management in the United States and is referred to as a base flood. Flood Insurance Rate Maps (FIRMs) prepared by FEMA provide the most readily available source of information for 100-year floods. These maps are used to support the NFIP. FIRMs delineate 100- and 500-year (a flood with a 0.2-percent probability of occurring within any given year) floodplain boundaries for identified flood hazards; these areas are Special Flood Hazard Areas (SFHAs) and provide the basis for flood insurance and floodplain management requirements. These maps represent a snapshot in time, and do not account for later changes which occurred in the floodplains. Development and other natural and artificial changes in the floodplain have caused changes to the rivers and streams in Lincoln County. Figure 2-16 provides an overview of the flood zones and extent in Lincoln County.

⁴⁶ FEMA, Lincoln County Flood Insurance Study, effective December 18, 2009, and FEMA, Risk MAP Discovery Report, January 10, 2013 (MAS-05-03).

Figure 2-16 Special Flood Hazard Area (100-year floodplain)



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

The FEMA FIRMs provide a comprehensive analysis of the 100- and 500-year floodplains. The maps cover the entire geographic extent of Lincoln County and therefore include small waterways, reservoirs and less densely populated areas that were not included in previous editions of the FIRMs.

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 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 2019 FEMA completed an update of all FIRMs in Lincoln County.

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

- [Lincoln County FIS: Volume 1 \(2019\)](#)
- [Lincoln County FIS: Volume 2 \(2019\)](#)

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:

- Coastal flood hazard study, Lincoln County, Oregon (2018, [O-15-06](#))
- Statewide subbasin-level channel migration screening (2017, [IMS-56](#)).

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

<https://www.oregongeology.org/pubs/pubsearch.htm>

History

Riverine flooding events with significant damage potential are relatively frequent; historically, floods with an estimated recurrence interval of 10 to 15 years have caused substantial property damage. Records for coastal flooding are mostly anecdotal, but the recurrence of damaging coastal floods has been less frequent than riverine floods.

Riverine flooding in Lincoln County typically occurs following snow accumulation in the upper reaches of watersheds in combination with southwestern storms that may bring warmer temperatures and heavy precipitation. Along the coast the high spring tides combined with storm surges produced by strong winds from winter storms often cause flooding.

The county has received presidential disaster declarations designation for the following events that included flooding: DR 184 (1964), DR 319 (1972), DR 413 (1974), DR 1099 (1996), DR 1107 (1997), DR 1632 (2006), DR 1672 (2006), DR 1683 (2007), DR 1733 (2007), DR 1956 (2011), DR 1964 (2011, Tsunami), and DR 4055 (2012), and DR 4258 (2016). Other recent flooding events occurred in December 2014, December 2015, and November 2016.

Probability Assessment

Based on the available data and research the Steering Committee determined the **probability of experiencing a coastal or riverine flood is “high”**, meaning at least one incident is likely within the next 35-year period.

Future Climate Projection:

According to OCCRI report “*Future Climate Projections: Lincoln County*” (Appendix G) the intensity of extreme precipitation is expected to increase as the atmosphere warms. The magnitude of the wettest days and the wettest consecutive five days is expected to increase by about 13% (range 4% to 28%) by the 2050s under the higher emissions scenario relative to historical baselines. The probability of winter flood risk will increase within coastal rain-dominated watersheds (such as the Siletz River) due to projected greater winter precipitation and warmer winter temperatures that will cause precipitation to fall more as rain than snow. There will also be an increase in atmospheric river events. Additionally, coastal flooding is expected to increase due to sea level rise (SLR) and changing wave dynamics. Sea level is projected to rise by 1.7 to 5.7 feet by 2100. Tidal wetlands and estuaries throughout the county are also expected to experience changes to their composition and area, thereby impacting their ability to naturally mitigate flood events.

Research has documented a pattern of climate variability in the Northern Pacific known as the Pacific Decadal Oscillation (PDO.) The PDO is a long-lived pattern of climate variability with alternating warm/dry-cool/wet cycles, which persist for 20-30 years. The predictability for this climate oscillation is not currently known but it is suggested that the riverine floods associated with high intensity precipitation events may tend to “cluster” in the decades of the cool/wet cycle of the PDO.⁴⁷

Although ocean storms can be expected every year, property damage associated with coastal flooding is rare in Lincoln County.

El Niño effects, which tend to raise ocean levels and produce higher intensity storms, occur about every three to five years.⁴⁸ V zones (wave velocity zones,) depicted on FEMA’s Flood Insurance Rate Maps, are areas subject to 100-year flood events (i.e., 1% chance in any given year). The Flood Insurance Rate Maps also show areas vulnerable to sheet-flow from waves over-topping dunes (AO and AH zones).

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 snowpack as winter precipitation falls as rain. This may

⁴⁷ Mantua, Nathan. The Pacific Decadal Oscillation. University of Washington, Seattle, WA.

⁴⁸ Taylor, G.H. and Hatton, R.R. The Oregon Weather Book: A State of Extremes. Oregon State University Press, Corvallis, OR. 1999

result in faster storm runoff with flashier flood events for upper watersheds and the need for greater attention to storm water management in floodplains.⁴⁹

Vulnerability Assessment

The Steering Committee rated the county as having a **“Moderate” vulnerability to coastal and riverine flood hazards**, meaning that between 1% and 10% of the unincorporated County’s population or property could be affected by a major coastal or riverine flood event.

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.

Lincoln 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, from local storm water drainage, from local and distant tsunamis, or from king tides.

Low-lying areas along the lower portions of the County’s major rivers (Salmon, Siletz, Yaquina, Alsea, Yachats) and larger tributaries are most vulnerable to flood hazards. Here, riverine flooding can be exacerbated by high tides (especially King Tides). Also, along the lower portions of the Salmon, Siletz and Alsea Rivers, rural subdivisions and substantial recreational and second home development took place in the 1960s and 1970s, (before Lincoln County entered the National Flood Insurance Program and implemented a system of flood hazard area regulation.) As a result, there are numerous structures located in flood hazard areas along these rivers that are classified as ‘pre-FIRM’ (Table 2-20), meaning their construction predates requirements to elevate above the base flood level, and are therefore subject to damage during larger flood events. The county has worked actively, mostly along the Siletz River (Lower Siletz Mitigation Project,) to assist property owners in retrofitting many of these pre-FIRM residences to meet current elevation requirements. This project has been a success for both homeowners and the government agencies that assisted. Having these homes elevated and out of harm’s way will certainly reduce the amount of property losses as well as insurance payments in the future. There are still, however, substantial numbers of structures in harm’s way in these areas.

Also, some areas along major rivers, highways and roads, in particular Highway 229 along the lower Siletz River, are subject to inundation and damage by flood waters.

In general, the following are subject to damage by riverine flooding:

⁴⁹ Mote, P.W., J. Abatzoglou, K.D. Dello, K. Hegewisch, and D.E. Rupp, 2019: Fourth Oregon Climate Assessment Report. Oregon Climate Change Research Institute. ocri.net/ocar4.

- Pre-FIRM residential structures, especially repetitive loss structures/properties
- Manufactured homes inside manufactured home parks
- Roads and highways

The primary economic activities at risk from riverine flood events include:

- RV park and campground operations
- Other businesses that rely on road and highway transportation corridors that may be interrupted by flooding.

Coastal developments within FEMA-designated Velocity (V) zones and A-O zones include the Bayshore development on Alsea spit and the Salishan development on the Siletz spit. Most residences in both developments are post-FIRM, meaning that they are built in compliance with current flood hazard area regulations. There has been no record of significant damage from flooding in either of these areas.

Natural Hazard Risk Report for Lincoln County

The **Risk Report** ([DOGAMI, O-20-11](#)) provides hazard analysis summary tables that identify populations and property within Lincoln County that are vulnerable to riverine and coastal flooding. The Risk Report provides distinct profiles for (1) unincorporated Lincoln County, and (2) the unincorporated communities of Otis-Rose Lodge, Salishan-Lincoln Beach, Otter Rock, Seal Rock-Bayshore, and Wakonda Beach.

The Risk Report provides a flood analysis for four flood scenarios (10-, 50-, 100-, and 500-year). The 100-year flood scenario is used for reporting since it is commonly used as a reference level for flooding and is the standard FEMA uses for regulatory purposes. In addition to the riverine flood scenarios coastal flooding information is available for the 100-year flood scenario for the “Rural” portions of Lincoln County, Otter Rock, Salishan-Lincoln Beach, Seal Rock-Bayshore, and Wakonda Beach. The Risk Report only analyzed buildings within a flood zone, or within 500 feet of a flood zone. First-floor building height and presence of basements was also considered. Buildings with a first-floor height above the flood level were not included in the flood loss estimate, however, their assumed building occupants (residents) were counted as potentially displaced. According to the Risk Report the following resident population and property (public and private) within the study area may be impacted by the profiled flood scenario.

Population Vulnerability (Residents)

Approximately 7% of unincorporated Lincoln County’s population (1,257 people) may be displaced by flooding within Lincoln County. These people are expected to have mobility or access issues due to surrounding water. It is important to note that impact from flooding may vary depending on which rivers are flooding. “Rural” Lincoln County has the most population at risk (963), although the population is dispersed throughout the County. The communities of Otis-Rose Lodge are vulnerable to flooding of the Salmon River.

Table 2-18 Potentially Displaced Residents, 1% Flood, by Unincorporated Area

	Resident Population	Potentially Displaced Residents	
		Number	Percent
"Rural" Lincoln County	10,293	963	9%
Otis-Rose Lodge	1,926	127	7%
Otter Rock	489	0	0%
Salishan-Lincoln Beach	2,093	83	4%
Seal Rock-Bayshore	2,766	43	2%
Wakonda Beach	1,326	41	3%
Total Unincorporated	18,893	1,257	7%

Source: IPRE. Data adapted from DOGAMI, Open-File Report O-20-11, Lincoln County Natural Hazard Risk Report. Tables A-1 through A-11; "Rural" Lincoln County includes all unincorporated areas that are not otherwise identified in this table. Note: City population based on the 2010 Census population.

Property Vulnerability

Riverine and coastal flooding have a significant impact on Lincoln County particularly within the floodplain and low-lying coastal areas. Approximately seven percent (1,660 buildings) of unincorporated Lincoln County buildings are exposed to the 1% Flood. An additional 499 are exposed but above the height of the 100-year flood extent. Elevating more of these exposed structures would reduce the potential damages sustained from flooding. The percent of exposed buildings is greatest in the dispersed "rural" Lincoln County (11.6%) and within Otis-Rose Lodge (4.6%). The value of losses is greatest in "rural" Lincoln County (\$15.6 million, loss ratio of 1.9%) and Salishan-Lincoln Beach (\$4.8 million, loss ratio of 1.2%). The value of exposed buildings is \$21.5 million.

Table 2-19 Damaged and Exposed Buildings, 1% Flood, by Unincorporated Area

	Total Buildings	Exposed Buildings		Value of Loss	
		Number	Percent	Loss Estimate (\$)	Loss Ratio
"Rural" Lincoln County	12,637	1,467	11.6%	\$15,579,000	1.9%
Otis-Rose Lodge	1,747	81	4.6%	\$300,000	0.4%
Otter Rock	634	0	0.0%	\$0	0.0%
Salishan-Lincoln Beach	2,847	66	2.3%	\$4,838,000	1.2%
Seal Rock-Bayshore	3,345	17	0.5%	\$372,000	0.1%
Wakonda Beach	1,614	29	1.8%	\$442,000	0.4%
Total Unincorporated	22,824	1,660	7.3%	\$21,531,000	1.2%

Source: IPRE. Data adapted from DOGAMI, Open-File Report O-20-11, Lincoln County Natural Hazard Risk Report. Tables A-1 through A-11; "Rural" Lincoln County includes all unincorporated areas that are not otherwise identified in this table.

Critical Facility Vulnerability⁵⁰

The following vulnerable critical facilities were determined to be within the 1% flood zone. Elevating these exposed structures would reduce the potential damages sustained from flooding.

- North Lincoln Fire Station 1700 (*Kernville, North Lincoln Fire & Rescue District*)
- Toledo State Airport

Risk Report Identified Areas of Vulnerability⁵¹

- The Port of Toledo and the Georgia Pacific manufacturing facility in the City of Toledo are highly vulnerable to flooding from the Yaquina River.
- Developed areas along the Siletz River in the unincorporated county and in Lincoln City are exposed to the 100-year flood.
- Many buildings in the low-lying business area of Waldport is particularly vulnerable to flooding. This area, along the riverbank, is subject to the 100-year flood due to the proximity of the Alsea River. Mitigation actions, such as elevating buildings, have alleviated some problems.
- Coastal flooding threatens many residences in Wakonda Beach and Salishan-Lincoln Beach.

National Flood Insurance Program (NFIP)

FEMA's Flood Insurance Study (FIS), and Flood Insurance Rate Maps (FIRMs) are effective as of October 10, 2010. Table 2-20 shows that as of August 2019, unincorporated Lincoln County has 1,089 National Flood Insurance Program (NFIP) policies in force, representing almost \$300 million in coverage. Of those, 453 are for properties that were constructed before the initial FIRMs. The last Community Assistance Visit (CAV) for the County was April 15, 2004. The table shows that most flood insurance policies are for residential structures, primarily single-family homes. Flood insurance covers only the improved land, or the actual building structure. There have been 271 paid flood insurance claims for a combined total of just over \$4 million.

The County complies with the NFIP through enforcement of their flood damage prevention ordinance and their floodplain management program.

The NFIP's Community Rating System (CRS) recognizes jurisdictions for participating in floodplain management practices that exceed NFIP minimum requirements. Lincoln County, and the incorporated jurisdictions, do not participate in the CRS and, therefore, do not receive discounted flood insurance premiums for residents in a special flood hazard zone.

⁵⁰ DOGAMI, Open-File Report O-20-11, Lincoln County Natural Hazard Risk Report, Table A-2.

⁵¹ Ibid. Page 31.

Repetitive Loss Properties:

The Community Repetitive Loss record for Lincoln County identifies 55 Repetitive Loss Properties⁵², of which 10 are Severe Repetitive Loss Properties⁵³. Fifty (50) of the repetitive loss properties are single-family residential (seven of these are severe repetitive loss properties), three (3) are condominium associations (all three are severe repetitive loss properties), and two are non-residential.

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.

⁵² A Repetitive Loss (RL) property is any insurable building for which two or more claims of more than \$1,000 were paid by the National Flood Insurance Program (NFIP) within any rolling ten-year period, since 1978. A RL property may or may not be currently insured by the NFIP.

⁵³ A Severe Repetitive Loss (SRL) property is a single family property (consisting of 1 to 4 residences) that is covered under flood insurance by the NFIP, and has incurred flood-related damage for which 4 or more separate claims payments have been paid under flood insurance coverage, with the amount of each claim payment exceeding \$5,000, and with cumulative amount of such claims payments exceeding \$20,000; or for which at least 2 separate claims payments have been made with the cumulative amount of such claims exceeding the reported value of the property.

Table 2-20 Flood Insurance Detail

	Lincoln County	Unincorporated Lincoln County
Effective FIRM and FIS	10/18/2019	10/18/2019
Initial FIRM Date	-	9/30/1980
Total Policies	2,325	1,089
Pre-FIRM Policies	1,067	453
Policies by Building Type		
Single Family	1,685	1,023
2 to 4 Family	57	10
Other Residential	462	33
Non-Residential	121	23
Minus Rated A Zone	98	56
Minus Rated V Zone	3	2
Insurance in Force	\$585,856,500	\$298,046,700
Total Paid Claims	343	271
Pre-FIRM Claims Paid	265	207
Substantial Damage Claims	53	49
Total Paid Amount	\$5,479,221	\$4,032,463
Repetitive Loss Structures	64	55
Severe Repetitive Loss Properties	12	10
CRS Class Rating	NP	NP
Last Community Assistance Visit	-	4/15/2004

Source: Department of Land Conservation and Development, August 2019. Repetitive Flood Loss information provided by FEMA correspondence on September 10, 2020. NP = Not Participating

More information on this hazard can be found in the [Risk Assessment for Region 1, Oregon Coast, Oregon SNHMP \(2020\)](#).

Landslide

Significant Changes since Previous NHMP:

New data is included from the Risk Report, OCCRI “Future Climate Projections”, and other technical reports.

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.

Lincoln County is subject to shallow- and deep-seated landslides and debris flows (mudslides) especially in the Coast Range in the eastern portion of the county, which may affect buildings, roads and utilities.

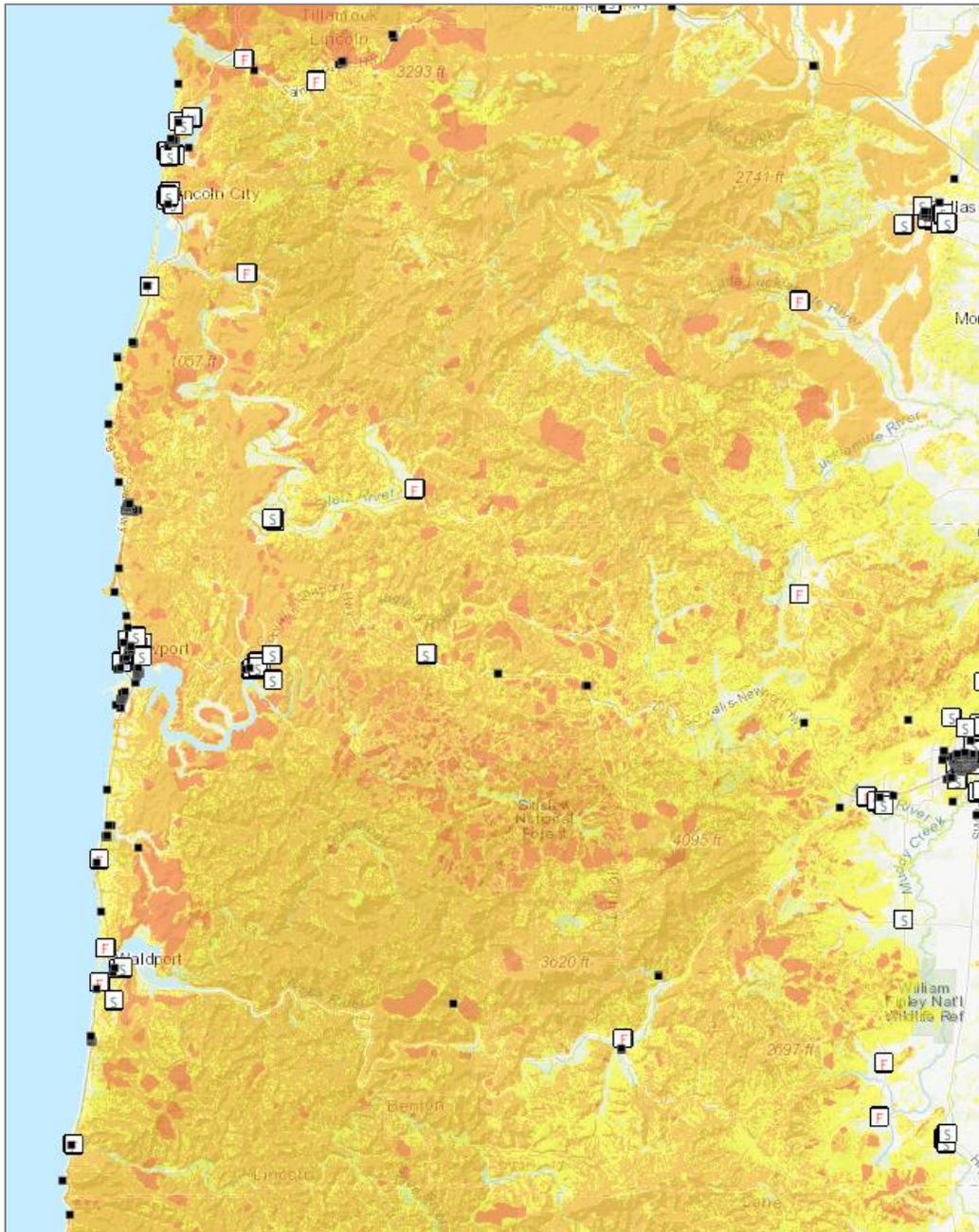
Additionally, landslides often occur together with other natural hazards, thereby exacerbating conditions, as described below:

- 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 Lincoln County, DOGAMI reports the slopes nearest to rivers are at greatest risk of landslides (Figure 2-17). Weak, low-permeability marine sediments overlain by basalts, and clay rich residual soils overlying basalts are susceptible to water-induced landslides on steep slopes and within existing slide masses. Features such as hummocky topography, disrupted drainage patterns, sag ponds, springs, back-tilted bedrock blocks, and subdued head scarps are indicative of landslide terrain. For Lincoln County, most landslide areas are found in less populated eastern hills, historic landslide areas are also present in or adjacent to urban areas. Landslides in these areas could cause disruptions in transportation and potable water systems.

Figure 2-17 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 explore and view map 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.

Landslide susceptibility exposure for Lincoln County is shown in Figure 2-17 and Table 2-21 shows landslide susceptibility exposure for Lincoln County and the incorporated cities. Approximately 73% of the county has high or very high landslide susceptibility exposure. These are concentrated in areas of high slopes, and close to river valleys. In general cities within the County have a lower landslide susceptibility exposure than does the unincorporated area of the County. *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 2-21 Landslide Susceptibility Exposure

Jurisdiction	Area, ft ²	Low	Moderate	High	Very High
Lincoln County	27,673,176,599	7.0%	21.1%	61.8%	11.1%
Depoe Bay	50,271,265	19.6%	26.0%	42.3%	12.1%
Lincoln City	166,883,441	22.9%	24.0%	49.6%	3.5%
Newport	291,240,190	44.2%	19.5%	28.7%	7.5%
Siletz	17,593,580	68.5%	21.4%	10.1%	0.0%
Toledo	64,963,983	26.4%	13.8%	39.3%	20.5%
Waldport	85,619,621	40.2%	26.7%	30.8%	2.3%
Yachats	25,746,552	32.6%	25.3%	32.5%	9.6%

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:

- Preparing for Landside Hazards, A Land Use Guide for Oregon Communities (October 2019) [Link](#)
- Statewide Landslide Susceptibility (2016, [O-16-02](#)).
- Landslide Susceptibility of Lifeline Routes in the Oregon Coast Range (2015, [O-15-01](#))
- Lidar data and landslide inventory maps of the North Fork Siuslaw River and Big Elk Creek watersheds, Lane, Lincoln, and Benton Counties, Oregon (2012, [O-12-07](#))
- Johnson Creek landslide research project, Lincoln County, Oregon: Final report to the Oregon Department of Transportation(2008, [SP-40](#))
- Slope failures in Oregon: GIS inventory for three 1996/97 storm events (2000, [Special Paper 34](#)).
- Storm Impacts and Landslides of 1996: [Final Report](#)

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 Lincoln County. Many landslides occur in undeveloped areas and thus may go unnoticed or unreported. For the most part, landslides become a problem only when they impact developed areas and have the potential to damage buildings, roads or utilities.

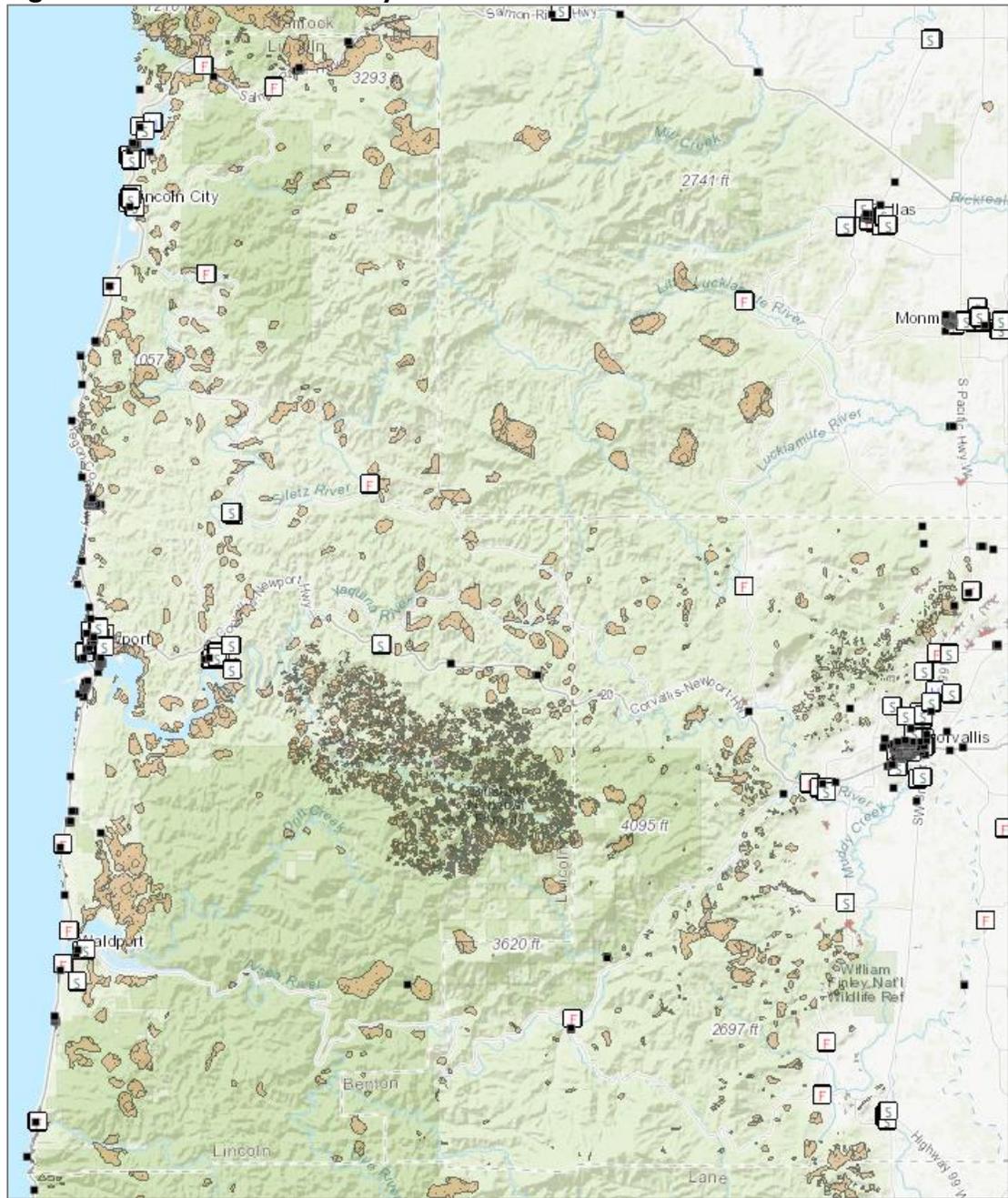
Landslides accompany almost every major storm system that impacts western Oregon. Although most landslides occur in the undeveloped forested areas of the county, landslides have also occurred in more developed areas. Lincoln County does not have a comprehensive list of landslide events, but they likely occur during major storms that impact the County. In recent history, particularly noteworthy landslides accompanied storms in 1964, 1966, 1982, 1996, 2005, 2006, 2007, 2011, 2012, and 2016. A major winter storm in November 1996 produced more than 9,500 landslides throughout western Oregon, including Lincoln County. More recently, similar winter storm events have resulted in significant slide damages in Lincoln County, including closures of Highway 101 at Cape Perpetua and Cape Foulweather, on Highway 18, and on old Highway 101, which lost a bridge. This isolation due to highway failures became problematic for business and commerce as well as for emergency response vehicles. Private property damage due to landslides has also occurred in recent years, including damage to a restaurant in Toledo, the destruction of a house on the Yaquina Bay Road near Newport, and damage to homes and streets at the west end of NW 57th Street in Newport. Most recently, heavy rains in November 2006 triggered a 17-18 acre landslide near Immonen Road, a county road located in the northern portion of the county. This slide continues to be active and has caused extensive damage to the county road.

Numerous slow moving slides affect portions of Highway 101 along the coast, including the very large Johnson Creek slide just south of Cape Foulweather. The Johnson Creek landslide is located along the Oregon coast south of Cape Foulweather and is a result of coastal processes. The landslide has a long history of impacting U.S. Highway 101, which passes over the middle section of the slide. The slide is up to 26 m thick, 200 m long, and 360 m wide. Total movement of the slide, as estimated from geologic cross-sections, is 28 m horizontally and 6 m vertically. The most recent significant movement of the slide occurred in early 2002, when it moved approximately 25 cm horizontally and several centimeters vertically.⁵⁴

Figure 2-18 shows the landslide inventory for Lincoln County from the [Statewide Landslide Information Database for Oregon](#).

⁵⁴ USGS. March, 16, 2007. Johnson Creek Landslide. http://landslides.usgs.gov/monitoring/johnson_creek/

Figure 2-18 Landslide Inventory



<p>  Scarp  Head Scarp </p>	<p>Deposits</p> <p>  Talus-Colluvium  Fan  Landslide </p>	<p>Scarps are concave, steep areas of a slope where material has been removed due to landsliding. A head scarp is the area at the top of a slope where material has been removed due to landsliding. Talus-colluvium is a general term for loose sediments built up at the base of a slope due to transportation by gravity. A fan is an outspread mass of material, usually at the base of a narrow channel, deposited by a landslide. Landslide is a general term for deposits of material that have been moved by landsliding.</p>
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Source: [Oregon HazVu: Statewide Geohazards Viewer](#) – To explore and view map detail click hyperlink to left.

Probability Assessment

Based on the available data and research the Steering Committee determined the **probability of experiencing a landslide or debris flow is “high”**, meaning at least one incident is likely within the next 35-year period.

The probability of rapidly moving landslide occurring depends on several 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.

Geo-engineers with DOGAMI estimate widespread landslides about every 20 years; landslides at a local level can be expected every two or three years.⁵⁵

Future Climate Projection:

According to OCCRI report *“Future Climate Projections: Lincoln County”* (Appendix G) the intensity of extreme precipitation is expected to increase as the atmosphere warms. The magnitude of the wettest days and the wettest consecutive five days is expected to increase by about 13% (range 4% to 28%) by the 2050s under the higher emissions scenario relative to historical baselines. Landslide risk is not expected to change significantly.

Vulnerability Assessment

The Steering Committee rated the County as having a **“high” vulnerability to landslide hazards**, meaning that more than 10% of the unincorporated County’s population or property could be affected by a major hazard event.

To a large degree, landslides are very difficult to predict. 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).

⁵⁵Mills, K. 2002. Oregon’s Debris Flow Warning System. Cordilleran Section–98th Annual Meeting. Corvallis.

Roads and Bridges

Large losses incurred from landslide hazards in Lincoln County have been associated with roads. The Lincoln County Public Works Department is responsible for responding to slides that inhibit the flow of traffic or are damaging a road or a bridge. The 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 Public Works Department 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.

Natural Hazard Risk Report for Lincoln County

The **Risk Report** ([DOGAMI, O-20-11](#)) provides hazard analysis summary tables that identify populations and property within Lincoln County that are vulnerable to landslides. The Risk Report provides distinct profiles for (1) unincorporated Lincoln County, and (2) the unincorporated communities of Otis-Rose Lodge, Salishan-Lincoln Beach, Otter Rock, Seal Rock-Bayshore, and Wakonda Beach.

The Risk Report provides an analysis of landslide susceptibility to identify the general level of susceptibility to landslide hazards, primarily shallow and deep landslides. The Risk Report performed an analysis of buildings, including critical facilities, to determine exposure for each community. According to the Risk Report the following resident population and property (public and private) within the study area may be impacted by the profiled landslide scenario.

Population Vulnerability (Residents)

Approximately 32% of unincorporated Lincoln County's population (6,033 people) may be displaced by landslides within Lincoln County. These people are expected to have mobility or access issues and/or may have their residences impacted by a landslide. It is important to note that impact from landslides may vary depending on the specific area that experiences landslides during an event. "Rural" Lincoln County has the most population at risk (4,530), although the population is dispersed throughout the County. About one-third of Otis-Rose Lodge and one-fifth of Otter Rock residents are exposed.

Table 2-22 Potentially Displaced Residents, High and Very High Landslide, by Unincorporated Area

	Resident Population	Potentially Displaced Residents	
		Number	Percent
"Rural" Lincoln County	10,293	4,530	44%
Otis-Rose Lodge	1,926	666	35%
Otter Rock	489	105	21%
Salishan-Lincoln Beach	2,093	256	12%
Seal Rock-Bayshore	2,766	364	13%
Wakonda Beach	1,326	112	8%
Total Unincorporated	18,893	6,033	32%

Source: IPRE. Data adapted from DOGAMI, Open-File Report O-20-11, Lincoln County Natural Hazard Risk Report. Tables A-1 through A-11; "Rural" Lincoln County includes all unincorporated areas that are not otherwise identified in this table. Note: City population based on the 2010 Census population.

Property Vulnerability

Properties that are most vulnerable to the landslide hazard are those that are developed in an area of, or at the base of, moderate to steep slopes. Approximately 30% (5,135 buildings) of unincorporated Lincoln County buildings are exposed to the High or Very High landslide susceptibility zones. The percent of exposed buildings is greatest in the dispersed "rural" Lincoln County (40.6%), Otis-Rose Lodge (34.5%), and Otter Rock (26.5%). The value of exposed buildings is \$526 million.

Table 2-23 Exposed Buildings, High & Very High Landslide, by Unincorporated Area

	Total Buildings	Exposed Buildings		Value of Loss	
		Number	Percent	Loss Estimate (\$)	Loss Ratio
"Rural" Lincoln County	12,637	5,135	40.6%	\$354,114,000	43.0%
Otis-Rose Lodge	1,747	602	34.5%	\$21,495,000	31.8%
Otter Rock	634	168	26.5%	\$23,648,000	28.8%
Salishan-Lincoln Beach	2,847	369	13.0%	\$63,765,000	16.4%
Seal Rock-Bayshore	3,345	445	13.3%	\$55,334,000	15.9%
Wakonda Beach	1,614	108	6.7%	\$7,879,000	6.4%
Total Unincorporated	22,824	6,827	29.9%	\$526,235,000	28.7%

Source: IPRE. Data adapted from DOGAMI, Open-File Report O-20-11, Lincoln County Natural Hazard Risk Report. Tables A-1 through A-11; "Rural" Lincoln County includes all unincorporated areas that are not otherwise identified in this table.

Critical Facility Vulnerability⁵⁶

The following vulnerable critical facilities were determined to be exposed to the High or Very High landslide susceptibility zones.

⁵⁶ DOGAMI, Open-File Report O-20-11, Lincoln County Natural Hazard Risk Report, Tables A-2, A-9, A-11.

- Central Oregon Coast Fire Station 7300 (*Tidewater, Central Oregon Coast Fire & Rescue District*)
- Toledo High School (*Toledo area, Lincoln County School District*)
- Waldport Water Treatment Plant (*Waldport Area, City of Waldport*)
- Seal Rock Water District
- Yachats Fire Station (*outside Waldport, Yachats Rural Fire Protection District*)

Risk Report Identified Areas of Vulnerability⁵⁷

- Many residential buildings in the unincorporated county and the City of Newport, along the Yaquina River, are exposed to high and very high landslide hazard.
- An area deemed very high susceptibility to landslides exists just to the east of the community of Seal Rock-Bayshore.
- Several places within the City of Toledo where there is exposure to very high landslide susceptibility. Nearly half of the buildings in the city, including all of its critical facilities, are threatened by landslide hazard.
- Nearly a quarter of the building in the community of Otis-Rose Lodge is exposed to very high landslide susceptibility.

More information on this hazard can be found in the [Risk Assessment for Region 1, Oregon Coast, Oregon SNHMP \(2020\)](#).

⁵⁷ Ibid. Page 33.

Severe Weather (Windstorm, Tornado, and Winter Storm)

Significant Changes since Previous NHMP:

New data is included from the OCCRI “Future Climate Projections” report. Tornado was individually assessed as a hazard unique from windstorm.

Severe wind events may occur throughout Oregon during all seasons. 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.⁵⁸ 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.⁵⁹ 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.

Future Climate Projections

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.⁶⁰

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.

According to OCCRI report “*Future Climate Projections: Lincoln County*” (Appendix G) windstorm events are not expected to increase, however, air temperatures on the coldest day of the year will increase by about 5°F by the 2050s under the higher emissions scenario relative to historical baselines.

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.⁶¹ 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,

⁵⁸ US Department of Agriculture. <http://www.fsa.usda.gov/or/Notice/Flp104.pdf>.

⁵⁹ Interagency Hazard Mitigation Team. 2000. State Hazard Mitigation Plan. Salem, OR: Oregon Office of Emergency Management.

⁶⁰ Oregon Climate Change Research Institute <http://occri.net/wp-content/uploads/2011/04/chapter9ocar.pdf> Page 412.

⁶¹ Oregon Climate Change Research Institute (OCCRI), 4th Oregon Climate Assessment Report (2019) and Northwest Climate Assessment Report (2013). <http://www.occri.net/publications-and-reports/publications/>

winter snow precipitation will likely shift to higher elevations and snowpack will be diminished as more precipitation falls as rain altering surface flows.

Windstorm

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 Lincoln County, they are especially dangerous near developed areas with large trees or tree stands.

The most common type of wind pattern affecting Lincoln 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 Lincoln County.

A windstorm is generally a short duration event involving straight-line winds and/or gusts in excess of 50 mph. Windstorms can affect developed areas of the county with significant tree stands and major infrastructure, especially above ground utility lines.

Tornado

Though tornadoes are not common in Oregon, these events do occasionally occur and sometime produce significant property damage and even injury. They are created by a vortex of rotating winds and strong vertical motion, which possess remarkable strength and cause widespread damage. The low pressure at the center of a tornado can destroy buildings and other structures it passes over. Tornadoes are the most concentrated and violent storms produced by earth's atmosphere, and can produce winds in excess of 300 mph. They have been reported in most of the counties throughout the state since 1887. Oregon's tornadoes can be formed in association with large Pacific storms arriving from the west. Lincoln County tornadoes are most common to originate offshore of Lincoln County during winter months. Waterspouts often form off the Lincoln County coast but decay before reaching land. Tornado intensity is measured by the Fujita Scale (F), or the Enhanced Fujita Scale (EF) since 2007, which is based on the damage tornadoes inflict upon human and natural infrastructure and vegetation. Since 1876 there have been six (6) documented tornadoes in Lincoln County (there have been six additional tornadoes in nearby Tillamook County). All tornadoes in Lincoln County have been rated F0 (sustained winds under 73 mph). However, there has been one F1 (1975, sustained winds between 73-112 mph) and one EF2 (2016, sustained winds between 111-135 mph) in the northern part of Tillamook County.

Location and Extent

The Oregon Residential Specialty Code, Oregon Basic Wind Speeds for 50 Year Mean Recurrence Interval, lists Lincoln County within the highest wind speed category as an area impacted by 85-110 mph wind speeds.

The extent of any windstorm, including tornadoes, is determined by its track, intensity and local terrain.⁶² 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 Lincoln County.

Along the Oregon Coast wind speed is typically 75 mph for 25-year storm events, 80 mph for 50-year storm events and 90 mph for 100-year storm events. Lincoln County has experienced multiple 25-, 50-, and 100-year windstorm events over the past century with impacts often occurring countywide (Table 2-24).

History

For winter weather events (including high winds,) the National Weather Service monitors gauging stations and provides public warnings for storms and high winds.

Windstorms in Lincoln County usually occur from October to March, and their extent is determined by their track, intensity (the air pressure gradient they generate), and local terrain.⁶³ The National Weather Service uses weather forecast models to predict oncoming windstorms, while monitoring storms with weather stations in protected valley locations throughout Oregon.⁶⁴

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 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.

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. Recent disaster declarations including high winds include DR-1107 (1996) and DR 4258 (2016). See the "Tornado" section above for tornado event history. Many of the winter storm declared disasters included high winds.

Probability Assessment

Based on the available data and research the Steering Committee determined the **probability of experiencing a windstorm or tornado is "high"**, meaning at least one severe incident is likely within the next 35-year period.

Table 2-24 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

⁶² DLCD. *Oregon Natural Hazards Mitigation Plan*. 2020.

⁶³ Ibid.

⁶⁴ "Some of the Area's Windstorms." National Weather Service, Portland.
<http://www.wrh.noaa.gov/pqr/paststorms/wind.php>

that structures in Region 1, which includes Lincoln County, can expect to be exposed to 75 mph winds in a 25-year recurrence interval (4% annual probability).

Table 2-24 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 1:			
Oregon Coast	75 mph	80 mph	90 mph

Source: DLCD. *Oregon Natural Hazards Mitigation Plan*. 2020.

Vulnerability Assessment

The Steering Committee rated the county as having a **“high” vulnerability to windstorm hazards**, meaning that more than 10% of the unincorporated County’s population or property could be affected by a major disaster. The Steering Committee rated the County as having a **“low” vulnerability to a tornado hazard**, meaning that less than 1% of the unincorporated County’s population or property could be affected by a major tornado event.

Many buildings, utilities and transportation systems within Lincoln 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 Lincoln 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 1, Oregon Coast, Oregon SNHMP \(2020\)](#).

Winter Storm

Characteristics

Winter storms occurring in Lincoln County result in several natural hazards— including floods, landslides/debris flows, snow, ice and wind. Each on its own, or in combination, can completely immobilize emergency response activities, close transportation corridors, and disrupt transportation and utilities. Each of these natural hazards is individually discussed in detail in their respective sections.

Winter storms in Lincoln County can bring rain as well as snow or can be followed by rising temperatures that melt newly fallen snow. Either scenario often causes flooding; most

floods in western Oregon occur as a result of winter storms. The flood hazard is described in detail in flood section of this document.

As is the case with flood, wind as a hazard in Lincoln County most frequently occurs as part of a winter storm. The nature, history, location, extent, and probability of future events for wind, including winter storm wind, are explored in detail in the wind section of this plan.

The winter storms that affect Lincoln 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.

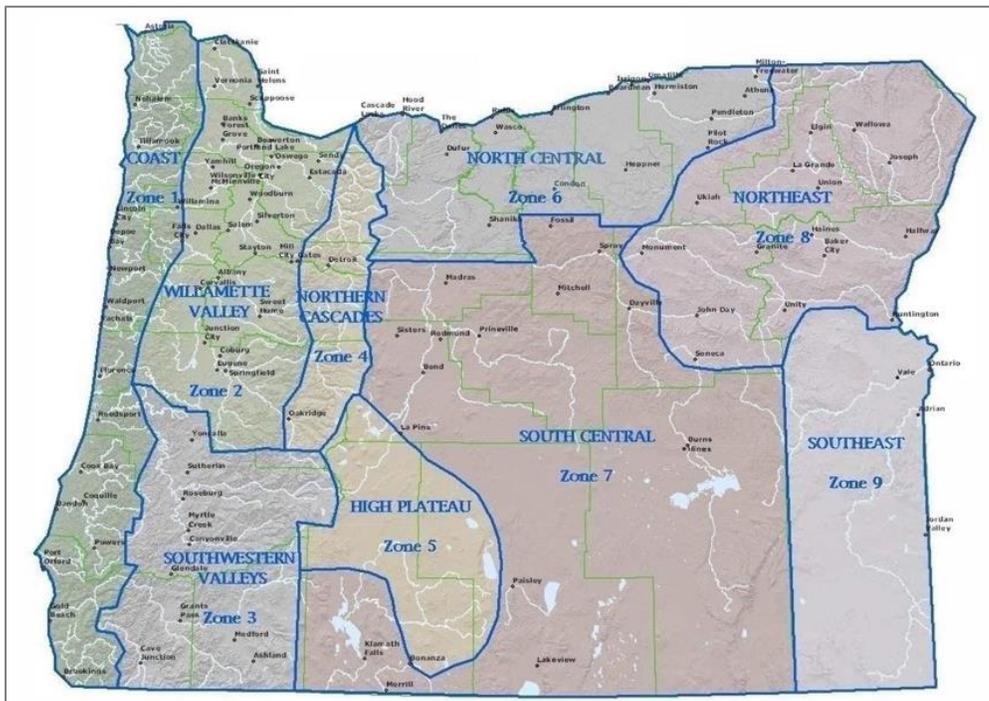
Ice storms are comprised of cold temperatures and moisture, but subtle changes can result in varying types of ice formation which may include freezing rain, sleet and hail. Of these, freezing rain can be the most damaging of ice formations.

Outside of mountainous areas, significant snow accumulations are much less likely in western Oregon than on the east side of the Cascades.

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 2-19 shows that Lincoln County is located within Zone 1: Coast. Winter storm events have relatively predictable and longer speeds of onset and the effects of winter storms are often long lasting.

Figure 2-19 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 2012 (DR-4055), 2014 (DR-4169), 2015 (DR-4258), 2016, 2017, and 2019.

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.

Probability Assessment

Based on the available data and research the Steering Committee determined the **probability of experiencing a winter storm is “high”**, meaning at least one incident is likely within the next 35-year period.

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 October through March. Lincoln County experiences moderate winter storms every year to every other year, more damaging winter storms happen less often.

Vulnerability Assessment

The Steering Committee rated the County as having a **“moderate” vulnerability to winter storm hazards**, meaning that between 1% and 10% of the unincorporated County’s population or property could be affected by a major disaster.

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 Lincoln County.

The most likely impact of snow and ice events on Lincoln 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 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, enough 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 1, Oregon Coast, Oregon SNHMP \(2020\)](#).

Volcanic Event

Significant Changes since Previous NHMP:

No significant change to the volcanic event profile.

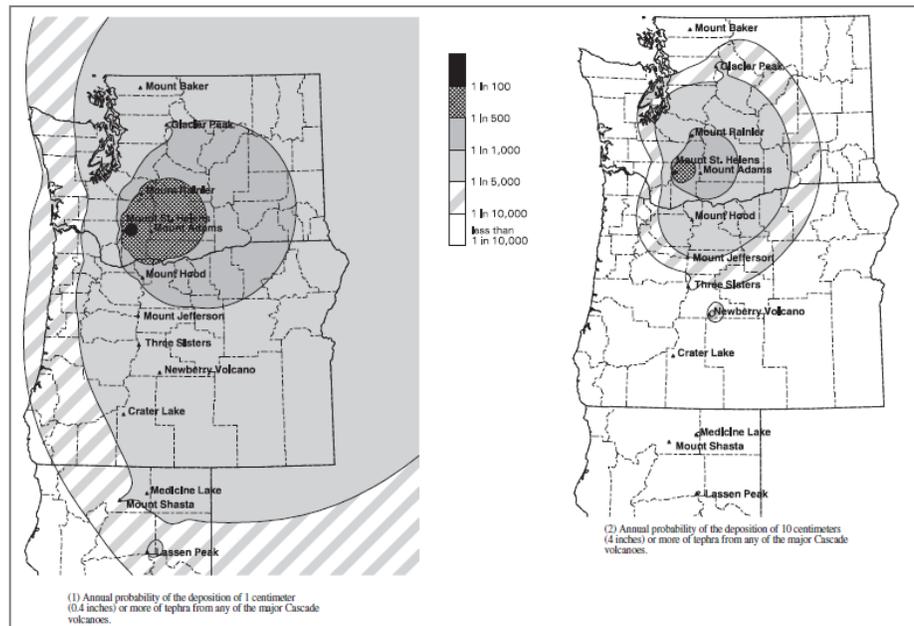
Characteristics

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

Three closest three volcanoes to Lincoln County, Mount St. Helens, Mount Hood, and Mount Jefferson, all lie to the east. Figure 2-20 depicts the potential and geographical extent of volcanic ash fall in excess of ten centimeters from a large eruption of Mt. St. Helens.

Figure 2-20 Regional Tephra-fall Maps



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

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. Volcanic activity from ash clouds that drift downwind to the county

from near or distant eruptions is possible from Mount Saint Helens, Mount Hood, the 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 Lincoln County is ash fallout, with potential 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. Regional tephra fall shows the annual probability of ten centimeters or more of ash accumulation from Pacific Northwest volcanoes.

Geologic hazard maps have been created for most of the volcanoes in the Cascade Range (including Mt. St Helens, Mt. Adams, Mt. Hood, and Mt. Jefferson) 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. Volcanic activity from more distant volcanoes will have less impact upon the County.

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

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

Other agency/ consultant reports:

- 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 St. Helens has been the most active volcano in the Cascade Range during the past 10,000 years. Mount St. Helens is in southern Washington State and has been active throughout its 50,000-year lifetime. Mount Hood is just over 100 miles northeast of the county and is more than 500,000 years old. It has had two significant eruptive periods in the past 1,500 years.

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 Steering Committee determined the **probability of experiencing volcanic activity is "low"**, meaning one incident is likely within the next 75 to 100-year period.

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 Lincoln County in forecasting potential tephra hazard problems (Figure 2-20). 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 USGS estimates there is annual probability of 0.2 to 1 percent that 10 centimeters or more of tephra (ash) accumulation will occur in Lincoln County.⁶⁵

Vulnerability Assessment

The Steering Committee rated the county as having a **“low” vulnerability to volcanic activity**, meaning that between less than 1% of the unincorporated County’s population or property could be affected by a major disaster (volcanic ash/lahar).

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).⁶⁶

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). Ashfall, and tephra, distal eruptive hazards, are of the greatest concern in Lincoln County. There are no proximal eruptive hazards in Lincoln County.

More information on this hazard can be found in the [Risk Assessment for Region 1, Oregon Coast, Oregon SNHMP \(2020\)](#).

⁶⁵ USGS, 1999, *Volcano Hazards in the Mount Jefferson Region, Oregon*, Open-File Report 99-24

⁶⁶ 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>.

Wildfire

Significant Changes since Previous NHMP:

New data is included from the Risk Report, OCCRI “Future Climate Projections”, and other technical reports including the Lincoln County CWPP.

The [Lincoln County Community Wildfire Protection Plan \(CWPP\)](#) was completed in 2010 and revised in 2018. The CWPP is hereby incorporated into this NHMP by reference and it will serve to supplement this wildfire section. The following presents a brief summary of key information; refer to the full CWPP 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

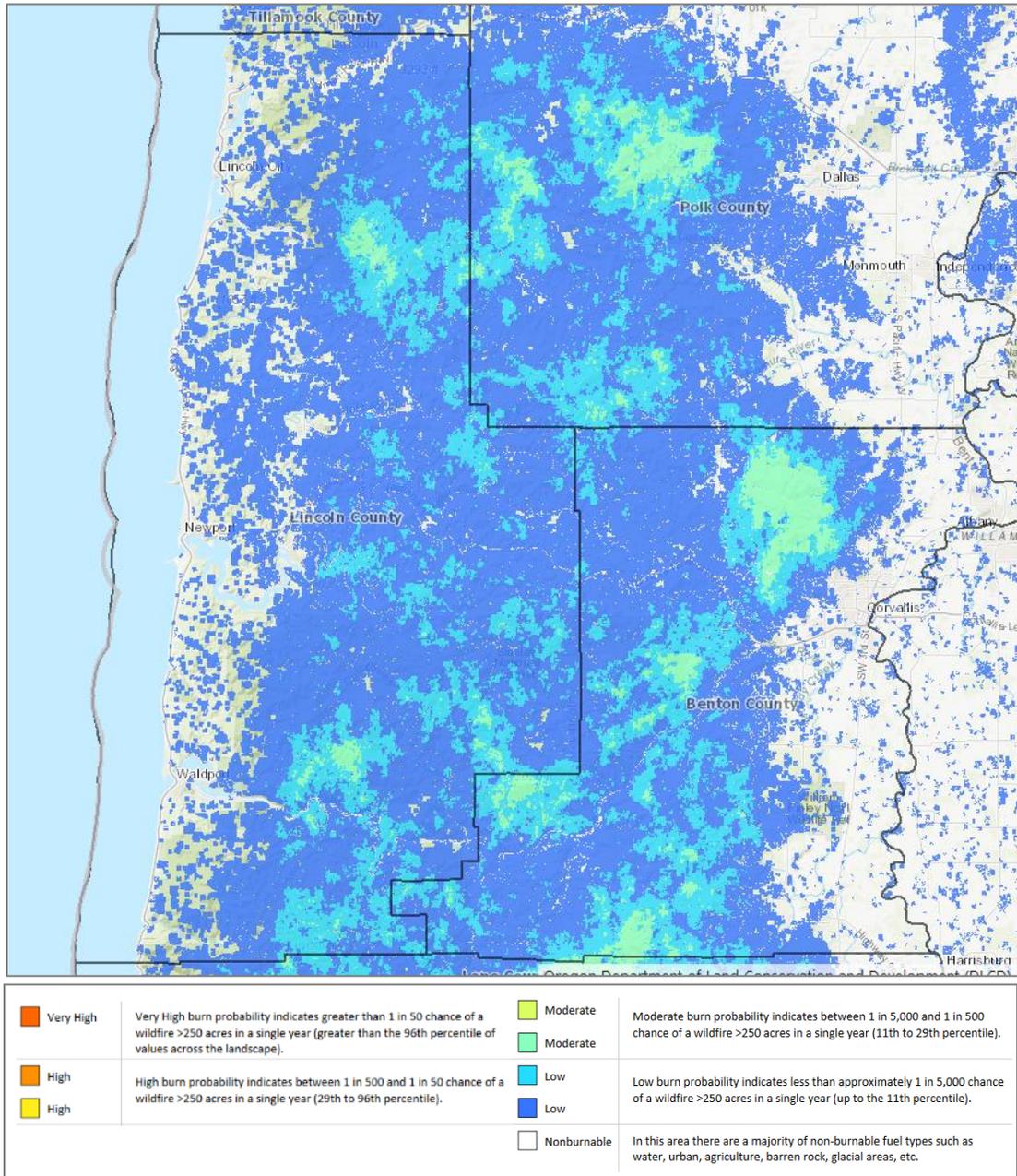
Wildfire hazard areas are commonly identified in regions as the Wildland Urban Interface (WUI). The interface is the urban-rural fringe where homes and other structures are built into a densely forested or natural landscape. If left unchecked, it is likely that fires in these areas will threaten lives and property. One challenge Lincoln County faces is from the increasing number of houses being built in the urban/rural fringe and areas with heavy fuel loads. 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.

In Lincoln County, Wildland/Urban Conflagrations burn primarily vegetative fuels, outside highly urbanized areas. The extent of the hazard is greatest along the county’s mountainous eastern boundary (see Figure 2-21). In these areas, there is low burn probability with expected flame lengths generally less than 4 to 8-feet under normal weather conditions. Most of the developed portion of the county has less severe (unburnable to low) wildfire burn probability (less than 1 in 5,000 chance of a wildfire greater than 250 acres in a single year) that include expected flame lengths less than 8-feet under normal weather conditions (except in the far eastern areas of the county where flame lengths may exceed 11-feet). Conditions vary widely and with local topography, fuels, and local weather (including wind) conditions. Under warm, dry, windy, and drought conditions expect higher likelihood of fire starts, higher intensity, more ember activity, and a more difficult to control wildfire that will include more fire effects and impacts.

Figure 2-21 Extent of Wildfire Hazard (Burn Probability)



Source: [Oregon Wildfire Risk Explorer: County Summary Report](#) (June 2020) – To explore and view map detail click hyperlink to left. July 10, 2020.

Other agency/ consultant reports:

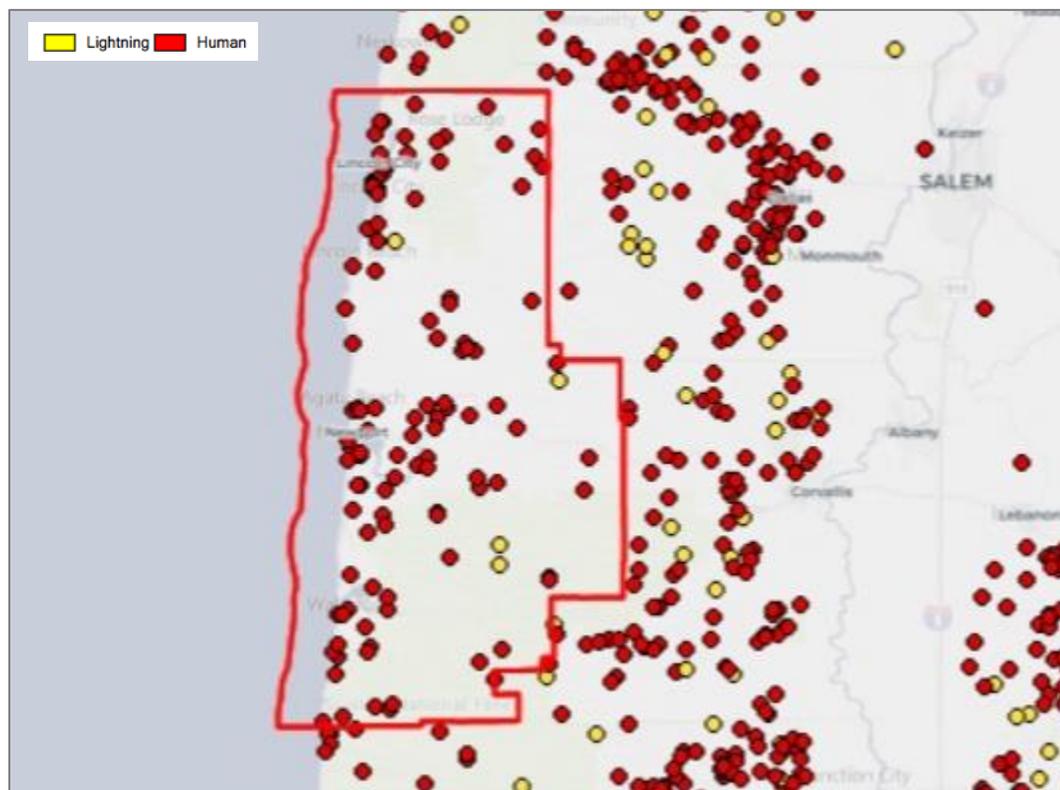
- Scott L. Stephens, Ralph E.J. Boerner, Jason J. Maghaddas, Emily E.Y. Maghaddas, Brandon M. Collins, Christopher B. Dow, Carl Edminster, Carl E. Fiedler, Danny L. Fry, Bruce R. Hartsough, Jon E. Keeley, Eric E. Knapp, James D. McIver, Carl N. Skinner, and Andrew P. Youngblood, Fuel treatment impacts on estimated wildfire carbon loss from forests in Montana, Oregon, California, and Arizona; 07 May 2012, available at <https://pubs.er.usgs.gov/publication/70157098>

History

The two most significant fires in Lincoln County occurred more than one hundred years ago. In 1849, the Siletz Fire claimed more than 800,000 acres between Lincoln and Polk County. The 1853 Yaquina Fire burned more than 450,000 acres of Douglas fir, Sitka spruce, and western cedar within Lincoln County. The Big Creek Fire (near Yachats) in 1936 burned buildings and a schoolhouse near a logging camp. Flames destroyed an “auto camp” near Yachats, and then continued toward the town. Some residences were lost, but the town was saved. Depoe Bay also lost homes to the flames, but firefighters kept the town from burning. The 1987 fire season included the Shady Lane Fire and the Rockhouse Creek fire burning 6,291 acres. In 2016, the 2500 Road fire burned over 200 acres 2 miles east of Depoe Bay.

From 2010 to 2019, 949 acres burned from a total of 110 fires.⁶⁷ Figure 2-22 shows fire starts from 2010 to 2019, fires ignited by humans are shown in red, lightning caused fires are shown in yellow. In the past 10 years 3% of all fires were caused by lightning and 97% of fires were caused by human activity (ranging from arson and debris burning to equipment use and fires caused along powerlines). Likely the most devastating wildfire year in Oregon is 2020. The Echo Mountain Fire Complex burned more than 2,500 acres and impacted hundreds of homes in the Otis, Rose Lodge, Panther Creek area.

Figure 2-22 Local Fire Starts (2010-2019)



Source: [Oregon Wildfire Risk Explorer: County Summary Report](#) (June 2020) – To explore and view map detail click hyperlink to left. July 10, 2020.

⁶⁷ Oregon Wildfire Risk Explorer, Area of Interest Report, Lincoln County, accessed September 11, 2019. http://oe.oregonexplorer.info/ExternalContent/wildfire_reports/WildfireRisk_summary_report_Lincoln_county.pdf

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. Wildland/Urban Conflagrations are not common on the Coast.

Urban fires are the most preventable type of fire, and future events depend largely on prevention measures. Although no historical urban conflagrations in have occurred, educating residents, building and maintenance code enforcement, and firefighting equipment, staff, and response systems upkeep are all steps that can ensure that highly likely localized urban fires do not become large-scale conflagrations.

While most 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.

Probability Assessment

Based on the available data and research the Steering Committee determined the **probability of experiencing a Wildfire is “high”**, meaning at least one incident is likely within the next 35-year period. See Figure 2-21 for more information on location of probable wildfires.

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 Lincoln County, creating a significant collective risk.

The Lincoln County CWPP addresses wildfires countywide and defined as either Strategic Planning Area (SPA) 1 or 2.

SPA 1, the western one-third of the county, is characterized by urban development within incorporated cities and unincorporated communities. Wildfire potential in SPA 1 is considered moderate to low. SPA 2, the eastern portion of the county, is heavily forested with development along transportation routes. Most of the land in SPA 2 is owned by timber companies, investors, the Confederated Tribes of the Siletz Indians, and state or federal agencies. Wildfire potential in SPA 2 is moderate to low due to the moderate and wet climate that prevails throughout the year.

Future Climate Projection:

According to OCCRI report *“Future Climate Projections: Lincoln County”* (Appendix G) wildfire risk is expected to increase as the frequency of higher fire danger days per year increases by 37% by the 2050s under the higher emissions scenario compared with the historical baseline.

Vulnerability Assessment

The Steering Committee rated the county as having a **“moderate” vulnerability to wildfire hazards**, meaning that between 1% and 10% of the County’s population or property could be affected by a major disaster.

Natural Hazard Risk Report for Lincoln County

The **Risk Report** ([DOGAMI, O-20-11](#)) provides hazard analysis summary tables that identify populations and property within Lincoln County that are vulnerable to landslides. The Risk Report provides distinct profiles for (1) unincorporated Lincoln County, and (2) the unincorporated communities of Otis-Rose Lodge, Salishan-Lincoln Beach, Otter Rock, Seal Rock-Bayshore, and Wakonda Beach.

The Risk Report provides an analysis of the West Wide Wildfire Risk Assessment’s Fire Risk Index (FRI) High Hazard category to identify the general level of susceptibility to the wildfire hazard. The Risk Report performed an analysis of buildings, including critical facilities, to determine exposure for each community. In general, the forested unincorporated areas of the county are most vulnerable to wildfire. Although the High Hazard category was used for analysis, it is noted that almost all communities have 30-60% exposure to the moderate wildfire hazard. According to the Risk Report the following resident population and property (public and private) within the study area may be impacted by wildfire.

Population Vulnerability (Residents)

Approximately five percent of unincorporated Lincoln County’s population (875 people) may be displaced by wildfires within Lincoln County. These people are expected to have mobility or access issues and/or may have their residences impacted by a wildfire (more people may also be impacted by smoke and traffic disruptions that are not accounted for within this analysis). It is important to note that impact from wildfires may vary depending on the specific area that experiences a wildfire. “Rural” Lincoln County has the most population at risk (725), although the population is dispersed throughout the County. About 21% of Otter Rock residents are exposed.

Table 2-25 Potentially Displaced Residents, Wildfire, by Unincorporated Area

	Resident Population	Potentially Displaced Residents	
		Number	Percent
"Rural" Lincoln County	10,293	725	7%
Otis-Rose Lodge	1,926	0	0%
Otter Rock	489	101	21%
Salishan-Lincoln Beach	2,093	42	2%
Seal Rock-Bayshore	2,766	0	0%
Wakonda Beach	1,326	7	1%
Total Unincorporated	18,893	875	5%

Source: IPRE. Data adapted from DOGAMI, Open-File Report O-20-11, Lincoln County Natural Hazard Risk Report. Tables A-1 through A-11; “Rural” Lincoln County includes all unincorporated areas that are not otherwise identified in this table. Note: City population based on the 2010 Census population.

Property Vulnerability

Properties that are most vulnerable to the wildfire hazard are those that are developed in the high hazard zone. Approximately five percent (1,091 buildings) of unincorporated Lincoln County buildings are exposed to the High Hazard wildfire zone. The percent of exposed buildings is greatest in Otter Rock (21%), however, the dispersed “rural” Lincoln County has the most exposed buildings (915). The value of exposed buildings is \$68.5 million.

Table 2-26 Exposed Buildings, Wildfire, by Unincorporated Area

	Total Buildings	Exposed Buildings		Value of Loss	
		Number	Percent	Loss Estimate (\$)	Loss Ratio
"Rural" Lincoln County	12,637	915	7.2%	\$53,619,000	6.5%
Otis-Rose Lodge	1,747	0	0.0%	\$0	0.0%
Otter Rock	634	133	21.0%	\$11,658,000	14.2%
Salishan-Lincoln Beach	2,847	38	1.3%	\$2,885,000	0.7%
Seal Rock-Bayshore	3,345	0	0.0%	\$0	0.0%
Wakonda Beach	1,614	5	0.3%	\$292,000	0.2%
Total Unincorporated	22,824	1,091	4.8%	\$68,454,000	3.7%

Source: IPRE. Data adapted from DOGAMI, Open-File Report O-20-11, Lincoln County Natural Hazard Risk Report. Tables A-1 through A-11; "Rural" Lincoln County includes all unincorporated areas that are not otherwise identified in this table.

Critical Facility Vulnerability⁶⁸

The following vulnerable critical facilities were determined to be exposed to the High wildfire hazard zone.

- North Lincoln Fire Station 1700 (*Kernville, North Lincoln Fire & Rescue District*)
- Siletz Bay Airport (*Gleneden Beach*)
- Toledo High School (*Toledo area, Lincoln County School District*)

Risk Report Identified Areas of Vulnerability⁶⁹

- Wildfire risk is high for hundreds of homes in the forested areas in the eastern portion of unincorporated Lincoln County (rural).

More information on this hazard can be found in the [Risk Assessment for Region 1, Oregon Coast, Oregon SNHMP \(2020\)](#), the [Lincoln County CWPP \(2018\)](#), and Oregon Explorer's [Wildfire Risk Explorer](#).

⁶⁸ DOGAMI, Open-File Report O-20-11, Lincoln County Natural Hazard Risk Report, Table A-2.

⁶⁹ Ibid. Page 39.

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SECTION 3: MITIGATION STRATEGY

This section outlines Lincoln 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 Steering Committee viewed 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 the 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.

To promote public policy and mitigation activities which will enhance the safety to life and property from natural hazards.

The 2020 NHMP update Steering Committee reviewed the 2015 plan mission statement and agreed it accurately describes the overall purpose and intent of this plan. This is the exact wording that was present in the 2009 and 2015 plan. The Steering Committee believes the concise nature of the mission statement allows for a comprehensive approach to mitigation planning.

Mitigation Plan Goals

Mitigation plan goals are more specific statements of direction that Lincoln 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 particular action items. The goals listed here serve as checkpoints as agencies and organizations begin implementing mitigation action items.

Public participation was a key aspect in developing the plan goals. Meetings with the project steering committee, stakeholder interviews and public workshops all served as methods to obtain input and priorities in developing goals for reducing risk and preventing loss for natural hazards in Lincoln County.

All the plan 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. Below is a list of the re-confirmed plan goals:

Goal 1: Protect life and reduce injuries resulting from natural hazards.

Goal 2: Minimize public and private property damages and the disruption of essential infrastructure and services from natural hazards.

Goal 3: Implement strategies to mitigate the effects of natural hazards and increase the quality of life and resilience of economies in Lincoln County.

Goal 4: Minimize the impact of natural hazards while protecting, restoring, and sustaining environmental processes.

Goal 5: Enhance and maintain local capability to implement a comprehensive hazard loss reduction strategy.

Goal 6: Document and evaluate progress in achieving hazard mitigation strategies and action items.

Goal 7: Motivate the public, private sector, and government agencies to mitigate the effects of natural hazards through information and education.

Goal 8: Apply development standards that mitigate or eliminate the potential impacts of natural hazards.

Goal 9: Mitigate damage to historic and cultural resources from natural hazards.

Goal 10: Increase communication, collaboration, and coordination among agencies at all levels of government and the private sector to mitigate natural hazards.

Goal 11: Integrate local NHMPs with comprehensive plans and implementing measures.

(Note: although numbered the goals are not prioritized.)

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.

Most of the action items were first created during the previous NHMP planning processes. During these processes, the Steering Committee 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 Steering Committee meetings and drafted specific actions that met the intent of the Steering Committee. All actions were then reviewed by the Steering Committee, discussed at length and revised as necessary before becoming a part of this document.

Figure 3-I Development of Action Items



Action Item Matrix

The action item matrix (Table 3-1) portrays the overall action plan framework and identifies linkages between the NHMP goals, partnerships (coordination and partner organizations), and actions. The matrix documents a brief description of the action, coordinating organization(s), timeline (ongoing, short, medium, or long), priority, and other jurisdictions that are partners to the action. Refer to Volume III, Appendix A for detailed information for each action.

Action Item Framework

Many of the Lincoln County NHMP’s recommendations are consistent with the goals and objectives of the County’s existing plans and policies. Where possible, Lincoln 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 NHMP’s action items through such plans and policies increases their likelihood of being supported and implemented. See *Volume II for the actions for each participating city or special district.*

Action Item Prioritization

Table 3-1 presents a list of mitigation actions. The steering committee decided to modify the prioritization of action items in this update to reflect current conditions (risk assessment), needs, and capacity. High priority actions are shown in **bold** text with grey highlight. The County will focus their attention, and resource availability, upon these achievable, high leverage, activities over the next five-years. Although this methodology provides a guide for

the steering committee in terms of implementation, the steering committee 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 currently listed as the highest priority.

See Volume III, Appendix A for an updated list of action items and Appendix B for information on additional changes.

Table 3-1 Lincoln County Action Items

Natural Hazard Action ID	Action Item	Coordinating Organization (Lead)	Cost	Timing	Partner Jurisdiction(s)						
					Depoe Bay	Lincoln City	Newport	Siletz	Toledo	Waldport	Yachats
Multi-Hazard #1	Consider Local Energy Assurance Planning for critical areas countywide	Emergency Management	L to M	Long	X	X	X	X	X	X	X
Multi-Hazard #2	Improve technology capacity of communities, agencies and responders needed to adequately map hazard areas, broadcast warnings, inform, and educate residents and visitors of natural hazard dangers	Emergency Management	L to M	Ongoing	X	X	X	X	X	X	X
Multi-Hazard #3	Develop, enhance, and implement strategies for debris management and/or removal after natural hazard events.	Emergency Management, Solid Waste District	L	Short	X	X	X	X	X	X	X
Multi-Hazard #4	Work with coastal communities, citizen groups, property owners, recreation areas, emergency responders, schools and businesses in promoting natural hazard mitigation opportunities.	Planning and Development, Emergency Management	L	Ongoing	X	X	X	X	X	X	X
Multi-Hazard #5	Encourage purchase of hazard insurance for business and homeowners by forming partnerships with the insurance and real estate industries.	Emergency Management	L	Ongoing	X			X		X	X
Multi-Hazard #6	Integrate the NHMP into County and City comprehensive plans.	Planning and Development	L	Medium	X	X	X	X	X	X	X
Multi-Hazard #7	Prepare long-term catastrophic recovery plan	Board of Commissioners/ Policy Group	L	Medium		X	X	X	X	X	X

Natural Hazard Action ID	Action Item	Coordinating Organization (Lead)	Cost	Timing	Partner Jurisdiction(s)						
					Depeo Bay	Lincoln City	Newport	Siletz	Toledo	Waldport	Yachats
Multi-Hazard #8	Review recommended mitigation strategies identified in DOGAMI reports (including O-19-06, O-20-03, O-20-11) and make recommendations to BOC for consideration as long-term mitigation strategies.	Planning and Development	L	Short							
Coastal Erosion #1	Improve knowledge of effects of climate change and understanding of vulnerability and risk to life and property in hazard prone areas.	Planning and Development	L	Ongoing	X					X	X
Coastal Erosion #2	Evaluate revising existing county coastal hazard area regulations based on the DOGAMI risk zone mapping.	Planning and Development	L	Ongoing	X	X				X	X
Earthquake #1	Integrate new earthquake hazard mapping data for Lincoln County and improve technical analysis of earthquake hazards.	GIS	L	Short	X	X	X	X	X	X	X
Earthquake #2	Identify, inventory, and retrofit county controlled critical facilities for seismic and tsunami rehabilitation (consider both structural and non-structural retrofit options).	Emergency Management	H	Long	X	X	X	X	X	X	X
Earthquake #3	Stay apprised of new earthquake and landslide data and perform mitigation of infrastructure where possible to increase resilience of critical transportation links to the valley and along the coast during earthquake events.	Roads/ Public Works	L	Long	X	X	X	X	X	X	X

Natural Hazard Action ID	Action Item	Coordinating Organization (Lead)	Cost	Timing	Partner Jurisdiction(s)						
					Depoe Bay	Lincoln City	Newport	Siletz	Toledo	Waldport	Yachats
Tsunami #1	Relocate county controlled critical/essential facilities and key resources, and encourage the relocation of other critical facilities and key resources that house vulnerable populations (e.g., hospitals, nursing homes, etc.) that are within the tsunami inundation zone and likely to be impacted by tsunami.	Emergency Management	H	Long	X					X	X
Tsunami #2	Implement land use strategies and options to increase community resilience	Planning and Development	L	Medium		X					X
Flood #1	Explore steps needed to qualify Lincoln County for participation in the NFIP Community Rating System (CRS)	Planning and Development	L to M	Short				X	X	X	X
Flood #2	Update the Lower Siletz Flood Mitigation Action Plan; develop flood mitigation action plan(s) for the lower Alsea and Salmon River, and Drift Creek and other areas.	Planning and Development	L to M	Short					X	X	X
Flood #3	Work with affected property owners to elevate or relocate non-conforming, pre-FIRM structures in flood hazard areas	Planning and Development	H	Ongoing	X				X	X	
Flood #4	Continue compliance with the National Flood Insurance Program (NFIP).	Planning and Development	L	Ongoing	X	X	X	X	X	X	X
Landslide #1	Encourage construction, site location and design that can be applied to steep slopes to reduce the potential threat of landslides.	Planning and Development	L	Ongoing	X	X	X		X	X	X
Landslide #2	Protect existing development in landslide-prone areas	Emergency Management, Public Works	L to H	Ongoing			X			X	

Natural Hazard Action ID	Action Item	Coordinating Organization (Lead)	Cost	Timing	Partner Jurisdiction(s)						
					Depoe Bay	Lincoln City	Newport	Siletz	Toledo	Waldport	Yachats
Landslide #3	Collaborate with the Oregon Department of Geology and Mineral Industries to work on landslide risk reduction.	Planning and Development	L	Long	X	X	X	X		X	X
Severe Weather #1	Develop and implement programs to keep trees from threatening lives, property, and public infrastructure during severe weather events (windstorms, tornados, and winter storms).	Public Works	L to H	Ongoing			X	X	X	X	X
Severe Weather #2	Continue and enhance severe weather (windstorm, tornado, winter storm) resistant construction methods where possible to reduce damage to utilities and critical facilities from windstorms and winter storms (snow/ice). In part, this may be accomplished by encouraging electric utility providers to convert existing overhead lines to underground lines.	Public Works	L	Ongoing	X	X		X	X	X	X
Wildfire #1	Implement actions identified within the Lincoln County Community Wildfire Protection Plan (CWPP) and continue to participate with ongoing maintenance and updates.	Emergency Management	L to H	Ongoing	X	X	X	X	X	X	X

Source Lincoln County NHMP Steering Committee, updated 2020

Cost: L (less than \$50,000), M (\$50,000-\$100,000), H (more than \$100,000)

Timing: Ongoing (continuous), Short (1-4 years), Medium (4-10 years), Long (10 or more years)

SECTION 4:

PLAN IMPLEMENTATION AND MAINTENANCE

The common objective of every local mitigation plan is to reduce the community's risk from and exposure to natural hazards before they occur. One of the most effective ways of institutionalizing mitigation in the community is to incorporate natural hazard planning into the community's comprehensive planning activities. In Oregon, comprehensive plans address a wide range of community issues and sectors – from land use and transportation to natural resources and economics. Lincoln County's Comprehensive plan addresses the following broad categories:

- Land Use and Urbanization
- Intergovernmental Coordination
- Citizen Involvement
- Air, Land and Water Resources
- Natural Hazards
- Forest, Agriculture, Estuarine, Coastal, Beaches and Dunes, and Open Space
- Economy
- Transportation
- Energy
- Housing
- Recreation
- Public Facilities
- Natural Resources
- Historic and Cultural Resources

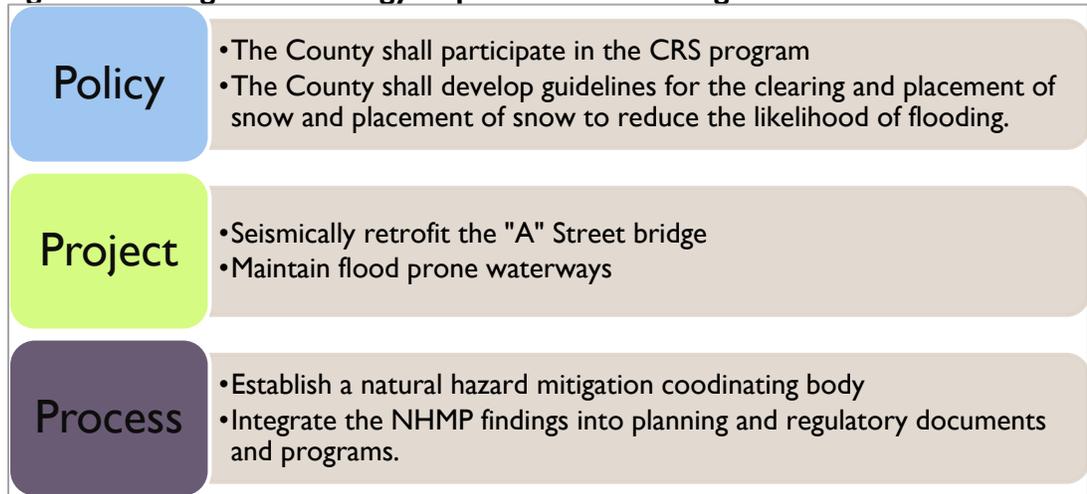
This section outlines a comprehensive approach to implement the mitigation strategies outline in this Multi-jurisdictional Natural Hazards Mitigation Plan (NHMP). This implementation strategy is informed by information collected and developed during the NHMP update process and concurrent Lincoln County Risk MAP project. The implementation strategy strives to demonstrate how risk specific data, both natural hazard and community vulnerability, can be integrated in existing programs, projects and policies.

For the purposes of this NHMP, the Plan Implementation and Maintenance section details the formal process that will ensure that the Lincoln County Multi-jurisdictional Natural Hazards Mitigation Plan (NHMP) remains an active and relevant document. This section includes a schedule for monitoring and evaluating the plan 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 plan maintenance and implementation process.

Implementing the Plan

There are three primary ways mitigation strategies can be implemented at the local level: Policies, Projects, and Processes. Figure 4-1 illustrates these categories with examples.

Figure 4-1 Mitigation Strategy Implementation Categories



Source: Oregon Partnership for Disaster Resilience

The success of the Lincoln County NHMP depends on how well the outlined action items are implemented. To ensure that the activities identified are implemented, the following steps will be taken. The plan will be formally adopted, a coordinating body will be assigned, a convener shall be designated, the identified activities will be prioritized and evaluated, and finally, the plan will be implemented through existing plans, programs, and policies.

Table 4-1 on the following pages demonstrates how the actions will be implemented within Lincoln County. For detailed information on action item implementation see Table 4-2.

Plan Adoption

The Lincoln County NHMP was developed and will be implemented through a collaborative process. After the Plan is locally reviewed and deemed complete, the Lincoln County Conveners submits it to the State Hazard Mitigation Officer (SHMO) at the Oregon Military Department – Office of Emergency Management (OEM). OEM submits the plan to the Federal Emergency Management Agency (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 and participating jurisdictions (cities and special districts) will adopt the plan via resolution. Once adopted and approved by FEMA the County and each participating jurisdiction that adopted their NHMP addendum will gain eligibility for the Building Resilient Infrastructure and Communities Grant Program, the Hazard Mitigation Grant Program, and the Flood Mitigation Assistance Grant Program.

Table 4-I Mitigation Implementation Opportunities for Lincoln County Hazards/ Risks

System	Potential Risks/Challenges	Mitigation and Implementation Opportunities	Community Planning Connections
<p>Infrastructure</p>	<p><u>Major Findings</u></p> <ul style="list-style-type: none"> Built infrastructure systems rely heavily on institutional standards for guidance, causing delayed implementation of new design or construction practices. Aging infrastructure and population growth are expected to create supply issues over the next 20-50 years. During an emergency, some of the different systems that make up the infrastructure sector are more prepared than others to meet operating and external standards. <p><u>Crucial Vulnerabilities</u></p> <ul style="list-style-type: none"> Communities do not have adequate fire protection due to inadequate water distribution US Highway 101 is at capacity during the summer months, including chokeholds at key city bridges Rural areas do not have as much built-in redundancy No redundancies exist in the wastewater system 	<p><u>Policy Opportunities:</u></p> <ul style="list-style-type: none"> Develop a long-term (20-50 year) infrastructure vision Focus Capital Improvement Planning on long-term infrastructure resilience Develop local energy assurance plans to increase redundancy and connectivity of energy systems. Develop formal mutual aid agreements between governments, districts – particularly water utilities. Comprehensive Plan Periodic Review <p><u>Project Opportunities:</u></p> <ul style="list-style-type: none"> Utilize Risk Report data to identify areas of critical infrastructure vulnerability (roads, bridges, buildings, water storage, etc.) and mitigate. Utilize Risk Report data to better assess community ability to evacuate residents/ tourists during a CSZ event. Retrofit water tanks/ reservoirs to withstand a CSZ event. Retrofit systems to withstand local tsunami events, include the development of system redundancies Utilize Risk Report data to enhance understanding of coastal erosion and mitigate vulnerability to roads, bridges, water pump stations, etc. <p><u>Process Opportunities:</u></p> <ul style="list-style-type: none"> Develop an infrastructure sub-committee to the NHMP coordinating body to prioritize and implement identified and new infrastructure actions. Identify supply chain gaps and develop a system to address them. 	<ul style="list-style-type: none"> Natural Hazards Mitigation Plan Transportation System/ Master Plans Access Management Plans Comprehensive Plans Local land use ordinances Port Business Strategic Plans and Capital Facilities Plans Lincoln County School District Capital Facilities Plan Solid Waste Management Plans Wastewater System Master Plans Water System Master Plans Bayshore Fore dune Management Plan (and Overlay Zone)
<p>Public Safety</p>	<p><u>Major Findings</u></p> <ul style="list-style-type: none"> Public Safety (law enforcement, fire) relies on property tax for funding, which may not sustain 	<p><u>Policy Opportunities:</u></p> <ul style="list-style-type: none"> Develop long-term public safety planning (CONOPS) to ensure the availability of resources during a catastrophic event (human, fuel, replacement/ repair parts, etc.) 	<ul style="list-style-type: none"> Natural Hazards Mitigation Plan Capital Improvement Plans Emergency Operations Plans Local land use ordinances Sherriff's Office Strategic Plan

System	Potential Risks/Challenges	Mitigation and Implementation Opportunities	Community Planning Connections
	<p>needed service over the next 20-years</p> <ul style="list-style-type: none"> Resources that function on a day to day basis (volunteer fire departments, interagency mutual aid agreements, specialty teams), would be heavily stressed during long term, widespread events Current budget and regulatory unknowns prevent planning beyond a two- to five-year timeframe <p><u>Crucial Vulnerabilities</u></p> <ul style="list-style-type: none"> Hazards that impact the entire region reduce the availability of resources from partner agencies and neighboring jurisdictions Extended events (more than 12 hours) tap available capacity Available fuel is a key limiting factor 	<ul style="list-style-type: none"> Develop a plan to attract and retain career public safety personnel (fire, police, etc.) Implement policy to require tourist accommodations to post evacuation routes to assembly areas (e.g., Newport policy). Develop stable long-term funding strategy <p><u>Project Opportunities:</u></p> <ul style="list-style-type: none"> Relocate critical and essential facilities out of the tsunami inundation area. Relocate mitigate critical and essential facilities from the flood hazard. <p><u>Process Opportunities:</u></p> <ul style="list-style-type: none"> Develop a Public Safety sub-committee to the NHMP coordinating body to prioritize and implement identified and new public safety actions. 	<ul style="list-style-type: none"> Regional Economic Development Strategy
Social Services	<p><u>Major Findings</u></p> <ul style="list-style-type: none"> Institutional and volunteer providers do their best to operate on a day to day basis; their ability to respond after a major disaster strikes is limited due to supplies, location of personnel, and lack of services Urban migration is especially detrimental to social services and the ability to provide for those in more rural locations The social fabric of the system county wide is strong and local leadership is supportive to planning efforts 	<p><u>Policy Opportunities:</u></p> <ul style="list-style-type: none"> Develop aid agreements between jurisdictions and districts to support recovery efforts. <p><u>Project Opportunities:</u></p> <ul style="list-style-type: none"> Develop communication redundancy for system. Relocate critical and essential facilities out of the tsunami inundation area (e.g., mental health clinics, ambulance service, etc.). Retrofit critical and essential facilities to address the earthquake hazard. Develop redundancies within the social services sector to assure that supplies and personnel are distributed across the county. Mitigate repetitive loss properties along the lower Siletz River near Lincoln City. 	<ul style="list-style-type: none"> Natural Hazards Mitigation Plan Community Health Improvement Plan Local land use ordinances Housing strategy Hospital/Clinics plan Medical Reserve Corps Regional Economic Development Strategy

System	Potential Risks/Challenges	Mitigation and Implementation Opportunities	Community Planning Connections
	<p><u>Crucial Vulnerabilities</u></p> <ul style="list-style-type: none"> • An aging population combined with a patchwork of service providers and lack of services • Large number of residents vulnerable to disasters with limited ability to shelter them after a disaster • Medical supplies are limited to a 2-5 day supply at any given time 	<p><u>Process Opportunities:</u></p> <ul style="list-style-type: none"> • Develop a Social Services sub-committee to the NHMP coordinating body to prioritize and implement identified and new social services actions. 	

Source: 2014 Risk MAP Resilience Workshop, revised 2020

Convener

The Lincoln County Emergency Manager and Director of Planning and Development will take responsibility for plan implementation and will facilitate the Natural Hazard Mitigation Coordinating body meetings and will assign tasks such as updating and presenting the plan to the rest of the members of the committee. Plan implementation and evaluation will be a shared responsibility among all the assigned Natural Hazard Mitigation Coordinating Body Members. The conveners' responsibilities include:

- Coordinate steering committee meeting dates, times, locations, agendas, and member notification;
- Documenting the discussions and outcomes of committee meetings;
- Serving as a communication conduit between the steering committee and the public/stakeholders;
- Identifying emergency management-related funding sources for natural hazard mitigation projects; and
- Utilizing the Risk Assessment as a tool for prioritizing proposed natural hazard risk reduction projects.

Coordinating Body

The Lincoln County Conveners will form a Natural Hazard Mitigation Coordinating Body (Steering Committee or Coordinating Body) for updating and implementing the NHMP. The coordinating body responsibilities include:

- Attending future maintenance and plan update meetings (or designating a representative to serve in your place);
- Serving as the local evaluation committee for funding programs such as the Pre-Disaster Mitigation Grant Program, the Hazard Mitigation Grant Program funds, and Flood Mitigation Assistance program funds;
- Prioritizing and recommending funding for natural hazard risk reduction projects;
- Evaluating and updating the Natural Hazards Mitigation Plan in accordance with the prescribed maintenance schedule;
- Developing and coordinating ad hoc and/or standing subcommittees as needed; and
- Coordinating public involvement activities.

Members

The following jurisdictions, agencies, and/ or organizations were represented and served on the steering committee during the development of the Lincoln County NHMP (for a list of individuals see the Acknowledgements section of this NHMP):

- Lincoln County
- City of Depoe Bay
- City of Lincoln City
- City of Newport
- City of Siletz
- City of Toledo
- City of Waldport
- City of Yachats
- Central Lincoln Peoples Utilities District

- Lincoln County School District
- Seal Rock Water District
- U.S. Coast Guard-North Bend
- Oregon State Parks
- Confederated Tribes of Siletz Indians
- Department of Land Conservation and Development

To make the coordination and review of the Lincoln County Multi-jurisdictional NHMP as broad and useful as possible, the coordinating body will engage additional stakeholders and other relevant hazard mitigation organizations and agencies to implement the identified action items. Specific organizations have been identified as either internal or external partners on the individual action item forms found in Appendix A. The roles of the internal and external partners are listed below.

Roles (Locals, DLCD, FEMA)

Implementation of the NHMP actions will be led primarily by local initiative through the identified implementation program (Table 4-1 and Table 4-2). FEMA, DLCD and other state agencies (OEM, DOGAMI, Business Oregon) will assist with project development and implementation when asked.

Locals

The conveners (Emergency Management and Planning and Development) will meet monthly to discuss progress towards plan implementation. The local coordinating body as identified in the NHMP process will initiate the process of implementing the identified actions. The actions identified in this report will also be provided as distinct actions within the county's NHMP. Quarterly, and as needed, the committee will meet to review actions and report on progress. As needed, the local committee will call upon DLCD staff (Regional Solutions Team, Oregon Coastal Management program) to provide technical assistance in moving an action forward.

DLCD

Governor Kitzhaber's Executive Order No. 11-12 signed on December 16, 2011 established 11 Regional Solutions Centers throughout the State of Oregon. State agency staff are co-located in Regional Solutions Centers and take a collaborative approach to problem-solving to maximize economic and community development opportunities at the state, regional and local level. Regional Advisory Committees adopt annual work plans that focus Team members' attention on projects that will leverage public, private and civic sector resources to address regional priorities. DLCD actively participates in the Regional Solutions framework along with the Oregon Military Department – Office of Emergency Management, Department of Environmental Quality, Department of Transportation, Business Oregon, the Infrastructure Finance Authority, and others. Key stakeholders include counties, cities, special districts, hospitals, utility providers, fire departments, business and property owners, volunteer groups (e.g., CERT), and citizens. Because the Regional Solutions Team is active in

this region, it should be viewed as a potential resource during the implementation phase of this planning effort.¹

FEMA

Staff from FEMA will assist on an as needed basis to provide technical assistance with action item implementation. They will aid with federal grant programs.

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 plan, FEMA requires the identification of existing programs that might be used to implement these action items. Lincoln County, and the participating cities and special districts, 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, Lincoln County, and participating jurisdictions (cities and special districts), will work to incorporate the recommended mitigation action items into existing programs and procedures.

Many of the NHMP's recommendations are consistent with the goals and objectives of the participating cities', special districts', and county's existing plans and policies. Where possible, Lincoln County, and participating jurisdictions, should implement the NHMP's recommended actions 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 NHMP's action items 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 & 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 III - Appendix C, *Community Profile* and Volume III, *Jurisdictional Addenda*.

Plan Maintenance

Plan maintenance is a critical component of the NHMP. Proper maintenance of the plan ensures that this plan will maximize the county and participating city's efforts to reduce the risks posed by natural hazards. This section was developed by the University of Oregon's Partnership for Disaster Resilience and includes a process to ensure that a regular review

¹ By way of example, Clatsop County and the cities of Gearhart, Seaside and Cannon Beach are served by the North Coast Regional Solutions Center located in the City of Tillamook. The North Coast Regional Solutions' adopted 2014-15 Work Plan identifies 'Resilience Planning' as one of its priority projects.

and update of the plan occurs. The conveners, coordinating body, and local staff are responsible for implementing this process, in addition to maintaining and updating the plan through a series of meetings outlined in the maintenance schedule below.

Meetings

The conveners will meet monthly to ensure implementation of the NHMP remains on schedule. The Coordinating Body will meet quarterly to complete the following tasks. During at least one meeting per year, the Coordinating Body will:

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

During at least one other meeting the Coordinating Body will:

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

These meetings are an opportunity for the cities and special districts to report back to the county on progress that has been made towards their components of the NHMP.

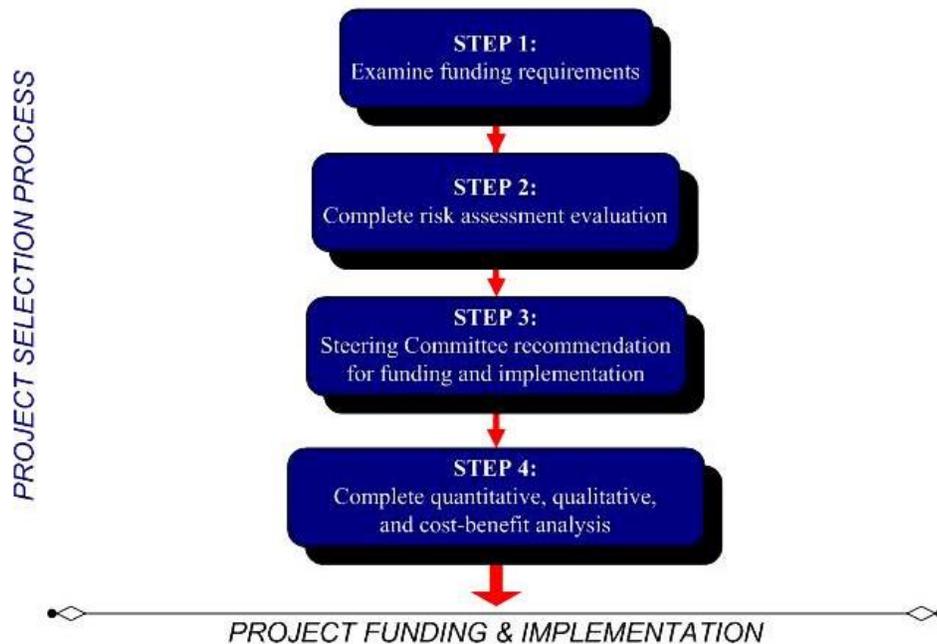
Monthly meetings between the conveners (Lincoln County Emergency Management and Planning and Development) will begin in the month following local adoption (expected October 2020). The Coordinating Body will meet quarterly and is scheduled to occur in October, January, April, and July of each year.

The conveners will be responsible for documenting the outcome of the semi-annual meetings in Appendix B. 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 NHMP that remains current and relevant to the participating jurisdictions.

Project Prioritization Process

The Disaster Mitigation Act of 2000 requires that jurisdictions identify a process for prioritizing potential actions. 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.

Figure 4-1 Action Item and Project Review Process



Source: Oregon Partnership for Disaster Resilience, 2008.

Step 1: Examine funding requirements

The first step in prioritizing the plan’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 Building Resilient Infrastructure and Communities competitive grant program (BRIC), 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 Appendix E, *Grant Programs and Resources* for a more comprehensive list of potential grant programs.

Because grant programs open and close on differing schedules, the coordinating body will examine upcoming funding streams’ requirements to determine which mitigation activities would be eligible. The coordinating body 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 coordinating body’s semi-annual plan maintenance meetings.

Step 2: Complete risk assessment evaluation

The second step in prioritizing the plan’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 coordinating body will determine whether the plan’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 coordinating body 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.

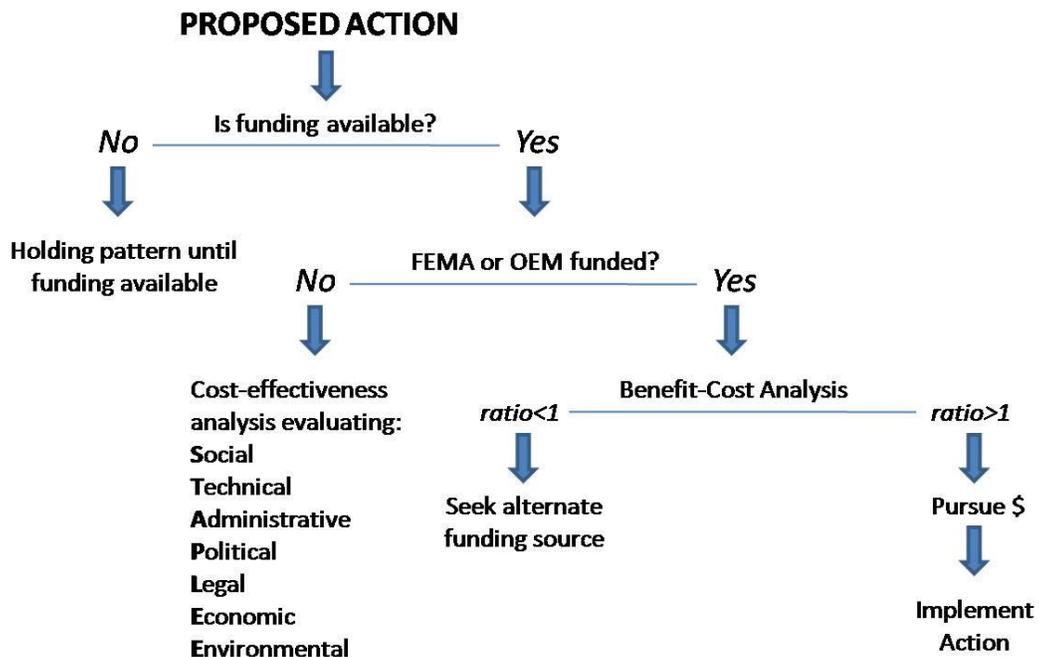
Step 3: Committee Recommendation

Based on the steps above, the coordinating body will recommend which mitigation activities should be moved forward. If the coordinating body decides to move forward with an action, the coordinating organization designated on the action item form will be responsible for taking further action and, if applicable, documenting success upon project completion. The coordinating body 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) benefit/cost analysis, and (2) cost-effectiveness analysis. Conducting benefit/cost 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 Committee will use a Federal Emergency Management Agency-approved cost-benefit analysis tool to evaluate the appropriateness of the activity. A project must have a benefit/cost 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 committee 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. The Oregon Partnership for Disaster Resilience 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 Lincoln County NHMP. Although members of the Coordinating Body represent the public to some extent, the public will have the opportunity to continue to provide feedback about the Plan.

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

- Post copies of their plans 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.

In addition to the involvement activities listed above, Lincoln County will ensure continued public involvement by posting the Lincoln County NHMP on the County's website (<https://www.co.lincoln.or.us/planning/page/natural-hazards-mitigation-plan>). The Plan 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 Plan

This plan will be updated every five years in accordance with the update schedule outlined in the Disaster Mitigation Act of 2000. **The Lincoln County NHMP is due to be updated by December 29, 2025.** The convener will be responsible for organizing the coordinating body to address plan update needs. The coordinating body will be responsible for updating any deficiencies found in the plan, and for ultimately meeting the Disaster Mitigation Act of 2000's plan update requirements.

The following 'toolkit' (Table 4-2) can assist the convener in determining which plan update activities can be discussed during regularly scheduled plan maintenance meetings, and which activities require additional meeting time and/or the formation of sub-committees.

Table 4-2 Natural Hazards 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

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, revised 2020.