Tillamook County
Multi-Jurisdictional
Natural Hazards Mitigation Plan

August 2017

Acknowledgments

Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan Update Steering Committee

Tillamook County

Bill Baertlein, Chair, County Commissioner
Mark Labhart, Former Chair and County Commissioner
Sarah Absher, Community Development Planner

City of Bay CIty

Shaena Peterson, Mayor
Lin Downey, City Recorder
Angie Cherry, Planning Secretary

City of Garibaldi

John O'Leary, City Manager
Terry Kandle, Emergency Preparedness Manager

City of Manzanita

Linda Kozlowski, City Council Member
Jerry Taylor, City Manager
Cynthia Alamillo, Assistant City Manager

City of Nehalem

Jim Welch, City Council Member,
Dale Shafer, City Manager & City Recorder

City of Rockaway Beach

Joanne Aagaard, Mayor,
Lars Gare, City Manager
Terry Michel, City Recorder

City of Tillamook

Suzanne Weber, Mayor
Paul Wyntergreen, City Manager

City of Wheeler

Stevie Burden, Mayor
Geoff Wullschlager

Port of Tillamook Bay

Michele Bradley, General Manager
Aaron Palter, Project Coordinator

Port of Garibaldi

Michael Saindon, General Manager

State and Federal Agencies

Federal Emergency Management Agency, Region X

Brett Holt, Amanda Siok, Cynthia McCoy

Oregon Department of Land Conservation and Development

Patrick Wingard, Meg Reed, Dave Lentzner, Marian Lahav, Steve Lucker, Laren Woolley

Oregon Department of Geology and Mineral Industries

Jed Roberts, Matt Williams, Christina Appleby

Oregon Military Department, Office of Emergency Management

Angie Lane, Joseph Murray, Christine O'Day, Nicole Hanson

University of Oregon, Oregon Partnership for Disaster Resilience

Josh Bruce, Michael Howard

Oregon Department of Forestry

Kate Skinner, Ed Wallmark

Other Contributors

Tillamook County

Isabel Gilda, Barrett Chaix, Rachel Hagerty

Project Managers

Oregon Department of Land Conservation and Development

Marian Lahav

Tillamook County

Sarah Absher

Federal Guidance and Review Team

Federal Emergency Management Agency Region X, Mitigation Division

Brett Holt, Amanda Siok

Desktop Publisher

Oregon Department of Geology and Mineral Industries

Deb Schueller

Funding for the Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan Update was provided in part by grants PDMC-PL-10-OR-2014-003, EMW-2014-CA-00288, and EMW-2014-CA-00279-S01 from the Federal Emergency Management Agency.

Table of Contents

List of Figures

List of Tables

I. INTRODUCTION

The dramatic increase in the costs associated with natural disasters over the past decades fostered interest in identifying and implementing effective means of reducing vulnerability. On February 26, 2002, the Federal Emergency Management Agency (FEMA) published Interim Final Rule 44 CFR Part 201, which required all states and local governments to develop natural hazards mitigation plans to be eligible for certain hazard mitigation grant programs, and in the case of the states, to be eligible for certain categories of disaster assistance.

Disasters occur as a predictable interaction among three broad systems: natural systems (e.g., watersheds and continental plates), the built environment (e.g., cities and roads), and social systems (community organization infrastructure that includes demographics, business climate, service provision, etc.). What is not predictable is exactly when natural hazards will occur or the extent to which they will affect communities within the state. However, with careful planning and collaboration it is possible to minimize the losses that can result from natural hazards.

Hazard mitigation is defined at 44 CFR 201.2 as *any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards*. Hazard mitigation is the responsibility of individuals, private businesses and industries, state and local governments, and the federal government. Engaging in mitigation actions provides the state, counties, cities, businesses, and citizens with a number of benefits: fewer injuries and deaths; less damage to buildings, critical facilities, and infrastructure; diminished interruption in essential services; reduced economic hardship; minimized environmental harm; and quicker, lower-cost recovery.

The 2017 Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan (MJNHMP, Plan) contains the most complete and up-to-date description of the natural hazards that impact each of the cities, ports, larger unincorporated communities, and unincorporated County. It assesses the probability of hazard occurrence and local vulnerabilities then establishes goals, objectives, and strategies for natural hazard mitigation. It identifies resources for implementing the mitigation strategies and also establishes processes, procedures, and responsibilities for periodically reviewing the plan, evaluating its effectiveness, and making adjustments throughout its five-year life. Every five years the plan must be reviewed in its entirety, updated as necessary, and re-approved by FEMA to maintain eligibility for FEMA's natural hazard mitigation grant programs.

Structure

Earlier editions of the Tillamook County Multi-Jurisdictional NHMP were approved by FEMA in 2006 and 2012. For the 2017 update, the entire plan was rewritten with new content and formatting, retaining only a few items from the 2012 Plan. The Steering Committee determined that the Plan would be stronger and better serve the County as a whole if it were integrated as much as possible. Therefore, the Plan is structured by content rather than by jurisdiction.

The Plan has three main components: Risk Assessment, Mitigation Strategy, and Planning Process.

Risk Assessment

The Risk Assessment also has three components in this Plan: Community Profile, Natural Hazards, and Community Risk Profiles.

The Community Profile discusses the unique geographic, demographic, economic, infrastructure, critical and essential facilities, built environment characteristics, and cultural and historic resources of the jurisdictions and larger unincorporated communities. This information is important for assessing local strengths and vulnerabilities with respect to natural hazard events and formulating mitigation strategies. For the first time, Tillamook County undertook an analysis of where new residential construction has occurred relative to the various natural hazard areas since the last edition of the Plan (VLG Consulting & Pearson, 2012). It is anticipated that this first step will lead to additional or deeper analysis in future updates.

The Natural Hazards section introduces and characterizes each natural hazard that impacts the County. It documents historically significant natural hazard events, assesses probability of each hazard occurring, and provides exposure and loss estimates.

The Community Risk Profiles summarize the previous information by jurisdiction, providing statistics and maps that indicate the geographic extent and intensity of natural hazards potentially impacting each community. These Profiles also identify the critical or essential facilities located in each jurisdiction, identify potential vulnerabilities ("Areas of Mitigation Interest") and suggest mitigation strategies.

Mitigation Strategy

The Mitigation Strategy establishes countywide goals and objectives for natural hazard mitigation. Each jurisdiction has identified and prioritized a set of mitigation actions with a strategy (leads, supporters, timeline, actual or potential funding sources) for implementing them. They are presented in a series of tables. Another table states the status of mitigation actions identified in the 2012 Plan. A discussion of the tools and assets available to each jurisdiction for implementing the NHMP is included, as is a system for integrating natural hazard mitigation with other planning documents and initiatives.

Planning Process

This chapter details the process of updating the Tillamook County MJNHMP, reports public comments received and responses to them, and identifies plan format and content revisions. It frames processes for tracking implementation progress, and for monitoring, evaluating, and eventually updating this edition of the Plan. Documentation of the Planning Process is presented in the Appendices.

Participating Jurisdictions

Tillamook County and its seven incorporated cities (Bay City, Garibaldi, Manzanita, Nehalem, Rockaway Beach, Tillamook, and Wheeler) participated in the previous Tillamook County MJNHMPs and in this update. The Port of Tillamook Bay and the Port of Garibaldi joined the planning process and developed their first NHMPs in 2017.

II. RISK ASSESSMENT

A. Introduction

Overview

The Risk Assessment identifies and characterizes Tillamook County's natural hazards and describes how each hazard can impact its communities. It reveals vulnerabilities and informs the mitigation strategy.

The Tillamook County MJNHMP assesses risk in unincorporated Tillamook County, the Cities of Bay City, Garibaldi, Manzanita, Nehalem, Rockaway Beach, Tillamook, Wheeler, and the Ports of Tillamook Bay and Garibaldi. Of the 13 unincorporated communities that also populate the County, Neskowin, Oceanside and Netarts together, and Pacific City and Woods together were selected for assessment as their population size and density are large enough to allow valid assessment relative to the other jurisdictions.

Risk Assessment Structure

The Risk Assessment consists of three components: Community Profile, Natural Hazards, and Community Risk Profiles.

Community Profile

The Community Profile discusses the unique geographic, demographic, economic, infrastructure, critical and essential facilities, built environment characteristics, and cultural and historic resources of the communities. This information is important for assessing local strengths and vulnerabilities with respect to natural hazard events and formulating mitigation strategies. For the first time, the Plan includes an analysis of the location of new residential construction since the last update (2012–2016) relative to areas subject to natural hazards.

Natural Hazards

The Natural Hazards section presents an overview of each natural hazard to which the communities of Tillamook County are subject, along with the impacted jurisdictions, historically significant hazard events, probability, and vulnerability including exposure, loss estimates, and the local assessment of relative hazard risk.

Community Risk Profiles

The Community Risk Profiles summarize DOGAMI's analyses by jurisdiction, providing statistics and maps that indicate the geographic extent and intensity of natural hazards potentially impacting each community. These Profiles also identify the critical or essential facilities located in each jurisdiction, identify potential vulnerabilities ("Areas of Mitigation Interest") and suggest mitigation strategies.

Tillamook County's Natural Hazards

Each of Tillamook County's communities is subject to some or all of 10 natural hazards.

Table 1. Tillamook County Jurisdictions Subject to Natural Hazards

Jurisdiction	Coastal Erosion	Earthquakes	Floods				Landslides	Severe Weather			Tsunamis	Volcanic Ashfall	Wildfires
			Riverine	Coastal	Channel Migration	Dam Failure		Drought	Windstorms	Winter Storms			
Unincorporated Tillamook County (rural)	X	X	X	X	X	–	X	X	X	X	X	X	X
Neskowin	X	X	X	X		–	X	X	X	X	X	X	X
Oceanside-Netarts		X		X		–	X	X	X	X	X	X	X
Pacific City–Woods	X	X	X	X	X	–	X	X	X	X	X	X	X
Bay City		X	X			–	X	X	X	X	X	X	X
Garibaldi		X	X			–	X	X	X	X	X	X	X
Manzanita	X	X		X		–	X	X	X	X	X	X	X
Nehalem		X	X		X	–	X	X	X	X	X	X	X
Rockaway Beach	X	X	X	X		–	X	X	X	X	X	X	X
Tillamook		X	X		X	–		X	X	X	X	X	X
Wheeler		X	X		X	–	X	X	X	X	X	X	X
Port of Tillamook Bay	X	X	X	X		–	X	X	X	X	X	X	X
Port of Garibaldi	X	X	X			–	X	X	X	X	X	X	X

Note: None of the jurisdictions is subject to flooding from dam failure.

Source: Derived from DOGAMI (2016)

Loss Estimation and Exposure Assessment

The Oregon Department of Geology and Mineral Industries (DOGAMI) produced a *Final Draft Multi-Hazard Risk Report for Tillamook County* (DOGAMI, 2016) that comprises much of this Risk Assessment. It includes a countywide building inventory developed from building footprint data, Tillamook County's tax assessor database, and a suite of datasets representing the best science for a variety of natural hazards. The full report may be found in Appendix A of this Plan.

Depending on the natural hazard, either losses were estimated or exposure was assessed; both were performed for the flood hazard. Loss estimation was modeled using Hazus-MH (https://www.fema.gov/hazus-software), a tool developed by FEMA for calculating damage to buildings from flood and earthquake. Loss estimates identify buildings in hazard areas and apply damage functions based on the hazard severity and building characteristics. Loss estimation is reported as a percentage of estimated loss relative to the total replacement value of a building. Loss estimation was performed for a Cascadia Subduction Zone (CSZ) Magnitude 9.0 earthquake and several flood scenarios.

Exposure is a determination of the number of buildings, building value, and people within a hazard zone. Population was determined by associating 2010 census data with residential buildings. Exposure is reported as the total value of buildings within a hazard zone and the number of potentially displaced residents. Exposure was assessed for floods, five CSZ tsunami scenarios, coastal erosion, landslides, and wildfires.

El Niño-Southern Oscillation (ENSO)

The El Niño-Southern Oscillation (ENSO) cycle plays an important role in Oregon's climate variability and by extension the frequency and intensity of certain natural hazard events.

The ENSO cycle is a scientific term that describes the fluctuations in temperature between the ocean and atmosphere in the east-central Equatorial Pacific. La Niña is sometimes referred to as the cold phase of ENSO and El Niño as the warm phase of ENSO. These deviations from normal surface temperatures can have large-scale impacts not only on ocean processes, but also on global weather and climate. El Niño and La Niña episodes typically last nine to 12 months, but some prolonged events may last for years. They often begin to form between June and August, reach peak strength between December and April, and then decay between May and July of the following year. While their periodicity can be quite irregular, El Niño and La Niña events occur about every 3 to 5 years. Typically, El Niño occurs more frequently than La Niña. (Source: NOAA, "What are El Niño and La Niña?" http://oceanservice.noaa.gov/facts/ninonina.html)

In Oregon, El Niño impacts associated with these climate features generally include warmer winter temperatures and reduced precipitation with drought conditions in extreme events. An El Niño winter may also lead to increased threat of large wildfires the following summer and autumn.

During La Niña events, heavy rain arrives in Oregon from the western tropical Pacific, where ocean temperatures are well above normal, causing greater evaporation, more extensive clouds, and a greater push of clouds across the Pacific toward Oregon. The prolonged heavy rainfall saturates the ground triggering landslides and debris flows and causing floods. During February 1996, for example, severe flooding — the worst in the state since 1964 — together with numerous landslides and debris flows killed several people and caused widespread property damage. Nearly every river in Oregon reached or exceeded flood stage, some setting all-time records.

Table 2. Recent ENSO Events in Oregon

El Niño Events	La Niña Events
1982-1983	1988-1989
1994-1995	1995-1996
1997-1998	1999-2000
2002-2003	
2004-2005	
2006-2007	2007-2009
2009-2010	2010-2012
2014-2016	

Source: NOAA, Multivariate ENSO Index (MEI)
http://www.esrl.noaa.gov/psd/enso/mei/

Local Risk Assessment

Local assessment of relative hazard risk is accomplished using a methodology developed by the Federal Emergency Management Agency (FEMA) and refined by the Oregon Office of Emergency Management (OEM). It is called the "Local Risk Assessment Methodology" or "OEM Methodology" in this Plan. This methodology produces scores that range from 24 to 240. Vulnerability and probability are its two key components. 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%.

Conducting this analysis is a useful early step in planning for hazard mitigation, response, and recovery. The OEM Methodology does not predict the occurrence of a particular hazard, but it does "quantify" the relative risk of one hazard compared with another.

Table 3. Local Risk Assessment Rankings

Jurisdiction	Coastal Erosion	Earthquakes	Floods	Landslides	Drought	Windstorms	Winter Storms	Tsunamis	Volcanic Ashfall	Wildfires
Unincorporated Tillamook County, including Neskowin, Oceanside-Netarts, Pacific City–Woods	High	Mod	High	Mod	N/A	High	High	Mod	Low	Low
Bay City	High	High	Low	Low	Low	High	Low	High	Low	High
Garibaldi	Low	Mod	Mod	Low	Low	Low	Low	Low	Low	Low
Manzanita	Low	Low	Low	Low	Low	High	High	Low	Low	Low
Nehalem	Low	Mod	High	Mod	High	High	High	Mod	Low	Mod
Rockaway Beach	High	Mod	High	Mod	High	High	High	Mod	Low	Mod
Tillamook	Low	High	High	Low	Low	High	High	High	Low	Low
Wheeler	Low	Mod	High	High	Mod	High	High	Low	Low	Low
Port of Tillamook Bay	High	High	High	Mod	Low	High	High	High	Low	Low
Port of Garibaldi	High	Mod	High	Low	Low	High	High	Mod	Mod	Low

N/A = not assessed

Source: Based on information presented at the Tillamook County Multi-Jurisdictional NHMP Update Steering Committee Meeting, September 23, 2016

B. Community Profile

1. Political and Physical Geography

Tillamook County

Tillamook County, the twelfth county in Oregon to be organized, was established on December 15, 1853, when the Territorial Legislature approved an act to create the new county out of an area previously included in Clatsop, Yamhill and Polk Counties in the northwestern portion of Oregon. It is bordered by Clatsop and Columbia Counties on the north, Washington and Yamhill Counties on the east, Polk and Lincoln Counties on the south, and the Pacific Ocean on the west. Tillamook County has 75 miles of rocky and irregular coastline, four bays, nine rivers, estuaries, stretches of coastal lowlands, and a heavily forested mountainous interior that rises eastward comprising the main span and several spurs of the Coast Range. The county was named after the Tillamook Indians who occupied the areas around the Tillamook and Nehalem Bays. (Oregon Blue Book, http://arcweb.sos.state.or.us/pages/records/local/county/tillamook/hist.html, accessed February 8, 2017)

Most settlement has taken place along the coast and interior lowlands, with all the incorporated cities located in the northwest and west-central portion of the County. A number of unincorporated urban communities are located along the coast and inland in the southern to central portion of the County.

Neahkahnie is the northernmost unincorporated urban community, located on the coast north of Manzanita. Barview, Watseco, and Twin Rocks are also located along the coast, south of Rockaway Beach. Oceanside and Netarts are neighbors on the south side of a peninsula between Tillamook Bay on the north and Netarts Bay on the south. Oceanside lies on the Pacific Ocean; Netarts on Netarts Bay. Farther south, Pacific City lies on both the Pacific Ocean and the Nestucca River. Its neighbor Woods is inland on the Nestucca River. Neskowin is the southernmost coastal community. East of Pacific City and Woods on US-101 heading north lie Cloverdale, Hebo, and Beaver. Siskeyville is located east of the City of Tillamook on Oregon 6, heading into the Coast Range.

The incorporated cities are all located between the center of the County and its northern bound. The northernmost triad — Manzanita, Nehalem, and Wheeler — clusters around Nehalem Bay with Manzanita on the coast and Nehalem and Wheeler inland on the Nehalem River. Rockaway Beach stretches between them and Tillamook Bay, where Garibaldi, the Port of Garibaldi, and Bay City are situated. The City of Tillamook is located inland, southeast of Tillamook Bay, between the Wilson and Trask Rivers. The Port of Tillamook Bay lies inland also, four miles south of the City of Tillamook. There are no incorporated cities south of the City of Tillamook.

Tillamook was the first city in the County, incorporated in 1891. Incorporation of the other cities came in pulses over a period of 55 years. The first pulse took place less than 10 years after the City of Tillamook incorporated; the second pulse came a little more than 10 years after that; and the third and final pulse occurred about 30 years later. No other cities have incorporated in Tillamook County in over 70 years. (Oregon Blue Book, http://arcweb.sos.state.or.us/pages/records/local/county/tillamook/hist.html, accessed February 8, 2017)

Table 4. Incorporation or Establishment Dates

Date Incorporated or Established	Jurisdiction
December 15, 1853	Tillamook County
February 18, 1891	City of Tillamook
February 2, 1899	City of Nehalem
September 13, 1910	City of Bay City
1910	Port of Garibaldi
June 11, 1913	City of Wheeler
July 14, 1943	City of Rockaway Beach
April 8, 1946	City of Garibaldi
April 15, 1946	City of Manzanita
1911	Port of Tillamook Bay

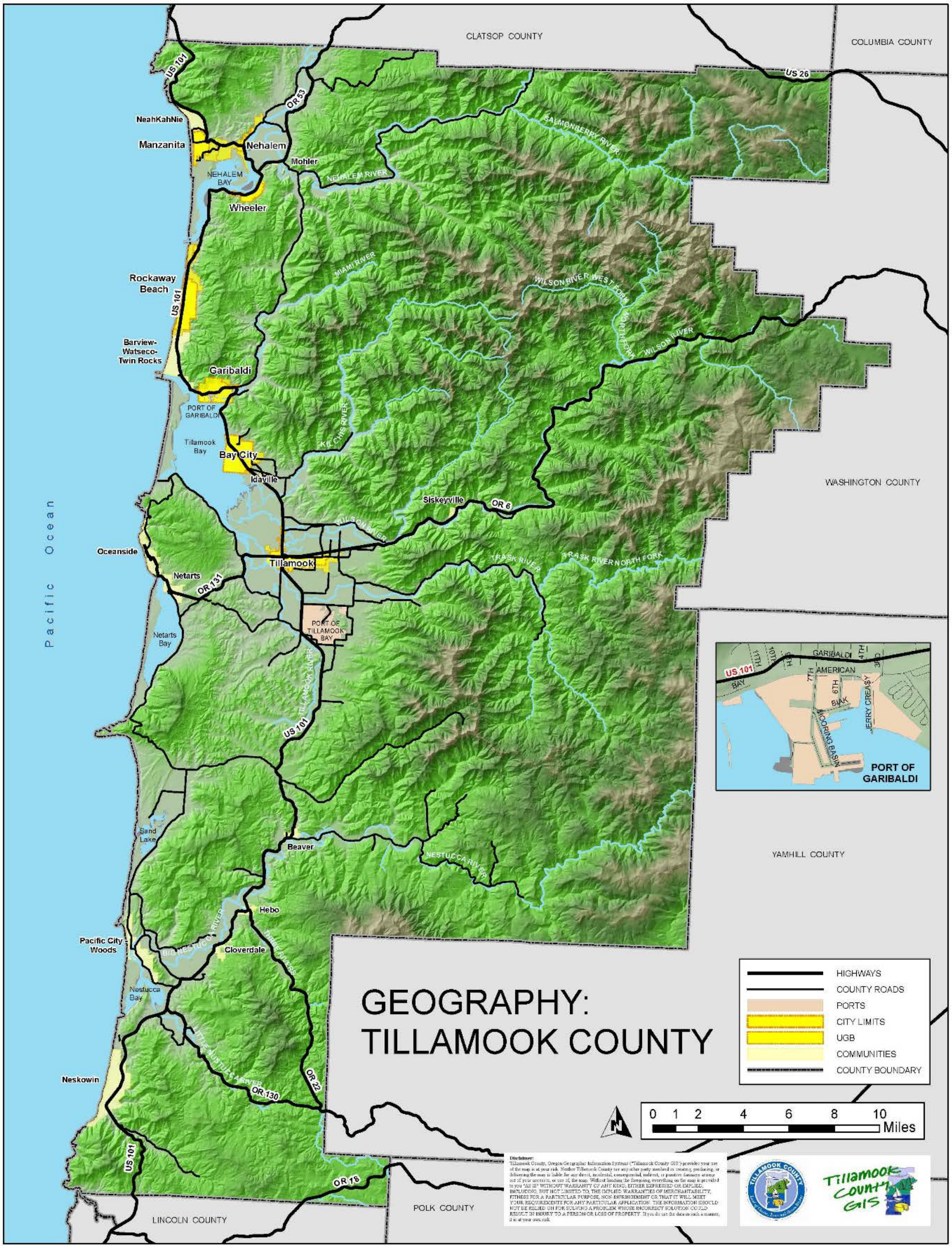
Source: Oregon Blue Book, http://arcweb.sos.state.or.us/pages/records/local/county/tillamook/hist.html, accessed February 8, 2017

Table 5. Approximate Land Area and Elevation

Jurisdiction	Area (Square Miles)	Elevation (Feet)
Tillamook County	1,125	0–3,706
City of Bay City	1.93	17
City of Garibaldi	1.45	22
City of Manzanita	0.72	78
City of Nehalem	0.29	11
City of Rockaway Beach	1.62	17
City of Tillamook	1.86	22
City of Wheeler	0.51	37
Neskowin	2.42	13
Netarts	0.73	66
Oceanside	0.85	148
Pacific City-Woods	1.41	13
Port of Garibaldi	0.23	0
Port of Tillamook Bay	2.50	36 (airport)

Source: Oregon Blue Book, http://arcweb.sos.state.or.us/pages/records/local/county/tillamook/hist.html, accessed February 8, 2017; https://en.wikipedia.org/wiki/Pacific_City,_Oregon; https://en.wikipedia.org/wiki/Neskowin,_Oregon; https://en.wikipedia.org/wiki/Oceanside,_Oregon; https://en.wikipedia.org/wiki/Netarts,_Oregon; https://en.wikipedia.org/wiki/Tillamook_Airport; https://www.anyplaceamerica.com/directory/or/tillamook-county-41057/harbors/port-of-garibaldi-2668339/, accessed April 27, 2017

Figure 1. Political and Physical Geography: Tillamook County



Source: Tillamook County Geographic Information System (GIS) Team

Unincorporated Communities

Of the 13 unincorporated communities, only Oceanside and Netarts together, Pacific City and Woods together, and Neskowin are addressed directly and separately from the rest of the unincorporated County. They were selected based on their population size and density, which allowed responsible characterization of exposure to and potential loss from natural hazards relative to the cities and County.

Neskowin

Neskowin lies at the southern reach of Tillamook County near the mouth of Slab Creek on the Pacific Ocean. It is generally low-lying and flat west of US-101 and hilly east of the highway. Neskowin Creek runs along its southern end and Butte Creek along its southeastern edge. Neskowin is nestled up against the forested hills of the Coast Range and Cascade Head. Proposal Rock, at the mouth of Neskowin Creek, is perhaps the most treasured of Neskowin's natural features. A submerged forest of stumps on the beach south of Neskowin Creek is visible only when the sands have washed out and the tide is low. "Radiocarbon dating analysis in 1958 of samples of the stumps showed them to be 1730 years old, plus or minus 160 years" (Rubin & Alexander, 1958, p. 1477). Due to its geographical isolation, Neskowin has grown slowly from the time it was platted in 1910 until the new Highway 101 was cut over Cascade Head in the 1960s. It is primarily residential in nature with limited commercial development.

Oceanside-Netarts

Oceanside and Netarts are adjacent communities located on the southern portion of a peninsula bounded on the south by Netarts Bay; on the north by Tillamook Bay; and on the west by the Pacific Ocean. Oceanside is located on the Pacific Ocean while its neighbor Netarts is located at the mouth of Netarts Bay. Both communities rise quickly from the water into hilly terrain. While Oceanside is more consistently mountainous, Netarts is punctuated by hills and valleys. Rice Creek and O'Hare Creek drain through Netarts to Netarts Bay. Fall Creek drains to the mouth of Netarts Bay between Netarts and Oceanside. Baughman Creek is the main drainage through Oceanside, but is a smaller stream than the creeks draining Netarts.

Oceanside and Netarts are bound together under the common administration of one sewer district. They are separated by a distance of about one and one-half miles and are about seven miles west of Tillamook City. Residential densities range from five to ten dwellings per acre. Services available include sewage disposal, public water, street lighting and fire protection as well as a range of countywide services. There is a fire hall and a post office in each community. There are a variety of commercial services in the communities, including grocery and general stores, gas stations, laundromats, restaurants and taverns.

Oceanside

The Oceanside Community Growth Boundary is defined by the Pacific Ocean to the west; the southerly boundary of "The Capes" planned development to the south; Oregon 131 (Netarts-Oceanside Highway) and forest zoning to the east; and Radar Road to the north. Oceanside is predominantly a second home and retirement community.

Netarts

Netarts is a small community situated at the mouth of the Netarts Bay, just south of Oceanside, along the Three Capes Scenic Route. Netarts Bay spans seven miles from north to south and is separated from the ocean by a long club-shaped stretch of forested sand known as the Netarts Spit. The Netarts Community Growth Boundary is defined by Netarts Bay to the west, the southerly boundary of "The Capes" planned development and forest lands to the north, forest lands to the east, and rural residential lands to the south. Netarts is also predominantly a second home and retirement community.

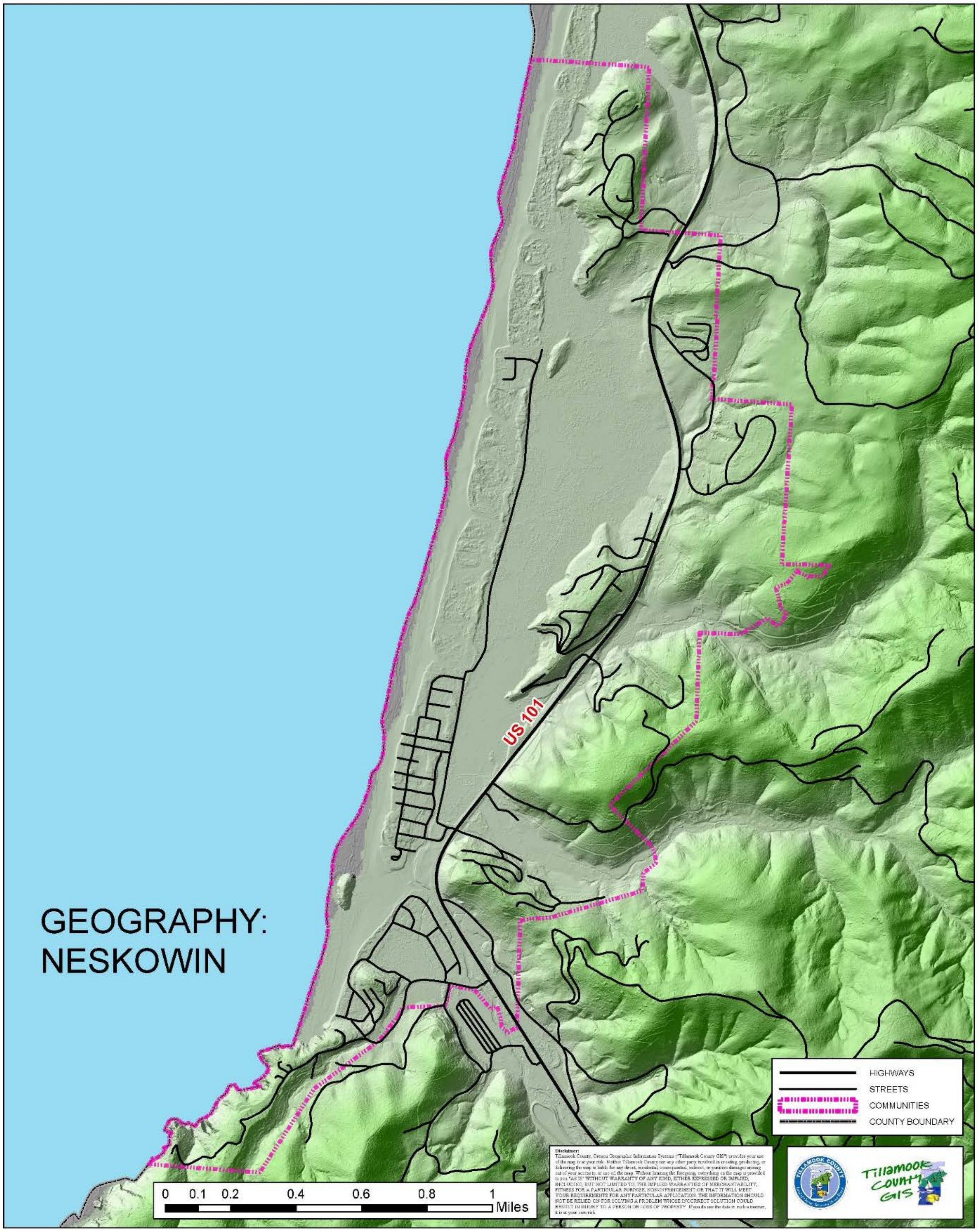
Pacific City–Woods

Pacific City–Woods is located along the Pacific Ocean adjacent to Bob Straub State Park. The Nestucca River bisects the community and, as the river meanders, forms an inland peninsula. The land by the river is flat, but the center of the peninsula is hilly. The area along the ocean is flat as well; the northern extent of the community is bounded by hills. Two small streams drain the hills to the north through the community. Many more drain the hills on the peninsula emptying into the Nestucca River.

Woods

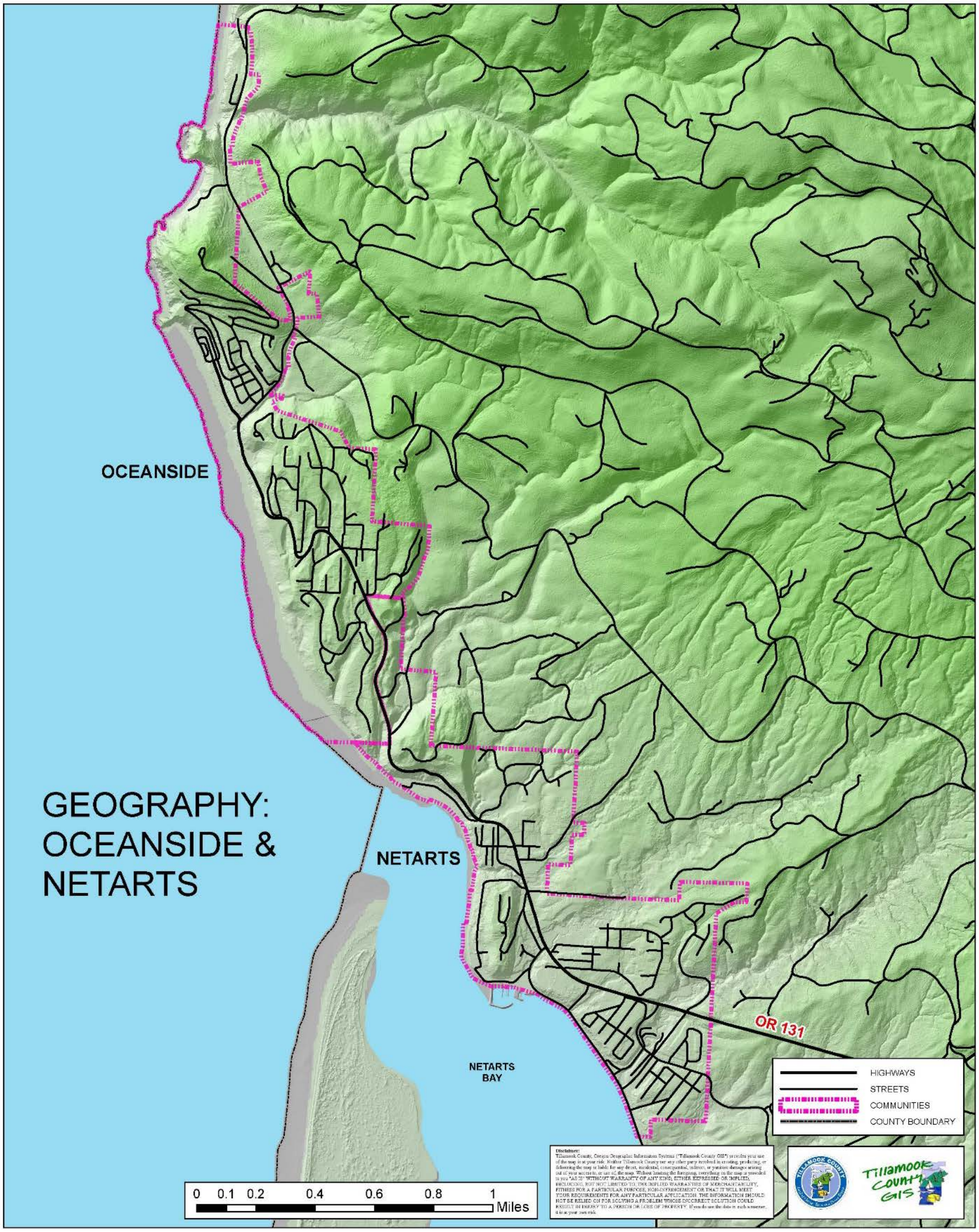
Woods developed before Pacific City. It offers a general store, drug store, sawmill, cabinet shop, photography gallery, postmaster, two weekly newspapers, and Rebecca Lodge. Thomas Malaney homesteaded and platted Pacific City (originally called “Ocean Park”) in 1883 along the south bank of the Nestucca River directly across from Woods. An 1894 flood caused the community to move to higher ground just downriver. The most distinctive natural features of this area are the Nestucca River and its estuary, tide pools, beaches, dunes, and Cape Kiwanda.

Figure 2. Political and Physical Geography: Neskowin



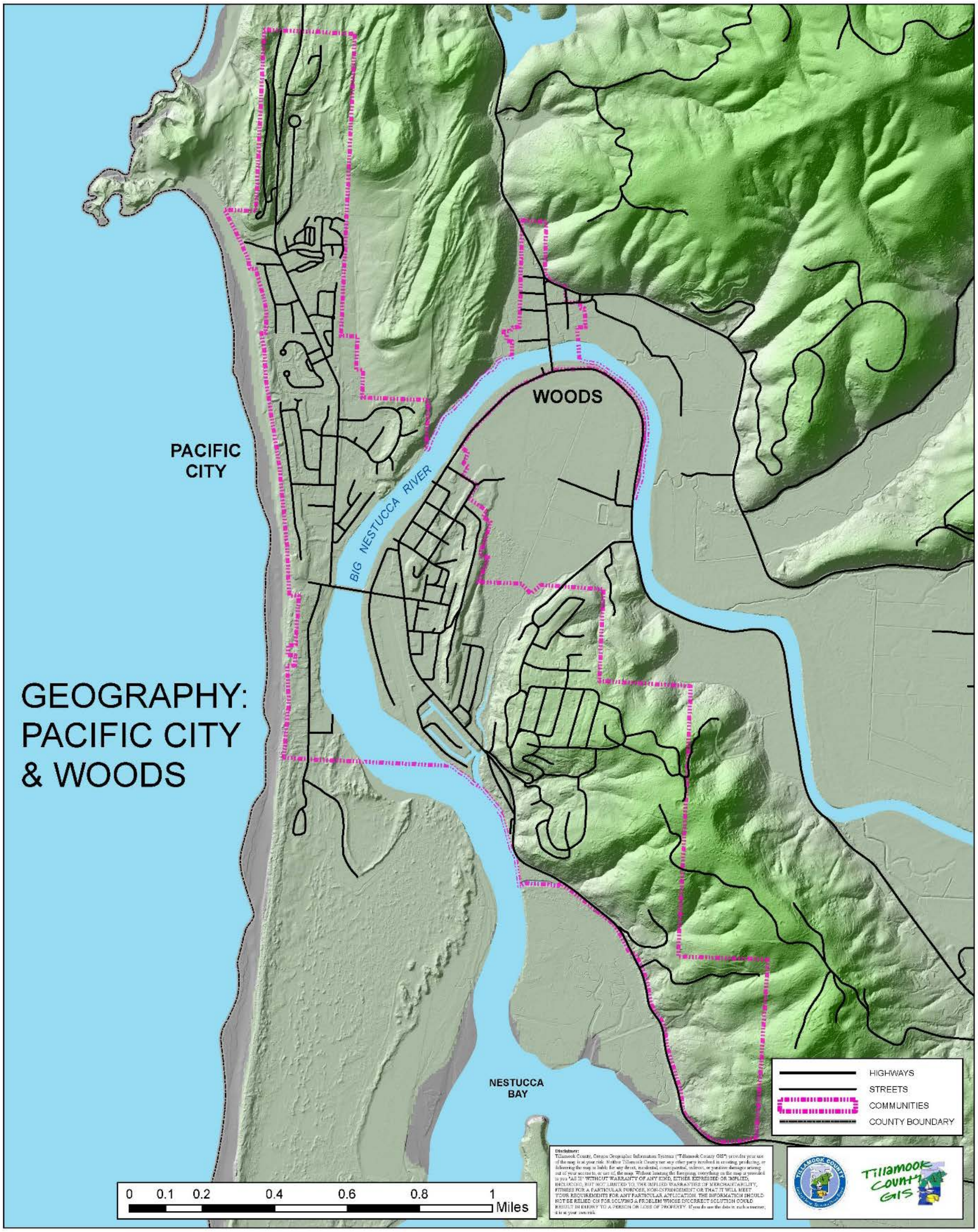
Source: Tillamook County Geographic Information System (GIS) Team

Figure 3. Political and Physical Geography: Oceanside and Netarts



Source: Tillamook County Geographic Information System (GIS) Team

Figure 4. Political and Physical Geography: Pacific City-Woods



Source: Tillamook County Geographic Information System (GIS) Team

Cities

City of Bay City

Bay City is a quiet coastal community that rests along the eastern shore of Tillamook Bay. It is primarily residential in nature with some commercial development. Recreational amenities include an art gallery, art center, crabbing & fishing. Pacific Oyster is housed in the remaining cannery located within Bay City on Tillamook Bay. Historically, two canneries and a mill were in operation through the turn of the 20th Century.

Bay City has developed among low hills and valleys. US-101 hugs the shoreline as it rolls through Bay City, slicing a sliver of land on the west and the southwestern corner from the majority of the city located east of the highway. West of the highway the land is flat. East of the highway a single creek formed by the confluence of Jacoby and Patterson Creeks drains the area between two rises. Another stream drains the area southern lowland area (Ash Creek Associates, Inc., 2007).

City of Garibaldi

The City of Garibaldi is located at the north end of Tillamook Bay. It is mostly flat, near sea level, and rises gently northward into the hills.

A small village nestled against a hillside at the northern end of Tillamook Bay, Garibaldi is known for fishing, crabbing and clamming. It is home to the Oregon Coast Scenic Railroad depot and two history museums. While Garibaldi attracts many tourists in the fall, spring, and summer months, it has many full-time residents and recent residential development includes multi-family housing projects. Several streams draining the hillside traverse Garibaldi as they flow into Tillamook Bay. US-101 separates the city on the north from the Port of Garibaldi to the south as it meanders along the north shore of Tillamook Bay.

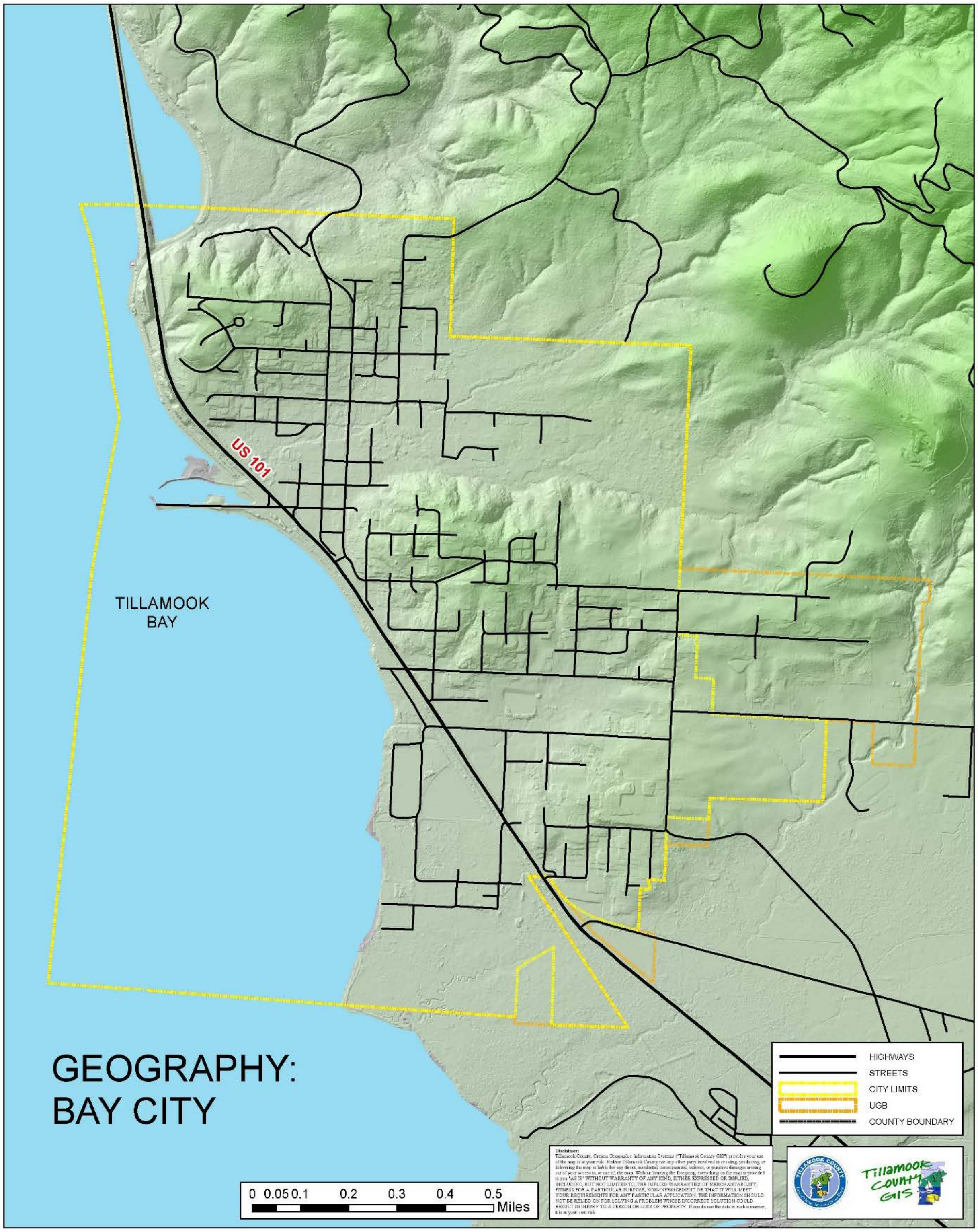
City of Manzanita

The City of Manzanita is the northernmost incorporated city in Tillamook County. Its sandy beaches give way to forested hills as the city rises from the Pacific Ocean south of Neakahnie Mountain. US-101 provides entry to the city where it touches its northeastern boundary as it skirts Neakahnie Lake. While there are no mapped streams in the city, there are a few wetlands.

City of Nehalem

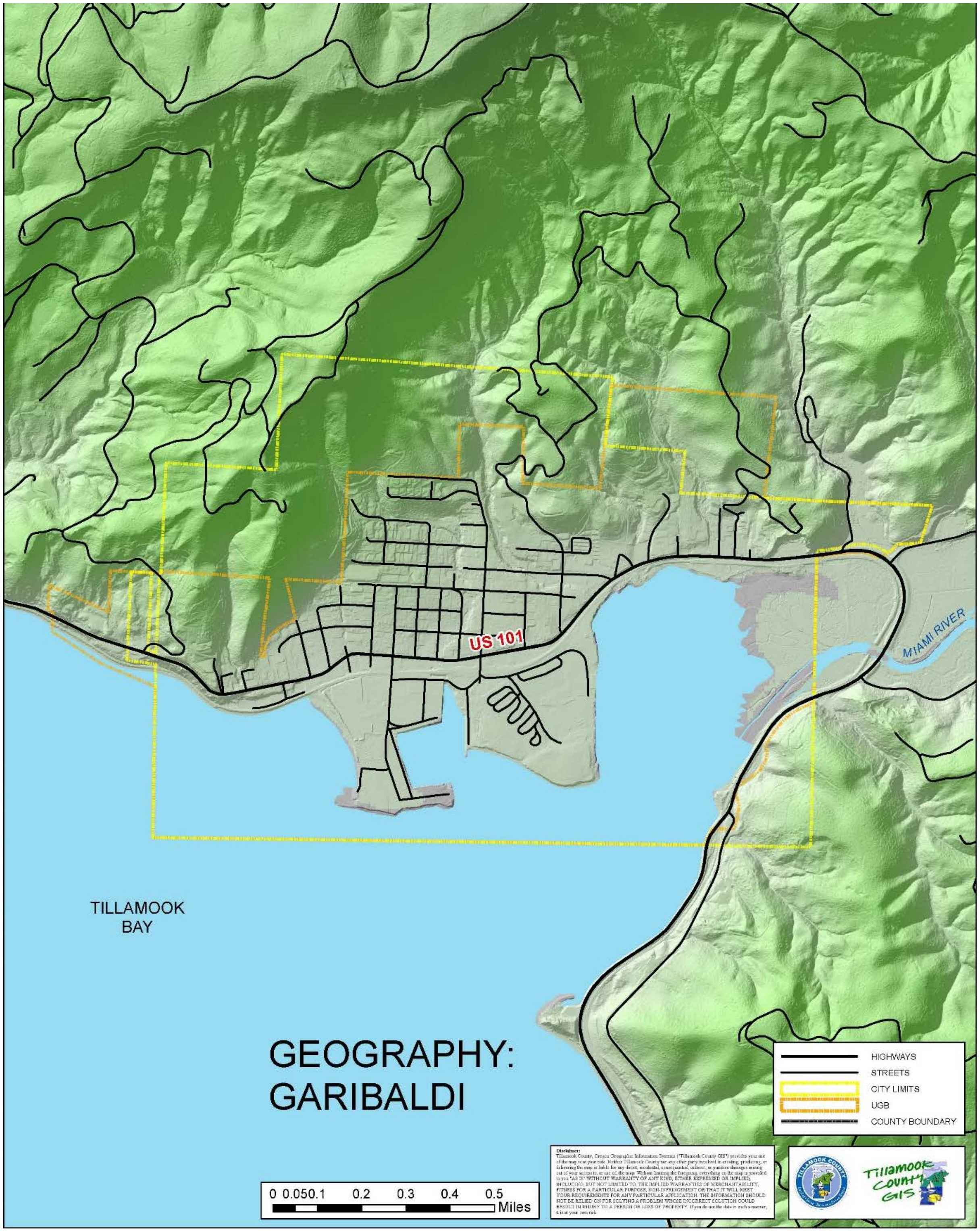
The City of Nehalem is situated on the Nehalem River, northeast of Nehalem Bay. It rises west from the river into hilly terrain. US-101 divides the majority of the city on its west from a sliver along the river. Several streams drain the city hills emptying into the Nehalem River.

Figure 5. Political and Physical Geography: City of Bay City



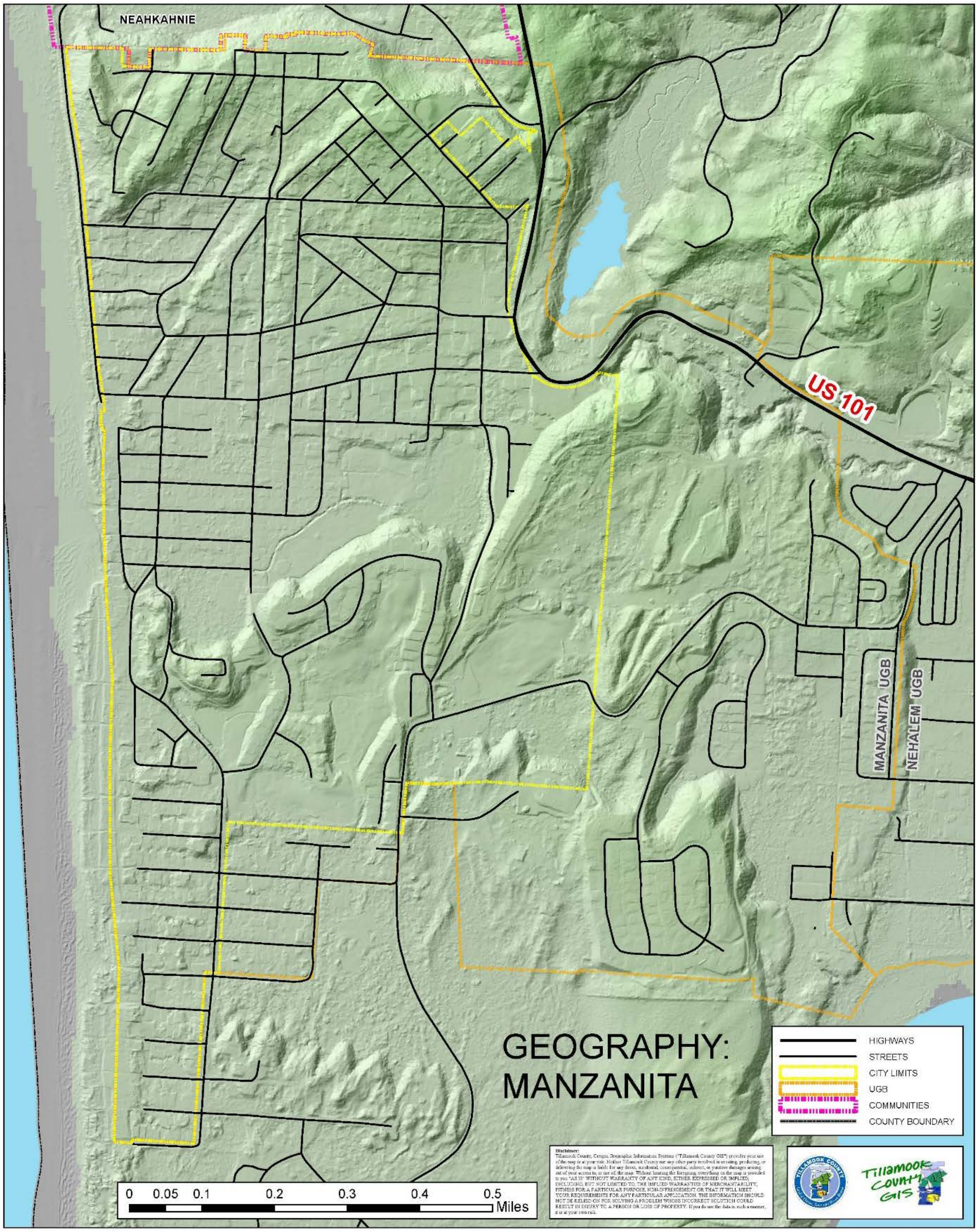
Source: Tillamook County Geographic Information System (GIS) Team

Figure 6. Political and Physical Geography: City of Garibaldi



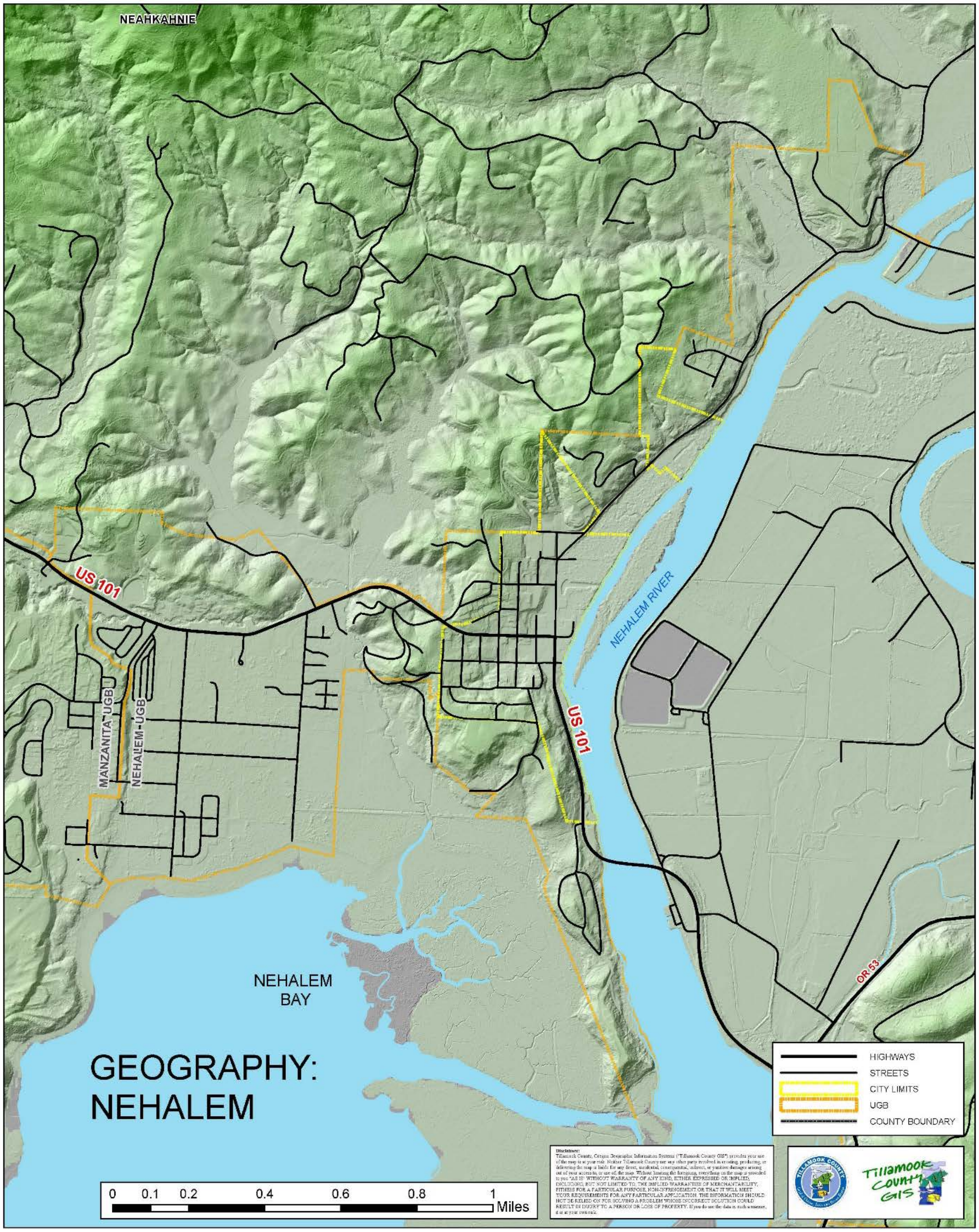
Source: Tillamook County Geographic Information System (GIS) Team

Figure 7. Political and Physical Geography: City of Manzanita



Source: Tillamook County Geographic Information System (GIS) Team

Figure 8. Political and Physical Geography: City of Nehalem



Source: Tillamook County Geographic Information System (GIS) Team

City of Rockaway Beach

The City of Rockaway Beach is situated north of Tillamook Bay and South of Nehalem Bay, laid out linearly along the Pacific Ocean. It is bisected by US-101 and the Oregon Coast Scenic Railroad running north-south, parallel to the ocean. The low-lying city has developed between the Pacific Ocean and large forested hills to the east. Several streams draining the hills run through the city. The main waterway through the city is Spring Creek, which feeds Lake Lytle.

Rockaway Beach was established as a seaside resort in 1909 by the Rockaway Beach Company and named after Rockaway Beach on Long Island in New York. Popular with tourists, Rockaway Beach is also home to many full-time residents. Barview-Twin Rocks-Watseco, an unincorporated community borders Rockaway Beach on the south. Nedonna, a residential development, and Neah-Kah-Nie High School are located in the most northern region of Rockaway Beach's urban growth boundary.

City of Tillamook

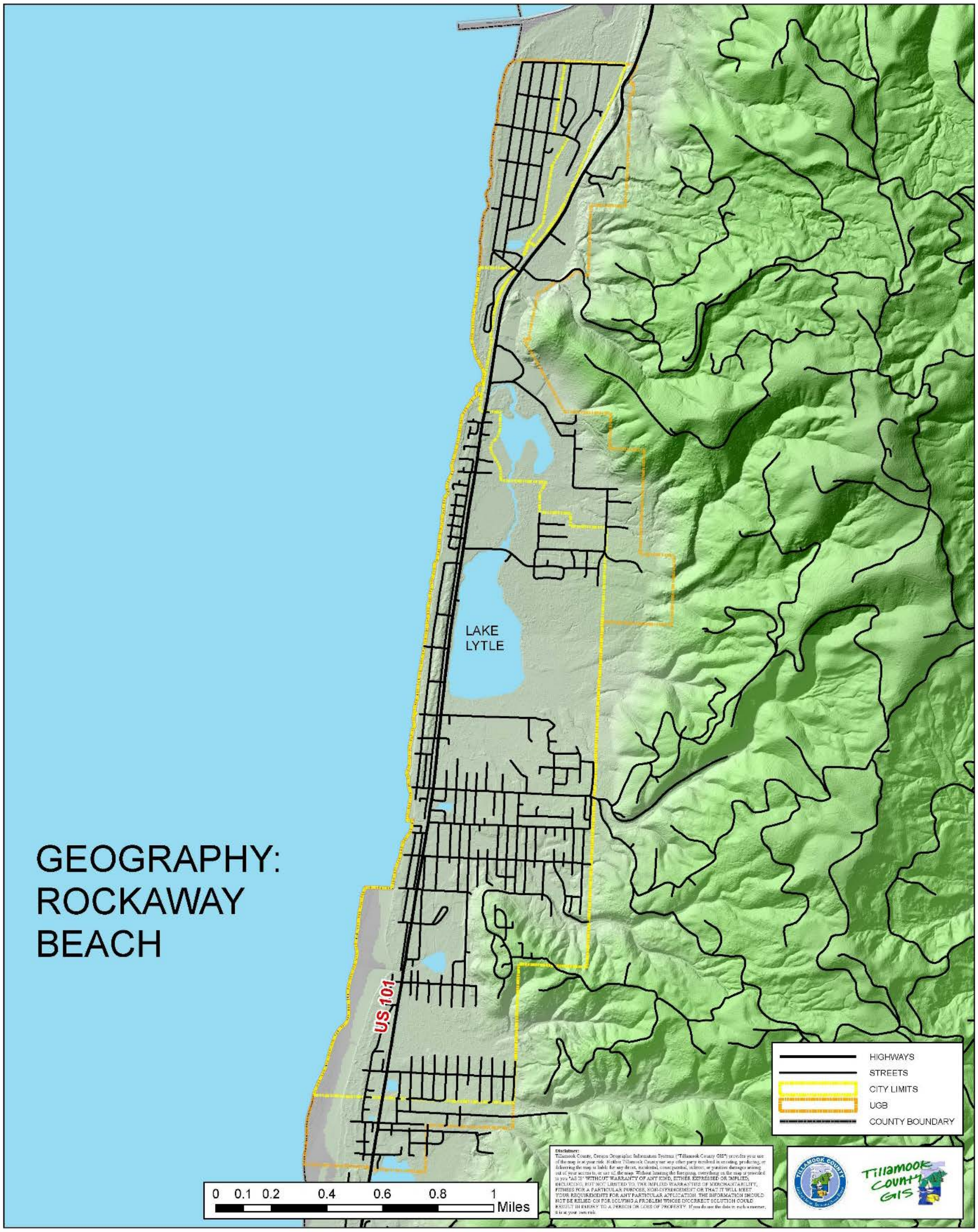
The City of Tillamook is located inland from the Pacific Ocean, southeast of Tillamook Bay. It runs mainly east-west along SR 6, with an extension north along US-101. It is roughly bounded by the Trask River and a tributary to it on the south and southwest, and Hoquarten Slough on the north. Dougherty Slough and Hall Slough pass under US-101 and through commercial and residential districts. The Wilson River forms the northern boundary of the city’s extension along US-101. The city is flat, on a natural peninsula that elevates most of it above the floodplain. It is surrounded primarily by farmland.

The City of Tillamook is named for the Tillamook people, a Native American tribe speaking a Salishan language who lived in this area until the early 19th century. The City of Tillamook is the County seat and the largest incorporated city in Tillamook County. The City is known for its dairy industry and the Tillamook County Creamery Association. With primarily a full-time resident population, the City of Tillamook supports several commercial districts. Efforts are underway for improvements to city infrastructure as well as renovations to commercial structures in the downtown core. A replacement for the US-101 bridge spanning Hoquarton Slough is currently under construction.

City of Wheeler

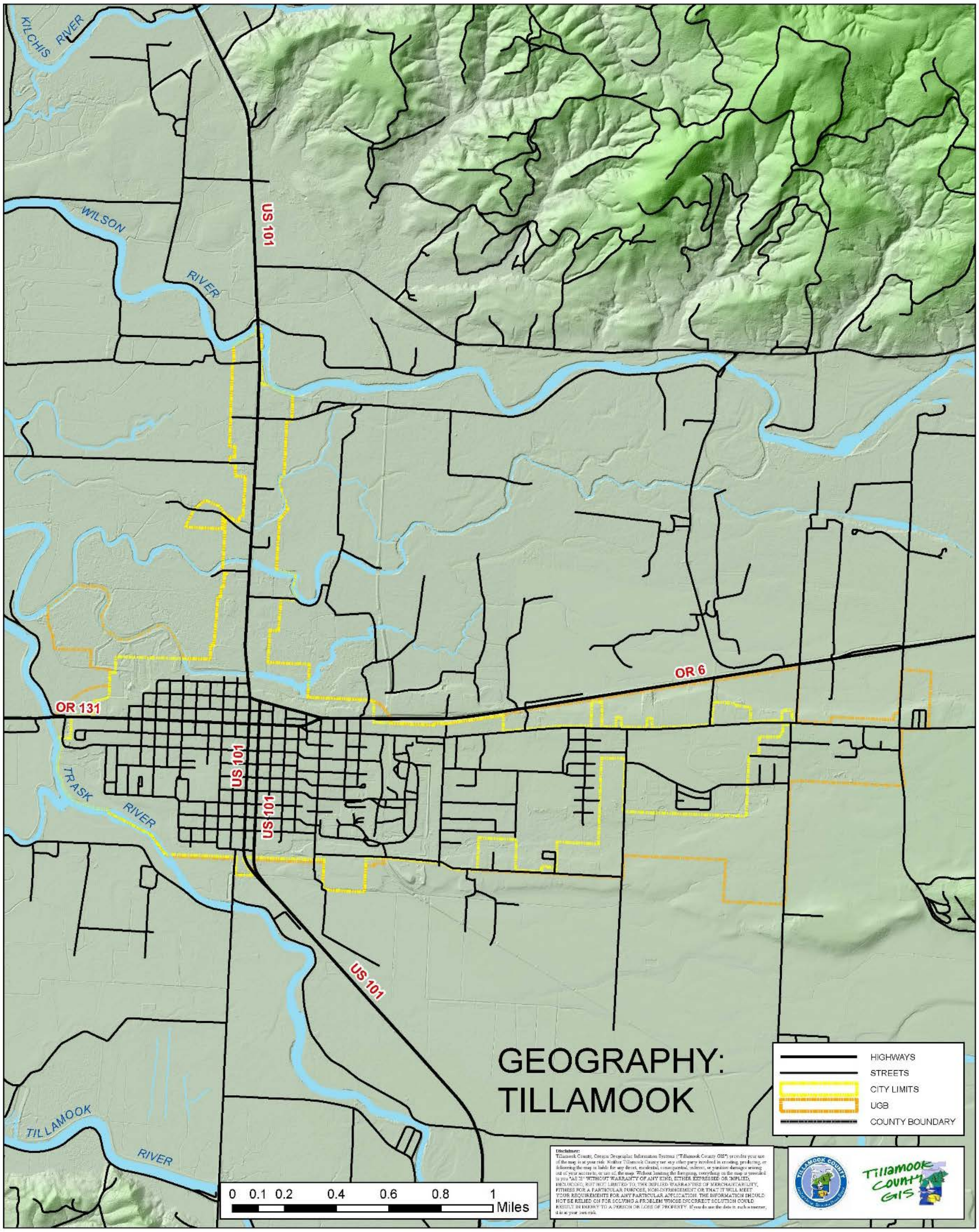
The City of Wheeler is located on the Nehalem River’s southeast bend at the bottom of mountainous area. US-101 runs along the riverbank and most of the city is located to its east, rising quickly up the steep terrain. While US-101 provides access, the city’s geography isolates it from its nearest neighbors. Four stream systems drain through the city, dividing it into discrete sections. These sections are in large measure isolated from one another.

Figure 9. Political and Physical Geography: City of Rockaway Beach



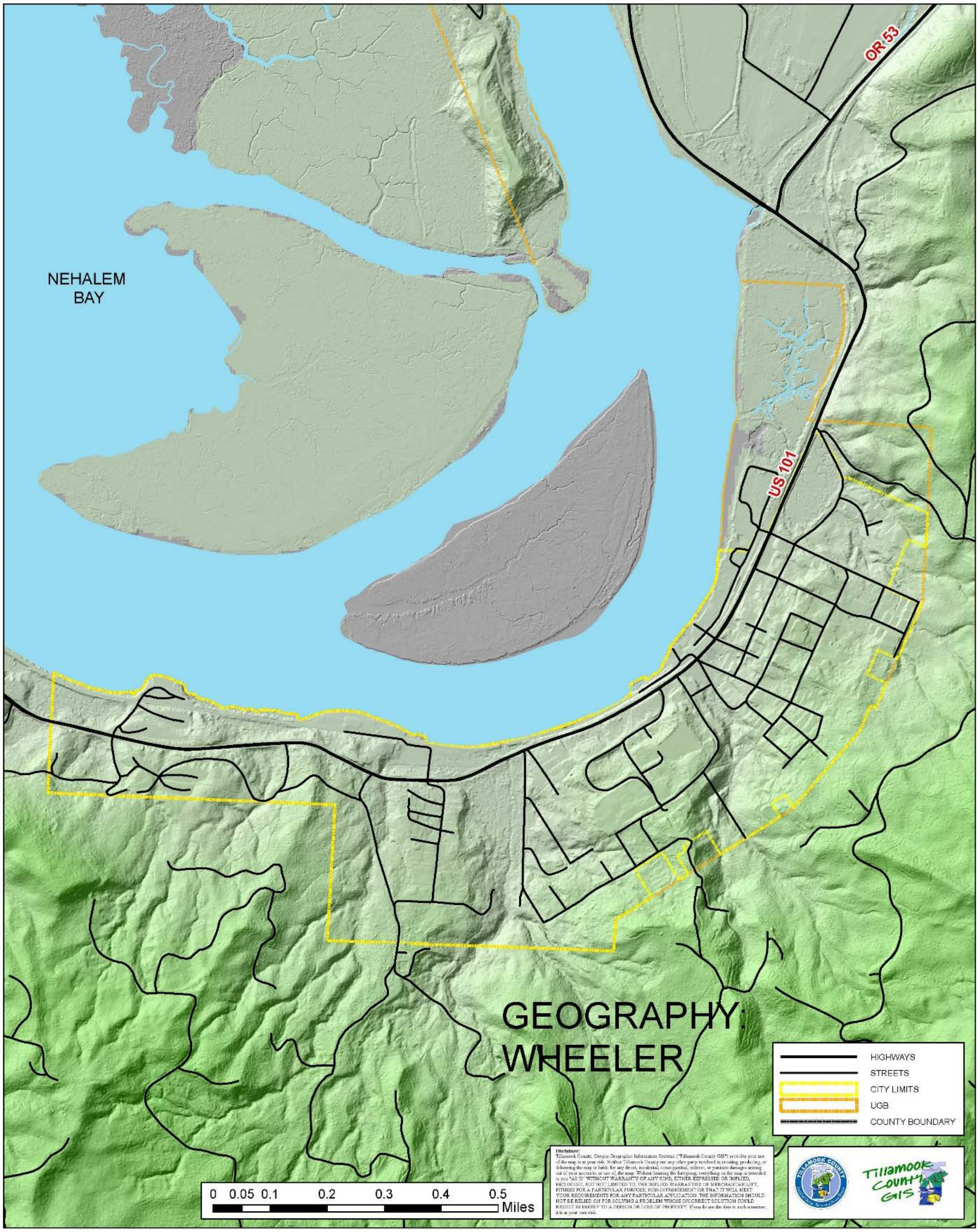
Source: Tillamook County Geographic Information System (GIS) Team

Figure 10. Political and Physical Geography: City of Tillamook



Source: Tillamook County Geographic Information System (GIS) Team

Figure 11. Political and Physical Geography: City of Wheeler



Source: Tillamook County Geographic Information System (GIS) Team

Ports

The Ports of Tillamook Bay and Garibaldi have chosen to participate in the Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan for the first time. The Port of Nehalem is not participating. A port's primary purpose is to support and facilitate commerce. Among other authorities, ports may own and lease property, provide services, and levy taxes within their District boundaries. Residents and residences, as well as businesses, public facilities, or other concerns not located on Port property fall within the primary jurisdiction of their respective cities or Tillamook County. Similarly, the Ports of Tillamook Bay and Garibaldi are located in Tillamook County and the City of Garibaldi, respectively, and fall under those jurisdictions for many purposes, including emergency response.

The Ports identify their primary areas of activity and development, land and submerged land ownership as "the Port" or being within the "Port Boundary." The maps in this Plan depict the most current tax lot information provided by the Tillamook County Departments of Assessment and Taxation and Geographic Information Systems as comprising the areas within the Ports' boundaries.

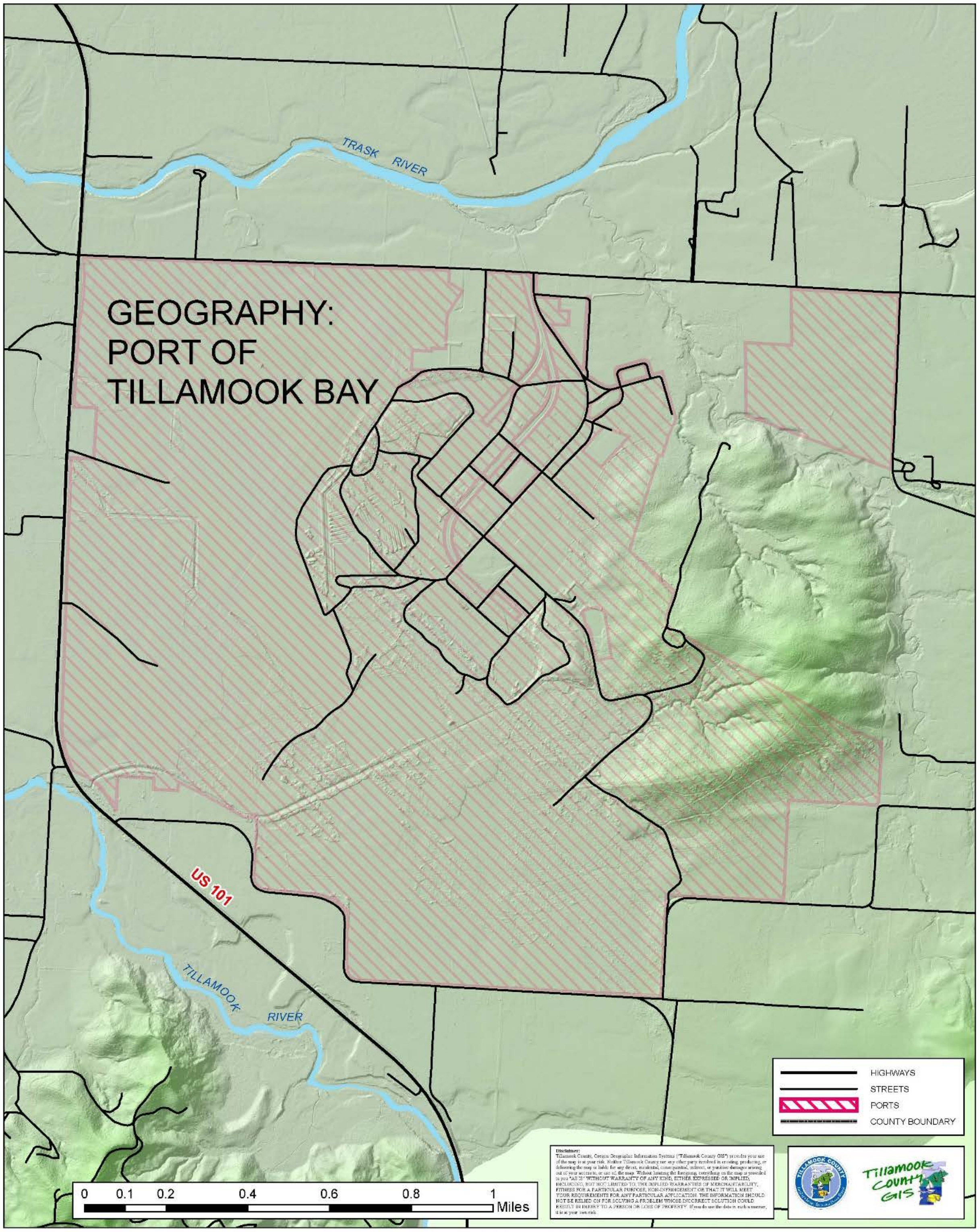
Port of Tillamook Bay

The Port of Tillamook Bay property comprises roughly 1,600 acres of land and is located approximately four miles south of downtown Tillamook, Oregon, along US Highway 101. Port property is accessed by Blimp Boulevard, which is approximately one mile east along Long Prairie Road from Highway 101. It is bounded roughly on the east by Brickyard Road; on the south by South Prairie Loop Road; on the west by Highway 101; and on the north by Long Prairie Road. Most of the Port's property lies upon flat ground, with one hill rising on its eastern edge. The hill is drained by a small stream running fairly parallel to Mill Creek through the Port proper.

The Port of Tillamook Bay's service and taxing district encompasses a much larger area: the entire width of the county from Cape Lookout on the south running north along the Pacific Ocean and enveloping the south side of the Tillamook Bay jetty system, then southeast through the center of Tillamook Bay and on east to Siskeyville and the county line. Discussions are underway to adjust the boundary between the Port of Tillamook Bay and the Port of Garibaldi, moving the south jetty into the Port of Garibaldi District. The boundary realignment would enable unified management of the north/south jetty system.

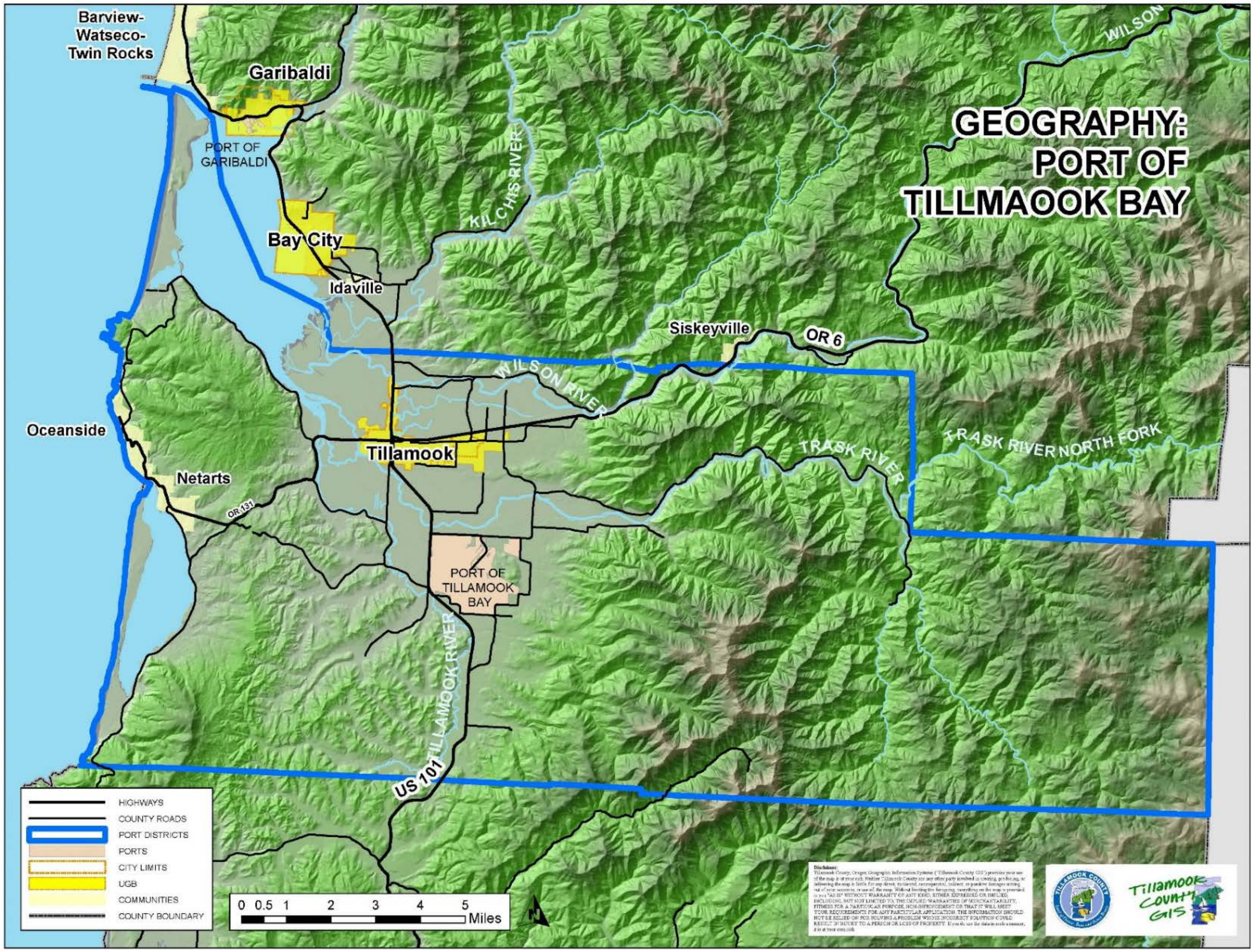
The Port of Tillamook Bay (originally formed as the Port of Bay Ocean in 1911) incorporated an approximate 1,600 acre parcel of land formerly known as the Naval Air Station Tillamook (1942–1948) into its district in 1953. Subsequent to that time, this area has evolved into the core of Tillamook County's industrial sector through Port's operation of a railroad system, the Tillamook Municipal Airport, and an approximate 200-acre industrial park complex serving multiple lease tenants engaged in varying levels of industrial manufacturing and development. After the storms of December 2007 that resulted in major damages to the rail line, the Port placed the railroad under a Discontinuance of Service with the Surface Transportation Board and has partnered with the Salmonberry Trail Intergovernmental Agency to explore the creation of a trail system along the rail corridor.

Figure 12. Political and Physical Geography: Port of Tillamook Bay



Source: Tillamook County Geographic Information System (GIS) Team

Figure 13. Political and Physical Geography: Port of Tillamook Bay – Port District



Source: Tillamook County Geographic Information System (GIS) Team

Port of Garibaldi

The Port of Garibaldi owns approximately 150 acres of land and submerged lands in the Cities of Garibaldi and Bay City. It is located primarily within the City of Garibaldi on a peninsula constructed of fill in Tillamook Bay at about sea level. It is flat and paved with access to US-101 at its north end. Piers have been constructed at the south end of the peninsula. A marina, the primary mooring facility with 277 slips is located in the center of the peninsula. About 400 linear feet of transient tie-ups are located opposite the marina in the boat basin. Two piers are located in Bay City. There is a mix of publicly and privately owned buildings and facilities on Port-owned land; however, there are no permanent residents on any Port property.

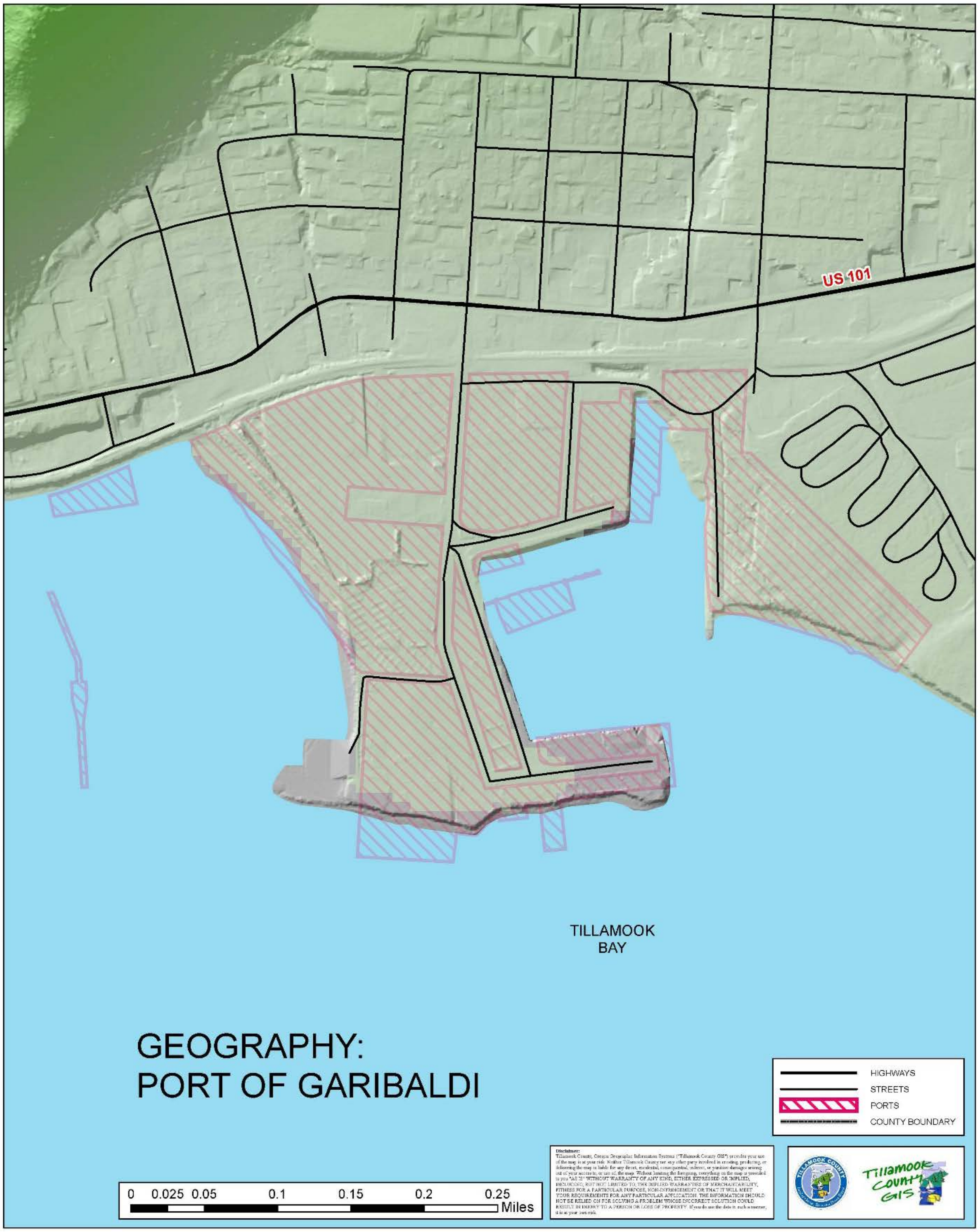
The Port of Garibaldi Special District encompasses approximately 350 square miles of Tillamook County. The District's boundaries extend from the Tillamook Cheese Factory north to Neah-Kah-Nie High School and east up Oregon 6 to Lee's Camp. Discussions are underway to adjust the boundary between the Port of Garibaldi and the Port of Tillamook Bay, moving the south jetty into the Port of Garibaldi District. The boundary realignment would enable unified management of the north/south jetty system. The District is characterized by coastal lowlands as well as forested mountains. Three of the primary rivers in the County — the Wilson, Kilches, and Miami — drain the District.

The Port of Garibaldi was initially established as the Port of Bay City in 1910 to facilitate construction of the Tillamook Bay north jetty. Historically it has focused on job creation through development of its resources, support for business opportunities, collaboration and partnerships, and community relations. Its infrastructure includes commercial piers, docks, a boat ramp, a boat basin, sea walls, hoists, utility services, various buildings, a recreational vehicle park, playground, and other infrastructure associated with the operation of a sea port. Recent federal, state, and local government investments of $10,000,000.00 in the port's infrastructure have spurred a resurgence of the local fishing and seafood processing industry.

The Port of Garibaldi also is working on diversification into new venues and business activities supportive of its authentic fishing harbor character. The Port's boat basin has moorage for 277 vessels and serves as the base of operations for several commercial fishermen and charter operations. The harbor also has a public boat launch for people wishing to fish, crab or get to the Pacific Ocean. Other businesses located in the Port include additional recreational vehicle parks, a hotel, restaurants, fishing charters, and a variety of other recreational businesses; shrimp, crab and fish processing facilities; and a lumber mill. Significantly, the Port of Garibaldi is home to the US Coast Guard Station Tillamook Bay.

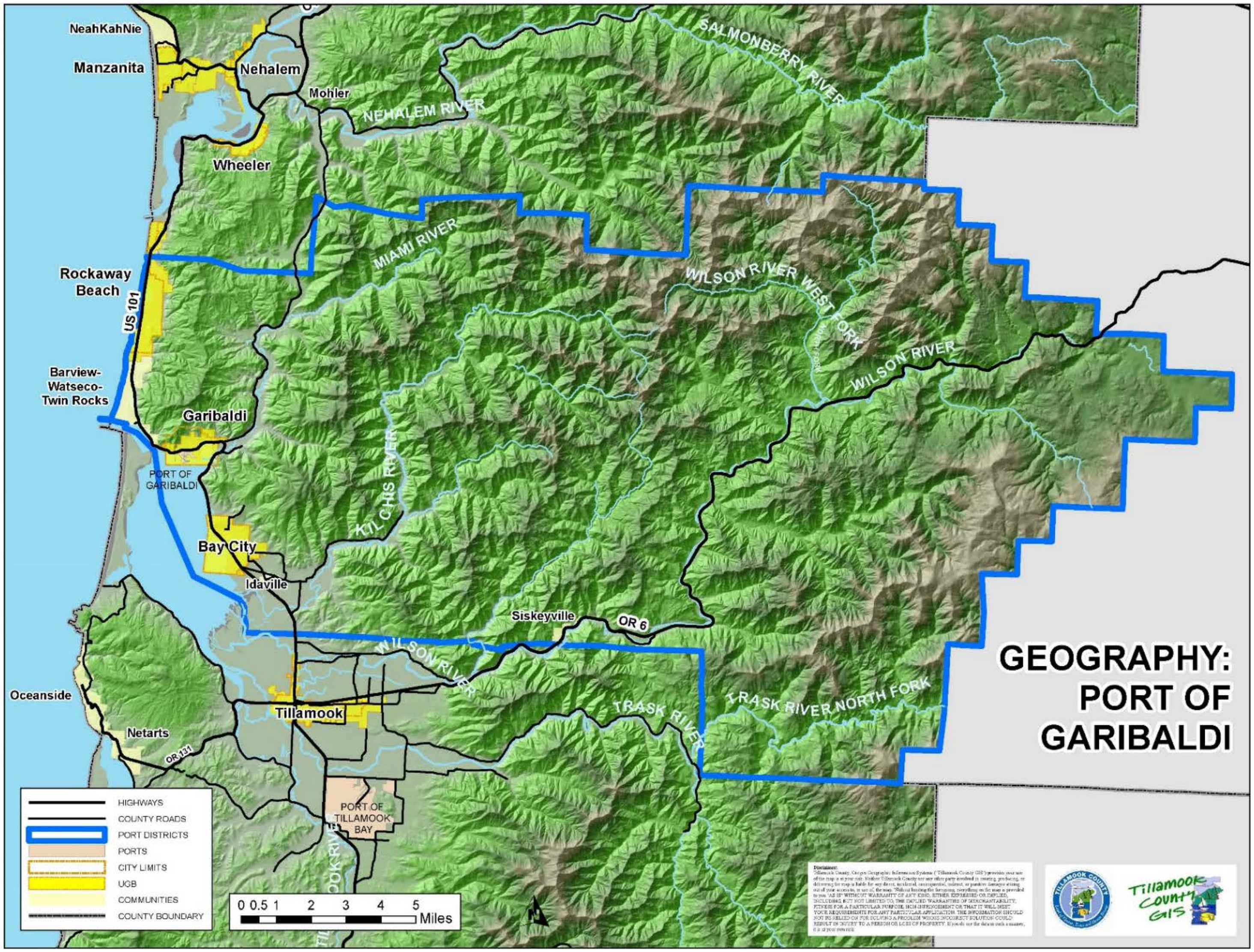
The Port's primary focus for natural hazards mitigation is on the protection of the navigable channels, boat basin, and infrastructure as they are important assets and critical infrastructure for and of Tillamook County.

Figure 14. Political and Physical Geography: Port of Garibaldi



Source: Tillamook County Geographic Information System (GIS) Team

Figure 15. Political and Physical Geography: Port of Garibaldi – Port District



Source: Tillamook County Geographic Information System (GIS) Team

Ecoregion

The US EPA uses “ecoregions” to describe areas of ecosystem similarity. Tillamook County is located in the US EPA ecoregion, “Coast Range.” Mountains in the Coast Range are low in elevation and high in precipitation, creating lush evergreen forests. Naturally occurring diverse forests have given way to monocrop plantings for timber harvest. The Oregon Coast Range is volcanic in origin and is drained by hundreds of creeks, streams, rivers, and lakes. Sedimentary soils are more prone to failure following clear cuts and road building than are areas with volcanic soils, which may be of concern as commercial Douglas fir forests are highly productive commercial logging areas. Landslides can impact the safety of nearby infrastructure and health of the region’s waterways. Sedimentary soils create more concerns for stream sedimentation than areas with volcanic soils. Low lands include beaches, dunes, forests, lakes, marshes, and streams. Many wetlands in the ecoregion have been converted to dairy pastures (Thorson et al., 2003).

Climate

The Oregon Coast has a predominantly mild climate with localized variation in precipitation levels. Precipitation occurs predominantly in the winter months, mostly in the form of rain due to the region’s low elevation. Wet winters and dry summers impact risk of drought, floods, landslides, and wildfires. Winter storms are often accompanied by high winds. Because there are a number of microclimates in the County, temperature and precipitation vary widely from one locale to another. Mean annual winter temperatures vary between 30 °F and 52 °F; mean annual summer temperatures between 48 °F and 78 °F. Mean annual precipitation ranges from 50 to 200 inches. (Oregon NHMP: Oregon Department of Land Conservation and Development, 2015).

Climate Change

The most reliable information on climate change is at the state level. In Tillamook County, coastal hazards, drought, wildfire, flooding, and landslides are projected to be impacted by climate change. Research shows that sea levels and wave heights along the Oregon Coast are rising and are expected to increase coastal erosion and coastal flooding. In addition, climate models project warmer drier summers and a decline in mean summer precipitation for Oregon. Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, Tillamook County is expected to be affected by an increased incidence of drought and wildfire. Furthermore, flooding and landslides are projected to occur more frequently. Tillamook County may experience an increase in extreme precipitation that can result in a greater risk of flooding, including increased magnitude and more frequent return intervals. Landslides in Oregon are strongly correlated with rainfall, so increased rainfall — particularly extreme events — will likely trigger more landslides. While winter storms and windstorms affect Tillamook County, there is little research on how climate change influences these hazards in the Pacific Northwest. (Oregon NHMP: Oregon Department of Land Conservation and Development, 2015).

2. Demographics

Statistics are reported from the US Census of 2010 (https://www.census.gov/2010census/data/) and the American Community Survey (ACS) of 2015 (https://factfinder.census.gov/). The American Community Survey is an estimate, rather than an actual count. Therefore, some of the estimates and calculations, particularly for the smaller cities, are within the margin of error and should be understood in that context. In some cases, data have not been reported or calculated for that reason.

We have included data where possible for the unincorporated urban areas of Neskowin, Oceanside-Netarts, and Pacific City and the remainder of the unincorporated area of the County ("Unincorporated County") to be consistent with the Multi-Hazard Risk Report (DOGAMI, 2016). The Port of Garibaldi has no residents. The Port of Tillamook Bay has one single-family residence located within its boundary, but not on Port property.

Resident Population

Understanding the population and certain of its characteristics help identify actions that can be taken to reduce the impacts of a disaster before it occurs.

The population of Tillamook County is located largely in low-lying areas along its coast, bays, and rivers, with the greatest population in the north and central regions.

As a whole, Tillamook County's population remained essentially unchanged, up not quite one percent between 2010 and 2015, with a barely positive annual growth rate. Because the ACS is an estimate and the communities are so small, the changes in their population and average annual growth rates would not be very accurate or meaningful and are not calculated. However, the data do estimate that all the cities and unincorporated urban areas have grown a bit except for Garibaldi and Pacific City, which are estimated to have lost some population. The Unincorporated County is also estimated to have lost population.

In general, the jurisdictions agree with this assessment. The City of Garibaldi reports a loss of residents due to closing of a mobile home park. However, demand for housing is increasing. Primary and secondary single-family homes and apartments are being developed. The City anticipates population to increase in the next few years. The City of Wheeler indicates that its steady population may be due to very little potential for new development or redevelopment in the City.

One privately owned property inside the Port of Tillamook Bay industrial park boundaries is developed with one single-family home with a population of two.

The Port of Garibaldi has no permanent residents.

Table 6. Population and Estimated Change, 2010–2015

	2010		2015		Population Change 2010/2015		Average Annual Growth Rate
	Population	% of County	Population	% of County	Population Change	Percent Change	
Oregon	3,761,925		3,939,233		177,308	4.7%	0.78
Tillamook County	25,200	100	25,430	100	230	0.9%	0.18%
Incorporated							
Bay City	1,286	5.1	1,466	5.7	–	–	–
Garibaldi	878	3.5	782	3.0	–	–	–
Manzanita	359	1.4	426	1.7	–	–	–
Nehalem	183	0.7	254	1.0	–	–	–
Rockaway Beach	1,112	4.4	1,227	4.8	–	–	–
Tillamook	4,897	19.4	4,958	19.5	–	–	–
Wheeler	284	1.1	397	1.6	–	–	–
Unincorporated							
Uninc. County (rural)	14,017	55.6	13,505	53.1	–	–	–
Neskowin	141	0.6	156	0.6	–	–	–
Oceanside-Netarts	958	3.8	1,296	5.1	–	–	–
Pacific City–Woods	1,085	4.3	963	3.8	–	–	–

Source: US Census Bureau, 2011–2015 American Community Survey (https://factfinder.census.gov/)

Tourists

In addition to year-round residents, Tillamook County attracts many tourists. The jurisdictions all indicate that the County's population explodes during the summer tourist season, especially on holidays and for special events. In addition to individuals and groups, many families arrive, significantly boosting the number of children throughout the County.

Table 7. Annual Visitor Estimates in Person Nights (x1000)

	2013	2014	2015
Tillamook County			
Hotel/Motel	730	777	818
Private Home	259	259	262
Other	1,487	1,498	1,525
Total Visitor Nights	**2,476**	**2,534**	**2,605**

Source: *Oregon Travel Impacts: 1991–2015*, May 2016, Dean Runyan Associates, http://www.deanrunyan.com/doc_library/ORImp.pdf

No similar official statistics exist for the individual jurisdictions. Bay City and Nehalem report hosting few visitors. These cities each have a recreational vehicle park and a few vacation rental homes, but no hotels. Wheeler reports hosting few overnight tourists but many day-trippers who take advantage of its transient boat ramp and dock for sport fishing. Garibaldi has two hotels, three recreational vehicle parks, and a few vacation home rentals. The Port of Garibaldi is home to one hotel, two recreational vehicle parks, a marina, and a public boat launch. Together the City of Garibaldi and the Port support sport fishing and other tourist activities as well as the year-round commercial fishing industry. The Port of Tillamook Bay owns and operates the Tillamook Air Museum, which receives approximately 65,000 visitors per year, and also operates a year-round recreational vehicle park just off US-101 approximately four miles south of downtown Tillamook. Rockaway Beach, Manzanita, Tillamook, and the unincorporated communities also report having many tourist accommodations and hosting many overnight tourists.

Difficulty locating or accounting for travelers increases their vulnerability in the event of a natural disaster. Further, tourists are often unfamiliar with evacuation routes, communication outlets, or even the type of hazard that may occur (MDC Consultants, n.d.). Targeting natural hazard mitigation outreach efforts to places where tourists lodge can help increase awareness and minimize the vulnerability of this population.

Age

Age is an indicator of vulnerability. Both children and the elderly are more vulnerable than are others to impacts of disasters.

Many seniors are sensitive to heat and cold, reliant upon public transportation or other people to transport them to obtain medication and access medical facilities, and have comparatively more difficulty in making home modifications that reduce risk to hazards. In addition, seniors may be reluctant to leave home in a disaster event. This implies the need for targeted preparatory programming that includes evacuation procedures and shelter locations accessible to seniors (Morrow, 1999; Oregon NHMP: Oregon Department of Land Conservation and Development, 2015). Seniors living alone may have more challenges knowing about and responding to a disaster than those living with other people.

Young children are also more vulnerable to heat and cold, have fewer transportation options, and require assistance to obtain medication and access medical facilities. In addition, parents may lose time and money when childcare facilities and schools are impacted by disasters. Therefore, special consideration should also be afforded young children, schools, and parents during the natural hazards mitigation process (Oregon NHMP: Oregon Department of Land Conservation and Development, 2015).

In general, Tillamook County has a high percentage of seniors and a low percentage of children. Notably, Neskowin has almost 90% seniors and no children under the age of 18. Pacific City also has almost no children, and seniors comprise only about a third of the population. Tillamook City has the youngest population overall, with less than 10% of its population of pre-school age, almost 20% of its population school-aged, and only about 14% seniors. Bay City, Garibaldi, and Manzanita indicate that the percentages of seniors estimated to live in their jurisdictions (19%, 25%, and 36%, respectively) appear low.

Table 8. Children and Seniors

Community	Total Population	≤ Age 5	% Total Population	> Age 5 & < Age 18	% Total Population	≥ Age 65	% Total Population	≥ Age 65 Living Alone	% Total Population
Oregon	3,939,233	23,2414	5.9	627,937	15.9	606,877	15.4	164,312	10.7
Tillamook County	25,430	1,368	5.4	3,550	14.0	6,155	24.2	1,595	15.8
Incorporated									
Bay City	1,466	82	5.6	226	15.4	279	19	52	9.4
Garibaldi	782	19	2.5	92	11.8	200	25.6	62	17.7
Manzanita	426	19	4.2	53	12.4	156	36.6	64	32.0
Nehalem	254	14	5.5	23	9.1	76	29.9	9	8.8
Rockaway									
Beach	1,227	16	1.3	224	18.2	346	28.1	78	13.8
Tillamook	49,58	361	7.3	929	18.7	694	13.9	313	16.9
Wheeler	397	14	3.5	64	16.2	130	32.7	22	13.8
Unincorporated									
Unincorp. County (rural)	13,505	733	5.4	2,366	17.5	3,085	22.8	786	15.1
Neskowin	156	0	0	0	0	139	89.1	53	47.3
Oceanside-Netarts	1,296	52	4.0	111	8.5	465	35.8	153	24.8
Pacific City–Woods	963	9	0.9	65	6.7	330	34.2	51	12.9

Source: US Census Bureau, 2011–2015 American Community Survey 5-Year Estimates (https://factfinder.census.gov/)

Disability

People with disabilities (physical, cognitive, or sensory) are disproportionately affected during disasters (Cutter, Boruff, & Shirley, 2003). The resources or assistance they need may not be available. Outreach targeted to disabled residents could help them, local governments, and non-government organizations prepare for and recover after a disaster.

In Tillamook County, almost 20% of the non-institutionalized population has a disability. In a county whose population is almost 25% seniors, this is not surprising. What is surprising is that almost half of Pacific City's very few children are disabled and over 20% of Garibaldi's. In addition, almost 60% of Nehalem's seniors are disabled.

Table 9. Non-Institutionalized Persons with a Disability

Community	Non-Inst Population	With a Disability	% Non-Inst Population	< Age 18 with a Disability	% Non-Inst Population	≥ Age 65 with a Disability	% Non-Inst Population
Oregon	3,900,771	562,324	14.4	39,690	4.6	224,698	37.6
Tillamook County	24,767	4,446	18.0	251	5.2	2,072	36.8
Incorporated							
Bay City	1,466	218	14.9	19	8.4	75	26.8
Garibaldi	775	192	24.8	25	22.5	67	33.5
Manzanita	426	61	14.3	0	0	43	26.9
Nehalem	254	60	23.6	1	2.7	44	57.8
Rockaway Beach	1,227	255	20.8	24	10.7	108	31.2
Tillamook	4,952	952	19.2	84	6.8	270	38.9
Wheeler	344	62	18.0	5	7.4	32	41.6
Unincorporated							
Unincorp. County	12,908	2,074	16.1	NA	–	NA	–
Neskowin	156	43	27.6	0	0	43	30.9
Oceanside-Netarts	1,296	263	20.3	0	0	189	40.6
Pacific City–Woods	963	266	27.6	32	43.2	48	20.8

Inst is Institutionalized; NA = not applicable

Source: US Census Bureau, 2011–2015 American Community Survey 5-Year Estimates (https://factfinder.census.gov/)

Language

For people who are not native English speakers, communication about hazards before, during, and after a disaster may be daunting, increasing their vulnerability. Culturally appropriate outreach and informative materials in the languages spoken in the County would reduce that vulnerability. A small proportion of Tillamook County's population speaks a language other than English at home. Of those, most speak Spanish or Spanish Creole, and most live in the unincorporated areas of the County. The City of Tillamook is home to the next greatest concentration with a very small number living in the other cities and unincorporated urban areas. Because the numbers are so small and an estimate they should be understood as general indicators only.

Table 10. Language Spoken at Home

Community	Spanish or Spanish Creole	Other Indo-European Languages	Asian & Pacific Island Languages	Total
Tillamook County	**1,532**	**168**	**82**	**1,782**
Incorporated				
Bay City	29	4	38	71
Garibaldi	11	3	0	14
Manzanita	21	0	19	40
Nehalem	2	1	0	3
Rockaway Beach	24	0	0	24
Tillamook	405	34	12	451
Wheeler	6	0	6	12
Unincorporated				
Unincorporated County (rural)	936	97	7	1,040
Neskowin	0	0	0	0
Oceanside-Netarts	63	29	0	92
Pacific City–Woods	35	0	0	35

Source: US Census Bureau, Census 2011–2015 American Community Survey 5-Year Estimates (https://factfinder.census.gov/)

Education

Studies (e.g., Cutter et al., 2003) show that education and socioeconomic status are deeply intertwined with higher educational attainment correlating to increased lifetime earnings. Education can also influence a person's and community's ability to access disaster information and resources. Neskowin has by far the greatest percentage of population with a graduate or professional degree (60%), but it also has the least population. Manzanita has about double Neskowin's population and about 20% of its population holds a graduate or professional degree while 35% of its population holds a bachelor's degree. Most jurisdiction's populations hover around a third with high school degrees. Tillamook and Pacific City have the greatest proportion of population without a high school degree, but that is only around 15%.

Table 11. Educational Attainment by Percent of Population Age 25 and Over

Community	Population ≥ 25 years	% Not a High School Graduate	% High School Graduate or GED	% Some College, No Degree	% Associate's Degree	% Bachelor's Degree	% Graduate or Professional Degree
Oregon	2,714,972	10.2	24.3	26.3	8.4	19.3	11.5
Tillamook County	18,918	10.5	34.6	38.8	6.2	13.4	7.6
Incorporated							
Bay City	1,058	8.1	38.1	31.0	7.9	11.7	3.1
Garibaldi	623	9.8	42.2	28.1	5.3	8.7	5.9
Manzanita	354	3.1	22.9	13.8	5.4	35.3	19.5
Nehalem	209	7.6	27.8	36.8	3.3	18.7	5.7
Rockaway Beach	949	7.0	33.9	30.2	4.6	16.6	7.6
Tillamook	3,370	13.7	37.4	28.9	8.7	7.7	3.5
Wheeler	313	6.4	32.9	39.3	5.1	7.3	8.9
Unincorporated							
Unincorp. County (rural)	10,176	NA	NA	NA	NA	NA	NA
Neskowin	156	0	0	23.7	5.8	4.5	66.0
Oceanside-Netarts	1,075	3.8	22.7	29.8	8.7	18.5	16.4
Pacific City–Woods	817	15.1	27.4	27.1	3.5	8.9	18.0

Source: US Census Bureau, Census 2011–2015 American Community Survey 5-Year Estimates (https://factfinder.census.gov/)

Housing Occupancy and Tenure

Housing tenure is often linked to household income, and household income to the ability to recover from a natural disaster. Renters are less likely to have the financial resources to recover from a natural disaster. In general, they do not make improvements or repairs to the rented structure and may lack sufficient shelter options when lodging becomes uninhabitable or unaffordable after a disaster. They are less likely to return after a disaster.

Tillamook County's owner occupancy rate is about 10% higher than Oregon's. Neskowin has 100% owner occupancy and Pacific City 92%. Nehalem and the unincorporated county have just over 80%. Conversely, the City of Tillamook has by far the highest proportion of renter-occupied housing at 63%.

A recently completed countywide housing analysis, *Creating a Healthy Housing Market for Tillamook County: Findings and Recommendations for the Tillamook County Housing Task Force* (czb, 2017), is based on 2014 data. Although it addresses the county as a whole rather than as individual jurisdictions, it generally supports the estimates in **Table 12**.

Most jurisdictions indicate owner occupancy rates tracking with the estimates below. Wheeler indicates that this estimate appears low, and that the ratio of owner- to renter-occupied is about 3:1 rather than about 1:1. Manzanita and Rockaway Beach in particular indicate that about two thirds to three fourths of homes are owned by people who are not permanent residents, so much of the housing stock sits empty for long periods during the off-season.

The Port of Tillamook Bay and the Port of Garibaldi have no housing.

Table 12. Housing Occupancy and Tenure

Community	Occupied Units	Owner-Occupied		Renter-Occupied	
		Estimate	Percent	Estimate	Percent
Oregon	153,430	939,637	61.3	593,793	38.7
Tillamook County	10,094	7,311	72.4	2,783	27.6
Incorporated					
Bay City	553	430	77.8	123	22.2
Garibaldi	350	262	74.9	88	25.1
Manzanita	200	142	71.0	58	29.0
Nehalem	102	83	81.4	19	18.8
Rockaway Beach	565	377	66.7	188	33.3
Tillamook	1,852	680	36.7	1,172	63.3
Wheeler	159	84	52.8	75	47.2
Unincorporated					
Unincorp. County (rural)	5,131	4,273	82.6	858	16.7
Neskowin	112	112	100	0	0
Oceanside-Netarts	615	448	72.8	167	27.2
Pacific City–Woods	455	420	92.3	35	7.7

Source: US Census Bureau, Census 2011–2015 American Community Survey 5-Year Estimates (https://factfinder.census.gov/)

3. Economics

Income and Poverty

Overall, Tillamook County's median income declined very slightly, and less than Oregon's, but the percentage of its households experiencing poverty is higher. However, that belies some major shifts in median income and apparent inconsistencies in poverty levels in the urban areas. Garibaldi and Nehalem have suffered significant declines in median income (about 16% and 13%, respectively) as has Pacific City, whose median income has declined even more significantly (by about 23%). A similar percentage of Pacific City's households are experiencing poverty, the greatest percentage in the County. Garibaldi's median income declined by about 16% and about 10% of its households are experiencing poverty. Interestingly, while Nehalem's median income declined by about 13%, none of its households are experiencing poverty. In contrast, Manzanita and Wheeler saw significant increases in median household income (about 38% and 46%, respectively). None of Wheeler's households are experiencing poverty, but about 11% of Manzanita's still are.

Manzanita indicates that the increase in median income is due to recovery from the Great Recession and agrees that some residents are living in poverty. Wheeler indicates that the increase in median income is due to an influx of retirees, but takes issue with the assessment that there are no households in poverty. The activity level at the local food bank is evidence that a significant proportion of Wheeler's residents are having trouble making ends meet.

People living in poverty suffer a disproportionate burden from disasters. They are more likely to be isolated and less likely to have the assets to withstand economic setback. When a disaster interrupts work, the ability to provide housing, food, and basic necessities becomes increasingly difficult. In addition, low-income populations are hit especially hard as public transportation, public food assistance, public housing, and other public programs upon which they rely for day-to-day activities are often impacted in the aftermath of the disaster.

Table 13. Median Household Income and Households below the Poverty Level

Community	Median Household Income 2010*	Median Household Income 2015	% Change in Median Household Income	Households in Poverty (%)
Oregon	53,520	51,243	-3.8	9.6
Tillamook Incorporated	42,820	42,581	-0.6	12.8
Bay City	43,382	46,726	7.7	5.0
Garibaldi	43,278	36,429	-15.8	9.8
Manzanita	37,348	51,429	37.7	10.9
Nehalem	50,250	43,500	-13.4	0.0
Rockaway Beach	34,375	37,227	8.3	11.2
Tillamook	29,436	29,889	1.5	14.6
Wheeler	29,490	42,917	45.5	0.0
Unincorporated				
Unincorp. County (rural)	NA	NA	–	NA
Neskowin	37,574	39,559	5.3	0.0
Oceanside-Netarts	NA	NA	–	0
Pacific City–Woods	32,594	25,230	-22.6	21.3

*2010 dollars are adjusted for 2015 using Bureau of Labor Statistics' Consumer Price Index Inflation Calculator (https://www.bls.gov/data/inflation_calculator.htm).

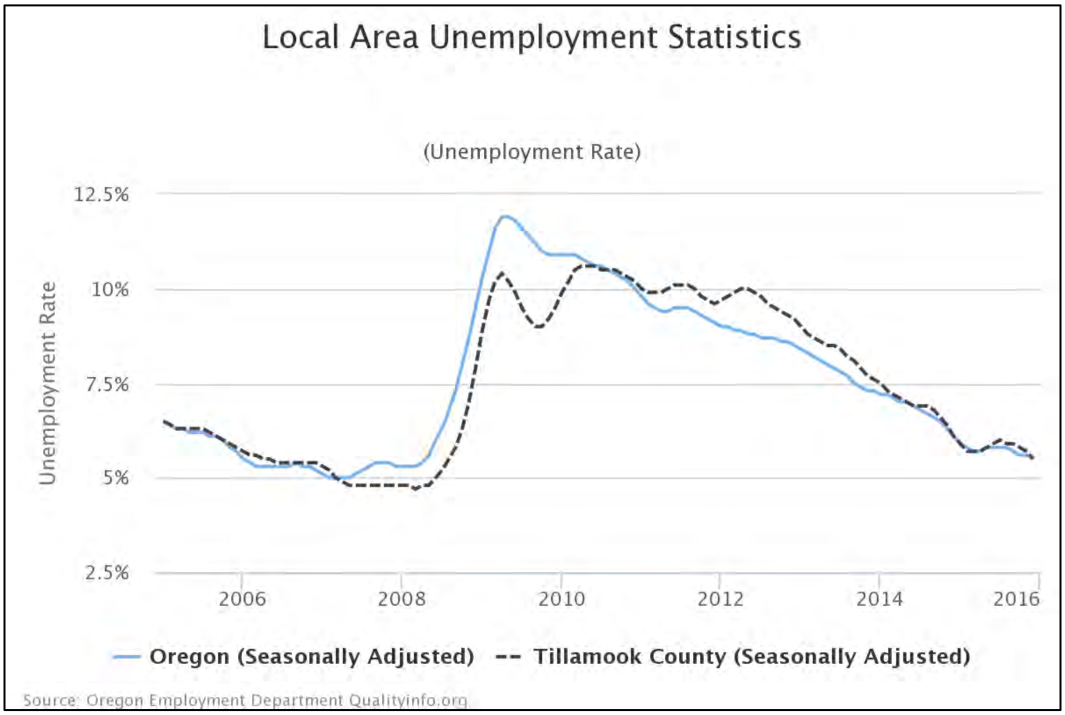
NA = not applicable

Source: US Census Bureau (https://www.census.gov/), and 2011–2015 American Community Survey (https://factfinder.census.gov/)

Unemployment

Unemployment is an indicator of vulnerability, in much the same way that household income and poverty are. Unemployment in Tillamook County has generally followed unemployment trends statewide, except that it declined more slowly between 2011 and 2014. Employment at the Oregon Coast tends to increase with tourism in the summer and decrease in the winter.

Figure 16. Tillamook County Unemployment Rates 2005–2015



Source: Oregon Employment Department, https://www.qualityinfo.org/ed-uesti/?at=1&t1=4101000000,4104000057~unemprate~y~2005~2015, accessed February, 10, 2017

Employment

"The potential loss of employment following a disaster exacerbates the number of unemployed workers in a community, contributing to a slower recovery from the disaster" (Cutter et al., 2003). Spring and summer months bring more jobs to the County, as tourism, retail trade, and construction increase. The economy is more vulnerable during winter months when tourism decreases and in turn the employment opportunities that support it.

In Tillamook County, employment is heaviest in the Government, Leisure/Hospitality, Accommodation/Food Services, Manufacturing, and Trade/Transportation/Utilities sectors. The Leisure/Hospitality and Accommodation/Food Services sectors support the tourism industry. Retail trade supports visitors as well as year-round residents. Manufacturers are not as dependent on local markets. However, these sectors are all dependent on the transportation system to transport goods and people into and out of the County. Disaster-caused disruption in the transportation system could have significant impacts on the local economy, jobs, and income from decreased tourism and impaired ability to transport goods into and out of the County.

Port Districts have a legal mandate to be a conduit for economic activity and commerce within their district boundaries. The Port of Tillamook Bay and the Port of Garibaldi nurture different economic sectors, together providing a wide range of opportunities and stoking the economic engine of Tillamook County. Adverse impacts to the Ports from natural hazards have far-reaching implications for the County's economy and employment outlook.

With 1,600 acres of industrial-zoned land, much of it accessible via US-101 and 500 acres available for development, the Port of Tillamook Bay is the driving economic force in Tillamook County. The Port operates the Tillamook Municipal Airport, an Airport Business Park, and Air Museum; a 200-acre industrial park with an assortment manufacturing and development operations; and a recreational vehicle park. A diverse assemblage of manufacturing and development operations including Stimson Lumber Mill, CHS Feed Mill, and Hallco Industries provides opportunities to earn a full spectrum of wages from entry-level on up. Near Space Corporation, a commercial provider of high-altitude, near-space platforms and flight services for government, academic, and commercial customers delivers high-end family-wage jobs.

The Port of Tillamook Bay is planning to grow three types of employment uses on its property:

(1) A mixture of retail and commercial uses on its land along Highway 101. These would potentially include both small-scale and large-format retail; facilities for visitors (e.g., a new museum); and a variety of businesses.

(2) Additional manufacturing in its Industrial Park. In 2012, the Port completed construction of three 18,000 square foot warehouses that can support small- to mid-scale manufacturing. Its 500 acres of vacant land could accommodate larger-scale manufacturers.

(3) Aviation and aerospace-related businesses. Firms in this sector will find opportunities for development in the Port's Airport Business Park.

The Port of Garibaldi supports timber, fishing, seafood processing and distribution, and recreation industries. Seafood is brought into the Port by commercial fishermen, processed on site, then distributed nationally and internationally. Hardwood harvested locally and throughout the Pacific Northwest is brought to the Port of Garibaldi for processing then distributed nationally. Each seafood and timber processing job at the Port of Garibaldi is linked with several jobs in harvesting and distribution. Distribution generates jobs not only locally, but also throughout the Pacific Northwest and the entire country.

The US Coast Guard Station Tillamook Bay is located in the Port of Garibaldi. Its area of operation stretches from Cape Kiwanda north to Cannon Beach and 15 nautical miles into the Pacific Ocean. Thirty people are employed here.

Table 14. Employment by Industry, 2015, and Employment Forecast

Industry	Tillamook County, 2015				Percent Change in Employment (2010–2015)	Employment Forecast (2014–2024)
	Firms	Employees	% of Workforce	Average Pay		
Total Payroll Employment	**969**	**9,121**	**100**	**35,334**	**7.2**	**7**
Total Private	**860**	**7,273**	**79.7**	**33,459**	**9.6**	**8**
Natural Resources & Mining	77	718	7.9	37,279	15.0	13
Animal Production	49	421	4.6	32,155	12.6	NA
Manufacturing	30	1,378	15.1	45,149	7.7	2
Trade, Transportation & Utilities	148	1,352	14.8	27,726	11.7	5
Retail Trade	99	1,015	11.1	23,956	10.4	4
Health Care and Social Assistance	64	898	9.8	14,141	14.0	NA
Professional & Business Services	72	426	4.7	34,652	5.2	14
Education & Health Services	74	932	10.2	46,569	12.6	10
Leisure & Hospitality	143	1,411	15.5	17,846	10.4	11
Accommodation & Food Services	130	1,354	14.8	17,660	12.5	12
Total Government	**109**	**1,847**	**20.2**	**42,737**	**-2.2**	
Federal	15	101	1.1	56,330	-44.5	-6
State	22	402	4.4	43,458	7.8	5
Local	72	1,343	14.7	41,531	-1.9	5

Source: Oregon Employment Department (https://www.qualityinfo.org/), “2010 and 2015 Employment and Wages by Industry” and “Northwest Oregon Industry Employment Projections 2014–2024”

4. Infrastructure

Roads

US-101 is the only continuous passage for automobiles and trucks traveling north-south along the Oregon Coast. Secondary roads provide other north-south connections between population centers. State Routes connect Tillamook County to the interior. SR-53 connects with US-101 between Wheeler and Nehalem, heading northeast to US-26 in Clatsop County. From there, one can head east directly to Portland. Alternatively, at the junction of SR-53 and US-26, one can head west to connect with US-101 and then north to Astoria and east to Portland. SR-6 runs east-west from the City of Tillamook, crossing the Coast Range to connect with US-26 farther inland, making it the shorter route to Portland. SR-22 meets US-101 at Hebo and runs east-west to Salem.

Portions of all these roadways are susceptible to damage and closure from earthquakes and landslides. Portions of US-101 and other lowland roadways are also susceptible to damage and closure from flooding and tsunamis. A Cascadia Subduction Zone event would have a devastating impact on automobile and truck travel in the County. Both north-south and east-west roads would be damaged or impassible hindering evacuation and emergency operations and hampering or severing ground connections with Portland and the Willamette Valley.

Travel along US-101 and other Tillamook County roads is disrupted or obstructed almost every year due to floods and landslides from winter storms. The roadbed itself may sustain damage and require costly repairs. Bay City indicates that its roads have not been subject to damage or closure from flooding but are at risk from landslides and earthquakes. Manzanita indicates that its roads are subject to damage from flooding, tsunamis, and earthquakes, but not from landslides. In addition to flooding, tsunamis and earthquakes, Rockaway Beach's roads are also at risk of debris flows from landslides in the hills to the city's east. Wheeler's location on the lower elevations of a steep mountain and on a riverbank make its roads particularly subject to damage and closure from earthquakes, tsunamis, landslides, and flooding, potentially isolating the city. The Port of Tillamook Bay owns the approximate 4.5 miles of roads within its property. Between 2012 and 2014, the Port spent over $4 million of its FEMA Alternate Project funds on a complete road rehabilitation project. Currently, the Port is working to develop a road maintenance fund to provide monies for ongoing maintenance and future project needs.

Bridges

Every primary or secondary roadway in the County has at least one bridge, and bridges are also highly vulnerable to seismic activity. Non-functional bridges disrupt local and freight traffic, emergency operations, and sever lifelines. These disruptions may exacerbate local economic losses if industries are unable to transport goods. The region's bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or that are part of regional and local systems maintained by the region's counties and cities.

Table 15 shows the structural condition of the County's bridges. A distressed bridge (Di) is a condition rating used by the Oregon Department of Transportation (ODOT) indicating that a bridge has been identified as having a structural or other deficiency, while a deficient bridge (De) is a federal performance measure used for non-ODOT bridges. The ratings do not imply that a bridge is unsafe (ODOT, 2012, 2013).

Table 15. Bridge Inventory

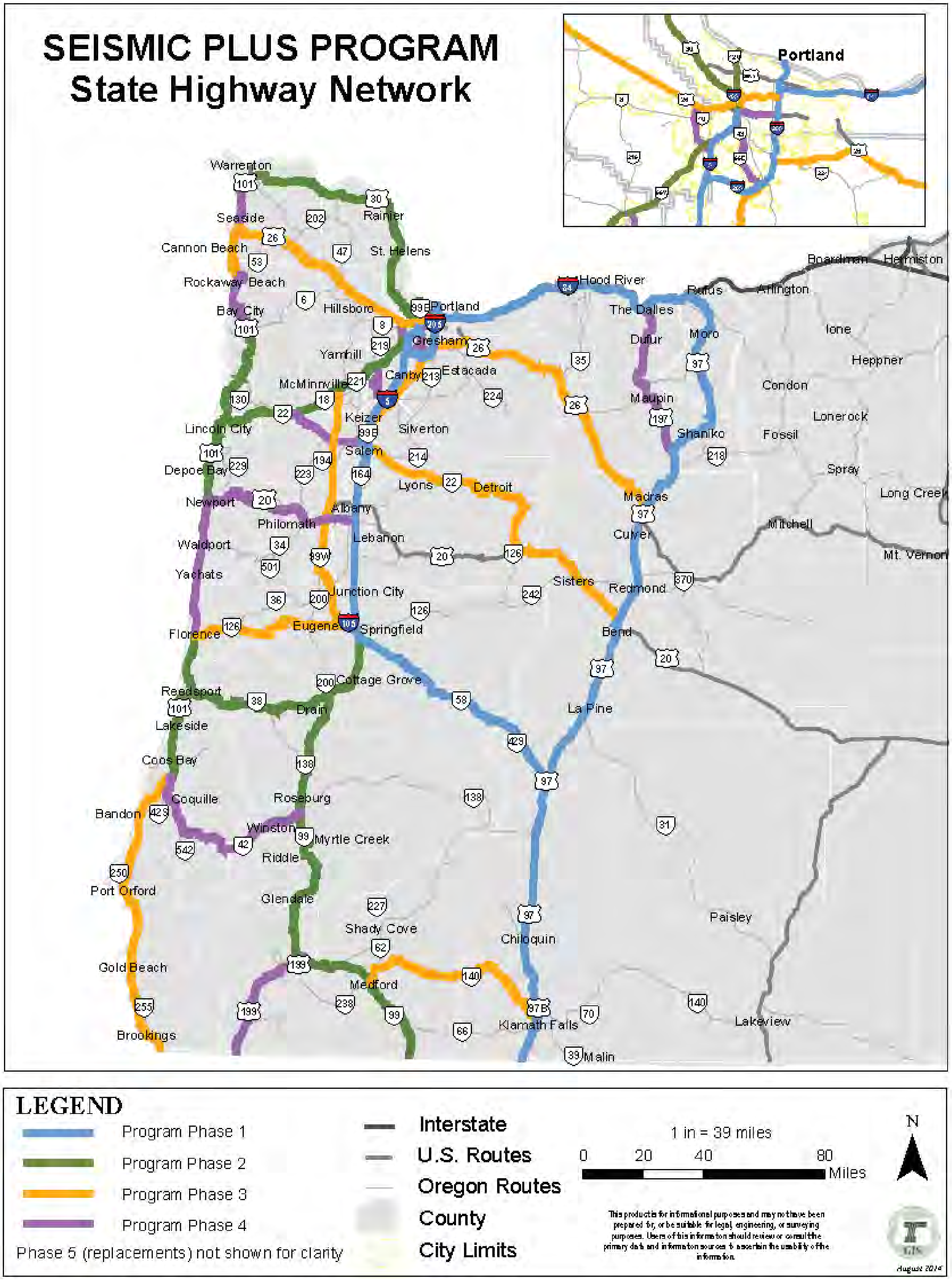
	State Owned			County Owned			City Owned			Other Owned			Area Total			Historic Covered
	Di	ST	%D*	De	ST	%D	De	ST	%D	De	ST	%D	D	T	%D	
Oregon	610	2,718	22%	633	3,420	19%	160	614	26%	40	115	35%	1,443	6,769	21%	334
Tillamook	45	76	48%	19	81	23%	0	1	0%	4	15	27%	68	190	36%	15

Note: Di = ODOT bridges Identified as distressed with structural or other deficiencies; De = Non-ODOT bridge Identified with a structural deficiency or as functionally obsolete; D = Total of Di and De bridges; ST = Jurisdictional Subtotal; %D = Percent distressed (ODOT) and/or deficient bridges; * = ODOT bridge classifications overlap and total (ST) is not used to calculate percent distressed, calculation for ODOT distressed bridges accounts for this overlap.

Source: ODOT (2012, 2013)

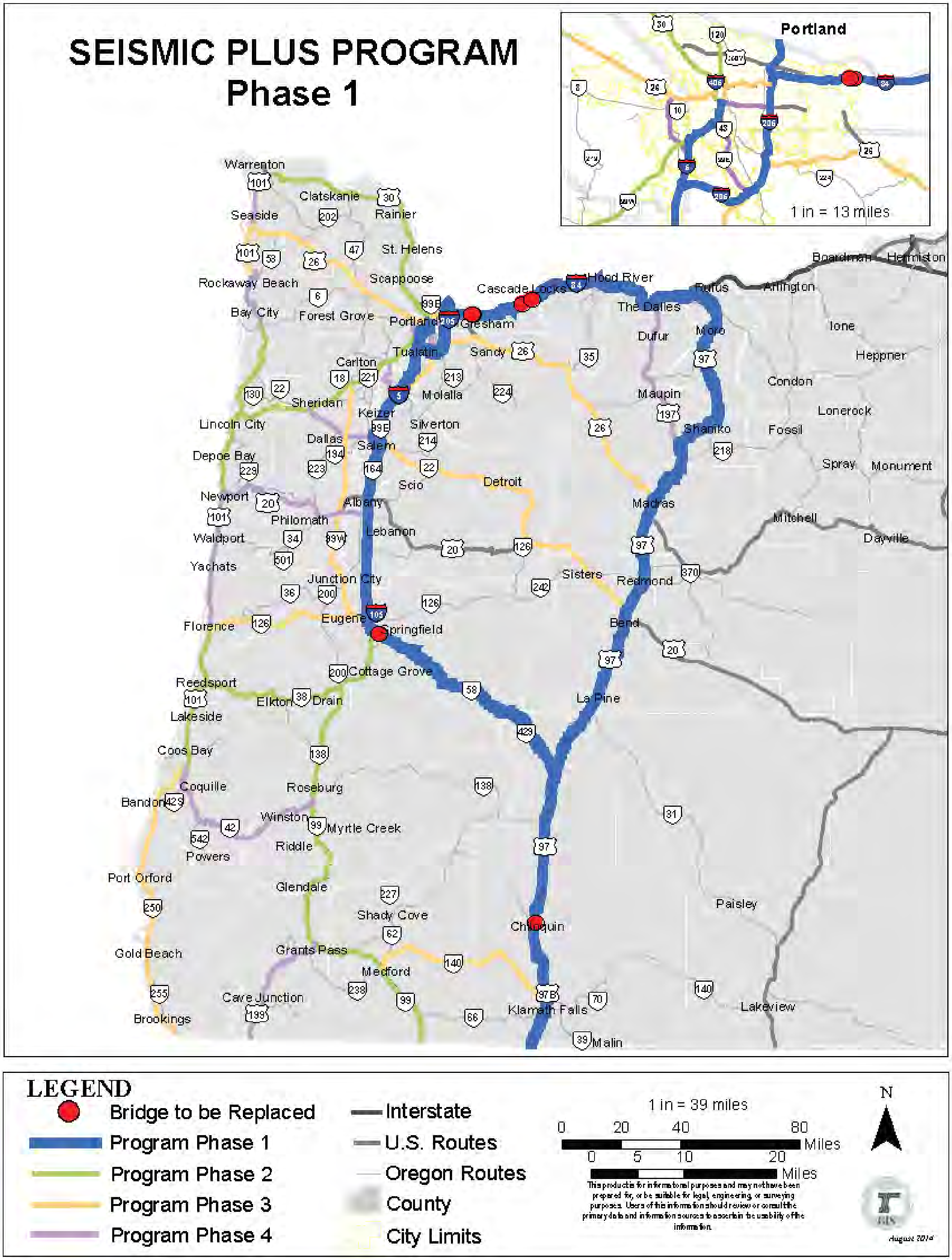
The ODOT's *Oregon Highways Seismic Plus Report* (2014) identifies only US-101 as a seismic lifeline in Tillamook County. Bridges along US-101 are designated for strengthening, rehabilitation, retrofitting, or replacement; landslides and rockfalls for mitigation. The Report recommends that this seismic resiliency work be undertaken in five phases across the state. Because the Redmond Airport will serve as Oregon's hub for moving goods and medical supplies into and across the state after a Cascadia event, Phase 1 is recommended to focus on the corridors that connect it with the most populated areas in the Willamette Valley. Coastal communities are recommended as the next areas on which to focus. Portions of US-101 in Tillamook County are identified for seismic resiliency work in Phases 2, 3, and 4.

Figure 17. Seismic Plus Program State Highway Network: Overview



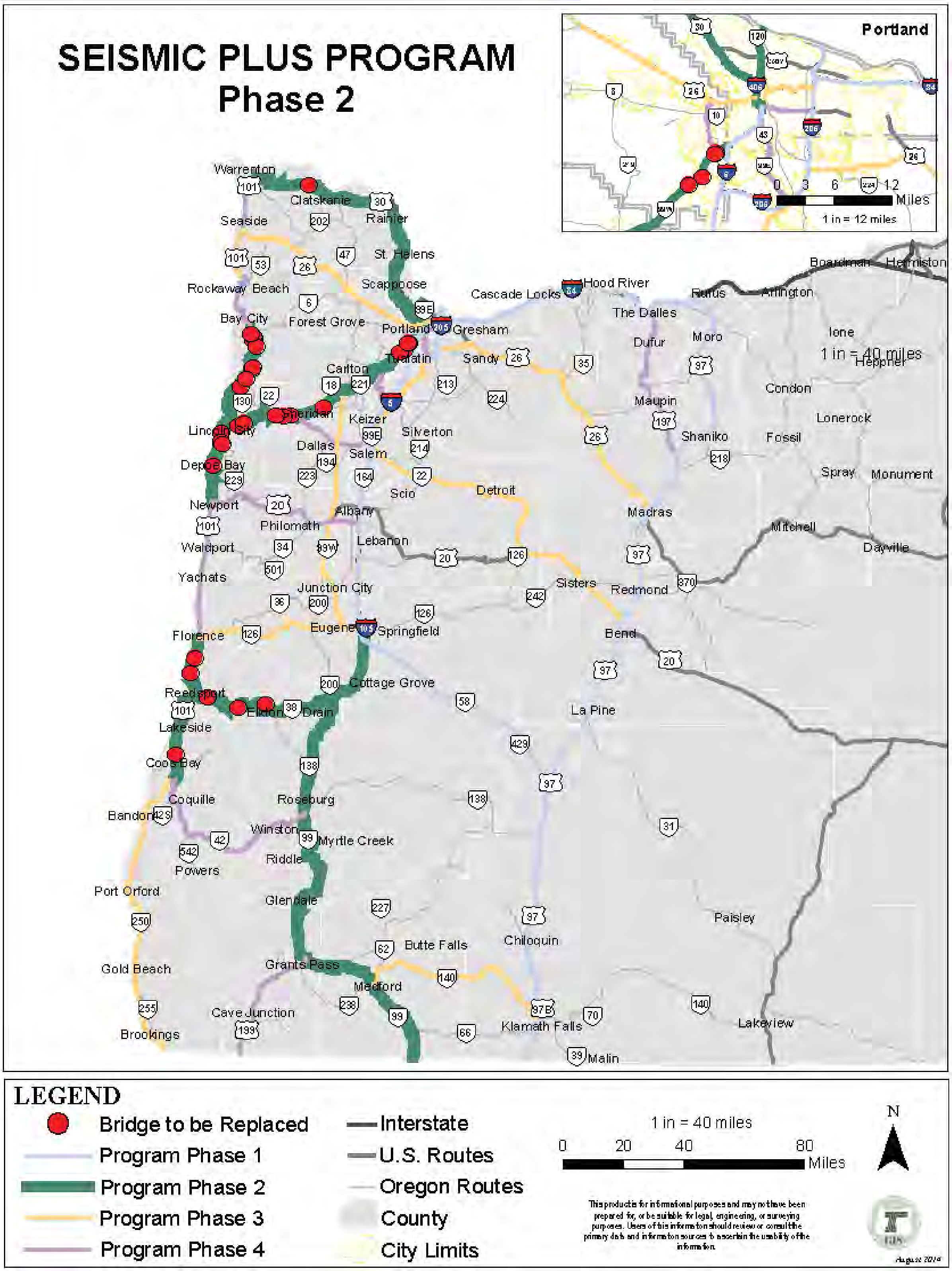
Source: ODOT (2014)

Figure 18. Seismic Plus Program State Highway Network: Phase 1



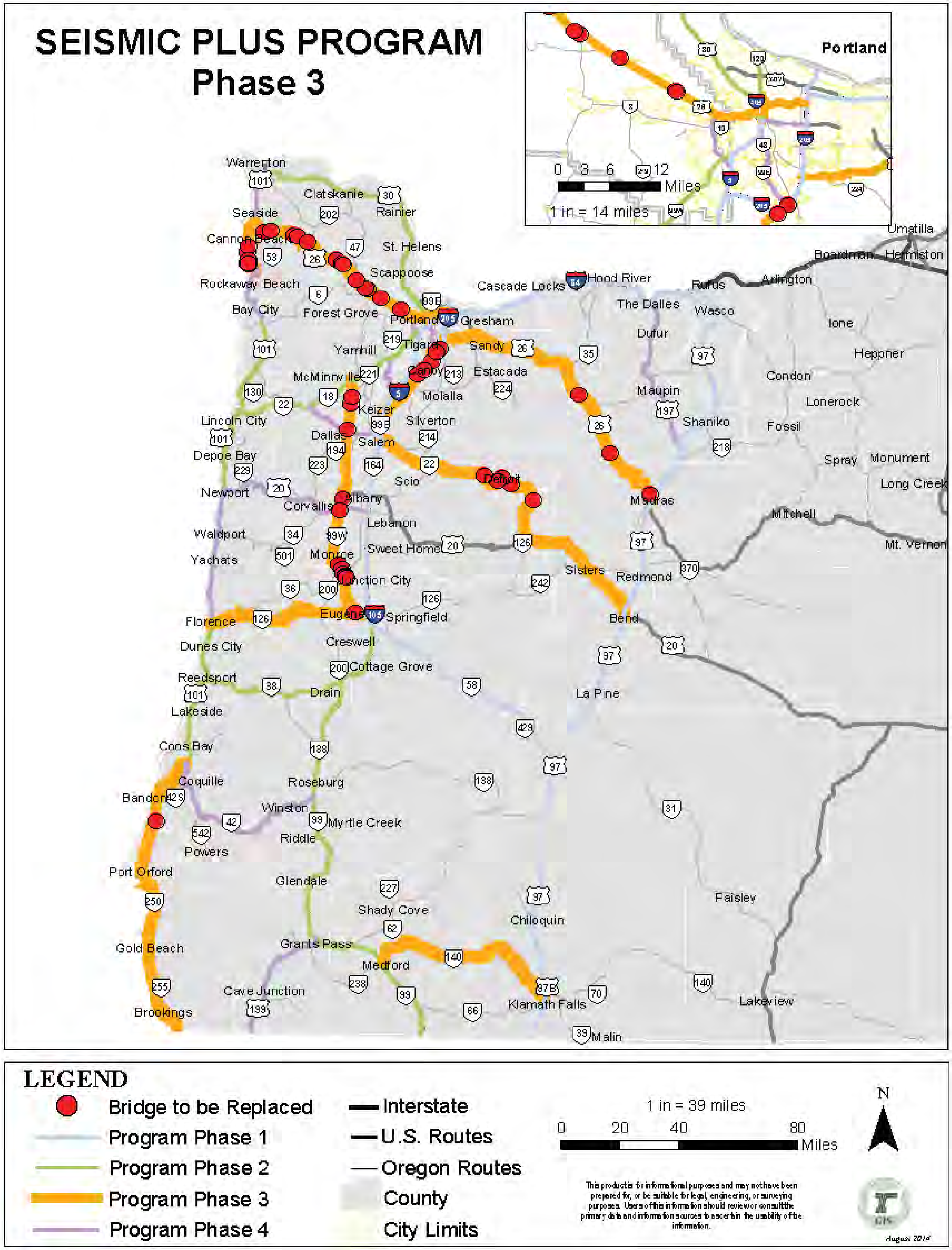
Source: ODOT (2014)

Figure 19. Seismic Plus Program State Highway Network: Phase 2



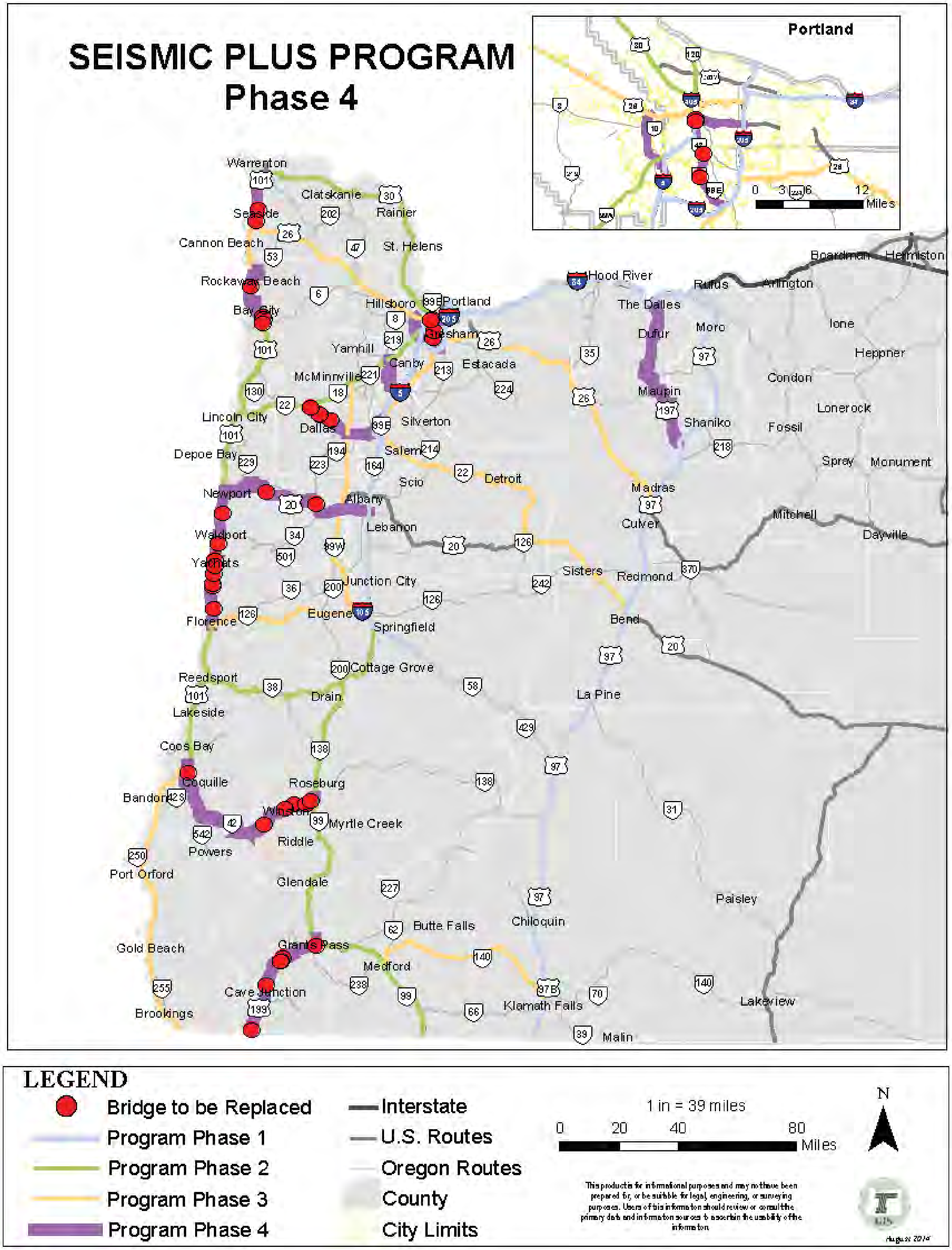
Source: ODOT (2014)

Figure 20. Seismic Plus Program State Highway Network: Phase 3



Source: ODOT (2014)

Figure 21. Seismic Plus Program State Highway Network: Phase 4



Source: ODOT (2014)

Public Transportation

The Tillamook County Transportation District provides local passenger and dial-a-ride service north to Cannon Beach, south to Lincoln City, and west to Pacific City. It also provides intercity connecting service to Portland daily that connects riders to Amtrak, Greyhound, Tri-Met, and Airport MAX. As a member of the Northwest Oregon Connector Alliance, the District has been able to offer regular connecting service Salem as well, including stops at casinos along the way.

Railroads

A single freight rail line previously ran north from the Port of Tillamook Bay to the confluence of the Nehalem and Salmonberry Rivers, then east along the Salmonberry River into Washington County. In December of 2007, flooding from a major winter storm destroyed large sections of the rail line in the mountainous area of the Salmonberry River Canyon. Rather than rebuild, the Port decided to invest in its industrial park and airport facilities. A large coalition of stakeholders and interested parties is working to turn this damaged portion of railway into a multi-use, non-motorized trail. The project is known as the *Salmonberry Trail*. The Oregon Coast Scenic Railroad operates on an undamaged portion of the rail line between Garibaldi and the confluence of the Nehalem and Salmonberry Rivers. Approximately 40 railroad bridges and trestles along the line are managed by the Oregon Coast Scenic Railroad. They are all subject to damage from various natural hazards including winter storms, flooding, earthquakes, landslides, and wildfires (Walker Macy, 2015).

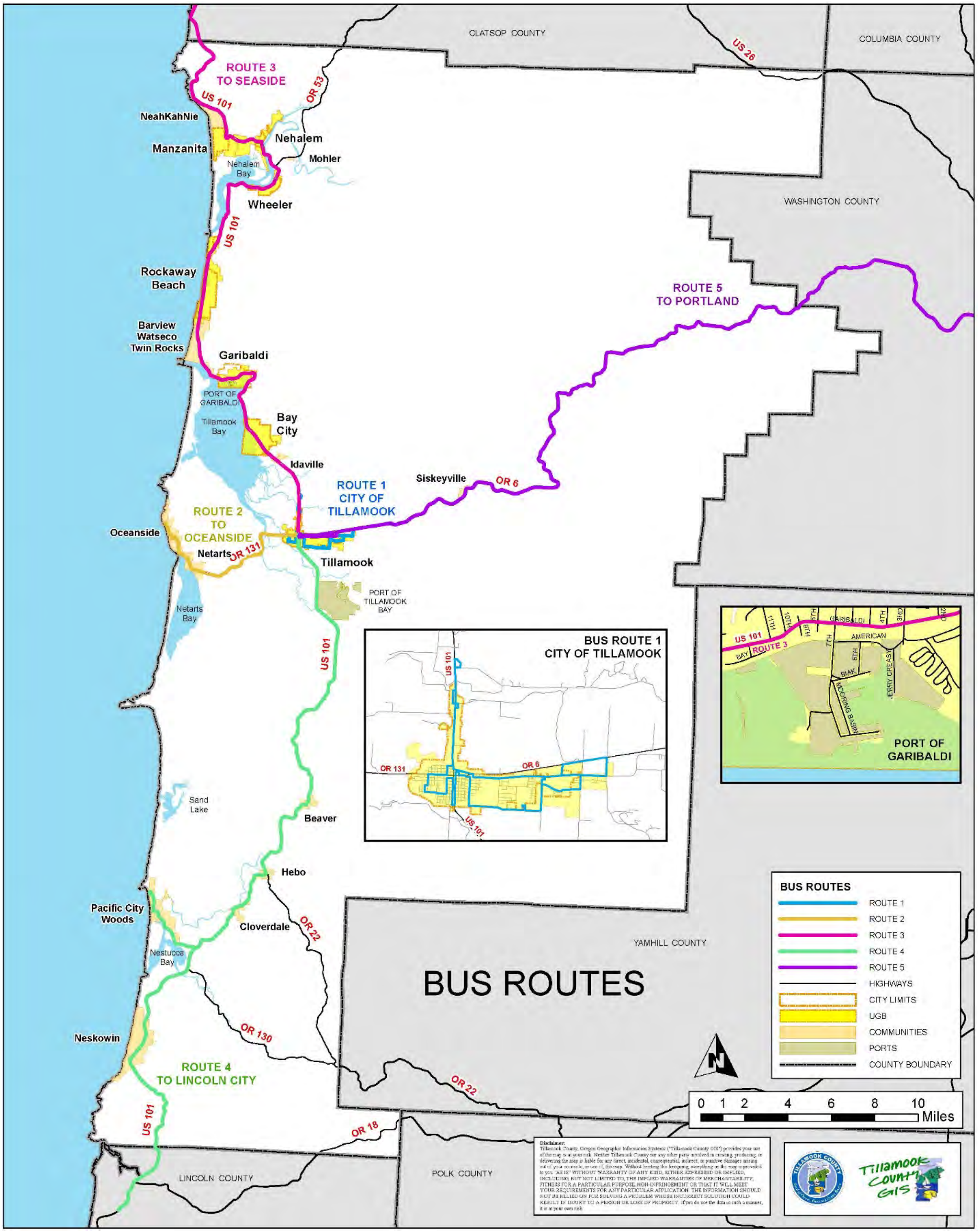
Airports

There are three publicly owned general aviation airports in Tillamook County and a fourth, privately owned medical helipad at Tillamook Regional Medical Center. Tillamook Municipal Airport is owned by the Port of Tillamook Bay located four miles south of the City of Tillamook. It has two runways and serves "light passenger and cargo planes, military aircraft on training missions, vintage military aircraft, experimental aircraft, airships, helicopters, private jets and NASA weather balloons" (Port of Tillamook Bay, http://www.potb.org/airport/, accessed February 25, 2017). The State of Oregon owns the Nehalem Bay and Pacific City State Airports. Each has a single runway and serves light passenger aircraft. (https://www.oregon.gov/OMD/OEM/plans_train/docs/aviation-annex/part_3_airport-heliport_directory_tillamook.pdf) All of these facilities, especially the Tillamook Municipal Airport due to its sophistication and inland location, could play an important role in a post-disaster situation where other modes of transportation are inoperable.

Electricity

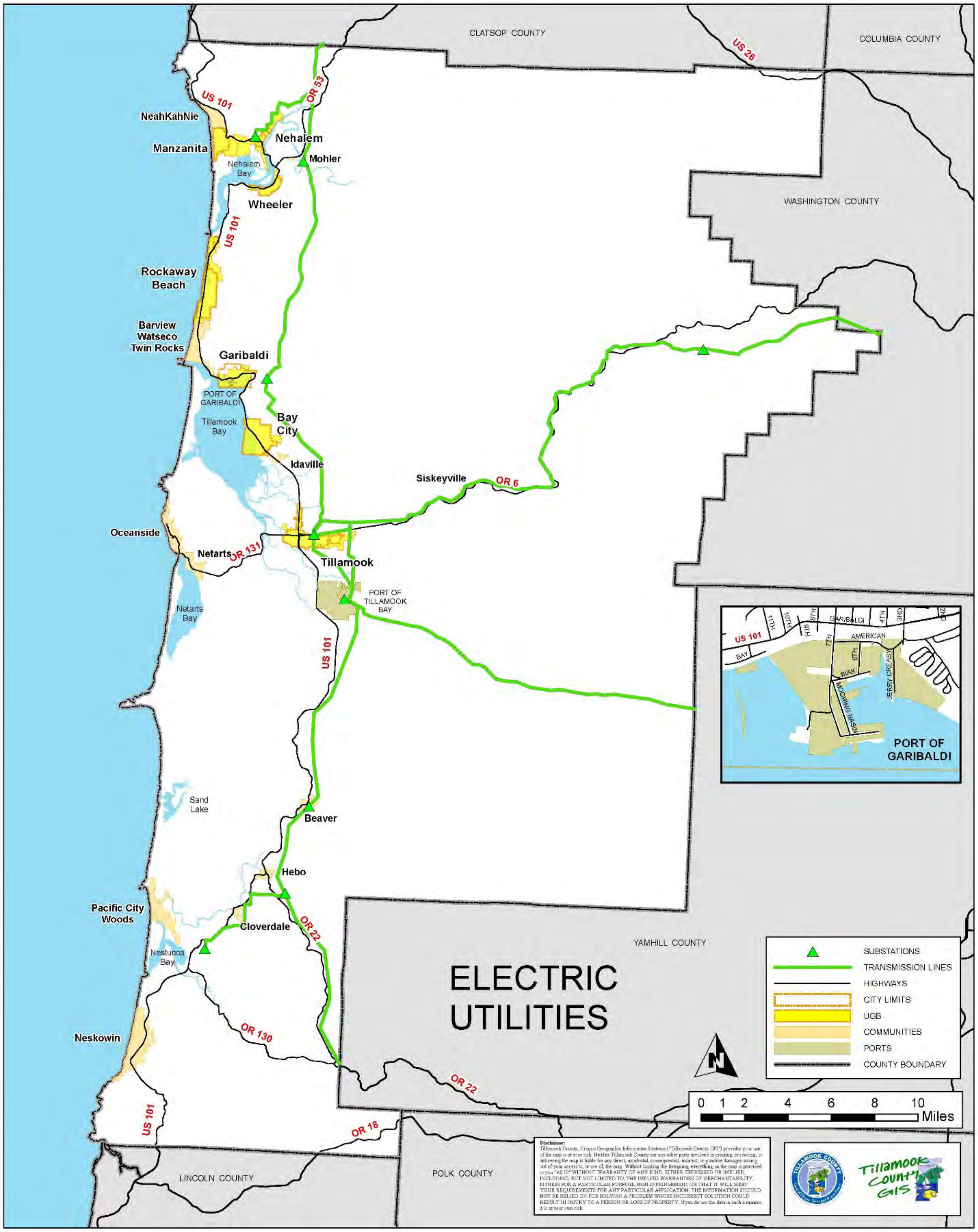
The Bonneville Power Administration (BPA) distributes electric power to the Tillamook People's Utility District that delivers it to approximately 20,000 customers throughout Tillamook County and in portions of Clatsop and Yamhill Counties. Substations are located at the Port of Tillamook Bay, Nestucca, Hebo, Beaver, Trask River, Wilson River, South Fork, Garibaldi, Nehalem and Mohler (Tillamook County People's Utility District, http://www.tpud.org/aboutus/service-area/, accessed February 25, 2017). The BPA also has an easement running through the Port of Tillamook Bay. Overhead electric lines are vulnerable to damage from winter storms with wind, snow, and ice and landslides. Underground lines are vulnerable to flooding and earthquakes.

Figure 22. Tillamook County Bus Routes



Source: Tillamook County Geographic Information System (GIS) Team

Figure 23. Tillamook County Utilities



Source: Tillamook County Geographic Information System (GIS) Team

Marina

The Port of Garibaldi's marina has 277 slips and about 400 linear feet of tie-ups, as well as a public boat launch and several piers. It provides direct access to the Pacific Ocean. In the event of an earthquake, tsunami, winter storm, windstorm, or landslide isolating the Cities of Garibaldi and Bay City, the marina could play an important role in transporting people and goods into and out of the area.

Telecommunications

Television, radio, traditional landline telephone, cell phone broadband, and internet services are available in the County. They are sources of a wide range of information and can play vital roles in emergency communications. Wireless providers sometimes offer free emergency mobile phones to those impacted by disasters, which can aid in communication when landlines and broadband services are unavailable. Residents in rural areas where cellular reception is low quality or unavailable rely upon landline service.

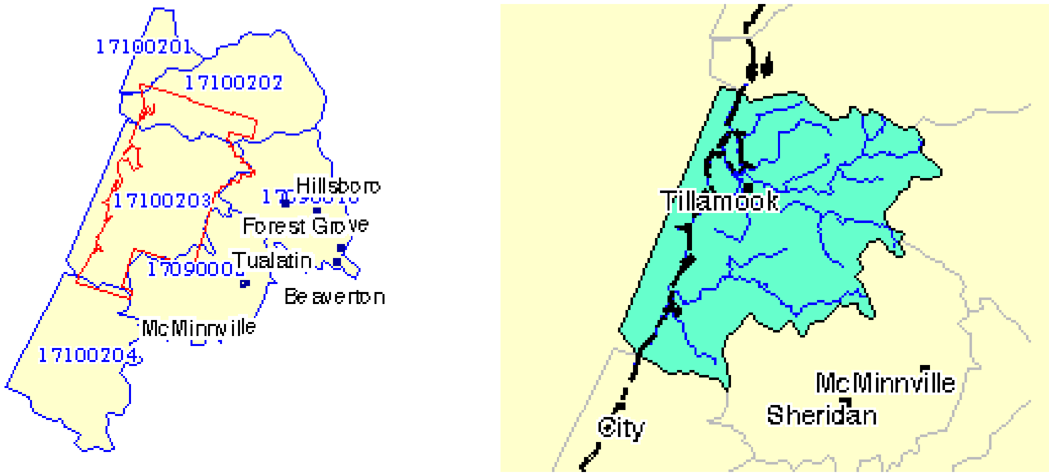
The Port of Tillamook Bay, the Tillamook People's Utility District, and Tillamook County are parties to an intergovernmental agreement creating the Tillamook Lightwave Intergovernmental Agency that was formed to design, construct, own, operate, and maintain a telecommunications network for the benefit of Tillamook County.

Ham radio is a service provided by licensed amateur radio operators (hams) and is considered to be an alternate means of communicating when normal systems are down or at capacity. Emergency communication is a priority for the Amateur Radio Relay League (ARRL). Tillamook County is served by Amateur Radio Emergency Service (ARES) District 5. Radio Amateur Civil Emergency Services (RACES) is a special phase of amateur radio recognized by FEMA that provides radio communications for civil preparedness purposes including natural disasters (http://www.usraces.org/). The official ham emergency station call for Tillamook County is KF7ARK (American Relay Radio League Oregon Chapter, www.arrloregon.org) (Oregon NHMP: Oregon Department of Land Conservation and Development, 2015).

Water

The Tillamook lowlands are a very productive water supply. Shallow ground water can be obtained throughout the lower floodplains of the Nehalem and Nestucca Rivers. The Kilchis River provides ground water for the Bay City regional water system. Some groundwater supplies are available under more localized conditions because they are perched above relatively impermeable materials. Limited yields of groundwater supplies are available in the marine sedimentary and volcanic rocks that underlie much of the County because they are largely impermeable. Also, coastal marine terrace deposits consisting of relatively permeable, unconsolidated sand, silt and gravel could provide groundwater in some areas because they receive large quantities of water during the rainy season. The six Tillamook County watersheds mainly rely upon the watershed identified by the USGS as HUC 17100203 to serve the population (Tillamook County MJNHMP: VLG Consulting & Pearson, 2012). The Port of Tillamook Bay receives its water from the City of Tillamook and re-sells this water to its lease tenants. The Port has multiple municipal water rights of its own within its property and has discussed developing its own water system in the future to better serve users of the Port.

Figure 24.   HUC 17100203



Source: Tillamook County MJNHMP (VLG Consulting & Pearson, 2012)

Drinking water for Bay City, Garibaldi, Manzanita, and Wheeler is sourced from groundwater. Bay City supplies water to the Tillamook Cheese Factory and is intertied with the City of Tillamook. The City of Tillamook also sources drinking water from surface water. Garibaldi and Manzanita both use surface water as a backup. Nehalem sources its drinking water from surface water. Rockaway Beach's primary source of drinking water is surface water; it is supplemented by groundwater.

5. Critical or Essential Facilities

Critical or essential facilities play a crucial role in response and recovery efforts. Mitigation actions that ensure these facilities remain operational during and after a disaster are of paramount importance to protecting people, property, and the environment and advancing community resilience.

DOGAMI initially identified hospitals, schools, fire stations, police stations, emergency operations and military facilities as essential facilities (also referred to in this Plan as *critical facilities*). The jurisdictions identified others, primarily airports, clinics, materiel distribution points ("CPODs"), water and wastewater facilities, and correctional facilities as critical facilities. After the jurisdictions identified the additional critical facilities, DOGAMI was able to include clinics, water and wastewater facilities, public works buildings, schools and city halls not also functioning as other essential facilities (e.g., fire or police stations), and correctional facilities in its analysis. The locally identified critical facilities are mapped in **Figure 25** through **Figure 37**. The essential facilities DOGAMI identified are shown on each jurisdiction's Multi-Hazard Community Map Set (see **Community Risk Profiles** section).

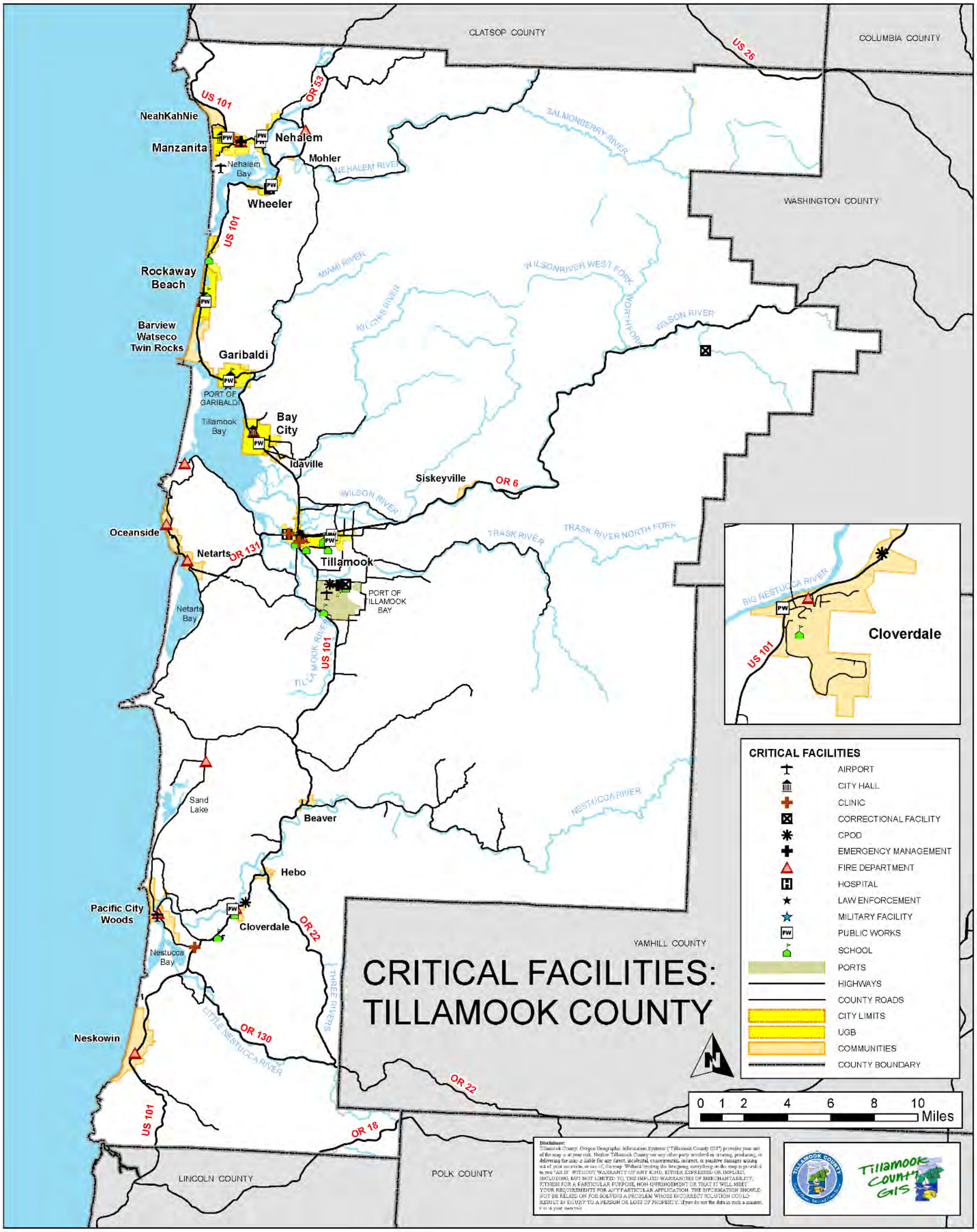
Table 16 shows DOGAMI-identified essential facilities by community. The Community Profiles list each jurisdiction's critical or essential facilities. The Tillamook Municipal Airport and a Community Point of Distribution (CPOD) are located within the Port of Tillamook Bay. Just outside its boundaries are two schools, the County Sheriff's office, emergency management center, and an adult correctional facility. A youth correctional facility is also located just off Port property, but can only be accessed from within the Port boundary. These essential facilities are included in Tillamook County's inventory. A US Coast Guard Station is located just within the Port of Garibaldi boundary, but not on Port property. It is included in the City of Garibaldi's essential facilities inventory. In addition, there are three ambulance quarters throughout the County: one at the Port of Garibaldi serving north Tillamook County; one at the Tillamook Regional Medical Center serving central Tillamook County; and one in Cloverdale serving south Tillamook County.

Table 16. Tillamook County Essential Facilities Inventory

	(all dollar amounts in thousands)													
	Hospital & Clinic		**School**		**Police/Fire**		**Emergency Services**		**Military**		**Other**		**Total**	
Community	**Count**	**Value ($)**	**Count**	**Value ($)**	**Count**	**Value ($)**	**Count**	**Value ($)**	**Count**	**Value ($)**	**Count**	**Value ($)**	**Count**	**Value ($)**
Unincorp. County (rural)	2	1,780	10	31,489	9	4,426	3	5,353	–	–	1	588	25	43,636
Neskowin	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Oceanside-Netarts	–	–	–	–	2	492	–	–	–	–	–	–	2	492
Pacific City–Woods	–	–	–	–	1	227	–	–	–	–	–	–	1	227
Total Unincorp. County	**2**	**1,780**	**10**	**31,489**	**12**	**5,145**	**3**	**5,353**	**–**	**–**	**1**	**588**	**28**	**44,355**
Bay City	–	–	–	–	1	231	2	784	–	–	1	2,770	4	3,785
Garibaldi	–	–	1	1,294	1	816	1	414	2	2,849	1	929	6	6,302
Manzanita	–	–	–	–	1	289	1	93	–	–	1	2,069	3	2,451
Nehalem	–	–	1	3,278	1	341	1	141	–	–	–	–	3	3,760
Rockaway Beach	–	–	1	241	2	209	1	1,699	–	–	1	677	5	2,826
Tillamook	2	11,531	7	20,549	2	570	3	1,701	–	–	–	–	14	34,351
Wheeler	1	2,455	–	–	–	–	1	135	–	–	–	–	2	2,590
Total Tillamook County	**5**	**15,766**	**20**	**56,851**	**20**	**7,601**	**13**	**10,320**	**2**	**2,849**	**5**	**7,033**	**65**	**100,420**

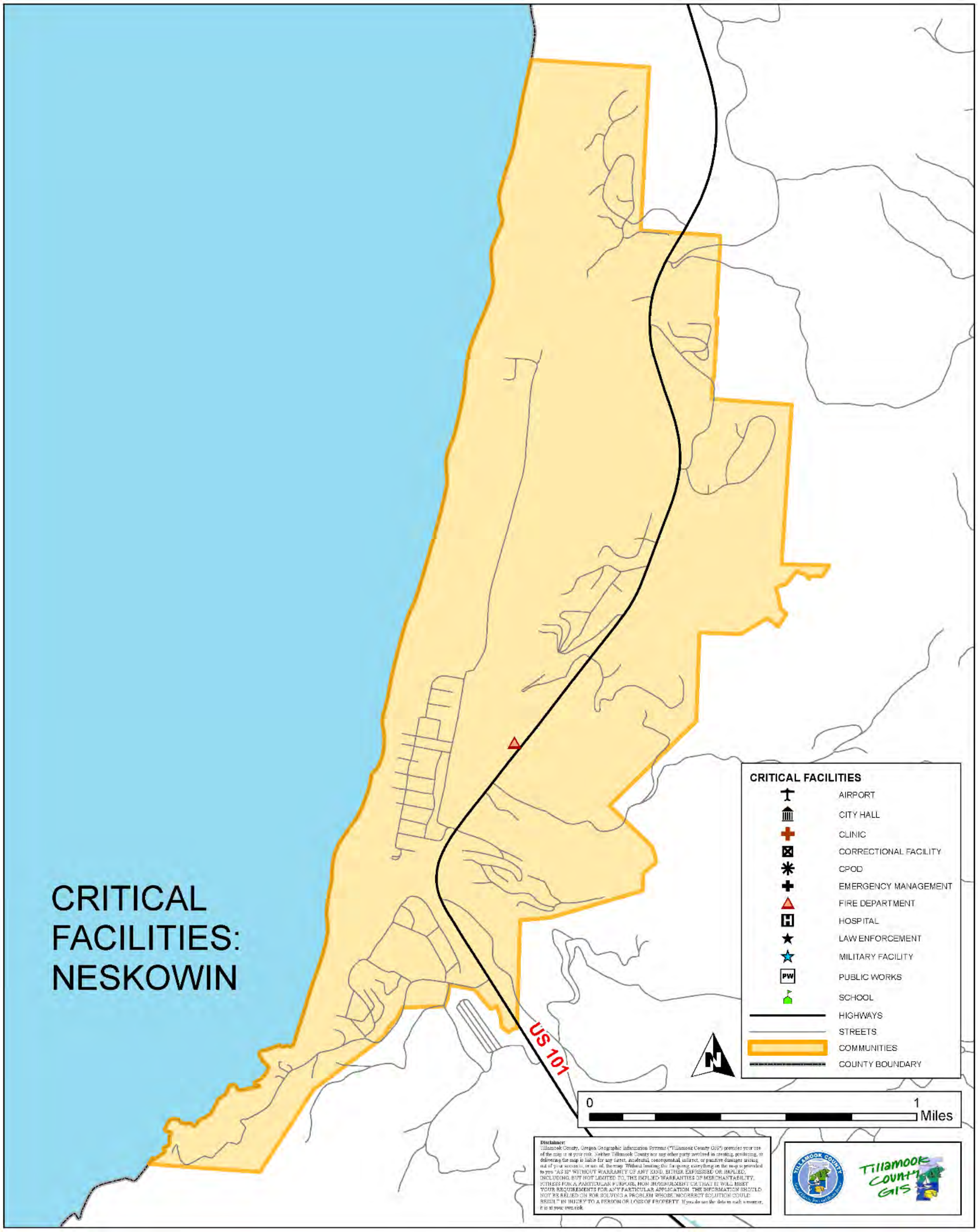
Notes: Facilities with multiple buildings were consolidated into one building. Data from DOGAMI (2016) revised based on community input. See p. 69 for detailed information about the critical facilities analyzed in this table.

Figure 25. Critical Facilities: Tillamook County



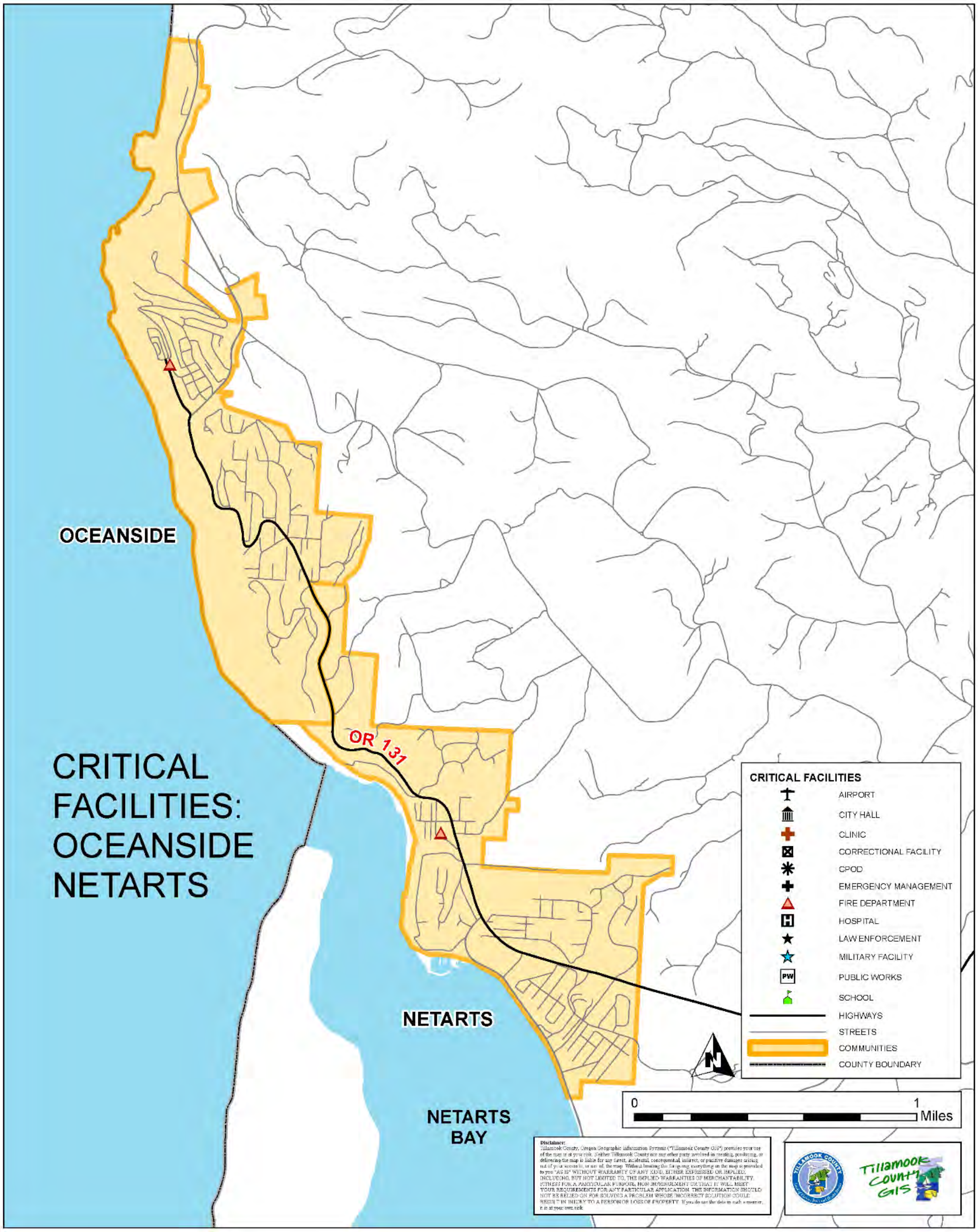
Source: Tillamook County Geographic Information System (GIS) Team

Figure 26. Critical Facilities: Neskowin



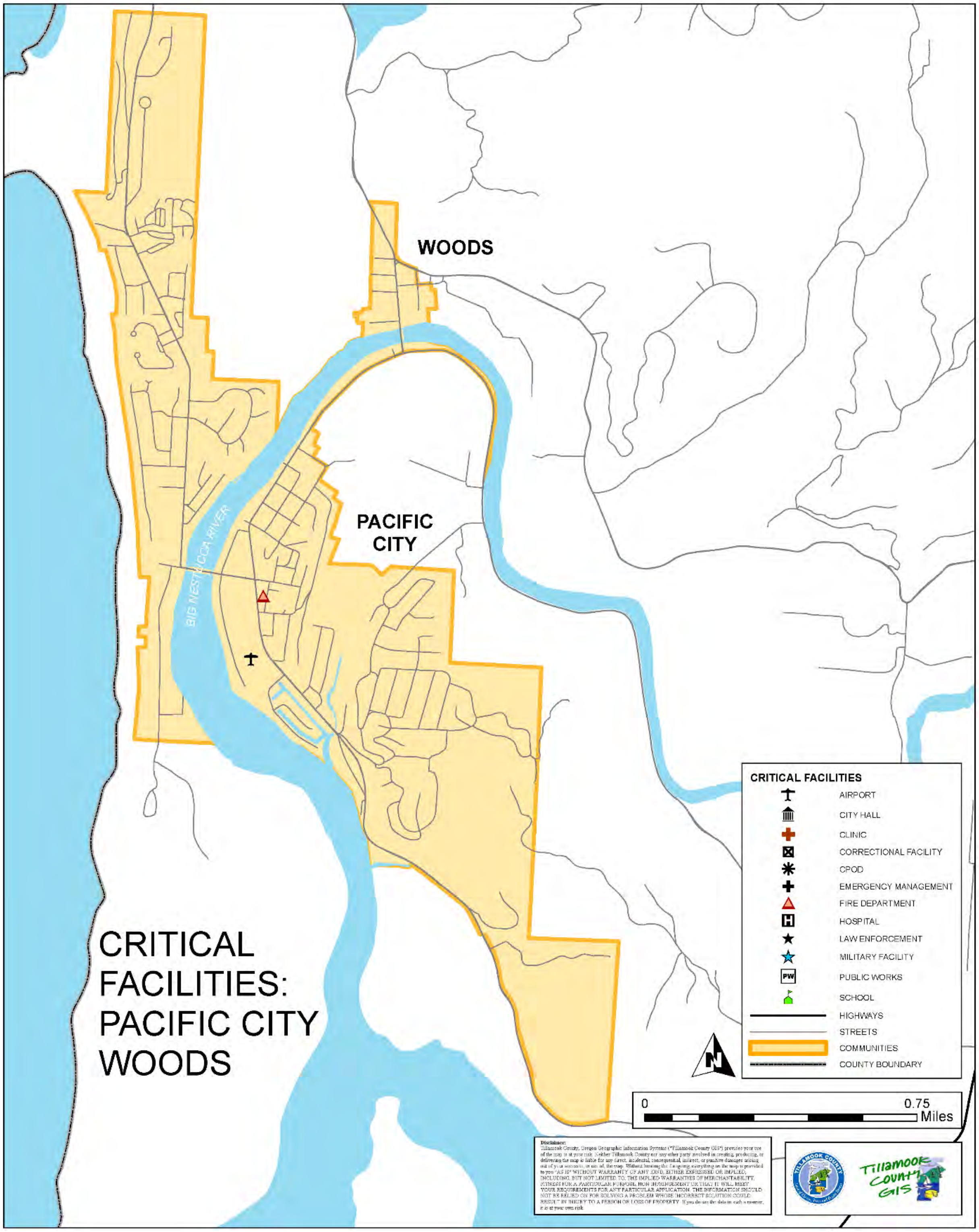
Source: Tillamook County Geographic Information System (GIS) Team

Figure 27. Critical Facilities: Oceanside and Netarts



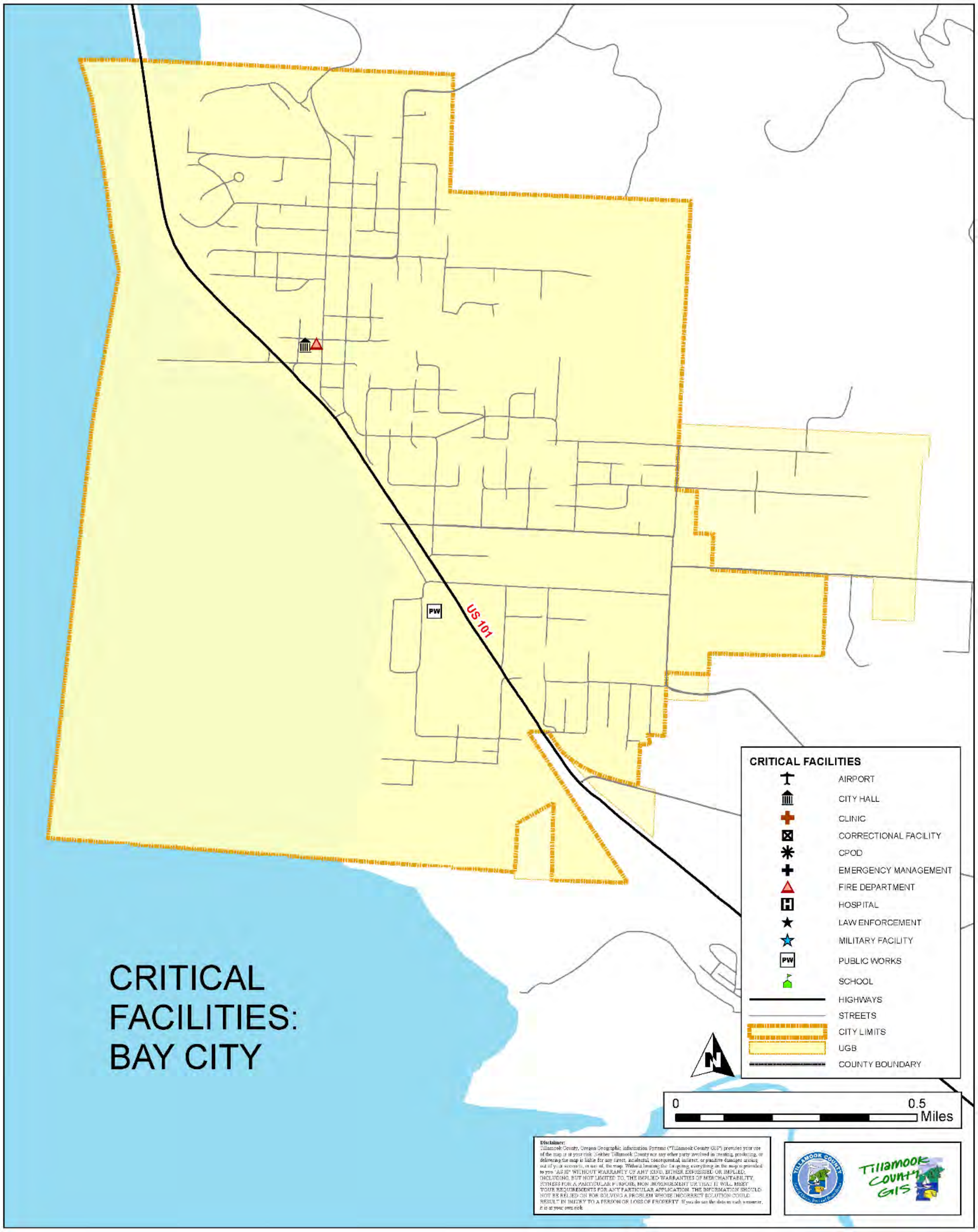
Source: Tillamook County Geographic Information System (GIS) Team

Figure 28. Critical Facilities: Pacific City–Woods



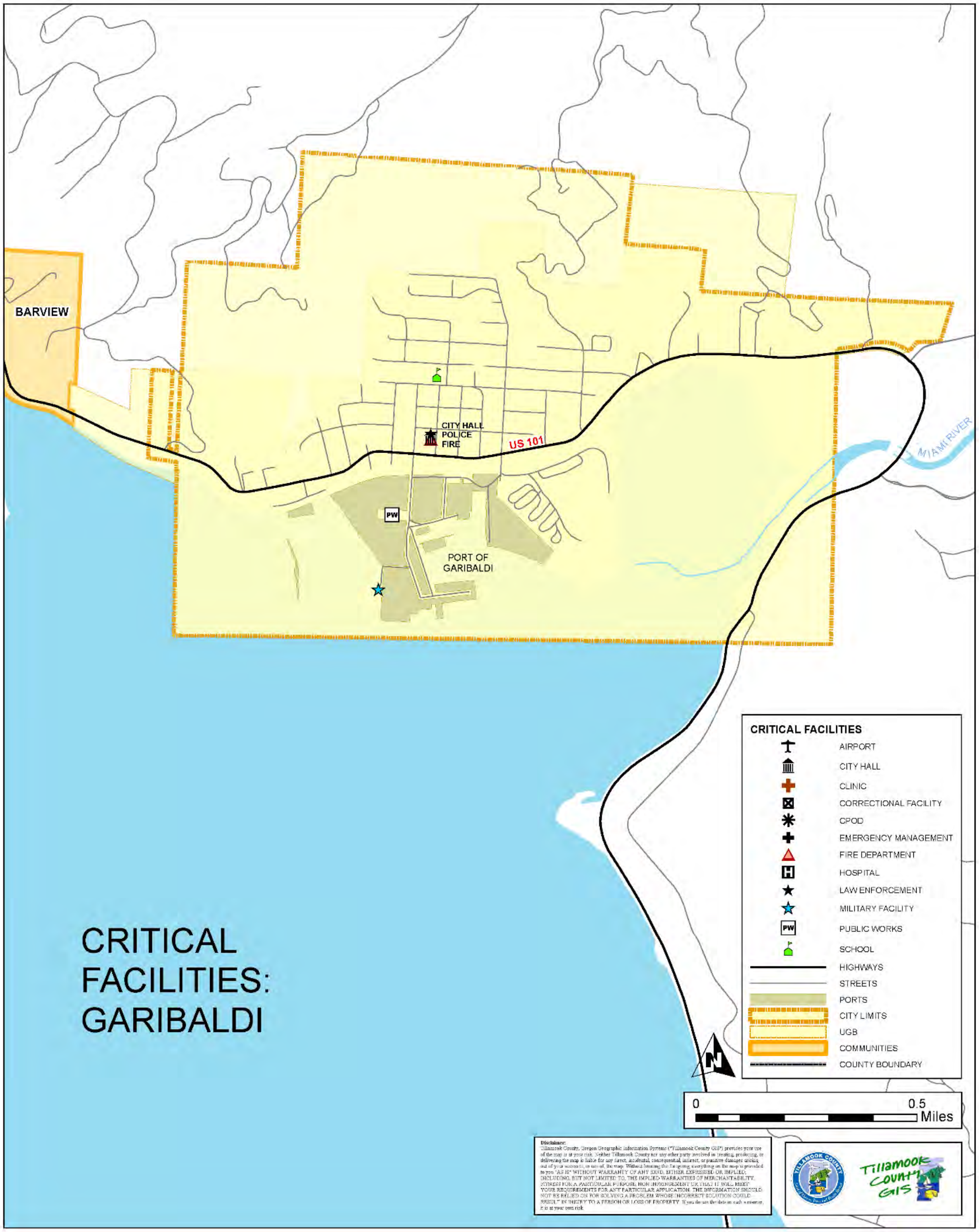
Source: Tillamook County Geographic Information System (GIS) Team

Figure 29. Critical Facilities: City of Bay City



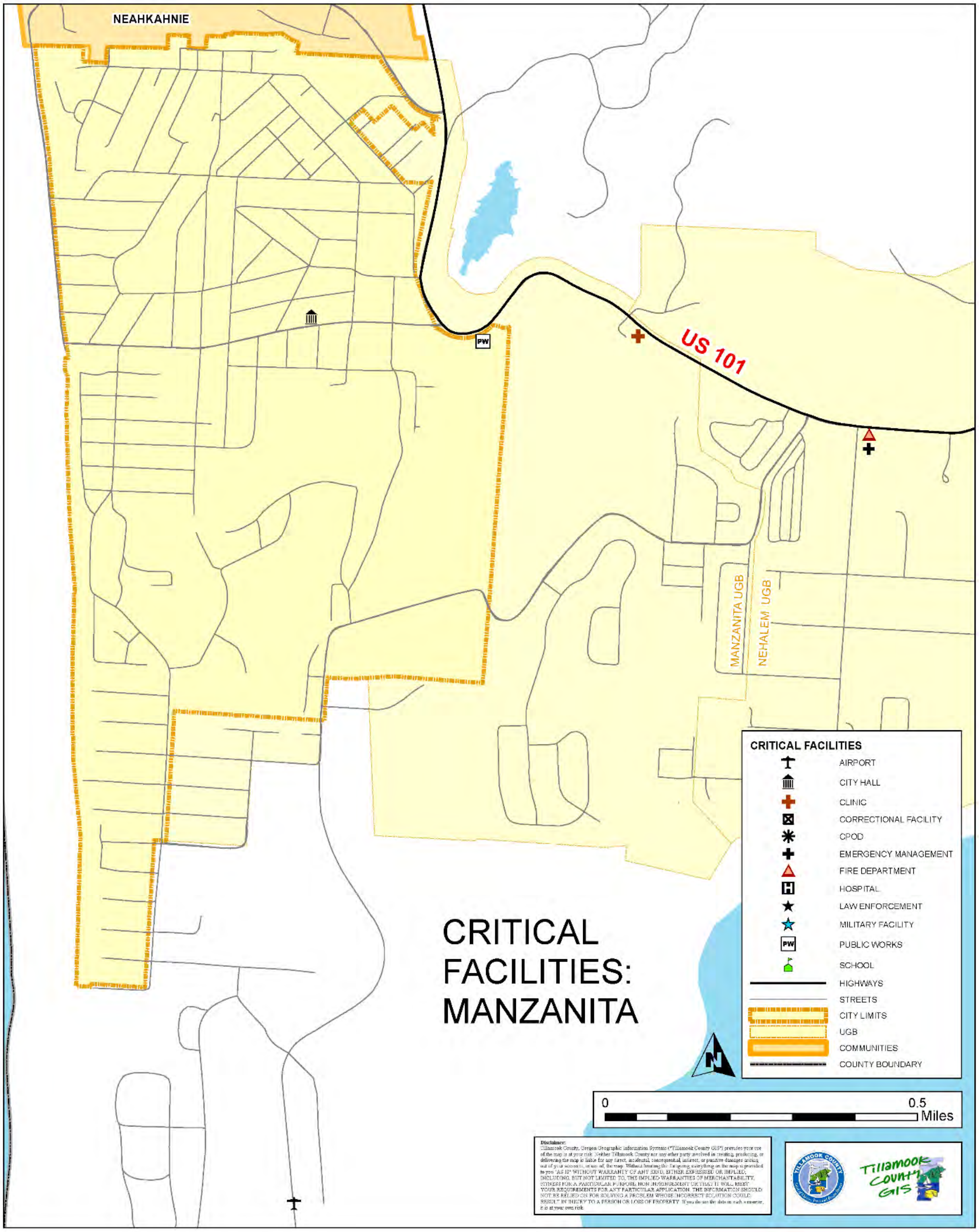
Source: Tillamook County Geographic Information System (GIS) Team

Figure 30. Critical Facilities: City of Garibaldi



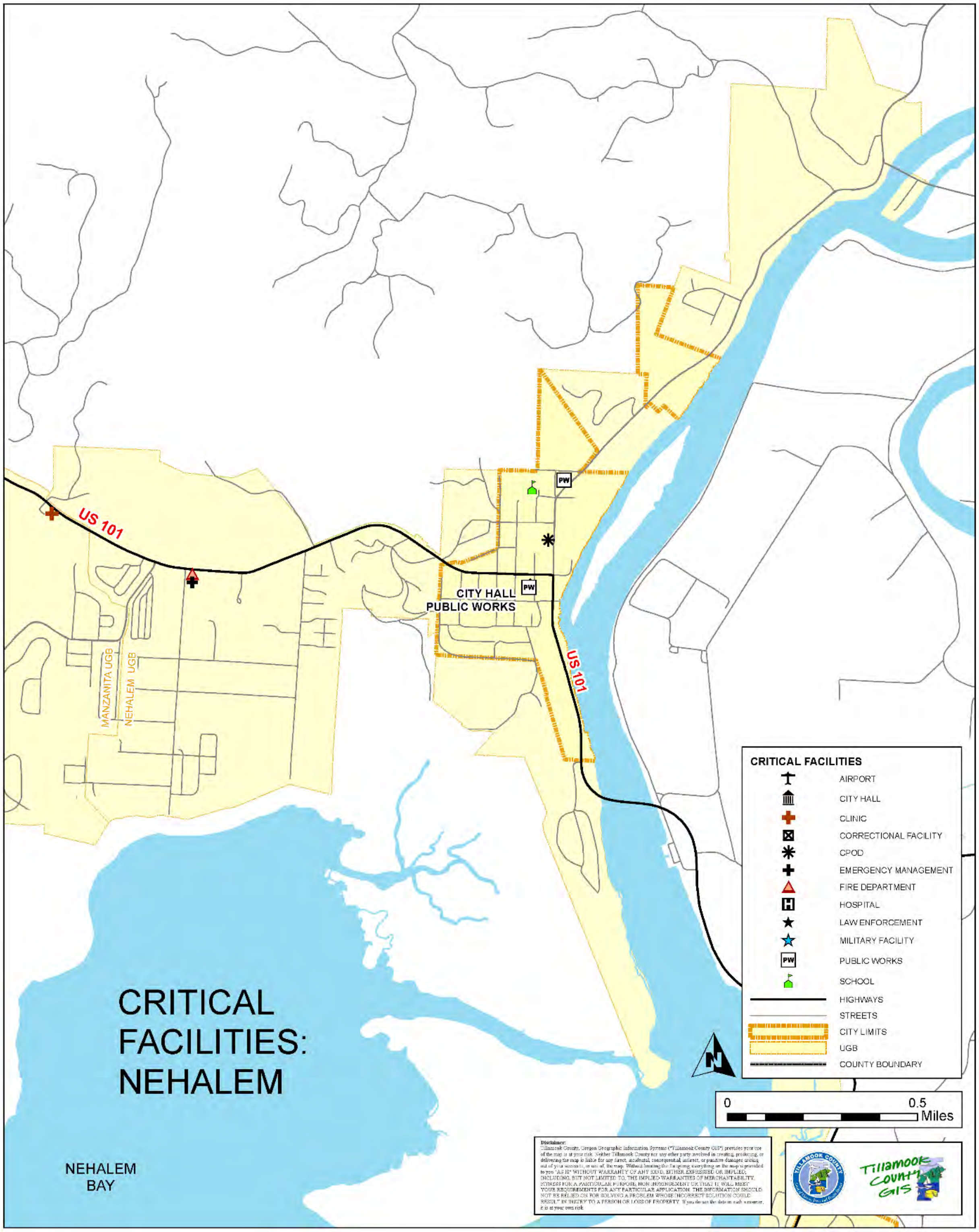
Source: Tillamook County Geographic Information System (GIS) Team

Figure 31. Critical Facilities: City of Manzanita



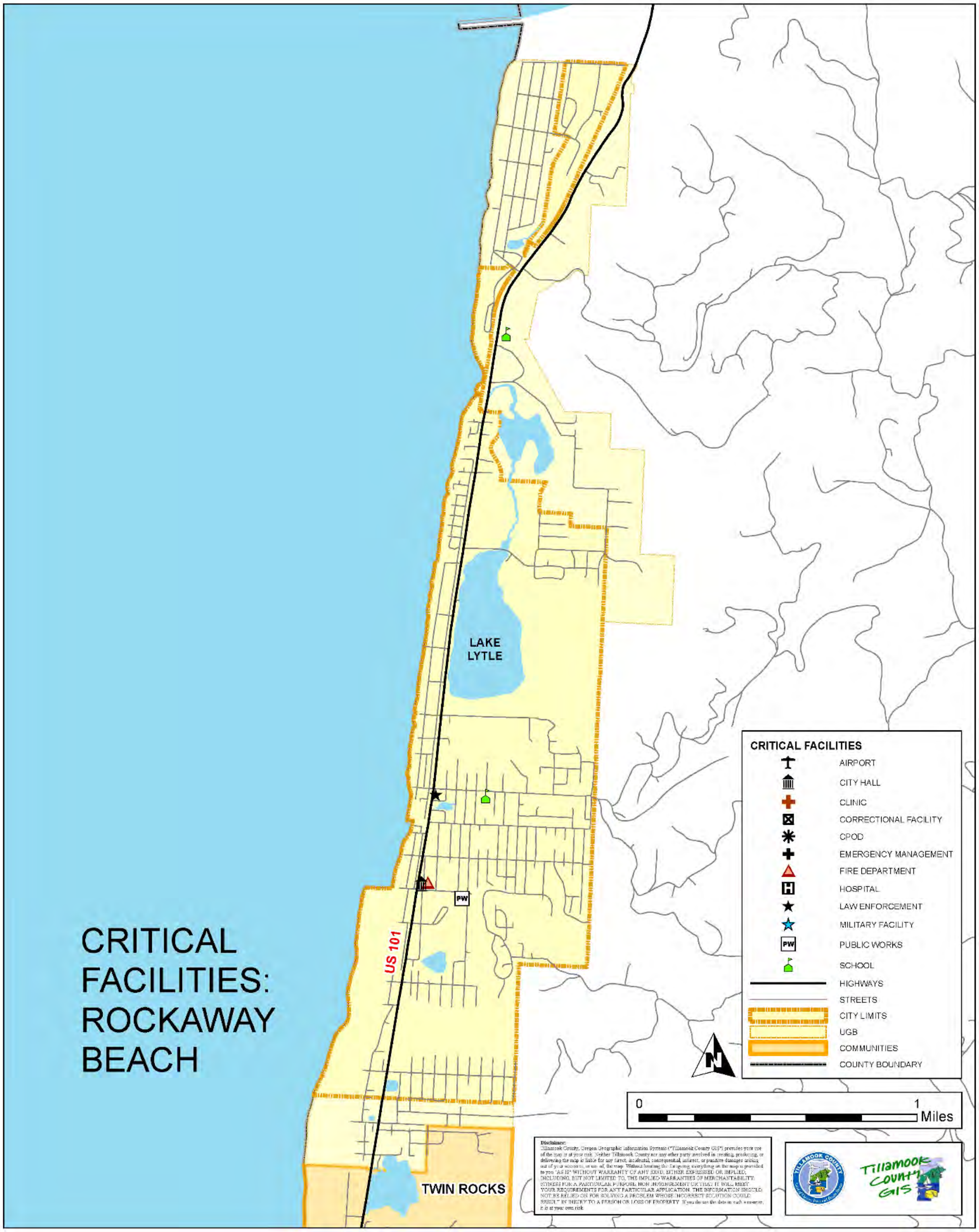
Source: Tillamook County Geographic Information System (GIS) Team

Figure 32. Critical Facilities: City of Nehalem



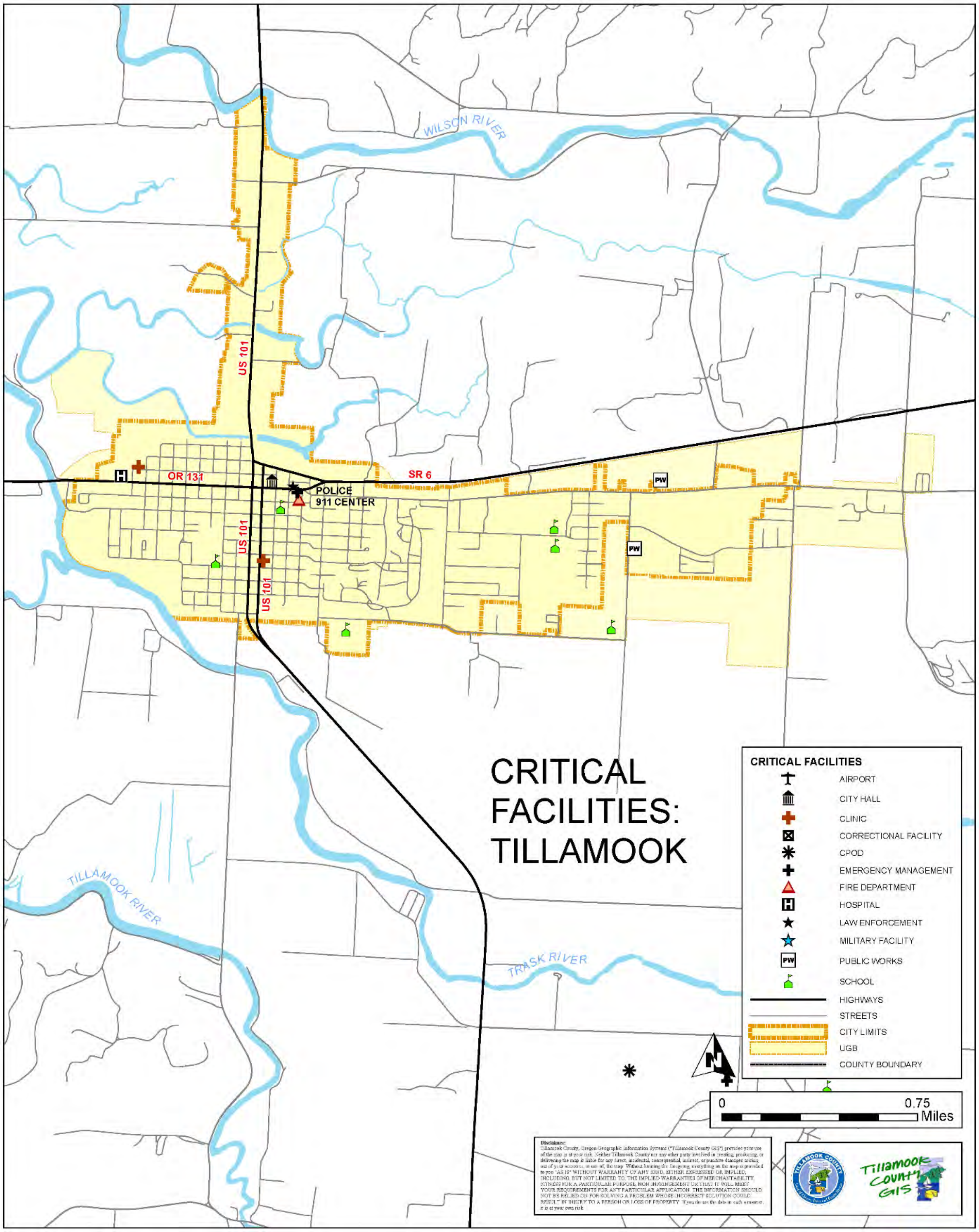
Source: Tillamook County Geographic Information System (GIS) Team

Figure 33. Critical Facilities: City of Rockaway Beach



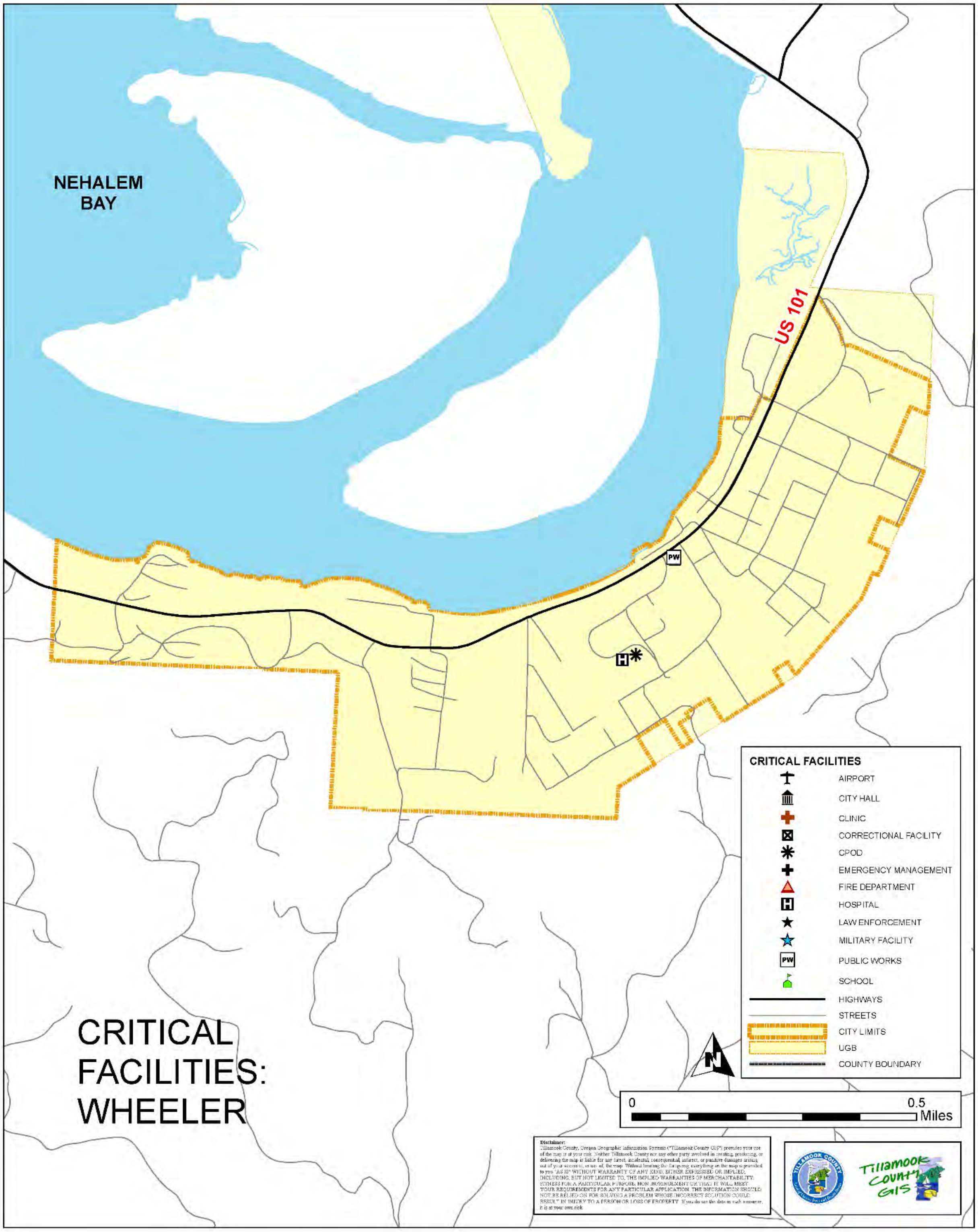
Source: Tillamook County Geographic Information System (GIS) Team

Figure 34. Critical Facilities: City of Tillamook



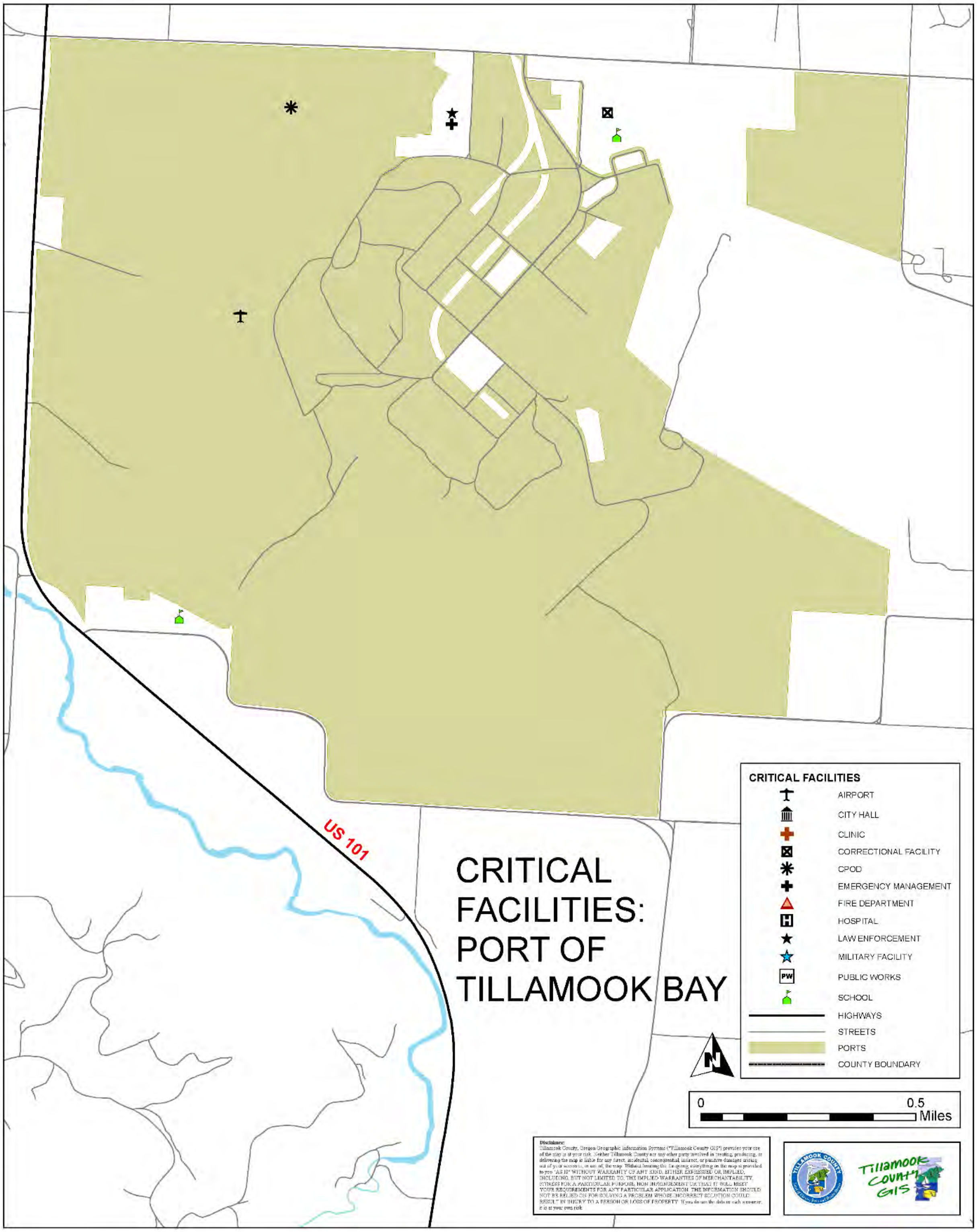
Source: Tillamook County Geographic Information System (GIS) Team

Figure 35. Critical Facilities: City of Wheeler



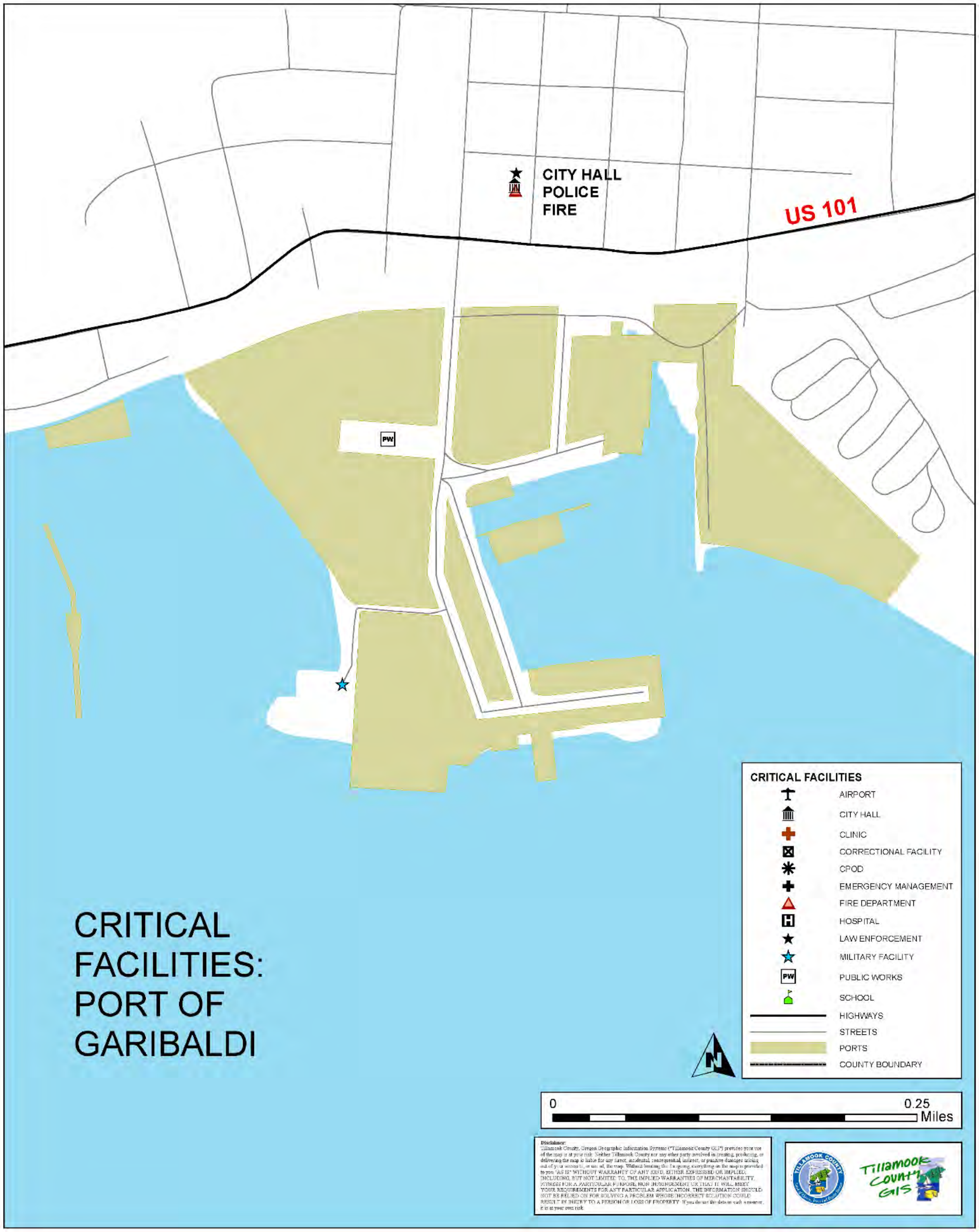
Source: Tillamook County Geographic Information System (GIS) Team

Figure 36. Critical Facilities: Port of Tillamook Bay



Source: Tillamook County Geographic Information System (GIS) Team

Figure 37. Critical Facilities: Port of Garibaldi



Source: Tillamook County Geographic Information System (GIS) Team

6. Built Environment

Settlement Patterns

Balancing growth with hazard mitigation is key to planning resilient communities. Therefore, understanding where development occurs and the vulnerabilities of the region's building stock is integral to developing mitigation efforts that move people and property out of harm's way. Eliminating or limiting development in hazard prone areas can reduce exposure to hazards, and potential losses and damages.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of Oregon's program is the 19 land use goals that "help communities and citizens plan for, protect and improve the built and natural systems." These goals are achieved through local comprehensive planning. The intent of Goal 7, Areas Subject to Natural Hazards, is to protect people and property from natural hazards (Department of Land Conservation and Development, http://www.oregon.gov/LCD/docs/goals/goal7.pdf).

Tillamook County and each of its seven cities has an acknowledged comprehensive plan and implementing ordinances.

Each of the unincorporated communities has a Community Plan identifying specific land use ordinances applicable to the housing, economy, water, stormwater, sewer, and geographic characteristics of the area.

Each city in the county also has identified an urban growth boundary intended to identify lands needed to accommodate population and employment growth for a 20-year period. Tillamook County and the cities jointly manage the urban growth areas through urban growth management agreements.

Most development has taken place along the coast and interior lowlands, with all the incorporated cities located in the northwest and west-central portion of the County. Slightly more than half the population is located in very low density settlements along transportation routes throughout the unincorporated area. Densities increase in the unincorporated communities, and peak in the cities.

Neskowin is almost entirely a residential community along the ocean with a few commercial establishments on the west side of the bend in US-101. The east side of the bend is hilly, and residences dot the hillside. An isolated residential development is sited along the west side of US-101 south of Lake Neskowin on another hill, and the southwest corner of the community is also developed on a hill. These three areas are susceptible to landslides, but due to their elevations, less susceptible than the rest of the community to tsunamis and not at all to flooding. Development along the shoreline is susceptible to coastal erosion, flooding, and tsunamis, and only the most northern, southern, and eastern parts of the community escape moderate risk of wildfires. The entire community is susceptible to earthquakes.

Oceanside and Netarts are adjacent, primarily residential communities developed in the hills above the Pacific Ocean (Oceanside) and the mouth of Netarts Bay (Netarts). OR-131 connects the communities to each other and to the City of Tillamook, approximately 6 miles east of Netarts. Due to their elevation and steep rise from the water, these communities are not subject to coastal erosion or flooding, and minimally subject to tsunamis. Also due to their situation in the hills, they are highly susceptible to earthquakes and landslides, and at moderate risk of wildfires.

Pacific City is primarily a residential community bounded by the Pacific Ocean on the west and bisected by the Nestucca River. A commercial district is developed on the inland bank of the river. Development along the shore is subject to coastal erosion, flooding, and tsunamis; development on the river is subject to flooding and tsunamis. Except for one small section, the entire community is at moderate risk of wildfires. Only the southwest portion of the community is highly susceptible to landslides. The entire community is susceptible to earthquakes.

Most development in Bay City has taken place on or at the bottom of hills where it is subject to earthquakes, tsunamis, landslides, and wildfires. Development located in the southwest corner of the city, on the west side of US-101 is also subject to flooding.

Garibaldi's business district is located in the lowlands along US-101 and at the waterfront. The Port of Garibaldi is within the city limits, built right on Tillamook Bay. Most residential development is located upslope, making it more susceptible to landslides and wildfires, but less so to tsunamis. The businesses in the lowlands and the Port of Garibaldi are highly susceptible to tsunamis. The entire city, including the Port, is susceptible to earthquakes.

Manzanita is developed along the coast, up the northern mountainous half of the city, and along a ridge overlooking a wetland area. The southeastern portion of the city is not developed. The business district is located along US-101 and Laneda Road, an east-west route from the uplands to the shore. Development along the shore is subject to coastal erosion, flooding, and tsunamis. While much of the city's development is too high to be subject to coastal flooding, it is still subject to tsunamis. All development in the city is highly susceptible to earthquakes and moderately so to wildfire. A small amount of residential development in the northwest corner and residential and commercial development in the northeast corner are subject to landslides. The entire city is moderately susceptible to earthquakes.

Nehalem is developed along the Nehalem River and US-101 which takes a ninety-degree turn west in the middle of the city and heads up into the hills toward Manzanita. Commercial development hugs US-101 along the river and the first few blocks heading west up the hill. Residential development is concentrated to the south and west of US-101 and in the hills to its north. The developed areas are highly susceptible to earthquakes and landslides and the lower portions to flooding and tsunamis.

Residential development in Rockaway Beach is concentrated all along the coast, in the southern two-thirds of the city, and at its northern reaches. The Oregon Coast Scenic Railway runs parallel to the coast and US-101. A great deal of residential development including motels is located between the rails and the shore. More residential development stretches east from the railway into toward the hills. Commercial development is clustered around the railroad and US-101 in the central portion of the city. Development along the water is susceptible to coastal erosion and flooding. With the exception of a small area in the central-southeast portion of the city that is a hill, the entire city is subject to tsunamis. That hill and another in the far northern portion of the city are both developed with housing and highly susceptible to landslides. The hills to the east contain many streams and springs, and are highly susceptible to landslide, raising concern of risk from landslide runout and debris flows even in areas shown as low susceptibility on the hazard maps. Scattered areas of residential development are moderately susceptible to wildfire. The entire city is susceptible to earthquakes.

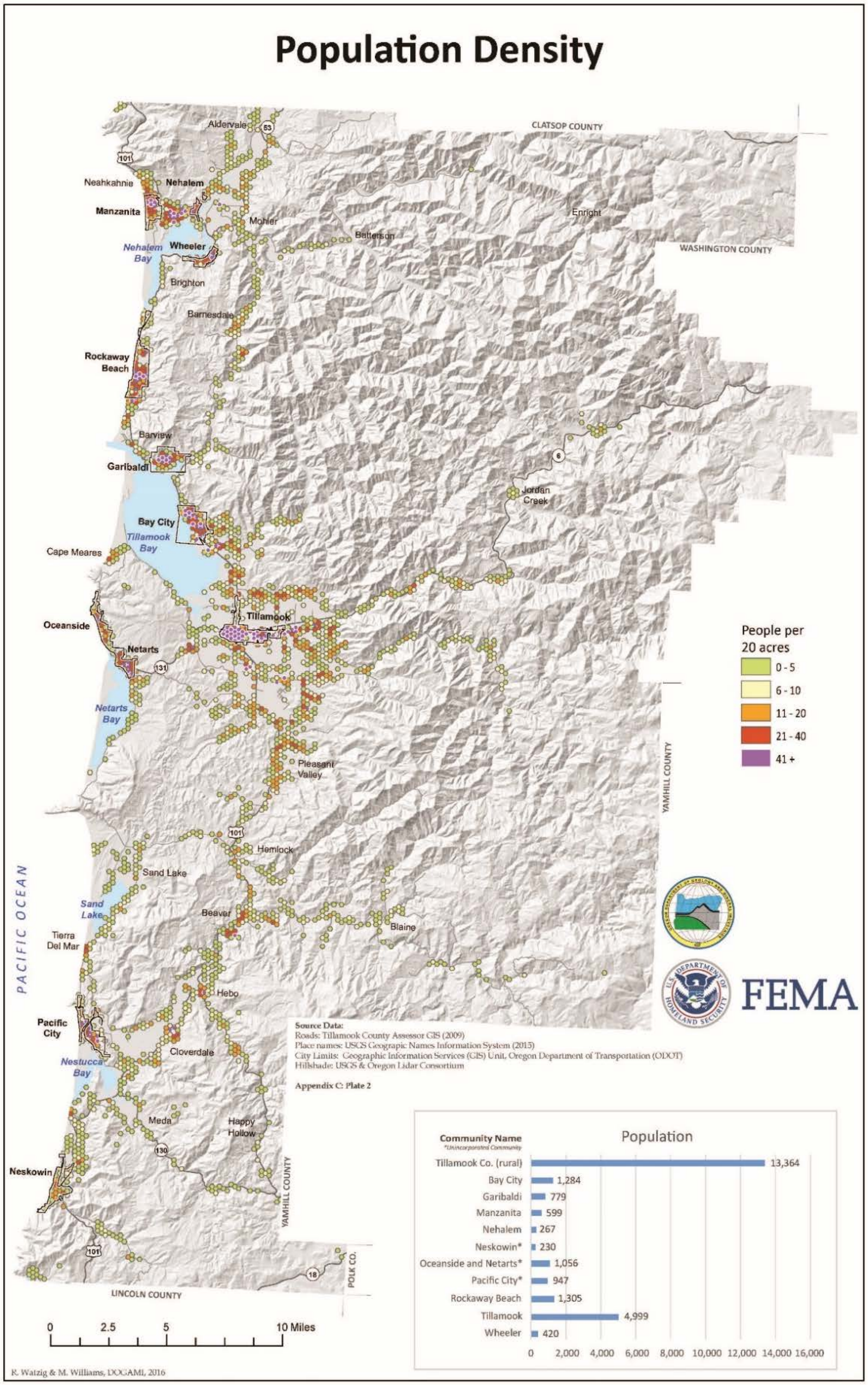
Development in the City of Tillamook is located primarily south of OR-6 and along US-101. Residential development is clustered in three areas south of OR-6. Commercial development is located along the highways and between the areas of residential development. Because most of the city (east-west) is built on a natural peninsula and is mostly flat, it is not very susceptible to landslides, wildfires, or flooding. However, the western edges of the city and the area along US-101 north of OR-6 are subject to flooding and susceptible to tsunamis. Flooding along US-101 often obstructs the roadway, isolating the city from areas to the north and impeding commutes. The entire city is subject to earthquakes.

The Port of Tillamook Bay is located inland, 4 miles south of the City of Tillamook on US-101. It contains public and non-profit offices, commercial and industrial development. Its northwest corner is subject to flooding and tsunamis. Most of the Port is at moderate risk of wildfires. One hill on the east side is highly susceptible to landslides and earthquakes.

Development in Wheeler is divided into sections by mountain drainages. Most development is in the northernmost section with commercial development at the bottom of the mountain along US-101 and the Nehalem River. Residential development stretches a few blocks up the steep sides of the mountain in each section. Most of the city is highly susceptible to earthquakes and landslides, and moderately so to wildfires. Flooding and tsunami susceptibility is low, and centered on the drainages.

The distribution of building stock reflects the difference between the urban and rural populations as well. Most agriculture and utility buildings are found along transportation routes throughout the unincorporated area where people are living at very low densities. The bulk of residential, commercial, industrial, public, and non-profit buildings are clustered in the cities and unincorporated communities.

Figure 38. Population Density



Source: DOGAMI (2016)

Building Inventory

The countywide building inventory is key to assessing risk. This inventory consists of all buildings larger than 500 square feet, as determined from building footprints or tax assessor data.

Table 17 shows the distribution of building count and value within the UDF database for Tillamook County. Table 18 and Table 19 detail the occupancy class distribution by community. Figure 39 illustrates the variation of building value and occupancy across the communities of Tillamook County. Figure 40 maps building distribution by occupancy class countywide.

The Port of Tillamook Bay's inventory is included in Unincorporated Tillamook County's; the Port of Garibaldi's inventory in the City of Garibaldi's.

Table 17. Tillamook County Building Inventory

Community	Total Number of Buildings	% of Buildings	Total Estimated Building Value ($)	% of Building Value
Unincorporated County (rural)	15,015	56%	1,282,436,000	46%
Neskowin	653	2%	118,463,000	4%
Oceanside-Netarts	1,701	6%	203,363,000	7%
Pacific City–Woods	1,707	6%	212,062,000	8%
Total Unincorporated County	**19,076**	**70%**	**1,816,324,000**	**65%**
Bay City	884	3%	74,769,000	3%
Garibaldi	755	3%	64,331,000	2%
Manzanita	1,523	6%	259,780,000	9%
Nehalem	260	1%	24,887,000	1%
Rockaway Beach	2,240	8%	211,809,000	8%
Tillamook	2,270	8%	322,398,000	11%
Wheeler	363	1%	30,556,000	1%
Total Tillamook County	**27,371**	**100%**	**2,804,854,000**	**100%**

Source: DOGAMI (2016)

Table 18. Tillamook County Building Inventory by Occupancy Class

	(all dollar amounts in thousands)															
	Residential			**Commercial & Industrial**			**Agricultural**			**Public & Non-Profit**			**All Buildings**			
Community	**Number of Buildings**	**Building Value ($)**	**Building Value Ratio**	**Number of Buildings**	**Building Value ($)**	**Building Value Ratio**	**Number of Buildings**	**Building Value ($)**	**Building Value Ratio**	**Number of Buildings**	**Building Value ($)**	**Building Value Ratio**	**Number of Buildings**	**Number of Buildings per County Total**	**Building Value ($)**	**Value of Buildings per County Total**
Unincorp. County (rural)	9,542	835,993	65%	514	153,910	12%	4,630	183,819	14%	329	108,714	8.5%	15,015	55%	1,282,436	46%
Neskowin	631	115,828	98%	8	1,642	1%	7	128	0%	7	865	0.7%	653	2%	118,463	4%
Oceanside-Netarts	1,606	196,094	96%	20	2,091	1%	64	1,259	1%	11	3,919	1.9%	1,701	6%	203,363	7%
Pacific City–Woods	1,555	195,882	92%	70	11,216	5%	54	1,408	1%	28	3,556	1.7%	1,707	6%	212,062	8%
Total Unincorp. County	**13,334**	**1,343,797**	**74%**	**612**	**168,859**	**9.3%**	**4,755**	**186,614**	**10%**	**375**	**117,054**	**6.4%**	**19,076**	**70%**	**1,816,324**	**65%**
Bay City	748	54,962	74%	43	13,242	18%	75	2,102	3%	18	4,463	6.0%	884	3%	74,769	3%
Garibaldi	582	39,527	61%	95	14,946	23%	45	1,676	3%	33	8,182	12.7%	755	3%	64,331	2%
Manzanita	1,425	245,415	94%	68	9,743	4%	6	141	0%	24	4,481	1.7%	1,523	6%	259,780	9%
Nehalem	191	13,733	55%	42	4,753	19%	10	292	1%	17	6,109	24.5%	260	1%	24,887	1%
Rockaway Beach	2,049	196,117	93%	51	6,245	3%	105	1,698	1%	35	7,749	3.7%	2,240	8%	211,809	8%
Tillamook	1,731	139,379	43%	401	119,603	37%	51	3,849	1%	87	59,567	18.5%	2,270	8%	322,398	11%
Wheeler	295	24,825	81%	33	4,261	14%	29	573	2%	6	897	2.9%	363	1%	30,556	1%
Total Tillamook County	**20,355**	**2,057,755**	**73%**	**1,345**	**341,652**	**12%**	**5,076**	**196,945**	**7%**	**595**	**208,502**	**7.4%**	**27,371**	**100%**	**2,804,854**	**100%**

Source: DOGAMI (2016)

Table 19. Port of Tillamook Bay and Port of Garibaldi Building Inventories by Occupancy Class

	(all dollar amounts in thousands)														
	Residential			**Commercial & Industrial**			**Agricultural**			**Public & Non-Profit**			**All Buildings**		
Community	**Number of Buildings**	**Building Value ($)**	**Building Value Ratio**	**Number of Buildings**	**Building Value ($)**	**Building Value Ratio**	**Number of Buildings**	**Building Value ($)**	**Building Value Ratio**	**Number of Buildings**	**Building Value ($)**	**Building Value Ratio**	**Number of Buildings**	**Building Value ($)**	**Building Value Ratio**
Port of Tillamook Bay[1]	1	58	0.1%	52	26,111	50.4%	0	0	0	34	25,639	49.5%	87	51,779	100%
Port of Garibaldi[1]	0	0	0	22	3,148	66.1%	0	0	0	13	1,614	33.9%	35	4,762	100%

[1]Port of Tillamook Bay buildings are counted in Tillamook County's inventory in Table 18. The Port of Garibaldi buildings are counted in the City of Garibaldi's inventory in Table 18.
Source: Personal communications, Aaron Palter, Port of Tillamook Bay, May 2017 and Michael Saindon, Port of Garibaldi, March 2017

The data in Table 19 were generated by the Port of Tillamook Bay and the Port of Garibaldi. Because the Ports' and DOGAMI's inventory methodologies differed, there are slight differences (see Hazard Profile tables and Multi-Hazard Community Map Set figures in the Community Risk Profiles section) in the total number of buildings and more significant differences, especially for the Port of Garibaldi, in the building values. Nevertheless, it is clear that the Commercial & Industrial and Public & Non-Profit occupancy classes dominate both Ports.

It is also important to note that Ports own properties that are used for their own public purposes, and also lease to other public or private entities for a variety of other uses. Privately owned buildings may also be located on Port property. Individual buildings may house more than one occupancy type. Ownership and occupancy are often not the same. In some cases, buildings are leased to more than one tenant and therefore house more than one occupancy class. Those have been enumerated as the occupancy class of the majority use of the building.

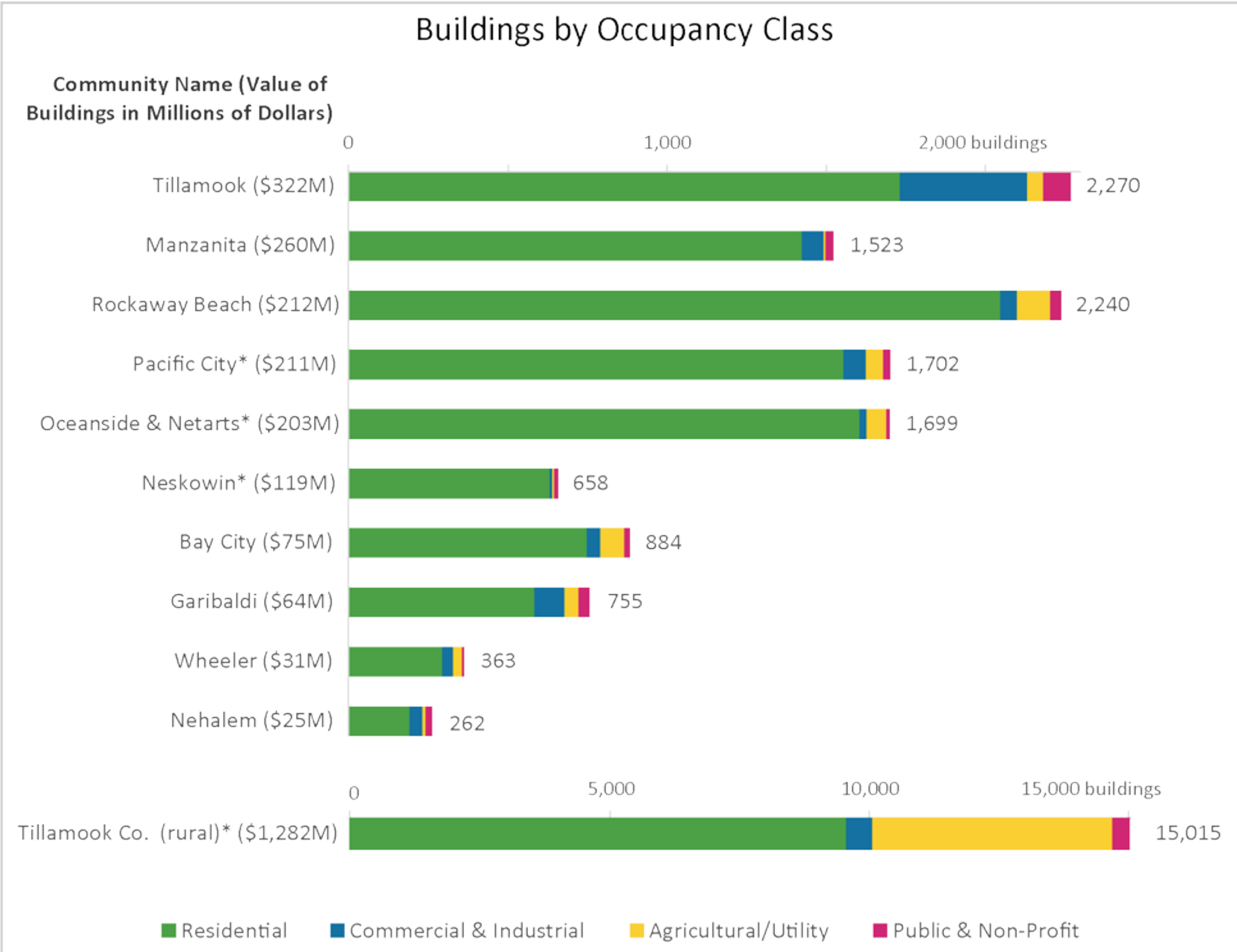
Port of Tillamook Bay:

- Of the 87 buildings within the Port of Tillamook Bay industrial park boundary, 52 are Port-owned and 35 are not.
- Of the 52 Port-owned buildings, 17 are occupied by Public & Non-Profit uses and 35 are occupied by Commercial & Industrial uses.
- Of the 35 buildings owned by other entities, 17 are occupied by Public & Non-Profit uses, 17 are occupied by Commercial & Industrial uses, and 1 is in residential use.

Port of Garibaldi:

- Of the 35 buildings within the Port of Garibaldi, 16 are Port-owned and 19 are not.
- All of the 19 buildings not owned by the Port are in Commercial & Industrial uses.
- Of the 16 Port-owned buildings, 3 are occupied by Commercial & Industrial uses.

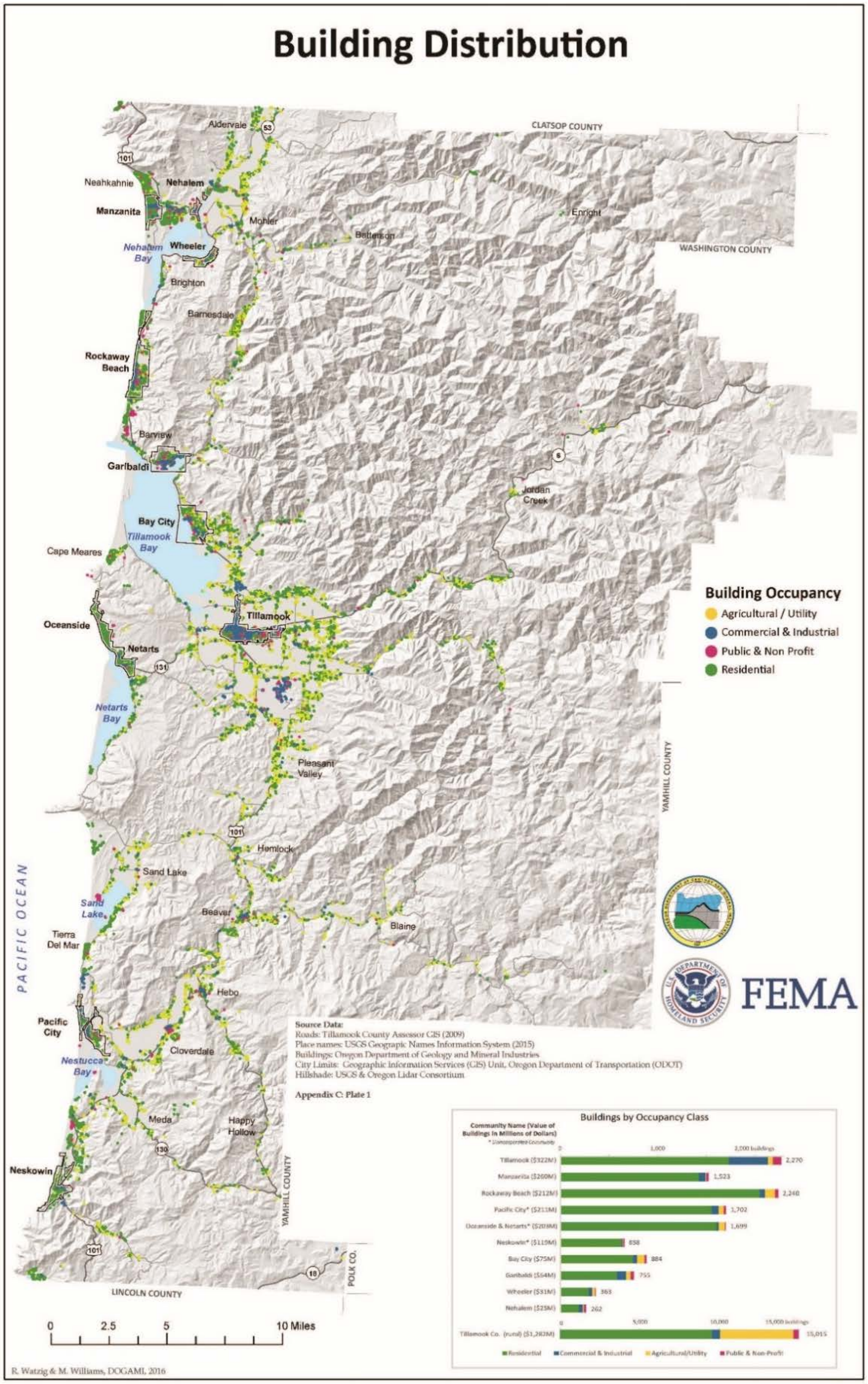
Figure 39. Building Value by Occupancy Class



*Unincorporated communities. Note that "Tillamook Co. (rural)" excludes incorporated communities, Pacific City, Oceanside-Netarts, and Neskowin.

Source: DOGAMI (2106)

Figure 40. Building Distribution



Source: DOGAMI (2106)

Housing Stock

In addition to location, the character of its housing stock can also affect the level of risk a community faces from natural hazards. A study of the 1994 earthquake in Northridge, California found that persons living in multi-family structures were more likely to have been injured than those in single-family homes (Centers for Disease Control and Agency for Toxic Substances and Disease Registry, n.d.). In natural hazard events such as earthquakes and floods, mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants and their neighbors (California Governor's Office of Emergency Services (OES), 1997).

Single-family homes comprise the vast majority of housing units in Tillamook County. The City of Tillamook has the most multi-family housing units, almost 900, trailed by Rockaway Beach with 262 and Oceanside-Netarts with 116. Pacific City has none. Rockaway Beach, Pacific City, and Oceanside-Netarts all have in the neighborhood of 200 mobile homes, followed by Bay City with 116. Manzanita has 3 and Neskowin none. The Port of Tillamook Bay and the Port of Garibaldi have no housing.

Table 20. Housing Type

Community	Total Housing Units	Single-Family		Multi-Family		Mobile Homes*	
		Number	% of Total	Number	% of Total	Number	% of Total
Oregon	1,695,183	1,154,878	68.1	396,724	23.4	143,581	8.5
Tillamook	18,474	14,638	79.2	1,614	8.7	2,222	12.0
Incorporated							
Bay City	678	543	80.1	19	2.7	116	17.1
Garibaldi	532	470	88.3	4	0.8	58	10.9
Manzanita	1,263	1,216	96.2	44	3.4	3	0.2
Nehalem	155	135	87.1	8	5.2	12	7.7
Rockaway Beach	2,105	1,623	77.1	262	12.4	220	10.4
Tillamook	2,226	1,301	58.4	886	39.8	39	1.8
Wheeler	234	172	73.5	48	20.5	14	6.0
Unincorporated							
Uninc. County (rural)	8,173	6,559	80.3	219	2.8	1,396	17.1
Neskowin	435	427	98.1	8	1.8	0	0
Oceanside-Netarts	1,349	1,056	78.2	116	8.6	176	13.0
Pacific City–Woods	1,324	1,136	85.8	0	0	188	14.2

*Mobile Homes category includes boats, recreational vehicles, vans, etc. when estimates are available.
Source: US Census Bureau, Census 2011–2015 American Community Survey 5-Year Estimates (https://factfinder.census.gov/)

Aside from location and type of housing, the year structures were built has implications for level of vulnerability to natural hazards. Seismic building standards were codified in Oregon building code starting in 1974. More rigorous building code standards passed in 1993 accounted for a Cascadia Subduction Zone (CSZ) catastrophic earthquake event (Judson, 2012). Therefore, homes built before 1994 within an earthquake hazard zone are more vulnerable to damage and loss caused by seismic events. In Bay City, Garibaldi, Nehalem, Tillamook, Wheeler, and Neskowin about 70-80% of the housing stock was built before 1990 and the codification of seismic building standards. Manzanita and Rockaway Beach, Oceanside-Netarts, and Pacific City are in a slightly better position, with between 45% and 67%

of their housing stock built before 1990 (not including the number of structures that are exposed to seismic activity) (Oregon NHMP: Oregon Department of Land Conservation and Development, 2015).

Also in the 1970s, FEMA began assisting communities with floodplain mapping as part of administering the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Upon receipt of floodplain maps, communities started to develop floodplain management ordinances to protect people and property from flood loss and damage. About 60% of the housing stock in Garibaldi, Nehalem, and Tillamook, and between 40% and 50% in Bay City, Wheeler, and Neskowin was built before the implementation of floodplain management ordinances not including the number of structures that are built within special flood hazard areas) (Oregon NHMP: Oregon Department of Land Conservation and Development, 2015).

Table 21. Housing Age

Community	Total Housing Units	Pre 1970		1970 to 1989		1990 or Later	
		Number	% of Total	Number	% of Total	Number	% of Total
Oregon	**1,695,183**	**598,608**	**35.3**	**552,010**	**30.8**	**574,565**	**33.9**
Tillamook County	**18,474**	**6,377**	**34.5**	**5,256**	**28.5**	**6,841**	**37.0**
Incorporated							
Bay City	678	272	40.1	210	31.0	196	28.9
Garibaldi	532	320	60.2	106	19.9	106	19.9
Manzanita	1,263	231	18.2	471	37.2	561	44.4
Nehalem	155	97	62.5	22	14.1	36	23.2
Rockaway Beach	2,105	668	31.7	523	24.8	914	43.4
Tillamook	2,226	1,355	60.9	295	13.3	576	25.9
Wheeler	234	110	47.0	55	23.5	69	29.5
Unincorporated							
Uninc. County (rural)	8,173	2,533	31.0	2,828	34.6	2,812	34.4
Neskowin	435	176	40.5	127	29.2	132	30.3
Oceanside-Netarts	1,349	228	16.9	403	29.9	718	53.2
Pacific City–Woods	1,324	387	29.2	216	16.3	721	54.5

Source: US Census Bureau, Census 2011–2015 American Community Survey 5-Year Estimates (https://factfinder.census.gov/)

Changes in Development

To begin to understand changes in development, Tillamook County has for the first time analyzed development with respect to natural hazards. Because analyzing all new development was beyond the resources available, this initial analysis is limited to new residential construction permits issued in the unincorporated County and each of the cities during the period January 1, 2012 through December 31, 2016, the time since the previous NHMP update was drafted. New residential construction was chosen because it would provide the clearest picture of potential impacts of natural hazards on the residents (permanent and seasonal) of Tillamook County and indicate whether land use or other action may be needed to reduce risk to people and property (Goal 1, Mitigation Strategy). Note that developable land is scarce in Tillamook County, and almost every location in the County is subject to at least one natural hazard. Therefore it is very difficult to avoid developing in a hazard area. This analysis confirms that, and demonstrates that adjusting city and urban growth boundaries to minimize exposure would not be a generally effective strategy because (a) development would remain subject to the same hazards; (b) development would become subject to other hazards; or (c) opportunities for urban development outside city and urban growth boundaries are limited by farm and forest zoning.

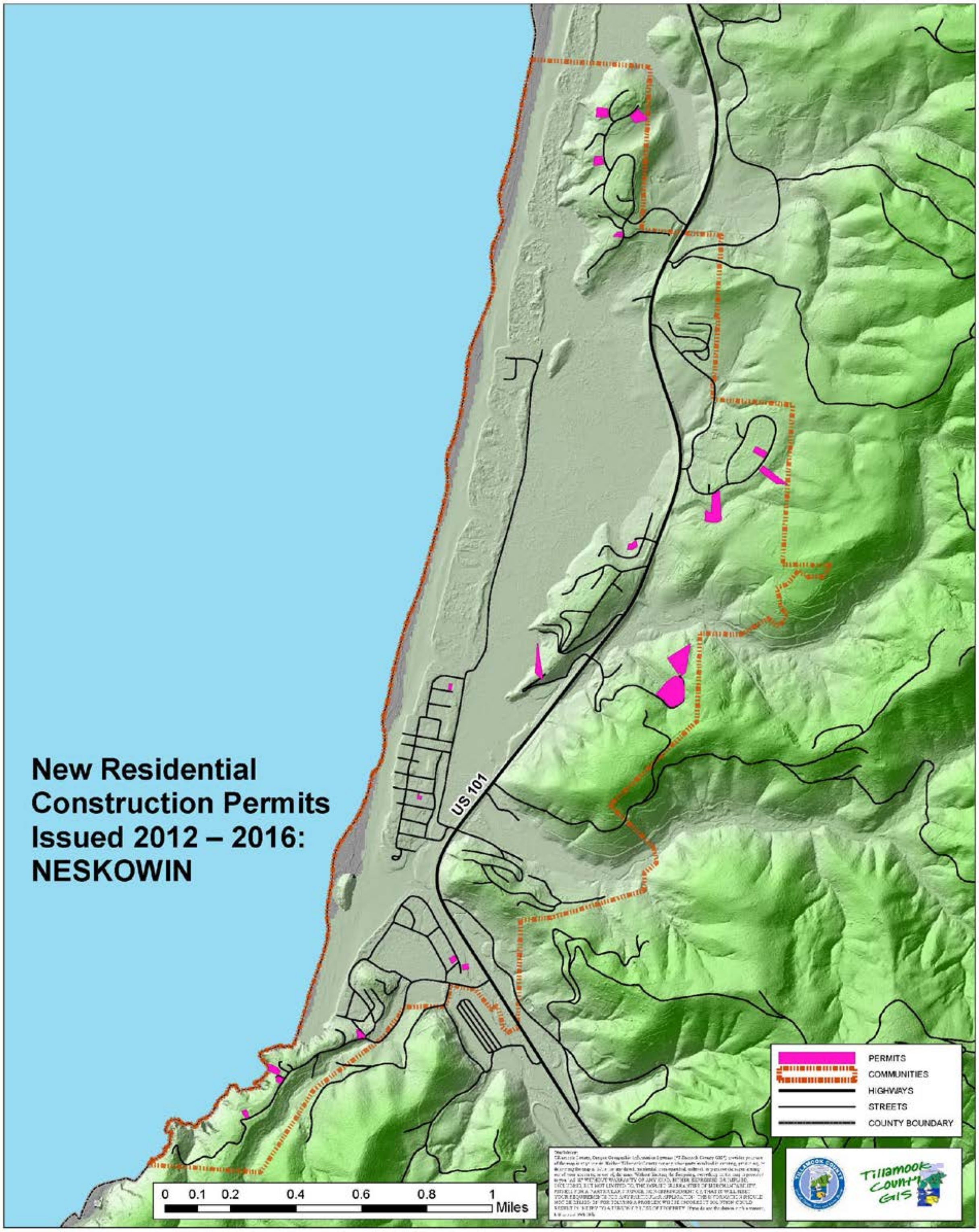
Neskowin

Neskowin is an unincorporated community located in south Tillamook County. Neskowin experienced some residential development between 2012 and 2016 within various regions of the community as depicted on the New Residential Construction Permits Issued 2012–2016 map. Development within Neskowin is susceptible to almost all of the hazards identified in the County including earthquakes, tsunamis, landslides, both riverine and coastal flooding. Coastal erosion and coastal flooding are the greatest hazards in this area. Neskowin has experienced severe coastal erosion and coastal flooding for the past two decades. The recently adopted Neskowin Coastal Hazards Overlay Zone addresses how development occurs within the regulated area. This overlay zone encompasses the DOGAMI Medium to XX-Large tsunami inundation boundaries and requires not only stricter development standards for construction but also limits or prohibits increased density or land division opportunities. There is moderate risk of wildfires and the lower-lying areas of this community are at low risk of landslides. Development has occurred in areas zoned for residential development, on built and committed lots of record. Due to the location of existing development, as well as topographical and geographical constraints, there are few alternatives for relocation of development outside of Neskowin’s existing unincorporated community boundary. The area outside Neskowin’s boundaries is susceptible to landslides, earthquakes, and wildfire. Therefore, moving development to an alternative location would not alleviate the need to continue to address natural hazard risks. Development potential in adjacent areas is also limited by protected wetlands and lands zoned Forest and Farm that are committed to resource uses.

Oceanside and Netarts

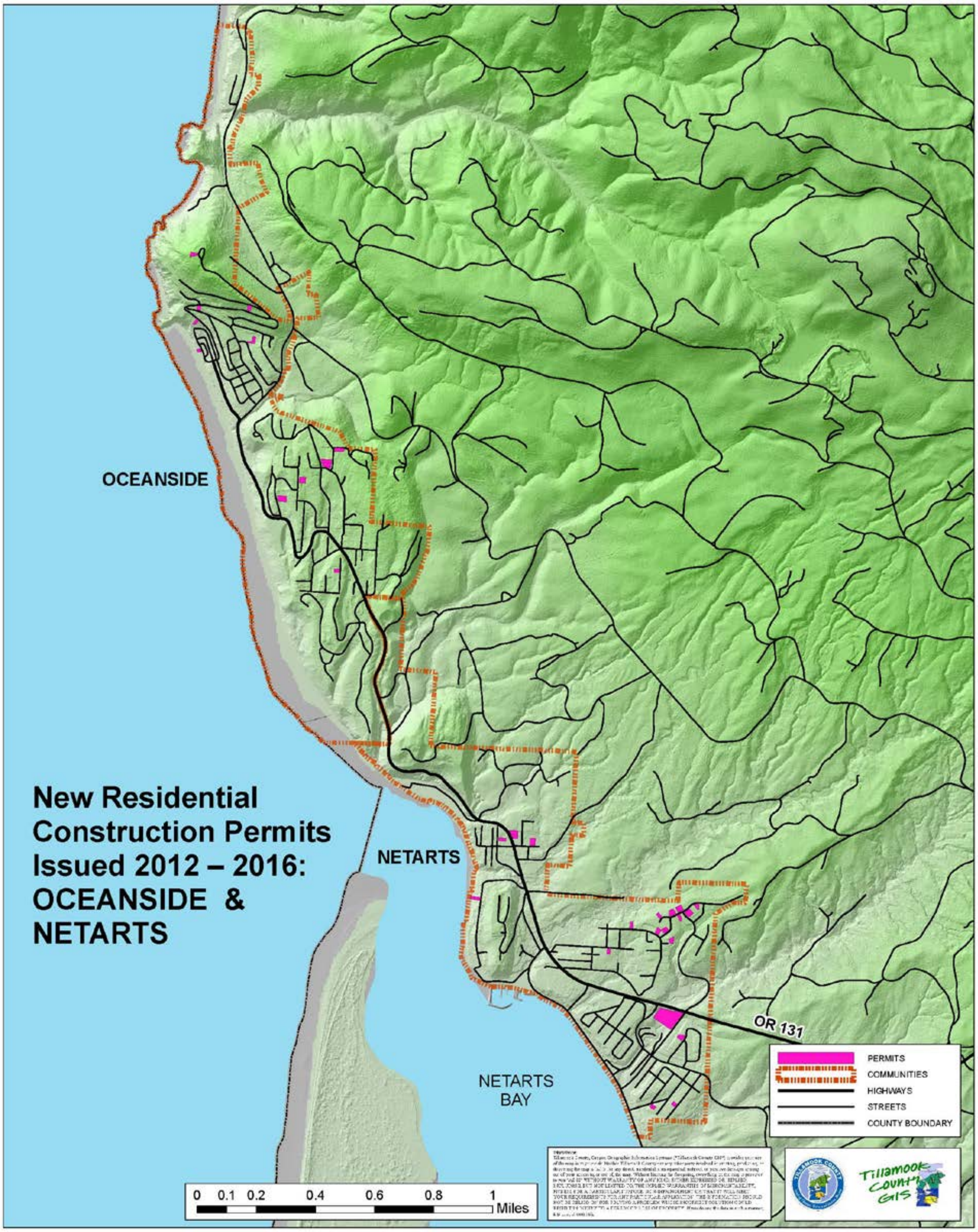
The combined unincorporated communities of Oceanside and Netarts both experienced some residential development within their respective community boundaries. Hazards identified in these two unincorporated communities include susceptibility to earthquakes, landslides, and wildfires. Due to the elevation of these communities, risk of coastal flooding and tsunami inundation is limited to lower-lying areas. Specifically, the area in Netarts identified as “Happy Camp” is located in the Velocity Zone within an Area of Special Flood Hazard. Lower elevation bay-front properties or those properties adjacent to streams in the Netarts community are within the tsunami inundation boundary. Development has occurred in areas zoned for residential development, on built and committed lots of record. Due to the location of existing development, as well as topographical and geographical constraints, there are few alternatives for relocation of development outside Oceanside’s and Netart’s existing unincorporated community boundaries. The area outside of their boundaries is susceptible to landslides, earthquakes, and wildfire. Moving development to an alternative location would not alleviate the need to continue to address natural hazard risks. Development potential in adjacent areas is also limited by Forest-zoned lands committed to resource uses.

Figure 41. New Residential Construction Permits 2012–2016: Neskowin



Source: Tillamook County Geographic Information System (GIS) Team

Figure 42. New Residential Construction Permits 2012–2016: Oceanside and Netarts



Source: Tillamook County Geographic Information System (GIS) Team

Pacific City–Woods

Pacific City–Woods is an unincorporated community located in south Tillamook County. The community experienced some residential development between 2012 and 2016 within its various regions as depicted on the New Residential Construction Permits Issued 2012–2016 map. Development within Pacific City–Woods is susceptible to most of the hazards in the County including earthquakes, tsunamis, landslides, both riverine and coastal flooding, and coastal erosion. The Nestucca River Floodway traverses this community. There is moderate risk of wildfires and the lower-lying areas of this community are at low risk of landslides. Development has occurred in areas zoned for residential development, on built and committed lots of record. Due to the location of existing development, as well as topographical and geographical constraints, there are few alternatives for relocation of development outside of Pacific City-Woods' existing unincorporated community boundary. The area outside its boundary is susceptible to riverine flooding, landslides, earthquakes, and tsunami inundation. Moving development to an alternative location would not alleviate the need to continue to address natural hazard risks. Development potential in adjacent areas is also limited by government-owned land and lands zoned Forest and Farm that are committed to resource uses.

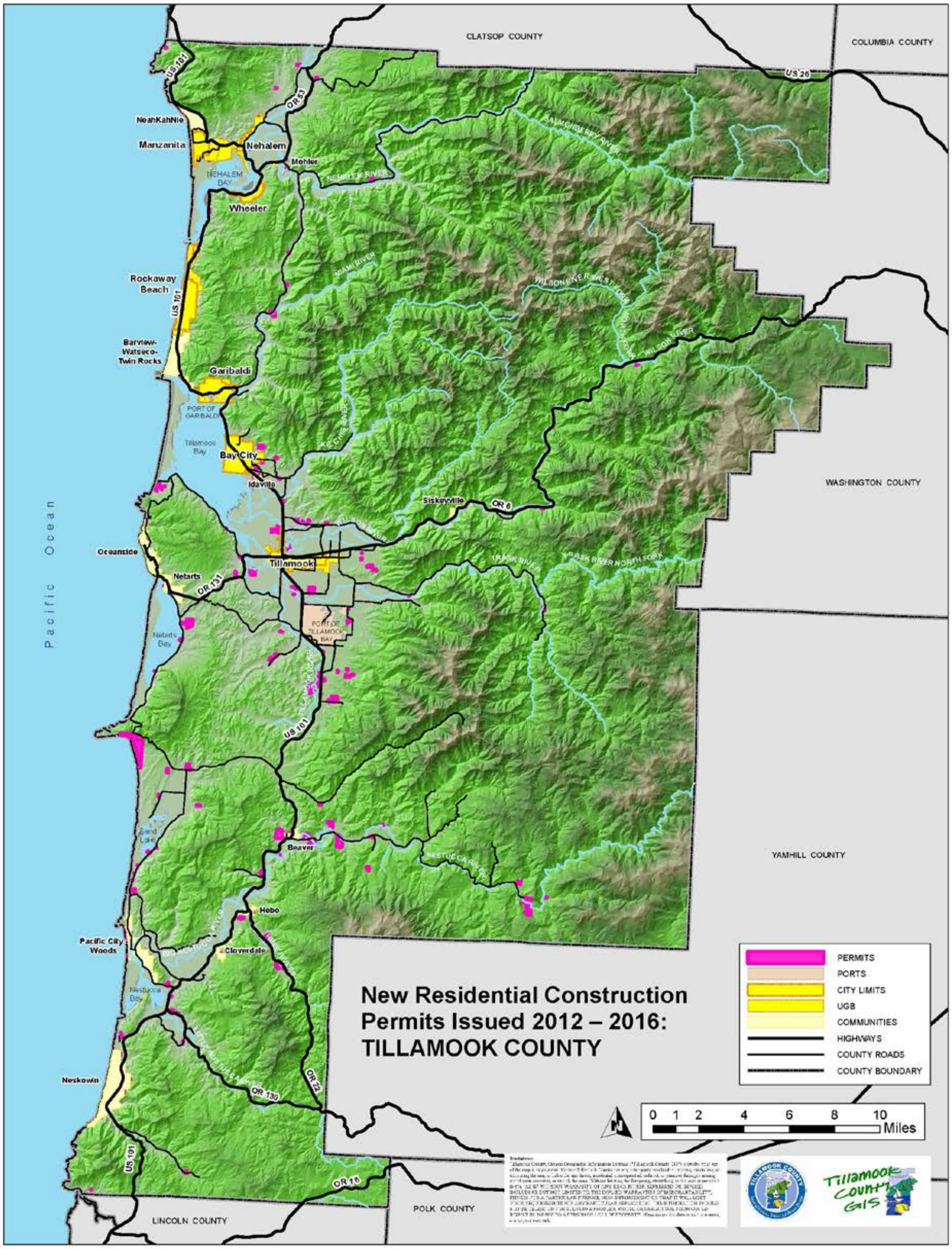
Unincorporated Tillamook County

Residential development is primarily concentrated within incorporated cities and unincorporated communities. Risks identified within unincorporated areas not included in the communities already discussed, and not included in the cities are primarily on properties zoned Rural Residential 2-Acre. Some farm- and forest-zoned properties have also experienced residential development through approved land use review processes. Hazards identified in areas within the unincorporated areas of Tillamook County that have experienced residential development between 2012 and 2016 include earthquakes, landslides, flooding (mostly riverine), and wildfire. Development within these areas occurs on existing lots of record or on properties zoned Farm or Forest that qualify for a dwelling. The Tillamook County Land Use Ordinance provides for development of unincorporated properties and includes standards for development within Areas of Special Flood Hazard (AO, A numbered or V zones); within Geologic Hazard or Beach and Dune Hazard areas; and within Forest (F) zones (fire siting standards for structures).

Figure 43. New Residential Construction Permits 2012–2016: Pacific City–Woods

Source: Tillamook County Geographic Information System (GIS) Team

Figure 44. New Residential Construction Permits 2012–2016: Unincorporated Tillamook County



Source: Tillamook County Geographic Information System (GIS) Team

City of Bay City

The City of Bay City has experienced some residential development between 2012 and 2016. The majority of this development has occurred within its upland areas, with the exception of one development known as "Sheltered Nook" that was developed in a low-lying area west of Highway 101. The City of Bay City and its urban growth area are primarily susceptible to earthquakes, landslides, and tsunamis (on the lower-elevation properties). Risk of wildfire is moderate and risk of flooding of creeks and streams appears to be primarily located on those properties west of Highway 101. Development has occurred in areas zoned for residential development, on built and committed lots of record. Due to the location of existing development, as well as topographical and geographical constraints, there are few alternatives for relocation of development outside of the existing city limits and urban growth boundary. The area outside these boundaries is susceptible to landslides, earthquakes, and wildfires. Moving development to an alternative location would not alleviate the need to continue to address natural hazard risks. Development potential in adjacent areas is also limited by Farm- and Forest-zoned lands committed to resource uses.

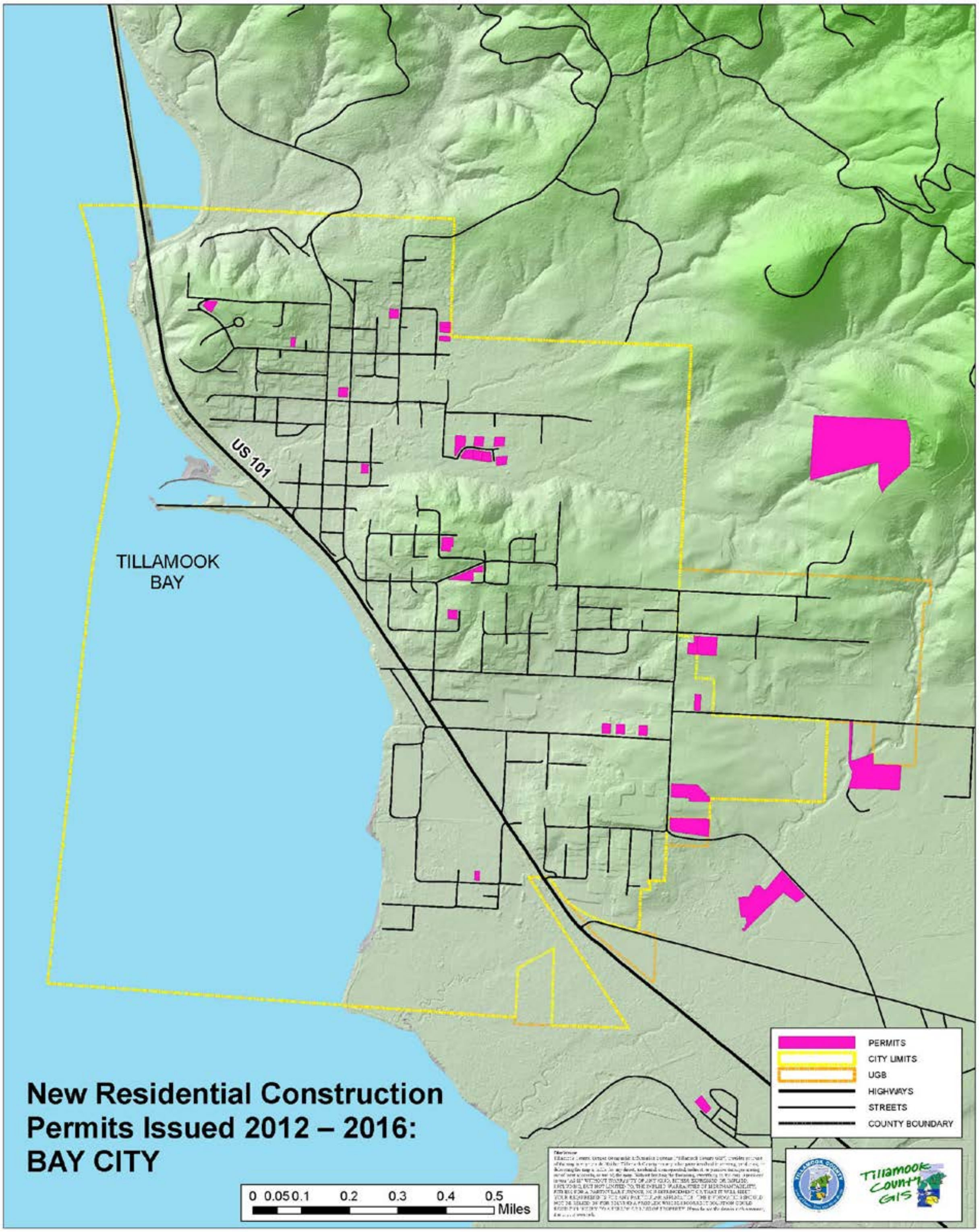
City of Garibaldi

The City of Garibaldi is highly susceptible to earthquakes, landslides, wildfires, and to a lesser extent, tsunamis and flooding. There was some residential development within the upland areas of the City, which appears to be located outside of the tsunami inundation zone and Areas of Special Flood Hazard (flooding of creeks and streams during heavy rain events), but remains susceptible to earthquakes, landslides, and wildfires. Development has occurred in areas zoned for residential development, on built and committed lots of record. Due to the location of existing development, as well as topographical and geographical constraints, there are few alternatives for relocation of development outside of the existing city limits, and urban growth area. Areas outside these boundaries are susceptible to landslides, earthquakes, and wildfires. Therefore, moving development to an alternative location would not alleviate the need to continue to address natural hazard risks. Development potential in adjacent areas is also limited by Farm- and Forest-zoned lands committed to resource uses as well as Areas of Special Flood Hazard.

Port of Garibaldi

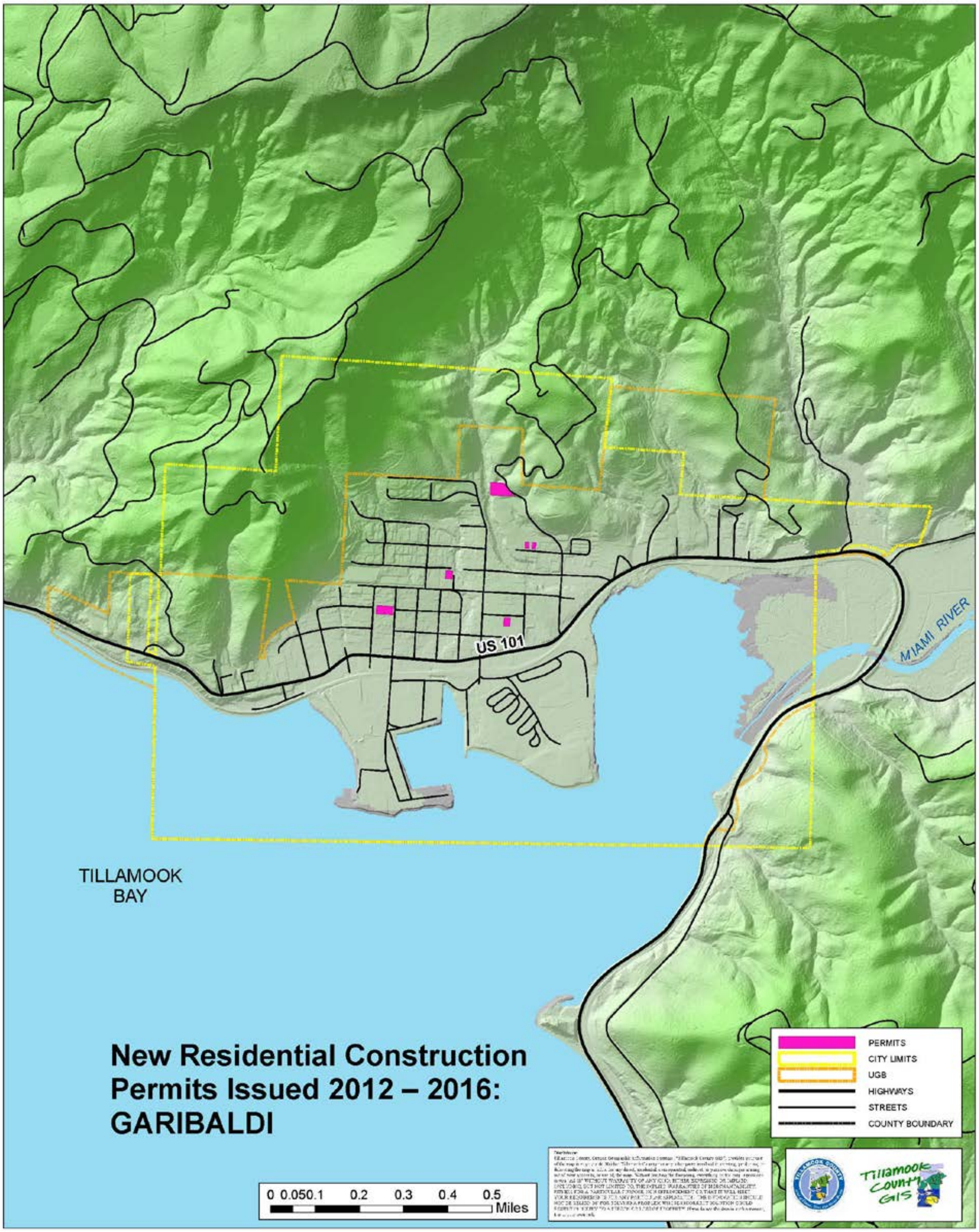
The Port of Garibaldi is located within the City of Garibaldi city limits. Owing to its low-elevation location on Tillamook Bay, it is primarily susceptible to earthquakes, tsunamis, and flooding. No new residential development occurred within the Port of Garibaldi from 2012 to 2016.

Figure 45. New Residential Construction Permits 2012–2016: City of Bay City



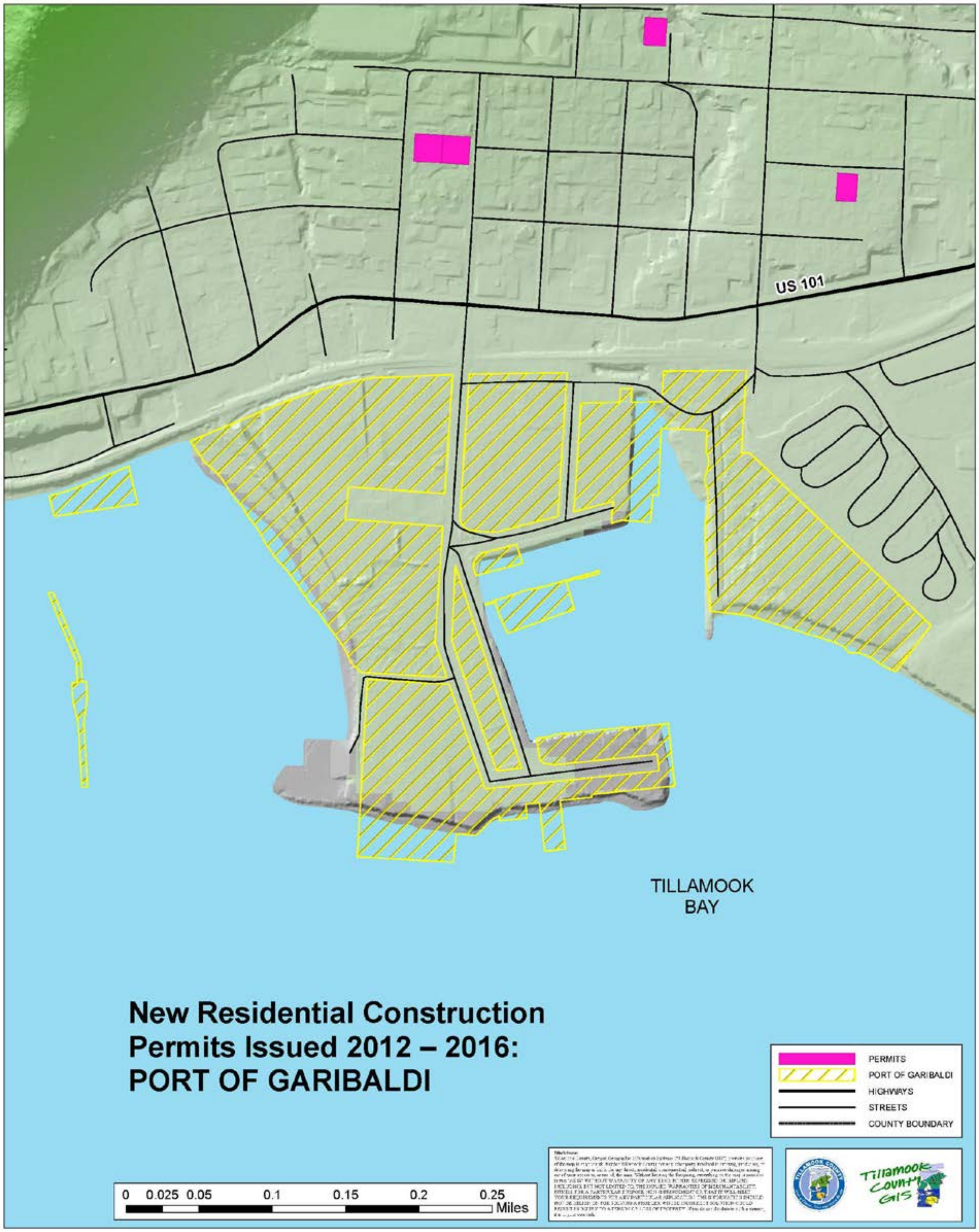
Source: Tillamook County Geographic Information System (GIS) Team

Figure 46. New Residential Construction Permits 2012–2016: City of Garibaldi



Source: Tillamook County Geographic Information System (GIS) Team

Figure 47. New Residential Construction Permits 2012–2016: Port of Garibaldi



Source: Tillamook County Geographic Information System (GIS) Team

City of Manzanita

The City of Manzanita experienced a substantial amount of residential lot development between 2012 and 2016. This development occurred in residentially zoned areas of the City of Manzanita and within Manzanita's urban growth area. These areas are primarily susceptible to earthquakes, tsunamis, and coastal erosion. With the exception of oceanfront properties, the majority of the City of Manzanita and its urban growth area are outside of the Special Flood Hazard Area (mostly coastal flooding, not riverine). These areas of Manzanita are built and committed areas, and development has occurred on lots of record. The City as a whole is located on a dune, at the base of Neahkahnie Mountain. Due to the location of existing development, as well as topographical and geographical constraints there are few alternatives for relocating development outside of the existing city limits and urban growth area. The area outside these boundaries is susceptible to landslides, flooding, and wildfires. Moving development to an alternative location would result in the need to address different natural hazard risks.

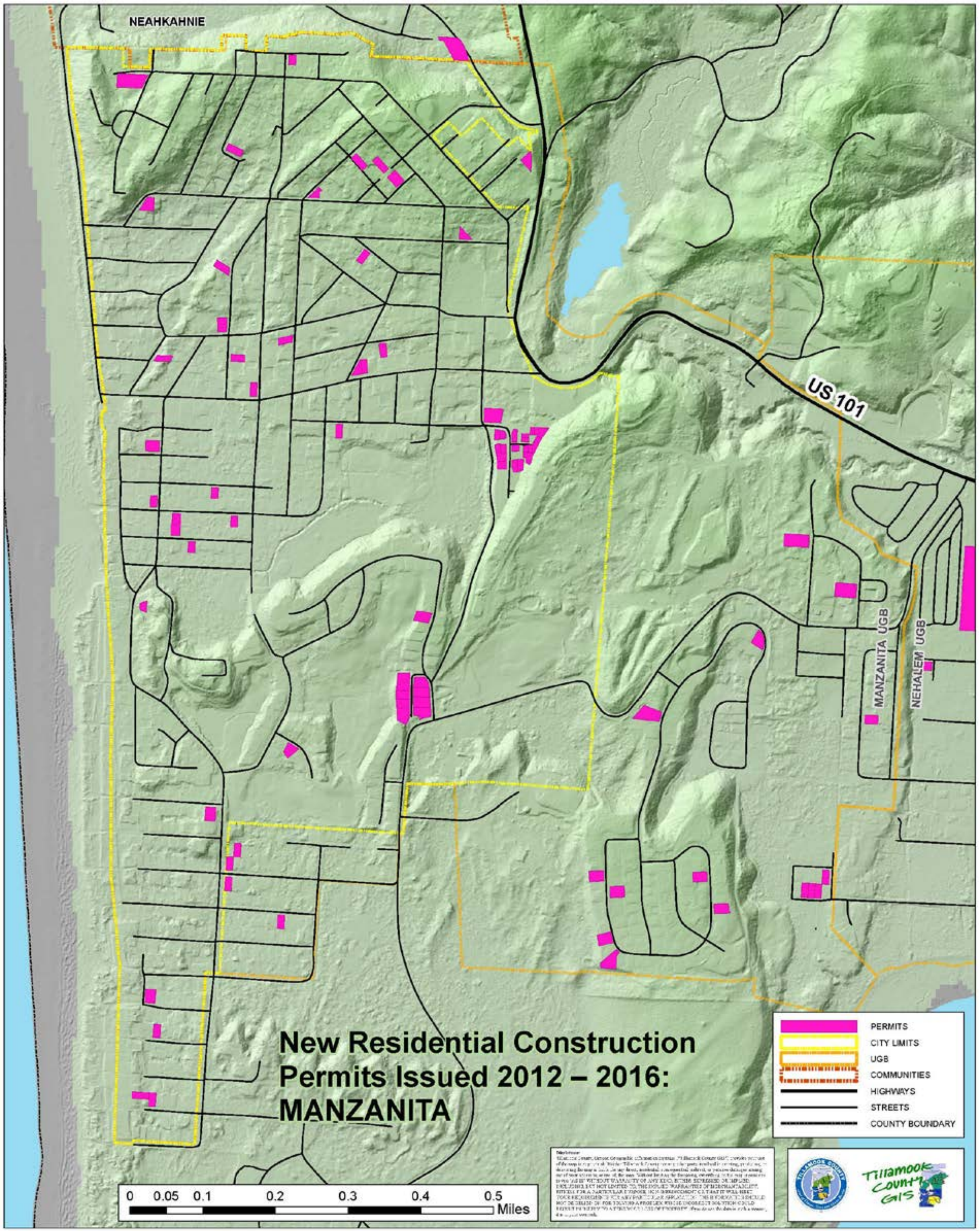
City of Nehalem

The City of Nehalem experienced most of its residential construction within its urban growth area, specifically within the area known as "Bayside Gardens" west of the city limits and abutting the City of Manzanita's urban growth boundary. The City of Nehalem and its urban growth area are susceptible to earthquakes and tsunamis due to minimal elevation change from Nehalem Bay as well as the close proximity of the Nehalem River. Most of the City of Nehalem is located within the regulatory floodway and Area of Special Flood Hazard. This area is also susceptible to landslides. Wildfire is a moderate risk. Development has occurred in areas zoned for residential development and on lots of record. Due to the location of existing development, as well as topographical and geographical constraints, there are few alternatives for relocating development outside of the existing city limits and urban growth area. Lands outside these boundaries are susceptible to landslides and flooding on Farm-zoned lands committed to agricultural uses. Relocating development from these portions of the City of Nehalem is not possible due to the Nehalem River, Nehalem Bay, Nehalem River Floodway, and outer lying areas currently zoned Farm and Forest.

City of Rockaway Beach

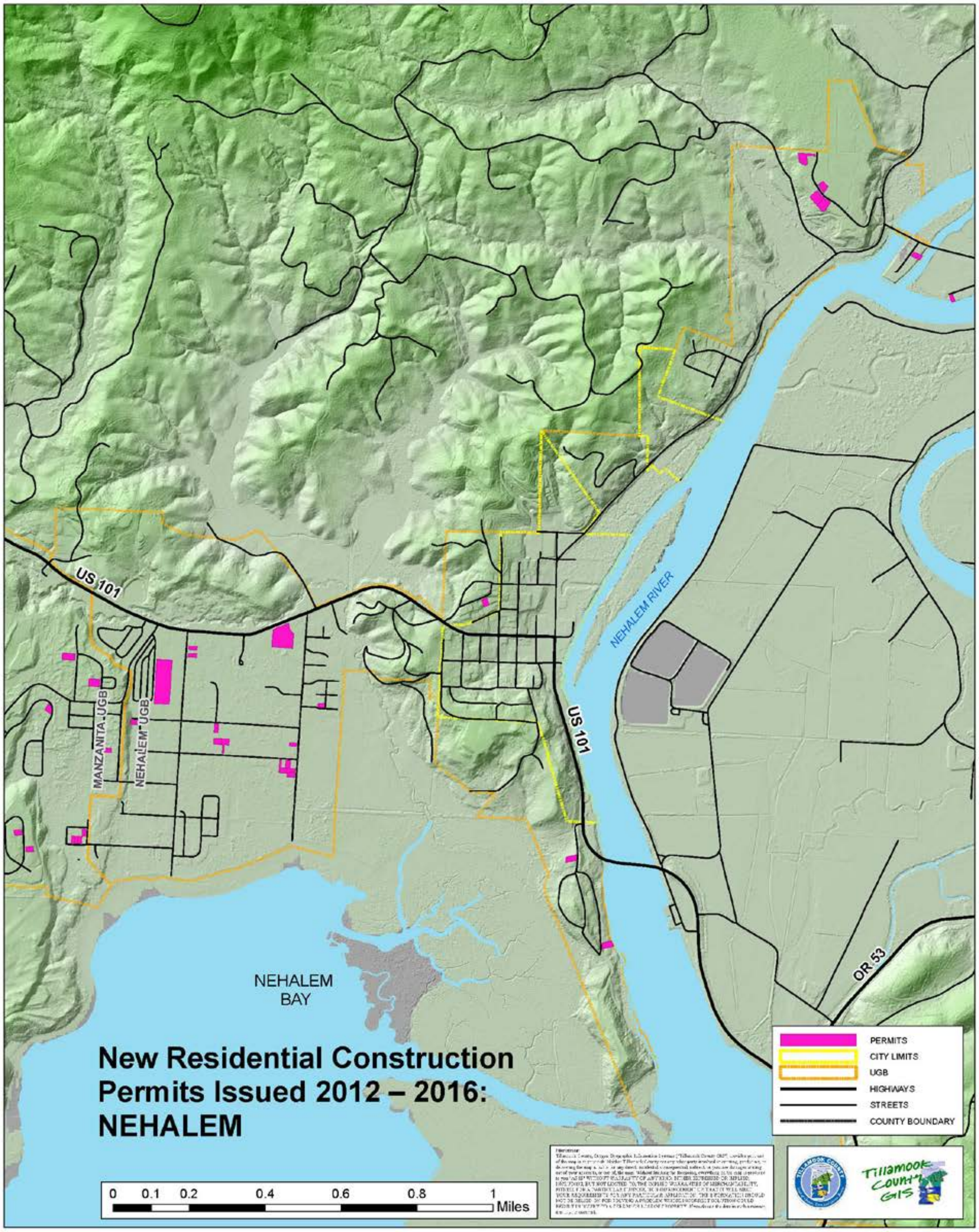
Hazards identified for areas within the City of Rockaway Beach and its urban growth boundary include earthquakes, tsunamis, coastal flooding (with some riverine flooding attributable to creeks and streams during heavy rain events), landslides, coastal erosion, and wildfires. Review of the hazard maps confirms that development within any portion of the City of Rockaway or its urban growth area is susceptible to all or most of these hazards. These areas of Rockaway Beach are built and committed, and development has occurred on lots of record. Due to the location of existing development, as well as topographical and geographical constraints, there are few alternatives for relocation of development outside of the existing city limits and urban growth area. Hazards outside these boundaries include landslides and wildfires. Moving development to an alternative location would not alleviate the need to continue to address natural hazard risks.

Figure 48. New Residential Construction Permits 2012–2016: City of Manzanita



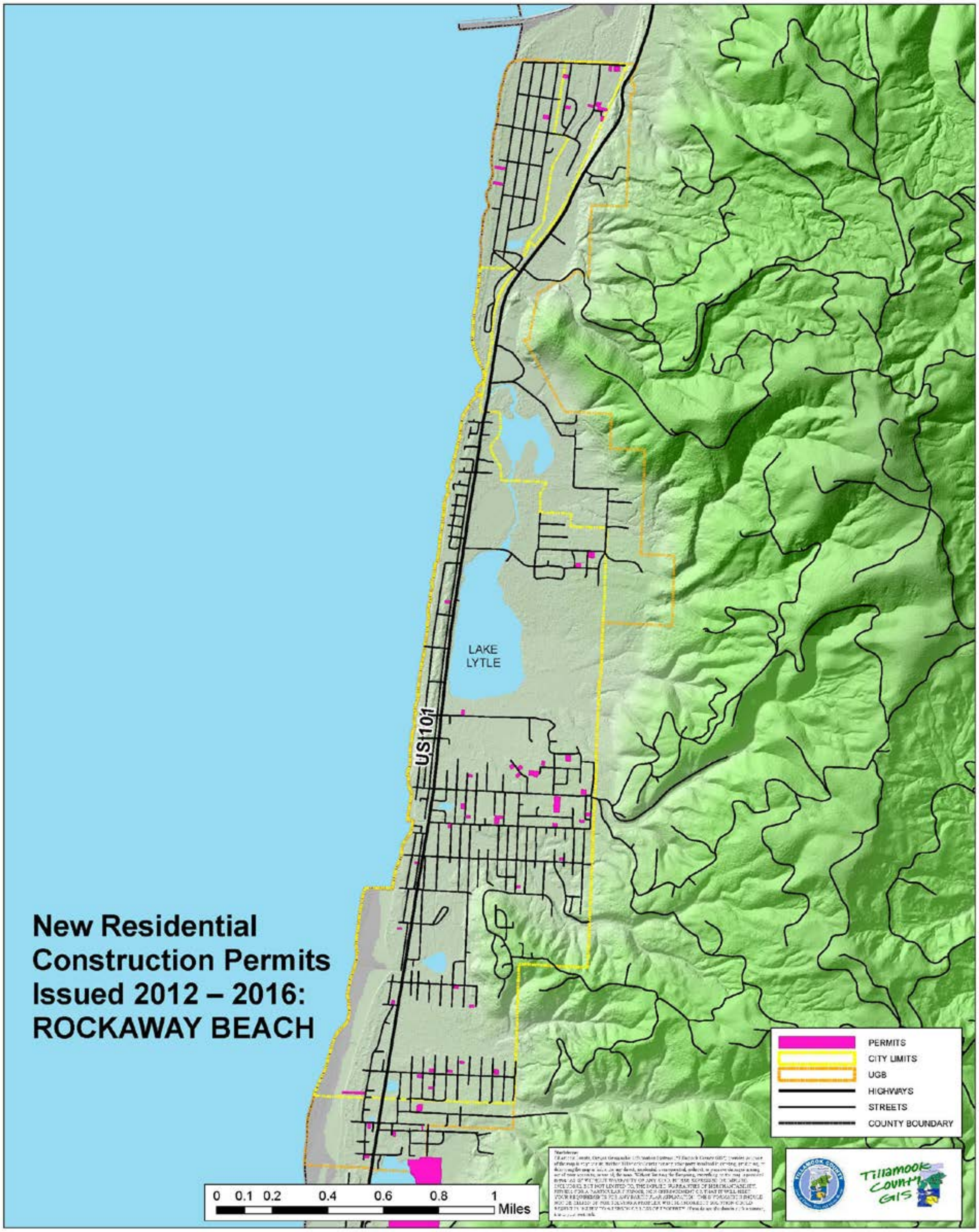
Source: Tillamook County Geographic Information System (GIS) Team

Figure 49. New Residential Construction Permits 2012–2016: City of Nehalem



Source: Tillamook County Geographic Information System (GIS) Team

Figure 50. New Residential Construction Permits 2012–2016: City of Rockaway Beach



Source: Tillamook County Geographic Information System (GIS) Team

City of Tillamook

While the City of Tillamook has experienced some residential development, primarily within its city limits, more residential development has occurred outside the city limits and urban growth area. The City of Tillamook and its urban growth area are susceptible to earthquakes, riverine flooding, and tsunamis. The northern, lower lying areas of the City along with the most westerly region of its upland area appear to be the most susceptible to riverine flooding (including river floodway), earthquake and tsunami hazards. The City of Tillamook as a whole is susceptible to earthquakes. The residential development that has occurred within the City appears to be located outside of areas at risk of flooding and tsunamis. Development has occurred in residentially zoned areas on built and committed lots of record. Due to the location of existing development, as well as topographical and geographical constraints, there are few alternatives for relocating development outside of the existing city limits and urban growth area. Outside the city limits, hazards include flooding, landslides, earthquakes, and wildfires. Therefore, moving development to an alternative location would not alleviate the need to continue to address natural hazard risks. Adjacent lands, including Farm- and Forest-zoned lands committed to resource uses are limited for development.

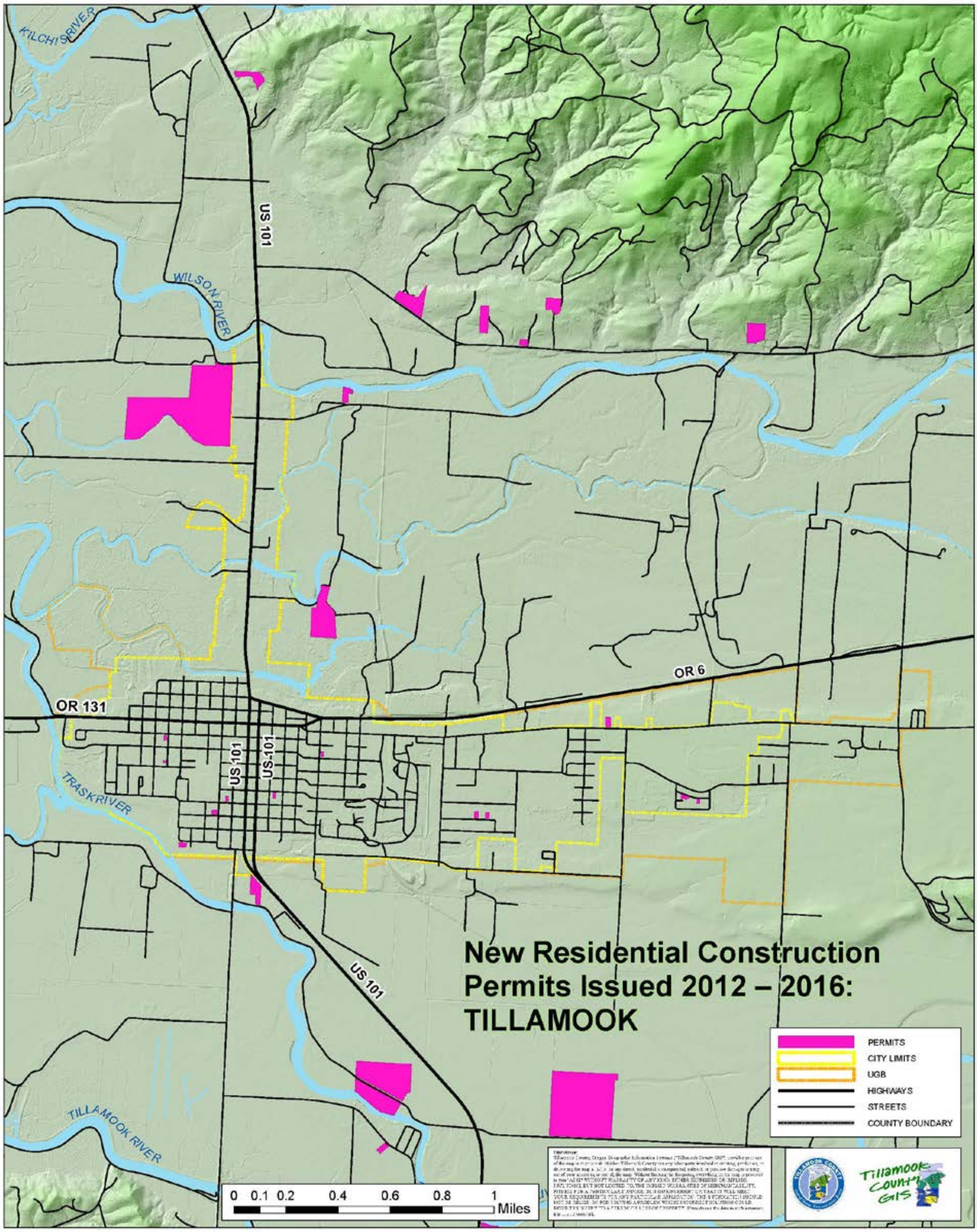
City of Wheeler

The City of Wheeler has experienced little residential construction from 2012 to 2016. While identified hazards within the City of Wheeler and its urban growth area include earthquakes, landslides, wildfires and tsunamis, development has occurred in the upland portion of the City where the aforementioned risks are minimal. Flooding as a result of heavy rain events that increase streamflow and runoff has also been identified as a hazard. Development has occurred in built and committed areas, on lots of record. Due to the location of existing development, as well as topographical and geographical constraints, there are few alternatives for relocating development outside of the city limits and urban growth area. Hazards outside of these boundaries include earthquakes and landslides, as well as wildfires. Areas north, south and east of the City of Wheeler are primarily zoned Forest and devoted to resource uses.

Port of Tillamook Bay

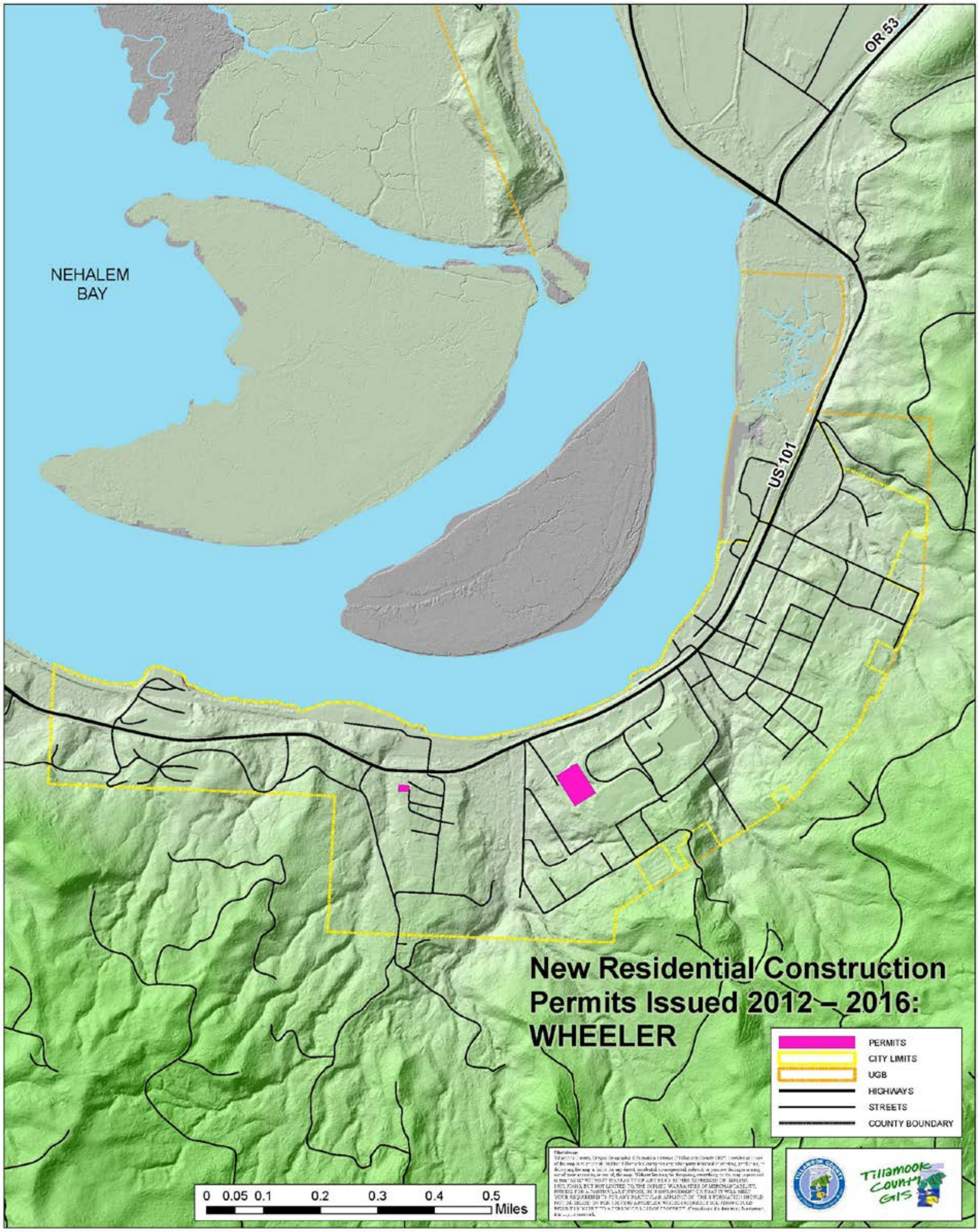
The New Residential Construction Permits Issued 2012–2016 map for the Port of Tillamook Bay confirms no residential development has occurred within the Port from 2012–2016. The Port of Tillamook Bay is primarily zoned General Industrial and residential construction beyond a caretaker dwelling for an existing industrial use is not allowed. The Port is primarily susceptible to earthquakes, landslides, and wildfire, and to a lesser extent flooding and tsunamis.

Figure 51. New Residential Construction Permits 2012–2016: City of Tillamook



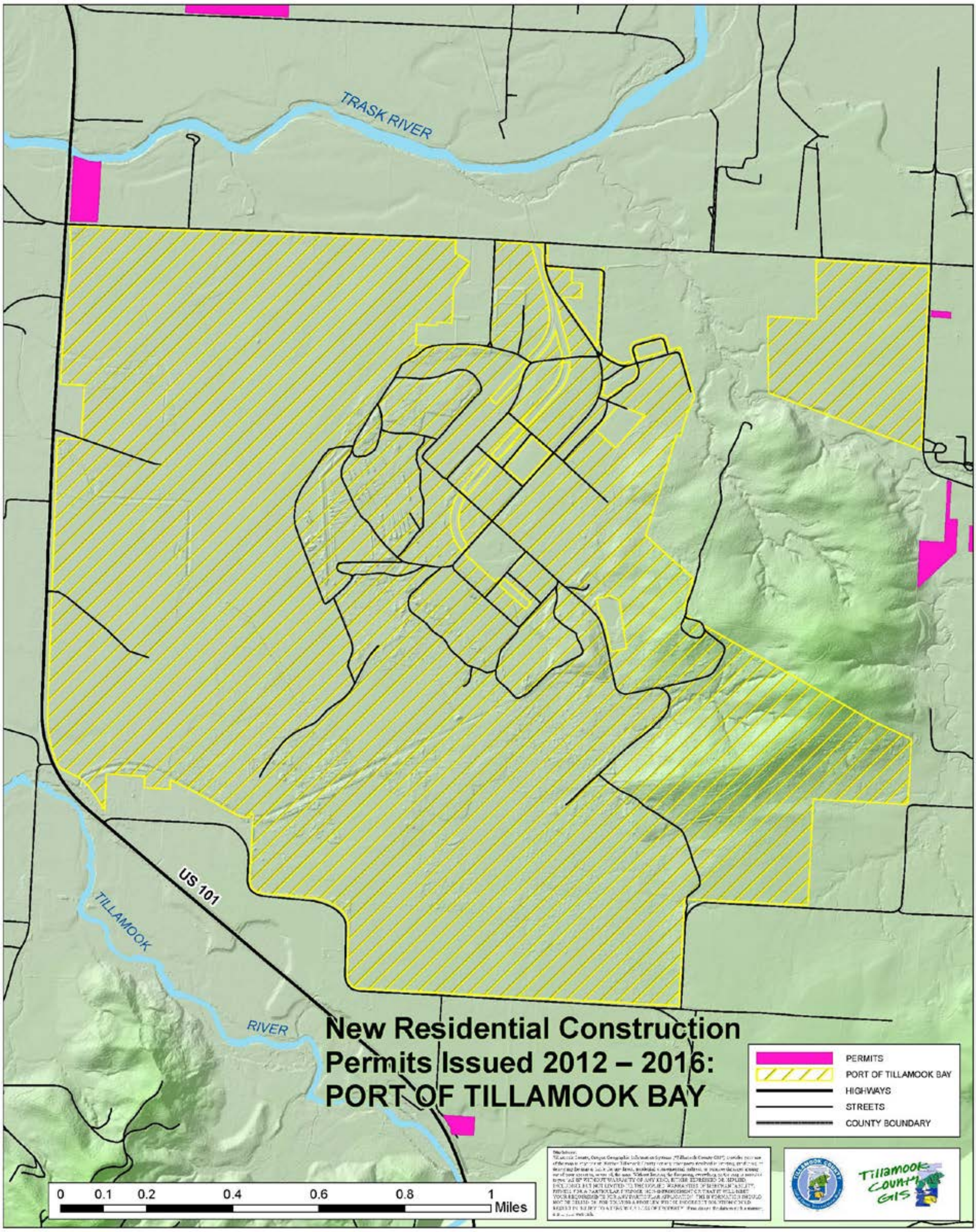
Source: Tillamook County Geographic Information System (GIS) Team

Figure 52. New Residential Construction Permits 2012–2016: Wheeler



Source: Tillamook County Geographic Information System (GIS) Team

Figure 53. New Residential Construction Permits 2012–2016: Port of Tillamook Bay



Source: Tillamook County Geographic Information System (GIS) Team

7. Cultural and Historic Resources

Cultural and historic resources provide information about our past, insight into our present, and frame our local character and identity. It is important to protect them from natural hazard events. There are over 300 historic and pre-historic resources in Tillamook County listed on the Oregon Historic Sites Database (http://heritagedata.prd.state.or.us/historic/, accessed February 25, 2017). At least two or three are located in or near each city; there are none at the Port of Garibaldi. Some are listed or eligible for listing on the National Register of Historic Places (https://www.nps.gov/Nr/index.htm), the official list of historic resources that have met criteria establishing their importance in our nation's history.

The Port of Tillamook Bay sits on land formerly designated as Naval Air Station Tillamook (1942–1948). Hangar B, currently operated as the Tillamook Air Museum, has been listed on the National Register of Historic Places since 1989. A cultural resource survey was performed in December 2010 as part of the Port's implementation of FEMA Alternate Projects within the industrial park and airport. The survey identified multiple historic buildings and artifacts and also an area eligible for listing on the National Register of Historic Places as a historic district. The Port has not pursued creation of the historic district.

C. Natural Hazards

1. Coastal Erosion

Introduction

The Pacific Northwest (PNW) coast of Oregon is without doubt one of the most dynamic coastal landscapes in North America, evident by its long sandy beaches, sheer coastal cliffs, dramatic headlands and vistas, and ultimately the power of the Pacific Ocean that serves to erode and change the shape of the coast. Beaches and coastal bluffs are some of the most dynamic landforms, changing in response to waves, nearshore currents, tides, rain, and wind.

The most important natural variables that influence changes to the shape and width of the beach and ultimately its stability are the beach sand budget (balance of sand entering and leaving the system) and the processes (waves, currents, tides, and wind) that drive the changes.

Human influences associated with jetty construction, dredging practices, coastal engineering, and the introduction of non-native dune grasses have all affected the shape and configuration of the beach, including the volume of sand on a number of Oregon's beaches, ultimately influencing the stability or instability of these beaches.

Figure 54. Erosion at "The Capes" Condominiums, Oceanside, Oregon

Notes: The Capes, a multi-million dollar condominium complex constructed on an old Holocene dune field adjacent to Oceanside. Due to erosion of the sand at the toe of the bluff during the 1997-98 El Niño winter, the bluff face began to fail threatening several of the homes built nearest the bluff edge.

Photo source: Jon Allan, DOGAMI

Table 22. Jurisdictions Subject to Coastal Erosion

Jurisdiction	Coastal Erosion
Unincorporated Tillamook County (rural)	X
Neskowin	X
Oceanside-Netarts	
Pacific City–Woods	X
Bay City	
Garibaldi	
Manzanita	X
Nehalem	
Rockaway Beach	X
Tillamook	
Wheeler	
Port of Tillamook Bay	X
Port of Garibaldi	X

Source: Derived from DOGAMI (2016)

Hazard Characterization

Geology and Geomorphology

Tillamook County's geomorphic features include almost all those found along the Oregon Coast: plunging cliffs, rocky shorelines and shore platforms, wide and narrow beaches backed by dunes, gravel and cobble beaches backed by cliffs, barrier spits, and estuaries. Geomorphically, the coast can be broken up into a series of "pocket beach" littoral cells that reflect resistant headlands (chiefly basalt) interspersed with short to long stretches of beaches backed by both less resistant cliffs and dunes as is the case in Tillamook County. The headlands effectively prevent the exchange of sand between adjacent littoral cells. Some beaches form barrier spits, creating estuaries or bays behind them (e.g., Netarts and Nestucca spits).

Sand Budget

The beach sand budget is the rate at which sand is brought into the coastal system versus the rate at which sand leaves the system. Potential sources of sand include rivers, bluffs, dunes, and the inner shelf. Potential sand sinks include bays (estuaries), dunes, dredging around the mouths of estuaries, and mining of sand. Sand volume is a factor in susceptibility of a bluff to failure from wave action causing erosion at its toe. Conversely, in some areas such as Pacific City and Manzanita excess sand build-up is a concern.

Human Influences

Population pressure on the Oregon coast is relatively low and is largely confined to small coastal cities separated by large tracts of coast with little to no development. Tillamook County is home to some of these small cities. Although the processes driving coastal erosion on bluff-backed shores are entirely a function of the delicate balance between the assailing forces (waves, tides, and currents) and properties of the rock (rock type, bedding, strength, etc.), human influences along with extensive erosion caused by major storms have contributed to the need for coastal engineering (such as riprap) to protect individual properties. The magnitude and extent of these erosion events have now left these communities entirely dependent on the integrity of the engineered structures.

Classifying Coastal Erosion

Chronic or catastrophic? Beach, dune, and bluff erosion are chronic hazards. They usually cause gradual and cumulative damage. However, storms that produce large winter waves, heavy rainfall, and/or high winds may result in very rapid erosion that can affect properties and infrastructure over a matter of hours. Damage from chronic hazards is generally less severe than that from catastrophic hazards. However, the wide distribution and frequent occurrence of chronic hazards makes them a more immediate concern.

Causes of Coastal Erosion

Most coastal hazards, coastal erosion among them, are the product of the annual barrage of rain, wind, and waves that batter the Oregon coast, causing ever-increasing property damage and losses. Coastal erosion may be further exacerbated by climate cycles such as the El Niño Southern Oscillation, or longer-term climate cycles associated with the Pacific Decadal Oscillation.

Waves

Along dune- and bluff-backed shorelines, waves are the major factor affecting the shape and composition of beaches. Short-term beach and shoreline variability is directly dependent on the size of the waves that break along the coast, along with high ocean water levels, and cell circulation patterns associated with rip currents. In contrast, long-term shoreline change is dependent on the balance of the beach sediment budget, changes in sea level over time, and patterns of storminess.

Figure 55. Bluff Failure Due to Toe Erosion by Ocean Waves

Note: The top of the bluff eroded landward by about 30 ft over a 48-hour period in November 2006.
Photo source: Oregon Partnership for Disaster Resilience

The Oregon coast is exposed to one of the most extreme ocean wave climates in the world, due to its long fetches and the strength of the extratropical storms that develop and track across the North Pacific. These storms exhibit a pronounced seasonal cycle producing the highest waves in the winter. Summer months are dominated by considerably smaller waves, enabling beaches to rebuild and gain sand eroded by the preceding winter. When large waves are superimposed on high tides, they can reach much higher elevations at the back of the beach, contributing to significantly higher rates of coastal erosion and flood hazards. It is the combined effect of these processes that leads to the erosion of coastal dunes and bluffs, causing them to retreat landward.

Winds and waves tend to arrive from the southwest during the winter and from the northwest during the summer. Net sand transport tends to be offshore and to the north in winter and onshore and to the south during the summer. El Niño events can exaggerate the characteristic seasonal pattern of erosion and accretion, and may result in an additional 60–80 ft of “hotspot” dune erosion along the southern ends of Oregon’s littoral cells, particularly those beaches that are backed by dunes, and on the north side of estuary inlets, rivers and creeks.

Ocean Water Levels

The elevation of the sea is controlled in part by the astronomical tide. High ocean water levels at the shoreline may be the product of combinations of high tides, storm surges, strong onshore-directed winds, El Niños, and wave runup. Tides tend to be highest in the winter and lowest in the summer. The typical seasonal variability in water levels enables waves to break closer to dunes or along the base of coastal bluffs.

Shoreline Changes

Dune-backed beaches respond very quickly to storm wave erosion, sometimes receding tens of feet during a single storm and hundreds of feet in a single winter season. Beach monitoring studies undertaken by DOGAMI (http://nvs.nanoos.org/BeachMapping) have documented storm induced erosion of 30–60 ft from single storm events, while seasonal changes may reach as much as 90–130 ft on dissipative, flat, sandy beaches. Furthermore, during the past 15 years a number of sites on the northern Oregon coast (e.g., Neskowin, Netarts Spit, and Rockaway Beach) have experienced considerable erosion and shoreline retreat. For example, erosion of the beach in Neskowin has resulted in the foredune having receded landward by as much as 150 ft since 1997. South of Twin Rocks near Rockaway, the dune has eroded about 140 ft over the same time period. Continued monitoring of these study sites are now beginning to yield enough data from which trends (erosion or accretion rates) may be extrapolated. These latter datasets are accessible via the web (http://nvs.nanoos.org/BeachMapping).

Recently, studies undertaken by the USGS provide additional insights into the spatial extent of erosion patterns on the Oregon coast. Long-term erosion rates (albeit low rates) dominate the bulk of Tillamook County (i.e., Bayocean Spit, Netarts, Sand Lake, and Neskowin littoral cells), while accretion prevailed in the north along Rockaway Beach and on Nehalem Spit. The significant rates of accretion identified adjacent to the mouth of Tillamook Bay are entirely due to construction of the Tillamook jetties, with the north jetty completed in 1917 and the south jetty in 1974. Short-term shoreline change patterns indicate that erosion has continued to dominate the bulk of the shoreline responses observed along the Tillamook County coast. Erosion is especially acute in the Neskowin, Sand Lake and Netarts littoral cells, and especially along Rockaway Beach. In many of these areas, the degree of erosion remains so significant, that were we to experience a major storm(s) in the ensuing winters, the risk of considerable damage to property and infrastructure in these areas would likely be high.

The processes of wave attack significantly affect shorelines characterized by indentations, known as inlets. Waves interact with ocean tides and river forces to control patterns of inlet migration. This is especially the case during El Niños. During an El Niño, large storm waves tend to arrive out of the south, which causes the mouth of the estuary to migrate to the north, where it may abut against the shoreline, allowing large winter waves to break much closer to the shore. This can result in significant “hotspot” erosion north of the estuary mouth. A recent example of the importance of inlet dynamics during an El Niño is Netarts Spit near Oceanside.

Similar processes occurred nearby during the 1972-73 winter, which led to one home having to be pulled off its foundation. Both examples provide a stark reminder of the danger of building too close to the beach and that these types of changes do occur relatively frequently.

Climate Change and Sea Level Rise

On the central to northern Oregon coast, sea level is rising faster than tectonic uplift of the land creating conditions supporting widespread erosion.

In 2012, the National Research Council completed a major synthesis of the relative risks of sea level rise on the US West Coast. Based on that report, erosion and flood hazards on the northern Oregon Coast will almost certainly accelerate over time, increasing the risk to property.

Human Activities

Human activities affect the stability of all types of shoreline. Large-scale human activities such as jetty construction and maintenance dredging have a long-term effect on large geographic areas. This is particularly true along dune-backed and inlet-affected shorelines such as the Rockaway littoral cell. The planting of European beach grass (*Ammophila arenaria*) since the early 1900s and, more recently, American beach grass (*Ammophila breviligulata*) has locked up sand in the form of high dunes. Such a process can contribute to a net loss in the beach sand budget and may help drive coastal erosion.

Residential and commercial development can affect shoreline stability over shorter time periods and smaller geographic areas. Activities such as grading and excavation, surface and subsurface drainage alterations, vegetation removal, and vegetative as well as structural shoreline stabilization can all affect shoreline stability.

While site-specific coastal engineering efforts such as the construction of riprap revetments is less likely to cause direct adverse impacts to the beach, the cumulative effect of constructing many of these structures along a particular shore (e.g., as has occurred along the communities of Neskowin, Pacific City, and Rockaway) will almost certainly decrease the volume of sediment being supplied to the beach system, potentially affecting the beach sediment budget and hence the stability of beaches within those littoral cells.

Heavy recreational use in the form of pedestrian and vehicular traffic can affect shoreline stability over shorter time frames and smaller spaces. Because these activities may result in the loss of fragile vegetative cover, they are a particular concern along dune-backed shorelines. Graffiti carving along bluff-backed shorelines is another byproduct of recreational use that can damage fragile shoreline stability.

Historic Coastal Hazard Events

Table 23. Historic Coastal Erosion Events in Tillamook County

Date	Location	Description
1931	Rockaway	coastal damage from December storm
Oct–Dec. 1934	Rockaway	coastal damage (Rockaway Beach)
Dec. 1935	Rockaway Beach	coastal damage
Jan. 1939	coastwide	severe gale; damage: coastwide
multiple spit breaches (southern portion of Netarts Spit)		
Jan. 1953	Rockaway	70-ft dune retreat; one home removed
Dec. 1967	Netarts Spit	damage: coastwide
State constructed wood bulkhead to protect foredune along 600 ft section (Cape Lookout State Park campground)		
1997–98	Tillamook Counties	El Niño winter (second strongest on record); erosion: considerable
1999	coastwide	five storms between January and March; coastal erosion: extensive, including causing significant erosion (Neskowin, Netarts Spit, Oceanside, Rockaway beach)

Sources: Allan and Priest (2001); Allan and Komar (2002); Allan, Komar and Priest (2003); Allan, Hart, & Tranquilli (2006); Allan and Hart (2007, 2008); Allan, Witter, Ruggiero, & Hawkes (2009); Allan, Ruggiero, & Roberts, 2012); Allan and Stimely (2013); Komar (1986); Jackson (1987); Komar and Rea (1976); McKinney (1977); Komar (1997; Komar and Allan (2010); Peterson, Jackson, O'Neil, Rosenfeld, & Kimerling (1990); Priest (1999); Revell, Komar, & Sallenger (2002); Schlicker, Deacon, Olcott, & Beaulieu (1973); Stembridge (1975); and Terich and Komar (1974)

Probability

The erosion of the Oregon coast is exceedingly complex, reflecting processes operating over both short and long time scales, and over large spatial scales. However, the most significant erosion effects are largely controlled by high-magnitude (relatively infrequent) events that occur over the winter when wave heights and ocean water levels tend to be at their highest.

Previous analyses of extreme waves for the Oregon coast estimated the “100-year” (1%) storm wave to be around 33 ft. In response to a series of large wave events that occurred during the latter half of the 1990s, the wave climate was subsequently re-examined and an updated projection of the 1% storm wave height was determined, which is now estimated to reach approximately 47–52 ft (**Table 24**), depending on which buoy is used. These estimates are of considerable importance to the design of coastal engineering structures and in terms of defining future coastal erosion hazard zones.

Table 24. Projection of Extreme Wave Heights for Various Recurrence Intervals: Each Wave Height Is Expected to Occur on Average Once during the Recurrence Interval

Recurrence Interval (Years)	Extreme Wave Heights (Feet)	
	NDBC Buoy #46002*(Oregon)	NDBC Buoy #46005+(Washington)
10	42.5	41.7
25	46.2	44.0
50	48.8	–
75	50.1	45.7
100	51.2	47.1

Sources: *Analyses by Jon Allan, DOGAMI; +Ruggiero, Komar and Allan (2010)

In order to understand the potential extent of erosion for different communities, DOGAMI has completed coastal erosion hazard maps for Tillamook County. The maps depict erosion hazard zones that fall into four categories: Active, High, Medium, and Low (**Figure 43**). The High and Medium hazard zones reflect erosion associated with a 2% and 1% storm, respectively. The Low hazard zone includes a 1% storm coupled with a Cascadia subduction zone earthquake and has a much lower probability of occurrence. The erosion scenarios were defined using a combination of probabilistic (waves) and deterministic (water levels) approaches.

Figure 56. Example Map Product Showing Erosion Hazard Zones Developed for Rockaway Beach in Tillamook County

Note the erosion that has taken place since 1998 (red line) up through 2009 (black line).
Photo source: DOGAMI

In July 2014, DOGAMI completed updated maps for the dune-backed beaches in Tillamook County using a fully probabilistic approach of the waves and water levels to map the erosion hazard zones. The revised modeling used three total water level scenarios (10%, 2%, and 1% events) produced by the combined effect of extreme wave runup (R) plus the measured tidal elevation (T), and erosion due to sea level rise (low/mean/maximum estimates) at 2030, 2050, and 2100. In total, 81 scenarios of coastal erosion were modeled; an additional two scenarios were also modeled that considered the effects of a Cascadia subduction zone earthquake, and the effects of a single (1%) storm, where the storm's duration was taken into account. The completed study ultimately recommended five hazard zones for consideration. A sixth hazard zone was also proposed. This latter zone was defined using a more sophisticated dune erosion model that accounted for the effect of the duration of a storm. Table 25 provides the calculated erosion associated with an extreme (1%) storm for Tillamook County, after accounting for the storms duration. The results indicate that the storm induced erosion ranges from about 47 to 73 ft. When the duration of the storm is removed from consideration the amount of beach and dune erosion increases substantially to about 70 to 260 ft. Finally, modeling coastal change by nature is fraught with large uncertainty that is a function of variations in the morphology of the beach and the beach sediment budget.

Table 25. Storm-Induced Erosion Defined for Selected Sites in Tillamook County after Having Accounted for the Duration of the Event

	Maximum 1% Erosion Distance	
	(Meters)	(Feet)
Neskowin	20.6	67.6
Nestucca Spit	14.5	47.6
Sand Lake	18.7	61.4
Netarts Spit	22.2	72.8
Bayocean Spit	17.6	57.7
Rockaway	19.9	65.3
Nehalem Spit	19.3	63.3

Modeled erosion is for a 1% storm.

Climate Change and Sea Level Rise

Recent research indicates that sea levels along Oregon's coast are rising as are wave heights off the Oregon coast. These conditions are expected to increase coastal erosion.

One of the climate risks discussed in the Oregon Climate Adaptation Framework (http://www.oregon.gov/LCD/docs/ClimateChange/Framework_Final.pdf) is "Increased coastal erosion and risk of inundation from increasing wave heights and storm surges." The executive summary of the Adaptation Framework provides a summary of various challenges associated with increased coastal erosion:

> *Increased wave heights, storm surges, and sea levels can lead to loss of natural buffering functions of beaches, tidal wetlands, and dunes. Accelerating shoreline erosion has been documented, and is resulting in increased applications for shore protective structures. Shoreline alterations typically reduce the ability of beaches, tidal wetlands, and dunes to adjust to new conditions.*
>
> *Increasing sea levels, wave heights, and storm surges will increase coastal erosion and likely increase damage to private property and infrastructure situated on coastal shorelands. Coastal erosion and the common response to reduce shoreland erosion can lead to long-term loss of natural buffering functions of beaches and dunes. Applications for shoreline alteration permits to protect property and infrastructure are increasing, but in the long term they reduce the ability of shore systems to adjust to new conditions.*

Vulnerability

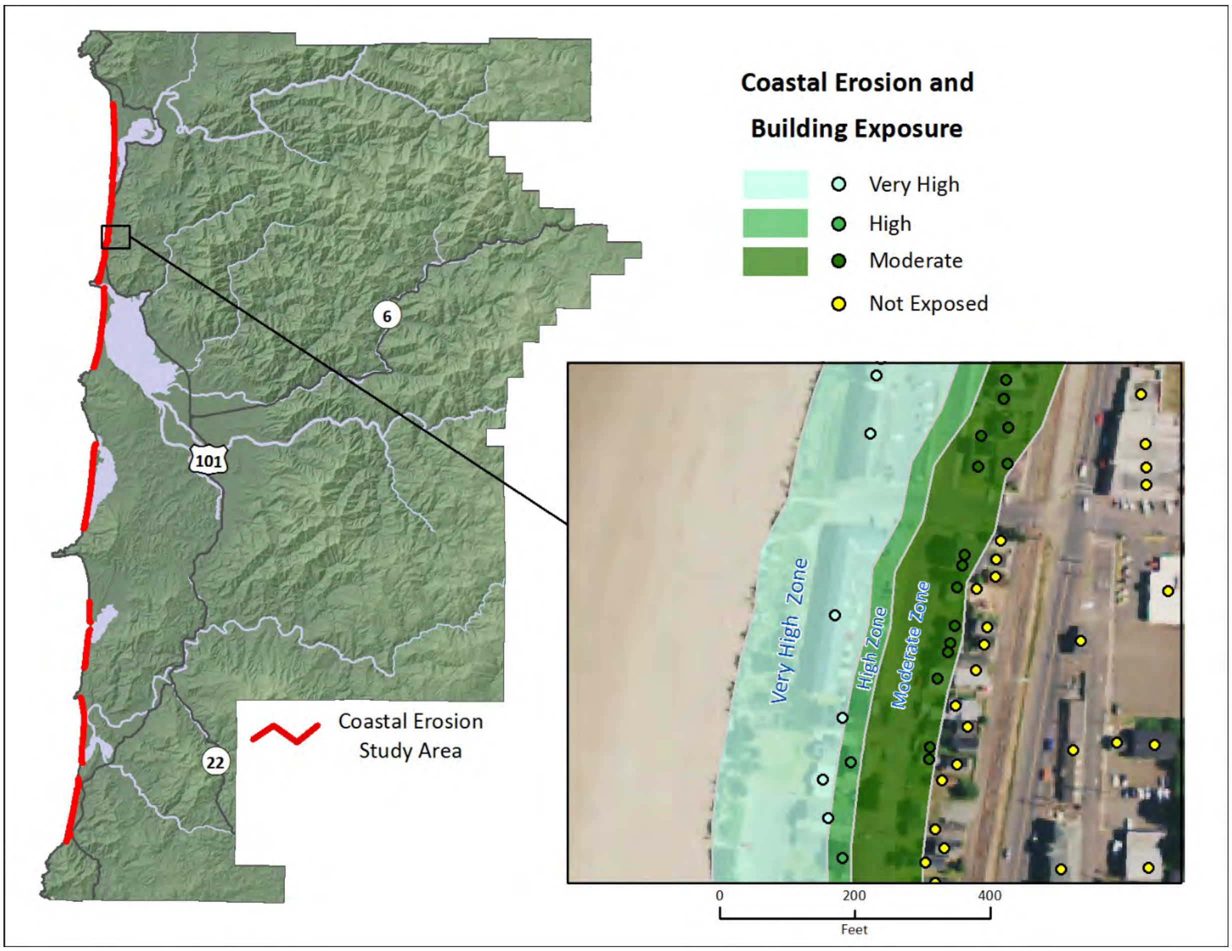
Oregon does not have one standard method to assess risk across all hazards statewide. Experts from DOGAMI compiled and analyzed data and determined the best method or combination of methods to identify vulnerability and potential impacts of coastal erosion for the following state assessment from the 2015 Oregon NHMP (Oregon Department of Land Conservation and Development, 2015).

Vulnerability expresses the impacts to people and the built environment anticipated from coastal erosion. Based on review of the available data, DOGAMI ranks Tillamook County first among counties vulnerable to coastal erosion in Oregon. Within Tillamook County, DOGAMI ranks the following communities addressed in this Plan as most to least vulnerable to coastal erosion:

- Neskowin
- Pacific City
- Rockaway Beach

The *Final Draft Multi-Hazard Risk Report for Tillamook County* (DOGAMI, 2016) provides a coastal erosion exposure analysis for Tillamook County. Figure 57 provides an example of the building exposure analysis. Exposure analysis results are shown in Table 26 and Table 27, and Figure 58 illustrates those results.

Figure 57. Coastal Erosion Zones and Building Exposure Example



Source: DOGAMI (2016)

Table 26. Coastal Erosion Exposure: Tillamook County and Cities

	(all dollar amounts in thousands)										
			Very High Hazard[1]			High Hazard[1]			Moderate Hazard[1]		
Community*	Total Number of Buildings	Total Estimated Building Value ($)	Number of Buildings	Building Value ($)	Ratio of Exposure Value	Number of Buildings	Building Value ($)	Ratio of Exposure Value	Number of Buildings	Building Value ($)	Ratio of Exposure Value
Unincorp. County (rural)	15,015	1,282,436	109	13,418	1.0%	161	18,928	1.5%	309	33,885	2.6%
Neskowin	653	118,463	95	32,205	27.2%	110	34,149	28.8%	156	40,374	34.1%
Pacific City–Woods	1,707	212,062	3	5,991	2.8%	25	8,909	4.2%	88	19,740	9.3%
Total Unincorp. County	**17,375**	**1,612,961**	**207**	**51,614**	**3.2%**	**296**	**61,986**	**3.8%**	**553**	**93,999**	**5.8%**
Manzanita	1,523	259,780	10	2,225	0.9%	25	4,389	1.7%	103	18,410	7.1%
Rockaway Beach	2,240	211,809	241	44,795	21.1%	288	50,675	23.9%	534	79,618	37.6%
Total Tillamook County*	**21,138**	**2,084,550**	**458**	**98,634**	**4.7%**	**609**	**117,050**	**5.6%**	**1,190**	**192,027**	**9.2%**

*Does not include non-coastal communities (these communities do not factor in to total amounts and percentages)

[1]Very High, High, and Moderate hazard correspond to the coastal erosion zones of High, Moderate, and Low 1 determined by Stimely and Allan (2014).

Source: DOGAMI (2016)

Table 27. Coastal Erosion Exposure: Port of Tillamook Bay and Port of Garibaldi

			Very High Hazard[1]			High Hazard[1]			Moderate Hazard[1]		
	Total Number of Buildings	Total Estimated Building Value ($)	Number of Buildings	Building Value ($)	Ratio of Exposure Value	Number of Buildings	Building Value ($)	Ratio of Exposure Value	Number of Buildings	Building Value ($)	Ratio of Exposure Value
Port of Garibaldi	36	8,035,760	0	0	0.00%	0	0	0.00%	0	0	0.00%
Port of Tillamook	83	61,545,144	0	0	0.00%	0	0	0.00%	0	0	0.00%

*Does not include non-coastal communities (these communities do not factor in to total amounts and percentages)

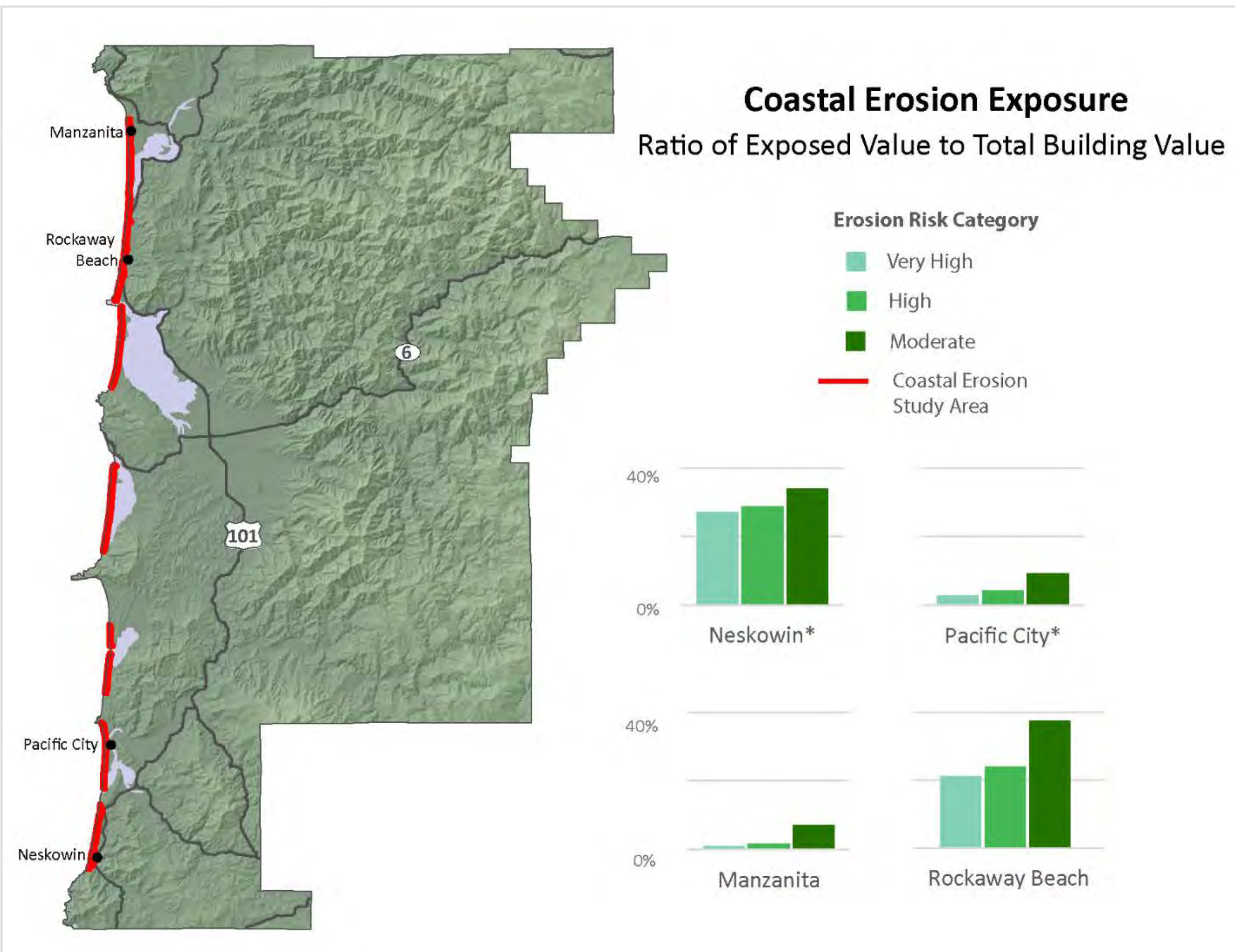
[1]Very High, High, and Moderate hazard correspond to the coastal erosion zones of High, Moderate, and Low 1 determined by Stimely and Allan (2014).

Source: DOGAMI (2016)

Neskowin and Rockaway Beach have by far the greatest ratio of exposure value across all three hazard risk categories. Neskowin drafted *Adapting to Coastal Erosion Hazards in Tillamook County: Framework Pla*n in 2011 (Woolley et al., 2011) and subsequently adopted a coastal erosion overlay zone to mitigate the effects of coastal erosion.

Coastal erosion is constantly impacting the north-south jetty system of Tillamook Bay. The tumultuous Pacific Ocean environment has caused recession of both the north and south jetties. The revetment has also experienced some damage caused by wave overtopping that over time destabilizes the stones and causes erosion within the structure. A 2010 rehabilitation project capped the north jetty at its current length of 5,214 feet and made necessary repairs to the revetment. The south jetty remains in need of attention. Funding is being pursued for south jetty repairs. The north jetty lies within the southwestern portion of the Port of Garibaldi District boundary; the south jetty within the northwestern portion of the Port of Tillamook Bay District boundary.

Figure 58. Coastal Erosion Exposure by Community



*Unincorporated communities

Note: Beyond the designated communities, in unincorporated Tillamook County, there is $13.4 million dollars of building value in areas of very high coastal erosion hazard, $18.9 million dollars of building value in areas of high hazard, and $33.9 million dollars of building value in areas of moderate hazard.

Source: DOGAMI (2016)

Local Risk Assessment Methodology

Tillamook County executed the "OEM Methodology" in October 2015 but did not consider the probability of and vulnerability to coastal erosion in the county.

Tillamook County and its cities executed the "OEM Methodology" again as an element of developing this risk assessment in September 2016. This time, Tillamook County considered only the rural areas of the county and the unincorporated urban communities of Neskowin, Oceanside-Netarts, and Pacific City. An assessment was also done by each city and the two ports. The assessment is based on the knowledge and experience of local officials and subject matter experts.

Neskowin and Pacific City were not assessed separately by the County, but overall the County assessed its risk of coastal erosion as high. The State's assessment was high overall for Neskowin and much lower overall for Pacific City. Rockaway Beach and the State both assessed the city's risk of coastal erosion as high. Manzanita and the state both assessed its risk of coastal erosion as low. The other cities assessed their risk as low, and the state indicated no risk to coastal erosion in those cities. The Port of Tillamook Bay assessed its risk as high due to the continuing erosion of the south jetty on Tillamook Bay. The Port of Garibaldi assessed its vulnerability to coastal erosion as high due to impacts to the north and south jetties. Overall, the state and local assessments agree.

Table 28. Local Risk Assessment: Coastal Erosion

Jurisdiction	History	Vulnerability	Maximum Threat	Probability	Total	Risk Level
Unincorporated Tillamook County, including Neskowin, Oceanside-Netarts, and Pacific City–Woods	16	45	80	63	204	High
Bay City	2	35	100	28	165	High
Garibaldi	10	10	30	35	85	Low
Manzanita	0	5	10	0	15	Low
Nehalem	2	5	10	7	24	Low
Rockaway Beach	16	30	90	70	206	High
Tillamook	0	0	0	0	0	Low
Wheeler	10	20	30	45	105	Low
Port of Tillamook Bay	16	45	80	63	223	High
Port of Garibaldi	20	50	100	70	240	High

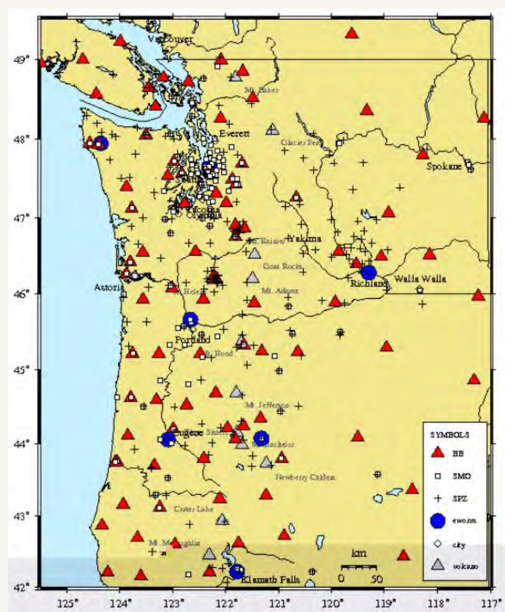
Source: Based on information presented at the Tillamook County Multi-Jurisdictional NHMP Update Steering Committee Meeting, September 23, 2016

2. Earthquakes

Introduction

Earthquakes are a highly variable natural phenomenon. The vast majority occur when two masses of rock in the earth's crust abruptly move past each other along a large crack or fracture called a fault. The energy released as the two parts slide along the fault produces waves of shaking that we perceive as an earthquake. Faults typically build up stress over decades to millennia in response to large-scale movement of the earth's tectonic plates. Even the most active faults only produce damaging earthquakes at intervals of a century or more, and for many the intervals are much longer. As a result, it is very difficult to forecast the likelihood of an earthquake on a particular fault because we rarely have a long enough record to determine a statistically meaningful return period (average time between earthquakes).

Figure 59. Earthquake Monitoring Stations in the Pacific Northwest



Note: The earthquake monitoring network system is operated out of the University of Washington by the Pacific Northwest Seismic Network.

Source: Pacific Northwest Seismic Network (http://www.pnsn.org/)

The history of earthquakes in a region comes from three types of information. Instrumental data come from networks of seismic recording instruments (seismographs) that are widely deployed in the Pacific Northwest.

Seismic networks can detect very small earthquakes, locate them to within a few miles, and determine their magnitude accurately. Seismographs have only existed for about a century, and in Oregon, the instrumental record is really only complete and modern from about 1990 on.

Historical felt location data come from verbal and written reports of earthquake effects. The felt record extends back to the mid-1800s for Oregon, but only locates moderate to large earthquakes, and those only with an accuracy of tens or even hundreds of miles.

Paleoseismic data use geologic records of earthquake effects to determine the approximate size and timing of earthquakes that happened in prehistoric times. The paleoseismic record can extend back for thousands or tens of thousands of years, but provides only approximate information about the size, time and place of past large earthquakes.

In Oregon, the combined earthquake history derived from these three sources clearly outlines two major types of earthquake hazard and two less significant sources. By far the greatest is the hazard posed by infrequent **megathrust earthquakes** on the Cascadia Subduction Zone. The second major hazard comes from smaller **crustal earthquakes** on faults in or near populated areas, which includes all of Oregon's damaging historic earthquakes. Intraplate earthquakes, which have been historically damaging in the Puget Sound area, are possible in Oregon but no damaging prehistoric or historic events are known. Finally, earthquakes associated with Oregon's many young volcanoes may produce damaging shaking in communities close to the volcano.

Location

All the communities in Tillamook County will be impacted by a Cascadia Subduction Zone earthquake. A crustal earthquake is unlikely to occur in the County, but a crustal earthquake that occurs elsewhere may impact the County.

Table 29. Jurisdictions Subject to Earthquakes

Jurisdiction	Earthquakes
Unincorporated Tillamook County (rural)	X
Neskowin	X
Oceanside-Netarts	X
Pacific City–Woods	X
Bay City	X
Garibaldi	X
Manzanita	X
Nehalem	X
Rockaway Beach	X
Tillamook	X
Wheeler	X
Port of Tillamook Bay	X
Port of Garibaldi	X

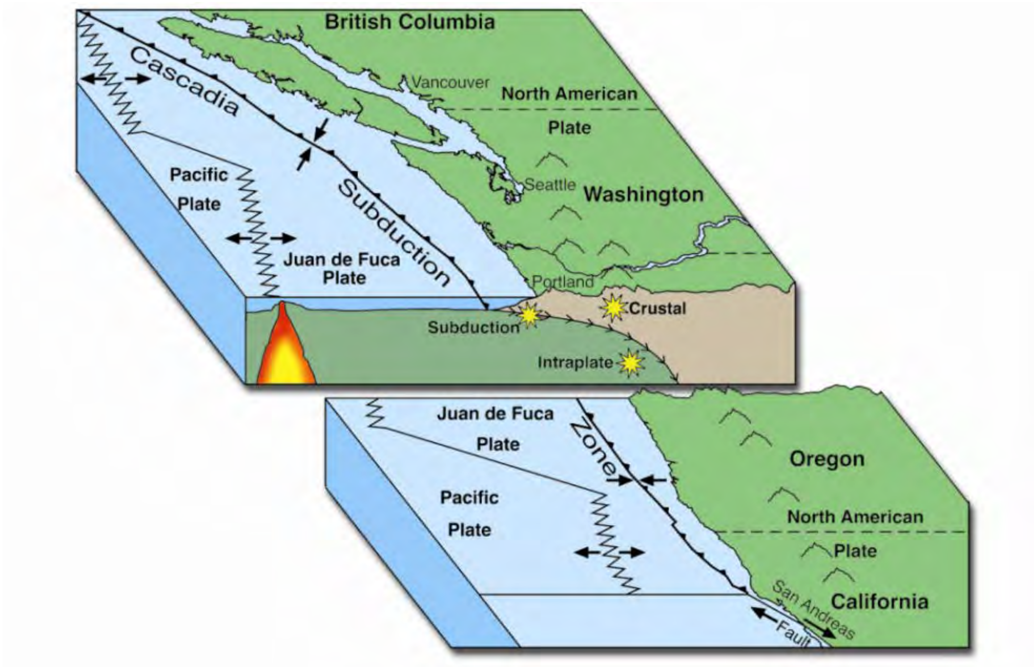
Source: Derived from DOGAMI (2016)

Hazard Characterization

The Cascadia Subduction Zone is the boundary between two of the earth's crustal plates. These continent-sized plates are in constant slow motion, and the boundaries between plates are the site of most earthquake activity around the globe. At the Cascadia Subduction Zone, the Juan De Fuca plate, located offshore of Oregon and Washington, slides to the northeast and under the North American plate, which extends from the Oregon coast clear to the middle of the Atlantic Ocean. The Juan de Fuca plate slides beneath the continent (subducts) at about 1.5 inches per year, a speed that has been directly measured using high-accuracy GPS. The fault that separates the plates extends from Cape Mendocino in Northern California to Vancouver Island in British Columbia, and slopes down to the east from the sea floor. The fault is usually locked, so that rather than sliding slowly and continuously, the 1.5 inches per year of subduction motion builds tremendous stress along the fault. This stress is periodically released in a megathrust earthquake, which can have a magnitude anywhere from 8.3 to 9.3.

Figure 60 is a schematic three-dimensional diagram with the generalized locations of the three types of earthquake sources found in Oregon: subduction zone, crustal, and intraplate.

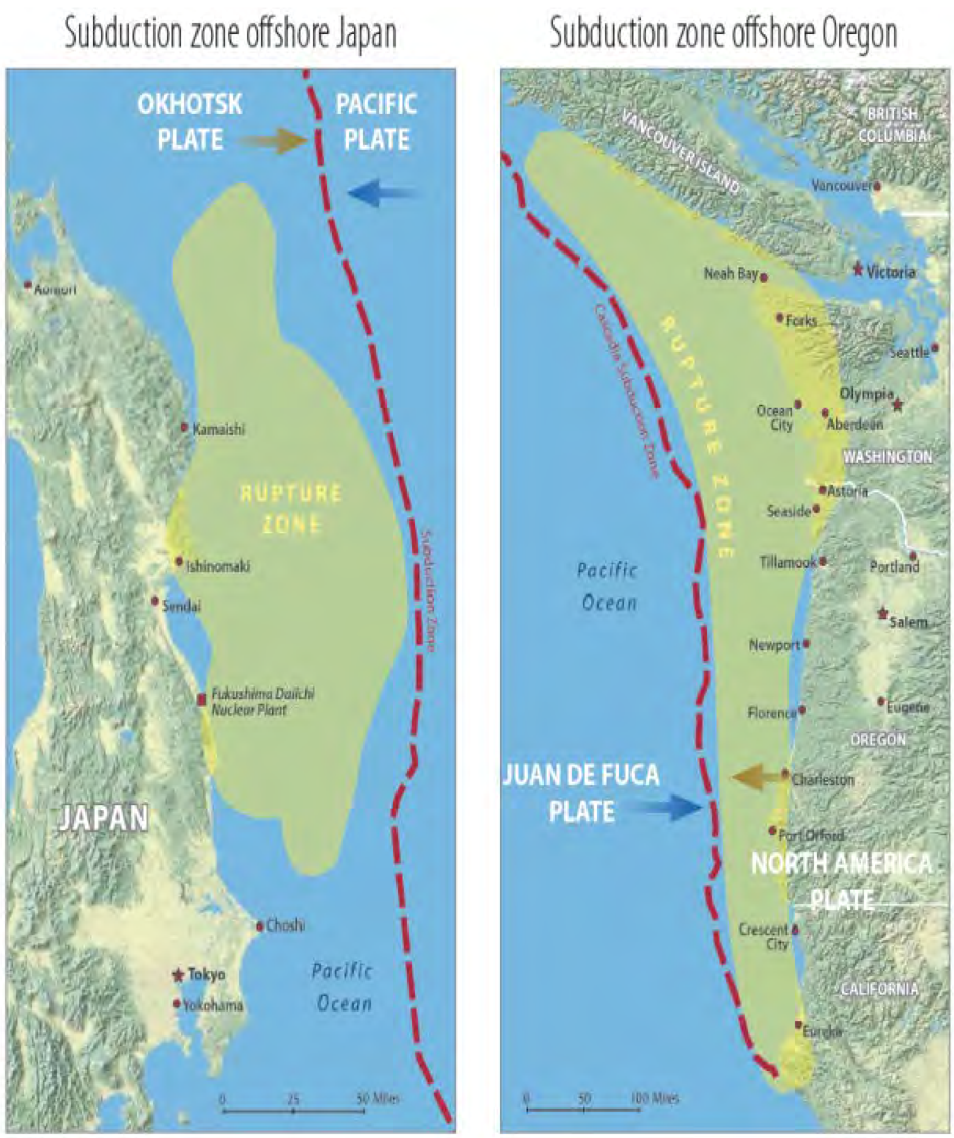
Figure 60. General Source Areas for Subduction Zone, Crustal Earthquakes, and Intraplate Earthquakes



Source: Cascadia Region Earthquake Workgroup, Roddey, and Clark (2005)

The Cascadia Subduction Zone closely mirrors the subduction zone in northern Japan that produced the 2011 Tohoku earthquake (**Figure 61**). This magnitude 9 megathrust event and its associated tsunami captured the world's attention with unforgettable images of destruction on a massive scale. Oregon should regard this as a window into our future, as this is the very type of earthquake that our best science tells us is likely on the Cascadia Subduction Zone. Particular attention must be paid to the incredibly destructive tsunami that accompanied the Tohoku earthquake, and we must plan for a similar tsunami in Oregon. (See the **Tsunamis** section of this Plan for more information about tsunamis in Oregon.)

Figure 61. Comparison of the Northern Japan Subduction Zone in and the Cascadia Subduction Zone



Note: Yellow patches are the measured earthquake rupture zone in Japan, modeled earthquake rupture zone in Oregon.
Source: DOGAMI (2012)

Crustal earthquakes occur for the most part on shore on much smaller faults located in the North American plate. These are the more familiar “California-style” earthquakes with magnitudes in the 5 to 7 range. Although much smaller than the megathrust earthquakes, crustal earthquakes may occur much closer to population centers, and are capable of producing severe shaking and damage in localized areas. These are not a significant threat on the northern Oregon Coast.

2011 Tohoku Earthquake Numbers

- about 16,000 dead
- 92% of deaths due to tsunami (drowning)
- Fatality rate within the tsunami inundation zone about 16%
- about 4,000 missing (as of 10/2/2011)
- about 6,000 injuries
- Population within 40 km of coastline about 3,000,000
- about 300,000 homes destroyed
- about 600,000 homes damaged

Source: https://earthquake-report.com/2011/10/02/japan-tohoku-earthquake-and-tsunami-catdat-41-report-october-2-2011/

Intraplate earthquakes are a third type that is common in the Puget Sound, where they represent most of the historical record of damaging events. In Oregon, these earthquakes occur at much lower rates, and none have ever been close to a damaging magnitude. They contribute little to the aggregate hazard in most of Oregon.

Earthquake Effects

Earthquake damage is largely controlled by the strength of shaking at a given site. The strength of shaking at any point is a complex function of many factors, but magnitude of the earthquake (which defines the amount of energy released) and distance from the epicenter or fault rupture, are the most important. The ripples in a pond that form around a dropped pebble spread out and get smaller as they move away from the source. Earthquake shaking behaves in the same way: you can experience the same strength of shaking 10 miles from a magnitude 6 earthquake as you would feel 100 miles from a magnitude 9 earthquake.

Two measurement scales are used to describe the magnitude and intensity of earthquakes. To measure the magnitude, the “moment magnitude” (M_w, or M) scale uses the Arabic numbering scale. It provides clues to the physical size of an earthquake (http://www.actforlibraries.org/understanding-the-richter-scale-and-moment-magnitude-scale/) and is more accurate than the previously used Richter scale for larger earthquakes. The second scale, the “modified Mercalli,” measures shaking intensity and is based on felt observations; it is therefore more subjective than the mathematically derived moment magnitude. It uses Roman numerals to indicate the severity of shaking. It is important to understand the relationship between the intensity of shaking the amount of damage expected from a given earthquake scenario.

Table 30 gives an abbreviated description of the 12 levels of Modified Mercalli intensity.

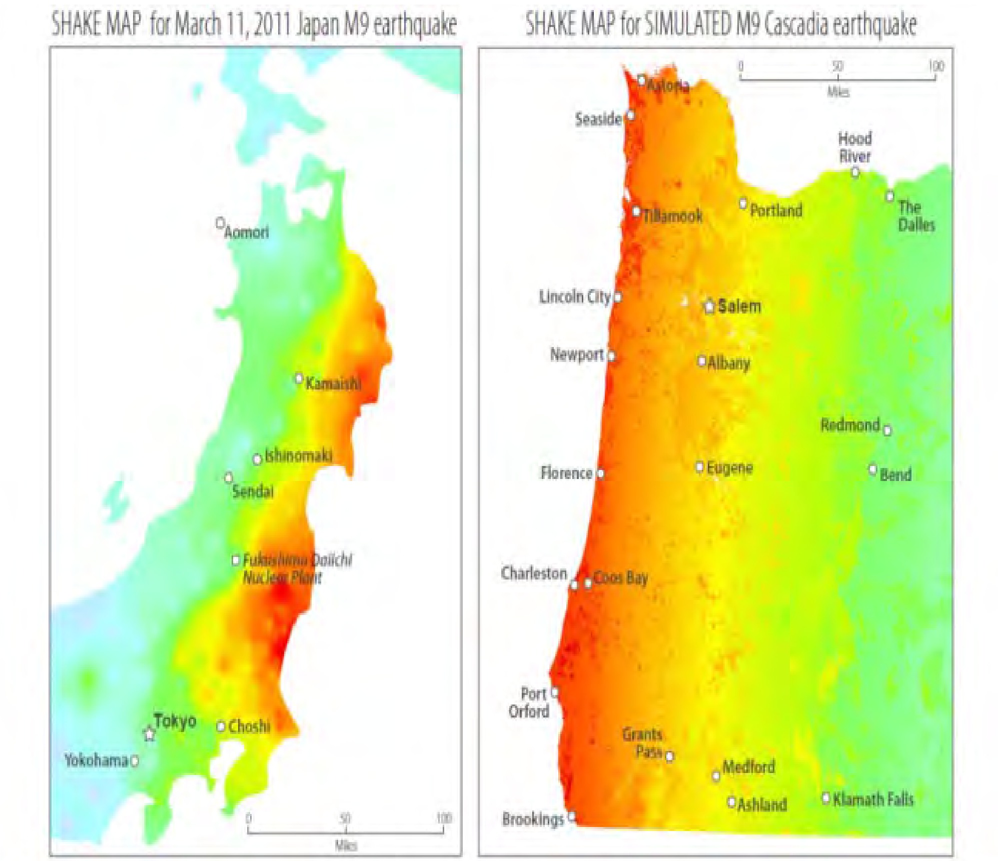
Table 30. Levels of Modified Mercalli Intensity

Level	Intensity
I	not felt except by a very few under especially favorable conditions
II	felt only by a few persons at rest, especially on upper floors of buildings
III	felt quite noticeably by persons indoors, especially on upper floors of buildings; many people do not recognize it as an earthquake; standing motor cars may rock slightly; vibrations similar to the passing of a truck; duration estimated
IV	felt indoors by many, outdoors by few during the day; at night, some awakened; dishes, windows, doors disturbed; walls make cracking sound; sensation like heavy truck striking building; standing motor cars rocked noticeably
V	felt by nearly everyone; many awakened; some dishes, windows broken; unstable objects overturned; pendulum clocks may stop
VI	felt by all, many frightened; some heavy furniture moved; a few instances of fallen plaster; damage slight
VII	damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken
VIII	damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse; damage great in poorly built structures; fall of chimneys, factory stacks, columns, monuments, walls; heavy furniture overturned
IX	damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; damage great in substantial buildings, with partial collapse; buildings shifted off foundations
X	some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; rails bent
XI	few, if any (masonry) structures remain standing; bridges destroyed; rails bent greatly
XII	damage total; lines of sight and level are distorted; objects thrown into the air

Sources: http://earthquake.usgs.gov/learn/topics/mercalli.php, abridged from *The Severity of an Earthquake* (http://pubs.usgs.gov/gip/earthq4/severitygip.html); US Geological Survey General Interest Publication 1989-288-913.

Future megathrust earthquakes on the Cascadia Subduction Zone (CSZ) will occur off the coast, and the strength of shaking will decrease inland. Oregon coastal communities will experience severe shaking. The other unique characteristic of megathrust earthquakes is that the strong shaking will last for several minutes, in contrast to a large crustal earthquake, which might shake for only 30 seconds. The long duration of shaking contributes greatly to damage, as structures go through repeated cycles of shaking. Figure 62 shows a side-by-side comparison of shake maps for (a) the 2011 M9 earthquake in Japan, and (b) a simulated M9 CSZ event in Oregon.

Figure 62. Comparison of Measured Shaking from Tohoku Earthquake and Simulated Shaking from M9 Cascadia Megathrust Earthquake

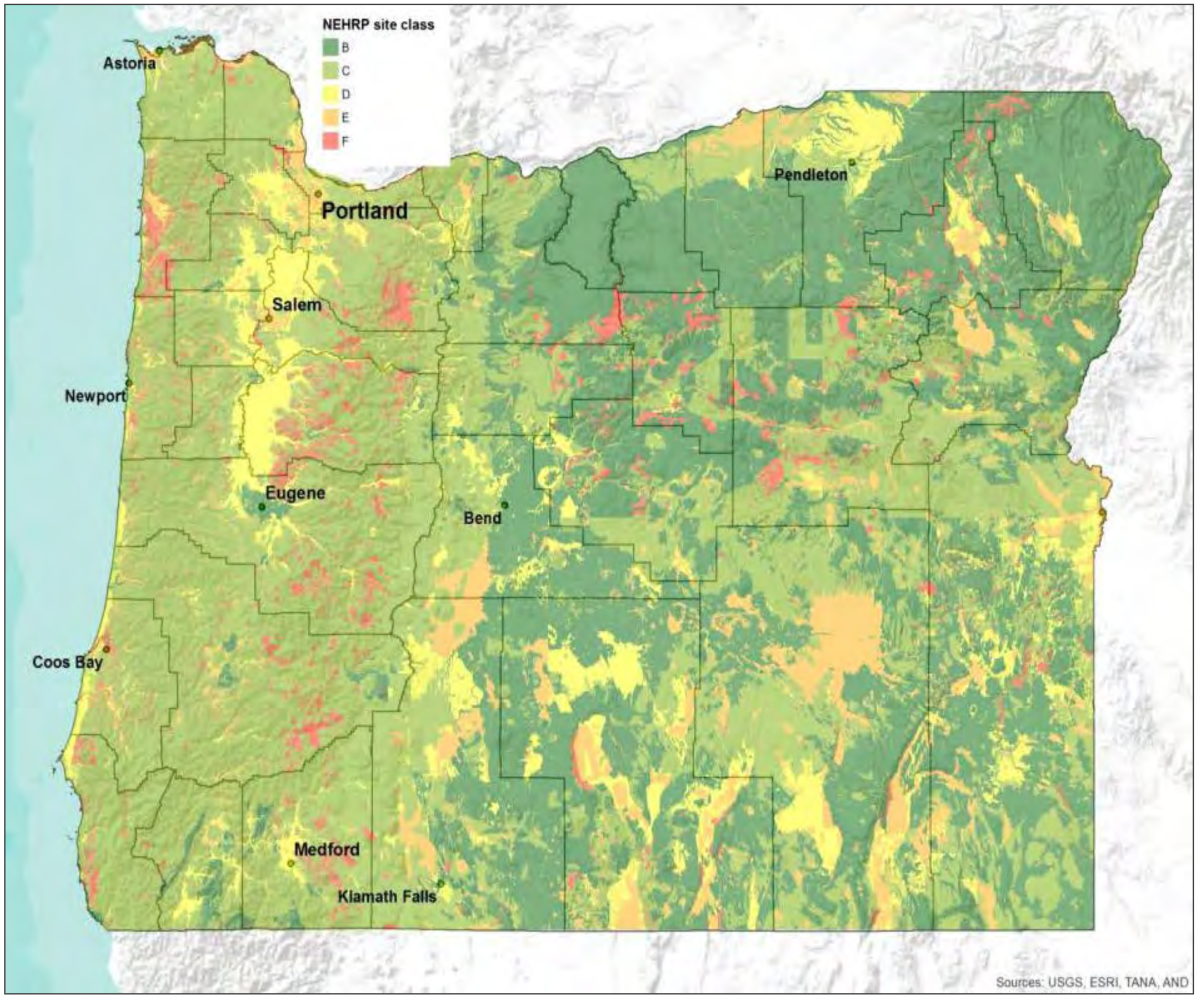


PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Source: DOGAMI, *Cascadia*, Winter 2012 (http://www.oregongeology.org/pubs/cascadia/CascadiaWinter2012.pdf)

The other important factor in controlling earthquake damage is the contribution of local geology. Soft soils can strongly amplify shaking (**Figure 63**). Loose saturated sand or silt can liquefy, causing dramatic damage, and new landslides can occur on steep slopes while existing landslide deposits may start to move again. These effects can occur regardless of earthquake source, and the geologic factors that cause them can be identified in advance by geologic and geotechnical studies. Liquefaction- and earthquake-induced landslides are both more likely to occur during the several minutes of shaking produced by a megathrust earthquake, and these effects are expected to be widespread during the next event (**Figure 64** through **Figure 67**). In 2013, DOGAMI published a suite of statewide earthquake hazard maps with GIS files in Open-File Report O-13-06, *Ground motion, ground deformation, tsunami inundation, coseismic subsidence, and damage potential maps for the 2012 Oregon Resilience Plan for Cascadia Subduction Zone earthquakes* (Madin and Burns, 2013).

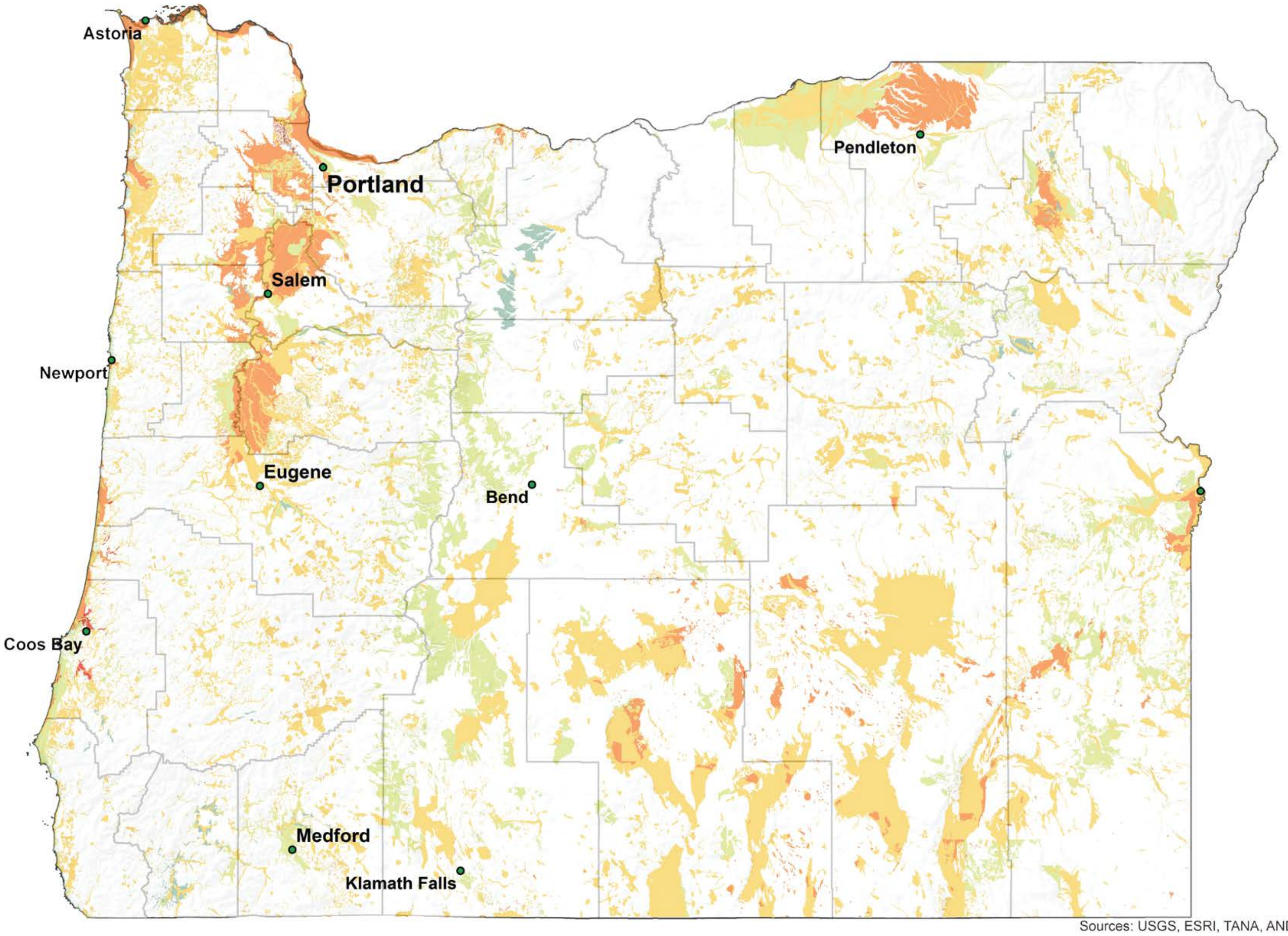
Figure 63. Soils Map Showing Where Soils Can Amplify Earthquake Ground Shaking



Note: This NEHRP soils map shows areas where soils can amplify the earthquake ground shaking. NEHRP site class F soils (dark orange on map) are prone to produce the greatest amplification.

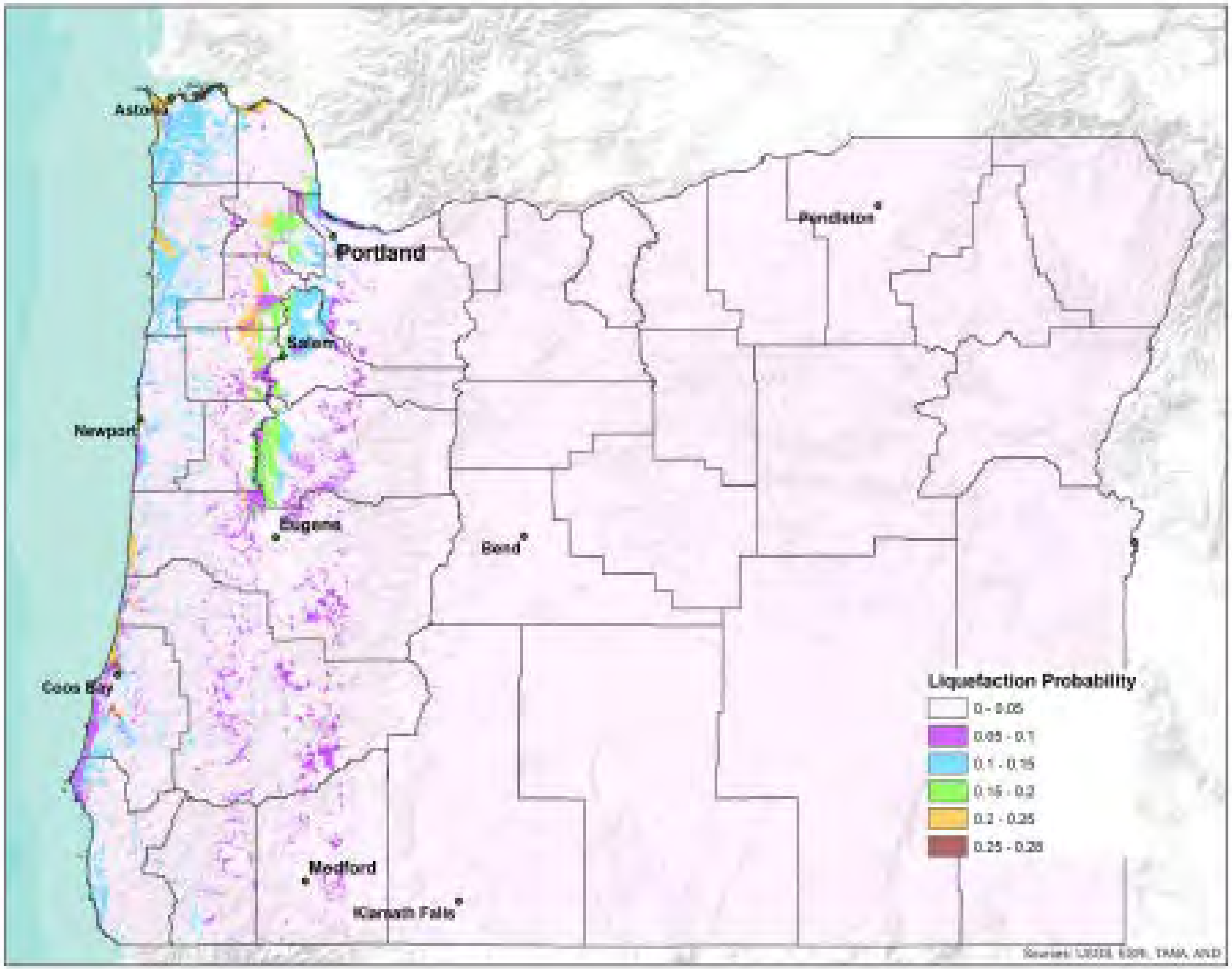
Source: Madin and Burns (2013)

Figure 64. Liquefaction Susceptibility Map



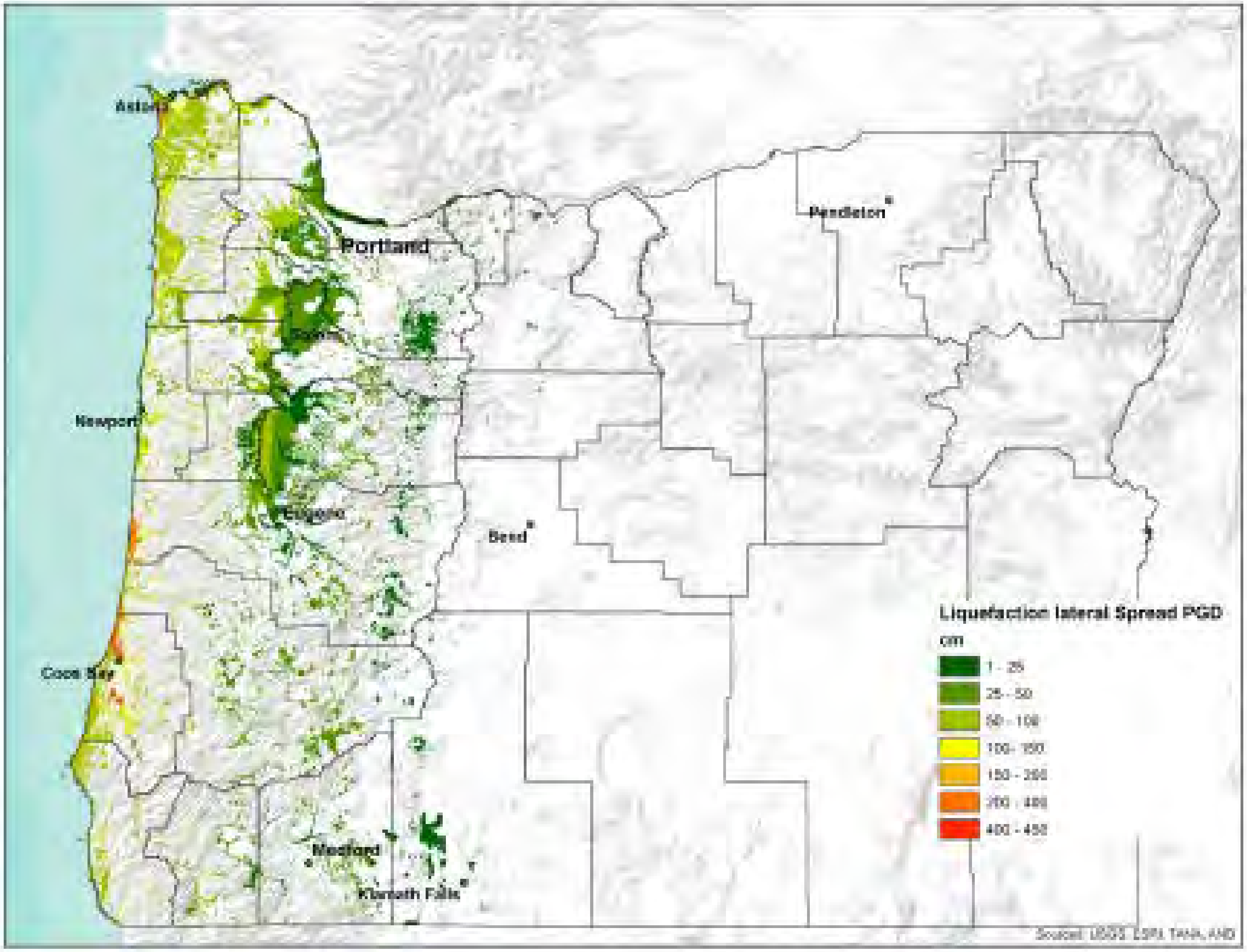
Note: This liquefaction susceptibility map shows areas where soils can liquefy due to the earthquake ground shaking. Areas in red are most prone to liquefy.
Source: Madin and Burns (2013)

Figure 65. Liquefaction Probability Map



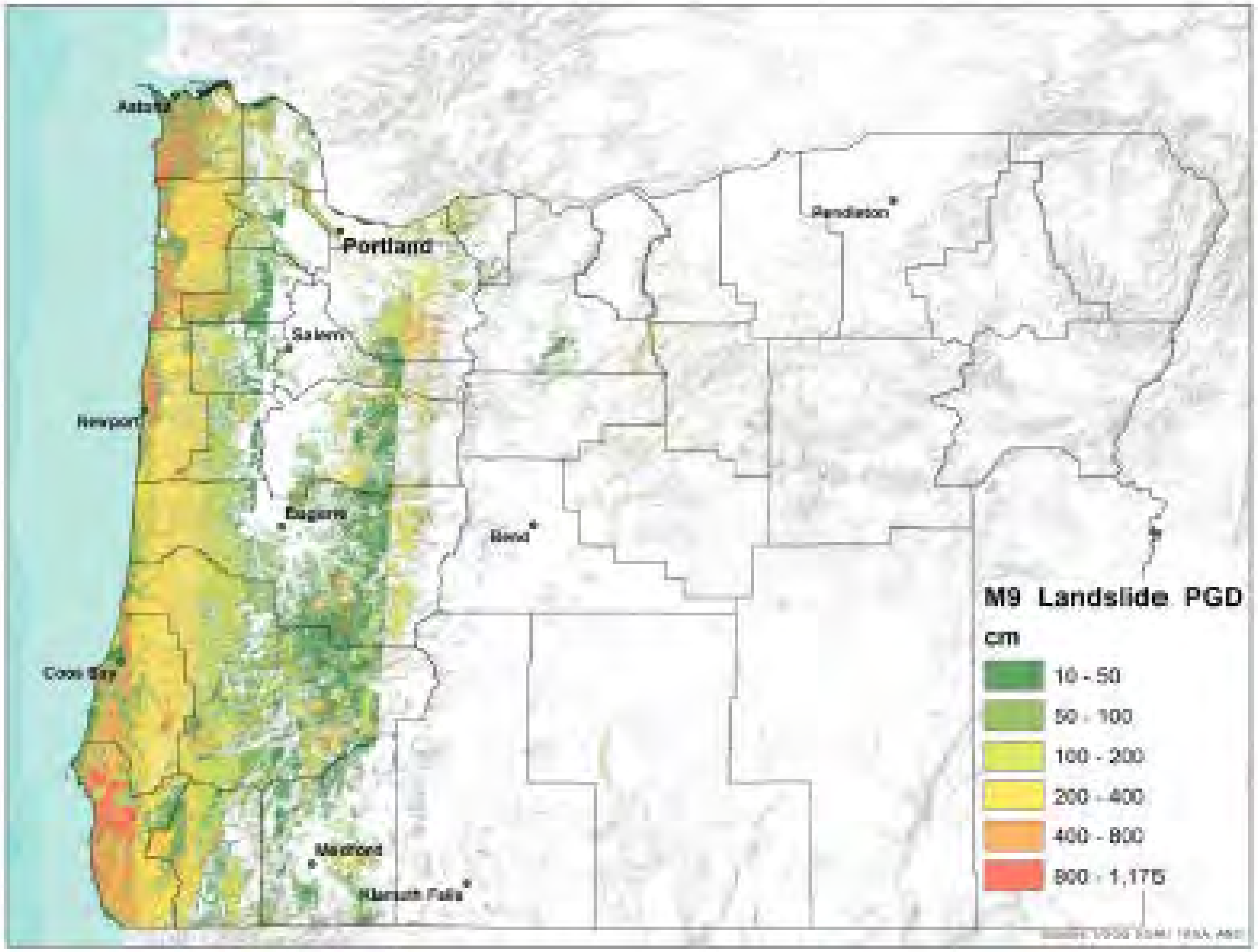
Note: This liquefaction probability map shows the probability of soil liquefaction due to a magnitude 9 Cascadia earthquake. Areas in dark red have the highest probability.
Source: Madin and Burns (2013)

Figure 66. Lateral Spreading Map



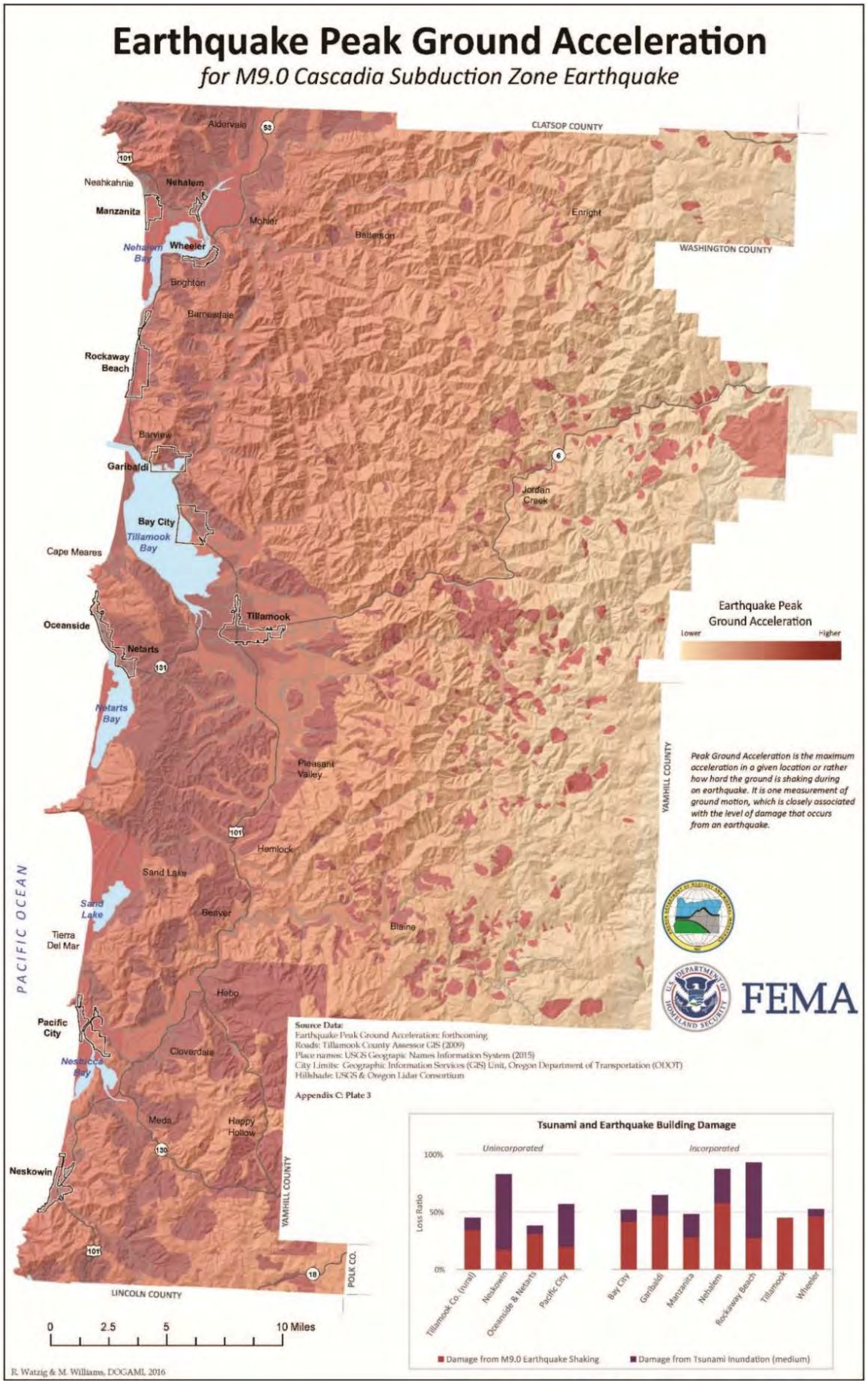
Note: This lateral spreading map shows areas of lateral spreading hazard due to a magnitude 9 Cascadia earthquake. Areas in red have the highest displacement.
Source: Madin and Burns (2013)

Figure 67. Expected Displacement Map



Note: This landslide hazard map shows areas and amount of expected displacement due to a magnitude 9 Cascadia earthquake. Areas in red have the highest displacement.
Source: Madin and Burns (2013)

Figure 68. Earthquake Peak Ground Acceleration



DOGAMI (2016)

Historic Earthquake Events

Table 31 lists historic earthquakes that impacted or may have impacted Tillamook County from both CSZ events and combined crustal events.

Table 31. Historic Earthquakes that May Have Impacted Tillamook County

Date	Location	Description
Approximate Years: 1400 BCE*, 1050 BCE, 600 BCE, 400, 750, 900	offshore, Cascadia Subduction Zone	probably 8-9 *these are the mid-points of the age ranges for these six events*
Jan. 1700	offshore, Cascadia Subduction Zone	about 9.0 generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast
18921	Portland, Oregon	intensity VI; affected area: 26,000 square kilometers; buildings swayed, people terrified and rushed into the street; felt in Astoria and Salem
Apr. 13, 19411	Olympia, Wash.	magnitude 7.0; at Olympia, Washington, and a broad area around the capital city; fatalities: 8; damage: $25 million; affected area: 388,000 sq km; damage: widespread (Oregon); injuries: several (Astoria and Portland); maximum intensity: VIII (Clatskanie and Rainier); chimneys twisted and fell; damage to brick and masonry
Dec. 15, 19531	Portland, Oregon	intensity: VI; minor damage (Portland area); affected area: 7,700 sq km; one cracked chimney and slight damage to fireplace tile; plaster cracking (Portland and Roy, Oregon, and Vancouver, Washington)
Nov. 6, 19611	Portland, Oregon	intensity VI; affected area: 23,000 sq km (northwestern Oregon and southwestern Washington); principle damage: plaster cracking; part of a chimney fell, and windows and lights broke
19932	Scott's Mills, Oregon	5.7 M_w; largest earthquake since 1981; felt from Puget Sound to Roseburg, Oregon4
20012	Nisqually, Wash.	felt as far south as central Oregon

*BCE: Before Common Era.

Sources: (1) USGS. Oregon Earthquake History. Retrieved October 28, 2013, http://earthquake.usgs.gov/earthquakes/states/oregon/history.php; (2) USGS. Earthquake Archive. Retrieved October 28, 2013, http://earthquake.usgs.gov/earthquakes/search/; (3) Sherrod (1993); (4) Thomas, Crosson, Carver & Yelin (1996); (5) Dewey (1993); (6) Bott and Wong (1993)

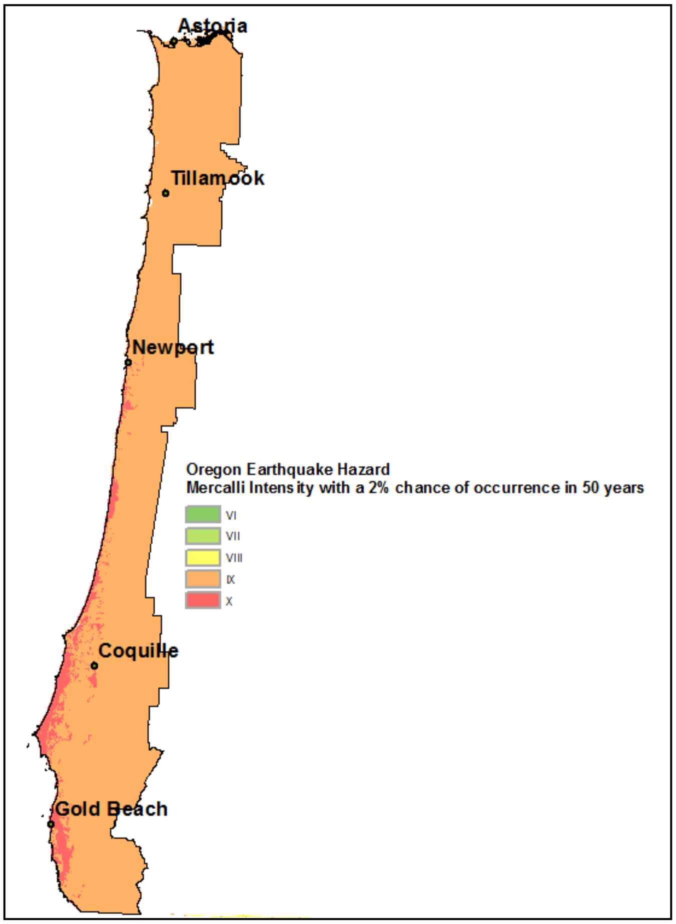
Probability

In coastal Oregon, the probability of damaging earthquakes is dominated by Cascadia subduction earthquakes originating from a single fault with a well-understood recurrence history.

Figure 69 shows the probabilistic hazard for the Oregon Coast. This map shows the expected level of earthquake damage that has a 2% chance of occurring in the next 50 years. The map is based on the 2008 USGS National Seismic Hazard Map and has been adjusted to account for the effects of soils following the methods of Madin and Burns (2013). In this case, the strength of shaking calculated as peak ground acceleration and peak ground velocity is expressed as Mercalli intensity, which describes the effects of shaking on people and structures. This map incorporates all that is known about the probabilities of earthquake on all faults, including the Cascadia Subduction Zone.

For the Oregon Coast, the Cascadia subduction zone is responsible for most of the hazard. The paleoseismic record includes 18 magnitude 8.8–9.1 megathrust earthquakes in the last 10,000 years that affected the entire subduction zone. The return period for the largest earthquakes is 530 years, and the probability of the next such event occurring in the next 50 years ranges from 7 to 12%.

Figure 69. Probabilistic Earthquake Hazard for the Oregon Coast



Color zones show the maximum level of earthquake shaking and damage (Mercalli Intensity Scale) expected with a 2% chance of occurrence in the next 50 years. A simplified explanation of the Mercalli levels is:

- VI Felt by all, weak buildings cracked;
- VII Chimneys break, weak buildings damaged, better buildings cracked;
- VIII Partial collapse of weak buildings, unsecured wood frame houses move;
- IX Collapse and severe damage to weak buildings, damage to wood-frame structures; and
- X Poorly built structures destroyed, heavy damage in well-built structures.

Source: Madin and Burns (2013)

Vulnerability

Vulnerability expresses the impacts to people and the built environment anticipated from an earthquake.

A major Cascadia earthquake (>M_W 8.5) would be devastating. Most of the state's major critical infrastructure such as energy sector lifelines, transportation hubs, and medical facilities is particularly vulnerable to damage from liquefaction and long periods of shaking. The long-term effects from a major earthquake would be felt for years.

Tillamook County is especially vulnerable to earthquake hazards. This is because of the built environment's proximity to the CSZ, regional seismicity, topography, bedrock geology, and local soil profiles. For example, a large number of buildings are constructed of unreinforced masonry (URM) or are constructed on soils that are subject to liquefaction during severe ground shaking. Also, some principal roads and highways are susceptible to earthquake-induced landslides. Bridges and tunnels need to be retrofitted to withstand ground shaking.

Seismic Lifelines

"Seismic lifelines" are the state highways ODOT has identified as most able to serve response and rescue operations, reaching the most people and best supporting economic recovery. According to ODOT's report, *Statewide Loss Estimates: Seismic Lifelines Evaluation, Vulnerability Synthesis, and Identification* (CH2M Hill, 2012), seismic lifelines on the Oregon Coast have the following vulnerabilities.

The Oregon Coast has the most seismically vulnerable highway system of all the geographic zones and is the most difficult to access due to multiple geographic constraints. While it could be argued that the region's critical post-earthquake needs should dictate that all coastal area routes be Tier 1 (first priority roadways), the reality is that — to make the entire lifeline system resilient — the vulnerabilities on the Coast are so extensive that the majority of the cost would be incurred for repairs done within this region. Furthermore, because of the high vulnerability of the region, it is paramount that emergency services and recovery resources are able to reach this region from other regions. Consequently, all needs are best served with a conservative Tier 1 backbone system, selected according to the criteria described in the report.

The Tier 1 (first roadway priority) system on the Oregon Coast consists of three access corridors:

- OR-30 from Portland to Astoria,
- OR-18 from the Willamette Valley to US-101 and north and south on US-101 between Tillamook and Newport, and
- OR-38 from I-5 to US-101, and north and south on US-101 from Florence to Coos Bay.

The Tier 2 (second roadway priority) system on the Oregon Coast consists of three access corridors:

- US-26 from OR-217 in Portland to US-101 and north and south on US-101 from Seaside to Nehalem,
- OR-126 from the Valley to US-101 at Florence, and
- US-101 from Coos Bay to the California border.

The Tier 3 (third roadway priority) system on the Oregon Coast would complete an integrated coastal lifeline system and consists of the following corridors:

- US-101 from Astoria to Seaside,
- US-101 from Nehalem to Tillamook,
- OR-22 from its junction with OR-18 to the Valley,
- OR-20 from Corvallis to Newport,
- OR-42 from I-5 to US-101, and
- US-199 from I-5 to the California border.

Regional Impact

Coastal highways, most importantly US-101, will be fragmented in many areas. In some areas there are possible detours inland from US-101, but many of those routes are also vulnerable to ground shaking, landslides, and other hazards.

- Ground shaking: On the Oregon Coast ground shaking will be intense and prolonged. Most unreinforced structures and many unreinforced roadbeds and bridges will be damaged to varying extents, and it is likely that many damaged areas will become impassable without major repairs.
- Landslides and Rockfall: Many areas along the coast highway, US-101, are cut into or along landslide prone features. Removal of slide and rockfall material is an ongoing responsibility of ODOT Maintenance crews on long stretches of the highway. A major seismic event will increase landslide and rockfall activities and may reactivate ancient slides that are currently inactive.
- Tsunami: Some reaches of US-101 and connecting and parallel routes will be inundated by tsunami. Tsunami debris may block large areas of the street and highway network.
- Liquefaction: Structures in wetland, estuarine, alluvial and other saturated areas will be subject to liquefaction damage; the total area of such impacts will vary with the extent of saturated soils at the time of the event.

Regional Loss Estimates

Highway-related losses include disconnection from supplies and replacement inventory, and the loss of tourists and other customers who must travel to do business with affected businesses.

Most Vulnerable Jurisdictions

The vulnerabilities studied in the Oregon Seismic Lifeline Report project are geographic rather than jurisdictional. Other research suggests that the risks of a subduction zone seismic event are somewhat higher along the Southern Oregon Coast, but the risks assessed in this study pertain to the vulnerability of highway facilities in the case of a CSZ event and the higher vulnerabilities are generally low lying areas, active and ancient landslide and rock fall areas, and where critical bridges may not be easily repaired or circumvented. Vulnerability also relates to a current conditions context — high groundwater and saturated soils, high tides, and time of day as it relates to where people are relative to the highway system and other vulnerable facilities. The Port of Garibaldi is built on fill in Tillamook Bay and is therefore subject to liquefaction of the entire facility in the event of an earthquake. Tillamook County is highly vulnerable to a CSZ event.

Loss Estimation

The *Final Draft Multi-Hazard Risk Report for Tillamook County* (DOGAMI, 2016) provides an explanation and supporting statistics illustrating the effect of iterative advancements in seismic building codes on structural losses due to earthquakes. It also provides an earthquake loss estimate for Tillamook County based on data created for the *Oregon Resilience Plan for Cascadia Subduction Zone Earthqua*kes (Madin & Burns, 2013) and a 9.0 magnitude CSZ earthquake.

Table 32. CSZ Earthquake Loss Estimates: Tillamook County and Cities

	(all dollar amounts in thousands)												
			Total Earthquake Damage (Includes Medium Tsunami Zone)		**Excludes Medium Tsunami Zone**								
			Buildings Damaged		**Buildings Damaged**				**All Buildings Changed to at Least Moderate Code**				
Community	**Total Number of Buildings**	**Total Estimated Building Value ($)**	**Sum of Economic Loss ($)**	**Loss Ratio**	**Yellow*-Tagged Buildings**	**Red**-Tagged Buildings**	**Sum of Economic Loss ($)**	**Loss Ratio**	**Yellow*-Tagged Buildings**	**Red**-Tagged Buildings**	**Sum of Economic Loss ($)**	**Loss Ratio**
Unincorp. County (rural)	15,015	1,282,436	458,478	36%	1,269	4,800	409,947	32%	1,657	3,023	318,719	25%
Neskowin	653	118,463	23,959	20%	6	26	6,658	5.6%	2	23	5,568	4.7%
Oceanside-Netarts	1,701	203,363	66,680	33%	79	544	61,450	30%	97	447	56,135	28%
Pacific City–Woods	1,707	212,062	50,563	24%	45	192	26,963	13%	42	147	23,839	11%
Total Unincorp. County	**19,076**	**1,816,324**	**599,680**	**33%**	**1,399**	**5,562**	**505,018**	**28%**	**1,798**	**3,640**	**404,261**	**22%**
Bay City	884	74,770	30,887	41%	82	321	29,014	39%	84	229	21,059	28%
Garibaldi	755	64,331	33,653	52%	52	293	26,182	41%	43	244	20,531	32%
Manzanita	1,523	259,780	75,704	29%	53	301	59,646	23%	28	270	53,424	21%
Nehalem	260	24,886	16,094	65%	11	99	10,349	42%	11	85	7,572	30%
Rockaway Beach	2,240	211,809	73,559	35%	49	276	18,721	8.8%	110	171	15,650	7.4%
Tillamook	2,270	322,398	152,170	47%	196	746	152,112	47%	167	499	101,753	32%
Wheeler	363	30,556	14,953	49%	28	150	13,858	45%	22	127	11,708	38%
Total Tillamook County	**27,371**	**2,804,854**	**996,701**	**36%**	**1,870**	**7,748**	**814,900**	**29%**	**2,263**	**5,265**	**635,958**	**23%**

*Yellow-tagged buildings are considered extensively damaged.

**Red-tagged buildings are considered a total loss.

Source: DOGAMI (2016)

Table 33. CSZ Earthquake Loss Estimates: Port of Tillamook Bay and Port of Garibaldi

			Total Earthquake Damage (Includes Medium Tsunami Zone)		Excludes Medium Tsunami Zone							
			Buildings Damaged		Buildings Damaged				All Buildings Changed to at Least Moderate Code			
Community	Total Number of Buildings	Total Estimated Building Value ($)	Sum of Economic Loss ($)	Loss Ratio	Yellow*-Tagged Buildings	Red**-Tagged Buildings	Sum of Economic Loss ($)	Loss Ratio	Yellow*-Tagged Buildings	Red**-Tagged Buildings	Sum of Economic Loss ($)	Loss Ratio
Port of Garibaldi	36	8,035,760	6,476,037	81%	0	4	544,725	7%	ND	ND	ND	ND
Port of Tillamook	83	61,545,144	29,138,980	47%	18	39	29,138,980	47%	ND	ND	ND	ND

*Yellow-tagged buildings are considered extensively damaged.

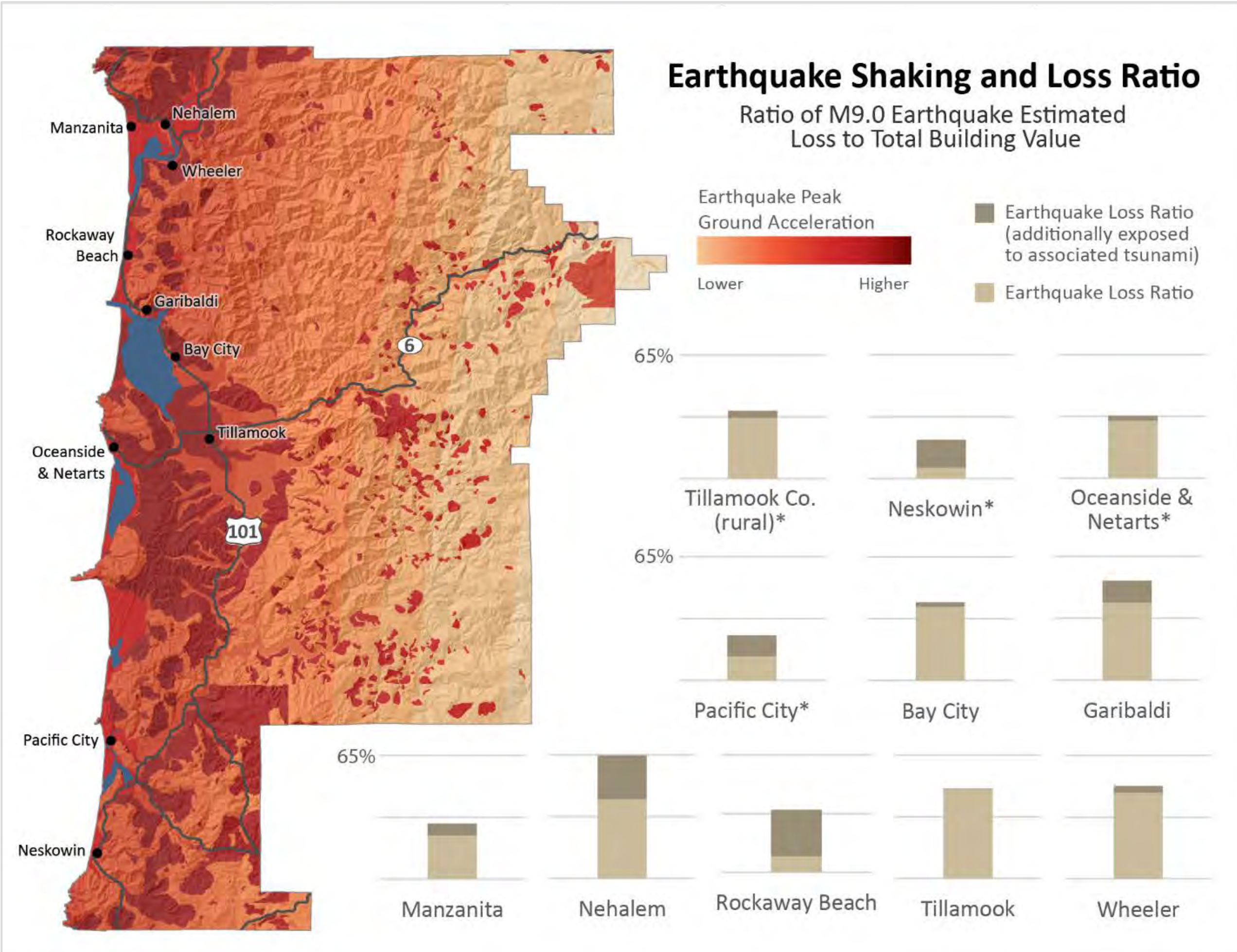
**Red-tagged buildings are considered a total loss.

ND = not done

Source: Derived from DOGAMI (2016)

The Port of Garibaldi would be 100% damaged in the event of a tsunami. It would also potentially suffer 100% damage from liquefaction in the event of an earthquake not associated with a tsunami.

Figure 70. Earthquake Loss Ratio by Community



*Unincorporated communities. Note that "Tillamook Co. (rural)" excludes incorporated communities, Pacific City, Oceanside-Netarts, and Neskowin.

Source: DOGAMI (2016)

Seismic Building Codes

The years that seismic building codes are enforced within a community, called "benchmark" years, have a great effect on the results produced from the Hazus-MH earthquake model. Oregon initially adopted seismic building codes in the mid-1970s. The established benchmark years of code enforcement are used in determining a "design level" for individual buildings. The design level attributes (pre-code, low-code, moderate-code, and high-code) are used in the Hazus earthquake model to determine what damage functions are applied to a given building. The year built or the year of the most recent seismic retrofit are the main considerations for an individual design level attribute. Seismic retrofitting information for structures would be ideal for this analysis but was not available for Tillamook County. The information in the **Table 34** outlines the various benchmark years that apply to buildings within Tillamook County.

Table 34. Tillamook County Seismic Design Level Benchmark Years

Building Type	Year Built	Design Level	Basis
Single Family Dwelling (includes Duplexes)	Prior to 1976	Pre Code	Interpretation of Judson (2012)
	1976–1991	Low Code	
	1992–2003	Moderate Code	
	2004–Present	High Code	
Manufactured Housing	Prior to 2003	Pre Code	Interpretation of OR BCD 2002 Manufactured Dwelling Special Codes http://www.oregon.gov/bcd/codes-stand/Documents/md-2002-mdparks-code.pdf
	2003–2010	Low Code	
	2011–Present	Moderate Code	Interpretation of OR BCD 2010 Manufactured Dwelling Special Codes Update http://www.oregon.gov/bcd/codes-stand/Documents/md-2010omdisc-codebook.pdf
All other buildings	Prior to 1976	Pre Code	Business Oregon (BO) 2014-0311 Oregon Benefit-Cost Analysis Tool (Business Oregon, 2015, p. 24)
	1976–1990	Low Code	
	1991–Present	Moderate Code	

Source: DOGAMI (2016)

Table 35 and **Table 36** and corresponding **Figure 71** and **Figure 72** illustrate the current state of seismic building codes for the county.

Table 35. Seismic Design Level: Tillamook County and Cities

Community	Total Number of Buildings	Pre-Code		Low-Code		Moderate-Code		High-Code	
		Number of Buildings	% of Buildings	Number of Buildings	% of Buildings	Number of Buildings	% of Buildings	Number of Buildings	% of Buildings
Unincorp. County (rural)	15,015	8,366	56%	2,607	17%	3,310	22%	732	5%
Neskowin	653	338	52%	107	16%	144	22%	64	10%
Oceanside-Netarts	1,701	719	42%	296	17%	433	25%	253	15%
Pacific City–Woods	1,707	767	45%	275	16%	435	25%	230	13%
Total Unincorp. County	**19,076**	**10,190**	**53%**	**3,285**	**17%**	**4,322**	**23%**	**1,279**	**7%**
Bay City	884	543	61%	141	16%	131	15%	69	8%
Garibaldi	755	534	71%	110	15%	86	11%	25	3%
Manzanita	1,523	509	33%	432	28%	431	28%	151	10%
Nehalem	260	172	66%	32	12%	27	10%	29	11%
Rockaway Beach	2,240	1,308	58%	322	14%	388	17%	222	10%
Tillamook	2,270	1,737	77%	193	9%	274	12%	66	3%
Wheeler	363	232	64%	43	12%	62	17%	26	7%
Total Tillamook County	**27,371**	**15,225**	**56%**	**4,558**	**17%**	**5,721**	**21%**	**1,867**	**7%**

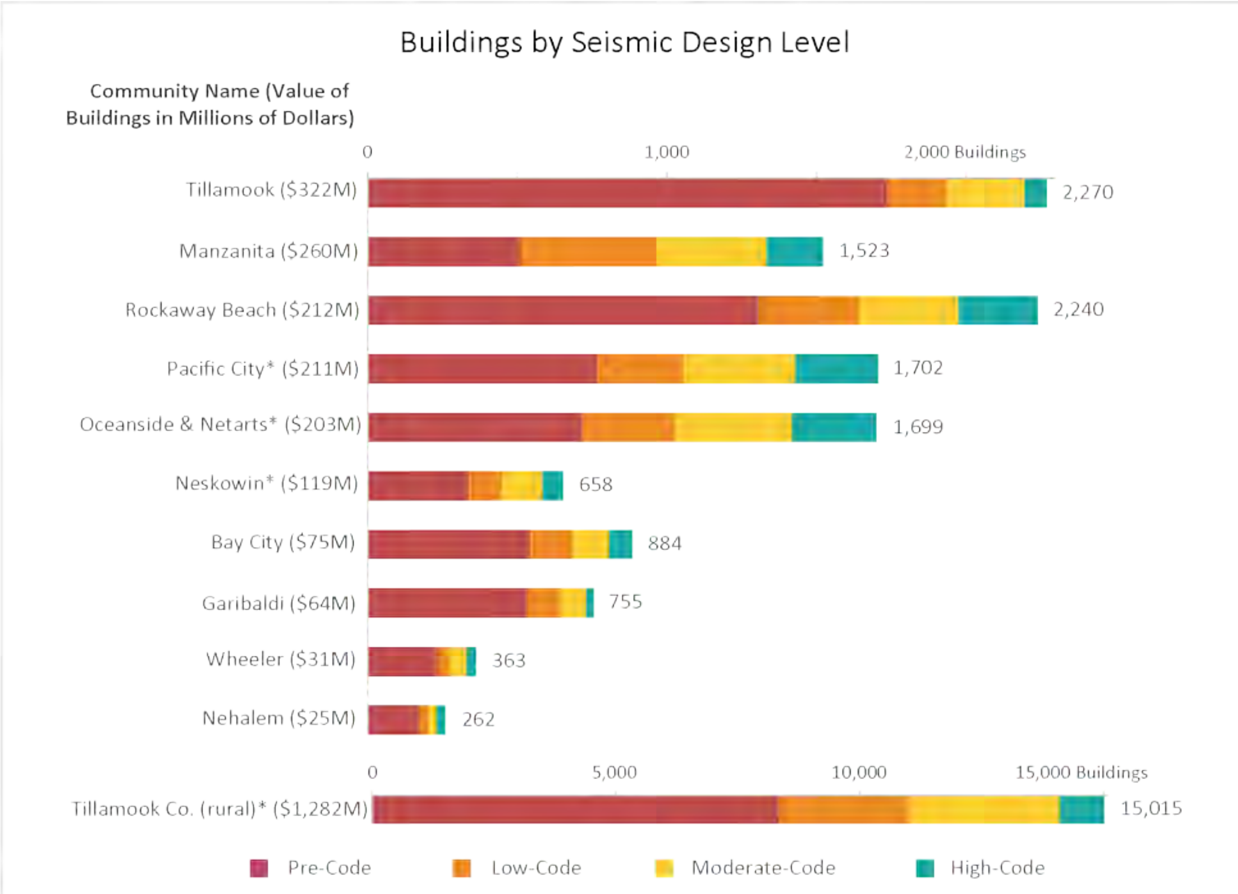
Source: DOGAMI (2016)

Table 36. Seismic Design Level: Port of Tillamook Bay and Port of Garibaldi

Community	Total Number of Buildings	Pre-Code		Low-Code		Moderate-Code		High-Code	
		Number of Buildings	% of Buildings	Number of Buildings	% of Buildings	Number of Buildings	% of Buildings	Number of Buildings	% of Buildings
Port of Tillamook Bay	87	20	23%	14	16%	53	61%	0	0%
Port of Garibaldi	35	11	31%	13	37%	11	31%	0	0%

Source: Derived from DOGAMI (2016)

Figure 71. Seismic Design Level by Community

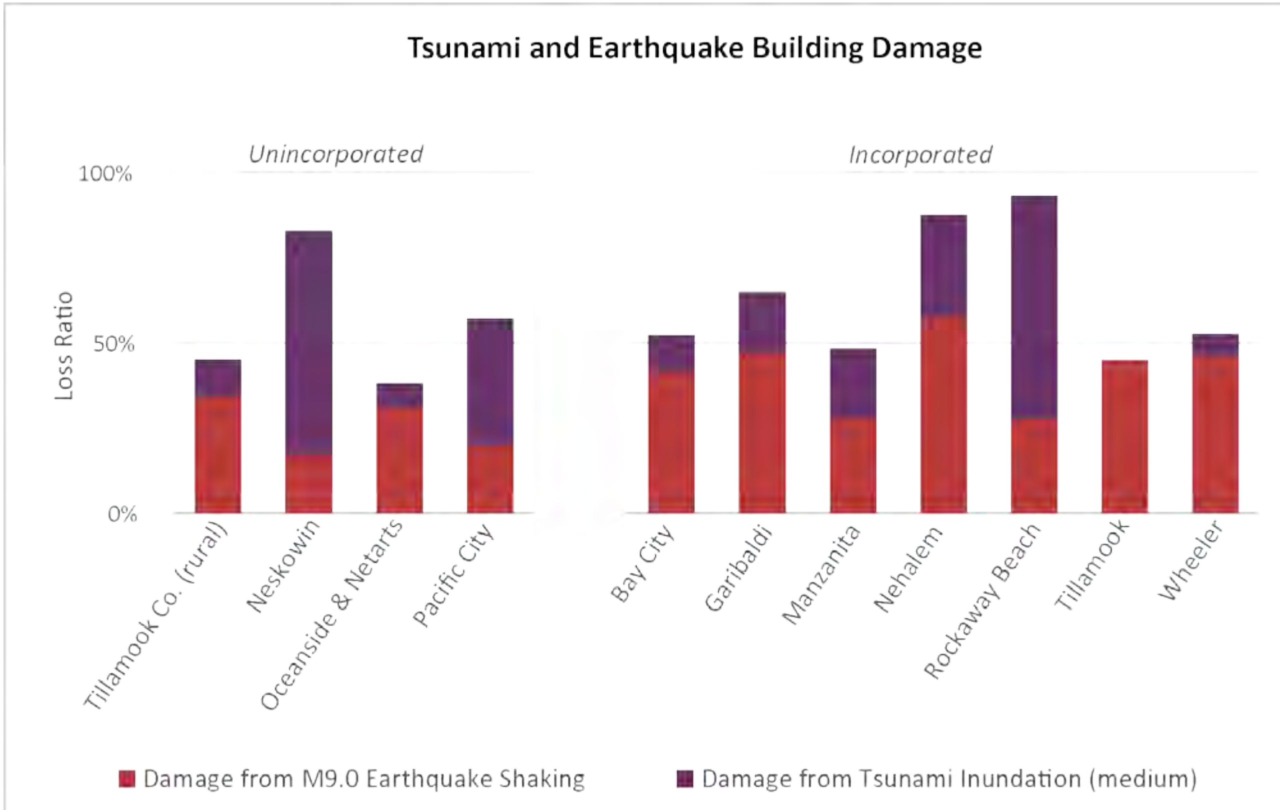


*Unincorporated communities. Note that "Tillamook Co. (rural)" excludes incorporated communities, Pacific City, Oceanside-Netarts, and Neskowin.

Source: DOGAMI (2016)

Because a CSZ earthquake is likely to produce a tsunami and the impacts of the two are closely related, DOGAMI assumed for this estimate that any structure in the medium tsunami zone would be a total loss, and so are analyzed as exposure only. Earthquake damage estimates are reported for structures outside the medium tsunami zone.

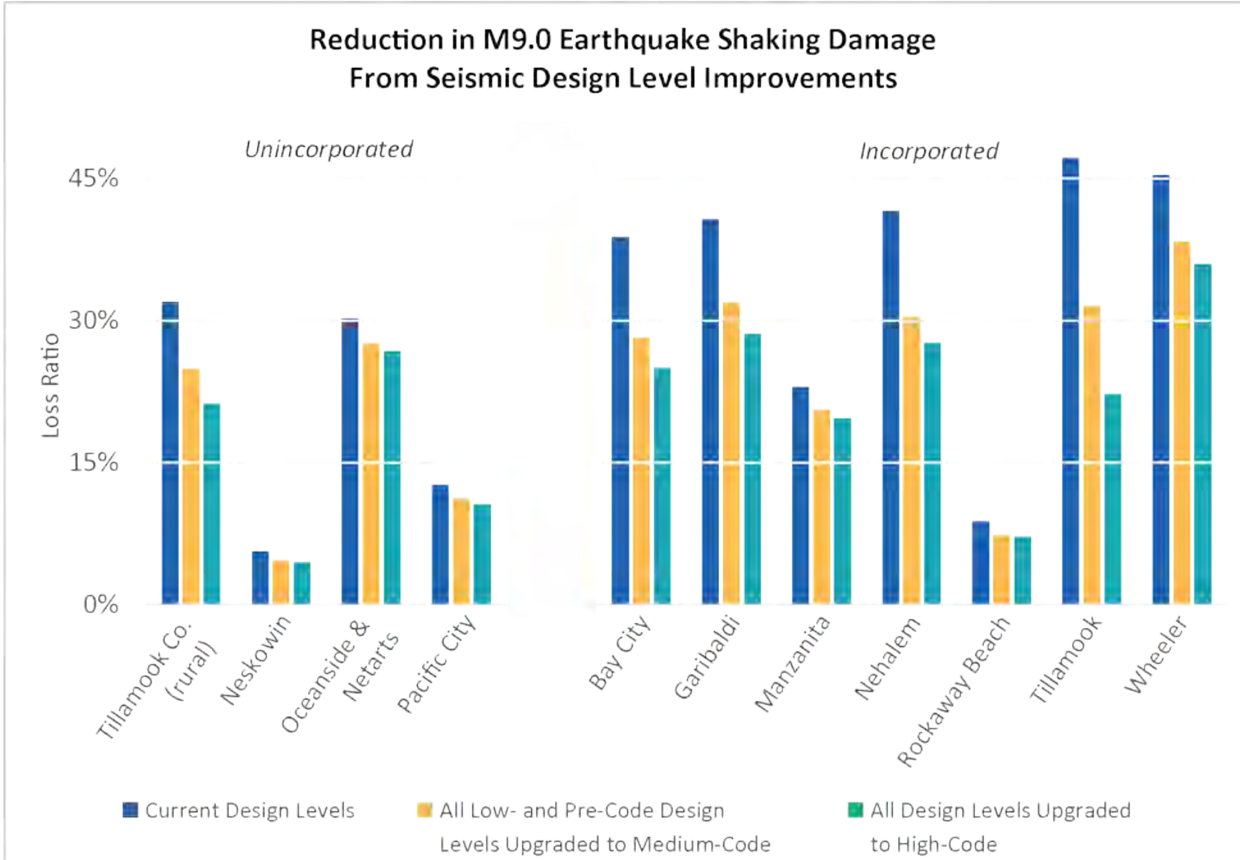
Figure 72. CSZ M9.0 Event Loss Ratio, for Both Shaking and Tsunami Inundation



Source: DOGAMI (2016)

So many buildings were constructed before the advent of seismic codes and with less stringent codes than we have today that we expect a great deal of earthquake damage. DOGAMI analyzed the potential for reducing such damage if buildings were retrofitted to higher seismic building code standards. These results are also reported in **Table 35** and **Table 36** and illustrated in **Figure 73**. The results demonstrate that damage could indeed be greatly reduced, except in areas where landslides, liquefaction or other factors would come into play.

Figure 73. CSZ M9.0 Earthquake Loss Ratio, with Alternate Seismic Design Level Results



Source: DOGAMI (2016)

Local Risk Assessment Methodology

Tillamook County executed the “OEM Methodology” in October 2015 considering probability of and vulnerability to earthquakes throughout the county. The County rated probability moderate and vulnerability high. The total score for earthquakes was lower than those for floods, winter storms, windstorms, and landslides.

Tillamook County and its cities executed the “OEM Methodology” again as an element of developing this risk assessment in September 2016. This time, Tillamook County considered only the rural areas of the county and the unincorporated urban communities of Neskowin, Oceanside-Netarts, and Pacific City. An assessment was also done by each city and the two ports. The assessment is based on the knowledge and experience of local officials and subject matter experts.

The State took a different approach to assessing risk of earthquakes than the jurisdictions. The State’s approach was to assess the earthquake damage from a CSZ event outside the tsunami zone only so as to avoid double counting damages. The jurisdictions’ qualitative assessment did not consider risk of tsunamis together with risk of earthquakes. Therefore, no comparison of the two assessments is made here.

Table 37. Local Risk Assessment: Earthquakes

Jurisdiction	History	Vulnerability	Maximum Threat	Probability	Total	Risk Level
Unincorporated Tillamook County, including Neskowin, Oceanside-Netarts, and Pacific City–Woods	2	50	70	49	171	Moderate
Bay City	2	50	100	70	222	High
Garibaldi	6	45	70	21	142	Moderate
Manzanita	0	5	10	0	15	Low
Nehalem	4	40	90	7	141	Moderate
Rockaway Beach	6	35	100	28	169	Moderate
Tillamook	0	50	100	21	171	High
Wheeler	2	40	100	7	149	Moderate
Port of Tillamook Bay	2	50	80	56	188	High
Port of Garibaldi	4	50	100	35	189	Moderate

Source: Based on information presented at the Tillamook County Multi-Jurisdictional NHMP Update Steering Committee Meeting, September 23, 2016

3. Floods

Introduction

In its most basic form, a flood is an accumulation of water over a normally dry area. When floods inundate areas where people live, work, and play, loss of life and property may result.

Tillamook County has an extensive history of flooding that is typically caused by large-scale weather systems generating prolonged rainfall or rain-on-snow events generating large amounts of runoff. The County also is subject to coastal flooding from high tides and wind-driven waves. While less common, potential also exists for flooding from tsunamis and channel migration. Flooding from tsunamis is discussed in the **Tsunamis** section.

The El Niño Southern Oscillation (ENSO) Cycle influences flooding. El Niño and La Niña are opposite phases of what is known as the El Niño-Southern Oscillation (ENSO) cycle. The ENSO cycle is a scientific term that describes the fluctuations in temperature between the ocean and atmosphere in the east-central Equatorial Pacific. La Niña is sometimes referred to as the cold phase of ENSO and El Niño as the warm phase of ENSO. These deviations from normal surface temperatures can have large-scale impacts not only on ocean processes, but also on global weather and climate. El Niño and La Niña episodes typically last nine to 12 months, but some prolonged events may last for years. They often begin to form between June and August, reach peak strength between December and April, and then decay between May and July of the following year. While their periodicity can be quite irregular, El Niño and La Niña events occur about every 3 to 5 years. Typically, El Niño occurs more frequently than La Niña. (Source: NOAA, “What are El Niño and La Niña?”, http://oceanservice.noaa.gov/facts/ninonina.html)

A measure of this cycle is the Southern Oscillation Index (SOI), which is “calculated from the monthly or seasonal fluctuations in the air pressure difference between Tahiti and Darwin, Australia.” The earliest systematic study of ENSO in the Northwest was Redmond and Koch (1991). The results were sufficiently strong that the authors suggested a cause-effect relationship between the SOI and Oregon weather. SOI values less than zero represent El Niño conditions, near zero values are average, and positive values represent La Niña conditions.

In Oregon El Niño impacts associated with these climate features generally include warmer winter temperatures and reduced precipitation with drought conditions in extreme events.

What Oregonians should especially plan for and monitor, however, is La Niña. During La Niña events, heavy rain arrives in Oregon from the western tropical Pacific, where ocean temperatures are well above normal, causing greater evaporation, more extensive clouds, and a greater push of clouds across the Pacific toward Oregon.

Types of Flooding

Riverine and coastal flooding are most the most common types of flooding in Tillamook County.

Riverine

Riverine flooding is caused by the passage of a larger quantity of water than can be contained within the normal stream channel. The increased stream flow is usually caused by heavy rainfall over a period of several days.

The most severe flooding conditions occur, however, when heavy rainfall is augmented by rapid snowmelt. These rain-on-snow events occur on mountain slopes within the low elevation snow zones of the Pacific Northwest. These events make more water available for runoff than does precipitation alone by melting the snowpack and by adding a small amount of condensate to the snowpack (van Heeswijk, Kimball, and Marks, 1996). If the ground is frozen, stream flow can be increased even more by the inability of the soil to absorb additional runoff.

There are two distinct periods of riverine flooding in Tillamook County — winter and late spring — with the most serious occurring December through February. The situation is especially severe when riverine flooding, caused by prolonged rain and melting snow, coincides with high tides and coastal storm surges. In short, the rivers back up and flood the lowlands. This type of flooding is especially troublesome in the Tillamook Bay area where homes and livestock can be isolated for several days. Several northern coastal rivers carry heavy silt loads that originated in areas burned during the "Tillamook Burn" fires (1933 to 1951) or from areas covered with volcanic ash during the Mount St. Helens eruption (1980). Consequently, some rivers actually may be elevated above local floodplains, which increases flood hazards. The costs and long-term benefits of dredging these rivers have not been determined.

Coastal

Coastal areas have additional flood hazards. Winds generated by tropical storms or intense off-shore low-pressure systems can drive ocean water inland and cause significant flooding. The height of storm surge is dependent on the wind velocity, water depth and the length of open water (the fetch) over which the wind is flowing. Storm surges are also affected by the shape of the coastline and by the height of tides.

Flooding from wind-driven waves is common during the winter, during El Niño events, and when spring and perigean tides occur. The Federal Emergency Management Agency has identified and mapped coastal areas subject to direct wave action (V zones) and sand dune over-topping (AH and AO zones). Direct wave action was especially severe during the winter storm event of 1978 (Nestucca Spit), and the El Niño event of 1997-98. Significant beach and cliff erosion occurred during this period and a number of homes were destroyed. The following lessons were learned:

- Oregon coastal processes are complex and dynamic, sometimes eroding, sometimes accreting;
- Some sections of the Oregon coast are rising in relation to ocean levels, others remain fairly constant or are becoming lower (Komar, 1992);
- Primary frontal dunes provide protection from ocean storms;
- Sand spits are not permanent features; and

- Erosion rates vary and are dependent on several factors including storm duration and intensity, composition of sea cliff, time of year, and impact of human activities (e.g., altering the base of sea cliffs, interfering with the natural movement of beach sand).

Channel Migration

Channel migration is the process by which streams move laterally over time. It is typically a gradual phenomenon that takes place over many years due to natural processes of erosion and deposition. In some cases, usually associated with flood events, significant channel migration can happen rapidly. In high flood flow events stream channels can “avulse” and shift to occupy a completely new channel.

Areas most susceptible to channel migration are transitional zones where steep channels flow from foothills into broad, flat floodplains. The most common physiographic characteristics of a landscape prone to channel migration include moderate channel steepness, moderate to low channel confinement (i.e., valley broadness), and erodible geology.

Dam Failure

Dam failures and accidents, though rare, can result in extreme flooding downstream of the dam. Catastrophic dam failures have occurred in other parts of the country and around the world. The South Fork Dam failure (1889 Johnstown flood) resulted in over 2,000 fatalities in western Pennsylvania. The Saint Francis Dam in southern California failed in 1928 with a loss of an estimated 600 people. Oregon’s dam safety statutes (ORS 540.350 through 400) came into effect shortly after the Saint Francis disaster. Many historical dam failures were triggered by flood events, others by poor dam construction, and some have been triggered by earthquakes.

Location

Table 38. Types of Flooding Hazards Potentially Impacting Each Jurisdiction

Jurisdiction	Riverine Flooding	Coastal Flooding	Channel Migration	Dam Failure
Unincorporated Tillamook County	X	X	X	–
Neskowin	X	X		–
Oceanside-Netarts		X		–
Pacific City	X	X	X	–
Bay City	X			–
Garibaldi	X			–
Manzanita		X		–
Nehalem	X		X	–
Rockaway Beach	X	X		–
Tillamook	X		X	–
Wheeler	X		X	–
Port of Tillamook Bay	X	X		–
Port of Garibaldi	X			–

Source: Derived from DOGAMI (2016)

Hazard Characterization

The principal flood sources in Tillamook County are its rivers, sloughs, and the Pacific Ocean. The Kilchis, Miami, Nehalem, Nestucca, Tillamook, Trask, and Wilson Rivers, Three Rivers, and the Dogherty and Hoquarten Sloughs all drain westward, eventually flowing into the Pacific Ocean. The Pacific Ocean is the source of coastal flooding.

Riverine

Floods are the most common and widely recognized of the hazards within Tillamook County. Flooding generally occurs quickly due to heavy concentrated rainfall. It can be confined to one river system or affect all 7 river systems within the County. Tidal changes coupled with high winds and/or snow accumulation at higher elevations has influence on the severity as well. Flood season is in effect from November 1 through March 31.

Many of the buildings built along the streams and the coast of unincorporated Tillamook County are exposed to the 100-year flood. In Neskowin, developed areas along Neskowin Creek, Kiwanda Creek, and the Pacific Ocean are exposed to the 100-year flood. The primary flood hazard in Pacific City is from the Nestucca River, though coastal flooding may occur. Several buildings inside the 1% flood zone are elevated above the estimated flood level. Central Pacific City is most affected by Nestucca River flooding.

Although some buildings in flood-prone areas have been elevated, greatly reducing overall flood risk, many buildings still can be impacted by floods. Nearly half of the buildings exposed to the 100-year flood in unincorporated Tillamook County and Neskowin, and nearly a quarter in Pacific City are estimated to be elevated above the predicted flood level. While the buildings themselves would not be damaged from flood, access to these buildings could be an issue.

The Cities of Nehalem, Rockaway Beach, and Tillamook are also subject to riverine flooding. Nehalem River flooding presents a particular hazard to structures in the City’s low-lying business area. Floods from Rock Creek and other minor creeks cause damage to structures in low-lying areas of Rockaway Beach. The City of Tillamook lies between two major floodplains created by the Trask, Wilson, and Tillamook Rivers as well as many adjoining tributaries. Numerous buildings in the low-lying areas of the City of Tillamook are exposed to the 100-year flood. Rockaway Beach and the City of Tillamook have sustained significant damage from many floods, most recently during the December 2015 winter storms.

Although many buildings in these cities’ flood-prone areas have been elevated, greatly reducing overall flood risk, many can still be impacted by floods. Nearly half of the buildings exposed to the 100-year flood in unincorporated Rockaway Beach and nearly a third in the City of Tillamook are estimated to be elevated above the predicted flood level. While the buildings themselves would not be damaged from flood, access to these buildings could be an issue. The Port of Garibaldi suffers impacts from flooding of rivers that empty into Tillamook Bay. Flooding causes increased sediment deposits in the Bay and boat basin hindering safe navigation of vessels and creating a need for frequent dredging.

Coastal

Coastal flooding regularly hammers low-lying areas of Neskowin and Rockaway Beach in particular, and to a lesser extent Pacific City. Rockaway Beach was particularly hard-hit during the December 2015 winter storms.

Channel Migration

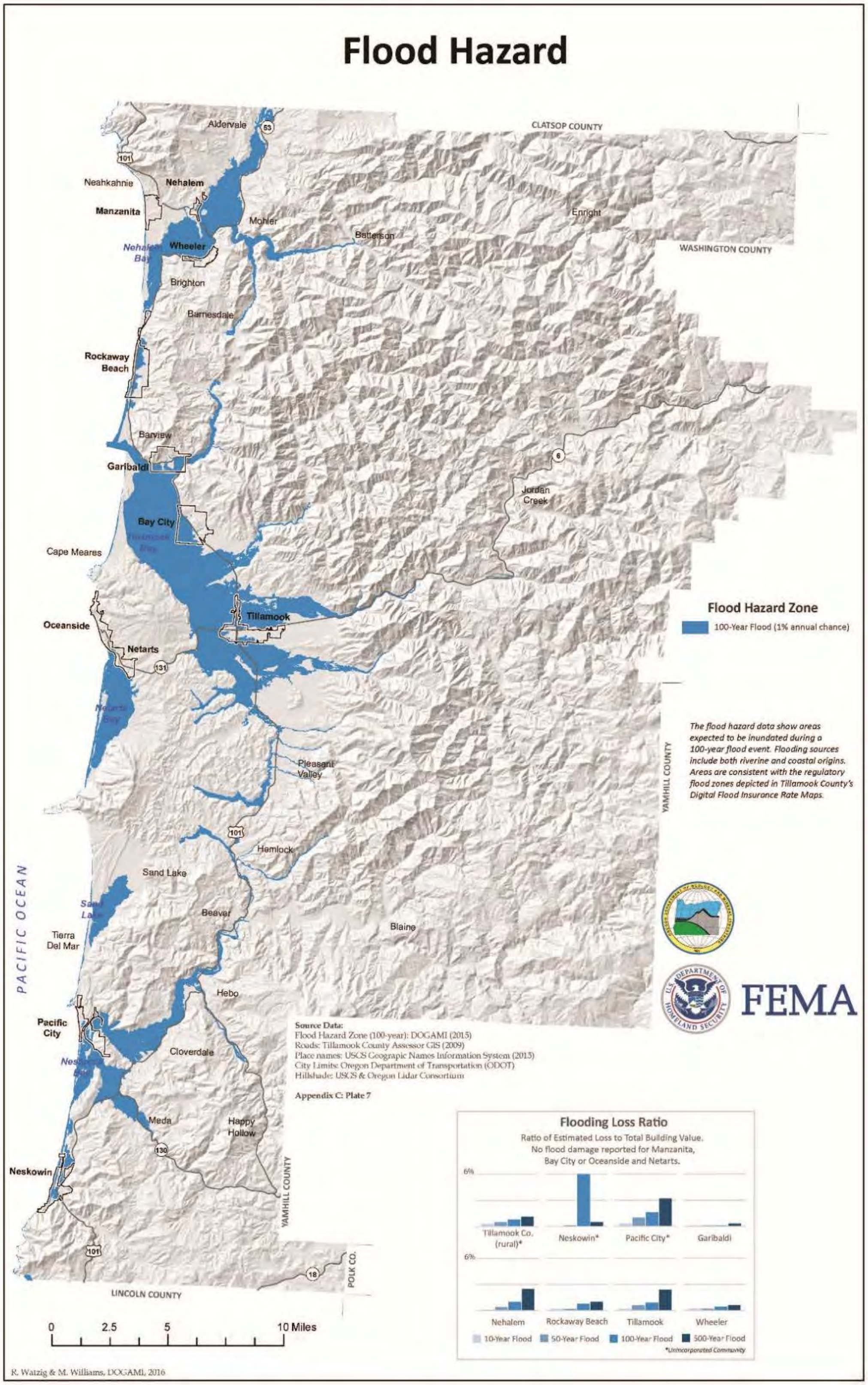
In 2015, DOGAMI produced *Statewide Subbasin-Level Channel Migration Screening for Oregon*, a statewide study of susceptibility to channel migration (Roberts and Anthony, 2015). The Nehalem, Wilson, Trask, and Nestucca Rivers were studied. In general, where these rivers flow through lower elevations, their susceptibility for channel migration is greatest. More study is necessary to accurately determine the area within which their channels are likely to migrate over time and evaluate potential losses.

Exposure to flooding of any type is minimal in Oceanside-Netarts and the Cities of Bay City, Garibaldi, Manzanita, and Wheeler.

Dam Failure

Only two dams exist today that could potentially pose a threat to Tillamook County — the Barney Reservoir and the McGuire Reservoir dams. However, both are among the most resistant to earthquakes in the Oregon, and are not likely to fail in a Cascadia event. (Keith Mills, Oregon Water Resources Department, personal communication, September 2016) Therefore, flooding from dam failure is not considered a hazard of concern in Tillamook County.

Figure 74. Flood Hazard



DOGAMI (2016)

Historically Significant Flood Events

Table 39. Historic Floods in Tillamook County

Date	Location	Description	Type of Flood
1813	NW Oregon	said to exceed “Great Flood” of 1861 (source: Native Americans)	unknown
Feb. 1890	coastal rivers	widespread flooding	rain on snow
Mar. 1931	western Oregon	extremely wet and mild; saturated ground	rain on snow
Dec. 1933	northern Oregon	intense warm rains; Clatskanie River set record	rain on snow
Dec. 1937	western Oregon	heavy coastal rain; large number of debris flows	rain on snow
Dec. 1953	western Oregon	heavy rain accompanied major windstorm; serious log hazards on Columbia	rain on snow
Dec. 1955	Columbia and coastal streams	series of storms; heavy, wet snow; many homes and roads damaged	rain on snow
Mar. 1964	coast and Columbia River estuary	ocean flooding	tsunami
Dec. 1964	entire state	two storms; intense rain on frozen ground	rain on snow
Jan. 1972	northern coast	severe flooding and mudslides; 104 evacuated from Tillamook	rain on snow
Jan. 1974	western Oregon	series of storms with mild temperatures; large snowmelt; rapid runoff	rain on snow
Dec. 1978	coastal streams	intense warm rain; widespread flooding	rain on snow
Feb. 1986	entire state	warm rain and melting snow; numerous homes evacuated	rain on snow
Feb. 1987	western Oregon	heavy rain; mudslides; flooded highways; damaged homes	rain on snow
Dec. 1989	Clatsop, Tillamook and Lincoln	warm Pacific storm system; high winds; fatalities; mudslides	rain on snow
Jan. 1990	W. Oregon	significant damage in Tillamook County; many streams had all-time records	rain on snow
Apr. 1991	Tillamook County	48-hour rainstorm. Wilson River 5 ft. above flood stage; businesses closed	rain on snow
Feb. 1996	NW Oregon	deep snow pack; warm temperatures; record-breaking rains	rain on snow
Nov. 1996	W. Oregon	record-breaking precipitation; flooding; landslides (FEMA-1149-DR-Oregon)	rain on snow
Nov. 2006	Tillamook County	heavy rains caused major flooding in Nehalem and Tillamook, causing $1 million in damage in Nehalem and $15 million in Tillamook	riverine
Dec. 2007	Tillamook County	heavy rains led to flooding in Tillamook along the Wilson River damaging businesses, homes, the railroad to the Port; county-wide damages total 26 million	riverine
Dec. 2008	Tillamook County	heavy rainfall caused flooding in downtown Tillamook; estimate of $3.8 million in damages throughout Tillamook County	riverine
Jan. 2012	Coos, Curry, Lincoln, and Tillamook Counties	a severe winter storm including flooding, landslides, and mudslides affected mostly the southern Oregon coastal counties	riverine
Sep. 2013	Tillamook County	heavy rain caused flooding at the Wilson River	riverine
Dec. 2015	W. Oregon	severe winter storm; Rockaway Beach flooded on the east side of Hwy 101 due to a combination of sand blocking outlets and high tides meeting large volumes of runoff from higher ground; the Hwy 101 corridor north of the City of Tillamook flooded causing a number of long-duration road closures; previous mitigation projects minimized losses	riverine

Source: Taylor and Hannan (1999), Hazards and Vulnerability Research Institute (2007); National Climatic Data Center, Storm Events, http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms; FEMA https://www.fema.gov/disaster/4258 accessed September 2016; Julie Slevin, OEM, personal communication, September 16, 2016; Chris Shirley, DLCD, personal communication, September 16, 2016

Probability

Flood risk or probability is generally expressed by frequency of occurrence and measured as the average recurrence interval of a flood of a given size and place. It is stated as the percent chance that a flood of a certain magnitude or greater will occur at a particular location in any given year.

FEMA's Flood Insurance Studies (FISs) and Flood Insurance Rate Maps (FIRMs) are the most widely used indicators of the probability of flooding. FIRMs depict the inundation area of a flood with a 1% chance of occurring in any year (also known as "base flood" or "100-year flood") as well as inundation area of a flood with a 0.2% chance ("500-year flood), areas where the probability of flooding is unknown, and base flood elevations (BFEs) where they have been calculated. BFE is the projected depth of floodwater at the peak of a base flood, generally measured as feet above sea level. It is important to recognize that floods occur more frequently near the flooding source. Information regarding the probability of flooding at a given location in the regulated flood zones is provided by Flood Insurance Studies (FIS) for large watersheds. FEMA does not provide information about floods emanating from small watersheds (less than one square mile), or for floods caused by local drainage issues. Probabilities for these types of flood are, as a result, difficult to obtain.

Ocean storms can be expected every year. El Niño effects, which tend to raise ocean levels, occur about every 3 to 5 years (Taylor & Hannan, 1999). V (wave velocity) zones, depicted on FEMA's Flood Insurance Rate Maps, are areas subject to 100-year flood events. The Flood Insurance Rate Maps show areas vulnerable to wave action (V zones), as well as ponding and sheet-flow from waves over-topping dunes (AO and AH zones). Currently, DOGAMI is working with FEMA to update and remap FEMA coastal flood zones established for Oregon's coastal communities.

Communities participating in the NFIP are required to regulate development in Areas of Special Flood Hazard (1% chance), also known as the 100-year flood zone. The FIRMs are also used to rate required flood insurance policies on homes and businesses with federally backed mortgages.

FEMA initially developed Flood Insurance Studies (FISs) and Flood Insurance Rate Maps (FIRMs) to administer the National Flood Insurance Program (NFIP) in Tillamook County in 1977 and 1978. The FIRMs for the Cities of Bay City, Garibaldi, and Wheeler have not been updated. The others have been updated, with the most recent update completed 12 years ago. FEMA is currently in the process of updating the FIS and FIRMs countywide. The Draft FIS and Draft FIRMs dated 2016, while currently unofficial, are the best available data and were used for this NHMP update. The Area of Special Flood Hazard (1% chance or 100-year flood zone) is basis of the flood exposure and loss analyses.

Table 40. Initial and Effective FIS and FIRM Dates

Jurisdiction	Initial FIRM	Effective FIS & FIRM	Preliminary FIS & FIRM
Unincorporated Tillamook County (includes the Port of Tillamook Bay)	Aug. 1, 1978	Aug. 20, 2002	Dec. 12, 2016
Bay City	Aug. 1, 1978	Aug. 1, 1978	Dec. 12, 2016
Garibaldi (includes the Port of Garibaldi)	Aug. 1, 1978	Aug. 1, 1978	Dec. 12, 2016
Manzanita	May 1, 1978	Jan. 12, 1982	Dec. 12, 2016
Nehalem	Apr. 3, 1978	Dec. 7, 1982	Dec. 12, 2016
Rockaway Beach	Sep. 29, 1978	Oct. 12, 1982	Dec. 12, 2016
Tillamook	May 1, 1978	Apr. 16, 2004	Dec. 12, 2016
Wheeler	Nov. 16, 1977	Nov. 16, 1977	Dec. 12, 2016

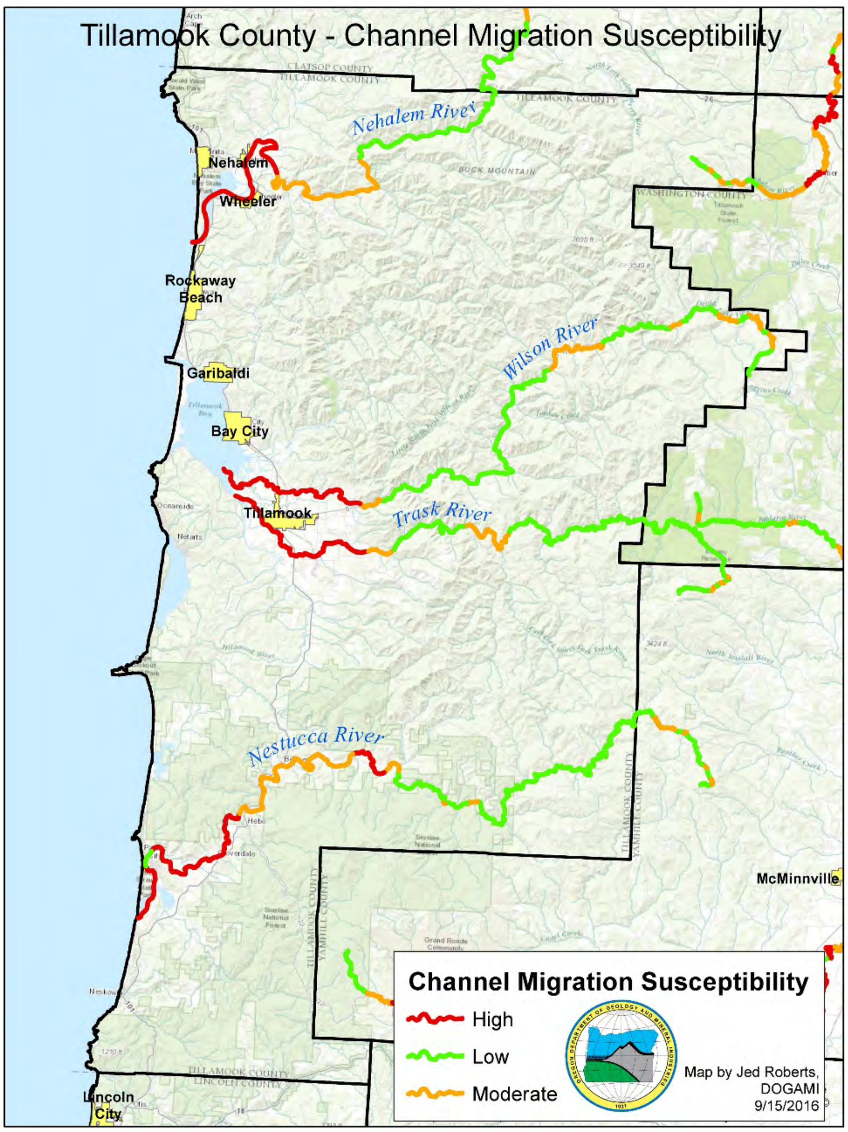
Source: FEMA Community Information System [online database https://isource.fema.gov/cis/], accessed September 16, 2016

Channel Migration

Channel migration associated with flooding also can be identified with respect to a probability of migration over a period of 100 years. Historic aerial photos are catalogued to calculate past rates of migration that are then projected out to define a channel migration zone. Avulsion (i.e., channel shifting) zones, which are a component of the larger channel migration zone, are an exception to the migration rate approach. Areas of likely avulsion are identified by professional judgment of a fluvial geomorphologist, using high-resolution topographic data, aerial photos, and field observation.

Identification of channel migration susceptibility at the regional level is described in terms of low, moderate, and high relative probabilities. Probability is determined by assessing physiographic parameters of channel gradient, confinement, and pattern.

Figure 75. Channel Migration Susceptibility in Tillamook County



Source: Jed Roberts, personal communication, September 15, 2016

Southern Flow Corridor Project

Five major rivers drain into Tillamook Bay. The lower valleys of the Wilson, Trask, and Tillamook rivers merge to form a broad floodplain at the head of the bay on which the City of Tillamook is located. The Wilson River flows through a steep canyon out of the mountains and does not have any significant floodplain until around six miles above the bay.

The river channel is perched, meaning it runs in a channel with natural banks that are higher than the floodplains around it. Consequently, flood flows that leave the Wilson River, especially to the much larger southern floodplain, never return to the channel but flow south to the lowest part of the valley and west to meet the Trask and Tillamook Rivers. Highway 101 crosses the Wilson River floodplain at grade and so suffers frequent deep inundation across its lowest portions between Hoquarton and Dougherty Sloughs.

Recent decades have seen a number of damaging floods occur in Tillamook County. The 1996 flood in particular was noted for its long duration and extensive damages. Since then, large floods have occurred in 1998 and most recently in 2006 and 2007, causing further damage.

Listed as "threatened" under the federal Endangered Species Act, Oregon coastal coho populations have been severely impacted by the loss of off-channel and tidal wetland habitats. In few places is this impact more pronounced than in Oregon's Tillamook Bay, where almost 90% of the estuary's tidal wetlands have been lost to agricultural and urban/residential development.

The resulting lack of available tidal wetland habitats has been a primary contributor to the decline of Tillamook Bay coho, and today's runs (just over 2,000 fish in 2012) represent a fraction of estimated historic abundance (~200,000). Likewise, the lack of available tidal wetland habitats has been identified as a key impediment to species recovery. These tidal habitat losses have impacted the Bay's four other anadromous species, as well, particularly Chinook, which use tidal wetlands extensively for rearing.

The primary intent of Southern Flow Corridor-Landowner Preferred Alternative Project (SFC-LPA) is to remove manmade impediments to flood flows to the maximum extent possible in the lower Wilson River floodplain. The project accomplishes this by extensive removal of existing levees and fill and the new construction of setback tidal dikes to protect adjacent private lands from inundation from daily tides.

Areas outside the setback levees will be restored to tidal marsh. Working with a diverse set of partners, Tillamook County is restoring the 522 acres of tidal marsh habitats at the confluence of the Bay's two most productive salmon systems, the Wilson and Trask Rivers. Representing 10% of the watershed's historic tidal acreage and a far greater percentage of the "restorable" tidal lands, the project site contains an expansive mosaic of tidal wetlands, disconnected freshwater wetlands, and drained pasture lands. As the site restores to a tidal regime, the resulting range of habitats (including mud flats, aquatic beds, emergent marsh, scrub-shrub wetlands, forested wetlands and sloughs) will provide substantial habitat benefits to not only Threatened coho, but also chum and Chinook salmon, and cutthroat trout. A conservation easement permanently protects over 506 acres of County owned lands in the project area.

Long-term ecological and socio-economic outcomes include:

- reduced flooding in the Highway 101 business corridor and adjacent residential/agricultural lands, including measureable reductions in flood elevation and duration;
- improved freshwater and estuarine water quality, including reductions in temperature, dissolved oxygen, and turbidity;
- increased habitat complexity and availability across the range of tidal wetland habitats; and
- enhanced ecological function benefitting other aquatic, terrestrial, and avian species.

At this writing, the second and final year of construction is starting up, with project completion by the end of 2017 (https://tillamookoregonsolutions.com/ accessed January 21, 2017; Rachel Hagerty, General Services Administrator, Tillamook County, personal communication, May 19, 2017).

Climate Change and Sea Level Rise

Recent studies make it clear that global ocean water levels are rising. Because Oregon's western edge is rising, the rates of sea level rise in Oregon are not as high as rates seen in other west coast locations, but they are rising. Flooding on the estuarine fringe is affected by ocean water levels — including tides and storm surges — in addition to freshwater inflow from the estuarine watershed.

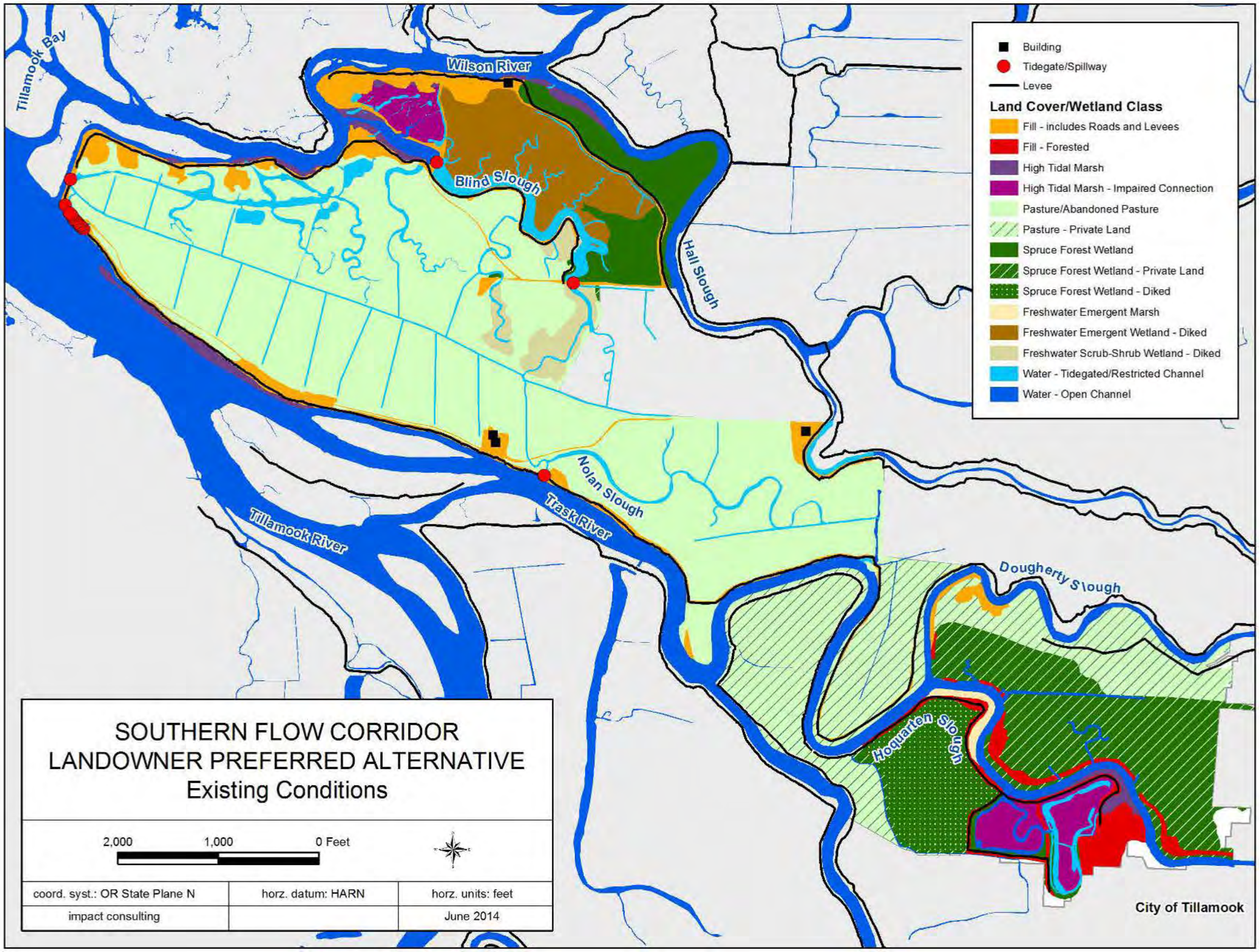
Recent research also indicates that significant wave heights off Oregon are increasing. Increasing significant wave heights may be a factor in the observed increase of coastal flooding events in Oregon. During El Niño events, sea levels can rise up to about 1.5 feet (0.5 meters) higher over extended periods (seasons). Rising sea levels and increasing wave heights are both expected to increase coastal erosion and coastal flooding.

Extreme precipitation events have the potential to cause localized flooding due partly to inadequate capacity of storm drain systems. Flood events are expected to increase in number and magnitude. Areas thought to be outside the floodplain may begin to experience flooding.

Figure 76. Southern Flow Corridor Landowner Preferred Alternative Site Location

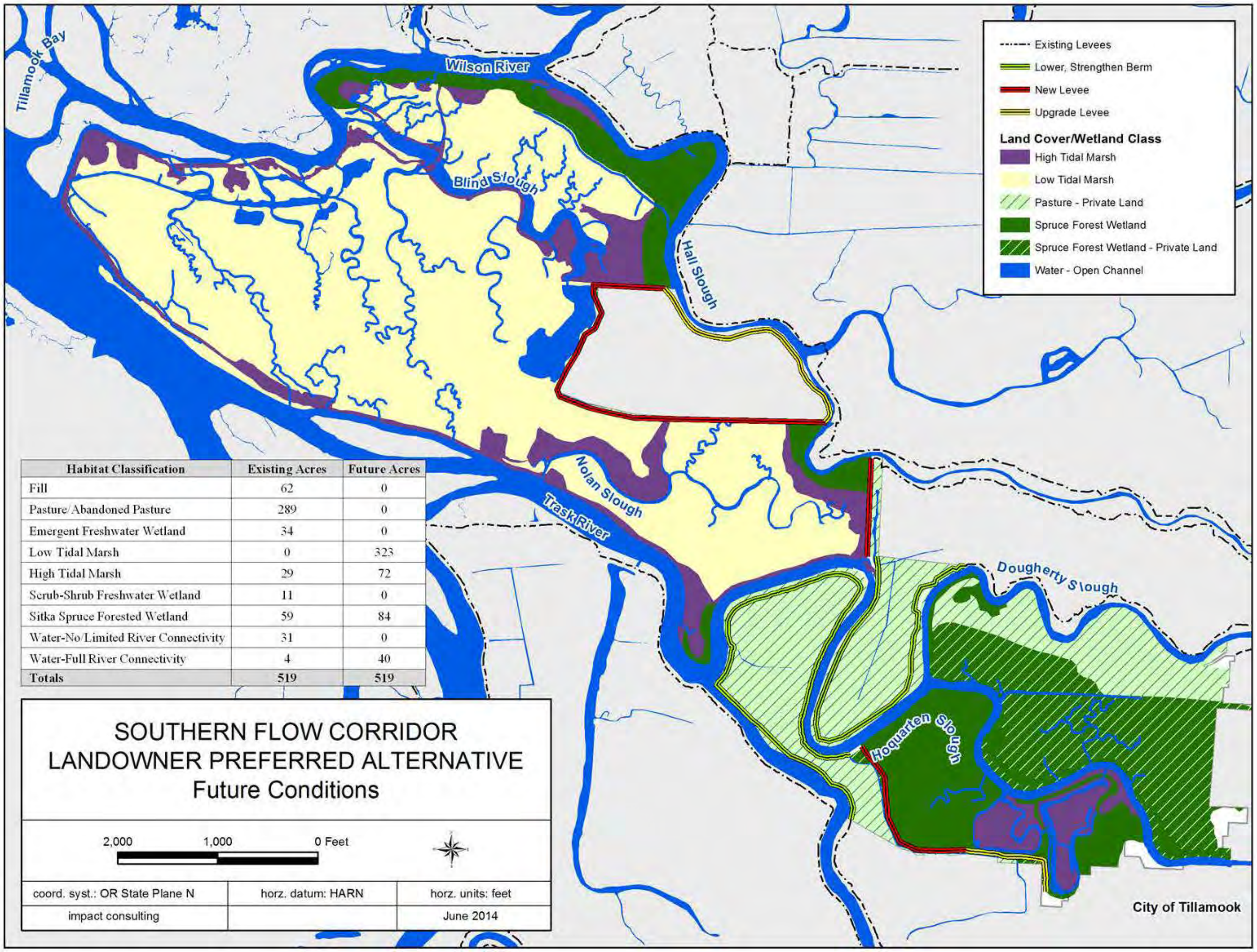
Source: https://ossfc.files.wordpress.com/2013/12/g-sfc_vicinity1.pdf, accessed January 21, 2017

Figure 77. Southern Flow Corridor Landowner Existing Conditions



Source: https://ossfc.files.wordpress.com/2014/01/g-sfc_pre1.pdf, accessed January 21, 2017

Figure 78. Southern Flow Corridor Landowner Future Conditions



Habitat Classification	Existing Acres	Future Acres
Fill	62	0
Pasture/Abandoned Pasture	289	0
Emergent Freshwater Wetland	34	0
Low Tidal Marsh	0	323
High Tidal Marsh	29	72
Scrub-Shrub Freshwater Wetland	11	0
Sitka Spruce Forested Wetland	59	84
Water-No/Limited River Connectivity	31	0
Water-Full River Connectivity	4	40
Totals	**519**	**519**

Source: https://ossfc.files.wordpress.com/2014/01/g-sfc_post.pdf, accessed January 21, 2017

Vulnerability

Vulnerability expresses the impacts to people and the built environment anticipated from flooding.

Properties near the rivers that feed Tillamook Bay have experienced significant flood losses. In fact, the meaning of the term “100-year flood” was lost when repetitive flood events impacting the City of Tillamook and adjacent portions of Tillamook County exceeded the base flood elevation numerous times, including major flood events in 1996, 1998 and 1999, 2007, 2011 and, most recently, 2015. Many buildings — including those built before and after FIRMs were first developed — experienced repetitive flood losses along US-101 north of the City of Tillamook, many of which have been mitigated using FEMA post-disaster mitigation (HMGP) grants.

In general, the north coast is more vulnerable to riverine flood damage than the south coast because it is more densely populated and consequently contains much of the region’s infrastructure. Physical location also makes a difference. For example, five rivers empty into Tillamook Bay, increasing risk from riverine flooding on the relatively flat valley floor.

Fortunately, unlike the East and Gulf coasts, only a few of Oregon’s coastal developments are within FEMA-designated Velocity (V) zones. Information from the National Flood Insurance Program (NFIP) indicates that Lincoln and Tillamook Counties and their coastal cities account for nearly all of the V-zone flood policies and losses on the Oregon coast.

Coastal highways have always been problematic. Much of the problem is linked to local geology; some sections are more susceptible to wave action than others and require continuous maintenance. There is no practical solution outside of relocation of the highway.

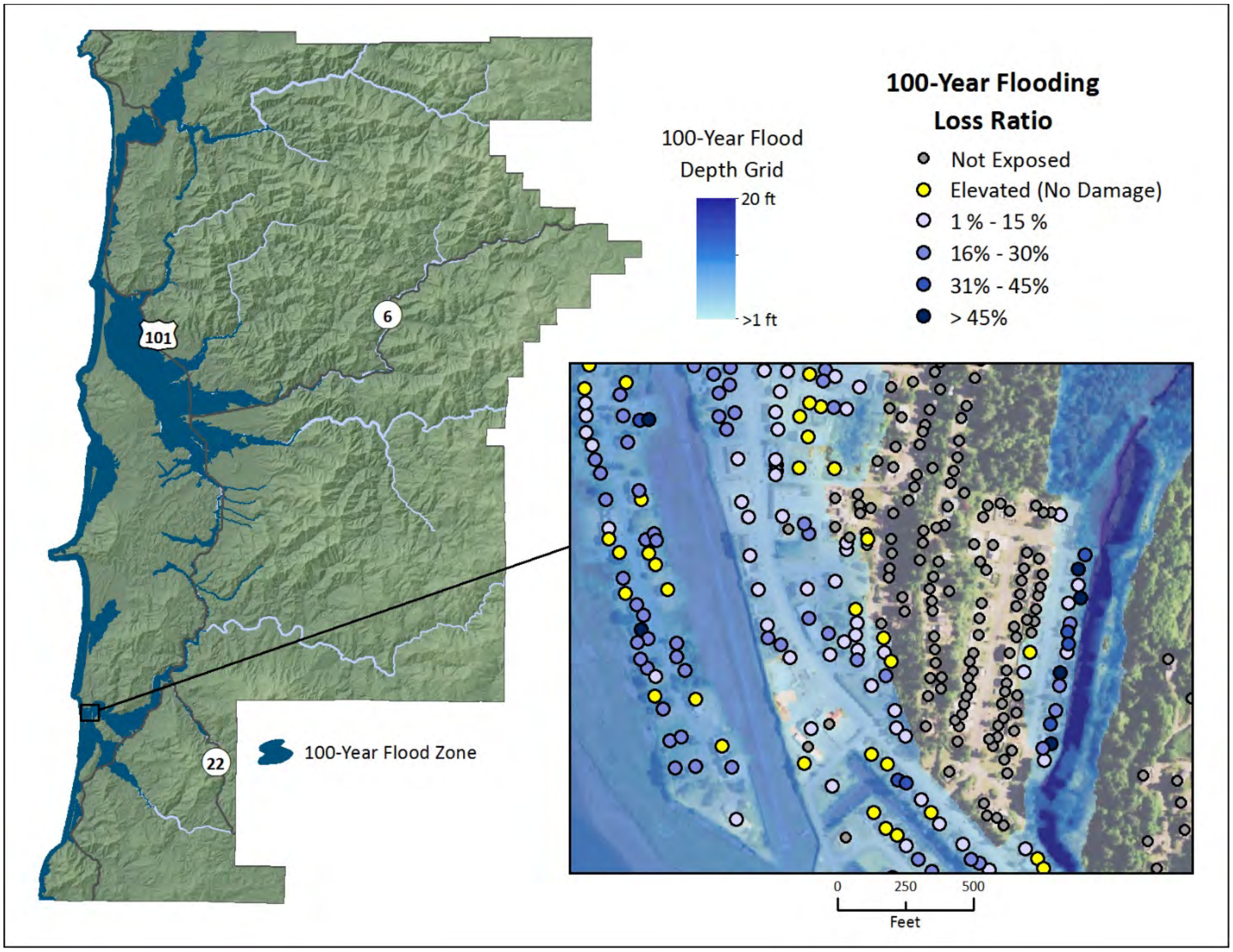
Loss Estimation and Exposure

The *Final Draft Multi-Hazard Risk Report for Tillamook County* (DOGAMI, 2016) provides flood loss estimation and exposure analyses for Tillamook County. Figure 79 provides an example of the building exposure analysis. Figure 80 provides an example of the depth grids used for loss estimation, and Figure 81 illustrates the estimated loss ratio. Exposure results are shown Table 41 and Table 43; loss estimation results in Table 42.

Most buildings exposed to flood throughout the County are expected to be subject to flood damage.

While the their potentially displaced populations are significant by percentage, the actual numbers of potentially displaced people in Neskowin, Nehalem, and Rockaway Beach are relatively low because they are small communities. Conversely, the percentages of potentially displaced people are lower in the rural parts of Tillamook County and Tillamook City, but the actual numbers of potentially displaced people are significant.

Figure 79. 100-year Flood Zone and Building Exposure Example



Source: DOGAMI (2016)

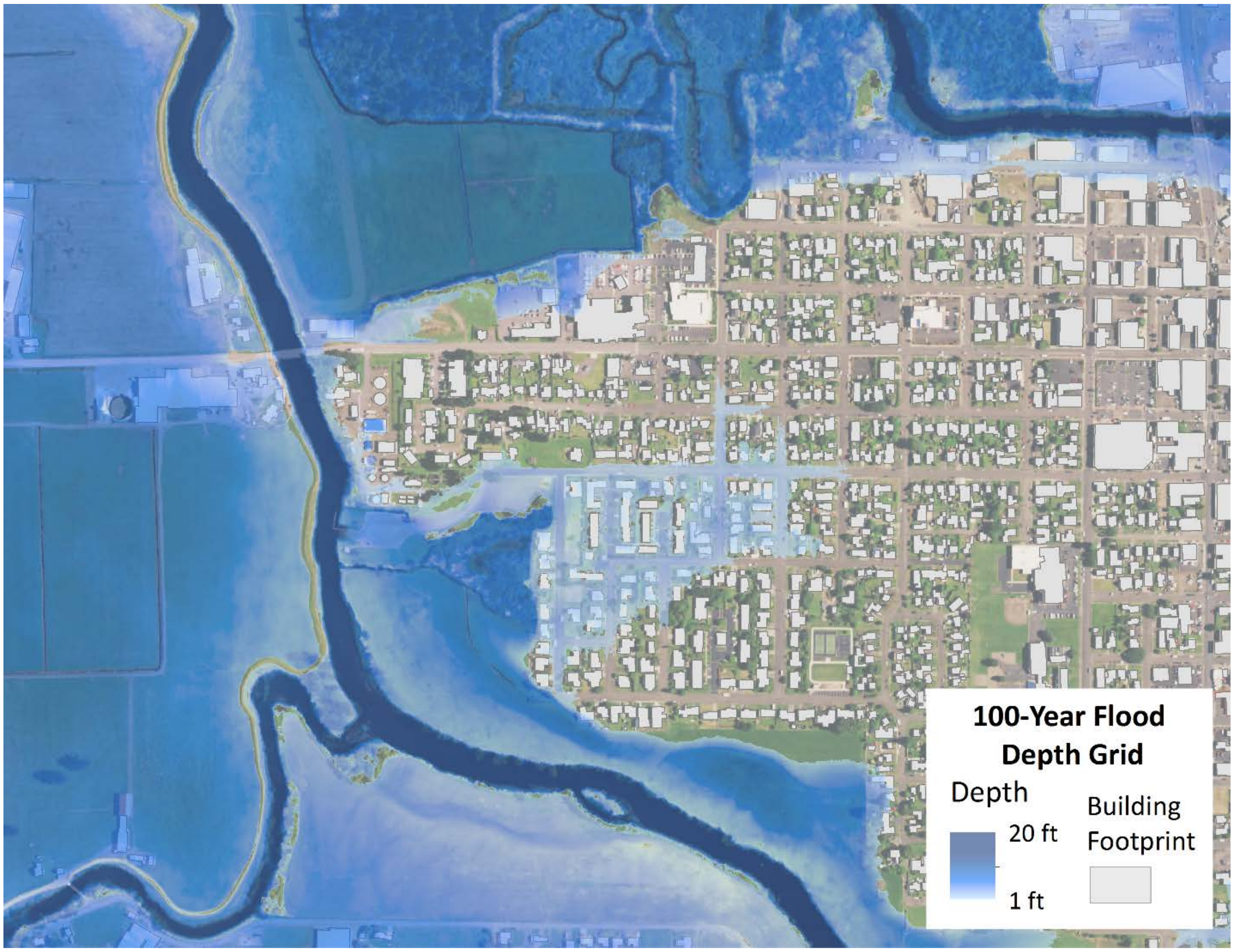
Table 41. Flood Exposure: Tillamook County and Cities

Community	Total Number of Buildings	Total Population	1% (100-yr)* Potentially Displaced Residents from Flood Exposure	% Potentially Displaced Residents from Flood Exposure	Number of Flood Exposed Buildings without Damage
Unincorp. County (rural)	15,015	13,360	1,078	8.1%	254
Neskowin	653	230	38	17%	53
Oceanside-Netarts	1,701	1,056	4	0.4%	45
Pacific City–Woods	1,707	947	270	29%	114
Total Unincorp. County	**19,076**	**15,597**	**1,390**	**8.9%**	**466**
Bay City	884	1,284	5	0.4%	7
Garibaldi	755	779	13	1.7%	10
Manzanita	1,523	599	0	0	3
Nehalem	260	271	41	15%	18
Rockaway Beach	2,240	1,305	152	12%	175
Tillamook	2,270	4,999	505	10%	64
Wheeler	363	420	9	2.1%	0
Total Tillamook County	**27,371**	**25,250**	**2,115**	**8.4%**	**743**

*1% results include coastal flooding source.

Source: DOGAMI (2016, Table A-2)

Figure 80. Flood Depth Grid Example, City of Tillamook



Source: DOGAMI (2016)

Table 42. Flood Loss Estimates: Tillamook County and Cities

Community	Total Number of Buildings	Total Estimated Building Value ($)	10% (10-yr) Number of Buildings	10% (10-yr) Loss Estimate	10% (10-yr) Loss Ratio	2% (50-yr) Number of Buildings	2% (50-yr) Loss Estimate	2% (50-yr) Loss Ratio	1% (100-yr)* Number of Buildings	1% (100-yr)* Loss Estimate	1% (100-yr)* Loss Ratio	0.2% (500-yr) Number of Buildings	0.2% (500-yr) Loss Estimate	0.2% (500-yr) Loss Ratio
	(all dollar amounts in thousands)													
Unincorp. County (rural)	15,015	1,282,436	553	3,277	0.3%	923	6,930	0.5%	1,106	10,178	0.8%	1,369	13,888	1.1%
Neskowin	653	118,463	3	12	0.0%	22	93	0.1%	82	7,132	6.0%	61	609	0.5%
Oceanside-Netarts	1,701	203,363	0	0	0.0%	1	1	0.0%	4	4	0.0%	6	83	0.0%
Pacific City–Woods	1,707	212,062	90	543	0.3%	268	2,167	1.0%	361	3,301	1.6%	492	6,711	3.2%
Total Unincorp. County	**19,076**	**1,816,324**	**646**	**3,832**	**0.2%**	**1,214**	**9,191**	**0.5%**	**1,553**	**20,615**	**1.1%**	**1,928**	**21,291**	**1.2%**
Bay City	884	74,770	0	0	0.0%	0	0	0.0%	0	0	0.0%	3	11	0.0%
Garibaldi	755	64,331	7	47	0.1%	14	71	0.1%	21	79	0.1%	39	189	0.3%
Manzanita	1,523	259,780	0	0	0.0%	0	0	0.0%	1	11	0.0%	0	0	0.0%
Nehalem	260	24,886	4	25	0.1%	12	73	0.3%	31	162	0.7%	50	433	1.7%
Rockaway Beach	2,240	211,809	70	370	0.2%	122	522	0.2%	170	1,671	0.8%	293	2,140	1%
Tillamook	2,270	322,398	52	600	0.2%	136	1,880	0.6%	205	3,060	0.9%	307	7,840	2.4%
Wheeler	363	30,556	5	49	0.2%	5	71	0.2%	12	113	0.4%	14	187	0.6%
Total Tillamook County	**27,371**	**2,804,854**	**784**	**4,923**	**0.2%**	**1,503**	**11,808**	**0.4%**	**1,993**	**25,711**	**0.9%**	**2,634**	**32,091**	**1.1%**

*1% results include coastal flooding source.

Source: DOGAMI (2016, Table A-2)

Table 43. Flood Loss Estimates: Port of Tillamook Bay and Port of Garibaldi

Community	Total Number of Buildings	Total Estimated Building Value ($)	10% (10-yr) Number of Buildings	10% (10-yr) Loss Estimate	10% (10-yr) Loss Ratio	2% (50-yr) Number of Buildings	2% (50-yr) Loss Estimate	2% (50-yr) Loss Ratio	1% (100-yr)* Number of Buildings	1% (100-yr)* Loss Estimate	1% (100-yr)* Loss Ratio	0.2% (500-yr) Number of Buildings	0.2% (500-yr) Loss Estimate	0.2% (500-yr) Loss Ratio
Port of Garibaldi	35	8,035,760	4	1,211	0.02%	4	19,764	0.25%	6	20,080	0.25%	6	21,026	0.26%
Port of Tillamook	83	61,545,144	2	30,473	0.05%	5	70,289	0.11%	5	72,863	0.12%	5	76,786	0.12%

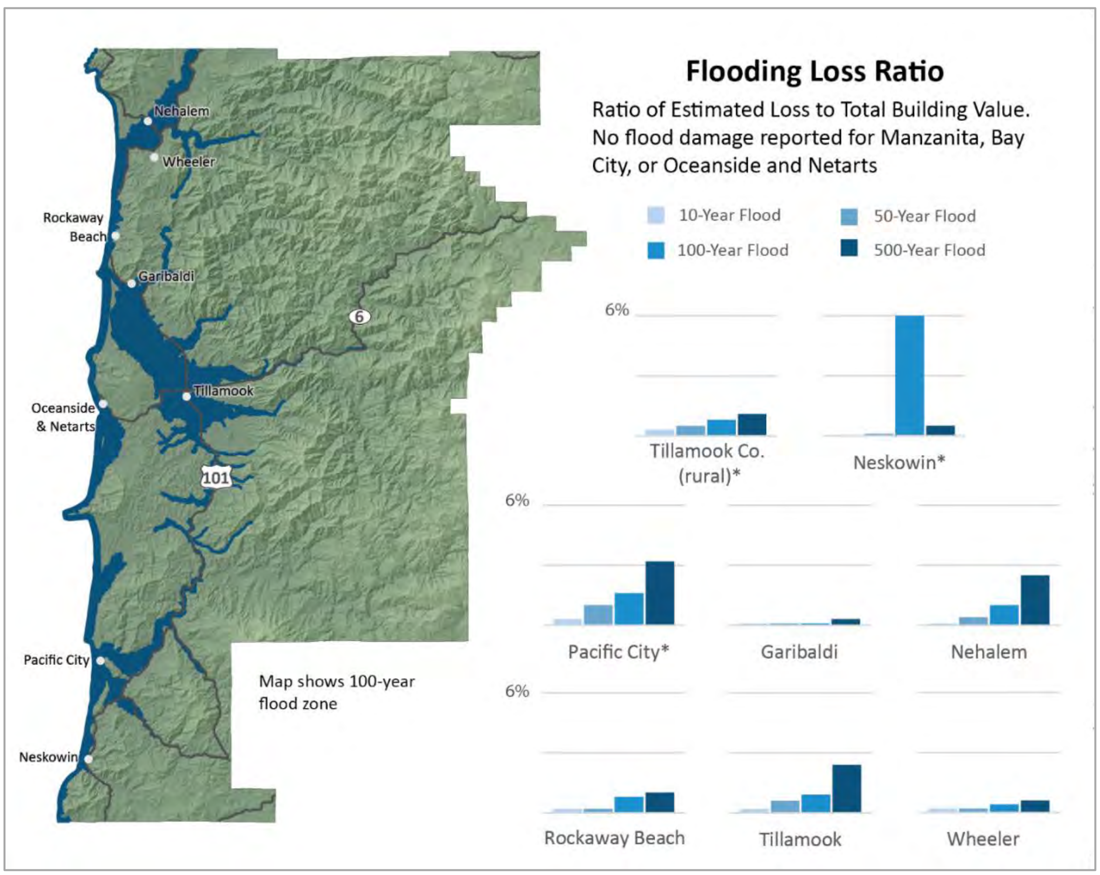
Source: Derived from DOGAMI (2916, Table A-2)

The loss estimate for a 1% probability flood countywide is about $26 million with about 2,000 buildings damaged. Neskowin has a significantly greater loss ratio (percentage of loss relative to replacement cost) than any of the other communities or the rural areas of the County.

The Port of Tillamook Bay Railroad runs from the Port's industrial park complex through eastern Tillamook City and north to Wheeler before turning east through the Salmonberry Canyon. Previous Salmonberry River flooding seriously damaged the rail line. In the Tillamook area, the elevated portion of the rail line has served as a pedestrian pathway during floods. Flooding of this portion would hamper mobility even further. The Port is a partner in the Southern Flow Corridor Project, which seeks to reduce the durational impact of recurrent floodwaters in the Highway 101 Business Corridor of Tillamook. Trask River floods block traffic along Long Prairie Road impacting the continuous flow of commerce into the Port's Airport and Industrial park complex; however, these periods of interruption are far less in duration than a flood event within the City of Tillamook area.

The Port of Garibaldi suffers impacts from flooding of rivers that empty into Tillamook Bay. Flooding causes increased sediment deposits in the Bay and boat basin hindering safe navigation of vessels and creating a need for frequent dredging. The expense of and operational disruptions caused by frequent dredging are considered economic losses from flooding.

Figure 81. Flood Loss Estimates by Community



*Unincorporated communities. Note that "Tillamook Co. (rural)" excludes incorporated communities, Pacific City, Oceanside/Netarts, and Neskowin. Coastal flooding information only available for the 100-year flood (non-cumulative results can occur, as seen in the community of Neskowin).
Source: DOGAMI (2016)

National Flood Insurance Program (NFIP)

All of the jurisdictions in Tillamook County participate in the NFIP and their floodplain management ordinances are in compliance. They will all be reviewed again after the Letter of Final Determination is issued for the FIS and FIRMs that are currently being updated.

Structures built prior to issuance of the initial NFIP FIS and FIRMs are known as "pre-FIRM" structures. Their lowest floors are often below the BFE making them particularly susceptible to flooding. Those with lowest floors at least one foot below the BFE are called "minus rated" and are more vulnerable to flood damage. **Table 44** indicates a large number of flood insurance policies for pre-FIRM buildings in the County. Two thirds of the structures are located in unincorporated Tillamook County and one fifth are in Rockaway Beach, two of the places most susceptible to both riverine and coastal flooding in the County.

Table 44. NFIP Flood Insurance Policies

	Number of Policies		Number of Policies by Building Type					
Jurisdiction	Total Policies	Pre-FIRM Policies	Single-Family	2-4 Family	Other Residential	Non-Residential	Minus-Rated A Zone	Minus-Rated V-Zone
Unincorporated Tillamook County	1,537	660	1,243	35	156	103	71	7
Bay City	14	7	14	0	0	0	1	0
Garibaldi	19	9	14	0	0	4	0	0
Manzanita	152	51	141	9	0	2	3	1
Nehalem	24	12	15	1	0	8	0	0
Rockaway Beach	415	197	256	29	118	12	35	7
Tillamook	112	57	67	4	4	37	2	0
Wheeler	6	5	4	0	0	2	0	0
Total	**2,279**	**998**	**1,754**	**78**	**278**	**168**	**112**	**15**

Source: FEMA Community Information System [online database https://isource.fema.gov/cis/], accessed August 22, 2016

Most of the NFIP insurance claims paid have been for flood damage in unincorporated Tillamook County and the City of Tillamook. Seventy-two percent and 65%, respectively, have been for damage to pre-FIRM structures. Countywide, 71% of all claims have been for damage to pre-FIRM structures. Although significantly fewer claims were paid for damage in the City of Tillamook than in unincorporated Tillamook County, the total amount paid was greater. The average amount paid per claim in unincorporated Tillamook County was $14,569, much less than the average $45,941 paid per claim in the City of Tillamook.

Table 45. NFIP Flood Insurance Claims

Jurisdiction	Insurance in Force ($)	Total # Paid Claims	# Pre-FIRM Paid Claims	# Post-FIRM Paid Claims	Total Paid ($)
Unincorporated Tillamook County	386,949,800	385	278	107	5,609,231
Bay City	3,677,400	1	1	0	4,145
Garibaldi	5,642,600	3	3	0	35,848
Manzanita	48,555,000	1	0	1	1,954
Nehalem	7,546,500	14	12	2	228,326
Rockaway Beach	87,290,900	44	32	12	621,057
Tillamook	31,774,200	174	113	61	7,993,652
Wheeler	925,100	1	1	0	62,616
Total	**572,361,500**	**623**	**440**	**183**	**14,556,830**

Source: FEMA Community Information System [online database https://isource.fema.gov/cis/], accessed August 22, 2016

Repetitive Loss Properties

FEMA has identified 61 buildings in Tillamook County as repetitive loss (RL) properties. The NFIP defines a RL property as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period since 1978. At least two of the claims must be more than 10 days apart but within 10 years of each other. Or, the property must have incurred flood-related damage on 2 occasions, in which the cost of the repair, on average, equaled or exceeded 25% of the market value of the structure at the time of each such flood event.

Beyond identifying vulnerable buildings, the RL list provided by FEMA has value for hazard mitigation planning because the location of these buildings may indicate areas of persistent flood or drainage problems. The City of Tillamook is the only city in the state with RL buildings numbering in the double digits.

Severe Repetitive Loss Properties

Severe repetitive loss (SRL) properties are a subset of RL properties. SRL properties:

1. Are covered under a contract for flood insurance made available under the NFIP; and
2. Have incurred flood related damage:
   a. For which four or more separate claims payments have been made under flood insurance coverage with the amount of each such claim exceeding $5,000, and with the cumulative amount of such claims payments exceeding $20,000; or
   b. For which at least two separate claims payments have been made under such coverage, with the cumulative amount of such claims exceeding the market value of the insured structure.

Table 46. NFIP Repetitive Loss and Severe Repetitive Loss Buildings by Type

	Totals			Building Type													
				Single-Family		2-4 Family		Other Residential		Commercial		Industrial		Agricultural		Other Non-Residential	
Jurisdiction	**RL**	**SRL**	**Total**	**RL**	**SRL**	**RL**	**SRL**	**RL**	**SRL**	**RL**	**SRL**	**RL**	**SRL**	**RL**	**SRL**	**RL**	**SRL**
Unincorporated Tillamook County	41	2	43	27	2	1	0	1	0	4	0	0	0	5	0	3	0
Bay City	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Garibaldi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manzanita	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nehalem	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rockaway Beach	2	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Tillamook	16	0	16	4	0	0	0	0	0	11	0	0	0	1	0	0	0
Wheeler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**59**	**2**	**61**	**33**	**2**	**1**	**0**	**1**	**0**	**15**	**0**	**0**	**0**	**6**	**0**	**3**	**0**

Source: FEMA BureauNet, accessed August 7, 2017

Community Rating System (CRS)

Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS), which results in reduced flood insurance costs. The Cities of Nehalem and Tillamook participate in CRS. Tillamook County participated in the past and is in the process of rejoining the program.

Local Risk Assessment Methodology

Tillamook County executed the "OEM Methodology" in October 2015 considering probability of and vulnerability to floods throughout the county. The County rated probability high and vulnerability medium to high. The total score for flood was the highest of all the hazards considered and equal to the scores for winter storms, windstorms, and landslides.

Tillamook County and its cities executed the "OEM Methodology" again as an element of developing this risk assessment in September 2016. This time, Tillamook County considered only the rural areas of the county and the unincorporated urban communities of Neskowin, Oceanside-Netarts, and Pacific City. An assessment was also done by each city and the two ports. The assessment is based on the knowledge and experience of local officials and subject matter experts.

Tillamook County assessed its overall risk of flood as high. The State assessed Neskowin and Pacific City's risk as high and Oceanside and Netarts' risk as low. As some areas in the county are more at risk of flooding than others and the County's assessment was very general and qualitative, these assessments are considered to be not inconsistent. Bay City and Manzanita assessed their risk of flooding as low and Nehalem assessed it as high; the State's assessments agree. The State assessed Garibaldi's risk of flood as low; Garibaldi assessed it as moderate. The Port of Garibaldi assessed its vulnerability to flood as high. Rockaway Beach, Tillamook, and Wheeler all assessed their risk as high while the State assessed Rockaway Beach's and Tillamook's as moderate and Wheeler's as low. Clearly flooding is a concern of most jurisdictions in the county.

Table 47. Local Risk Assessment: Flood

Jurisdiction	History	Vulnerability	Maximum Threat	Probability	Total	Risk Level
Unincorporated Tillamook County, including Neskowin, Oceanside-Netarts, and Pacific City–Woods	18	45	90	70	223	High
Bay City	2	15	50	35	102	Low
Garibaldi	10	20	50	70	150	Moderate
Manzanita	0	5	10	0	15	Low
Nehalem	20	50	100	70	240	High
Rockaway Beach	20	40	90	70	220	High
Tillamook	20	50	100	70	240	High
Wheeler	14	45	100	56	215	High
Port of Tillamook Bay	18	45	90	70	223	High
Port of Garibaldi	18	40	100	70	228	High

Source: Based on information presented at the Tillamook County Multi-Jurisdictional NHMP Update Steering Committee Meeting, September 23, 2016

4. Landslides

Introduction

One of the most common and devastating geologic hazards in Oregon is landslides. Average annual repair costs for landslides in Oregon exceed $10 million and individual severe winter storm losses can exceed $100 million (Wang, Summers & Hofmeister, 2002). As population growth continues to expand and development into landslide susceptible terrain occurs, greater losses are likely to result.

Three main factors influence an area's susceptibility to landslides: geometry of the slope, geologic material, and water. Certain geologic formations are more susceptible to landslides than others. In general, locations with steep slopes are most susceptible to landslides, and the landslides occurring on steep slopes tend to move more rapidly and therefore may pose life safety risks.

Landslides in Oregon are typically triggered by periods of heavy rainfall and/or rapid snowmelt, such as those occurring during La Niña periods of the ENSO cycle. On the Oregon Coast, soft bluff soils can become saturated, increasing the likelihood of landslides. In addition, as waves remove sediment from the toe of a bluff its vulnerability to landslide increases. Earthquakes, volcanoes, and human activities also trigger landslides.

In general, the coast and Coast Range Mountains have a very high incidence of landslides. On occasion, major landslides occur on US or state highways and sever these major transportation routes (including rail lines), causing temporary but significant economic damage to the state. Less commonly, landslides and debris flows in this area cause loss of life.

Tillamook County has one of the highest landslide counts of the all Oregon counties (Oregon Department of Land Conservation and Development, 2015) on the basis of data in SLIDO-2 [Burns, Mickelson, & Saint-Pierre, 2011), and DOGAMI estimates that count to be potentially as little as 25% of those that actually exist. Although a statewide landslide susceptibility map was released in 2016 (Burns, Mickelson, & Madin, 2016), until landslides can be mapped using lidar and susceptibility modeled for Tillamook County, we will not fully understand the location and extent of its landslide hazards.

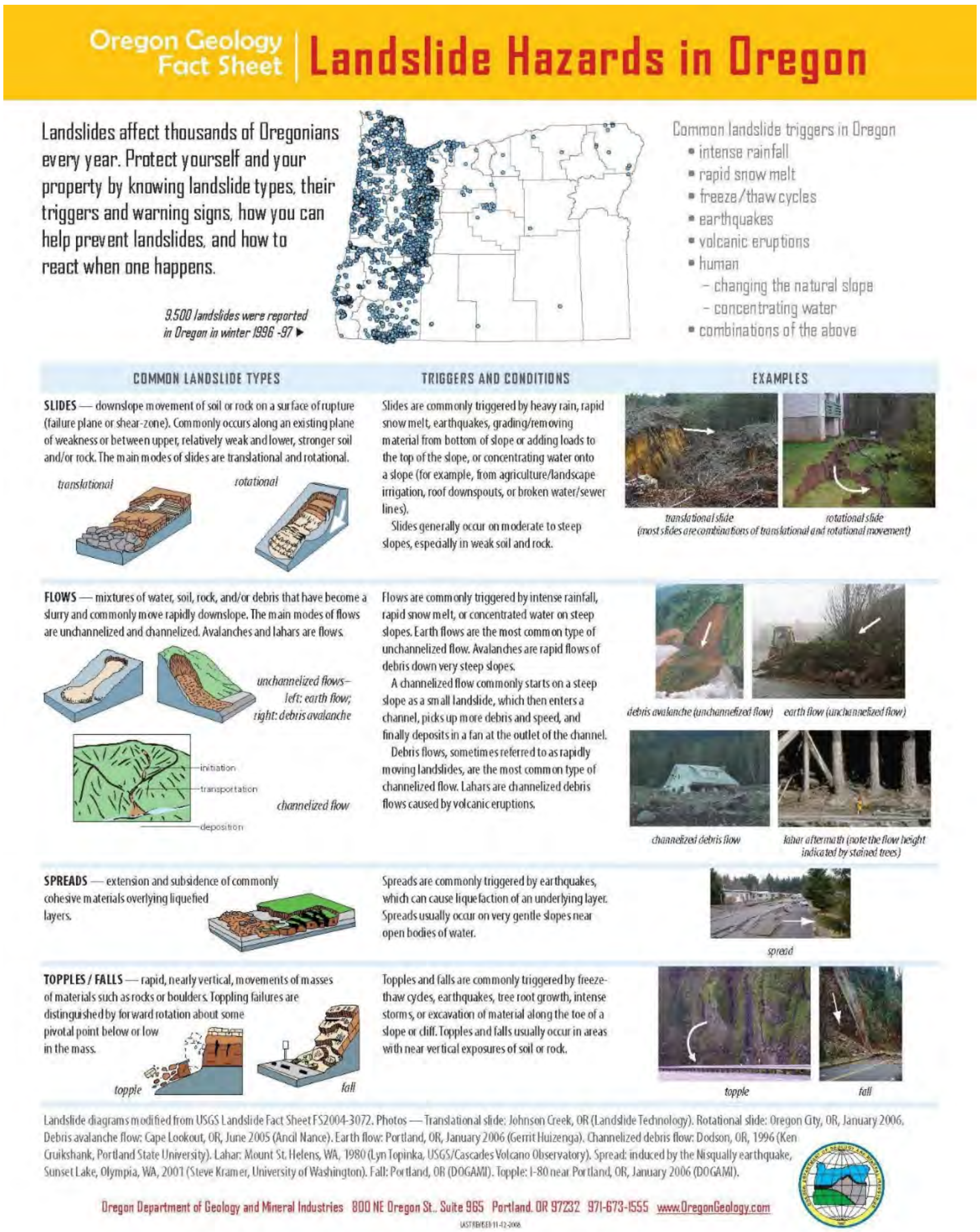
Types of Landslides

The general term "landslide" refers to a range of mass movement including rock falls, debris flows, earth slides, and other mass movements. All landslides have different frequencies of movements, triggering conditions, and very different resulting hazards.

All landslides can be classified into one the following six types of movements: (a) slides, (b) flows, (c) spreads, (c) topples, (d) falls, and (f) complex (**Figure 51**). Most slope failures are complex combinations of these distinct types, but the generalized groupings provide a useful means for framing discussion of the type of hazard associated with the landslide, the landslide characteristics, identification methods, and potential mitigation alternatives. These types of movements can be combined with other aspects of the landslide such as type of material, rate of movement, depth of failure, and water content for a better understanding of the type of landslide.

One potentially life-threatening type of landslide is the channelized debris flow or “rapidly moving landslide,” which initiates upslope, moves into and down a steep channel (or drainage) and deposits material, usually at the mouth of the channel. Debris flows are also commonly initiated by other types of landslides that occur on slopes near a channel. They can also initiate within the channel in areas of accelerated erosion during heavy rainfall or snowmelt. Rapidly moving landslides have caused most of the recent landslide related injuries and deaths in Oregon. Debris flows or rapidly moving landslides caused eight deaths in Oregon in 1996 following La Niña storms.

Figure 82. Common Types of Landslides in Oregon



Source: DOGAMI, Landslides in Oregon fact sheet (http://www.oregongeology.org/pubs/fs/landslide-factsheet.pdf)

Location

Table 48. Jurisdictions Subject to Landslides

Jurisdiction	Landslides
Unincorporated Tillamook County (rural)	X
Neskowin	X
Oceanside-Netarts	X
Pacific City	X
Bay City	X
Garibaldi	X
Manzanita	X
Nehalem	X
Rockaway Beach	X
Tillamook	
Wheeler	X
Port of Tillamook Bay	X
Port of Garibaldi	X

Source: Derived from DOGAMI (2016)

Hazard Characterization

Areas that have failed in the past often remain in a weakened state, and many of these areas tend to fail repeatedly over time. Other types of landslides tend to occur in the same locations.

The velocity of landslides varies from imperceptible to over 35 miles per hour. Some volcanic induced landslides have been known to travel between 50 to 150 miles per hour. Debris flows typically start on steep hillsides as shallow landslides, enter a channel, then liquefy and accelerate. Canyon bottoms, stream channels, and outlets of canyons can be particularly hazardous. Landslides can move long distances, sometimes as much as several miles. On less steep slopes, landslides tend to move slowly and cause damage gradually. Large, slow moving landslides frequently cause significant property damage, but are far less likely to result in serious injuries. One such landslide occurred in Tillamook County in 1997.

Landslide recurrence interval is highly variable. Some large landslides move continuously at very slow rates. Others move periodically during wet periods. Very steeply sloped areas can have relatively high landslide recurrence intervals (10 to 500 years on an initiation site basis).

Because debris flows can be initiated at many sites over a watershed, in some cases recurrence intervals can be less than 10 years. Slope alterations can greatly affect recurrence intervals for all types of landslides, and also cause landslides in areas otherwise not susceptible. Most slopes in Western Oregon steeper than 30 degrees (about 60%) have a risk of rapidly moving landslide activity regardless of geologic unit. Areas directly below these slopes in the paths of potential landslides are at risk as well. Based on the Oregon Department of Forestry storm impacts study (Robison et al., 1999), the debris flow hazard is high in much of the Coast Range.

Deep landslides are generally defined as having a failure plane within the regional bedrock unit (generally greater than 15 feet deep), whereas the failure plane of shallow landslides is commonly between the thin soil mantle and the top of the bedrock. Deep landslide hazard is high in parts of the Coast Range. Deep landslides are fairly common in fine-grained sedimentary rock units of the Coast Range. Deep landslides also occur in semi-consolidated sedimentary rocks in Tillamook County.

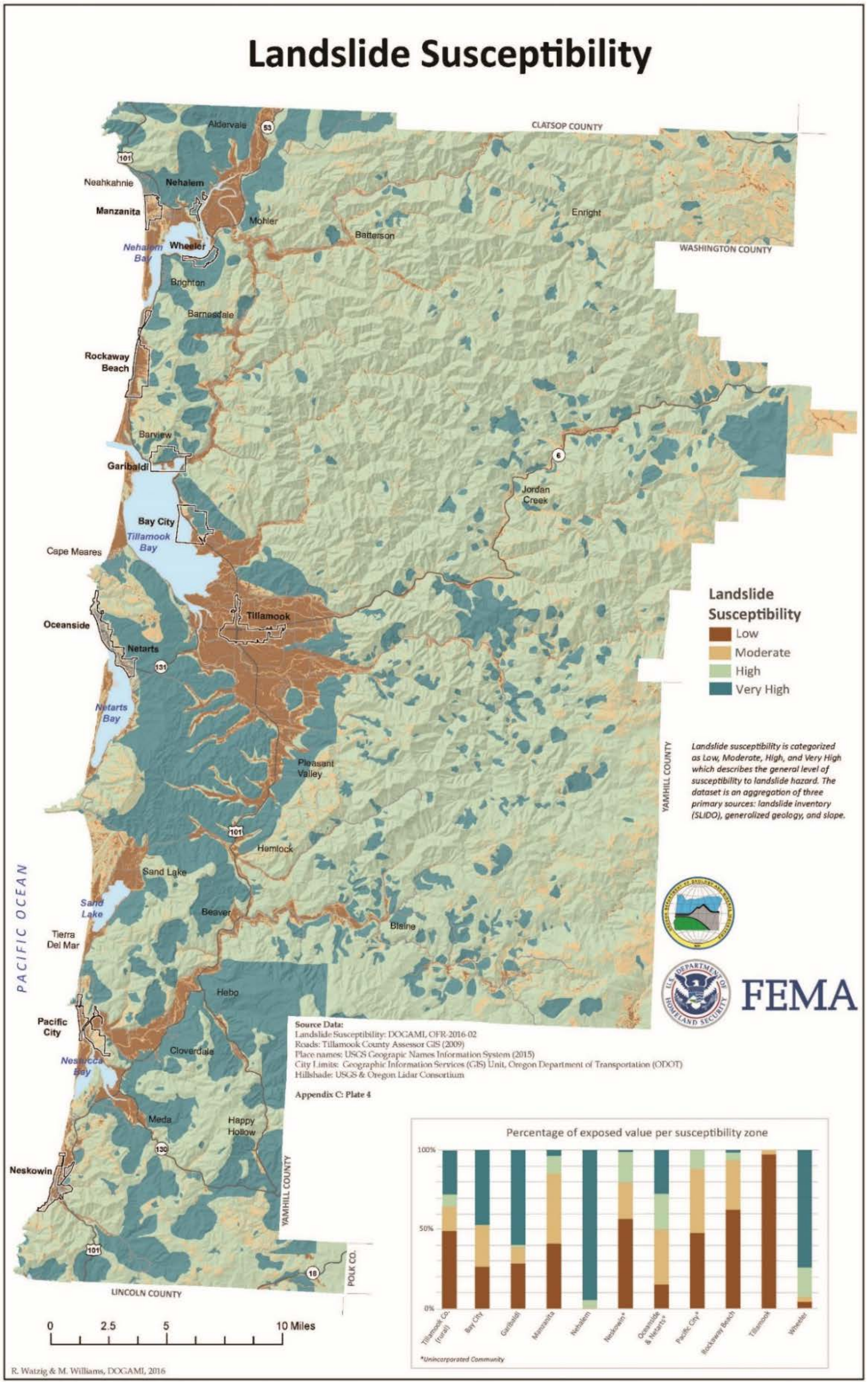
The ODF storm impacts study (Robison et al., 1999) estimated that tens of thousands of landslides occurred on steep slopes in the forests of Western Oregon during 1996. The Oregon Department of Geology and Mineral Industries' *Slope Failures in Oregon* (Hofmeister, 2000) inventoried thousands of reports of landslides across the state resulting from the 1996-97 storms. The number of injuries and deaths in the future will be directly related to vulnerability: the more people in these areas, the greater the risk of injury or death.

The *Landslide Susceptibility Overview Map of Oregon* (Burns et al., 2016) identifies the general level of susceptibility of a given area to primarily shallow and deep-seated landslides. It was developed by aggregating three primary sources: landslide inventory, generalized geology, and slope. The landslide inventory was taken from DOGAMI's previous landslide mapping effort, the *Statewide Landslide Information Database for Oregon* (Burns et al., 2011). Together these documents indicate that thousands of landslides have occurred throughout Tillamook County and much of the County is susceptible to future landslides.

Figure 83. Landslide in Tillamook County

Source: DLCD

Figure 84. Landslide Susceptibility



Source: DOGAMI (2016)

Historically Significant Landslides

Table 49. Historic Landslides in Tillamook County

Date	Location	Description
Feb. 1996	Statewide	FEMA-1099-DR-Oregon; heavy rains and rapidly melting snow contributed to hundreds of landslides and debris flows across the state, many on clear cuts that damaged logging roads
Dec. 2005–Jan. 2006	Western and Central Oregon including Tillamook County	FEMA-1632-DR; Oregon Severe Storms, Flooding, Landslides, and Mudslides
Nov. 2006	North Coast and Hood River County	FEMA-1672-DR; Oregon Severe Storms, Flooding, Landslides, and Mudslides
Dec. 2007	Clatsop and Tillamook	FEMA-1733-DR; Oregon Severe Storms, Flooding, Landslides, and Mudslides
Dec. 2008	Tillamook	FEMA-1824-DR; Severe Winter Storm, Record And Near Record Snow, Landslides, and Mudslides
Jan. 2011	Several counties from Western to Central Oregon including Tillamook County	FEMA-1956-DR; Severe Winter Storm, Flooding, Mudslides, Landslides and Debris Flows
Jan. 2012	Western Oregon including Tillamook County	FEMA-4055-DR; Oregon Severe Winter Storm, Flooding, Landslides, and Mudslides
Dec. 2015	Western Oregon including Tillamook County	FEMA-4258-DR: Oregon Severe Winter Storms, Straight-line Winds, Flooding, Landslides, and Mudslides

Sources: Taylor and Hatton (1999); EMA After-Action Report, 1996 events; interviews, Oregon Department of Transportation representatives; Hazards and Vulnerability Research Institute (2007); FEMA, Disaster Declarations for Oregon, https://www.fema.gov/disasters/grid/state-tribal-government/88?field_disaster_type_term_tid_1=All&order=field_disaster_declaration_date&sort=desc, accessed January 22, 2017

Probability

There is a 100% probability of landslides occurring in Tillamook County in the future. Although we do not know exactly where and when they will occur, they are more likely to happen in the general areas where landslides have occurred in the past. Also, they will likely occur during heavy rainfall events or during a future earthquake.

Climate Change

Flooding and landslides are projected to occur more frequently throughout western Oregon. Landslides in Oregon are strongly correlated with rainfall, so the likelihood of landslides may increase in areas where rainfall is projected to increase. Widespread damaging landslides that accompany intense rainstorms (such as "Pineapple Express" winter storms) and related floods occur during most winters. Particularly high consequence events occur about every decade; recent examples include those in February 1996, November 2006, and December 2007.

Vulnerability

Vulnerability expresses the impacts to people and the built environment anticipated from landslides.

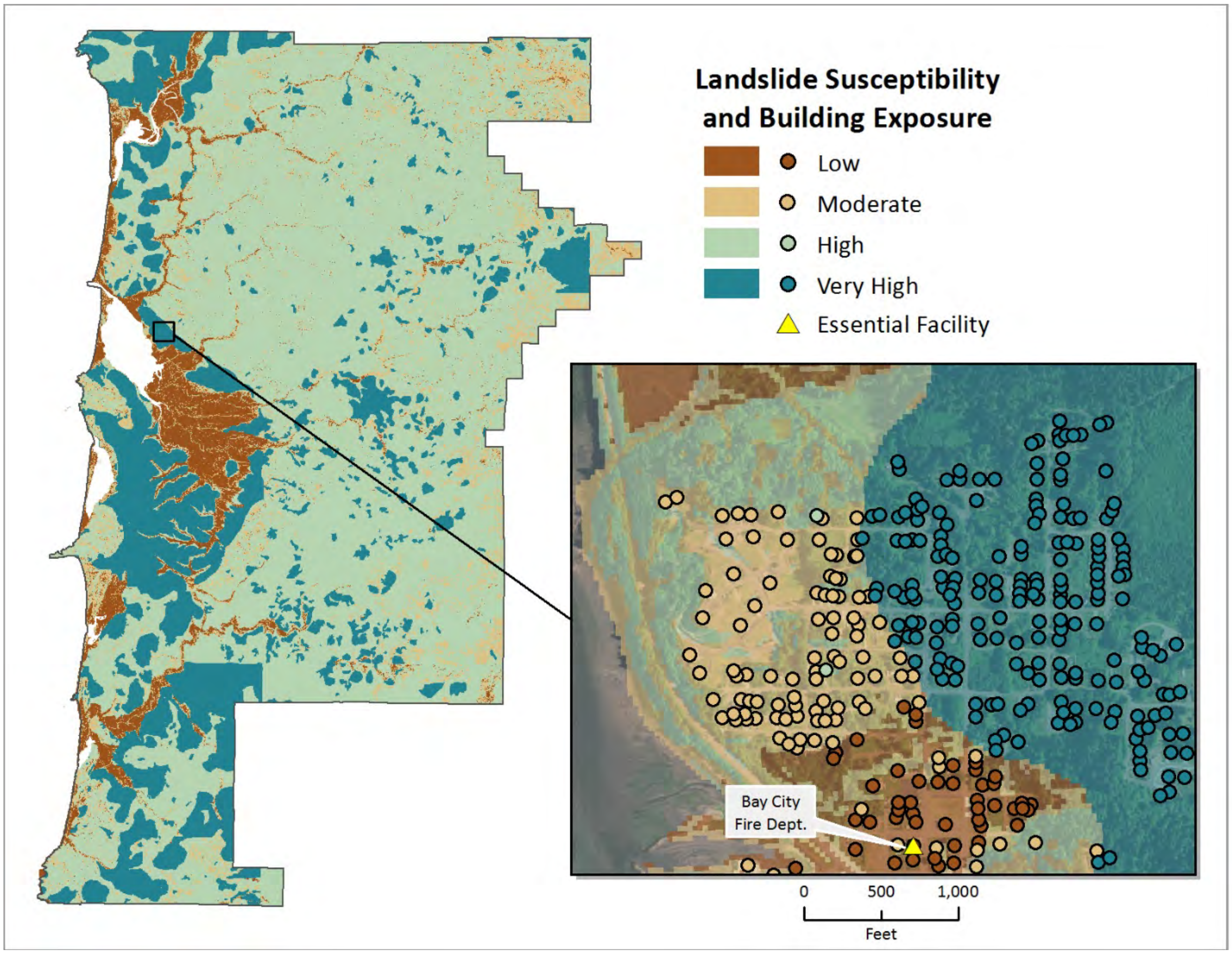
The new *Landslide Susceptibility Overview Map of Oregon* (Burns et al., 2016) indicates that many developed areas of Tillamook County are highly susceptible to damage and potentially loss of life from landslides.

Rain-induced landslides and debris flows can potentially occur during any winter in Tillamook County. Increased landslides due to climate change will cause more damage to property and infrastructure and will disrupt transportation and the distribution of water, food, and essential services. Some of the greatest exposure to damage from landslides in Tillamook County comes from the potential for injury and loss of life from rapidly moving landslides along the east-west roadways carrying traffic to and from the coast.

This area is also subject to future very large earthquakes, which will trigger landslides.

The *Final Draft Multi-Hazard Risk Report for Tillamook County* (DOGAMI, 2016) provides a landslide exposure analysis for Tillamook County. **Figure 85** provides an example of the building exposure analysis. Exposure analysis results are shown in **Table 50** and **Table 51**, and **Figure 86** illustrates those results.

Figure 85. Landslide Susceptibility and Building Exposure Example



Source: DOGAMI (2016)

All of the communities in Tillamook County are exposed to some level of landslide risk. Those with development in areas of moderate to steep slopes or at the base of steep slopes are at greater risk. Countywide, almost a third of the buildings located are in areas that are highly or very highly susceptible to landslides. Almost all the buildings in Nehalem, close to three quarters of the buildings in Wheeler and Garibaldi, and about half of the buildings in Bay City are located in areas of very high susceptibility to landslides. In Nehalem, 94% of the building value is in an area of very high landslide susceptibility. Should a landslide occur there, the community would suffer a tremendous loss in terms of both property damage and potentially loss of life, as 99% of the population would be displaced. Wheeler, Garibaldi, and Bay City would also be tremendously impacted. Ninety-three percent of Wheeler's population, 74% of Garibaldi's and 54% of Bay City's would be displaced.

The Port of Tillamook Bay is vulnerable to impacts from landslides due to the proximity of Anderson Hill to Port's eastern industrial park boundary. The Port's Truck Route runs through this area; a landslide here would likely result in the interruption of commerce throughout the industrial park and a fair amount of damage to buildings. The Bonneville Power Administration's electrical transmission lines that provide power to the greater Tillamook area run through the Anderson Hill area. An electrical substation belonging to the Tillamook People's Utility District lies adjacent to Anderson Hill. A landslide here could bring down power lines and damage the substation causing a major interruption of power impacting thousands of electrical customers.

Table 50. Landslide Exposure: Tillamook County and Cities

Community	Total Number of Buildings	Total Estimated Building Value ($)	Very High Susceptibility: Number of Buildings	Very High Susceptibility: Building Value ($)	Very High Susceptibility: Ratio of Exposure Value	High Susceptibility: Number of Buildings	High Susceptibility: Building Value ($)	High Susceptibility: Ratio of Exposure Value	Moderate Susceptibility: Number of Buildings	Moderate Susceptibility: Building Value ($)	Moderate Susceptibility: Ratio of Exposure Value
	(all dollar amounts in thousands)										
Unincorp. County (rural)	15,015	1,282,436	3,680	353,459	28%	1,253	95,872	7.5%	2,531	198,311	15%
Neskowin	653	118,463	8	1,353	1.1%	124	22,834	19%	195	26,971	23%
Oceanside-Netarts	1,701	203,363	446	55,589	27%	292	45,647	22%	652	70,937	35%
Pacific City–Woods	1,707	212,062	2	42	0.0%	181	24,888	12%	597	85,603	40%
Total Unincorp. County	**19,076**	**1,816,324**	**4,136**	**410,443**	**23%**	**1,850**	**189,240**	**10%**	**3,975**	**381,820**	**21%**
Bay City	884	74,770	476	35,108	47%	4	154	0.2%	261	19,717	26%
Garibaldi	755	64,331	516	38,377	60%	18	956	1.5%	84	6,627	10%
Manzanita	1,523	259,780	44	9,050	3.5%	162	29,389	11%	651	114,586	44%
Nehalem	260	24,886	250	23,502	94%	9	1,233	5.0%	1	151	0.6%
Rockaway Beach	2,240	211,809	19	2,932	1.4%	85	10,504	5.0%	661	65,832	31%
Tillamook	2,270	322,398	0	0	0.0%	1	13	0.0%	54	8,273	2.6%
Wheeler	363	30,556	263	22,601	74%	73	5,655	19%	10	947	3.1%
Total Tillamook County	**27,371**	**2,804,854**	**5,704**	**542,013**	**19.3%**	**2,202**	**237,145**	**8.5%**	**5,697**	**597,954**	**21%**

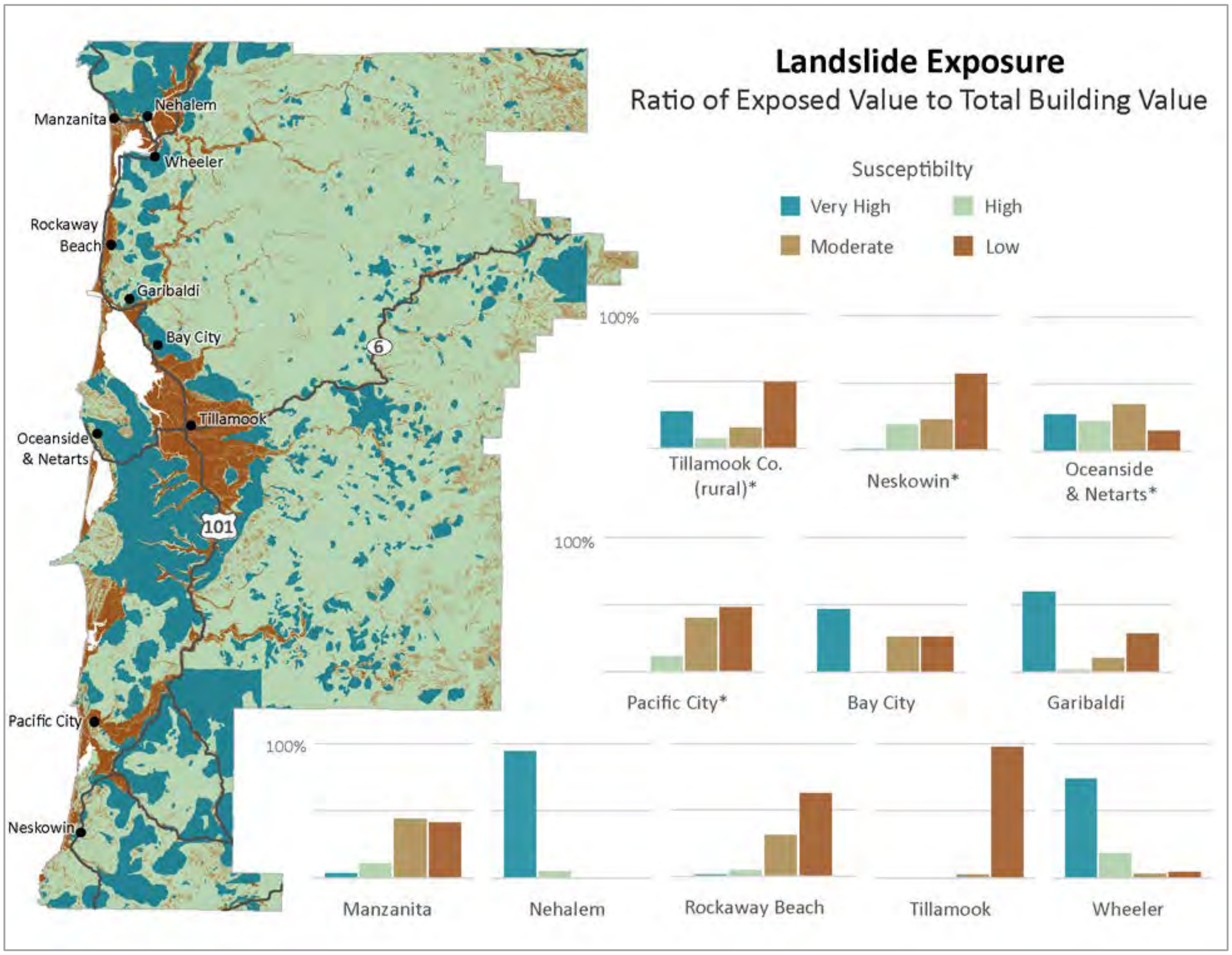
Source: DOGAMI (2016, Table A-6).

Table 51. Landslide Exposure: Port of Tillamook Bay and Port of Garibaldi

	Total Number of Buildings	Total Estimated Building Value ($)	Very High Susceptibility: Number of Buildings	Very High Susceptibility: Building Value ($)	Very High Susceptibility: Ratio of Exposure Value	High Susceptibility: Number of Buildings	High Susceptibility: Building Value ($)	High Susceptibility: Ratio of Exposure Value	Moderate Susceptibility: Number of Buildings	Moderate Susceptibility: Building Value ($)	Moderate Susceptibility: Ratio of Exposure Value
Port of Garibaldi	36	8,035,760	0	0	0%	2	78,810	0.98%	4	137,921	1.72%
Port of Tillamook	83	61,545,144	1	34,419	0.06%	1	22,425	0.04%	1	28,552	0.05%

Source: Derived from DOGAMI (2016, Table A-6)

Figure 86. Landslide Susceptibility Exposure by Community



*Unincorporated communities. Note that "Tillamook Co. (rural)" excludes incorporated communities, Pacific City, Oceanside/Netarts, and Neskowin.

Source: DOGAMI (2016)

Local Risk Assessment Methodology

Tillamook County executed the "OEM Methodology" in October 2015 considering probability of and vulnerability to landslides throughout the county. The County rated probability high and vulnerability moderate. The total score for landslides was the highest of all the hazards considered and equal to the scores for winter storms, windstorms, and floods.

Tillamook County and its cities executed the "OEM Methodology" again as an element of developing this risk assessment in September 2016. This time, Tillamook County considered only the rural areas of the county and the unincorporated urban communities of Neskowin, Oceanside-Netarts, and Pacific City. An assessment was also done by each city and the two ports. The assessment is based on the knowledge and experience of local officials and subject matter experts.

Tillamook County assessed its overall risk of landslides as moderate. The State assessed Oceanside and Netarts as well as small portions of Pacific City and Neskowin as being at high risk of landslides, most of the rest of the rural area as being at high or very high risk. Large areas surrounding the City of Tillamook and near Hebo are assessed as very high risk. Overall, it appears that the State considers the unincorporated areas and urban communities as more at risk of landslides than the County does. Bay City and Garibaldi assessed their risk as low; Nehalem assessed its as moderate. The State's assessment for all three is high or very high. Manzanita and Tillamook assessed their risk as low, and Wheeler assessed its as high. The State's assessment agrees.

Table 52. Local Risk Assessment: Landslide

Jurisdiction	History	Vulnerability	Maximum Threat	Probability	Total	Risk Level
Unincorporated Tillamook County, including Neskowin, Oceanside-Netarts, and Pacific City–Woods	16	30	60	63	169	Moderate
Bay City	10	15	50	35	110	Low
Garibaldi	6	25	80	7	118	Low
Manzanita	0	5	40	0	45	Low
Nehalem	6	25	80	21	132	Moderate
Rockaway Beach	4	50	100	28	182	Moderate
Tillamook	0	10	40	7	57	Low
Wheeler	12	25	100	35	172	High
Port of Tillamook Bay	10	40	80	56	186	Moderate
Port of Garibaldi	2	5	30	7	44	Low

Source: Based on information presented at the Tillamook County Multi-Jurisdictional NHMP Update Steering Committee Meeting, September 23, 2016

5. Severe Weather

Severe weather encompasses droughts, windstorms, and winter storms.

Droughts

Introduction

Despite its rainy reputation, the state of Oregon is often confronted with continuing challenges associated with drought and water scarcity. Precipitation in Oregon follows a distinct spatial and temporal pattern; it tends to fall mostly in the cool season (October–March). The Cascade Mountains block rain-producing weather patterns, creating a very arid and dry environment east of these mountains. Moist air masses originating from the Pacific Ocean cool and condense when they encounter the mountain range, depositing precipitation primarily on the inland valleys and coastal areas.

Oregon's water-related challenges are greater than just the temporal and spatial distribution of precipitation in Oregon. A rapidly growing population in the American West has placed a greater demand on this renewable, yet finite resource. The two terms, drought and water scarcity, are not necessarily synonymous; distinctly, water scarcity implies that demand is exceeding the supply. The combined effects of drought and water scarcity are far-reaching and merit special consideration.

Drought – The Nebulous Natural Hazard

- Drought is often associated with water scarcity, which usually is perceived as a "human-caused" hazard, rather than a "natural" hazard.
- Drought is frequently an "incremental" hazard, the onset and end are often difficult to determine. Also, its effects may accumulate slowly over a considerable period of time and may linger for years after the termination of the event.
- Quantifying impacts and provisions for disaster relief is a less clear task than it is for other natural hazards.
- The lack of a precise and universally accepted definition adds to the confusion about whether or not a drought actually exists.
- Droughts are often defined by growing seasons, the water year, and livestock impacts.

Drought is typically measured in terms of water availability in a defined geographic 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 does not provide a very accurate indication of drought conditions in Oregon and the Pacific Northwest, although it can be very useful because of its a long-term historical record of wet and dry conditions.

Types of Drought

Defining drought can be difficult given the issue of both water supply and demand. Redmond (2002) puts forth a simple definition that encapsulates both supply and demand, "drought is insufficient water to meet needs." Oregon's Legislative Assembly describes drought as a potential state emergency when a lack of water resources threatens the availability of essential services and jeopardizes the peace, health, safety, and welfare of the people of Oregon (Oregon Revised Statute §539.710).

Droughts can be characterized by the dominant impact caused by increased demand or decreased supply. In the early 1980s, researchers with the National Drought Mitigation Center and the National Center for Atmospheric Research located more than 150 published definitions of drought. There clearly was a need to categorize the hazard by "type of drought.” The following definitions are a response to that need. However, drought cannot always be neatly characterized by the following definitions, and sometimes all four definitions can be used to describe a specific instance of drought.

Meteorological or Climatological Droughts

Meteorological or climatological droughts usually are defined in terms of the departure from a normal precipitation pattern and the duration of the event. Drought is a slow-onset phenomenon that usually takes at least three months to develop and may last for several seasons or years.

Agricultural Droughts

Agricultural droughts link the various characteristics of meteorological drought to agricultural impacts. The focus is on precipitation shortages and soil-water deficits. Agricultural drought is largely the result of a deficit of soil moisture. A plant’s demand for water is dependent on prevailing weather conditions, biological characteristics of the specific plant, its stage of growth, and the physical and biological properties of the soil.

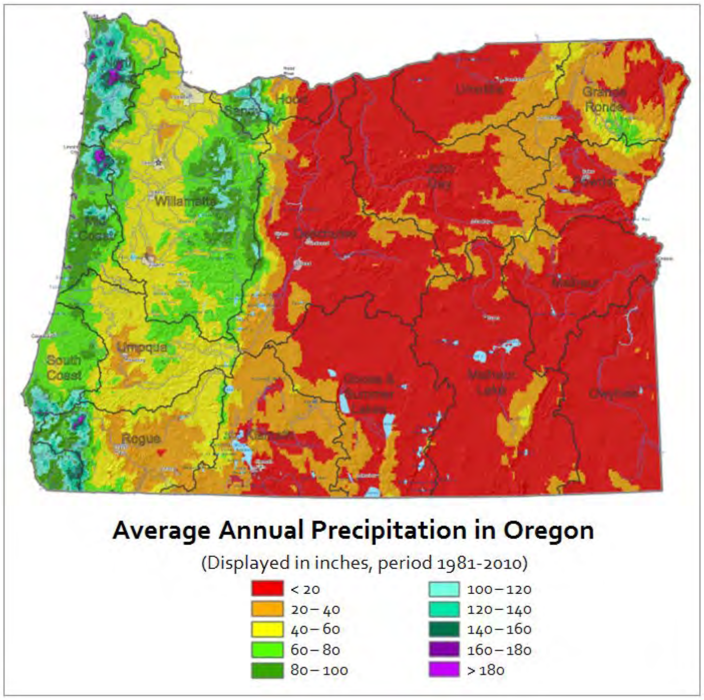
Hydrological Droughts

Hydrological droughts refer to deficiencies in surface water and sub-surface water supplies. It is reflected in the level of streamflow, lakes, reservoirs, and groundwater. Hydrological measurements are not the earliest indicators of drought. When precipitation is reduced or deficient over an extended period of time, the shortage will be reflected in declining surface and sub-surface water levels.

Socioeconomic Droughts

Socioeconomic droughts occur when physical water shortage begins to affect people, individually and collectively. Most socioeconomic definitions of drought associate it with supply, demand, and economic good. One could argue that a physical water shortage with no socio-economic impacts is a policy success.

Figure 87. Oregon Average Annual Precipitation, 1981–2010



Sources: PRISM Climate Group, Oregon State University (http://www.prism.oregonstate.edu/); map by Oregon Water Resources Department.

Location

Table 53. Jurisdictions Subject to Drought

Jurisdiction	Drought
Unincorporated Tillamook County (rural)	X
Neskowin	X
Oceanside-Netarts	X
Pacific City	X
Bay City	X
Garibaldi	X
Manzanita	X
Nehalem	X
Rockaway Beach	X
Tillamook	X
Wheeler	X
Port of Tillamook Bay	X
Port of Garibaldi	X

Source: Derived from DOGAMI (2016)

Hazard Characterization

Low streamflows prevailed in western Oregon during the period 1976–1981, but the worst year, by far, was 1976-77, the single driest year of the century. The Portland Airport received only 7.19 inches of precipitation between October 1976 and February 1977, only 31% of the average 23.16 inches for that period. This drought also impacted California and other parts of the West Coast. It is often acknowledged as one of the most significant droughts in Oregon's history.

The 1992 drought was not as severe as the 1976-77 drought; however, it did occur toward the end of several years of drier than normal conditions in the late 1980s and early 1990s, making it the peak year for drought conditions. The Governor declared a drought emergency for all Oregon counties (Executive Order 92-21). Forests throughout the state suffered from a lack of moisture. Fires were common and insect pests, which attacked the trees, flourished.

In 2001 and 2002, Oregon experienced drought conditions, affecting most of the state including the coast. More recent droughts have not affected the coast.

Historic Drought Events

Table 54. Historic Droughts and Dry Periods in Tillamook County

Date	Location	Description
1924	statewide	prolonged statewide drought that caused major problems for agriculture
1928–41	statewide	the 1920s and 1930s, known more commonly as the Dust Bowl, were a period of prolonged drier than normal conditions across much of the state and country; moderate to severe drought affected much of the state; caused major problems for agriculture; the three Tillamook burns, in the normally wet coastal range, the first in 1933, were the most significant impacts of this very dry period
1939	statewide	Water Year 1939 was one of the more significant drought years for the Oregon Coast; the second of the three Tillamook Burns started in 1939
1976-77	western Oregon	the 1977 drought was one of the most significant on record in western Oregon
1985–94	statewide	generally dry period, capped by statewide droughts in 1992 and 1994; the Oregon Coast suffered a severe drought in 1992; the winter of 1991-92 was a moderate El Niño event, which can manifest itself in warmer and drier winters in Oregon; Governor declared a drought for all 36 counties in September 1992; 10 consecutive years of dry conditions caused problems throughout the state, such as fires and insect outbreaks
2001-02	statewide except Portland metro area and northern Willamette Valley	the second most intense drought in Oregon's history; 18 counties with state drought declaration (2001); 23 counties state-declared drought (2002); some of the 2001 and 2002 drought declarations were in effect through June or December 2003

Sources: Taylor and Hatton (1999); Governor-declared drought declarations obtained from the Oregon State Archives division (http://sos.oregon.gov/archives/); NOAA's Climate at a Glance (https://www.ncdc.noaa.gov/cag/); Western Regional Climate Center's Westwide Drought Tracker, (http://www.wrcc.dri.edu/wwdt); Kathie Dello, Oregon Climate Service, Oregon State University, personal communication.

Probability

Drought is a normal, recurrent feature of climate. Despite impressive achievements in the science of climatology, estimating drought probability and frequency continues to be difficult. This is because of the many variables that contribute to weather behavior, climate change, and the absence of historic information. Based on limited data, the probability of drought occurring in Tillamook County is low.

Climate Variability

The variability of Oregon's climate often can be attributed to long-term oscillations in the equatorial Pacific Ocean: El Niño and La Niña. Simply stated, these systems involve the movement of abnormally warm or cool water into the eastern Pacific, dramatically affecting the weather in the Pacific Northwest. El Niño tends to bring warm and dry winters; the inverse is true with La Niña. However, there have been wet years during an El Niño event, dry years in a La Niña, and both types of water years in neutral conditions. In other words, El Niño and La Niña do not explain all of the variability in every given winter. Also, climate change is reducing the robustness of the low-elevation snowpack, which will likely influence the frequency of drought conditions and associated impacts on Oregon communities.

An El Niño system moves heat, both in terms of water temperature and in atmospheric convection. The heat is transported toward North America, producing mild temperatures and dry conditions in Oregon. Its effects are most pronounced from December through March.

La Niña conditions are more or less opposite of those created by El Niño. It involves the movement of abnormally cool water into the eastern Pacific. This event produces cooler than normal temperatures in Oregon and increased precipitation. It also is most pronounced from December to March.

Predicting Droughts in Oregon

Predicting weather patterns is difficult at best; however, the 1997-98 El Niño event marked the first time in history that climate scientists were able to predict abnormal flooding and drought months in advance for various locations around the United States (http://www.nationalgeographic.com/elnino/mainpage2.html). The methodology consists of monitoring water temperatures, air temperatures, and relative humidity plus measuring sea-surface elevations. Once an El Niño or La Niña pattern is established, climatologists can project regional climatic behavior. Although the scientific community is optimistic about its recent forecasting achievements, not all droughts are associated with El Niño or La Niña events.

Climate Change

Climate models project warmer, drier summers for Oregon, with mean projected seasonal increases in summer temperatures of 2.6 °C to 3.6 °C by mid-century, and a decline in mean summer precipitation amounts of 5.6 to 7.5% by mid-century. These summer conditions will be coupled with projected decreases in mountain snowpack due to warmer winter temperatures. Models project a mean increase in winter temperatures of 2.5 °C to 3.2 °C by mid-century. This combination of factors exacerbates the likelihood of drought. These same conditions often lead to an increase in the likelihood of wildfires.

Vulnerability

Droughts are not just a summer-time phenomenon; winter droughts can have a profound impact on the state's agricultural sector, particularly east of the Cascade Mountains. Below-average snowfall in Oregon's higher elevations has a far-reaching effect on the entire state, especially in terms of hydroelectric power generation, irrigation, recreation, and industrial uses.

There also are environmental consequences. A prolonged drought in Oregon's forests promotes an increase of insect pests, which in turn, damage trees already weakened by a lack of water. Water stress brought on by drought and other factors is the central cause in tree mortality events (Oregon Department of Forestry, 2008). A moisture-deficient forest constitutes a significant fire hazard. In addition, drought and water scarcity add another dimension of stress to imperiled species.

The following addresses the impacts of a severe or prolonged drought on the population, infrastructure, facilities, economy, and environment generally in Oregon:

Population

Droughts can affect all segments of Oregon'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) during times of drought and could see increases in electricity consumption and associated costs.

Infrastructure

Infrastructure such as highways, bridges, energy and water conveyance systems, etc., is typically unaffected by drought. However drought can cause structural damage. An example would include be areas of severe soil shrinkage. In these uncommon situations, soil shrinkage would affect the foundation upon which the infrastructure was built. In addition, water-borne transportation systems (e.g., ferries, barges, etc.) could be impacted by periods of low water.

Critical/essential facilities

Facilities affected by drought conditions include communications facilities, hospitals, and correctional facilities that are subject to power failures. Storage systems for potable water, sewage treatment facilities, water storage for firefighting, and hydroelectric generating plants also are vulnerable. Low water also means reduced hydroelectric production especially as the habitat benefits of water compete with other beneficial uses.

State-owned or -operated facilities

A variety of state-owned or -operated facilities could be affected by a prolonged drought. The most obvious include schools, universities, office buildings, health-care facilities, etc. Power outages are always a concern. Maintenance activities (e.g., grounds, parks, etc.) may be curtailed during periods of drought. The Oregon Parks and Recreation Department operates several campground and day-use facilities that could be impacted by a drought.

Economy

Drought has an impact on a variety of economic sectors. These include water-dependent activities and economic activities requiring significant amounts of hydroelectric power. The agricultural sector is especially vulnerable as are some recreation-based economies (e.g., boating, fishing, water or snow skiing). Whole communities can be affected. This was particularly evident during the 2001 water year when many Oregon counties sought relief through state and federal drought assistance programs.

Environment

Oregon has several fish species listed as threatened or endangered under the Endangered Species Act (ESA). Some of these species have habitat requirements that are jeopardized by the needs or desires of humans. For example, in times of scarcity, the amount of water needed to maintain habitat for fish species may conflict with the needs of consumptive uses of water. The state of Oregon is committed to implementation of the ESA and the viability of a productive economic base. There are no easy solutions, only continuous work to resolve difficult drought situations.

Based on a review of Governor-declared drought declarations since 1992, Tillamook County is less vulnerable to drought impacts than most of Oregon. Nevertheless, even short-term droughts can be problematic. Potential impacts to community water supplies are the greatest threat. Tillamook County's dairy industry can suffer catastrophic losses due to lack of feed production and therefore milk production. The economic consequences would impact not only individual dairy farmers but also the local and state economies. Long-term drought periods of more than a year can impact forest conditions and set the stage for potentially devastating wildfires. Severe drought conditions resulted in the four disastrous Tillamook fires (1933, 1939, 1945, and 1951), collectively known as the Tillamook Burn.

The Port of Garibaldi could suffer secondary impacts from drought. Droughts both local and in Southern Oregon and Northern California can affect current year fish returns and impact quotas for upcoming years. These reduced numbers can have a drastic impact on the local economy for both the commercial fishing and seafood processing industries. Low fish stock returns can also drastically impact the local sport fishing industry having negative impacts on the many support services in and around the Port of Garibaldi such as charter business, restaurants, hotels, fuel sales, grocery sales, and others.

Local Risk Assessment Methodology

Tillamook County executed the “OEM Methodology” in October 2015 considering probability of and vulnerability to drought throughout the county. The County rated probability low and vulnerability moderate. The total score for drought trailed the scores for floods, winter storms, windstorms, landslides, earthquakes and volcanic ash fall.

Tillamook County and its cities executed the “OEM Methodology” again as an element of developing this risk assessment in September 2016. This time, Tillamook County considered only the rural areas of the county and the unincorporated urban communities of Neskowin, Oceanside-Netarts, and Pacific City. An assessment was also done by each city and the two ports. The assessment is based on the knowledge and experience of local officials and subject matter experts.

Most jurisdictions in Tillamook County assessed their risk of drought as low; one as moderate; and two as high. Both that were assessed as high were assessed in conjunction with windstorms and winter storms. Therefore it is not clear that risk of drought alone would have been assessed as high. The State assessment is that Tillamook County is susceptible to drought, but less so than other areas of the state. When drought does occur, the county as a whole can be quite vulnerable.

Table 55. Local Risk Assessment: Drought

Jurisdiction	History	Vulnerability	Maximum Threat	Probability	Total	Risk Level
Unincorporated Tillamook County, including Neskowin, Oceanside-Netarts, and Pacific City–Woods	Not Assessed	Not Assessed	Not Assessed	Not Assessed	Not Assessed	Not Assessed
Bay City	2	20	90	28	140	Low
Garibaldi*	12	15	50	42	119	Low
Manzanita	0	20	40	0	60	Low
Nehalem*	16	30	90	56	192	High
Rockaway Beach*	20	45	100	56	221	High
Tillamook	0	15	30	0	45	Low
Wheeler	8	15	80	56	159	Moderate
Port of Tillamook Bay	0	5	10	7	22	Low
Port of Garibaldi	2	5	10	7	24	Low

*Assessed as part of “severe weather” together with windstorms and winter storms.

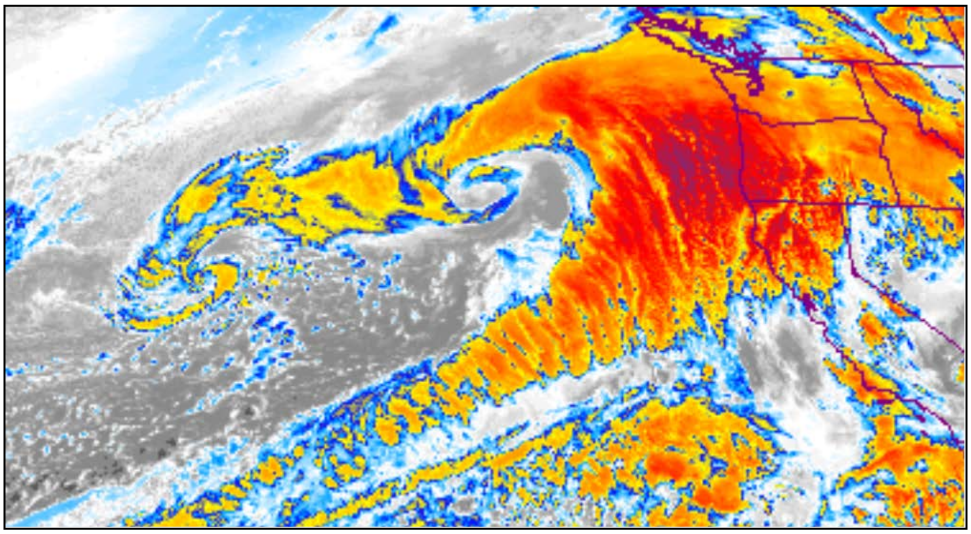
Source: Based on information presented at the Tillamook County Multi-Jurisdictional NHMP Update Steering Committee Meeting, September 23, 2016

Windstorms

Introduction

This section covers most kinds of windstorm events in Oregon, including the wind aspects of Pacific storm events. The precipitation aspects of Pacific storm events are covered with floods. Winds specifically associated with blizzards and ice storms are covered with Winter Storms.

Figure 88. Satellite Image of the Type of Severe Pacific Storm that Can Bring High Winds to Western Oregon



Source: NOAA

Types of Windstorms

High winds can be among the most destructive weather events in Oregon; they are especially common in the exposed coastal regions and in the mountains of the Coast Range. Most official wind observations in Oregon are sparse, taken at low-elevation locations where both the surface friction and the blocking action of the mountain ranges substantially decrease the speed of surface winds. Furthermore, there are few long-term reliable records of wind available. Even the more exposed areas of the coast are lacking in any long-term set of wind records. From unofficial, but reliable observations, it is reasonable to assume that gusts well above 100 mph occur several times each year across the higher ridges of the Coast and Cascade Ranges. At the most exposed Coast Range ridges, it is estimated that wind gusts of up to 150 mph and sustained speeds of 110 mph will occur every 5–10 years.

Destructive wind storms are less frequent, and their pattern is fairly well known. They form over the North Pacific during the cool months (October through March), move along the coast, and swing inland in a northeasterly direction. Wind speeds vary with the storms. Gusts exceeding 100 miles per hour have been recorded at several coastal locations but lessen as storms move inland. These storms, such as the Columbus Day Storm of October 1962, can be very destructive. Less destructive storms can topple trees and power lines and cause building damage. Flooding can be an additional problem. A large percentage of Oregon's annual precipitation comes from these events (Taylor & Hatton, 1999; FEMA-1405-DR-OR, https://www.fema.gov/disaster/1405; Oregon Emergency Management and the Federal Emergency Management Agency, 2002).

Tornadoes, while generally not associated with the State of Oregon, do occur, and have occurred on the Oregon Coast and in Tillamook County. The first recorded tornado on the Oregon Coast occurred in 1897. They are characteristically brief and small, but also damaging.

Location

Table 56. Jurisdictions Subject to Windstorms

Jurisdiction	Windstorms
Unincorporated Tillamook County (rural)	X
Neskowin	X
Oceanside-Netarts	X
Pacific City–Woods	X
Bay City	X
Garibaldi	X
Manzanita	X
Nehalem	X
Rockaway Beach	X
Tillamook	X
Wheeler	X
Port of Tillamook Bay	X
Port of Garibaldi	X

Source: Derived from DOGAMI (2016)

Hazard Characterization

Pacific storms can produce high winds and often are accompanied by significant precipitation and low barometric pressure. These storms usually produce the highest winds in Western Oregon, especially in the coastal zone. These storms are most common from October through March. The impacts of these storms on the state are influenced by storm location, intensity, and local terrain.

Additional wind hazards occur on a very localized level, due to several down-slope windstorms along mountainous terrain. These regional phenomena known as foehn-type winds, result in winds exceeding 100 mph, but they are of short duration and affect relatively small geographic areas.

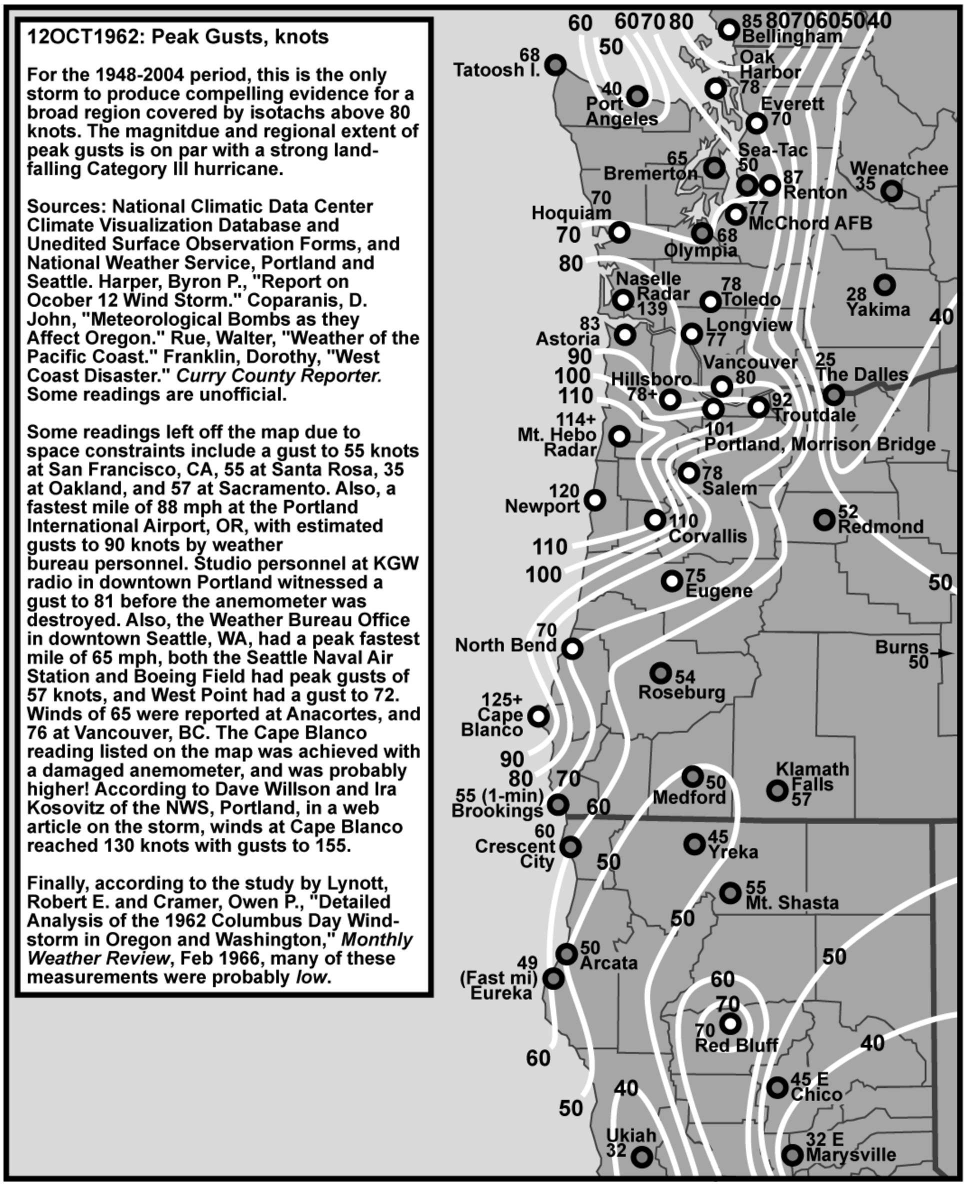
The historian Lancaster Pollard documented exceptional storms that occurred in 1880, 1888, 1920, 1931, and 1962. On January 29, 1920 a hurricane off the mouth of the Columbia River had winds estimated at 160 miles per hour (Pitzer, 1988).

One easterly windstorm that affected much of Oregon, particularly northern Oregon, was the northeasterly gale of April 21-22, 1931. This storm proved to be very destructive. Dust was reported by ships 600 miles out to sea. "While officially recorded wind speeds were not extreme, sustained wind speeds observed were 36 mph at Medford, 32 mph at Portland, 28 mph at Baker, and 27 mph at

Roseburg. Unofficial wind measuring equipment reported winds of up to 78 mph. Damage was heavy to standing timber and fruit orchards" (http://www.wrh.noaa.gov/Portland/windstorm.html).

The most destructive winds are those that blow from the south, parallel to the major mountain ranges. The Columbus Day Storm of 1962 was a classic example of a south windstorm. The storm developed from Typhoon Freda remnants in the Gulf of Alaska, deepened off the coast of California and moved from the southwest, then turned, coming into Oregon directly from the south. This was the most damaging windstorm in Oregon of the last century. Winds in the Willamette Valley topped 100 mph, while in the Coast Range they exceeded 140 mph. The Columbus Day Storm was the equivalent of a Category IV hurricane in terms of central pressure and wind speeds.

Figure 89. Peak Gusts for Windstorm on October 12, 1962



Source: Wolf Read, Climatologist, Oregon Climate Center, Oregon State University, http://www.climate.washington.edu/stormking/October1962.html

Historic Windstorm Events

Table 57. Historic Windstorms in, near, or Impacting Tillamook County

Date	Location	Description	Remarks
Jan. 1880	western Oregon	very high winds, 65-80 mph near Portland	flying debris; fallen trees
Jan. 1921	Oregon coast / Lower Columbia	winds 113 mph at mouth of Columbia; gusts at Astoria, 130 mph	widespread damage
Apr. 1931	western Oregon	unofficial reports of wind speeds up to 78 mph	widespread damage
Nov. 1951	most of Oregon	winds 40–60 mph with 75–80 mph gusts	widespread damage, especially to transmission lines
Dec. 1951	most of Oregon	winds, 60–100 mph, strongest along coast	many damaged buildings; telephone/power lines down
Jan. 1956	western Oregon	heavy rains, high winds, mud slides	estimated damage: $95,000 (1956 dollars)
Nov. 1958	most of Oregon	wind gusts to 75 mph at Astoria; gusts to 131 mph at Hebo	damage to buildings and utility lines
Oct.. 1962	statewide	wind speeds of 131 mph on the Oregon coast (Columbus Day Windstorm Event)	Oregon's most destructive storm: 23 fatalities; damage at $170 million
Mar. 1963	Coast and NW Oregon	100 mph gusts (unofficial)	widespread damage
Oct. 1967	western and N. Oregon	winds on Oregon Coast 100–115 mph	significant damage to buildings, agriculture, and timber
Mar. 1971	most of Oregon	notable damage in Newport	falling trees took out power lines; building damage
Nov. 1981	Oregon coast and N. Willamette Valley, Oregon	back-to-back storms on Nov. 13 and 15	
Jan. 1986	N and central Oregon coast	75 mph winds	damaged trees, buildings, power lines
Dec. 1987	Oregon coast / NW Oregon	winds on coast 60 mph	saturated ground enabled winds to uproot trees
Mar. 1988	N. and central coast	wind gusts 55–75 mph	one fatality near Ecola State Park; uprooted trees
Jan. 1990	statewide	100 mph winds in Netarts and Oceanside	one fatality; damaged buildings; falling trees (FEMA-853-DR-Oregon)
Feb. 1990	Oregon coast	wind gusts of 53 mph at Netarts	damage to docks, piers, boats
Jan. 1991	most of Oregon	winds of 63 mph at Netarts; 57 at Seaside	75-foot trawler sank NW of Astoria
Nov. 1991	Oregon coast	slow-moving storm; 25-foot waves off shore	buildings, boats, damaged; transmission lines down
Jan. 1993	Oregon coast / N. Oregon	Tillamook wind gusts at 98 mph	widespread damage, esp. Nehalem Valley
Dec. 1995	statewide	wind gusts over 100 mph; Sea Lion Caves: 119 mph; followed path of Columbus Day Storm (Dec. 1962)	four fatalities; many injuries; widespread damage (FEMA-1107-DR-Oregon)
Nov. 1997	western Oregon	winds of 89 mph at Florence; 80 mph at Netarts and Newport	severe beach erosion; trees toppled

Date	Location	Description	Remarks
Dec. 2004	Tillamook County		$6,250 in property damage (figure includes damages outside of Tillamook County)
Jan. 2006	Clatsop, Tillamook, Lincoln, Lane Counties	two storm events with high winds of 86 mph and 103 mph	$244,444 and $144,444 in estimated property damage among all four coastal counties; the storm also impacted 5 other counties outside Region 1; total damages equal $300,000 and $200,000, respectively
Feb. 2006	Clatsop, Tillamook, Lincoln, Lane Counties	wind storm event with winds measured at 77 mph	$150,000 and $91,600 in estimated property damage among all four coastal counties; the storm also impacted nine other counties outside of Region 1; total damages equal $300,000 and $275,000
Mar. 2006	Clatsop, Tillamook, Lincoln, Lane Counties	two wind storm events with winds measured at 60 mph and 75 mph	$75,000 and $211,000 in estimated property damage among all four coastal counties; the storms also impacted 10 other counties outside of Region 1; total damages equal $75,000 and $475,000
Dec. 2006	Clatsop, Tillamook Counties	storm with high winds	total of $10,000 in damages
Feb. 2007	NW and central coast and north central Oregon	severe winter storm with a wind component	FEMA-1683-DR-Oregon
Nov. 2007	Clatsop, Tillamook Counties	storm with high winds	total of $10,000 in damages
Dec. 2007	Clatsop, Tillamook Counties	series of powerful Pacific storms	resulted in Presidential Disaster Declaration; $180 million in damage in the state, power outages for several days, and five deaths attributed to the storm
Dec. 2008	Clatsop, Lane, Tillamook, Lincoln Counties	intense wind and rain events	resulted in nearly $8 million in estimated property and crop damages for Clatsop, Lane, Tillamook, and Lincoln Counties

Sources: Oregon Climate Service, http://www.ocs.oregonstate.edu/; Pitzer (1988)

Table 58. Tornadoes Recorded in Tillamook County

Date	Location	Remarks
June 1897	Bay City, Oregon	observed, but no damage recorded
Dec. 1975	Tillamook, Oregon	90 mph wind speed; damage to several buildings
Oct. 2016	Manzanita, Oregon	20 homes and several businesses damaged; no injuries
OCt. 2016	Oceanside, Oregon	no damage

Sources: National Weather Service, Portland; Taylor and Hatton (1999); Storm Events Database, http://www.ncdc.noaa.gov/stormevents/; Hazards and Vulnerability Research Institute (2007); US Tornado Climatology, http://www.ncdc.noaa.gov/oa/climate/severeweather/tornadoes.html

Probability

The Central and North Coast experience the highest wind speeds under the influence of winter low-pressure systems in the Gulf of Alaska and North Pacific Ocean, and the Columbia River Gorge, when cold air masses funnel down through the canyon in an easterly direction.

The much more frequent and widespread strong winds from the southwest are associated with storms moving onto the coast from the Pacific Ocean. If winds are from the west, they are often stronger on the coast than in interior valleys due to the north-south orientations of the Coast Range and Cascades. These mountain ranges obstruct and slow the westerly surface winds.

High winds are especially common in coastal regions and in the mountains of the Coast Range between October and March. From unofficial but reliable observations, it is reasonable to assume that gusts well above 100 mph occur several times each year across the higher ridges of the Coast and Cascades Ranges. At the most exposed Coast Range ridges, it is estimated that wind gusts of up to 150 mph and sustained speeds of 110 mph will occur every 5 to 10 years.

The probability of a severe wind event is expressed as a percentage annual probability or a specific return interval, similar to the probability of a flood. A 25-year event is a storm with one-minute average wind speed of 75 mph and a 4% chance of occurring each year. A 50-year event has a one-minute average wind speed of 80 mph and a 2% chance of occurring each year. A 100-year event has a one-minute wind speed of 90 mph and a 1% chance of occurring each year (Oregon Public Utilities Commission).

Climate Change

There is insufficient research on changes in the likelihood of wind storms in the Pacific Northwest as a result of climate change.

Vulnerability

The damaging effects of windstorms may extend for distances of 100 to 300 miles from the center of storm activity. Isolated wind phenomena in the mountainous regions have more localized effects. Near-surface winds and associated pressure effects exert loads on walls, doors, windows, and roofs, sometimes causing structural components to fail.

Positive wind pressure is a direct and frontal assault on a structure, pushing walls, doors, and windows inward. Negative pressure also affects the sides and roof: passing currents create lift and suction forces that act to pull building components and surfaces outward. The effects of high-velocity winds are magnified in the upper levels of multi-story structures. As positive and negative forces impact and remove the building protective envelope (doors, windows, and walls), internal pressures rise and result in roof or leeward building component failures and considerable structural damage. Structures most vulnerable to high winds in Tillamook County include insufficiently anchored manufactured homes and older buildings in need of roof repair.

Debris carried along by extreme winds can directly contribute to loss of life and indirectly to the failure of protective building envelope components. Upon impact, wind-driven debris can rupture a building, allowing more significant positive and internal pressures. When severe windstorms strike a community, downed trees, power lines, and damaged property are major hindrances to response and recovery.

Many buildings, utilities, and transportation systems in Tillamook County are vulnerable to wind damage. This is especially true in open areas, natural grasslands, or farmland. It also is 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.

Fallen trees are especially troublesome. They can block roads and rails for long periods, which can affect emergency operations. In addition, uprooted or shattered trees can down power and/or utility lines, effectively bringing local economic activity and other essential activities to a standstill. Much of the problem may be attributed to a shallow or weakened root system in saturated ground. Many roofs have been destroyed by uprooted ancient trees growing next to a house.

Unstable trees near electric lines left after a logging operation near electric lines pose a serious threat of personal injury, forest fire, and outages should high winds develop. Forest owners and workers need to coordinate their "leave trees" with electric utilities to prevent dangerous conditions as depicted in Figure 57.

Figure 90. Unstable Trees near Electric Lines Remaining after a Logging Operation

Photo source: Randy Miller, PacifiCorp

Wind-driven waves are common along the Oregon coast and are responsible for road and highway wash-outs and the erosion of beaches and headlands.

Windstorms and winter storms pose the greatest threat to the Port of Garibaldi's infrastructure due to their frequency and the Port's exposure and vulnerability. At the Port, it is common for high winds to exceed 70 mph with gusts up to 100 mph and damage buildings and mooring facilities. Over the last 15 years, many roofs and structures have sustained damage during windstorms and winter storms.

High winds out of the south create rough water conditions on Tillamook Bay causing swells that impact Port property by eroding all exposed areas. These swells also cause a severe surge to enter the boat basin, which can damage docks and exposed vessels.

The Port of Tillamook Bay has suffered multiple losses from windstorms over many years. Hangar B, which houses the Tillamook Air Museum and other tenants is a prime example. High winds from the southwest wreak havoc on the southern portion of this building. Other Port buildings, most of which were constructed in the 1940s, are similarly vulnerable to these high-wind events.

In 1962 dollars, the Columbus Day Storm caused an estimated $230–280 million in damage to property in California, Oregon, Washington and British Columbia combined, with $170–200 million happening in Oregon alone. The Columbus Day Storm was declared the worst natural disaster of 1962 by the Metropolitan Life Insurance Company. In terms of timber loss, about 11.2 billion board feet was felled... in Oregon and Washington combined" (http://www.climate.washington.edu/stormking/). "The storm claimed 46 lives, injured hundreds more, and knocked power out for several million people" (http://www.wrh.noaa.gov/pqr/info/pdf/pacwindstorms.pdf).

Local Risk Assessment Methodology

Tillamook County executed the "OEM Methodology" in October 2015 considering probability of and vulnerability to windstorms throughout the county. The County rated probability high and vulnerability moderate. The total score for windstorms was the highest, equal to the scores for floods, winter storms, and landslides.

Tillamook County and its cities executed the "OEM Methodology" again as an element of developing this risk assessment in September 2016. This time, Tillamook County considered only the rural areas of the county and the unincorporated urban communities of Neskowin, Oceanside-Netarts, and Pacific City. An assessment was also done by each city and the two ports. The assessment is based on the knowledge and experience of local officials and subject matter experts.

The State's general assessment of risk of windstorms in Tillamook County appears to be that the entire county is at high risk, particularly from south winds. Only Garibaldi assessed its risk of windstorms as low.

Table 59. Local Risk Assessment: Windstorms

Jurisdiction	History	Vulnerability	Maximum Threat	Probability	Total	Risk Level
Unincorporated Tillamook County*, including Neskowin, Oceanside-Netarts, and Pacific City–Woods	20	50	100	70	240	High
Bay City	16	20	100	35	171	High
Garibaldi**	12	15	50	42	119	Low
Manzanita	16	25	90	56	187	High
Nehalem**	16	30	90	56	192	High
Rockaway Beach**	20	45	100	56	221	High
Tillamook	16	50	100	70	236	High
Wheeler	16	25	90	56	187	High
Port of Tillamook Bay	18	45	90	63	216	High
Port of Garibaldi**	20	50	100	70	240	High

*Tillamook County and the Port of Garibaldi assessed windstorms and winter storms together.

**Assessed as part of "severe weather" together with drought and winter storms

Source: Based on information presented at the Tillamook County Multi-Jurisdictional NHMP Update Steering Committee Meeting, September 23, 2016

Winter Storms

Introduction

Winter storms are among nature's most impressive spectacles. Their combination of heavy snow, ice accumulation, and extreme cold can totally disrupt modern civilization, closing down roads and airports, creating power outages, and downing telephone lines. Winter storms remind us how vulnerable we are to nature's awesome powers.

For the most part, the wind aspects of winter storms are covered with windstorms. Heavy precipitation aspects associated with winter storms in some parts of the state, which sometimes lead to flooding, are covered with floods. This section generally addresses snow and ice hazards and extreme cold.

Location

Table 60. Jurisdictions Subject to Winter Storms

Jurisdiction	Winter Storms
Unincorporated Tillamook County (rural)	X
Neskowin	X
Oceanside-Netarts	X
Pacific City–Woods	X
Bay City	X
Garibaldi	X
Manzanita	X
Nehalem	X
Rockaway Beach	X
Tillamook	X
Wheeler	X
Port of Tillamook Bay	X
Port of Garibaldi	X

Source: Derived from DOGAMI (2016)

Hazard Characterization

According to the National Weather Service (2003) —

> *Most snowstorms need two ingredients: cold air and moisture. Rarely do the two ingredients occur at the same time over western Oregon, except in the higher elevations of the Coast Range and especially in the Cascades. But snowstorms do occur over eastern Oregon regularly during December through February. Cold arctic air sinks south along the Columbia River Basin, filling the valleys with cold air. Storms moving across the area drop precipitation, and if conditions are right, snow will occur.*
>
> *However, it is not that easy of a recipe for western Oregon. Cold air rarely moves west of the Cascade Range. The Cascades act as a natural barrier, damming cold air east of the range. The*

> *only spigot is the Columbia River Gorge, which funnels the cold air into the Portland area. Cold air then begins deepening in the Columbia River valley, eventually becoming deep enough to sink southward into the Willamette valley. If the cold air east of the Cascades is deep, it will spill through the gaps of the Cascades and flow into the western valleys via the many river drainage areas along the western slope. The cold air in western Oregon is now in place. The trick is to get a storm to move near or over the cold air, which will use the cold air and produce freezing rain, sleet, and/or snow. Sometimes, copious amounts of snow are produced. Nearly every year, minor snowfalls of up to six inches occur in the western interior valleys. However, it is a rare occurrence for snowfalls of over a foot in accumulations* [sic].

Snow is relatively rare on the Oregon Coast. Freezing rain, ice and snow are most common the Coast Range passes, making travel to the east treacherous. They also cause widespread power outages in Tillamook County. Ice storms and freezing rain can cause severe problems when they occur.

Freezing Rain

Also known as an ice storm, freezing rain is rain that falls onto a surface with a temperature below freezing. The cold surface causes the rain to freeze so the surfaces, such as trees, utilities, and roads, become glazed with ice. Even small accumulations of ice can cause a significant hazard to property, pedestrians, and motorists.

Sleet

Sleet is rain that freezes into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and does not stick to objects; however, it can accumulate like snow and cause roads and walkways to become hazardous.

Black Ice

Black ice can fool drivers into thinking water is on the road. What they may not realize is that condensation, such as dew, freezes when temperatures reach 32 °F or below, forming a thin layer of ice. This shiny ice surface is one of the most dangerous road conditions. Black ice is likely to form under bridges and overpasses, in shady spots and at intersections.

Heavy Snow

Meteorologists define heavy snow as 6 inches or more falling in less than 12 hours, or snowfall of 8 inches or more in 24 hours.

Blizzard

A blizzard is a severe winter weather condition characterized by low temperatures and strong winds blowing a great deal of snow. The National Weather Service defines a blizzard as having wind speeds of 35 mph or more, with a visibility of less than a quarter mile. Sometimes a condition known as a whiteout can occur during a blizzard. This is when the visibility drops to zero because of the amount of blowing snow.

Wind Chill

Wind blowing across your body makes you feel colder. The wind chill factor is a measure of how cold the combination of temperature and wind makes you feel. Wind chill of 50 °F or lower can be very dangerous: exposed skin can develop frostbite in less than a minute, and a person or animal could freeze to death after just 30 minutes of exposure.

Historic Winter Storm Events

Table 61. Historic Winter Storms in Oregon

Date	Location	Description
Dec. 9–11, 1919	statewide	one of three heaviest snowfall-producing storms to hit Oregon on record; lowest statewide average temperature since record keeping began in 1890; the Columbia River froze over, closing the river to navigation from the confluence with the Willamette River upstream; nearly every part of the state affected; snow totals (inches): Albany, 25.5; Bend, 49.0; Cascade Locks, 21.5; Eugene, 8.5; Heppner, 16.0; Parkdale, 63.0; Pendleton, 15.0; Siskiyou Summit, 50.0
Feb. 10, 1933	statewide	cold outbreak across state; the city of Seneca, in northeast Oregon, recorded the state's all-time record low temperature of -54 °F; the next day high was nearly 100 degrees warmer at 45 °F
Mid Jan.–Feb, 1950	statewide	extremely low temperatures injured a large number of orchard and ornamental trees and shrubs, and harmed many power and telephone lines and outdoor structures; severe blizzard conditions and a heavy sleet and ice storm together caused several hundred thousand dollars damage and virtually halted traffic for two to three days; Columbia River Highway closed between Troutdale and The Dalles leaving large numbers of motorists stranded, removed to safety only by railway; damage to orchard crops, timber, and power services, costing thousands in damages.
Feb. 1–8, 1989	statewide	heavy snow across state; up to 6–12 inches of snow at the coast, 9 inches in Salem, more than a foot over the state; numerous record temperatures set; wind chill temperatures 30–60 degrees below 0 °F; power failures throughout state, with home and business damage resulting from frozen plumbing; several moored boats sank on the Columbia River because of ice accumulation; five weather-related deaths (three auto accidents caused by ice and snow, and two women froze to death); damage estimates exceeded one million dollars
Dec.28, 2003 – Jan. 9, 2004	statewide	Presidential disaster declaration for 30 of Oregon's 36 counties. Estimated the cost of damages to public property at $16 million; 2-6 inches of snow along the North Oregon Coast
Dec. 2007	Tillamook County	heavy winds, rain, flooding, power outages, and two deaths
Feb. 6–10, 2014	Lane, Benton, Polk, Yamhill, Columbia, Clackamas, Multnomah, Washington, Linn, Marion, Hood River, Lincoln, Tillamook and Clatsop Counties	a strong winter storm system affected the Pacific Northwest during the February 6–10, 2014 time period bringing a mixture of arctic air, strong east winds, significant snowfall and freezing rain to several counties in northwest Oregon; a much warmer and moisture-laden storm moved across northwest Oregon after the snow and ice storm (Feb. 11-14), which produced heavy rainfall and significant rises on area rivers from rain and snowmelt runoff; during the 5-day period Feb. 6–10, 5 to 16 inches of snow fell in many valley locations and 2 to10 inches in the coastal region of northwest Oregon; freezing rain accumulations generally were 0.25 to 0.75 inches; the snowfall combined with the freezing rain had a tremendous impact on the region
Feb. 11–14, 2014	Lane, Benton, Polk, Yamhill, Columbia, Clackamas, Multnomah, Washington, Linn, Marion, Hood River, Lincoln, Tillamook and Clatsop Counties	another weather system moved across northwest Oregon during the February 11–14 time frame; this storm was distinctly different from the storm that produced the snow and ice the week prior and brought abundant moisture and warm air from the sub-tropics into the region; as this storm moved across the area, 2 to 7 inches of rain fell across many counties in western Oregon; the heavy rainfall combined with warm temperatures led to snowmelt and rainfall runoff that produced rapid rises on several rivers, which included flooding on three rivers in northwest Oregon
December 6-23, 2015	Clatsop, Columbia, Coos, Curry, Lane, Lincoln, Linn, Multnomah, Polk, Tillamook, Washington, and Yamhill Counties	Presidential disaster declaration DR-4258: severe winter storms, straight-line winds, flooding, landslides, and mudslides

Source: The National Weather Service, https://www.fema.gov/disaster/4258 and https://www.fema.gov/news-release/2016/02/18/president-declares-disaster-state-oregon, accessed January 29, 2017.

Probability

Because there is not a statewide effort to track and gather data about winter storm impacts, either historical or for future planning, probability is difficult to quantify. There are only limited snowfall sensors distributed mainly through the mountain ranges of the state and there is not an annual tracking system in place for snowfall statewide.

Winter storms occur annually in Oregon bringing snow to Oregon's mountains and much of Eastern Oregon. In Tillamook County, most often winter storm hazards occur in the Coast Range, rather than in the low-lying areas of the County.

Climate Change

There is no current research available about changes in the incidence of winter storms in Oregon due to changing climate conditions.

Vulnerability

A major winter storm can last for days and can include high winds, freezing rain or sleet, heavy snowfall, and cold temperatures. In Tillamook County, the major vulnerabilities are isolation from being unable to transport people and freight over the Coast Range and large-scale power outages.

Winter storms and windstorms pose the greatest threat to the Port of Garibaldi's infrastructure due to their frequency and the Port's exposure and vulnerability. At the Port, it is common for high winds to exceed 70 mph with gusts up to 100 mph and damage buildings and mooring facilities. Over the last 15 years, many roofs and structures have sustained damage during winter storms and windstorms.

High winds out of the south create rough water conditions on Tillamook Bay causing swells that impact Port of Garibaldi property by eroding all exposed areas. These swells also cause a severe surge to enter the boat basin, which can damage docks and exposed vessels.

The Port of Tillamook Bay's railroad has suffered repetitive losses during past winter storms, most notably in 1996 and 2007. The December 2007 storm damaged an approximately 15-mile portion of the rail line. Winter storms also damage building (e.g. roofs, siding, etc.) and depending on severity may cause other ancillary damages.

Local Risk Assessment Methodology

Tillamook County executed the "OEM Methodology" in October 2015 considering probability of and vulnerability to winter storms throughout the county. The County rated probability high and vulnerability moderate. The total score for winter storms was the highest, equal to the scores for floods, windstorms, and landslides.

Tillamook County and its cities executed the "OEM Methodology" again as an element of developing this risk assessment in September 2016. This time, Tillamook County considered only the rural areas of the county and the unincorporated urban communities of Neskowin, Oceanside-Netarts, and Pacific City. An assessment was also done by each city and the two ports. The assessment is based on the knowledge and experience of local officials and subject matter experts.

Only Bay City and Garibaldi assessed their risk of winter storms as low. The State's general assessment indicates that risk countywide would be high from the potential for isolation.

Table 62. Local Risk Assessment: Winter Storms

Jurisdiction	History	Vulnerability	Maximum Threat	Probability	Total	Risk Level
Unincorporated Tillamook County*, including Neskowin, Oceanside-Netarts, and Pacific City–Woods	20	50	100	70	240	High
Bay City	8	10	40	28	86	Low
Garibaldi**	12	15	50	42	119	Low
Manzanita	8	40	80	28	156	High
Nehalem**	16	30	90	56	192	High
Rockaway Beach**	20	45	100	56	221	High
Tillamook	20	50	80	70	220	High
Wheeler	16	20	80	56	172	High
Port of Tillamook Bay	18	45	90	63	216	High
Port of Garibaldi	20	50	100	70	240	High

*Tillamook County assessed windstorms and winter storms together.

**Assessed as part of "severe weather" together with windstorms and winter storms

Source: Based on information presented at the Tillamook County Multi-Jurisdictional NHMP Update Steering Committee Meeting, September 23, 2016

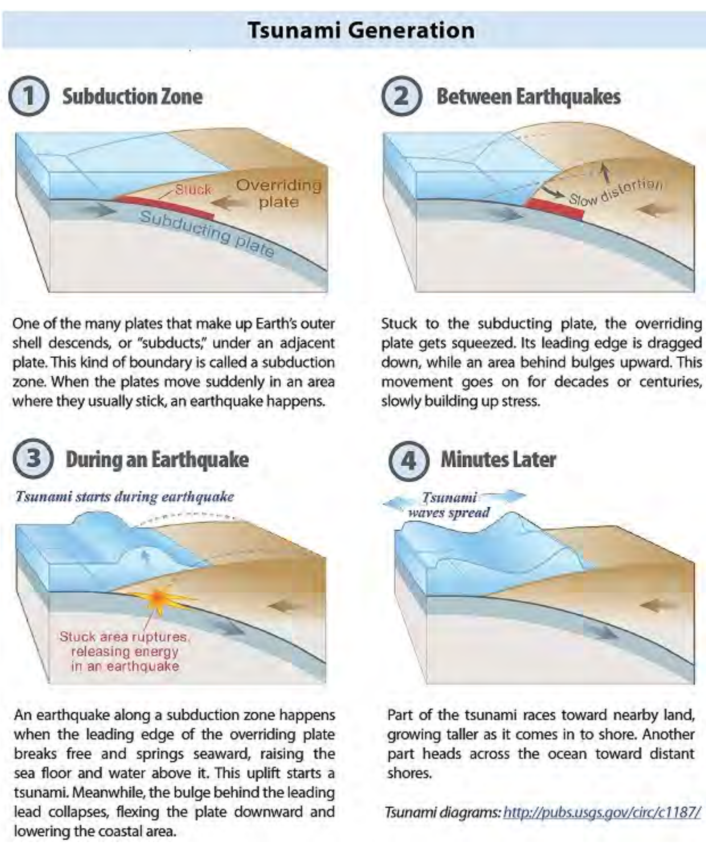
6. Tsunamis

Introduction

Tsunamis are a low frequency natural hazard in Oregon and are restricted almost exclusively to coastal areas. Tsunamis are most often caused by the abrupt change in the seafloor accompanying an earthquake (**Figure 91**). The most common sources of the largest tsunamis are earthquakes that occur at subduction zones like the Cascadia Subduction Zone (CSZ), where an oceanic plate descends beneath a continental plate (**Figure 92**). Other important processes that may trigger a tsunami include underwater volcanic eruptions and landslides (includes landslides that start below the water surface and landslides that enter a deep body of water from above the water surface). Tsunamis can travel thousands of miles across ocean basins, so that a particular coastal area may be susceptible to two different types of tsunami hazard caused by:

1. Distant sources across the ocean basin, and
2. Local sources that occur immediately adjacent to a coast.

Figure 91. Generation of a Tsunami by Subduction Zone Earthquakes



Source: DOGAMI, *Cascadia,* Winter 2012 (http://www.oregongeology.org/pubs/cascadia/CascadiaWinter2012.pdf)

Figure 92. Cascadia Subduction Zone (CSZ) Active Fault Map

Note: The fault, indicated by the triangles, is the contact where the Juan de Fuca Plate plunges beneath the North American continental plate.

Source: DOGAMI

Distant tsunamis that may threaten the Oregon Coast are usually generated by a subduction zone earthquake elsewhere in the Pacific and would take at least 4 hours to reach the Oregon coastline from the closest source, the subduction zone in the Gulf of Alaska. For example, the 1964 Alaska tsunami reached the Oregon Coast in four to five hours after the magnitude 9.2 earthquake that generated it. In contrast, a local tsunami generated by a CSZ earthquake, would take about 15-20 minutes to reach most of the coast.

Most locally generated tsunamis will be higher and travel farther inland (overland and up river) than distant tsunamis. By the time the tsunami wave hits the coastline, it may be traveling at 30 mph and have heights of 20 to about 100 feet, depending on the local coastal bathymetry (water depths), shape of the shore, and the amount of fault movement on the subduction zone. The tsunami wave will break up into a series of waves that will continue to strike the coast for a day or more, with the most destructive waves arriving in the first 4-5 hours after the local earthquake. As was seen in the 2004 Sumatra tsunami, the first wave to strike the coast is not always the most destructive. This was again the case during the 2011 Japan tsunami.

Location

Table 63. Jurisdictions Subject to Tsunamis

Jurisdiction	Tsunamis
Unincorporated Tillamook County (rural)	X
Neskowin	X
Oceanside-Netarts	X
Pacific City–Woods	X
Bay City	X
Garibaldi	X
Manzanita	X
Nehalem	X
Rockaway Beach	X
Tillamook	X
Wheeler	X
Port of Tillamook Bay	X
Port of Garibaldi	X

Source: Derived from DOGAMI (2016)

Hazard Characterization

The coasts of Washington, Oregon, and northern California are particularly vulnerable to tsunamis from magnitude 9+ earthquakes that occur about every 500 years on the CSZ. Additional, smaller tsunamis and earthquakes occur in the subduction zone south of Waldport. The combined recurrence for both types of Cascadia earthquake can be as low as about 230 years in Curry County.

The initial tsunami wave mimics the shape and size of the sea floor movement that causes it, but quickly evolves into a series of waves that travel away from the source of disturbance, reflect off of coastlines, and then return again and again over many hours. The tsunami is thus “trapped” owing to the processes of reflection and refraction. In the deep ocean, tsunami waves may be only a few feet high and can travel at wave speeds of 300–600 mph. As a tsunami approaches land where the water depth decreases, the forward speed of the wave will slow as wave height increases dramatically. When the wave makes landfall, the water is mobilized into a surging mass that floods inland until it runs out of mass and energy. The wave then retreats, carrying all sorts of debris. Successive waves then batter the coast with this debris. Swimming through such turbulent debris-laden water is next to impossible.

Tsunamis are potentially more destructive than the earthquake that caused them. Loss of lives from the tsunami can often be many times the loss from the earthquake ground shaking. This was highlighted by the December 26, 2004 tsunami, associated with a magnitude 9.3 earthquake, which occurred offshore from the Indonesian island of Sumatra. The tsunami impacted almost every county located around the Indian Ocean rim and claimed the lives of approximately 350,000 people. The greatest loss of life occurred along the coast of Sumatra, close to the earthquake epicenter. The event displaced some 2 to 3 million people and its economic impact continues to be felt to the present. The Sumatra event is a direct analogue for what can be expected to occur along the Oregon Coast due to its close proximity to the Cascadia Subduction Zone.

In addition, fires started by the preceding earthquake are often spread by the tsunami waves, if there is a gasoline or oil spill. As was seen in the Sumatra 2004 tsunami, flood inundation from a tsunami may be extensive, as tsunamis can travel up rivers and streams that lead to the ocean. Delineating the inland extent of flooding, or inundation, is the first step in preparing for tsunamis.

Distant tsunamis caused by earthquakes on Pacific Rim strike the Oregon coast frequently but only a few of them have caused significant damage or loss of life. Local tsunamis caused by earthquakes on the Cascadia Subduction Zone (CSZ) happen much less frequently but will cause catastrophic damage and, without effective mitigation actions, great loss of life.

On March 11, 2011, a magnitude (M_w) 9.0 earthquake struck off the east coast of Japan. This caused a massive tsunami that inundated much of the eastern coastline of Japan, and reached the west coast of the US many hours later. There was one death and millions of dollars of damage to ports and harbors in Oregon and California. Japan suffered many thousands of dead and missing as well as a nuclear catastrophe that will continue to be a hazard far into the future. Oregon received a Presidential Declaration of Disaster (DR-1964) that brought millions of dollars of financial aid to repair and mitigate future tsunami damage. Debris from tsunami-damaged buildings in Japan floated across the Pacific Ocean and began arriving on the Canadian and US West Coast in December 2011 and is expected to continue to arrive for years.

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 (1964 dollars). Approximately 120 people drowned. The tsunami spread across the Pacific Ocean and caused damage and fatalities in other coastal areas, including Oregon. The tsunami killed five people in Oregon and caused an estimated $750,000 to $1 million in damage. In Crescent City, California, there were 10 fatalities, while damage to property and infrastructure was estimated to range from $11 to 16 million.

Going still further back in time, there is scientific consensus that the Pacific Northwest experienced a subduction zone earthquake estimated at magnitude 9 on January 26, 1700. The earthquake generated a tsunami that caused death and damage as far away as Japan, where it was well-documented in the literature of the time. The earthquake and tsunami left behind geologic “footprints” in the form of (a) tsunami sand sheets in marshes, (b) layers of marsh vegetation covered by tide-borne mud when the coast abruptly subsided, and (c) submarine sand and silt slurries shaken off the continental shelf by the earthquake (turbidites). The widespread and large body of oral traditional history of the Thunderbird and Whale stories passed down by First Nations people depict both strong ground shaking and marine flooding that may have been inspired by this event. Although this earthquake undoubtedly produced tsunamis that reached about 30–40 ft at the coast, geologic evidence from study of 10,000 years of turbidite deposits suggests that the 1700 earthquake was just an average event. Some Cascadia earthquakes have been many times larger, so, while devastating, the earthquake and tsunami were far from the worst case.

The tsunami wave tends to arrive at the coast as a fast moving surge of rising water. As the tsunami 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 wave of water can often cause most or all of the damage, and the current may be just as destructive when it is retreating from the land as when it is advancing. 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 and wind waves may ride on top of the tsunami waves, further compounding the level of destruction.

During Cascadia earthquakes there is also the added effect of coastal subsidence, or the downward movement of the land relative to the sea level, during the earthquake. This is due to the release of the accumulated strain that caused the western edge of the North American Plate to bend and bulge. The new earthquake models used for the local tsunami scenarios indicate that portions of the Oregon coast could drop by a few to several feet.

In 2010 the Oregon Department of Geology and Mineral Industries (DOGAMI) completed an analysis of the full range of Cascadia tsunamis and earthquakes, separating the results into five size classes with "T-shirt" names, S, M, L, XL, and XXL (Witter, 2011). The XL or XXL events probably only happened once or twice in the last 10,000 years, but estimated tsunami heights were comparable to those of the 2011 Japan and 2004 Sumatra tsunamis, the largest known.

Historic Tsunami Events

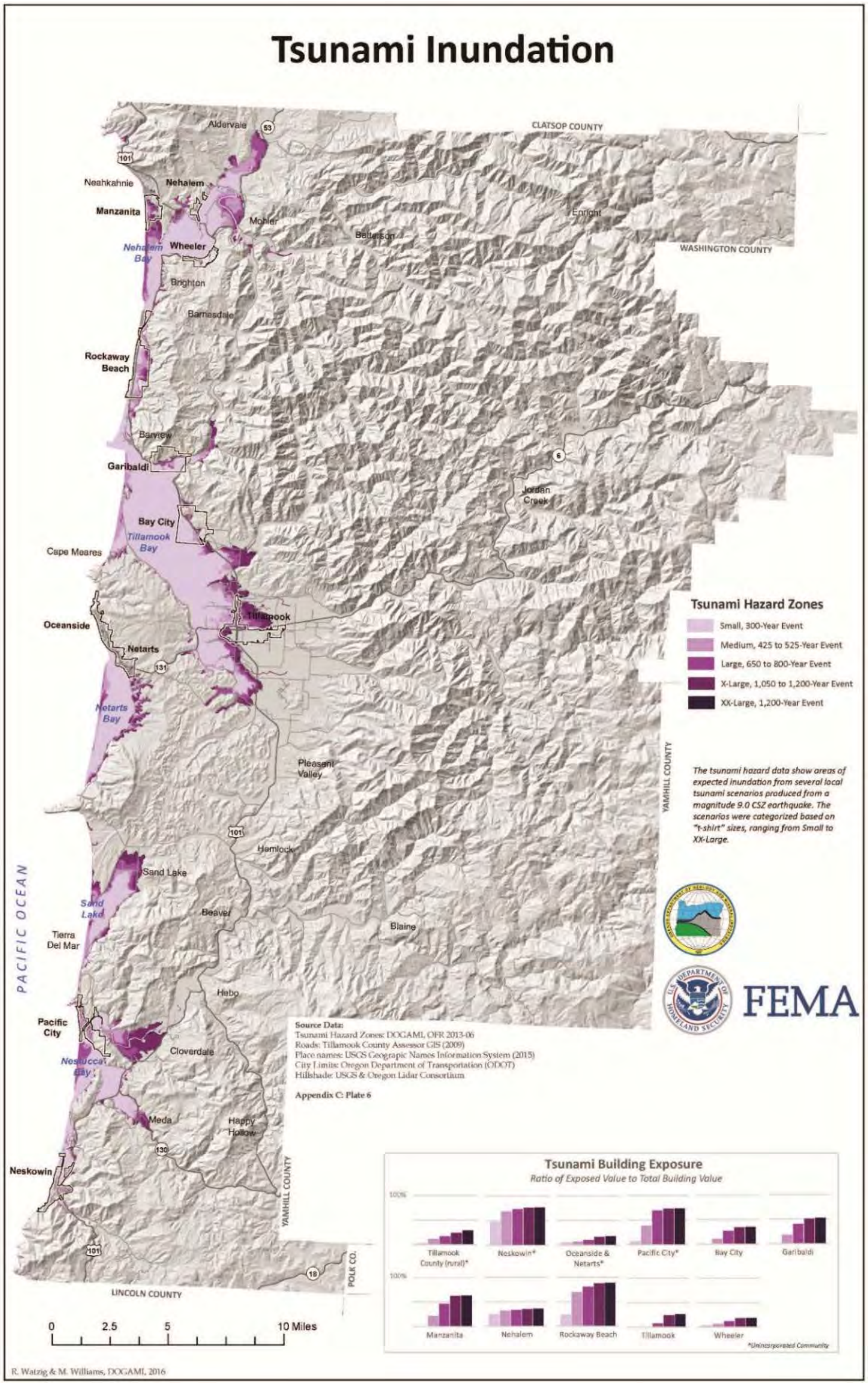
Table 64. Historic Tsunamis that Impacted the Northern Oregon Coast

Date	Origin of Event	Affected Oregon Community	Damage	Remarks
Apr. 1868	Hawaii	Astoria		observed
Aug. 1868	N. Chile	Astoria		observed
Aug. 1872	Aleutian Islands	Astoria		observed
Apr. 1946		Clatsop Spit		water 3.7 m above MLLW
Apr. 1946		Seaside		wall of water swept up Necanicum River
Nov. 1952	Kamchatka	Astoria		observed
May 1960	S. Cent. Chile	Astoria		observed
May 1960		Seaside	bore on Necanicum River damaged boat docks	
May 1960		Netarts	some damage observed	
Mar. 1964	Gulf of Alaska	Cannon Beach	bridge and motel unit moved inland; $230,000 damage	
Mar. 1964		Seaside	1 fatality (heart attack); damage to city: $41,000; private: $235,000; four trailers, 10–12 houses, two bridges damaged	
Oct. 1994	Japan	coast		tsunami warning issued, but no tsunami observed
Mar. 2011	Japan	coast	$6.7 million; extensive damage to the Port of Brookings	tsunami warning issued, observed ocean waves

Sources: Lander, Lockridge, & Kozuch, 1993; FEMA, 2011, Federal Disaster Declaration (https://www.fema.gov/disasters)

In addition to the historical distant tsunamis of **Table 64**, the last CSZ tsunami struck at 9 PM on January 26, 1700. This may be considered a historical event, because the tsunami was recorded in historical port records in Japan. The date and time of occurrence here in Oregon were inferred by Japanese and USGS researchers from a tsunami and earthquake model.

Figure 93. Tsunami Inundation Scenarios and Building Exposure Example

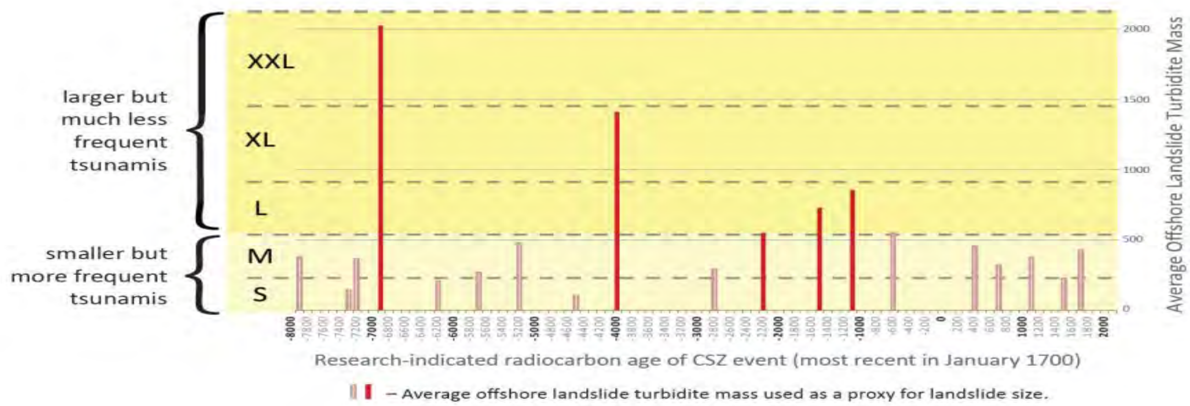


Source: DOGAMI (2016

Probability

While large (about magnitude 9) CSZ earthquakes and associated tsunamis have occurred on average every 500 years over the last 10,000 years, the time interval between events has been as short as decades and as long as 1,150 years. Smaller earthquakes on the southern part of the CSZ have occurred about as often as larger earthquakes, making CSZ events in southernmost Oregon about twice as likely as in northern Oregon. The size and frequency of the 19 large earthquakes on the CSZ are inferred from offshore turbidite deposits and are shown in **Figure 94**. All 19 of these large CSZ events were likely magnitude 8.7–9.2 earthquakes.

Figure 94. Occurrence and Relative Size of Cascadia Subduction Zone Megathrust Earthquakes



Source: Turbidite data from C. Goldfinger, Oregon State University; relative earthquake size comparison from Witter et al. (2011)

In April 2008 USGS workers indicated that for the next 30 years there is a 10% probability of a magnitude 8-9 earthquake somewhere along the 750-mile-long Cascadia Subduction Zone (Field, Milner & the 2007 Working Group on California Earthquake Probabilities: https://pubs.usgs.gov/fs/2008/3027/fs2008-3027.pdf). In 2012 Goldfinger et al. showed that the southern part of the CSZ also ruptures in segments, so probabilities some type of CSZ earthquake increase from north to south. Segment earthquakes and tsunamis will generally be smaller than full-margin events. Segment tsunamis, by the time they travel more than about 43 miles north of a segment, are similar in size to distant tsunamis with the largest waves striking 2 hours or more after the earthquake (Priest et al., 2014). New tsunami inundation maps from DOGAMI illustrate the range of inundation from all full-margin and significant segment ruptures on the CSZ.

Vulnerability

The entire coastal zone is highly vulnerable to tsunami impact. Distant tsunamis caused by earthquakes on the Pacific Rim strike the Oregon coast frequently but only a few of them have caused significant damage or loss of life. Local tsunamis caused by earthquakes on the Cascadia Subduction Zone (CSZ) happen much less frequently but will cause catastrophic damage and, without effective mitigation actions, great loss of life.

Because tsunamis in Oregon typically occur as a result of earthquakes, the unknown time and magnitude of such events adds to the difficulty in adequately preparing for such disasters. If a major earthquake occurs along the CSZ, a local tsunami could follow within 5 to 30 minutes. Although tsunami evacuation routes have been posted all along the Oregon Coast, damage to bridges and roadways from an earthquake could make evacuation quite difficult even if a tsunami warning were given. In addition, if a major earthquake and tsunami occur during the "tourist season," causalities and fatalities from these disasters would be far greater than if the same events occurred during the winter months.

It is also important to consider where the impact of a tsunami would be the greatest. Owing to relatively large resident and visitor populations located at very low elevations, cities facing the Pacific Ocean on the northern Oregon Coast are more vulnerable to inundation and have the greater potential for loss of life than coastal cities in central and southern Oregon.

Distant tsunamis, except for the most extreme events, will not affect significant numbers of residents, since they flood principally beaches and immediate waterfront areas. Loss of life from distant tsunamis will also be far less than for local tsunamis, because there will be at least four hours to evacuate prior to wave arrival rather than 15–20 minutes.

That said, visitors are more vulnerable than are residents to both distant and locally generated tsunamis, because they are more likely to be at beaches and shoreline parks and are generally less aware of hazard response and preparedness. During the summer and holidays, visitors can greatly outnumber residents in the small coastal towns. While intensive education and outreach programs led by DOGAMI and OEM have greatly increased awareness and preparedness, residents are much more likely to have received this education than are visitors.

The Oregon Resilience Plan (ORP) uses the impact of a "Medium" or "M" CSZ earthquake and tsunami for planning purposes, because this was judged the most likely CSZ event (see DOGAMI Special Paper 43 [Witter et al., 2011] for explanation). The current regulatory tsunami inundation used by the Oregon Building Code to limit new construction of critical, essential, large occupancy, and hazardous facilities also uses a scenario similar to the "Medium" case. The ORP describes the "M" impact as follows:

> *Following the Cascadia event, the coastal communities will be cut off from the rest of the state and from each other. The coastal area's transportation system, electrical power transmission and distribution grid, and natural gas service will be fragmented and offline, with long-term setbacks to water and wastewater services. Reliable communications will be similarly affected. Because so many of these connecting systems are single lines with little or no redundancy, any break or damage requiring repair or replacement will compromise the service capacity of the entire line.*

> *The loss of roads and bridges that run north and south will make travel up and down the coast and into the valley difficult, if not impossible, due to the lack of alternate routes in many areas. Reestablishing the roads and utility infrastructure will be a challenge, and the difficulties will be exacerbated in the tsunami inundation area by its more complete destruction. Even businesses outside of the tsunami inundation may not recover from the likely collapse of a tourist-based economy during the phased and complicated recovery and reconstruction period.*
>
> *Based on the resilience targets provided by the Transportation, Energy, Communications, and Water/Wastewater task groups, current timelines for the restoration of services up to 90-percent operational levels will take a minimum of one to three years, and often over three years in the earthquake-only zone. Restoration in the tsunami zone will take even longer than that... The most critical infrastructure is the road and highway system. Without functioning road systems, none of the infrastructure can be accessed to begin repairs.*
>
> *The tsunami will also create an enormous amount of debris that needs to be gathered, sorted, and managed. The recent experience of Japan, with a similar mountainous coastline, has shown that debris management competes with shelter and reconstruction needs for the same flat land that is often in the inundation zone.*

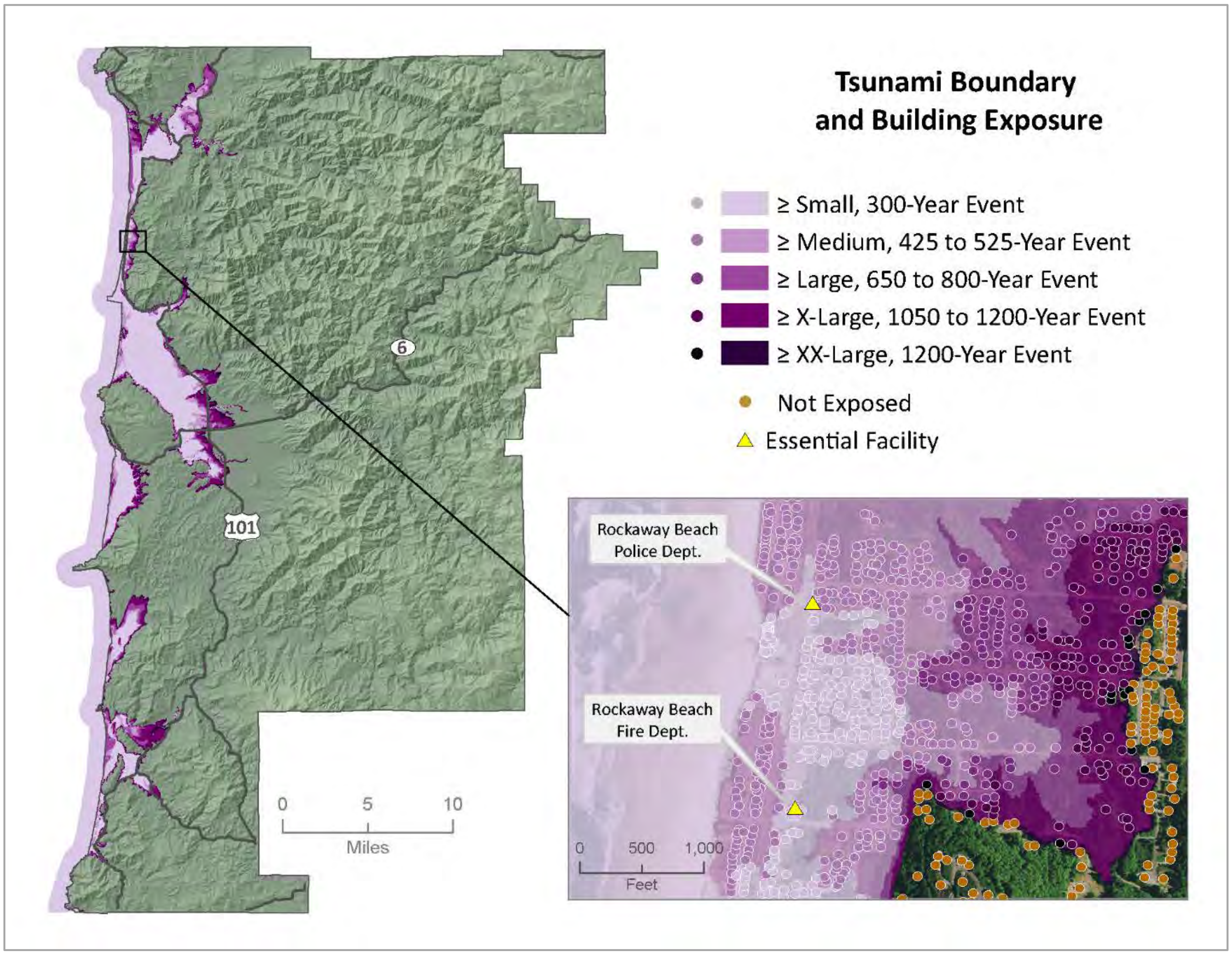
The ORP estimates that times for recovery of the coastal infrastructure for a Medium CSZ event will be as follows: electricity and natural gas, 3–6 months; drinking water and sewer systems, 1–3 years; and Healthcare facilities, 3 years. The ORP gives no estimate for times to recover police and fire stations or the coastal transportation system, but times for the latter would no doubt be measured in years. Economic recovery would also be many years, since much of the coast is dependent on tourism that is directly dependent on the transportation system. According to the ORP:

> *Even if a business had sufficient capital to relocate, it is unlikely that the tourist industry will recover rapidly enough to support business start-up. Local authorities may need to keep tourists out of the inundation zones, for safety reasons, for months or years after a tsunami.*

Exposure Analysis

The *Final Draft Multi-Hazard Risk Report for Tillamook County* (DOGAMI, 2016) provides a tsunami exposure analysis for Tillamook County. Figure 95 provides an example of the building exposure analysis. Exposure analysis results are shown in Table 65 and Table 66, and Figure 96 illustrates those results. For the Medium size tsunami scenario, thought to be the most likely, Rockaway Beach and Neskowin are most vulnerable, with 69% ratio of exposure value. Pacific City and Nehalem follow with 39% and 32%, respectively. Further, Rockaway Beach, Pacific City, and Neskowin are extremely difficult to evacuate owing to local geographic factors and significant percentages of retirees with limited mobility.

Figure 95. Tsunami Inundation Scenarios and Building Exposure Example



Source: DOGAMI (2016)

Table 65. Tsunami Exposure: Tillamook County and Cities

	(all dollar amounts in thousands)														
			Small (Low Severity)			Medium (Moderate Severity)			Large (High Severity)			XX Large (Very High Severity)			
Community	Total Number of Buildings	Total Estimated Building Value ($)	Number of Buildings	Building Value ($)	Ratio of Exposure Value	Number of Buildings	Building Value ($)	Ratio of Exposure Value	Number of Buildings	Building Value ($)	Ratio of Exposure Value	Number of Buildings	Building Value ($)	Ratio of Exposure Value
Unincorp. County (rural)	15,015	1,282,436	520	46,924	3.7%	1,692	147,262	11%	2,548	223,814	18%	3,706	370,556	29%
Neskowin	653	118,463	268	56,198	47%	461	81,824	69%	485	86,960	73%	508	91,182	77%
Oceanside-Netarts	1,701	203,363	62	11,292	5.6%	88	15,432	7.6%	141	21,433	11%	326	36,738	18%
Pacific City–Woods	1,707	212,062	175	15,825	7.5%	806	83,301	39%	1,252	148,741	70%	1,355	156,498	74%
Total Unincorp. County	**19,076**	**1,816,324**	**1,025**	**130,239**	**7.2%**	**3,047**	**327,819**	**18%**	**4,426**	**480,948**	**26%**	**5,895**	**654,974**	**36%**
Bay City	884	74,770	4	370	0.5%	62	8,455	11%	136	20,515	27%	234	26,459	35%
Garibaldi	755	64,331	9	549	0.9%	91	11,870	18%	197	26,106	41%	336	33,894	53%
Manzanita	1,523	259,780	0	0	0.0%	354	56,238	22%	703	121,483	47%	966	163,906	63%
Nehalem	260	24,886	45	6,091	25%	61	7,856	32%	67	8,261	33%	77	8,872	36%
Rockaway Beach	2,240	211,809	591	49,215	23%	1,525	146,945	69%	1,888	170,195	80%	2,095	186,898	88%
Tillamook	2,270	322,398	0	0	0.0%	3	71	0.2%	84	24,651	7.6%	482	84,661	26%
Wheeler	363	30,556	14	1,047	3.4%	24	2,072	6.8%	33	3,798	12%	56	5,703	19%
Total Tillamook County	**27,371**	**2,804,854**	**1,688**	**187,511**	**6.7%**	**5,167**	**561,327**	**20%**	**7,534**	**855,957**	**31%**	**10,141**	**1,165,367**	**42%**

Source: DOGAMI (2016)

Table 66. Tsunami Exposure: Port of Tillamook Bay and Port of Garibaldi

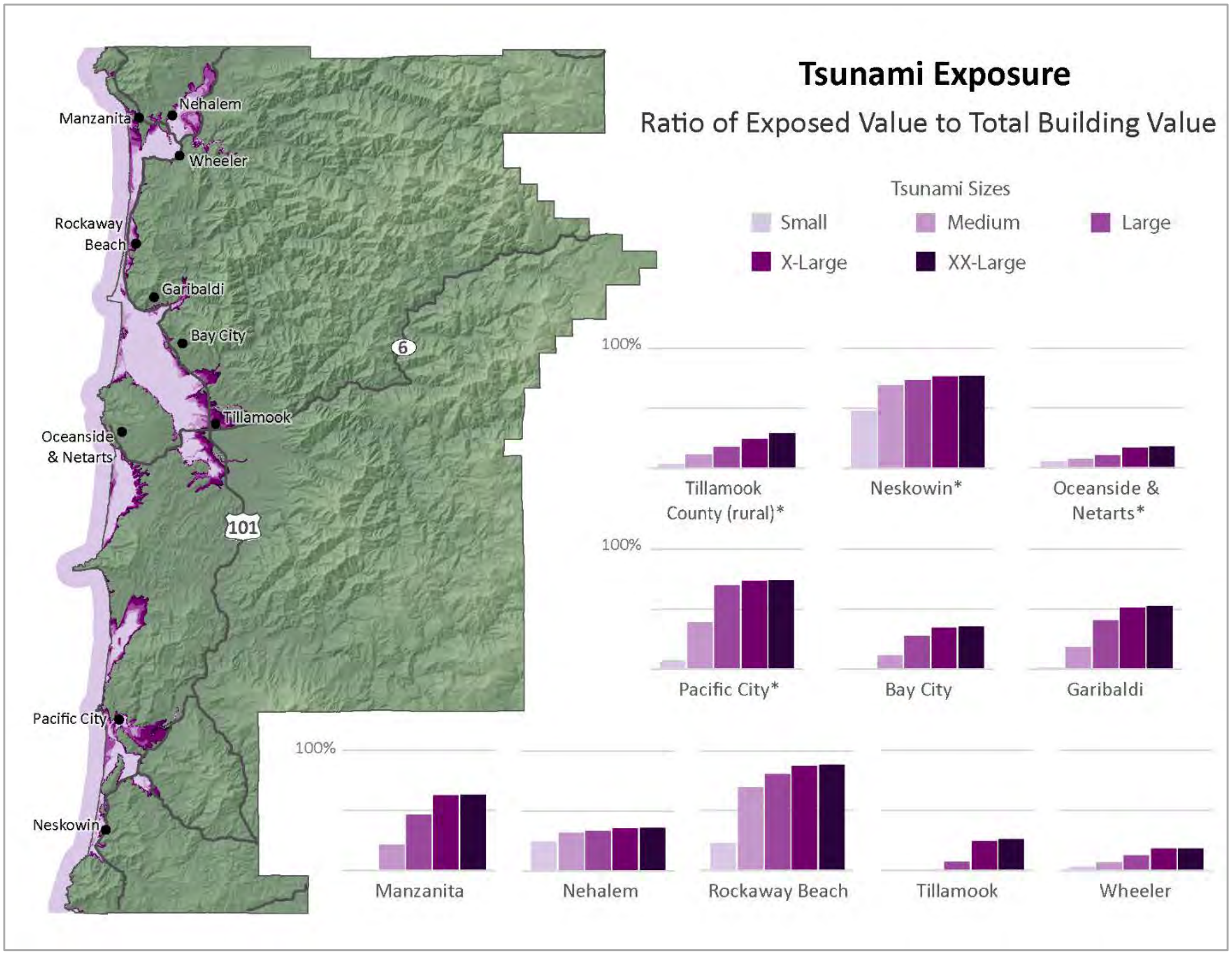
			Small (Low Severity)			Medium (Moderate Severity)			Large (High Severity)			XX Large (Very High Severity)		
	Total Number of Buildings	Total Estimated Building Value ($)	Number of Buildings	Building Value ($)	Ratio of Exposure Value	Number of Buildings	Building Value ($)	Ratio of Exposure Value	Number of Buildings	Building Value ($)	Ratio of Exposure Value	Number of Buildings	Building Value ($)	Ratio of Exposure Value
Port of Garibaldi	36	8,035,760	4	555,180	6.91%	26	3,427,250	43%	35	8,035,760	100%	35	8,035,760	100%
Port of Tillamook	83	61,545,144	0	0	0%	0	0	0%	0	0	0%	0	0	0%

Source: Derived from DOGAMI (2016)

The Port of Garibaldi is susceptible to infrastructure damage from tsunamis. The mooring basin, docks, and vessels are at risk from tsunamis of all scales as they cause surges and rapid changes in water levels. They may also cause excessive sediment deposits in the boat basin and navigational channels requiring additional dredging. Further, tsunamis may damage the Tillamook Bay Jetty system.

The Port of Tillamook Bay is less susceptible to tsunamis. Only the northwestern portion is expected be inundated by a larger tsunami event. Depending on the severity of the event, much of the western portion of the Port of Tillamook Bay, including the Tillamook Municipal Airport, may be inaccessible for quite some time.

Figure 96. Tsunami Inundation Exposure by Community



*Unincorporated communities. Note that "Tillamook Co. (rural)" excludes incorporated communities, Pacific City, Oceanside-Netarts, and Neskowin.

Source: DOGAMI (2016)

Local Risk Assessment Methodology

Tillamook County executed the "OEM Methodology" in October 2015 considering probability of and vulnerability to tsunamis throughout the county. The County rated probability low and vulnerability high. The total score for tsunamis ranked in the middle of all the hazards considered.

Tillamook County and its cities executed the "OEM Methodology" again as an element of developing this risk assessment in September-October 2016. This time, Tillamook County considered only the rural areas of the county and the unincorporated urban communities of Neskowin, Oceanside-Netarts, and Pacific City. An assessment was also done by each city and the two ports. The assessment is based on the knowledge and experience of local officials and subject matter experts.

While all the communities in Tillamook County are at risk of tsunamis, some are much more at risk than others. Bay City, Tillamook, and the Port of Tillamook Bay assessed their risk as high. The State's assessment indicates that only small areas of Bay City and the Port of Tillamook Bay are at risk of tsunamis, and that only the portion of Tillamook along US-101 north of OR-6 and the very western tip of the city are at risk. Nehalem, Rockaway Beach, and the Port of Garibaldi assessed their risk as moderate. The State's assessment is low for Nehalem and high for Rockaway Beach. Garibaldi, Manzanita, and Wheeler assessed their risk as low. The State's assessments for Garibaldi and Wheeler are low, but high for Manzanita.

Table 67. Local Risk Assessment: Tsunami

Jurisdiction	History	Vulnerability	Maximum Threat	Probability	Total	Risk Level
Unincorporated Tillamook County, including Neskowin, Oceanside-Netarts, and Pacific City–Woods	2	30	70	56	158	Moderate
Bay City	2	20	100	70	192	High
Garibaldi	4	25	90	7	126	Low
Manzanita	0	5	10	0	15	Low
Nehalem	2	40	80	14	136	Moderate
Rockaway Beach	2	50	100	28	180	Moderate
Tillamook	0	50	100	7	157	High
Wheeler	0	10	60	7	129	Low
Port of Tillamook Bay	2	45	90	56	193	High
Port of Garibaldi	4	50	100	35	189	Moderate

Source: Based on information presented at the Tillamook County Multi-Jurisdictional NHMP Update Steering Committee Meeting, September 23, 2016

7. Volcanic Ashfall

Introduction

Volcanoes are potentially destructive natural phenomena, constructed as magma ascends and then erupts onto the earth's surface. Volcanic eruptions are typically focused around a single vent area, but vary widely in explosivity. Therefore volcanic hazards can have far reaching consequences. Volcanic hazards may occur during eruptive episodes or in the periods between eruptions. Eruptive events may include hazards such as, pyroclastic surges and flows, ashfall, lava flows, or slurries of muddy debris and water known as lahars. Eruptions may last days, weeks, or years, and have the potential to dramatically alter the landscape for decades. Unlike other geologic hazards (e.g., earthquakes, tsunamis), impending eruptions are often foreshadowed by a number of precursors including ground movements, earthquakes, and changes in heat output and volcanic gases. Scientists use these clues to recognize a restless volcano and to prepare for events that may follow. Hazards occurring between eruptive periods are typically related to earthquakes or natural erosion, which may trigger debris avalanches or debris flows on the flanks of the volcano. Such events often occur without warning.

Potentially hazardous volcanoes in Oregon are present along the crest of the Cascade Range and to a much lesser extent in the High Lava Plains. The volcanoes within these regions provide some of Oregon's most spectacular scenery and popular recreational areas, yet the processes that led to their formation also present significant challenges and hazard to communities within the region. The catastrophic eruption of Washington's Mount St. Helens in 1980 and subsequent activity demonstrate both the power and detrimental consequences that Cascade-type volcanoes can have on the region. Lessons learned at Mount St. Helens led the US Geological Survey (USGS) to establish the Cascades Volcano Observatory (CVO) in Vancouver, Washington. Scientists at CVO continually monitor volcanic activity within the Cascade Range and in cooperation with the Oregon Department of Geology and Mineral Industries (DOGAMI), study the geology of volcanic terrains in Oregon.

Location

A number of hazards are associated with volcanoes (**Figure 97**). In general, volcanic hazards are commonly divided into those that occur in proximal (near the volcano) and distal (far from the volcano) hazard zones. In the distal hazard zone, volcanic activity includes lahars (volcanic mudflows or debris flows) and fallout of ash; in the proximal hazard zone, activity can be much more devastating and includes rapidly moving pyroclastic flows (glowing avalanches), lava flows, and landslides. Each eruption is a unique combination of hazards. Not all hazards will be present in all eruptions, and the degree of damage will vary. It is important to know that during an active period for a volcano many individual eruptions may occur and each eruption can vary in intensity and length. For example, while Mount St. Helens is best known for its catastrophic May 1980 eruption, periodic eruptions of steam and ash and the growth of a central lava dome have continued to pose a hazard since that time.

Table 68. Jurisdictions Subject to Volcanic Ashfall

Jurisdiction	Volcanic Ashfall
Unincorporated Tillamook County (rural)	X
Neskowin	X
Oceanside-Netarts	X
Pacific City–Woods	X
Bay City	X
Garibaldi	X
Manzanita	X
Nehalem	X
Rockaway Beach	X
Tillamook	X
Wheeler	X
Port of Tillamook Bay	X
Port of Garibaldi	X

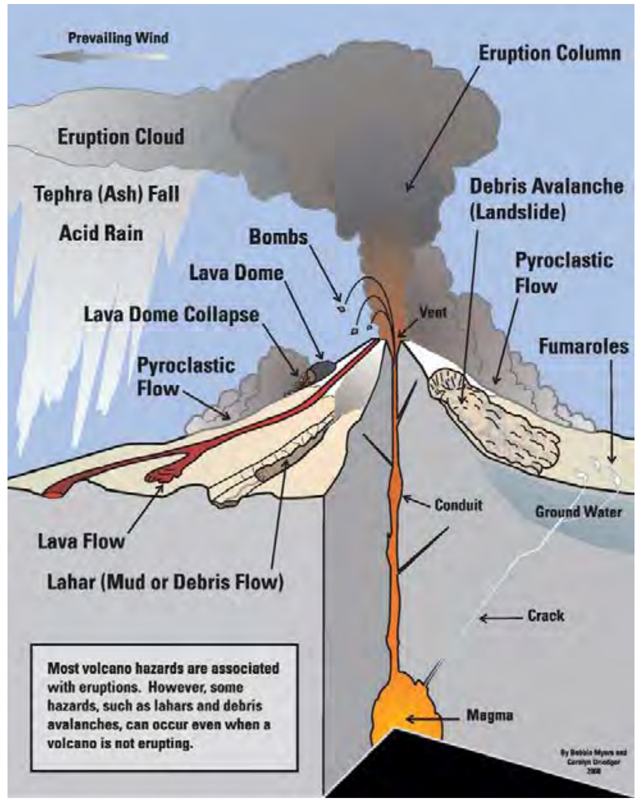
Source: Derived from DOGAMI (2016)

Hazard Characterization

The volcanic Cascade Range extends southward from British Columbia into northern California. The volcanoes are a result of the complex interaction of tectonic plates along the Cascadia Subduction Zone (CSZ). Subduction is the process that results in the Juan de Fuca plate (oceanic crust) subducting, or sinking, underneath the North American plate (continental crust) on which we live. As the subducted plate descends, it heats up and begins to melt. This provides the reservoir of heat and molten rock needed to create the magma chambers that lie kilometers deep, beneath the Cascades.

Stratovolcanoes like Mount Hood, also called composite volcanoes, are generally tall, steep, conical shaped features, built up through layering of volcanic debris, lava, and ash. Eruptions tend be explosive, for example, the violent 1980 eruption of Mount St. Helens, and they produce volcanic mudflows (lahars) that can travel far from the mountain. Future eruptions are likely to be similar and present a severe hazard to the surrounding area. Volcanoes also pose other hazards because of their geology and resulting geomorphology. The relatively high elevation of volcanoes usually results in the meteorological effect called orographic lifting, which causes high precipitation and snow on the mountains that can result in flooding. The geologic material tends to be relatively weak and, when combined with the steep slopes, can cause frequent and hazardous landslides. Cascade Mountain Range volcanoes are also located near the active CSZ and nearby potentially active crustal faults, which contribute to moderate seismic hazard in the area.

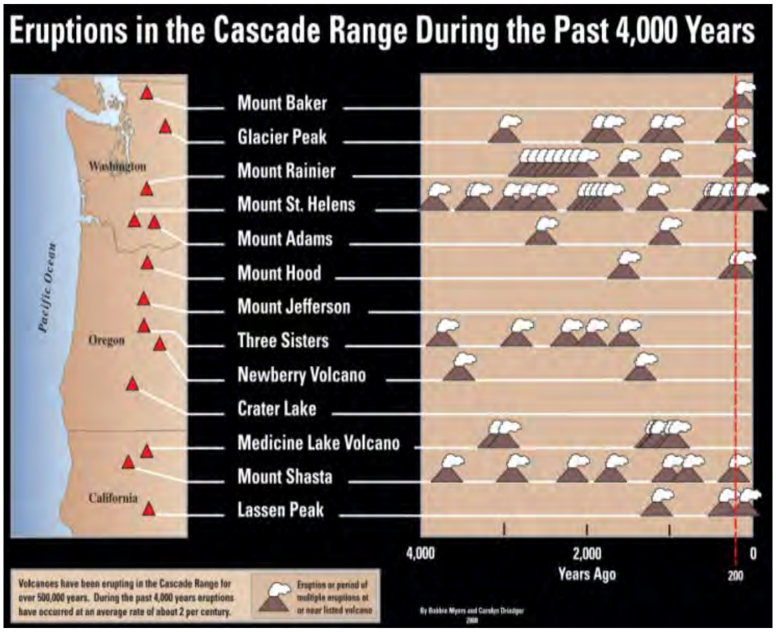
Figure 97. Potential Hazards at a Stratovolcano



Source: Myers and Dreidger (2008a)

The volcanoes of the Cascade Range have a long history of eruption and intermittent quiescence. Each volcano has a different frequency of eruption. Not all Cascade volcanoes have been active in the recent past. This is typical of a volcanic range and is one of the reasons forecasting eruptions can be difficult.

Figure 98. Eruptions in the Cascade Range During the Past 4,000 Years



Source: Myers and Driedger (2008b)

Several smaller volcanoes, including Diamond Craters and Jordan Craters, in the High Lava Plains of southeast Oregon have experienced eruptions in the last 6,000 years. Generally nonexplosive eruptions at these sites have built complexes of lava flow fields and cinder cones. Unlike the far-reaching effects that may be generated by large, potentially explosive stratovolcanoes in the Cascade Range, hazards associated with future eruptions in sparsely populated southeast Oregon are most likely limited to localized lava flows.

Geological Survey has attempted to rank the relative hazard of volcanoes in North America. According to this study, Oregon has four Very High Threat Volcanoes: Crater Lake, Mount Hood, Newberry Volcano, and South Sister (Ewert, Guffanti, & Murray, 2005).

Ashfall

Dust-sized ash particles are the by-products of many volcanic eruptions. Ash, when blown into the air, can travel large distances causing significant problems for distal hazard zones. During ash-dominated eruptions, deposition is largely controlled by the prevailing wind direction. The predominant wind pattern over the Cascade Range is from the west to the east. Previous eruptions documented in the geologic record indicate most ashfall drifting to and settling in areas to the east of the Cascade volcanoes.

Within a few miles of the vent, the main ashfall hazards to human-made structures and humans include high temperatures, being buried, and being hit by falling fragments. Within 10–12 miles, hot ashfall may set fire to forests and flammable structures.

Structural damage can also result from the weight of ash, especially if it is wet. Four inches of wet ash may cause buildings to collapse. Accumulations of a half inch of ash can impede the movement of most vehicles, disrupt transportation, communication, and utility systems, and cause problems for human and animal respiratory systems. It is extremely dangerous for aircraft, particularly jet planes, as volcanic ash accelerates wear to critical engine components, can coat exposed electrical components, and erodes exposed structure. Ashfall may severely decrease visibility, or even cause darkness, which can further disrupt transportation and other systems. Recent work by the Volcano Hazards Group of the US Geological Survey has attempted to rank the relative hazard of volcanoes in North America. According to this study, Oregon has four Very High Threat Volcanoes: Crater Lake, Mount Hood, Newberry Volcano, and South Sister (Ewert et al., 2005).

Ashfall can severely degrade air quality and trigger health problems. In areas with considerable ashfall, people with breathing problems might need additional services from doctors or emergency rooms. In severe events an air quality warning could be issued, informing people with breathing problems to remain inside

Ashfall can create serious traffic problems as well as road damage. Vehicles moving over even a thin coating of ash can cause clouds of ash to swell. This results in visibility problems for other drivers, and may force road closures. Extremely wet ash creates slippery and hazardous road conditions. Ash filling roadside ditches and culverts can prevent proper drainage and cause shoulder erosion and road damage. Blocked drainages can also trigger debris flows if the blockage causes water to pool on or above susceptible slopes. Removal of ash is extremely difficult as traditional methods, such as snow removal equipment, stir up ash and cause it to continually resettle on the roadway.

Historic Volcanic Events

Table 69. Historic Volcanic Events in Oregon over the Last 20,000 Years

Date	Location	Description
about 18,000 to 7,700 YBP	Mount Bachelor, central Cascades	cinder cones, lava flows
about 20,000 to 13,000 YBP	Polallie Eruptive episode, Mount Hood	lava dome, pyroclastic flows, lahars, tephra
about 13,000 YBP	Lava Mountain, south-central Oregon	Lava Mountain field, lava flows
about 13,000 YBP	Devils Garden, south-central Oregon	Devils Garden field, lava flows
about 13,000 YBP	Four Craters, south-central Oregon	Four Craters field, lava flows
about 7,780 to 15,000 YBP	Cinnamon Butte, southern Cascades	basaltic scoria cone and lava flows
about 7,700 YBP	Crater Lake Caldera	formation of Crater Lake caldera, pyroclastic flows, widespread ashfall
about 7,700 YBP	Parkdale, north-central Oregon	eruption of Parkdale lava flow
<7,000 YBP	Diamond Craters, eastern Oregon	lava flows and tephra in Diamond Craters field
< 7,700 YBP; 5,300 to 5,600 YBP	Davis Lake, southern Cascades	lava flows and scoria cones in Davis Lake field
about 10,000 to <7,700 YBP	cones south of Mount Jefferson; Forked Butte and South Cinder Peak	lava flows
about 4,000 to 3,000 YBP	Sand Mountain, central Cascades	lava flows and cinder cones in Sand Mountain field
< 3,200 YBP	Jordan Craters, eastern Oregon	lava flows and tephra in Jordan Craters field
about 3,000 to 1,500 YBP	Belknap Volcano, central Cascades	lava flows, tephra
about 2,000 YBP	South Sister Volcano	rhyolite lava flow
about 1,500 YBP	Timberline eruptive period, Mount Hood	lava dome, pyroclastic flows, lahars, tephra
about 1,300 YBP	Newberry Volcano, central Oregon	eruption of Big Obsidian flow
about 1,300 YBP	Blue Lake Crater, central Cascades	spatter cones and tephra
1760–1810	Crater Rock/Old Maid Flat on Mount Hood	pyroclastic flows in upper White River; lahars in Old Maid Flat; dome building at Crater Rock
1859/1865	Crater Rock on Mount Hood	steam explosions/tephra falls
1907 (?)	Crater Rock on Mount Hood	steam explosions
1980	Mount St. Helens (Washington)	debris avalanche, ashfall, flooding on Columbia River
1981–1986	Mount St. Helens (Washington)	lava dome growth, steam, lahars
1989–2001	Mount St. Helens (Washington)	hydrothermal explosions
2004–2008	Mount St. Helens (Washington)	lava dome growth, steam, ash

Note: YBP is years before present.

Sources: US Geological Survey, Cascades Volcano Observatory: http://volcanoes.usgs.gov/observatories/cvo/;
Wolfe and Pierson (1995); Sherrod, Mastin, Scott, and Schilling (1997); Scott et al. (1997); Scott, Iverson, Schilling, and Fisher (2001); Bacon, Mastin, Scott, and Nathenson (1997); Walder, Gardner, Conrey, Fisher, and Schilling (1999)

Tillamook County experienced ashfall from the Mount St. Helens eruption in May 1981.

Probability

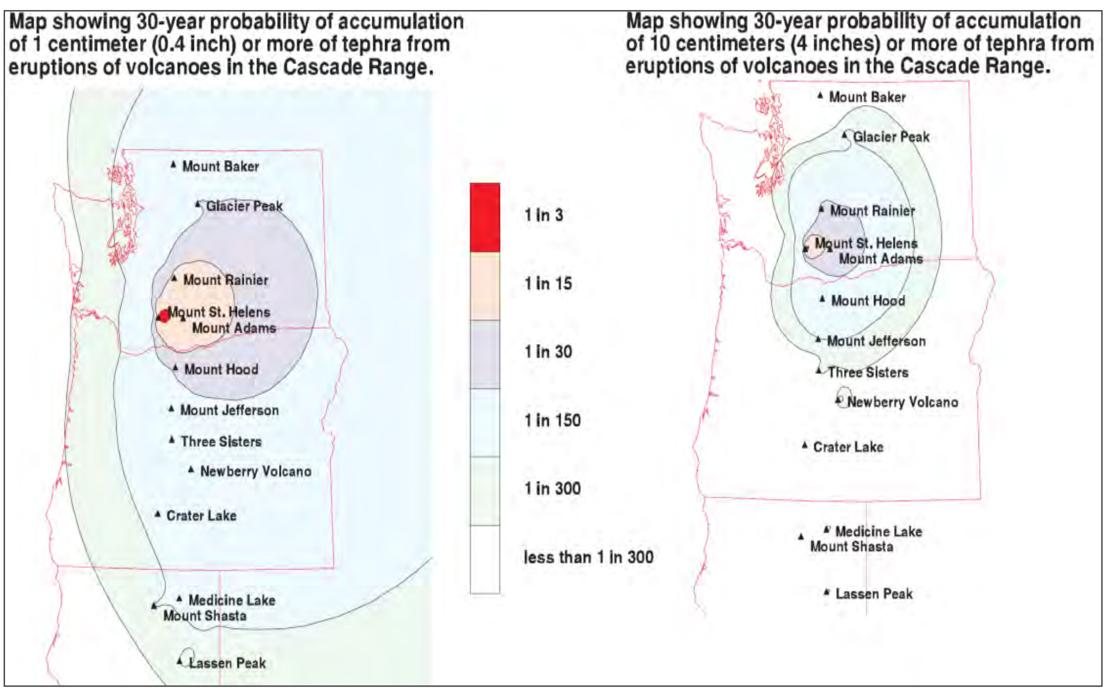
Geologists can make general forecasts of long-term volcanic activity from careful characterization of past activity, but they cannot supply a timeline. Several US Geological Survey open-file reports provide the odds of certain events taking place at particular volcanoes. However, the US Geological Survey stresses that government officials and the public must realize the limitations in forecasting eruptions and be prepared for such uncertainty.

Short-range forecasts, on the order of months or weeks, are often possible. There are usually several signs of impending volcanic activity that may lead up to eruptions. The upward movement of magma into a volcano prior to an eruption generally causes a significant increase in small, localized earthquakes and an increase in emission of carbon dioxide and compounds of sulfur and chlorine that can be measured in volcanic springs and the atmosphere above the volcano. Changes in the depth or location of magma beneath a volcano often cause changes in elevation. These changes can be detected through ground instrumentation or remote sensing. (This, in fact, was how the South Sister Bulge uplift was discovered.)

The Cascades Volcanic Observatory (CVO) employs scientists from a range of disciplines to continually assess and monitor volcanic activity in the Cascade Ranges. If anomalous patterns are detected (for example, an increase in earthquakes), CVO staff coordinate the resources necessary to study the volcano.

The probability of Tillamook County receiving ashfall is about 1 in 10,000. The probable geographic extent of volcanic ashfall from select volcanic eruptions in the Pacific Northwest is shown in **Figure 99**.

Figure 99. Probable Geographic Extent of Volcanic Ashfall from Select Volcanic Eruptions in the Pacific Northwest



Source: Scott et al. (1997)

Vulnerability

The Cascade Mountains, which separate Western Oregon from Central Oregon, pose the greatest threat for volcanic activity. Within the State of Oregon, there are several volcanoes that may pose a threat of future eruption. These include Mount Hood, which most recently erupted about 200 years ago, Newberry Volcano with recent eruptions about 1,300 years ago, and the Three Sisters and Mount Jefferson with eruptions about 15,000 years ago. Eruptions from volcanoes in Washington State, like the Mount St. Helens eruption in 1980, can also significantly impact Oregon.

The volcanic Cascade Mountain Range is not near Tillamook County; consequently, the risk from proximal volcano-associated hazards (e.g., lahars, pyroclastic flows, lava flows, etc.) is not a priority consideration. However, there is some risk from volcanic ashfall. This fine-grained material, blown aloft during a volcanic eruption, can travel many miles from its source. For example, the cities of Yakima (80 miles) and Spokane (150 miles), Washington, were inundated with ash during the May 1980, Mount St. Helens eruption. Ashfall can reduce visibility to zero, and bring street, highway, and air traffic to an abrupt halt. The material is noted for its abrasive properties and is especially damaging to machinery. It would be prudent for communities that may be exposed to ashfall to identify disposal areas for large quantities of ash.

While considered a low risk, ashfall within the Port of Tillamook Bay's industrial park would wreak major havoc. Aside from lack of visibility, the Port's economy and infrastructure would be impacted. For example, building HVAC systems inundated with ash would be unusable for some time. The consequences of impacts to critical infrastructure, such as the Tillamook Municipal Airport, would echo throughout the County.

For the Port of Garibaldi, excessive accumulation of volcanic ash carries a moderate risk. Volcanic ash falling directly into Tillamook Bay and imported by the five rivers that flow into it may cause excessive sediment build-up in both the Bay and boat basin, making navigation difficult and requiring additional expensive dredging. Water contaminated with volcanic ash may also hinder the operation of vessels in the area and damage local fish stocks, hurting the local commercial seafood and sport fishing industries.

Local Risk Assessment Methodology

Tillamook County executed the “OEM Methodology” in October 2015 considering probability of and vulnerability to volcanic hazards (ashfall) throughout the county. The County rated probability low and vulnerability moderate. The total score for winter storms was the highest, equal to the scores for floods, windstorms, and landslides.

Tillamook County and its cities executed the “OEM Methodology” again as an element of developing this risk assessment in September 2016. This time, Tillamook County considered only the rural areas of the county and the unincorporated urban communities of Neskowin, Oceanside-Netarts, and Pacific City. An assessment was also done by each city and the two ports. The assessment is based on the knowledge and experience of local officials and subject matter experts. All the jurisdictions assessed their risk of volcanic ashfall as low except the Port of Garibaldi, which assessed its risk as moderate. The State’s assessment appears to be in agreement with the assessment of low risk.

Table 70. Local Risk Assessment: Volcanic Ashfall

Jurisdiction	History	Vulnerability	Maximum Threat	Probability	Total	Risk Level
Unincorporated Tillamook County, including Neskowin, Oceanside-Netarts, and Pacific City–Woods	2	5	10	7	24	Low
Bay City	2	5	10	7	24	Low
Garibaldi	2	10	30	7	49	Low
Manzanita	0	0	10	0	10	Low
Nehalem	2	5	10	7	24	Low
Rockaway Beach	2	5	10	7	24	Low
Tillamook	0	15	100	0	115	Low
Wheeler	2	40	80	7	129	Low
Port of Tillamook Bay	2	5	10	7	24	Low
Port of Garibaldi	2	10	80	14	106	Moderate

Source: Based on information presented at the Tillamook County Multi-Jurisdictional NHMP Update Steering Committee Meeting, September 23, 2016

8. Wildfires

Introduction

Wildfires are a common and widespread natural hazard in Oregon; the state has a long and extensive history of wildfire. A significant portion of Oregon's forestland is dominated by ecosystems dependent upon fire for their health and survival. In addition to being a common, chronic occurrence, wildfires frequently threaten communities. These communities are often referred to as the "wildland-urban interface" (WUI), the area where structures and other human development meet or intermingle with natural vegetative fuels.

Oregon has in excess of 41 million acres (more than 64,000 square miles) of forest and rangeland that is susceptible to damage from wildfire. In addition, significant agricultural areas of the Willamette Valley, north central, and northeastern Oregon grow crops such as wheat that are also susceptible to damage by wildfire.

Wildfires occur throughout the state and may start at any time of the year when weather and fuel conditions combine to allow ignition and spread. The majority of wildfires take place between June and October, and primarily occur in inland southwest, central, and northeastern Oregon. Historically, Oregon's largest wildfires have burned in the Coast Range where the average rainfall is high, but heavy fuel loads created a low-frequency, high-intensity fire environment during the dry periods.

According to OEM, extreme winds are experienced throughout Oregon. The most persistent high winds occur along the Oregon Coast and the Columbia River Gorge. Wind is a primary factor in fire spread, and can significantly impede fire suppression efforts.

Historically, 70% of the wildfires suppressed on lands protected by the Oregon Department of Forestry (ODF) result from human activity. The remaining 30% result from lightning. Typically, large wildfires result primarily from lightning in remote, inaccessible areas.

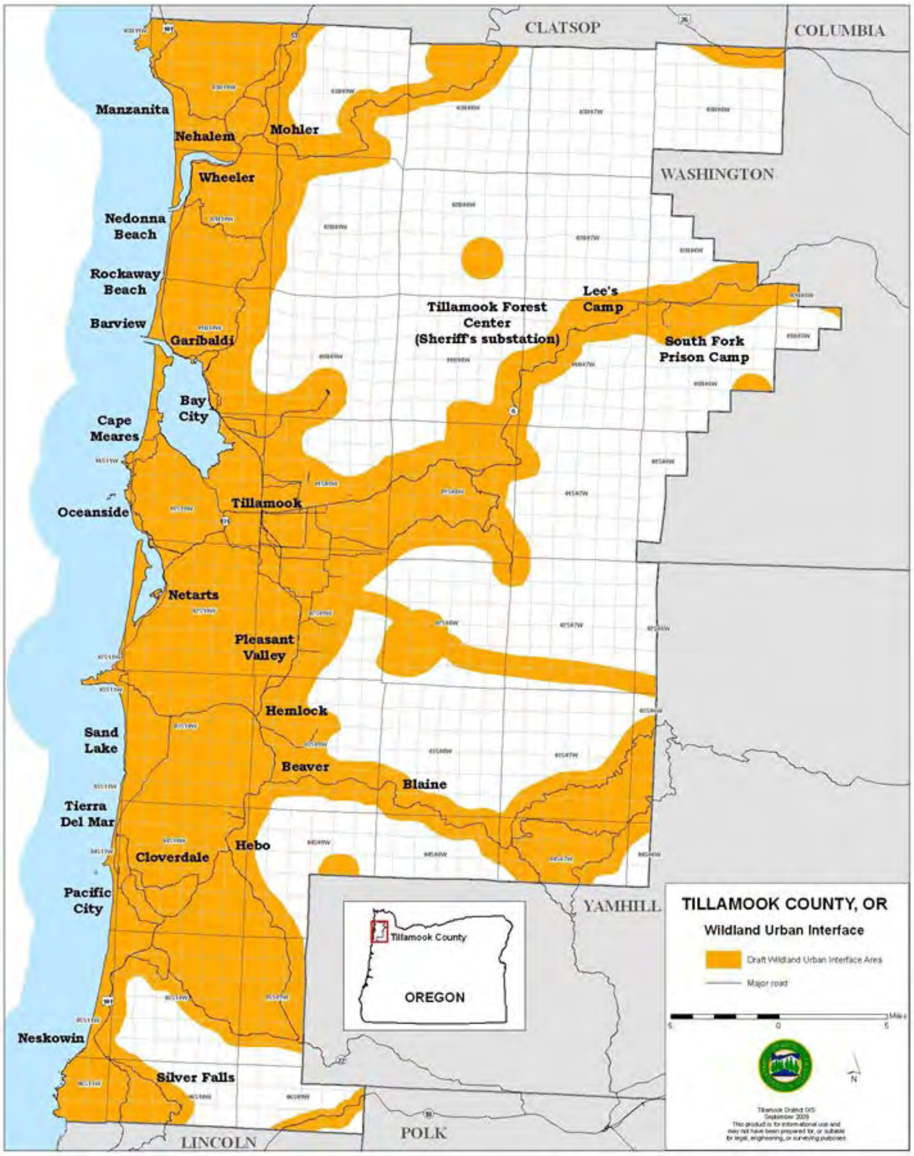
According to a University of Oregon study, *The Economic Impacts of Large Wildfires* (https://ewp.uoregon.edu/largefires/content), conducted between 2004 and 2008, the financial and social costs of wildfires impact lives and property, and cause negative short- and long-term economic and environmental consequences.

Life safety enhancement and cost savings may be realized by appropriate mitigation measures, starting with coordinated fire protection planning by local, state, tribes, federal agencies, the private sector, and community organizations. Additionally, and often overlooked, is the role that individual WUI property owners play in this coordinated effort.

Wildfire suppression costs escalate dramatically when agencies must adjust suppression tactics to protect structures. The cost of mobilizing personnel and equipment from across the state is significant. Non-fire agencies may also incur costs for providing or supporting evacuations, traffic control, security, public information, and other services during WUI fire incidents. These costs vary widely and have not been well documented.

The number of people living in Oregon's Wildland-Urban Interface (WUI) areas is increasing. Where people have moved into these areas, the number of wildfires has escalated dramatically. Many people arriving from urban settings expect an urban level of fire protection. The reality is many WUI homes are located in jurisdictions with limited capacity for structural protection and sometimes no fire protection whatsoever. Many Oregon communities (incorporated and unincorporated) are within or abut areas subject to serious wildfire hazards. In Oregon, there are about 240,000 homes worth around $6.5 billion within the WUI, which has greatly complicated firefighting efforts and significantly increased the cost of fire suppression. While Oregon's Emergency Conflagration Act helps protect WUI communities that have depleted their local resources when threatened by an advancing wildfire, the escalating number of fires has led to the recognition that citizens in high fire risk communities need to provide mitigation and an appropriate level of local fire protection. Oregon's seller disclosure law requires a statement of whether or not property is classified as forestland-urban interface. Collaboration and coordination is ongoing among several agencies to promote educational efforts through programs like Firewise, the Oregon Forestland-Urban Interface Fire Protection Act, and Fire Adapted Communities from the National Cohesive Wildfire Strategy.

Figure 100. Wildland-Urban Interface in Tillamook County



Source: Tillamook County Community Wildfire Protection Plan (White et al., 2006)

Increasing construction in vulnerable areas increases risk for vulnerable populations. Oregon's Statewide Planning Goals 4 (Forest Lands) and 7 (Areas Subject to Natural Hazards) play critical roles in guiding development in these areas. Measures to enhance life safety and save costs include Community Wildfire Protection Plans (CWPPs), coordinated fire protection planning, and coordination by local, state, tribal, federal agencies, the private sector, and community organizations. Many local communities incorporate their CWPPs into their local Natural Hazards Mitigation Plans (NHMPs).

Wildfire mitigation discussions are focused on reducing overabundant, dense forest fuels, particularly on public lands. The Healthy Forest Restoration Act aims to create fuel breaks by reduce overly dense vegetation and trees. It provides funding and guidance to reduce or eliminate hazardous fuels in National Forests, improve forest fire fighting, and research new methods to reduce the impact of invasive insects.

Oregon's efforts in and near WUI areas are massive, and are resulting in improvements. Sustaining the work over the many years it takes requires a substantial, ongoing financial commitment. Progress is often challenging because fuel mitigation methods are not universally accepted and are often controversial. However, recurring WUI fires continue to bring the issue into public focus as well as unite communities and stakeholders in a common set of objectives.

While Tillamook County is heavily forested, its cool, moist climate contributes to its primarily moderate risk of wildfire. Most of the areas considered to be at high risk are in areas along Highway 6 east of the City of Tillamook and along Highway 101, most notably near the cities of Bay City, Garibaldi, Tillamook, and Rockaway Beach, within the wildland-urban interface area established in the Tillamook County CWPP (White et al., 2006), **Figure 100**. The communities in Tillamook County located within the WUI are:

- Bay City
- Beaver
- Blaine
- Cape Meares
- Cloverdale
- Foley Creek
- Garibaldi
- Hebo
- Hemlock
- Jordan Creek
- Lees Camp
- Manzanita
- Nehalem
- Neskowin
- Oceanside/Netarts
- Oretown
- Pacific City-Woods
- Pleasant Valley
- Rockaway Beach
- Sandlake
- Siskeyville
- Tierra del Mar
- Tillamook
- Winema Beach

Wildfires in the wildland-urban interface (WUI) pose serious threats to life and endanger property, critical infrastructure, water resources, and valued commercial and ecological forest resources. Although the wildfire risk in Tillamook County is considered moderate, when a wildfire does occur it can be catastrophic. The historic Tillamook Burn, comprising devastating wildfires every 6 years between 1933 and 1951, burned a total of 355,000 acres. Much of the burn was attributed to powerful east wind events and heavy fuels.

Location

Table 71. Jurisdictions Subject to Wildfires

Jurisdiction	Wildfires
Unincorporated Tillamook County (rural)	X
Neskowin	X
Oceanside-Netarts	X
Pacific City–Woods	X
Bay City	X
Garibaldi	X
Manzanita	X
Nehalem	X
Rockaway Beach	X
Tillamook	X
Wheeler	X
Port of Tillamook Bay	X
Port of Garibaldi	X

Source: Derived from DOGAMI (2016)

Hazard Characterization

Types of Wildfire

Wildfires burn primarily in vegetative fuels located outside highly urbanized areas. Wildfires may be broadly categorized as agricultural, forest, range, or WUI fires.

Agricultural

Fires burning in areas where the primary fuels are flammable cultivated crops, such as wheat. This type of fire tends to spread very rapidly, but is relatively easy to suppress if adequate resources are available. Structures threatened are usually few in number and generally belong to the property owner. There may be significant losses in terms of agricultural products from such fires.

Forest

The classic wildfire, forest fires burn in fuels composed primarily of timber and associated brush, grass, and logging residue. Due to variations of fuel, weather, and topography, forest fires may be extremely difficult and costly to suppress. In wilderness areas they are often monitored and allowed to burn for the benefits brought by the ecology of fire, but also pose a risk to private lands when they escape the wilderness areas.

Range

Fires that burn across lands typically open and lacking timber stands or large accumulations of fuel. Such lands are used predominantly for grazing or wildlife management purposes. Juniper, bitter-brush, and sage are the common fuels involved. These fires tend to spread rapidly and vary from being easy to difficult to suppress. They often occur in areas lacking both wildland and structural fire protection services.

Wildland-urban interface (WUI)

These fires occur where urbanization and natural vegetation fuels are mixed together. This mixture may allow fires to spread rapidly from natural fuels to structures and vice versa. Such fires are known for the large number of structures simultaneously exposed to fire. Especially in the early stage of WUI fires, structural fire suppression resources may be quickly overwhelmed, which may lead to the destruction of a large number of structures. Nationally, wildland interface fires have frequently resulted in catastrophic structure losses.

Common Sources of Wildfire

For statistical tabulation purposes, wildland fires are grouped into nine categories based on historically common wildfire ignition sources.

Arson

Oregon experienced a rapid rise in the frequency of arson caused fires in the early 1990s. 1992 was the worst fire season for arson with 96 fires attributed to the category. In response, the state instituted aggressive arson prevention activities with solid working relationships with local law enforcement and the arson division of the Oregon State Police. The result is a slight decline in the 10-year average with just 41 fires occurring annually since 2004.

Debris burning

Historically, debris burning activities have been a leading source of human-caused wildfires. Aggressive prevention activities coupled with increasing local burning bans during the wildfire season have begun to show positive results. Many debris burning fires occur outside of fire season, resulting in increased awareness during the spring and fall months.

Equipment use

This source ranges from small weed eaters to large logging equipment; many different types of equipment may readily ignite a wildfire, especially if used improperly or illegally. Although fire agencies commonly limit or ban certain uses of fire-prone equipment, the frequency of fires caused by equipment has been trending upward in recent years. This increase may be related to the expansion of the wildland interface, which results in more people and equipment being in close proximity to forest fuels.

Juvenile

The trend in the incidence of juveniles starting wildland fires is downward in recent years. This is attributed to concerted effort by local fire prevention cooperatives to deliver fire prevention messages directly to school classrooms and the Office of the State Fire Marshal's (OSFM's) aggressive youth intervention program. In 1999, according to the ODF, juveniles were reported to have started 60 wildland fires. Conversely, juveniles accounted for just 17 fires in 2013 and, on average, have only accounted for 25 fires per year over the last 10 years. Additionally, parents or guardians, under Oregon Law, are responsible for damages done by fires started by their children. ORS 30.765 covers the liability of parents; ORS 163.577 holds parents or guardians accountable for child supervision, ORS 477.745 makes parents liable for wildfire suppression costs of a fire by a minor child, and ORS 480.158 holds a parent liable for fireworks-caused fires. Additionally, parents may be assessed civil penalties.

Lightning

There are tens of thousands of lightning strikes in Oregon each year. Of the nine categories, lightning is the leading ignition source of wildfires. In addition, lightning is the primary cause of fires that require activation of Oregon's Conflagration Act.

Miscellaneous

Wildfires resulting from a wide array of causes: automobile accidents, burning homes, pest control measures, shooting tracer ammunition and exploding targets, and electric fence use are a few of the causes in this category. The frequency of such fires has been rising in recent years.

Railroad

Wildfires caused by railroad activity are relatively infrequent. In the early twentieth century, this had been a major cause of fires, but has been decreasing for many years. Over the past 10-year period, the number of railroad-caused fires has leveled out. In the past few decades, Oregon has responded to railroad-caused fires with aggressive fire investigation and cost recovery efforts. Oregon Department of Forestry works with the railroad on hazard abatement along tracks and requires water cars and chase vehicles during high fire danger. The resulting quick return to normal fire incidence showed that railroad fires are preventable.

Recreation

The trend in fires caused by people recreating in and near Oregon's forests has been rising over the past 10 years. This trend may reflect the state's growing population and as well as a greater interest in outdoor recreation opportunities.

Smoking

Fires caused by smoking and improperly discarded cigarettes is down. It is not known if this is due to fewer people smoking, recent modifications producing fire standard compliant cigarettes, or better investigation of fire causes.

According to the *Tillamook County Community Wildfire Protection Plan* (White et al., 2006), the leading cause of fires in Tillamook County is **recreation**, primarily due to escaped, abandoned, or unattended warming or cooking fires. Fires caused by recreation are most prevalent during major holidays, extremely hot weather, school breaks and hunting season. The second leading cause is **debris burning**, both general and slash pile burning. There are a number of reasons for this from inadequate clearing, inability to control, failure to recognize the severity of burning conditions, burning prohibited material, failure to follow permit instructions, inadequate mop-up, and inattention. Escaped slash burning accounts for a small percentage of the number of fires, but impacts a large area. And finally, the third leading cause is **equipment use**. Sparks or friction from the rigging and the cable system of logging equipment have caused fires.

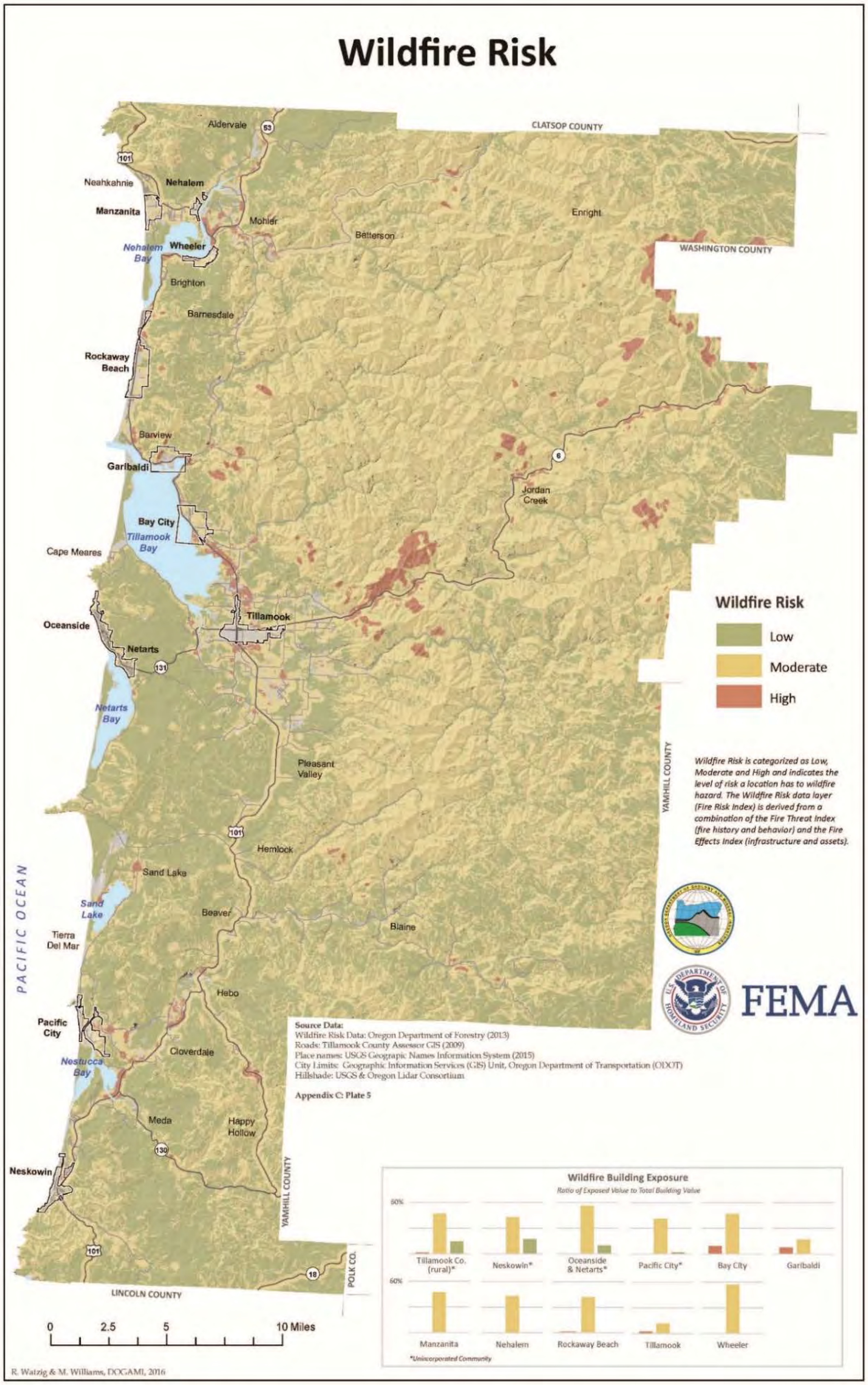
Secondary Hazards

Increased risk of landslides and erosion are secondary hazards associated with wildfires that occur on steep slopes. Wildfires tend to denude the vegetative cover and burn the soil layer creating a less permeable surface prone to sheetwash erosion. This in turn increases sediment load and the likelihood of downslope failure and impact.

Wildfires can also impact water quality (e.g., drinking water intakes). During fire suppression activities some areas may need coordinated efforts to protect water resource values from negative impact.

Wildfire smoke may also have adverse effects on air quality and visibility, and create nuisance situations. Strategies to limit smoke from active wildfires are limited, but interagency programs exist to alert the public of potential smoke impact areas where hazardous health or driving conditions may occur.

Figure 101. Wildfire Risk



Source: DOGAMI (2016)

Historic Wildfire Events

Table 72. Historic Wildfires in Tillamook County

Date	Name	Description
1853	Nestucca	burned more than 320,000 acres
1933, 1939, 1945, 1951	Tillamook County	the Tillamook Burn included four fires occurring every 6 years over an 18-year period that burned 355,000 acres and killed one person
Aug. 1933	Tillamook Fire	burned 240,000 acres; the Tillamook Forest burned every 6 years between 1933 and 1951; total acreage burned was over 350,000 acres; together, the four events are called the Tillamook Burn; dry forest conditions seems to have been a major factor
Aug. 1939	Saddle Mountain Fire	burned 190,000 acres; much of the land had already been burned in the previous fires; burned 50,091 new acres
Jul. 1945	Salmonberry Fire Wilson River Fire	the two fires burned together; much of the land had already been burned in the previous fires; burned 65,150 new acres
Apr. 1951 Jul. 1951 Sep. 1951	North Fork Trask Fire Elkhorn Fire Edwards Creek Fire	burned 33,000 acres total; the Edwards Creek Fire was a re-kindling of the Elkhorn Fire; all of the acreage had been burned in the Elkhorn and North Trask Fires
Oct. 1970	Smith Creek Fire	burned 202 acres
Oct. 1976	Cronin Creek Fire	burned 834 acres
Oct. 1986	Prouty Creek Fire	burned 105 acres
Sep. 1995	Steampot Fire	burned 30 acres
Nov. 2002	Butte Creek Fire	burned 45 acres
Nov. 2002	Blue Lake Fire	burned 45 acres
Nov. 2002	Bay Overlook Fire	burned 46 acres
Jul. 2006	Spring Creek Fire	Burned 35 acres

Source: Oregon Natural Hazards Mitigation Plan (Oregon Department of Land Conservation and Development, 2015); Tillamook County Community Wildfire Protection Plan (White et al., 2006)

Probability

The potential that wildland fires, both small and large, will threaten life, property and natural resources is a reality. The natural ignition of forest fires is largely a function of weather and fuel. Dry and diseased forests can be mapped accurately and some statement can be made about the probability of lightning strikes. Human-caused fires add another dimension to the probability.

On lands protected by ODF, the 10-year trend in both the incidence of human-caused fires and the acres they burn is rising. Population growth and development continue to encroach into and fragment forests. Fire statistics show that fire incident rates, and therefore risks, are prevalent in WUI areas.

The probability of significant fire activity occurring in Tillamook County is most likely during the late summer and early fall months when temperatures remain high, vegetation has had the entire summer to dry out and east winds coming out of the Columbia Gorge are more prevalent.

Climate Change

El Niño winters can be warmer and drier than average. This often leads to an increased threat of large wildfires the following summer and autumn, even in cool, wet Tillamook County. According to ODF, state firefighting agencies will continue to monitor correlations between seasonal weather conditions and wildfire occurrences and severity to refine planning tools for fire seasons and to aid in the pre-positioning of firefighting resources to reduce the vulnerability posed by large wildfires to natural resources and structures.

Vulnerability

Vulnerability expresses the impacts to people and the built environment anticipated from wildfire. The greatest impacts of wildfire in Tillamook County will be to people and property in the WUI area and to the timber, recreation, and tourism industries.

Tillamook County has moderate risk of wildfire throughout based primarily on cool, moist weather conditions and infrequent activity. However, the County has had some of the largest wildfires that posed threats to communities when they occurred. Any new development within or on the edge of the forest would increase vulnerability to wildfire.

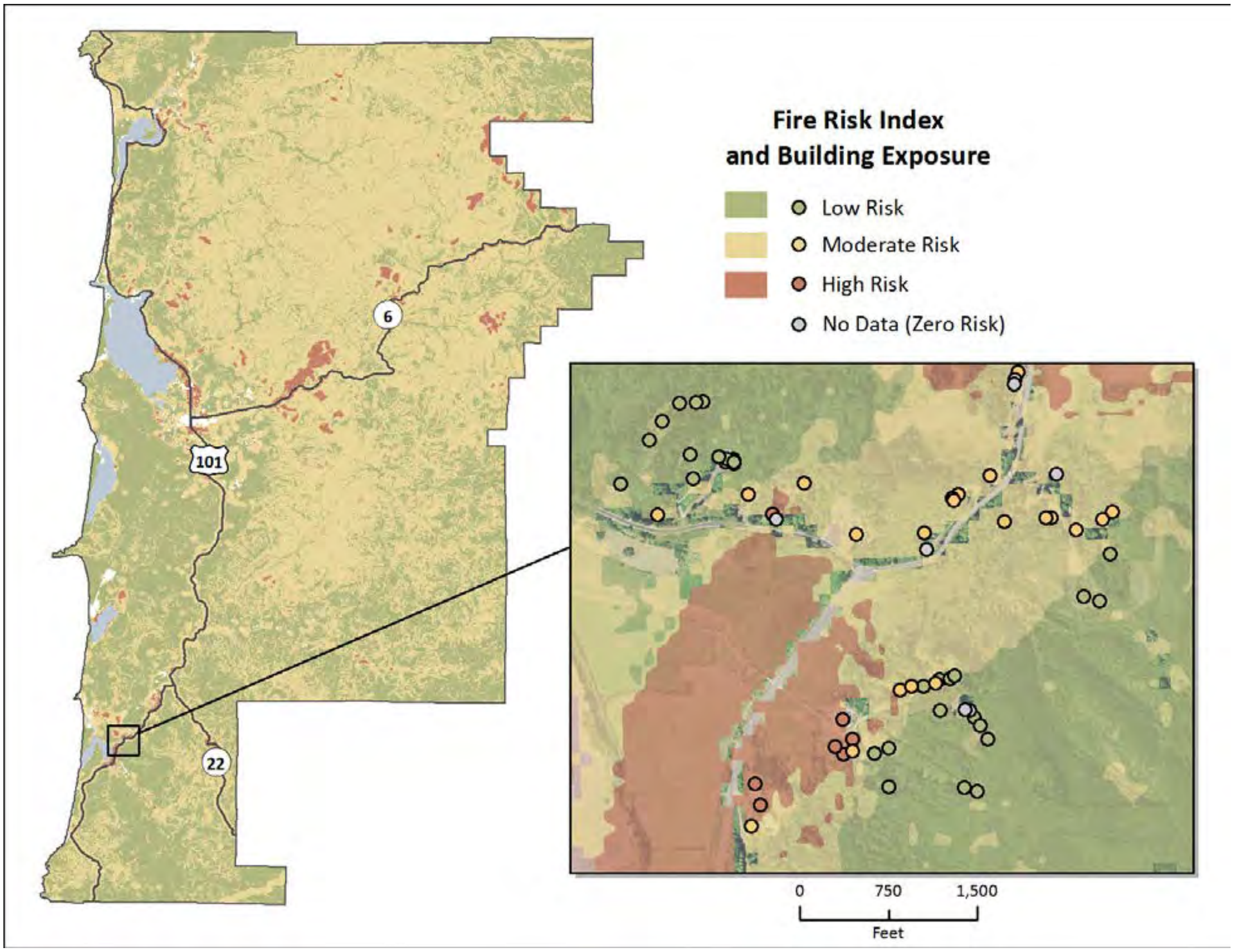
While the risk of wildfire impacting the Port of Tillamook Bay is considered low, should a wildfire spread to the Port damage to buildings, contents, and critical infrastructure could have a chilling effect on the County's economy.

The economic stability of the County is also dependent on a major state highway (US-101) that runs along the Oregon Coast and several east-west highways connecting the County to Portland and Salem. Should a major wildfire (or other natural hazard event) threaten or impact these routes, coastal tourism and recreational economies would come to a halt.

Exposure

The *Final Draft Multi-Hazard Risk Report for Tillamook County* (DOGAMI, 2016) provides a wildfire exposure analysis for Tillamook County. **Figure 102** provides shows the WWA's Fire Risk Index and building exposure analysis. Exposure analysis results are shown in **Table 73** and **Table 74**, and **Figure 103** illustrates those results.

Figure 102. Wildfire Risk Exposure and Building Exposure Example



Source: DOGAMI (2016)

Table 73. Wildfire Exposure: Tillamook County and Cities

	(all dollar amounts in thousands)							
			High Risk			Moderate Risk		
Community	**Total Number of Buildings**	**Total Estimated Building Value ($)**	**Number of Buildings**	**Building Value ($)**	**Ratio of Exposure Value**	**Number of Buildings**	**Building Value ($)**	**Ratio of Exposure Value**
Unincorp. County (rural)	15,015	1,282,436	383	22,892	1.8%	8,130	607,204	47%
Neskowin	653	118,463	2	288	0.2%	319	50,895	43%
Oceanside-Netarts	1,701	203,363	0	0	0%	866	113,942	56%
Pacific City–Woods	1,707	212,062	3	226	0.1%	656	86,116	41%
Total Unincorp. County	**19,076**	**1,816,324**	**388**	**23,406**	**1.3%**	**9,971**	**858,157**	**47%**
Bay City	884	74,770	58	7,089	9.5%	456	34,921	47%
Garibaldi	755	64,331	83	5,014	7.8%	93	11,144	17%
Manzanita	1,523	259,780	0	0	0%	681	121,658	47%
Nehalem	260	24,886	0	0	0%	105	10,822	43%
Rockaway Beach	2,240	211,809	25	2,938	1.4%	782	89,488	42%
Tillamook	2,270	322,398	8	8,892	2.8%	218	37,552	12%
Wheeler	363	30,556	3	188	0.6%	180	17,373	57%
Total Tillamook County	**27,371**	**2,804,854**	**565**	**47,527**	**1.7%**	**12,486**	**1,181,115**	**42%**

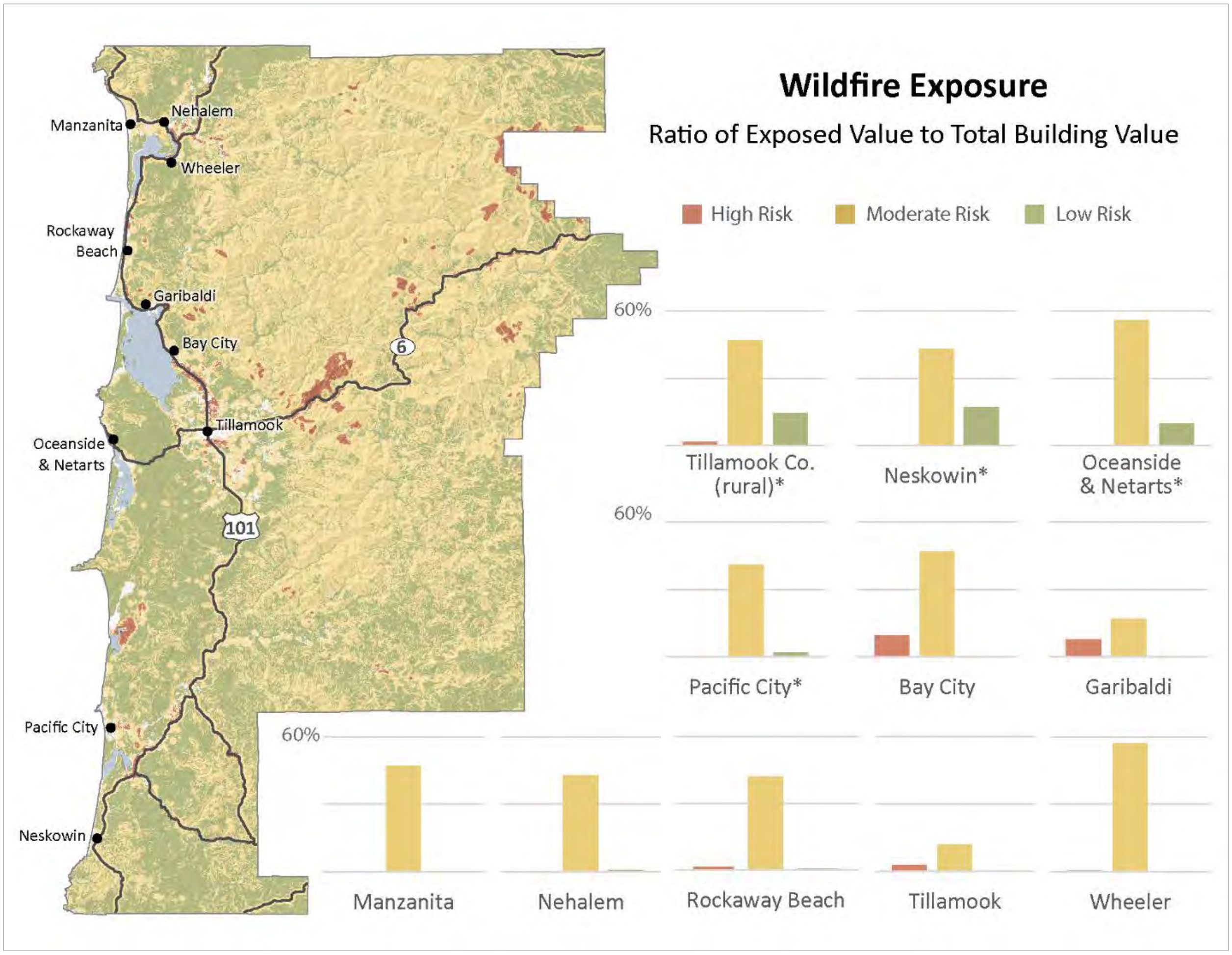
Source: DOGAMI (2016)

Table 74. Wildfire Exposure: Port of Tillamook Bay and Port of Garibaldi

			High Risk			Moderate Risk		
	Total Number of Buildings	**Total Estimated Building Value ($)**	**Number of Buildings**	**Building Value ($)**	**Ratio of Exposure Value**	**Number of Buildings**	**Building Value ($)**	**Ratio of Exposure Value**
Port of Garibaldi	36	8,035,760	0	0	0.00%	0	0	0%
Port of Tillamook	83	61,545,144	0	0	0.00%	0	0	0%

Source: Derived from DOGAMI (2016)

Figure 103. Wildfire Risk Exposure by Community



*Unincorporated communities.

Source: DOGAMI (2016)

Local Risk Assessment Methodology

Tillamook County executed the "OEM Methodology" in October 2015 considering probability of and vulnerability to wildfire throughout the county. The County rated both probability vulnerability moderate. The total score for wildfire trailed the scores for floods, winter storms, windstorms, landslides, and earthquakes.

Tillamook County and its cities executed the "OEM Methodology" again as an element of developing this risk assessment in September 2016. This time, Tillamook County considered only the rural areas of the county and the unincorporated urban communities of Neskowin, Oceanside-Netarts, and Pacific City. An assessment was also done by each city and the two ports. The assessment is based on the knowledge and experience of local officials and subject matter experts.

Most of the jurisdictions assessed their risk of wildfire as low. The State's assessment is that in most places risk is low to moderate. Tillamook, the risk is moderate around the edges of the city; there are no data for the interior. In Garibaldi, the lowlands are not at risk, but the hills have areas of moderate and high risk. Located away from the forested hillsides and on the water, the Port of Garibaldi assessed its risk as low. However, it could suffer secondary impacts. Damage to the ecosystem surrounding the local rivers may reduce fish returns and therefore local fish stocks, hurting the local commercial seafood and sport fishing industries.

Table 75. Local Risk Assessment: Wildfire

Jurisdiction	History	Vulnerability	Maximum Threat	Probability	Total	Risk Level
Unincorporated Tillamook County, including Neskowin, Oceanside-Netarts, and Pacific City–Woods	2	25	20	14	61	Low
Bay City	0	15	90	21	126	High
Garibaldi	6	15	50	21	92	Low
Manzanita	0	20	40	0	60	Low
Nehalem	2	35	100	14	151	Moderate
Rockaway Beach	2	30	80	35	147	Moderate
Tillamook	0	20	80	7	107	Low
Wheeler	8	5	50	28	91	Low
Port of Tillamook Bay	0	5	10	7	22	Low
Port of Garibaldi	2	5	10	14	31	Low

Source: Based on information presented at the Tillamook County Multi-Jurisdictional NHMP Update Steering Committee Meeting, September 23, 2016

D. Community Risk Profiles

Community Risk Profiles summarize the risk assessment and include a multi-hazard map set for each community. In addition, they provide risk reduction strategies for each community except the Ports to consider. Areas of mitigation interest were not analyzed for the Ports.

1. Unincorporated Tillamook County

Note: the statistics in this section do not include the unincorporated communities of Neskowin, Oceanside-Netarts, or Pacific City–Woods.

Risk Assessment Summary

Table 76. Hazard Profile: Unincorporated Tillamook County

Community Overview				
Community Name	Population	Number of Buildings	Essential Facilities[1]	Total Building Value ($)
Unincorporated Tillamook County	13,360	15,015	25	1,282,436,000

Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	658	4.9%	1,106	1	10,178,000	0.8%
*Earthquake**	*CSZ Mag 9.0 Deterministic*	*4,100*	*31%*	*6,069*	*19*	*409,947,000*	*32%*
Earthquake (within Tsunami Zone)		202	1.5%	647	2	48,531,000	3.8%

Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Tsunami	*CSZ Mag 9.0 – Medium*	*753*	*5.6%*	*1,692*	*2*	*147,262,000*	*11%*
Tsunami	Senate Bill 379 Regulatory Line	690	5.2%	1,662	2	155,993,000	12%
Landslide	High and Very High Susceptibility	4,428	33%	4,933	9	449,331,000	35%
Wildfire	High Risk	408	3.1%	383	1	22,892,000	1.8%
Coastal Erosion	High Hazard	59	0.4%	161	0	18,928,000	1.5%

*Earthquake damage was calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in Figure 104.

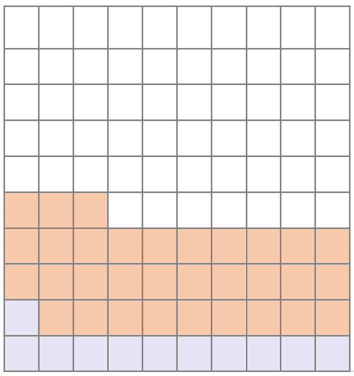
[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First Floor Heights" above the level of flooding (base flood elevation).

The natural hazards to which rural Tillamook County is most vulnerable are the CSZ-related events (earthquake and tsunami), flood, and landslide. Coastal erosion and wildfire to a lesser extent are also hazard risks. As with every community in Tillamook County, the proximity to the CSZ makes earthquake a high risk hazard. Developments along the Pacific Coast and in estuarine areas have exposed a huge amount of the coastal region of rural Tillamook County to tsunami hazard, as well as to coastal erosion. Potential flooding from riverine and coastal sources can affect many buildings in the low-lying rural areas in the 100-year flood zone. Risk of landslide exists throughout the county.

The CSZ event is a significant natural hazard risk to rural Tillamook County and is a priority hazard for this community. Moderate to high liquefaction zones exist throughout the county, which increases the risk from earthquake. Another consideration of these areas is that liquefaction could present difficulties for evacuation from the subsequent tsunami. The combination of earthquake and tsunami will have a tremendous impact to the entire coastal and estuarine portions of rural Tillamook County.

Figure 104. Loss Ratio from CSZ Event: Unincorporated Tillamook County



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. In order to avoid double counting to buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

= Estimated damage due to tsunami.
= Estimated damage due to earthquake (outside of tsunami zone).

Many of the buildings built along the streams and the coast are exposed to the 100-year flood in rural parts of the county. Although there are some elevated buildings in the flood-prone areas, which have greatly reduced overall flood risk, there are still many buildings that can be impacted by flood. It is estimated that nearly half of the buildings exposed to the 100-year flood are elevated above the predicted level of flooding. So while the buildings themselves would not be damaged from flood, access to these buildings could be an issue.

Roughly one third of the buildings in rural Tillamook County are at risk to landslide hazard. Low susceptibility landslide zones generally correspond to estuaries and floodplains near estuaries that also are in the vicinity of the county's populated areas. However, outside of these areas, susceptibility is high to very high almost everywhere. The rugged terrain of rural Tillamook County lends itself to potential landslide hazard.

To a lesser extent coastal erosion and wildfire hazards pose some concerns. Coastal erosion hazards exist all along the coast, but much of coastal rural Tillamook County is undeveloped. Wildfire risk is high for hundreds of homes within this community, but the overall exposure percentage is fairly low.

Table 77. Essential Facilities: Unincorporated Tillamook County

Essential Facilities by Community	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ M 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Risk	Coastal Erosion High Hazard
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Adventist Clinic North		X		X		
Adventist Clinic South		X		X		
Cape Meares Fire Station #73						
Fire Mountain School		X		X		
Neah-Kah-Nie Jr/Sr High School		X	X			
Nehalem Bay Fire and Rescue #11		X				
Nehalem Bay Fire and Rescue #13		X				
Neskowin Valley School		X		X		
Nestucca Fire and Rescue Station #87 (Hebo)	X			X		
Nestucca High School		X		X		
Nestucca RFPD Beaver #83		X				
Nestucca RFPD Blaine #86		X				
Nestucca RFPD Neskowin #84		X	X	X		
Nestucca RFPD Sand Lake #85					X	
Nestucca Valley Elementary		X		X		
Nestucca Valley Middle School		X				
South Fork Prison Camp		X				
South Prairie Elementary School		X				
Tillamook Adventist School						
Tillamook Co. Public Works - South		X		X		
Tillamook County Sheriff's Office And Oregon State Police		X				
Tillamook Fire Station South Prairie Station #72		X				
Tillamook Co. Public Works		X				
Tillamook Youth Correctional Facility		X				
Trask River High School		X				

Areas of Mitigation Interest

Hazard results from Hazus and exposure analyses sometimes show specific locations where concentrations of high risk exist. These high risk locations, when considered along with other factors like number of people affected, potential economic impact, and level of damage, can be determined “Areas of Mitigation Interest (AOMI).” Potential mitigation actions that would also address the results of the Hazus and exposure analyses were culled from the current (2012) Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan.

Note: The statistics in this section do not include the unincorporated communities of Neskowin, Oceanside, Netarts, or Pacific City.

Table 78. Areas of Mitigation Interest: Unincorporated Tillamook County

Hazard	Area	Description	Recommended Strategy
Flood	many buildings located adjacent to Nehalem River, just upstream of the City of Nehalem	clusters of buildings along the banks of the Nehalem River are not elevated above the predicted level of 100-year flooding	
Flood	Tillamook Cheese Factory	the top employer in Tillamook County is within the area predicted to flood due to a 100-year flood	
Flood	many buildings located adjacent to Trask River	a cluster of mobile homes along the banks of the Trask River tis not elevated above the predicted level of 100-year flooding	
Earthquake	mobile home park off Necarney City Rd and Hwy 101	a cluster of manufactured homes is estimated to have high probability to destruction due to earthquake	
Earthquake	many buildings located adjacent to Nehalem River, just upstream of the City of Nehalem	clusters of buildings along the banks of the Nehalem River are within a high liquefaction zone and have high probability to destruction due to earthquake	
Earthquake	mobile home park off of Hwy 101 and Idaville Rd	a cluster of manufactured homes is estimated to have high probability to destruction due to earthquake	
Earthquake	cluster of homes adjacent to Highway 131 and near the Tillamook River	a cluster of buildings is within a high liquefaction zone and has high probability to destruction due to earthquake	
Coastal Erosion	area of homes north of Rockaway Beach along the shoreline	a long strip of houses are all within the high coastal erosion designated zone	
Coastal Erosion	area of homes in the unincorporated community of Terra del Mar along the shoreline	a long strip of houses that are all within the high coastal erosion designated zone	

Table 79. Hazard Mitigation Plan Analysis: Unincorporated Tillamook County

Hazard	Projects	Additional Information from Risk Report
Coastal erosion	Coastal Erosion Risk Analysis and Response Plan	
Multi-hazard	animal mortality plan, 8,000 dead cows per year without a natural disaster	
Flood	continue to replace culverts and bridges	
Multi-hazard	pre-position disaster response supplies and equipment	
Multi-hazard	create public hazard mitigation event data entry port	
Flood	apply for funding to repair two levees	
Multi-hazard	Emergency Response Siren Committee to determine where the sirens are to be located	
Flood	implement Oregon Solutions Team Flood Hazard Reduction Plan	
Flood	drainage asset management plan and inventory; inventory the condition of the culverts and develop a repair/replacement schedule	
Multi-hazard	establish Tillamook County Emergency Management Advisory Committee (EMAC) including public works, fire departments, emergency medical services, first responders from the entire county coordinated centrally from the 911 center	
Multi-hazard	restock mass casualty trailer annually	
Multi-hazard	mass casualty exercise annually	
Flood	inspect the seven levees annually	
Multi-hazard	established disaster event chain of command between county, cities, unincorporated communities and non-governmental bodies, Tillamook County Emergency Management Department, Oregon Emergency Management and FEMA	
Multi-hazard	partner with DOGAMI through a DOGAMI grant to engage four communities in the “follow the elephant” evacuation practice program; Pacific City–Woods, Neskowin, Rockaway Beach, Manzanita, and Nedonna Beach on their own	
Multi-hazard	practice evacuations with Manzanita and Pacific City-Woods	
Multi-hazard	airborne warning and speaker system controlled by the civil air control dispatched through the Emergency Management Response System	
Wildfire	implement Nehalem Bay Emergency Volunteer Corps (NBEVC) agreement for assistance with Nehalem Bay Regional Fire District	
Multi-hazard	partner with BLM and ODF to provide adequate staffing	
Flood	buy out repetitive loss properties through FEMA	
Multi-hazard	provide significant ham radio training throughout the county	
Multi-hazard	train CERT volunteers in North Tillamook County and Rockaway Beach	

2. Neskowin

Risk Assessment Summary

Table 80. Hazard Profile: Unincorporated Community of Neskowin

Community Overview							
Community Name		Population	Number of Buildings	Essential Facilities[1]		Total Building Value ($)	
Neskowin		230	653	0		118,463,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	21	9.1%	82	0	7,132,000	6%
*Earthquake**	*CSZ Mag 9.0 Deterministic*	*10*	*4.3%*	*32*	*0*	*6,658,000*	*5.6%*
Earthquake (within Tsunami Zone)		32	14%	95	0	17,301,000	15%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Tsunami	*CSZ Mag 9.0 – Medium*	*133*	*58%*	*461*	*0*	*81,824,000*	*69%*
Tsunami	Senate Bill 379 Regulatory Line	136	59%	471	0	84,248,000	71%
Landslide	High and Very High Susceptibility	62	27%	132	0	24,187,000	20%
Wildfire	High Risk	0	0%	2	0	288,000	0.2%
Coastal Erosion	High Hazard	36	16%	110	0	34,149,000	29%

*Earthquake was damage calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in Figure 105.

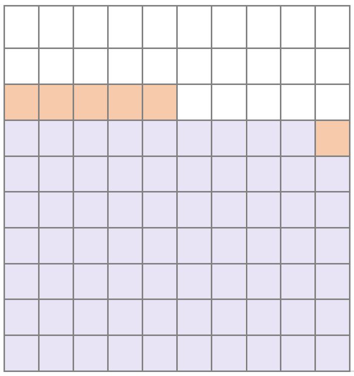
[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First Floor Heights" above the level of flooding (base flood elevation).

The natural hazards to which Neskowin is most vulnerable are the CSZ-related events (earthquake and tsunami), flood, and coastal erosion. As with every community in Tillamook County, the proximity to the CSZ makes earthquake a high risk hazard. Development along the Pacific Coast has exposed a huge section of Neskowin to tsunami hazard, as large portions of the community are within the Medium-sized tsunami zone. Potential flooding from riverine and coastal sources can affect many buildings in the low-lying areas of the community. Many of the residences built adjacent to the beach are also exposed to coastal erosion risk.

The CSZ event is a significant natural hazard risk to Neskowin and is a priority hazard for this community. Moderate to high liquefaction zones exist throughout the community, which increases the risk from earthquake. These liquefaction areas also correspond closely with the areas predicted to be inundated by the most likely tsunami scenario. Since we have deemed buildings within the tsunami zone to be red-tagged, these buildings have been excluded from the earthquake loss estimates. Another consideration of these areas is that liquefaction could present difficulties for evacuation from the subsequent tsunami. The combination of earthquake and tsunami will have a tremendous impact to this community.

Figure 105. Loss Ratio from CSZ Event: Unincorporated Community of Neskowin



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. In order to avoid double counting to buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

= Estimated damage due to tsunami.
= Estimated damage due to earthquake (outside of tsunami zone).

Developed areas within the community along Neskowin Creek, Kiwanda Creek, and the Pacific Ocean are exposed to the 100-year flood. Although there have been efforts to elevate buildings in the flood-prone areas, which has greatly reduced overall flood risk, there are still many buildings that can be impacted by flood. It is estimated that nearly half of the building exposed to the 100-year flood are elevated above the predicted level of flooding. So while the buildings themselves would not be damaged from flood, access to these buildings could be an issue.

Coastal erosion is another hazard that is a concern and can have a major impact for many within the community. The residential area along the coast and north of the Neskowin Creek mouth is likely to experience coastal erosion. The current placement of riprap at the base of these areas is reducing the rate of erosion.

While vulnerabilities to landslide do exist within Neskowin, they do so to a far less degree than flood, coastal erosion, and CSZ-related hazards. Monitoring for ground movement, especially during particularly wet conditions, is one way of increasing public safety from landslide.

Areas of Mitigation Interest

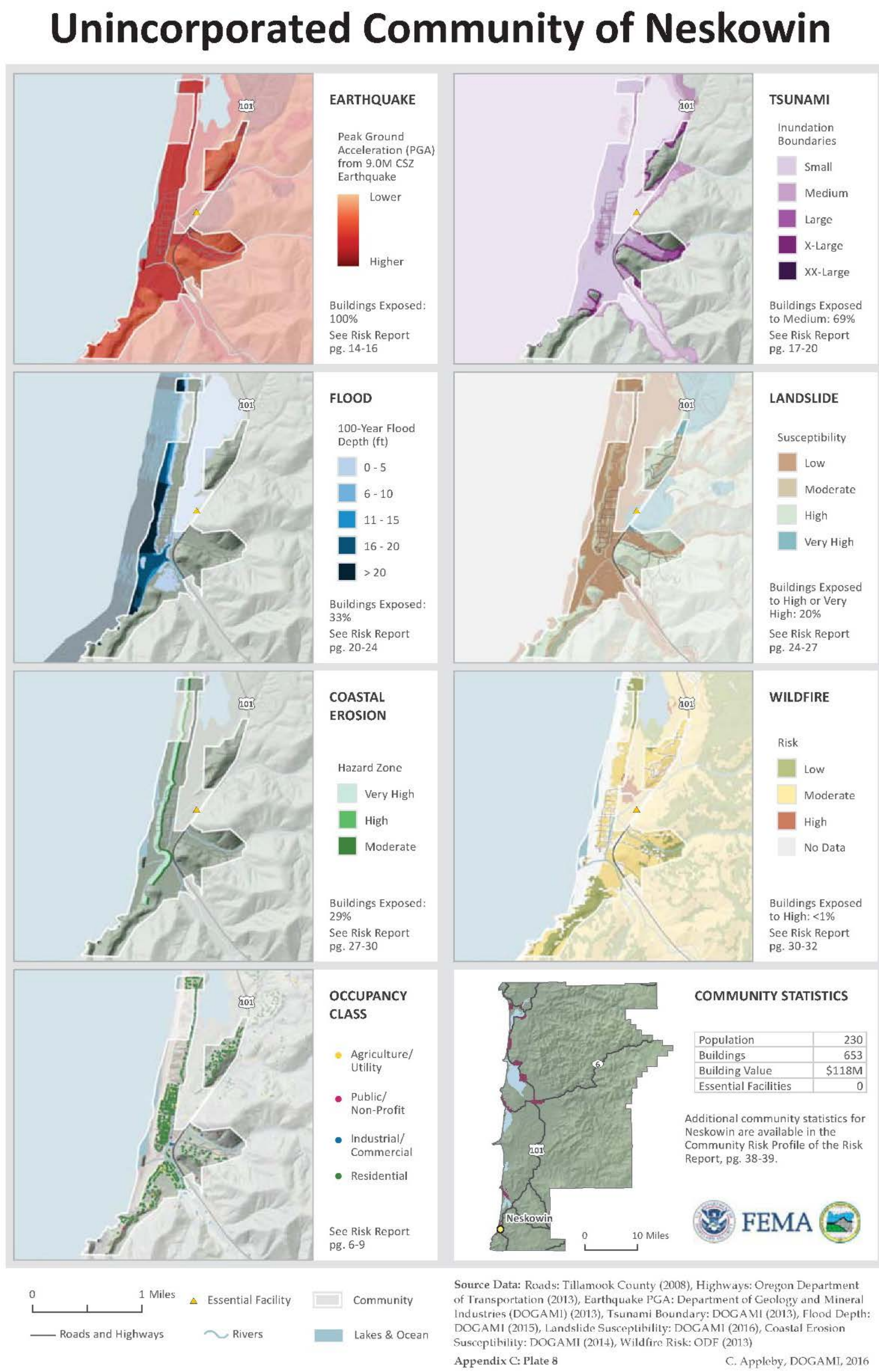
Hazard results from Hazus and exposure analyses sometimes show specific locations where concentrations of high risk exist. These high risk locations, when considered along with other factors like number of people affected, potential economic impact, and level of damage, can be determined "Areas of Mitigation Interest (AOMI)." Potential mitigation actions that would also address the results of the Hazus and exposure analyses were culled from the current (2012) Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan.

Table 81. Areas of Mitigation Interest: Unincorporated Community of Neskowin

Hazard	Area	Description	Recommended Strategy
Flood	primary commercial area subject to 100-year flooding	Neskowin's primary commercial area experiences tidal flooding from the Pacific Ocean; many structures are not elevated above predicted level of 100-year flooding	
Coastal Erosion	a large number of homes along the shoreline	a long strip of houses all within the high coastal erosion designated zone	

No potential mitigation actions identified from the 2012 Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan.

Figure 106. Multi-Hazard Community Map Set: Neskowin



Source: DOGAMI (2016)

3. Oceanside and Netarts

Risk Assessment Summary

Table 82. Hazard Profile: Unincorporated Communities of Oceanside and Netarts

Community Overview

Community Name	Population	Number of Buildings	Essential Facilities1	Total Building Value ($)
Oceanside and Netarts	1,056	1,701	2	203,363,000

Hazus Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	4	0	4,000	0%
*Earthquake**	*CSZ Mag 9.0 Deterministic*	*363*	*34%*	*623*	*1*	*61,450,000*	*30%*
Earthquake (within Tsunami Zone)		4	0.5%	32	0	5,230,000	2.6%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Tsunami	*CSZ Mag 9.0 – Medium*	*16*	*1.5%*	*88*	*0*	*15,432,000*	*7.6%*
Tsunami	Senate Bill 379 Regulatory Line	12	1.1%	68	0	12,254,000	6%
Landslide	High and Very High Susceptibility	406	38%	738	1	101,235,000	50%
Wildfire	High Risk	0	0%	0	0	0	0%
Coastal Erosion	High Hazard	59	0.4%	0	0	0	0%

*Earthquake damage was calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in Figure 107.

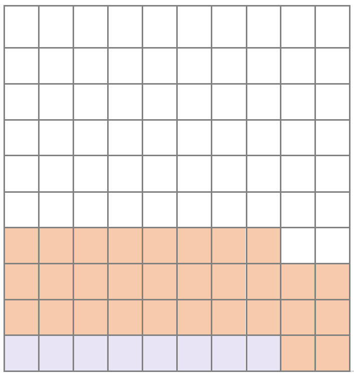
[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First Floor Heights" above the level of flooding (base flood elevation).

The level of risk to most natural hazards in the communities of Oceanside and Netarts is relatively low compared to the other communities of Tillamook County. The level of risk to the CSZ earthquake is still considerable, but fares better than other coastal communities. Landslide hazard is the primary natural hazard threat to these communities.

While the threat of earthquake is still a major issue, damages from shaking are reduced due to a younger building stock. High liquefaction soils are found throughout Oceanside and Netarts, except for the northern hilly section of the community. There is some exposure to the Medium-sized tsunami for buildings along the estuary in Netarts.

Figure 107. Loss Ratio from CSZ Event: Unincorporated Communities of Oceanside and Netarts



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. In order to avoid double counting to buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

= Estimated damage due to tsunami.
= Estimated damage due to earthquake (outside of tsunami zone).

The landslide hazard for Oceanside and Netarts poses the biggest risk to the community and its potential impact is a serious concern. An area deemed very high susceptibility to landslides makes up a large portion of Oceanside. The rest of the communities, for the most part, are within moderate to high susceptibility zones. There are few options for future development in low landslide hazard areas within these communities.

Table 83. Essential Facilities: Unincorporated Communities of Oceanside and Netarts

Essential Facilities by Community	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ M 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Risk	Coastal Erosion High Hazard
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Netarts-Oceanside RFPD Station #61		X				
Netarts-Oceanside RFPD Station #62				X		

Areas of Mitigation Interest

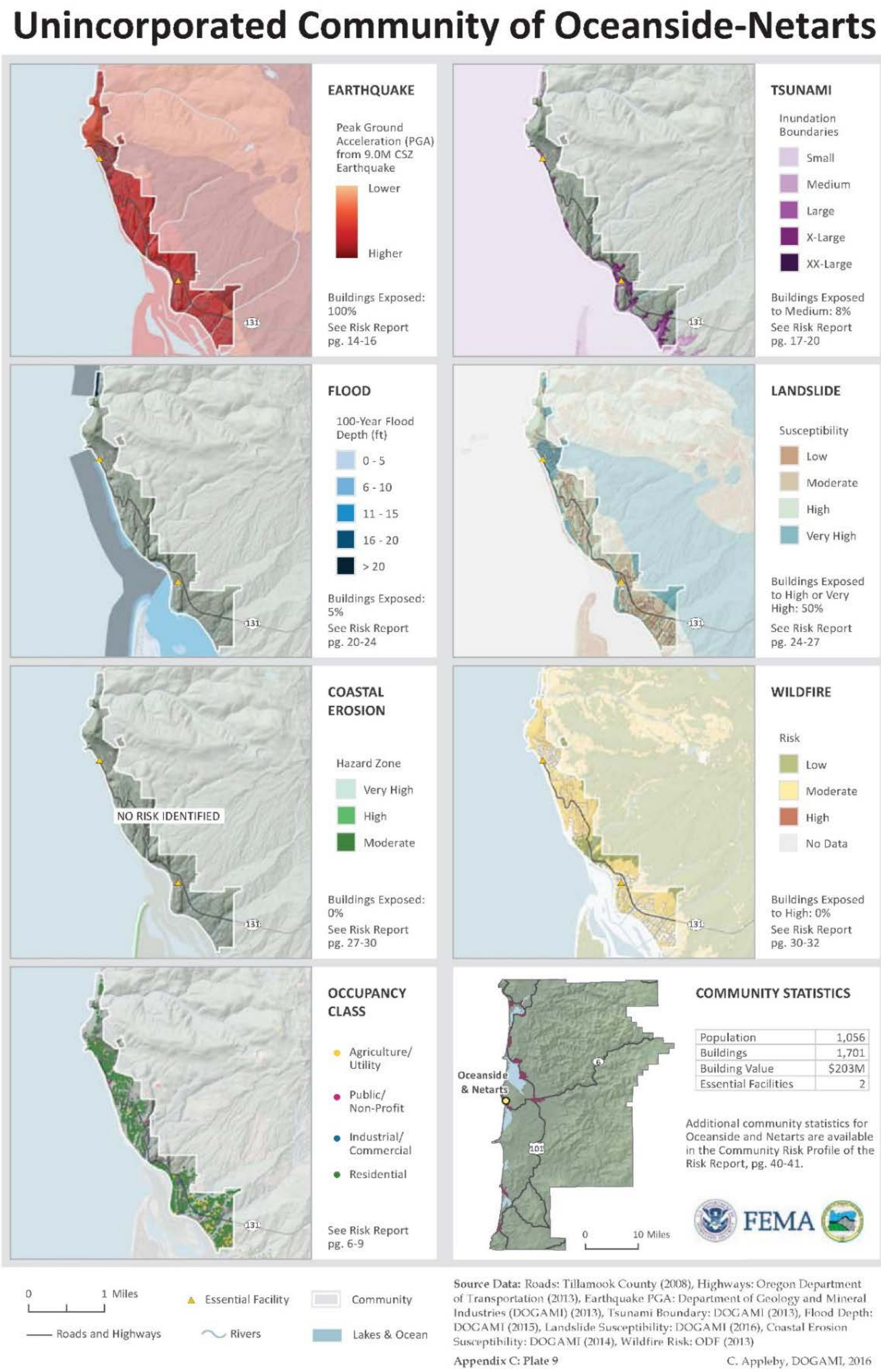
Hazard results from Hazus and exposure analyses sometimes show specific locations where concentrations of high risk exist. These high risk locations, when considered along with other factors like number of people affected, potential economic impact, and level of damage, can be determined “Areas of Mitigation Interest (AOMI).” Potential mitigation actions that would also address the results of the

Hazus and exposure analyses were culled from the current (2012) Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan.

No identified Areas of Mitigation Interest.

No potential mitigation actions identified from the 2012 Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan.

Figure 108. Multi-Hazard Community Map Set: Oceanside and Netarts



Source: DOGAMI (2016)

4. Pacific City–Woods

Risk Assessment Summary

Table 84. Hazard Profile: Unincorporated Community of Pacific City–Woods

Community Overview							
Community Name		Population	Number of Buildings		Essential Facilities[1]		Total Building Value ($)
Pacific City–Woods		947	1,707		1		212,062,000
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	198	21%	361	1	3,301,000	1.6%
*Earthquake**	*CSZ Mag 9.0 Deterministic*	*100*	*11%*	*237*	*0*	*26,963,000*	*13%*
Earthquake (within Tsunami Zone)		112	12%	280	1	23,600,000	11%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Tsunami	*CSZ Mag 9.0 – Medium*	*386*	*41%*	*806*	*1*	*83,301,000*	*39%*
Tsunami	Senate Bill 379 Regulatory Line	583	62%	1,239	1	135,375,000	64%
Landslide	High and Very High Susceptibility	125	13%	183	0	24,930,000	12%
Wildfire	High Risk	1	0%	3	0	226,000	0.1%
Coastal Erosion	High Hazard	4	0.4%	25	0	50,675,000	4.2%

*Earthquake damage was calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in **Figure 109**.

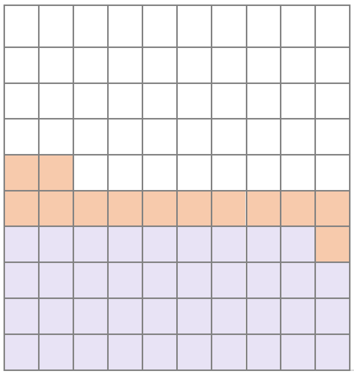
[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First Floor Heights" above the level of flooding (base flood elevation).

The natural hazards to which Pacific City–Woods is most vulnerable are the CSZ-related events (earthquake and tsunami) and flood. As with every community in Tillamook County, the proximity to the CSZ makes earthquake a high risk hazard. Development along the Nestucca River has exposed part of Pacific City to tsunami hazard, as portions of the city are within the Medium-sized tsunami zone. Another risk to the community is flood hazard, which is along the Nestucca River floodplain.

For the most part, the Medium-sized tsunami zone corresponds to the Nestucca floodplain within this community and is the source of the majority of damages from the CSZ event. While the threat of earthquake is still a major issue, damages from shaking are reduced due to a younger building stock. Moderate to high liquefaction is throughout Pacific City–Woods, except for the southern hilly section of the community. The combination of earthquake and tsunami will have a tremendous impact to this community.

Figure 109. Loss Ratio from CSZ-Event: Unincorporated Community of Pacific City–Woods



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. In order to avoid double counting to buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

= Estimated damage due to tsunami.

= Estimated damage due to earthquake (outside of tsunami zone).

Flooding from the Nestucca River is from a riverine source instead of tidal flooding from the Pacific Ocean. Several buildings that are within the 1% flood zone are elevated above the estimated level of flooding. The central part of community is most affected from this flooding, while the Cape Kiwanda area is not at risk. Although there are many buildings elevated in the flood-prone areas, there are still many that can be impacted by flood. It is estimated that nearly a quarter of the buildings exposed to the 100-year flood are elevated above the predicted level of flooding. However, while the buildings themselves would not be damaged from flood, access to these buildings could be an issue.

To a lesser extent landslide and coastal erosion hazards pose some concern. Landslide hazards are highest in the most southern and northern sections of the community. Coastal erosion risk exists for several homes along the beach just north of the Pacific Ave. Bridge. The higher loss ratio compared to the percentage of building exposure implies that higher value homes are exposed to coastal erosion.

Table 85. Essential Facilities: Unincorporated Community of Pacific City–Woods

Essential Facilities by Community	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ M 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Risk	Coastal Erosion High Hazard
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Nestucca RFPD Pacific City Station #82	X	X	X			

Areas of Mitigation Interest

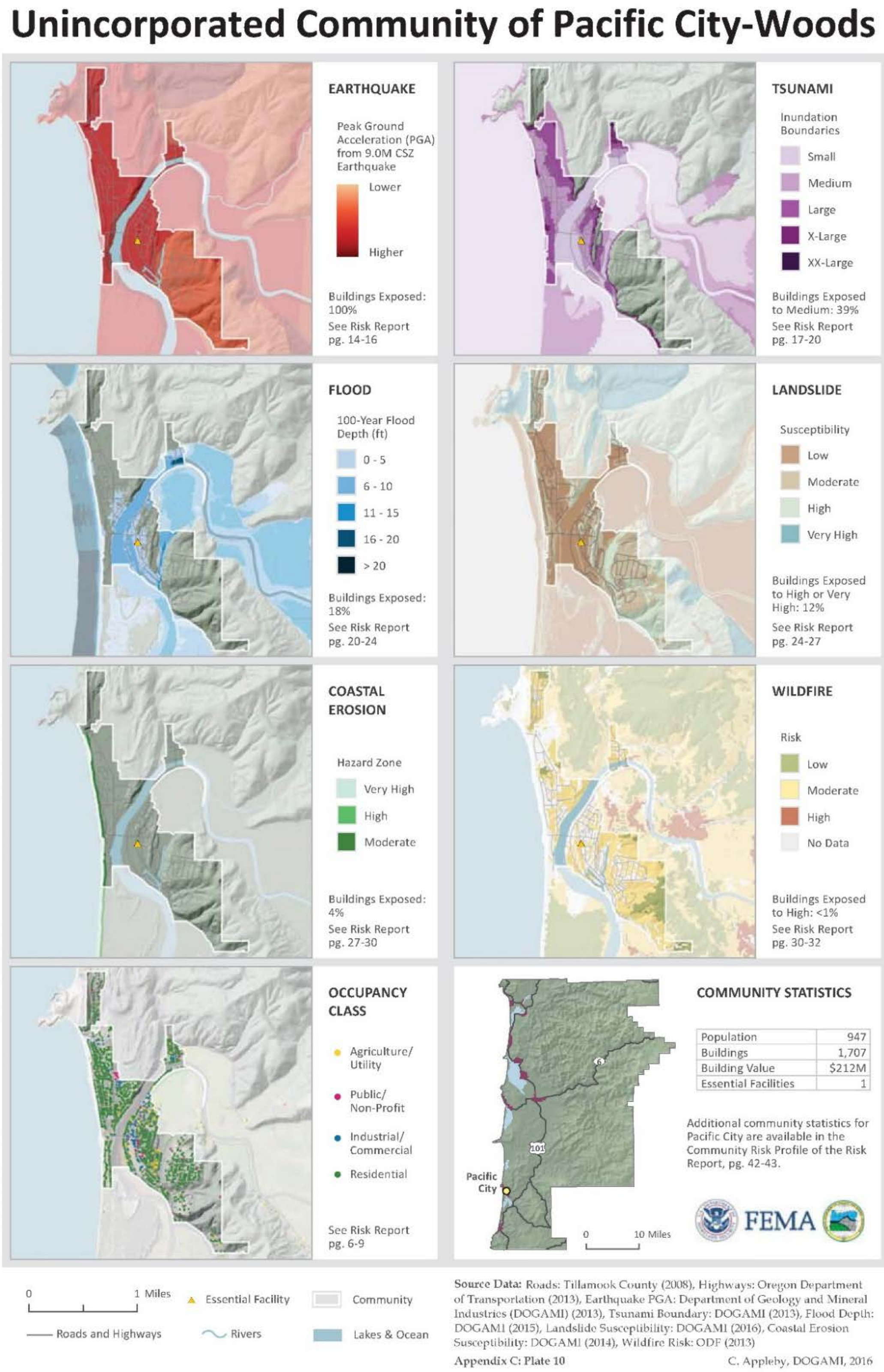
Hazard results from Hazus and exposure analyses sometimes show specific locations where concentrations of high risk exist. These high risk locations, when considered along with other factors like number of people affected, potential economic impact, and level of damage, can be determined "Areas of Mitigation Interest (AOMI)." Potential mitigation actions that would also address the results of the Hazus and exposure analyses were culled from the current (2012) Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan.

Table 86. Areas of Mitigation Interest: Unincorporated Community of Pacific City–Woods

Hazard	Area	Description		Recommended Strategy
Flooding	primary commercial area subject to 100-year flooding	Pacific City's primary commercial area experiences flooding from the Nestucca River; many structures are not elevated above predicted level of 100-year flooding		
Earthquake	two mobile home parks near Pacific Ave and Booten Rd.	clusters of manufactured homes estimated to have high probability to destruction due to earthquake		
Flood, Tsunami and Earthquake	volunteer fire department exposed to natural hazards	Pacific City's only essential facility is at risk to flood and tsunami; this building is also in a very high liquefaction zone; during an emergency situation this building might be non-functional		

No potential mitigation actions identified from the 2012 Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan.

Figure 110. Multi-Hazard Community Map Set: Pacific City–Woods



Source: DOGAMI (2016)

5. City of Bay City

Risk Assessment Summary

Table 87. Hazard Profile: City of Bay City

Community Overview							
Community Name		Population		Number of Buildings	Essential Facilities[1]		Total Building Value ($)
Bay City		1,284		884	4		74,769,000
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0	0	0	0	0%
*Earthquake**	*CSZ Mag 9.0 Deterministic*	*447*	*35%*	*403*	*2*	*29,014,000*	*39%*
Earthquake (within Tsunami Zone)		16	1.2%	18	2	1,873,000	2.5%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Tsunami	*CSZ Mag 9.0 – Medium*	*77*	*6%*	*62*	*2*	*8,455,000*	*11%*
Tsunami	Senate Bill 379 Regulatory Line	38	3%	35	2	6,313,000	8.4%
Landslide	High and Very High Susceptibility	690	54%	480	0	35,262,000	47%
Wildfire	High Risk	94	7.3%	58	2	7,089,000	9.5%

*Earthquake damage was calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in Figure 111.

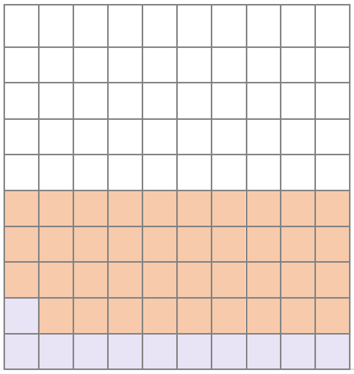
[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First Floor Heights" above the level of flooding (base flood elevation).

The natural hazards to which Bay City is most vulnerable are the CSZ-related events (earthquake and tsunami) and landslide. As with every community in Tillamook County, the proximity to the CSZ makes earthquake a high risk hazard. Development along Tillamook Bay has exposed part of Bay City to tsunami hazard, as portions of the city are within the Medium-sized tsunami zone. Another risk to the community is landslide hazard, which comprises a large portion of Bay City. The few buildings that are within the 1% flood zone are elevated above the estimated level of flooding.

The CSZ earthquake hazard is a significant natural hazard risk to Bay City and is a priority hazard for this community. A large part of the community lies within an area of moderate liquefaction, which slightly increases the probability for structural damage to buildings. Also the building inventory for Bay City is relatively older, which implies lower building design codes with regards to earthquake. The tsunami generated from the CSZ earthquake is not expected to cause as much damage, but still is a concern.

Figure 111. Loss Ratio from CSZ Event: City of Bay City



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. In order to avoid double counting to buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

= Estimated damage due to tsunami.
= Estimated damage due to earthquake (outside of tsunami zone).

The landslide hazard for Bay City poses a great risk to the community and its potential impact is a serious concern. An area deemed very high susceptibility to landslides makes up approximately half of the entirety of Bay City. The hilly residential area in the northwest part of Bay City is within a very high landslide susceptibility zone. Monitoring for ground movement, especially during particularly wet conditions, is one way of increasing public safety from landslide.

While vulnerabilities to flood and wildfire do exist within Bay City, they do so to a far less degree than the CSZ event and landslide. Elevating structures and building outside of the flood zone as well as creating building buffers from forestland are examples to further reduce the risk to these hazards.

Table 88. Essential Facilities: City of Bay City

Essential Facilities by Community	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ M 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Risk	Coastal Erosion High Hazard
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Bay City City Hall		X				
Bay City Fire Department		X				
Bay City Public Works		X	X		X	
Bay City Water Treatment		X	X		X	

Areas of Mitigation Interest

Hazard results from Hazus and exposure analyses sometimes show specific locations where concentrations of high risk exist. These high risk locations, when considered along with other factors like number of people affected, potential economic impact, and level of damage, can be determined "Areas of Mitigation Interest (AOMI)." Potential mitigation actions that would also address the results of the Hazus and exposure analyses were culled from the current (2012) Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan.

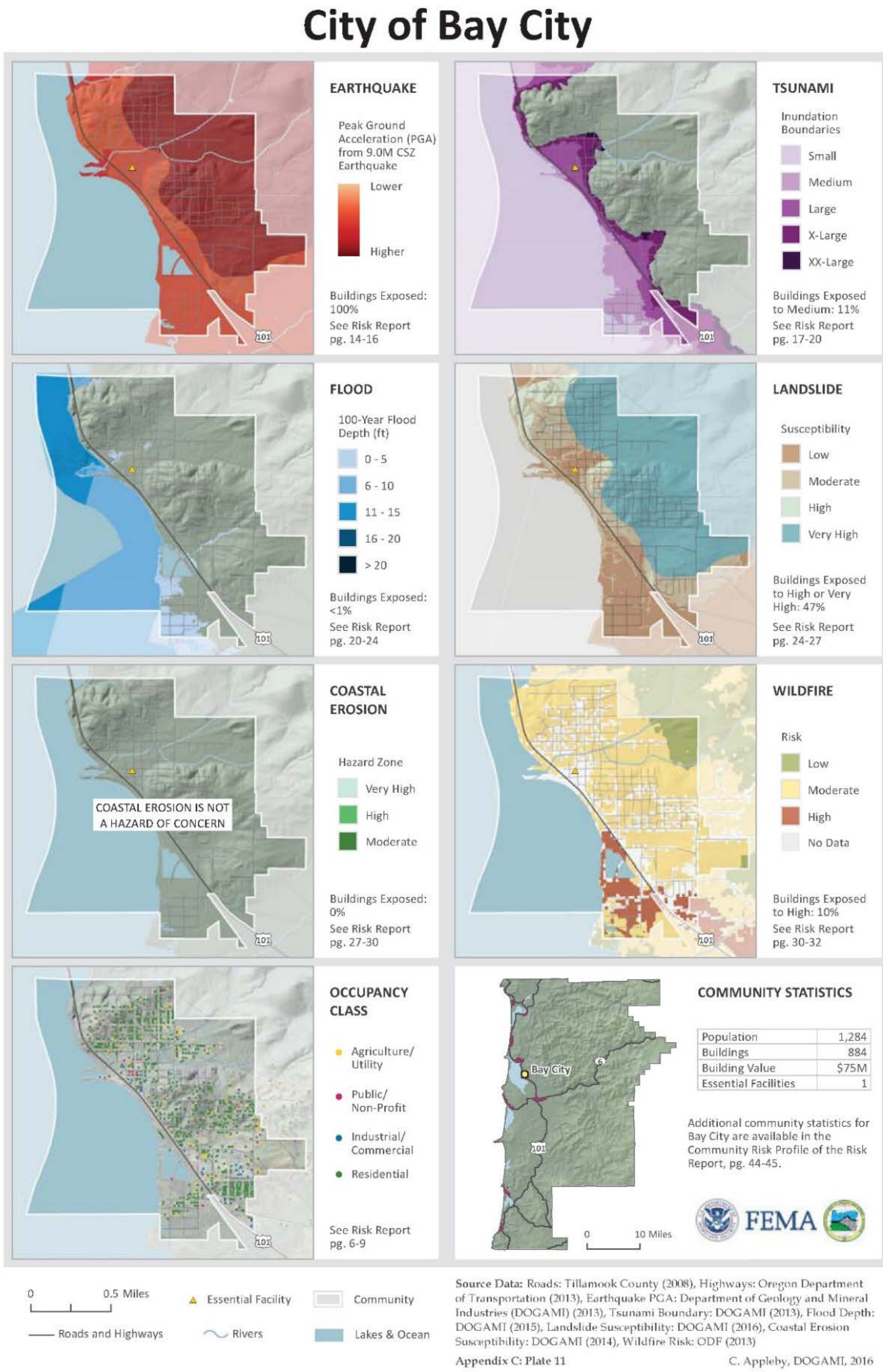
Table 89. Areas of Mitigation Interest: City of Bay City

Hazard	Area	Description	Recommended Strategy
Earthquake	large percentage of the buildings in Bay City	many buildings in the community are in high liquefaction and earthquake-induced landslide areas	

Table 90. Hazard Mitigation Plan Analysis: City of Bay City

Hazard	Projects	Additional Information from Risk Report
Multi-hazard	remove two water lines from bridges to borings under the Kilchis River; connect the City of Tillamook water system and City of Bay City water system (Kilchis Regional Water System) by a boring under the Wilson River	
Tsunami	relocate the fire station and city hall out of the tsunami Impact area	
Multi-hazard	relocate public works equipment and emergency supplies to evacuation sites in the community	
Flood	create new risk maps and flood maps using lidar	
Flood	strengthen the banks of the wastewater treatment ponds to prevent erosion	

Figure 112. Multi-Hazard Community Map Set: City of Bay City



Source: DOGAMI (2016)

6. City of Garibaldi

Risk Assessment Summary

Table 91. Hazard Profile: City of Garibaldi

Community Overview							
Community Name		Population	Number of Buildings		Essential Facilities[1]	Total Building Value ($)	
Garibaldi		779	755		6	64,331,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	6	0.8%	21	0	79,000	0.1%
*Earthquake**	*CSZ Mag 9.0 Deterministic*	*304*	*39%*	*345*	*4*	*26,182,000*	*41%*
Earthquake (within Tsunami Zone)		16	2.1%	61	1	7,471,000	12%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Tsunami	*CSZ Mag 9.0 – Medium*	*56*	*7.2%*	*91*	*1*	*11,870,000*	*18%*
Tsunami	Senate Bill 379 Regulatory Line	26	3.3%	55	3	12,961,000	20%
Landslide	High and Very High Susceptibility	575	74%	534	3	39,334,000	61%
Wildfire	High Risk	79	10%	83	1	5,014,000	7.8%

*Earthquake damage was calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in Figure 113.

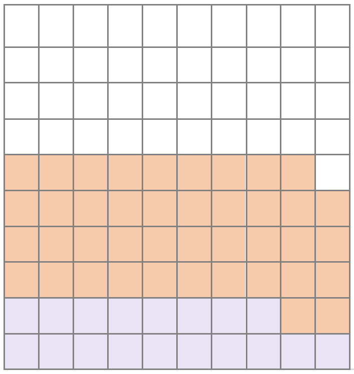
[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First Floor Heights" above the level of flooding (base flood elevation).

The natural hazards to which Garibaldi is most vulnerable are the CSZ-related events (earthquake and tsunami) and landslide. As with every community in Tillamook County, the proximity to the CSZ makes earthquake a high risk hazard. Developments along Tillamook Bay are exposed to tsunami hazard, as portions of the community are within the Medium-sized tsunami zone. Another substantial risk to the community is landslide hazard, since a large percentage of Garibaldi is within a very high susceptibility landslide zone.

The CSZ earthquake hazard is a significant natural hazard risk to Garibaldi and is a priority hazard for this community. A large part of the community lies within an area of moderate to high liquefaction, which increases the probability for structural damage to buildings. Also the building inventory for Garibaldi is relatively older, which implies lower building design codes with regards to earthquake. The tsunami generated from the CSZ earthquake is not expected to cause as much damage, but still is a concern.

Figure 113. Loss Ratio from CSZ Event: City of Garibaldi



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. In order to avoid double counting to buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

= Estimated damage due to tsunami.

= Estimated damage due to earthquake (outside of tsunami zone).

The landslide hazard for Garibaldi poses a great risk to the community and its potential impact is a serious concern. An area deemed very high susceptibility to landslides makes up the majority of Garibaldi. Monitoring for ground movement, especially during particularly wet conditions, is one way of increasing public safety from landslide.

While vulnerabilities to flood and wildfire do exist within Garibaldi, they do so to a far less degree than the CSZ event and landslide. Elevating structures and building outside of the flood zone as well as creating building buffers from forest land are examples to further reduce the risk to these hazards.

Table 92. Essential Facilities: City of Garibaldi

Essential Facilities by Community	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ M 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Risk	Coastal Erosion High Hazard
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
City Of Garibaldi Fire Department / City Hall / Police				X		
Garibaldi Elementary School		X		X		
Garibaldi Public Works		X				
Garibaldi Wastewater Treatment Plant		X				
United States Coast Guard - Admin		X		X	X	
Coast Guard Station - Tillamook		X	X			

Areas of Mitigation Interest

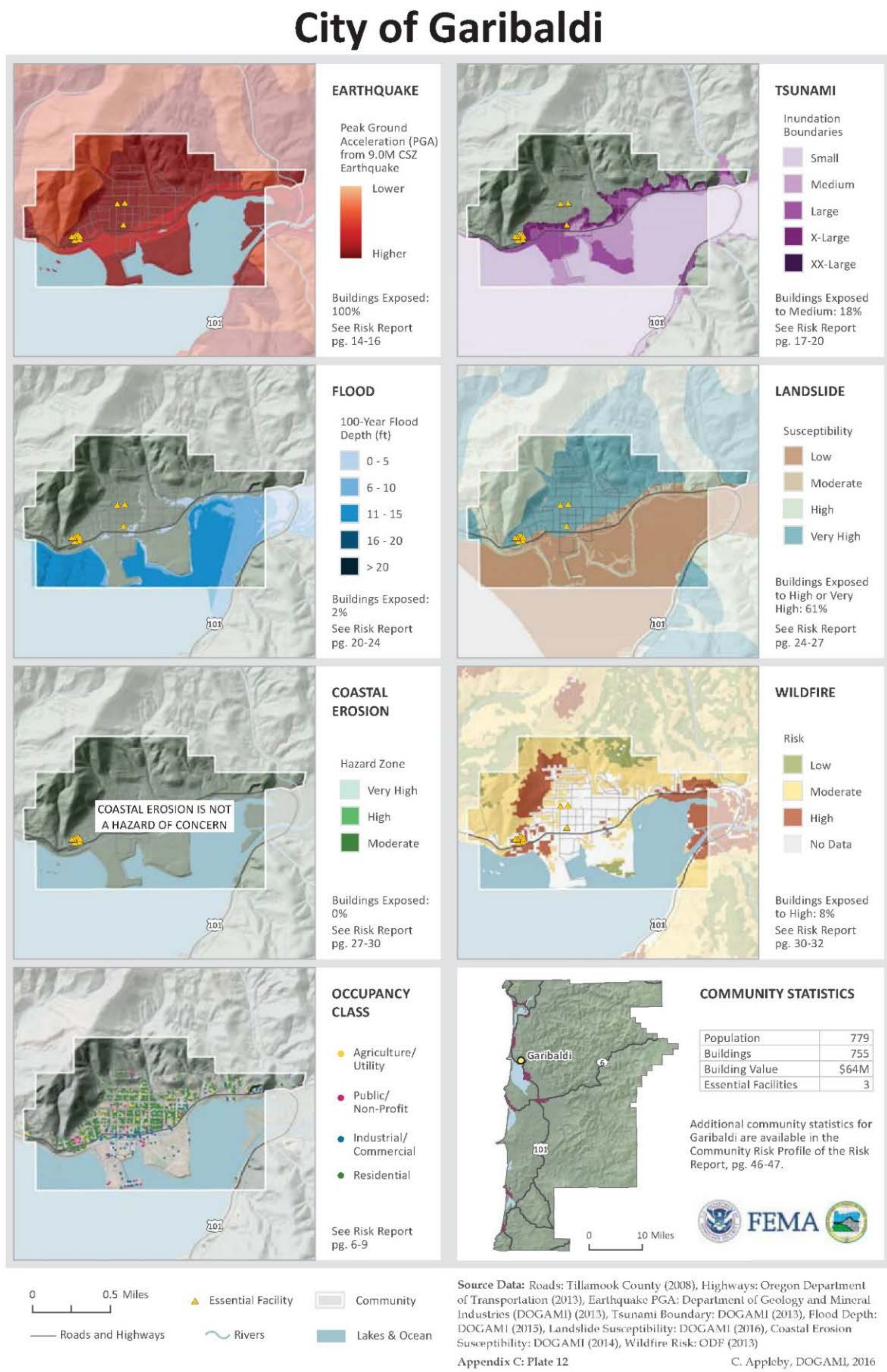
Hazard results from Hazus and exposure analyses sometimes show specific locations where concentrations of high risk exist. These high risk locations, when considered along with other factors like number of people affected, potential economic impact, and level of damage, can be determined "Areas of Mitigation Interest (AOMI)." Potential mitigation actions that would also address the results of the Hazus and exposure analyses were culled from the current (2012) Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan.

No identified areas of mitigation interest.

Table 93. Hazard Mitigation Plan Analysis: City of Garibaldi

Hazard	Projects	Additional Information from Risk Report
Earthquake, tsunami	retrofit Garibaldi city hall / fire department building for seismic stability with financial assistance from the Oregon Department of Emergency Management	
Earthquake, tsunami	dismantle 100 ft tall relic smoke stack	
Earthquake, tsunami	develop action plan for analyzing and decontaminating water in the event of an earthquake	
Multi-hazard	refine hazard analysis with scientific data: DOGAMI risk map	
Multi-hazard	agreement to use forest roads in an emergency or disaster response	
Earthquake, tsunami	seismic retrofits to bridges and culverts on US Highway 101 to prevent collapse in an earthquake	
Earthquake, tsunami	analysis of Jetty infrastructure and port to determine if action could better assure usability for fishing the transport of goods to the area in the event of a disaster	
Earthquake, landslide	equip reservoirs with seismic-activated shutoff valves	
Earthquake, landslide	replace 2 miles of asbestos/concrete pipe	

Figure 114. Multi-Hazard Community Map Set: City of Garibaldi



Source: DOGAMI (2016)

7. City of Manzanita

Risk Assessment Summary

Table 94. Hazard Profile: City of Manzanita

Community Overview							
Community Name	Population		Number of Buildings	Essential Facilities[1]		Total Building Value ($)	
Manzanita	599		1,523	3		259,780,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0	1	0	11,000	0%
*Earthquake**	*CSZ Mag 9.0 Deterministic*	*129*	*22%*	*354*	*3*	*59,646,000*	*23%*
Earthquake (within Tsunami Zone)		24	4%	98	0	16,058,000	6.2%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Tsunami	*CSZ Mag 9.0 – Medium*	*94*	*16%*	*354*	*0*	*56,238,000*	*22%*
Tsunami	Senate Bill 379 Regulatory Line	130	22%	484	0	84,870,000	33%
Landslide	High and Very High Susceptibility	97	16%	206	0	38,439,000	15%
Wildfire	High Risk	0	0%	0	0	0	0%
Coastal Erosion	High Hazard	6	1.0%	25	0	4,389,000	1.7%

*Earthquake damage was calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in **Figure 115**.

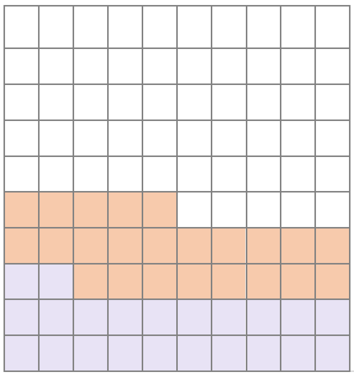
[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First Floor Heights" above the level of flooding (base flood elevation).

The natural hazards to which Manzanita is most vulnerable are the CSZ-related events (earthquake and tsunami). As with every community in Tillamook County, the proximity to the CSZ makes earthquake a high risk hazard. Developments along the coast are exposed to tsunami hazard, as large portions of the community are within the Medium-sized tsunami zone.

The CSZ event is a significant natural hazard risk to Manzanita and is a priority hazard for this community. High liquefaction zones exist throughout the community, which increase the risk from earthquake. Another consideration of these areas is that liquefaction could present difficulties for evacuation from the subsequent tsunami. The coastal and low-lying areas of Manzanita are predicted to be inundated by the most likely tsunami scenario. Since we have deemed buildings within the tsunami zone to be red-tagged, these buildings have been excluded from the earthquake loss estimates. The combination of earthquake and tsunami will have a tremendous impact to this community.

Figure 115. Loss Ratio from CSZ Event: City of Manzanita



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. In order to avoid double counting to buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

= Estimated damage due to tsunami.

= Estimated damage due to earthquake (outside of tsunami zone).

To a lesser extent landslide and coastal erosion hazards pose some additional concerns. Landslide hazard risk is highest for several buildings in the northern section of the community near Highway 101. Coastal erosion risk exists for several homes along the beach in the community. It is unclear if any steps have been taken to limit the amount of erosion occurring. The presence of vegetation cover in many places can reduce the rate of erosion.

Table 95. Essential Facilities: City of Manzanita

Essential Facilities by Community	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ M 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Risk	Coastal Erosion High Hazard
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Manzanita City Hall		X				
Manzanita Department Of Public Safety		X				
Manzanita Water Treatment Plant		X				

Areas of Mitigation Interest

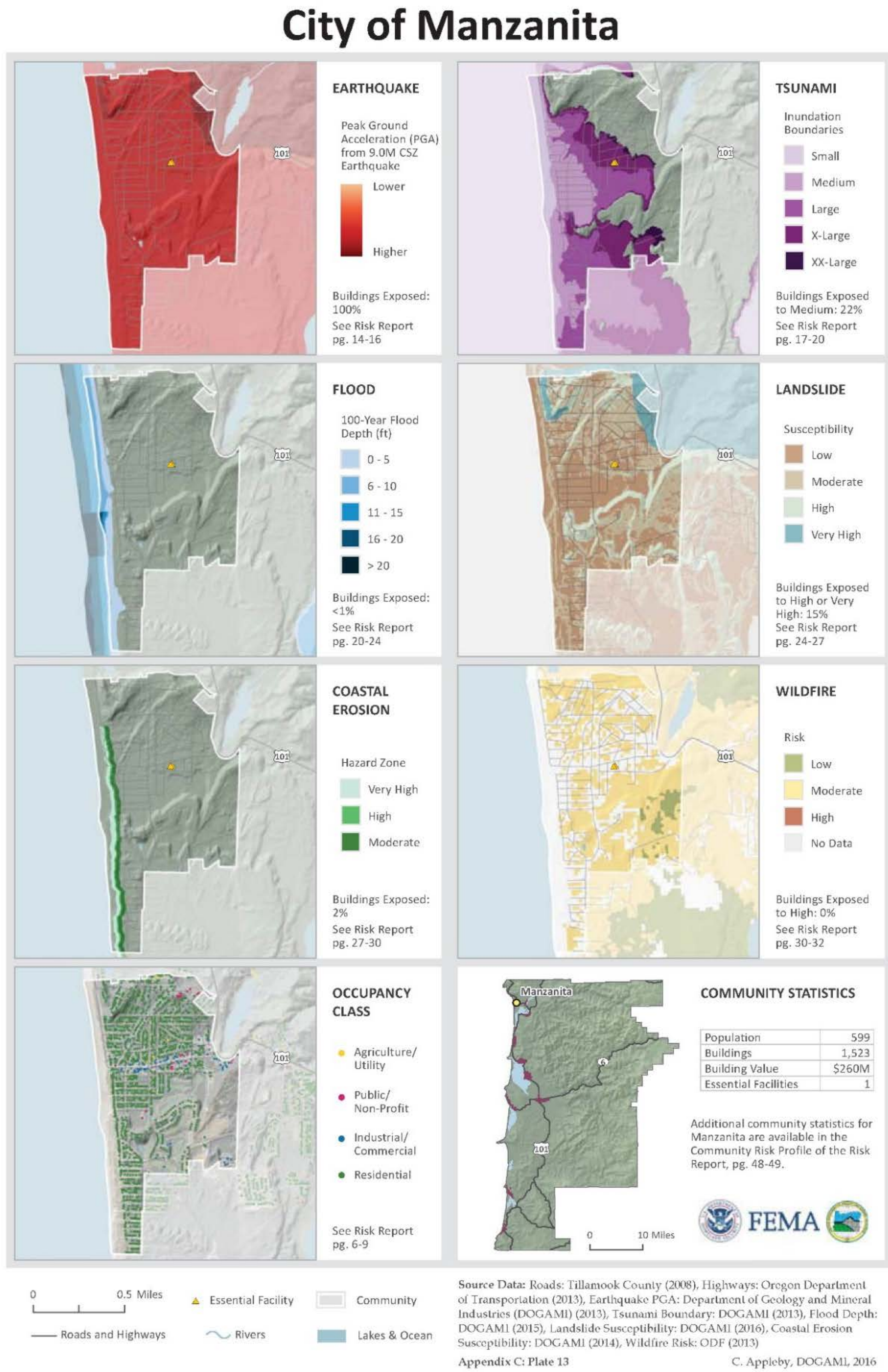
Hazard results from Hazus and exposure analyses sometimes show specific locations where concentrations of high risk exist. These high risk locations, when considered along with other factors like number of people affected, potential economic impact, and level of damage, can be determined “Areas of Mitigation Interest (AOMI).” Potential mitigation actions that would also address the results of the Hazus and exposure analyses were culled from the current (2012) Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan.

No identified Areas of Mitigation Interest.

Table 96. Hazard Mitigation Plan Analysis: City of Manzanita

Hazard	Projects	Additional Information from Risk Report
Flood	create new risk maps and flood maps using lidar	
Earthquake	the water tank serving the upper portion of Manzanita is older and not constructed to earthquake standards; the tank needs to be retrofitted so that water system capability can be maintained after an earthquake	
Earthquake	Manzanita City Hall is an unreinforced masonry building and is likely to collapse in an earthquake; City Council Chambers used to stage emergency operations and provide public information during disasters	
Multi-hazard	the City needs to develop and approve a specific plan for Manzanita hazard mitigation needs	

Figure 116. Multi-Hazard Community Map Set: City of Manzanita



Source: DOGAMI (2016)

8. City of Nehalem

Risk Assessment Summary

Table 97. Hazard Profile: City of Nehalem

Community Overview

Community Name	Population	Number of Buildings	Essential Facilities[1]	Total Building Value ($)
Nehalem	271	260	3	24,886,000

Hazus Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	23	8.5%	31	1	162,000	0.7%
*Earthquake**	*CSZ Mag 9.0 Deterministic*	*104*	*38%*	*110*	*2*	*10,349,000*	*42%*
Earthquake (within Tsunami Zone)		19	7.0%	48	1	5,745,000	23%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Tsunami	*CSZ Mag 9.0 – Medium*	*46*	*17%*	*61*	*1*	*7,856,000*	*32%*
Tsunami	Senate Bill 379 Regulatory Line	0	0%	1	0	7,000	0%
Landslide	High and Very High Susceptibility	270	99%	259	3	24,735,000	99%
Wildfire	High Risk	0	0%	0	0	0	0%

*Earthquake damage was calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in Figure 117.

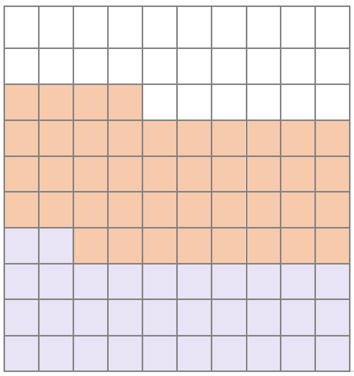
[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First Floor Heights" above the level of flooding (base flood elevation).

The natural hazards to which Nehalem is most vulnerable are the CSZ-related events (earthquake and tsunami), flood, and landslide. As with every community in Tillamook County, the proximity to the CSZ makes earthquake a high risk hazard. Part of Nehalem is exposed to tsunami hazard, as the low-lying business area of this community is within the Medium-sized tsunami zone. Potential flooding from riverine sources can affect many buildings along the riverfront. Another substantial risk to the community is landslide hazard, since a large percentage of Nehalem is within a very high susceptibility landslide zone.

The CSZ event is a significant natural hazard risk to Nehalem and is a priority hazard for this community. Moderate liquefaction zones and areas at risk to earthquake-induced landslide exist throughout the community, which increases the risk from earthquake. Also the building inventory for Nehalem is relatively older, which implies lower building design codes with regard to earthquake. Low-lying areas of Nehalem are predicted to be inundated by the most likely tsunami scenario. Since we have deemed buildings within the tsunami zone to be red-tagged, these buildings have been excluded from the earthquake loss estimates. The combination of earthquake and tsunami will have a tremendous impact to this community.

Figure 117. Loss Ratio from CSZ Event: City of Nehalem



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. In order to avoid double counting to buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

= Estimated damage due to tsunami.
= Estimated damage due to earthquake (outside of tsunami zone).

Many buildings in the low-lying business area of Nehalem are particularly vulnerable to flooding. This area, along the river bank, is subject to the 100-year flood due to the close proximity of the Nehalem River. Although there have been efforts to elevate buildings in the flood-prone areas, which has greatly reduced overall flood risk, there are still many buildings that can be impacted by flood. It is estimated that nearly half of the building exposed to the 100-year flood are elevated above the predicted level of flooding. So while the buildings themselves would not be damaged from flood, access to these buildings could be an issue.

The landslide hazard for Nehalem poses a great risk to the community and its potential impact is a serious concern. A preexisting landslide zone, which is considered very high susceptibility to landslides, has been designated for much of the Nehalem River and surrounding hills. An area deemed very high susceptibility to landslides makes up the majority of the community of Nehalem.

Table 98. Essential Facilities: City of Nehalem

Essential Facilities by Community	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ M 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Risk	Coastal Erosion High Hazard
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
County Public Works - North		X		X		
Nehalem Elementary School		X		X		
Nehalem Volunteer Fire Department/City Hall	X	X	X	X		

Areas of Mitigation Interest

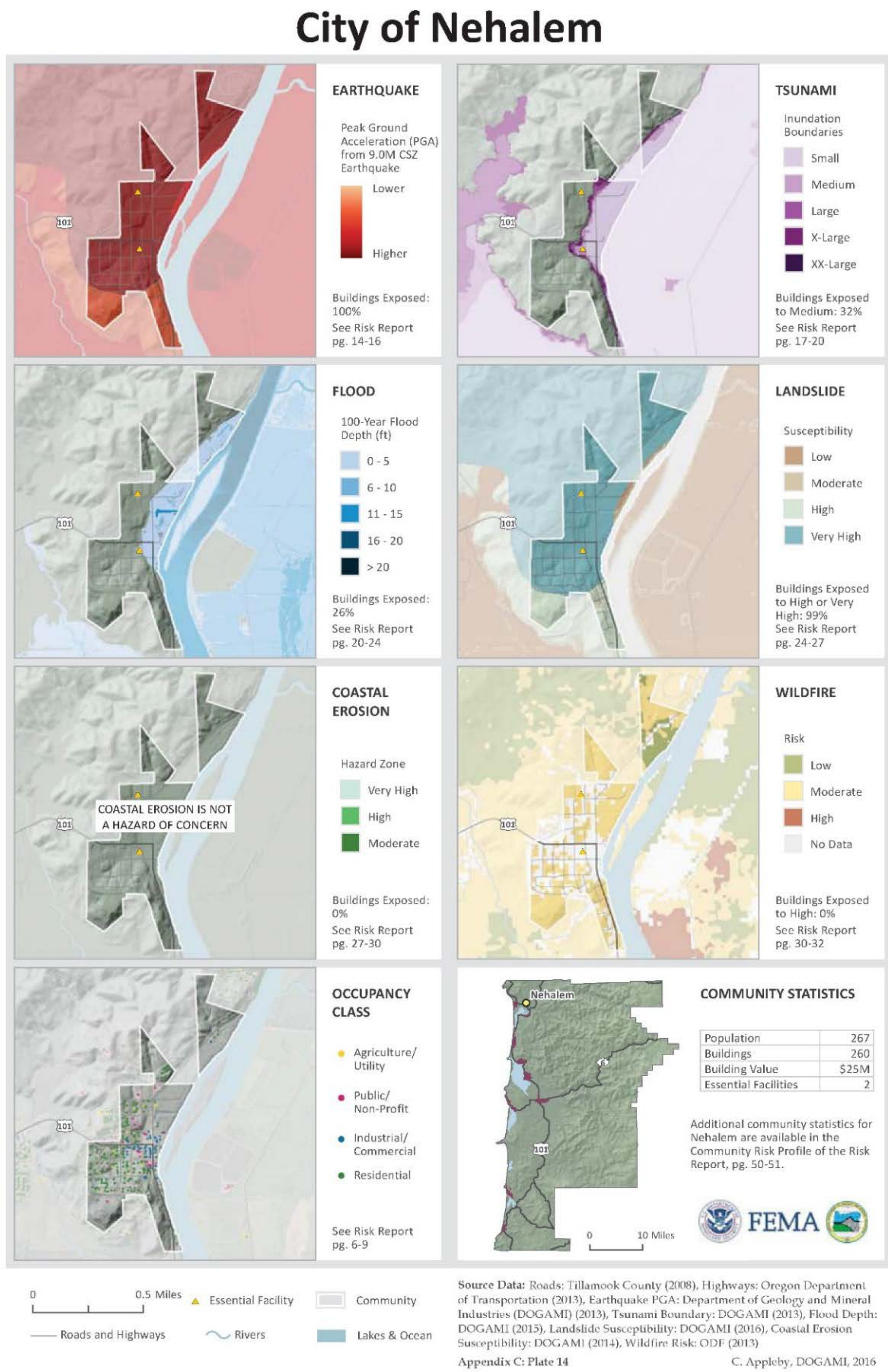
Hazard results from Hazus and exposure analyses sometimes show specific locations where concentrations of high risk exist. These high risk locations, when considered along with other factors like number of people affected, potential economic impact, and level of damage, can be determined "Areas of Mitigation Interest (AOMI)." Potential mitigation actions that would also address the results of the Hazus and exposure analyses were culled from the current (2012) Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan.

Table 99. Areas of Mitigation Interest: City of Nehalem

Hazard	Area	Description	Recommended Strategy
Flood	commercial area adjacent to Nehalem River subject to 100-year flooding	Nehalem's primary commercial area experiences flooding from the Nehalem River; many structures are not elevated above predicted level of 100-year flooding	

No potential mitigation actions identified from the 2012 Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan.

Figure 118. Multi-Hazard Community Map Set: City of Nehalem



Source: DOGAMI (2016)

9. City of Rockaway Beach

Risk Assessment Summary

Table 100. Hazard Profile: City of Rockaway Beach

Community Overview							
Community Name		Population	Number of Buildings	Essential Facilities[1]		Total Building Value ($)	
Rockaway Beach		1,305	2,240	5		211,809,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	69	5.3%	170	1	1,671,000	0.8%
*Earthquake**	*CSZ Mag 9.0 Deterministic*	*234*	*18%*	*325*	*0*	*18,721,000*	*8.8%*
Earthquake (within Tsunami Zone)		287	22%	616	5	54,838,000	26%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Tsunami	*CSZ Mag 9.0 – Medium*	*722*	*55%*	*1,525*	*5*	*146,945,000*	*69%*
Tsunami	Senate Bill 379 Regulatory Line	604	46%	1,367	4	139,141,000	66%
Landslide	High and Very High Susceptibility	78	6%	104	0	13,436,000	6.3%
Wildfire	High Risk	6	0.5%	25	0	2,938,000	1.4%
Coastal Erosion	High Hazard	52	4%	288	0	50,675,000	24%

*Earthquake damage was calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in **Figure 119**.

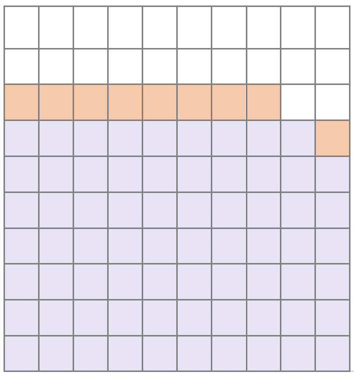
[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with “First Floor Heights” above the level of flooding (base flood elevation).

The natural hazards to which Rockaway Beach is most vulnerable are the CSZ-related events (earthquake and tsunami), flood, and coastal erosion. As with every community in Tillamook County, the proximity to the CSZ makes earthquake a high risk hazard. A significant portion of the community is exposed to the Medium-sized tsunami zone. Potential flooding from riverine and coastal sources can affect many buildings along the coast and in the flood-prone areas of local streams. A large amount of the residences built adjacent to the beach are also exposed to coastal erosion risk.

The CSZ event is a significant natural hazard risk to Rockaway Beach and is a priority hazard for this community. High liquefaction zones exist throughout the community, which increases the risk from earthquake. Another consideration of these areas is that liquefaction could present difficulties for evacuation from the subsequent tsunami. The coastal and low-lying areas of Rockaway Beach are predicted to be inundated by the most likely tsunami scenario. The combination of earthquake and tsunami will have a tremendous impact to this community.

Figure 119. Loss Ratio from CSZ Event: City of Rockaway Beach



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. In order to avoid double counting to buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

= Estimated damage due to tsunami.
= Estimated damage due to earthquake (outside of tsunami zone).

Many buildings in the low-lying areas of Rockaway Beach along the Pacific Ocean, Rock Creek, and other minor creeks are exposed to the 100-year flood. Although there are many elevated buildings in the flood-prone areas, which will greatly reduce overall flood risk, there are still many buildings that can be impacted by flood. It is estimated that nearly half of the buildings exposed to the 100-year flood are elevated above the predicted level of flooding. So while the buildings themselves would not be damaged from flood, access to these buildings could still be an issue.

Coastal erosion is another hazard that is a major concern and can have a significant impact for many within the community. The entire mostly residential area along the coast is likely to experience coastal erosion. During times of high tide occurring along with powerful storms, the rate of erosion can greatly increase. The current placement of riprap at the base of some areas is helping to reduce the rate of erosion.

Table 101. Essential Facilities: City of Rockaway Beach

Essential Facilities by Community	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ M 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Risk	Coastal Erosion High Hazard
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Neah-Kah-Nie School District		X	X			
Rockaway Beach City Hall and Public Works		X	X			
Rockaway Beach Fire Dept	X	X	X			
Rockaway Beach Water Treatment Plant		X	X			
Rockaway Beach Police Dept		X	X			

Areas of Mitigation Interest

Hazard results from Hazus and exposure analyses sometimes show specific locations where concentrations of high risk exist. These high risk locations, when considered along with other factors like number of people affected, potential economic impact, and level of damage, can be determined "Areas of Mitigation Interest (AOMI)." Potential mitigation actions that would also address the results of the Hazus and exposure analyses were culled from the current (2012) Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan.

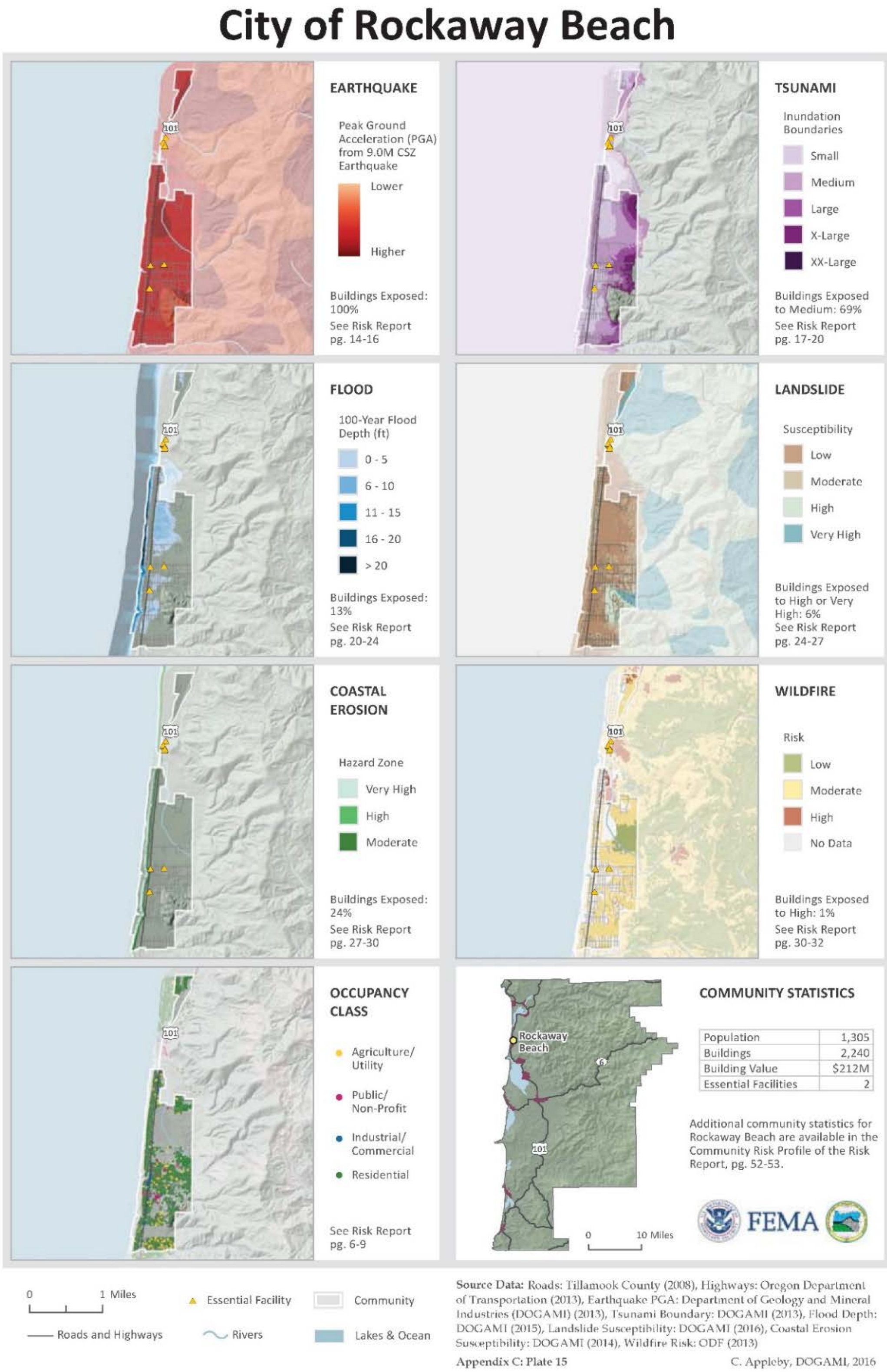
Table 102. Areas of Mitigation Interest: City of Rockaway Beach

Hazard	Area	Description	Recommended Strategy
Tsunami	police and fire departments are in the Medium tsunami zone	inundation could make these emergency services nonfunctional during a Medium-sized tsunami; if functional, could provide much needed services during a tsunami crisis	
Earthquake	many buildings located adjacent to Lake Lytle	a cluster of manufactured homes is in a very high liquefaction zone and is estimated to have high probability to destruction due to earthquake	
Earthquake	many buildings located adjacent to Clear Lake	a cluster of manufactured homes is in a very high liquefaction zone and is estimated to have high probability to destruction due to earthquake	
Coastal Erosion	area of homes in Rockaway Beach along the shoreline	a long strip of houses all in the high coastal erosion designated zone	

Table 103. Hazard Mitigation Plan Analysis: City of Rockaway Beach

Hazard	Projects	Additional Information from Risk Report
Multi-hazard	continue to work on our Emergency Operation Plan	
Multi-hazard	continue to be NIMSCAST compliant	
Multi-hazard	continue to send "key" players to FEMA/ICS classes/training	
Multi-hazard	continue to have staff representation at Command Post to insure coordination with the Incident Command Team	

Figure 120. Multi-Hazard Community Map Set: City of Rockaway Beach



Source: DOGAMI (2016)

10. City of Tillamook

Risk Assessment Summary

Table 104. Hazard Profile: City of Tillamook

Community Overview					
Community Name		Population	Number of Buildings	Essential Facilities[1]	Total Building Value ($)
Tillamook		4,999	2,270	14	322,398,000

Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	339	6.8%	205	1	3,060,000	0.9%
*Earthquake**	*CSZ Mag 9.0 Deterministic*	*1083*	*22%*	*942*	*13*	*152,112,000*	*47%*
Earthquake (within Tsunami Zone)		0	0%	3	0	58,000	0%

Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Tsunami	*CSZ Mag 9.0 – Medium*	*1*	*0%*	*3*	*0*	*71,000*	*0%*
Tsunami	Senate Bill 379 Regulatory Line	11	0.2%	16	0	4,771,000	1.5%
Landslide	High and Very High Susceptibility	0	0%	1	0	13,000	0%
Wildfire	High Risk	3	0%	8	0	8,892,000	2.8%

*Earthquake damage was calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in **Figure 121**.

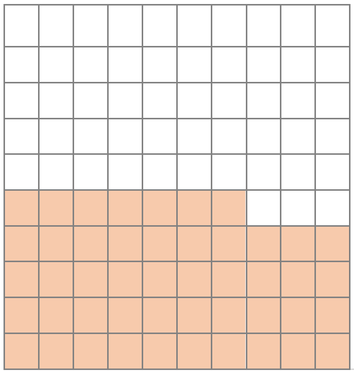
[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First Floor Heights" above the level of flooding (base flood elevation).

The natural hazards to which Tillamook is most vulnerable are the CSZ-related earthquake and flood. As with every community in Tillamook County, the proximity to the CSZ makes earthquake a high risk hazard. Potential flooding from riverine sources can affect many buildings in the low-lying areas of the community.

The CSZ earthquake hazard is a significant natural hazard risk to Tillamook and is a priority hazard for this community. A large part of the community lies within an area of high liquefaction, which increases the probability for structural damage to buildings. Also the building inventory for Tillamook is relatively older, which implies lower building design codes with regards to earthquake.

Figure 121. Loss Ratio from CSZ Event: City of Tillamook



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. In order to avoid double counting to buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

= Estimated damage due to tsunami.
= Estimated damage due to earthquake (outside of tsunami zone).

The City of Tillamook lies between two major floodplains created by the Trask, Wilson, and Tillamook Rivers as well as many adjoining tributaries. Many buildings in the low-lying areas of Tillamook are exposed to the 100-year flood. Although there are many elevated buildings in the flood-prone areas, which will greatly reduce overall flood risk, there are still many buildings that can be impacted by flood. It is estimated that nearly a third of the buildings exposed to the 100-year flood are elevated above the predicted level of flooding. So while the buildings themselves would not be damaged from flood, access to these buildings could still be an issue.

Table 105. Essential Facilities: City of Tillamook

Essential Facilities by Community	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ M 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Risk	Coastal Erosion High Hazard
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
County Health Department		X				
East Elementary School		X				
Liberty Elementary School		X				
Pacific Christian School		X				
Sacred Heart Catholic School		X				
Tillamook 911 Center		X				
Tillamook Bay Community College						
Tillamook City Hall		X				
Tillamook City Police Dept		X				
Tillamook Co. Public Works - Central		X				
Tillamook Fire Dist Main Station #71		X				
Tillamook High School	X	X				
Tillamook Junior High School		X				
Tillamook Regional Medical Center		X				

Areas of Mitigation Interest

Hazard results from Hazus and exposure analyses sometimes show specific locations where concentrations of high risk exist. These high risk locations, when considered along with other factors like number of people affected, potential economic impact, and level of damage, can be determined "Areas of Mitigation Interest (AOMI)." Potential mitigation actions that would also address the results of the Hazus and exposure analyses were culled from the current (2012) Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan.

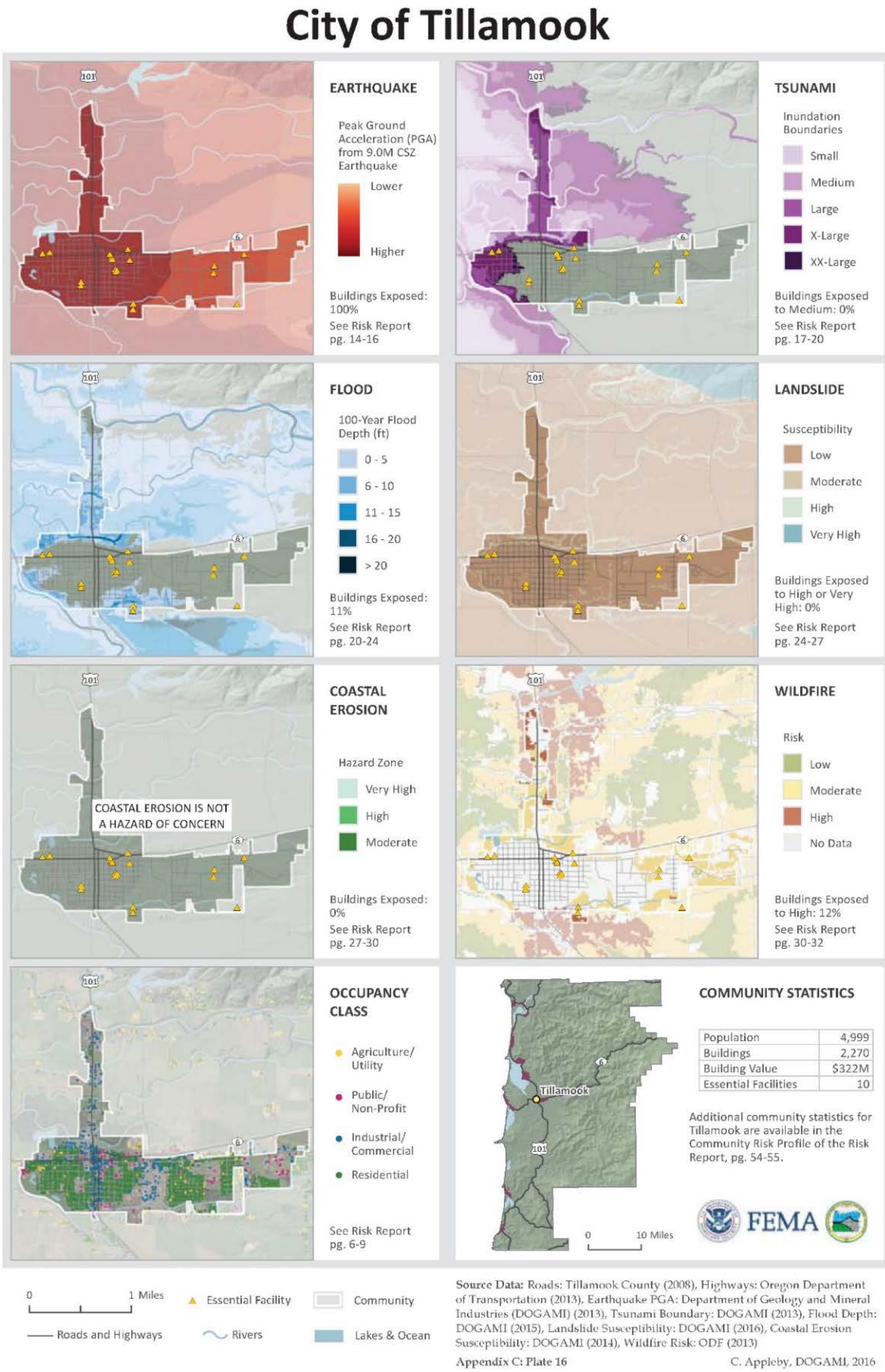
Table 106. Areas of Mitigation Interest: City of Tillamook

Hazard	Area	Description	Recommended Strategy
Flood	many buildings located along Highway 101 and north of downtown Tillamook are subject to 100-year flooding	clusters of buildings are predicted to experience flooding from a 100-year event from tributaries of the Wilson River; many structures are not elevated above the BFE; flood waters would cut off a primary route for travelers	
Flood	many buildings located along Highway 101 south of downtown Tillamook are subject to 100-year flooding	clusters of buildings are predicted to experience flooding from a 100-year event from the Trask River; many structures are not elevated above the BFE; flood waters would cut off a primary route for travelers	
Flood	Tillamook High School is subject to 100-year flooding	flooding from the Trask River would make the school nonfunctional during a 100-year flood event; if functional, could act as emergency shelter during periods of intense flooding	

Table 107. Hazard Mitigation Plan Analysis: City of Tillamook

Hazard	Projects	Additional Information from Risk Report
Earthquake	retrofit or replace school buildings to be earthquake resistant	
Multi-hazard	obtain generators for the school buildings to provide electricity, especially kitchen facilities.	
Multi-hazard	conduct a full natural hazard impact analysis.	
Multi-hazard	develop an emergency response plan for Tillamook School District #9.	

Figure 122. Multi-Hazard Community Map Set: City of Tillamook



Source: DOGAMI (2016)

11. City of Wheeler

Risk Assessment Summary

Table 108. Hazard Profile: City of Wheeler

Community Overview							
Community Name		Population	Number of Buildings		Essential Facilities[1]	Total Building Value ($)	
Wheeler		420	363		2	30,556,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	9	2.1%	12	0	113,000	0.4%
*Earthquake**	*CSZ Mag 9.0 Deterministic*	*166*	*40%*	*178*	*2*	*13,858,000*	*45%*
Earthquake (within Tsunami Zone)		9	2.1%	14	0	1,095,000	3.6%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Tsunami	*CSZ Mag 9.0 – Medium*	*25*	*6%*	*24*	*0*	*2,072,000*	*6.8%*
Tsunami	Senate Bill 379 Regulatory Line	22	5.2%	28	0	2,152,000	7%
Landslide	High and Very High Susceptibility	391	93%	336	1	28,256,000	92%
Wildfire	High Risk	0	0%	3	0	188,000	0.6%

*Earthquake damage was calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in **Figure 123**.

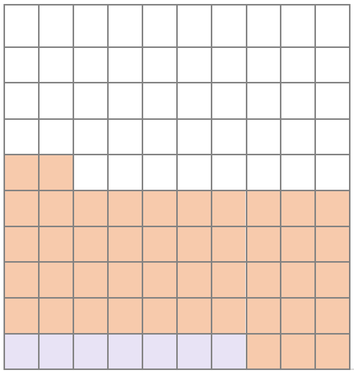
[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First Floor Heights" above the level of flooding (base flood elevation).

The natural hazards to which Wheeler is most vulnerable are the CSZ-related events (earthquake and tsunami) and landslide. As with every community in Tillamook County, the proximity to the CSZ makes earthquake a high risk hazard. Developments along the Nehalem River are exposed to tsunami hazard, as portions of the community are within the Medium-sized tsunami zone. Another substantial risk to the community is landslide hazard, since a large percentage of Wheeler is within a very high susceptibility landslide zone.

The CSZ earthquake hazard is a significant natural hazard risk to Wheeler and is a priority hazard for this community. A large part of the community lies within an area of moderate liquefaction, which slightly increases the probability for structural damage to buildings. Also the building inventory for Wheeler is relatively older, which implies lower building design codes with regard to earthquake. The tsunami generated from the CSZ earthquake is not expected to cause as much damage, but still is a concern.

Figure 123. Loss Ratio from CSZ Event: City of Wheeler



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. In order to avoid double counting to buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

= Estimated damage due to tsunami.
= Estimated damage due to earthquake (outside of tsunami zone).

The landslide hazard for Wheeler poses a great risk to the community and its potential impact is a serious concern. An area deemed very high susceptibility to landslides makes up the majority of Wheeler. Monitoring for ground movement, especially during particularly wet conditions, is one way of increasing public safety from landslide.

Table 109. Essential Facilities: City of Wheeler

Essential Facilities by Community	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ M 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Risk	Coastal Erosion High Hazard
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Nehalem Valley Care Center		X		X		
Wheeler City Hall and Public Works		X				

Areas of Mitigation Interest

Hazard results from Hazus and exposure analyses sometimes show specific locations where concentrations of high risk exist. These high risk locations, when considered along with other factors like number of people affected, potential economic impact, and level of damage, can be determined "Areas of Mitigation Interest (AOMI)." Potential mitigation actions that would also address the results of the Hazus and exposure analyses were culled from the current (2012) Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan.

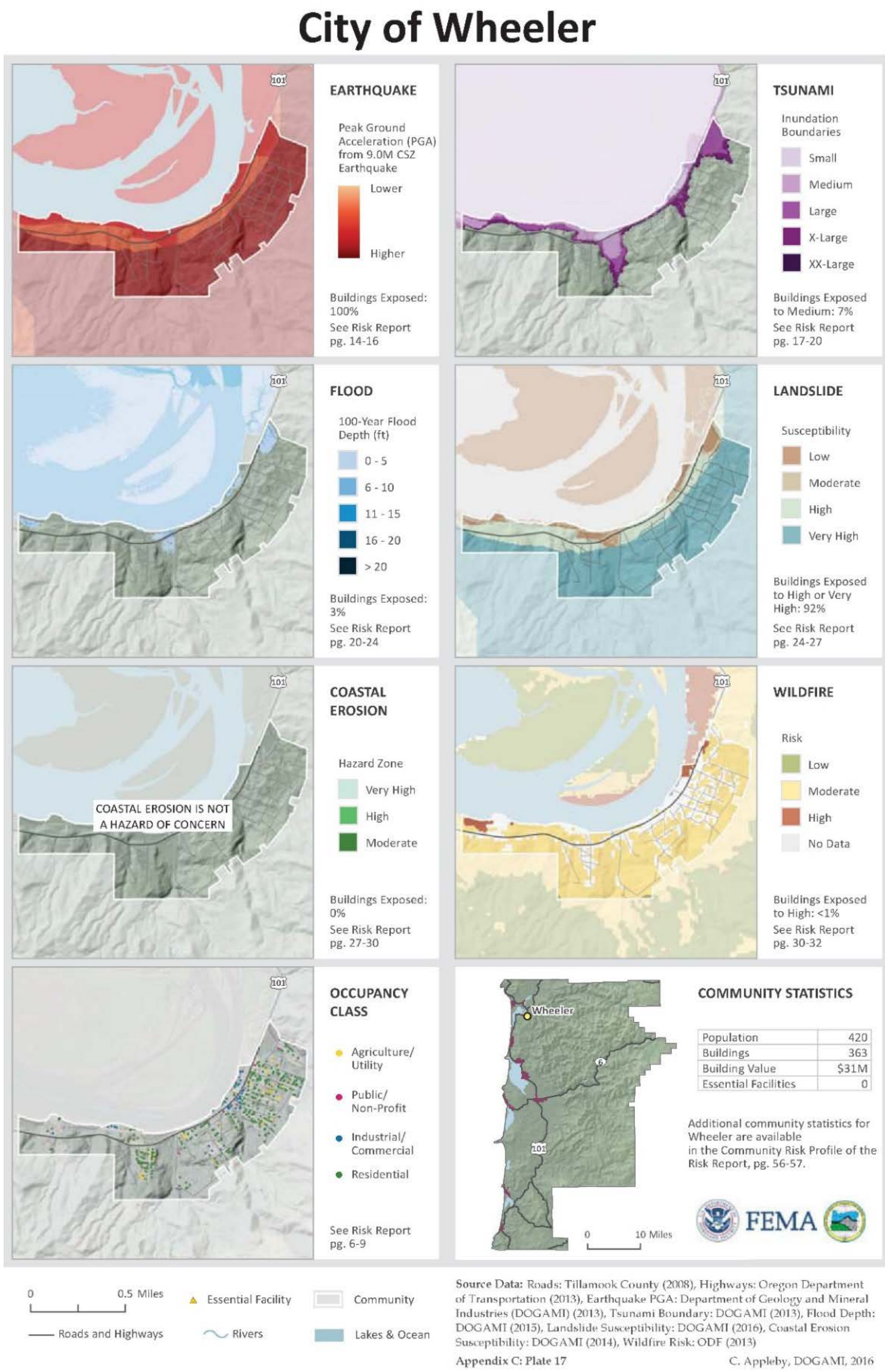
Table 110. Areas of Mitigation Interest: City of Wheeler

Hazard	Area	Description	Recommended Strategy
Flood	commercial area on the riverside of Highway 101 subject to 100-year flooding	Wheeler's commercial area experiences flooding from the Nehalem River; many structures are not elevated above predicted level of 100-year flooding	

Table 111. Hazard Mitigation Plan Analysis: City of Wheeler

Hazard	Projects	Additional Information from Risk Report
Flood	create new risk maps and flood maps using lidar	
Multi-hazard	establish evacuation routes above inundation zone, alternate to US-101	

Figure 124. Multi-Hazard Community Map Set: City of Wheeler



Source: DOGAMI (2016)

12. Port of Tillamook Bay

Areas of mitigation interest were not analyzed for the Port of Tillamook Bay.

Risk Assessment Summary

Table 112. Hazard Profile: Port of Tillamook Bay

Community Overview							
Community Name	Population		Number of Buildings	Essential Facilities[1]		Total Building Value ($)	
Port of Tillamook Bay	0		83	0		61,545,144	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0	0	0	0	0
*Earthquake**	*CSZ Mag 9.0 Deterministic*	*0*	*0*	*57*	*13*	*29,138,980*	*47%*
Earthquake (within Tsunami Zone)		0	0%	0	0	0	0%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Coastal Erosion	High Hazard	0	0%	0	0	0	0%
Tsunami	*CSZ Mag 9.0 – Medium*	*0*	*0%*	*0*	*0*	*0*	*0%*
Tsunami	Senate Bill 379 Regulatory Line	0	0%	0	0	0	0%
Landslide	High and Very High Susceptibility	0	0%	2	0	56,844	0.09%
Wildfire	High Risk	0	0%	0	0	0	0%

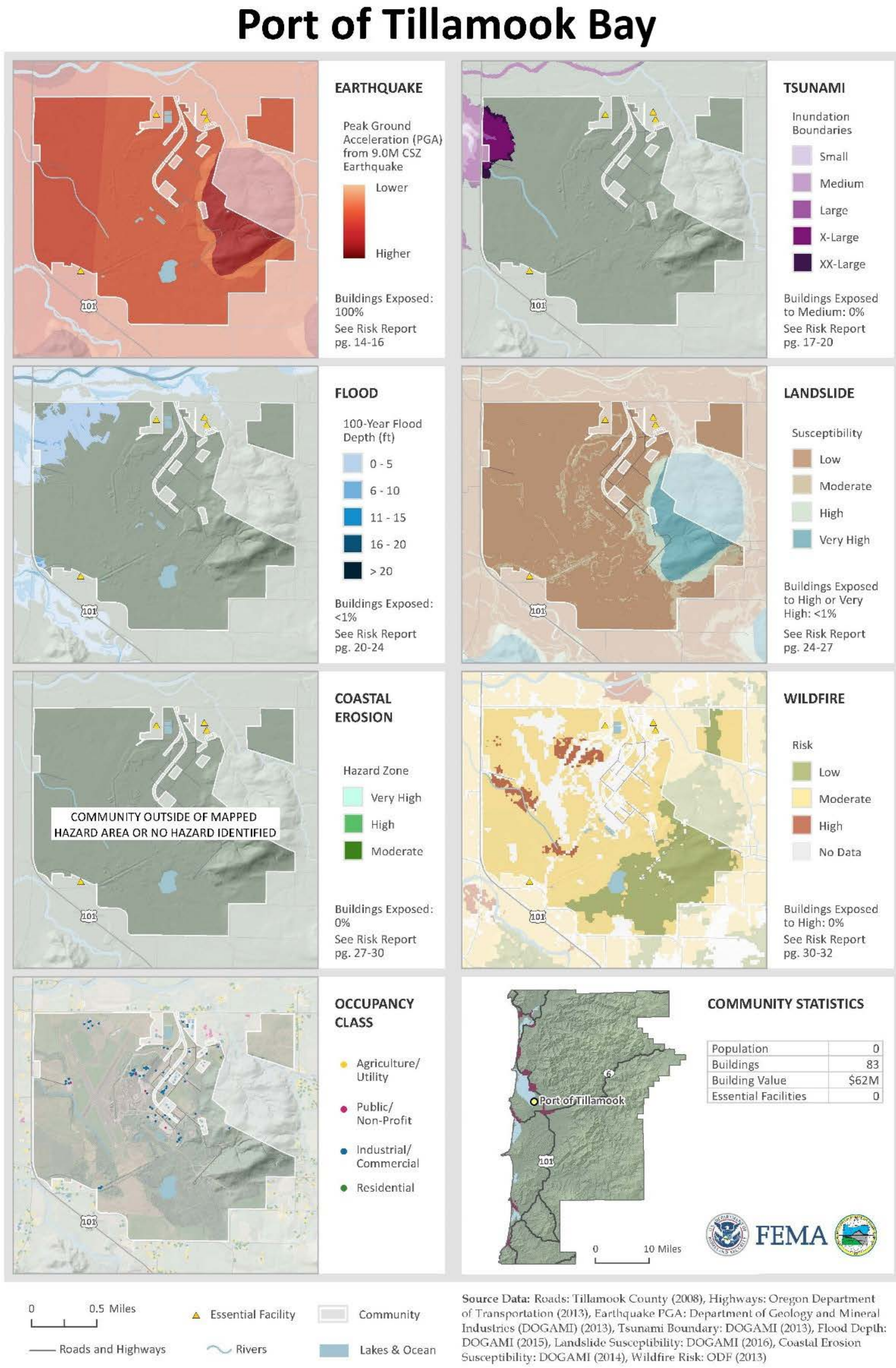
*Earthquake damage was calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another.

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with “First Floor Heights” above the level of flooding (base flood elevation).

Figure 125. Multi-Hazard Community Map Set: Port of Tillamook Bay



Source: DOGAMI (2016)

13. Port of Garibaldi

Areas of mitigation interest were not analyzed for the Port of Garibaldi.

Risk Assessment Summary

Table 113. Hazard Profile: Port of Garibaldi

Community Overview							
Community Name		Population	Number of Buildings		Essential Facilities[1]		Total Building Value ($)
Port of Garibaldi		0	36		0		8,035,760
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0	0	0	0	0
*Earthquake**	*CSZ Mag 9.0 Deterministic*	*0*	*0*	*4*	*0*	*544,725*	*7%*
Earthquake (within Tsunami Zone)		0	0%	21	0	2,996,704	37%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Coastal Erosion	High Hazard	0	0%	0	0	0	0%
Tsunami	*CSZ Mag 9.0 – Medium*	*0*	*0*	*26*	*0*	*3,427,250*	*43%*
Tsunami	Senate Bill 379 Regulatory Line	0	100%	33	0	7,986,217	99%
Landslide	High and Very High Susceptibility	0	0%	2	0	78,810	0.98%
Wildfire	High Risk	0	0%	0	0	0	0%

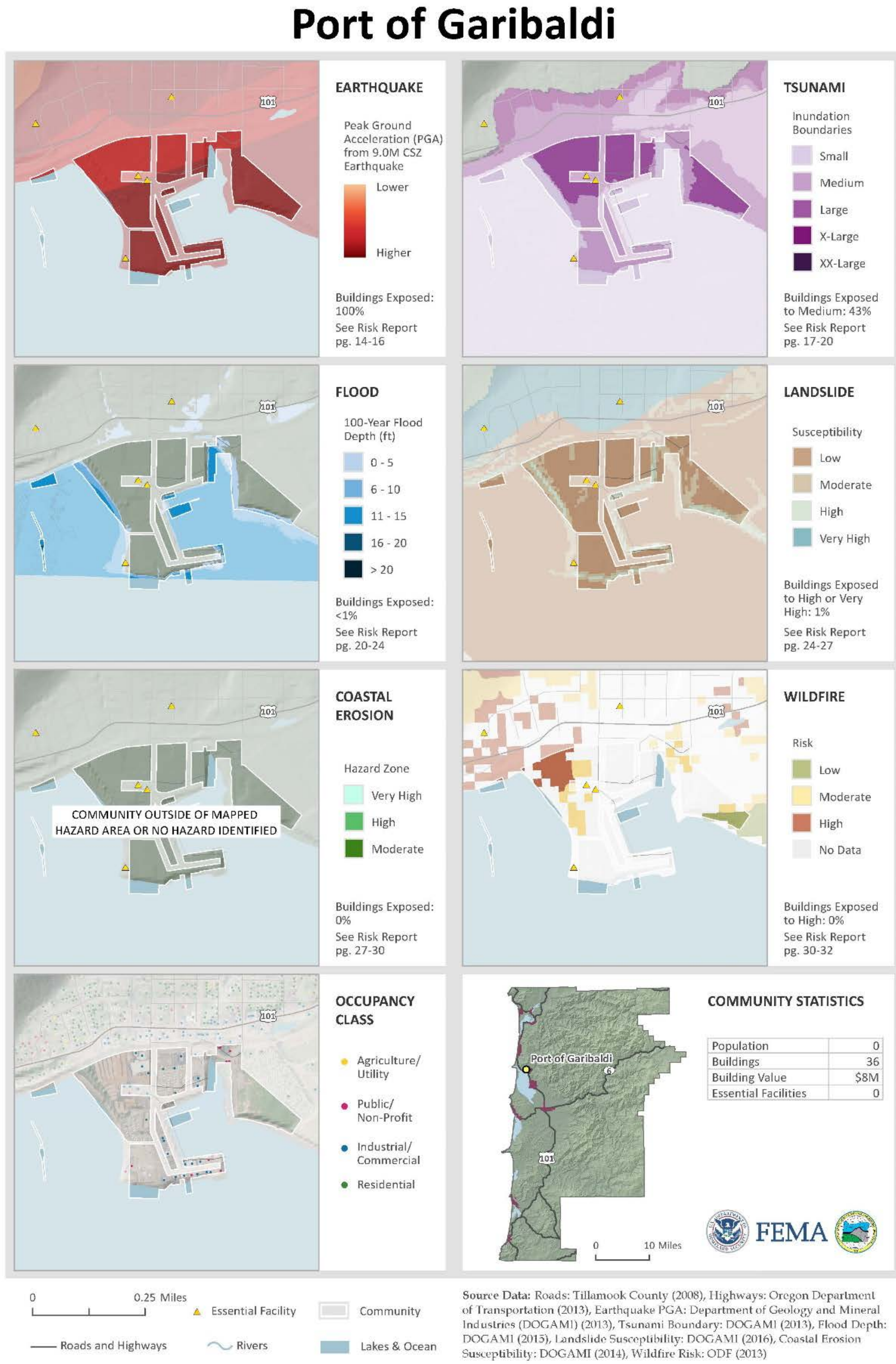
*Earthquake damage was calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another.

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First Floor Heights" above the level of flooding (base flood elevation).

Figure 126. Multi-Hazard Community Map Set: Port of Garibaldi



Source: DOGAMI (2016)

III. MITIGATION STRATEGY

A. Introduction

The Mitigation Strategy establishes a policy framework and implementation pathway for reducing risk from natural hazards over the long term. It presents the natural hazards mitigation goals and objectives of Tillamook County, its cities, and the Ports of Garibaldi and Tillamook Bay along with actions to achieve them, a strategy for implementation, and a process for integrating the NHMP into other planning mechanisms. It also identifies the tools and assets that support implementation available to each jurisdiction. Further, it documents progress in achieving mitigation actions since the Tillamook County Multi-Jurisdiction Natural Hazards Mitigation Plan was last approved in 2012.

B. Goals and Objectives

The Steering Committee reviewed the existing four multi-jurisdictional goals and decided to retain and combine them into three. In addition, several items previously identified as actions pertaining to each goal and other implementation items were revised and transformed into objectives. The overall priorities have not changed from the previous plan; they have been reconsidered, reorganized, and refined.

Goal 1. Develop and implement effective mitigation initiatives, projects, and activities to reduce hazards to life, businesses, property, and environmental systems.

- Objective 1A. Maintain effective natural hazards mitigation plans and regulations.
- Objective 1B. Promote purchase of insurance coverage to mitigate economic loss and enhance post-disaster resilience.
- Objective 1C. Preserve environmental systems to serve natural hazard mitigation functions.
- Objective 1D. Advance natural hazards mitigation with updated data and information as it becomes available.
- Objective 1E. Educate the public about natural hazards and mitigation.
- Objective 1F. Seek funding and partnerships as needed to implement mitigation initiatives, projects, and activities.

Goal 2. Enhance emergency services and the capabilities of local first responders.

- Objective 2A. Enhance the ability of individuals and businesses to be self-reliant for an extended period of time.
- Objective 2B. Seek funding to provide first responders with the training and tools they need to respond effectively to all hazard events.
- Objective 2C. Strengthen emergency operations by improving communication and coordination.

Goal 3. Improve regional coordination and communication.

- Objective 3A. Participate in the countywide Hazard Mitigation Steering Committee.

Objective 3B. Maintain active and collaborative emergency preparedness committees covering the county.

Objective 3C. Improve communication and collaboration between Emergency Operations Centers, including the Tillamook Citizens Corps Council, Emergency Volunteer Corps of Nehalem Bay, Community Emergency Response Teams, Incident Command Teams, Fire Districts, Emergency Services Departments, Public Works Departments, Law Enforcement Agencies, and others. In particular, collaborate on updating the County Emergency Response Plan.

Objective 3D. As funding becomes available, individual jurisdictions will continue to survey their populations about personal preparedness and develop coordinated response plans for each potential hazard.

C. Mitigation Actions

Mitigation actions are specific actions, projects, activities, or processes that reduce risk to people, property, and the environment from the impacts of natural hazard events.

The University of Oregon's Community Service Center conducted a review of the Tillamook County Development Code, focusing on supplementing and strengthening code associated with natural hazard mitigation. The task included reviewing a range of regulatory and non-regulatory standards that could be used by Tillamook County to mitigate the risk of natural hazards impacting the County. This information was reviewed for potential mitigation actions.

Table 114 through **Table 123** list each jurisdiction's prioritized mitigation actions and implementation strategy. Actions marked "ongoing" are those in which a jurisdiction engages regularly or continually and expects to continue doing so. Therefore these actions have not been assigned a specific timeline. **Table 124** shows progress in mitigation actions since the last plan update.

Each jurisdiction prioritized its mitigation actions qualitatively in accordance with their levels of necessity and urgency for the protection of people, property, and the environment; internal capacity or need for assistance to accomplish the action; and cost versus benefit. In general, actions considered to be of great necessity or urgency were assigned high priority even if they were expected to be extremely costly. Length of time to complete the action was not a criterion for prioritizing. Therefore some high-priority actions, even if they were considered urgent, have long timelines.

Table 114. Tillamook County Mitigation Actions

Tillamook County Mitigation Actions							
				Implementation			
Priority	Mitigation Action Description	Progress	Goal Addressed	Leads	Supporters	Target Completion Date	Actual or Potential Funding Sources
High	Adopt new FIS and FIRM.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	DLCD	Tillamook County DCD	2017	Tillamook County
High	Complete beach and dune code update.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	DLCD	Tillamook County DCD	2017	Tillamook County
High	Amend Beach and Dune code.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	DLCD	Tillamook County DCD	2017	Tillamook County
High	Work with the rural unincorporated communities to develop coastal erosion adaptation sub-plans based on the information in the "Framework Plan."	Not Started	Reduce hazards to life, businesses, property, and environmental systems	DCD	Unincorporated Communities	2017	Tillamook County/DLCD
High	Implement three outreach events on hazard insurance (flood, earthquake) over the life of the NHMP.	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	DCD	EM	2022	Tillamook County
High	Continue to implement the Southern Flow Corridor Plan.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	Tillamook County	Southern Flow Corridor Plan Partners	2017	POTB/TEP/ TBFID/Various state and federal agencies
High	Re-join the CRS program.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	DCD	DLCD, FEMA	2018	Tillamook County
High	Maintain GIS natural hazards geodatabase and program capability	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	DCD	County Assessor/ DOGAMI/ DLCD	Not Applicable	Tillamook County/FEMA/NOAA
High	Develop a drainage asset management plan with a culvert repair/replacement schedule.	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	PW	–	Not Applicable	Tillamook County/ODOT/ FEMA
High	Continue to replace culverts and bridges.	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	PW	–	Not Applicable	Tillamook County/ODOT/ FEMA
High	Apply for funding to repair two levees (Shilo and Stillwell).	Not Started	Reduce hazards to life, businesses, property, and environmental systems	PW	–	2022	FEMA/ACOE/ ODOT/ Drainage Districts
High	Continue outreach on natural hazards mitigation to residents and tourists.	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	DCD	EM/ Oregon Coast	Not Applicable	Tillamook County
High	Implement education and outreach strategies on seismic resilience, retrofitting, and the building code program.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	Building Official	EM	2018	Tillamook County
High	Continue to partner with DOGAMI through a DOGAMI grant to engage four communities in the "Follow the Elephant" evacuation practice program. (Pacific City, Neskowin, Rockaway Beach, Manzanita, Nedonna Beach).	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	DOGAMI	Tillamook County	Not Applicable	Grant
High	Conduct a mass casualty exercise annually.	Ongoing	Enhance emergency services and local first responders	EM	Cities/ Ports/ OEM	2018	Tillamook County
High	Maintain airborne warning and speaker system.	Ongoing	Enhance emergency services and local first responders	EM	–	Not Applicable	Tillamook County
High	Maintain disaster event chain of command.	Ongoing	Enhance emergency services and local first responders	EM	–	Not Applicable	Tillamook County
Medium	Update the Community Wildfire Protection Plan in coordination with ODF and the County Fire Board	Progressing	Reduce hazards to life, businesses, property, and environmental systems	ODF	Fire Board/ Tillamook County	2019	ODF
Medium	Complete tsunami "Beat the Wave" project.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	DCD	DLCD/DOGAMI	2018	NOAA
Medium	Consult with the Watershed Councils and Tillamook Estuary Partnership about developing and partnering on strategies to preserve environmental systems to serve natural hazards mitigation functions.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	DCD	TCBOCC/ TEP/DLCD	2020	Tillamook County/TEP/ DLCD

Tillamook County Mitigation Actions							
				Implementation			
Priority	Mitigation Action Description	Progress	Goal Addressed	Leads	Supporters	Target Completion Date	Actual or Potential Funding Sources
Medium	Maintain EVCNB agreement for assistance with NBRFD.	Ongoing	Enhance emergency services and local first responders	EM	–	Not Applicable	Tillamook County
Medium	Provide significant ham radio training throughout the county.	Ongoing	Enhance emergency services and local first responders	IS	EM/Cities/Ports	Not Applicable	Tillamook County/ Cities/Ports/ OEM/FEMA
Low	Develop an Animal Mortality Plan	Not Started	Reduce hazards to life, businesses, property, and environmental systems	ODA	EM/DEQ/ TCHealth/ Creamery Assn/ POTB	2022	ODA/DEQ/ FEMA/TC/ Creamery Association

Table 115. City of Bay City Mitigation Actions

City of Bay City Mitigation Actions							
				Implementation			
Priority	Mitigation Action Description	Progress	Goal Addressed	Leads	Supporters	Target Completion Date	Actual or Potential Funding Sources
High	Relocate public works equipment and emergency supplies to evacuation sites in the community.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	Public Works	City	2018	City/FEMA
High	Develop secondary access for the wastewater treatment plant and public works facilities that would result in direct access to US-101, avoiding interim access through the flood zone.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	Public Works	ODOT, FHWA	2020	City/FEMA
High	Design and implement an outreach program on hazard mitigation topics including outreach specific to non-English speakers and people with disabilities.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	City Emergency Preparedness Committee	OEM, Oregon Division of Financial Regulation (ODFR) - Insurance	2018	City/OEM/ DLCD/Local Social Service Orgs.
High	Include infrastructure response plan in EOP.	Not Started	Enhance emergency services and local first responders	Public Works Director	Fire Chief	2017	City
High	Reinvigorate the Emergency Preparedness and Mitigation Committee.	Not Started	Improve regional coordination and communication	City Council	City Manager	2017	FEMA
Medium	Create new risk and flood maps using lidar.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	FEMA	DOGAMI, DLCD	2017	FEMA
Medium	Relocate the fire station and City Hall out of the tsunami impact area. Use impounding franchise tax fees to purchase land, then apply for funding for construction.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	City	–	2022	Budgeted through reserve fund to purchase location for Fire/City Hall
Medium	Strengthen the banks of the wastewater treatment ponds to prevent erosion.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	City	–	2022	City
Medium	Develop and implement an outreach program to encourage seismic retrofitting, particularly fastening structures to their foundations.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	City Emergency Preparedness Committee	OEM	2019	City/OEM/ State Division of Financial Regulation (Insurance)/ Tillamook County Building Dept.
Medium	Assist CERT with pre-deploying supplies by placing containers at the north and south evacuation sites.	Not Started	Enhance emergency services and local first responders	City Emergency Preparedness Committee	CERT	2019	City

Table 116. City of Garibaldi Mitigation Actions

City of Garibaldi Mitigation Actions							
				Implementation			
Priority	Mitigation Action Description	Progress	Goal Addressed	Leads	Supporters	Target Completion Date	Actual or Potential Funding Sources
High	Equip reservoirs with seismically activated shut-off valves.	Not Started	Enhance emergency services and local first responders	City Engineer	–	2020	City Water Utility Revenue
High	Add surface water treatment. Develop an action plan for analyzing and decontaminating water in the event of an earthquake.	Not Started	Enhance emergency services and local first responders	City Engineer	–	2022	City Water Utility Revenue
High	Work with the USACE, Tillamook County, and the Port of Tillamook Bay to repair and maintain the jetties.	Progressing	Enhance emergency services and local first responders	City Manager	USACE, Tillamook County, Port of Tillamook Bay	2022	USACE
High	Replace 2 miles of asbestos-concrete pipe.	Progressing	Enhance emergency services and local first responders	City Engineer	–	2022	City Water Utility Revenue
High	Install seismically sound fuel tanks (1 diesel, 1 gas), generators, and storage for emergency supplies on the least hazard-susceptible area out of the floodplain and tsunami zone.	Not Started	Enhance emergency services and local first responders	City Engineer	City Manager	2022	City Utility/General Revenues
Medium	Seismic retrofits to bridges and culverts on US-101 to prevent collapse in an earthquake.	Not Started	Enhance emergency services and local first responders	City Engineer	City Manager	2022	ODOT
Medium	Complete Tourism Plan. The plan will incorporate (1) emergency management into tourism promotion operations so tourists are prepared for natural hazard events; and (2) evaluation of emergency facilities for accommodating tourism demand.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	Tourism Promotion Department	City Manager	2019	City
Low	Dismantle 200+ feet tall relic smoke stack.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	City Manager	–	2022	Private, Non-Profit
Low	Develop an agreement to use forest roads in an emergency or disaster response. Garibaldi has an observably high risk of isolation as a result of earthquake and tsunami events based on apparent vulnerability of transportation infrastructure. General vehicular access to Garibaldi is facilitated by US-101, which runs north and south along the Oregon Coast. Garibaldi can also be accessed through a series of forest land utility roads that interconnect throughout the Coast Range. However, use of these roads requires access to private property and no agreements are in place at this time for use of these roads in either an emergency or for emergency preparation.	Not Started	Enhance emergency services and local first responders	City Manager	USFS, ODF, Private property owners	2020	City, Private

Table 117. City of Manzanita Mitigation Actions

City of Manzanita Mitigation Actions							
				Implementation			
Priority	Mitigation Action Description	Progress	Goal Addressed	Leads	Supporters	Target Completion Date	Actual or Potential Funding Sources
High	Review and update Nehalem Bay Emergency Response Plan.	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	EVCNB	Manzanita, Nehalem, Wheeler	2022	Grants, Cities
High	Earthquake retrofits of water storage facilities. The water tanks serving the upper portion of Manzanita are older and not constructed to earthquake standards. The tanks need to be retrofitted so that water system capability can be maintained after an earthquake.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	PW	CM/CC	2022	City/FEMA
High	Continue to educate the public about natural hazards mitigation through links to EVCNB's website, www.evcnb.org.	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	EVCNB	CM	Not Applicable	EVCNB
High	Continue to provide first responders with training and equipment.	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	CM	CC	Not Applicable	City
High	Provide short-range and long-range communication systems in the water treatment plant and EOC.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	CM	PW	2018	City/FEMA
High	Enhance city organization self-sustainability by continuing to work with EVCNB, the fire districts, Nehalem, and Wheeler.	Ongoing	Enhance emergency services and local first responders	EVCNB	CC	Not Applicable	EVCNB/City
High	The City and EVCNB have begun outreach and training of neighborhood groups with the goal of increasing self-reported preparedness by 35% in 2017.	Progressing	Enhance emergency services and local first responders	EVCNB	CM	2017	EVCNB
High	The Nehalem Bay Community Emergency Preparedness Forum meets twice each year.	Ongoing	Improve regional coordination and communication	EVCNB	CM/PW	Not Applicable	EVCNB/City
Medium	Update flood maps using lidar.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	FEMA	DLCD/ DOGAMI	2017	FEMA
Medium	As hazard events occur, update NHMP and related plans.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	PW	CM/CC	2020	City
Medium	Evaluate the success of mitigation projects and activities.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	PW	CM	2022	City
Medium	Invite the public to NHMP maintenance meetings.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	CM	–	2017	City
Medium	Consider earthquake retrofit of City Hall. The City is considering whether to keep the building and retrofit it or move.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	CM	CC	2018	City/FEMA
Medium	Establish a regional cooperative GIS system for utilities and for enhancing activities and communication of response teams. Focus in areas of greatest need.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	NBCEPF	Cities of Manzanita, Nehalem, and Wheeler	2020	FEMA/City/NBWA
Medium	Continue to meet monthly with the EVCNB.	Ongoing	Improve regional coordination and communication	EVCNB	CM	Not Applicable	EVCNB
Low	Review and update Community Wildfire Protection Plan (CWPP).	Not Started	Reduce hazards to life, businesses, property, and environmental systems	NBFRD	CC	2019	NBFRD/City

City of Manzanita Mitigation Actions							
				Implementation			
Priority	Mitigation Action Description	Progress	Goal Addressed	Leads	Supporters	Target Completion Date	Actual or Potential Funding Sources
Low	Implement strategies from the CWPP for wildfire safety.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	NBFRD	CC	2019	NBFRD/City
Low	Maintain the wetland at City Park for conservation and natural hazards mitigation functions in perpetuity.	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	CM	–	Not Applicable	City
Low	Encourage general service organizations to become self-sustaining.	Not Started	Enhance emergency services and local first responders	EVCNB	CC	2019	EVCNB/City

Table 118. City of Nehalem Mitigation Actions

City of Nehalem Mitigation Actions							
				Implementation			
Priority	Mitigation Action Description	Progress	Goal Addressed	Leads	Supporters	Target Completion Date	Actual or Potential Funding Sources
High	Provide tsunami evacuation map to short-term rental applicants.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	ACM	–	2017	City/FEMA
High	Complete mass casualty and shelter plan with EVCNB	Progressing	Enhance emergency services and local first responders	CM	–	2019	EVCNB
High	Maintain Forest Management Plan	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	CM	ACM	Not Applicable	CIty
High	Continue working with EVCNB on effective mitigation projects	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	CM	ACM/PW	Not Applicable	CIty
High	Continue to provide brochures about flood insurance.	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	ACM	–	Not Applicable	CIty
High	Continue education and outreach about natural hazards to residents and tourists.	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	CM	ACM	Not Applicable	CIty
High	Continue working with EVCNB to store supplies and emergency equipment	Ongoing	Enhance emergency services and local first responders	CM	PW	Not Applicable	CIty
High	Continue recruiting and training ham radio operators with EVCNB	Ongoing	Enhance emergency services and local first responders	CM	ACM/PW	Not Applicable	CIty
High	Continue purchasing yellow emergency radios for ham operators with EVCNB	Ongoing	Enhance emergency services and local first responders	CM	ACM	Not Applicable	CIty
High	Continue to encourage citizens to purchase yellow emergency radios with EVCNB	Ongoing	Enhance emergency services and local first responders	CM	ACM/PW	Not Applicable	CIty
High	Continue working with EVCNB to implement all Goal 3 mitigation actions.	Ongoing	Enhance emergency services and local first responders	CM	ACM/PW	Not Applicable	CIty
Medium	Include information about flood insurance on water bills once each year.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	ACM	–	2017	City
Medium	Complete wayfinding project.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	CM	ACM/PW	2017	CIty
Medium	Continue managing 11-acre wetland for conservation and hazard mitigation in perpetuity.	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	CM	PW	Not Applicable	CIty

Table 119. City of Rockaway Beach Mitigation Actions

City of Rockaway Beach Mitigation Actions							
				Implementation			
Priority	Mitigation Action Description	Progress	Goal Addressed	Leads	Supporters	Target Completion Date	Actual or Potential Funding Sources
High	Build a "Public Safety Assembly Facility."	Not Started	Reduce hazards to life, businesses, property, and environmental systems	City	–	2019	City/Grants
High	Maintain a link to FEMA's flood hazard mitigation information on the City's website.	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	City	–	Not Applicable	City
High	Rejuvenate CERT Team.	Not Started	Enhance emergency services and local first responders	City	CERT	2017	City/Grants
High	Continue selling Life Straws.	Ongoing	Enhance emergency services and local first responders	City	–	Not Applicable	City
High	Prepare applications for mitigation projects to be ready when funding becomes available.	Not Started	Enhance emergency services and local first responders	City	OEM/DLCD	2017	City
High	Budget for professional assistance as necessary for preparing the applications.	Not Started	Enhance emergency services and local first responders	City	–	2017	City
High	Hire an Emergency Manager for the City.	Not Started	Improve regional coordination and communication	City	–	2017	City
High	Join the Tillamook Citizens Corps Council.	Not Started	Improve regional coordination and communication	City	–	2018	City
Medium	Manage the Nature Preserve for conservation and natural hazards mitigation in perpetuity.	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	City	–	Not Applicable	City/OPDR Trails Grant
Medium	Hold a full-scale citywide evacuation drill every October in conjunction with Earthquake Awareness Month or the Great Oregon Shake-Out.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	CERT	City	2017	City
Medium	Broadcast a public service announcement every fall at the beginning of flood season.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	City	DLCD	2017	City/FEMA
Medium	Publish a newsletter with flood hazard mitigation information each fall.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	City	DLCD	2107	City/FEMA
Medium	Help reorganize and re-start operation of our Emergency Volunteer Feeding Group (EVFG).	Not Started	Enhance emergency services and local first responders	EVFG	City	2018	City/EVFG/ Grants
Medium	Continue to be NIMSCAST compliant.	Ongoing	Enhance emergency services and local first responders	City	Fire Dept.	Not Applicable	City/FEMA
Medium	Continue to send key players to FEMA/ICS classes and training.	Ongoing	Enhance emergency services and local first responders	City	Fire Dept.	Not Applicable	City/FEMA
Medium	Consider purchasing emergency radios for staff and for sale to the public.	Not Started	Enhance emergency services and local first responders	City	–	2018	City/Grants
Medium	Continue to draft an Emergency Operations Plan.	Progressing	Enhance emergency services and local first responders	City	–	2022	City/FEMA
Medium	Become involve with the Tillamook County Incident Command Team.	Not Started	Improve regional coordination and communication	City	Tillamook County EM	2017	City
Medium	Consider executing the EVCNB survey or similar in Rockaway Beach.	Not Started	Improve regional coordination and communication	City	–	2018	City/Grants/ Universities

Table 120. City of Tillamook Mitigation Actions

City of Tillamook Mitigation Actions							
				Implementation			
Priority	Mitigation Action Description	Progress	Goal Addressed	Leads	Supporters	Target Completion Date	Actual or Potential Funding Sources
High	Evaluate City Capital Improvement Plan.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	City	–	2017	City
High	Extend 2010 Flood Mitigation Plan.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	City	DLCD/ FEMA	2018	DLCD/FEMA
High	Retrofit or replace school buildings to be earthquake resistant.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	TSD 9	City, OEM	2022	FEMA/OEM/TSD 9
High	Obtain generators for the school buildings to provide electricity, especially for the kitchen facilities.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	TSD 9	City, FEMA	2022	FEMA/OEM/TSD 9
High	Implement two methods for informing the public about how to be disaster-ready and self-reliant, and promote and enhance flood/hazard mitigation through education.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	City	EVCNB, OEM, DLCD, ODFR - Insurance	2017	City
High	Relocation of Water Transmission Line - In cooperation with the POTB, the City will examine the relocation of the City's main water transmission line that currently runs under the Tillamook Municipal Airport and needs to be repaired to provide a functional water source in case of disaster.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	City	POTB/ FEMA	2022	City/FEMA
High	Sewer Line Connection with the POTB (Two purposes: general health, safety, welfare of citizens and hazard mitigation to provide functional sewer to POTB in case of disaster).	Not Started	Reduce hazards to life, businesses, property, and environmental systems	City	POTB	2018	City/POTB/ FEMA
High	Construct a ground-level reservoir tank.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	City	City	2018	City/FEMA
High	Develop 3-Day Storage Reserve for Disaster Preparedness.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	City	TSD 9/ FEMA	2018	City/FEMA
High	Participate in the update of Tillamook County's Emergency Operations Plan.	Ongoing	Enhance emergency services and local first responders	City Police Dept.	Tillamook County EM	Not Applicable	City
High	Community Points of Distribution (C-PODS). Worked with Tillamook County Emergency Management to identify the Tillamook Municipal Airport as a C-POD during periods of emergency.	Ongoing	Enhance emergency services and local first responders	Tillamook County Emergency Management	POTB/ City	Not Applicable	POTB
High	Emergency Drop Location. Worked with Tillamook County Health Department to identify the Tillamook Municipal Airport as an emergency drop location site for medical supplies.	Ongoing	Enhance emergency services and local first responders	Tillamook County Health Dept.	POTB/ City	Not Applicable	POTB
High	Emergency Radio Communication System Upgrades. Acquisition of updated radio equipment to provide continued, uninterrupted intra- and interagency communication during periods of emergency in/around the airport, industrial park complex and community.	Progressing	Enhance emergency services and local first responders	Tillamook County Emergency Mgmt.	City, Port of Tillamook Bay	2017	City/POTB
Medium	Preserve Natural Areas Related to Flooding.	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	City	FEMA	Not Applicable	FEMA (NFIP)
Medium	Improve Structural Projects/Buyouts.	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	City	FEMA	Not Applicable	FEMA (NFIP)
Medium	Develop a post-disaster recovery plan and implementing code.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	City	OEM/DLCD	2022	City/OEM/DLCD

Table 121. City of Wheeler Mitigation Actions

City of Wheeler Mitigation Actions							
				Implementation			
Priority	Mitigation Action Description	Progress	Goal Addressed	Leads	Supporters	Target Completion Date	Actual or Potential Funding Sources
High	DOGAMI, FEMA, and DLCD are creating new Risk Maps and Flood Maps using lidar. The City received the Preliminary maps, distributed as of 12/9/2106. Meetings are scheduled for April 2017 which will be followed by a 90 day appeal period.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	Wheeler	FEMA/ DLCD/ DOGAMI	2017	FEMA
High	Strengthen emergency operations through improvements to communication and coordination such as: (a) acquisition and instillation of a repeater; (b) acquisition of backup power equipment; (c) acquisition of appropriate ancillary equipment; (d) updating of emergency operations plans (as necessary).	Progressing	Enhance emergency services and local first responders	Wheeler	–	2022	Wheeler, FEMA
High	Repair Hemlock Street. Inundated by rain in disaster event DR – 4258 – OR, Hemlock St. experienced surface cracking and degradation due to stormwater surplus overflow from the adjacent drainage that undercut the roadway. The City of Wheeler has applied for and received approval for FEMA Public Assistance funding to provide 75% of the repair cost.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	Wheeler	FEMA	2017	Wheeler, FEMA
High	Adopt a Storm Water Master Plan. The City is on constant vigilance with monitoring, maintenance, and repairs in the existing stormwater drainage system as the City is situated on the east side of the Nehalem Bay and is surrounded by hillsides that extend upwards approximately 1,300 feet in elevation and include a drainage area of 4,400 acres. Many of the streets lack sufficient surface curvature or crown to direct water effectively to a suitable ditch or intake. Rainfall sheets directly down roadways in many places. In some gravel roadways, the sheeting has eroded channels on the surface itself. The City of Wheeler has a Stormwater Master Plan that was produced by HGE Inc. which included extensive field work in winter and spring of 2005 to locate and document existing culverts and other stormwater related problems and infrastructure. A detailed list of capital improvements was generated identifying and prioritizing projects. Detailed mapping was prepared to show locations of existing physical features, drainage basins, general drainage flow patterns, and storm water infrastructure. The city budgets for these improvements each year and completes the high priority projects as budget allows.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	Wheeler	EVCNB	2022	Wheeler, Grants
High	Replace Gervais Creek Drainage. The project is in an effort to reroute Gervais Creek (Drainage of Basin G2) under an existing city street, Rorvik St., state highway US-101, railroad right of way, and city park with an outfall into the Lower Nehalem Watershed (Proposed drainage of Basin G2). The work and location of the pipe would be located toward the center of Rorvik St. to avoid sidewalks and utilities, which reduces construction cost. This would also keep the project from having a direct impact on any existing structures. The diversion of Gervais Creek to a 36” pipe (Current Stormwater System Gervais Creek) is reported to have been completed in the early 1900s. The pipe passes under developed properties and the business core of downtown Wheeler. Documented occurrences of flooding of at least one building of the business core has been recorded for the following periods: 1982, December 1994, January 1995, 1996, November 2000, January 2001, December 2002, February 2003, December 2007, and December 2015. It should be noted that these flooding events typically cause heavy damages to a number of buildings, both commercial and residential. Gervais Creek also has the potential to flood the east part of the business core if the intake structure is obstructed or if stream flows exceed the hydraulic capacity of the 36” line. The proposed project will alleviate these hazards by mitigating storm events in meeting minimum hydraulic requirements of the system.	Not started	Reduce hazards to life, businesses, property, and environmental systems	Wheeler	EVCNB/ Tillamook County/ NBFR	2018	FEMA

City of Wheeler Mitigation Actions

Priority	Mitigation Action Description	Progress	Goal Addressed	Implementation: Leads	Supporters	Target Completion Date	Actual or Potential Funding Sources
High	Re-route Zimmerman Creek. Zimmerman Creek is currently routed under a residential neighborhood in Wheeler and has contributed to two separate instances of roadway failure on Hemlock St. as inventoried during disaster event DR 1672 – OR and DR – 4258 – OR.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	Wheeler	EVCNB	2022	Wheeler, FEMA
High	Participate in the Countywide Hazard Mitigation Steering Committee.	Ongoing	Improve regional coordination and communication	Wheeler	–	Not Applicable	Wheeler
High	Continue participation in an active regional Emergency Preparedness Committee.	Ongoing	Improve regional coordination and communication	Wheeler	–	Not Applicable	Wheeler
High	The City will continue to work in partnership with community resources to develop response plans for potential hazards.	Ongoing	Improve regional coordination and communication	Wheeler	–	Not Applicable	Wheeler
Medium	Establish evacuation routes above inundation zone, alternate to US-101. Establish evacuation routes along the Stimson logging roads above Wheeler. Stimson is requiring that a gravel base be laid down. Estimated cost: $4,500 for gravel. Completed central Wheeler access, but maintenance is an ongoing burden due to difficulty of access for maintenance by City equipment. South Wheeler access is accessible and maintained. North Wheeler access is currently unavailable and further development needs to be addressed with Stimson logging. Ongoing access to 3rd. St. easement must be maintained as well. This access is also compromised by difficulty to access by City maintenance equipment.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	Wheeler	DOGAMI, OEM, Stimson Lumber	2020	Progressing
Medium	Emergency Access Paving. Establish access along paved portions of Wheeler street inventory for emergency evacuation and emergency response staging. The City of Wheeler has received a paving grant from ODOT to provide paving to 1st St. between Hwy 101 and Hemlock for North end evacuation. The City has also received paving funding to create access, parking, and staging areas at Wheeler Upper Park as this is the designated gathering point following a natural disaster. This will allow the City to consolidate supplies and recovery efforts. Additionally the City will pave 3rd. St. between Hemlock and Cedar St. with ODOT paving funds as this will maintain the primary thoroughfare from Central to North Wheeler.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	Wheeler	ODOT/ EVCNB	2017	ODOT
Medium	Continuously develop and update relationships or partnerships to provide updates of natural hazard related data. (Example: Connie Ozawa (Planning) and Paul Manson (Sea Grant, Hatfield School PhD student in Public Affairs Program) After the Wave Survey on Tsunami Resilience Efforts.	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	Wheeler	DOGAMI, PSU, OSG, etc.	Not Applicable	Wheeler, PSU. Sea Grant, others
Medium	Develop a maintenance schedule and inventory lists for city infrastructure equipment used in preparing for and addressing the effects of natural hazards. The City has a list of maintenance schedules and inventory for maintaining many of the systems within the infrastructure. These schedules are very helpful and are updated regularly. These lists include: equipment lists, repair parts, water system inventory list and master plan inventory, and stormwater master plan inventory. The City maintains these lists and continually updates them as appropriate. These lists are kept as a separate inventory from this Hazard Mitigation Plan.	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	Wheeler	–	Not Applicable	Wheeler
Low	Continue to review utilization and evaluation of ordinances that reduce potential for hazards.	Progressing	Develop and implement effective mitigation initiatives, projects, and activities to reduce hazards to life, businesses, property, and environmental systems.	Wheeler	DLCD	2022	Wheeler
Low	City will continue to update the Water Master Plan as required or as necessary.	Progressing	Develop and implement effective mitigation initiatives, projects, and activities to reduce hazards to life, businesses, property, and environmental systems.	Wheeler	–	2022	Wheeler

Table 122. Port of Tillamook Bay Mitigation Actions

Port of Tillamook Bay Mitigation Actions							
				Implementation			
Priority	Mitigation Action Description	Progress	Goal Addressed	Leads	Supporters	Target Completion Date	Actual or Potential Funding Sources
High	Establish secondary ingress/egress at the industrial park.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	POTB	ODOT, FHWA, Tillamook County	2022	Road Maintenance Fees
High	City of Tillamook water transmission line relocation. In cooperation with the City of Tillamook, this project would examine the relocation of its main water transmission line that currently runs underneath the Tillamook Municipal Airport to a more viable location along POTB's outside property boundary.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	City of Tillamook	POTB/ODOT	2022	City of Tillamook/ POTB to provide/revise easements
High	Provide for needed improvements to Hangar B, a Nationally registered structure that houses the Tillamook Air Museum and other clients.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	POTB	Oregon Heritage Commission	2022	Grants, Donations
High	Provide for multiple Tillamook Municipal Airport improvements through continued participation in the FAA's Airport Improvement Program (AIP) to maintain adequate, uninterrupted airport service to the community. One such project is the replacement of a culvert adjacent to Long Prairie Road to mitigate recurrent floodwaters from the Trask River that may impede/block travel.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	POTB	FAA/ODA	2022	FAA AIP (Revolving) Funds; Grants
High	Community Points of Distribution (C-PODS). Worked with Tillamook County Emergency Management to identify the Tillamook Municipal Airport as a C-POD during periods of emergency.	Progressing	Enhance emergency services and local first responders	Tillamook County Emergency Mgmt.	POTB/ Stake-holders	2017	Tillamook County, POTB
High	Emergency Drop Location. Worked with Tillamook County Health Department to identify the Tillamook Municipal Airport as an emergency drop location site for medical supplies.	Ongoing	Enhance emergency services and local first responders	Tillamook County Health Dept.	POTB/ Tillamook County Emergency Mgmt.	Not Applicable	Tillamook County, POTB
High	Emergency Radio Communication System Upgrades. Acquisition of updated radio equipment to provide continued, uninterrupted intra- and interagency communication during periods of emergency in/around the airport, industrial park complex and community.	Progressing	Enhance emergency services and local first responders	POTB	–	2017	POTB, other non-federal sources
High	POTB Emergency Operations Plan (Update as needed).	Ongoing	Enhance emergency services and local first responders	POTB	Stakeholders	Not Applicable	POTB
High	Update of the Tillamook Municipal Airport Response Plan. Also identifies the Airport as an emergency fuel up spot for the Coast Guard and other agencies.	Ongoing	Enhance emergency services and local first responders	POTB	FAA	Not Applicable	POTB/FAA
High	Participate in countywide Hazard Mitigation Steering Committee meetings, etc.	Ongoing	Improve regional coordination and communication.	POTB	–	Not Applicable	POTB
High	Participate in planning meetings for hazard training events.	Ongoing	Improve regional coordination and communication.	POTB	–	Not Applicable	POTB
Medium	Continue to support Tillamook County, the Port of Garibaldi and other stakeholders to obtain funding to undertake needed repairs to the South Jetty, which is located within Port's (northernmost) district boundary and is part of the primary entrance/exit to/from Tillamook Bay to the Pacific Ocean.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	Tillamook County	POTB/ Port of Garibaldi	2022	Federal Appropriations Request
Low	Cooperate with stakeholders to establish a bovine mortality disposal facility in Tillamook County.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	TCCA	POTB/ ODA/ DEQ/ Tillamook Farming Comm./ TCoDCD/ TCo Emer. Mgmt.	2022	Local, State, and Federal sources

Table 123. Port of Garibaldi Mitigation Actions

Port of Garibaldi Mitigation Actions							
				Implementation			
Priority	Mitigation Action Description	Progress	Goal Addressed	Leads	Supporters	Target Completion Date	Actual or Potential Funding Sources
High	Continue to lobby for and support USACE funding to repair the Tillamook Bay South Jetty and push for continued support of entire jetty system.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	POG	Tillamook County/ USACE, OPPA/ PNWA	2020	USACE
High	Continue insuring boat/mooring basin and entrance channels are kept dredged and free from hazards to navigation.	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	POG (Boat Basin)/ USACE (Channel)	OSMB/ DSL	Not Applicable	POG/USACE/ OSMB
High	Install break wall to protect boat/mooring basin from storm surge, excess sediment deposit, and tsunami surge.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	POG	FEMA/ OSMB, DSL, USACE, FEMA	2022	FEMA/OSMB/ EDA
High	Re-enforce mooring basin road sea wall to prevent underpinning and to stabilize mooring basin road and boat basin from collapse.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	POG	ODOT/ City of Garibaldi/ USDOT/ OSMB	2018	ODOT, USDOT
High	Continue working with local vessel owners to create network of individuals to assist in catching fish and crab to assist feeding population during post event recovery period.	Progressing	Enhance emergency services and local first responders	POG	Stake-holders	2018	EDA
Medium	Replace wooden loading pier with seismically engineered structure to serve as primary unloading platform for county disaster relief from ocean access.	Progressing	Reduce hazards to life, businesses, property, and environmental systems	POG	EDA/ Business Oregon	2022	EDA/FEMA/ Business Oregon
Medium	Continue to develop post event Port of Garibaldi restoration of operations and return of services plan.	Ongoing	Reduce hazards to life, businesses, property, and environmental systems	POG	USCG, Business Owners	Not Applicable	POG
Medium	Continue to support and coordinate with the City of Garibaldi on development of its Emergency Operations Plan.	Ongoing	Improve regional coordination and communication	City of Garibaldi	POG	Not Applicable	City of Garibaldi/POG
Low	Investigate, procure, and strategically stage equipment to help restore critical function following a disaster.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	POG	USCG, Utilities, Business Owners	2020	POG/State of Oregon/Local Governments/ NGOs/ Businesses/ Other Stakeholders
Low	Research feasibility of constructing tsunami safe structure for evacuation safety.	Not Started	Reduce hazards to life, businesses, property, and environmental systems	POG	DOGAMI, OEM, Oregon Building Codes Division	2020	POG/FEMA/ OEM

Table 124. Mitigation Action Progress

Mitigation Action Progress							
				Implementation			
Jurisdiction	Mitigation Action Description	Progress	Goal Addressed	Leads	Supporter	Target Completion Date	Actual or Potential Funding Sources
Tillamook County	Complete flood code update.	DONE	Reduce hazards to life, businesses, property, and environmental systems	DCD			Tillamook County
Tillamook County	Review Geohazard code.	DONE	Reduce hazards to life, businesses, property, and environmental systems	DCD			Tillamook County
Tillamook County	Amend code to incorporate standards from the brochure: Fire Resistant Plants for Home Landscapes	DONE	Reduce hazards to life, businesses, property, and environmental systems				
Tillamook County	Inventory drainage assets and condition of the culverts.	DONE	Reduce hazards to life, businesses, property, and environmental systems	PW			Tillamook County/ODOT/FEMA
Tillamook County	Buyout repetitive loss properties through FEMA.	DONE	Reduce hazards to life, businesses, property, and environmental systems				
Tillamook County	Write a brochure: Fire Resistant Plants for Home Landscapes.	DONE	Reduce hazards to life, businesses, property, and environmental systems				
Tillamook County	Practice evacuations with Manzanita and Pacific City.	DONE	Reduce hazards to life, businesses, property, and environmental systems				
Tillamook County	Airborne warning and speaker system controlled by the civil air control dispatched through the Emergency Management Response System.	DONE	Enhance emergency services and local first responders				
Tillamook County	Establish disaster event chain of command between county, cities, unincorporated communities and non-governmental bodies, Tillamook County Emergency Management Department, Oregon Emergency Management, and FEMA.	DONE	Enhance emergency services and local first responders				
Tillamook County	Implement Emergency Volunteer Corps of Nehalem Bay (EVCNB) agreement for assistance with Nehalem Bay Regional Fire District (NBRFD).	DONE	Enhance emergency services and local first responders				
Tillamook County	Train CERT volunteers in north Tillamook County and Rockaway Beach.	DONE	Enhance emergency services and local first responders				
Tillamook County	Create public hazard mitigation event data entry port.	Not Being Pursued	Reduce hazards to life, businesses, property, and environmental systems				
Tillamook County	Secure funding to install warning sirens countywide.	Not Being Pursued	Enhance emergency services and local first responders				
Bay City	Waterline borings - Remove two water lines from bridges to borings under the Kilchis River; connect the City of Tillamook water system and City of Bay City water system (Kilchis Regional water system) by a boring under the Wilson River.	DONE	Enhance emergency services and local first responders				FEMA
Garibaldi	Refine tsunami hazard analysis with scientific data from DOGAMI.	DONE	Reduce hazards to life, businesses, property, and environmental systems				
Garibaldi	Retrofit City Hall/Fire Department building for seismic stability.	DONE	Reduce hazards to life, businesses, property, and environmental systems				

Mitigation Action Progress							
				Implementation			
Jurisdiction	**Mitigation Action Description**	**Progress**	**Goal Addressed**	**Leads**	**Supporter**	**Target Completion Date**	**Actual or Potential Funding Sources**
Garibaldi	Analysis of jetty infrastructure and port to determine if action could better assure usability for fishing and the transport of goods to the area in the event of a disaster.	DONE	Enhance emergency services and local first responders				
Manzanita	The City purchased generators for critical infrastructure, Nehalem Bay Fire and Rescue District, and City Hall.	DONE	Enhance emergency services and local first responders				
Manzanita	The EVCNB surveyed the Nehalem Bay communities about individual preparedness and has a detailed analysis with an executive summary on its website.	DONE	Improve regional coordination and communication				
Nehalem	New City Hall	DONE	Reduce hazards to life, businesses, property, and environmental systems				City
Nehalem	Remove 11-acres wetland from development.	DONE	Reduce hazards to life, businesses, property, and environmental systems				City
Nehalem	Participate in the CRS Program.	DONE	Reduce hazards to life, businesses, property, and environmental systems				City
Nehalem	Provide tsunami evacuation map to beachfront property managers.	DONE	Reduce hazards to life, businesses, property, and environmental systems				City
Nehalem	Purchase yellow emergency radios for the City.	DONE	Enhance emergency services and local first responders				City
Nehalem	New Community Center	Not Being Pursued	Reduce hazards to life, businesses, property, and environmental systems				City
Nehalem	New Public Works Facility	Not Being Pursued	Reduce hazards to life, businesses, property, and environmental systems				City
Rockaway Beach	Purchased a portable generator for the Water Treatment Plant in 2012.	DONE	Reduce hazards to life, businesses, property, and environmental systems				
Rockaway Beach	Installed generator disconnect switches on three wells.	DONE	Reduce hazards to life, businesses, property, and environmental systems				
Rockaway Beach	Installed a special water faucet at Pacific View Estates Reservoir in 2016 to facilitate the distribution of potable water in an emergency if the plant was operational but the water lines were damaged.	DONE	Reduce hazards to life, businesses, property, and environmental systems				
Rockaway Beach	Placed an emergency container at McMillan Creek Reservoir in 2014.	DONE	Reduce hazards to life, businesses, property, and environmental systems				
Tillamook	Evaluate applicable city ordinances.	DONE	Reduce hazards to life, businesses, property, and environmental systems	City	DLCD/FEMA		
Tillamook	Train individual residents to be disaster-ready and self-reliant.	DONE	Enhance emergency services and local first responders	City	DOGAMI		
Tillamook	Commit to writing procedures for cooperation during storms.	DONE	Enhance emergency services and local first responders	City Police Dept.			
Tillamook	Develop response plans for each hazard as part of Tillamook County's Emergency Operations Plan.	DONE	Improve regional coordination and communication	City Police Dept.			
Tillamook	Develop an emergency response plan for Tillamook School District #9 (TSD 9) to transport students if a disaster event occurs while they are in school.	DONE	Improve regional coordination and communication	Tillamook School District #9			
Wheeler	Adopt Ordinance 2006-01: NIMS process for preparing for disaster	DONE	Enhance emergency services and local first responders				

Mitigation Action Progress							
				Implementation			
Jurisdiction	Mitigation Action Description	Progress	Goal Addressed	Leads	Supporter	Target Completion Date	Actual or Potential Funding Sources
Wheeler	Adopt Ordinance 2000-01: identifying succession of authority	DONE	Enhance emergency services and local first responders				
Wheeler	Repair Hemlock Street. Inundated by rain in disaster event DR – 1672- OR, Hemlock St. slid into Zimmerman Creek taking sewer, water, and stormwater utilities with it.	DONE	Reduce hazards to life, businesses, property, and environmental systems				
Wheeler	Adopt a Water Master Plan. The City of Wheeler has a Water Master Plan that was produced by Lee Engineering, and most recently was replaced by and updated plan by Pace Engineering Inc. that has helped keep the city in compliance with the Federal Safe Water Drinking Act of 1986. A major project (Redacted) was undertaken to change the source of the cities drinking water from surface water to a ground water source in partnership with the City of Manzanita. We will continue to update this master plan for future water system needs. Completed; City will continue to update this plan as required or as necessary.	DONE	Reduce hazards to life, businesses, property, and environmental systems				
Wheeler	Periodically review, evaluate, and amend or adopt as necessary ordinances that reduce potential for hazards. Ordinances, permits, and inspections for control of new construction are in place to insure that development or land alteration does not create downstream sedimentation, water quality, flooding, or drainage problems and provides for adequate drainage systems and soil protection for the site being developed, and its adjacent sites. The permit process allows for review of grading and erosion control plans and details contours of properties, including drainage areas that may affect property. Completed: review utilization and evaluation of these ordinances is ongoing.	DONE	Reduce hazards to life, businesses, property, and environmental systems				
Port of Tillamook Bay	Provide fire suppression service upgrades at the Tillamook Municipal Airport.	DONE	Reduce hazards to life, businesses, property, and environmental systems	POTB	FEMA/ State of Oregon/ Tillamook Pilots' Assn./ Tillamook Fire Marshal		
Port of Garibaldi	Completed a new $4M seismically engineered commercial wharf/pier structure.	DONE	Reduce hazards to life, businesses, property, and environmental systems	POG			
Port of Garibaldi	Completed a $2M upgrade to Commercial Avenue roadway and undergrounded utilities to ensure resilience from winter storms and windstorms.	DONE	Reduce hazards to life, businesses, property, and environmental systems	POG			
Port of Garibaldi	Dredged the main channel to ensure vessels can safely navigate to the boat basin.	DONE	Reduce hazards to life, businesses, property, and environmental systems	POG			

D. Integration

To achieve risk reduction, it is necessary to consider natural hazards mitigation in jurisdictional planning processes, from land use to infrastructure to emergency response. Every advance in mitigation reduces impact, decreasing the need for response and recovery and increasing resilience. Each jurisdiction engages in comprehensive planning and other processes (budget, capital facilities, public works and engineering, open space and recreation, environmental planning, etc.) within which mitigation can be considered and accomplished. However, it is not yet generally embedded in the context of these conversations. For most jurisdictions this will constitute a type of awareness campaign and require a change in organizational culture. The Port of Garibaldi has already successfully integrated natural hazards mitigation into its organizational culture, planning, projects, and operations. As it works closely on these issues with the City of Garibaldi, mitigation has also become an integral part of the City's considerations in its planning and operations.

Steering Committee members will be responsible for communicating the importance and necessity of integrating mitigation goals, objectives, and actions into the everyday business of the jurisdiction to those within their individual organizational structures responsible for developing and implementing the various planning and operations documents and processes. Steering Committee members will also engage in those planning and operations processes to the extent necessary and appropriate to ensure that mitigation goals, objectives, and actions are duly considered and incorporated as applicable and feasible.

DLCD has committed to assisting the jurisdictions with integration of the updated, FEMA-approved NHMP into comprehensive plans and other planning and operations processes and documents. The process for this endeavor will be determined with each participating jurisdiction after this updated NHMP is approved.

Table 125 identifies by jurisdiction the types of plans and implementing codes into which natural hazard mitigation goals, objectives, and actions may be integrated.

E. Tools and Assets

Beyond the planning and other processes available for integration, each jurisdiction has a variety of tools and assets available for implementing natural hazards mitigation. Many are the same or similar among the jurisdictions. A few are unique. **Table 126** identifies both.

The Cities of Manzanita, Nehalem, and Wheeler are fortunate to work with the Emergency Volunteer Corps of Nehalem Bay on natural hazards mitigation and preparation activities. The Corps is a highly organized and effective organization that is well-respected far beyond the borders of Oregon. The other cities look to the activities of the Corp and the northern cities for examples of activities they can take on and partnerships they can form to enhance mitigation.

In general, the jurisdictions are small, understaffed, and dealing with difficult financial circumstances. Even so, their long experience with natural disasters elevates their individual and collective commitment to mitigation. Their mitigation strategies ground their visions and aspirations, demonstrating that they will use and leverage their tools and assets as fully as possible to advance mitigation, focusing on improving communication, supporting their first responders, and reducing risk to people, businesses, property, and the environment.

Table 125. Plans and Codes for Potential Integration

	Strategic Plan	Comprehensive Plan	Capital Improvements Plan	Economic Development Plan	Emergency Response Plan	Post-Disaster Recovery Plan	Building Code	Zoning Code	Subdivision Code	Site Plan Review Code	Special Purpose Codes	Post-Disaster Recovery Code	Real Estate Disclosure Requirements	Comments
Tillamook County	X	X	X	X	X	X	X	X	X	X	X	–	X	Neskowin has real estate disclosure requirements.
Bay City	X	X	X	–	X	–	X	X	X	X	X	–	–	Enterprise zone. Continuity of Gov't plan.
Garibaldi	X	X	X	–	X	–	X	X	X	X	X	–	–	
Manzanita	X	X	X	–	X	–	X	X	X	X	X	–	–	Off-season tourism promotion plan. Working on post-disaster recovery plan – more than 5 years out.
Nehalem	X	X	–	–	X	–	X	X	X	X	X	–	–	Working forest funds capital projects. Working on post-disaster recovery plan – more than 5 years out. Only special purpose code is floodplain management.
Rockaway Beach	X	X	X	–	–	–	X	X	X	X	X	–	–	Draft ERP stalled.
Tillamook	X	X	X	–	X	–	X	X	X	X	X	–	–	CIP being updated. TSP to be updated next year.
Wheeler	X	X	X	–	X	–	X	X	X	X	X	–	–	Water/Sewer CIP. Draft TSP. Waterfront development plan. Water Operations Emergency Response Plan.
Port of Tillamook Bay	X	–	X	X	X	–	X	–	–	–	–	–	–	Subject to Tillamook County development codes.
Port of Garibaldi	X	–	X	X	X	–	X	–	–	–	–	–	–	Subject to City of Garibaldi development codes.

Table 126. Tools and Assets Supporting Mitigation

	Land Use Planner or Engineer	Public Works or Construction Engineer	Natural Hazards Planner or Engineer	Floodplain Manager	Surveyor	Vulnerability Assessment Expertise	GIS or Hazus Expertise	Scientists with local Hazards Expertise	Emergency Manager	Grant Writing Expertise	CDBG	CIP Funding	Authority to Levy Taxes	Water, Sewer, Electric, Gas** Fees	Impact Fees	General Obligation Bonds*	Special Tax Bonds*	Private Activity Bonds*	Withhold Spending in Hazard Areas	Comments
Tillamook County	X	X	–	X	X	–	X	–	X	X	X	X	X	–	X	X	X	X	–	Water, sewer, electric provided by utility districts.
Bay City	X	X	X	X	X	X	–	–	–	X	X	X	X	X	–	X	X	X	–	Expertise by contract. Water and sewer SDCs. Electric provided by utility district.
Garibaldi	X	X	X	X	X	X	–	–	X	X	X	X	X	X	–	X	X	X	–	Floodplain Manager on contract. EOP Manager, Mayor, City Manager all have Emergency Manager responsibilities. Capital improvements funded internally and through USDA, Urban Renewal Agency, OR IFA. Occasional access to other grants such as assistance to fire fighters. Water and sewer SDCs. Electric provided by utility district.
Manzanita	X	X	X	X	X	X	–	–	–	X	X	X	X	X	–	X	X	X	–	Engineer and surveyor on contract. Working on securing GIS expertise. There are a number of highly educated people, not necessarily scientists, familiar with Manzanita's hazards. CIP funded by City, USDA, and Oregon State loans. Water fees through a regional sewerage agency. Electric provided by utility district. Stormwater utility fee being considered. Park fees.
Nehalem	X	X	X	X	X	X	X	X	X	X	–	X	X	X	–	X	X	–	–	Expertise obtained through contracts funded with timber receipts. CIP funded with timber receipts. SDCs for water system. Electric provided by utility district. Private activity bonds not used for mitigation.
Rockaway Beach	X	X	X	X	X	X	X	–	–	X	–	X	X	X	X	X	X	X	–	Planner, engineers, surveyor, vulnerability assessment expert, GIS expert all on contract. City wants to hire an Emergency Manager. CIP funded internally and through USDA and ARRA funds. City levies taxes for roads and streets. Water and sewer SDCs. Electric provided by utility district. Impact fees for transportation. City has never used its authority to bond.
Tillamook	X	X	–	X	X	X	–	–	–	–	X	X	X	X	–	X	X	X	–	Contract with County for building inspection. Public Works personnel are not engineers. Surveyor on contract. CIP funded through grants. Water and sewer SDCs. Electric provided by utility district.
Wheeler	X	X	X	X	X	X	–	X	–	X	X	X	X	X	–	X	X	X	–	Most expertise on contract or through the county. Electric provided by utility district. City does not use authority for special tax or private activity bonds.
Port of Tillamook Bay	–	–	–	–	–	–	–	–	–	X	–	X	X	–	–	X	X	X	–	
Port of Garibaldi	–	X	X	–	–	X	X	–	X	X	–	X	X	–	–	X	X	X	–	

*In general, all jurisdictions can incur debt through bonds, but only with voter approval.

**No gas service in Tillamook County.

F. Economic Analysis of Natural Hazard Mitigation Projects

This section is constructed from a paper developed by the Oregon Partnership for Disaster Resilience (n.d.) at the University of Oregon's Community Service Center. The paper has been reviewed and accepted by the Federal Emergency Management Agency as a means of documenting how the prioritization of actions shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.

The paper outlines three approaches for conducting economic analyses of natural hazard mitigation projects. It describes the importance of implementing mitigation activities, different approaches to economic analysis of mitigation strategies, and methods to calculate costs and benefits associated with mitigation strategies. Information in this section is derived in part from: The Interagency Hazards Mitigation Team, *State Hazard Mitigation Plan* (Oregon Military Department – Office of Emergency Management, 2000), and Federal Emergency Management Agency Publication 331, *Report on Costs and Benefits of Natural Hazard Mitigation*. This section is not intended to provide a comprehensive description of benefit/cost analysis, nor is it intended to evaluate local projects. It is intended to (1) raise benefit/cost analysis as an important issue, and (2) provide some background on how economic analysis can be used to evaluate mitigation projects.

Why Evaluate Mitigation Strategies?

Mitigation activities reduce the cost of disasters by minimizing property damage, injuries, and the potential for loss of life, and by reducing emergency response costs, which would otherwise be incurred. Evaluating possible natural hazard mitigation activities provides decision-makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects.

Evaluating mitigation projects is a complex and difficult undertaking, which is influenced by many variables. First, natural disasters affect all segments of the communities they strike, including individuals, businesses, and public services such as fire, police, utilities, and schools. Second, while some of the direct and indirect costs of disaster damages are measurable, some of the costs are non-financial and difficult to quantify in dollars. Third, many of the impacts of such events produce "ripple-effects" throughout the community, greatly increasing the disaster's social and economic consequences.

While not easily accomplished, there is value, from a public policy perspective, in assessing the positive and negative impacts from mitigation activities, and obtaining an instructive benefit/cost comparison. Otherwise, the decision to pursue or not pursue various mitigation options would not be based on an objective understanding of the net benefit or loss associated with these actions.

What are some Economic Analysis Approaches for Evaluating Mitigation Strategies?

The approaches used to identify the costs and benefits associated with natural hazard mitigation strategies, measures, or projects fall into three general categories: benefit/cost analysis, cost-effectiveness analysis and the STAPLE/E approach. The distinction between the three methods is outlined below:

Benefit/Cost Analysis

Benefit/cost analysis is a key mechanism used by the state Oregon Military Department – Office of Emergency Management (OEM), the Federal Emergency Management Agency, and other state and federal agencies in evaluating hazard mitigation projects, and is required by the Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 93-288, as amended.

Benefit/cost analysis is used in natural hazards mitigation to show if the benefits to life and property protected through mitigation efforts exceed the cost of the mitigation activity. Conducting benefit/cost analysis for a mitigation activity can assist communities in determining whether a project is worth undertaking now, in order to avoid disaster-related damages later. Benefit/cost analysis is based on calculating the frequency and severity of a hazard, avoiding future damages, and risk. In benefit/cost analysis, all costs and benefits are evaluated in terms of dollars, and a net benefit/cost ratio is computed to determine whether a project should be implemented. A project must have a benefit/cost ratio greater than 1 (i.e., the net benefits will exceed the net costs) to be eligible for FEMA funding.

Cost-Effectiveness Analysis

Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. This type of analysis, however, does not necessarily measure costs and benefits in terms of dollars. Determining the economic feasibility of mitigating natural hazards can also be organized according to the perspective of those with an economic interest in the outcome. Hence, economic analysis approaches are covered for both public and private sectors as follows.

Investing in Public Sector Mitigation Activities

Evaluating mitigation strategies in the public sector is complicated because it involves estimating all of the economic benefits and costs regardless of who realizes them, and potentially to a large number of people and economic entities. Some benefits cannot be evaluated monetarily, but still affect the public in profound ways. Economists have developed methods to evaluate the economic feasibility of public decisions that involve a diverse set of beneficiaries and non-market benefits.

Investing in Private Sector Mitigation Activities

Private sector mitigation projects may occur on the basis of one or two approaches: it may be mandated by a regulation or standard, or it may be economically justified on its own merits. A building or landowner, whether a private entity or a public agency, required to conform to a mandated standard may consider the following options:

1. Request cost sharing from public agencies;
2. Dispose of the building or land either by sale or demolition;
3. Change the designated use of the building or land and change the hazard mitigation compliance requirement; or
4. Evaluate the most feasible alternatives and initiate the most cost effective hazard mitigation alternative.

The sale of a building or land triggers another set of concerns. For example, real estate disclosure laws can be developed which require sellers of real property to disclose known defects and deficiencies in the property, including earthquake weaknesses and hazards to prospective purchases. Correcting deficiencies can be expensive and time consuming, but their existence can prevent the sale of the building. Conditions of a sale regarding the deficiencies and the price of the building can be negotiated between a buyer and seller.

STAPLE/E Approach

Considering detailed benefit/cost or cost-effectiveness analysis for every possible mitigation activity could be very time consuming and may not be practical. There are some alternate approaches for conducting a quick evaluation of the proposed mitigation activities that could be used to identify those mitigation activities that merit more detailed assessment. One of those methods is the STAPLE/E approach.

Using STAPLE/E criteria, mitigation activities can be evaluated quickly by steering committees in a synthetic fashion. This set of criteria requires the committee to assess the mitigation activities based on the Social, Technical, Administrative, Political, Legal, Economic, and Environmental (STAPLE/E) constraints and opportunities of implementing the particular mitigation item in your community. The second chapter in FEMA's How-To Guide "Developing the Mitigation Plan — Identifying Mitigation Actions and Implementation Strategies" as well as the "State of Oregon's Local Natural Hazard Mitigation Plan: An Evaluation Process" outline some specific considerations in analyzing each aspect. The following are suggestions for how to examine each aspect of the STAPLE/E approach from the "State of Oregon's Local Natural Hazard Mitigation Plan: An Evaluation Process."

Social

Community development staff, local non-profit organizations, or a local planning board can help answer these questions.

- Is the proposed action socially acceptable to the community?
- Are there equity issues involved that would mean that one segment of the community is treated unfairly?
- Will the action cause social disruption?

Technical

The city or county public works staff, and building department staff can help answer these questions.

- Will the proposed action work?
- Will it create more problems than it solves?
- Does it solve a problem or only a symptom?
- Is it the most useful action in light of other community goals?

Administrative

Elected officials or the city or county administrator, can help answer these questions.

- Can the community implement the action?
- Is there someone to coordinate and lead the effort?
- Is there sufficient funding, staff, and technical support available?
- Are there ongoing administrative requirements that need to be met?

Political

Consult the mayor, city council or city board of commissioners, city or county administrator, and local planning commissions to help answer these questions.

- Is the action politically acceptable?
- Is there public support both to implement and to maintain the project?

Legal

Include legal counsel, land use planners, risk managers, and city council or county planning commission members, among others, in this discussion.

- Is the community authorized to implement the proposed action? Is there a clear legal basis or precedent for this activity?
- Are there legal side effects? Could the activity be construed as a taking?
- Is the proposed action allowed by the comprehensive plan, or must the comprehensive plan be amended to allow the proposed action?
- Will the community be liable for action or lack of action?
- Will the activity be challenged?

Economic

Community economic development staff, civil engineers, building department staff, and the assessor's office can help answer these questions.

- What are the costs and benefits of this action?
- Do the benefits exceed the costs?
- Are initial, maintenance, and administrative costs taken into account?
- Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private?)
- How will this action affect the fiscal capability of the community?
- What burden will this action place on the tax base or local economy?
- What are the budget and revenue effects of this activity?
- Does the action contribute to other community goals, such as capital improvements or economic development?
- What benefits will the action provide? (This can include dollar amount of damages prevented, number of homes protected, credit under the CRS, potential for funding under the HMGP or the FMA program, etc.)

Environmental

Watershed councils, environmental groups, land use planners and natural resource managers can help answer these questions.

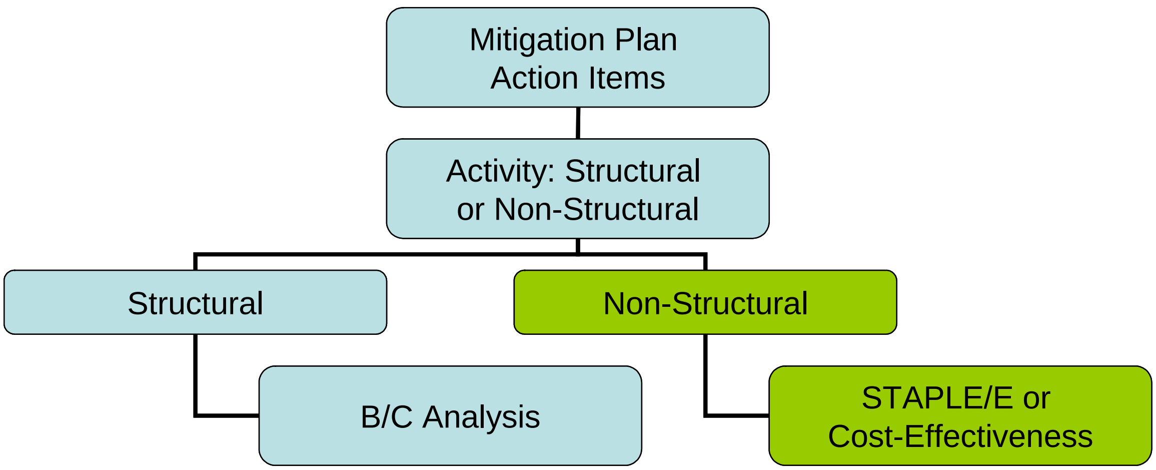
- How will the action impact the environment?
- Will the action need environmental regulatory approvals?
- Will it meet local and state regulatory requirements?
- Are endangered or threatened species likely to be affected?

The STAPLE/E approach is helpful for doing a quick analysis of mitigation projects. Most projects that seek federal funding and others often require more detailed benefit/cost analyses.

When to use the Various Approaches

It is important to realize that various funding sources require different types of economic analyses. The following figure is to serve as a guideline for when to use the various approaches.

Figure 127. Economic Analysis Flowchart



Source: Oregon Partnership for Disaster Resilience (2005)

Implementing the Approaches

Benefit/cost analysis, cost-effectiveness analysis, and the STAPLE/E are important tools in evaluating whether or not to implement a mitigation activity. A framework for evaluating mitigation activities is outlined below. This framework should be used in further analyzing the feasibility of prioritized mitigation activities.

1. Identify the Activities

Activities for reducing risk from natural hazards can include structural projects to enhance disaster resistance, education and outreach, and acquisition or demolition of exposed properties, among others. Different mitigation projects can assist in minimizing risk to natural hazards, but do so at varying economic costs.

2. Calculate the Costs and Benefits

Choosing economic criteria is essential to systematically calculating costs and benefits of mitigation projects and selecting the most appropriate activities. Potential economic criteria to evaluate alternatives include:

Determine the project cost

This may include initial project development costs, and repair and operating costs of maintaining projects over time.

Estimate the benefits

Projecting the benefits, or cash flow resulting from a project can be difficult. Expected future returns from the mitigation effort depend on the correct specification of the risk and the effectiveness of the project, which may not be well known. Expected future costs depend on the physical durability and potential economic obsolescence of the investment. This is difficult to project. These considerations will also provide guidance in selecting an appropriate salvage value. Future tax structures and rates must be projected. Financing alternatives must be researched, and they may include retained earnings, bond and stock issues, and commercial loans.

Consider costs and benefits to society and the environment

These are not easily measured, but can be assessed through a variety of economic tools including existence value or contingent value theories. These theories provide quantitative data on the value people attribute to physical or social environments. Even without hard data, however, impacts of structural projects to the physical environment or to society should be considered when implementing mitigation projects.

Determine the correct discount rate

Determination of the discount rate can just be the risk-free cost of capital, but it may include the decision maker's time preference and also a risk premium. Including inflation should also be considered.

3. Analyze and Rank the Activities

Once costs and benefits have been quantified, economic analysis tools can rank the possible mitigation activities. Two methods for determining the best activities given varying costs and benefits include net present value and internal rate of return.

Net present value.

Net present value is the value of the expected future returns of an investment minus the value of the expected future cost expressed in today's dollars. If the net present value is greater than the projected costs, the project may be determined feasible for implementation. Selecting the discount rate, and identifying the present and future costs and benefits of the project calculates the net present value of projects.

Internal rate of return.

Using the internal rate of return method to evaluate mitigation projects provides the interest rate equivalent to the dollar returns expected from the project. Once the rate has been calculated, it can be compared to rates earned by investing in alternative projects. Projects may be feasible to implement when the internal rate of return is greater than the total costs of the project. Once the mitigation projects are ranked on the basis of economic criteria, decision-makers can consider other factors, such as risk, project effectiveness, and economic, environmental, and social returns in choosing the appropriate project for implementation.

Economic Returns of Natural Hazard Mitigation

The estimation of economic returns, which accrue to building or land owners as a result of natural hazard mitigation, is difficult. Owners evaluating the economic feasibility of mitigation should consider reductions in physical damages and financial losses. A partial list follows:

- Building damages avoided
- Content damages avoided
- Inventory damages avoided
- Rental income losses avoided
- Relocation and disruption expenses avoided
- Proprietor's income losses avoided

These parameters can be estimated using observed prices, costs, and engineering data. The difficult part is to correctly determine the effectiveness of the hazard mitigation project and the resulting reduction in damages and losses. Equally as difficult is assessing the probability that an event will occur. The damages and losses should only include those that will be borne by the owner. The salvage value of the investment can be important in determining economic feasibility. Salvage value becomes more important as the time horizon of the owner declines. This is important because most businesses depreciate assets over a period of time.

Additional Costs from Natural Hazards

Property owners should also assess changes in a broader set of factors that can change as a result of a large natural disaster. These are usually termed "indirect" effects, but they can have a very direct effect on the economic value of the owner's building or land. They can be positive or negative, and include changes in the following:

- Commodity and resource prices
- Availability of resource supplies
- Commodity and resource demand changes
- Building and land values
- Capital availability and interest rates
- Availability of labor
- Economic structure
- Infrastructure
- Regional exports and imports
- Local, state, and national regulations and policies
- Insurance availability and rates

Changes in the resources and industries listed above are more difficult to estimate and require models that are structured to estimate total economic impacts. Total economic impacts are the sum of direct and indirect economic impacts. Total economic impact models are usually not combined with economic feasibility models. Many models exist to estimate total economic impacts of changes in an economy. Decision makers should understand the total economic impacts of natural disasters in order to calculate the benefits of a mitigation activity. This suggests that understanding the local economy is an important first step in being able to understand the potential impacts of a disaster, and the benefits of mitigation activities.

Additional Considerations

Conducting an economic analysis for potential mitigation activities can assist decision-makers in choosing the most appropriate strategy for their community to reduce risk and prevent loss from natural hazards. Economic analysis can also save time and resources from being spent on inappropriate or unfeasible projects. Several resources and models are listed on the following page that can assist in conducting an economic analysis for natural hazard mitigation activities.

Benefit/cost analysis is complicated, and the numbers may divert attention from other important issues. It is important to consider the qualitative factors of a project associated with mitigation that cannot be evaluated economically. There are alternative approaches to implementing mitigation projects. With this in mind, opportunity rises to develop strategies that integrate natural hazard mitigation with projects related to watersheds, environmental planning, community economic development, and small business development, among others. Incorporating natural hazard mitigation with other community projects can increase the viability of project implementation.

Resources

CUREe Kajima Project, *Methodologies for Evaluating the Socio-Economic Consequences of Large Earthquakes*, Task 7.2 Economic Impact Analysis, Prepared by University of California, Berkeley Team, Robert A. Olson, VSP Associates, Team Leader; John M. Eidinger, G&E Engineering Systems; Kenneth A. Goettel, Goettel and Associates, Inc.; and Gerald L. Horner, Hazard Mitigation Economics Inc., 1997

Federal Emergency Management Agency, *Benefit/Cost Analysis of Hazard Mitigation Projects*, Riverine Flood, Version 1.05, Hazard Mitigation Economics, Inc., 1996

Federal Emergency Management Agency, *Report on the Costs and Benefits of Natural Hazard Mitigation*. Publication 331, 1996.

Goettel & Horner Inc., *Earthquake Risk Analysis Volume III: The Economic Feasibility of Seismic Rehabilitation of Buildings in the City of Portland*, Submitted to the Bureau of Buildings, City of Portland, August 30, 1995.

Goettel & Horner Inc., *Benefit/Cost Analysis of Hazard Mitigation Projects* Volume V, Earthquakes, Prepared for FEMA's Hazard Mitigation Branch, Ocbober 25, 1995.

Horner, Gerald, *Benefit/Cost Methodologies for Use in Evaluating the Cost Effectiveness of Proposed Hazard Mitigation Measures*, Robert Olsen Associates, Prepared for Oregon Military Department – Office of Emergency Management, July 1999.

Interagency Hazards Mitigation Team, *State Hazard Mitigation Plan*, (Oregon State Police – Office of Emergency Management, 2000.)

Risk Management Solutions, Inc., *Development of a Standardized Earthquake Loss Estimation Methodology*, National Institute of Building Sciences, Volume I and II, 1994.

VSP Associates, Inc., *A Benefit/Cost Model for the Seismic Rehabilitation of Buildings*, Volumes 1 & 2, Federal Emergency management Agency, FEMA Publication Numbers 227 and 228, 1991.

VSP Associates, Inc., *Benefit/Cost Analysis of Hazard Mitigation Projects*: Section 404 Hazard Mitigation Program and Section 406 Public Assistance Program, Volume 3: Seismic Hazard Mitigation Projects, 1993.

VSP Associates, Inc., *Seismic Rehabilitation of Federal Buildings: A Benefit/Cost Model*, Volume 1, Federal Emergency Management Agency, FEMA Publication Number 255, 1994.

IV. PLANNING PROCESS

A. Introduction

Tillamook County and its seven cities were included, along with several other jurisdictions, in a Pre-Disaster Mitigation (PDM) grant application DLCD made to FEMA in 2014 to update the Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan. After a significant delay, DLCD received grant approval and funding from FEMA. That was followed by another delay to obtain permission from Oregon's legislature for accepting the grant. Because of these delays, DLCD requested and received from FEMA a one-year extension of the grant performance period to September 30, 2017. Also due to changing circumstances during the long delays and FEMA grant requirements, DLCD and the County determined that the most efficacious path forward was for DLCD to use the grant funding to lead the plan update, assisting the County and its cities as would a consultant. The County and cities provided in-kind services as part of the required cost-share.

During the long delays, DLCD learned that special districts are also required to have NHMPs in order to be eligible for certain pre- and post-disaster mitigation funding from FEMA. DLCD reached out to the three ports in Tillamook County and invited them to join the plan update. The Port of Tillamook Bay joined. The Ports of Garibaldi and Nehalem did not. However, both the City of Garibaldi and the Port of Garibaldi believed that because the Port is located within the City of Garibaldi and because the City and Port collaborate very closely on many issues including natural hazards mitigation and emergency management, the City's participation covered the Port. Upon learning that belief was erroneous, the Port of Garibaldi immediately requested to join the effort and has been an active participant since. The full list of participating jurisdictions is:

1. Tillamook County
2. City of Bay City
3. City of Garibaldi
4. City of Manzanita
5. City of Nehalem
6. City of Rockaway Beach
7. City of Tillamook
8. City of Wheeler
9. Port of Tillamook Bay
10. Port of Garibaldi

DLCD and ODF discussed updating and integrating Tillamook County's 2006 Community Wildfire Protection Plan (CWPP) into the updated NHMP. The CWPP update process did get underway, but soon was thwarted by circumstance and tabled. Information from the 2006 CWPP and its Wildland Urban Interface Map are referenced and incorporated into this Plan's Wildfire Hazard chapter.

Fortuitously, the Oregon Department of Geology and Mineral Industries (DOGAMI) and the University of Oregon Community Service Center (UOCSC) also were recipients of FEMA grants to generate products for Tillamook County and its cities, and the timing was such that all three projects could be coordinated for the benefit of the communities.

UOCSC was conducting a review of the Tillamook County Development Code, focusing on supplementing and strengthening code associated with natural hazard mitigation. The task included reviewing a range of regulatory and non-regulatory standards that could be used by Tillamook County to mitigate the risk of natural hazards impacting the County. This information was reviewed for potential mitigation actions.

DOGAMI was producing a multi-hazard risk report with two goals: (1) provide a quantitative risk assessment that informs communities of their risks related to certain natural hazards; and (2) interpret the results to identify specific mitigation opportunities (i.e. areas of mitigation interest) upon which the communities may act. This report contains information and analysis providing the vulnerability and risk assessment (exposure, and where possible loss estimation) for coastal erosion, earthquakes, flooding, landslides, tsunamis, and wildfires. Mitigation actions suggested by the report's findings are also offered. They were considered by the communities in developing mitigation actions.

In addition, this update process was able to be coordinated with a FEMA Risk MAP process wrapping up new flood mapping. The new preliminary flood maps were used in DOGAMI's analysis and the NHMP. The Risk MAP program's Resilience Meeting took on a new complexion beginning with this project. Because the new preliminary flood maps were being issued as the communities were finishing up development of their mitigation actions, FEMA was able to use the Resilience Meeting as a springboard for the implementation phase of the Risk MAP program — the initiation of a long-term relationship between FEMA and the communities to advance implementation of the new flood mapping, the findings of the Multi-Hazard Risk Report, and the NHMP. Productive dialogue about the communities' concerns, mitigation priorities, and resource needs matched with FEMA's ability to provide resources to support mitigation actions set the stage for continued future engagement. Further, DLCD has committed to assisting the communities with integrating the NHMP into their comprehensive plans and other planning mechanisms after the updated NHMP receives FEMA approval.

The degree of coordination that was able to be achieved for the benefit of Tillamook County, its cities, and the two ports was impressive. The success of this experiment on all fronts — administrative, fiscal, and organizational — is being leveraged for the next round of FEMA grant funding for mitigation planning efforts. We expect that it will lead to more efficient and effective projects statewide, far into the future.

Plan Format and Content Changes

The first Tillamook County Multi-Jurisdictional NHMP was approved by FEMA in 2006. The update, approved in 2012, was a laser-focused review and update. With that approach having been taken and 10 years having passed since the first plan was completed, it was necessary to modernize the plan. Therefore, the entire plan was rewritten with new content and formatting. There are only a few pieces of information that remain from the previous update. This updated Plan addresses the hazards, mitigation strategy, and planning process more clearly.

The Steering Committee also determined that the plan would be stronger, better serving not only the individual jurisdictions but also the entire county, if it were integrated as much as possible, rather than being formatted as a very repetitive compilation of individual annexes to the County Plan. That approach has been taken, and where necessary, each jurisdiction has been addressed individually.

B. Planning Process and Participation

During the long delays, DLCD began project planning. A Memorandum of Agreement with a Scope of Work was developed and signed by the original eight participating jurisdictions. Later the MOA was amended to include the Ports. Because there was no funding flowing between DLCD and the jurisdictions, the purpose of the MOA was to set expectations and establish responsibilities. Steering Committee members and technical advisors were identified, contacted, and invited to participate.

The Steering Committee comprises a member and at least one alternate from each jurisdiction. People with authority for land use policymaking such as County Commissioners and Mayors, City Managers, and Planning Directors were targeted for membership. In some cases, the primary member delegated responsibility to a particular staff member or two. Technical advisors were identified using FEMA's six "whole community" sectors. Representatives of each sector were identified for each community. They were contacted individually, advised of the project, and invited to participate.

Table 127. Steering Committee Members and Alternates by Community

Community	Member/Alternate	Title
Tillamook County	**Bill Baertlein, Chair**	**County Commissioner**
Tillamook County	Sarah Absher	Community Development Planner
Bay City	**Shaena Peterson**	**Mayor**
Bay City	Lin Downey	City Recorder
Bay City	Angie Cherry	City Planning Secretary
Garibaldi	**Terry Kandle**	**City Emergency Preparedness Manager**
Garibaldi	John O'Leary	City Manager
Manzanita	**Linda Kozlowski**	**City Council Member**
Manzanita	Jerry Taylor	City Manager
Manzanita	Cynthia Alamillo	Assistant City Manager
Nehalem	**Jim Welch**	**City Council Member**
Nehalem	Dale Shafer	City Manager & City Recorder
Rockaway Beach	**Joanne Aagaard**	**Mayor**
Rockaway Beach	Lars Gare	City Manager
Rockaway Beach	Terri Michel	City Recorder
Tillamook City	**Suzanne Weber**	**Mayor**
Tillamook City	Paul Wyntergreen	City Manager
Wheeler	**Stevie Burden**	**Mayor**
Wheeler	Geoff Wullschlager	City Manager
Port of Tillamook Bay	**Michele Bradley**	**General Manager**
Port of Tillamook Bay	Aaron Palter	Project Coordinator
Port of Garibaldi	**Michael Saindon**	**General Manager**

Note: Steering Committee Members are indicated by boldface type.

Table 128. Technical Advisors by "Whole Community" Sector and Jurisdiction

Sector/Jurisdiction	Name	Title
Emergency Management		
Tillamook County	Gordon McCraw	Emergency Management Director
Tillamook County Sheriff's Office	Andy Long	Sheriff
Tillamook 911	Doug Kettner	Administrator
Emergency Volunteer Corps of Nehalem Bay	Linda Kozlowski	President
Manzanita Police	Erik Harth	Chief of Police
Rockaway Beach Police	Charlie Stewart	Chief of Police
CERT Representative	William Harshbarger	CERT Point of Contact
Tillamook Police	Terry Wright	Chief of Police
Bay City Fire	Daryl Griffith	Fire Chief
Garibaldi Fire	Jay Marugg	Fire Chief
Nehalem Bay Fire	Perry Sherbaugh	Fire Chief
Nestucca Fire	Kris Weiland	Fire Chief
Rockaway Beach Fire	Barry Mammano	Fire Chief
Tillamook County Fire	Rick Adams	Fire Chief

Sector/Jurisdiction	Name	Title
Economic Development		
Tillamook County Economic Development District	Mike Cohen	Director, Economic and Small Business Dev.
Port of Garibaldi	Mike Sainden	Manager
Port of Nehalem	Jim Peters	Commissioner
Port of Nehalem	Terry Fullan	Commissioner
Port of Tillamook Bay	Michelle Bradley	Manager
Tillamook Coast	Nan Devlin	Tourism Director
Tillamook Area Chamber of Commerce	Justin Aufdermauer	Executive Director
Pacific City–Nestucca Valley Chamber of Commerce		Manager
Land Use and Development		
Garibaldi	John O'Leary	City Manager
Bay City	Lin Downey	City Recorder
Bay City	Sabrina Pearson	City Planner
Manzanita	Jerry Taylor	City Manager
Nehalem	Dale Shafer	City Manager/Recorder
Tillamook County	Sarah Absher	Community Development Planner
Tillamook	Paul Wyntergreen	City Manager
Tillamook	David Mattison	City Planner
Rockaway Beach	Terri Michel	City Recorder
Rockaway Beach	Lars Gare	City Manager
Rockaway Beach	John Fregonese	President, Fregonese Associates
Wheeler	Geoff Wullschlager	City Manager
CAC - Barview-Watseco-Twin Rocks	Gary Albright	Chair
CAC - Cloverdale (Inactive)	Steve Dotson	Chair
CAC - Oceanside Neighborhood Association	Jud Randall	Chair
CAC - Neskowin	Richard Hook	Chair
CAC - Netarts	Jim Carlson	Chair
CAC - Pacific City–Woods	Sean Carlton	Chair Elect
Tillamook County Futures Council	David Yamamoto	Chair
Housing		
Neah Casa Community Housing Trust	Linda Kozlowski	Board Member
Northwest Oregon Housing Authority	Todd Johnston	Executive Director
Heath and Social Services		
Tillamook County Health Department	Marlene Putman	Director
Tillamook School District #9	Randy Schild	Superintendent
Neah-Kah-Nie School District	Paul Erlebach	Superintendent
Nestucca School District	David Phelps	Superintendent
Adventist Health	David Butler	CEO
CARTM	Karen Reddick-Yurka	Executive Director
Community Action Resource Enterprises (CARE)	Erin Skaar	Executive Director

Sector/Jurisdiction	Name	Title
Infrastructure		
Tillamook County Road Department	Liane Welch	County Road Department Director
Tillamook County Solid Waste	David McCall	Solid Waste Director
Tillamook County Building	Mark Brien	Building Official
Bay City Public Works	Brian Bettis	Public Works Director
Garibaldi Public Works	Blake Lettenmaier	City Engineer
Garibaldi	Martin McCormick	Systems Operator
Manzanita Public Works	Dan Weitzel	Public Works Director
Nehalem Public Works	Donald D. Davidson	Superintendent
Rockaway Public Works	Luke Shepard	Public Works Director
Wheeler Public Works	Joe Velkinburg	Public Works Director
Tillamook Public Works	Timothy Lyda	Public Works Director
Tillamook Public Utility District	Ray Sieler	Manager
Nehalem Bay Wastewater Agency	Bruce Halverson	Manager
Neahkahnie Water District	Richard Felley	General Manager
Pacific City Joint Water-Sanitary Authority	Tony Owen	Authority Manager
Neskowin Regional Water District	Troy Trute	General Manager
Natural and Cultural Resources		
Tillamook County Pioneer Museum	Gary Albright	Director
Nehalem Valley Historical Society	Tom Mock	
Tillamook Estuary Partnership	Lisa Phipps	Executive Director
Tillamook County Creamery Association	Mark Wustenberg	
Confederated Tribes of Grand Ronde	Reyn Leno	Tribal Council Chair
Confederated Tribes of Siletz Indians	Delores Pigsley	Tribal Chairman
Clatsop-Nehalem Confederated Tribes	Roberta Basch	
Clatsop-Nehalem Confederated Tribes	Diane Collier	Tribal Council Chairman
Oregon Department of Forestry	Kate Skinner	District Forester
Tillamook Bay Flood Improvement District	Tilda Jones	Staff

DLCD attended two early-interest meetings and presented an introduction to the project at each meeting. The first, held April 6, 2016, was a joint meeting of Tillamook County Commissioners and Planning Commissioners. Its dual purposes were to (a) present and discuss OPDR's Code Review Project; and (b) present and discuss the Risk MAP and Mitigation Plan Update projects and how all three projects related to one another. The second, held April 20, 2016, was a regular quarterly "Mayors Meeting" of the Mayors of Tillamook County cities. DLCD again presented an introduction to the mitigation plan update and discussed its relationship to the Risk MAP and Code Review Projects.

Work began in earnest with a Steering Committee meeting held June 6, 2016 to introduce and organize the project, and unfolded from there:

Table 129. Planning Process

Date(s)	Activity	Purpose
April 6, 2016	Joint Meeting of Tillamook County Board of Commissioners and Planning Commission	Present and discuss OPDR's Code Review Project, Risk MAP Multi-Hazard Risk Report project, NHMP update project, their relationships to one another and how they would be integrated, and how they would benefit, separately and together, the County and its cities.
April 20, 2016	Quarterly Mayors Meeting	Present and discuss the NHMP update project and its relationship to the Risk MAP and Code Review projects.
June 6, 2016	Steering Committee Meeting	NHMP Update Project Initiation Meeting: Project overview, MOA, Plan content; Scope of Work and Project Schedule; Integration of NHMP with other planning documents
September 23, 2016	Steering Committee Meeting	Plan structure and content; Multi-Hazard Risk Report; Community Hazard Risk Analysis
December 15, 2016	Steering Committee Meeting	Public Involvement; Post-Disaster Funding (FEMA & SHMO); Project Schedule; Multi-Hazard Risk Report
January 31, 2017	Steering Committee Meeting	Follow-up on Post-Disaster Funding; Resilience Meeting; Project Schedule; Draft Risk Assessment; Mitigation Goals
February 27 – March 3, 2017	Individual Jurisdiction Meetings with DLCD	Review goals, mitigation action status; Identify and prioritize mitigation actions for updated plan; Identify opportunities for integration; identify tools and assets; develop plan maintenance system including opportunity for public involvement
March 1 – 15, 2017	Public Comment Period	Review Draft Risk Assessment Chapter
March 7, 2017	Steering Committee Meeting	Review results of individual jurisdiction meetings; decide on multi-jurisdictional goals and mitigation actions; decide on multi-jurisdictional system for plan maintenance including opportunity for public involvement
April 4, 2017	Resilience Meeting	Share local mitigation concerns and resource needs; learn what FEMA can offer to assist with advancing mitigation actions; develop relationship between community leaders and FEMA for long-term collaboration on advancing hazard mitigation in Tillamook County
May 8 – 26, 2017	Public Comment Period	Review updated Draft Risk Assessment Chapter and Mitigation Strategy Chapter
May 16 – 18, 2017	Public Open Houses	Review updated Draft Risk Assessment Chapter and Mitigation Strategy Chapter
Late May 2017	OEM Review	Initial review to ensure Plan meets minimum requirements for approval
Mid-June 2017	FEMA Review/APA	Formal review resulting in "Approvable Pending Adoption" letter
August 2017	Local Adoption	Local governments adopt plan demonstrating commitment to natural hazards mitigation.
September 2017	FEMA Approval	FEMA approval affirms the local governments' commitment to and plans for advancing natural hazards mitigation and confers eligibility for certain mitigation planning and project funding programs

Each of the original eight jurisdictions was present at the June 6, 2016 project initiation meeting. The Port of Tillamook Bay began attending at the first opportunity after it was invited with the September 23, 2016 meeting. Each jurisdiction strived to have at least one representative at each meeting; occasionally that was not possible and the representative caught up after the meeting. The December 15, 2016 meeting was especially challenging due to winter weather conditions, yet all jurisdictions but Rockaway Beach were ultimately able to have a representative there. The meeting time was changed to avoid rush hour and the iciest conditions, allowing more representatives to attend. Notably, DLCD and DOGAMI were unable to attend in person, so the meeting location was also changed to facilitate their remote participation. All the jurisdictions were represented at the January 31, 2017 Steering Committee meeting.

The June meeting was dedicated to initiation of the project: understanding the project scope, timelines, and Plan content; reviewing the MOA to facilitate agreement and approval as well as to establish expectations and responsibilities; and discuss integration of the approved plan with other planning documents.

The September meeting was focused on two items: DOGAMI's presentation of the Draft Multi-Hazard Risk Report that would form the basis of most of the Risk Assessment, and performing local Hazard Vulnerability Assessments.

December's meeting agenda also had multiple items of significance. The State Hazard Mitigation Officer, Angie Lane, and representatives of FEMA Region X were present to discuss post-disaster funding in general and in light of the fact that the current Plan would expire in April 2017, which was a source of concern for the jurisdictions. FEMA representatives also asked how FEMA could support the jurisdictions in advancing natural hazard mitigation. Lively conversation sparked a number of ideas. Tillamook County introduced its NHMP update web page to which the other jurisdictions would drive their web traffic. And DOGAMI presented the revised and now Final Draft Multi-Hazard Risk Report on which most of the Plan's Risk Assessment would be based.

In January, the meeting again presented a number of substantive discussion items: FEMA's responses to the jurisdictions requests for support; review of the first Draft Risk Assessment that would be published for public review and comment on February 10; mitigation goals; and planning for the Resilience Meeting. The Resilience Meeting is an integral element of the Risk MAP process, and for the first time we would have the chance to leverage that meeting to serve both Risk MAP and NHMP process purposes. We reviewed agendas and other documents from previous Resilience Meetings in other jurisdictions; discussed options for the goals and character of the meeting; and identified the best (in fact, it turned out to be the only) date that would work for all the jurisdictions.

To proceed with the Resilience Meeting as re-imagined, it was necessary for the jurisdictions to have identified mitigation goals and actions in advance of the meeting. To that end, and for the purposes of the NHMP update schedule, DLCD planned and carried out a week of consecutive meetings, one with each jurisdiction (except the Port of Tillamook Bay and Tillamook County met together at their request), to develop elements of the mitigation strategy. DLCD requested that the jurisdictions cast a wide net, inviting anyone who they thought should be included in the conversation. The attendees generally included City Managers, Mayors, City Council Members or County Commissioners, Planners, Emergency Managers, Fire or Police Chiefs, and Public Works personnel. Some jurisdictions have all those positions and some do not. In some jurisdictions one person may perform multiple functions. The Cities of Tillamook, Wheeler, and Tillamook County cast wider nets. A representative of the local Chamber of Commerce attended the City of Tillamook's meeting. A number of Planning Commissioners and interested citizens attended the City of Wheeler's meeting. Representatives of the Pacific City Joint Water-Sanitary Authority, Oregon Department of Forestry, Neskowin CAC, and the Tillamook County Creamery Association attended the joint Tillamook County/Port of Tillamook Bay meeting. (Sign-in sheets are in the Appendix.) Each meeting lasted three hours during which the jurisdictions reviewed the current NHMP goals and mitigation actions; identified and prioritized mitigation actions (old, modified, or new) for the updated Plan; discussed the tools and assets they possessed for implementing the actions; discussed opportunities for integrating the updated Plan with other planning documents; and discussed how they would maintain the Plan over its five-year life, both internally and cooperatively countywide.

During that week, two more drafts of the Risk Assessment were released for public review and comment. The first, on March first, accidentally omitted some maps. That was rectified and the draft was re-released on March third.

The next week, the same people who were invited to the individual jurisdiction meetings the week before were invited to a multi-jurisdictional meeting held on March 7th to review the work of their colleagues; decide on multi-jurisdictional goals for the updated Plan; determine whether to include multi-jurisdictional mitigation actions; and decide on a multi-jurisdictional system for plan maintenance. All the jurisdictions were represented at the meeting. This was also the first meeting in which the Port of Garibaldi participated separately from the City of Garibaldi. The Port of Garibaldi met separately with DLCD in late March to get caught up.

The information from the individual and multi-jurisdictional meetings was compiled and the mitigation actions provided to FEMA Region X for use in the Resilience Meeting. While highlighted, the discussion of mitigation actions during the meeting was limited and no changes were made based on this meeting. DLCD also provided all the NHMP update contacts (Steering Committee, Technical Advisors, individual meeting invitees, and other interested parties) to FEMA Region X to ensure they were all invited to participate in the Resilience Meeting. The Resilience Meeting was held on April 4, 2017 and was successful. All the jurisdictions except Rockaway Beach attended. The jurisdictions were able to meet FEMA personnel and discuss face-to-face their jurisdictions' natural hazards, geographies, capabilities, constraints, concerns, desires, and opportunities. FEMA personnel were able to meet the people they would be working with over time to implement the Risk MAP program and natural hazards mitigation and learn more about how they could support the jurisdictions in those endeavors. FEMA provided literature for the taking on a wide range of hazards and mitigation topics. The meeting provided a positive beginning for what all hope will be a productive long-term relationship.

On May 8, 2017, a third draft of the Risk Assessment and first draft of the Mitigation Strategy were released for public review and comment. The following week, a series of three open houses was held — one in the north, one in the south, and one located centrally — to showcase the draft and solicit comments. The long, three-week comment period and open houses were advertised by all the jurisdictions through their websites and in a local paper. The northern open house drew the most interest and comments.

C. Public Outreach

The jurisdictions discussed and committed to various forms of outreach early on in the project, including deciding that Tillamook County would provide the main web presence for the project and each community would drive web traffic to Tillamook County's website. However, uptake was slow and web presence was not fully operational until early December 2016. Once up and running, however, it drew public interest. Hits spiked with release of the first Risk Assessment draft in February 2017 and again with the Resilience Meeting in April, then stayed high with release of the Draft Risk Assessment and Mitigation Strategy in May.

Table 130. Public Interest as Gauged by Website Hits

Public Interest	
Month	**Hits**
January	148
February	225
March	174
April	281
May	248

The County posted the Draft Risk Assessment and notice of the comment period on its website in February 2017. Each jurisdiction posted a notice and drove web traffic to the County's website. In addition, notices were posted in each city hall, public libraries, and one of the local newspapers. No comments were received.

The February/March 2017 individual jurisdiction meetings were an opportunity for DLCD to spend time with each jurisdiction focusing on their specific situations and concerns, mitigation goals and actions, programs, codes, tools, and assets, as well as a method for maintaining the plan. Steering Committee members were asked to invite any and all people they thought should be involved in the discussion in their jurisdictions. Most jurisdictions invited planning, public works, law enforcement, and emergency management staff. Some jurisdictions also invited City Council members, Planning Commissioners, and other interested parties.

All those invited to participate in the individual jurisdiction meetings were also invited to participate in the Steering Committee meeting on March 7. This meeting was also open to the public, and some interested parties attended. At this meeting, the jurisdictions discussed their thoughts on goals and mitigation actions, and decided on a plan maintenance strategy with public involvement.

Again, all those invited to participate in the individual jurisdiction meetings and the March 7th multi-jurisdictional meeting as well as all the Technical Advisors were invited to attend the Resilience Meeting where FEMA and the communities laid the groundwork for a long and successful collaboration to reduce risk from natural hazards in Tillamook County. FEMA was responsible for the public outreach for the Resilience Meeting. DLCD provided contact information for all the local NHMP-related invitees.

An updated version of the Risk Assessment and a new draft of the Mitigation Strategy were issued for public review on May 8, 2017. Again, the document and notice of the extensive comment period (three weeks) was posted on Tillamook County's website and each jurisdiction drove its web traffic to that website. Notice of the review period was combined with notice of the upcoming open houses. Notice of the open houses was also published in one of the local newspapers. Email notices of the comment period and invitations to the public open houses were sent directly to Planning Directors or Managers and Emergency Managers in each of the neighboring counties: Clatsop, Columbia, Washington, Yamhill, Polk, and Lincoln. The same information was emailed to everyone who was invited to the Resilience Meeting, approximately 124 people. The open houses were held in three different parts of the County: Nehalem in the north; Tillamook Bay Community College centrally; and Pacific City in the south. The meeting in Nehalem was better attended than the others. Comments from four citizens were generated.

Table 131. Comments and Responses

#	Commenter	Comment	Response
1	Tom Bender Neahkahnie, OR	What is actual earthquake hazard being considered - what does "M 9.0" mean? Is that the same as R-9? XXL quake is R-9.5, with FIVE TIMES the lateral movement of R9.0. Triple confusion with other two ratings having MM wording!	The earthquake being considered is a Cascadia Subduction Zone (CSZ) event with a "moment magnitude" (M or Mw) of 9.0. The moment magnitude is more accurate for large earthquakes than the Richter scale, which is often used for earthquakes that are up to a magnitude 6.5. Magnitude measures the energy released by an earthquake. Most people feel nearby earthquakes of M3.0 or greater. Shaking intensity is measured by the Modified Mercalli (MM) scale. It is based on observation and therefore subjective. Rather than an earthquake measurement, XXL (extra, extra large) is one of five sizes that express the extent of tsunami inundation expected from various CSZ event scenarios. The XXL line is used to depict the tsunami evacuation zone boundary.
2	Tom Bender Neahkahnie, OR	The use of a "Medium" CZE earthquake for Resilience Planning and location of essential facilities feels improper. A careful look at the quake history chart on page 156 of your study clearly shows that the next 3000 yr. XXL quake (last which was a "cluster") is 65 years "overdue", and should be used for planning as well as the smaller "Medium" size quakes.	The Oregon Resilience Plan uses the impact of a "Medium" Cascadia Subduction Zone (CSZ) earthquake and tsunami for planning purposes because this was judged the most likely CSZ event. (For explanation see DOGAMI Special Paper 43, http://www.oregongeology.org/pubs/sp/p-SP-43.htm.) The current regulatory tsunami inundation used by the Oregon Building Code to limit new construction of critical, essential, large occupancy, and hazardous facilities also uses a scenario similar to the "Medium" case.
3	Tom Bender Neahkahnie, OR	Neahkahnie is not included in unincorporated communities, and is shown as "grey" and not rated on most maps.	Of the unincorporated communities in Tillamook County, only Oceanside and Netarts together, Pacific City and Woods together, and Neskowin are addressed directly and separately from the rest of the unincorporated County. They were selected based on their population size and density which allowed responsible characterization of exposure to and potential loss from natural hazards relative to the cities and County.

#	Commenter	Comment	Response
4	Tom Bender Neahkahnie, OR	Essential facilities not shown on maps: Wheeler - skilled care center, clinic, pharmacy; Nehalem - NCRD evacuation center; Manzanita - Adventist Health, evac. center?; Falcon Cove - Fire Mountain School/evac. center.	Hospitals, schools, fire stations, police stations, emergency operations, and military facilities comprised the initial set of essential facilities included in this analysis. That set has been expanded somewhat based on conversations with the individual jurisdictions.
5	Tom Bender Neahkahnie, OR	The new Nehalem City Hall is located in tsunami inundation zone and flood zone. Although floor level is above current outdated "flood zone", its access is blocked every year by street flooding.	Thank you for this information.
6	Tom Bender Neahkahnie, OR	HAZARDS NOT ADDRESSED: • Wildfires can also be caused by beach fires being reignited by late afternoon winds. At least 4 have occurred in the last 50-60 years in Neahkahnie, the last setting four homes on fire, the previous one luckily being blown north of residences. Another, after the one affecting 4 homes, was narrowly avoided when improper procedures by ODF intentionally burning beach wood almost caused another fire when the "wind changed". • "Blue clay" impervious soils from volcanic ash deposits on existing slopes increases landslide hazards. • Ground level drop after quake, ocean-rising, more storm severity impacts not addressed.	• The Wildfire section notes that according to the Tillamook County Community Wildfire Protection Plan (CWPP), recreation is the leading cause of wildfires in Tillamook County. This may be augmented in future updates of this Plan and the CWPP. • Geology at a statewide scale, which may or may not include local units like this, was used for this analysis. DOGAMI has recently received funding approval from FEMA to perform a detailed landslide study for Tillamook County. That study will address issues like this at a fine scale. The study timeline is not yet set, but it should be completed over approximately the next two to three years. • Coastal subsidence is addressed briefly in the Tsunami section. Sea level rise is addressed briefly in the Coastal Erosion section. Increased impacts from coastal storms after a CSZ event is a secondary hazard and not addressed.

#	Commenter	Comment	Response
7	Tom Bender Neahkahnie, OR	MITIGATION ACTIONS: • Install solar PVs on emergency facilities, hospitals, fire stations, cow barns • Set up for heat at emergency facilities, potentially needed for months without power. • Similarly, what about food at emergency facilities? Nehalem, for example could tie NCRD Evac Center with the new grade school with cafeteria, which could cycle emergency food storage. • Seismic upgrades at emergency facilities have not been adequately addressed or implemented. • Where have "Tsunami Zone" signs on roads been updated or not updated for XXL quakes and tsunami inundation? • Develop access plans for military "bridges" to reestablish road access as soon as possible and long before permanent replacement bridges could occur. • Develop debris management plans. Wood-chipping for electric generation, separation of recyclable materials and those with toxic burning potential; tagging of buildings with asbestos and other hazardous materials that need to be avoided until proper treatment. • Local stockpiling of water mains, utility poles and transformers, etc. to allow more rapid repairs. • Emergency power supply for water pumping to storage facilities drained by broken water mains. • Mapping shutoffs for water service, etc. to allow most rapid phasing of repair and resupply. Similarly, distributed location of water shut-off wrenches to shut off lines to damaged homes so mains can supply remaining ones. • Nehalem Bay State Park continues, after 9 years, to post fraudulent "Evacuation Route" signs, though there is almost no possibility that any of 1500 visitors at a time could escape by those routes even if drivable. They continue to ignore signing of walkable escape routes to the high eastern parts of the park. Mitigation action: implement on-foot escape routes. • Another mitigation action is that "danger trees" growing at 30 - 45 degree angles out over Hwy 101 and other important roads can be removed BEFORE storms causing them to fall. • Logging impacts on streams, flooding, landslides are not addressed, nor banning logging in areas with potential landslide impact on communities.	Thank you for these ideas. The jurisdictions chose not to adopt any for this update; however they may be considered for implementation over the five-year life of the Plan.

#	Commenter	Comment	Response
		• An important mitigation action not addressed for earthquakes and landslides is to prohibit additional construction in those impact areas, and to bring additional land outside impact zones into "buildable lands" category. The "value added" from such upzoning can be captured as is done in other jurisdictions, to pay for infrastructure serving those new areas, payments to development-banned properties, etc. • Another major issue not discussed is whether to ban rebuilding in Inundation Zone after the Big One. Seaview WA - Sou'wester Lodge is an example where building is not allowed out to the beach. Sendai, Japan, had rocks in place 300 years ago saying "do not build beyond this point because of tsunamis". Obviously ignored, causing major losses from Fukushima quake.	
8	Guy Sievert Neskowin, OR	I worry that the county's plan stops at Neskowin's south beach….US101 is a major landslide risk.	The Draft Risk Assessment covers all of Tillamook County, including the area south of Neskowin to Lincoln County. The Landslide susceptibility map shows high and very high landslide susceptibility in the vast majority of the area south of Neskowin and along US-101.
9	Tilda Jones Tillamook Bay Flood Improvement District	Southern Flow Corridor Project (a public flood and environmental safety project) described on pages 105-106 rewritten (Rachael?) to be more factual, accurately described, and updated.	This section was reviewed and revised as requested.
10	John Coopersmith Pete Anderson Realty Manzanita, OR	Residential Seismic Upgrading could be a cost effective method to preserve or minimize housing loss after a catastrophic earthquake. On the Oregon Construction Contractors Board website there is a page discussing Residential Seismic Upgrades. The information indicates a cost of between $4000 and $10,000 for an average upgrade. At the $7,000 mid-point, for a $10 million investment over 1400 could be seismically retrofitted. To preserve the state's capital investment these could be a part-grant part-loan to home owners. Loans could be in the form of perhaps 1% interest with no payments but due on sale of the property. The loan would be recorded as a lien on the property. In this way, over time, the capital investment would return to the state replenishing the fund thus allowing for more retro-fits. If the state would fund this at $10 million per year over 10 years with loans being paid back a substantial fund would be created. Over time tens of thousands of homes could be saved.	Thank you for this suggestion. We will follow-up with you.

D. Plan Maintenance

A system for plan maintenance that would include public participation was discussed with each jurisdiction at the February/March 2017 meetings, and with the Steering Committee at the multi-jurisdictional level. Plan maintenance is a process to facilitate periodic *monitoring* and *evaluation* of Plan performance, and *making adjustments* to better achieve plan goals.

Monitoring means tracking implementation of the Plan over time. This would include at a minimum and at regular intervals:

- Documenting the status of mitigation actions and the reasons for any no longer being pursued
  - Completed, Progressing, Not Yet Started, Not Being Pursued
- Documenting added mitigation actions
- Documenting whether the objectives associated with each goal have been implemented and to what degree
- Documenting mitigation success stories
- Documenting any disasters that have occurred, their nature, impacts, and costs
- Documenting and discussing how to employ any new hazards data
- Documenting the sources of mitigation funding that has been obtained or used
- Documenting the sources of mitigation funding, how much has been obtained, how fully it has been used, how well it was leveraged
- Documenting new sources of mitigation funding
- Documenting training opportunities, who attended, and how the information has been distributed and used
- Documenting any changes in tools, assets, and capability to implement the Plan
- Documenting whether and how each of the objectives related to each of the Plan goals has been advanced

Evaluating means assessing the effectiveness of the plan at achieving its stated purpose and goals. This would include assessing the monitoring data at regular intervals to determine at a minimum:

- The degree of progress that has been made developing and implementing effective mitigation initiatives, projects, and activities to reduce hazards to life, businesses, property, and environmental systems. (Goal 1)
- Whether the mitigation initiatives, projects, and activities have served to enhance emergency services and the capabilities of local first responders. (Goal 2)
- Whether regional coordination and communication has been improved. (Goal 3)

The next step is to determine the reasons that parts of the Plan were more or less successful, and to make adjustments to increase success during the next Plan implementation period.

Making adjustments or *updating* the plan occurs throughout the five-year life of the Plan as well as at the five-year mark. At each point that the plan monitoring documentation is evaluated, updates and adjustments to advance implementation and improve the Plan must be identified and documented. During the life of the Plan, adjustments are not subject to FEMA approval.

In addition, monitoring, evaluation, and adjustment must occur as soon as practical after a natural hazard event or disaster, both by the impacted jurisdiction and by all the jurisdictions together. In addition to the regular monitoring and evaluation items, specifically with respect to the disaster, the following will be discussed and documented:

- The nature of the disaster
- The impacts of the disaster
- The costs of the disaster (life, property, business, environment)
- Whether any actions that had been taken to mitigate this type of disaster worked, and if not why not, and what improvements could be made
- If a mitigation action did help to lessen the impacts of the disaster, document the success story.
- What actions could be taken to mitigate this type of disaster in the future
- How to capture, store, and use data from this disaster
- Effectiveness of support for emergency services and first responders
- Effectiveness of regional coordination and communication
- Other lessons learned
- Public comments
- Summary of actions to be taken pursuant to this disaster to improve mitigation

Monitoring and Evaluation System

Monitoring and evaluation will be undertaken by the jurisdictions individually and together. Each jurisdiction will convene at least one meeting each year coordinated with the multi-jurisdictional meeting, both ahead of the spring budget cycle. The meetings will be duly advertised and open to the public. The jurisdictions will post meeting notices on their websites and employ other means that have proven effective at engaging their citizens (e.g., distributing flyers, media releases, newspaper ads, water bill inserts, social media strategies, email, etc.). A jurisdiction may choose to have an internal plan maintenance meeting to prepare for the public meeting.

Each jurisdiction will maintain a static copy of the Plan. Tillamook County will maintain a static copy of the Plan on its website and will maintain a dynamic copy that is updated pursuant to each year's multi-jurisdictional plan maintenance meeting. Tillamook County will also maintain a log of all changes to the Plan during its five-year life cycle. This will facilitate the five-year update.

Individual Jurisdictions

The Steering Committee member and at least one alternate for each jurisdiction will take joint responsibility for convening their own jurisdiction's plan maintenance meeting in January of each year. At a minimum, they will invite all the same people or positions who were invited to the February/March 2017 individual jurisdiction meetings. They will also invite the Technical Advisors with interests in their jurisdictions. The meeting will be duly advertised and open to the public. Each jurisdiction's convener will take responsibility for ensuring that meeting notices are posted on the jurisdiction's website and that other means that have proven effective at engaging their citizens (e.g., distributing flyers, media releases, newspaper ads, water bill inserts, social media strategies, email, etc.) are employed to provide the opportunity for citizens to engage in the plan maintenance process. The meeting will be held in conjunction with a Planning Commission, City Council, or Board of Commissioners meeting and the agenda will provide sufficient time for public comment. The conveners will take responsibility for ensuring that notes are taken at the meeting and seeing that the notes are finalized, distributed, and filed within two weeks of the meeting. One of the individual jurisdiction's conveners will provide the filed notes to the multi-jurisdictional plan maintenance meeting convener (Steering Committee Chair who is a Tillamook County Commissioner) to be incorporated into the dynamic copy of the Plan maintained by Tillamook County and used for the next five-year plan update.

In addition, the conveners will take responsibility for convening a plan maintenance meeting as soon as practical after any natural hazard event or disaster impacting their jurisdiction. The same requirements and procedures apply to this meeting as to any other plan maintenance meeting.

This is a minimum process to which all jurisdictions have agreed. Additional meetings may be held. As an example, the Port of Garibaldi has committed to include discussion of the Tillamook County Multi-Jurisdictional NHMP on every regular monthly Port Commission meeting agenda and semi-annual Capital Improvement Plan workshop agendas. Opportunity for public comment is provided at all these meetings.

Table 132. Individual Jurisdiction Plan Maintenance Meeting Conveners

Jurisdiction	Convener Title/Position	Currently (2017)
Tillamook County	**County Commissioner**	**Bill Baertlein, Chair**
Tillamook County	Community Development Planner	Sarah Absher
Bay City	**Mayor**	**Shaena Peterson**
Bay City	City Recorder	Lin Downey
Bay City	City Planning Secretary	Angie Cherry
Garibaldi	**City Emergency Preparedness Mgr.**	**Terry Kandle**
Garibaldi	City Manager	John O'Leary
Manzanita	**City Council Member**	**Linda Kozlowski**
Manzanita	City Manager	Jerry Taylor
Nehalem	**City Council Member**	**Jim Welch**
Nehalem	City Manager & City Recorder	Dale Shafer
Rockaway Beach	**Mayor**	**Joanne Aagaard**
Rockaway Beach	City Manager	Lars Gare
Tillamook City	**Mayor**	**Suzanne Weber**
Tillamook City	City Manager	Paul Wyntergreen
Wheeler	**Mayor**	**Stevie Burden**
Wheeler	City Manager	Geoff Wullschlager
Port of Tillamook Bay	**General Manager**	**Michele Bradley**
Port of Tillamook Bay	Project Coordinator	Aaron Palter
Port of Garibaldi	**General Manager**	**Michael Saindon**

All Participating Jurisdictions

At the multi-jurisdictional level, the Steering Committee will meet each year ahead of the annual budget process so any funding necessary for accomplishing mitigation actions could be planned, requested, and to the extent possible leveraged to attract additional funds. Because all of the jurisdictions operate on a July 1 to June 30 fiscal year, their budget processes take place in the spring. Therefore, the annual multi-jurisdictional plan maintenance meeting would take place in February of each year. This schedule allows the jurisdictions to meet individually in January, and to bring the results of those meetings to the

Steering Committee meeting. It would also allow for follow-up meetings or activities as necessary prior to initiation of the budget process.

The Chair of the Steering Committee, a County Commissioner (currently Commissioner Baertlein), will take responsibility for convening the meeting. Technical Advisors will be invited. The meeting will be duly advertised and open to the public. Tillamook County will post meeting notices on its website — on the home, Community Development, and Emergency Management web pages at a minimum — and employ other means that have proven effective at engaging citizens (e.g., distributing flyers, media releases, newspaper ads, water bill inserts, social media strategies, email, etc.) to provide the opportunity for citizens to engage in the plan maintenance process. The agenda will include sufficient time for public comment. The convener will take responsibility for having notes taken at the meeting and seeing that the notes are finalized, distributed, and filed within two weeks of the meeting. Filed notes will be used for the next five-year plan update.

In addition, the convener will take responsibility for convening a plan maintenance meeting as soon as practical after any natural hazard event or disaster impacting any one or more of the jurisdictions participating in the Plan. The same requirements and procedures apply to this meeting as to any other plan maintenance meeting.

This is a minimum process to which all jurisdictions have agreed. Additional meetings may be held.

Five-Year Plan Updates

This plan will be updated every five years, as required by the Disaster Mitigation Act of 2000. The Chair of the Steering Committee, a County Commissioner (currently Commissioner Baertlein), will take responsibility for convening a Steering Committee meeting three years prior to the Plan's expiration date to discuss securing funding for the update and to plan the update process.

The conveners for each individual jurisdiction will follow up by convening a meeting in their jurisdiction to organize for the update as agreed at the multi-jurisdictional meeting.

The steering committee will use the data from the regular plan maintenance meetings to address the following questions in planning the five-year update.

- Are the plan goals still applicable? If no, what modification should be made?
- Do the plan's priorities align with state priorities? If no, what steps do we take to align priorities?
- What new partners should be brought to the table?
- What new local, regional, state or federal policies influencing natural hazards should be addressed?
- What mitigation activities has the community successfully implemented since the plan was last updated?
- What new issues or problems related to hazards have been identified in the community?
- What existing actions need to be reprioritized for implementation?
- Are the actions still appropriate given current resources?
- What changes in development patterns could influence the effects of hazards?
- What significant changes in the community's demographics could influence the effects of hazards?

- What new studies or data would enhance the risk assessment?
- Has the community been affected by any disasters? How did the plan accurately or inaccurately address the impacts of these events?

Discussing these questions will help the committee determine what components of the mitigation plan need updating and establish an effective and efficient approach for the update.

V. REFERENCES

Allan, J. C., & Hart, R. (2007). *Assessing the temporal and spatial variability of coastal change in the Neskowin littoral cell: Developing a comprehensive monitoring program for Oregon beaches* (Open-File Report O-07-01). Portland, OR: Oregon Department of Geology and Mineral Industries. Retrieved from http://www.oregongeology.org/pubs/ofr/O-07-01.pdf

Allan, J. C., & Hart, R. (2008). *Oregon beach and shoreline mapping and analysis program: 2007-2008 beach monitoring report* (Open-File Report O-08-15). Portland, OR: Oregon Department of Geology and Mineral Industries. Retrieved from http://www.oregongeology.org/pubs/ofr/O-08-15.pdf

Allan, J. C., Hart, R., & Tranquilli, V. (2006). The use of Passive Integrated Transponder tags (PIT-tags) to trace cobble transport in a mixed sand-and-gravel beach on the high-energy Oregon coast, USA. *Marine Geology*, *232*(1-2), 63–86. https://doi.org/10.1016/j.margeo.2006.07.005

Allan, J. C., & Komar, P. D. (2002). Extreme storms on the Pacific Northwest coast during the 1997-98 El Niño and 1998-99 La Niña. *Journal of Coastal Research*, *18*(1), 175–193. http://www.jstor.org/stable/4299063

Allan, J. C., Komar, P. D., & Priest, G. R. (2003). Shoreline variability on the high-energy Oregon coast and its usefulness in erosion-hazard assessments. In M. R. Byrnes, M. Crowell & C. Fowler (Eds.), *Shoreline mapping and change analysis: Technical considerations and management implications*, *Journal of Coastal Research* [Special issue], *38*, 83–105. West Palm Beach, FL: Coastal Education & Research Foundation, Inc. (CERF). http://www.jstor.org/stable/25736601

Allan, J. C., & Priest, G. R. (2001). *Evaluation of coastal erosion hazard zones along dune and bluff backed shorelines in Tillamook County, Oregon: Cascade Head to Cape Falcon* (Open-File Report O-01-03). Portland, OR: Oregon Department of Geology and Mineral Industries. Available at http://www.oregongeology.org/pubs/ofr/O-01-03.zip

Allan, J. C., Ruggiero, P. & Roberts, J. T. (2012). *Coastal flood insurance study, Coos County, Oregon* (Special Paper 44). Portland, OR: Oregon Department of Geology and Mineral Industries. Retrieved from http://www.oregongeology.org/pubs/sp/SP-44.pdf

Allan, J. C., & Stimely, L. L. (2013). *Oregon Beach Shoreline Mapping and Analysis Program: Quantifying short- to long-term beach and shoreline changes in the Gold Beach, Nesika Beach, and Netarts littoral cells, Curry and Tillamook Counties, Oregon* (Open File Report O-13-07). Portland, OR: Oregon Department of Geology and Mineral Industries. Retrieved from http://www.oregongeology.org/pubs/ofr/O-13-07.pdf

Allan, J. C., Witter, R. C., Ruggiero, P., & Hawkes, A. D. (2009). Coastal geomorphology, hazards, and management issues along the Pacific Northwest coast of Oregon and Washington. In J. E. O'Connor, R. J. Dorsey & I. P. Madin (Eds.), *Volcanoes to vineyards: Geologic field trips through the dynamic landscape of the Pacific Northwest* (Field Guide 15), pp. 495–519. Boulder, CO: Geological Society of America.

Ash Creek Associates, Inc. (2007). *Geologic and geotechnical hazards assessment: Bay City, Oregon.* Prepared for City of Bay City, OR. Portland, OR.

Bacon, C. R., Mastin, L. G., Scott, K., & Nathenson, M. (1997). *Volcano and earthquake hazards in the Crater Lake region, Oregon* [Open-File Report 97-487]. Reston, VA: US Geological Survey. Retrieved from http://pubs.er.usgs.gov/publication/ofr97487

Bott, J. D., & Wong, I. G. (1993). Historical earthquakes in and around Portland. Oregon. *Oregon Geology*, *55*(5), 116–122.

Burns, W. J., Mickelson, K. A., & Madin, I. P. (2016). *Landslide susceptibility overview map of Oregon* (Open-File Report O-16-02). Portland, OR. Oregon Department of Geology and Mineral Industries. Retrieved from http://www.oregongeology.org/pubs/ofr/p-O-16-02.htm.

Burns, W. J., Mickelson, K. A., & Saint-Pierre, E. C. (2011). *Statewide landslide information database for Oregon, release 2 (SLIDO-2)* [Data set]. Portland, OR: Oregon Department of Geology and Mineral Industries. Most recent published data set available at http://www.oregongeology.org/sub/slido/index.htm

Business Oregon. (2015). *Oregon benefit-cost analysis tool for evaluation of seismic rehabilitation grant program applications*: User's guide: Salem, OR, Infrastructure Finance Authority Division, 34 p. http://www.orinfrastructure.org/assets/apps/IFA/2015Oregon-SRGP/BCAusersGuideAppend.pdf

California Governor's Office of Emergency Services (OES) (1997). *Emergency plans for mobilehome parks;completed in compliance with the Flood Emergency Action Team (FEAT): Initiative Number 5*. Retrieved from https://adacounty.id.gov/Portals/Accem/Doc/PDF/mobilehomeparkplan.pdf. Updated version: http://www.caloes.ca.gov/PlanningPreparednessSite/Documents/FEAT_5-EmergencyPlansforMobile%20Home%20Parks%28FEAT%20doc%29.pdf

Cascadia Region Earthquake Workgroup, Roddey, J., and Clark, L. (2005). Cascadia Subduction Zone earthquakes: A magnitude 9.0 earthquake scenario. Available from DOGAMI website as http://www.oregongeology.org/pubs/ofr/O-05-05.pdf

Centers for Disease Control and Agency for Toxic Substances and Disease Registry. (n.d.). *The CDC/ATSDR Public Health Vulnerability Mapping System: Using a Geographic Information System for depicting human vulnerability to environmental emergencies*. Available at https://ftp.cdc.gov/pub/nceh/opter/Public%20Health%20Vulnerability%20Mapping%20System_A.doc

CH2M Hill. (2012). *Seismic lifelines evaluation, vulnerability synthesis, and identification* [prepared for Oregon Department of Transportation]. Corvallis, OR. Retrieved from Oregon Department of Land Conservation and Development website: http://www.oregon.gov/LCD/HAZ/docs/2015ORNHMP/App_9.1.13_SeismicLifelines_PREFL.pdf

Cutter, S. L., Boruff, B. J., & Shirley, W. L. (2003). Social vulnerability to environmental hazards. *Social Science Quarterly*, *28*(2), 242–261.

czb. (2017). *Creating a healthy housing market for Tillamook County: Findings and recommendations for the Tillamook County Housing Task Force.* [Prepared for Tillamook County, OR]. Alexandria, VA. Retrieved from http://www.edctc.com/wp-content/uploads/2012/07/TillamookJan31DRAFT.pdf.

Dewey, J. W. (1993). Damages from the 20 September earthquakes near Klamath Falls, Oregon. *Earthquakes & Volcanoes, 24*(3), 121.

DOGAMI [Oregon Department of Geology and Mineral Industries]. (2008 rev.). *Landslide hazards in Oregon* [fact sheet]. Retrieved from http://www.oregongeology.org/pubs/fs/landslide-factsheet.pdf

DOGAMI [Oregon Department of Geology and Mineral Industries] (2012, Winter). Oregon's tectonic setting: a mirror image of Japan's, in *The 2011 Japan earthquake and tsunami: Lessons for the Oregon Coast*. (*Cascadia* newsletter). Portland, OR. Retrieved from http://www.oregongeology.org/pubs/cascadia/CascadiaWinter2012.pdf

DOGAMI [Oregon Department of Geology and Mineral Industries]. (2016). *Final draft multi-hazard risk report for Tillamook County* [Prepared for the Federal Emergency Management Agency, Risk MAP Program]. Portland, OR.

Ewert, J. W., Guffanti, M., & Murray, T. L. (2005). *An assessment of volcanic threat and monitoring capabilities in the United States: Framework for a National Volcano Early Warning System (NVEWS)* (Open-File Report 2005-1164). Reston, VA: US Geological Survey. Retrieved from http://pubs.usgs.gov/of/2005/1164/

Field, E.H., Milner, K. R., & the 2007 Working Group on California Earthquake Probabilities. (2008). *Forecasting California's earthquakes; what can we expect in the next 30 years?* (Fact Sheet 2008-3027.): Reston, VA: US Geological Survey. Retrieved from http://pubs.usgs.gov/fs/2008/3027/

Goldfinger, C., Nelson, C.H., Morey, A.E., Johnson, J.E., Patton, J.R., Karabanov, E., Gutiérrez-Pastor, J., Eriksson, A.T., Gràcia, E., Dunhill, G., Enkin, R.J., Dallimore, A., & Vallier, T. (2012). *Turbidite event history—Methods and implications for Holocene paleoseismicity of the Cascadia subduction zone* (Professional Paper 1661–F). Reston, VA: U.S. Geological Survey. Retrieved from https://pubs.usgs.gov/pp/pp1661f/

Hazards and Vulnerability Research Institute. (2007). The spatial hazard events and losses database for the United States, Version 5.1 [Online database]. Columbia, SC: University of South Carolina. Retrieved from http://www.sheldus.org.

Hofmeister, R. J. (2000). *Slope failures in Oregon: GIS inventory for three 1996/97 storm events* (Special Paper 34). Portland, OR: Oregon Department of Geology and Mineral Industries. Available at http://www.oregongeology.org/pubs/sp/SP-34.zip

Judson, S. (2012). *Earthquake design history: a summary of requirements in the State of Oregon*. Salem, OR: State of Oregon, Building Codes Division, Feb. 7, 2012. Retrieved from http://www.oregon.gov/OMD/OEM/osspac/docs/history_seismic_codes_or.pdf

Komar, P. D. (1986). The 1982-83 El Niño and erosion on the coast of Oregon. *Shore & Beach*, *54*(2), 3–12. Retrieved from http://www.oregongeology.org/pubs/og/OGv49n05.pdf

Komar, P. D. (1992). Ocean processes and hazards along the Oregon Coast. In J. W. Good & S. S. Ridlington (Eds.), *Coastal Natural Hazards: Science, Engineering, and Public Policy* (ORESU-B-92-001). Corvallis, OR: Oregon State University, Oregon Sea Grant College Program (pp. 38–74). Available from http://nsgl.gso.uri.edu/oresu/oresub92001/oresub92001index.html

Komar, P. D. (1997). *The Pacific Northwest Coast: Living with the shores of Oregon and Washington*. Durham, NC: Duke University Press.

Komar, P. D., & Allan, J. C. (2010). "Design with Nature" strategies for shore protection: The construction of a cobble berm and artificial dune in an Oregon State Park. In H. Shipman, M. N. Dethier, G. Gelfenbaum, K. L. Fresh, and R. S. Dinicola (Eds.), *Puget Sound shorelines and the impacts of armoring — Proceedings of a state of the science workshop, May 2009* (Scientific Investigations Report 2010-5254), pp. 117–126. Reston, VA: US Geological Survey. Retrieved from https://pubs.usgs.gov/sir/2010/5254/pdf/sir20105254_chap12.pdf

Komar, P. D., & Rea, C. C. (1976). Erosion of Siletz Spit. Oregon, *Shore and Beach*, *44*(1), 9–15.

Jackson, P. L. (1987). Erosional changes at Alsea Spit, Waldport, Oregon. *Oregon Geology*, *49*(5), 55–59.

Lander, J. F., Lockridge, P. A., & Kozuch, M. J. (1993). *Tsunamis affecting the west coast of the United States 1806–1992* (NGDC Key to Geophysical Records Documentation No. 29). Boulder, CO: NOAA National Geophysical Data Center. Retrieved from ftp://ftp.ngdc.noaa.gov/hazards/publications/Kgrd-29.pdf.

Madin, I. P., & Burns, W. J. (2013). *Ground motion, ground deformation, tsunami inundation, coseismic subsidence, and damage potential maps for the 2012 Oregon Resilience Plan for Cascadia Subduction Zone earthquakes* (Open-File Report O-13-06). Portland, OR: Oregon Department of Geology and Mineral Industries. Retrieved from http://www.oregongeology.org/pubs/ofr/p-O-13-06.htm

McKinney, B. A. (1977). *The spring 1976 erosion of Siletz Spit, Oregon: With an analysis of the causative wave and tide conditions* [Master's thesis]. Corvallis, OR: Oregon State University School of Oceanography. Available from https://ir.library.oregonstate.edu/xmlui/handle/1957/27700?show=full

MDC Consultants (n.d.). *When disaster strikes — Promising practices— Tourists*. Durham, NC. Retrieved from http://www.mdcinc.org/sites/default/files/resources/When%20Disaster%20Strikes%20-%20Promising%20Practices%20-%20Tourists.pdf

Morrow, B. H. (1999). Identifying and mapping community vulnerability. *Disasters*, *23*(1), 1–18. Available from http://onlinelibrary.wiley.com/doi/10.1111/1467-7717.00102/abstract

Myers, B., and Driedger, C. (2008a). *Geologic hazards at volcanoes* [Poster] (General Information Product 64). Reston, VA: US Geological Survey. Retrieved from https://pubs.usgs.gov/gip/64/gip64.pdf

Myers, B., and Driedger, C. (2008b). *Eruptions in the Cascade Range during the past 4,000 years* [poster] (General Information Product 63). Reston, VA: US Geological Survey. Retrieved from http://pubs.usgs.gov/gip/63/

Oregon Emergency Management and the Federal Emergency Management Agency. (2002). *Reducing Windstorm Damage to Property and Electrical Utilities*.

Oregon Department of Forestry (2008). *Drought and conifer mortality in the Willamette Valley*. Retrieved from http://library.state.or.us/repository/2007/200710091228502/index.pdf

Oregon Department of Land Conservation and Development. (2015). *Oregon natural hazards mitigation plan*. Salem, OR. Available from http://www.oregon.gov/LCD/HAZ/pages/nhmp.aspx

Oregon Department of Transportation (2012). *2012 bridge condition report*. Salem, OR: ODOT, Bridge Section. Retrieved from ftp://ftp.odot.state.or.us/Bridge/bridge_website_chittirat/2012_Br_Condition_Report_web_080612.pdf

Oregon Department of Transportation (2013). *Oregon's historic bridge field guide*. Salem, OR. Retrieved from http://www.oregon.gov/ODOT/HWY/BRIDGE/docs/OHBG.pdf

Oregon Department of Transportation (2014). Oregon Highways Seismic Plus Report. Salem, OR: ODOT, Technical Services Branch, Bridge and Geo-Environmental Sections. Retrieved from http://www.oregon.gov/ODOT/Bridge/Documents/Bridge_seismic/2014_Seismic_Plus_Report.pdf

Oregon Partnership for Disaster Resilience (n.d.). *Economic analysis of natural hazard mitigation projects*. Eugene, OR: University of Oregon, Community Service Center.

Peterson, C. D., Jackson, P. L., O'Neil, D. J., Rosenfeld, C. L., & Kimerling, A. J. (1990). Littoral cell response to interannual climatic forcing 1983–1987 on the central Oregon coast, USA, *Journal of Coastal Research*, *6*(1), 87–110. Available from http://www.jstor.org/stable/4297647

Pitzer, P. C. (1988). The atmosphere tasted like turnips: the Pacific Northwest dust storm of 1931. *Pacific Northwest Quarterly*, *79*(2), 50–55.

Priest, G. R. (1999). Coastal shoreline change study northern and central Lincoln County, Oregon. In M. Crowell and S. P. Leatherman (Eds.), Coastal Erosion Mapping and Management, *Journal of Coastal Research* [Special issue]. *28*, 140–157. Available at http://www.jstor.org/stable/25736192

Priest, G. R., Zhang, Y., Witter, R. C., Wang, K., Goldfinger, C., and Stimely, L. (2014). Tsunami impact to Washington and northern Oregon from segment ruptures on the southern Cascadia subduction zone. *Natural Hazards*, *72*(2), 849–870. Retrieved from http://link.springer.com/article/10.1007/s11069-014-1041-7

Redmond, K. (2002). The depiction of drought: a commentary. *Bulletin of the American Meteorological Society*. *83*(8), 1143–1147.

Redmond, K. T., & Koch, R. W. (1991). Surface climate and streamflow variability in the Western United States and their relationship to large-scale circulation indices. *Water Resources Research*, *27*(9), 2381–2399.

Revell, D., Komar, P. D., & Sallenger, A. H. (2002). An application of LIDAR to analyses of El Niño erosion in the Netarts littoral cell, Oregon. *Journal of Coastal Research*, *18*(4), 792–801.

Roberts, J. T., & Anthony, L. H. (2015). *Statewide subbasin-level channel migration screening for Oregon* (Report to Oregon Department of Land Conservation and Development). Portland, OR: Oregon Department of Geology and Mineral Industries.

Robison, E. G., Mills, K., Paul, J. T., Dent, L., & Skaugset, A. (1999). Oregon Department of Forestry 1996 Storm Impacts Monitoring Project: Final Report. Forest Practices Technical Report # 4. Oregon Department of Forestry, Salem, Oregon. 141 pp.

Rubin, M., & Alexander, C. (1958). U.S. Geological Survey Radiocarbon Dates IV. *Science*, 127, 1476–1487. https://doi.org/10.1126/science.127.3313.1476

Ruggiero, P., Komar, P. D., & Allan, J. C. (2010). Increasing wave heights and extreme value projections: The wave climate of the U.S. Pacific Northwest. *Coastal Engineering*, *57*(5), 529-552. Accessible from http://www.sciencedirect.com/science/article/pii/S0378383909002142

Schlicker, H. G., Deacon, R. J., Olcott, G. W., & Beaulieu, J. D. (1973). *Environmental geology of Lincoln County, Oregon* (Bulletin 81). Portland, OR: Oregon Department of Geology and Mineral Industries. Retrieved from http://www.oregongeology.org/pubs/B/B-081.pdf

Scott, W. E., Pierson, T., Schilling, S. P., Costa, J., Gardner, C., Vallance, J. W., & Major, J. (1997). *Volcano hazards in the Mount Hood region, Oregon* (Open-File Report 97-89). Reston, VA: US Geological Survey. Retrieved from http://pubs.er.usgs.gov/publication/ofr9789

Scott, W. E., Iverson, R., Schilling, S. P., & Fisher, B. J. (2001). *Volcano hazards in the Three Sisters region, Oregon* (Open-File Report 99-437). Reston, VA: US Geological Survey. Retrieved from http://pubs.usgs.gov/of/1999/0437/

Sherrod, D. R. (1993). Historic and prehistoric earthquakes near Klamath Falls, Oregon. *Earthquakes & Volcanoes*, *24*(3), 106.

Sherrod, D. R., Mastin, L. G., Scott, W. E., & Schilling, S. P. (1997). *Volcano hazards at Newberry Volcano, Oregon* (Open-File Report 97-513). Reston, VA: US Geological Survey. Retrieved from http://pubs.er.usgs.gov/publication/ofr97513

Stembridge, J. E. (1975). *Shoreline changes and physiographic hazards on the Oregon Coast* (Doctoral dissertation). University of Oregon, Eugene.

Stimely, L. L., & Allan, J. C. (2014). Evaluation of erosion hazard zones for the dune-backed beaches of Tillamook County, Oregon (Open-File Report O-14-02). Portland, OR: Oregon Department of Geology and Mineral Industries. Accessible from http://www.oregongeology.org/pubs/ofr/p-O-14-02.htm

Taylor, G. H., & Hannan, C. (1999). *The climate of Oregon: from rain forest to desert*. Corvallis, OR: Oregon State University Press. Available from http://osupress.oregonstate.edu/book/climate-of-oregon

Taylor, G. H., & Hatton, R. (1999). *The Oregon weather book: a state of extremes*. Corvallis, OR: Oregon State University Press. Available from http://osupress.oregonstate.edu/book/oregon-weather-book

Terich, T. A., & Komar, P. D. (1974). Bayocean Spit, Oregon: History of development and erosional destruction. *Shore & Beach*, *42*(2), 3–10.

Thorson, T. D., Bryce, S. A., Lammers, D. A., Woods, A. J., Omernik, J. M., Kagan, J., Pater, D. E., & Comstock, J. A. (2003). *Level IV Ecoregions of Oregon* [color poster with map, descriptive text, summary tables, and photographs; map scale 1:1,500,000]. Reston, VA: US Geological Survey. Accessible from Environmental Protection Agency website, https://www.epa.gov/eco-research/ecoregion-download-files-state-region-10#pane-35.

Thomas, G. C., Crosson, R. S., Carver, D. L., & Yelin, T. S. (1996). The 25 March 1993 Scotts Mills, Oregon, earthquake and aftershock sequence: Spatial distribution, focal mechanisms, and the Mount Angel Fault. *Bulletin of the Seismological Society of America*, *86*(4), 925–935.

University of Oregon Community Service Center. (2017). *Tillamook County Natural Hazards Code and Program Review* [Prepared for Tillamook County, Oregon Risk MAP, and Federal Emergency Management Agency]. Eugene, OR: University of Oregon, Community Service Center. Retrieved from http://www.starr-team.com/starr/RegionalWorkspaces/RegionX/mitigationplanning/Shared%20Documents/4-Mitigation_Planning_Grants/HMGP_Planning_Activity_Project_Example-Code%20Review.pdf

van Heeswijk, M., Kimball, J., and Marks, D. (1996). *Simulation of water available for runoff in clearcut forest openings during rain-on-snow events in the western Cascade Range of Oregon and Washington* (Water-Resources Investigations Report 95-4219). Reston, VA: US Geological Survey. Retrieved from https://pubs.usgs.gov/wri/1995/4219/report.pdf

VLG Consulting & Pearson, S. (2012). *Tillamook County, Oregon Multi-Jurisdiction Natural Hazards Mitigation Plan, Update 2011* [Prepared for Tillamook County]. Tillamook, OR: VLG Consulting. Retrieved from http://www.co.tillamook.or.us/gov/ComDev/documents/Tillamook%20County%20MJHMP%20Final%20to%20FEMA.pdf

Walder, J. S., Gardner, C. A., Conrey, R. M., Fisher, B. J., & Schilling, S. P. (1999). *Volcano hazards in the Mount Jefferson region, Oregon* (Open-File Report 99-24): Reston, VA: US Geological Survey. Retrieved from http://pubs.usgs.gov/of/1999/0024/

Walker Macy (2015). *Salmonberry Trail concept plan*. Prepared for the Salmonberry Coalition. Portland, OR: Walker Macy. Retrieved from http://www.potb.org/wp-content/uploads/2016/04/salmonberry-concept-plan_final.pdf

Wang, Y., Summers, R. D., & Hofmeister, R.J. (2002). *Landslide loss estimation pilot project in Oregon* (Open-File Report O-02-05). Portland, OR: Oregon Department of Geology and Mineral Industries. Retrieved from http://www.oregongeology.org/pubs/ofr/O-02-05.pdf

White, A., et al. (2006). *Tillamook County community wildfire protection plan*. [Prepared for Tillamook County]. Tillamook, OR: Oregon Department of Forestry. Retrieved from http://www.oregon.gov/ODF/Documents/Fire/CWPP/Tillamook.pdf

Witter, R. C., Zhang, Y., Wang, K., Priest, G. R., Goldfinger, C., Stimely, L. L., English, J. T., & Ferro, P. A. (2011). *Simulating tsunami inundation at Bandon, Coos County, Oregon, using hypothetical Cascadia and Alaska earthquake scenario* [Oregon Department of Geology and Mineral Industries Special Paper 43]. Retrieved from http://www.oregongeology.org/pubs/sp/p-SP-43.htm.

Wolfe, E. W., & Pierson, T. (1995). *Volcanic-hazard zonation for Mount St. Helens, Washington, 1995* (Open-File Report, 95-497). Reston, VA: US Geological Survey. Retrieved from http://pubs.usgs.gov/of/1995/0497/

Woolley, L., et al. (2011). *Final draft: Adapting to coastal erosion hazards in Tillamook County: Framework plan*. [Prepared for Tillamook County]. Salem, OR: Department of Land Conservation and Development. Retrieved from http://www.neskowincommunity.org/Adaptation%20Plan%20Final%20Draft%2010%20Jun%202011%20(2).pdf

VI. APPENDICES

A. Risk Assessment

Multi-Hazard Risk Report for Tillamook County including the Cities of Bay City, Garibaldi, Manzanita, Nehalem, Rockaway Beach, Tillamook, Wheeler & Unincorporated Communities of Neskowin, Oceanside, Netarts, and Pacific City

Final Draft – December 1, 2016

DOGAMI

Multi-Hazard Risk Report

For Tillamook County including the Cities of Bay City, Garibaldi, Manzanita, Nehalem, Rockaway Beach, Tillamook, Wheeler & Unincorporated Communities of Neskowin, Oceanside, Netarts, and Pacific City

Final Draft – December 1, 2016

FEMA

Table of Contents

*Cover photo: Tillamook River, Tillamook River Road, December 22, 2014, following a 2-year flood event. Credit: Outlier Solutions, Inc., and LightHawk

Executive Summary

This report describes the methods and results of natural hazard risk assessments performed by the Oregon Department of Geology and Mineral Industries (DOGAMI) for the communities of Tillamook County. This effort was funded by Federal Emergency Management Agency (FEMA) Region 10 through its Risk Mapping Assessment and Planning (Risk MAP) Program. All data used to generate the results are provided in the Risk Assessment Database, which is distributed with this report. The Multi-Hazard Risk Report has two goals: (1) to provide a quantitative risk assessment that informs communities of their risks related to certain natural hazards and (2) interpret the results to identify specific mitigation opportunities (i.e. areas of mitigation interest) that the communities can act upon. State and local officials should use the summary information provided in this report in conjunction with the data in the Risk Assessment Database to:

- **Update local hazard mitigation plans and community comprehensive plans** – Planners can use risk information in the development or update of hazard mitigation plans, comprehensive plans, future land use maps, and zoning regulations. For example, zoning codes may be changed to better provide for appropriate land uses in high hazard areas.
- **Update emergency operations and response plans** – Emergency managers can identify low risk areas for potential evacuation and sheltering. Risk assessment information may show vulnerable areas, facilities and infrastructure for which planning for continuity of operations plans (COOP), continuity of government (COG) plans, and emergency operations plans (EOP) would be essential.
- **Communicate risk** – Local officials can use the information in this report to communicate with property owners, business owners, and other citizens about risks and areas of mitigation interest.
- **Inform the modification of development standards** – Planners and public works officials can use information in this report to support the adjustment of development standards for certain locations.
- **Identify mitigation projects** – Planners and emergency managers can use this risk assessment to determine specific mitigation projects. For example, a floodplain manager may identify critical facilities that need to be elevated or removed from the floodplain.

The risk assessment was performed using Esri's ArcGIS Desktop software. Two risk assessment approaches were used: (1) estimate damage (in dollar loss) to buildings from flood and earthquake scenarios using FEMA's Hazus-MH methodology, and (2) tally number of buildings, their value, and associated populations that are exposed to earthquake, flood, and tsunami inundation scenarios, or susceptible to varying levels of hazard from landslides, coastal erosion, and wildfire.

Results were broken out for the following geographic areas:

- Tillamook County (unincorporated areas)
- Community of Oceanside-Netarts
- City of Bay City
- City of Manzanita
- City of Rockaway Beach
- City of Wheeler
- Community of Neskowin
- Community of Pacific City
- City of Garibaldi
- City of Nehalem
- City of Tillamook

Selected Countywide Results

Total buildings: **27,371**

Total estimated building value: **$2.8 billion**

Cascadia Subduction Zone Magnitude 9.0 Earthquake Shaking[1]
Buildings (red tagged): 7,748
Buildings (yellow tagged): 1,870
Loss Estimate: $815 million

Cascadia Subduction Zone Magnitude 9.0 Tsunami Inundation
Number of buildings exposed: 5,167
Exposed building value: $561 million

100-year Flood Scenario
Number of buildings damaged: 1,999
Loss estimate: $26 million

Landslide (High and Very High-Susceptibility):
Number of buildings exposed: 7,906
Exposed building value: $779 million

Coastal Erosion (High-Hazard):
Number of buildings exposed: 609
Exposed building value: $117 million

Wildfire Results (High Risk):
Number of buildings exposed: 565
Exposed building value: $48 million

[1]*Excludes loss estimates to buildings within the Medium Tsunami Zone.*

Background

This natural hazard risk assessment was conducted by the Oregon Department of Geology and Mineral Industries (DOGAMI) in 2015-16. It was funded by Federal Emergency Management Agency (FEMA) Region 10 through its Risk MAP program (Cooperative Agreement EMW-2014-CA-00288). In addition to FEMA, DOGAMI worked closely with the Oregon Department of Land Conservation and Development (DLCD) and the Oregon Partnership for Disaster Resilience (OPDR) to complete the risk assessment and produce this report. All communities in the study area participated in the Tillamook County Multi-Jurisdiction Natural Hazard Mitigation Plan (NHMP), last updated in 2011. DLCD and OPDR have begun coordinating with communities on the next NHMP update, which will incorporate the findings from this risk assessment. The primary goal of the risk assessment is to inform communities of their risks to natural hazards and to enable them to act to reduce their risk.

Project Scope

A natural hazard risk assessment analyzes how a hazard impacts the built environment, population, and local economy. In natural hazard mitigation planning, risk assessments are the basis for developing mitigation strategies and actions. A risk assessment defines the impact of hazards and enhances the decision making process.

For this risk assessment, we took a quantitative approach and applied it to buildings and population. The decision to limit the project scope to buildings and population was driven by data availability, strengths and limitations of the risk assessment methodology, and funding availability. Depending on the natural hazard we used one of two methodologies: loss estimation or exposure. Loss estimation was modeled using methodology from Hazus-MH, a tool developed by FEMA for calculating damage to buildings from flood and earthquake. Exposure is a simpler methodology, where buildings are categorized based on their location relative to various hazard zones. To account for impacts on population, 2010 census data were associated with residential buildings.

A critical component of this risk assessment was a countywide building inventory that was developed from building footprint data and Tillamook County's tax assessor database. The other primary component is a suite of datasets that represent the best science for a variety of natural hazards. The geologic hazard scenarios were selected by DOGAMI staff based on their expert knowledge of the datasets – most of the datasets are DOGAMI publications. In addition to geologic hazards, wildfire was included by suggestion from FEMA. The following is a list of the natural hazards and the risk assessment methodology that was applied:

Cascadia Subduction Zone (CSZ) Earthquake and Related Hazards

- Earthquake Hazus-MH loss estimation from a CSZ Magnitude 9.0 event
- Tsunami exposure to five potential CSZ scenarios

Flood Risk Assessment

- Hazus-MH loss estimation to four recurrence intervals (10%, 2%, 1%, 0.2% annual chance)
- Exposure to 1% annual chance recurrence interval

Landslide Risk Assessment

- Exposure based on Landslide Susceptibility Index (low to very high)

Coastal Erosion Risk Assessment

- Exposure based on Coastal Erosion Zones (none to very high)

Wildfire Risk Assessment

- Exposure based on Fire Risk Index (low to high)

Study Area

The study area for this project is the entirety of Tillamook County, Oregon. Tillamook County is a coastal county located in the northwestern portion of the state and is bordered by Clatsop County on the north, Washington and Yamhill Counties on the east, Polk and Lincoln Counties on the south, and by the Pacific Ocean on the west. The total area of Tillamook County is approximately 1,125 square miles. A significant portion of the county is within the Tillamook State Forest, or managed as industrial forest land.

The geography consists of rocky and irregular coastline and dune-backed beaches that form the county's western boundary, stretches of coastal lowlands, and a heavily timbered interior that comprises the main span and several spurs of the Coast Range (TNHMP, 2011).

Principal industries are agriculture, lumber, fishing, and recreation. Dairy farms dominate the county's fertile valleys providing milk for the well-known Tillamook Dairy Co-op. Logging and lumbering are becoming a significant economic force due to the reforestation of most the "Tillamook Burn" area (TNHMP, 2011).

The population of Tillamook County is approximately 25,250 according to the 2010 census. The county seat and county's largest community is the City of Tillamook. All the communities in the study, incorporated and unincorporated, are located in the western portion of the county within a few miles of the Pacific Ocean. Included within this study area are the incorporated communities of Bay City, Garibaldi, Manzanita, Nehalem, Wheeler, Rockaway Beach, and Tillamook (**Figure 1**).

Also included are the unincorporated communities of Neskowin, Oceanside-Netarts, and Pacific City. These unincorporated communities were selected based on population size and density, which makes them distinct from the overall unincorporated county jurisdiction. The boundaries of the unincorporated communities are based on census block areas. DOGAMI considered using the administrative boundaries defined for Community Planning Advisory Committees (CPACs) as proxies for unincorporated communities, but determined that several CPAC areas were too small to produce useful results – building sample sizes would be too small to responsibly characterize losses and exposure relative to other communities. It was also determined that the census block-based areas are very similar to the CPAC boundaries for larger unincorporated communities that were included.

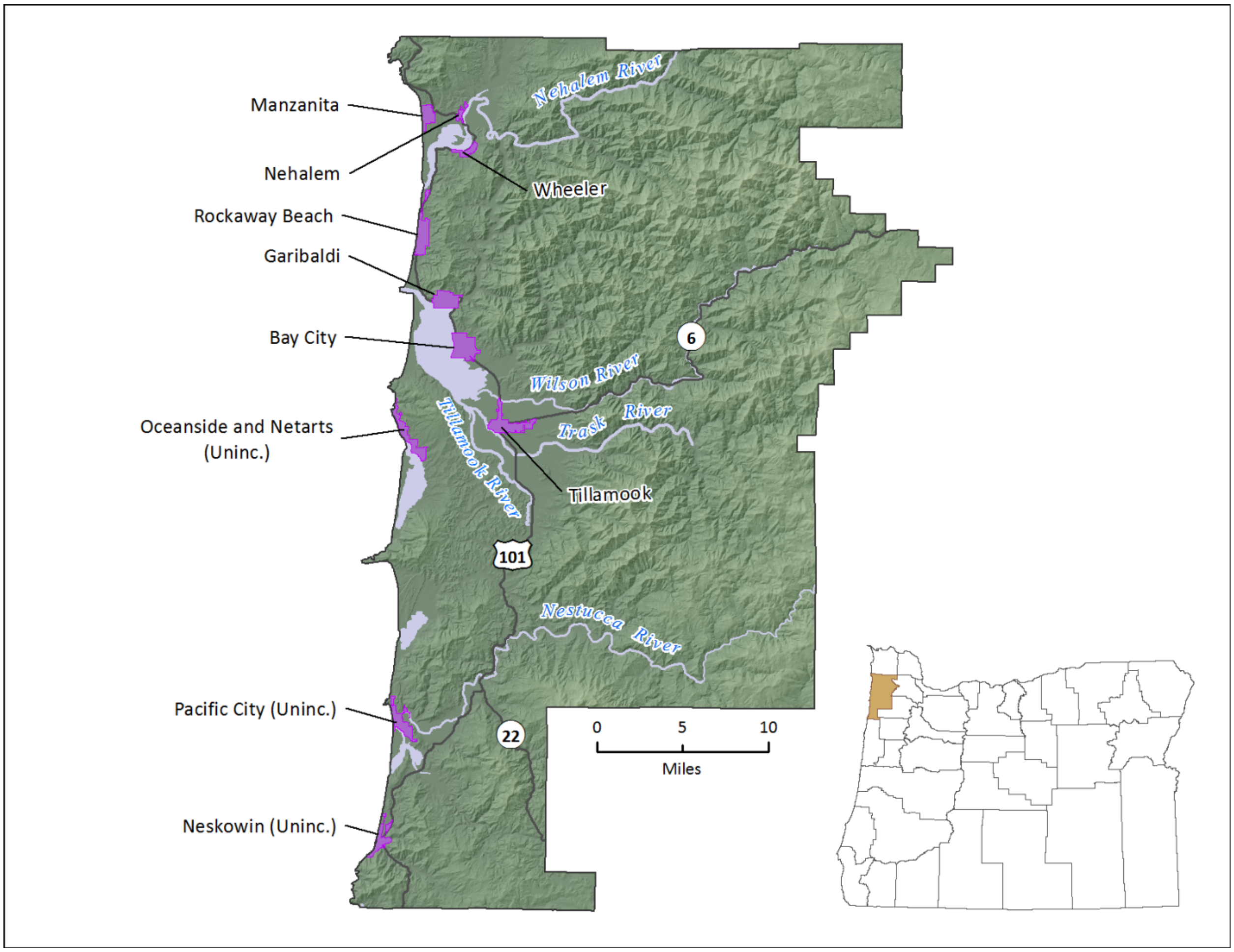


Figure 1: Study area with communities identified.

Natural Hazard Risk Assessment

HAZUS-MH Loss Estimation

Hazus-MH is a nationally applicable and standardized methodology that contains models for estimating potential losses from earthquakes, floods and hurricanes. Hazus-MH was developed by FEMA and uses Geographic Information Systems (GIS) technology to estimate physical, economic and social impacts of disasters (FEMA Hazus, 2015).

Defined Terms:

- *Loss estimation:* Damage that occurs to a building in an earthquake or flood scenario, as modeled with Hazus-MH methodology.
- *Loss ratio:* Percentage of estimated loss relative to the total replacement value of a building.
- *Damage function or curve:* A formula that represents the relationship between a given hazard parameter(s) (e.g. depth of flooding) and the estimated loss to a building.
- *Replacement cost:* Monetary amount to restore a building to its pre-loss value. This term is used in the context of Hazus loss estimation.

Hazus-MH is used for mitigation and recovery, as well as preparedness and response. Government planners, GIS specialists, and emergency managers use Hazus-MH to estimate potential losses and then determine the most beneficial mitigation approaches to minimize them. Hazus-MH can be used in the risk assessment phase of the mitigation planning process, which is the foundation for a community's long-term strategy to reduce disaster losses and break the cycle of disaster damage, reconstruction and repeated damage (FEMA Hazus, 2015).

Hazus-MH can be used in different modes depending on the level of detail required. Given the high spatial precision of the natural hazard data, DOGAMI chose the user-defined facility (UDF) mode. This mode makes loss estimations for individual buildings relative to their replacement cost, which DOGAMI then aggregates to the community level to report loss ratios.

Damage functions are at the core of Hazus-MH. The damage functions stored within the Hazus-MH data model were developed and calibrated from the observed results of past disasters. Estimates of loss are made by intersecting building locations with natural hazard layers and applying damage functions based on the hazard severity and building characteristics.

DOGAMI used Hazus-MH version 2.2, which was the latest version available at the outset of this risk assessment.

Exposure

Exposure is the straightforward methodology of tallying the buildings and population that are within a natural hazard zone. This is an alternative for natural hazards that do not have readily available damage functions and, therefore, loss estimation is not possible. Exposure results are communicated in terms of total building value exposed, rather than replacement cost, since the loss ratio is unknown.

Defined Terms:

- *Exposure:* Determination of whether a building is within or outside of a hazard zone. No loss estimation is modeled.
- *Building value:* Total monetary value of a building. This term is used in the context of exposure.

Exposure is used for landslide, tsunami, coastal erosion, and wildfire. For comparison with loss estimates, exposure is also used for the 1% annual chance flood.

Building Inventory

A key piece of the risk assessment is the countywide building inventory. This inventory consists of all buildings larger than 500 square feet, as determined from building footprints or tax assessor data. **Figure 2** shows an example of occupancy types of Tillamook County's building inventory used in the Hazus and exposure analyses. See also **Plates 1 and 2** in **Appendix D**.

To use building location points within the Hazus-MH methodology, DOGAMI migrated the building inventory into a UDF database with standardized field names and attribute domains. The UDF database formatting allows for the correct damage function to be applied to each building. See Hazus-MH Technical Manual 2.1 for reference of acceptable field names, field types, and attributes. **Table 1** shows the distribution of building count and value within the UDF database for Tillamook County. A table detailing the occupancy class distribution by community is included in **Appendix A**.

Table 1. Tillamook County building inventory.

Community	Total Number of Buildings	Percentage of Buildings	Total Estimated Building Value ($)	Percentage of Building Value
Unincorp. County (rural)	15,015	56%	1,282,436,000	46%
Neskowin	653	2%	118,463,000	4%
Oceanside-Netarts	1,701	6%	203,363,000	7%
Pacific City	1,707	6%	212,062,000	8%
Total Unincorp. County	19,076	70%	1,816,324,000	65%
Bay City	884	3%	74,769,000	3%
Garibaldi	755	3%	64,331,000	2%
Manzanita	1,523	6%	259,780,000	9%
Nehalem	260	1%	24,887,000	1%
Rockaway Beach	2,240	8%	211,809,000	8%
Tillamook	2,270	8%	322,398,000	11%
Wheeler	363	1%	30,556,000	1%
Total Tillamook County	27,371	100%	2,804,854,000	100%

Essential facilities were identified within the UDF database so that they could be highlighted in the results. Most essential facilities were available from DOGAMI's Statewide Seismic Needs Assessment (Lewis, 2007). Essential facilities in this risk assessment include hospitals, schools, fire stations, police stations, emergency operations, and military facilities. Essential facilities are important to note because these facilities play a crucial role in recovery efforts. Communities that have essential facilities which can function during and immediately after a natural disaster are more resilient than those with essential facilities that are inoperable after a disaster. **Table 2** shows the essential facilities on a community basis. In addition, a list of individual essential facilities can be found in each of the community profiles.

Table 2. Tillamook County essential facilities inventory.

Community	*(all dollar amounts in thousands)*											
	Hospital		School		Police/Fire		Emergency Services		Military		Total	
	Building Count	Building Value ($)	Building Count	Building Value ($)	Building Count	Building Value ($)	Building Count	Building Value ($)	Building Count	Building Value ($)	Building Count	Building Value ($)
Unincorp. County (rural)	-	-	9	30,708	7	4,279	1	4,879	-	-	17	39,866
Neskowin	-	-	-	-	-	-	-	-	-	-	-	-
Oceanside-Netarts	-	-	-	-	2	492	-	-	-	-	2	492
Pacific City	-	-	-	-	1	227	-	-	-	-	1	227
Total Unincorp. County	-	-	9	30,708	10	4,998	1	4,879	-	-	20	40,585
Bay City	-	-	-	-	1	231	-	-	-	-	1	231
Garibaldi	-	-	1	1,294	1	816	-	-	1	1,268	3	3,378
Manzanita	-	-	-	-	1	289	-	-	-	-	1	289
Nehalem	-	-	1	3,278	1	341	-	-	-	-	2	3,619
Rockaway Beach	-	-	-	-	2	209	-	-	-	-	2	209
Tillamook	1	10,960	6	19,109	2	570	1	871	-	-	10	31,510
Wheeler	-	-	-	-	-	-	-	-	-	-	-	-
Total Tillamook County	1	10,960	17	54,389	18	7,454	2	5,750	1	1,268	39	79,821

[1]*Facilities with multiple buildings were consolidated into 1 individual building.*

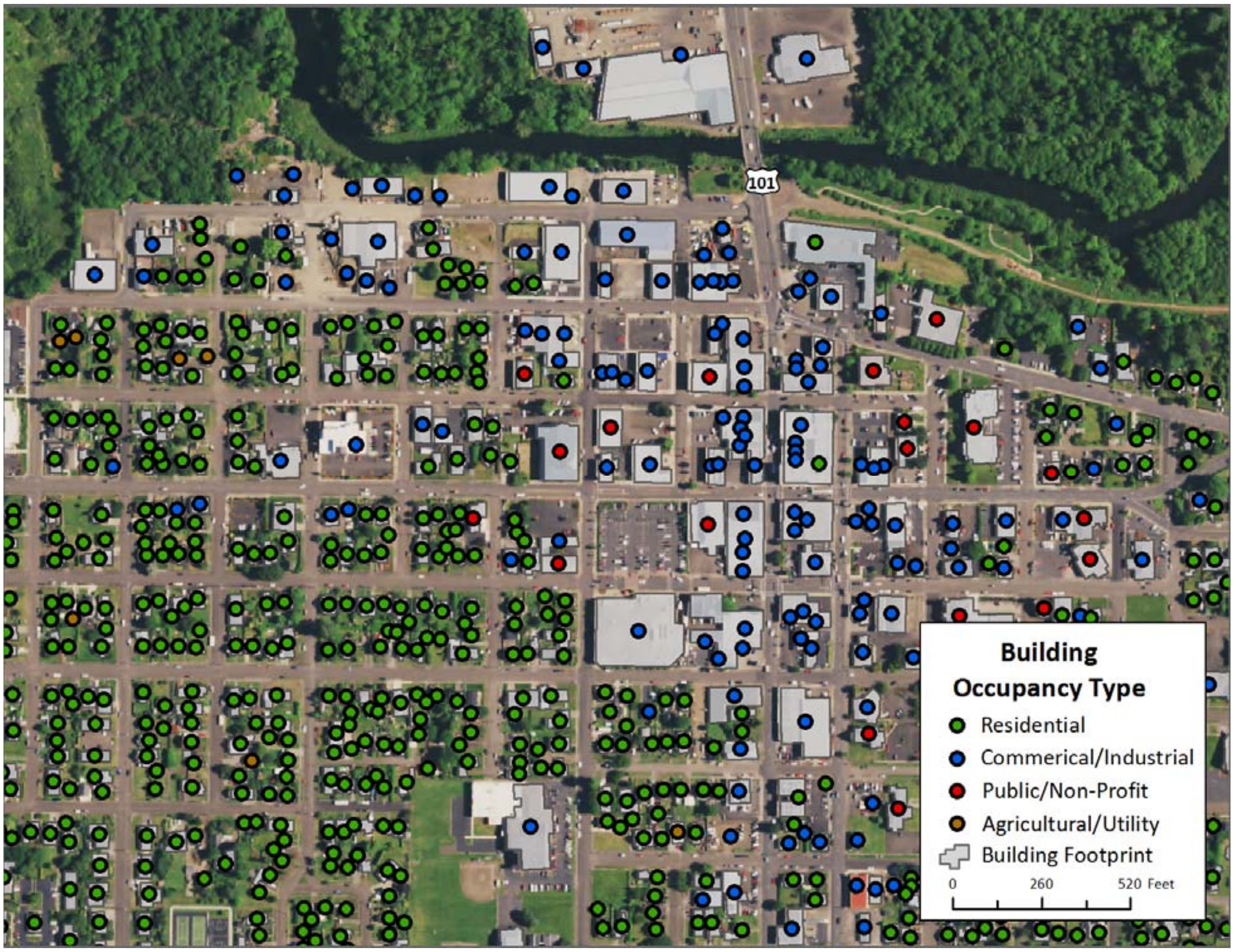


Figure 2: User-defined facilities (UDF) database, City of Tillamook.

The building inventory was developed from several data sources and was refined for use in loss estimation and exposure analyses. A database of building footprints for a significant portion of Tillamook County was already available from a previous DOGAMI project. Buildings were digitized from high resolution lidar collected in 2009 and 2011. The building footprints provide a spatial location and 2D representation of a structure. Locally supplied assessor data was formatted for use in the risk assessment. The assessor data contains an array of information about each improvement (i.e. building). Taxlot data, which contains property boundaries and other information regarding the property, was obtained from the county assessor and was used to link buildings with assessor data. The linkage between the two results in a database of building location points which contain attributes for each building. These points are used in the risk assessments for both loss estimation and exposure analysis. **Figure 3** illustrates the variation of building value and occupancy across the communities of Tillamook County.

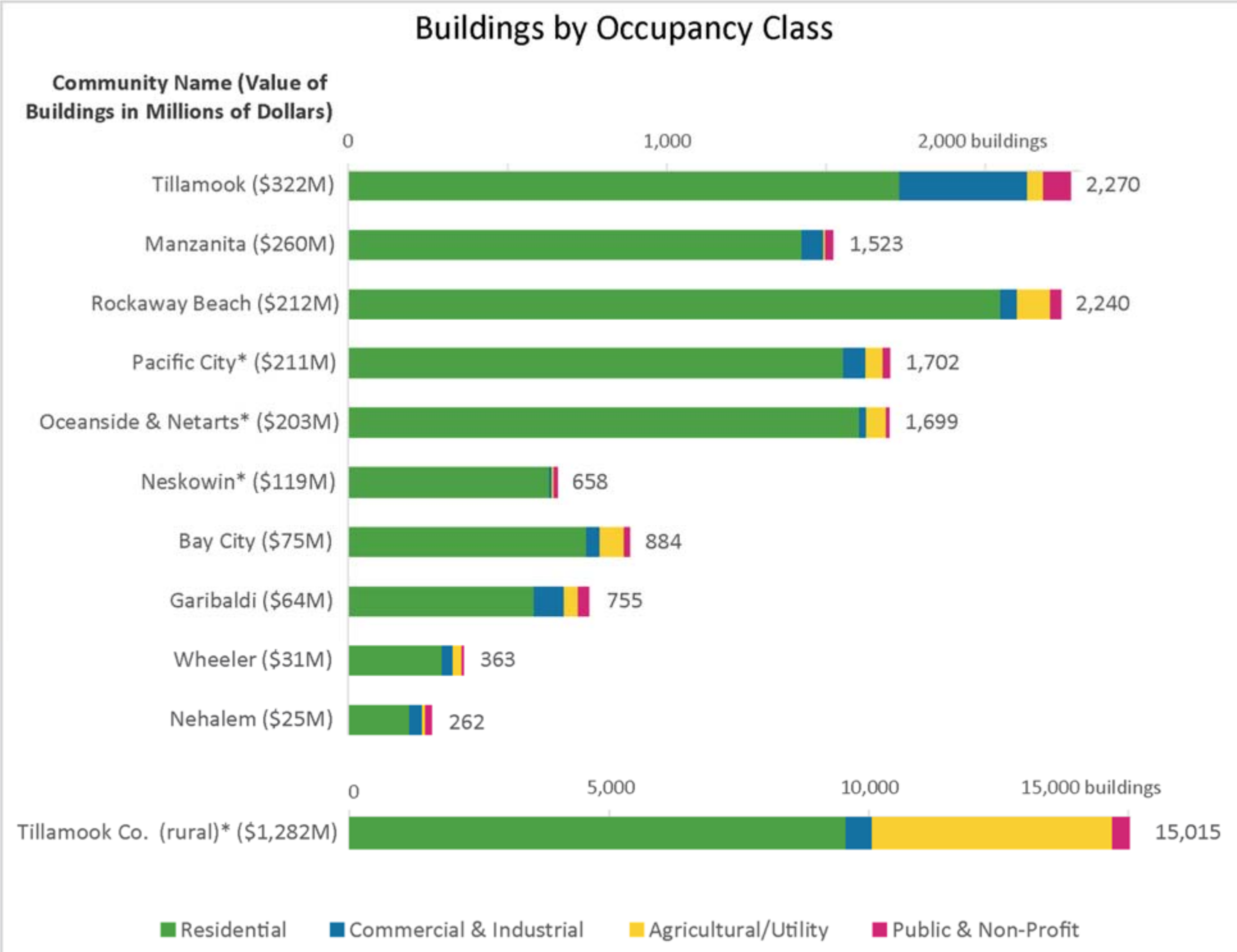


Figure 3: Building value by occupancy class.
**Unincorporated communities. Note that "Tillamook Co. (rural)" excludes incorporated communities, Pacific City, Oceanside/Netarts, and Neskowin.*

Principal Attributes:

Listed below are the required attributes for the Hazus-MH UDF database. Hazus-MH attribute defaults were used when information was not available or unreliable.

- **Longitude** (*flood, earthquake*) – Determines the x-position of the UDF point. This must be in decimal degrees. Derived from GIS processing of DOGAMI's building footprints.
- **Latitude** (*flood, earthquake*) – Determines the y-position of the UDF point. This must be in decimal degrees. Derived from GIS processing of DOGAMI's building footprints.
- **Occupancy Class** (*flood, earthquake*) – A coded value that indicates the use of the building (e.g. 'RES1' is a single family dwelling). Determines the applied damage function for flood analysis. Used to attribute the Building Type field for the earthquake analysis. Obtained from county assessor data.
- **Cost** (*flood, earthquake*) – The monetary value of an individual building. Loss ratio is derived from this value. Obtained from county assessor data.
- **Year Built** (*earthquake*) – The year that the structure was built. Used to attribute the Building Design Level field for the earthquake analysis. Obtained from county assessor data.

- **Square Feet** (*building inventory*) – The size of the building. Used to pro-rate the total taxlot value for taxlots with multiple buildings. Also used to pro-rate the Number of People field for residential buildings within a census block. Obtained from county assessor data or DOGAMI's building footprints.
- **Number of Stories** (*flood*) – The number of floors for an individual building. Along with Occupancy Class, it determines the applied damage function for flood analysis. Obtained from county assessor data.
- **Foundation Type** (*flood*) – The type of foundation of a building. This correlates with a First Floor Height values (***see Table 3.11*** in the Hazus-MH Technical Manual for the Flood Model). It functions within the flood model by indicating if a basement exists or not. Specific damage functions are applied to buildings with basements. Obtained from county assessor data.
- **First Floor Height** (*flood*) – The height in feet above grade for the lowest habitable floor. The height is factored during the depth of flooding analysis. Derived from Foundation Type attribute or observation via oblique imagery or Google Street Maps.
- **Building Type** (*earthquake*) – Determines the construction material and structural integrity of an individual building. This attribute is factored in when calculating earthquake damage. Unavailable from the county assessor data, so instead derived from the default general building stock in Hazus and applied based on the Occupancy Class attribute.
- **Building Design Level** (*earthquake*) – Determines the seismic building code for an individual building. This attribute is factored in when calculating earthquake damage (*see "Seismic Building Codes" section below*). Derived from the Year Built attribute and local Seismic Building Code benchmark years.
- **Number of People** (*flood, earthquake*) – The estimated number of permanent residents living within an individual residential structure. Used in the post-analysis phase to determine the amount of people affected by a given hazard (*see "Population" section below*). Derived from default Hazus database of population per census block and distributed across residential buildings.
- **Community** (*flood, earthquake*) – The community that a building is within. Used in the post-analysis for reporting results. Derived from an intersection of community areas and building locations in GIS.

Population

Within the UDF database, the population reported per census block were distributed amongst residential buildings, pro-rated based on the square footage. Note that due to lack of information within the assessor and census databases this distribution also includes vacation homes, which in many of the coastal communities make up a large but unknown percentage of the total residential building stock.

Using this distribution DOGAMI estimated the number of permanent residents that could be affected by a natural hazard scenario. For each natural hazard, with the exception of the CSZ earthquake shaking scenario, a simple exposure was used to find the number of potentially displaced residents within a hazard zone. For the CSZ earthquake scenario the potentially displaced residents were based on a combination of residents exposed to tsunami and those in buildings estimated to be significantly damaged by the earthquake.

Seismic Building Codes

The years that seismic building codes are enforced within a community, called "benchmark" years, have a great effect on the results produced from the Hazus-MH earthquake model. Oregon initially adopted seismic building codes in the mid-1970's. The established benchmark years of code enforcement are used in determining a "design level" for individual buildings. The design level attributes (pre-code, low-code, moderate-code, and high-code) are used in the Hazus earthquake model to determine what damage functions are applied to a given building. The year built or the year of the most recent seismic retrofit are the main considerations for an individual design level attribute. Seismic retrofitting information for structures would be ideal for this analysis but was not available for Tillamook County. The information in the **Table 3** outlines the various benchmark years that apply to buildings within Tillamook County.

Table 3. Tillamook County seismic design level benchmark years.

Building Type	Year Built	Design Level	Basis
Single Family Dwelling (includes Duplexes)	Prior to 1976	Pre Code	Interpretation of Judson (Judson, 2012)
	1976-1991	Low Code	
	1992-2003	Moderate Code	
	2004 - Present	High Code	
Manufactured Housing	Prior to 2003	Pre Code	Interpretation of OR BCD 2002 Manufactured Dwelling Special Codes
	2003-2010	Low Code	
	2011 - Present	Moderate Code	Interpretation of OR BCD 2010 Manufactured Dwelling Special Codes Update
All other buildings	Prior to 1976	Pre Code	Business Oregon (BO) 2014-0311 Oregon Benefit-Cost Analysis Tool, p. 24 (Business Oregon, 2013)
	1976-1990	Low Code	
	1991 - Present	Moderate Code	

Table 4 and corresponding **Figure 4** illustrate the current state of seismic building codes for the county.

Table 4. Seismic design level in Tillamook County.

Community	Total Number of Buildings	Pre-Code		Low-Code		Moderate-Code		High-Code	
		Number of Buildings	Percentage of Buildings	Number of Buildings	Percentage of Buildings	Number of Buildings	Percentage of Buildings	Number of Buildings	Percentage of Buildings
Unincorp. County (rural)	15,015	8,366	56%	2,607	17%	3,310	22%	732	5%
Neskowin	653	338	52%	107	16%	144	22%	64	10%
Oceanside-Netarts	1,701	719	42%	296	17%	433	25%	253	15%
Pacific City	1,707	767	45%	275	16%	435	25%	230	13%
Total Unincorp. County	19,076	10,190	53%	3,285	17%	4,322	23%	1,279	7%
Bay City	884	543	61%	141	16%	131	15%	69	8%
Garibaldi	755	534	71%	110	15%	86	11%	25	3%
Manzanita	1,523	509	33%	432	28%	431	28%	151	10%
Nehalem	260	172	66%	32	12%	27	10%	29	11%
Rockaway Beach	2,240	1,308	58%	322	14%	388	17%	222	10%
Tillamook	2,270	1,737	77%	193	9%	274	12%	66	3%
Wheeler	363	232	64%	43	12%	62	17%	26	7%
Total Tillamook County	27,371	15,225	56%	4,558	17%	5,721	21%	1,867	7%

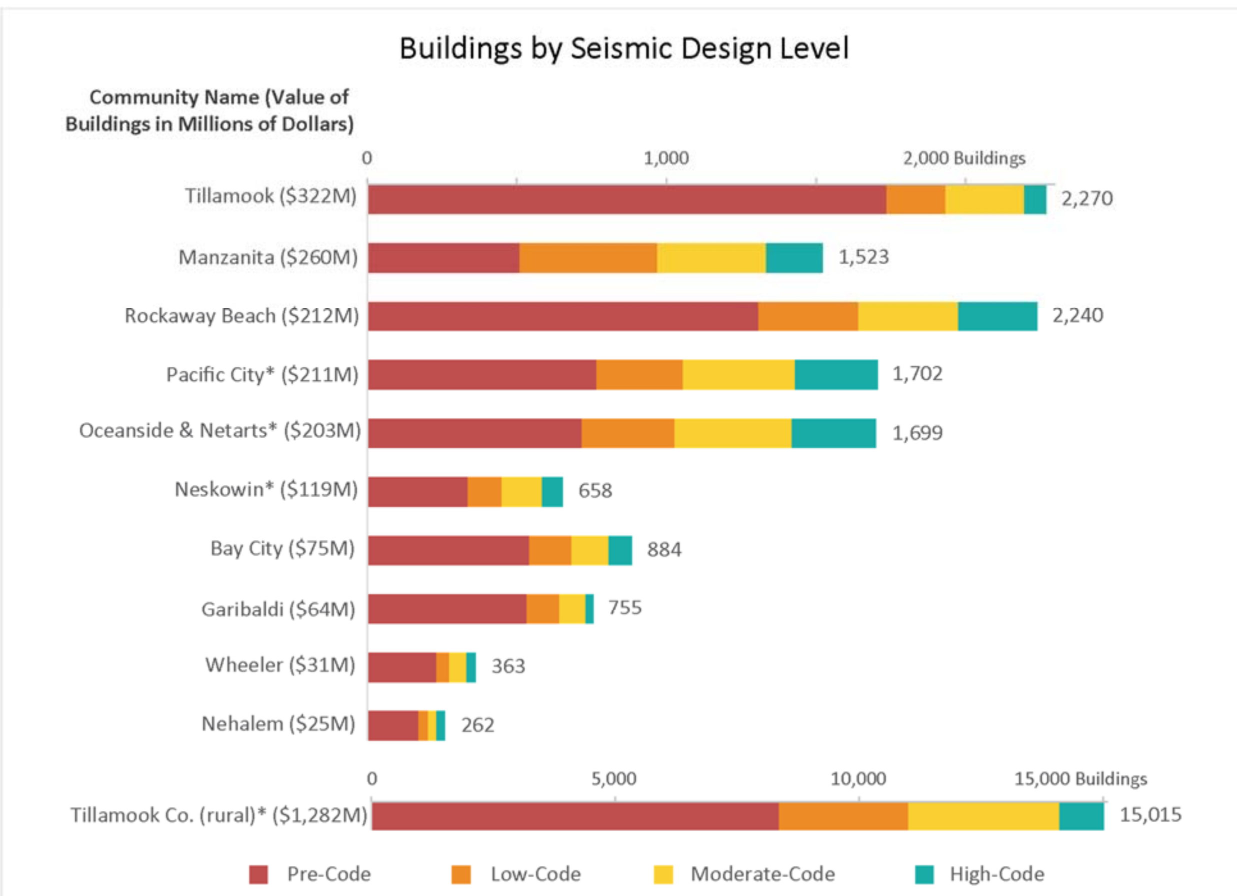


Figure 4: Seismic design level by community.

**Unincorporated communities. Note that "Tillamook Co. (rural)" excludes incorporated communities, Pacific City, Oceanside/Netarts, and Neskowin.*

Limitations

There are several limitations to keep in mind when interpreting the results of this risk assessment. The following is a list of weaknesses and opportunities for improvement.

- **Spatial and Temporal Variability of Natural Hazard Occurrence** – Flood, landslide, coastal erosion, and wildfire are extremely unlikely to occur at one time to the fully mapped extent of the hazard zones. For instance, areas mapped in the 1% annual chance flood zone will be prone to flooding on occasion in certain watersheds during specific events, but not all at once throughout the entire county or even the entire community. The possible exception is earthquake-induced landslides, however, potential ground failure due to landslide is captured as a component of the earthquake loss estimation.
- **Loss Estimation for Individual Buildings** – Hazus-MH is a model, not reality, which should be front-of-mind when considering the loss ratio of an individual building. Hazus-MH is not providing a site-specific analysis. On-the-ground mitigation, such as elevation of buildings to avoid flood loss, has been only minimally captured. Also, due to a lack of building material information, assumptions were made about the distribution of wood, steel, and un-reinforced masonry buildings. Loss estimation is most insightful when individual building results are aggregated to the community level, smoothing out the noise.
- **Loss Estimation Versus Exposure** – One should be cautious in their interpretation of exposure results. This is due to the spatial and temporal variability of natural hazards (described above) and the inability to perform loss estimations due to the lack of Hazus-MH damage functions. Exposure is reported in terms of total building value, which could imply a total loss of the buildings in a particular hazard zone, but this is not the case. Exposure is simply a tally of the number of buildings and their value and does not make estimates about the level to which an individual building could be damaged. We note the tsunami hazard as a possible exception, given the extreme and widespread damage inflicted on buildings in recent events in Japan and Sumatra.
- **Population Variability** – Many of the coastal communities in Tillamook County are popular vacation destinations, particularly during the summer. Our estimates of potentially displaced people rely on permanent populations published in the 2010 census. As a result, we are underestimating the number of people that may be in harm's way on a summer weekend. To address this, one could use permanent occupancy rates for residential buildings in a community with few vacation rentals and apply the rate to a vacation community to estimate population for a maximum occupancy scenario.

Hazards and Countywide Results

This risk assessment considers many of the natural hazard issues that pose a risk to Tillamook County. It illustrates some of the localized concerns, as well as widespread challenges that impact all communities. Through communicating loss estimation and exposure to various natural hazard scenarios, a greater understanding of the scale of disasters can be attained. Communities are encouraged to use this rich dataset to update plans and identify risk, so that they can work towards becoming more resilient to future disasters.

It should be noted that each natural hazard comes with its own classes of probability, levels of severity, calculated risk, and risk assessment methodology. Therefore, drawing comparisons between them is difficult. The focus should be on the individual communities and how they face differing levels of risk to these natural hazards.

In this section results are presented for the entire county. Individual community results are in the subsequent section. The "entire county" includes all unincorporated areas, unincorporated communities, and cities within Tillamook County.

Cascadia Subduction Zone Earthquake and Related Hazards

Oregon is affected by the CSZ where the Juan de Fuca plate slides underneath the North American plate. This convergent motion is resisted and potential energy at the plate boundary is built up until the overriding plate suddenly slips releasing a tremendous amount of energy as strong shaking spread over a wide area. Earthquakes along this giant fault zone occur on average every 400-500 years, and can be extremely large. It is because of these factors that the coastal areas of Oregon are especially vulnerable to earthquakes and tsunamis (ONHMP, 2015). Due to this risk potential, the CSZ event is the scenario used in our analysis.

During the CSZ earthquake, the suddenly shifting plate along the CSZ margin is likely to produce a very large tsunami that will have an impact along the Oregon Coast. This type of tsunami poses a significant risk to the low-lying coastal and estuarine developed areas of Tillamook County due to the CSZ's proximity to the shoreline, leaving little warning time. The tsunami inundation zone maps created by DOGAMI can serve as a tool for planning and mitigation efforts.

Another risk factor associated with the CSZ event is co-seismic subsidence (not examined in this report). According to DOGAMI Open-File Report O-97-05, a CSZ earthquake can result in coastal subsidence of up to several feet. A significant and permanent lowering of coastal terrain would expose buildings and infrastructure to tidal inundation in low lying coastal areas that were formerly above high tide. Low-lying developed areas near beaches and estuaries are most susceptible to this long-term hazard.

In this section earthquake and tsunami are examined together due to their strong relationship to one another as a result of a CSZ event. Their widespread effects and close association to one another present a challenge for planners to prepare for the CSZ event.

Earthquake

An earthquake is a sudden movement of a fault in the earth's crust, abruptly releasing strain that has accumulated over a long period of time. The movement along the fault produces waves of strong shaking that spread in all directions. Damage from liquefaction and landslides can be potential threats as a result of the shaking. If the earthquake occurs near populated areas, it may cause causalities, economic disruption, and extensive property damage. Oregon is underlain by a large and complex system of faults that can produce damaging earthquakes. Although smaller faults produce smaller earthquakes, they are often close to populated areas and damage can be extensive to nearby buildings (State of Oregon Natural Hazards Mitigation Plan [ONHMP], 2015).

Data Sources

Much of the hazard data inputs for the Hazus analysis were created for the 2012 Oregon Resilience Plan for Cascadia Subduction Zone Earthquakes (DOGAMI O-13-06, 2013). In conducting their vulnerability assessment, the seismic workgroup chose an earthquake scenario of magnitude 9.0 off the coast of Oregon along the subduction zone.

Hazus-MH offers two scenario methods for estimating damage from earthquake, probabilistic and deterministic. A probabilistic scenario uses U.S. Geological Survey (USGS) National Seismic Hazard Maps which are derived from seismic hazard curves calculated on a grid of sites across the US that describe the annual frequency of exceeding a set of ground motions as a result of all possible earthquake sources (USGS Earthquake Hazards Program, 2014). A deterministic scenario is based on a specific seismic event, which in this case is the CSZ magnitude (M) 9.0 event. The preferred method used in this study was the deterministic scenario, since the CSZ event is easily the biggest seismic risk to this area. This method was used along with the UDF database so that damage estimates could be calculated on a building-by-building basis.

The hazard layers derived from the work conducted in OFR O-13-06 and used for loss estimation were: peak ground acceleration (PGA), peak ground velocity (PGV), spectral acceleration at 1.0 second period and 0.3 second period (SA10 & SA03), permanent ground deformation (due to lateral spreading), permanent ground deformation (due to landslide), probability of liquefaction, and probability of landslide. **Figure 5** shows the intensity of peak ground acceleration from a CSZ M9.0 and the loss estimates by community for Tillamook County.

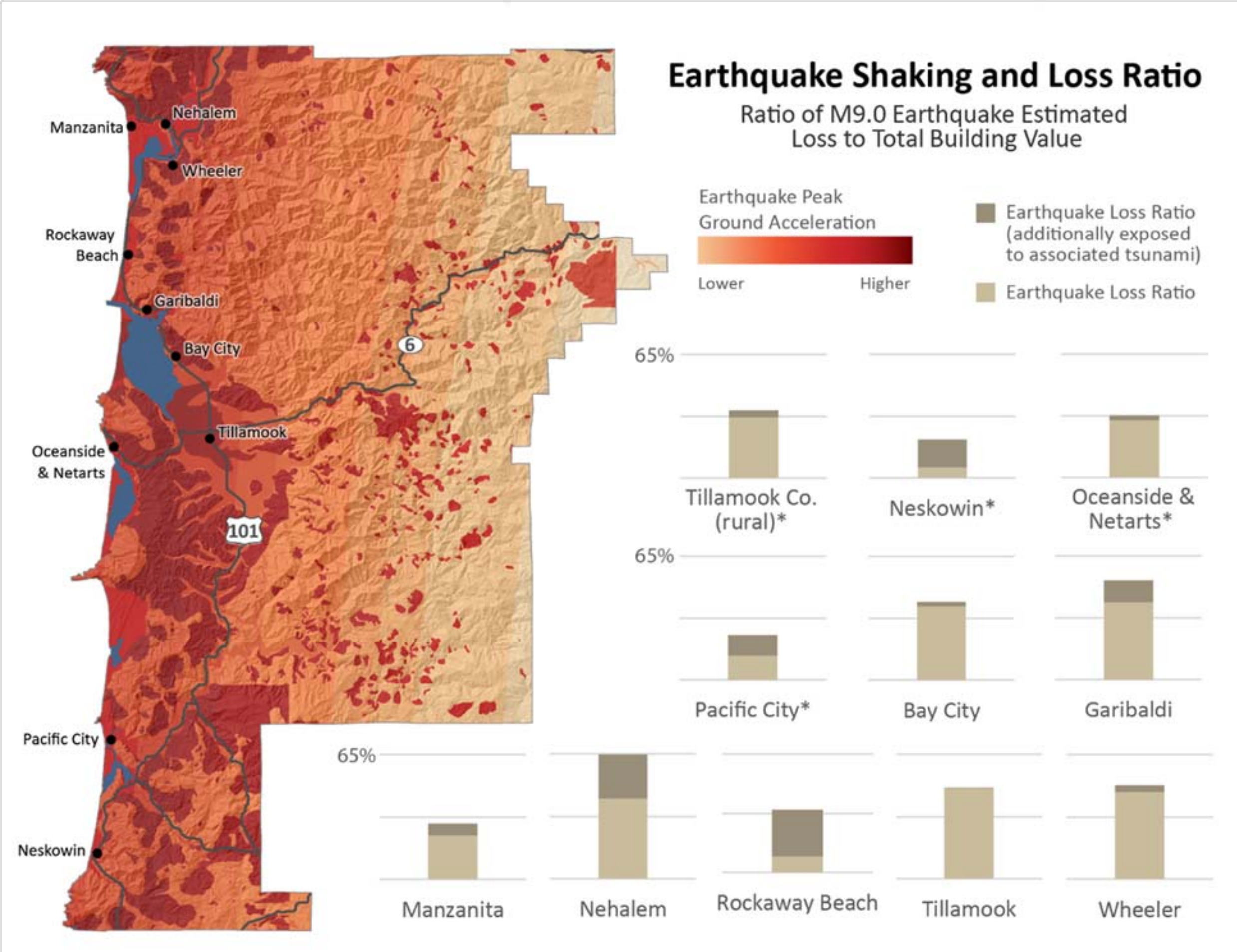


Figure 5: Earthquake loss ratio by community.
**Unincorporated communities. Note that "Tillamook Co. (rural)" excludes incorporated communities, Pacific City, Oceanside/Netarts, and Neskowin.*

Countywide Results

The CSZ event is highly likely to produce severe ground shaking and ground failure, as well as a large and swift moving tsunami. Due to the close relationship of these two natural hazards, the damage results have been parsed in order to avoid double counting. This is to say, that the damaged buildings within the (Medium-sized) tsunami zone are reported based on exposure only, while the buildings outside of the tsunami zone are reported based on Hazus earthquake damage estimates. Tsunami damages are assumed to be complete within the inundation area. Tsunami results are provided in the subsequent tsunami section.

Because an earthquake can simultaneously affect a wide area, it is unique from other hazards within this report since every building in Tillamook County, to some degree, will be affected by a CSZ magnitude 9.0 earthquake. Hazus damage estimates for each building are based on a formula where coefficients are multiplied to each of the five damage state percentages (none, low, moderate, extensive, and complete). This provides a loss ratio which is then multiplied to the total value resulting in a damage estimate. Once again, the damage estimates reported for earthquake are for buildings outside of the

(Medium-sized) tsunami inundation zone. **Figure 6** shows loss ratios from the CSZ event (tsunami and earthquake) for the communities of Tillamook County.

In keeping with earthquake damage convention, we implemented the federal color-tagging system to represent damage states. Red tagged buildings correspond to a Hazus damage state of complete, while yellow is the extensive damage state. The number of buildings in each damage state is based on an aggregation of probabilities per community and does not represent individual buildings.

Essential facilities were considered non-functioning if the Hazus earthquake analysis showed that a building or complex of buildings to be at least moderately damaged (>50%). The non-functioning essential facility numbers were only for buildings outside of the (Medium-sized) tsunami inundation zone, tsunami results are presented in the tsunami section below.

The number of potentially displaced residents from the CSZ earthquake was based on the number of red-tagged and a percentage of yellow tagged residences that were determined in the Hazus earthquake analysis results. The potentially displaced resident numbers were only for residences outside of the (Medium-sized) tsunami inundation zone, tsunami results are presented in the tsunami section below.

Tillamook Countywide CSZ M9.0 Earthquake Results:

- *Number of buildings (red tagged)*: 7,748
- *Number of buildings (yellow tagged)*: 1,870
- *Loss Estimate*: $814,900,000
- *Loss Ratio*: 29%
- *Essential Facilities*: 27
- *Potentially Displaced Population*: 7,037
- *Loss Estimate (Design level changed to at least moderate code)*: $635,958,000
- *Loss Ratio (Design level changed to at least moderate code)*: 23%

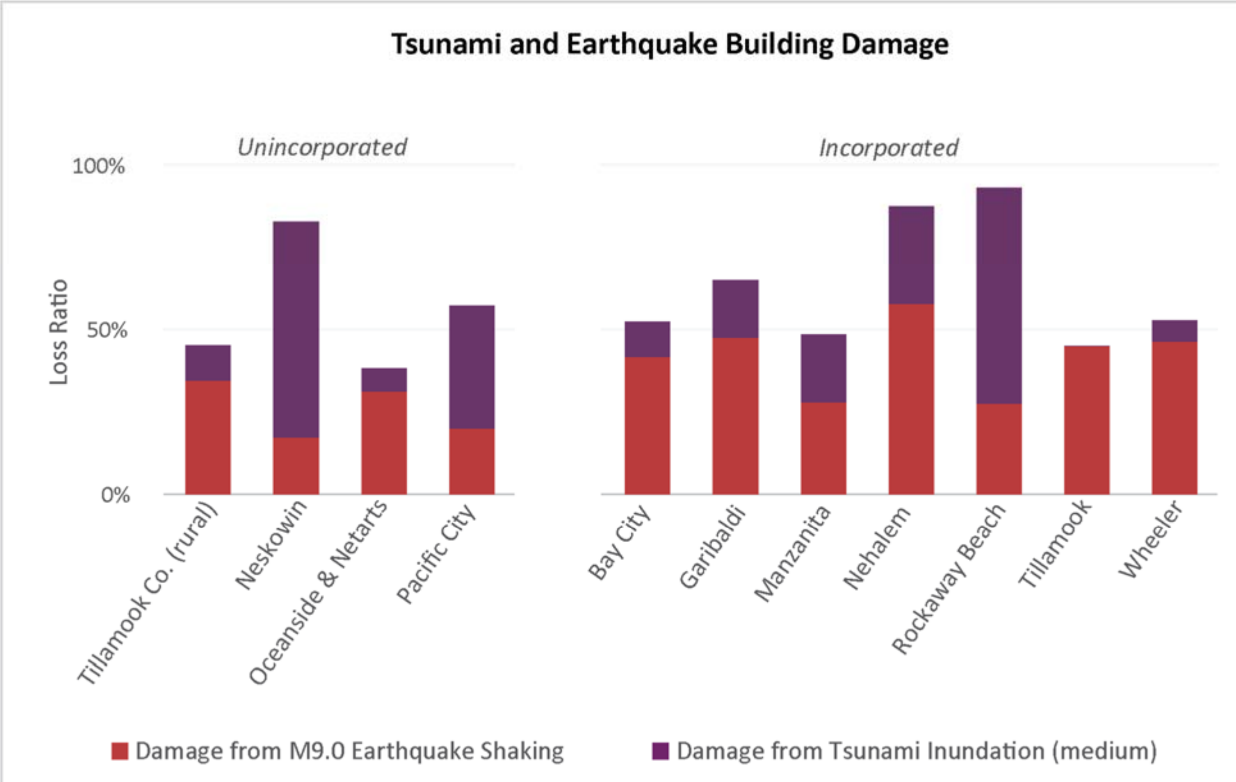


Figure 6: CSZ M9.0 event loss ratio, for both shaking and tsunami inundation.

The results indicate that Tillamook County would incur a significant amount of damage due to a CSZ M9.0 earthquake. These results are significantly influenced by heavy weighting of the seismic design level attribute. Seismic building codes were implemented in Oregon in the 1970's, as such, nearly 75% of buildings were built before "moderate" code enforcement. This factor, along with the proximity of Tillamook County to the CSZ subduction zone, results in high levels of damage.

If buildings could be updated to moderate or high code, the impact of this event can be greatly reduced. However, this is not true in all places, such as landslide or liquefaction areas, where building design level has less of an effect over damage estimates. **Figure 7** illustrates the reduction in damage from a CSZ 9.0 earthquake through seismic upgrading buildings to moderate and high code. Communities that are mostly within the tsunami hazard zone do not benefit from seismic upgrades as much as others.

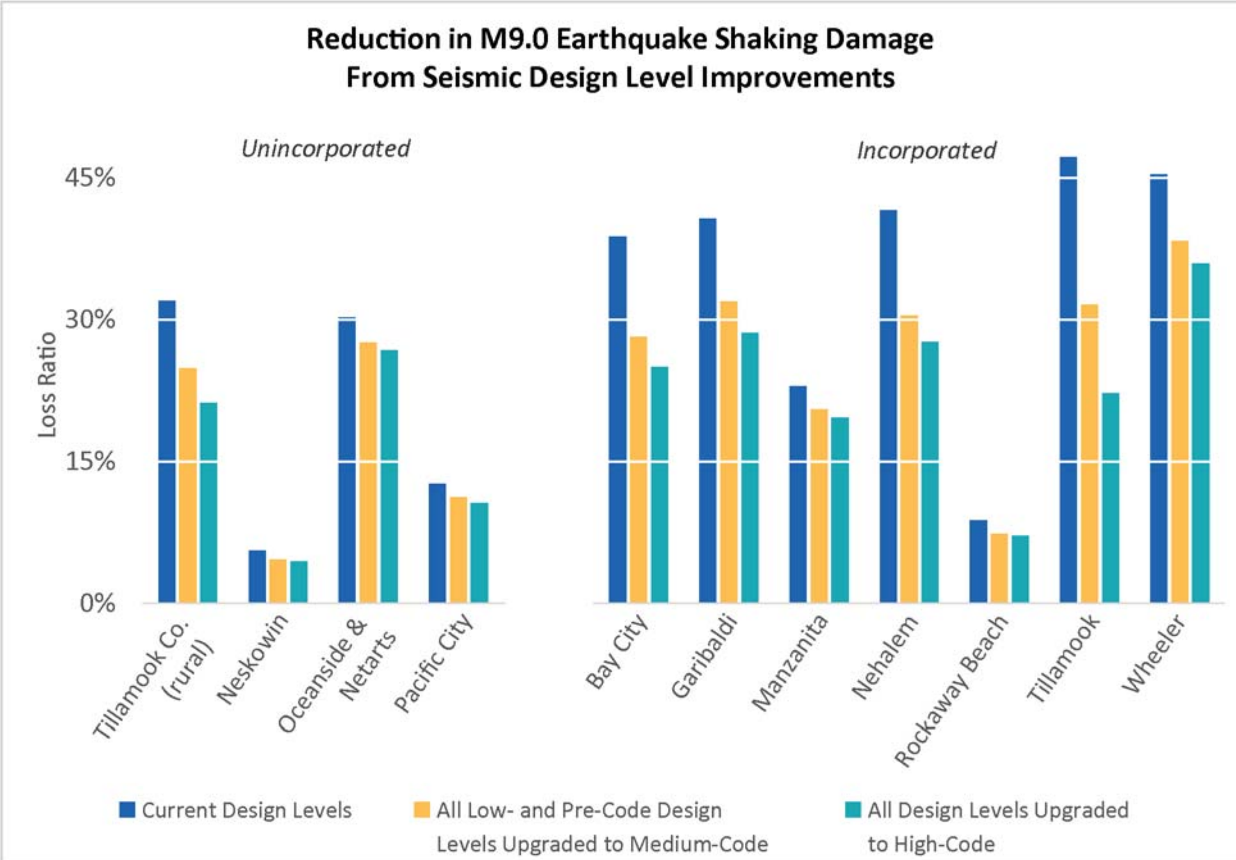


Figure 7: CSZ M9.0 earthquake loss ratio, with alternate seismic design level results.

Tsunami

Tsunamis are a low frequency natural hazard in Oregon and are restricted almost exclusively to coastal areas. Tsunamis are most often caused by the abrupt change in the seafloor accompanying an earthquake. The most common sources of the largest tsunamis are earthquakes that occur at subduction zones like the CSZ, where an oceanic plate descends beneath a continental plate. Other important processes that may trigger a tsunami include underwater volcanic eruptions and landslides (includes landslides that start below the water surface and landslides that enter a deep body of water from above the water surface). Tsunamis can travel thousands of miles across ocean basins, so that a particular coastal area may be susceptible to two different types of tsunami hazard caused by:

1. Distant sources across the ocean basin, and
2. Local sources that occur immediately adjacent to a coast (ONHMP, 2015).

Data Sources

The tsunami hazard data used in this report were originally from DOGAMI Open-File Report O-13-19. The data show areas of expected inundation from several local tsunami scenarios and two distant sources that were modeled in the OFR. The local tsunami scenarios used in this report for exposure analysis were CSZ “t-shirt” sizes of small (Sm), medium (M), large (L), extra large (XL), and extra-extra large (XXL). The distant source tsunami scenarios were not used in this report. Tsunami Inundation Maps were created for each of these scenarios.

The recurrence interval associated with each local source tsunami scenario is as follows:

- XXL: 1,200 years
- XL: 1,050 – 1,200 years
- L: 650 – 800 years
- M: 425 – 525 years
- Sm: 300 years

For this risk assessment, location of buildings and essential facilities were compared to the geographic extent of the local source tsunami inundation zones to assess the exposure for each community. The exposure results shown below are for the medium scenario only. The total dollar value of exposed buildings was summed for the study area and reported below. We were also able to estimate the number of people at risk from tsunami hazard. Refer to **Appendix A** to view the cumulative multi-scenario analysis results. **Figure 8** shows the extent of inundation from different tsunami scenarios due to the CSZ M9.0 earthquake within Tillamook County.

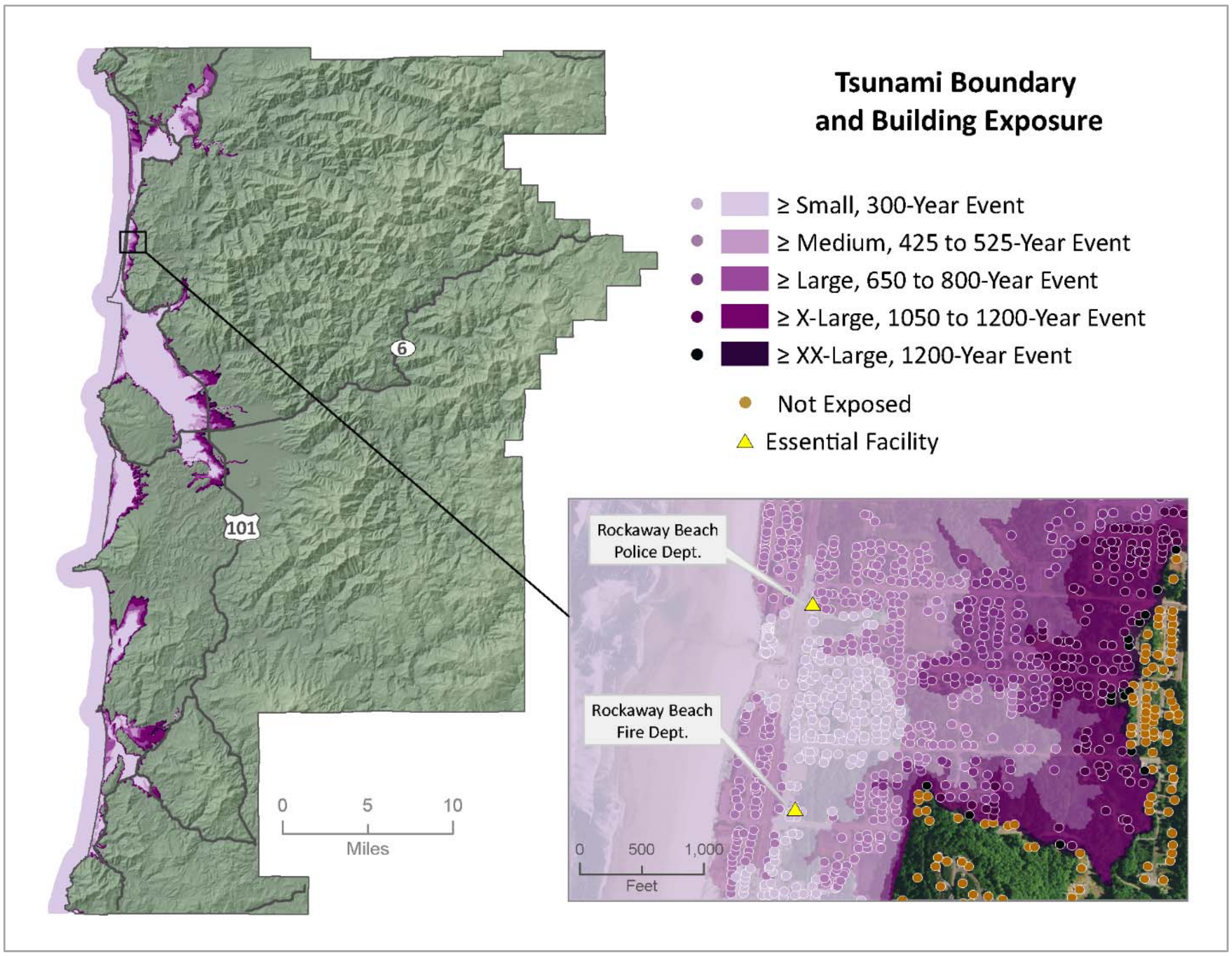


Figure 8: Tsunami inundation scenarios and building exposure example.

Countywide Results

Because every community in Tillamook County is near the Pacific Ocean, all communities in the county would be affected by the largest of DOGAMI's calculated tsunami scenarios. Most communities built along the open coast will be impacted from a tsunami; communities built along the bays and estuaries will be affected to a lesser extent.

The medium tsunami size was used as the primary scenario for reporting the tsunami results. According to OFR O-13-19, the medium tsunami is the most likely to occur from a CSZ event.

Tillamook Countywide CSZ M9.0 Tsunami Exposure (Medium):

- *Number of buildings exposed*: 5,167
- *Exposure Value*: $561,327,000
- *Ratio of Exposure Value*: 20%
- *Essential facilities exposed*: 6
- *Potentially Displaced Population*: 2,310

Approximately a third of the county's buildings have exposure to tsunami inundation from the medium predicted scenario. Tsunami hazard exists along the entire coast and estuarine areas of Tillamook County, which is important to be aware of for future planning and mitigation efforts in these areas (**Figure 9**). Two to three thousand permanent residents could be impacted from a CSZ sourced tsunami event, requiring services, like medical care and shelter.

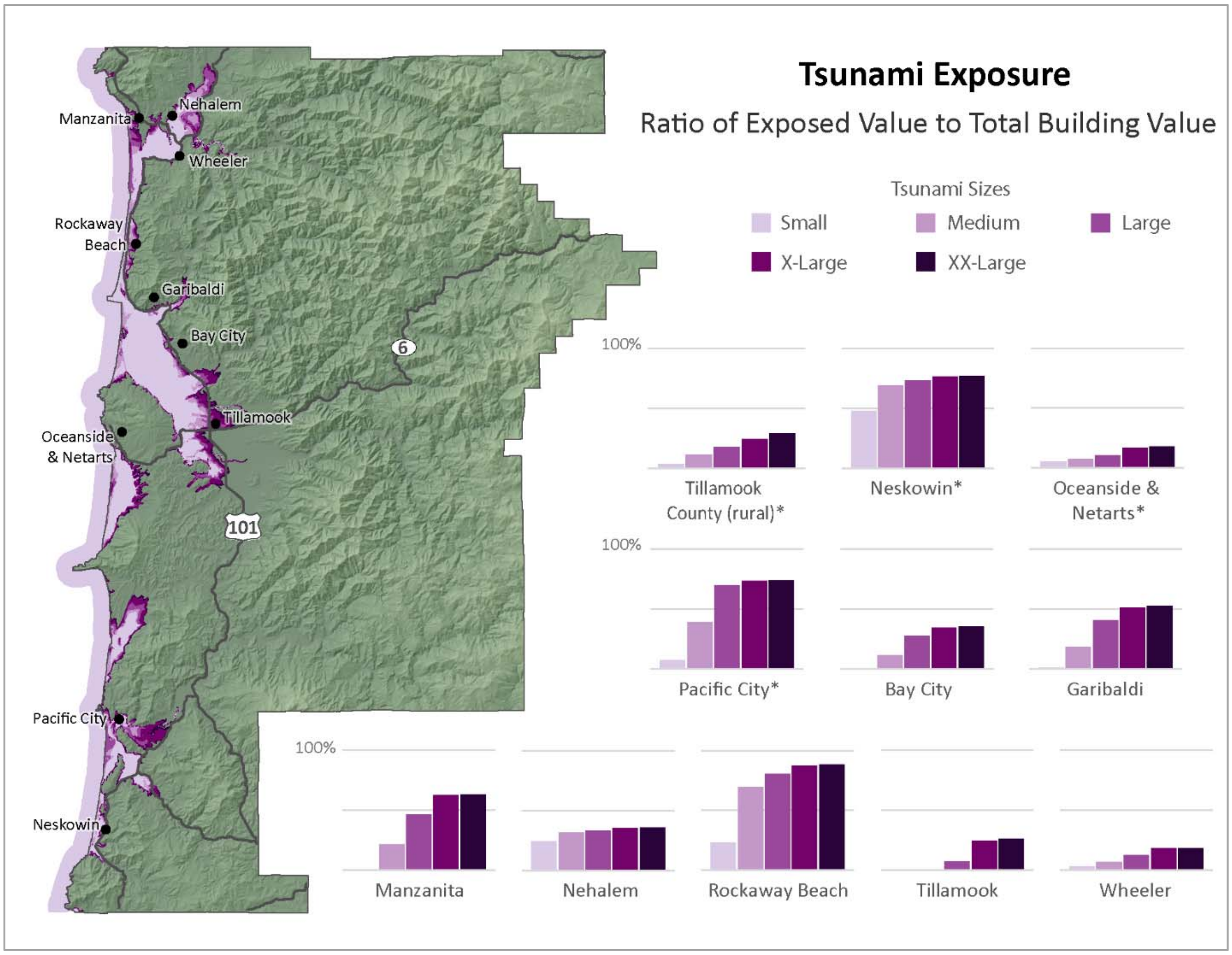


Figure 9: Tsunami inundation exposure by community.
**Unincorporated communities. Note that "Tillamook Co. (rural)" excludes incorporated communities, Pacific City, Oceanside/Netarts, and Neskowin.*

Flooding

Floods are naturally occurring phenomena that can and do happen almost anywhere. In its most basic form, a flood is an accumulation of water over normally dry areas. Floods become hazardous to people and property when they inundate an area where development has occurred, causing losses. They are the most common natural hazard in Tillamook County, and have created public health hazards, public safety concerns, closed and damaged major highways, destroyed railways, damaged structures, and caused major economic disruption (TNHMP, 2011). The most common method for determining flood risk is to identify the probability of flooding and the consequences of flooding. The probabilities calculated for flood hazard used in this report are 10%, 2%, 1%, and 0.2%, henceforth referred to as 10-year, 50-year, 100-year, and 500-year, respectively.

All the rivers in the county drain westward and, eventually, into the Pacific Ocean. The major rivers within the county are the Nehalem, Miami, Kilchis, Wilson, Trask, Tillamook, and Nestucca. All the listed rivers are subject to flooding and causing damage to buildings within the floodplain. Further flooding effects are due to coastal flooding from the Pacific Ocean for low-lying coastal developments and within

Tillamook County's five estuaries. Flooding is the most frequently occurring damage-causing natural hazard in Tillamook County.

The ability to assess the probability of a flood, and the level of accuracy of that assessment, is also influenced by modeling methodology advancements, better knowledge, and longer periods of record for the water body in question. The consequences of a flood are the estimated impacts associated with the flood occurrence. Consequences relate to humans activities within an area and how a flood impacts the natural and built environment. **Figure 10** displays the areas of Tillamook County that are subject to 100-year flooding.

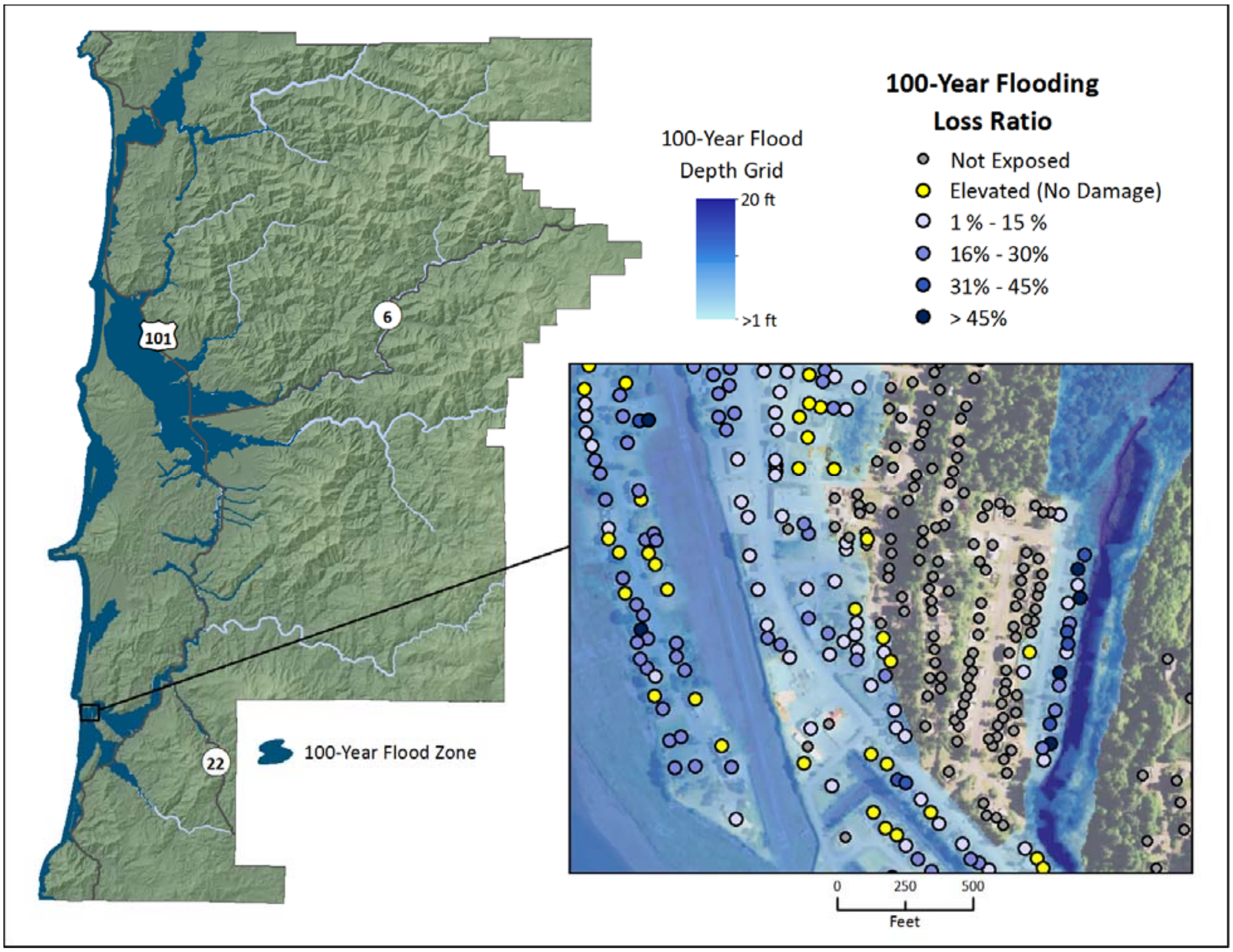


Figure 10: 100-year flood zone and building exposure example.

Data Sources

The Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRMs) for Tillamook County were updated in 2016, which included a recently completed study of coastal flooding; these were the primary data sources for the flood risk assessment. As of the completion of this report the FIS and FIRMs were draft, with release of preliminary products expected later in 2016. The currently effective FIS and FIRMs were adopted in 1978. Further information regarding NFIP related statistics can be found at FEMA's website: https://www.fema.gov/policy-claim-statistics-flood-insurance.

Depth grids, developed by DOGAMI in 2015 to revise the FIRMs, were used in this risk assessment to determine the level to which buildings are impacted by flooding. Depth grids are raster GIS datasets where each digital pixel value represents the depth of flooding at that location within the flood zone, as seen in **Figure 11**. Though considered draft at the time of this analysis, it is the best available flood hazard data. Depth grids for four riverine flooding scenarios (10-, 50-, 100- and 500-year) and one coastal scenario (100-year) were used for loss estimations and, for comparative purposes, exposure analysis.

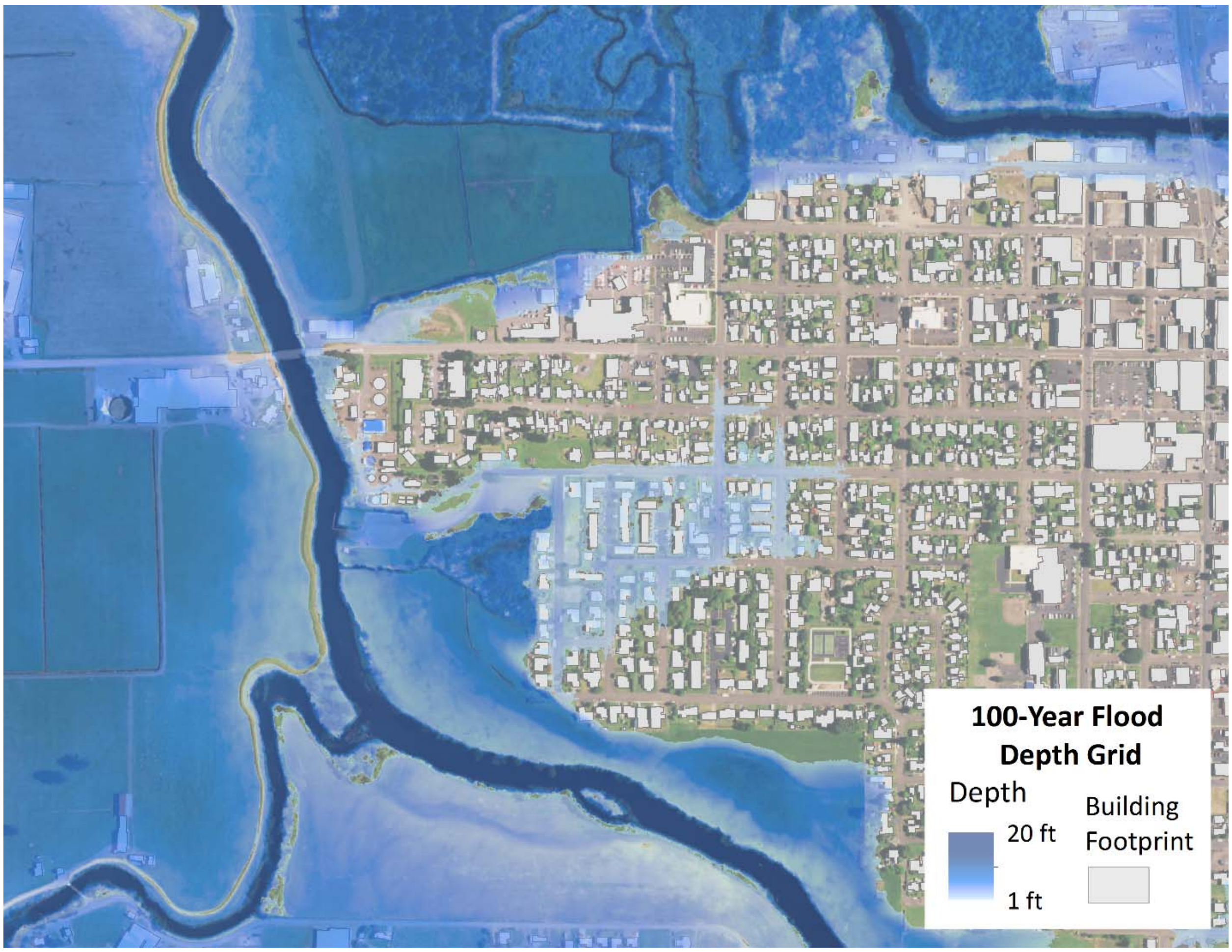


Figure 11: Flood depth grid example, City of Tillamook.

Depth damage functions (DDFs) are applied to buildings affected by flooding by intersecting buildings in the UDF database with flood depth grids. The key attributes used to apply DDF's were populated from local assessor data when available. For Tillamook County, occupancy type and basement presence attributes were available from the assessor database for most buildings. Depending on the quality and availability of oblique imagery, building information for number of stories, basement presence, first floor height, and foundation type can be estimated. Only buildings in a flood zone or within 500 feet of one were examined closely to attribute them with more accurate information. Since our analysis accounted for building first floor height, buildings that have been properly elevated above the flood level were not given a damage value nor were the residents in those structures counted as displaced.

For information about structures exposed to flooding but not damaged, please review the Exposure Analysis section below. Since individual building data were incorporated in the UDF database, it allowed for losses to be estimated at the building level. Damage estimates from flooding were also produced for all essential facilities. Based on the assumption that people cannot live in flood-damaged homes, the number of potentially displaced people is equivalent to the total number of occupants who currently live in buildings that are likely to be damaged during a given flood.

Countywide Results

Due to the many large rivers that drain Tillamook County and its proximity to the ocean, there are many issues within the county pertaining to flooding. The results of the loss estimates for the 100-year event are shown below.

The 100-year flood was used as the primary scenario for reporting the flood results. The twofold reason is that it has traditionally been used as a reference level for flooding and because it the standard probability that FEMA uses for regulatory purposes.

For this risk assessment, the countywide UDF data and depth grids were imported into Hazus-MH and a flood analysis was ran for the four flood scenarios. Only the 100-year results were reported below. Refer to **Appendix A** to view the multi-scenario cumulative results.

Tillamook Countywide 100-year Flood Loss:

- *Number of buildings damaged*: 1,999
- *Loss Estimate*: $25,831,000
- *Loss Ratio*: 0.9%
- *Damaged essential facilities*: 5
- *Potentially Displaced Population*: 1,322

Hazus Analysis

The loss estimate for 100-year flood for the entire county is approximately $25 million. Areas of the county in the floodplain and low-lying coastal zones are estimated to have more problems due to flood than other parts of the county. Both riverine and coastal flooding has significant impact to Tillamook County (**Figure 12**). Communities and other areas of the county that have a potential to flood might consider measures, such as elevating structures, to alleviate some of the problems caused by flooding. Communities that take steps to reduce the impact of flooding can greatly increase their resilience to flooding issues.

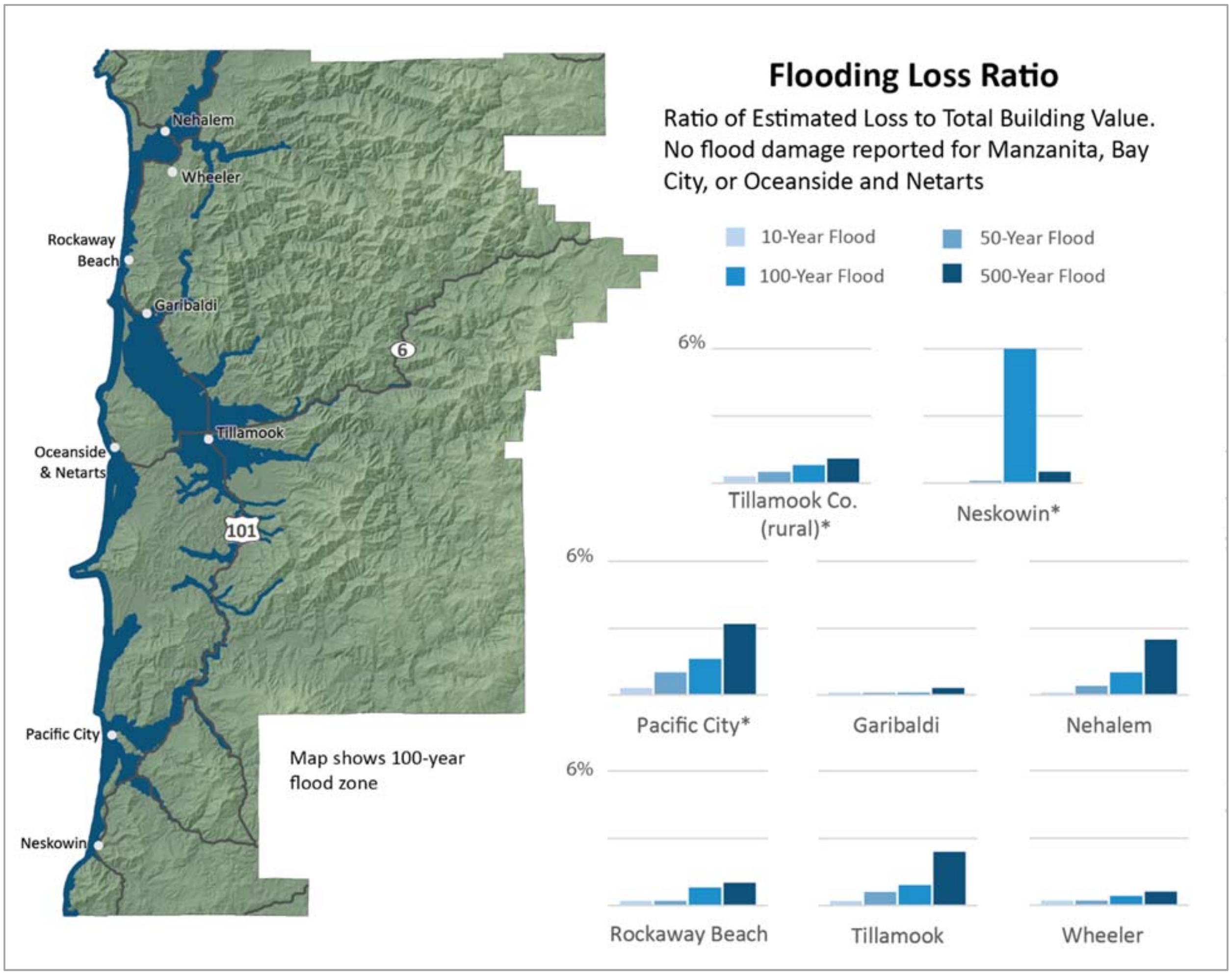


Figure 12: Flood loss estimates by community.
**Unincorporated communities. Note that "Tillamook Co. (rural)" excludes incorporated communities, Pacific City, Oceanside/Netarts, and Neskowin.*
Note: Coastal flooding information only available for the 100-year flood (non-cumulative results can occur, as seen in the community of Neskowin).

Exposure Analysis

Separate from the Hazus flood analysis, an exposure analysis was done by comparing building locations to the 100-year flood extent. A significant number of Tillamook County's buildings are within designated flood zones. By comparing Hazus damage estimates of zero against exposed buildings; we can estimate the number of buildings that could be elevated above the level of flooding. This comparison can also shed some light on the number of residents that might have immobility or non-access issues due to surrounding water. See **Table A-3** in **Appendix A** for community-based results of flood exposure.

Landslide Susceptibility

Landslides are downhill movements of rock, debris, or soil. Debris flow, shallow- and deep-seated landslides are the different types of landslides that occur within the state. The size of a landslide usually depends on the geology and the initial cause of the landslide (i.e. excessive moisture, earthquake, erosion, grading at bottom of slope, or adding loads on top of slope). Some characteristics that determine the type of landslide are slope of the hillside, moisture content, and the nature of the underlying materials. Landslides can cause severe damage to buildings and infrastructure. Fast-moving landslides may pose life safety risks and can occur throughout Oregon and Washington (ONHMP, 2015).

Data Sources

The Landslide Susceptibility Overview Map of Oregon (Open-File Report, O-16-02) used for this report is a statewide overview that identifies the general level of susceptibility a given area has to landslide hazards, primarily shallow and deep-seated landslides. The dataset is an aggregation of three primary sources: landslide inventory, generalized geology, and slope. The data from a previous landslide mapping effort from DOGAMI called the Statewide Landslide Information Database for Oregon (SLIDO), which identified existing landslides, provided the mapping for the landslide inventory in this new report.

The zones of susceptibility are categorized as low, moderate, high, and very high (**Figure 13**). These categories are based on a combination of two datasets, Landslide Density and Slopes Prone to Landsliding, along with the existing landslides found in the SLIDO dataset. The SLIDO sources existing landslide data and corresponds to the very high susceptibility category. The other categories are based on varying levels of Landslide Density and Slopes Prone to Landsliding, see **Table 5**.

Table 5. Matrix to combine data sets into final landslide susceptibility classes.

			Landslide Density			Landslides
			Generalized Geologic Map + Landslide Inventory			Landslide Inventory
			Low (< 3%)	Moderate (3% - 17%)	High (> 17%)	Existing Landslides
Slope Prone to Landsliding	Landslide Inventory + Slope Map	Low (< 1 SD)	Low	Moderate	High	Very High
		Moderate (mean to 1 SD)	Moderate	Moderate	High	Very High
		High (≥ mean)	High	High	High	Very High

Source: *DOGAMI OFR: O-16-02*

We overlaid buildings and essential facilities on the landslide susceptibility zones to assess the exposure for each community. The total dollar value of exposed buildings was summed for the study area and reported below. We were also able to estimate the number of people at risk from landslides. Land value losses due to landslides were not examined for this report.

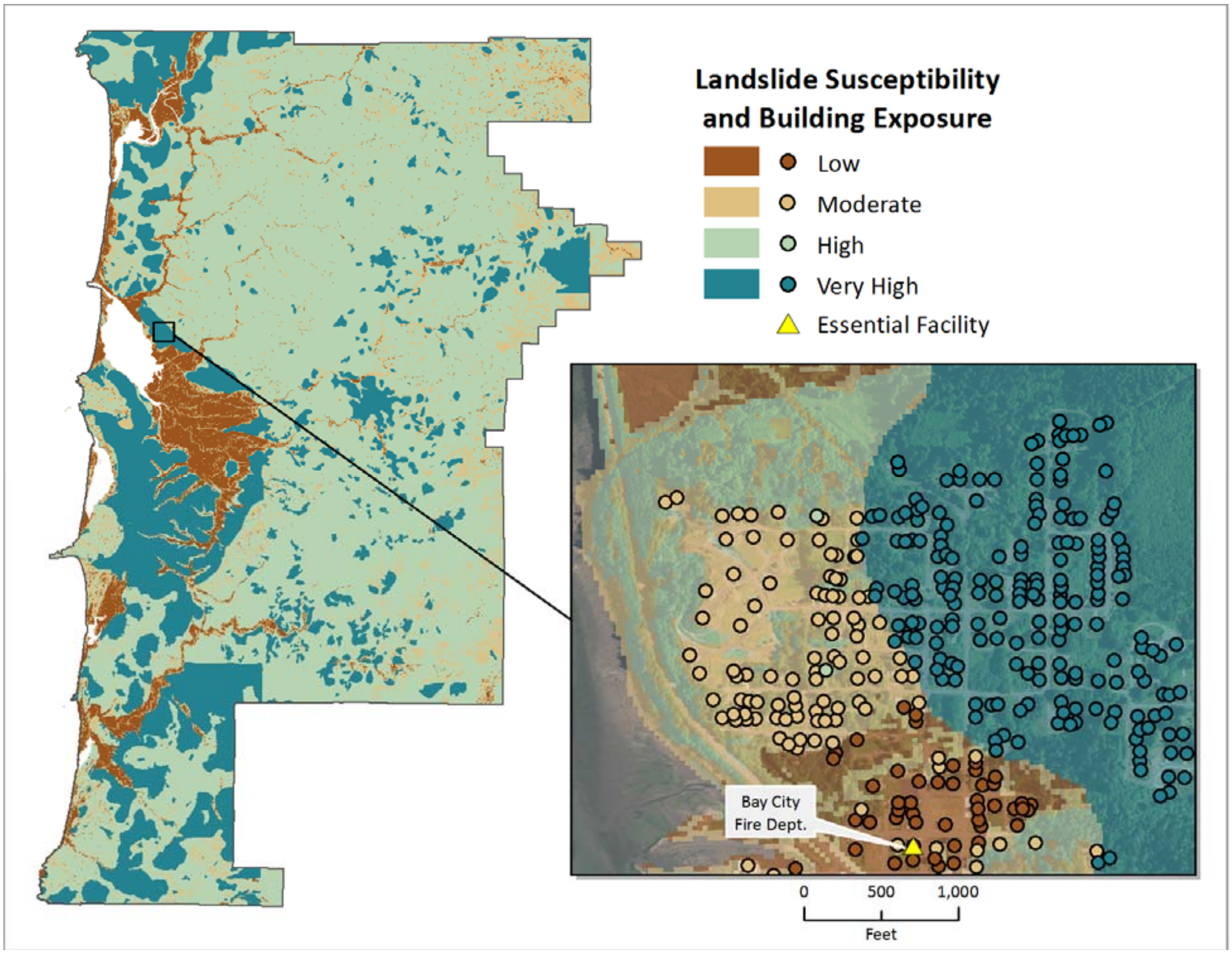


Figure 13: Landslide susceptibility and building exposure example.

Countywide Results

Many of Tillamook County's communities have some level of exposure to landslide risk. Communities that have developed in terrain with moderate to steep slopes or at the base of steep hillsides may be at risk to landslides. Due to Tillamook County's proximity to the Coastal Range, a considerable percentage of the area is steep and landslide-prone. The combination of rugged terrain and historically active landslides with large amounts of rainfall makes for a situation where landslide risk is a serious concern. Results for landslides induced by an earthquake were included in the earthquake section, but not this section.

The combined high and very high susceptibility categories were chosen as the primary scenarios to provide a general sense of community risk for planning purposes. These susceptibility categories represent areas most prone to landslides with the highest impact to the community. Since reporting exposure for these categories are on a non-cumulative basis, it is necessary to combine exposure for both to accurately depict the level of landslide risk to communities.

For this risk assessment building locations were compared to the geographic extent of the landslide susceptibility zones (**Figure 14**). The exposure results shown below are for the high and very high susceptibility scenarios. Refer to **Appendix A** to view the multi-scenario analysis results.

Tillamook Countywide Landslide Exposure (High and Very High-Susceptibility):

- *Number of buildings*: 7,906
- *Exposure Value*: $779,159,000
- *Ratio of Exposure Value*: 28%
- *Essential facilities*: 12
- *Potentially Displaced Population*: 7,121

Approximately a third of the county's buildings have exposure to at least high susceptibility to landslides. Landslide hazard is ubiquitous throughout the county, so is a major concern for future planning and mitigation efforts. Every community and rural area of the county should be aware of nearby areas of landslide risk.

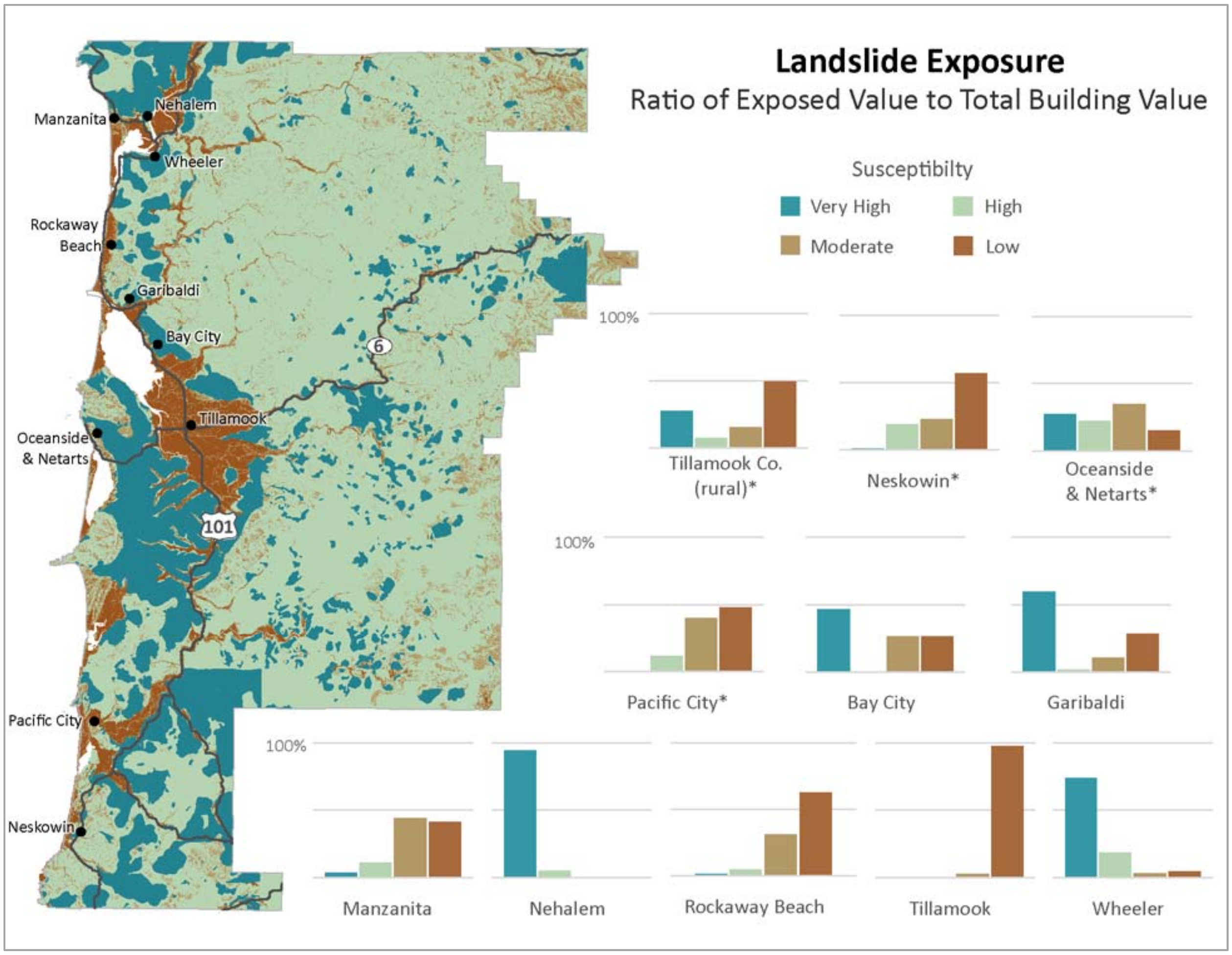


Figure 14: Landslide susceptibility exposure by community.
**Unincorporated communities. Note that "Tillamook Co. (rural)" excludes incorporated communities, Pacific City, Oceanside/Netarts, and Neskowin.*

Coastal Erosion

Erosion along the coast is a continuous process that occurs through a complex interaction of many geologic, atmospheric, and oceanic factors (including sea level rise). Beaches and dunes are highly susceptible to erosion and are among the most mutable of all landforms. Coastal erosion is increasingly affecting people due to properties and infrastructure being built near the beach or coastal bluffs. Oftentimes, shoreline stabilization efforts end in failure due to the relentless and powerful force of the ocean. Whether it is a gradual process or in the form of landslides, coastal erosion can cause loss of property (ONHMP, 2015). **Figure 15** shows the sections of coastline subject to coastal erosion that have been studied in Tillamook County.

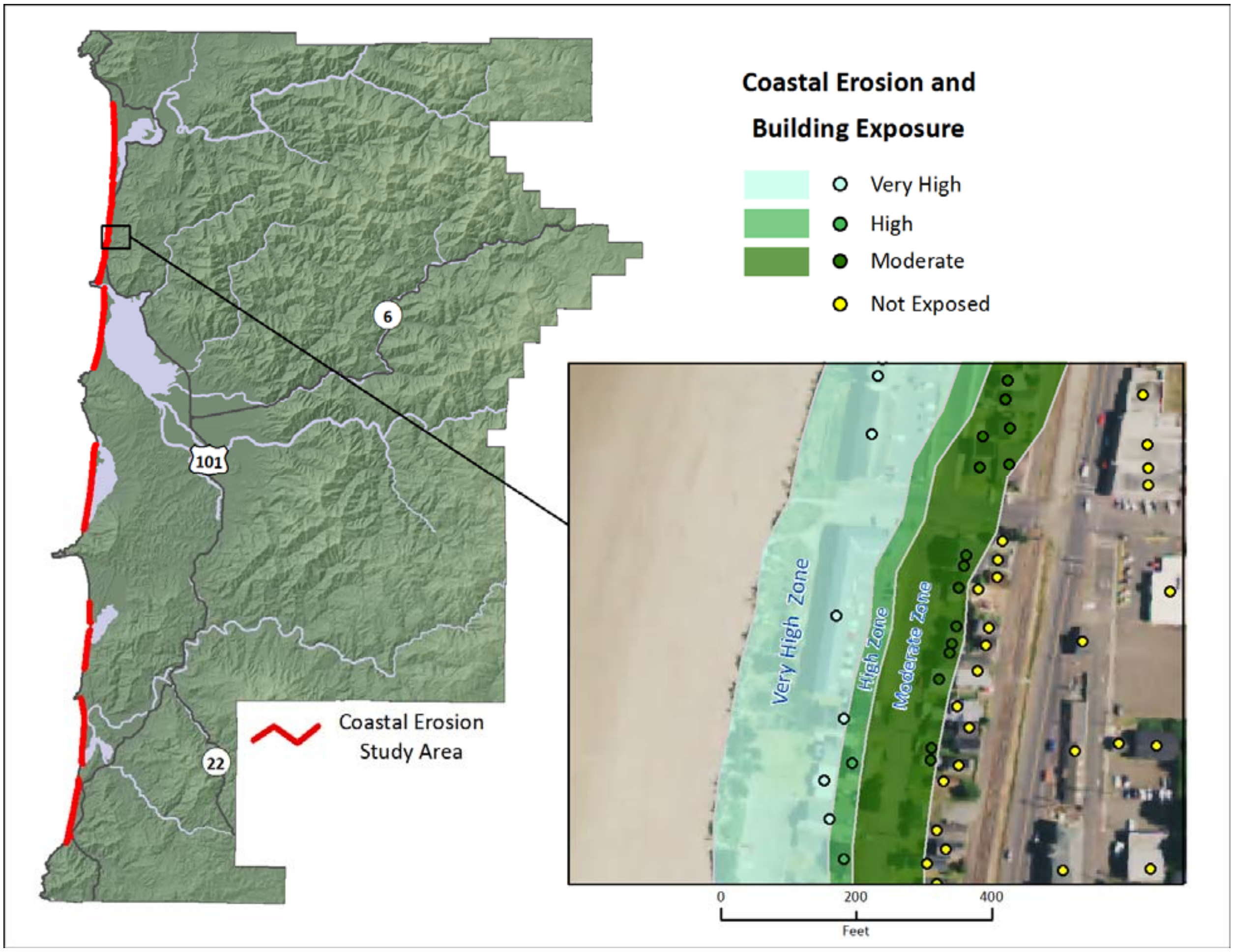


Figure 15: Coastal erosion zones and building exposure example.

Data Sources

Coastal erosion hazard zones were determined in DOGAMI Open-File Report O-14-02 using two approaches, storm-induced and erosion due to sea level rise. The final derived hazard zones reflect the combined effect of both sets of processes. The very high hazard zone was based on a mid-range estimate of 2030 sea level rise (SLR) along with 2% annual chance (50-year) storm total water level scenario. The high hazard zone was based on mid-range 2050 SLR along with the 2% annual chance storm total water level. The moderate hazard zone on mid-range 2100 SLR along with the 1% annual chance (100-year) storm total water level.

We overlaid buildings and essential facilities on the coastal erosion hazard zones to assess the exposure for each community. The total dollar value of exposed buildings was summed for the study area and reported below. We were also able to estimate the number of people at risk from coastal erosion. Land value losses due to coastal erosion were not examined for this report.

Countywide Results

Coastal erosion, for obvious reasons, only affects communities and areas along the open coast of Tillamook County. Coastal communities in Tillamook County all have some level of exposure to coastal erosion. The steep nature of the dunes and bluffs adjacent to the ocean makes for dramatic scenery, but also contributes to coastal erosion hazards.

The high hazard category (mid-range 2050 SLR) was chosen as the primary scenario for this report because it fits best for long term planning purposes. The high hazard zone represents an area of a reasonable level of probability with a high level of consequences to a community.

For this risk assessment the results of the exposure analysis were limited to the communities included in DOGAMI OFR O-14-02, which are communities along the coast with dune-backed beaches. The "Ratio of Exposure Value" below does not factor in the non-coastal incorporated communities of Tillamook County. Refer to **Appendix A** to view the multi-scenario analysis results.

Tillamook Countywide Coastal Erosion Exposure (High-Hazard):

- *Number of buildings*: 609
- *Exposure Value*: $117,050,000
- *Ratio of Exposure Value*: 5.6%
- *Essential facilities*: 0
- *Potentially Displaced Population*: 156

The coastal communities and unincorporated areas of Tillamook County have a high degree of exposure to coastal erosion, with the exception of Oceanside-Netarts. Future developments along Tillamook County's coastline should take this hazard into consideration before building. Long term community plans that make allowance for coastal erosion encourage more resilience within the community. **Figure 16** illustrates the distribution of damages due to coastal erosion with the different communities of Tillamook County.

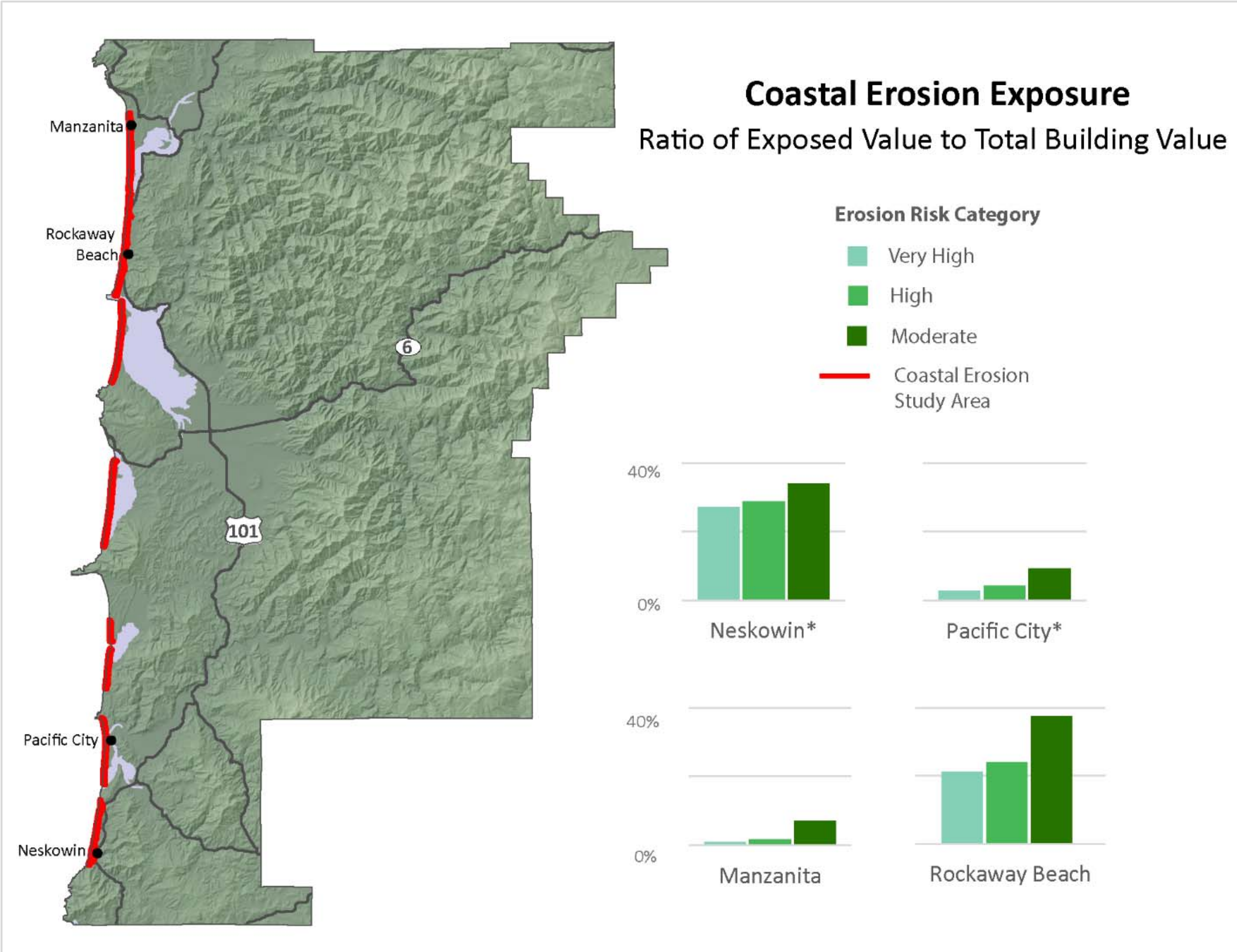


Figure 16: Coastal erosion exposure by community.

Note: Beyond the designated communities, in unincorporated Tillamook County, there is $13.4 million dollars of building value in areas of very high coastal erosion hazard, $18.9 million dollars of building value in areas of high hazard, and $33.9 million dollars of building value in areas of moderate hazard.
**Unincorporated communities.*

Wildfire

Fires are a natural part of the ecosystem in Oregon. However, wildfires can present a substantial hazard to life and property in growing communities. The most common wildfire conditions include: 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 (TNHMP, 2011).

There is potential for losses due to wildland-urban interface fires in Tillamook County. Forests cover approximately 90% of Tillamook County and play an important role in the local economy, as well as surrounding its resident's homes and businesses (TNHMP, 2011). In an effort to limit exposure to wildfire, Tillamook County's Comprehensive Plan (1982) requires a 100 foot setback for residences that abut forest or farmland in most zoning districts (50 feet for Oceanside) (Bryan Pohl, Tillamook Co. Community Development Director, email communication, Oct. 5, 2015).

Data Sources

The West Wide Wildfire Risk Assessment (WWA) is a comprehensive database developed over the course of several years for 17 Western states and Pacific Islands. The steward of this database in Oregon is the Oregon Department of Forestry (ODF). The database was created to assess the level of risk residents and structures have to wildfire. For this project, the Fire Risk Index (FRI) dataset, a dataset included in the WWA database, was used to measure the level of risk to communities in Tillamook County.

For the wildfire exposure analysis, the FRI was categorized into low, moderate, and high risk zones. We overlaid the buildings layer and critical facilities with each of the fire risk zones to determine exposure (**Figure 17**). In certain areas no wildfire data was calculated, which indicates areas that have minimal risk to wildfire hazard.

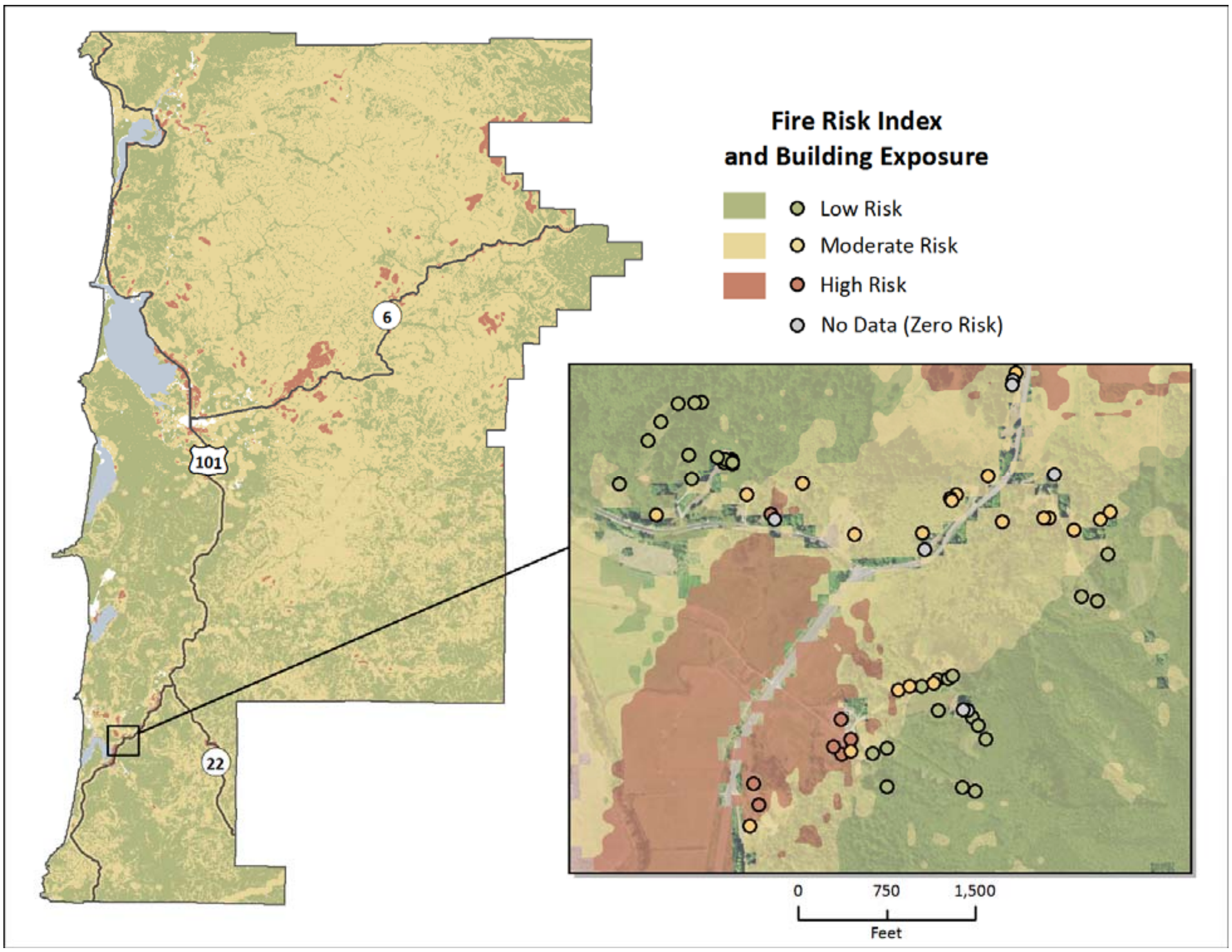


Figure 17: Wildfire risk exposure and building exposure example.

Countywide Results

The high risk category was chosen as the primary scenario for this report because it represents the areas that are most likely to burn. However, a large amount of damage would occur if the moderate risk areas were to burn, as almost every community has ~40-50% of exposure to moderate wildfire risk. Still, the focus of this section is on high risk areas within Tillamook County to emphasize the areas with the greatest chance of threatening lives and property.

Tillamook Countywide Wildfire Exposure (High Risk):

- *Number of buildings*: 565
- *Exposure Value*: $47,527,000
- *Ratio of Exposure Value*: 1.7%
- *Essential facilities*: 2
- *Potentially Displaced Population*: 590

For this risk assessment the building locations were compared to the geographic extent of the wildfire risk categories. Most communities in Tillamook do not have high risk exposure to wildfire. The primary areas of exposure to this hazard are in the forested unincorporated areas of the county. The communities of Bay City, Garibaldi, and to a certain extent Tillamook have elevated levels of high risk exposure to wildfire. **Figure 18** illustrates the distribution of damages due to wildfire with the different communities of Tillamook County. Refer to **Appendix A** to view the multi-scenario analysis results.

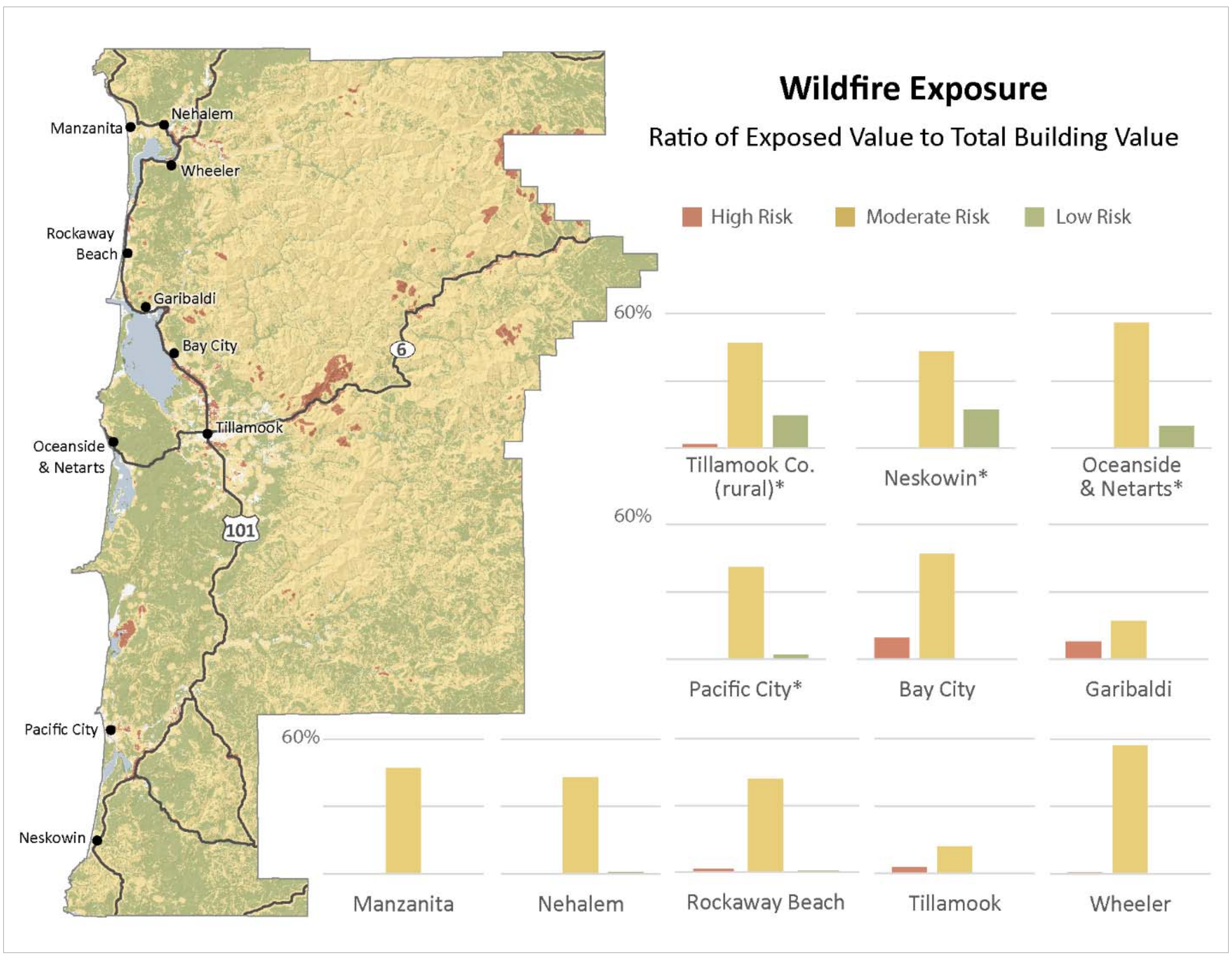


Figure 18: Wildfire risk exposure by community.
**Unincorporated communities.*

Community Risk Profiles

In order to assist communities on an individual basis, risk profiles and recommendations have been provided in the community subsections below. Specific strategies for each community are given, so that more focused approaches to natural hazard risk reduction are available to them. Increasing disaster preparedness, public hazards communication and education, ensuring functionality of emergency services, and access to evacuation routes are things that every community can do to reduce their risk.

Tables for each community are there to show an overview of the community and the level of risk from each natural hazard analyzed. A table is also provided showing the community's essential facilities and assumed impact from individual hazards. Within each community subsection is a review of the specific vulnerabilities that exist, reasons for these vulnerabilities, and strategies that can alleviate some of the risk.

Unincorporated Tillamook County

Note: the statistics in this section do not include the unincorporated communities of Neskowin, Oceanside, Netarts, or Pacific City.

Table 6: Unincorporated Tillamook County Hazard Profile

Community Overview				
Community Name	Population	Number of Buildings	Essential Facilities[1]	Total Building Value ($)
Unincorporated Tillamook County	13,364	15,015	17	1,282,436,000

Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	658	4.9%	1,106	1	10,178,000	0.8%
Earthquake*	CSZ Mag 9.0 Deterministic	4,100	31%	6,069	12	409,947,000	32%
Earthquake *(within Tsunami Zone)*		202	1.5%	647	2	48,531,000	3.8%

Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Tsunami	CSZ Mag 9.0 – Medium	753	5.6%	1,692	2	147,262,000	11%
Tsunami	Senate Bill 379 Regulatory Line	690	5.2%	1,662	2	155,993,000	12%
Landslide	High and Very High Susceptibility	4,428	33%	4,933	6	449,331,000	35%
Wildfire	High Risk	408	3.1%	383	1	22,892,000	1.8%
Coastal Erosion	High Hazard	59	0.4%	161	0	18,928,000	1.5%

**Earthquake damages calculated for buildings outside of Medium tsunami zone.*

Colors indicates results should be considered in tandem as they are expected to occur within minutes of one another

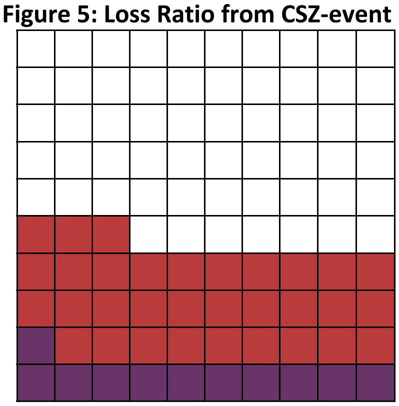
[1]*Facilities with multiple buildings were consolidated into 1 building complex.*

[2]*No damage is estimated for exposed structures with "First Floor Heights" above the level of flooding (base flood elevation).*

The natural hazards that rural Tillamook County are most vulnerable to are the CSZ-related events (earthquake and tsunami), flood, and landslide. Coastal erosion and wildfire to a lesser extent are also hazard risks. As with every community in Tillamook County, the proximity to the CSZ makes earthquake a high risk hazard. Developments along the Pacific Coast and in estuarine areas have exposed a huge amount of the coastal region of rural Tillamook County to tsunami hazard, as well as coastal erosion. Potential flooding from riverine and coastal sources can affect many buildings in the low-laying rural areas in the 100-year flood zone. Risk of landslide exists throughout the county.

The CSZ event is a significant natural hazard risk to rural Tillamook County and is a priority hazard for this community. Moderate to high liquefaction zones exist throughout the county, which increases the risk from earthquake. Another consideration of these areas is that liquefaction could present difficulties for evacuation from the subsequent tsunami. The combination of earthquake and tsunami will have a tremendous impact to the entire coastal and estuarine portions of rural Tillamook County.

Figure 5: Loss Ratio from CSZ-event



†Each cell represents 1% of building value

= Estimated damage due to tsunami

= Estimated damage due to earthquake (outside of tsunami zone)

The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus modeling for loss ratio is only available for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. In order to avoid double counting to buildings, the earthquake loss ratio was only calculated for buildings outside of the tsunami zone.

Many of the buildings built along the streams and the coast are exposed to the 100-year flood in rural parts of the county. Although there are some elevated buildings in the flood-prone areas, which have greatly reduced overall flood risk, there are still many buildings that can be impacted by flood. It is estimated that nearly half of the buildings exposed to the 100-year flood are elevated above the predicted level of flooding. So while the buildings themselves would not be damaged from flood, access to these buildings could be an issue.

Roughly one-third of the buildings in rural Tillamook County are at risk to landslide hazard. Low susceptibility landslide zones generally correspond to estuaries and floodplains near estuaries which also are in the vicinity of the county's populated areas. However, outside of these areas are almost completely high to very high susceptibility zones. The rugged terrain of rural Tillamook County lends itself to potential landslide hazard.

To a lesser extent coastal erosion and wildfire hazards pose some concerns. Coastal erosion hazards exist all along the coast, but much of coastal rural Tillamook County is undeveloped. Wildfire risk is high for hundreds of homes within this community, but the overall exposure percentage is fairly low.

Table 7: Unincorporated Tillamook County Essential Facilities

Essential Facilities by Community*	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ M 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Risk	Coastal Erosion High Hazard
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Fire Mountain School		X		X		
Neah-Kah-Nie Jr/Sr High School		X	X			
Nehalem Bay Fire and Rescue		X				
Neskowin Valley School		X		X		
Nestucca Fire and Rescue Station #87 (Hebo)	X			X		
Nestucca High School		X		X		
Nestucca RFPD Beaver #83		X				
Nestucca RFPD Blaine #86		X				
Nestucca RFPD Neskowin #84		X	X	X		
Nestucca RFPD Sand Lake #85						
Nestucca Valley Elementary		X		X		
Nestucca Valley Middle School		X				
South Prairie Elementary School		X				
Tillamook Adventist School						
Tillamook County Sheriff's Office And Oregon State Police		X				
Tillamook Fire Station South Prairie Station #72		X				
Tillamook Youth Correctional Facility		X				

Unincorporated Community of Neskowin

Table 8: Unincorporated Community of Neskowin Hazard Profile

Community Overview				
Community Name	Population	Number of Buildings	Essential Facilities[1]	Total Building Value ($)
Neskowin	230	653	0	118,463,000

Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	21	9.1%	82	0	7,132,000	6%
Earthquake*	CSZ Mag 9.0 Deterministic	10	4.3%	32	0	6,658,000	5.6%
Earthquake (within Tsunami Zone)		32	14%	95	0	17,301,000	15%

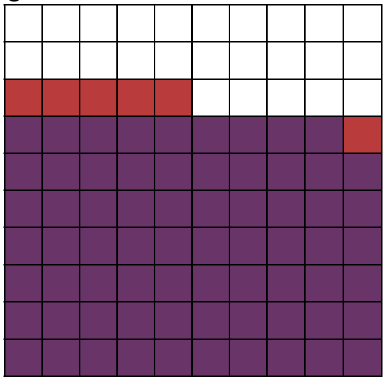
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Tsunami	CSZ Mag 9.0 – Medium	133	58%	461	0	81,824,000	69%
Tsunami	Senate Bill 379 Regulatory Line	136	59%	471	0	84,248,000	71%
Landslide	High and Very High Susceptibility	62	27%	132	0	24,187,000	20%
Wildfire	High Risk	0	0%	2	0	288,000	0.2%
Coastal Erosion	High Hazard	36	16%	110	0	34,149,000	29%

**Earthquake damages calculated for buildings outside of Medium tsunami zone.*
Colors indicates results should be considered in tandem as they are expected to occur within minutes of one another
[1]*Facilities with multiple buildings were consolidated into 1 building complex.*
[2]*No damage is estimated for exposed structures with "First Floor Heights" above the level of flooding (base flood elevation).*

The natural hazards that Neskowin is most vulnerable to are the CSZ-related events (earthquake and tsunami), flood, and coastal erosion. As with every community in Tillamook County, the proximity to the CSZ makes earthquake a high risk hazard. Development along the Pacific Coast has exposed a huge section of Neskowin to tsunami hazard, as large portions of the community are within the Medium-sized tsunami zone. Potential flooding from riverine and coastal sources can affect many buildings in the low-laying areas of the community. Many of the residences built adjacent to the beach are also exposed to coastal erosion risk.

The CSZ event is a significant natural hazard risk to Neskowin and is a priority hazard for this community. Moderate to high liquefaction zones exist throughout the community, which increases the risk from earthquake. These liquefaction areas also correspond closely with the areas predicted to be inundated by the most likely tsunami scenario. Since we have deemed buildings within the tsunami zone to be red-tagged, these buildings have been excluded from the earthquake loss estimates. Another consideration of these areas is that liquefaction could present difficulties for evacuation from the subsequent tsunami. The combination of earthquake and tsunami will have a tremendous impact to this community.

Figure 6: Loss Ratio from CSZ-event



The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus modeling for loss ratio is only available for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. In order to avoid double counting to buildings, the earthquake loss ratio was only calculated for buildings outside of the tsunami zone.

†Each cell represents 1% of building value

= Estimated damage due to tsunami

= Estimated damage due to earthquake (outside of tsunami zone)

Developed areas within the community along Neskowin Creek, Kiwanda Creek, and the Pacific Ocean are exposed to the 100-year flood. Although there have been efforts to elevate buildings in the flood-prone areas, which has greatly reduced overall flood risk, there are still many buildings that can be impacted by flood. It is estimated that nearly half of the building exposed to the 100-year flood are elevated above the predicted level of flooding. So while the buildings themselves would not be damaged from flood, access to these buildings could be an issue.

Coastal erosion is another hazard that is a concern and can have a major impact for many within the community. The residential area along the coast and north of the Neskowin Creek mouth is likely to experience coastal erosion. The current placement of riprap at the base of these areas is reducing the rate of erosion.

While vulnerabilities to landslide do exist within Neskowin, they do so to a far less degree than flood, coastal erosion, and CSZ-related hazards. Monitoring for ground movement, especially during particularly wet conditions, is one way of increasing public safety from landslide.

Unincorporated Communities of Oceanside and Netarts

Table 9: Unincorporated Communities of Oceanside and Netarts Hazard Profile

Community Overview				
Community Name	Population	Number of Buildings	Essential Facilities[1]	Total Building Value ($)
Oceanside and Netarts	1,056	1,701	2	203,363,000

Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	4	0	4,000	0%
Earthquake*	CSZ Mag 9.0 Deterministic	363	34%	623	1	61,450,000	30%
Earthquake *(within Tsunami Zone)*		4	0.5%	32	0	5,230,000	2.6%

Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Tsunami	CSZ Mag 9.0 – Medium	16	1.5%	88	0	15,432,000	7.6%
Tsunami	Senate Bill 379 Regulatory Line	12	1.1%	68	0	12,254,000	6%
Landslide	High and Very High Susceptibility	406	38%	738	1	101,235,000	50%
Wildfire	High Risk	0	0%	0	0	0	0%
Coastal Erosion	High Hazard	59	0.4%	0	0	0	0%

**Earthquake damages calculated for buildings outside of Medium tsunami zone.*

Colors indicates results should be considered in tandem as they are expected to occur within minutes of one another

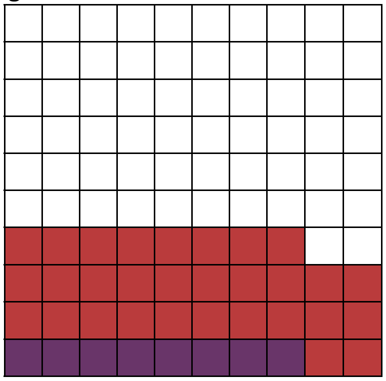
[1]Facilities with multiple buildings were consolidated into 1 building complex.

[2]No damage is estimated for exposed structures with "First Floor Heights" above the level of flooding (base flood elevation).

The level of risk to most natural hazards in the communities of Oceanside and Netarts is relatively low compared to the other communities of Tillamook County. The level of risk to the CSZ earthquake is still considerable, but fares better than other coastal communities. Landslide hazard is the primary natural hazard threat to these communities.

While the threat of earthquake is still a major issue, damages from shaking are reduced due to a younger building stock. High liquefaction soils are found throughout Oceanside and Netarts, except for the northern hilly section of the community. There is some exposure to the Medium-sized tsunami for buildings along the estuary in Netarts.

Figure 7: Loss Ratio from CSZ-event



†Each cell represents 1% of building value
= Estimated damage due to tsunami
= Estimated damage due to earthquake (outside of tsunami zone)

The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus modeling for loss ratio is only available for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. In order to avoid double counting to buildings, the earthquake loss ratio was only calculated for buildings outside of the tsunami zone.

The landslide hazard for Oceanside and Netarts poses the biggest risk to the community and its potential impact is a serious concern. An area deemed very high susceptibility to landslides makes up a large portion of Oceanside. The rest of the communities, for the most part, are within moderate to high susceptibility zones. There are few options for future development in low landslide hazard areas within these communities.

Table 10: Unincorporated Communities of Oceanside and Netarts Essential Facilities

Essential Facilities by Community*	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ M 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Risk	Coastal Erosion High Hazard
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Netarts - Oceanside RFPD Station #61		X				
Netarts - Oceanside RFPD Station #62				X		

Unincorporated Community of Pacific City

Table 11: Unincorporated Community of Pacific City Hazard Profile

Community Overview				
Community Name	Population	Number of Buildings	Essential Facilities[1]	Total Building Value ($)
Pacific City	947	1,707	1	212,062,000

Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	198	21%	361	1	3,301,000	1.6%
Earthquake*	CSZ Mag 9.0 Deterministic	100	11%	237	0	26,963,000	13%
Earthquake (within Tsunami Zone)		112	12%	280	1	23,600,000	11%

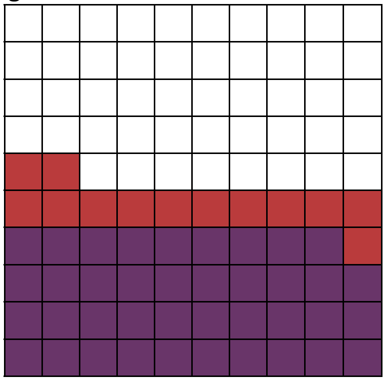
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Tsunami	CSZ Mag 9.0 – Medium	386	41%	806	1	83,301,000	39%
Tsunami	Senate Bill 379 Regulatory Line	583	62%	1,239	1	135,375,000	64%
Landslide	High and Very High Susceptibility	125	13%	183	0	24,930,000	12%
Wildfire	High Risk	1	0%	3	0	226,000	0.1%
Coastal Erosion	High Hazard	4	0.4%	25	0	50,675,000	4.2%

**Earthquake damages calculated for buildings outside of Medium tsunami zone.*
Colors indicates results should be considered in tandem as they are expected to occur within minutes of one another
[1]Facilities with multiple buildings were consolidated into 1 building complex.
[2]No damage is estimated for exposed structures with "First Floor Heights" above the level of flooding (base flood elevation).

The natural hazards that Pacific City is most vulnerable to are the CSZ-related events (earthquake and tsunami) and flood. As with every community in Tillamook County, the proximity to the CSZ makes earthquake a high risk hazard. Development along the Nestucca River has exposed part of Pacific City to tsunami hazard, as portions of the city are within the Medium-sized tsunami zone. Another risk to the community is flood hazard, which is along the Nestucca River floodplain.

For the most part, the Medium-sized tsunami zone corresponds to the Nestucca floodplain within this community and is the source of the majority of damages from the CSZ event. While the threat of earthquake is still a major issue, damages from shaking are reduced due to a younger building stock. Moderate to high liquefaction is throughout Pacific City, except for the southern hilly section of the community. The combination of earthquake and tsunami will have a tremendous impact to this community.

Figure 8: Loss Ratio from CSZ-event



The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus modeling for loss ratio is only available for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. In order to avoid double counting to buildings, the earthquake loss ratio was only calculated for buildings outside of the tsunami zone.

†Each cell represents 1% of building value
= Estimated damage due to tsunami
= Estimated damage due to earthquake (outside of tsunami zone)

Flooding from the Nestucca River is from a riverine source instead of tidal flooding from the Pacific Ocean. Several buildings that are within the 1% flood zone are elevated above the estimated level of flooding. The central part of community is most affected from this flooding, while the Cape Kiwanda area is not at risk. Although there are many buildings elevated in the flood-prone areas, there are still many that can be impacted by flood. It is estimated that nearly a quarter of the buildings exposed to the 100-year flood are elevated above the predicted level of flooding. However, while the buildings themselves would not be damaged from flood, access to these buildings could be an issue.

To a lesser extent landslide and coastal erosion hazards pose some concern. Landslide hazards are highest in the most southern and northern sections of the community. Coastal erosion risk exists for several homes along the beach just north of the Pacific Ave. Bridge. The higher loss ratio compared to the percentage of building exposure implies that higher value homes are exposed to coastal erosion.

Table 12: Unincorporated Community of Pacific City Essential Facilities

Essential Facilities by Community*	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ M 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Risk	Coastal Erosion High Hazard
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Nestucca RFPD Pacific City Station #82	X	X	X			

City of Bay City

Table 13: City of Bay City Hazard Profile

Community Overview				
Community Name	Population	Number of Buildings	Essential Facilities[1]	Total Building Value ($)
Bay City	1,284	884	1	74,769,000

Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0	0	0	0	0%
Earthquake*	CSZ Mag 9.0 Deterministic	447	35%	403	1	29,014,000	39%
Earthquake *(within Tsunami Zone)*		16	1.2%	18	0	1,873,000	2.5%

Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Tsunami	CSZ Mag 9.0 – Medium	77	6%	62	0	8,455,000	11%
Tsunami	Senate Bill 379 Regulatory Line	38	3%	35	0	6,313,000	8.4%
Landslide	High and Very High Susceptibility	690	54%	480	0	35,262,000	47%
Wildfire	High Risk	94	7.3%	58	0	7,089,000	9.5%

**Earthquake damages calculated for buildings outside of Medium tsunami zone.*

Colors indicates results should be considered in tandem as they are expected to occur within minutes of one another

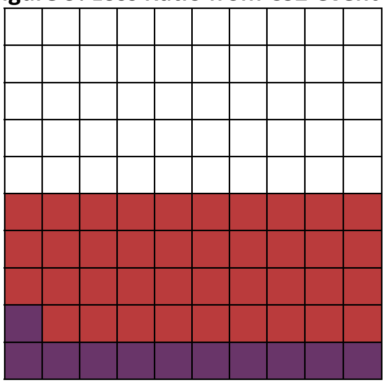
[1]*Facilities with multiple buildings were consolidated into 1 building complex.*

[2]*No damage is estimated for exposed structures with "First Floor Heights" above the level of flooding (base flood elevation).*

The natural hazards that Bay City are most vulnerable to are the CSZ-related events (earthquake and tsunami) and landslide. As with every community in Tillamook County, the proximity to the CSZ makes earthquake a high risk hazard. Development along Tillamook Bay has exposed part of Bay City to tsunami hazard, as portions of the city are within the Medium-sized tsunami zone. Another risk to the community is landslide hazard, which comprises a large portion of Bay City. The few buildings that are within the 1% flood zone are elevated above the estimated level of flooding.

The CSZ earthquake hazard is a significant natural hazard risk to Bay City and is a priority hazard for this community. A large part of the community lies within an area of moderate liquefaction, which slightly increases the probability for structural damage to buildings. Also the building inventory for Bay City is relatively older, which implies lower building design codes with regards to earthquake. The tsunami generated from the CSZ earthquake is not expected to cause as much damage, but still is a concern.

Figure 9: Loss Ratio from CSZ-event



†Each cell represents 1% of building value
= Estimated damage due to tsunami
= Estimated damage due to earthquake (outside of tsunami zone)

The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus modeling for loss ratio is only available for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. In order to avoid double counting to buildings, the earthquake loss ratio was only calculated for buildings outside of the tsunami zone.

The landslide hazard for Bay City poses a great risk to the community and its potential impact is a serious concern. An area deemed very high susceptibility to landslides makes up approximately half of the entirety of Bay City. The hilly residential area in the northwest part of Bay City is within a very high landslide susceptibility zone. Monitoring for ground movement, especially during particularly wet conditions, is one way of increasing public safety from landslide.

While vulnerabilities to flood and wildfire do exist within Bay City, they do so to a far less degree than the CSZ event and landslide. Elevating structures and building outside of the flood zone, as well as, creating building buffers from forestland are examples to further reduce the risk to these hazards.

Table 14: City of Bay City Essential Facilities

Essential Facilities by Community*	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ M 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Risk	Coastal Erosion High Hazard
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Bay City Fire Department		X				

City of Garibaldi

Table 15: City of Garibaldi Hazard Profile

Community Overview				
Community Name	Population	Number of Buildings	Essential Facilities[1]	Total Building Value ($)
Garibaldi	779	755	3	64,331,000

Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	6	0.8%	21	0	79,000	0.1%
Earthquake*	CSZ Mag 9.0 Deterministic	304	39%	345	2	26,182,000	41%
Earthquake *(within Tsunami Zone)*		16	2.1%	61	0	7,471,000	12%

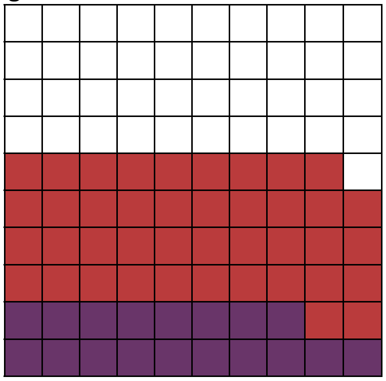
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Tsunami	CSZ Mag 9.0 – Medium	56	7.2%	91	0	11,870,000	18%
Tsunami	Senate Bill 379 Regulatory Line	26	3.3%	55	0	12,961,000	20%
Landslide	High and Very High Susceptibility	575	74%	534	3	39,334,000	61%
Wildfire	High Risk	79	10%	83	1	5,014,000	7.8%

**Earthquake damages calculated for buildings outside of Medium tsunami zone.*
Colors indicates results should be considered in tandem as they are expected to occur within minutes of one another
[1]Facilities with multiple buildings were consolidated into 1 building complex.
[2]No damage is estimated for exposed structures with "First Floor Heights" above the level of flooding (base flood elevation).

The natural hazards that Garibaldi is most vulnerable to are the CSZ-related events (earthquake and tsunami) and landslide. As with every community in Tillamook County, the proximity to the CSZ makes earthquake a high risk hazard. Developments along Tillamook Bay are exposed to tsunami hazard, as portions of the community are within the Medium-sized tsunami zone. Another substantial risk to the community is landslide hazard, since a large percentage of Garibaldi is within a very high susceptibility landslide zone.

The CSZ earthquake hazard is a significant natural hazard risk to Garibaldi and is a priority hazard for this community. A large part of the community lies within an area of moderate to high liquefaction, which increases the probability for structural damage to buildings. Also the building inventory for Garibaldi is relatively older, which implies lower building design codes with regards to earthquake. The tsunami generated from the CSZ earthquake is not expected to cause as much damage, but still is a concern.

Figure 10: Loss Ratio from CSZ-event



The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus modeling for loss ratio is only available for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. In order to avoid double counting to buildings, the earthquake loss ratio was only calculated for buildings outside of the tsunami zone.

†Each cell represents 1% of building value
= Estimated damage due to tsunami
= Estimated damage due to earthquake (outside of tsunami zone)

The landslide hazard for Garibaldi poses a great risk to the community and its potential impact is a serious concern. An area deemed very high susceptibility to landslides makes up the majority of Garibaldi. Monitoring for ground movement, especially during particularly wet conditions, is one way of increasing public safety from landslide.

While vulnerabilities to flood and wildfire do exist within Garibaldi, they do so to a far less degree than the CSZ event and landslide. Elevating structures and building outside of the flood zone, as well as, creating building buffers from forest land are examples to further reduce the risk to these hazards.

Table 16: City of Garibaldi Essential Facilities

Essential Facilities by Community*	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ M 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Risk	Coastal Erosion High Hazard
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
City Of Garibaldi Fire Department / City Hall / Police				X		
Garibaldi Elementary School		X		X		
United States Coast Guard		X		X		

City of Manzanita

Table 17: City of Manzanita Hazard Profile

Community Overview				
Community Name	Population	Number of Buildings	Essential Facilities[1]	Total Building Value ($)
Manzanita	599	1,523	1	259,780,000

Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0	1	0	11,000	0%
Earthquake*	CSZ Mag 9.0 Deterministic	129	22%	354	1	59,646,000	23%
Earthquake (within Tsunami Zone)		24	4%	98	0	16,058,000	6.2%

Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Tsunami	CSZ Mag 9.0 – Medium	94	16%	354	0	56,238,000	22%
Tsunami	Senate Bill 379 Regulatory Line	130	22%	484	0	84,870,000	33%
Landslide	High and Very High Susceptibility	97	16%	206	0	38,439,000	15%
Wildfire	High Risk	0	0%	0	0	0	0%
Coastal Erosion	High Hazard	6	1.0%	25	0	4,389,000	1.7%

**Earthquake damages calculated for buildings outside of Medium tsunami zone.*

Colors indicates results should be considered in tandem as they are expected to occur within minutes of one another

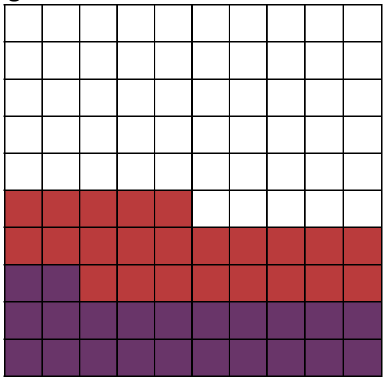
[1]Facilities with multiple buildings were consolidated into 1 building complex.

[2]No damage is estimated for exposed structures with "First Floor Heights" above the level of flooding (base flood elevation).

The natural hazards that Manzanita is most vulnerable to are the CSZ-related events (earthquake and tsunami). As with every community in Tillamook County, the proximity to the CSZ makes earthquake a high risk hazard. Developments along the coast are exposed to tsunami hazard, as large portions of the community are within the Medium-sized tsunami zone.

The CSZ event is a significant natural hazard risk to Manzanita and is a priority hazard for this community. High liquefaction zones exist throughout the community, which increases the risk from earthquake. Another consideration of these areas is that liquefaction could present difficulties for evacuation from the subsequent tsunami. The coastal and low-laying areas of Manzanita are predicted to be inundated by the most likely tsunami scenario. Since we have deemed buildings within the tsunami zone to be red-tagged, these buildings have been excluded from the earthquake loss estimates. The combination of earthquake and tsunami will have a tremendous impact to this community.

Figure 11: Loss Ratio from CSZ-event



†Each cell represents 1% of building value

= Estimated damage due to tsunami

= Estimated damage due to earthquake (outside of tsunami zone)

The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus modeling for loss ratio is only available for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. In order to avoid double counting to buildings, the earthquake loss ratio was only calculated for buildings outside of the tsunami zone.

To a lesser extent landslide and coastal erosion hazards pose some additional concerns. Landslide hazard risk is highest for several buildings in the northern section of the community near Highway 101. Coastal erosion risk exists for several homes along the beach in the community. It is unclear if any steps have been taken to limit the amount of erosion occurring. The presence of vegetation cover in many places can reduce the rate of erosion.

Table 18: City of Manzanita Essential Facilities

Essential Facilities by Community*	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ M 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Risk	Coastal Erosion High Hazard
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Manzanita Department Of Public Safety		X				

City of Nehalem

Table 19: City of Nehalem Hazard Profile

Community Overview				
Community Name	Population	Number of Buildings	Essential Facilities[1]	Total Building Value ($)
Nehalem	267	260	2	24,887,000

Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	23	8.6%	37	1	281,000	1%
Earthquake*	CSZ Mag 9.0 Deterministic	101	38%	110	1	10,349,000	42%
Earthquake (within Tsunami Zone)		19	7.1%	48	1	5,745,000	23%

Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Tsunami	CSZ Mag 9.0 – Medium	46	17%	61	1	7,856,000	32%
Tsunami	Senate Bill 379 Regulatory Line	0	0%	1	0	7,000	0%
Landslide	High and Very High Susceptibility	266	99%	259	2	24,735,000	99%
Wildfire	High Risk	0	0%	0	0	0	0%

**Earthquake damages calculated for buildings outside of Medium tsunami zone.*

Colors indicates results should be considered in tandem as they are expected to occur within minutes of one another

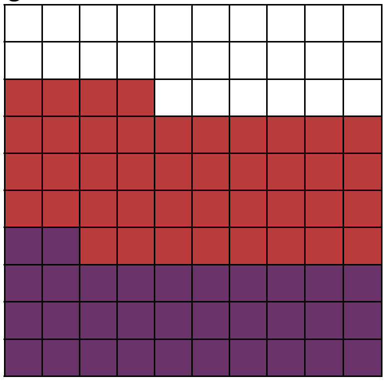
[1]Facilities with multiple buildings were consolidated into 1 building complex.

[2]No damage is estimated for exposed structures with "First Floor Heights" above the level of flooding (base flood elevation).

The natural hazards that Nehalem are most vulnerable to are the CSZ-related events (earthquake and tsunami), flood, and landslide. As with every community in Tillamook County, the proximity to the CSZ makes earthquake a high risk hazard. Part of Nehalem is exposed to tsunami hazard, as the low-laying business area of this community is within the Medium-sized tsunami zone. Potential flooding from riverine sources can affect many buildings along the riverfront. Another substantial risk to the community is landslide hazard, since a large percentage of Nehalem is within a very high susceptibility landslide zone.

The CSZ event is a significant natural hazard risk to Nehalem and is a priority hazard for this community. Moderate liquefaction zones and areas at risk to earthquake-induced landslide exist throughout the community, which increases the risk from earthquake. Also the building inventory for Nehalem is relatively older, which implies lower building design codes with regards to earthquake. Low-laying areas of Nehalem are predicted to be inundated by the most likely tsunami scenario. Since we have deemed buildings within the tsunami zone to be red-tagged, these buildings have been excluded from the earthquake loss estimates. The combination of earthquake and tsunami will have a tremendous impact to this community.

Figure 12: Loss Ratio from CSZ-event



The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus modeling for loss ratio is only available for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. In order to avoid double counting to buildings, the earthquake loss ratio was only calculated for buildings outside of the tsunami zone.

†Each cell represents 1% of building value

= Estimated damage due to tsunami

= Estimated damage due to earthquake (outside of tsunami zone)

Many buildings in the low-laying business area of Nehalem are particularly vulnerable to flooding. This area, along the river bank, is subject to the 100-year flood due to the close proximity of the Nehalem River. During prolonged periods of rainfall (or other conditions conducive to flooding), the Nehalem River can flood and is capable of causing damage to homes and businesses within the community of Nehalem.

The landslide hazard for Nehalem poses a great risk to the community and its potential impact is a serious concern. A preexisting landslide zone, which is considered very high susceptibility to landslides, has been designated for much of the Nehalem River and surrounding hills. An area deemed very high susceptibility to landslides makes up the majority of the community of Nehalem.

Table 20: City of Nehalem Essential Facilities

Essential Facilities by Community*	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ M 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Risk	Coastal Erosion High Hazard
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Nehalem Elementary School		X		X		
Nehalem Volunteer Fire Department/City Hall	X	X	X	X		

City of Rockaway Beach

Table 21: City of Rockaway Beach Hazard Profile

Community Overview				
Community Name	Population	Number of Buildings	Essential Facilities[1]	Total Building Value ($)
Rockaway Beach	1,305	2,240	2	211,809,000

Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	69	5.3%	170	1	1,671,000	0.8%
Earthquake*	CSZ Mag 9.0 Deterministic	234	18%	325	0	18,721,000	8.8%
Earthquake *(within Tsunami Zone)*		287	22%	616	2	54,838,000	26%

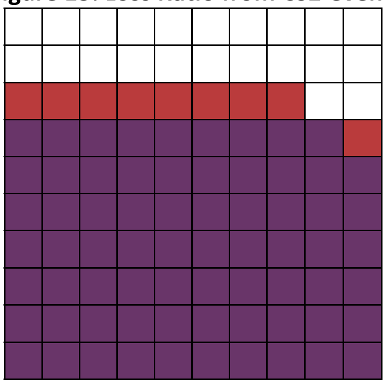
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Tsunami	CSZ Mag 9.0 – Medium	722	55%	1,525	2	146,945,000	69%
Tsunami	Senate Bill 379 Regulatory Line	604	46%	1,367	2	139,141,000	66%
Landslide	High and Very High Susceptibility	78	6%	104	0	13,436,000	6.3%
Wildfire	High Risk	6	0.5%	25	0	2,938,000	1.4%
Coastal Erosion	High Hazard	52	4%	288	0	50,675,000	24%

**Earthquake damages calculated for buildings outside of Medium tsunami zone.*
Colors indicates results should be considered in tandem as they are expected to occur within minutes of one another
[1]Facilities with multiple buildings were consolidated into 1 building complex.
[2]No damage is estimated for exposed structures with "First Floor Heights" above the level of flooding (base flood elevation).

The natural hazards that Rockaway Beach is most vulnerable to are the CSZ-related events (earthquake and tsunami), flood, and coastal erosion. As with every community in Tillamook County, the proximity to the CSZ makes earthquake a high risk hazard. A significant portion of the community is exposed to the Medium-sized tsunami zone. Potential flooding from riverine and coastal sources can affect many buildings along the coast and in the flood-prone areas of local streams. A large amount of the residences built adjacent to the beach are also exposed to coastal erosion risk.

The CSZ event is a significant natural hazard risk to Rockaway Beach and is a priority hazard for this community. High liquefaction zones exist throughout the community, which increases the risk from earthquake. Another consideration of these areas is that liquefaction could present difficulties for evacuation from the subsequent tsunami. The coastal and low-laying areas of Rockaway Beach are predicted to be inundated by the most likely tsunami scenario. The combination of earthquake and tsunami will have a tremendous impact to this community.

Figure 13: Loss Ratio from CSZ-event



†Each cell represents 1% of building value

= Estimated damage due to tsunami

= Estimated damage due to earthquake (outside of tsunami zone)

The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus modeling for loss ratio is only available for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. In order to avoid double counting to buildings, the earthquake loss ratio was only calculated for buildings outside of the tsunami zone.

Many buildings in the low-laying areas of Rockaway Beach along the Pacific Ocean, Rock Creek, and other minor creeks are exposed to the 100-year flood. Although there are many elevated buildings in the flood-prone areas, which will greatly reduce overall flood risk, there are still many buildings that can be impacted by flood. It is estimated that nearly half of the buildings exposed to the 100-year flood are elevated above the predicted level of flooding. So while the buildings themselves would not be damaged from flood, access to these buildings could still be an issue.

Coastal erosion is another hazard that is a major concern and can have a significant impact for many within the community. The entire mostly residential area along the coast is likely to experience coastal erosion. During times of high tide occurring along with powerful storms, the rate of erosion can greatly increase. The current placement of riprap at the base of some areas is helping to reduce the rate of erosion.

Table 22: City of Rockaway Beach Essential Facilities

Essential Facilities by Community*	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ M 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Risk	Coastal Erosion High Hazard
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Rockaway Beach Fire Dept	X	X	X			
Rockaway Beach Police Dept		X	X			

City of Tillamook

Table 23: City of Tillamook Hazard Profile

Community Overview				
Community Name	Population	Number of Buildings	Essential Facilities[1]	Total Building Value ($)
Tillamook	4,999	2,270	10	322,398,000

Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	339	6.8%	205	1	3,060,000	0.9%
Earthquake*	CSZ Mag 9.0 Deterministic	1083	22%	942	9	152,112,000	47%
Earthquake (within Tsunami Zone)		0	0%	3	0	58,000	0%

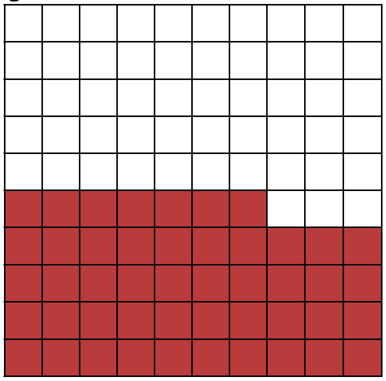
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Tsunami	CSZ Mag 9.0 – Medium	1	0%	3	0	71,000	0%
Tsunami	Senate Bill 379 Regulatory Line	11	0.2%	16	0	4,771,000	1.5%
Landslide	High and Very High Susceptibility	0	0%	1	0	13,000	0%
Wildfire	High Risk	3	0%	8	0	8,892,000	2.8%

**Earthquake damages calculated for buildings outside of Medium tsunami zone.*
Colors indicates results should be considered in tandem as they are expected to occur within minutes of one another
[1]*Facilities with multiple buildings were consolidated into 1 building complex.*
[2]*No damage is estimated for exposed structures with "First Floor Heights" above the level of flooding (base flood elevation).*

The natural hazards that Tillamook are most vulnerable to are the CSZ-related earthquake and flood. As with every community in Tillamook County, the proximity to the CSZ makes earthquake a high risk hazard. Potential flooding from riverine sources can affect many buildings in the low-laying areas of the community.

The CSZ earthquake hazard is a significant natural hazard risk to Tillamook and is a priority hazard for this community. A large part of the community lies within an area of high liquefaction, which increases the probability for structural damage to buildings. Also the building inventory for Tillamook is relatively older, which implies lower building design codes with regards to earthquake.

Figure 14: Loss Ratio from CSZ-event



The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus modeling for loss ratio is only available for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. In order to avoid double counting to buildings, the earthquake loss ratio was only calculated for buildings outside of the tsunami zone.

†Each cell represents 1% of building value
= Estimated damage due to tsunami
= Estimated damage due to earthquake (outside of tsunami zone)

The City of Tillamook lies between two major floodplains created by the Trask, Wilson, and Tillamook Rivers, as well as, many adjoining tributaries. Many buildings in the low-laying areas of Tillamook are exposed to the 100-year flood. Although there are many elevated buildings in the flood-prone areas, which will greatly reduce overall flood risk, there are still many buildings that can be impacted by flood. It is estimated that nearly a third of the buildings exposed to the 100-year flood are elevated above the predicted level of flooding. So while the buildings themselves would not be damaged from flood, access to these buildings could still be an issue.

Table 24: City of Tillamook Essential Facilities

Essential Facilities by Community*	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ M 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Risk	Coastal Erosion High Hazard
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
East Elementary School		X				
Liberty Elementary School		X				
Sacred Heart Catholic School		X				
Tillamook 911 Center		X				
Tillamook Bay Community College						
Tillamook City Police Dept		X				
Tillamook Fire Dist Main Station #71		X				
Tillamook High School	X	X				
Tillamook Junior High School		X				
Tillamook Regional Medical Center		X				

City of Wheeler

Table 25: City of Wheeler Hazard Profile

Community Overview				
Community Name	Population	Number of Buildings	Essential Facilities[1]	Total Building Value ($)
Wheeler	420	363	0	30,556,000

Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Essential Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	9	2.1%	12	0	113,000	0.4%
Earthquake*	CSZ Mag 9.0 Deterministic	166	40%	178	0	13,858,000	45%
Earthquake *(within Tsunami Zone)*		9	2.1%	14	0	1,095,000	3.6%

Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Building Value ($)	Exposure Ratio
Tsunami	CSZ Mag 9.0 – Medium	25	6%	24	0	2,072,000	6.8%
Tsunami	Senate Bill 379 Regulatory Line	22	5.2%	28	0	2,152,000	7%
Landslide	High and Very High Susceptibility	391	93%	336	0	28,256,000	92%
Wildfire	High Risk	0	0%	3	0	188,000	0.6%

**Earthquake damages calculated for buildings outside of Medium tsunami zone.*

Colors indicates results should be considered in tandem as they are expected to occur within minutes of one another

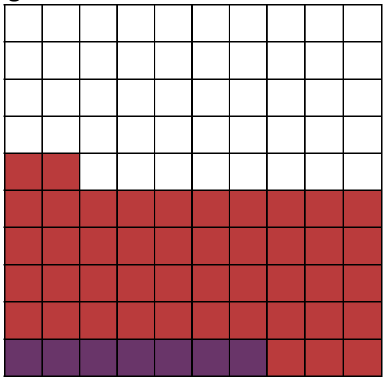
[1]*Facilities with multiple buildings were consolidated into 1 building complex.*

[2]*No damage is estimated for exposed structures with "First Floor Heights" above the level of flooding (base flood elevation).*

The natural hazards that Wheeler is most vulnerable to are the CSZ-related events (earthquake and tsunami) and landslide. As with every community in Tillamook County, the proximity to the CSZ makes earthquake a high risk hazard. Developments along the Nehalem River are exposed to tsunami hazard, as portions of the community are within the Medium-sized tsunami zone. Another substantial risk to the community is landslide hazard, since a large percentage of Wheeler is within a very high susceptibility landslide zone.

The CSZ earthquake hazard is a significant natural hazard risk to Wheeler and is a priority hazard for this community. A large part of the community lies within an area of moderate liquefaction, which slightly increases the probability for structural damage to buildings. Also the building inventory for Wheeler is relatively older, which implies lower building design codes with regards to earthquake. The tsunami generated from the CSZ earthquake is not expected to cause as much damage, but still is a concern.

Figure 15: Loss Ratio from CSZ-event



> The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus modeling for loss ratio is only available for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. In order to avoid double counting to buildings, the earthquake loss ratio was only calculated for buildings outside of the tsunami zone.

†Each cell represents 1% of building value

= Estimated damage due to tsunami

= Estimated damage due to earthquake (outside of tsunami zone)

The landslide hazard for Wheeler poses a great risk to the community and its potential impact is a serious concern. An area deemed very high susceptibility to landslides makes up the majority of Wheeler. Monitoring for ground movement, especially during particularly wet conditions, is one way of increasing public safety from landslide.

Areas of Mitigation Interest

Hazard results from Hazus and exposure analyses sometimes show specific locations where concentrations of high risk exist. These high risk locations, when considered along with other factors like number of people affected, potential economic impact, and level of damage, can be determined “Areas of Mitigation Interest” (AOMI). Conversations with local stakeholders through the Risk MAP process will ultimately determine which of these initial locations will be considered AOMI. Mitigation strategies, provided by FEMA, can advise on reducing the natural hazard risk and impact to these areas. Potential projects can be developed from these strategies which can foster local collaboration and highlight activities that can reduce hazard risk.

Unincorporated Tillamook County

Note: the statistics in this section do not include the unincorporated communities of Neskowin, Oceanside, Netarts, or Pacific City.

Table 26: Unincorporated Tillamook County Areas of Mitigation Interest.

Hazard	Area	Description	Recommended Strategy
Flood	Many buildings located adjacent to Nehalem River, just upstream of the City of Nehalem.	Clusters of buildings along the banks of the Nehalem River are not elevated above the predicted level of 100-year flooding.	
Flood	Tillamook Cheese Factory.	The top employer in Tillamook County is within the area predicted to flood due to a 100-year flood.	
Flood	Many buildings located adjacent to Trask River.	A cluster of mobile homes along the banks of the Trask River are not elevated above the predicted level of 100-year flooding.	
Earthquake	Mobile home park off of Necarney City Rd and Hwy 101.	A cluster of manufactured homes are estimated to have high probability to destruction due to earthquake.	
Earthquake	Many buildings located adjacent to Nehalem River, just upstream of the City of Nehalem.	Clusters of buildings along the banks of the Nehalem River are within a high liquefaction zone and have high probability to destruction due to earthquake.	
Earthquake	Mobile home park off of Hwy 101 and Idaville Rd.	A cluster of manufactured homes are estimated to have high probability to destruction due to earthquake.	
Earthquake	Cluster of homes adjacent to Highway 131 and near the Tillamook River.	A cluster of buildings are within a high liquefaction zone and have high probability to destruction due to earthquake.	
Coastal Erosion	Area of homes north of Rockaway Beach along the shoreline.	A long strip of houses that are all within the high coastal erosion designated zone.	
Coastal Erosion	Area of homes in the unincorporated community of Terra del Mar along the shoreline.	A long strip of houses that are all within the high coastal erosion designated zone.	

Table 27: Unincorporated Tillamook County Hazard Mitigation Plan Analysis

Hazard	Projects	Additional Information from Risk Report
Coastal erosion	Coastal Erosion Risk Analysis and response plan.	
Multi-hazard	Animal mortality plan, 8,000 dead cows per year without a natural disaster.	
Flood	Continue to replace culverts and bridges.	
Multi-hazard	Pre-position disaster response supplies and equipment	
Multi-hazard	Create public hazard mitigation event data entry port.	
Flood	Apply for funding to repair two levees	
Multi-hazard	Emergency Response Siren Committee to determine where the sirens are to be located.	
Flood	Implement Oregon Solutions Team Flood Hazard Reduction Plan.	
Flood	Drainage asset management plan and inventory; inventory the condition of the culverts and develop a repair / replacement schedule.	
Multi-hazard	Establish Tillamook County Emergency Management Advisory Committee (EMAC) including public works, fire departments, emergency medical services, first responders from the entire county coordinated centrally from the 911 center.	
Multi-hazard	Restock mass casualty trailer annually	
Multi-hazard	Mass casualty exercise annually.	
Flood	Inspect the seven levees annually.	
Multi-hazard	Established disaster event chain of command between county, cities, unincorporated communities and non-governmental bodies, Tillamook County Emergency Management Department, Oregon Emergency Management and FEMA.	
Multi-hazard	Partner with DOGAMI through a DOGAMI grant to engage four communities in the “follow the elephant” evacuation practice program. Pacific City, Neskowin, Rockaway Beach, Manzanita, and Nedonna Beach on their own.	
Multi-hazard	Practice evacuations with Manzanita and Pacific City	
Multi-hazard	Airborne warning and speaker system controlled by the civil air control dispatched through the Emergency Management Response System.	
Wildfire	Implement Nehalem Bay Emergency Volunteer Corps (NBEVC) agreement for assistance with Nehalem Bay Regional Fire District	
Multi-hazard	Partner with BLM and ODF to provide adequate staffing.	
Flood	Buy out repetitive loss properties through FEMA.	
Multi-hazard	Provide significant ham radio training throughout the county.	
Multi-hazard	Train CERT Volunteers in North Tillamook County and Rockaway Beach.	

Unincorporated Community of Neskowin

Table 28: Neskowin Areas of Mitigation Interest.

Hazard	Area	Description	Recommended Strategy
Flood	Primary commercial area subject to 100-year flooding.	Neskowin's primary commercial area experiences tidal flooding from the Pacific Ocean. Many structures are not elevated above predicted level of 100-year flooding.	
Coastal Erosion	A large number of homes along the shoreline.	A long strip of houses that are all within the high coastal erosion designated zone.	

Unincorporated Communities of Oceanside and Netarts

No identified Areas of Mitigation Interest.

Unincorporated Community of Pacific City

Table 29: Pacific City Areas of Mitigation Interest.

Hazard	Area	Description	Recommended Strategy
Flooding	Primary commercial area subject to 100-year flooding.	Pacific City's primary commercial area experiences flooding from the Nestucca River. Many structures are not elevated above predicted level of 100-year flooding.	
Earthquake	Two mobile home parks near Pacific Ave and Booten Rd.	Clusters of manufactured homes estimated to have high probability to destruction due to earthquake.	
Flood, Tsunami and Earthquake	The volunteer fire department exposed to natural hazards.	Pacific City's only essential facility is at risk to flood and tsunami. This building is also in a very-high liquefaction zone. During an emergency situation this building might be non-functional.	

City of Bay City

Table 30: Bay City Areas of Mitigation Interest.

Hazard	Area	Description	Recommended Strategy
Earthquake	Large percentage of the buildings within Bay City.	Much of the buildings within the community are within high liquefaction and earthquake-induced landslides areas.	

Table 31: Incorporated City of Bay City Hazard Mitigation Plan Analysis

Hazard	Projects	Additional Information from Risk Report
Multi-hazard	Remove two water lines from bridges to borings under the Kilchis River; connect the City of Tillamook water system and City of Bay City water system (Kilchis Regional Water System) by a boring under the Wilson River.	
Tsunami	Relocate the Fire Station and City Hall out of the Tsunami Impact area.	
Multi-hazard	Relocate public works equipment and emergency supplies to evacuation sites in the community.	
Flood	Create New Risk Maps and Flood Maps using LIDAR.	
Flood	Strengthen the banks of the wastewater treatment ponds to prevent erosion.	

City of Garibaldi

No identified Areas of Mitigation Interest.

Table 32: Incorporated City of Garibaldi Hazard Mitigation Plan Analysis

Hazard	Projects	Additional Information from Risk Report
Earthquake, tsunami	Retrofit Garibaldi City Hall/Fire Department building for seismic stability with financial assistance from the Oregon Department of Emergency Management.	
Earthquake, tsunami	Dismantle 100’ tall relic smoke stack.	
Earthquake, tsunami	Develop action plan for analyzing and decontaminating water in the event of an earthquake.	
Multi-hazard	Refine hazard analysis with scientific data: DOGAMI Risk Map.	
Multi-hazard	Agreement to use forest roads in an emergency or disaster response.	
Earthquake, tsunami	Seismic retrofits to bridges and culverts on U.S. Highway 101 to prevent collapse in an earthquake.	
Earthquake, tsunami	Analysis of Jetty infrastructure and port to determine if action could better assure usability for fishing the transport of goods to the area in the event of a disaster.	
Earthquake, landslide	Equip reservoirs with seismic-activated shut-off valves.	
Earthquake, landslide	Replace two miles of asbestos / concrete pipe.	

City of Nehalem

Table 33: Nehalem Areas of Mitigation Interest.

Hazard	Area	Description	Recommended Strategy
Flood	Commercial area adjacent to Nehalem River subject to 100-year flooding.	Nehalem’s primary commercial area experiences flooding from the Nehalem River. Many structures are not elevated above predicted level of 100-year flooding.	

City of Manzanita

No identified Areas of Mitigation Interest.

Table 34: Incorporated City of Manzanita Hazard Mitigation Plan Analysis

Hazard	Projects	Additional Information from Risk Report
Flood	Create New Risk Maps and Flood Maps using LIDAR.	
Earthquake	The water tank serving the upper portion of Manzanita is older and not constructed to earthquake standards. The tank needs to be retrofitted so that water system capability can be maintained after an earthquake.	
Earthquake	Manzanita City Hall is an unreinforced masonry building and is likely to collapse in an earthquake. The City Council Chambers is used to stage emergency operations and provide public information during disasters.	
Multi-hazard	The City needs to develop and approve a specific plan for Manzanita Hazard Mitigation Needs.	

City of Rockaway Beach

Table 35: Rockaway Beach Areas of Mitigation Interest.

Hazard	Area	Description	Recommended Strategy
Tsunami	Police and Fire Departments are within the Medium-sized tsunami zone.	Inundation could make these emergency services non-functional during a Medium-sized tsunami. If functional, could provide much needed services during a crisis due to a tsunami.	
Earthquake	Many buildings located adjacent to Lake Lytle.	A cluster of manufactured homes are in a very high liquefaction zone and is estimated to have high probability to destruction due to earthquake.	
Earthquake	Many buildings located adjacent to Clear Lake.	A cluster of manufactured homes are in a very high liquefaction zone and is estimated to have high probability to destruction due to earthquake.	
Coastal Erosion	Area of homes in Rockaway Beach along the shoreline.	A long strip of houses that are all within the high coastal erosion designated zone.	

Table 36: Incorporated City of Rockaway Beach Hazard Mitigation Plan Analysis

Hazard	Projects	Additional Information from Risk Report
Multi-hazard	Continue to Work on our Emergency Operation Plan.	
Multi-hazard	Continue to be NIMSCAST compliant.	
Multi-hazard	Continue to send “key” players to FEMA/ICS classes / training.	
Multi-hazard	Continue to have staff representation at Command Post to insure coordination with the Incident Command Team.	

City of Tillamook

Table 37: City of Tillamook Areas of Mitigation Interest.

Hazard	Area	Description	Recommended Strategy
Flood	Many buildings located along Highway 101 and north of downtown Tillamook are subject to 100-year flooding.	Clusters of buildings are predicted to experience flooding from a 100-year event from tributaries of the Wilson River. Many structures are not elevated above the BFE. Flood waters would cut off a primary route for travelers.	
Flood	Many buildings located along Highway 101 south of downtown Tillamook are subject to 100-year flooding.	Clusters of buildings are predicted to experience flooding from a 100-year event from the Trask River. Many structures are not elevated above the BFE. Flood waters would cut off a primary route for travelers.	
Flood	The Tillamook High School is subject to 100-year flooding.	Flooding from the Trask River would make the school non-functional during a 100-year flood event. If functional, could act as emergency shelter during periods of intense flooding.	

Table 38: Incorporated City of Tillamook Hazard Mitigation Plan Analysis

Hazard	Projects	Additional Information from Risk Report
Earthquake	Retrofit or replace school buildings to be earthquake resistant	
Multi-hazard	Obtain generators for the school buildings to provide electricity, especially kitchen facilities.	
Multi-hazard	Conduct a full natural hazard impact analysis.	
Multi-hazard	Develop an emergency response plan for Tillamook School District #9.	

City of Wheeler

Table 39: Wheeler Areas of Mitigation Interest.

Hazard	Area	Description	Recommended Strategy
Flood	Commercial area on the riverside of Highway 101 subject to 100-year flooding.	Wheeler's commercial area experiences flooding from the Nehalem River. Many structures are not elevated above predicted level of 100-year flooding.	

Table 40: Incorporated City of Tillamook Hazard Mitigation Plan Analysis

Hazard	Projects	Additional Information from Risk Report
Flood	Create New Risk Maps and Flood Maps using LIDAR.	
Multi-hazard	Establish evacuation routes above inundation zone, alternate to U.S. 101.	

References

Allan et al. 2015, Coastal Flood Hazard Study, Tillamook County, Oregon: Oregon Department of Geology and Mineral Industries Special Paper SP-47.

Burns et al., 2011, Multi-Hazard and Risk Study for the Mount Hood Region, Multnomah, Clackamas, and Hood River Counties, Oregon: Oregon Department of Geology and Mineral Industries Open-File Report O-11-16.

Burns, William J., 2016, The Landslide Susceptibility Index: Oregon Department of Geology and Mineral Industries Open-File Report (OFR, O-16-02)

Burns, William J. and Rudie J. Watzig, 2014, Statewide Landslide Information Database for Oregon, release 3 (SLIDO-3.0): Oregon Department of Geology and Mineral Industries, SLIDO-3.0.

Business Oregon, Infrastructure Finance Authority, 2013. Oregon Benefit-Cost Analysis Tool User's Guide for Evaluation of Seismic Rehabilitation Grant Program Applications

FEMA (Federal Emergency Management Agency). 2013, HAZUS-MH software, FEMA's tool for estimating potential losses from natural disasters. Available on CD-ROM disks from the Federal Emergency Management Agency (FEMA) or the National Institute of Building Sciences 1090 Vermont Avenue, NW, Suite 700 Washington, DC, 20005-4905, phone (202) 289-7800, fax (202) 289-1092, e-mail hazus@nibs.org. Web: http://www.fema.gov/ hazus/.

FEMA. (2006). HAZUS-MH MR2 Technical Manual, Federal Emergency Management Agency, Washington, DC, USA.

FEMA (Federal Emergency Management Agency), To be determined, Preliminary flood insurance study for Tillamook County, Oregon and incorporated areas: Washington D.C., Region X Mitigation Division, Flood Insurance Study Number 41057CV001A, TBD.

Judson, S. (2012). Earthquake Design History: A summary of Requirements in the State of Oregon: State of Oregon, Building Codes Division, Feb. 7, 2012, 7 p. Available at: http://www.oregon.gov/OMD/OEM/osspac/docs/history_seismic_codes_or.pdf

Lewis, D, 2007, Statewide Seismic Needs Assessment: Implementation of Oregon 2005 Senate Bill 2 Relating to Public Safety, Earthquakes, and Seismic Rehabilitation of Public Buildings: Oregon Department of Geology and Mineral Industries Open-File Report O-07-02.

Madin, Ian P. and William J. Burns, 2013, *Ground motion, ground deformation, tsunami inundation, coseismic subsidence, and damage potential maps for the 2012 Oregon Resilience Plan for Cascadia Subduction Zone Earthquakes:* Oregon Department of Geology and Mineral Industries Open-File Report O-13-06.

Oregon Building Codes Division, "Oregon Manufactured Dwelling and Park Specialty Code" 2002 Edition

Oregon Building Codes Division, "2010 Oregon Manufactured Dwelling Installation Specialty Code"

Oregon Department of Forestry, 2013, The West Wide Wildfire Risk Assessment: The Sanborn Map Company, Inc., 2012.

Oregon Department of Land Conservation and Development, 2015. Oregon Natural Hazards Mitigation Plan. Oregon Department of Land Conservation and Development.

Peterson et al., 1997, Estimates of coastal subsidence from great earthquakes in the Cascadia Subduction Zone, Vancouver Island, B. C., Washington, Oregon, and northernmost California: Oregon Department of Geology and Mineral Industries Open-File Report O-97-05.

Priest et al., 2013, Tsunami inundation scenarios for Oregon: Oregon Department of Geology and Mineral Industries Open-File Report O-13-19.

Stimely, Laura and Jonathan C. Allan, 2014, Evaluation of erosion hazard zones for the dune-backed beaches of Tillamook County, Oregon: Oregon Department of Geology and Mineral Industries Open-File Report O-14-02.

VLG Consulting and Sabrina Peterson, 2011. Tillamook County, Oregon Multi-Jurisdiction Natural Hazards Mitigation Plan. Tillamook, OR.

Tillamook County Planning Commission, 1982. Tillamook County Comprehesive Plan. Tillamook, OR.

United States Geological Survey. (2015, May). Lower 48 Maps and Data. Retrieved from http://earthquake.usgs.gov/hazards/products/conterminous/

Witter et al., 2011, Simulating Tsunami Inundation at Bandon, Oregon Using Hypothetical Cascadia and Alaska Earthquake Scenarios: Oregon Department of Geology and Mineral Industries Special Paper SP-43.

Appendices

A. Detailed Risk Assessment Tables

Table A-1. Tillamook County building inventory.

(all dollar amounts in thousands)

Community	Residential			Commercial & Industrial			Agricultural			Public & Non-Profit			All Buildings			
	Number of Buildings	Building Value ($)	Building Value Ratio	Number of Buildings	Building Value ($)	Building Value Ratio	Number of Buildings	Building Value ($)	Building Value Ratio	Number of Buildings	Building Value ($)	Building Value Ratio	Number of Buildings	Number of Buildings per County Total	Building Value ($)	Value of Buildings per County Total
Unincorp. County (rural)	9,542	835,993	65%	514	153,910	12%	4,630	183,819	14%	329	108,714	8.5%	15,015	55%	1,282,436	46%
Neskowin	631	115,828	98%	8	1,642	1%	7	128	0%	7	865	0.7%	653	2%	118,463	4%
Oceanside-Netarts	1,606	196,094	96%	20	2,091	1%	64	1,259	1%	11	3,919	1.9%	1,701	6%	203,363	7%
Pacific City	1,555	195,882	92%	70	11,216	5%	54	1,408	1%	28	3,556	1.7%	1,707	6%	212,062	8%
Total Unincorp. County	13,334	1,343,797	74%	612	168,859	9.3%	4755	186,614	10%	375	117,054	6.4%	19076	70%	1,816,324	65%
Bay City	748	54,962	74%	43	13,242	18%	75	2,102	3%	18	4,463	6.0%	884	3%	74,769	3%
Garibaldi	582	39,527	61%	95	14,946	23%	45	1,676	3%	33	8,182	12.7%	755	3%	64,331	2%
Manzanita	1,425	245,415	94%	68	9,743	4%	6	141	0%	24	4,481	1.7%	1,523	6%	259,780	9%
Nehalem	191	13,733	55%	42	4,753	19%	10	292	1%	17	6,109	24.5%	260	1%	24,887	1%
Rockaway Beach	2,049	196,117	93%	51	6,245	3%	105	1,698	1%	35	7,749	3.7%	2,240	8%	211,809	8%
Tillamook	1,731	139,379	43%	401	119,603	37%	51	3,849	1%	87	59,567	18.5%	2,270	8%	322,398	11%
Wheeler	295	24,825	81%	33	4,261	14%	29	573	2%	6	897	2.9%	363	1%	30,556	1%
Total Tillamook County	20,355	2,057,755	73%	1,345	341,652	12%	5,076	196,945	7%	595	208,502	7.4%	27,371	100%	2,804,854	100%

Table A-2. Flood loss estimates.

Community	*(all dollar amounts in thousands)*													
	Total Number of Buildings	Total Estimated Building Value ($)	10% (10-yr)			2% (50-yr)			1% (100-yr)*			0.2% (500-yr)		
			Number of Buildings	Loss Estimate	Loss Ratio	Number of Buildings	Loss Estimate	Loss Ratio	Number of Buildings	Loss Estimate	Loss Ratio	Number of Buildings	Loss Estimate	Loss Ratio
Unincorp. County (rural)	15,015	1,282,436	553	3,277	0.3%	923	6,930	0.5%	1,106	10,178	0.8%	1,369	13,888	1.1%
Neskowin	653	118,463	3	12	0.0%	22	93	0.1%	82	7,132	6.0%	61	609	0.5%
Oceanside-Netarts	1,701	203,363	0	0	0.0%	1	1	0.0%	4	4	0.0%	6	83	0.0%
Pacific City	1,707	212,062	90	543	0.3%	268	2,167	1.0%	361	3,301	1.6%	492	6,711	3.2%
Total Unincorp. County	19,076	1,816,324	646	3,832	0.2%	1,214	9,191	0.5%	1,553	20,615	1.1%	1,928	21,291	1.2%
Bay City	884	74,770	0	0	0.0%	0	0	0.0%	0	0	0.0%	3	11	0.0%
Garibaldi	755	64,331	7	47	0.1%	14	71	0.1%	21	79	0.1%	39	189	0.3%
Manzanita	1,523	259,780	0	0	0.0%	0	0	0.0%	1	11	0.0%	0	0	0.0%
Nehalem	260	24,886	6	31	0.1%	15	98	0.4%	37	281	1.0%	53	627	2.5%
Rockaway Beach	2,240	211,809	70	370	0.2%	122	522	0.2%	170	1,671	0.8%	293	2,140	1%
Tillamook	2,270	322,398	52	600	0.2%	136	1,880	0.6%	205	3,060	0.9%	307	7,840	2.4%
Wheeler	363	30,556	5	49	0.2%	5	71	0.2%	12	113	0.4%	14	187	0.6%
Total Tillamook County	27,371	2,804,854	786	4,929	0.2%	1,506	11,833	0.4%	1,999	25,830	0.9%	2,637	32,285	1.2%

**1% results include coastal flooding source.*

Table A-3. Flood exposure.

Community	Total Number of Buildings	Total Population	1% (100-yr)*		
			Potentially Displaced Residents from flood exposure	% Potentially Displaced Residents from flood exposure	Number of flood exposed buildings without damage
Unincorp. County (rural)	15,015	13,364	1,078	8.1%	254
Neskowin	653	230	38	17%	53
Oceanside-Netarts	1,701	1,056	4	0.4%	45
Pacific City	1,707	947	270	29%	114
Total Unincorp. County	19,076	15,597	1,390	8.9%	466
Bay City	884	1,284	5	0.4%	7
Garibaldi	755	779	13	1.7%	10
Manzanita	1,523	599	0	0	3
Nehalem	260	267	41	15%	12
Rockaway Beach	2,240	1,305	152	12%	175
Tillamook	2,270	4,999	505	10%	64
Wheeler	363	420	9	2.1%	0
Total Tillamook County	27,371	25,250	2,115	8.4%	737

**1% results include coastal flooding source.*

Table A-4: CSZ Earthquake loss estimates.

Community	(all dollar amounts in thousands)												
	Total Number of Buildings	Total Estimated Building Value ($)	***Total Earthquake Damage (Includes Medium Tsunami Zone)***		***Excludes Medium Tsunami Zone***								
			Buildings Damaged		**Buildings Damaged**				**All buildings changed to at least Moderate Code**				
			Sum of Economic Loss	Loss Ratio	Yellow-Tagged Buildings	Red-Tagged Buildings	Sum of Economic Loss	Loss Ratio	Yellow-Tagged Buildings	Red-Tagged Buildings	Sum of Economic Loss	Loss Ratio
Unincorp. County (rural)	15,015	1,282,436	458,478	36%	1,269	4,800	409,947	32%	1,657	3,023	318,719	25%
Neskowin	653	118,463	23,959	20%	6	26	6,658	5.6%	2	23	5,568	4.7%
Oceanside-Netarts	1,701	203,363	66,680	33%	79	544	61,450	30%	97	447	56,135	28%
Pacific City	1,707	212,062	50,563	24%	45	192	26,963	13%	42	147	23,839	11%
Total Unincorp. County	19,076	1,816,324	599,680	33%	1,399	5,562	505,018	28%	1,798	3,640	404,261	22%
Bay City	884	74,770	30,887	41%	82	321	29,014	39%	84	229	21,059	28%
Garibaldi	755	64,331	33,653	52%	52	293	26,182	41%	43	244	20,531	32%
Manzanita	1,523	259,780	75,704	29%	53	301	59,646	23%	28	270	53,424	21%
Nehalem	260	24,886	16,094	65%	11	99	10,349	42%	11	85	7,572	30%
Rockaway Beach	2,240	211,809	73,559	35%	49	276	18,721	8.8%	110	171	15,650	7.4%
Tillamook	2,270	322,398	152,170	47%	196	746	152,112	47%	167	499	101,753	32%
Wheeler	363	30,556	14,953	49%	28	150	13,858	45%	22	127	11,708	38%
Total Tillamook County	27,371	2,804,854	996,701	36%	1,870	7,748	814,900	29%	2,263	5,265	635,958	23%

Table A-5: Tsunami exposure.

Community	Total Number of Buildings	Total Estimated Building Value ($)	Small (low-severity)			Medium (moderate severity)			Large (high-severity)			XX Large (very high-severity)		
			(all dollar amounts in thousands)											
			Number of Buildings	Building Value ($)	Ratio of Exposure Value	Number of Buildings	Building Value ($)	Ratio of Exposure Value	Number of Buildings	Building Value ($)	Ratio of Exposure Value	Number of Buildings	Building Value ($)	Ratio of Exposure Value
Unincorp. County (rural)	15,015	1,282,436	520	46,924	3.7%	1,692	147,262	11%	2,548	223,814	18%	3,706	370,556	29%
Neskowin	653	118,463	268	56,198	47%	461	81,824	69%	485	86,960	73%	508	91,182	77%
Oceanside-Netarts	1,701	203,363	62	11,292	5.6%	88	15,432	7.6%	141	21,433	11%	326	36,738	18%
Pacific City	1,707	212,062	175	15,825	7.5%	806	83,301	39%	1,252	148,741	70%	1,355	156,498	74%
Total Unincorp. County	19,076	1,816,324	1,025	130,239	7.2%	3,047	327,819	18%	4,426	480,948	26%	5,895	654,974	36%
Bay City	884	74,770	4	370	0.5%	62	8,455	11%	136	20,515	27%	234	26,459	35%
Garibaldi	755	64,331	9	549	0.9%	91	11,870	18%	197	26,106	41%	336	33,894	53%
Manzanita	1,523	259,780	0	0	0.0%	354	56,238	22%	703	121,483	47%	966	163,906	63%
Nehalem	260	24,886	45	6,091	25%	61	7,856	32%	67	8,261	33%	77	8,872	36%
Rockaway Beach	2,240	211,809	591	49,215	23%	1,525	146,945	69%	1,888	170,195	80%	2,095	186,898	88%
Tillamook	2,270	322,398	0	0	0.0%	3	71	0.2%	84	24,651	7.6%	482	84,661	26%
Wheeler	363	30,556	14	1,047	3.4%	24	2,072	6.8%	33	3,798	12%	56	5,703	19%
Total Tillamook County	27,371	2,804,854	1,688	187,511	6.7%	5,167	561,327	20%	7,534	855,957	31%	10,141	1,165,367	42%

Table A-6: Landslide exposure.

Community	Total Number of Buildings	Total Estimated Building Value ($)	Very High Susceptibility			High Susceptibility			Moderate Susceptibility		
	(all dollar amounts in thousands)		Number of Buildings	Building Value ($)	Ratio of Exposure Value	Number of Buildings	Building Value ($)	Ratio of Exposure Value	Number of Buildings	Building Value ($)	Ratio of Exposure Value
Unincorp. County (rural)	15,015	1,282,436	3,680	353,459	28%	1,253	95,872	7.5%	2,531	198,311	15%
Neskowin	653	118,463	8	1,353	1.1%	124	22,834	19%	195	26,971	23%
Oceanside-Netarts	1,701	203,363	446	55,589	27%	292	45,647	22%	652	70,937	35%
Pacific City	1,707	212,062	2	42	0.0%	181	24,888	12%	597	85,603	40%
Total Unincorp. County	19,076	1,816,324	4,136	410,443	23%	1,850	189,240	10%	3,975	381,820	21%
Bay City	884	74,770	476	35,108	47%	4	154	0.2%	261	19,717	26%
Garibaldi	755	64,331	516	38,377	60%	18	956	1.5%	84	6,627	10%
Manzanita	1,523	259,780	44	9,050	3.5%	162	29,389	11%	651	114,586	44%
Nehalem	260	24,886	250	23,502	94%	9	1,233	5.0%	1	151	0.6%
Rockaway Beach	2,240	211,809	19	2,932	1.4%	85	10,504	5.0%	661	65,832	31%
Tillamook	2,270	322,398	0	0	0.0%	1	13	0.0%	54	8,273	2.6%
Wheeler	363	30,556	263	22,601	74%	73	5,655	19%	10	947	3.1%
Total Tillamook County	27,371	2,804,854	5,704	542,013	19.3%	2,202	237,145	8.5%	5,697	597,954	21%

Table A-7: Coastal erosion exposure.

Community*	*(all dollar amounts in thousands)*										
	Total Number of Buildings	Total Estimated Building Value ($)	Very High Hazard			High Hazard			Moderate Hazard		
			Number of Buildings	Building Value ($)	Ratio of Exposure Value	Number of Buildings	Building Value ($)	Ratio of Exposure Value	Number of Buildings	Building Value ($)	Ratio of Exposure Value
Unincorp. County (rural)	15,015	1,282,436	109	13,418	1.0%	161	18,928	1.5%	309	33,885	2.6%
Neskowin	653	118,463	95	32,205	27.2%	110	34,149	28.8%	156	40,374	34.1%
Pacific City	1,707	212,062	3	5,991	2.8%	25	8,909	4.2%	88	19,740	9.3%
Total Unincorp. County	17,375	1,612,961	207	51,614	3.2%	296	61,986	3.8%	553	93,999	5.8%
Manzanita	1,523	259,780	10	2,225	0.9%	25	4,389	1.7%	103	18,410	7.1%
Rockaway Beach	2,240	211,809	241	44,795	21.1%	288	50,675	23.9%	534	79,618	37.6%
Total Tillamook County*	21,138	2,084,550	458	98,634	4.7%	609	117,050	5.6%	1,190	192,027	9.2%

**Does not include non-coastal communities (these communities do not factor in to total amounts and percentages).*

[1]The coastal erosion zones of "High, Moderate, and Low 1" determined in OFR O-14-02 corresponds to "Very High, High, and Moderate."

Table A-8: Wildfire exposure.

Community	Total Number of Buildings	Total Estimated Building Value ($)	High Risk			Moderate Risk		
(all dollar amounts in thousands)			Number of Buildings	Building Value ($)	Ratio of Exposure Value	Number of Buildings	Building Value ($)	Ratio of Exposure Value
Unincorp. County (rural)	15,015	1,282,436	383	22,892	1.8%	8130	607,204	47%
Neskowin	653	118,463	2	288	0.2%	319	50,895	43%
Oceanside-Netarts	1,701	203,363	0	0	0%	866	113,942	56%
Pacific City	1,707	212,062	3	226	0.1%	656	86,116	41%
Total Unincorp. County	19,076	1,816,324	388	23,406	1.3%	9971	858,157	47%
Bay City	884	74,770	58	7,089	9.5%	456	34,921	47%
Garibaldi	755	64,331	83	5,014	7.8%	93	11,144	17%
Manzanita	1,523	259,780	0	0	0%	681	121,658	47%
Nehalem	260	24,886	0	0	0%	105	10,822	43%
Rockaway Beach	2,240	211,809	25	2,938	1.4%	782	89,488	42%
Tillamook	2,270	322,398	8	8,892	2.8%	218	37,552	12%
Wheeler	363	30,556	3	188	0.6%	180	17,373	57%
Total Tillamook County	27,371	2,804,854	565	47,527	1.7%	12486	1,181,115	42%

B. Hazus Methodology

<u>Software</u>
All loss estimations were performed using Hazus-MH 2.2 and ArcGIS Desktop 10.2.2.

<u>User-Defined Facilities (UDF) Database</u>
A UDF database was compiled for all buildings in Tillamook County for use in both the flood and earthquake modules of Hazus-MH. The Tillamook County assessor database (acquired in 2015) was used to determine which taxlots had improvements (i.e. buildings) and how many building points should be included in the UDF database.

<u>Locating Buildings Points</u>
The Oregon Department of Geology and Mineral Industries (DOGAMI) used its existing dataset of building footprints (unpublished) to help precisely locate the centroid of each building. Where the building footprint dataset lacked coverage in the eastern portion of the county the centroid of the taxlot was taken, and for taxlots larger than 10 acres the building centroid was moved and approximated using orthoimagery. Extra effort was spent to locate building points along the 1% and 0.2% annual chance inundation fringe. When buildings were partially within the inundation zone, the building point was moved to the centroid of the portion of the building within the inundation zone. An iterative approach was used to further refine locations of building points for the flood module by generating results, reviewing the highest value buildings, and moving the building point over a representative elevation on the lidar digital elevation model to ensure an accurate first floor height.

<u>Attributing Building Points</u>
Populating the required attributes for Hazus-MH was achieved through a variety of approaches. The Tillamook County assessor database was used whenever possible, but in many cases it did not provide the necessary information. The following is list of attributes and their source:

- **Longitude and Latitude** – Location information that provides Hazus-MH the x and y-position of the UDF point. This allows for an overlay to occur between the UDF point and the flood or earthquake input data layers. The hazard model uses this spatial overlay to determine the correct hazard risk level that will be applied to the UDF point. The format of the attribute must be in decimal degrees. A simple geometric calculation using GIS software is done on the point to derive this value.
- **Occupancy Class** – An alphanumeric attribute that indicates the use of the UDF (e.g. 'RES1' is a single family dwelling). The alphanumeric code is composed of seven broad occupancy types (RES = residential, COM = commercial, IND = industrial, AGR = agricultural, GOV = public, REL = non-profit/religious, EDU = education) and various suffixes that indicate more specific types. This code determines the damage function to be used for flood analysis. It is also used to attribute the Building Type field, discussed below, for the earthquake analysis. The code was interpreted from "Stat Class" or "Description" data found in the Tillamook County assessor database. When data was not available the default value of RES1 was applied throughout.

- **Cost** – The replacement cost of an individual UDF. Loss ratio is derived from this value. The value was obtained from the Tillamook County assessor database. When not available, cost was based on the square footage of the building footprint or from the square footage found in the Tillamook County assessor database. When multiple UDF's occupied a single taxlot, the overall cost of the taxlot was distributed to the UDF's based on square footage.
- **Year Built** – The year of construction that is used to attribute the Building Design Level field for the earthquake analysis (*see Building Design below*). The year a UDF was built is obtained from Tillamook County assessor database. When not available, the year of "1900" was applied.
- **Square Feet** – The size of the UDF is used to pro-rate the total improvement value for taxlots with multiple UDF's. The value distribution method will ensure that UDF's with the most square footage will be the most expensive on a given taxlot. This value is also used to pro-rate the Number of People field for Residential UDF's within a census block. The value was obtained from DOGAMI's building footprints; where (RES) footprints were not available, we used the Tillamook County assessor database.
- **Number of Stories** – The number of stories for an individual UDF, along with Occupancy Class, determines the applied damage function for flood analysis. The value was obtained from the Tillamook County assessor database when available. For UDF's without assessor information for number of stories that are within the flood zone, closer inspection using Google Street View or available oblique imagery was used for attribution.
- **Foundation Type** – The UDF foundation type correlates with First Floor Height values in feet (***see Table 3.11*** in the Hazus-MH Technical Manual for the Flood Model). It also functions within the flood model by indicating if a basement exists or not. UDF's with a basement have a different damage curve from UDF's that do not have one. The value was obtained from the Tillamook County assessor database when available. For UDF's without assessor information for basements that are within the flood zone, closer inspection using Google Street View or available oblique imagery was used to ascertain if one exists or not.
- **First Floor Height** – The height in feet above grade for the lowest habitable floor. The height is factored during the depth of flooding analysis. The value is used directly by Hazus-MH, where Hazus-MH overlays a UDF location on a depth grid and using the first floor height determines the level of flooding occurring to a building. It is derived from the Foundation Type attribute (Tillamook Assessor data) or observation via oblique imagery or Google Street Maps.
- **Building Type** – This attribute determines the construction material and structural integrity of an individual UDF. It is used by Hazus-MH for estimating earthquake damage by determining which damage function will be applied. This information was unavailable from the Tillamook County assessor data, so instead it was derived from a statistical distribution based on Occupancy Class.
- **Building Design Level** – This attribute determines the seismic building code for an individual UDF. It is used by Hazus-MH for estimating earthquake damage by determining which damage function will be applied. (*see "Seismic Building Codes" section below for further information*). This information is derived from the Year Built attribute (Tillamook Assessor) and state/regional Seismic Building Code benchmark years.

- **Number of People** – The estimated number of permanent residents living within an individual residential structure. It is used in the post-analysis phase to determine the amount of people affected by a given hazard (*see "Population" section below*). This attribute is derived from default Hazus database (2010 Census data) of population per census block and distributed across residential UDF's.
- **Community** – The community that a UDF is within. These areas are used in the post-analysis for reporting results. The communities were based on incorporated boundaries and for unincorporated areas, based on building density.

Seismic Building Codes

The years that seismic building codes are enforced within a community, called "benchmark" years, have a significant effect on the results produced from the Hazus earthquake model. Oregon initially adopted seismic building codes in the mid-1970's. The established benchmark years of code enforcement are used in determining a "design level" for individual buildings. The design level attributes (pre-code, low-code, moderate-code, and high-code) are used in the Hazus earthquake model to determine what damage functions are applied to a given building. The year built or the year of the most recent seismic retrofit are the main considerations for an individual design level attribute. Seismic retrofitting information for structures would be ideal for this analysis, but based on local inquiry, no community in Tillamook County imposed seismic design building codes that exceeded Oregon Building Code Division rules.

Population

Within the UDF database, the 2010 U.S. Census population reported per census block were distributed amongst residential buildings, pro-rated based on the square footage. Note that due to lack of information within the assessor and census databases this distribution also includes vacation homes, which in many of the coastal communities make up a large but unknown percentage of the total residential building stock.

Using this distribution, DOGAMI estimated the number of permanent residents that could be affected by a natural hazard scenario. For each natural hazard, with the exception of the CSZ earthquake scenario, a simple exposure was used to find the number of potentially displaced residents within a hazard zone. For the CSZ earthquake scenario the potentially displaced residents were based on a combination of residents exposed to tsunami and those in buildings estimated to be significantly damaged by the earthquake.

Flood Hazard Data

DOGAMI developed flood hazard data in 2014 for a revision of the Tillamook County FEMA Flood Insurance Study. The hazard data was based on some previous flood studies and new riverine and coastal hydrologic and hydraulic analyses. For riverine areas, the flood elevations for the 10-, 50-, 100-, and 500-year events for each stream cross-section were used to develop depth of flooding raster datasets or "depth grids." For coastal zones and other stillwater flood areas, a 100-year stillwater elevation was used to create the depth grid.

A countywide, 2-meter, lidar-based depth grid was developed for each of the 10-, 50-, 100-, and 500-year annual chance flood events. The depth grids were imported into Hazus-MH for determining the depth of flooding for areas within the FEMA flood zones.

Once the UDF database was developed into a Hazus-compliant format, the Hazus-MH methodology was applied using a Python script developed by DOGAMI. The analysis is then run for a given flood event and the script cross references a UDF location with the depth grid to find the depth of flooding. The script then applies a specific damage function, based on a UDF's Occupancy Class which is used to determine the loss ratio for a given amount of flood depth, relative to the UDF's first floor height.

Earthquake Hazard Data

Several data layers were used for the deterministic analysis conducted for this report. Data layers created for the Oregon Resilience Plan (ORP) provided most of the earthquake inputs for the CSZ M9.0 event modeled in Hazus-MH. Liquefaction susceptibility data came directly from the ORP, but site ground motion data (PGA, PGV, SA03, and SA10) were derived from NEHRP soil data. The landslide susceptibility data from the ORP was replaced with newer and more accurate data from DOGAMI's 2016 Landslide Susceptibility Dataset (OFR, O-16-02).

The hazard layers were formatted for use in a Python script developed by DOGAMI to apply the Hazus-MH methodology. The earthquake hazard datasets that were used in the analysis were: ground motion data (PGA, PGV, SA03, and SA10), a landslide susceptibility map and liquefaction susceptibility map. Permanent ground deformation (PGD) for landslide and liquefaction were both calculated using Hazus-MH methodology for each of the susceptibility maps. In addition to the earthquake data layers, it is necessary to define a water table parameter for PGD due to liquefaction. As this data was unavailable, the study area was set with a water table depth of 5 feet.

A deterministic method for the CSZ M9.0 was deemed the most likely and impactful earthquake scenario for Tillamook County. Past work has shown that probabilistic models of a 500-year event for this area are roughly the same as the CSZ M9.0 event.

During the Hazus earthquake analysis, each UDF is analyzed given its site-specific parameters (ground motion and ground deformation) and are evaluated for its damage, expressed as a probability of a damage state. Specific damage functions based on Building Type and Design Level are used to calculate the damage states given the site-specific parameters for each UDF. The output provides probabilities of the five damage states (None, Slight, Moderate, Extensive, Complete) from which losses in dollar amount is derived.

Post-Analysis Quality Control

Ensuring the quality of the results from Hazus flood and earthquake is an essential part of the process. A primary characteristic of the process is that it is iterative. A UDF database without errors is highly unlikely, so this process is intended to limit and reduce the influence that these errors have on the final outcome. Before applying the Hazus-MH methodology, closely examining the top 10 largest area UDFs and the top 10 most expensive UDFs is advisable. Special consideration should also be given to essential facilities due to their importance to the communities.

Identifying, verifying, and correcting (if needed) the outliers in the results is the most efficient way to improve the UDF database. This can be done by sorting the results based on the loss estimates and closely scrutinizing the top 10 to 15 records. If corrections are made, then subsequent iterations are necessary. We continued checking the loss leaders until no more corrections were needed.

Finding anomalies and investigating the source of the error (if one exists) is crucial in making a correction to the data. There are a wide range of corrections that might be required to produce a better outcome. For example, floating homes may need to have a first floor height adjustment or a UDF point position might need to be moved due to issues with the depth grid. Incorrect basement or occupancy type attribution could be the cause of a problem. Sometimes inconsistencies between the assessor’s data and the taxlot geometry can be the source of an error. These are just a few of the many types of problems that should be addressed in the quality control process.

C. Risk Assessment Database (To Be Distributed with Final Risk Report)

List of Feature Classes within Risk Assessment Database:

- S_FRD_Pol_Ar (Communities)
- HAZUS_Study_Area
- UserDefinedFacilities
- EssentialFacilities
- Hex_Density_20ac
- NHD_Rivers
- S_FRD_Fld_Haz_Ar
- Landslide_PGD
- Landslide_Prob
- Liquefaction_PGD_Lat
- Liquefaction_PGD_Set
- Liquefaction_Prob
- SA03
- SA10
- PGV
- PGA
- NEHRP_Soils
- Tsunami_Inundation
- Landslide_Susceptibility
- Wildfire_Risk_Index
- Coastal_Erosion_Haz_Zone

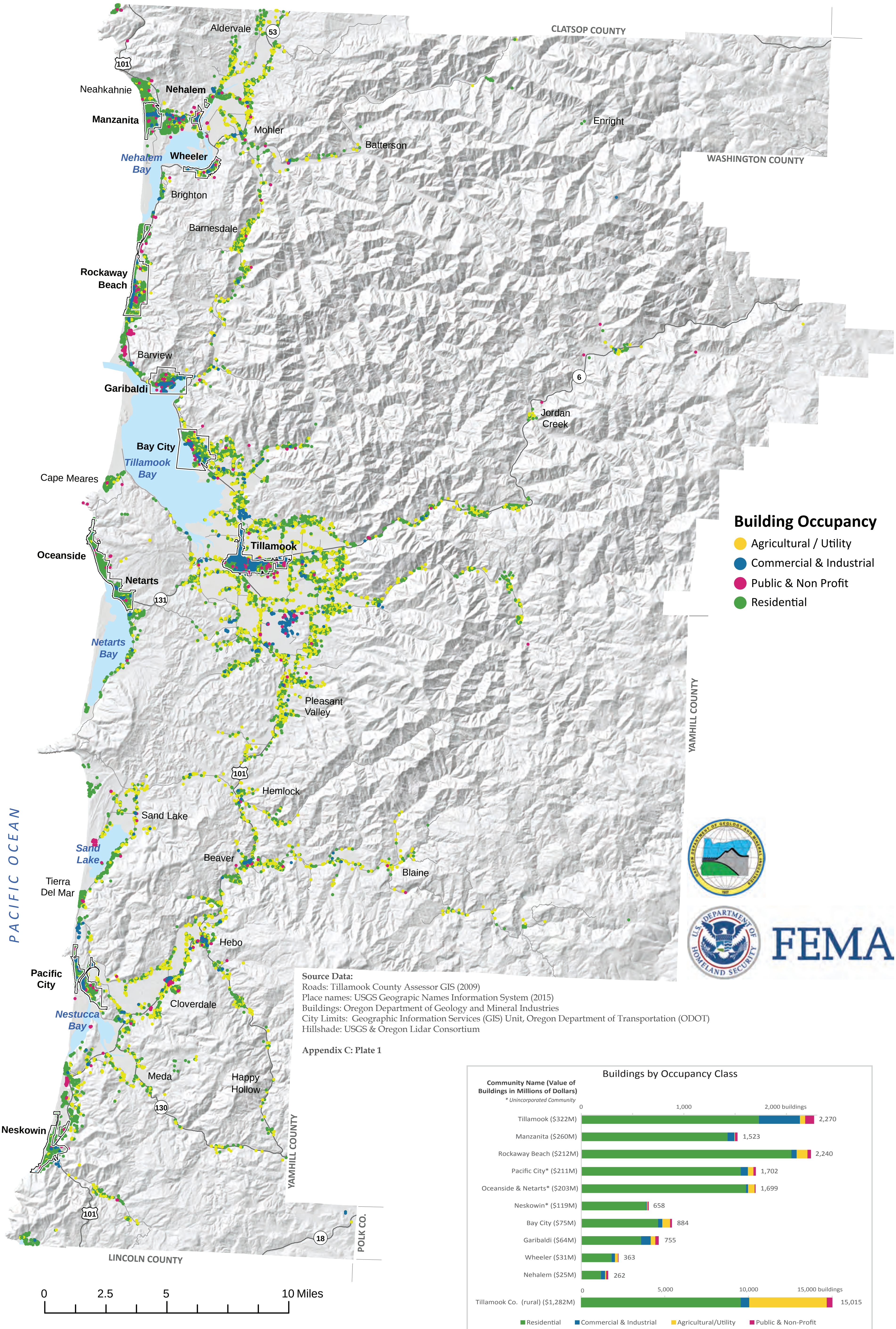
List of Rasters within Risk Assessment Database:

- DEM.tif
- Depth_01pct
- Depth_0_2pct
- Depth_02pct
- Depth_10pct
- WSEL_01pct.tif
- WSEL_0_2pct.tif
- WSEL_02pct.tif
- WSEL_10pct.tif
- Coseismic_Subsidence.tif

D. Large Format Maps

- **Plate 1** – User-defined facility (UDF) distribution in Tillamook County, Oregon. *(See attached)*
- **Plate 2** – Population Density per 20 Acres, Tillamook County, Oregon. *(See attached)*
- **Plate 3** – Earthquake Peak Ground Acceleration (for M9.0 Cascadia Subduction Zone Earthquake), Tillamook County, Oregon. *(See attached)*
- **Plate 4** – Landslide Susceptibility in Tillamook County, Oregon. *(See attached)*
- **Plate 5** – Wildfire Risk in Tillamook County, Oregon. *(See attached)*
- **Plate 6** – Tsunami Inundation in Tillamook County, Oregon. *(See attached)*
- **Plate 7** – Flood Hazard in Tillamook County, Oregon. *(See attached)*
- **Plate 8** – Multi-Hazard Community map set for Neskowin, Tillamook County, Oregon. (See attached)
- **Plate 9 –** Multi-Hazard Community map set for Oceanside and Netarts, Tillamook County, Oregon. (See attached)
- **Plate 10 –** Multi-Hazard Community map set for Pacific City, Tillamook County, Oregon. (See attached)
- **Plate 11 –** Multi-Hazard Community map set for Bay City, Tillamook County, Oregon. (See attached)
- **Plate 12 –** Multi-Hazard Community map set for Garibaldi, Tillamook County, Oregon. (See attached)
- **Plate 13 –** Multi-Hazard Community map set for Manzanita, Tillamook County, Oregon. (See attached)
- **Plate 14 –** Multi-Hazard Community map set for Nehalem, Tillamook County, Oregon. (See attached)
- **Plate 15 –** Multi-Hazard Community map set for Rockaway Beach, Tillamook County, Oregon. (See attached)
- **Plate 16 –** Multi-Hazard Community map set for Tillamook, Tillamook County, Oregon. (See attached)
- **Plate 17 –** Multi-Hazard Community map set for Wheeler, Tillamook County, Oregon. (See attached)

Building Distribution

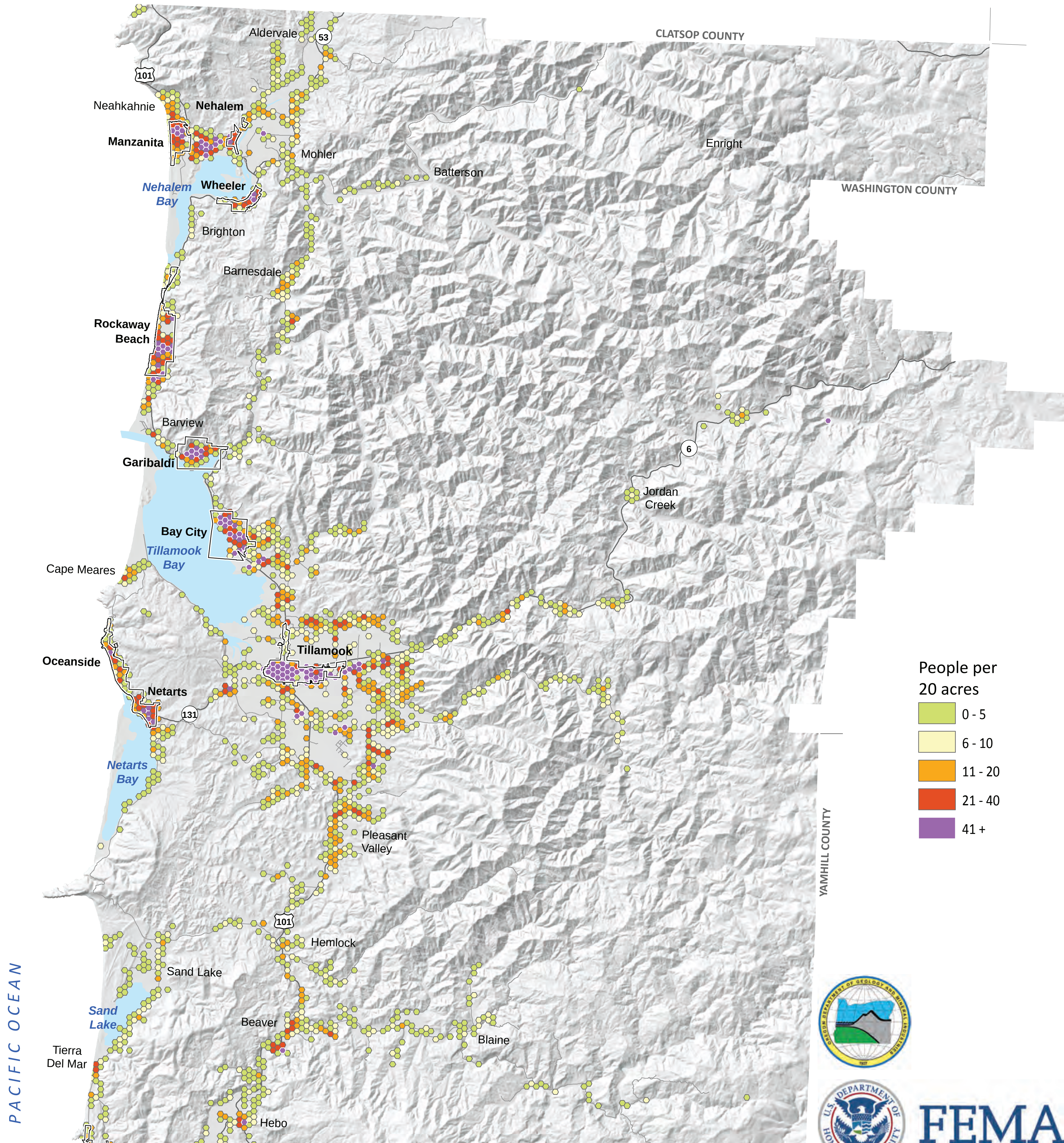


Source Data:
Roads: Tillamook County Assessor GIS (2009)
Place names: USGS Geograpic Names Information System (2015)
Buildings: Oregon Department of Geology and Mineral Industries
City Limits: Geographic Information Services (GIS) Unit, Oregon Department of Transportation (ODOT)
Hillshade: USGS & Oregon Lidar Consortium

Appendix C: Plate 1

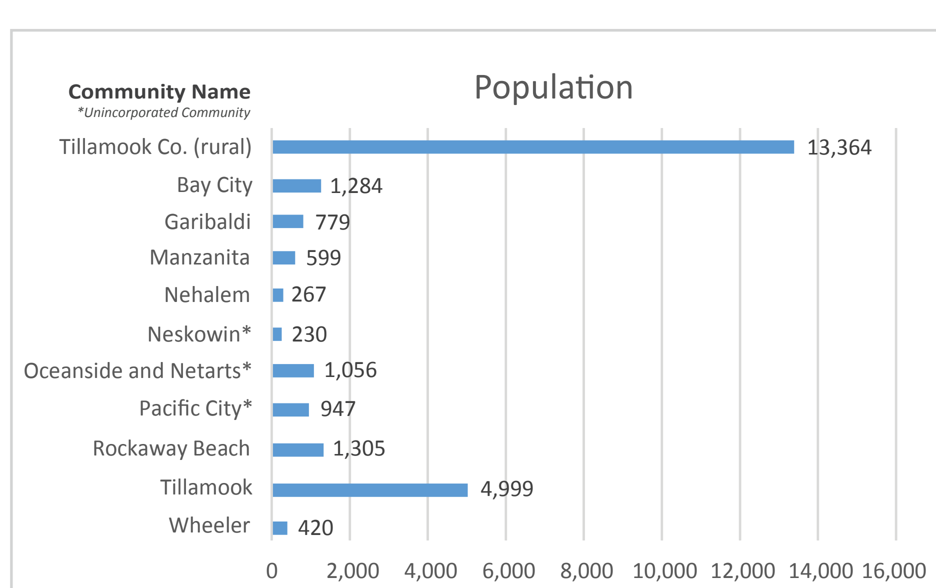
R. Watzig & M. Williams, DOGAMI, 2016

Population Density



Source Data:
Roads: Tillamook County Assessor GIS (2009)
Place names: USGS Geograpic Names Information System (2015)
City Limits: Geographic Information Services (GIS) Unit, Oregon Department of Transportation (ODOT)
Hillshade: USGS & Oregon Lidar Consortium

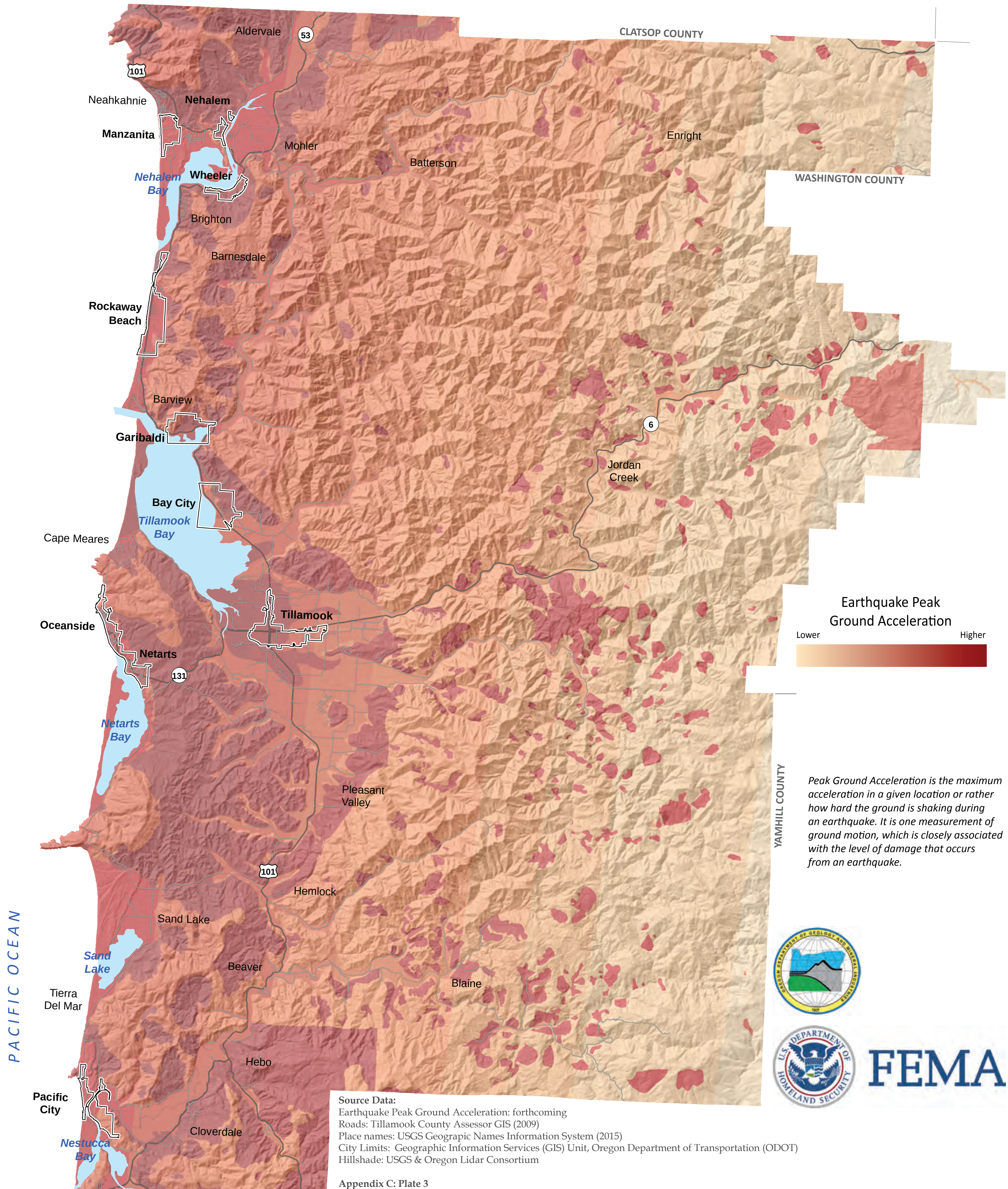
Appendix C: Plate 2



R. Watzig & M. Williams, DOGAMI, 2016

Earthquake Peak Ground Acceleration

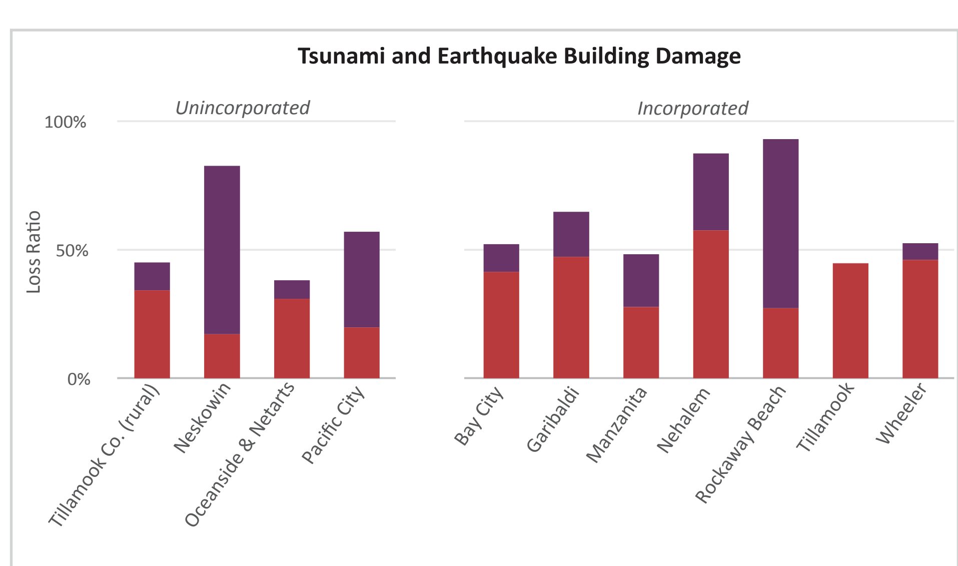
for M9.0 Cascadia Subduction Zone Earthquake



Peak Ground Acceleration is the maximum acceleration in a given location or rather how hard the ground is shaking during an earthquake. It is one measurement of ground motion, which is closely associated with the level of damage that occurs from an earthquake.

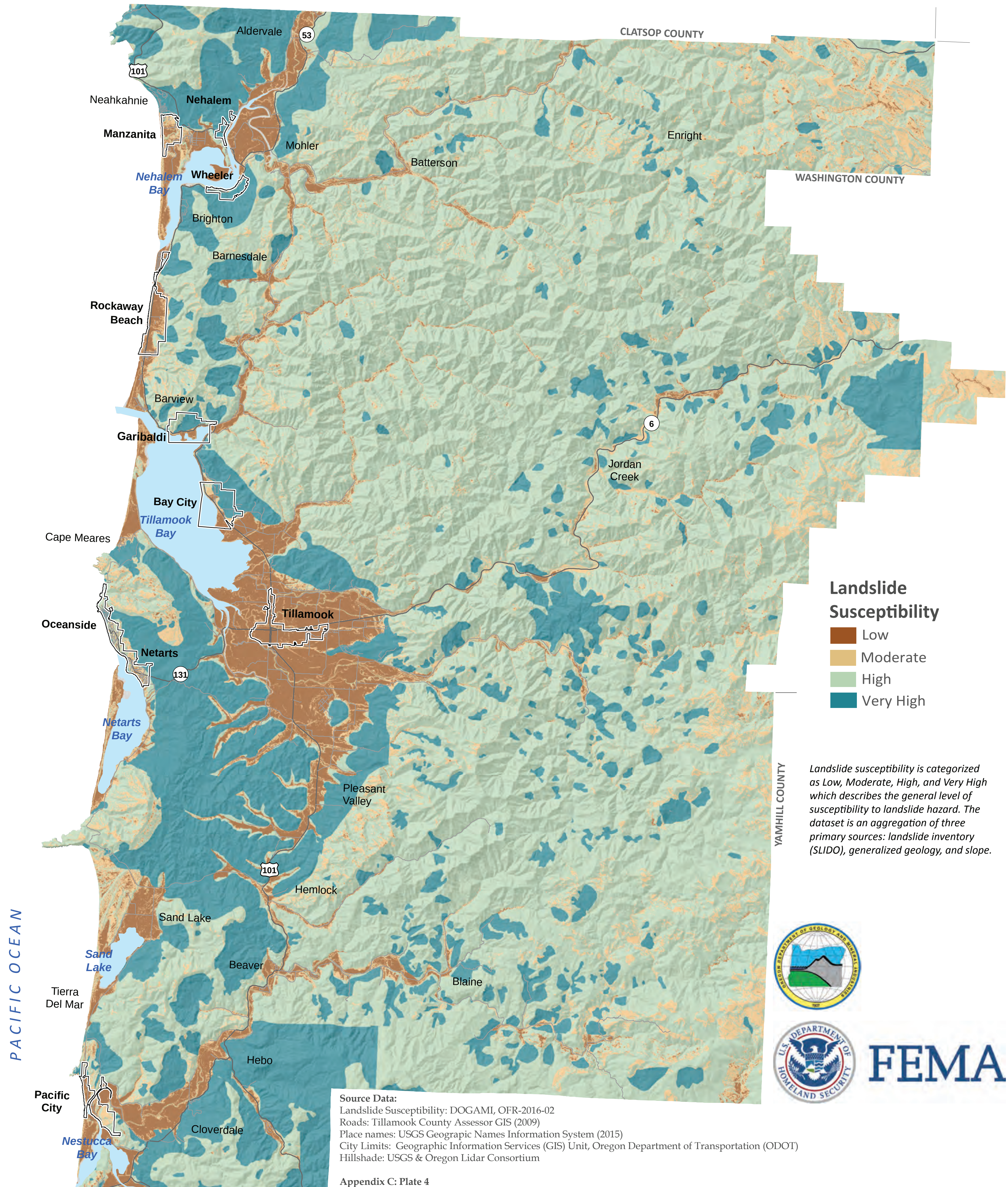
Source Data:
Earthquake Peak Ground Acceleration: forthcoming
Roads: Tillamook County Assessor GIS (2009)
Place names: USGS Geograpic Names Information System (2015)
City Limits: Geographic Information Services (GIS) Unit, Oregon Department of Transportation (ODOT)
Hillshade: USGS & Oregon Lidar Consortium

Appendix C: Plate 3



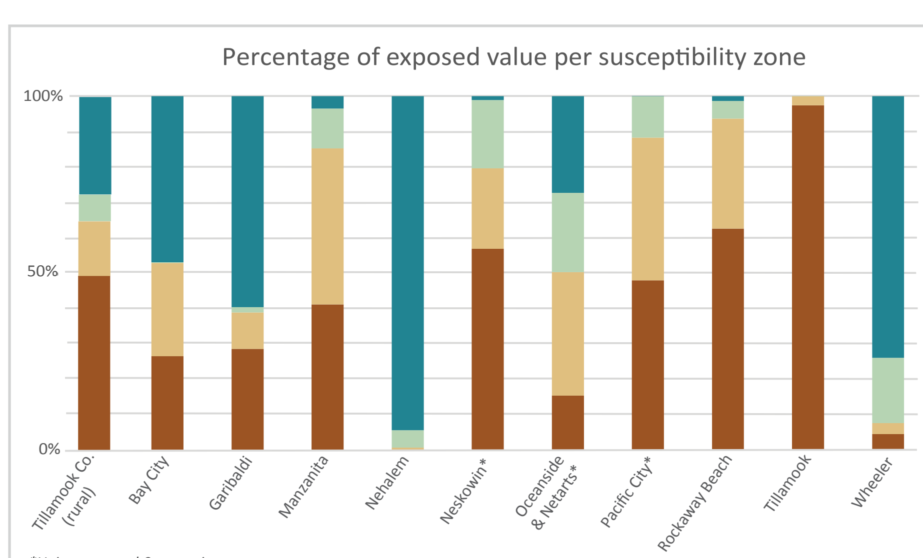
R. Watzig & M. Williams, DOGAMI, 2016

Landslide Susceptibility



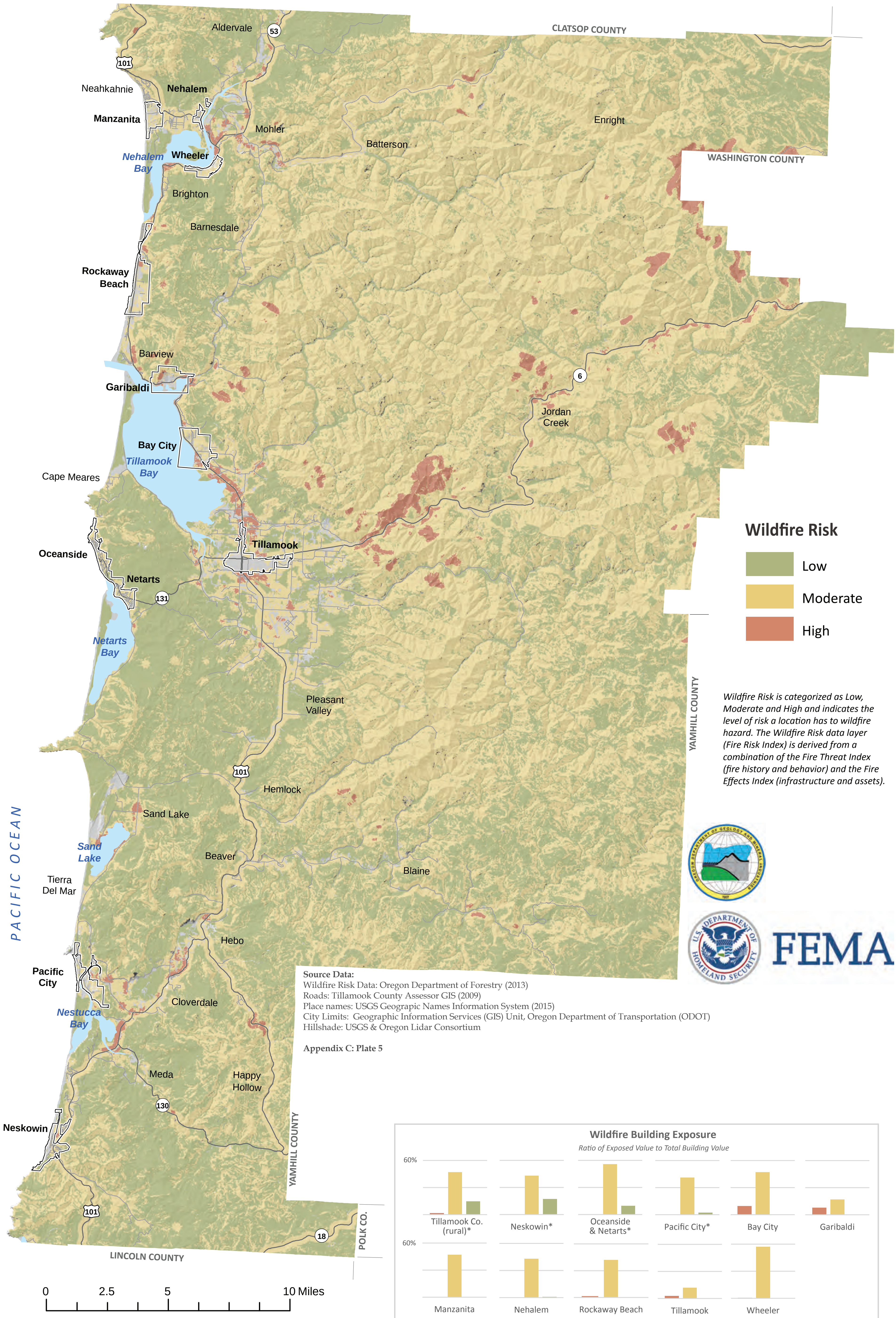
Source Data:
Landslide Susceptibility: DOGAMI, OFR-2016-02
Roads: Tillamook County Assessor GIS (2009)
Place names: USGS Geographic Names Information System (2015)
City Limits: Geographic Information Services (GIS) Unit, Oregon Department of Transportation (ODOT)
Hillshade: USGS & Oregon Lidar Consortium

Appendix C: Plate 4



R. Watzig & M. Williams, DOGAMI, 2016

Wildfire Risk

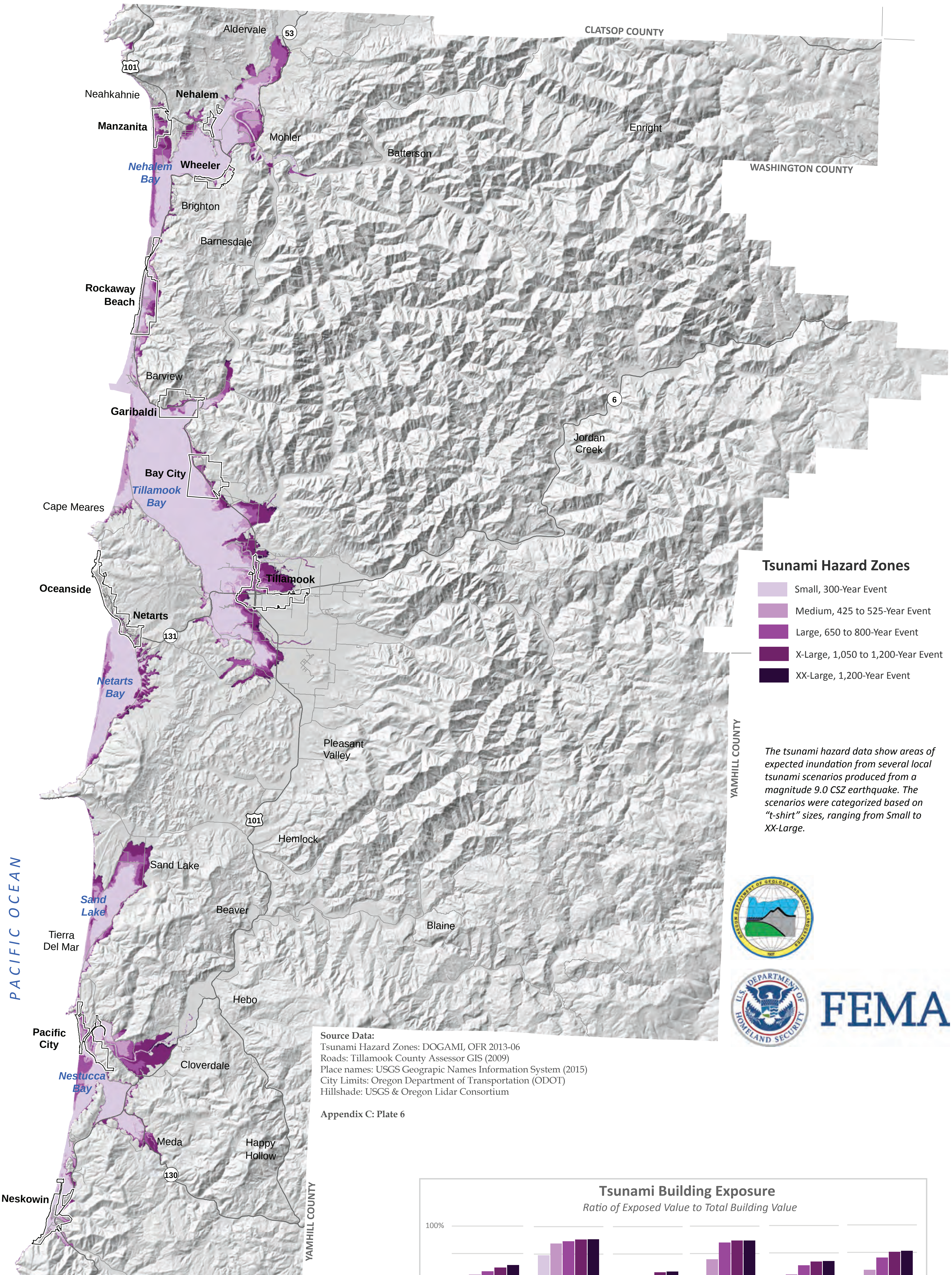


Source Data:
Wildfire Risk Data: Oregon Department of Forestry (2013)
Roads: Tillamook County Assessor GIS (2009)
Place names: USGS Geographic Names Information System (2015)
City Limits: Geographic Information Services (GIS) Unit, Oregon Department of Transportation (ODOT)
Hillshade: USGS & Oregon Lidar Consortium

Appendix C: Plate 5

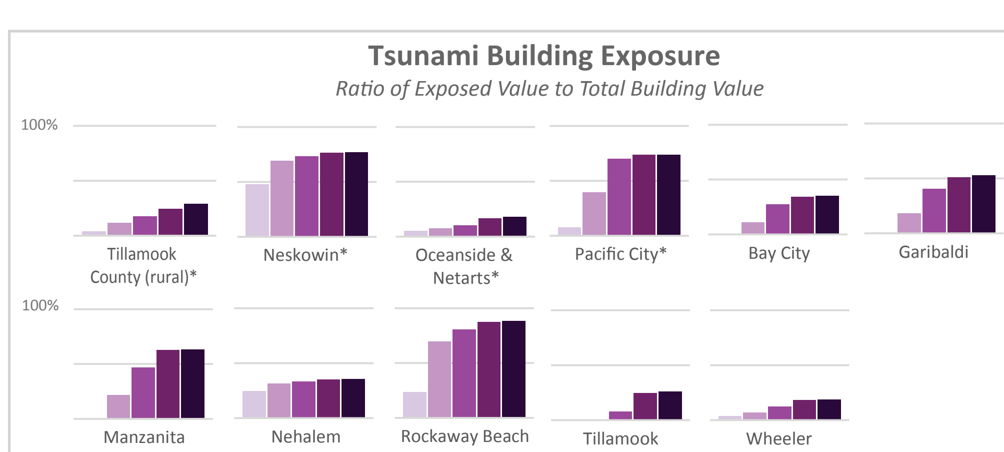
R. Watzig & M. Williams, DOGAMI, 2016

Tsunami Inundation



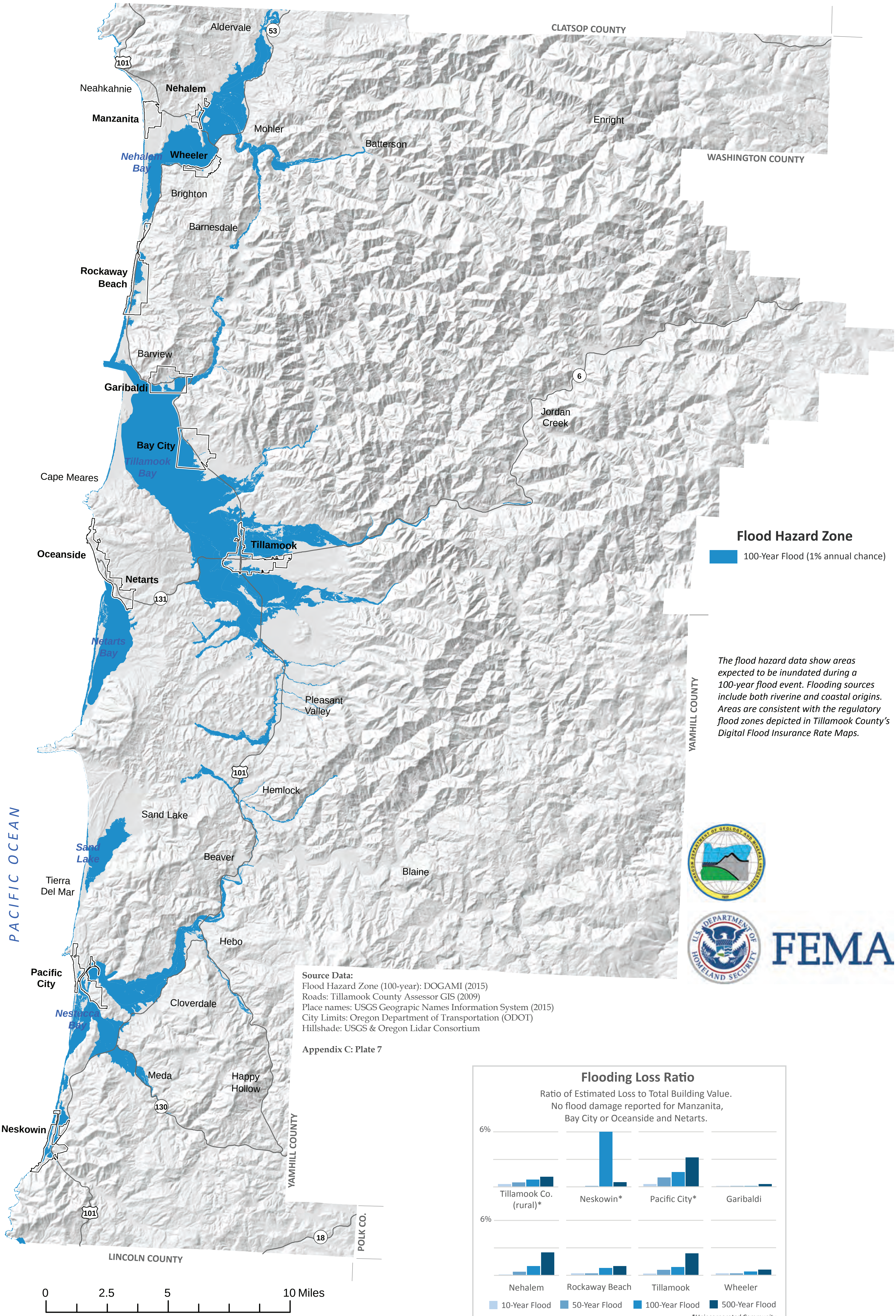
Source Data:
Tsunami Hazard Zones: DOGAMI, OFR 2013-06
Roads: Tillamook County Assessor GIS (2009)
Place names: USGS Geograpic Names Information System (2015)
City Limits: Oregon Department of Transportation (ODOT)
Hillshade: USGS & Oregon Lidar Consortium

Appendix C: Plate 6



R. Watzig & M. Williams, DOGAMI, 2016

Flood Hazard



Flood Hazard Zone

100-Year Flood (1% annual chance)

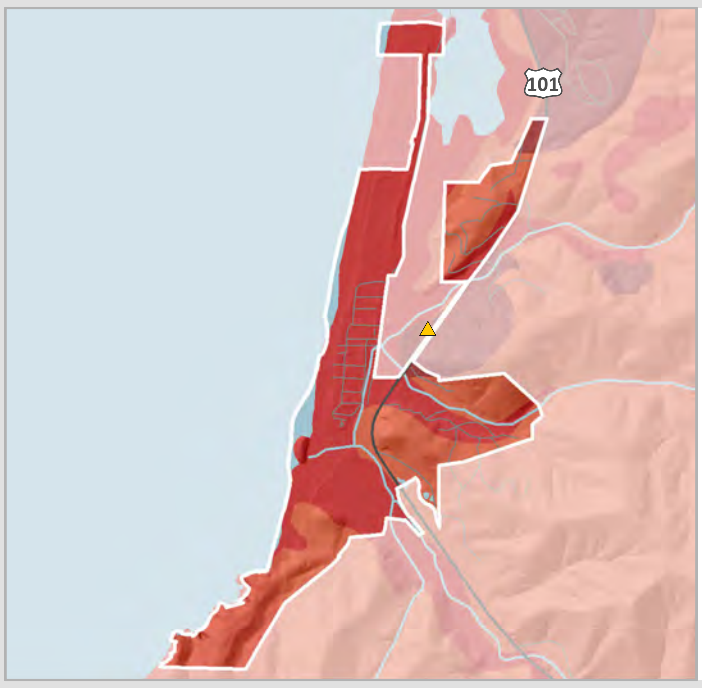
The flood hazard data show areas expected to be inundated during a 100-year flood event. Flooding sources include both riverine and coastal origins. Areas are consistent with the regulatory flood zones depicted in Tillamook County's Digital Flood Insurance Rate Maps.

Source Data:
Flood Hazard Zone (100-year): DOGAMI (2015)
Roads: Tillamook County Assessor GIS (2009)
Place names: USGS Geographic Names Information System (2015)
City Limits: Oregon Department of Transportation (ODOT)
Hillshade: USGS & Oregon Lidar Consortium

Appendix C: Plate 7

R. Watzig & M. Williams, DOGAMI, 2016

Neskowin



EARTHQUAKE

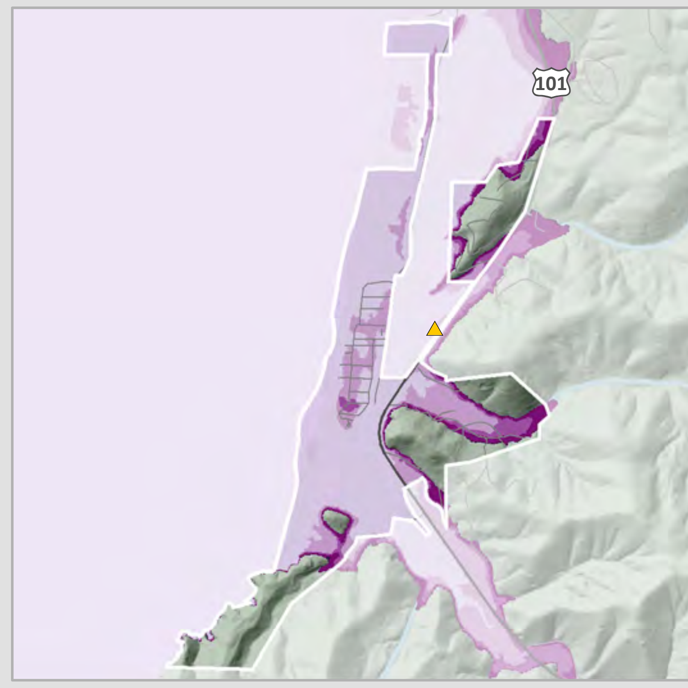
Peak Ground Acceleration (PGA) from 9.0M CSZ Earthquake

Lower

Higher

Buildings Exposed: 100%

See Risk Report pg. 14-16



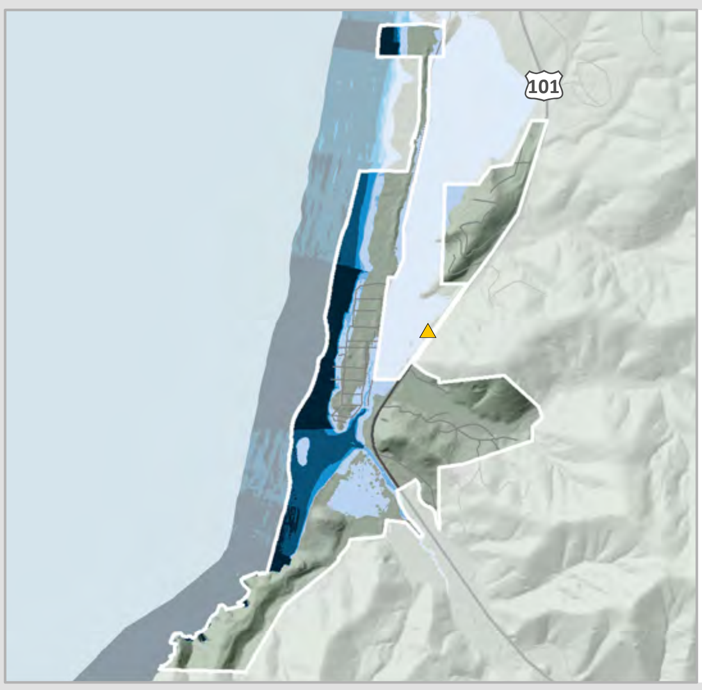
TSUNAMI

Inundation Boundaries

- Small
- Medium
- Large
- X-Large
- XX-Large

Buildings Exposed to Medium: 69%

See Risk Report pg. 17-20



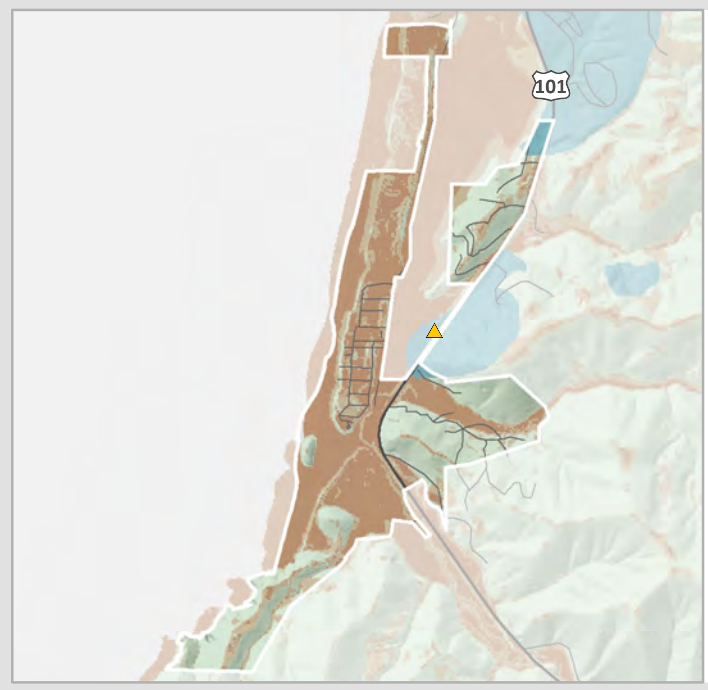
FLOOD

100-Year Flood Depth (ft)

- 0 - 5
- 6 - 10
- 11 - 15
- 16 - 20
- > 20

Buildings Exposed: 33%

See Risk Report pg. 20-24



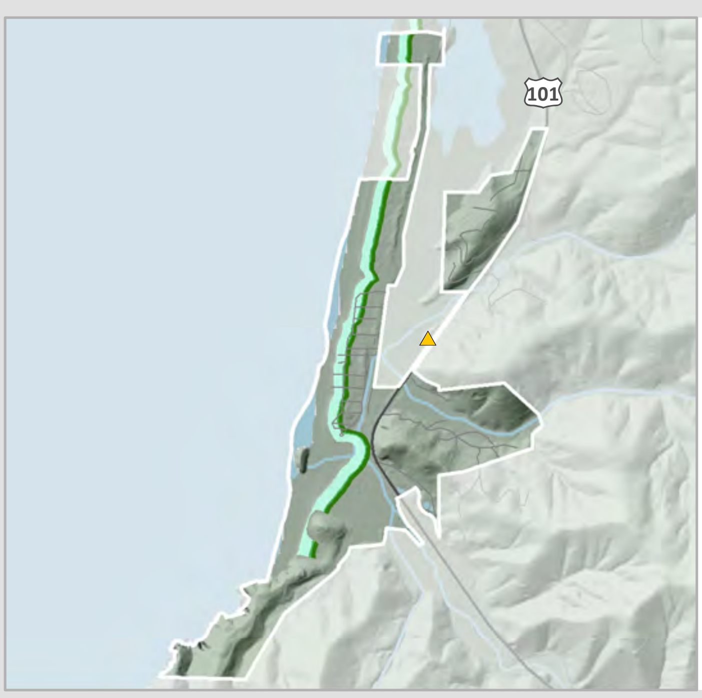
LANDSLIDE

Susceptibility

- Low
- Moderate
- High
- Very High

Buildings Exposed to High or Very High: 20%

See Risk Report pg. 24-27



COASTAL EROSION

Hazard Zone

- Very High
- High
- Moderate

Buildings Exposed: 29%

See Risk Report pg. 27-30

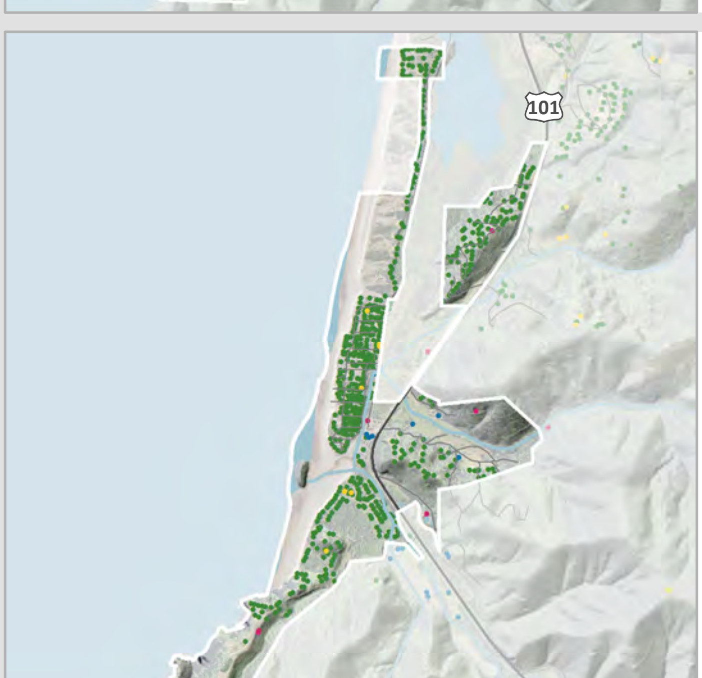
WILDFIRE

Risk

- Low
- Moderate
- High
- No Data

Buildings Exposed to High: <1%

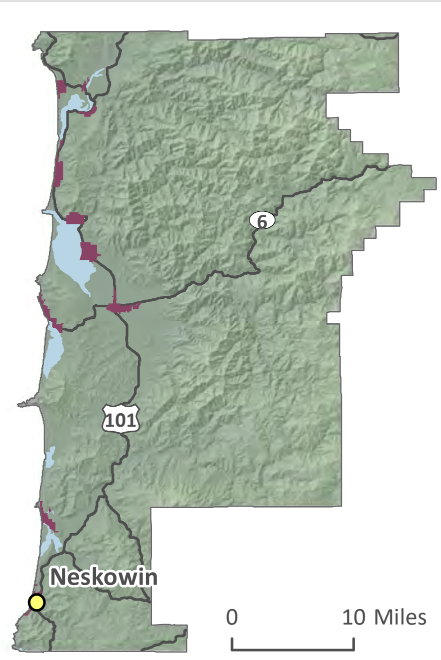
See Risk Report pg. 30-32



OCCUPANCY CLASS

- Agriculture/ Utility
- Public/ Non-Profit
- Industrial/ Commercial
- Residential

See Risk Report pg. 6-9



COMMUNITY STATISTICS

Population	230
Buildings	653
Building Value	$118M
Essential Facilities	0

Additional community statistics for Neskowin are available in the Community Risk Profile of the Risk Report, pg. 38-39.

FEMA

0 1 Miles

Essential Facility

Community

Roads and Highways

Rivers

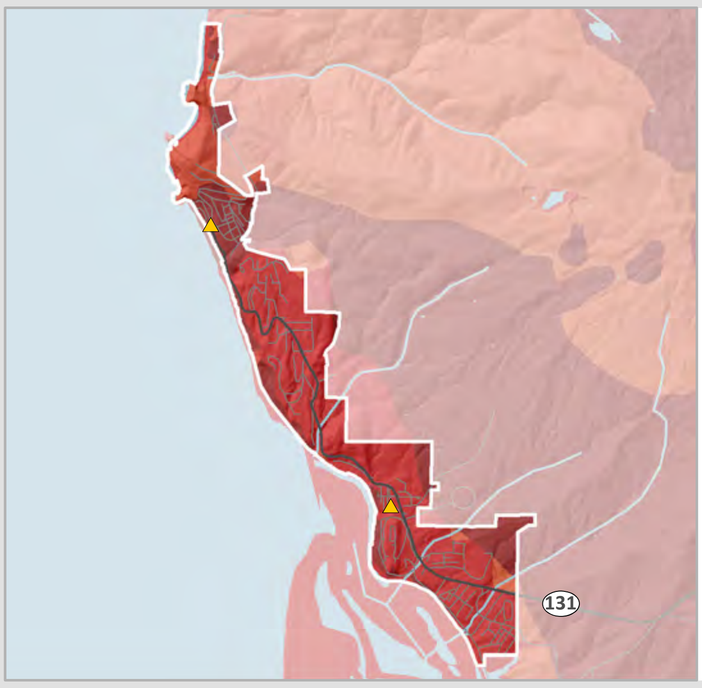
Lakes & Ocean

Source Data: Roads: Tillamook County (2008), Highways: Oregon Department of Transportation (2013), Earthquake PGA: Department of Geology and Mineral Industries (DOGAMI) (2013), Tsunami Boundary: DOGAMI (2013), Flood Depth: DOGAMI (2015), Landslide Susceptibility: DOGAMI (2016), Coastal Erosion Susceptibility: DOGAMI (2014), Wildfire Risk: ODF (2013)

Appendix C: Plate 8

C. Appleby, DOGAMI, 2016

Oceanside & Netarts



EARTHQUAKE

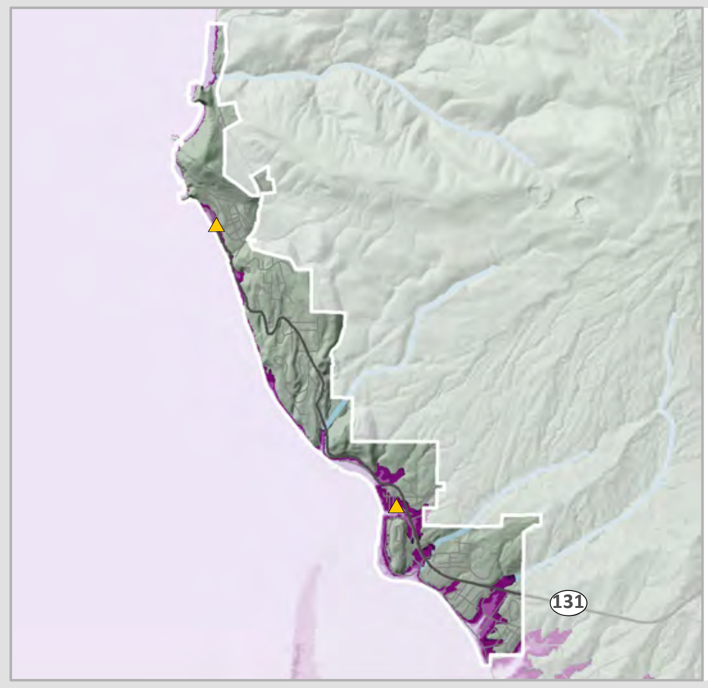
Peak Ground Acceleration (PGA) from 9.0M CSZ Earthquake

Lower

Higher

Buildings Exposed: 100%

See Risk Report pg. 14-16



TSUNAMI

Inundation Boundaries

- Small
- Medium
- Large
- X-Large
- XX-Large

Buildings Exposed to Medium: 8%

See Risk Report pg. 17-20

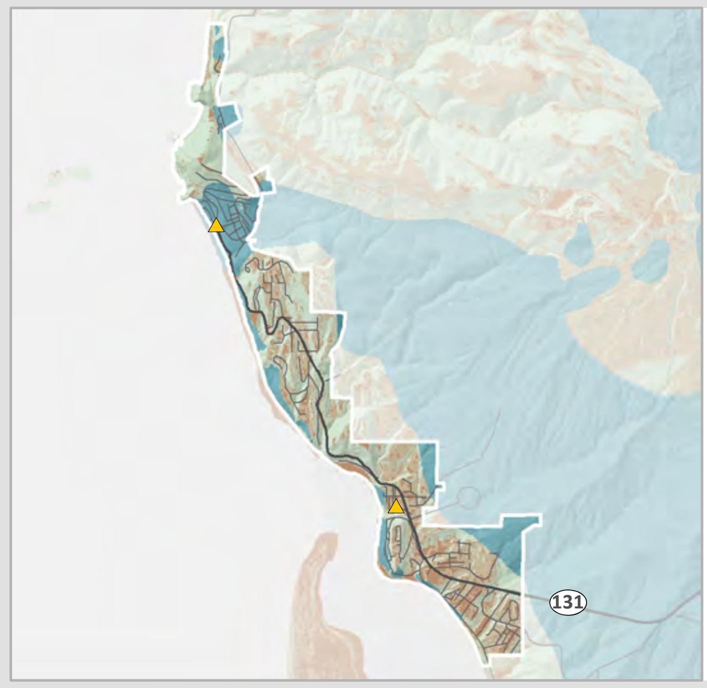
FLOOD

100-Year Flood Depth (ft)

- 0 - 5
- 6 - 10
- 11 - 15
- 16 - 20
- > 20

Buildings Exposed: 5%

See Risk Report pg. 20-24



LANDSLIDE

Susceptibility

- Low
- Moderate
- High
- Very High

Buildings Exposed to High or Very High: 50%

See Risk Report pg. 24-27

COASTAL EROSION

Hazard Zone

- Very High
- High
- Moderate

Buildings Exposed: 0%

See Risk Report pg. 27-30

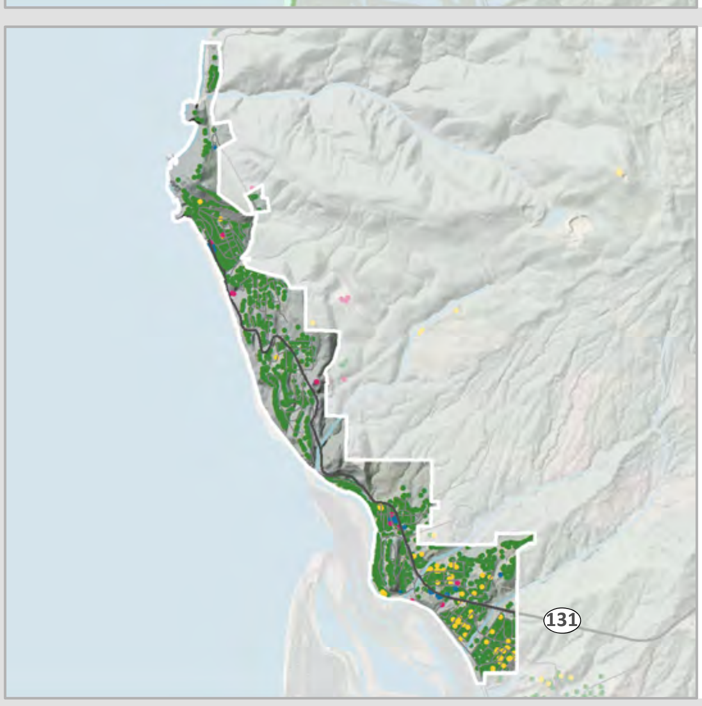
WILDFIRE

Risk

- Low
- Moderate
- High
- No Data

Buildings Exposed to High: 0%

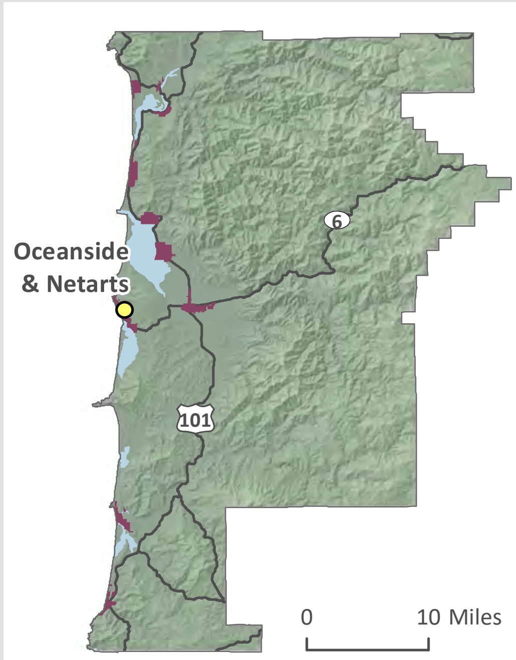
See Risk Report pg. 30-32



OCCUPANCY CLASS

- Agriculture/ Utility
- Public/ Non-Profit
- Industrial/ Commercial
- Residential

See Risk Report pg. 6-9



COMMUNITY STATISTICS

Population	1,056
Buildings	1,701
Building Value	$203M
Essential Facilities	2

Additional community statistics for Oceanside and Netarts are available in the Community Risk Profile of the Risk Report, pg. 40-41.

FEMA

0 1 Miles

Essential Facility

Community

Roads and Highways

Rivers

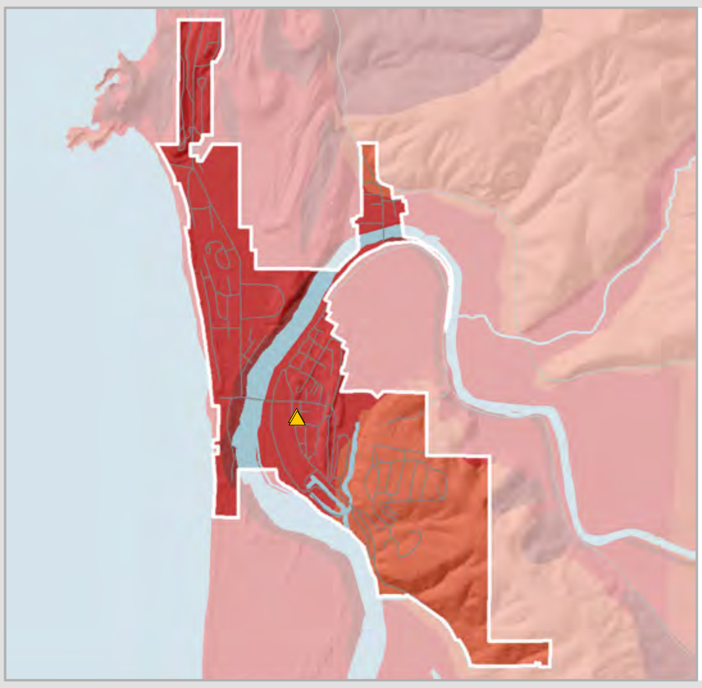
Lakes & Ocean

Source Data: Roads: Tillamook County (2008), Highways: Oregon Department of Transportation (2013), Earthquake PGA: Department of Geology and Mineral Industries (DOGAMI) (2013), Tsunami Boundary: DOGAMI (2013), Flood Depth: DOGAMI (2015), Landslide Susceptibility: DOGAMI (2016), Coastal Erosion Susceptibility: DOGAMI (2014), Wildfire Risk: ODF (2013)

Appendix C: Plate 9

C. Appleby, DOGAMI, 2016

Pacific City



EARTHQUAKE

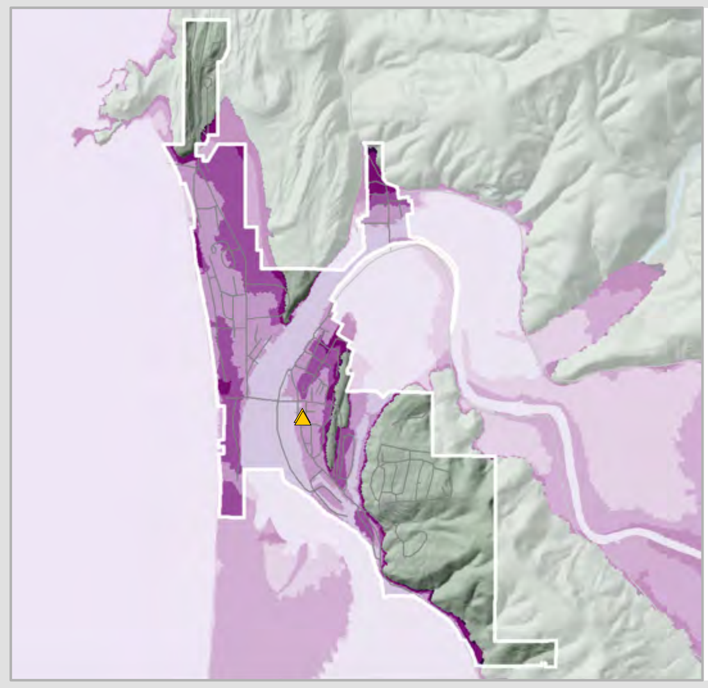
Peak Ground Acceleration (PGA) from 9.0M CSZ Earthquake

Lower

Higher

Buildings Exposed: 100%

See Risk Report pg. 14-16



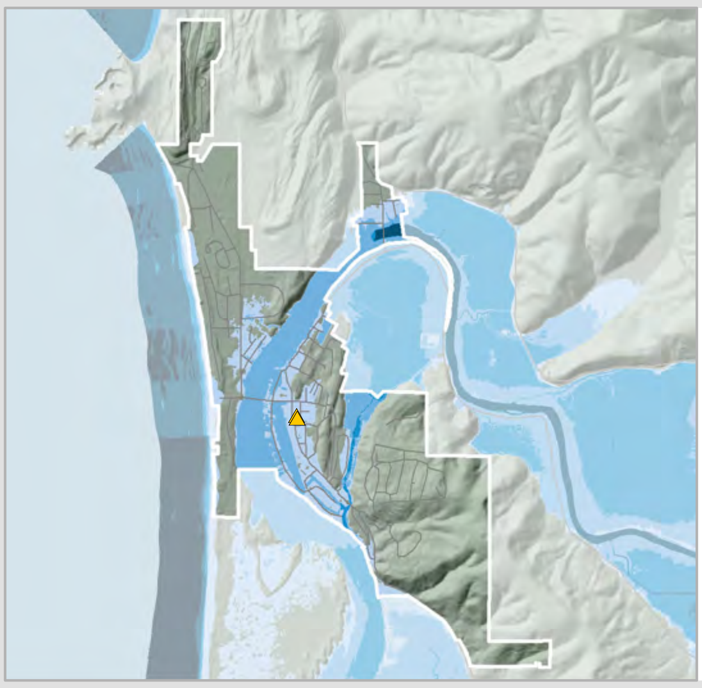
TSUNAMI

Inundation Boundaries

- Small
- Medium
- Large
- X-Large
- XX-Large

Buildings Exposed to Medium: 39%

See Risk Report pg. 17-20



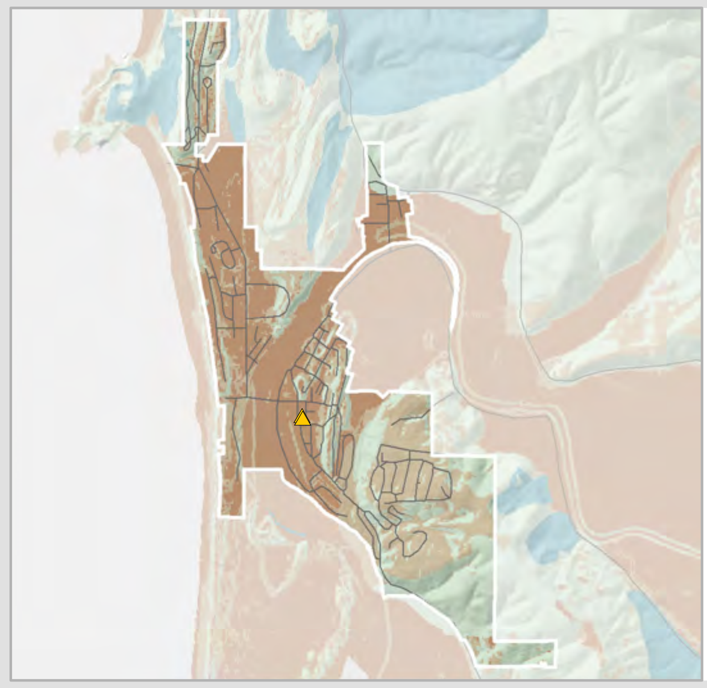
FLOOD

100-Year Flood Depth (ft)

- 0 - 5
- 6 - 10
- 11 - 15
- 16 - 20
- > 20

Buildings Exposed: 18%

See Risk Report pg. 20-24



LANDSLIDE

Susceptibility

- Low
- Moderate
- High
- Very High

Buildings Exposed to High or Very High: 12%

See Risk Report pg. 24-27

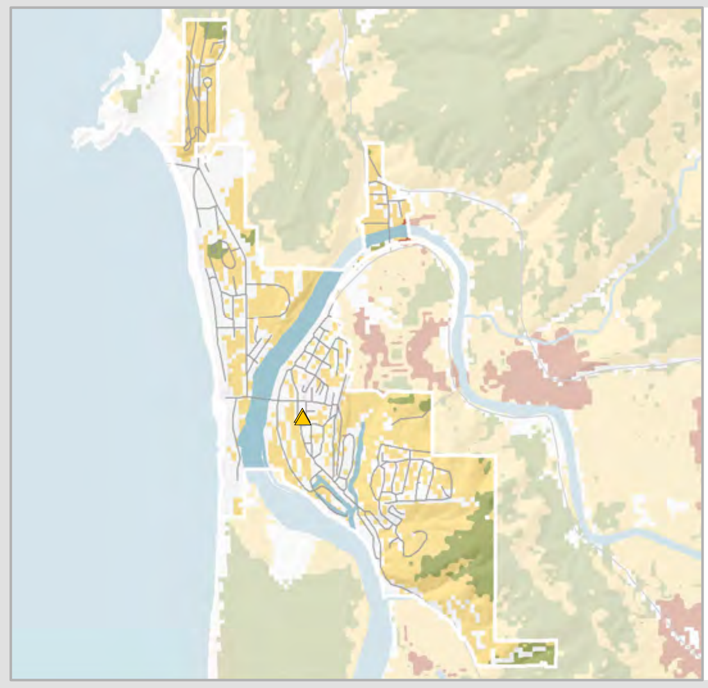
COASTAL EROSION

Hazard Zone

- Very High
- High
- Moderate

Buildings Exposed: 4%

See Risk Report pg. 27-30



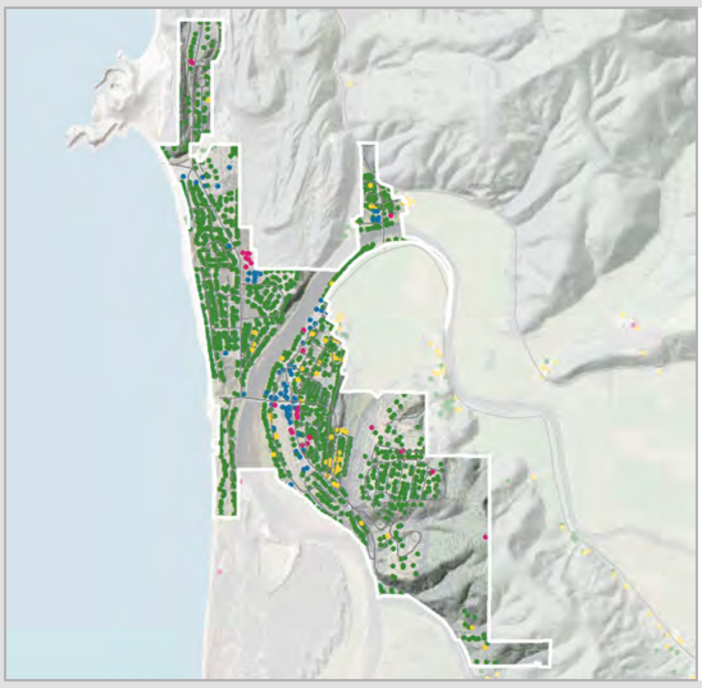
WILDFIRE

Risk

- Low
- Moderate
- High
- No Data

Buildings Exposed to High: <1%

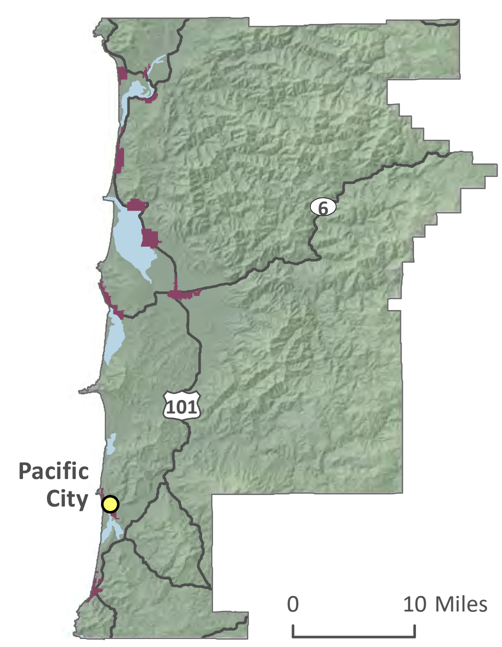
See Risk Report pg. 30-32



OCCUPANCY CLASS

- Agriculture/ Utility
- Public/ Non-Profit
- Industrial/ Commercial
- Residential

See Risk Report pg. 6-9



COMMUNITY STATISTICS

Population	947
Buildings	1,707
Building Value	$212M
Essential Facilities	1

Additional community statistics for Pacific City are available in the Community Risk Profile of the Risk Report, pg. 42-43.

FEMA

0 1 Miles

Essential Facility

Community

Roads and Highways

Rivers

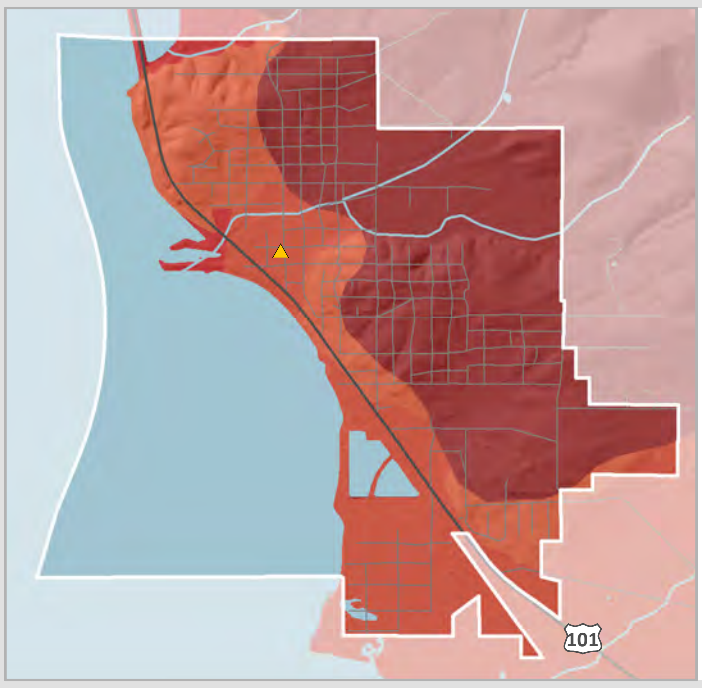
Lakes & Ocean

Source Data: Roads: Tillamook County (2008), Highways: Oregon Department of Transportation (2013), Earthquake PGA: Department of Geology and Mineral Industries (DOGAMI) (2013), Tsunami Boundary: DOGAMI (2013), Flood Depth: DOGAMI (2015), Landslide Susceptibility: DOGAMI (2016), Coastal Erosion Susceptibility: DOGAMI (2014), Wildfire Risk: ODF (2013)

Appendix C: Plate 10

C. Appleby, DOGAMI, 2016

Bay City



EARTHQUAKE

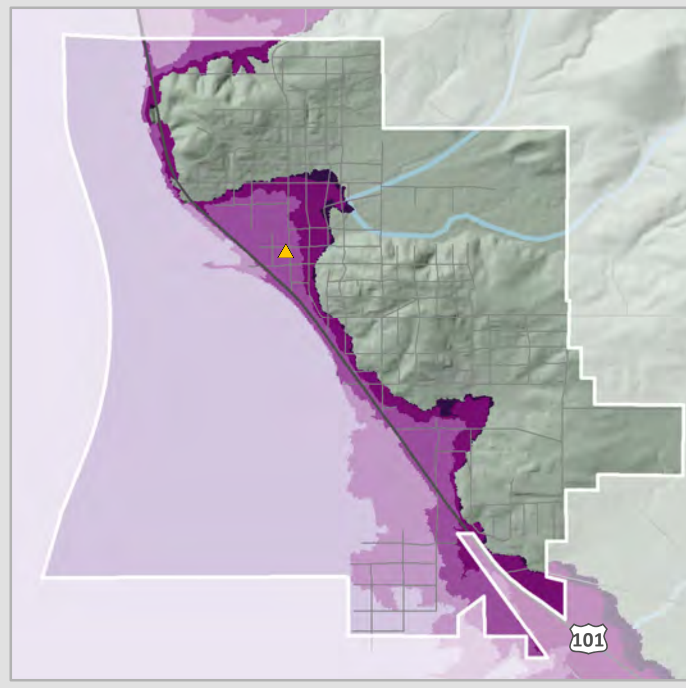
Peak Ground Acceleration (PGA) from 9.0M CSZ Earthquake

Lower

Higher

Buildings Exposed: 100%

See Risk Report pg. 14-16



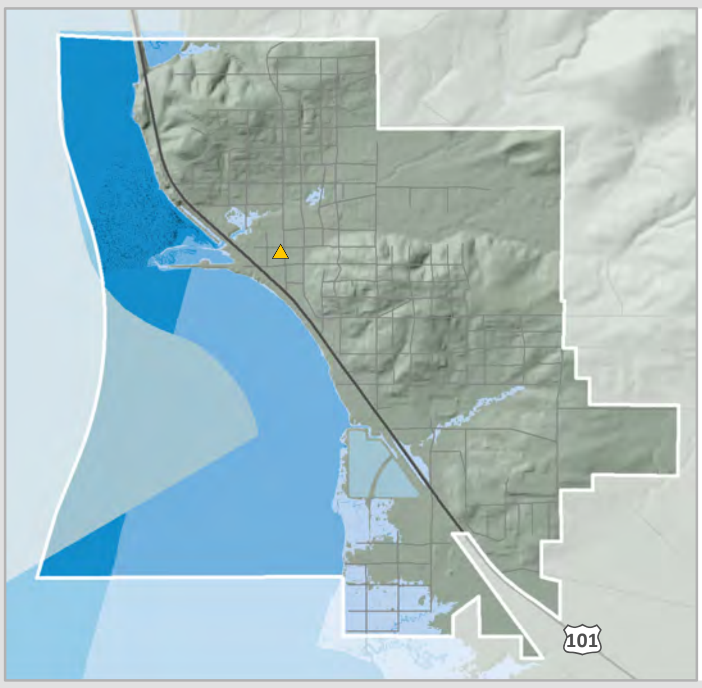
TSUNAMI

Inundation Boundaries

- Small
- Medium
- Large
- X-Large
- XX-Large

Buildings Exposed to Medium: 11%

See Risk Report pg. 17-20



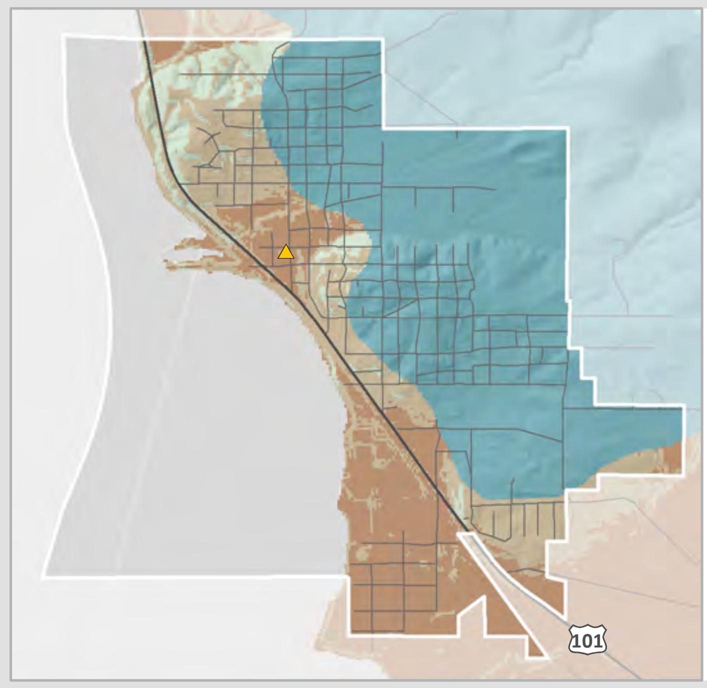
FLOOD

100-Year Flood Depth (ft)

- 0 - 5
- 6 - 10
- 11 - 15
- 16 - 20
- > 20

Buildings Exposed: <1%

See Risk Report pg. 20-24



LANDSLIDE

Susceptibility

- Low
- Moderate
- High
- Very High

Buildings Exposed to High or Very High: 47%

See Risk Report pg. 24-27

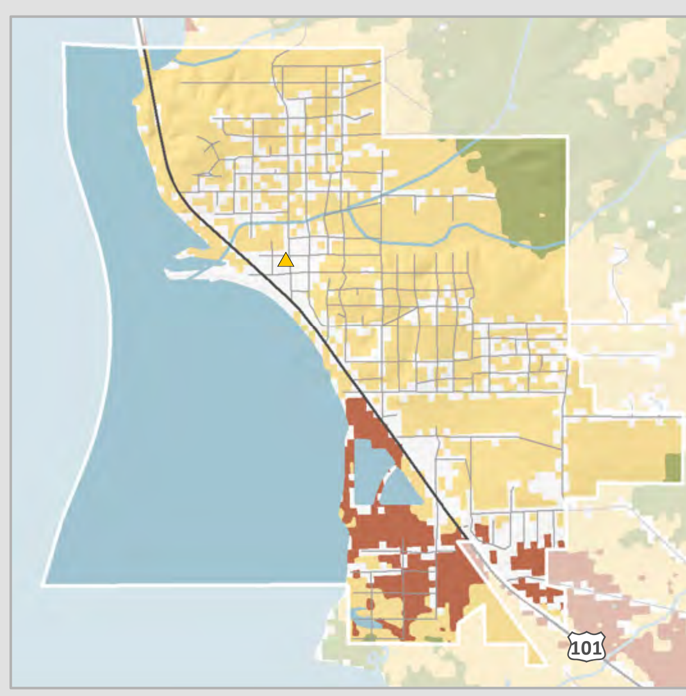
COASTAL EROSION

Hazard Zone

- Very High
- High
- Moderate

Buildings Exposed: 0%

See Risk Report pg. 27-30



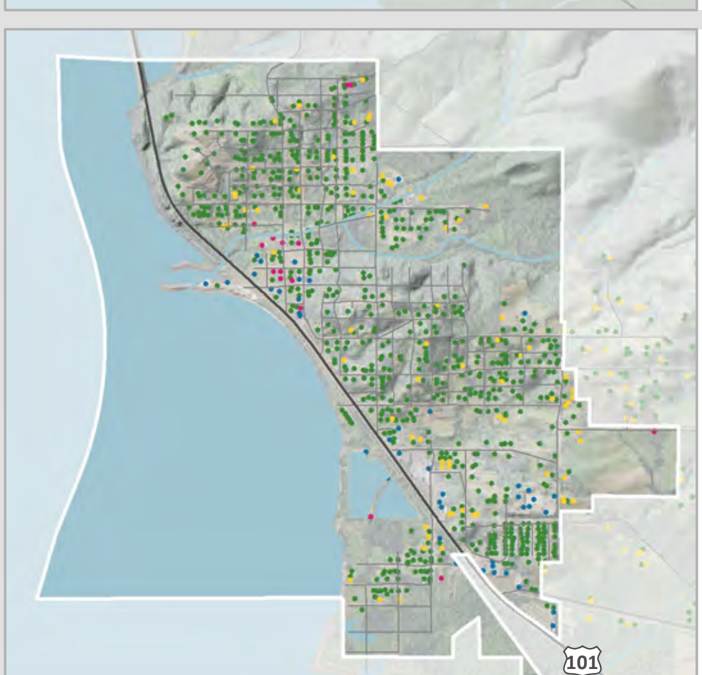
WILDFIRE

Risk

- Low
- Moderate
- High
- No Data

Buildings Exposed to High: 10%

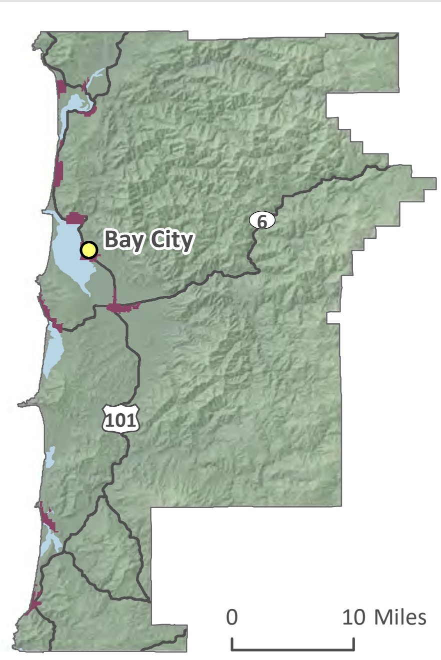
See Risk Report pg. 30-32



OCCUPANCY CLASS

- Agriculture/ Utility
- Public/ Non-Profit
- Industrial/ Commercial
- Residential

See Risk Report pg. 6-9



COMMUNITY STATISTICS

Population	1,284
Buildings	884
Building Value	$75M
Essential Facilities	1

Additional community statistics for Bay City are available in the Community Risk Profile of the Risk Report, pg. 44-45.

FEMA

0 0.5 Miles

Essential Facility

Community

Roads and Highways

Rivers

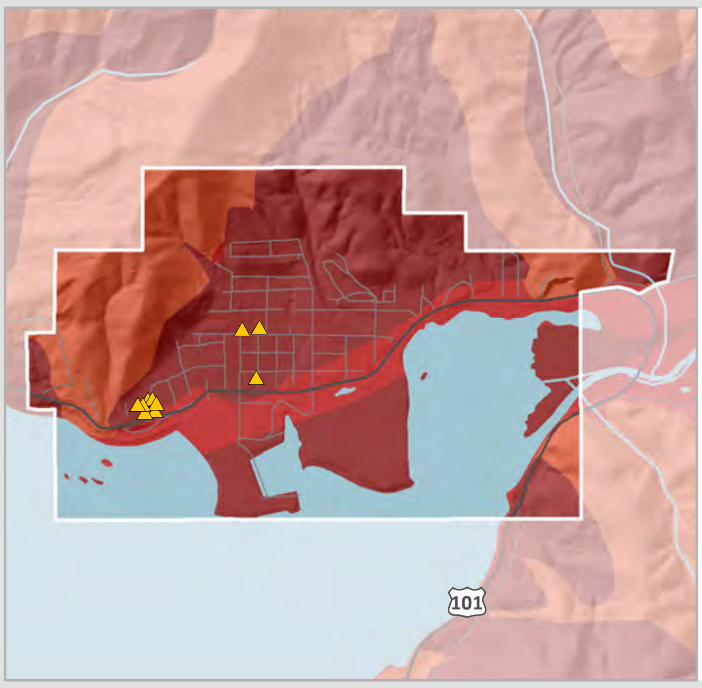
Lakes & Ocean

Source Data: Roads: Tillamook County (2008), Highways: Oregon Department of Transportation (2013), Earthquake PGA: Department of Geology and Mineral Industries (DOGAMI) (2013), Tsunami Boundary: DOGAMI (2013), Flood Depth: DOGAMI (2015), Landslide Susceptibility: DOGAMI (2016), Coastal Erosion Susceptibility: DOGAMI (2014), Wildfire Risk: ODF (2013)

Appendix C: Plate 11

C. Appleby, DOGAMI, 2016

Garibaldi



EARTHQUAKE

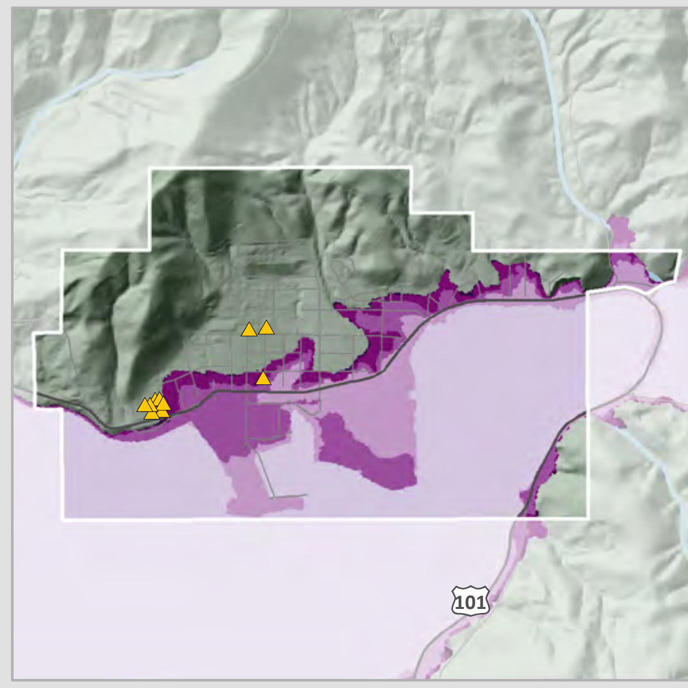
Peak Ground Acceleration (PGA) from 9.0M CSZ Earthquake

Lower

Higher

Buildings Exposed: 100%

See Risk Report pg. 14-16



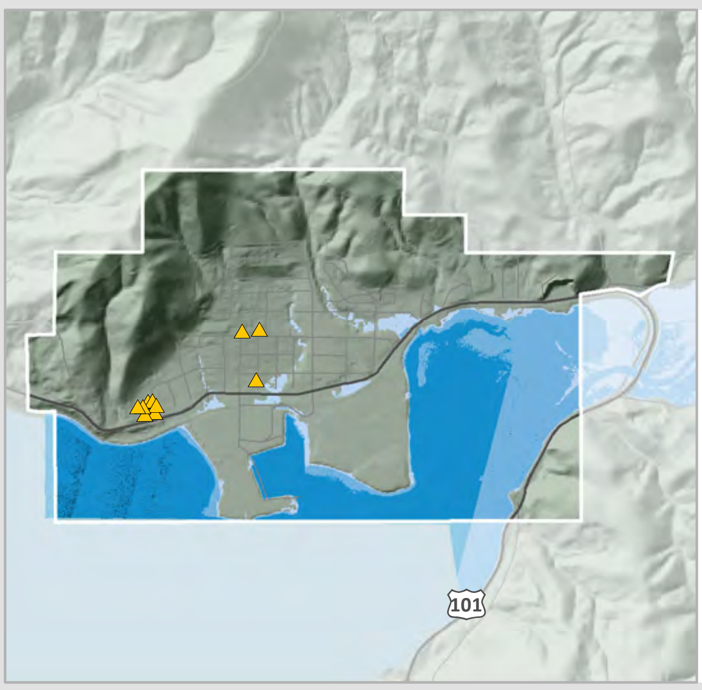
TSUNAMI

Inundation Boundaries

- Small
- Medium
- Large
- X-Large
- XX-Large

Buildings Exposed to Medium: 18%

See Risk Report pg. 17-20



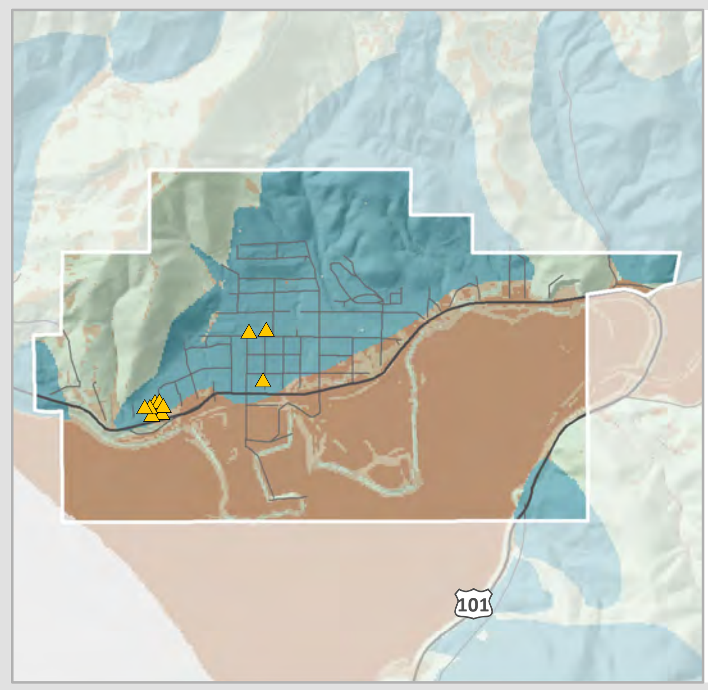
FLOOD

100-Year Flood Depth (ft)

- 0 - 5
- 6 - 10
- 11 - 15
- 16 - 20
- > 20

Buildings Exposed: 2%

See Risk Report pg. 20-24



LANDSLIDE

Susceptibility

- Low
- Moderate
- High
- Very High

Buildings Exposed to High or Very High: 61%

See Risk Report pg. 24-27

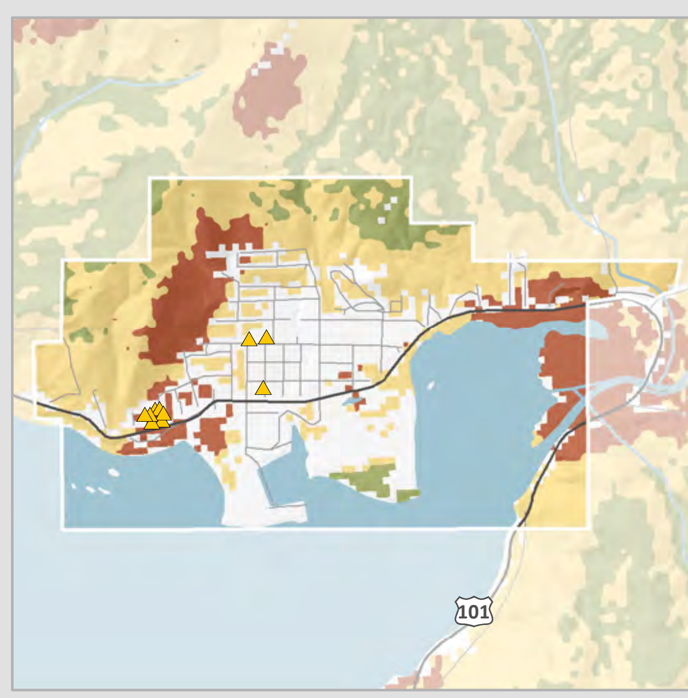
COASTAL EROSION

Hazard Zone

- Very High
- High
- Moderate

Buildings Exposed: 0%

See Risk Report pg. 27-30



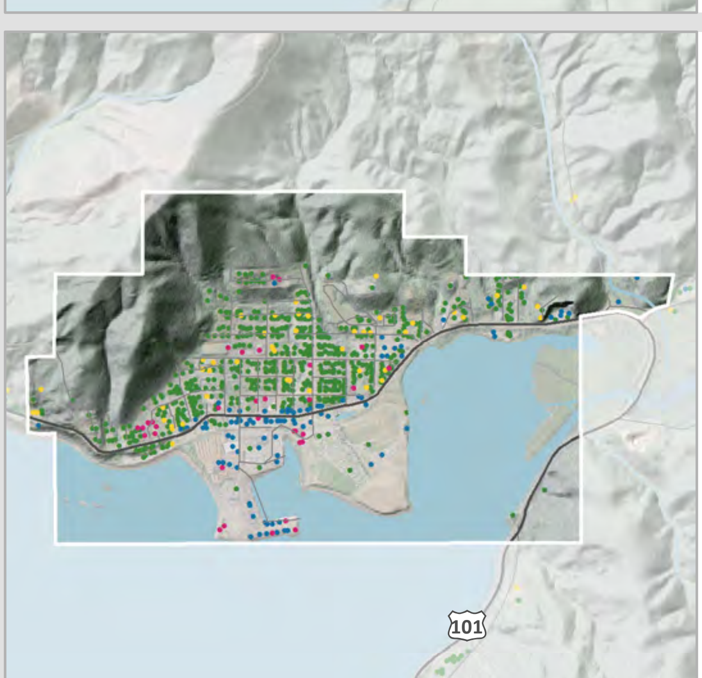
WILDFIRE

Risk

- Low
- Moderate
- High
- No Data

Buildings Exposed to High: 8%

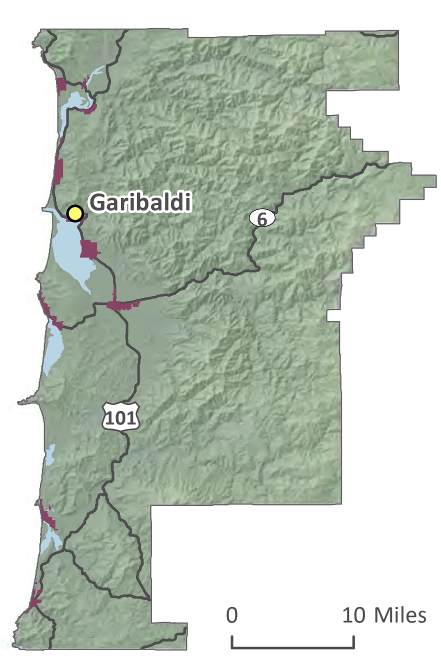
See Risk Report pg. 30-32



OCCUPANCY CLASS

- Agriculture/ Utility
- Public/ Non-Profit
- Industrial/ Commercial
- Residential

See Risk Report pg. 6-9



COMMUNITY STATISTICS

Population	779
Buildings	755
Building Value	$64M
Essential Facilities	3

Additional community statistics for Garibaldi are available in the Community Risk Profile of the Risk Report, pg. 46-47.

FEMA

0 0.5 Miles

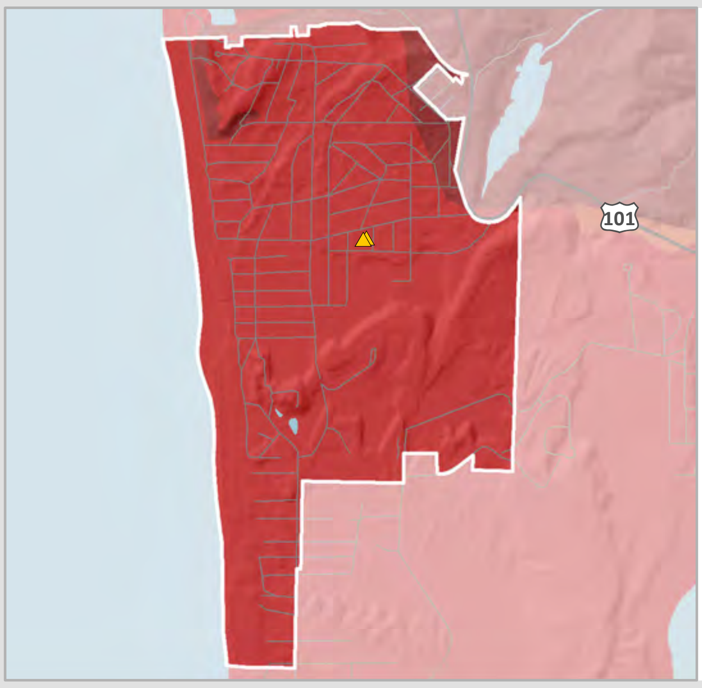
- Essential Facility
- Community
- Roads and Highways
- Rivers
- Lakes & Ocean

Source Data: Roads: Tillamook County (2008), Highways: Oregon Department of Transportation (2013), Earthquake PGA: Department of Geology and Mineral Industries (DOGAMI) (2013), Tsunami Boundary: DOGAMI (2013), Flood Depth: DOGAMI (2015), Landslide Susceptibility: DOGAMI (2016), Coastal Erosion Susceptibility: DOGAMI (2014), Wildfire Risk: ODF (2013)

Appendix C: Plate 12

C. Appleby, DOGAMI, 2016

Manzanita



EARTHQUAKE

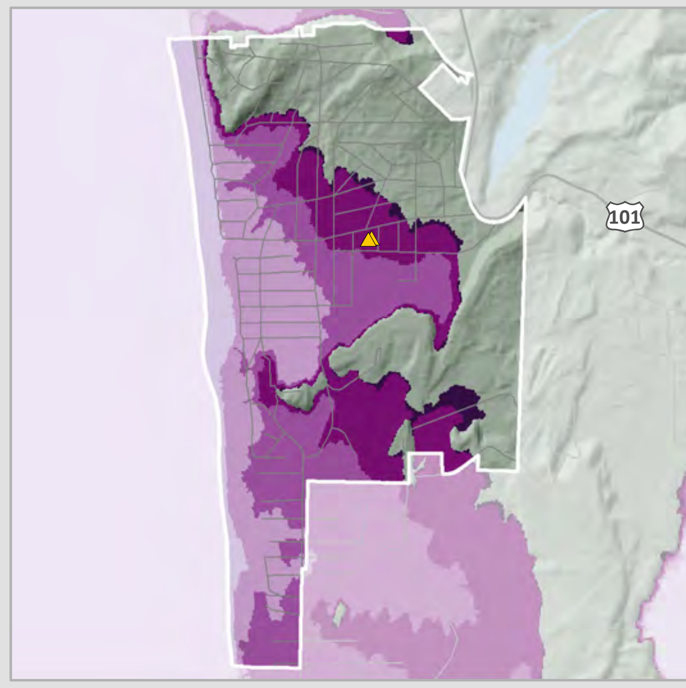
Peak Ground Acceleration (PGA) from 9.0M CSZ Earthquake

Lower

Higher

Buildings Exposed: 100%

See Risk Report pg. 14-16



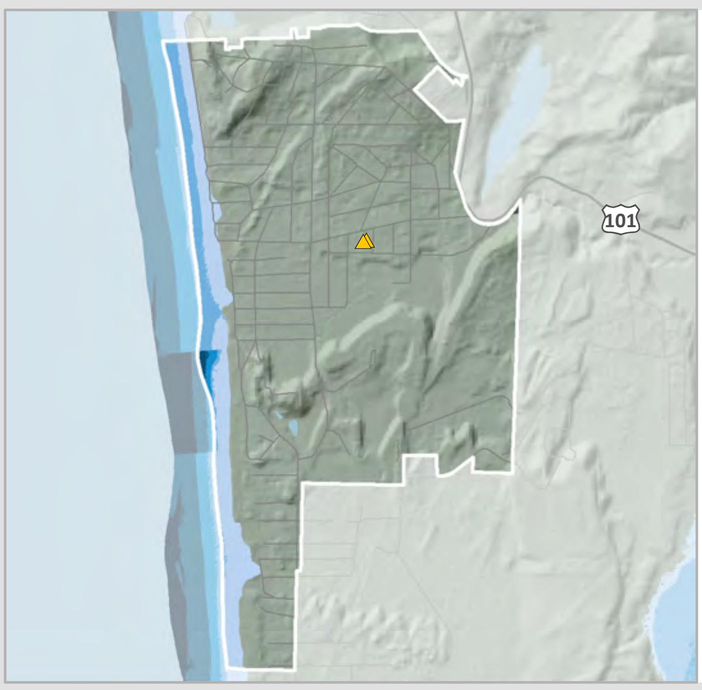
TSUNAMI

Inundation Boundaries

- Small
- Medium
- Large
- X-Large
- XX-Large

Buildings Exposed to Medium: 22%

See Risk Report pg. 17-20



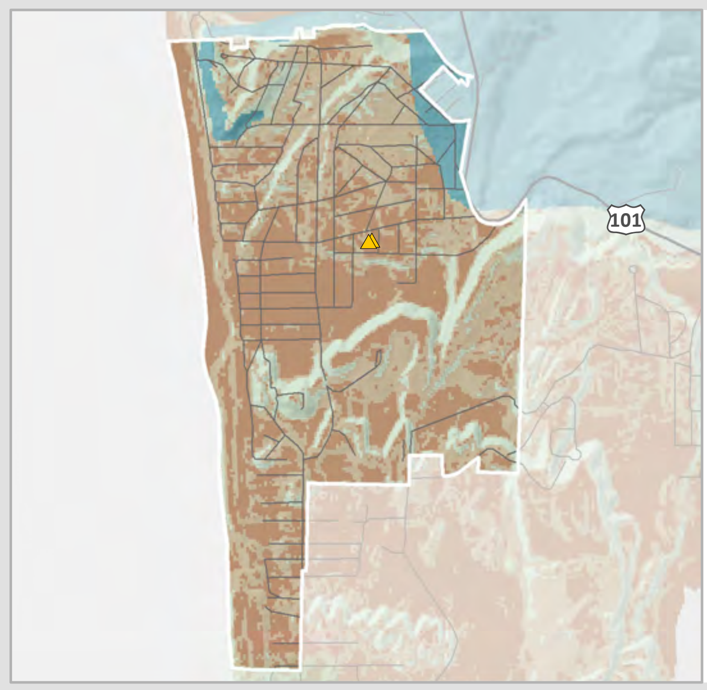
FLOOD

100-Year Flood Depth (ft)

- 0 - 5
- 6 - 10
- 11 - 15
- 16 - 20
- > 20

Buildings Exposed: <1%

See Risk Report pg. 20-24



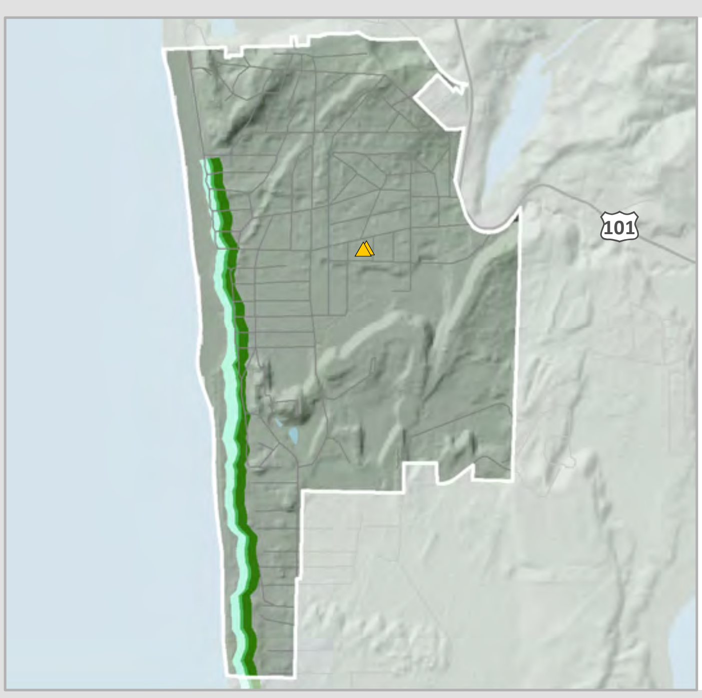
LANDSLIDE

Susceptibility

- Low
- Moderate
- High
- Very High

Buildings Exposed to High or Very High: 15%

See Risk Report pg. 24-27



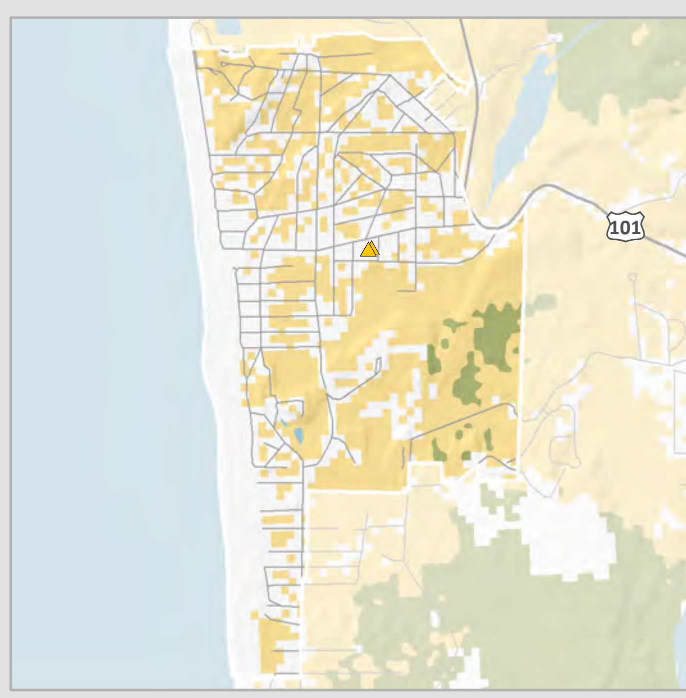
COASTAL EROSION

Hazard Zone

- Very High
- High
- Moderate

Buildings Exposed: 2%

See Risk Report pg. 27-30



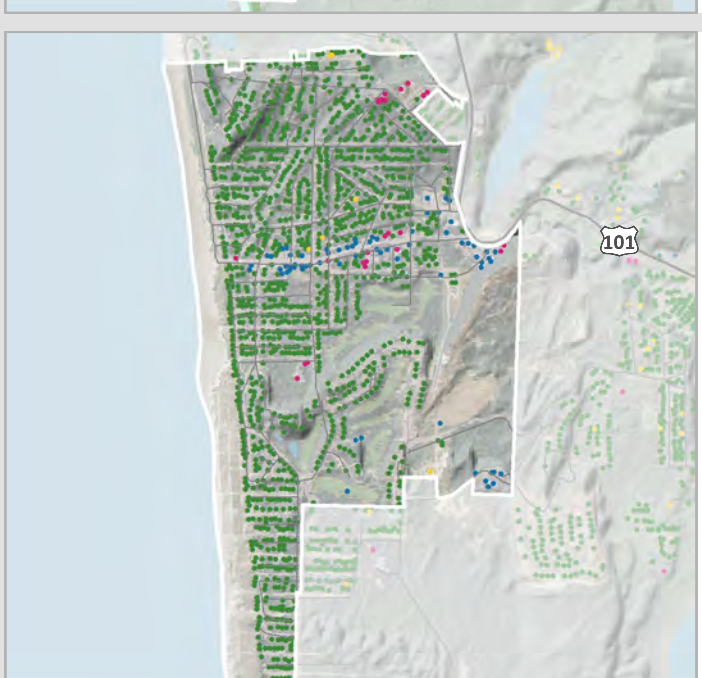
WILDFIRE

Risk

- Low
- Moderate
- High
- No Data

Buildings Exposed to High: 0%

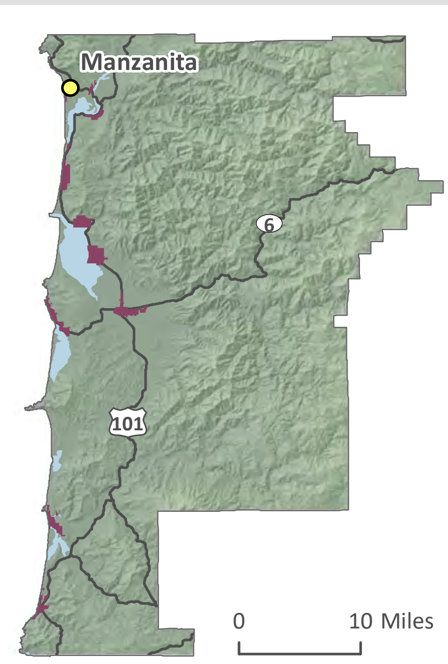
See Risk Report pg. 30-32



OCCUPANCY CLASS

- Agriculture/ Utility
- Public/ Non-Profit
- Industrial/ Commercial
- Residential

See Risk Report pg. 6-9



COMMUNITY STATISTICS

Population	599
Buildings	1,523
Building Value	$260M
Essential Facilities	1

Additional community statistics for Manzanita are available in the Community Risk Profile of the Risk Report, pg. 48-49.

FEMA

0 0.5 Miles

Essential Facility

Community

Roads and Highways

Rivers

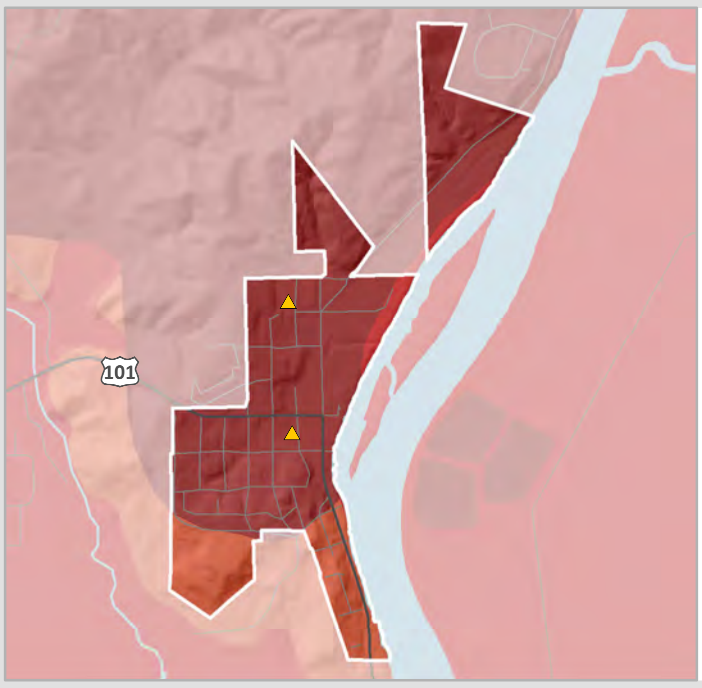
Lakes & Ocean

Source Data: Roads: Tillamook County (2008), Highways: Oregon Department of Transportation (2013), Earthquake PGA: Department of Geology and Mineral Industries (DOGAMI) (2013), Tsunami Boundary: DOGAMI (2013), Flood Depth: DOGAMI (2015), Landslide Susceptibility: DOGAMI (2016), Coastal Erosion Susceptibility: DOGAMI (2014), Wildfire Risk: ODF (2013)

Appendix C: Plate 13

C. Appleby, DOGAMI, 2016

Nehalem



EARTHQUAKE

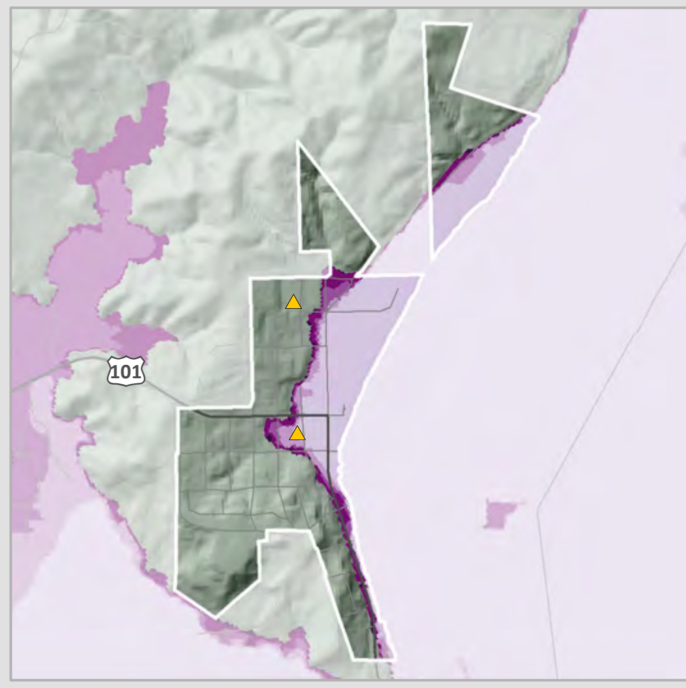
Peak Ground Acceleration (PGA) from 9.0M CSZ Earthquake

Lower

Higher

Buildings Exposed: 100%

See Risk Report pg. 14-16



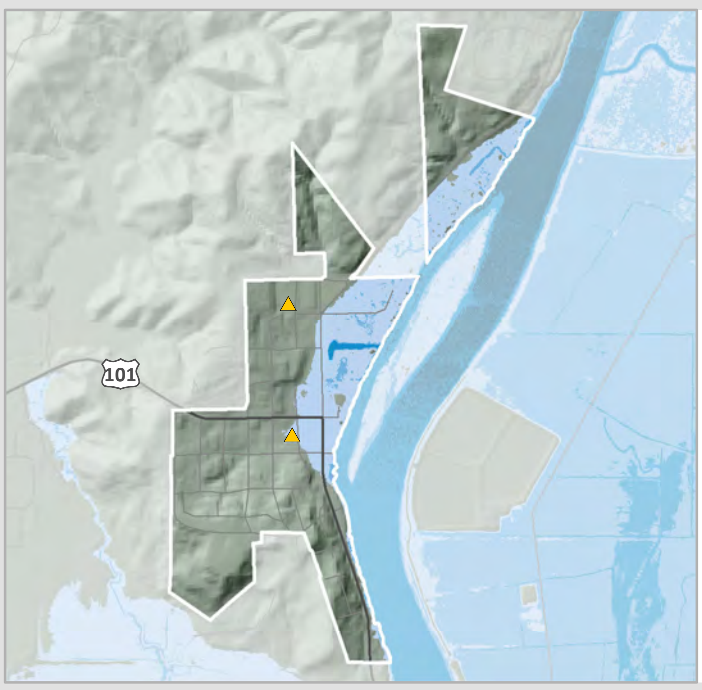
TSUNAMI

Inundation Boundaries

- Small
- Medium
- Large
- X-Large
- XX-Large

Buildings Exposed to Medium: 32%

See Risk Report pg. 17-20



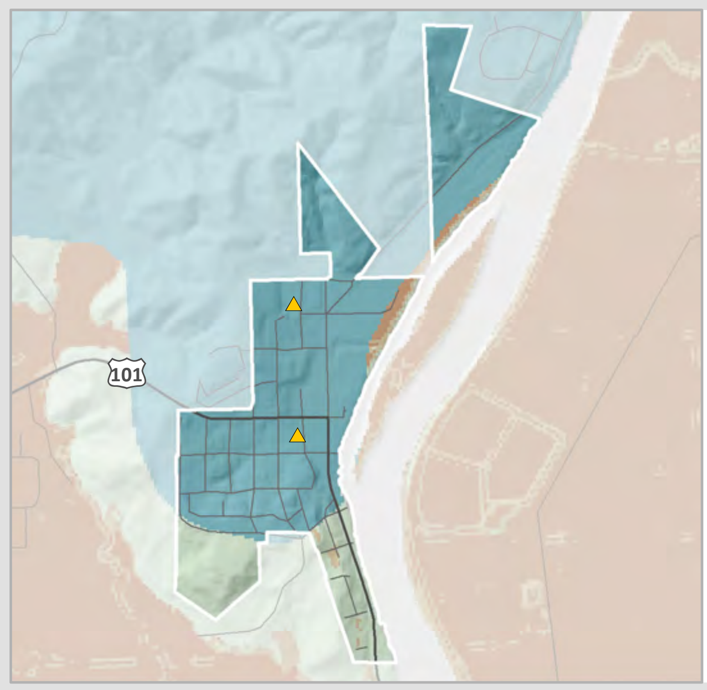
FLOOD

100-Year Flood Depth (ft)

- 0 - 5
- 6 - 10
- 11 - 15
- 16 - 20
- > 20

Buildings Exposed: 26%

See Risk Report pg. 20-24



LANDSLIDE

Susceptibility

- Low
- Moderate
- High
- Very High

Buildings Exposed to High or Very High: 99%

See Risk Report pg. 24-27

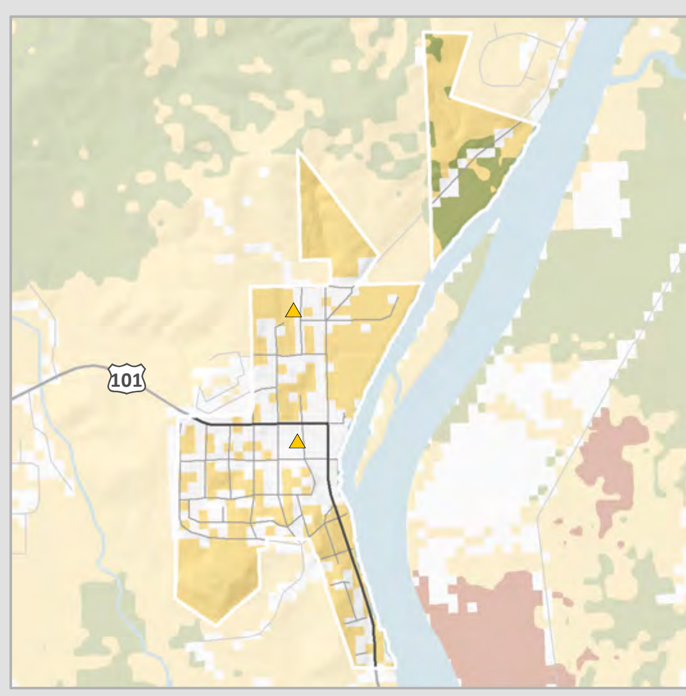
COASTAL EROSION

Hazard Zone

- Very High
- High
- Moderate

Buildings Exposed: 0%

See Risk Report pg. 27-30



WILDFIRE

Risk

- Low
- Moderate
- High
- No Data

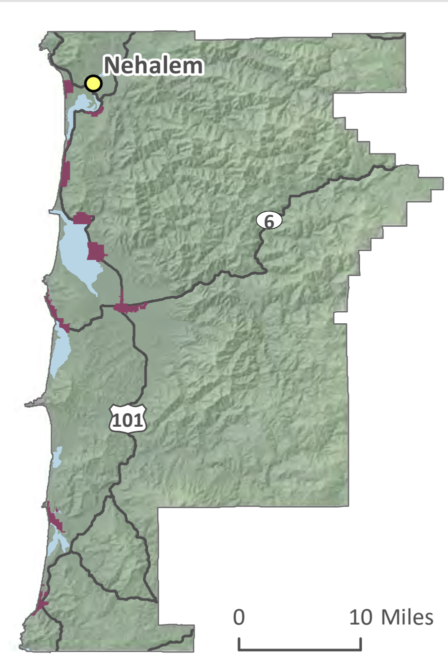
Buildings Exposed to High: 0%

See Risk Report pg. 30-32

OCCUPANCY CLASS

- Agriculture/ Utility
- Public/ Non-Profit
- Industrial/ Commercial
- Residential

See Risk Report pg. 6-9



COMMUNITY STATISTICS

Population	267
Buildings	260
Building Value	$25M
Essential Facilities	2

Additional community statistics for Nehalem are available in the Community Risk Profile of the Risk Report, pg. 50-51.

FEMA

0 0.5 Miles

Essential Facility

Community

Roads and Highways

Rivers

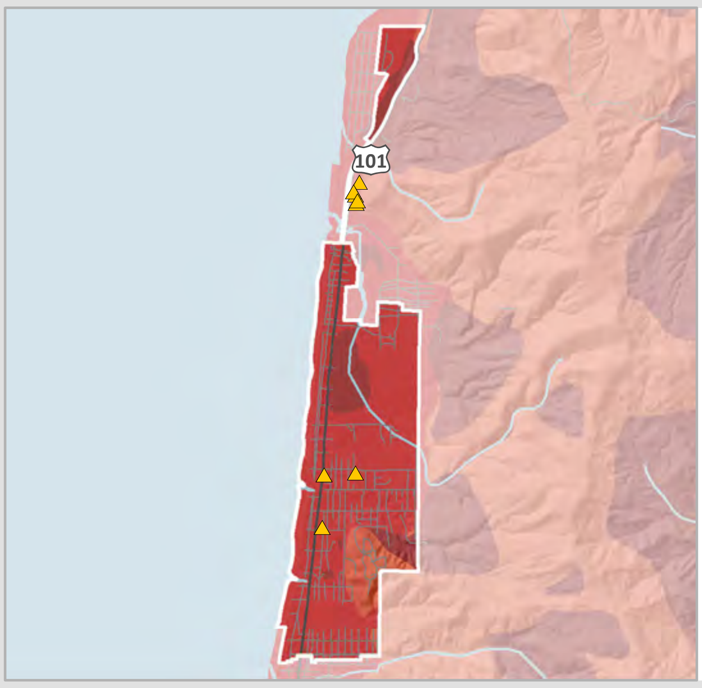
Lakes & Ocean

Source Data: Roads: Tillamook County (2008), Highways: Oregon Department of Transportation (2013), Earthquake PGA: Department of Geology and Mineral Industries (DOGAMI) (2013), Tsunami Boundary: DOGAMI (2013), Flood Depth: DOGAMI (2015), Landslide Susceptibility: DOGAMI (2016), Coastal Erosion Susceptibility: DOGAMI (2014), Wildfire Risk: ODF (2013)

Appendix C: Plate 14

C. Appleby, DOGAMI, 2016

Rockaway Beach



EARTHQUAKE

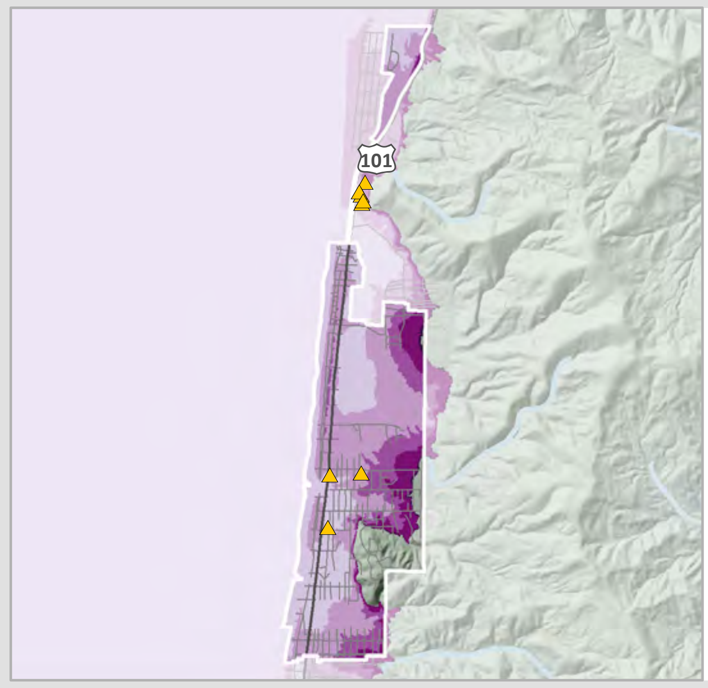
Peak Ground Acceleration (PGA) from 9.0M CSZ Earthquake

Lower

Higher

Buildings Exposed: 100%

See Risk Report pg. 14-16



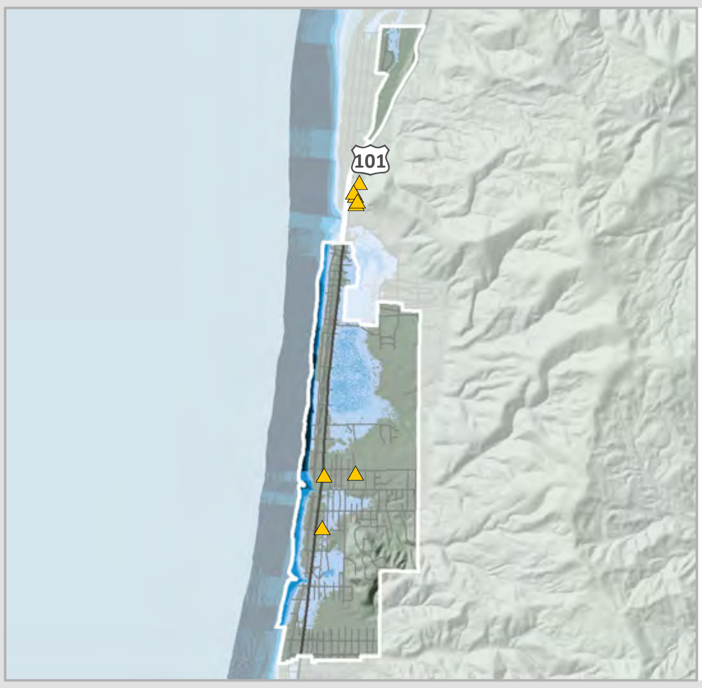
TSUNAMI

Inundation Boundaries

- Small
- Medium
- Large
- X-Large
- XX-Large

Buildings Exposed to Medium: 69%

See Risk Report pg. 17-20



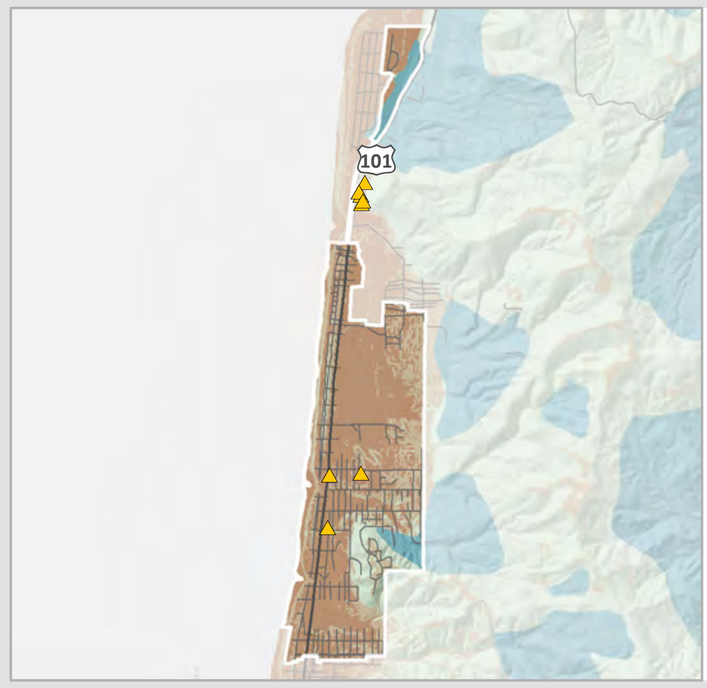
FLOOD

100-Year Flood Depth (ft)

- 0 - 5
- 6 - 10
- 11 - 15
- 16 - 20
- > 20

Buildings Exposed: 13%

See Risk Report pg. 20-24



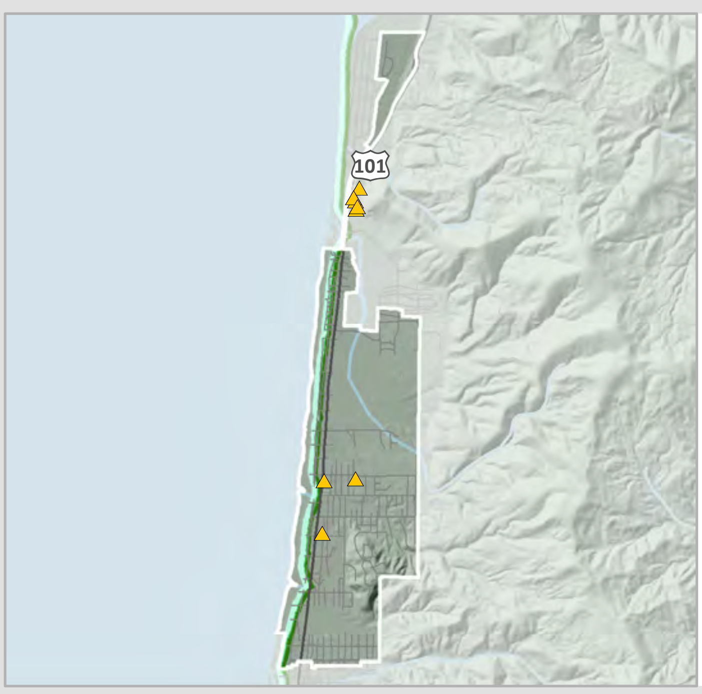
LANDSLIDE

Susceptibility

- Low
- Moderate
- High
- Very High

Buildings Exposed to High or Very High: 6%

See Risk Report pg. 24-27



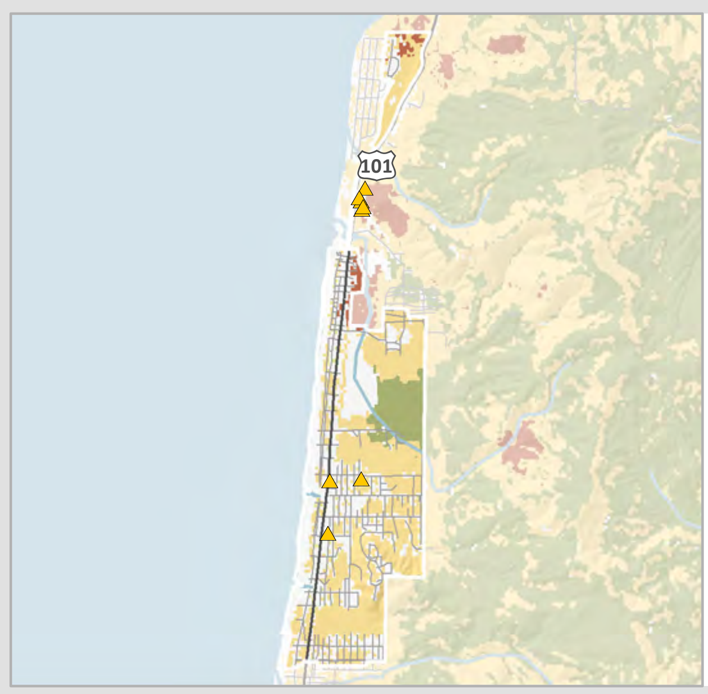
COASTAL EROSION

Hazard Zone

- Very High
- High
- Moderate

Buildings Exposed: 24%

See Risk Report pg. 27-30



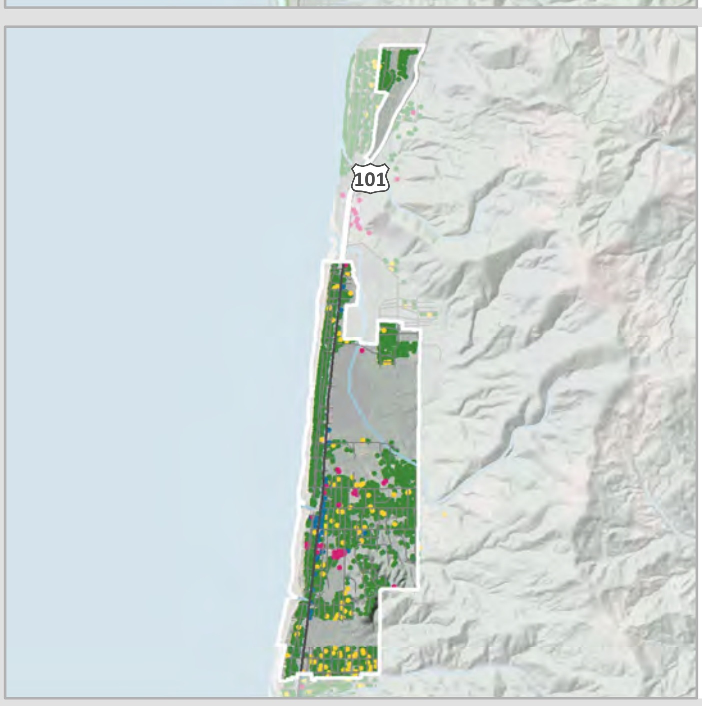
WILDFIRE

Risk

- Low
- Moderate
- High
- No Data

Buildings Exposed to High: 1%

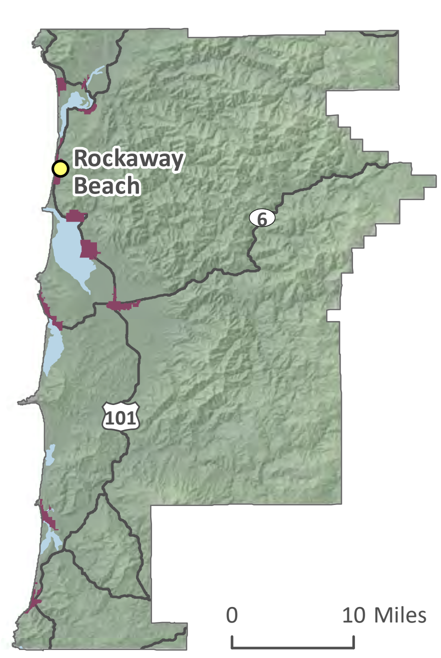
See Risk Report pg. 30-32



OCCUPANCY CLASS

- Agriculture/ Utility
- Public/ Non-Profit
- Industrial/ Commercial
- Residential

See Risk Report pg. 6-9



COMMUNITY STATISTICS

Population	1,305
Buildings	2,240
Building Value	$212M
Essential Facilities	2

Additional community statistics for Rockaway Beach are available in the Community Risk Profile of the Risk Report, pg. 52-53.

FEMA

0 1 Miles

Essential Facility

Community

Roads and Highways

Rivers

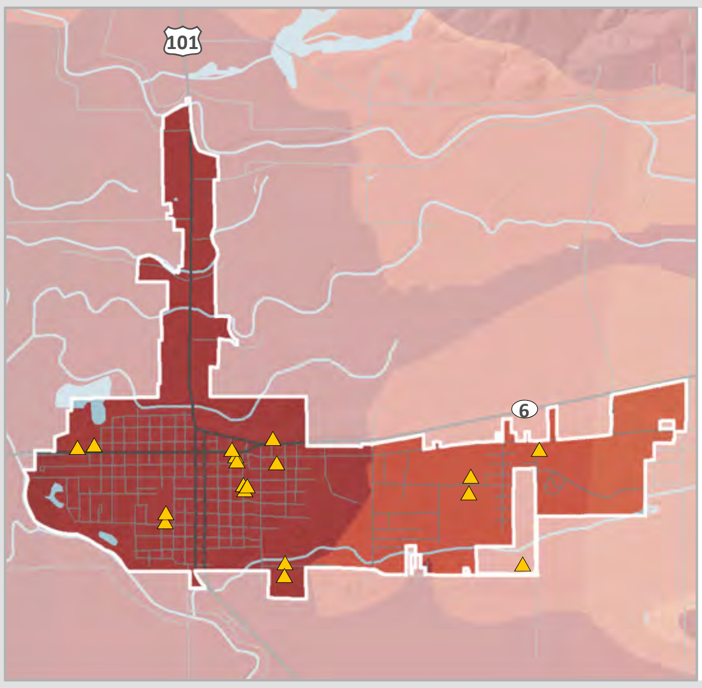
Lakes & Ocean

Source Data: Roads: Tillamook County (2008), Highways: Oregon Department of Transportation (2013), Earthquake PGA: Department of Geology and Mineral Industries (DOGAMI) (2013), Tsunami Boundary: DOGAMI (2013), Flood Depth: DOGAMI (2015), Landslide Susceptibility: DOGAMI (2016), Coastal Erosion Susceptibility: DOGAMI (2014), Wildfire Risk: ODF (2013)

Appendix C: Plate 15

C. Appleby, DOGAMI, 2016

Tillamook



EARTHQUAKE

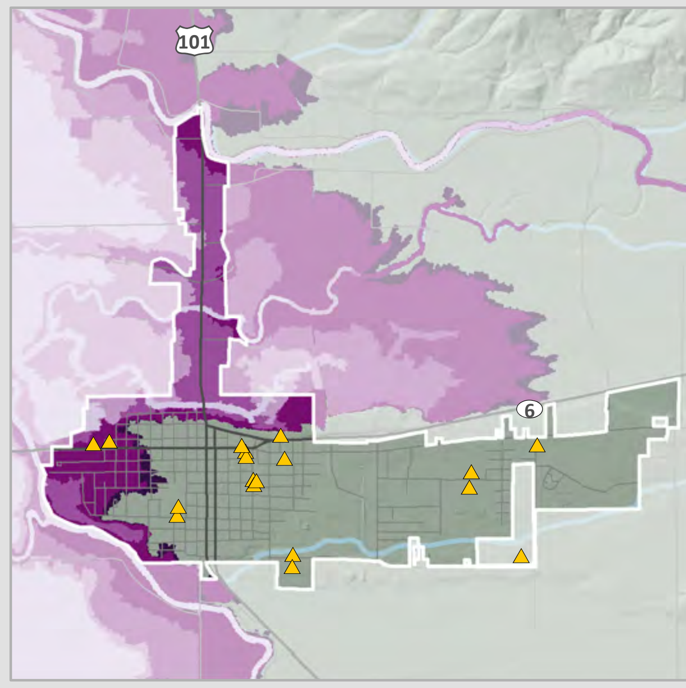
Peak Ground Acceleration (PGA) from 9.0M CSZ Earthquake

Lower

Higher

Buildings Exposed: 100%

See Risk Report pg. 14-16



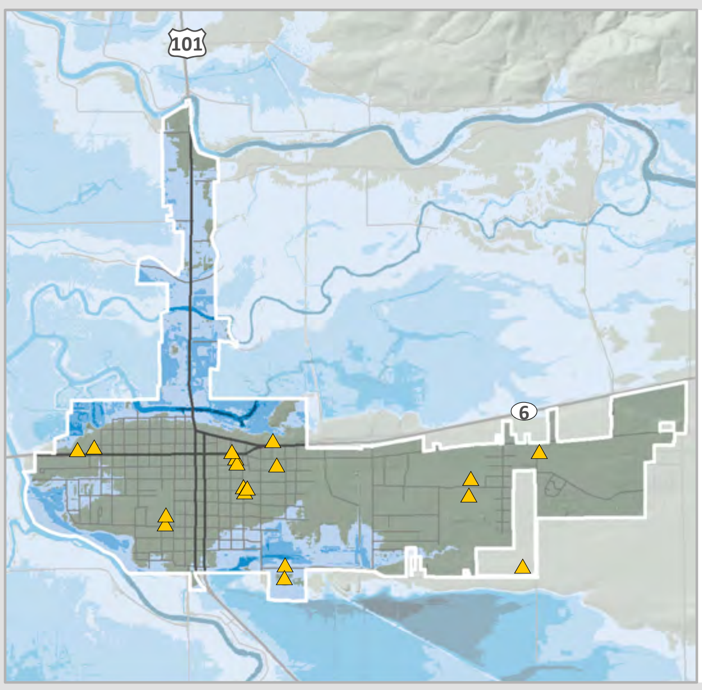
TSUNAMI

Inundation Boundaries

- Small
- Medium
- Large
- X-Large
- XX-Large

Buildings Exposed to Medium: 0%

See Risk Report pg. 17-20



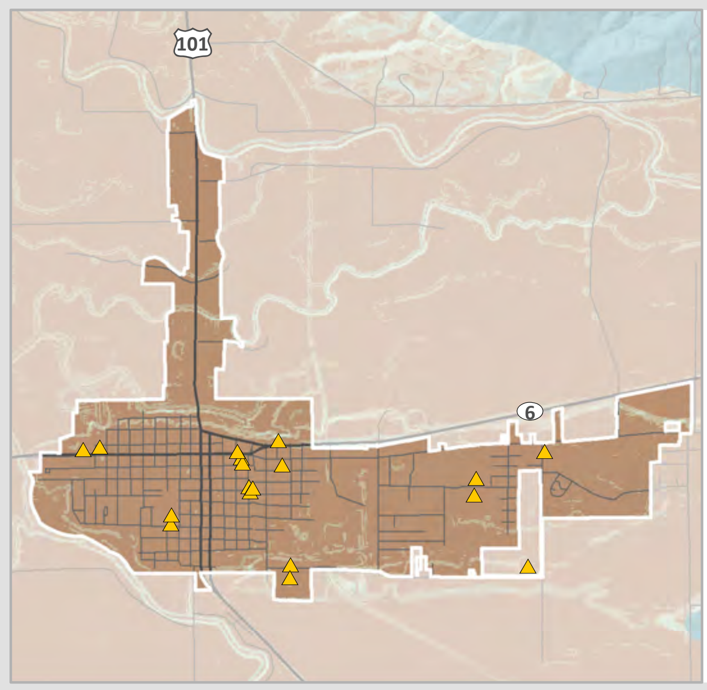
FLOOD

100-Year Flood Depth (ft)

- 0 - 5
- 6 - 10
- 11 - 15
- 16 - 20
- > 20

Buildings Exposed: 11%

See Risk Report pg. 20-24



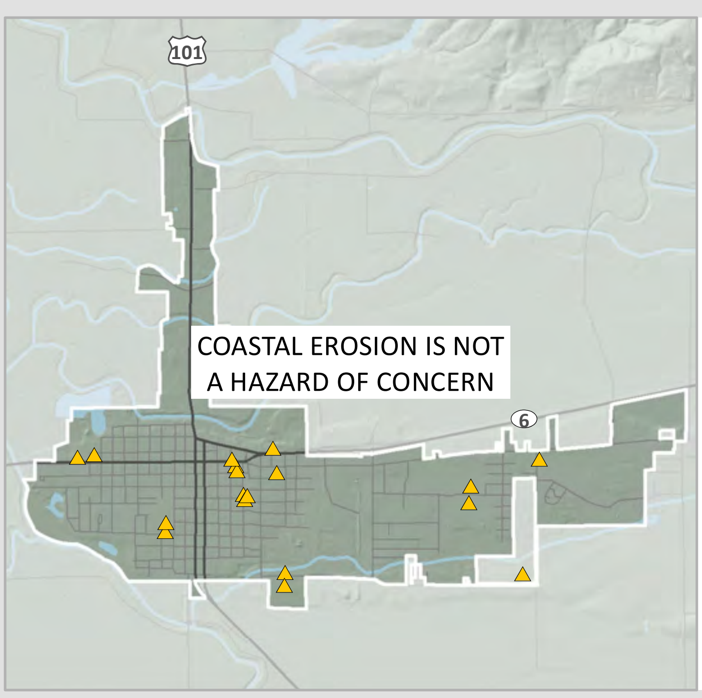
LANDSLIDE

Susceptibility

- Low
- Moderate
- High
- Very High

Buildings Exposed to High or Very High: 0%

See Risk Report pg. 24-27



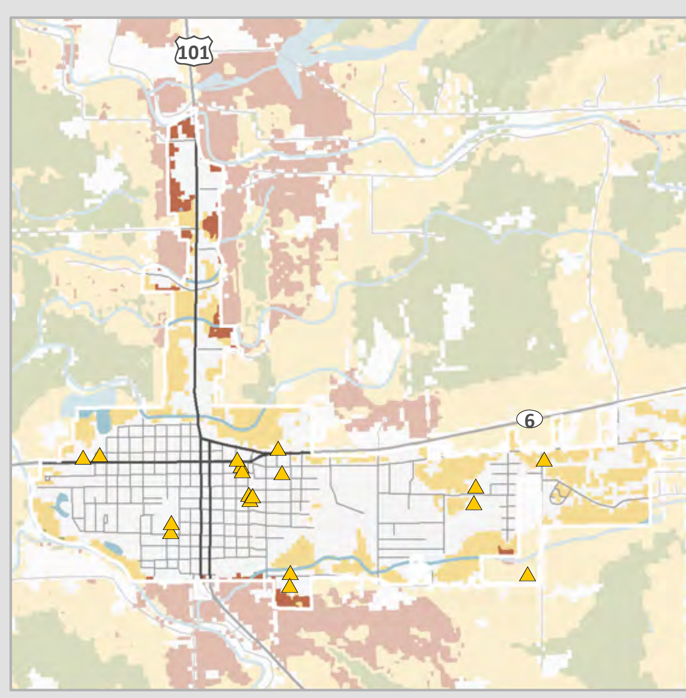
COASTAL EROSION

Hazard Zone

- Very High
- High
- Moderate

Buildings Exposed: 0%

See Risk Report pg. 27-30



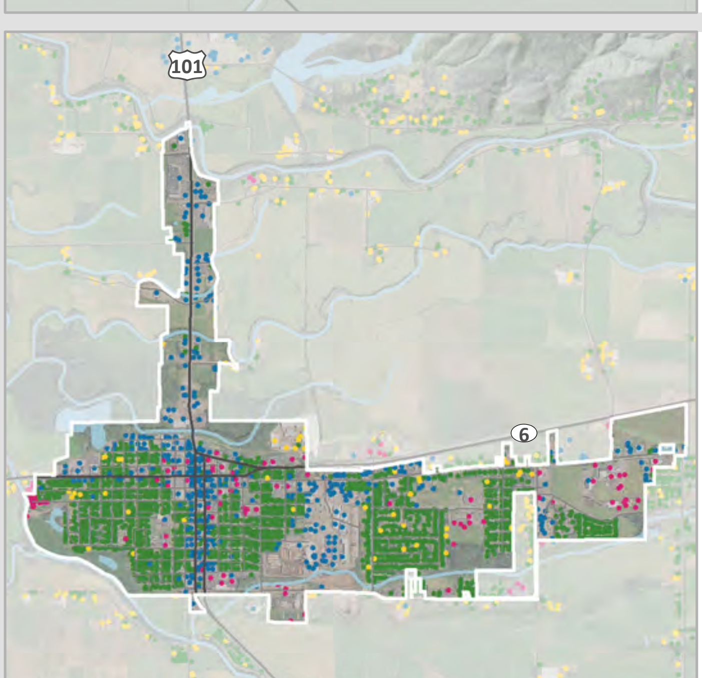
WILDFIRE

Risk

- Low
- Moderate
- High
- No Data

Buildings Exposed to High: 12%

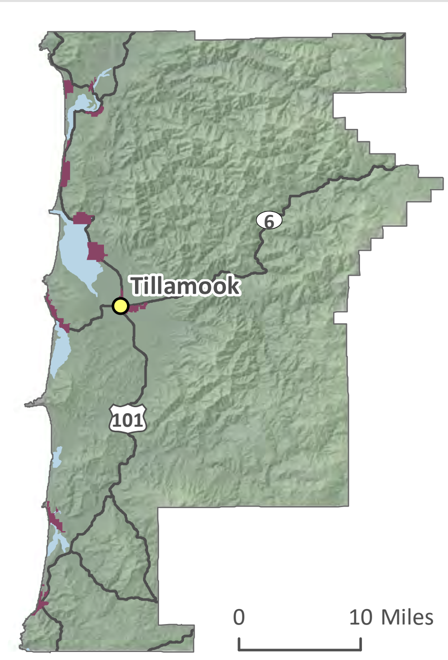
See Risk Report pg. 30-32



OCCUPANCY CLASS

- Agriculture/ Utility
- Public/ Non-Profit
- Industrial/ Commercial
- Residential

See Risk Report pg. 6-9



COMMUNITY STATISTICS

Population	4,999
Buildings	2,270
Building Value	$322M
Essential Facilities	10

Additional community statistics for Tillamook are available in the Community Risk Profile of the Risk Report, pg. 54-55.

0 1 Miles

Essential Facility

Community

Roads and Highways

Rivers

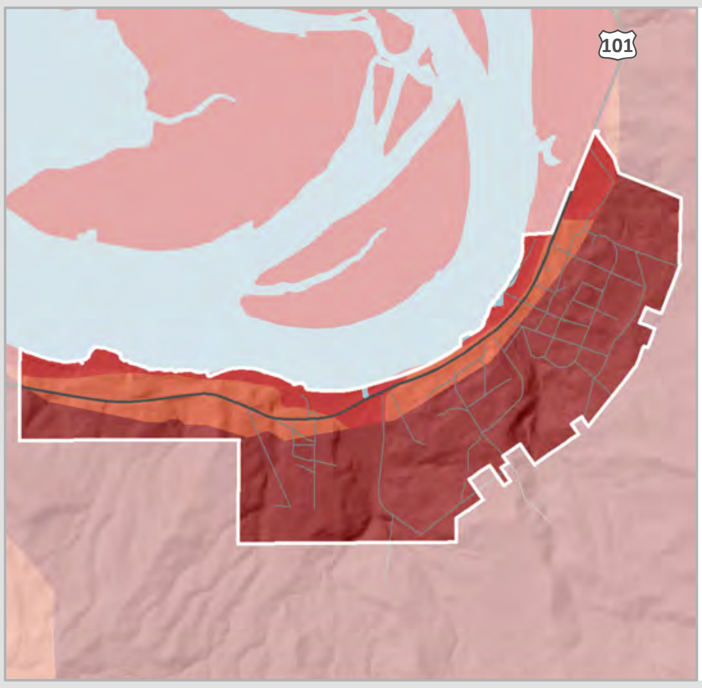
Lakes & Ocean

Source Data: Roads: Tillamook County (2008), Highways: Oregon Department of Transportation (2013), Earthquake PGA: Department of Geology and Mineral Industries (DOGAMI) (2013), Tsunami Boundary: DOGAMI (2013), Flood Depth: DOGAMI (2015), Landslide Susceptibility: DOGAMI (2016), Coastal Erosion Susceptibility: DOGAMI (2014), Wildfire Risk: ODF (2013)

Appendix C: Plate 16

C. Appleby, DOGAMI, 2016

Wheeler



EARTHQUAKE

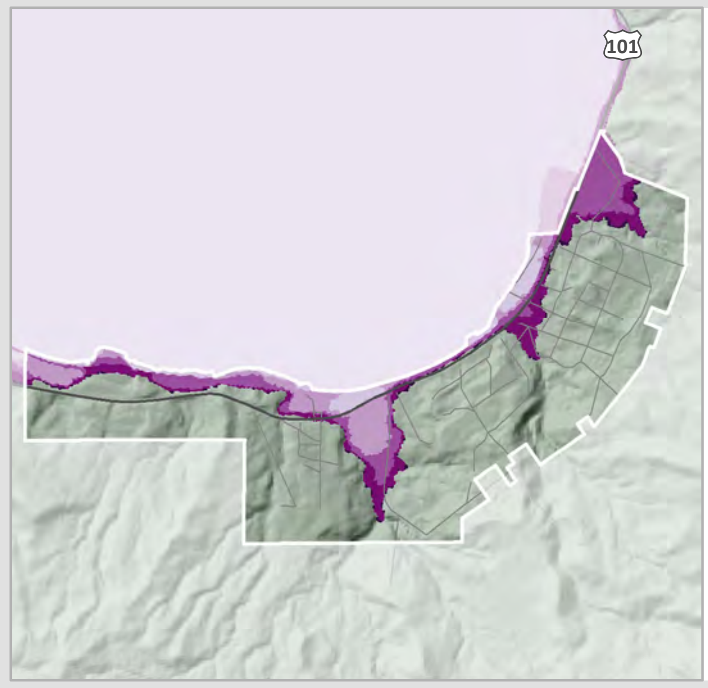
Peak Ground Acceleration (PGA) from 9.0M CSZ Earthquake

Lower

Higher

Buildings Exposed: 100%

See Risk Report pg. 14-16



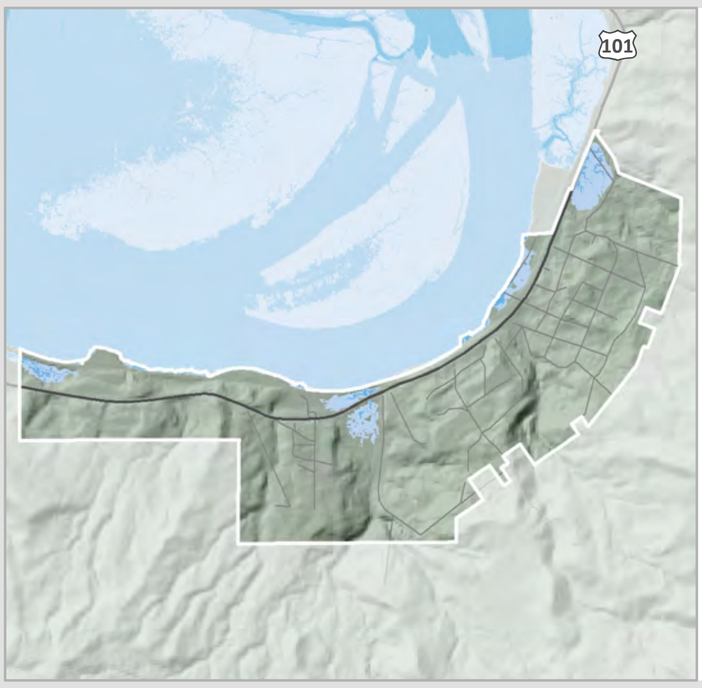
TSUNAMI

Inundation Boundaries

- Small
- Medium
- Large
- X-Large
- XX-Large

Buildings Exposed to Medium: 7%

See Risk Report pg. 17-20



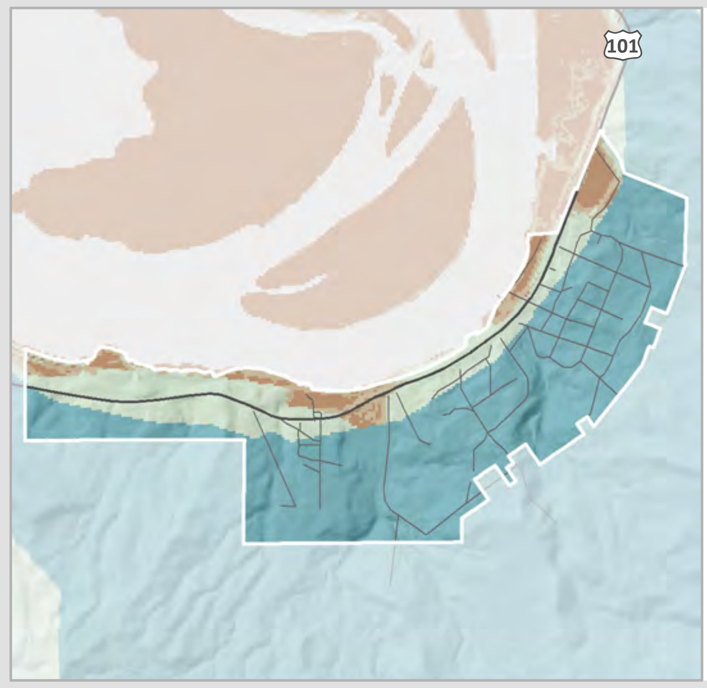
FLOOD

100-Year Flood Depth (ft)

- 0 - 5
- 6 - 10
- 11 - 15
- 16 - 20
- > 20

Buildings Exposed: 3%

See Risk Report pg. 20-24



LANDSLIDE

Susceptibility

- Low
- Moderate
- High
- Very High

Buildings Exposed to High or Very High: 92%

See Risk Report pg. 24-27

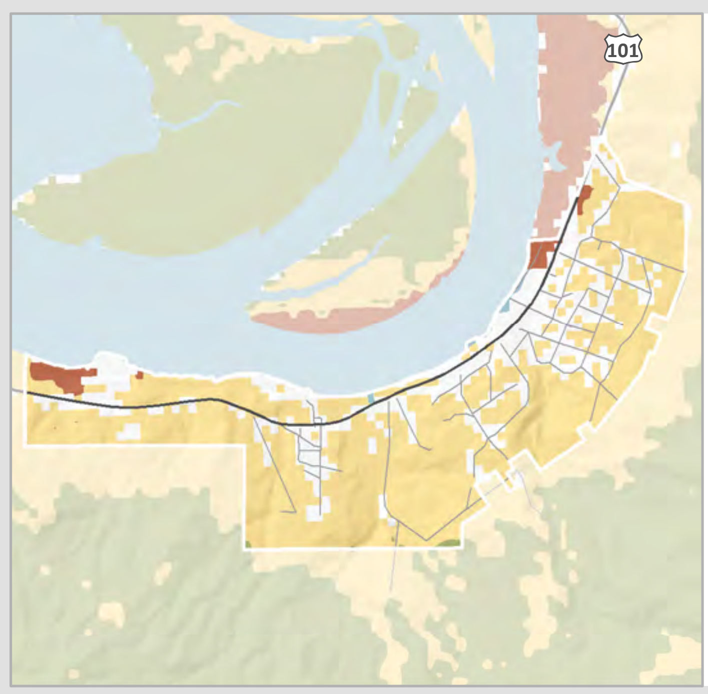
COASTAL EROSION

Hazard Zone

- Very High
- High
- Moderate

Buildings Exposed: 0%

See Risk Report pg. 27-30



WILDFIRE

Risk

- Low
- Moderate
- High
- No Data

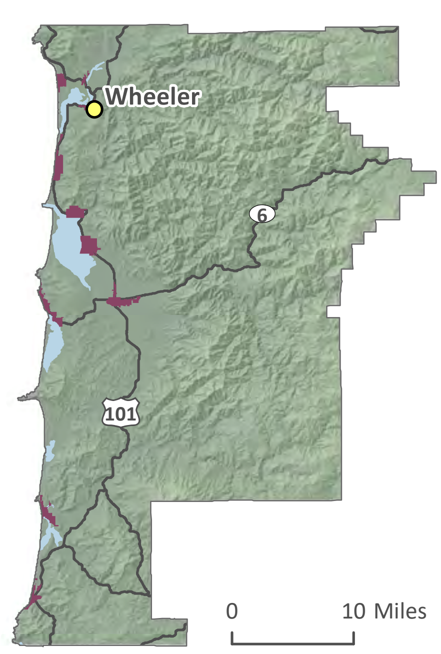
Buildings Exposed to High: <1%

See Risk Report pg. 30-32

OCCUPANCY CLASS

- Agriculture/ Utility
- Public/ Non-Profit
- Industrial/ Commercial
- Residential

See Risk Report pg. 6-9



COMMUNITY STATISTICS

Population	420
Buildings	363
Building Value	$31M
Essential Facilities	0

Additional community statistics for Wheeler are available in the Community Risk Profile of the Risk Report, pg. 56-57.

FEMA

0 0.5 Miles

Essential Facility

Community

Roads and Highways

Rivers

Lakes & Ocean

Source Data: Roads: Tillamook County (2008), Highways: Oregon Department of Transportation (2013), Earthquake PGA: Department of Geology and Mineral Industries (DOGAMI) (2013), Tsunami Boundary: DOGAMI (2013), Flood Depth: DOGAMI (2015), Landslide Susceptibility: DOGAMI (2016), Coastal Erosion Susceptibility: DOGAMI (2014), Wildfire Risk: ODF (2013)

Appendix C: Plate 17

C. Appleby, DOGAMI, 2016

E. Acronyms and Definitions

ACRONYMS

A

AOMI	Areas of Mitigation Interest

C

CSZ	Cascadia Subduction Zone

D

DFIRM	Digital Flood Insurance Rate Map
DLCD	Oregon Department of Land Conservation and Development
DOGAMI	Department of Geology and Mineral Industries (State of Oregon)

F

FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study

G

GIS	Geographic Information System

N

NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration

O

ODF	Oregon Department of Forestry
OEM	Oregon Emergency Management
OFR	Open File Report
OPDR	Oregon Partnership for Disaster Resilience

P

PGA	Peak Ground Acceleration
PGD	Permanent Ground Deformation
PGV	Peak Ground Velocity

R

Risk MAP	Risk Mapping, Assessment, and Planning

S

SFHA	Special Flood Hazard Area
SLIDO	State Landslide Information Layer for Oregon

U

UDF	User Defined Facilities

USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey

DEFINITIONS

1-% annual chance flood – The flood elevation that has a 1-percent chance of being equaled or exceeded each year. Sometimes referred to as the 100-year flood.

0.2% annual chance flood – The flood elevation that has a 0.2-percent chance of being equaled or exceeded each year. Sometimes referred to as the 500-year flood.

Base flood elevation (BFE) – Elevation of the 1-percent-annual-chance flood. This elevation is the basis of the insurance and floodplain management requirements of the NFIP.

Digital Flood Insurance Rate Map (DFIRM) - An official digital database that contains a dataset showing the SFHAs and risk premium zones applicable to a community, as well as a variety of

Essential facilities – Facilities that, if damaged, would present an immediate threat to life, public health, and safety. As categorized in HAZUS-MH, essential facilities include hospitals, emergency operations centers, police stations, fire stations and schools.

Exposure – Determination of whether a building is within or outside of a hazard zone. No loss estimation is modeled.

Flood Insurance Rate Map (FIRM) – An official map of a community, on which FEMA has delineated both the SFHAs and the risk premium zones applicable to the community. See also Digital Flood Insurance Rate Map.

Flood Insurance Study (FIS) – Contains an examination, evaluation, and determination of the flood hazards of a community and, if appropriate, the corresponding water-surface elevations.

Flood risk – Probability multiplied by consequence; the degree of probability that a loss or injury may occur as a result of flooding. Sometimes referred to as vulnerability.

Floodway (regulatory)– The channel of a river or other watercourse and the portion of the adjacent floodplain that must remain unobstructed to permit passage of the base flood without cumulatively increasing the water surface elevation more than a designated height (usually 1 foot).

Floodway fringe – The portion of the SFHA that is outside of the floodway.

Hazus-MH – A GIS-based risk assessment methodology and software application created by FEMA and the National Institute of Building Sciences for analyzing potential losses from floods, hurricane winds, and earthquakes.

Lidar – A remote sensing technology that measures distance by illuminating a target with a laser and analyzing the reflected light. Lidar is popularly used as a technology to make high-resolution maps.

Liquefaction – Describes a phenomenon whereby a saturated soil substantially loses strength and stiffness in response to an applied stress, usually an earthquake, causing it to behave like liquid.

Loss Ratio – The expression of loss as a fraction of the value of the local inventory (total value/loss).

Magnitude – A scale used by seismologists to measure the size of earthquakes in terms of energy released.

Orthorectified – Describing an image that has been orthorectified to be geometrically corrected so that distances shown are uniform and can be measured like a map.

Risk MAP – The vision of this FEMA strategy is to work collaboratively with State, local, and tribal entities to deliver quality flood data that increases public awareness and leads to action that reduces risk to life and property.

Riverine – Of or produced by a river. Riverine floodplains have readily identifiable channels.

Special Flood Hazard Area (SFHA) – Portion of the floodplain subject to inundation by the base flood.

Susceptibility – Degree of proneness to natural hazards that is determined based on physical characteristics that are present.

B. Mitigation Strategy

Tillamook County Natural Hazards Code and Program Review

Final Report – March 2017

Community Service Center, University of Oregon

Tillamook County Natural Hazards Code and Program Review

September 2016 **Final Report (rev. March 2017)**

Prepared for:

Tillamook County, Oregon Risk MAP,
and Federal Emergency Management Agency

Prepared by:

Community Service Center

http://csc.uoregon.edu/

SPECIAL THANKS AND ACKNOWLEDGEMENTS

The Community Service Center (CSC) developed this Natural Hazards Code and Program Review for Tillamook County through a contract with the Federal Emergency Management Agency. FEMA awarded the contract to support the implementation of the Risk Mapping Assessment and Planning (Risk MAP) data and analysis efforts into the county's regulatory and non-regulatory planning processes. Elements of the Risk MAP process will be used to support ongoing risk assessment activities in the county as well as other emergency management related activities including mitigation, recovery, emergency operations and emergency preparedness. The CSC thanks Bryan Pohl (Community Development Director) and Sarah Absher (Senior Planner) for their assistance with this project.

Community Service Center Team

Michael Howard, OPDR Assistant Program Director
Josh Bruce, OPDR Program Director
Ethan Lockwood, Research Assistant
Madi Pluss, Research Assistant
Ethan Stuckmayer, Research Assistant

About the Community Service Center

The Community Service Center (CSC), a research center affiliated with the Department 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 CSC 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 Community Service Center at the University of Oregon, the OPDR employs a service-learning model to increase community capacity and enhance disaster safety and resilience statewide.

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

This report includes analysis of the Tillamook County Comprehensive Plan and Development Code, how they are interpreted and applied to development, and the implications for natural hazard preparedness. Case studies and model ordinances providing examples of natural hazard best management practices are used to support the report's recommendations.

Background

The Federal Emergency Management Agency (FEMA) invited the Community Service Center's (CSC) Oregon Partnership for Disaster Resilience (OPDR) at the University of Oregon to become a Cooperating Technical Partner (CTP) and to work under a FEMA grant funded by the Risk Mapping Assessment and Planning (Risk MAP) program. Parallel to this process the Oregon Department of Geology and Mineral Industries (DOGAMI) is developing natural hazard risk assessments for Tillamook County and cities (Tillamook Multi-Hazard Risk Report, 2016 draft; Risk Report). The Risk Report has two goals: *"(1) to provide a quantitative risk assessment that informs communities of their risks related to certain natural hazards, and (2) interpret the results to identify specific mitigation opportunities (i.e., areas of mitigation interest) that the communities can act upon."*[1]

Consistent with Oregon Statewide Planning Goal 7 (Hazards), the Tillamook County Development Code includes provisions that aim to protect life and property from natural disasters and hazards. Tillamook County has contracted with the University of Oregon's Community Service Center (CSC) to conduct a review of the Tillamook County Development Code, focusing on supplementing and strengthening code associated with natural hazard mitigation.

The CSC team will integrate the non-regulatory Tillamook Multi-Hazard Risk Report (2016, draft) with on-the-ground planning efforts in Tillamook County. This report provides recommendations for policies, regulations, and programs that will help mitigate financial loss and injury associated with floods, tsunamis, landslides, coastal erosion, wildfires, and sand inundation. Ultimately the recommendations in this report will be used to inform a public process that will lead to comprehensive plan and code updates.

Purpose and Methods

The purpose of this report is to identify and review a range of regulatory and non-regulatory standards that can be utilized by Tillamook County to mitigate the risk of natural hazards impacting the region. This report includes potential code language

[1] DOGAMI, "Multi-Hazard Risk Report for Tillamook County including the Cities of Bay City, Garibaldi, Manzanita, Nehalem, Rockaway Beach, Tillamook, Wheeler & Unincorporated Communities of Neskowin, Oceanside, Netarts, and Pacific City." (Final Draft - December 1, 2016)

from model ordinances and other sources, but review and adoption of code revisions is not within the scope of this project.

To develop recommendations, CSC evaluated related case studies, ordinances, model codes, literature, best practices, and programs implemented by other jurisdictions. To be most applicable, the reviews are based on examples of comparable geography and demographics. The final mitigation strategies reflect a spectrum of regulation, ranging from highly controlled ordinances and strict permitting procedure, to non-regulatory programs that reward best practices. Implementation steps and recommendations are provided within Chapter 10 to summarize the results of our research and present implementation steps for consideration.

Organization of Report

Chapter 2: Strategies for Mitigating Risk provides an overview of the nature of risks related to development in hazardous areas.

Chapter 3: Flooding Hazards identifies the extent of the hazard in relation to development patterns, summarizes existing tsunami planning in the county, discusses model ordinances, and presents policy options to strengthen the Tillamook County Development Code as it relates to flood hazard.

Chapter 4: Tsunami Hazards identifies the extent of the hazard in relation to development patterns, summarizes existing tsunami planning in the county, discusses model ordinances, and presents policy options to strengthen the Tillamook County Development Code as it relates to tsunami hazard.

Chapter 5: Landslide Hazards identifies the extent of the hazard in relation to development patterns, summarizes existing tsunami planning in the county, discusses model ordinances, and presents policy options to strengthen the Tillamook County Development Code as it relates to landslide hazard.

Chapter 6: Coastal Erosion Hazards identifies the extent of the hazard in relation to development patterns, summarizes existing coastal erosion planning in the county, discusses model ordinances, and presents policy options to strengthen the Tillamook County Development Code as it relates to coastal erosion hazard.

Chapter 7: Wildfire Hazards identifies the extent of the hazard in relation to development patterns, summarizes existing coastal erosion planning in the county, discusses model ordinances, and presents policy options to strengthen the Tillamook County Development Code as it relates to wildfire hazard.

Chapter 8: Sand Inundation Hazards identifies the extent of the hazard in relation to development patterns, summarizes existing dune migration planning in the county, discusses model ordinances, and presents policy options to strengthen the Tillamook County Development Code as it relates to sand inundations hazards.

Chapter 9: Multiple Hazards identifies mitigation strategies that apply to multiple hazards.

Chapter 10: Recommendations and Implementation presents implementation strategies for each specific hazard and provides direction to move project forward.

Appendix A contains case studies that informed and strengthened the policy options recommended in this report.

CHAPTER 2: MULTI-HAZARD FRAMEWORK

The Federal Policy and Program Framework

Federal Emergency Management Agency

The pre-disaster mitigation role of the Federal Emergency Management Agency (FEMA) is to provide support and assistance to all communities across the nation to preemptively mitigate and respond to emergencies. FEMA offers financial assistance in the form of grant money through a variety of general and hazard specific programs and grants. The primary grant programs include the Hazard Mitigation Grant Program (HMGP)[2] for long-term hazard mitigation following a major disaster, Pre-Disaster Mitigation (PDM)[3] for hazard mitigation planning and projects, and Flood Mitigation Assistance (FMA)[4] for projects to reduce or eliminate risk of flood damage to buildings that are insured under the National Flood Insurance Program (NFIP).

Risk Mapping, Assessment, and Planning (Risk MAP)

Risk Mapping, Assessment, and Planning (Risk MAP) is the Federal Emergency Management Agency (FEMA) Program that provides communities with information and tools they can use to enhance their mitigation plans and take action to better protect their citizens. Through more precise mapping products, risk assessment tools, and planning and outreach support, Risk MAP strengthens local ability to make informed decisions about reducing risk. Through collaboration with State, Tribal, and local entities, Risk MAP delivers quality data that increases public awareness and leads to action that reduces risk to life and property.

Disaster Mitigation Act

The Disaster Mitigation Act of 2000 is an amendment to the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1998. This amendment made the existing requirement for states to have natural hazard mitigation plans a prerequisite for disaster assistance. Additionally, incentive was provided in the form of additional funding for states that enhanced coordination and integration of state, local, and tribal natural hazards planning.

---

[2] " Hazard Mitigation Grant Program." Federal Emergency Management Agency. Available at: *https://www.fema.gov/hazard-mitigation-grant-program*

[3] "Pre-Disaster Mitigation Grant Program." Federal Emergency Management Agency. Available at: *https://www.fema.gov/pre-disaster-mitigation-grant-program*

[4] "Flood Mitigation Assistance Grant Program." Federal Emergency Management Agency. Available at: *https://www.fema.gov/flood-mitigation-assistance-grant-program*

National Marine Fisheries Service and Endangered Species Act

For several years, the National Oceanic and Atmospheric Administration Fisheries Service (NOAA-Fisheries) and FEMA have been working together to identify measures that will reduce negative impacts from the National Flood Insurance Program minimum standards on salmon, steelhead and other species listed under the Endangered Species Act (ESA). This will become even more important as Oregon and Tillamook County face extreme weather events and other challenges due to a changing climate.

On April 14th, 2016, the National Marine Fisheries Service (NMFS) delivered a Biological Opinion (BiOp) to FEMA. Based on the BiOp, FEMA will be setting new minimum requirements for local floodplain development ordinances based on federal requirements to protect endangered species. The “Reasonable and Prudent Alternative” contains six elements that are designed to achieve these outcomes.

After having been sued, FEMA must now consult with the NMFS or the U.S. Fish and Wildlife Service (USFWS) and get approval of compliance for any programs that may impact endangered species listed as under the Endangered Species Act (ESA). The lawsuit deals with certain policies that FEMA promotes, specifically policies regarding development in their Special Flood Hazard Areas (SFHA), can negatively impact certain endangered species.

The State Policy and Program Framework

Oregon Statewide Planning Goals

Planning for natural hazards is an integral element of Oregon’s statewide land use planning program that began with the passage of Senate Bill 100 in 1973. All Oregon counties and cities are required to have comprehensive plans and implementing ordinances that comply with the 19 statewide planning goals that direct the state’s policies on land use issues.

The Department of Land Conservation and Development (DLCD) administers the state land use planning program and is responsible for reviewing local comprehensive plans for consistency with the 19 statewide goals.

Goal 7: Areas Subject to Natural Hazards

Goal 7 calls for local plans to include inventories, policies, and ordinances to guide development in, or away from, hazard areas to protect life and property. Natural hazards considered for purposes of Goal 7 are: wildfires, floods (coastal and riverine), landslides, earthquakes, tsunamis, and coastal erosion. Local governments may identify and plan for other natural hazards as they apply.

Goal 17: Coastal Shorelands

Goal 17 calls for local plans to reduce the hazard to human life and property resulting from the use and enjoyment of Oregon’s coastal shorelands. Land use plans and implementing actions and permit reviews are to include consideration of the critical relationships between coastal shorelands and resources of coastal waters, and of the geologic and hydrologic hazards associated with coastal shorelands.

Goal 18: Beaches and Dunes

Goal 18 calls for local plans to reduce the hazard to human life and property from human-induced actions in coastal beach and dune areas. These plans must be designed to conserve, protect, where appropriate develop, and where appropriate restore the resources and benefits of coastal beach and dune areas.

Oregon Department of Geology and Mineral Industries

The mission of the Oregon Department of Geology and Mineral Industries (DOGAMI) is to provide earth science information and regulation to make Oregon safe and prosperous. DOGAMI produces maps and reports that can be used by the public and by government to reduce the loss of life and property due to geologic hazards and to manage geologic resources. DOGAMI produces hazard maps associated with earthquakes, flooding, landslide and debris flows, volcanic eruptions, and coastal geologic hazards including coastal erosion and tsunami. Utilization and incorporation of these maps into planning documents and development codes is left to the individual counties and communities.

Overview of Natural Hazards in Tillamook County

Tillamook's unique geographic setting increases the county's vulnerability to geophysical, coastal, and inland hazards. Flood, tsunami, landslide, wildfire, and coastal erosion are assessed in the Tillamook Multi-Hazard Risk Report (2016 draft). Sand inundation also impacts portions of Tillamook County and is assessed in this report. Understanding the causes, characteristics, and consequences associated with each hazard will inform the best set of options on how to mitigate impacts to future development. The following table provides a synthesis of each hazards impact on Tillamook County from the Risk Report and provides a hazard score based on the county's most recent hazard vulnerability assessment (1 = hazard of higher concern, 8 = hazard of lower concern).[5] For local governments, conducting the hazard vulnerability assessment is a useful step in planning for hazard mitigation, response, and recovery. The method provides a set of hazard priorities, but does not predict the occurrence of a hazard. Coastal erosion and dune migration were not analyzed as part of the hazard vulnerability assessment and therefore are listed as unranked. For more detailed information on each of the profiled natural hazards see the hazard specific chapters of this report and the Risk Report.

[5] Tillamook County Natural Hazards Mitigation Plan (draft, 2017), "Local Risk Assessment".

Table 1: Tillamook County Natural Hazard Impacts & Risk Assessment

Hazard	Scenario	Potential Displaced Residents	Exposed Buildings	Exposed Essential Facilities	Exposure Value (In Millions)	Hazard Score (Ranking)
Flood	1% Annual Chance*	1,322	1,999	5	$26	223 (#3)
Coastal Erosion	High Hazard**	156	609	0	$117	204 (#4)
Landslide	High and Very High Susceptibility***	7,121	7,906	12	$779	169 (#6)
Tsunami	CSZ M9.0—Medium****	2,310	5,167	6	$561	158 (#7)
Wildfire	High Risk*****	590	565	2	$48	61 (#8)
Sand Inundation	-	-	-	-	-	Unranked

Source: Tillamook County Multi-Hazard Risk Report (2016, draft)
* The flooding 1% annual chance represent the effects of the maximum flood event expected to occur once every hundred years.
** The coastal erosion high hazard zone was determined using the DOGAMI Open-File Report O-14-02, Evaluation of erosion hazard zones for the dune-backed beaches of Tillamook County, Oregon.
*** The landslide high and very-high susceptibility zones were determined by the Landslide Susceptibility Index, DOGAMI open-file report 0-16-02
**** The tsunami CSZ Mag 9.0, medium, refers to a tsunami resulting from a Cascadia Subduction Zone magnitude 9 earthquake event.
***** The wildfire high risk area was determined using the West Wide Wildfire Risk Assessment (WWA) database. The Tillamook Risk Report notes this methodology may underestimate the risk of wildfire within the county.

Climate Change

Research has shown that sea level and wave heights along the coast are rising and increased landslides, coastal erosion, and coastal flooding is predicted.[6] Warmer winter temperatures are causing decreases in mountain snowpack and an increased incidence of drought and wildfire are expected. An increase in extreme precipitation is projected for areas of Coastal Oregon and can result in a greater risk of flooding in certain basins, including an increased incidence of magnitude and return intervals. Landslides in Oregon are strongly correlated with rainfall, so increased rainfall, particularly extreme events, will likely trigger more landslides.

Overall, climate change forces communities to reconsider their long held belief that the past natural hazard trends sufficiently predict future natural hazards. As the climate shifts floodplain boundaries will change, new areas of coast may begin to erode, and existing hazard may change in frequency and magnitude.

[6] Northwest Climate Assessment Report (NWCAR, 2013) *http://occri.net/reports*

Strategies for Risk Mitigation: Regulatory and Non-Regulatory

Programs and policies discussed in this report can be divided into two major subgroups: regulatory (non-voluntary), or non-regulatory (voluntary). This section describes the functional differences between regulatory and non-regulatory risk mitigation strategies and provides a high-level summary of strategies currently employed by Tillamook County.

Regulatory

Regulatory strategies are written instruments containing enforceable rules. They create and constrain rights, duties, and responsibilities. In the case of the Tillamook County Land Use Ordinance, developments within County jurisdiction must gain regulatory approval and abide by the constraints put forth within. Enforcement can be either proactive – requiring a development plan to meet certain standards before construction may begin; or reactive – requiring an inspector to ensure that a development is compliant with relevant regulations.

The broad goal of development codes is to protect the public health, safety and welfare and to provide developers and landowners with transparent rules that reduce the risks associated with development in natural hazard areas. Regulatory natural hazards mitigation strategies discussed in this report are enforceable elements of the Tillamook County Land Use Ordinance that dictate the location and characteristics of future development activity.

Regulatory policy options presented in this report are based upon model ordinances, best practices, and case studies, and relevant sections of development codes from jurisdictions that have addressed natural hazard risks similar to those of Tillamook County.

The Role of Land Use Planning in Hazard Mitigation

Land use planning guides and regulates land use so as to ensure land development is efficient, ethical, and prevents conflicts. By regulating the actions of property owners and developers, land use planning has a decisive influence on development patterns. Often, the most desirable lands for residential development are also the most hazardous. Development along coastal lands is popular for its favorable views and convenient water access. However, it places homes at a greater risk for flood, coastal erosion, strong wind, and tsunami damage. Likewise, forest-urban interface areas are ideal for residents seeking privacy and access to wooded areas, but there is an elevated risk of wildfire and landslide damage.

Land use planning can shape development in ways that mitigate risk by prescribing regulatory provisions to types of land that are exposed to the risks of natural hazards. Development codes can prohibit development in dangerous locations or regulate development in a manner that minimizes risk.

A key consideration is that land use plans and their implementing ordinances come into effect at the time of a land use action. The implication is that they only apply to development that is subject to the regulation. Most ordinances do not apply retroactively; existing uses are “grandfathered” in and are often not subject to new regulation.

Non-Regulatory

Non-regulatory tools serve as guidance rather than law, and they are often used to complement regulatory policies. These tools rely on voluntary efforts and public support. They can increase awareness and buy-in to programs and are often developed to increase the effectiveness of regulations through education, outreach, incentives, or interagency coordination.

Non-regulatory strategies to mitigate natural hazards are not dependent upon government oversight, but are achieved primarily through public and community participation. Non-regulatory strategies may rely on the county government for financial and structural support.

Natural Hazards Mitigation Plan

Natural Hazards Mitigation Plans are a planning requirement for local governments to access funds from the Disaster Mitigation Act of 2000. State natural hazard mitigation plans are required before local governments can access federal funds. Oregon completed a statewide hazard mitigation plan that was last amended and adopted in 2015. Tillamook County last updated their natural hazards mitigation plan in 2012 and is currently in an update process. Although the plan is required for pre-disaster funding, its contents are non-regulatory in nature. Rather, it sets forth voluntary goals, objectives, and actions that can increase disaster preparedness or decrease recovery time.

The aim of the NHMP is to promote sound public policy designed to protect citizens, critical facilities, infrastructure, private property, and the environment from natural hazards. This can be achieved by increasing public awareness, documenting the resources for risk reduction and loss-prevention, and identifying activities to guide the county towards building a safer, more disaster resistant community. The NHMP is intended to serve many purposes.

The actions described in the NHMPs are designed for implementation through existing plans and programs within each jurisdiction.

Policy Options Matrix

The following matrices list each policy option listed in this document, with a condensed breakdown of applicable county code, a description of the policy option, and the issues each policy option addresses.

Table 2: Flood Policy Options Matrix

Comprehensive Plan			
Policy Option	**Applicable Code**	**Implication**	**Implementation**
Provide stronger policy language related to the use of Wetlands as a flood conveyance option	Goal 5, Section 1.3b.3 Wetlands	Including language stating that the County intends to keep wetlands clear of development, fill, and obstructions, future flooding events can be better mitigated.	Include in Tillamook County's Comprehensive Plan Update Process
Update Finding and Policies section of Goal 7 to reflect data and findings from new FIRM/FIS and Risk Report	Goal 7, Section 2.5 Flood Findings and Policies	Preliminary Flood Insurance Rate Maps (FIRM)/ Flood Insurance Study (FIS) for the county will be available in summer 2016. The FIS and FIRMs are expected to become effective in Fall 2017. Comprehensive Plan and Flood Ordinance updates to reflect the updated FIS and FIRMs should follow.	Include in Tillamook County's Comprehensive Plan Update Process
Adopt Policies and Findings that result from NMFS Biologiol Opinion and DLCD model language related to National Flood Insurance Program	Goal 17, Section 4.2 Shoreland Development	Based on the BiOp, FEMA will be setting new minimum requirements for local floodplain development ordinances based on federal requirements to protect endangered species.	Tillamook County should work closely with FEMA, the Department of Land Conservation and Development (DLCD), and NMFS to understand and enforce standards set forth by this policy change. DLCD expects to provide guidance and model codes and to provide technical assistance.
Land Use Ordinance			
Effected Areas/Communities	**Neskowin and Pacific City**		
Policy Option	**Applicable Code**	**Implication**	**Implementation**
Update Land Use Ordinance Methods Language	Section 3.510 Flood Hazard Overlay Zone (FH)	CPW recommends adding a methods section in order to provide more detail related to the rationale for development standards and an overview of mitigation strategies.	Amend Flood Hazard Overlay standards in Tillamook County Land Use Ordinance
Adopt updated FIRM/FIS	Section 3.510(2) Flood Hazard Overlay Zone (FH)	Preliminary Flood Insurance Rate Maps (FIRM)/ Flood Insurance Study (FIS) for the county will be available in summer 2016. The FIS and FIRMs are expected to become effective in Fall 2017. Comprehensive Plan and Flood Ordinance updates to reflect the updated FIS and FIRMs should follow.	Review updated FIRM/FIS beginning in late 2016. Adopt updated version in 2017.
Cumulative Substantial Improvements	Section 3.510(4) Flood Hazard Overlay Zone (FH)	Currently substantial improvement is calculated cumulatively over a five-year period. Increasing the calculation period to ten years may provide additional assurance that improved structures are flood resistant (the CRS allocates 20 points for such a policy).	Amend Flood Hazard Overlay standards in Tillamook County Land Use Ordinance
Development Limitation - Use of Fill	Section 3.510(13)(b) Flood Hazard Overlay Zone (FH)	Tillamook County currently discourages the use of fill in the Flood Hazard Zone but will still allow its use under certain conditions. By fully prohibiting the use of fill in the flood hazard areas, communities can earn up to 280 points.	Amend Flood Hazard Overlay standards in Tillamook County Land Use Ordinance
Development Limitation - Probihition of Building Types	Section 3.510(13)(b) Flood Hazard Overlay Zone (FH)	Prohibition of buildings within the floodplain is the highest regulatory practice the County can take to limit the risk to life and property from flooding. CRS awards 1,000 points to communities that place Development Limitations to prohibit all buildings within the floodplain, points are prorated if a jurisdiction prohibits some development, such as residences.	Amend Flood Hazard Overlay standards in Tillamook County Land Use Ordinance
Development Limitation - Protection of Critical Facilities	Section 3.510(13)(b) Flood Hazard Overlay Zone (FH)	Tillamook County currently does not include a provision for the protection of critical facilities. Protection of critical facilities from flood damage awards 80 points. For CRS credit purposes, critical facilities are defined in Section 120 of the CRS Coordinator's Manual.	Amend Flood Hazard Overlay standards in Tillamook County Land Use Ordinance
Development Limitation - Enclosure Limits	Section 3.510(13)(b) Flood Hazard Overlay Zone (FH)	Prohibit the enclosure of property below base flood elevation, particularly in V-zones.	Amend Flood Hazard Overlay standards in Tillamook County Land Use Ordinance

Source: Community Service Center

Table 3: Tsunami Policy Options Matrix

Comprehensive Plan			
Policy Option	**Applicable Code**	**Implication**	**Implementation**
Update Finding section of Goal 7 to reflect data and finding from the Risk Report	Goal 7, Section 2.6 Tsunami (Seismic Waves) Findings and Policies	Provide Findings that reflect current science on tsunami in unincorporated Tillamook County	Include in Tillamook County's Comprehensive Plan Update Process
Include additional Policies within Goal 7 to reflect proposed Tsunami Hazard Overlay Zone	Goal 7, Section 2.6 Tsunami (Seismic Waves) Findings and Policies	Utilize the Comprehensive Plan to inform the process of development standards to be implemented in the Land Use Ordinance	Include in Tillamook County's Comprehensive Plan Update Process
Land Use Ordinance			
Effected Areas/Communities	**Neskowin and Pacific City**		
Policy Option	**Applicable Code**	**Implication**	**Implementation**
Create a new Tsunami Hazard Overlay Zone	3.500 Tsunami Hazard Overlay Zone (proposed)	There is currently no mitgation policy or standards directly related to tsunami in the Tillamook County Land Use Ordinance. The creation of a Tsunami Hazard Overlay, not only provides citizens with standards to use to protect them from tsunami inundation but also raises awareness of the risks associated with developing in a tsunami inundation area.	Use the DLCD Tsunami Land Use Guide's model ordinance to create the standards for the new Tsunami Hazard Overlay.
Require a Tsunami Hazard Development Permit	3.500 Tsunami Hazard Overlay Zone (proposed)	A Tsunami Hazard Area permit provides site and development specific hazard analysis and details engineering requirements to minimize the risk posed by coastal hazards.	Require for all new development in the proposed 3.500 Tsunami Hazard Overlay Zone
Prohibit Essential/Hazardous Facilities within the Tsunami Hazard Overlay	3.500 Tsunami Hazard Overlay Zone (proposed)	By locating essential facilities outside of the Tsunami Hazard Overlay, there is a higher likelihood of these facilities being available to serve those in need post-tsunami event.	Include this provision as part of the proposed 3.500 Tsunami Hazard Overlay Zone
Allow for the use of Flexible Development Options	3.500 Tsunami Hazard Overlay Zone (proposed)	Allow for greater flexibility and encourage development designs that incorporate evacuation measures, appropriate building siting, and other features that reduce the risks to life and property from tsunami hazard.	Include this provision as part of the proposed 3.500 Tsunami Hazard Overlay Zone

Source: Community Service Center

Table 4: Coastal Erosion Policy Options Matrix

Comprehensive Plan			
Policy Option	**Applicable Code**	**Implication**	**Implementation**
Update Finding and Policies section of Goal 7 to reflect data and finding from the Risk Report	Goal 7, Section 2.4 Erosion - Findings and Policies	Provide Findings and Policies that reflect current science on coastal erosion in unincorporated Tillamook County	Include in Tillamook County's Comprehensive Plan Update Process
Update the inventory and mapping of coastal erosion to reflect the finding of the Risk Report and DOGAMI mapping efforts.	Goal 18, Beaches and Dunes Element 4 Coastal Erosion	Provide up-to-date mapping of the extent and severity of the risk posed by coastal erosion in unincorporated Tillamook County.	Include in Tillamook County's Comprehensive Plan Update Process
Land Use Ordinance			
Effected Areas/Communities	**Neskowin and Pacific City**		
Policy Option	**Applicable Code**	**Implication**	**Implementation**
County Wide Coastal Hazards Overlay Zone	3.500 Countywide Coastal Hazards Overlay Zone (proposed)	Provide consistent coastal hazard development regulations for all of unincorporated Tillamook County.	The overlay zone should combine the High Hazard and Medium Hazard zones from the DOGAMI OFR O-14-02 into a single regulatory trigger zone.
Coastal Hazard Area Permit	3.500 Countywide Coastal Hazards Overlay Zone (proposed)	Require a permit containing site specific analysis of natural hazards and mitigation of risks to these hazards.	Require for all new development in the proposed 3.500 Countywide Coastal Hazards Overlay Zone
Bluff-Backed Shoreline Setback	3.500 Countywide Coastal Hazards Overlay Zone (proposed)	Utilize a scientifically determined setback for bluff-backed shoreline development.	Require for all new development in the proposed 3.500 Countywide Coastal Hazards Overlay Zone
Moveable Structure Design	3.500 Countywide Coastal Hazards Overlay Zone (proposed)	Require that building design allow structures to be relocated further back or even off site in the event of significant coastal erosion.	Require for all new development in the proposed 3.500 Countywide Coastal Hazards Overlay Zone
New Infrastructure Requirement	3.500 Countywide Coastal Hazards Overlay Zone (proposed)	Require that new infrastructure be located as far inland as possible to protect it from coastal erosion.	Require for all new development in the proposed 3.500 Countywide Coastal Hazards Overlay Zone
Hazard Disclosure and County Liability Waiver	3.500 Countywide Coastal Hazards Overlay Zone (proposed)	Require property owners to acknowledge risk and to waive county liability for the effects of a natural hazard.	Require for all new development in the proposed 3.500 Countywide Coastal Hazards Overlay Zone
Safest Site Requirement	3.500 Countywide Coastal Hazards Overlay Zone (proposed)	Require that structures be located on the safest part of a site as determined by a certified engineering geologist.	Require for all new development in the proposed 3.500 Countywide Coastal Hazards Overlay Zone
Subdivision Standards	3.500 Countywide Coastal Hazards Overlay Zone (proposed)	Prevent the creation of new lots or parcels that do not contain an area of buildable land outside of high coastal hazard risk areas.	Require for all new development in the proposed 3.500 Countywide Coastal Hazards Overlay Zone
Residential Density Limitations	3.500 Countywide Coastal Hazards Overlay Zone (proposed)	Prevent new residential development in areas of preexisting development that are susceptible to high coastal hazard risk.	Require for all new development in the proposed 3.500 Countywide Coastal Hazards Overlay Zone
Erosion Control and Stormwater Management	3.500 Countywide Coastal Hazards Overlay Zone (proposed)	Provide erosion control and stormwater management standards to decrease the impact of new development on coastal erosion.	Require for all new development in the proposed 3.500 Countywide Coastal Hazards Overlay Zone

Source: Community Service Center

Table 5: Landslide Policy Options Matrix

Comprehensive Plan			
Policy Option	Applicable Code	Implication	Implementation
Adopt DOGAMI's landslide susceptibility index to determine the specific locations that will be impacted by regulatory landslide mitigation actions	Landslides- Findings and Policies Goal 7, 2.1	Accurately identify areas susceptible to landslide	Include during Comprehensive Plan Update process.
Land Use Ordinance			
Effected Areas/Communities	Oceanside/Netarts and Neskowin		
Policy Option	Applicable Code	Implication	Implementation
Geologic Hazard Overlay Zone	3.500 Geologic Hazard Overlay (proposed)	Provide consistent geologic hazard development regulations for all of unincorporated Tillamook County.	Require for all new development in the proposed 3.500 Geologic Hazards Overlay Zone
Development Requirements for Geologic Hazard Areas	3.500 Geologic Hazard Overlay (proposed)	Require a site specific analysis of geologic hazards through a geologic assessment or report.	Require for all new development in the proposed 3.500 Geologic Hazards Overlay Zone
Geologic Hazard Point-Based Assessment System	3.500 Geologic Hazard Overlay (proposed)	Provide appropriate level of site specific hazard analysis based on prexisiting geologic condition and the type of development.	Require for all new development in the proposed 3.500 Geologic Hazards Overlay Zone
Buffer Zone Requirement	3.500 Geologic Hazard Overlay (proposed)	Utilize a geologic engineer to determine buffer requirements in highly susceptible areas.	Require for all new development in the proposed 3.500 Geologic Hazards Overlay Zone
Revegetation Standards	3.500 Geologic Hazard Overlay (proposed)	Provide standards for revegetation of steep sloes to mitigate increases in geologic hazard risk.	Require for all new development in the proposed 3.500 Geologic Hazards Overlay Zone
Non-Regulatory Geologic Hazard Abatement District	N/A	Provides citizens with a non-regulatoy tool for protecting structures and people from the risk of geologic hazards.	Require for all new development in the proposed 3.500 Geologic Hazards Overlay Zone

Source: Community Service Center

Table 6: Wildfire Policy Options Matrix

Comprehensive Plan			
Policy Option	Applicable Code	Implication	Implementation
Adopt Northwest Inter-Agency Fire Prevention Group guide fire safety measures	Forest Lands Fire Protection- Goal 4, Section 4.10	Uphold stringent requirements for proposed development within the Fire zone	Include during Comprehensive Plan Update process.
Land Use Ordinance			
Effected Areas/Communities	Blaine, Cloverdale, Oceanside/Netarts		
Policy Option	Applicable Code	Implication	Implementation
Firewise Standards or Firewise Recognition	N/A	Provide a voluntary approach to mitigating the risk posed by wildfire	Require for all new development in the proposed 3.500 Wildfire Hazard Overlay
Wildfire Hazard Overlay	Section 3.500 Wildfire Hazard Overlay (proposed)	Provide consistent wildfire hazard development regulations for all of unincorporated Tillamook County.	Require for all new development in the proposed 3.500 Wildfire Hazard Overlay
Class A Roofing Material Requirment	Section 3.500 Wildfire Hazard Overlay (proposed)	Protect structures from wildfires by requiring the highest fire-resistance roofing material to be used for all new development	Require for all new development in the proposed 3.500 Wildfire Hazard Overlay
Road Identification and Address Marking Requirment	Section 3.500 Wildfire Hazard Overlay (proposed)	Require that buidlng be easily locatable in the even of a wildfire event to protect people and property	Require for all new development in the proposed 3.500 Wildfire Hazard Overlay
Fire Protection Proof for Subdivision Requirment	Section 3.500 Wildfire Hazard Overlay (proposed)	Require proof of fire protection for a fire district to protect new development from the risk of wildfire	Require for all new development in the proposed 3.500 Wildfire Hazard Overlay
Wildland Fire Hazard Assessment	Section 3.500 Wildfire Hazard Overlay (proposed)	Conduct a site specific analysis of wildfire risk to determine appropriate mitigation strategies.	Require for all new development in the proposed 3.500 Wildfire Hazard Overlay

Source: Community Service Center

Table 7: Sand Inundation Policy Options Matrix

Comprehensive Plan			
Policy Option	**Applicable Code**	**Implication**	**Implementation**
Identify that sand inundation occurs throughout Pacific City not just along Sunset Drive.	Goal 18 Beaches and Dunes 2.2b, Active Foredunes (FDA)	Accurately identify the extend of sand inundation in Pacific City.	Include during Comprehensive Plan Update process.
Acknowledge the existing Pacific City Foredune Management Plan	Goal 18 Beaches and Dunes 3., Foredune Management	The Comprehensive Plan should reflect all existing foredune grading plans and allowances.	Include during Comprehensive Plan Update process.
Identify the need for dune management studies in Pacific City and Nedonna Beach to undergo a review and update process.	Goal 18 Beaches and Dunes 3.3, Foredune Management Policies	The Pacific City and Nedonna Beach dune management studies are over 15 years old and the dynamic nature of dunes necessitates an review and update to these studies.	Include during Comprehensive Plan Update process.
Land Use Ordinance			
Effected Areas/Communities	**Neskowin and Pacific City**		
Policy Option	**Applicable Code**	**Implication**	**Implementation**
Update beach and dune landform maps	Section 3.530 Beach and Dune Overlay (BD) (2)(a) Foredune Grading	Beach and dune landforms are dynamic and the current referenced report was conducted in 1975, there is a need up-to-date GIS maps of beach and dune landforms should be developed to consistently and accurately apply overlay requirements	Possible funding is through FEMA and the actual mapping should be conducted by DOGAMI.
Foredune Management Plans for all areas of sand inundation	Section 3.530 Beach and Dune Overlay (BD) (2)(a) Foredune Grading	Foredune management plans should be created for Tierra del Mar and Neskowin and the existing plans for Pacific City and Nedonna Beach should be reviewed and updated.	Funding for Foredune Management Plans can come in part from the affected areas and communities, but outside financial assistance will also be required.
Grading type specific permits	Section 3.530 Beach and Dune Overlay (BD) (4)(C.)(2) Foredune Grading	Tillamook County should restructure and strengthen its grading permit specification and process to provide clear requirements based on the type of grading that is occurring.	Restructure and clarify the Foredune Grading section of the Land Use Ordinace
Foredune grading definitions	Section 3.530 Beach and Dune Overlay (BD) (4)(C.)(2) Foredune Grading	Provide clear definitions that distinguish between view grading, preventive grading, remedial grading, and infrastructure grading.	Restructure and clarify the Foredune Grading section of the Land Use Ordinace
Foredune grading plan requirements	Section 3.530 Beach and Dune Overlay (BD) (4)(C.)(2) Foredune Grading	Provide foredune grading plan requiriments within a disctinct and easy to read section of the code.	Restructure and clarify the Foredune Grading section of the Land Use Ordinace
Foredune grading plan decision criteria	Section 3.530 Beach and Dune Overlay (BD) (4)(C.)(2) Foredune Grading	Provide foredune grading plan decision critieria within a disctinct and easy to read section of the code.	Restructure and clarify the Foredune Grading section of the Land Use Ordinace
Foredune grading permit conditions	Section 3.530 Beach and Dune Overlay (BD) (4)(C.)(2) Foredune Grading	Provide foredune grading permit conditions within a disctinct and easy to read section of the code.	Restructure and clarify the Foredune Grading section of the Land Use Ordinace
Remedial/infrastructure grading plan requirements	Section 3.530 Beach and Dune Overlay (BD) (4)(C.)(2) Foredune Grading	Provide remedial/infrastructure grading plan requiriments within a disctinct and easy to read section of the code.	Restructure and clarify the Foredune Grading section of the Land Use Ordinace

Source: Community Service Center

CHAPTER 3: FLOOD

This chapter identifies the risk coastal erosion poses to unincorporated Tillamook County, the extent of risk, and the rate and location of development affected by flood. Following are policy options the county can consider to strengthen the Tillamook County Comprehensive Plan, Land Use Ordinance, and Land Division Ordinance. Policy options are presented with descriptions of best practices, identification of the applicable county code sections, and details of economic, administrative, health, or environmental impacts of implementing the policy.

Extent of Risk

Floods are naturally occurring phenomena that can and do happen almost anywhere. In its most basic form, a flood is an accumulation of water over normally dry areas. Floods become hazardous to people and property when they inundate an area where development has occurred, causing losses. Severe flood losses can destroy buildings, crops, and cause severe injuries or death. Floods represent the most common of the natural hazard threats in Tillamook County. Floods in Tillamook County have created public health hazards, public safety concerns, closed and damaged major highways, destroyed railways, damaged structures, and caused major economic disruption. Tilllamook County is susceptible to two different types of flooding. Riverine flooding affects development along many of the riverbanks within the county, and due to its location along the Pacific Ocean, a significant portion of the county is exposed to coastal flooding. The preliminary flood insurance rate maps (FIRMs), flood insurance study (FIS), and database will be available on FEMA's Map Service Center website at: *https://msc.fema.gov/portal/advanceSearch* or *www.fema.gov/preliminaryfloodhazarddata*. Once the data is final you may also find them on the Oregon Risk MAP website at: *http://www.oregonriskmap.com*.

Development in Hazardous Areas

The Tillamook County Multi-Hazard Risk Report estimates four probabilities of riverine flooding based on recurrence intervals of a 10-year (10%), 50-year (2%), 100-year (1%), and 500-year (.2%) events. The draft Risk Report also estimates losses based on the 100-year (1%) coastal flooding event. Because data is available for both riverine and coastal flooding at the 1% chance, loss estimation statistics for this event are used. A 1% annual flood corresponds to the chance that a 100-year flood event occurs each year. A 100-year flood could have many times within a short period of time or longer than 100-years apart. The countywide exposure to a 1% flooding exposure totals approximately $290 million. A large portion of this building value is located within unincorporated Tillamook County, with value exposure over $217 million. Two essential facilities are exposed to a 1% annual flood event, the Nestucca Fire and Rescue Station #87 and Pacific City Fire Station #82.

Existing Programs and Resources

National

National Flood Insurance Program (NFIP)

The NFIP provides affordable flood insurance to homeowners, business owners, and renters in participating communities. In exchange, those communities must adopt and enforce minimum floodplain management regulations to reduce the risk of damage from future floods.

Community Rating System (CRS)

Within the NFIP, CRS is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. Flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community's higher regulatory standards.

State

Statewide Planning Goal 5: Natural Hazards

The purpose of Goal 5 is to protect natural resources and conserve scenic and historic areas and open spaces. Local governments shall adopt programs that will protect natural resources and conserve scenic, historic, and open space resources for present and future generations. These resources promote a healthy environment and natural landscape that contributes to Oregon's livability. Related to flood specifically, Goal 5 removes wetlands from developments due to their flood conveyance properties.

Statewide Planning Goal 17: Coastal Shorelands

The purpose of Goal 17 is to reduce the hazard to human life and property, and the adverse effects upon water quality and fish and wildlife habitat, resulting from the use and enjoyment of Oregon's coastal shorelands. Programs to achieve these objectives shall be developed by local, state, and federal agencies having jurisdiction over coastal shorelands. Land use plans, implementing actions and permit reviews shall include consideration of the critical relationships between coastal shorelands and resources of coastal waters. Related to flood, the management of uses and development in floodplain areas should be expanded beyond the minimal considerations necessary to comply with the National Flood Insurance Program.

Division of State Lands Fill and Removal Permit

The purpose of Oregon´s 1967 Removal-Fill Law (ORS 196.795-990) is to protect public navigation, fishery and recreational uses of the waters. "Waters of the state" are defined as "natural waterways including all tidal and non-tidal bays, intermittent streams, constantly flowing streams, lakes, wetlands and other bodies of water in this state, navigable and non-navigable, including that portion of the Pacific Ocean that is in the boundaries of this state." The law applies to all landowners, whether private individuals or public agencies.

The Oregon Plan for Salmon and Watersheds

The Oregon Plan for Salmon and Watersheds organized specific actions - called "measures" - around the factors that contributed to the decline in fish populations and watershed health. Most of these focus on actions to improve water quality and quantity and habitat restoration. Landowners and other private citizens, community organizations, interest groups, and all levels of government came together to organize, fund, and implement these measures. Watershed councils and soil and water conservation districts have led efforts in many watersheds.

Oregon's Wetlands Protection Program

The Oregon Wetland Protection Program is designed to focus wetland protection and restoration work in a strategic way, and communicate long- and short-term objectives to the Environmental Protection Agency and others. The plan was developed under a 2010 EPA development grant, and was approved for the 2011-2016 period. It is the first such plan to be approved in EPA Region 10.

County

Flood Hazard Overlay

The purpose of the Flood Hazard zone to promote the public health, safety, and general welfare and to minimize public and private losses or damages due to flood conditions in specific areas. The overlay lays out specific standards and regulations to guide development that falls within the flood hazard area to help mitigate potential damage.

Comprehensive Plan Review

Tillamook County's Comprehensive Plan provides the framework for the existing flood mitigation actions. This section identifies how the hazard has been included in the comprehensive plan and suggests ways to strengthen and improve its inclusion in support of mitigation strategies.

Wetlands: Goal 5, Section 1.3b.3

Tillamook County has adopted regulations to assist in preventing future flood damage. The Comprehensive Plan outlines policies to achieve this goal. The key to these regulations is the reservation of a flood conveyance area that is kept free of buildings, fill and other obstructions. The policy outlined in this section of the comprehensive plan provides rationale for the County to hold land from development within the floodway.

CSC Comment: This is a significant best practice in mitigating the risk to people and property in the event of flooding. Flood conveyance areas were mapped from detailed engineering studies. An updated Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRMs) are being created through the Risk MAP program. A preliminary FIS and FIRMs will be available in summer 2016. Final versions of the FIS and FIRMs are expected to be complete and ready for adoption in 2017.

Flooding: Goal 7, Section 2.5

Policies specified in the Comprehensive Plan related to flood management are controlled under the Flood Hazard Overlay. The Comprehensive Plan dictates that areas identified in the FIRMs shall comply with the Flood Hazard standards. The plan further outlines the standards to be included in the Flood Hazard Overlay, stating that they should at least meet the minimum standards set forth by the National Flood Insurance Program (NFIP).

CSC Comment: DOGAMI Bulletin 74 referenced in the Comprehensive Plan was published in 1972 and is out of date. Weather patterns and development have changed flooding patterns in Tillamook County. Updated flood studies and maps should be incorporated in the comprehensive plan inventory to allow for a more accurate description of the hazard. The Flood Insurance Rate Map for Tillamook County is in the process of being updated and will be available for the County's review in late 2016 before it is formally adopted in 2017.

Shoreland Development: Goal 17, Section 4.2

New shoreland development, expansion, maintenance or restoration of existing development; or restoration of historic waterfront areas shall be sited, designed, constructed and maintained to minimize adverse impacts on riparian vegetation, water quality and aquatic life and habitat in adjacent aquatic areas, and to be consistent with existing hazards to life and property posed by eroding areas and flood hazard areas. To accomplish this the requirements of the NFIP shall be used to regulate development in flood hazard areas within coastal shorelands.

CSC Comment: Maintaining consistency in development policy related to flooding is crucial. The NFIP outlines *minimum requirements* for development within a flood hazard area. Local governments, participating in the NFIP, must use this a baseline regulatory framework, but are encouraged to impose stricter regulations based on need. The *Community Rating System Coordinator's Manual* (2013) offers a wealth of higher regulatory standards that could be implemented in Tillamook County, and is utilized to make policy recommendations later in this document.

Land Use Ordinance Policy Options

This section presents a toolbox of flood hazard mitigation strategies. Recommendations range from highly regulatory to incentive-based, and best practices are linked to specific case studies found in Appendix A**,** as appropriate. Within each strategy, best practices identified through policy analysis research form the basis for the recommendation. Location of applicable Land Use Ordinance sections related to the implementation of the strategy is identified and any model code language is presented for potential adoption. The implications of adoption are also discussed.

In the following section, model development code is **bold**.

For a complete list of the recommended comprehensive plan and land use ordinance policy options see Tables 2 through 7.

Methods for Reducing Flood Loses

Best Practice:

The Oregon Model Flood Damage Prevention Ordinance offers specific methods to be implemented in order to reduce flood loss. These help define how the county will accomplish the purpose of the flood ordinance.

Applicable Development Code:

Section 3.510 Flood Hazard Overlay Zone (FH)

Model Development Code:

Methods for Reducing Flood Losses

In order to accomplish its purposes, this ordinance includes methods and provisions for:

(1) Restricting or prohibiting uses which are dangerous to health, safety, and property due to water or erosion hazards, or which result in damaging increases in erosion or in flood heights or velocities;

(2) Requiring that uses vulnerable to floods, including facilities which serve such uses, be protected against flood damage at the time of initial construction;

(3) Controlling the alteration of natural flood plains, stream channels, and natural protective barriers, which help accommodate or channel flood waters;

(4) Controlling filling, grading, dredging, and other development which may increase flood damage;

(5) Preventing or regulating the construction of flood barriers which will unnaturally divert flood waters or may increase flood hazards in other areas.

(6) Coordinating and supplementing the provisions of the state building code with local land use and development ordinances.

Implication for Tillamook County:

This section of model code language matches the *Oregon Model Flood Damage Prevention Ordinance*[7]. However, immediately following this section, the model ordinance offers more specific methods for reducing flood losses. This section is

[7] *Oregon Model Flood Damage Prevention Ordinance*, Department of Land Conservation and Development. 2014 *https://www.oregon.gov/LCD/HAZ/docs/Flood_model_ordinance_01_14.pdf*

included below in order to outline the methods and provisions demonstrating how the County could reduce loss to flooding events. The methods section differs from the General Standards section that already exists in the Tillamook County Land Use Ordinance in that it provides more detail related to the rationale for development standards and provides an overview of mitigation strategies.

Update and Adopt FIS and FIRMs

Best Practice:

A Flood Insurance Study (FIS) is an in depth scientific report that details factors catalytic to flooding, flood patterns, and floodplain changes over time. The Flood Insurance Rate Map (FIRM) is the geographic representation of the FIS and shows, on a map, where the floodplain exists. Updated preliminary versions will be available in summer 2016. After a period of review by the County, the FIS and FIRMs are expected to become effective in 2017. Comprehensive Plan and Flood Ordinance updates to reflect the updated FIS and FIRMs should follow.

Applicable Development Code:

Section 3.510(2) Flood Hazard Overlay Zone

Implication for Tillamook County:

The use of current Flood Insurance Rate Maps (FIRMs) is a best practice as identified by FEMA. These maps represent the most detailed data available for the coast and Tillamook County. Preliminary Flood Insurance Rate Maps (FIRM) and updated Flood Insurance Study (FIS) for the county will be available in summer 2016. The FIS and FIRMs are expected to become effective in Fall 2017. Comprehensive Plan and Flood Ordinance updates to reflect the updated FIS and FIRMs should follow.

Cumulative Substantial Improvements

Best Practice:

Improvements to a property within the Flood Hazard Overlay Zone are subject to standards of this zone only if the improvements account for 50% or more of the property's value. Currently, this is calculated cumulatively over a five-year period. Extending this period to 10 years would bring more properties into land use code review to ensure compliance with existing standards.

Applicable Development Code:

Section 3.510(4) Flood Hazard Overlay Zone

Implication for Tillamook County:

The Tillamook County Land Use Ordinance allows, improvements to structures valued at up to 50% of the structure's pre-improvement value located in the Flood

Hazard Overlay to be permitted without needing to meet the current flood protection requirements. Improvements are calculated cumulatively over a five-year period. Under current standards a property owner could make a 49% improvement every 5 years and not be required to abide by Flood Hazard Overlay standards (potentially greatly increasing the size of the structure and its impact upon the flood hazard and community). Increasing the cumulative time frame from five to 10 years has the effect of requiring more structures to come into compliance if the owners want to improve them or if they are damaged.

The existing requirement would net Tillamook County 20 Community Rating System (CRS) points. However, an additional 20 points can be earned if the time frame for improvements is increased from five years to 10 years. Another 20 points can be earned if the Land Use Ordinance defines "reconstruction" to include substantially damaged structures as defined in Section 430-18 of the *CRS Coordinators Manual*[8].

Development Limitations - Fill

Best Practice:

The use of fill to elevate buildings reduces floodplain storage capacity and has an adverse impact on native vegetation, wetlands, drainage, and water quality. Tillamook County currently allows the use of fill under certain conditions. The highest standard is to prohibit fil in order to preserve the integrity of the floodplain.

Applicable Development Code:

Section 3.510(13) Flood Hazard Overlay Zone

Implication for Tillamook County

Tillamook County currently discourages the use of fill in the Flood Hazard Zone but allows its use under certain conditions. The use of fill to elevate buildings has advantages that make it desirable for developers and homeowners. However, there are problems with using fill: it reduces floodplain storage capacity and it has an adverse impact on native vegetation, wetlands, drainage, and water quality. The best practice as stated in the *CRS Coordinator's Manual* Development Limitations (DL) (430-6&7), is to outright prohibit the use of this type of development. By fully prohibiting the use of fill in the flood hazard areas, communities can earn up to 280 points.

[8] Community Rating System Coordinator's Manual. National Flood Insurance Program. 2013 *http://www.fema.gov/media-library-data/1406897194816-fc66ac50a3af94634751342cb35666cd/FIA-15_NFIP-Coordinators-Manual_2014.pdf*

Development Limitation – Building Prohibition

Best Practice:

Jurisdictions have the option of prohibiting residential, nonresidential, essential facilities, or hazardous uses in flood hazard areas. Prohibition of buildings within the Special Flood Hazard Area (SFHA) is among the highest regulatory actions the County can take to limit the risk to life and property from flooding. A prohibition of this kind would reduce the number of structures that are subject to damage by a flooding event.

Applicable Development Code:

Section 3.510(13) Flood Hazard Overlay Zone

Implication for Tillamook County:

Because a complete prohibition on floodplain development is a significant best practice for flood risk mitigation, it would require heavy public consideration and support. The prohibition of all uses may not be feasible and special consideration should be taken to address which uses should be prohibited should the County choose to pursue this recommendation. The County may prefer to choose a less strict prohibition of uses, such as prohibiting only residential uses within the Special Flood Hazard Areas, or limiting the prohibition to the floodway. CRS awards 1,000 points to communities that place Development Limitations (DL) to prohibit all buildings within the Special Flood Hazard Area, but points will be prorated if the jurisdiction prohibits only certain types of buildings, such as residences, commercial, or warehousing. CRS points are also available should the County choose to prohibit structures within the regulatory floodway only.

Development Limitations – Prohibit Critical Facilities

Best Practice:

Generally, facilities that can aid in flood response or facilities that, if flooded, make the problem worse are considered critical facilities. These types of building uses should not be allowed to be built within flood hazard areas.

Applicable Development Code:

Section 3.510(13) Flood Hazard Overlay Zone

Implication for Tillamook County:

Other provisions to help comply with the CRS criteria include the protection of critical facilities from flood damage (Protection of Critical Facilities (PCF)). For CRS credit purposes, critical facilities are defined in Section 120 of the *CRS Coordinator's Manual*. There are usually two kinds of critical facilities that a community should address:

- Facilities that are vital to flood response activities or critical to the health and safety of the public before, during, and after a flood, such as a hospital, emergency operations center, electric substation, police station, fire station, nursing home, school, vehicle and equipment storage facility, or shelter.
- Facilities that, if flooded, would make the flood problem and its impacts much worse, such as a hazardous materials facility, power generation facility, water utility, or wastewater treatment plant.

Tillamook County code currently does not include a provision for the protection of critical facilities. Full credit is for a prohibition on new critical facilities in the 500-year floodplain. Inclusion of language to that end would net the County 80 CRS points.

Development Limitations – Enclosure Limits

Best Practice:

Enclosed sections of buildings that lay below the base flood elevation can significantly alter flood patterns, raise property owner insurance premiums, and put life and property at risk. Prohibition of these types of enclosures is a floodplain management best practice.

Applicable Development Code:

Section 3.510(13) Flood Hazard Overlay Zone

Implication for Tillamook County:

Tillamook County should consider placing regulatory standards on the enclosure of property below the base flood elevation to achieve have two objectives: 1) they protect the structural integrity of the building from wave action or hydrostatic pressure, and 2) they discourage property owners from finishing the area below the base flood elevation and storing valuable or hazardous items in that area. These regulations are particularly useful in V Zones and other coastal areas subject to wave damage and in places where projected flood depths result in lowest floors constructed eight (8) feet or more above grade. For the second objective, over time there is a tendency on the part of property owners to enclose the lower areas and convert them to bedrooms, family rooms, or other finished areas, in violation of floodplain management regulations. Regulatory standards to limit the development of these enclosures can accumulate CRS points for the County; a full 240 points are earned if regulations prohibit any building enclosures, including breakaway walls, below the base flood elevation.

Table 8: Summary Community Rating System Higher Standards Recommended for Tillamook County

CRS Higher Standard	*CRS Coordinator's Manual* Reference	Potential Points Scored
Cumulative Substantial Improvements (CSI)	432.d, Page 430-18	**20 points** can be earned if the time frame for improvements is increased from five years to 10 years. Another **20 points** can be earned if the Land Use Ordinance can better clarify if "reconstruction" includes substantially damaged structures.
Development Limitation - Use of Fill	432.a, Page 430-6	Up to **280 points** for fully prohibiting the use of fill in the flood hazard areas.
Development Limitation - Prohibition of Building Types	432.a, Page 430-6	**1,000 points** to communities that prohibit all buildings within the floodplain. Pro-rated if prohibiting only certain types of buildings, such as residences.
Development Limitation - Protection of Critical Facilities	432.f, Page 430-21	**80 points** for a prohibition on new critical facilities in the 500-year floodplain.
Development Limitation - Enclosure Limits	432.g, Page 430-23	**240 points** if regulations prohibit any building enclosures, including breakaway walls, below the base flood elevation.

Source: Community Service Center

Model Ordinance and Codes

The following model ordinances and standards were identified during research on flood mitigation. These documents have example language for specific mitigation strategies that could be implemented in Tillamook's development code.

Oregon Model Flood Damage Prevention Ordinance

This *Oregon Model Flood Damage Prevention Ordinance* was developed by the State of Oregon in cooperation with the Federal Emergency Management Agency (FEMA). This model companion ordinance incorporates by reference the Oregon Specialty Codes as adopted and administered by the Oregon Building Code Division.

Community Rating System Coordinator's Manual 2013

The Community Rating System (CRS) is a national program developed by the Federal Emergency Management Agency (FEMA). The *CRS Coordinator's Manual* spells out the credits and credit criteria of the CRS for community activities and programs that go above and beyond the minimum requirements for participation in FEMA's National Flood Insurance Program.

CHAPTER 3: TSUNAMI

This chapter identifies the risk coastal erosion poses to unincorporated Tillamook County, the extent of risk, and the rate and location of development affected by tsunami. Following are policy options the county can consider to strengthen the Tillamook County Comprehensive Plan, Land Use Ordinance, and Land Division Ordinance. Policy options are presented with descriptions of best practices, identification of the applicable county code sections, and details of economic, administrative, health, or environmental impacts of implementing the policy.

Extent of Risk

Tsunamis are rare and extremely large waves that are caused by undersea volcanic eruptions, landslides, or earthquakes. In a Cascadia Subduction Zone (CSZ) earthquake scenario, rapidly shifting sea floor along a fault transfers its energy to the ocean surface creating waves. As these waves travel into shallower water close to land, they increase in height and can cause extensive destruction along the coast and estuaries. The extent of risk to life and property from tsunami varies greatly and is dependent upon the size scenario of the tsunami and the amount of development that exists within the resulting inundation zone. The tsunami scenarios for exposure analysis used in the draft Risk Report were from local source CSZ events and represented by “t-shirt” sizes of small, medium, large, X large, and XX large. These tsunami scenarios are determined by analyzing different CSZ rupture locations and intensities in relation to Tillamook County. To view the Tsunami Inundation Maps for Tillamook County visit the DOGAMI website: *http://www.oregongeology.org/pubs/tim/p-TIM-overview.htm#TIMindexmap*.

Development in Hazardous Areas

Most development along the coast will experience extensive impact from a tsunami, and communities built along the bays and estuaries will be affected to a lesser extent. The most severe tsunami scenario event from a Cascadia Subduction Zone (CSZ) earthquake would affect all communities in the county as development in Tillamook County has predominately occurred within close proximity to the Pacific Ocean. Communities such as Rockaway Beach, Pacific City, and Neskowin are particularly vulnerable to tsunamis due to their low-lying coastal development. While tsunami hazards are unpredictable and cannot be prevented, steps can be taken to lessen the impact a tsunami event might have on the development of Tillamook County coastal communities.

The draft Risk Report includes an assessment of risk to development within tsunami inundation zones. The Risk Report indicates that during a Medium tsunami event, approximately 3,000 buildings, valued at approximately $328 million, are at risk of damage. This represents nearly half of all building value in unincorporated Tillamook County. The Medium tsunami event scenario is the event scenario that correlates with the earthquake scenario utilized in the Risk Report. For exposure and loss information for the other tsunami scenarios see the Risk Report.

Table 9: Extent of Risk to Medium Tsunami event in Tillamook County

Tsunami - CSZ Mag 9.0 – Medium					
Community	**Total number of buildings**	**Total estimated building value ($, in thousands)**	**Exposed Buildings**	**Building Value ($, in thousands)**	**Ratio of Exposure Value**
Unincorporated Tillamook (rural)	520	$ 46,924	1,692	$ 147,262	11%
Neskowin	268	$ 56,198	461	$ 81,824	69%
Oceanside - Netarts	62	$ 11,292	88	$ 15,432	8%
Pacific City	175	$ 15,825	806	$ 83,301	39%
Total	1,025	$ 130,239	3,047	$ 327,819	18%

Source: Risk Report, 2016 (modified by CSC), Table A-5.

The Risk Report indicates that during a Large tsunami event, approximately 4,400 buildings, valued at approximately $481 million, are at risk of damage. This represents nearly half of all building value in unincorporated Tillamook County. The large tsunami scenario is the most likely recommended to replace the existing SB 379 line. For exposure and loss information for the other tsunami scenarios see the Risk Report.

Table10: Extent of Risk to Large Tsunami event in Tillamook County

Tsunami - CSZ Mag 9.0 – Large					
Community	**Total number of buildings**	**Total estimated building value ($, in thousands)**	**Exposed Buildings**	**Building Value ($, in thousands)**	**Ratio of Exposure Value**
Unincorporated Tillamook (rural)	520	$ 46,924	2,548	$ 223,814	18%
Neskowin	268	$ 56,198	485	$ 86,960	73%
Oceanside - Netarts	62	$ 11,292	141	$ 21,433	11%
Pacific City	175	$ 15,825	1,252	$ 148,741	70%
Total	1,025	$ 130,239	4,426	$ 480,948	26%

Source: Risk Report, 2016 (modified by CSC), Table A-5.

Existing Programs and Resources

National

NOAA National Coastal Zone Management Program

The National Coastal Zone Management Program is a voluntary partnership between the federal government and 34 coastal, as well as Great Lakes, states. The program provides the basis for protecting, restoring, and responsibly developing our nation's diverse coastal communities and resources.

Administrative Grants

Under section 306 of the Coastal Zone Management Program 1:1 matching funding is provided for state program administration.

Coastal Resource Improvement Program

Up to half of state section 306 funding can be used for small-scale construction or land acquisition projects that enhance public access to the coastal, facilitate redevelopment of urban waterfronts, or preserve and restore coastal resources.

Coastal Zone Enhancement Grants

Under section 309 zero match funding is provided to states to enhance their coastal zone management programs in one or more areas of national significance.

Coastal Nonpoint Pollution Control Program (Technical Assistance)

Congress appropriates 1:1 matching funding to help state coastal zone managements programs.

State

Oregon Coastal Management Program

The Coastal Management Program was approved by NOAA in 1977 and is led by the Oregon Department of Land Conservation within a network of cooperating agencies that have authority in the coastal zone. The Oregon Land Use Planning Act and 19 statewide planning goals provide the primary authority for the coastal management program.

Oregon Senate Bill 379

The Oregon Tsunami Regulatory Maps, enacted in 1995 by Oregon Senate Bill 379, show a single tsunami inundation line on U.S. Geological Survey topographic maps. The official maps were created by DOGAMI and are used for implementation of Oregon Revised Statutes (ORS) 455.446 and 455.447, which limits, through the Oregon Building Code, construction of certain critical and essential facilities in the tsunami inundation zone. These regulatory maps are not intended for emergency evacuation purposes and do not necessarily represent tsunami inundation from a worst-case event. They show the best estimate of tsunami inundation from the most likely tsunami originating from an earthquake on the Cascadia subduction zone fault.

County

Comprehensive Plan Chapter 7 Section 2.6 Tsunami (Seismic Waves) – Finding and Policies

The tsunami section is the smallest section within Chapter 7 of Tillamook County's Comprehensive Plan. The sections within this chapter outline policies and findings related to the natural hazards impacted the county. Section 2.6 relates to tsunami and lists only one policy; that the county mitigate tsunami risk through use of the National Flood Insurance Program's minimum standards.

Comprehensive Plan Review

Tillamook County's Comprehensive Plan provides the framework for the existing tsunami mitigation actions. This section identifies how the hazard has been included in the comprehensive plan and suggests ways to strengthen and improve its inclusion in support of mitigation strategies.

Chapter 7 Section 2.6 Tsunami (Seismic Waves) – Finding and Policies

CSC Comment: The tsunami section represents the shortest section in the Goal 7 (Hazards) Chapter of the Tillamook County Comprehensive Plan. While this is likely due to the limited and unreliable tsunami data available at the time, federal, state and local agencies have produced updated maps, data, and reports related to tsunami risk and mitigation. Specifically, reports from FEMA, DOGAMI, and the DLCD can be used to better inform the "Findings" portion of this section, including updated harbor, bay, and estuary reactions and inundation predictions. Additionally, it's important to note that while flood and tsunami hazards are similar in nature, Tillamook County should not rely solely on its coastal flood zone regulations to mitigate tsunami risk. Policies outlined in the 2015 DLCD's *Preparing for a Cascadia Subduction Zone Tsunami: A Land Use Guide for Oregon Coastal Communities* can be used to supplement this section's current policies.

Land Use Ordinance Policy Options

This section presents a toolbox of tsunami hazard mitigation strategies. Recommendations range from highly regulatory to incentive-based, and best practices are linked to specific case studies found in Appendix A, as appropriate. Within each strategy, best practices identified through policy analysis research form the basis for the recommendation. Location of applicable Land Use Ordinance sections related to the implementation of the strategy is identified and any model code language is presented for potential adoption. The implications of adoption are also discussed.

In the following section, model development code is **bold**

For a complete list of the recommended comprehensive plan and land use ordinance policy options see Tables 2 through 7.

Tsunami Hazard Overlay Zone

Best Practice

Utilize an overlay zone based on the “large” tsunami event from the 2013 DOGAMI *Tsunami Inundation Scenarios for Oregon* (OFR O-13-19) to form a regulatory trigger zone.

Applicable Development Code:

3.500 Overlay Zones. A Tsunami Hazard Overlay does not exist in current code, this recommendation is to create a new overlay.

Model Code Language:

Purpose

The purpose of the Tsunami Hazard Overlay Zone is to increase the resilience of the community to a local source (Cascadia Subduction Zone) tsunami by establishing standards, requirements, incentives, and other measures to be applied in the review and authorization of land use and development activities in areas subject to tsunami hazards. The standards established by this section are intended to limit, direct and encourage the development of land uses within areas subject to tsunami hazards in a manner that will:

(a) Reduce loss of life;

(b) Reduce damage to private and public property;

(c) Reduce social, emotional, and economic disruptions; and

(d) Increase the ability of the community to respond and recover.

[…]

Implication for Tillamook County

Tillamook County should incorporate the model ordinance introduced by DLCD’s *Preparing for a Cascadia Subduction Zone Tsunami: A Land Use Guide for Oregon Coastal Communities.* The ordinance includes regulation related to inundation zone mapping and mitigation strategies. DOGAMI has produced Tsunami Inundation Maps (TIMs) that provide detailed information on the tsunami event scenarios described above and in the Risk Report. The Risk Report primarily provides exposure analysis for the “medium” TIM line (although there is information provided for other event scenarios in the appendices). The DLCD Land Use Guide recommends jurisdictions use the “large” Tsunami Inundation Map *(TIM-Till-1 through 14)* line to define its overlay zone boundary. DOGAMI is in the process of recommending that the “large” tsunami event scenario be used to inform the update of the Senate Bill 379 regulatory inundation line (this zone would then identify the area to which ORS 455 development restrictions apply). The DLCD Land

Use Guide provides code language the County can use to form standards, by which future development within this new overlay must comply.

Alternatively, as a higher regulatory action, the county could adopt the use of all five of the TIM scenarios ranging from small to XXlarge to create a “gradient” of development standards. This option would apply different regulations to developments depending upon which area they are located in. Development within the most probable/highest risk area (e.g., “small” scenario) would have a more strict set of regulations than a development within the less probable/ lower risk areas (e.g., “XXlarge” scenario).

Tsunami Hazard Development Permit

Best Practice:

A Hazard Acknowledgement and Disclosure Statement shall accompany all applications for new development or substantial improvements in the Tsunami Hazard Overlay Zone. Development shall be conditioned to require the recording of the required Hazard Acknowledgement and Disclosure Statement in the deed record.

Applicable Development Code:

3.500 Overlay Zones. Because a Tsunami Hazard Overlay does not exist in current code, this recommendation is to create a new overlay.

Model Code Language:

(a) All applications for new development or substantial improvements in the Tsunami Hazard Overlay Zone shall be accompanied by a Hazard Acknowledgement and Disclosure Statement, executed by the property owner, which sets forth the following:

(A) A statement that the property is subject to inundation by a local source Cascadia event tsunami, including the DOGAMI scenarios (S, M, L, XL, or XXL) that could potentially flood the site, and that development thereon is subject to risk of damage from tsunami;

(B) A statement that a local source tsunami poses a potential life safety threat to occupants of the property, and that the protection of life safety will require occupants to evacuate to high ground in the event of a local source tsunami; and

(C) A statement acknowledging that the property owner accepts and assumes all risks of damage from tsunami associated with the development of the subject property.

(b) Approval of new development or substantial improvements in the Tsunami Hazard Overlay Zone shall be conditioned to require the recording of the required Hazard Acknowledgement and Disclosure Statement in the deed records of [insert name of county].

Implication for Tillamook County:

A Tsunami Hazard Area permit provides site and development specific hazard analysis and details engineering requirements to minimize the risk posed by coastal hazard.

Prohibit Essential/Hazardous Facilities within the Tsunami Hazard Overlay

Best Practice:

Establish restrictions on the types of facilities within the Tsunami Hazard Overlay Zone. Specifically, facilities that are “essential” or “hazardous” should be prohibited within the tsunami inundation areas. Essential facilities are those that are critical to the response and recovery of an earthquake/-tsunami event. These may include but are not limited to: hospitals, fire and police stations, government communication centers, buildings with the capacity to hold 250+ individuals, large educational facilities, jails, and detention centers. Hazardous facilities are those facilities that, if damaged or destroyed, would only make the impacts of the disaster greater.

Applicable Development Code:

3.500 Overlay Zones. Because a Tsunami Hazard Overlay does not exist in current code, this recommendation is to create a new overlay.

Model Code Language:

(1) “Essential Facilities” means:

(a) Hospitals and other medical facilities having surgery and emergency treatment areas;
(b) Fire and police stations;
(c)Tanks or other structures containing, housing or supporting water or fire-suppression materials or equipment required for the protection of essential or hazardous facilities or special occupancy structures;
(d) Emergency vehicle shelters and garages;
(e) Structures and equipment in emergency preparedness centers;
(f) Standby power generating equipment for essential facilities; and
(g) Structures and equipment in emergency preparedness centers.

(2) “Hazardous facility” means structures housing, supporting or containing sufficient quantities of toxic or explosive substances to be of danger to the safety of the public if released.

Implication for Tillamook County:

Per the Risk Report, there are currently three essential facilities located within the medium tsunami inundation area. By locating essential facilities outside of the Tsunami Hazard Overlay, there is a higher likelihood of these facilities being available to serve those in need post-tsunami event.

It is also understood that due to restricted land availability, development costs, and level of service requirements for emergency services, locating these facilities outside of the tsunami inundation area may not be possible. In these cases, the County should consider imposing stricter standards to prohibit essential and hazardous facilities from being located within the "large" event scenario boundary (i.e., to identify as the area to which ORS development restrictions currently apply).

Flexible Development Option

Best Practice:

The County should consider providing incentives that encourage and promote site planning and development within the Tsunami Hazard Overlay that results in lower risk exposure to tsunami hazard than what would otherwise be achieved through established development standards. These incentives could include but are not limited to density bonuses, relaxed setback requirements, and clustering development in lower hazard risk areas of the parcel.

Applicable Development Code:

3.500 Overlay Zones. Because a Tsunami Hazard Overlay does not exist in current code, this recommendation is to create a new overlay.

Model Code Language:

a) The purpose of the Flexible Development Option is to provide incentives for, and to encourage and promote, site planning and development within the Tsunami Hazard Overlay Zone that results in lower risk exposure to tsunami hazard than would otherwise be achieved through the conventional application of the requirements of this chapter. The Flexible Development Option is intended to:

(A) Allow for and encourage development designs that incorporate enhanced evacuation measures, appropriate building siting and design, and other features that reduce the risks to life and property from tsunami hazard; and

(B) Permit greater flexibility in the siting of buildings and other physical improvements and in the creation of new lots and parcels in order to allow the full realization of permitted development while reducing risks to life and property from tsunami hazard.

Implication for Tillamook County:

Allow for greater flexibility and encourage development designs that incorporate evacuation measures, appropriate building siting, and other features that reduce the risks to life and property from tsunami hazard

Model Ordinance and Codes

The following model ordinances and standards were identified during research on tsunami mitigation. These documents have example language for specific mitigation strategies that could be implemented in Tillamook's development code.

Preparing for a Cascadia Subduction Zone Tsunami: A Land Use Guide for Oregon Coastal Communities[9]

The *land use guide* is designed to be tailored by communities to address their individual tsunami risk and location, and provides comprehensive information focused on land use planning approaches to reduce tsunami hazard risk and implement important land use resilience measures. The guidance includes sample tsunami related comprehensive land use plan text and policies, information on needed map amendments, a tsunami hazard overlay (THO) zone model to implement resilience measures, tsunami land use strategy financing and incentive concepts, and more.

Clatsop County Tsunami Overlay District

The Clatsop County Tsunami Hazard Overlay Project set forth to create a more concrete set of policies and standards for which types of development could, or could not, take place within the tsunami inundation zone. The Overlay Project used the *Land Use Guide for Oregon Coastal Communities* as a model to write its code language.

[9] Preparing for a Cascadia Subduction Zone Tsunami: A Land Use Guide for Oregon Coastal Communities, Accessed May 12, 2016
http://www.oregon.gov/LCD/OCMP/docs/Publications/TsunamiGuide20150407.pdf

CHAPTER 5: COASTAL EROSION

This chapter identifies the risk coastal erosion poses to unincorporated Tillamook County, the extent of risk, and the rate and location of development affected by coastal erosion. Following are policy options the county can consider to strengthen the Tillamook County Comprehensive Plan, Land Use Ordinance, and Land Division Ordinance. Policy options are presented with descriptions of best practices, identification of the applicable county code sections, and details of economic, administrative, health, or environmental impacts of implementing the policy.

Extent of Risk

Coastal erosion is a continuous process influenced by numerous variables including geologic, atmospheric, and oceanic factors. The Oregon Climate Change Research Institute (OCCRI) Northwest Climate Assessment Report (NWCAR, 2013) predicts that continued sea level rise and increased wave action along the Oregon coast will result in an overall increased risk from coastal erosion in the coming years and decades.[10] Coastal erosion poses a risk to property near the coastline both due to the gradual loss of sediment (a chronic problem) and from rapidly occurring landslides (an episodic problem). Erodible dune-backed and bluff-backed beaches make up 90% of the Tillamook County coastline making coastal erosion an extensive natural hazard.[11]

Development in Hazardous Areas

The Tillamook County Multi-Hazard Risk Report (2016, draft), hereafter Risk Report, indicates that there are 296 structures located within unincorporated Tillamook County within a high hazard coastal erosion zone with a total value of $62 million. There are an additional 207 structures within the very high hazard coastal erosion zone with a total value of $52 million. The unincorporated community of Neskowin has the highest ratio of building exposure within the moderate to very high coastal erosion susceptibility categories.

[10] Northwest Climate Assessment Report (NWCAR, 2013) Accessed June 1, 2016 *http://occri.net/reports*

[11] Appendix D: Adapting to Coastal Erosion Hazards in Tillamook County: FRAMEWORK PLAN Final Draft, June 10, 2011 Accessed June 1, 2016 *http://www.co.tillamook.or.us/gov/ComDev/documents/planning/Website Forms/Revised Neskowin Adaptation Plan 25Jun14.pdf*

Table 11: Coastal Erosion Exposure Analysis for Unincorporated Areas

Community/Area	Loss Ratio of Total Building Value*		
	Very High Hazard[1]	High Hazard[2]	Moderate Hazard[3]
Unincorporated County (rural)	1.0%	1.5%	2.6%
Neskowin	27.2%	28.8%	34.1%
Oceanside and Netarts	0%	0%	0%
Pacific City	2.8%	4.2%	9.3%
Total	**3.20%**	**3.80%**	**5.80%**

Source: Risk Report, 2016 (modified by CSC), Table A-7.
1. Mid-range estimate of 2030 sea level rise (SLR) along with 2% annual chance (50-year) storm total water level scenario.
2. Mid-range 2050 SLR along with the 2% annual chance storm total water level
3. Mid-range 2100 SLR along with the 1% annual chance (100-year) storm total water level

Per the Oregon Natural Hazards Mitigation Plan (Oregon NHMP) over the past five years Tillamook County's population increased by roughly 30% and the number of housing units increased by 40%. Population growth, unsurprisingly, was found to cluster around major corridors and waterways. Additionally, the *Adapting to Coastal Erosion Hazards in Tillamook County: Framework Plan (*2011) found that development pressures are often the highest for lands most vulnerable to coastal hazards.[12] This, in combination with the increasing population, indicate that new development will likely put more building value and people in areas susceptible to coastal erosion in the coming years.

Existing Policies and Programs

National

NOAA National Coastal Zone Management Program

The National Coastal Zone Management Program is a voluntary partnership between the federal government and 34 coastal, as well as Great Lakes, states. The program provides the basis for protecting, restoring, and responsibly developing our nation's diverse coastal communities and resources. Funding grant and program resources available through this program are identified below.

Administrative Grants

Under section 306 of the Coastal Zone Management Program 1:1 matching funding is provided for state program administration.

---

[12] Appendix D: Adapting to Coastal Erosion Hazards in Tillamook County: FRAMEWORK PLAN Final Draft, June 10, 2011

Coastal Resource Improvement Program

Up to half of state section 306 funding can be used for small-scale construction or land acquisition projects that enhance public access to the coastal, facilitate redevelopment of urban waterfronts, or preserve and restore coastal resources.

Coastal Zone Enhancement Grants

Under section 309 zero match funding is provided to states to enhance their coastal zone management programs in one or more areas of national significance.

Coastal Nonpoint Pollution Control Program (Technical Assistance)

Congress appropriates 1:1 matching funding to help state coastal zone managements programs.

FEMA Community Rating System (CRS) Credit for Management of Coastal Erosion Hazards

While the mapping and regulatory standards of NFIP program do not directly address coastal erosion, Tillamook County can receive points toward higher flood insurance premium reductions within the CRS by (1) informing the public about coastal erosion hazards, (2) mapping and regulating the coastal erosion hazard, (3) special structural and nonstructural coastal erosion mitigation, and (4) through special emergency preparedness efforts specific to the hazard of coastal erosion.

State

Oregon Coastal Management Program

The Coastal Management Program was approved by NOAA in 1977 and is lead by the Oregon Department of Land Conservation and Development (DLCD) within a network of cooperating agencies that have authority in the coastal zone. The Oregon Land Use Planning Act and 19 statewide planning goals provide the primary authority for the coastal management program. The following grant offers potential funding through this program.

OCMP Technical Assistance Grants

High priority project technical assistance grants support major projects that are "above and beyond" the ongoing, regular plan implementation activities. These special allocations for high priority coastal resources management and critical planning needs address issues identified by local planners, state agency resource specialists, and federal agency representatives. Examples of types of special high priority projects that have been funded include: GIS information development and mapping for local needs, GIS training and software for planners, riparian habitat inventories, and buildable lands inventories. Applications for special high priority projects are submitted by local jurisdictions and evaluated by OCMP staff. The grants are executed using the existing DLCD "technical assistance grants" procedure.

Oregon Natural Hazards Mitigation Plan, 2015

The statewide hazard mitigation plan found Tillamook County to be the county most vulnerable to coastal hazards in the state. In particular, the communities of Neskowin, Pacific City, Tierra del Mar, Twin Rocks, and Rockaway beach were identifies as being susceptible to coastal erosion. There are two state-owned or leased critical or essential facilities within coastal erosion areas of Tillamook County and additionally there are 10 state-owned or leased non-critical facilities within the County. These 12 properties are valued at $12.8 million. [13]

House Bill 1601

Known as the Oregon Beach Bill, HB 1601 passed in 1967 and defined the ocean shore area to be all wet sand within sixteen vertical feet of the low tide line and established this strip of land to be a state recreation area.

Comprehensive Plan Review

Tillamook County's Comprehensive Plan provides the framework for the existing coastal erosion mitigation actions. This section identifies how the hazard has been included in the comprehensive plan and suggests ways to strengthen and improve its inclusion in support of mitigation strategies.

Goal 7, Section 2.4 Erosion - Findings and Policies

Comment The findings in the erosion section come from DOGAMI report, Geologic Hazards Inventory of the Oregon Coast (Miscellaneous Report, 1974)[14]. These findings should be updated to reflect the new analysis found in the Risk Report and other more current documents. Furthermore, the risk of coastal erosion should be explicitly recognized as distinct from general erosive processes and stream erosion. In the policies section, setbacks from blufftops should be explicitly included in section a.7 and policy b. should be clarified to require a certified geotechnical report.

Goal 18, Beaches and Dunes Element 4 Coastal Erosion

CSC Comment: The inventory and mapping of coastal erosion should be updated to reflect the finding of the Risk Report and DOGAMI mapping efforts. It is recommended that the comprehensive plan should adopt the DOGAMI Evaluation of Erosion Hazard Zones for the Dune-Backed Beaches of Tillamook County (Open-

---

[13] Oregon Natural Hazards Mitigation Plan, 2015 pg 341 https://www.oregon.gov/LCD/HAZ/docs/2015ORNHMP/2015ORNHMPApproved/Approved_2015ORNHMP.pdf

[14] Geologic Hazards Inventory of the Oregon Coast (Miscellaneous Report, 1974) accessed May 12, 2016 http://www.oregongeology.org/pubs/MP/MP-17.pdf

File Report O-14-02, 2014)15 bluff or dune backed shoreline areas within high or active hazard zones as the coastal erosion natural hazard zone in which mitigation policies will be applied through a hazard overlay. It should be noted that maps are currently labeled within the comprehensive plan, but they are not visible in the online Goal 18 pdf file.

Land Use Ordinance Policy Options

This section presents a toolbox of costal erosion hazard mitigation strategies. Recommendations range from highly regulatory to incentive-based, and best practices are linked to specific case studies found in Appendix **A,** as appropriate. Within each strategy, best practices identified through policy analysis research form the basis for the recommendation. Location of applicable Land Use Ordinance sections related to the implementation of the strategy is identified and any model code language is presented for potential adoption. The implications of adoption are also discussed.

In the following section, model development code is **bold**

For a complete list of the recommended comprehensive plan and land use ordinance policy options see Tables 2 through 7.

Countywide Coastal Hazards Overlay Zone

Best Practice:

Currently, Tillamook County utilizes a coastal erosion hazards overlay zone only within the Neskowin area. This overlay applies only to the Neskowin area and does not provide consistent land use regulations for all areas susceptible to coastal erosions as defined in the *2014 DOGAMI Evaluation of Erosion Hazard Zones for the Dune-Backed Beaches of Tillamook County (OFR O-14-02)*. A Coastal Erosions Hazard Overlay should be defined for unincorporated Tillamook County that utilizes an overlay zone that combines the High Hazard and Medium Hazard zones from the *DOGAMI OFR O-14-02* into a single regulatory trigger zone.[16] Precedent for using the DOGAMI Hazard zones to define an overlay is seen in the Newport Geological Hazard Overlay, see Appendix A: Case Studies.

Applicable Development Code:

This would be a new overlay found in 3.500 Overlay Zone that would supplant or replace Section 3.570 Neskowin Coastal Hazards Overlay Zone. Hereafter this new

---

[15] Evaluation of Erosion Hazard Zones for the Dune-Backed Beaches of Tillamook County (Open-File Report O-14-02, 2014) accessed May 12, 2016 *http://www.oregongeology.org/pubs/ofr/p-O-14-02.htm*

[16] DOGAMI Evaluation of Erosion Hazard Zones for the Dune-Backed Beaches of Tillamook County (OFR O-14-02), Accessed May 1, 2016 *http://www.oregongeology.org/pubs/ofr/p-O-14-02.htm*

section is referred to as 3.500 Countywide Coastal Hazards Overlay Zone (proposed).

Model Code Language:

The following code language is from the Model Coastal Erosion Overlay Zone. Precedent for using this model code language is seen in in the Tillamook Land Use Section 3.570 Neskowin Coastal Erosion Hazards Overlay Zone and in the Newport OR, Geologic Hazard Overlay. Model code below is representative of code that County should consider adopting but is not comprehensive or complete, full text of the Model Coastal Erosion Overlay Zone is available online.[17]

Applicability of Coastal Hazard Overlay Zone

The following areas are considered potentially geologically hazardous and are therefore subject to the requirements of this section:

(a) Bluff or dune backed shoreline areas within medium and high hazard zones identified in the Department of Geology and Mineral Industries (DOGAMI) Open File Report Evaluation of Erosion Hazard Zones for the Dune-Backed Beaches of Tillamook County (OFR O-14-02).

…

(d) Any other documented geologic hazard within or adjacent to hazard risk zones described in (a) above and on file in the office of the County of Tillamook Community Development Director. A "documented geologic hazard area" as used in this subsection means a unit of land, which is shown by reasonable written evidence to contain geological characteristics/conditions which are hazardous or potentially hazardous for the improvement thereof.

Implication for Tillamook County:

Tillamook County created the *Adapting to Coastal Erosion Hazards in Tillamook County: FRAMEWORK PLAN* (see appendix D) from which each community or area could develop its own set of regulations, however this Framework Plan was not adopted. Neskowin has been the only area to adopt development code regulations specific to coastal hazards. Implementing a Countywide Coastal Hazards Overlay Zone without regulations may be a first step in getting communities and areas to recognize that they are susceptible to chronic coastal hazards. The Community Advisory Councils (CACs) and the County may then determine what permit and development restrictions found in the following sections are appropriate for the County at large, and what may only be appropriate for specific communities and areas.

[17] Model Coastal Erosion Overlay Zone, accessed May 12, 2016 *https://www.oregon.gov/LCD/OCMP/docs/Publications/ModelCoastalHazardsOverlayZone.pdf*

Coastal Hazard Area Permit

Best Practice:

For all development that occurs within the proposed Countywide Coastal Hazards Overlay Zone, a specific development permit should be required. This permit is currently only required in the Neskowin Coastal Hazards Overlay Zone and identifies the proposed development, the chronic natural hazards that are present on the site, and an engineering certified geologist reports finding and required engineering remediation necessary to minimize risk to the structure.

Applicable Development Code:

This would be a new overlay found in 3.500 Overlay Zone that would supplant or replace Section 3.570 Neskowin Coastal Hazards Overlay Zone. Hereafter this new section is referred to as 3.500 Countywide Coastal Hazards Overlay Zone (proposed).

Model Code Language:

Model code below is representative of code that the County should consider adopting but is not comprehensive or complete, full text of the *Model Coastal Erosion Overlay Zone* is available online.

Coastal Hazard Area Permit

An application for a Coastal Hazard Area Permit shall include the following:

(A) A site plan that illustrates areas of disturbance, ground topography (contours), roads and driveways, an outline of wooded or naturally vegetated areas, watercourses, erosion control measures, and trees with a diameter of at least 8-inches dbh (diameter breast height) proposed for removal;

(B) An estimate of depths and the extent of all proposed excavation and fill work;

(C) Identification of the bluff or dune backed hazard zone or landslide hazard zone for the parcel or lot upon which development is to occur. In cases where properties are mapped with more than one hazard zone, a certified engineering geologist shall identify the hazard zone(s) within which development is proposed based on the DOGAMI report referenced above;

(D) An engineering geologic report prepared by a certified engineering geologist which meets the content requirements of subsection (5); and

(E) If engineering remediation is required to make the site suitable for the proposed development, an engineering report, prepared by a registered civil engineer, geotechnical engineer, or certified engineering geologist (with experience relating to coastal processes), which provides design and construction specifications for the required remediation.

Implication for Tillamook County:

A Coastal Hazard Area Permit allows the County to review all new development for its ability to minimize risk to chronic coastal hazards to an acceptable level. This permit has explicit conditions that allow developers to clearly understand the natural hazard risk and mitigation information that must be provide to the County. The permit process allows the County to review development proposals for their ability consistently and efficiently to reduce risk to chronic coastal hazards.

Engineering Geologic Report Standards

Best Practice:

The required Coastal Hazard Area Permit must have a site-specific analysis of natural hazards and associated mitigation conducted as the DOGAMI report that defines the overlay boundaries does not provide data at detailed enough scale to accurately assess the location and type of chronic coastal hazards at the site level. This report needs to be conducted by an appropriately qualified specialist, a certified engineering geologist, and needs to meet specific evaluation standards. Such a report and standards are currently required within the Neskowin Coastal Hazards Overlay Zone, but this does not apply outside of the Neskowin area.

Applicable Development Code:

This would be a new overlay found in 3.500 Overlay Zone that would supplant or replace Section 3.570 Neskowin Coastal Hazards Overlay Zone. Hereafter this new section is referred to as 3.500 Countywide Coastal Hazards Overlay Zone (proposed).

Model Code Language:

Model code below is representative of code that County should consider adopting but is not comprehensive or complete, full text of the *Model Coastal Erosion Overlay Zone* is available online

(a) Engineering geologic reports required by this section shall be prepared consistent with standard geologic practices employing generally accepted scientific and engineering principles, and shall, at a minimum, contain the items outlined in the Oregon State Board of 7 DLCD/OCMP Model Overlay Coastal Hazard Code Geologist Examiners "Guidelines for Preparing Engineering Geologic Reports in Oregon", [insert date of issuance of current version of the published guidelines]. All Geologic Reports are valid as prima facie evidence of the information therein contained for a period of five (5) years.

Such reports are valid only for the development plan addressed in the report. The County assumes no responsibility for the quality or accuracy of such reports.

(b) Engineering geologic reports required by this section shall include a statement of the certified engineering geologist's professional opinion as to whether the

proposed development will be within the acceptable level of risk established by the community, considering site conditions and the recommended mitigation.

As used in this section, "acceptable level of risk" means the maximum risk to people and property from identified natural hazards deemed acceptable to the community in fulfilling its duty to appropriately protect life and property from natural hazards. For development subject to the provisions of this section, the acceptable level of risk is:

• Assurance that life safety will be protected from the identified hazard(s) for a time period which exceeds the life of the associated structure, considering site conditions and specified mitigation; and

• A [high likelihood] that the proposed structures will be protected from substantial damage from the identified hazard(s) for a period of [50-70] years, considering site conditions and specified mitigation.

Implication for Tillamook County:

The availability of Certified Engineering Geologists within Tillamook County needs to be assessed to determine the cost and time required for an Engineering Geologic Report to be conducted. The County should also consider allowing reports to be prepared by both an Oregon Registered Geologist and a qualified Oregon Registered Engineer. Site specific chronic coastal hazard analysis by a qualified professional is the best method for limiting the exposure of property and people to coastal natural hazards.

In addition to the conditions, requirements, and limitation imposed by the Certified Engineering Geologist in the Engineering Geologic Report all development should be subject to the following hazard mitigation requirements.

Bluff-Backed Shoreline Setback

Best Practice:

Development on bluff-backed shoreline lots should be set back from the bluff edge in accordance with the both the expected lifetime of the structure and the average annual erosion rate. Such a setback is required in the Neskowin Coastal Hazards Overlay Zone, but outside of this area in the Beach and Dune Overlay development cannot occur in front of the Oceanfront Setback Line (OSL). Per the Beach and Dune Overlay, the OSL is landward of the crest of the active foredune and is approximately parallel to the Oregon Coordinate Line. In all cases, the OSL is measured from the most ocean ward point of a structure which is higher than three feet from existing grade. A scientifically determined bluff-backed shoreline setback provides site specific protection from expected erosion and better protects development than a fixed OSL setback requirement that does not recognize variations in erosions rate. An example of bluff-backed shoreline setbacks that utilize a 75-year setback is found in San Luis Obispo County, CA see Appendix A: Case Studies.

Applicable Development Code:

This would be a new overlay found in 3.500 Overlay Zone that would supplant or replace Section 3.570 Neskowin Coastal Hazards Overlay Zone. Hereafter this new section is referred to as 3.500 Countywide Coastal Hazards Overlay Zone (proposed).

Model Code Language:

Model code below is representative of code that County should consider adopting and is taken from the Neskowin Coastal Hazards Overlay Zone and recommended by the *Model Coastal Erosion Overlay Zone*.

In areas subject to the provisions of this section, the building footprint of all new construction or substantial improvement subject to a Coastal Hazard Area Permit shall be set back from the ocean shore in accordance with the following requirements:

(a) Of the following, the requirement that imposes the greatest setback shall determine the minimum oceanfront setback:

(A) A setback specified in a required geologic report;

(B) A setback that coincides with the Oceanfront Setback Line (OSL); or

(C) On bluff-backed shorelines, a setback from the bluff edge a distance of 50 times the annual erosion rate (as determined by an engineering geologist) plus 20 feet (or other distance determined to be an adequate buffer). The bluff edge shall be as defined in the required geologic report.

(b) On lots or parcels subject to the minimum oceanfront setback, the required yard setback opposite the oceanfront may be reduced by one foot for each one foot of oceanfront setback provided beyond the required minimum, down to a minimum of 10 feet.

(c) On lots or parcels created prior to the effective date of this section, where the application of the minimum oceanfront setback, together with any other required yards and/or setbacks, results in a building footprint area of less than 1,500 square feet, the minimum oceanfront setback may be reduced by an amount necessary to provide a building footprint of not more than 1,500 square feet.

Implication for Tillamook County:

Ninety-percent of the Tillamook County coast is composed of dune-backed and bluff-backed beaches, as such a site-specific setback for bluff-backed development sites would recognize that variation in erosion rates due to different geological and oceanographic conditions and provide a scientific rational setback requirement. The County should look to assess what is a reasonable lifetime for new construction on the coast that recognizes that the value of coastal property and the lack of alternative building sites can lead to buildings having longer lifespans on the coast than in other locations. The Neskowin Coastal Hazards Overlay Zone uses a 50-year window of protection while in San Luis Obispo, CA a 75-year window is utilized with a recommendation from the California Coastal Commission to use a 100-year window, see San Luis Obispo Case Study in Appendix A.

Moveable Structure Design

Best Practice:

In the event that significant chronic coastal hazards threaten a building above and beyond the required setbacks stipulated in the previous section, moveable structure design allows buildings to be relocated further back on the site or even entirely removed from the site as conditions change. Construction standards that allow for building to be relocated in the event of a natural hazard should be recommended and possible required for high hazard areas. Moveable structure design is required in the Neskowin Coastal Hazards Overlay Zone but is not found outside of this overlay.

Applicable Development Code:

This would be a new overlay found in 3.500 Overlay Zone that would supplant or replace Section 3.570 Neskowin Coastal Hazards Overlay Zone. Hereafter this new section is referred to as 3.500 Countywide Coastal Hazards Overlay Zone (proposed).

Model Code Language:

Model code below is representative of code that County should consider adopting but is not comprehensive or complete, full text of the *Model Coastal Erosion Overlay Zone* is available online and a definition of how moveable structure design is defined is found on page 16.

(a) New development [should/shall] be designed and sited in such a manner that improvements may be relocated in the event they are jeopardized by coastal hazards. Considerations shall include:

(A) Construction techniques that will render new buildings readily moveable [shall be used/should be considered]

(B) Properties shall possess access of sufficient width and grade to permit new buildings to be relocated or dismantled and removed from the site.

Implication for Tillamook County:

Moveable structure design allows buildings to be relocated when threatened by chronic coastal natural hazards limiting damage to people and property. The County should determine if a recommendation to use moveable structure design is sufficient or if there is development in especially high risk areas where moveable structure design should be required.

New Infrastructure Requirement

Best Practice:

Infrastructure associated with new development is susceptible to the same chronic coastal hazards as is the development itself. Buildings are required to be setback from the coast and for the same reasons new infrastructure should be located as far landward as is practicable to protect it from coastal erosion. Such a requirement is not found in the Neskowin Coastal Hazards Overlay Zone or anywhere else in the Tillamook Land Use Ordinance.

Applicable Development Code:

This would be a new overlay found in 3.500 Overlay Zone that would supplant or replace Section 3.570 Neskowin Coastal Hazards Overlay Zone. Hereafter this new section is referred to as 3.500 Countywide Coastal Hazards Overlay Zone (proposed).

Model Code Language:

Model code below is representative of code that County should consider adopting but is not comprehensive or complete, full text of the Model Coastal Erosion Overlay Zone is available online.

All new infrastructure (e.g., roads, water, and sewer lines) shall be located landward of active and high hazard areas, whenever possible.

Implication for Tillamook County:

County review of Coastal Hazard Area Permits should assess whether new infrastructure has been sufficiently located landward of high hazard areas.

Hazard Disclosure and County Liability Waiver

Best Practice:

Property owners should formally acknowledge the chronic natural hazards that their property is subject to. A hazard disclosure statement documents the fact the property owner has been made aware of the natural hazard risk intrinsically found on their property and is responsible for the damage that may occur from chronic natural hazards. In conjunction with the hazard disclosure is a liability waiver that releases the County from all claims associated with natural hazards. The Neskowin Coastal Hazards Overlay Zone requires hazard disclosure but not a county liability waiver.

Applicable Development Code:

This would be a new overlay found in 3.500 Overlay Zone that would supplant or replace Section 3.570 Neskowin Coastal Hazards Overlay Zone. Hereafter this new section is referred to as 3.500 Countywide Coastal Hazards Overlay Zone (proposed).

Model Code Language:

Model code below is representative of code that the County should consider adopting but is not comprehensive or complete, full text of the *Model Coastal Erosion Overlay Zone* is available online.

Hazard Disclosure and Liability Waiver which sets forth the following:

(i) A statement that the property is subject to potential chronic natural hazards and that development thereon is subject to risk of damage from such hazards;

(ii) A statement that the property owner has commissioned an engineering geologic report for the subject property, a copy of which is on file with the jurisdiction, and that the property owner has reviewed the engineering geologic report and has thus been informed and is aware of the type and extent of hazards present and the risks associated with development on the subject property;

(iii) A statement acknowledging that the property owner assumes all risks of damage from natural hazards associated with the development of the subject property; and

(iv) A statement releasing the jurisdiction, its agents and employees from any and all claims which may arise as a result of damages, losses or injuries sustained by the property owner and his/her heirs, successors and assigns, from natural hazards.

Implication for Tillamook County:

Hazard disclosure and waiver of liability do not in and of themselves protect people or property from natural hazards, but the process of developing the hazard disclosure document and the requirement to sign a County liability waiver may cause people to choose stronger mitigation approaches to better protect their development.

Safest Site Requirement

Best Practice:

The existence of multiple hazards, complex topography and/or geology, and other site conditions such as streams mean that determining the safest site for development on a lot or parcel is more complex than simply utilizing a setback from a bluff edge or the crest of a bluff. A safest site requirement has a certified engineering geologist assess all site conditions and hazards to determine where best to locate development. Development in this area should be incentivized with relaxed yard or property line setbacks. A safest site requirement is found in the in the Neskowin Coastal Hazards Overlay Zone but is not found outside of this overlay.

Applicable Development Code:

This would be a new overlay found in 3.500 Overlay Zone that would supplant or replace Section 3.570 Neskowin Coastal Hazards Overlay Zone. Hereafter this new section is referred to as 3.500 Countywide Coastal Hazards Overlay Zone (proposed).

Model Code Language:

Model code below is representative of code that County should consider adopting but is not comprehensive or complete, full text of the *Model Coastal Erosion Overlay Zone* is available online. it is recommended that the County incorporate specific language into this code section containing the standards and requirements for variances which specifies that the reduction of risk from identified geologic hazards can constitute a circumstance justifying a variance from yard, setback, or similar dimensional standard. Representative examples of standards and requirements for variances are included, (A) and (B), from the Neskowin Coastal Erosion Hazards Overlay Zone.

Proposed development on lots/parcels within the Coastal Hazard Overlay Zone must be located within an area most suitable for development as determined by a certified engineering geologist as part of an engineering geologic report prepared in accordance with subsection (5). As necessary to comply with this requirement, applicants shall consider seeking a variance to required yards or property line setbacks as authorized in section [insert code section authorizing the granting of variances to dimensional standards].

(A) Any required yard or setback may be reduced by up to 50%; and,

(B) The maximum building width may be increased to up to 90% of the distance between opposite side lot lines.

Implication for Tillamook County:

The coastline of Tillamook is susceptible to multiple overlapping hazard including coastal erosion, wildfire, flooding, tsunami, sand inundation, and landslide. A safest site requirement recognizes that this means locating a development In the most appropriate location can be a complex and technical process that requires the skills of a certified engineering geologist. Utilizing a safest site requirement best minimizes risk to people and property from multiple natural hazards.

Subdivision Standards

Best Practice:

Preventing the creation of new lots or parcels without buildable areas outside of the hazard zone is a best practice in preventing development from occurring where life and property are at unacceptably high levels of risk. The County should require that a buildable site of 1,500 square feet be present in all new lots and parcels.

Such a subdivision standard is found in the in the Neskowin Coastal Hazards Overlay Zone but is not found outside of this overlay.

Applicable Development Code:

This would be a new overlay found in 3.500 Overlay Zone that would supplant or replace Section 3.570 Neskowin Coastal Hazards Overlay Zone. Hereafter this new section is referred to as 3.500 Countywide Coastal Hazards Overlay Zone (proposed).

Model Code Language:

Model code below is representative of code that County should consider adopting but is not comprehensive or complete, full text of the Model Coastal Erosion Overlay Zone is available online.

All new lots and parcels shall have a building site located outside the Hazard Overlay Zone. Such a building site shall consist of a minimum of 1,500 contiguous square feet of area that complies with all required lot setbacks and is located landward of the area subject to the provisions of this section.

Implication for Tillamook County:

The lands most vulnerable to coastal hazards can be some of the most desirable sites for development and the County should conduct an economic assessment of development with the coastal hazard area and consider prohibiting the creation of new lots or parcels that would increase risk to people and property on areas where risks from chronic coastal hazards cannot be sufficiently mitigated.

Residential Density Limitation

Best Practice:

Limiting the amount of people and property in extreme coastal erosion risk areas should be a priority. If development has already occurred in these areas, then no new dwelling units should be allowed. Such a requirement is not found in the Neskowin Coastal Hazards Overlay Zone or anywhere else in the Tillamook Land Use Ordinance.

Applicable Development Code:

This would be a new overlay found in 3.500 Overlay Zone that would supplant or replace Section 3.570 Neskowin Coastal Hazards Overlay Zone. Hereafter this new section is referred to as 3.500 Countywide Coastal Hazards Overlay Zone (proposed).

Model Code Language:

Model code below is representative of code that County should consider adopting but is not comprehensive or complete, full text of the *Model Coastal Erosion Overlay Zone* is available online.

Residential density limitation: Notwithstanding the residential density allowances of the underlying zone, on lots or parcels which are developed with an existing dwelling or dwellings, the construction of additional dwelling units within the [insert hazard areas deemed appropriate and could include active, high, and medium hazard zone areas] erosion hazard zone areas is prohibited.

Implication for Tillamook County:

The County should assess if there are specific high hazard area in which new dwelling units should be specifically prohibited. Such a prohibition can recognize that where development has historically occurred in extremely high hazard area no additional dwelling units should be allowed to minimize the amount of building value and residents at risk to chronic coastal hazards.

Erosion Control and Stormwater Management Standards

Best Practice:

Increased coastal erosion can occur during and after development that does not properly utilize sedimentation barriers and permanent plantings. Likewise, increased runoff from impervious surfaces can exacerbate coastal erosion and stormwater runoff should not be allowed to decrease the stability of bluff faces, foredune areas, known landslides, or other areas identified as unstable slopes prone to earth movement. Section 5.100 Neskowin Erosion Control and Stormwater Management proved erosion control and stormwater management standards for the Neskowin area, but is not found outside of this overlay and the county lacks a stormwater ordinance.

Applicable Development Code:

This would be a new overlay found in 3.500 Overlay Zone that would supplant or replace Section 3.570 Neskowin Coastal Hazards Overlay Zone. Hereafter this new section is referred to as 3.500 Countywide Coastal Hazards Overlay Zone (proposed).

Model Code Language:

Model code below is representative of code that County should consider adopting but is not comprehensive or complete. The following model code is taken from Section 5.100 Neskowin Erosion Control and Stormwater Management. Additional erosion control and stormwater management code sections area available in Attachment C: City of Newport Erosion Control Measures (page 23) and Attachment D: Astoria Erosion Control and Stormwater Management Code Language (page 25) of the *Model Coastal Erosion Overlay Zone* is available online.

Additionally, Appendix A contains a case study on the Newport Erosion Control Measures.

EROSION CONTROL: All applications for development subject to the provisions of this section shall include detailed plans for the control of erosion and sedimentation during the course of construction and/or other ground disturbing activities. Such plans shall, at a minimum, incorporate the following measures:

(a) Stripping of vegetation, grading, or other soil disturbance shall be done in a manner which will minimizes soil erosion, allow the soil to be stabilized as quickly as practicable, and disturb the smallest practical area at any one time during construction;

(b) Development plans shall minimize cut or fill operations so as to prevent off-site impacts;

(c) Sedimentation barriers, as described in the Oregon Department of Environmental Quality publication "Best Management Practices for Stormwater Discharges Associated with Construction Activities" shall be placed to control sedimentation and minimize any sediment discharge from the site. Such barriers shall be installed prior to site clearing or grading activities;

(d) Temporary vegetation and/or mulching shall be used to protect exposed critical areas during development; and,

(e) Permanent plantings and any required structural erosion control and drainage measures shall be installed as soon as practical.

(4) STORMWATER MANAGEMENT: Applications for development subject to the provisions of this section shall include plans for the long-term management of stormwater that, at a minimum, conform to the following requirements:

(a) Provisions shall be made to effectively accommodate increased runoff caused by altered soil and surface conditions during and after development. The rate of surface water runoff shall be structurally controlled where necessary to prevent increased erosion; and

(b) Permanent drainage provisions adequate to convey surface runoff from the twenty-year frequency storm to suitable drainage ways such as storm drains, natural watercourses, or drainage swales shall be provided. In no case shall runoff be directed in such a way as to significantly decrease the stability of bluff faces, foredune areas, known landslides, or other areas identified as unstable slopes prone to earth movement, either by erosion or increase of groundwater pressure.

(c) A geologic report, required within the NESK CH Overlay Zone, shall address management of surface water runoff at or behind active foredunes and riprap structures in order to reduce erosion and structure failure potential.

Implication for Tillamook County:

Tillamook County currently lacks a stormwater ordinance and developing one would be a lengthy and involved process. Adopting erosion control and stormwater management standards within the proposed Countywide Coastal Hazards Overlay Zone would be an efficient and effective way to prevent development from unduly increasing the rate, extend, and severity of coastal erosion.

Model Ordinance and Codes

The following model ordinances and standards were identified during research on coastal erosion hazard mitigation. These documents have example language for specific mitigation strategies that could be implemented in Tillamook's development code.

Chronic Coastal Natural Hazards Model Overlay Zone [18]

This model overlay zone was developed in 2008 by DLCD and the Oregon Coastal Management Program (OCMP) to be used in conjunction with DOGAMI coastal hazard risk maps and analysis. The model overlay includes the hazard overlay code, example comprehensive plan amendments, and sample adopting ordinance language. This model code was heavily utilized in the Tillamook County Neskowin Coastal Hazards Overlay as well as within the Newport OR, Geologic Hazard Overlay.

[18] Model Coastal Erosion Overlay Zone, accessed May 12, 2016
https://www.oregon.gov/LCD/OCMP/docs/Publications/ModelCoastalHazardsOverlayZone.pdf

CHAPTER 7: LANDSLIDE

This chapter identifies the risk landslide poses to unincorporated Tillamook County, the extent of risk, and the rate and location of development affected by landslide. Following are policy options the county can consider to strengthen the Tillamook County Comprehensive Plan, Land Use Ordinance, and Land Division Ordinance. Policy options are presented with descriptions of best practices, identification of the applicable county code sections, and details of implementing the policy.

Extent of Risk

Landslides pose a significant threat to communities across Tillamook's rugged and varied topography. Geographic conditions combined with increasing development have led to increased landslide susceptibility. Reduction of landslide risk requires that communities understand landslide processes and occurrence, and initiate a more robust approach for developmental requirements and mitigation action at the local level.

Development in Hazardous Areas

Landslide susceptibility determined by combined generalized geology and landslide inventory establishes classes of low, moderate, and high risk. Spatial statistics of the slope map determines classes of low, moderate, and high slopes prone to land sliding within each geologic unit. DOGAMI conducted an analysis in their report, O-16-02. The study suggests that over 33% of the unincorporated county is exposed to high or very high landslide risk. The Tillamook County Risk Report (2016, draft) indicates that 10% of buildings in unincorporated areas including Neskowin, Oceanside, Netarts, and Pacific City are located within High Susceptible areas (Table 12), and 23% are located within Very High Susceptibility areas (Table 13).

Table 12: High Susceptibility Landslide Exposure Analysis

			High Susceptibility		
Community	Total Number of Buildings	Total Estimated Building Value ($, in thousands)	Number of Buildings	Building Value ($, in thousands)	Ratio of Exposure Value
Unincorporated County (rural)	15,015	$ 1,282,436	4,933	$ 95,872	8%
Neskowin	653	$ 118,436	132	$ 22,834	19%
Oceanside and Netarts	1,701	$ 203,363	738	$ 45,647	22%
Pacific City	1,707	$ 212,062	183	$ 24,888	12%
Total	19,076	$ 1,816,324	5,986	$ 189,240	10%

Source: Risk Report, 2016 (modified by CSC), Table A-6

Table 13: Very High Susceptibility Landslide Exposure Analysis

			Very High Susceptibility		
Community	Total Number of Buildings	Total Estimated Building Value ($, in thousands)	Number of Buildings	Building Value ($, in thousands)	Ratio of Exposure Value
Unincorporated County (rural)	15,015	$ 1,282,436	3,680	$ 353,459	28%
Neskowin	653	$ 118,436	8	$ 1,353	1%
Oceanside and Netarts	1,701	$ 203,363	446	$ 55,589	27%
Pacific City	1,707	$ 212,062	2	$ 42	0%
Total	19,076	$ 1,816,324	4,136	$ 410,443	23%

Source: Risk Report, 2016 (modified by CSC), Table A-6

There are six (6) essential facilities within the unincorporated county that are exposed to the high or very high landslide susceptibility hazard.

Table 14: Essential Facilities Exposed to Landslide Threat

Community	Exposed Essential Facility
Unincorporated County (rural)	Nestucca Fire and Rescue Station #87 Nestucca High School Fire Mountain School Nestucca RFPD #84 Nestucca Valley Elementary
Neskowin	Neskowin Valley School
Oceanside and Netarts	Oceanside RFPD #62

Source: Risk Report, 2016 (modified by CSC), Table 7.

Existing Programs and Resources

National

United States Geological Survey Landslide Hazard Program (LHP)

The USGS Landslide Hazard Program (LHP) provides scientific information to minimize loss of life and property from landslides, improve understanding and increase mitigation action. The LHP conducts landslide hazard assessments, pursues landslide investigations and forecasts, provides technical assistance to respond to landslide emergencies, and engages in outreach activities.

State

Oregon Senate Bill 12

Specifically addresses rapidly moving landslides and delegates various mitigation responsibilities to statewide agencies such as DOGAMI, DLCD, Oregon Department of Transportation (ODOT), and Oregon Department of Forestry (ODF). The bill requires local governments to "regulate through mitigation measures and site development standards the siting of dwellings and other structures designed for human occupancy in further review areas where there is evidence of substantial risk for rapidly moving landslides."

Oregon Senate Bill 1211

A precursor to Senate Bill 12, authorizes the ODF to prohibit forest operations on certain landslide-prone areas above homes and busy roads in the interest of public safety. The bill also created the Interim Task Force on Landslides and Public Safety.

County

There are currently no landslide mitigation programs in Tillamook County.

Comprehensive Plan Review

Tillamook County's Comprehensive Plan provides the framework for the existing landslide mitigation actions. This section identifies how the hazard has been included in the comprehensive plan and suggests ways to strengthen and improve its inclusion in support of mitigation strategies.

Landslides- Findings and Policies Goal 7, 2.1

Current code language within the comprehensive plan primarily focuses on landslides in terms of the uniform building code, as well as engineering standards for excavation, fills/drainage, and vegetation removal.

CSC Comment: Existing language that relates to geologic hazards does not comprehensively address and define the extent and characteristics of at-risk areas. Zoning regulations, standards, and requirements related to development within hazardous areas are contingent on the designation of concise spatial parameters. The comprehensive plan should adopt DOGAMI's landslide susceptibility index to determine the specific locations that will be impacted by regulatory landslide mitigation actions.

Land Use Ordinance Policy Options

This section presents a toolbox of landslide hazard mitigation strategies. Recommendations range from highly regulatory to incentive-based, and best practices are linked to specific case studies found in Appendix **A,** as appropriate. Within each strategy, best practices identified through policy analysis research form the basis for the recommendation. Location of applicable Land Use Ordinance sections related to the implementation of the strategy is identified and any model code language is presented for potential adoption. The implications of adoption are also discussed.

In the following section, model development code is **bold**

For a complete list of the recommended comprehensive plan and land use ordinance policy options see Tables 2 through 7.

Establish a Geologic Hazard Overlay Zone

Best Practice:

Establish a Geologic Hazard Overlay zone based on recent county LIDAR data to form a regulatory trigger zone. Current land use code provides standards for geologically hazardous areas, however, the extent of these areas are not defined and without specific boundaries, there is a lack of accountability that can be attributed to development. Development standards based on geologic characteristics should reflect information that is outlined in the DOGAMI *Landslide Susceptibility Overview Map of Oregon* (Open File Report O-16-02, 2016), as well as data available through mapping services provided by the *Statewide Landslide Information Database (SLIDO) version 3.2.* Replace 1972 and 1973 landslide DOGAMI Bulletins 74 and 79 maps to provide consistent land use regulations for countywide landslide hazard areas to best protect people and property. Current code revolves around outdated mapping that does not supply sufficient coverage for highly susceptible areas. Looking at both the degree of hazard threat and exposure and sensitivity analysis provided by the Risk Report, the county should specifically target mapping projects in Nehalem, Wheeler, Manzanita, Neskowin (unincorporated), and Oceanside/Netarts (unincorporated).

Applicable Development Code:

The County should consider moving Section 4.130.1 Development Requirements for Geologic Hazard Areas to 3.500 Geologic Hazard Overlay.

Implication for Tillamook County:

Further analysis of county LIDAR data is required to properly define this overlay zone with support from the FEMA Risk MAP program. Defining Geologic Hazard Areas based on DOGAMI Bulletins 74 and 79 relies on data that is over thirty years old and does not accurately represent current conditions. Additionally, the more recent mapping outlined in DOGAMI O-16-02 and the Risk Report addresses landslide hazard at a state and county level, which can generalize many geologic anomalies and features.

Development Requirements for Geologic Hazard Areas

Best Practice:

For all development in or partially in the Geologic Hazard Overlay a Geologic Hazard Area Permit and *geologic assessment* or *geologic report* prepared by an engineering geologist is required. A geologic report created by a certified geologist includes very clear stipulations that are site specific and are determined based on the unique geologic characteristics of the surveyed area.

Applicable Development Code:

Section 3.500 Geologic Hazard Overlay (proposed)

Implication for Tillamook County:

Existing development standards included in the geologic hazard report are not specific and do not assure effective mitigation actions. This section should be amended to include more concise and explicit requirements for each standard. It is essential that the code contain language that provides straightforward guidance that will inform development within geologic hazard areas. A Geologic Hazard Area permit and report provides site and development specific hazard analysis and details engineering requirements to minimize the risk posed by geologic hazards.

Geologic Hazard Point-Based Assessment System

Best Practice:

A point-based system quantifies development site landslide risk and triggers either a *geologic assessment* or a *geologic report*. The following is adopted from the Marion County Comprehensive Land Use Plan (See Appendix).

Applicable Development Code:

The County should consider moving Section 4.130.1 Development Requirements for Geologic Hazard Areas to 3.500 Geologic Hazard Overlay.

Model Code Language:

Model Code Language: Building plans and development applications will be evaluated based upon a point system that combines the landslide risk exhibited by the subject property (a function of soil types, slopes, underlying geological conditions, etc.) with the intensity of the proposed use.

Table 15: Geologic Hazard Point-Based Assessment System Steps

Landslide Risk Assessment		
Step 1*	Earthquake-induced landslide susceptibility based points*	
Step 2*	Water-induced landslide susceptibility based points*	
Step 3	Slope based points	
Step 4	Development and type of proposed use based points	
Step 5	Calculate cumulative score	
Step 6	Determine requirements category	
Category A: Low Risk	**Category B: Moderate Risk**	**Category C: High Risk**
No Requirements	Geologic Assessment	Engineering Geology Report

Source: Marion County Comprehensive Plan (modified by CSC)
* Further data collection and analysis is needed to inform point allocation and rating system for Steps 1 and 2.

Implication for Tillamook County:

Considerations for point allocations include geology, slope, and proposed development type. Modeled after Marion County (see Appendix B), this requirement creates a quantitative evaluation of both the geologic and structural variables that threaten the area. Different degrees of hazard are thus distinguished and are then translated into a permit request process. Quantitative evaluation defines degree of hazard and a more regulated permit request process discourages construction in high-risk areas.

Buffer Zone Requirement

Best Practice:

Through the expert guidance supplied by the geological report, a buffer zone in a highly susceptible area can be defined and used to determine the safest site for development. The following code is borrowed from the King County, WA Development Code (See Appendix A).

Applicable Development Code:

Section 3.005 Geologic Hazard Overlay (proposed)

Model Code Language:

A buffer zone is based on a critical area report prepared by a geotechnical engineer or geologist. If a critical area report is not submitted to the department, the minimum buffer is fifty feet with an additional 15-foot building setback requirement. If the structure has a vertical rise that is significantly higher, setback should be increased.

Implication for Tillamook County:

Currently, Tillamook County's development code does not include provisions related to the area surrounding structures proposed within a high-risk landslide area. It is in the County's best interest to reduce the potential damage to these structures through a buffer zone regulation. The amended code would include language modeled after King County's example. The responsibility falls on the developer to fulfill the buffer requirement. The zone defines an area contiguous to a steep slope or landslide hazard area intended to protect slope stability, attenuation of surface water flows, and landslide hazards.

Revegetation Standards

Best Practice:

Certain plant species are valuable landslide mitigation tools, contributing complex root systems that bind to the soil and increase slope stability. Existing code mentions revegetation however; this requirement is deficient and lacks the specificity needed to mandate a level of accountability. Determine which trees may be cut and removed, while stipulating which species, stumps, and root systems must be left undisturbed. Set requirements for revegetation to compensate for damaged or removed plants. The following code is adopted from the City of Mukilteo Municipal Code (See Appendix A).

Applicable Development Code:

Section 3.005 Geologic Hazard Overlay (proposed)

Model Code Language:

Certain tree types may be cut and removed in a method determined by planning director and public works director. Stumps and root systems must be left undisturbed to protect the slope from erosion. Certain deep rooted bushes or ground cover shall be planted around the stump to establish erosion control functions. Certain tree types cannot be cut down, except with the submittal of a geotechnical report. Trimming must preserve a minimum of sixty percent of original canopy/foliage. "Windowing", "interlimbing", or "skirting-up" trimming practices may be utilized, but must adhere to requirements based on type of trimming practice.

Implication for Tillamook County:

Section 2.1 “Landslides” of the Comprehensive Plan stipulates that vegetation removal in areas of mass movement topography shall be engineered to minimize sliding (7-17). Section 4.130-2 instructs the documentation of “minimum removal of vegetation to accommodate use” within an associated geologic hazard report. Including more specific and direct vegetation standards within the development code increases stabilization of soils and reduce the risk of landslides. The city of Mukilteo, WA addresses landslide threat by incorporating a comprehensive description of regulated landscape practices within geologically sensitive areas.

Non-Regulatory Geologic Hazard Abatement District

Best Practice:

A Geologic Hazard Abatement District (GHAD) necessitates voluntary community involvement, forming a district of residents within the determined boundary, and requiring homeowners to contribute a fixed monthly amount to a community fund for ongoing hazard reduction efforts that can also be utilized for post emergency event funding. To form a GHAD, City Council must adopt a resolution to initiate formation and set a date for a public hearing. The following is informed by the City of San Ramon (See Appendix A).

Model Code Language:

The primary mission of the Geologic Hazard Abatement District (GHAD) is the prevention, mitigation, abatement, and/or control of geologic hazards within its boundaries that have damaged, or that pose a significant threat of damage to site improvements within the developed areas of the projects. Communities elect to establish an abatement district and allocate an agreed-upon quantity of funding each month that is set aside for ongoing reduction efforts, as well as a contribution to an emergency pool that can be utilized in the case of an emergency event.

Implication for Tillamook County:

Following the practices set forth by San Ramon’s example, Tillamook County could adopt a Landslide Hazard Abatement District. The district would provide the protection of life and properties from landslide risk through ongoing mitigation projects. As a resident, the GHAD is beneficial as it provides a type of insurance and security, as well as management and maintenance.

Model Ordinance and Codes

The following model ordinances and standards were identified during research on landslide mitigation. These documents have example language for specific mitigation strategies that could be implemented in Tillamook’s development code.

City of Mukilteo Vegetation Standards for Geologic Sensitive Areas

City of Mukilteo Vegetation Standards for Geologic Sensitive Areas Ordinance 17.52A.070 outlines specific regulations for vegetation management on steep slopes. Includes prohibitions for landscape alteration and removal of certain species, as well as stipulations related to trimming practices.

King County Title 21A.24 – Critical Areas

King County Title 21A.24- Critical Areas Ord. 10870 § 176, 1993: Provides stringent regulations and buffer zone requirements for proposed development within a high landslide risk area. The zone is based on a critical area report prepared by a geotechnical engineer or geologist. If a critical area report is not submitted to the department, the minimum buffer is fifty feet with an additional 15-foot building setback requirement.

Marion County, Oregon Geologically Hazardous Overlay Zone Ordinance

The *Marion County Geologically Hazardous Overlay Zone Ordinance* **as**signs point values to particular development activities on certain properties that reflect landslide risk. Depending on the level of risk, the applicant for a proposed development activity is required to submit a geological assessment, geotechnical report, and/or apply for permitting.

San Ramon Geologic Hazard Abatement District:

Under authority of the California Public Resources Code (Division 17, commencing with Section 26500), the City of San Ramon, in 1990, adopted Resolution No. 90-106 forming the West Branch Geologic Hazard Abatement District ("GHAD" or "District") 1990-01. Assessment is a vital component for the management of an abatement district. To property and appropriately allocate funding, it is essential that the district be fully informed on the current conditions that may impact hazard threat levels. A funding program provides concise organization and structure for the distribution and collection of finances.

CHAPTER 7: WILDFIRE

This chapter identifies the risk wildfire poses to unincorporated Tillamook County, the extent of risk, and the rate and location of development affected by wildfire. Following are policy options the county can consider to strengthen the Tillamook County Comprehensive Plan, Land Use Ordinance, and Land Division Ordinance. Policy options are presented with descriptions of best practices, identification of the applicable county code sections, and details of implementing the policy.

Extent of Risk

Wildfires are a natural and necessary component of many ecosystems across the country. Historically, wildfires have shaped the forests and wildlands valued by residents and visitors. These ecosystems are significantly altered due to fire prevention efforts, modern suppression activities and a general lack of large-scale fires, resulting in overgrown forests and wildland-urban interfaces (WUI) with dense fuels that burn more intensely than in the past. Wildfires can be divided into three categories: interface, wildland, and firestorms.

Interface fires occur where wildland and developed areas meet (the wildland-urban interface). In these locations, both vegetation and structural development combine to provide fuel. The wildland-urban interface can be divided into three categories: classic wildland-urban interface, mixed wildland-urban interface, and occluded wildland-urban interface.

Classic wildland-urban interface exists where well-defined urban and suburban development presses up against open expanses of wildland areas.

Mixed wildland-urban interface is found in areas of exurban or rural development: isolated homes, subdivisions, resorts and small communities situated in predominantly wildland settings.

Occluded wildland-urban interface where islands of wildland vegetation exist within a largely urbanized area.

The growth in development in interface areas increases the risk of wildfires. Fire has historically been a natural wildland element and can sweep through vegetation adjacent to combustible homes. There is potential for losses due to wildland-urban interface fires in Tillamook County. The forest comprises approximately 90% of Tillamook County (draft Risk Report 2016). Tillamook County's forests play an important role in the local economy, as well as surrounding its resident's homes and businesses (draft Risk Report 2016).

Development in Hazardous Areas

There is minimal exposure to wildfire within the unincorporated communities of Tillamook County. The countywide exposure is approximately $13 million for moderate threat and $2.3 million for high threat (draft Risk Report, 2016) throughout the entire county. Focusing on the unincorporated areas, analysis indicates a minimal level of building exposure. Less than 1% of buildings in Neskowin, Oceanside, Netarts, and Pacific City are located within areas of moderate or high threat (Risk Report).

The 2010 Tillamook CWPP outlines perceived risk to fire threat. Tillamook fire districts were asked to use a numerical rating system (1-3) to determine the amount of risk associated with a given site. 1 represents extreme, 2 represents moderate, and 3 represents low threats. These were broken out into three different categories based on fire behavior potential, values at risk, and Infrastructures. The results are indicated in the table below:

Table 16: Communities-at-Risk Matrix

Community/Area	Risk Factor 1: Fire Behavior Potential Situation Level	Risk Factor 2: Values At-Risk Situation Level	Risk Factor 3: Infrastructure Situation Level
Beaver	2	2	2
Blaine	**1**	**1**	**1**
Cloverdale	**1**	**1**	**1**
Hebo	1	2	2
Sandlake	2	2	1
Tierra Del Mar	2	2	2
Neskowin	**1**	**1**	**1**
Netarts/Oceanside	**1**	**1**	**1**
Beachfront Oceanside to Netarts Bay	**1**	**1**	**1**

Source: Tillamook County Community Wildfire Protection Plan, 2010

Almost all the unincorporated communities evaluated were categorized as presenting extreme or moderate risk to all three categories. Blaine, Hebo, Neskowin, and Netarts/Oceanside indicated an extreme risk for fire potential, values, and infrastructure exposure.

Table 17: Wildfire Exposure Analysis for Unincorporated Areas

Community	Total Number of Buildings	Total Estimated Building Value ($, in thousands)	High Risk		
			Number of Buildings	Building Value ($, in thousands)	Ratio of Exposure Value
Unincorporated County (rural)	15,015	$ 1,282,436	383	$ 22,892	1.8%
Neskowin	653	$ 118,463	2	$ 288	0.2%
Oceanside and Netarts	1,701	$ 203,363	0	$ -	0.0%
Pacific City	1,707	$ 212,062	3	$ 226	0.1%
Total	19,076	$ 1,816,324	388	$ 23,406	1.3%

Source: Risk Report, 2016 (modified by CSC), Table A-8.

Existing Programs and Resources

There are several wildfire mitigation programs at the National, State, and County level that are in effect within Tillamook County. While non-regulatory in nature, they provide useful guidance to the County's decision makers, residents, and developers. These programs provide frameworks for outreach, education, and coordination regarding the mitigation of wildfire risk. This section outlines the general programs, state programs, and county programs that are in effect in Tillamook County.

National

Healthy Forests Restoration Act: Community Wildfire Protection Plans

In 2003, the US Congress passed the Healthy Forests Restoration Act that directed federal agencies to collaborate with communities in the wildland urban interface to create Community Wildfire Protection Plans (CWPP). CWPPs allow communities to identify and prioritize areas needing hazardous fuels treatment. CWPPs provide consistent analysis of existing fuels and WUI conditions along with recommendations and priorities for hazardous fuels reductions treatments on public and private lands. Community Wildfire Protection Plans allow communities to set wildland urban interface (WUI) boundaries and conducted risk assessments for each community.

National Fire Protection Association

The National Fire Protection Association (NFPA) is a national non-profit organization that sets national fire safety codes and standards. The codes that NFPA provides are standards that range from building, process, service, design, and installation. Besides providing national fire safety codes and standards, the NFPA provides training and education about fire safety and standards.

NFPA 1141: Standard for Fire Protection Infrastructure for Land Development in Wildland, Rural, and Suburban Areas

This standard provides guidance on the development of the community infrastructure necessary to eliminate fire protection problems that result from rapid growth and change.

NFPA 1144: Standard for Reducing Structure Ignition Hazards from Wildland Fire

This standard provides guidance on individual structure hazards. It requires a new spatial approach to assessing and mitigating wildfire hazards around existing structures and includes improved ignition-resistant requirements for new construction.

International Wildland-Urban Interface Code (2012)

This comprehensive wildland-urban interface code establishes minimum regulations for land use and the built environment in designated wildland-urban interface areas using prescriptive and performance-related provisions. It is founded on data collected from tests and fire incidents, technical reports, and mitigation strategies from around the world.

Firewise Communities

Firewise Communities USA is a program that nationally recognized communities that have taken an organized approach to wildfire preparedness. Firewise Communities educate community members on how live with the threat of wildfire and encourage neighbors to work together and act to prevent loss of property and life. Typically, Firewise Communities have defensible space, well- marked evacuation routes, and community cohesion.

State

Oregon Senate Bill 360

The Oregon Department of Forestry (ODF) supplies information about fuel reduction standards to property owners. ODF mails each property owner a certification card, which may be signed and returned to ODF after the fuel reduction standards have been met. Certification relieves a property owner of liability of fire suppression costs if a fire were to occur on the property.[19] If a certification card has not been received by OFD, the state of Oregon may seek to recover certain fire suppression costs from a property owner if a fire originates on the owner's property, the fuel reduction standards have not been met, and ODF incurs extraordinary suppression costs. The cost-recovery liability under the Oregon Forestland Urban Interface Fire Protection Act is capped at $100,000[20.]

Oregon Ready, Set, Go!

Oregon Ready, Set, Go! is an online wildfire assessment tool that provides awareness and educational materials to property owners in Wildland Urban Interface. The website allows property owners to enter their home address and identify structural and vegetative information to calculate a wildfire risk score. Based on the score, information will be provided to help reduce the home's risk including building materials or outside landscaping. This is an educational tool for

---

[19] Oregon Forestland-Urban Interface Fire Protection Act Property Evaluation and Self-Certification Guide. July 2006. Oregon Department of Forestry. State of Oregon. Available at: http://www.oregon.gov/ODF/FIRE/SB360/docs/guide/guide_0106.pdf

[20] Oregon Forestland-Urban Interface Fire Protection Act Property Evaluation and Self-Certification Guide. July 2006. Oregon Department of Forestry. State of Oregon. Available at: http://www.oregon.gov/ODF/FIRE/SB360/docs/guide/guide_0106.pdf

homeowners that can help protect their life and property as well as keep First Responders safe when fighting fires. [21]

Comprehensive Plan Review

Tillamook County's Comprehensive Plan provides the framework for the existing wildfire mitigation actions. This section identifies how the hazard has been included in the comprehensive plan and suggests ways to strengthen and improve its inclusion in support of mitigation strategies.

Forest Lands Fire Protection- Goal 4, Section 4.10

Findings
Fire protection agencies are concerned about residential development in forested areas because many developments lack proper controls or consideration for fire safety measures and are creating a design for disaster. Every little consideration for fire protection has been given so far in the land use planning process and that as the demand and need for developments in forest areas increase, comprehensive land use planning becomes more necessary

Policy
Tillamook County recognizes the significant fire hazard and potential public costs that result from improper residential development in rural forested areas. Further development in the Forest zone shall not be approved unless provision has been made for fire safety measures in accordance with the guide published by the Northwest Inter-Agency Fire Prevention Group entitled Fire Safety Considerations for Development in Forest Areas.

CSC Comment: It is important that the county continue to uphold stringent requirements for proposed development within the Fire zone. The fire safety measures outlined in the Northwest Inter-Agency Fire Prevention Group guide provide the necessary framework and standards to best mitigate wildfire risk.

Land Use Ordinance Policy Options

This section presents a toolbox of wildfire hazard mitigation strategies. Recommendations range from highly regulatory to incentive-based, and best practices are linked to specific case studies found in Appendix A**,** as appropriate. Within each strategy, best practices identified through policy analysis research form the basis for the recommendation. Location of applicable Land Use Ordinance sections related to the implementation of the strategy is identified and any model code language is presented for potential adoption. The implications of adoption are also discussed.

In the following section, model development code is **bold**

[21] Ready, Set, Go! > Home. Accessed June 8, 2015. *http://www.wildlandfirersg.org* .

For a complete list of the recommended comprehensive plan and land use ordinance policy options see Tables 2 through 7

Firewise Standards or Firewise Recognition

Best Practice:

Achieve Firewise Standards or Firewise Recognition. *Firewise* is a non-regulatory program managed by the National Fire Protection Association (NFPA) that provides principles or standards that include many NFPA 1141 (*Standards for Fire Protection Infrastructure for Land Development in Wildland, Rural, and Suburban Areas*) and 1144 (*Standard for Reducing Structure Ignition Hazards from Wildland Fire)* standards. These represent industry standards that reduce wildfire ignition to the home through fire resistant building materials and the creation of defensible space around structures. Communities can receive Firewise Recognition by following five steps that include: a wildfire hazard assessment, creating a community task force, holding an annual Firewise Day, spending $2 per capita on Firewise projects, and submitting an annual report to Firewise documenting the community's progress.

Implication for Tillamook County

We recognize that a highly regulatory approach to wildfire mitigation may not be a necessary action for current conditions in Tillamook County. Taking a more voluntary approach to reduction of wildfire risk may be sufficient and offers a more individualized strategy that provides communities with the opportunity to make efforts that most appropriately address their specific needs. Firewise provides guidance for small scale mitigation and is highly effective at the neighborhood and community level (See Appendix C, Ashland). Through ongoing projects, education, and available services, areas that opt to adhere to Firewise standards greatly reduce their risk to wildfire.

Creation of Wildfire Hazard Overlay

Best Practice:

The County should consider creating a new overlay zone based on the rural fire protection districts (see Figure 1), the Wildland-Urban Interface[22] (WUI) extent (see Figure 2), and Risk MAP findings to form a regulatory "trigger zone". The existing Forest zone does not include developable areas within the unincorporated communities, as such these areas do not need to comply to the residential wildfire standards of the Forest zone. A basic wildfire overlay zone, defined by the current WUI extent, would allow the residential wildfire protection standards of the Forest zone to cover the unincorporated communities within the WUI area. An expanded

---

[22] The Wildland-Urban Interface (WUI) is the area where humans and their development meet or intermix with wildland fuel. The WUI is defined within the Tillamook County Community Wildfire Protection Plan (CWPP).

overlay zone would include the rural fire districts (see Figure 1), and the high threat fire areas defined by the draft Risk Report, in addition to the WUI area.

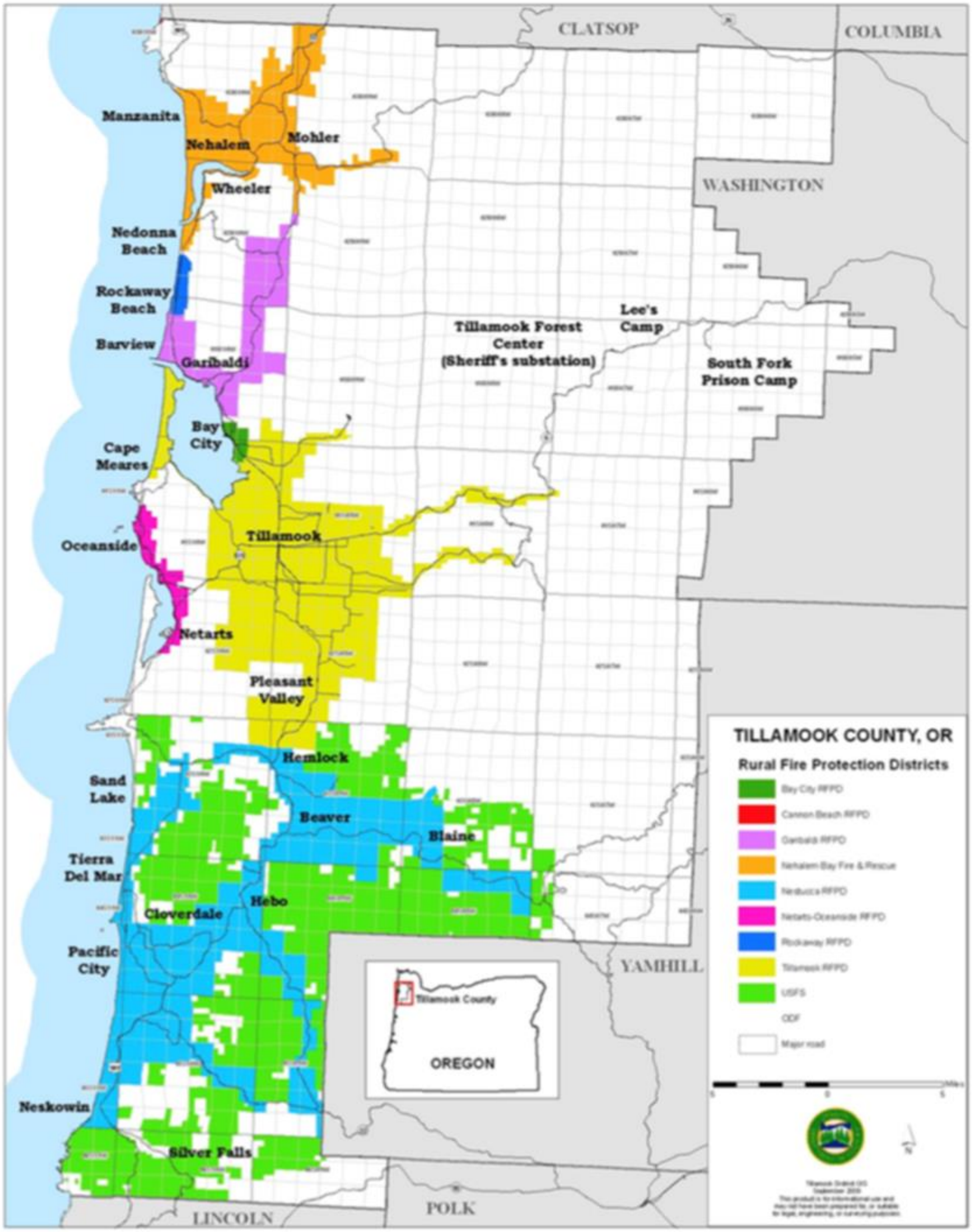
Applicable Development Code:

Section 3.500 Wildfire Hazard Overlay (proposed)

Implication for Tillamook County:

Specific components of the Forest (F) Zone that should be included in the proposed wildfire hazard overlay include: water supply requirements for fire protection requirements (4,000gal minimum or continuous streamflow), road access to dwellings, and prohibition of development on steep slopes (>40%). One of the most salient and effective requirements set forth in the Forest Zone relates to 'fuel break standards', also known as defensible space. The code clearly outlines concise conditions for a defensible space based on the slope of the development site, and includes a mandate to include additional distance when building down slope.

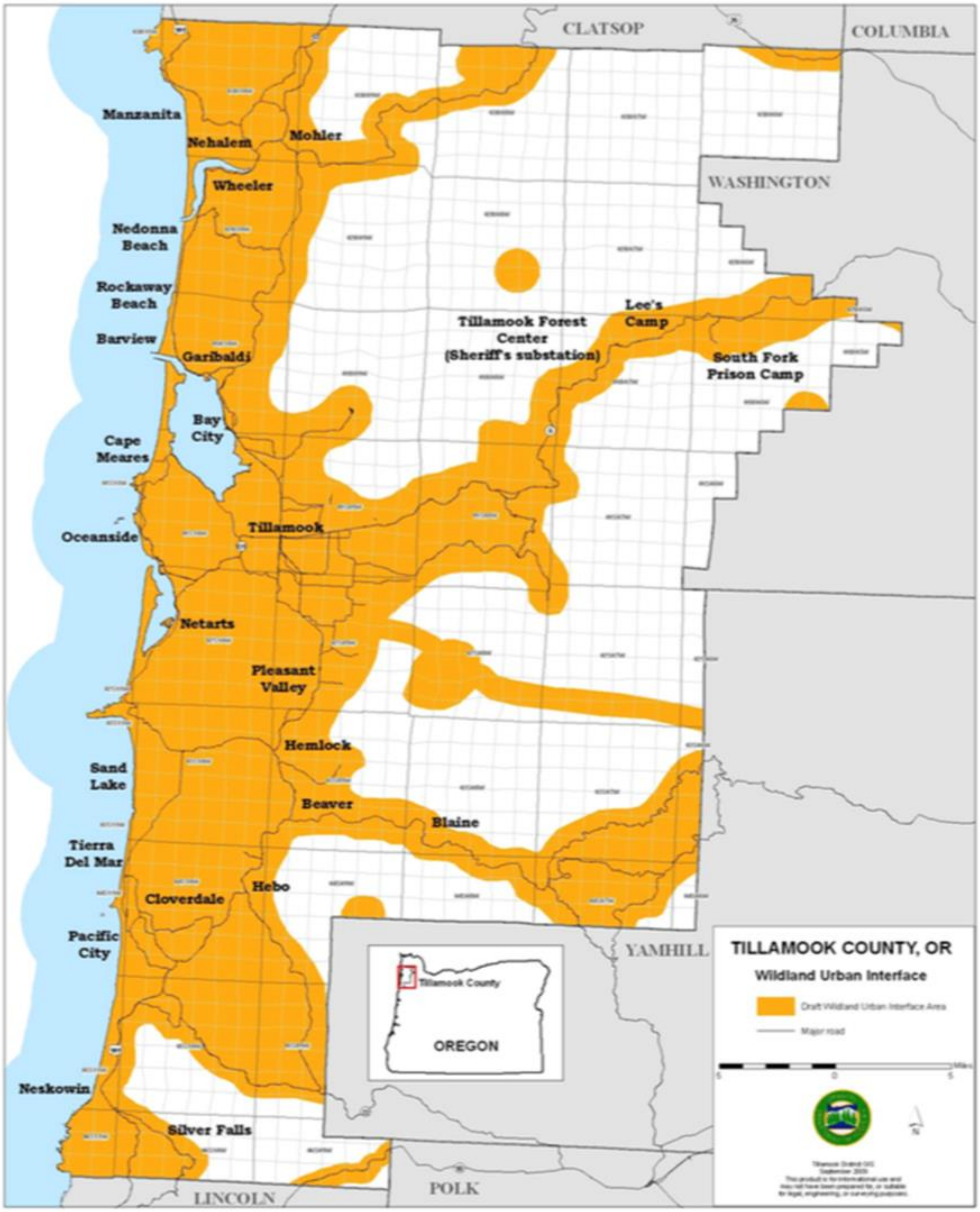
Figure 1: Tillamook Rural Fire Districts



Source: Tillamook County Community Wildfire Protection Plan. 2006
https://www.oregon.gov/ODF/Documents/Fire/CWPP/Tillamook.pdf

The Community Wildfire Protection Plan (CWPP) outlines Tillamook County's nine (9) rural fire protection districts. When evaluating the extent of a revision to the Forest zone, the County should consider future development areas and other areas that may be currently excluded from existing wildfire protection. Tillamook County's WUI (see Figure 2) encompasses all incorporated areas along the coast and cuts across the county towards the eastern boundary through Blaine and Lee's camp. Integrating the fire protection standards of the residential areas of the Forest zone into the high-risk areas of the WUI should be considered.

Figure 2: Tillamook Wildland-Urban Interface Extent



Source: Tillamook County Community Wildfire Protection Plan. 2006
https://www.oregon.gov/ODF/Documents/Fire/CWPP/Tillamook.pdf

Require Class A Roofing Materials in Wildfire Hazard Zone

Best Practice:

The most vulnerable part of a house to firebrands is the roof. If the roof is constructed of combustible materials such as untreated wood shakes and shingles, the house is in jeopardy of igniting and burning. Roofing materials are defined by ASTM E108 and tests conducted at UL Inc., FM Global, or any other certified testing laboratory. Class A roof requirements can be found in the Colorado Springs Development Code Section 8.4.105 (See Appendix).

Applicable Development Code:

3.500 Wildfire Hazard Overlay (proposed)

Model Code Language:

A minimum of a Class A roof covering (excluding solid wood roofing products) shall be installed on all Residential Occupancies within Overlay Zoning Code

Implication for Tillamook County

Current roof material requirements include code language that is not sufficiently specific. Detailing stringent roof material requirements more effectively reduces a structure's risk to wildfire. Class A, the highest fire-resistance rating for roofing as per ASTM E-108, indicates roofing can withstand severe exposure to fire originating from sources outside the building. Applying this standard to all new development and when roofs are substantially improved will provide the greatest protection.

Road Identification and Address Marking Requirements

Best Practice:

The International Wildland-Urban Interface Code section 403.4 and 403.6 provide specific language addressing road and address marking. The International Wildland-Urban Interface Code section 403.6 includes specific standards for address identification signs that could help emergency responders quickly and easily locate a residence in danger.

Applicable Development Code:

3.500 Wildfire Hazard Overlay (proposed)

Model Code Language:

All buildings shall have a permanently posted address, which shall be placed at each driveway entrance and be visible from both directions of travel along the road. In all cases, the address shall be posted at the beginning of construction and shall be maintained thereafter, and the address shall be visible and legible from the road on which the address is located.

Implication for Tillamook County:

Clearly identifiable signage for roads and residences helps emergency responders quickly locate and identify residences in time-sensitive situations (c) The owners of the dwellings and structures shall maintain a primary fuel-free break area surrounding all structures and clear and maintain a secondary fuel-free break area on land surrounding the dwelling that is owned or controlled by the owner in accordance with the provisions in "Recommended Fire Siting Standards for Dwellings and Structures and Fire Safety Design Standards for Roads" dated March 1, 1991, and published by the Oregon Department of Forestry and shall demonstrate compliance with Table (10)(c)1

Require Fire Protection Proof for Subdivisions

Best Practice:

Proof of Fire Protection is a best practice found in the Jefferson County, CO Land Development Regulation Section 4.C.18 (See Appendix). Requiring proof of fire protection from a fire district to serve the development will help ensure that emergency responders will adequately be able to service the property.

Applicable Development Code:

3.500 Wildfire Hazard Overlay (proposed)

Model Code Language:

Require a written statement from the appropriate fire district indicating that they will serve the property. If the property is not within a fire district, a contract with the district would need to be established indicating that fire protection to the property will be provided.

Implication for Tillamook County:

The Tillamook County Code does not currently require proof of fire protection for subdivisions; however, the county does require Fire Chief input. If a property is not currently provided fire protection service a contract, or annexation into a fire district, will help ensure fire protection can be provided. This policy could be restrictive to developers and cause service problems for fire districts however; it will ensure that adequate protection can be provided before property is developed

Wildland Fire Hazard Assessment

Best Practice:

Wildland Fire Hazard Assessments were initially introduced through Senate Bill 360. Assessments can be used to measure the hazard rating and applicable requirements necessary for each parcel. The following assessment is modeled from the Seven Basins Community Wildfire Risk Assessment.

Applicable Development Code:

3.500 Wildfire Hazard Overlay (proposed)

Model Code Language:

Building plans and development applications will be evaluated based upon a point system. The hazard rating (low, moderate, high and extreme) refers to the potential for damage from a wildfire, and is dependent on the combined effect of these environmental factors and how they affect fire behavior. The fire hazard rating includes the combined values for vegetation and landscape factors.

Implication for Tillamook County:

The county should consider including language stating the fire hazard risk would be determined by a wildland fire hazard assessment. A Wildland Hazard Assessment initiated before development would identify the level of risk to a property and ensure adequate mitigation standards are obtained before construction and occupancy.

Model Ordinance and Codes

The following model ordinances and standards were identified during research on wildfire mitigation. These documents have example language for specific mitigation strategies that could be implemented in Tillamook's development code.

National Fire Protection Association

The National Fire Protection Association (NFPA) is a national non-profit organization that sets national fire safety codes and standards. The codes that NFPA provides are standards that range from building, process, service, design and installation. Besides providing national fire safety codes and standards, the NFPA provides training and education about fire safety and standards.

NFPA 1141: Standard for Fire Protection Infrastructure for Land Development in Wildland, Rural, and Suburban Areas

This standard provides guidance on the development of the community infrastructure necessary to eliminate fire protection problems that result from rapid growth and change.

NFPA 1144: Standard for Reducing Structure Ignition Hazards from Wildland Fire

This standard provides guidance on individual structure hazards. It requires a new spatial approach to assessing and mitigating wildfire hazards around existing structures and includes improved ignition-resistant requirements for new construction.

International Wildland-Urban Interface Code (2012)

This comprehensive *wildland-urban interface code* establishes minimum regulations for land use and the built environment in designated wildland-urban interface areas using prescriptive and performance-related provisions. It is founded on data collected from tests and fire incidents, technical reports, and mitigation strategies from around the world.

CHAPTER 8: SAND INUNDATION

This chapter identifies the risk coastal erosion poses to unincorporated Tillamook County, the extent of risk, and the rate and location of development affected by coastal erosion. Following are policy options the county can consider to strengthen the Tillamook County Comprehensive Plan and Land Use Ordinance. Policy options are presented with descriptions of best practices, identification of the applicable county code sections, and details of economic, administrative, health, or environmental impacts of implementing the policy.

Extent of Risk

Sand inundation is the naturally occurring process of sand movement caused by wind and gravity. Sand accumulation causes damage to structures, buries lawns and septic systems, can block driveways and roads, and can prevent access to buried water lines, water meters, and fire hydrants. Sand inundation does not pose a short-term episodic risk to people and property, but the long-term chronic risks can be significant. Sand inundation is usually a chronic issue faced within a small geography and residents of these areas must continually work to prevent and remove sand buildup.

Development in Hazardous Areas

Sand inundation occurs in active dune areas where there is considerable movement of sand. The draft Risk Report does not analyze the risk of sand inundation in Tillamook County, but the Tillamook County Comprehensive Plan does indicate that sand inundation occurs along Sunset Drive in unincorporated Pacific City, as well as within foredune lots of the unincorporated areas of Nedonna, Tierra del Mar, and Neskowin. The county is providing for emergency sand removal in Tierra de Mar, Pacific City, and Neskowin indicating significant sand accumulation in these areas that is currently threating building stability and access.

Development on active foredune areas is not allowed under state Goal 18 Implementation Requirement number 2, but the County is has taken exemption to this in Cape Meares, Tierra del Mar, Pacific City, and Neskowin. The Ocean Shore Data Viewer[23] produced through the Oregon Coastal Management Program is a parcel level mapping of Goal 18 exemptions within the county and shows which lots are have been exempted and may be susceptible to sand inundation.

[23]Ocean Shores Data Viewer, accessed May 28, 2016
http://www.coastalatlas.net/index.php/tools/planners/67-ocean-shores-viewer

Existing Policies and Programs

State

Goal 18: Beaches and Dunes

Statewide planning goal 18 addresses the beaches and dunes of Oregon and prohibits development on active foredunes unless specific conditions are met. Goal 18 stipulates that “grading or sand movement necessary to maintain views or to prevent sand inundation may be allowed for structures in foredune areas only if the area is committed to development or is within an acknowledged urban growth boundary and only as part of an overall plan for managing foredune grading.” Additional specifications for foredune grading plans are provided within Goal 18 and such plans have been successfully implemented in communities along the Oregon Coast.

House Bill 1601

Known as the Oregon Beach Bill, HB 1601 passed in 1967 and defined the ocean shore area to be all wet sand within sixteen vertical feet of the low tide line and established this strip of land to be a state recreation area. Alternations to this strip of land require an Oregon Parks and Recreation Department Ocean Shore Alteration Permit.

Oregon Department of State Lands – Removal-Fill Law and Permit

The purpose of Oregon´s 1967 Removal-Fill Law (ORS 196.795-990) is to protect public navigation, fishery, and recreational uses of the waters. "Waters of the state" are defined as "natural waterways including all tidal and nontidal bays, intermittent streams, constantly flowing streams, lakes, wetlands and other bodies of water in this state, navigable and non-navigable, including that portion of the Pacific Ocean that is in the boundaries of this state." The law applies to all landowners, whether private individuals or public agencies.

Oregon´s Removal-Fill Law requires people to obtain a permit from the Department of State Lands (DSL) who plan to remove or fill material in waters of the state, including activities between extreme low-tide elevation seaward to the limits of the territorial sea, which is three nautical miles into the Pacific Ocean. Note that this area does not include the beach which is defined as the area between extreme low tide (lowest estimated tide) and the “line of statutory vegetation” or “actual vegetation line” whichever is further inland. The beach is regulated through the Oregon Parks and Recreation’s Ocean Shore Permit Program.

Many projects that require a DSL removal-fill permit also will require a federal permit from the U.S. Army Corps of Engineers, however DSL and the Corps use a joint permit application form.

Oregon Parks and Recreation Department – Ocean Shore Permit

The Oregon Parks and Recreation Department (OPRD) has been charged with the protection and preservation of the recreation, scenic, and natural resource values found on Oregon's ocean shore. To help accomplish this, ocean shore alterations include the construction of shoreline protective structures, beach access ways, dune grading and other sand alterations, the routing of pipelines and cables beneath the ocean shore, and other natural product removal require an Ocean Shore Permit.

House Bill 3030 – Sand Control Districts

The Oregon governor signed House Bill 3030 in June 2015 authorizing the formation of sand control districts for the purposes of controlling drifting sand. Sand control districts are voluntary districts that must be approved by voters within their boundaries. A district board composed of three members has the power to pass taxes to fund an account that can be drawn from for sand control activities and further manages the district. Additionally, sand control districts may issue general obligation bonds to fund sand management controls. House Bill 3030 does not form any sand control districts, instead it provides the legal framework for them to be formed. At this time, there are no sand control districts in Oregon, but Bayshore has expressed interest in utilizing this new sand management tool.

County

Nedonna Beach Foredune Management Plan

Passed in 1987, the Nedonna Beach Foredune Management Plan consists of a Technical Report that analyzes the factors that affect dune stability in the management area, a Grading Plan that details when and how grading may occur, and a Management Plan which recommends other regulations to enhance the stability of the foredune. The County considers this foredune management plan to be a framework that can be utilized for further management plans.

Pacific City Foredune Management Plan

Passed in 1998, the Pacific City Foredune Management Plan is composed of a Technical Report, Grading Plan, and Management plan for grading activities the specified management area.

Comprehensive Plan Review

Tillamook County's Comprehensive Plan provides the framework for the existing sand inundation mitigation actions. This section identifies how this hazard has been included in the comprehensive plan and suggests ways to strengthen and improve its inclusion in support of further mitigation strategies. In the following sections Comprehensive Plan text is italicized, suggested edits are in **bold,** and suggested text removals are ~~crossed out~~.

Goal 18 Beaches and Dunes 2.2b, Active Foredunes (FDA)

CSC Comment: The Comprehensive Plan identifies areas of sand inundation within the County, however this information is not updated. This section should be critically reviewed for consistency with current sand inundation occurring in the County. Sand inundation occurs throughout Pacific City not just along Sunset Drive, and it is recommended that the comprehensive plan be revised to reflect the extent of the risk.

In the Nedonna, Pacific City, and Neskowin areas, severe wave erosion necessitated the placement of riprap~~***. In the Pacific City area, sand inundates several houses along Sunset Drive every year***~~***. In the Pacific City area, sand inundates houses along the entire coast including the Sunset Drive area.***

Goal 18 Beaches and Dunes 3., Foredune Management

CSC Comment: The Comprehensive Plan currently acknowledges the Nedonna Beach Foredune Management Plan. The Pacific City Foredune Management Plan should also be acknowledged in this section of the Comprehensive Plan.

Although undeveloped foredunes in the County remain protected by Goal 18, many active foredune and conditionally stable foredune areas were platted for residential subdivisions before the unsuitability of such areas for development was realized. In the Necarney City, Nedonna, Tierra del Mar, Pacific City and Neskowin areas sand periodically inundates houses on foredune lots. The County is providing for sand removal under emergency conditions in the Tierra del Mar, Pacific City, and Neskowin areas.

Necarney City is within the city of Manzanita urban growth boundary area, however their Comprehensive Plan does not provide for foredune grading. Nedonna is within the City of Rockaway Beach urban growth boundary and a Foredune Management Plan pursuant to Goal 18 implementation requirement 7, is included in the City's Comprehensive Plan to allow foredune grading.

The Nedonna Beach Foredune Management Plan consists of three parts: a Technical Report analyzes the factors affecting the stability of the dunes in the area, a Grading Plan which specifies how and when grading may occur in Nedonna Beach, and a Management Plan which recommends how other alterations should be regulated to enhance the stability of the foredune. While this foredune study focused on the Nedonna/Rockaway Beach shoreline, many of the management recommendations, standards for foredune grading, and general information on coastal processes can be applied to the Tierra del Mar~~*, Pacific City,*~~ *and Neskowin foredune areas, when the County develops Foredune Management Plans for these areas.*

The Pacific City Foredune Management Plan was created in 1998 and guides grading activities within the Pacific City Foredune Management area units A-H as defined in the report.

Goal 18 Beaches and Dunes 3.3, Foredune Management Policies

CSC Comment: In this section of the Comprehensive Plan, the need for dune management studies for view maintenance in Pacific City, Tierra del Mar, and Neskowin is identified. Additionally, Pacific City has an existing Foredune Management Plan that should be listed. Both the existing foredune management plans in Nedonna Beach and Pacific City are over 15 years old and should be reviewed and updated. The need for updated foredune management plans in these areas should be an identified in this section of the Comprehensive Plan.

Tillamook County strongly urges that the Department of Land Conservation and Development initiate studies of dune management for view maintenance in the communities of ~~Pacific City,~~ Tierra del Mar, and Neskowin. Additionally, the dune management studies previously conducted for Pacific City and Nedonna Beach should undergo a review and update process.

Land Use Ordinance Policy Options

This section presents a toolbox of wildfire hazard mitigation strategies. Recommendations range from highly regulatory to incentive-based, and best practices are linked to specific case studies found in Appendix **A,** as appropriate. Within each strategy, best practices identified through policy analysis research form the basis for the recommendation. Location of applicable Land Use Ordinance sections related to the implementation of the strategy is identified and any model code language is presented for potential adoption. The implications of adoption are also discussed.

In the following section, model development code is **bold**

For a complete list of the recommended comprehensive plan and land use ordinance policy options see Tables 2 through 7

Updated Beach and Dune Landform Report and Maps

Best Practice:

Beach and dune landforms are dynamic landforms that change over time and the current inventory referenced in the Comprehensive Plan and utilized in the Section 3.530 Beach and Dune Overlay is from the 1975 “Beaches and Dunes of Oregon Coast” report. Up-to-date GIS maps of beach and dune landforms should be developed to apply overlay requirements consistently and accurately.

Applicable Development Code:

Section 3.530 Beach and Dune Overlay (BD) (2)(a) Foredune Grading

Implication for Tillamook County:

The County will need to identify funding sources, possible through FEMA, and work in collaboration with DOGAMI to have an updated beach and dune form study conducted for the county. The new mapping would then need to be formally adopted by the County. Accurate mapping allows for consistent and legally prudent application of the Beach and Dune Overlay requirements.

Foredune Management Plans for All Areas of Sand Inundation

Best Practice:

Foredune Management Plans should be developed for all areas where considerable sand inundation is occurring to guide grading in accordance with state regulations and environmental best practices. Foredune management plans are composed of a Technical Report that analyzes the factors that affect dune stability in the management area, a Grading Plan that details when and how grading may occur, and a Management Plan which recommends other regulations to enhance the stability of the foredune

Applicable Development Code:

Section 3.530 Beach and Dune Overlay (BD) (2)(a) Foredune Grading

Implication for Tillamook County

The Tillamook County Comprehensive Plan identifies four areas for Dune Management Plans: Nedonna Beach, Pacific City, Tierra del Mar, and Neskowin. Plans exist for Nedonna Beach and Pacific City, however these plans and their technical reports are from 1987 and 1998 respectively and they should be reviewed and updated. Foredune management plans should be created for Tierra del Mar and Neskowin. The County should develop the technical reports, grading plan, and management plans that compose a foredune management plan. DOGAMI may be an option to provide technical assistance. Funding may come from a variety of sources including FEMA.

Grading Type Specific Permits

Best Practice:

Grading of the foredune occurs for multiple reasons from viewshed protection to removal of sand physically inundating a structure. The grading permit process should be specific to the type of grading that is occurring and should recognize the differences between grading type requirements in a clear and easy to understand manner. Currently, Tillamook County utilizes a single set of general grading permit conditions that are not specific to the type of grading and grading specification are dispersed and challenging to differentiate in the Foredune Grading code section.

Applicable Development Code:

Section 3.530 Beach and Dune Overlay (BD) (4)(C.)(2) Foredune Grading

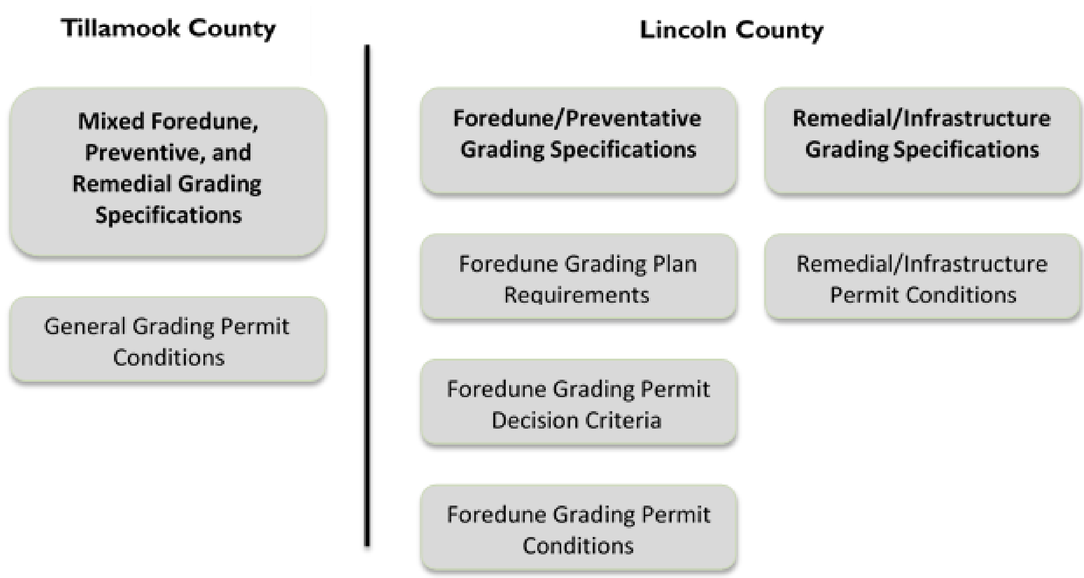
Model Code Language:

Lincoln County's Zoning Code Section 1.1385 Foredune Management Overlay Zone provides clear and comprehensive grading permits for distinct types of grading. [24] The Lincoln County Overlay Zone is a model code that includes practices that could strengthen Tillamook County's Foredune Grading code section. Specific code language from this overlay is found in the following sections.

Implication for Tillamook County

The Foredune Grading section of the Beach and Dune Overlay has a mixed set of requirements for various types of grading followed by general grading permit conditions. The format and structure of this section makes determining grading specifications and permit requirements challenging and does not represent the most comprehensive or clear foredune grading requirements. The following diagram summarizes the structural differences between the Tillamook County and Lincoln County code sections.

Figure 3: Comparison of Tillamook and Lincoln County Foredune Review Procedure



Source: Community Service Center

[24] Zoning Code Section 1.1385 Foredune Management Overlay Zone *http://www.co.lincoln.or.us/sites/default/files/fileattachments/county_counsel/page/384/2013-lcc-chapter-01.pdf*

Foredune Grading Definitions

To provide clarity and to improve the readability the following definitions from Lincoln County should be adopted within a "definitions" section of the Tillamook County Foredune Grading section of the Land Use Code. Currently, the Tillamook County Foredune Grading section provides only a single definition for foredune grading that does not distinguish between grading for view protection, preventive grading, infrastructure grading, and remedial grading.

Model Code Language:

(a) "Dune nourishment" means augmentation of the natural sediment supply within a foredune area.

(b) "Foredune grading" means alteration of the foredune area through sand transfer or removal of sand by mechanical means in order to accomplish view grading and/or preventative grading.

(c) "Infrastructure grading" means removal of sand which is physically inundating roadways, beach accesses, septic systems, and underground utilities, thereby causing damage, impeding vehicular and pedestrian movements, and otherwise interfering with service provision and operations related to the impacted infrastructure systems.

(d) "Management Unit" means a discrete segment of foredune area identified, described and numbered as a Management Unit in an approved Foredune Management Plan.

(e) "Preventative grading" means the removal of sand which threatens to inundate a structure from the immediate vicinity of the structure.

(f) "Qualified Professional" means either an Oregon Registered Geologist or Certified Engineering Geologist, with experience working on Pacific Northwest beaches.

(g) "Remedial grading" means removal of sand from a developed lot which is physically inundating a structure and causing damage or preventing access to the structure, or removal of sand from a vacant lot which is threatening to inundate adjoining lots.

(h) "Sand Removal" means the mechanical movement of sand to alternative disposal areas outside the Foredune Management Area.

(i) "Sand Transfer" means the mechanical or natural movement of sand within and between management units.

(j) "View grading" means grading of dune areas for the purpose of restoring, obtaining, or maintaining views from existing structures.

Foredune Grading Plan Requirements

Best Practice:

The Tillamook County Foredune Management code should clearly identify the requirements for a Foredune Grading Plan in a single location within the code.

Model Code Language

In the following tables, current Tillamook code is *italicized*, model Lincoln County code is **bold**, and model code that is substantively different than the existing code is both **<u>bold and underlined.</u>** The leftmost column of the table shows the Foredune Grading subsection where the Tillamook County requirement is found. It should be noted that these requirements are currently dispersed through the code section, and some are found in list format while others are found as sentences in paragraph sections.

Table 18: Foredune Grading Plan Requirement Comparison

(4)C.2	Tillamook County Requirement	Lincoln County Requirement
e.1.	*Description of the proposed work, including location and timing of activities, and equipment to be used.*	**(A) Narrative describing the proposed work;**
e.2.	*Plan view and elevations of existing conditions in the grading area;*	**(B) Plan view and elevations <u>expressed in NAVD 88</u> of existing conditions in the work area;**
e.3.	*Plan view and elevations of proposed modifications in the grading area.*	**(C) Plan view and elevations <u>expressed in NAVD 88</u> of proposed modifications in the work area, <u>demonstrating general consistency with grading profiles for the Management Unit(s) in which the work is to be performed</u>;**
-		**<u>(D) Identification of needed remedial and/or infrastructure grading within the project area and a description of how such grading will be integrated into the proposed work;</u>**
d.	*Outline requirements for future monitoring.*	**<u>(E) Surveyed profiles for subarea grading designs sufficient to establish a baseline for monitoring;</u>**
-		**<u>(F) Revegetation plans consistent with the specific Management Unit recommendations;</u>**
d.	*Outline requirements for future monitoring.*	**<u>(G) Monitoring and maintenance plan for the work area consistent with the requirements of this section;</u>**
e.4.	*Identity of the individual(s) responsible for supervising the project, and for conducting monitoring and maintenance activities.*	**(H) Identification of the person(s) responsible for supervising the project;**

Source: Community Service Center

Foredune Grading Permit Decision Criteria

Best Practice:

The Tillamook County Foredune Management code should clearly identify the Foredune Grading Permit Decision Criteria in a single location within the code.

Model Code Language:

Table 19: Foredune Grading Permit Decision Criteria Comparison

(4)C.2	Tillamook County Requirement	Lincoln County Requirement
e.	*All grading plans shall cover all or at least a 500 foot portion of a Management Unit plan contained in the Management Strategy and shall have approval of 60% of the property owners in the area covered.*	**(A)The proposed grading, restoration, monitoring and maintenance plan encompasses an entire Management Unit or a contiguous segment of not less than 500 feet, as measured along the statutory vegetation line;**
d.	*Grading in foredune crest areas shall only be allowed where the dune elevation is more than four feet above the base flood elevation.*	**(B) The proposed grading will not reduce the height of any foredune below four feet above the V-zone Base Flood Elevation.**
-		**(C) The plan incorporates, to the extent practicable, all needed remedial and infrastructure grading within the project area; and**
e.	*Administrative Review of the plan shall be confined to determining consistency with the approved Foredune Management Plan.*	**(D)The proposed grading, restoration, monitoring and maintenance plan is consistent with the policies and requirements for the affected Management Units as set forth in approved Foredune Management Plans.**

Source: Community Service Center

Foredune Grading Permit Conditions

Best Practice:

The Tillamook County Foredune Management code should clearly identify the Foredune Grading Permit Conditions in a single location within the code.

Model Code Language:

Table 20: Foredune Grading Permit Conditions Comparison

(4)C.2	Tillamook County Requirement	Lincoln County Requirement
b.	*Sand graded from foredune lots shall be relocated either to the beach, to low and narrow dune areas on the site, or to alternative beach and dune areas as specified in an approved Foredune Management Plan.*	**(A) Sand removal is prohibited. Transfers between and within Management Units is permitted in accordance with the approved Foredune Grading Plan;**
d.	*Grading in foredune crest areas shall only be allowed where the dune elevation is more than four feet above the base flood elevation*	**(B) No foredune shall be reduced in height to less than four feet above the V-zone Base Flood Elevation;**
d.	*Define the appropriate timing for grading actions.*	**(C) Grading shall be conducted only between February 1 and April 1, or between October 1 and October 31;**
-		**(D) Upon completion of authorized grading activities, revegetation shall be accomplished in accordance with the approved Foredune Grading Plan;**
-		**(E) Within 30 days of completion of the initial grading and revegetation, the permitee shall submit to the director a written statement from a qualified professional that the project has been completed in conformance with the provisions of the Foredune Grading Plan;**
d.	*Outline requirements for future monitoring*	**(F) Within one year of completion of the initial grading and revegetation, and annually thereafter during the time within which the permit remains valid, the permitee shall submit a monitoring report prepared by a qualified professional**

Source: Community Service Center

Remedial/Infrastructure Grading Plan Requirements

Best Practice:

The Tillamook County Foredune Management code should clearly identify the remedial/infrastructure grading plan requirements in a single location within the code.

Model Code Language:

Table 21: Remedial/Infrastructure Grading Plan Comparison

(4)C.2	Tillamook County Requirement	Lincoln County Requirement
-		**(A) All remedial and infrastructure grading activities shall be performed in a manner that avoids alteration of the existing height of the foredune and does not significantly damage existing vegetation;**
c.	*Inundating sand shall be disposed of seaward of existing structures and distributed in a manner that shall not impact adjacent dwellings or adversely impact the public beach .*	**(B) All sand removed from a property during remedial grading shall be moved up and over the foredune seaward of the building and shall be accomplished in a manner that minimizes disturbance to existing dune height, vegetation, and the beach;**
-		**(C) Only one disposal access shall be allowed on the property for the purpose of pushing sand up and over the foredune seaward of the structure. The access shall be limited to the minimum width necessary to accommodate the equipment being used and in no case wider 94 feet. Upon completion of the project, the access shall be re-contoured to the height of the existing adjacent dune;**
-		**(D) On properties where the foredune has been previously lowered below the undisturbed foredune height on the rear (seaward) yard, the foredune shall be allowed to build up and no grading is allowed;**
c.	*Areas graded between November and April shall be replanted with beachgrass or other appropriate vegetation approved by the Department. If grading occurs between the months of May and October, approved temporary stabilization measures, such as mulching with ryegrass straw or matting shall be employed.*	**(E) Permanent stabilization of any portion of the foredune disturbed by remedial sand removal activities shall be accomplished through planting, fertilization, and maintenance of European beachgrass. Beach grass shall be planted at a spacing of 18 inches and carried out between November 1 and April 1. After initial planting and fertilization, stabilization shall include follow-up fertilization. Planting shall also include the re-contoured area used for the disposal access road. Documentation of revegetation efforts shall be provided to the Planning & Development Department within 10 days after planting has been completed;**
	Comment: In the Planning Commission workshops, concern was expressed over the use of European beach grass as it can over stabilize a dune to the point that natural ocean processes are disrupted. Native vegetation is often out competed by European Beachgrass that is already an extensive species on Oregon's foredunes. Managing European Beachgrass is extremely challenging given its deep root system and ability to regrow after being cut. Tillamook County should assess the extent and severity of European Beachgrass and determine an appropriate strategy for managing it and for replacing it with native vegetation.	

Source: Community Service Center

Table 21: Remedial/Infrastructure Grading Plan Comparison (continued)

(4)C.2	Tillamook County Requirement	Lincoln County Requirement
-		(F) Remedial grading adjacent to structures shall be limited to the following: (i) Rear yard: (Rear yard is the yard seaward of the structure). Sand may be removed to the level of the top of the sill of the foundation within 10 feet of the building, or the base of an existing deck. From the 10-foot line, all grading shall slope upward to where it intersects the ground surface of the existing dune at a ratio of 2:1 (horizontal:vertical). (ii) Side yards: Sand may be removed to the level of the top sill of the foundation within 10 feet of the building (if possible). From the 10-foot line, sand grading shall slope upward at a ratio of 2:1. (iii) Front yard: All sand that is landward of the building may be removed down to the sill level of the foundation, provided removal does not create slopes of more than 2:1 with adjacent properties. Grading may not lower the front yard below the level of adjacent streets or roads except to clear sidewalks or driveways;
-		(G) Remedial grading on vacant lots shall conform to the following requirements: (i) Vacant lots shall, at a minimum, be graded to alleviate sand sloughing hazards to adjoining properties by grading the slopes of the vacant lots so they do not exceed gradients of 2:1 (horizontal:vertical). Such minimal grading is expected to require regular maintenance to maintain a maximum slope of 2:1. (ii) Vacant lots should optimally be graded to elevations that are similar to adjoining lots but in no case shall be lowered below an elevation which is 4 feet above the BFE for the relevant management unit. (iii)A site-specific plan should be prepared specifying where the sand will be placed on the beach or lower seaward side of the foredune. (iv)Vegetation Stabilization: Graded areas shall be stabilized with vegetation after completion of grading. 1. Planting and fertilization for vacant lots and associated disposal areas shall be carried out during rainy months between November 1 and April 1 in accordance with specifications in approved Foredune Management Plans, except that approved disposal areas within the typical tidal range need not be vegetated. 2. Barriers should be constructed around graded vacant lots to prevent trampling of the planted areas.

Source: Community Service Center

Sand Control Districts

Best Practice:

Sand control districts are voluntary sand management programs in which residents may vote to form a district that funds sand management through taxes and general obligation bonds. In 2015, *House Bill 3030* legalized the formation of sand control districts in Oregon and provides regulations for the formation and operation. At this time, no sand control districts have been formed through this new process.

The Tillamook Land Use Ordinance should recognize the existence of this new sand management tool and its implications for foredune grading permits should be assessed.

Applicable Development Code:

Section 3.530 Beach and Dune Overlay (BD) (2)(a)

Implication for Tillamook County:

Sand control districts have the potential to leverage much larger sums of money for sand control than under Foredune Management Plans or as a single property owner. There is the potential for an increase in the number and scale of foredune grading permit applications if sand control districts are formed. The County should look to adopt grading type specific permit requirements, as detailed in the previous sections, prior to the formation of sand control districts in the county to ensure that all sand grading follows best practices and minimizes risk to people, property, and the environment.

Model Ordinance and Codes

The following model ordinances and standards were identified during research on **s**and inundation mitigation. These documents have example language for specific mitigation strategies that could be implemented in Tillamook's development code.

Lincoln County, OR Foredune Management Overlay Zone

Lincoln County utilizes a specific overlay zone for foredune management. In this overlay zone, specific requirements for foredune grading by type of grading are provided for foredune and preventive grading and for infrastructure and remedial grading.

CHAPTER 9: MULTI-HAZARD

This section identifies natural hazard mitigation strategies and policies that unincorporated Tillamook County should consider using to limit risk to future development within natural hazard prone areas. These recommendations are not particular to a single hazard; instead they apply to high-risk property whether from a single natural hazard or due to the cumulative impacts of multiple natural hazards. Multi-hazard mitigation tool options are presented with descriptions of best practices, applicability to unincorporated Tillamook County, and identification of how such a program could be implemented within the County.

Transfer of Development Rights

Transfer of Development Rights (TDR) programs effectively prohibit development within areas highly susceptible to hazards, and alternatively encourage development in an area that is less susceptible and can better serve the community. TDR is a program that allows landowners to sell development rights of land that may be in a highly-impacted area to an interested party who then can use those rights to increase the density of development on a different property. The definition of a highly-impacted area can range from development in a hazard prone area to development in preservation areas. Existing TDR programs in Oregon are limited to a few jurisdictions, specifically the City of Portland, Deschutes County, and Douglas County.

TDR Program in Tillamook County

By allowing landowners to enter a Transfer of Development Rights Program, the consumption of government emergency resources is reduced; thereby decreasing costs to local government. Additionally, prohibition of development helps to protect residents from high-risk and dangerous areas.

As local government develops a TDR program they need to explore development incentives to provide tax relief for encumbered sending areas. In doing so, local government should add a program component that provides methods to transfer property ownership conservatorship. Conservatorship might be biased toward preservation of open spaces.

Model Code Language:

The following information comes from *the Douglas County Model Transfer of Development Rights Guide:*

TDR programs have several features each of which can be used to gauge the impact or effectiveness of focused development.

1) Ease of Understanding: To have an effective TDR program, a program should be simple and easy for all parties to understand (e.g., landowners and the public). Citizens and leadership of a community entering into a TDR program must be totally committed to the process.

2) Managed Growth: TDR programs should be incorporated into Tillamook's comprehensive plan. The county, municipality, or regional planning area must also utilize zoning ordinances and overlays that support TDR programs.

3) Adequate Incentives: Developers need adequate incentives to sell their development rights. Also, receiving areas must be attractive enough for developers to want to purchase rights.

4) Careful Management: Trained planning staff must manage the program to identify and authorize the use of a development credit. Jurisdictions should be aware when parcels are determined not buildable (by a geotechnical report) they should remove it from the buildable lands inventory.

Property Acquisition

In a situation where hazard threat is too high to justify improvement funding or mitigation action, the acquisition of property can be an effective way to move people and property away from high-risk areas. FEMA's Hazard Mitigation Grant Program (HMGP) may provide funding for voluntary selling of property in such areas. FEMA also offers the following mitigation grant programs: the Flood Mitigation Assistance Grant Program (FMA) and the Pre-Disaster Mitigation Grant Program (PDM). An acquisition can apply to a single piece of property or an entire neighborhood. After dialogue and collaboration, the purchase of damaged property is made through an agreement between the local government and the property owner. Under these grant programs, once an acquisition project is approved by the state and FEMA, the community uses Federal funds to purchase the home or building, and the land is restricted to open space, recreation, or wetlands in perpetuity. Alternatively, the local government can use their own funding sources, such as fundraising, assets liquidation, and the general fund, to purchase property.

Property Acquisition in Tillamook County

Property acquisition can be most effective for reducing exposure and vulnerability of property and people, especially in areas highly susceptible to flood, landslide, and coastal erosion. Though FEMA funding may be available to facilitate the acquisition of high-risk properties, the most important element of this mitigation strategy is political will. Successful property acquisition hinges on the willingness of the residents and community to recognize the danger associated with the property in question, and collaboration with government agencies to determine fair compensation.

Post-Disaster Building Moratorium

Post-disaster building moratoriums include two key components. The first is a proactive ordinance that establishes the conditions and framework under which a building moratorium will be imposed. The second is reactive ordinance that is adopted immediately following a disaster that is tailored to the specific event and defined community area in which the event occurred. Such a building moratorium provides affected areas with an often-overlooked period of reflection on the extent and severity of the natural hazard prior to making decisions concerning rebuilding and redevelopment. This window of time can be used to formulate thoughtful planning in hazard areas that ensure appropriate measures are taken to avoid repetitive losses.

Post-Disaster Building Moratorium in Tillamook County

Tillamook County has considerable development in high hazard areas as highlighted in the preceding individual hazard sections. Additionally, development has occurred in Goal 18 exemptions areas where inherent site conditions pose risk to development. For these reasons Tillamook County should consider adopting a proactive Post-Disaster Building Moratorium Ordinance that established the conditions that may trigger a moratorium and details the requirements that must be addressed in a post-disaster moratorium.

Some communities may choose to adopt a tiered approach to development activities restricted under a moratorium. For example, the *Hillsborough County, Florida ordinance* establishes different timelines following a disaster for destroyed structures, major damaged structures, minor damaged structures, new development, previously issued building permits, development orders, and site plan reviews.[25]

When considering a Post-Disaster Building Moratorium in Tillamook County, the following model code from the *Planning for Hazards: Land Use Solutions for Colorado guide* produced by the Colorado Department of Local Affairs may provide guidance and clarification on what such an ordinance specifies.[26]

Model Code Language

The purpose of this ordinance is to:

A. Authorize the implementation of a building moratorium when the following actions or findings occur:

The [municipality or county] is declared a disaster area by the Governor of Oregon or the President of the United States;

The [City Council, Board of County Commissioners, or equivalent] declares a local state of emergency; or

The [municipality or county] is unable to maintain acceptable levels of service following an event as determined by the [City Council, Board of County Commissioners, or equivalent].

---

[25] Redevelopment and Mitigation Ordinance, Hillsborough County FL, accessed June 7, 2016 *http://www.hillsboroughcounty.org/DocumentCenter/Home/View/1051*

[26] Post-Disaster Building Moratorium Model and Commentary, Planning For Hazards Land Use Solutions for Colorado, accessed June 7, 2016 *http://planningforhazards.com/post-disaster-building-moratorium-model-and-commentary*

B. Foster appropriate response during and after a disaster, which often require extraordinary actions.

C. Modify development approval procedures to allow property owners to build, repair, or rebuild in a timely, safe, and responsible manner.

Any moratorium imposed shall be subject to review by the [City Council, Board of County Commissioners, or equivalent] at the earliest possible time, but no later than [90 days] after it begins. At that time, the [City Council, Board of County Commissioners, or equivalent] shall extend, terminate, or modify the moratorium.

A. Public Notice

Notice of any moratorium shall be posted in the defined location for all other public notices and shall identify the geographic area for which the moratorium is in effect and the review and permitting procedures impacted by such moratorium.

B. Suspension of Development Activity

The [City Council, Board of County Commissioners, or equivalent] shall have the authority to temporarily suspend the issuance of land use and development permits they administer under the land use code, building code, and any other ordinance where suspension of such permit is deemed necessary and reasonable to protect the public health, safety, and welfare of the community.

The suspension of permits may also include applications currently under review. If an application under review is suspended, the applicable review timeframes shall also be suspended until the development activity suspension has been terminated.

C. Deconstruction or Demolition of Damaged Structures

Any deconstruction or structure demolition requires the appropriate permit from the [building official, planning director, city/county engineer, city/county manager, or equivalent]. The [building official, planning director, city/county engineer, city/county manager, or equivalent] may waive any or all permitting requirements depending on the type of work and the extent of the disaster.

E. Emergency Repairs

Emergency repairs necessary to prevent imminent danger to life or property is exempt from this section except that the property owner shall notify the [building official, planning director, city/county engineer, city/county manager, or equivalent] within [72 hours/one week/10 days/other timeframe] of the work conducted and shall apply for any required permit as deemed necessary by the [building official, planning director, city/county engineer, city/county manager, or equivalent].

Post-Disaster Recovery Plans

Post-disaster recovery is defined as developing a set of strategies including a management strategy to assist a community to rebuild after a disaster occurs. It involves making decisions in advance that provide alternatives for the early return to normalcy, reduction of future vulnerability, and opportunities to improve the community. The framework for creating Post-Disaster Recovery Plans was developed in 2008 by the Oregon Natural Hazards Workgroup (now the Oregon Partnership for Disaster Resilience) at the University of Oregon's Community Service Center.[27] The purpose of these plans is to better prepare coastal communities in the Cascadia Region for the short-term recovery and long-term reconstruction efforts communities may face because of a catastrophic Cascadia Subduction Zone event. Experts say that the Oregon coast has a 10-20% chance of facing a region wide catastrophic Cascadia Subduction Zone earthquake and tsunami in the next 50 years, and research indicates that communities can recover more easily if they identify ahead of time strategic priorities for how they will rebuild, restore, improve, and grow in the aftermath of a catastrophic disaster.

Post-Disaster Recovery Plans in Tillamook County

Tillamook County currently has no Disaster Recovery Plans in place to help guide the rebuilding, restoration, improvement, and growth of its communities and areas in the event of a catastrophic disaster. Tillamook County has considerable property and life exposed to numerous natural hazards as detailed in the previous natural hazard chapters and the County should look to develop strategies and build capacity prior to a large-scale catastrophe (a Cascadia Subduction Zone earthquake and tsunami).

The process of creating Post-Disaster Recovery Plans is complex and there are no recovery plans in Oregon. The South Coast Post Disaster Recovery Frameworks (Curry, Coos, Douglas, and Lane) provide a template for developing a Post-Disaster Recovery Plan. Additional Post-Disaster Recovery resources developed by the Oregon Natural Hazards Workgroup are provided below. Lastly, a link is provided to FEMA's Planning for Post Disaster Recovery and Reconstruction guide that introduces community planners to policies for rebuilding and recovery after disasters and provides guidance on how to plan for post-disaster reconstruction.

---

[27] Community Post Disaster Recovery Planning Forum Process, University of Oregon, accessed June 7, 2016
https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/5570/CREW_Report_07.17.06.pdf?sequence=1&isAllowed=y

Table 22: Post-Disaster Recovery Plan Resources

Resource	Description
Coos County Post Disaster Recovery Framework	Coos County developed this Post-Disaster Recovery Framework in an effort to better prepare for the aftermath of catastrophic disasters, understand their response capabilities and limitations, and to establish comprehensive long-term recovery and rebuilding strategies
Community Post Disaster Recovery Planning Forum Process	The purpose of this report is to describe the process used to conduct a community post-disaster recovery-planning forum aimed at addressing a catastrophic disaster event. The report highlights methods used to implement and document the forum process in Cannon Beach and findings from a post-forum participant evaluation.
Catastrophic Post-disaster Long-term Recovery Planning: A Capacity and Needs Assessment of the Oregon Coast	In order to identify what opportunities and challenges coastal communities currently face in planning for catastrophic post-disaster long-term recovery a capacity and needs assessment was conducted of the thirty-two incorporated cities along the Oregon coast.
Cannon Beach Case Study Report	The purpose of this report is to document the community post-disaster recovery planning forum outcomes from Cannon Beach.
Planning for Post-Disaster Recovery and Reconstruction	This FEMA document equips planners and others involved in post-disaster reconstruction at all levels of government with the tools needed to create (or re-create) communities that will withstand natural disasters.

Source: Community Service Center

Stormwater Management / Low Impact Development

Low Impact Development (LID) is development that preserves natural resources and allows for the management of stormwater runoff. The Puget Sound Partnership defines LID as “a stormwater and land use management strategy that strives to mimic pre-disturbance hydrologic processes of infiltration, filtration, storage, evaporation and transpiration by emphasizing conservation, use of on-site natural features, site planning, and distributed stormwater management practices that are integrated into a project design.“[28] Low Impact Development standards may be used to enhance existing stormwater management practices.

Stormwater Management / Low Impact Development in Tillamook County

The Puget Sound Partnership in the State of Washington has been a national leader in developing LID standards and has published extensive guidance documents aimed to assist jurisdictions implement these standards. The process for this and

[28] Low Impact Development in Western Oregon: A Practical Guide for Watershed Health. Green Girl LLC. 2016 http://www.greengirlpdx.com/Publications.htm

further details related to LID standards is outlined in a case study which can be found in Appendix A of this report.

At the time of publishing there are no adopted LID regulatory standards in use in the State of Oregon, but there are some communities, small businesses, and non-profit organizations that are working to encourage its use in the future. There are examples of LID being used to manage stormwater as a voluntary practice by a property owner. The ocean-friendly garden installed at Seven Devils Brewery in Coos Bay, is an example of a local government and property owner collaborating to utilize LID practices that go above and beyond the regulatory stormwater management minimum standards, on a voluntary basis. Tillamook County staff can encourage the use of LID by offering incentives to property owners or by entering public-private partnerships.

Tillamook County also has the option take a more regulatory approach to LID and stormwater management. By formalizing the use of LID into its Land Use Ordinance as an alternative to conventional stormwater management practices, the County can require developers to think more critically about the impact they have on public infrastructure. The Oregon Department of Environmental Quality has published Low Impact Development in Western Oregon: A Practical Guide for Watershed Health to offer local governments with a template to LID regulations. The guide, created in partnership with Green Girl Land Development Solutions LLC, a consultancy working to advance the use of cost-effective green infrastructure, provides jurisdictions with all the information needed to implement an LID strategy, including model code language.

Chapter 10: Implementation and Recommendations

Implementation

This chapter identifies possible implementation strategies and provides recommendations for how unincorporated Tillamook County can achieve natural hazard mitigation. Implementation is considered from both a County process perspective as well as from a public outreach and education perspective as both are critical to achieving reductions in risk from natural hazards. Policy options are presented with descriptions of the most affected community, the type of process required, and a matrix table of the complete mitigation toolbox.

County Process

Implementation of any of the recommendations made within this report will require some level of formal adoption or acknowledgement by staff, the Planning Commission, or the Board of County Commissioners. The administrative process for each recommendation will vary depending on its level of regulation. The Tillamook County Land Use Ordinance Section 10.040 provides the structure for review required in each decision. All land use applications and decisions are reviewed using one of four review types, ranging from Type I Ministerial Review to Type IV Legislative Review. Due to the nature of the recommendations within this report, changing or adding ordinance language, many of the recommendations will warrant a Type IV Legislative Review. Type IV reviews are considered by the Planning Commission, who makes a recommendation to the Board of Commissioners. The Board of County Commissioners makes the final decision on a legislative proposal thorough the enactment of an ordinance. Type IV reviews are subject to public notice requirements of Tillamook County Land Use Ordinance Section 10.090, as well in accordance with Oregon Revised Statute 215.503.

Table 23: County Administrative Process

Review Type	Decision	Appeal
Type I	Director	Planning Commission/Board of County Commissioners
Type II	Director	Planning Commission/Board of County Commissioners
Type III	Planning Commission	Board of County Commissioners
Type IV	Board of County Commissioners	Land Use Board of Appeals (LUBA)

Source: Tillamook County Land Use Ordinance (Modified by CSC)

Public Outreach

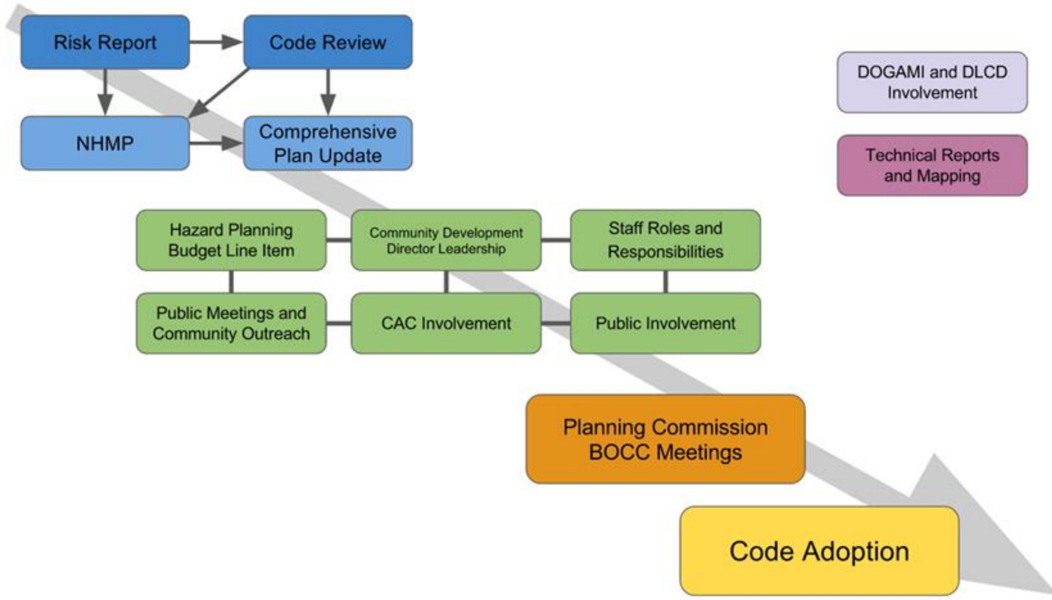
Public outreach is an essential component of plan implementation. To address hazard risk most appropriately, each community in the unincorporated county should be involved in the mitigation process. Public outreach is a twofold process. On one hand, collaborating with the community provides planners with a better understanding of the conditions that may not be evident in data. Discussion can illuminate unforeseen problems or circumstances that may impact the feasibility of the proposed plan. On the other hand, public outreach serves to educate the community and offer them insight into the legislative work and processes that are underway. Public education can be used to spread awareness and empower community members, ultimately increasing the efficacy of actions and catalyzing change. Some examples of public outreach include surveys, public hearings, focus groups, or media projects such as newspaper articles, radio shows, podcasts, or blogs.

This report's toolbox of regulations for mitigating risk from natural hazards could be intimidating to property owners within the County. To foster positive community response, County staff should present new regulations to affected communities in meetings that involve citizen advisory committees (CACs) and community champions in an open and transparent process. The County could look to the Neskowin Coastal Erosion Hazards Overlay Zone community participation process as a model to be implemented elsewhere. The process should determine if proposed development requirements would apply in the form of an overlay zone, to specific parcels, or a combination of both. It is possible that the degree of regulations could differ by community or area. Any development regulations should be developed in collaboration with community members, formally written by county staff, and approved by the appropriate commission or board.

Hazard Mitigation

While code adoption represents the final step in achieving reduction in risks from natural hazards in the Tillamook County Land Use Ordinance, there is a complex and interconnected chain of events that is occurring, and that will need to occur, prior to final comprehensive plan and development code updates and adoption. In order to facilitate this process a general implementation framework illustrating major reports, actors, and steps has been developed. To supplement this implementation framework, implementation processes specific to each individual hazard are also provided.

Figure 4: General Implementation Framework



Source: Community Service Center

In this general implementation framework, the four blue boxes at the upper left of the diagram show the connections between the current Risk Report project, this code review project, the Natural Hazard Mitigation Plan (NHMP) update, and the County Comprehensive Plan update. The Risk Report informed the recommendations made in this report, and it is informing the ongoing NHMP update. This report will inform the ongoing NHMP update and provides recommendations for the Comprehensive Plan update.

The connected green boxes represent critical steps that County planning staff will need to take to secure funding for developing formal land use ordinance natural hazard mitigation code changes. The Community Development Director will need to provide strong leadership in this process and should clearly define staff roles and responsibilities to the project. Public meetings in which member of the public have their comments and feedback heard and considered will need to be held. Community outreach is required to let people know about these meetings and to ensure the meetings have appropriate times and locations. Comments and feedback should also be solicited in this outreach for those unable to attend public meetings. Community advisory committees (CACs) should have representatives present at all meetings and discussions, and they should report back to their areas and communities. It is important to emphasize that public involvement in this process should go beyond the traditional comment and feedback gathering activities. The public needs to be engaged and involved in the process, this may look like having property owners, business owners, and community champions consulted and brought into meetings from the beginning of the process all the way through to it conclusion.

On the top right of the diagram, the two purple boxes represent involvement of two state groups, DOGAMI and DLCD, who will need to be relied on to provide technical reports and mapping for some hazard mitigation strategies. Details of their potential involvement, and funding opportunities, are identified in the individual hazard implementation sections below.

Once County planning staff, in cooperation with local communities, community groups, and other members of the public, develop mitigation strategy code changes the proposed changes will face review by the Planning Commission and Board of County Commissioners as shown in the orange box. Through the formal administrative process, comprehensive plan and development code changes will be adopted and the natural hazard mitigation best practices will better protect people and property from the risks of natural hazards in Tillamook County.

Flooding

Description of hazard mitigation

Flood hazard mitigation in Tillamook County primarily revolves around strategies that lessen the risk to life and property during and after a flooding event. Many of these strategies are implemented through Land Use Ordinance standards that regulate where and what type of developments can be built within the floodplain. However, some strategies are non-regulatory in nature such as geographically defining the floodplain, which is dependent on maintaining up to date mapping techniques. The following implementation strategies address necessary steps in establishing a framework for flood hazard mitigation, followed by the individual actions that carry out certain standards in conjunction with the adoption of new language within the county's land use ordinance.

What communities are affected?

Nearly all communities within Tillamook County are exposed to damage from flooding. Much of this exposure is related to riverine flooding caused by raised water levels in local rivers, streams, and creeks. However, portions of the County are subject to coastal flooding risk, communities such as Neskowin, Oceanside-Netarts, and Rockaway Beach. Per the Risk Report, Neskowin has the greatest sensitivity and highest exposure to flood within unincorporated Tillamook County. In Neskowin, 33% of building value is exposed to the 100-year flood and 17% of permanent residents are at risk of being displaced. Only one critical facility is located within the 100-year floodplain within unincorporated Tillamook County, the Nestucca Fire and Rescue Station #87 in Hebo.

Type of processes required

Adopt new FIS and FIRMs

A Flood Insurance Study (FIS) is an in depth scientific report that details factors catalytic to flooding, flood patterns, and floodplain changes over time. The Flood Insurance Rate Map (FIRM) is the geographic representation of the FIS and shows, on a map, where the floodplain exists. FEMA also uses these maps to determine which properties are located within the floodplain and are therefore required to have a flood insurance policy. Updates to Tillamook County's FIS and FIRMs will be submitted to the County for review in Summer 2016. After a period of review, the County will adopt the updated FIS and FIRMs in late 2017.

Review and update floodplain management practices and standards

Upon adoption of the updated FIS and FIRMs, the County will enter a review of its floodplain management practices and standards. During this process, the County will have the opportunity to review its existing floodplain management practices to determine if they are consistent with updated information or to adopt other mitigation strategies listed as recommendations in this report. This review process is an opportune time to also consider adopting any model code language created by the *Department of Land Conservation and Development related to the National Marine Fisheries Service's Biological Opinion* and its "Prudent and Reasonable Alternatives" to the National Flood Insurance Program's Minimum Standards.

Re-enter the NFIP's Community Rating System

Concurrent with the above recommendations, the County should consider re-entering the Community Rating System (CRS) offered by the National Flood Insurance Program (NFIP). This voluntary program offers flood insurance premium discounts to policyholders within jurisdictions who implement floodplain management strategies that are above and beyond the NFIP minimum standards. Prior to 2012, Tillamook County was part of the CRS but was removed for noncompliance issues. As of the 2007 CRS Coordinator's Manual, the County was categorized as a Class 6 jurisdiction. Re-entering the CRS at this classification would provide flood insurance policy holders within the County a 20% premium discount.

Consider adopting Community Rating System's Higher Regulatory Standards

At the time of the flood ordinance review and update, Tillamook County should consider adopting the additional higher regulatory standards outlined in this report. The standards reviewed in the flood section of this report are national best practices that are not included in the existing code. Not only would implementation of these standards mitigate the risk to life and property within Tillamook County, but they would also net the County additional CRS points, potentially further discounting premiums for local flood insurance policyholders.

Tsunami

Description of hazard mitigation

Tsunami hazard mitigation in Tillamook County primarily revolves around strategies that lessen the risk to life and property during a tsunami event. Mitigation of tsunami risk in Tillamook County largely focuses on the utilization of a Tsunami Hazard Overlay and then reducing risk to areas within the zone through regulatory standards. Defining at risk areas that are subject to tsunami inundation decreases the severity and probability of damage to both people and structures involved in future development projects. The following implementation strategies address necessary steps in establishing a framework for the introduction of the proposed overlay, followed by the individual actions that carry out certain standards in conjunction with the adoption of new language within the county's land use ordinance.

What communities are affected?

Tsunamis originate in the ocean and terminate along the ocean shore, therefore only communities along the coastline and bays are affected by the hazard. Per the Risk Report, Neskowin and Pacific City are the communities in the unincorporated county that have the greatest sensitivity and degree of exposure to tsunami. In Neskowin, 69% of building value is exposed to the Medium-sized Cascadian Subduction Zone 9.0 tsunami, putting 58% of the community's permanent residents at risk of being displaced. During the Large-sized Cascadian Subduction Zone 9.0 tsunami, 73% of the building value in Neskowin is exposed. In Pacific City, 39% of building value is exposed to the Medium-sized tsunami, potentially displacing 41% of Pacific City's residents. During the Large-sized Cascadian Subduction Zone 9.0 tsunami, 70% of the building value in Pacific City is exposed.

Type of processes required

Adopt the Tsunami Inundation Maps

The Department of Oregon Geologic and Mineral Industries (DOGAMI) is in the process of updating Oregon's Tsunami Regulatory Maps (SB 379 maps). The SB 379 maps are the official maps for implementing Oregon Revised Statutes (ORS) 455.446 and 455.447 which limit, through the Oregon Building Code, construction of certain critical and essential facilities in the tsunami inundation zone. These regulatory maps have not been updated since 1995, and are based on the best available data and scientific tools in that year. While there is no estimated date for the completion of this project, the County should be ready to adopt the report and map as regulatory standards within the Land Use Ordinance.

DOGAMI has also produced Tsunami Inundation Maps (TIMs) that provide inundation mapping for communities based on a range of tsunami event sizes. These sizes range from "small" to "XXLarge" and are based on location and extent of tsunami inducing earthquakes. It is recommended by DLCD, that if, and when, local governments adopt policies and standards related to tsunami hazard mitigation, they use the TIM corresponding to the "large" tsunami inundation. This is to ensure that should Senate Bill 379 rulemaking identify the "large" tsunami inundation line, which is thought of as most likely, local governments will already comply.

Create a new Tsunami Hazard Overlay

As noted above, the statewide Senate Bill 379 tsunami regulatory maps and TIM's are in the process of being updated. Using these updated maps, the County should consider the creation of a new Tsunami Overlay Zone to better protect citizens and properties within inundation areas. It is recommended that Tillamook County adopt a Tsunami Hazard Overlay Zone with area defined by DOGAMI's "large" tsunami inundation line, which would serve as a trigger zone that would then mandate specific standards for future development. Within this new overlay, model code language from DLCD's Tsunami Land Use Guide can be applied to ensure mitigation best practices are being utilized. Clatsop County was the first county in Oregon to use this Land Use Guide for tsunami hazard overlay regulations. While the final adoption of the ordinance was tabled due to community concerns of overregulation, Clatsop County's process offers learning opportunities for Tillamook County's future processes. Other counties are currently nearing completion of implementing the model ordinance offered by DLCD. Curry County is the furthest along in this process. Should Curry County adopt the ordinance, Tillamook County can use it, in conjunction with the DLCD guidance, to adopt similar overlay regulations.

Landslide

Description of hazard mitigation

Mitigation of landslides in Tillamook County primarily revolves around the utilization of a Geologic Hazard Overlay and then reducing risk to areas within the zone through regulatory standards. Adopting regulations pertaining to at-risk areas of landslide inevitably decreases the severity and probability of damage to both people and structures involved in future development projects. The following implementation strategies address necessary steps in establishing a framework for the introduction of the proposed overlay, followed by the individual actions that carry out certain standards in conjunction with the adoption of new language within the county's land use ordinance.

What communities are affected?

Per the Risk Report, the communities of Oceanside/Netarts and Neskowin have the greatest sensitivity and degree of exposure to landslide. In Oceanside/Netarts, 49% of building value is highly susceptible to landslide risk, including one essential facility (Oceanside RFPD Station #62), and 39% of permanent residents reside in highly susceptible areas. In Neskowin, 21% is of building value is highly susceptible to landslide risk, including one essential facility (Neskowin Valley School), and 28% of the city's residents reside in highly susceptible areas.

Type of processes required

Request funding to assess and map landslide risk at a more detailed level.

Current mapping presented in DOGAMI's Open File Report O-16-02 "Landslide Susceptibility Overview Map of Oregon" and the Risk Report assess landslide susceptibility at a large scale. The report includes data analysis and maps that evaluates slope, lithology, historic landslide locations, and other significant geologic features. The existing map products primarily examine landslide risk at a level (state and county) that generalizes the threat and do not address specific topographic nuances and features. To best determine the extent of a geologic hazard overlay, the county should consider requesting funding (possibly through Risk MAP) to initiate future mapping that would more closely examine the areas included within the currently defined “highly susceptible areas”.

Create a new Geologic Hazard Overlay

Based on new mapping products, combined with geologic reports, geotechnical advice, and collaboration with planning staff, the creation of a new Geologic Hazard Overlay would serve as a trigger zone that would then mandate specific standards for future development.

Consult a certified ecologist regarding revegetation species

If the county chooses to adopt revegetation standards, a certified state ecologist may be required to supply the necessary relevant information regarding specific plant species that need to be included in the code language. Certain native species have higher levels of performance and will more effectively increase slope stability. It is important to include specific and stringent requirements that stipulate both the preservation and introduction of these species, as well as prohibit the removal of these species.

Create a Geologic Hazard Point Based Assessment System

Marion County and the City of Salem have both employed a point based assessment system that characterizes degree of hazard based on results from a quantified measurement. If Tillamook chooses to include a similar assessment, the county should determine how points will be allocated and prioritize variables.

Public outreach regarding Geologic Hazard Abatement Districts

The formation of a Geologic Hazard Abatement District hinges on a high degree of public involvement and willingness of the community to participate in mitigation projects, as well as allocate monthly funding towards an insurance pool that can be utilized in the instance of a severe disaster event. Initiating a GHAD program necessitates first a series of educational meetings that inform the community on the impending hazard/risk. Additionally, it is important to gain feedback regarding attitudes towards implementation of such a program and how the district can be adopted to address community needs most appropriately.

Coastal Erosion

Description of hazard mitigation

Mitigation of coastal erosion in Tillamook County primarily revolves around the utilization of a countywide Coastal Erosion Overlay that reduces risk to areas within the zone through regulatory standards. The following implementation strategies address necessary steps in establishing a framework for the introduction of the proposed overlay, followed by the individual actions that carry out certain standards in conjunction with the adoption of new language within the county’s land use ordinance.

What communities are affected?

Coastal erosion affects the entire coastline of Tillamook County, however, per the Risk Report Pacific City and Neskowin have the greatest sensitivity and degree of exposure. While the unincorporated county outside of these communities currently has little building value exposed to coastal erosion, the County should consider a proactive approach to adopting development code regulations for areas susceptible to coastal erosion prior to significant development occurring.

Type of processes required

Create a Countywide Coastal Erosion Hazard Overlay Zone and attach overlay regulations

A county wide coastal erosion hazard overlay zone would be physically defined by the 2014 DOGAMI *Evaluation of Erosion Hazard Zones for the Dune-Backed Beaches of Tillamook County (Open-File Report O-14-02)* high and/or active hazard zones. Adoption of this report and its associated maps would occur in Section 3.500 Overlays of the Tillamook County Land Use Ordinance. Such an overlay zone could either supplant or replace the Section 3.570 Neskowin Coastal Erosion Hazards Overlay Zone that currently exists within the code. Adoption of this mapping product to define the overlay zone without attaching specific development code regulations may allow the County to emphasize to communities and areas that coastal erosion is a present and serious natural hazard that needs to be properly mitigated to best protect people and property. The Countywide Coastal Erosion Hazard Overlay code language would need to be formally written by County staff, approved by the Planning Commission, and then would be adopted by the Board of County Commissioners.

This top down definition of the hazard overly zone would then be paired with a bottom up community and area based assessment of permit and develop requirements as discussed in the following sections. This process would allow the County to create an overlay zone while relying upon the community advisor committees CACs to define the regulations with staff assistance.

Require a Coastal Hazard Area Permit for development

A specific develop permit should be required for development within the Countywide Coastal Erosion Overlay Zone as is currently required in the Neskowin Coastal Hazard Overlay Zone. Such a permit would require a site- specific hazard analysis and hazard risk minimizations recommendation to be developed by a certified engineering geologist. This permit process, review, and associated requirements would be drawn from the Oregon Chronic Natural Hazards Model Overlay Zone in conjunction with meetings with effected communities and areas. The Coastal Hazard Area Permit code language, as suggested in the *Model Coastal Erosion Overlay Zone*, would need to be formally written by County Staff, approved by the Planning Commission, and then adopted by the Board of County Commissioners.

Wildfire

Description of hazard mitigation

Reducing wildfire risk for people and property in Tillamook is directed through the utilization of a Wildfire Hazard Overlay that brings a regulatory approach to the standards established in both the Community Wildfire Protection Plan (CWPP) combined with the requirements set forth in the Forest (F) Zone. Implementation of wildfire mitigation strategies necessitates further study to specify areas of development that are not currently protected by rural fire protection districts and are not covered by the Oregon Department of Forestry (ODF) in the Forest Zone. Feasibility of an overlay hinges on this analysis of wildfire protection coverage, and if it is determined that a highly regulatory action is unnecessary and current zoning is sufficient, the county should recognize the value of public education and take a more voluntary approach. Forming Firewise Communities allows residents and neighborhoods to effectively reduce their risk to wildfire through small scale improvement projects and local services.

What communities are affected?

Forest characteristics and fire protection infrastructure determine wildfire risk. The Risk Report addresses wildfire risk through sensitivity assessment and location of essential facilities. The CWPP measures risk by acknowledging areas that lack protection services such as available water supplies, evacuation routes, and location of historic fires. To determine highest degree of community impact more accurately, the county should anticipate information from the West Wide Wildfire Risk Assessment as well as an updated CWPP. Based on the available research, the areas most affected by wildfire risk are Blaine, Cloverdale, and Oceanside/Netarts.

Type of processes required

Create a Wildfire Hazard Overlay

The introduction of a new overlay requires collaboration and communication between representatives from the rural fire protection districts, the Oregon Department of Forestry, and land use planners. Mapping and discussion between planners and forest management should determine whether there are populations that are not protected under current standards. If there is a significant population at risk to wildfire that is not currently protected, the utilization of a wildfire hazard overlay will protect these at-risk communities. The overlay should utilize information from the West Wide Risk Assessment and the CWPP and should assess the WUI extents. This overlay will serve as a trigger zone for mitigation actions stipulated in the associated code language.

Establish Firewise Communities

To be recognized as Firewise Community, the first step is to survey different sites and engage with the public. The success of this voluntary program hinges on a high level of community involvement and active participation. The Firewise agency and

NFPA have defined five necessary steps that include: a wildfire hazard assessment, creating a community task force, holding an annual Firewise Day, spending $2 per capita on Firewise projects, and submitting an annual report to Firewise documenting the community's progress. Once these tasks are completed, ongoing reduction projects, services, information, and events should be documented.

Sand Inundation

Description of hazard mitigation

Sand inundation is primarily managed by physically removing sand from a specific location through grading. Foredune Management Plans are used to guide the sand grading process. Clearer and more comprehensive requirements for these plans should be added to the Foredune Grading Permit requirements in the Beach and Dune Overlay. Foredune Management Plans should be updated or created for all areas of Tillamook County that are undergoing sand inundation.

What communities are affected?

Sand inundation is not a natural hazard covered in the Risk Report. However, the Comprehensive plan designates Necarney City, Nedonna, Tierra del Mar, Pacific City, and Neskowin to be areas and communities that are experiencing sand inundation of houses and infrastructure on foredune lots. In Pacific City sand inundates houses throughout the community (particularly along Sunset Drive). Additionally, The County is providing for remedial sand removal under emergency conditions in the Tierra del Mar, Pacific City, and Neskowin areas.

Type of processes required

Update mapping of dune and beach forms

The County should have more accurate and up to date data and mapping of dune and beach conducted to replace the 1975 "Beaches and Dunes of the Oregon Coast" report as beach and dune forms are dynamic and change over time. This mapping could be conducted by DOGAMI. Funding resources that can be explored include the FEMA Risk MAP program. New studies, data, and maps would then need to be adopted into the Comprehensive Plan Goal 18: Beaches and Dunes and the Land Use Code Beach and Dune Overlay.

Conduct Dune Management Studies for Tierra del Mar and Neskowin and updates for Nedonna Beach and Pacific City

The County should to look to have Dune Management Studies for Pacific City, Tierra del Mar, and Neskowin conducted possibly by DLCD or DOGAMI. Funding may be available through the FEMA Risk MAP program. The need for the studies should also be included as a mitigation action within the Natural Hazard Mitigation Plan (NHMP) in order to underscore the need for such reports and provide further rational for funding grant requests.

Develop Foredune Management Plans for Tierra del Mar and Neskowin and acknowledge in Comprehensive Plan

Dune Management Studies developed in the previous process would form the basis for new Foredune Management Plans that would be developed directly with the affected communities. The Foredune Management Plans would likely need to be contracted out to an outside consultant. The Foredune Management Plans would need to be acknowledged in the Comprehensive Plan.

Adopt more comprehensive and clear Foredune Grading Permit requirements in the Beach and Dune Overlay

This report's toolbox of recommendations for restructuring and strengthening the Foredune Grading section of the Tillamook County Land Use Ordinance should be critically reviewed by County staff. Staff recommended code language would need to be approved by the Planning Commission, and then adopted by the Board of County Commissioners.

APPENDIX A

Case Studies

TSUNAMI

COASTAL EROSION

LANDSLIDE

WILDFIRE

MULTI-HAZARD

TSUNAMI: TSUNAMI HAZARD OVERLAY PROJECT CLATSOP COUNTY, OR

Introduction

The purpose of this case study is to evaluate Clatsop County's use and implementation of a Tsunami Hazard Overlay (THO). This study will briefly discuss the history of tsunami planning in Oregon and how that relates to Clatsop County's efforts to mitigate tsunami risks. An examination of the Clatsop County Tsunami Hazard Overlay project's best practices, model ordinances, and implementation rationale will be conducted in order to offer policy recommendations for Tillamook County.

Context

Clatsop County is located north of Tillamook County along the northern Oregon Coast. As with Tillamook County, and every county on the coast, Clatsop County is susceptible to tsunami and ocean flooding hazards that pose serious risks to life and property. The State of Oregon has many policies and regulations to help communities mitigate natural hazards, including tsunami. In 1995, the Oregon Legislature passed Senate Bill 379 creating Tsunami Regulatory Maps, which indicate a single tsunami inundation line on U.S. Geological Survey topographic maps. They show the best estimate of tsunami inundation from a typical or most likely tsunami originating from earthquakes on the Cascadia subduction zone fault. Tsunami Regulatory Maps are the official State maps for implementation of Oregon Revised Statutes (ORS) 455.446 and 455.447, limiting, through the Oregon Building Code, construction of certain critical and essential facilities in the

Case Study Significance

The Clatsop County Tsunami Hazard Overlay Zone highlights the challenges of tsunami planning and provides important lessons for Tillamook County.

Signage indicating tsunami inundation zone

"The primary purposes of this project [was] to develop a comprehensive knowledge of tsunami hazards within the county, identify what strategies and options apply in Clatsop County, and to determine what level of detail [was] necessary to adequately implement those options and strategies within the Clatsop County land use planning program."

- Clatsop County, OR

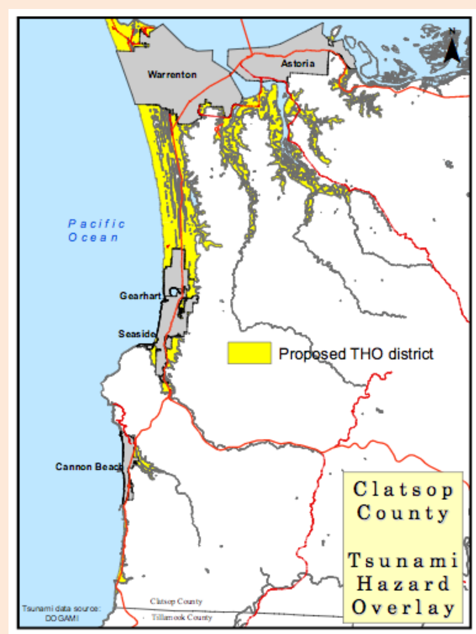
tsunami inundation zone. In 2013 the Oregon Department of Geology and Mineral Industries (DOGAMI) completed a multi-year process to update these maps using improved technology. A new Tsunami Inundation Map for Clatsop County was adopted in June 2013, and as a result the County began the Tsunami Hazard Overlay Project. The primary purposes of the project were to develop a comprehensive knowledge of tsunami hazards within the county, identify what strategies and options apply in Clatsop County, and to determine what level of detail is necessary to adequately implement those options and strategies within the Clatsop County land use planning program. The project resulted in amendments to the Comprehensive Plan and Land and Water Development and Use Ordinance.

Current Programs

The Clatsop County Tsunami Hazard Overlay Project set forth to create a more concrete set of policies and standards for which types of development could, or could not, take place within the tsunami inundation zone. To fund the project, the County received a $7,000 technical assistance grant from DLCD to help offset the costs of materials, published notices, mailed notices and staff time, allowing them to propose text amendments to both the Comprehensive Plan and the County's Development Ordinance.

Updates to the Comprehensive Plan include amending Goals 7 (Hazards), 11 (Public Facility and Services), and 12 (Transportation). The most extensive amendments were made to the Goal 7 (Hazards) section, adding tsunami related language to the General Policies, and adding new tsunami specific sections such as Evacuation Policy Concepts, Reducing Development Risk in High Tsunami Risk Areas, Hazard Mitigation Planning, Tsunami Awareness Education and Outreach, Debris Management, and Hazardous Materials.

Enforcement of these policies would have been established through the implementation of a new Tsunami Hazards Overlay that was outlined as the fourth policy listed in the Goal 7 Hazards General Policies section of the Comprehensive Plan. The concept is codified in the County's Land and Water Development and Use Ordinance as Section 4.500 Tsunami Hazard Overlay (THO) District. The outlined purpose of the Tsunami Hazard Overlay District is to increase the resilience of the community to a local source tsunami by establishing standards, requirements, incentives, and other measures to be applied in areas subject to tsunami hazards. The standards established by this section are intended to limit, direct and encourage the development of land uses within areas subject to tsunami hazards in a manner that will reduce loss of life, reduce



Location of proposed *Clatsop County Tsunami Hazard Overlay* within unincorporated county lands damage to private and public property, reduce social, emotional, and economic disruptions, and increase the ability of the community to respond and recover.

Key Takeaways for Tillamook County

Due to its location along the coast of the Pacific Ocean, a significant portion of the communities in Tillamook County are susceptible to tsunami hazards. Communities such as Rockaway Beach, Pacific City, and Neskowin are particularly vulnerable to tsunamis due to low-lying coastal developments. In a simulated scenario, Rockaway Beach has 80% of its building value exposed to tsunami inundation. While tsunami hazards cannot be prevented, steps can be taken to lessen the impact that a tsunami event might have on the development of the Tillamook County coastal communities. One tool that the county can use to mitigate the risk to life and property, is to implement a Tsunami Hazard Overlay outlining development restrictions on new developments occurring within the areas that would be most impacted by a tsunami event.

A Tsunami Hazard Overlay is a large regulatory task to take on at the county level, one that can be politically charged and controversial. However, the current status of the Tillamook County Land Use Ordinance does little to regulate development within the DOGAMI Tsunami Inundation Zone, putting lives and private property as risk. Following the practices set forth by Clatsop County, a Tsunami Hazard Overlay throughout the at risk areas of unincorporated Tillamook County would ensure that future development is conducted with an eye towards the safety and resiliency of the county.

Key Resources

Source	Description
Clatsop County	Tsunami Hazard Overlay Project
Department of Land Conservation and Development	Land Use Guide Model Ordinance
DOGAMI	Tsunami Mapping and Scientific Research

TSUNAMI: A LAND USE GUIDE FOR OREGON COASTAL COMMUNITIES

Introduction

The purpose of this case study is to evaluate the Department of Land Conservation and Development's (DLCD) *Preparing for a Cascadia Subduction Zone Tsunami: A Land Use Guide for Oregon Coastal Communities* as a model land use ordinance to mitigate risk from tsunami. This study briefly describes the need for such a model code and how it can best implemented. Specific code language significant for the Tillamook County context is highlighted and the implications of implementing such an overlay in the County are discussed.

Context

The Oregon Coast is within a zone vulnerable to earthquake and tsunami. Scientific evidence suggests a potential large scale earthquake and tsunami event is likely to occur in the future and will impact many coastal communities. These large earthquakes will occur under the ocean just offshore of the Oregon coast and can cause destructive tsunamis that can strike the coast 15 to 20 minutes after the earthquake. It is likely that in most Oregon coast communities, the only warning will be the earthquake itself. To help communities better prepare for such an event, DLCD teamed with public and private officials to create a land use guide to be used to mitigate the risk to life and property that these tsunamis pose.

The Land Use Guide provides coastal communities examples of comprehensive plan language and development code

Case Study Significance

The model Tsunami Hazard Overlay in Preparing for a Cascadia Subduction Zone Tsunami: A Land Use Guide for Oregon Coastal Communities uses historic and scientific tsunami inundation information to formulate code that protects people and development from the dangers of tsunami.

Cascadia Subduction Zone and its proximity to the Oregon Coast

"The Japan earthquake and tsunami are what we can expect here in Oregon. This is a serious threat to our coast and we need to prepare now."

- Mark Barnes, Planning Director for the City of Cannon Beach provisions that can serve to help communities reduce their risk to tsunami hazards. These examples are intended to provide general guidance allowing communities to tailor land use policies and regulations appropriate to their individual circumstances. The guide is focused on land use planning approaches to reduce tsunami hazard risk, and is not intended to address the full range of efforts needed for overall disaster preparedness.

To inform the creation of this guide, DLCD and the Advisory Committee studied the events of the 2011 earthquake and tsunami in Japan. The Japan 2011 event is a close parallel to what the Oregon Coast will face in a Cascadia event, and impacts to the Oregon coast and its communities will be similarly devastating. As part of Japan's recovery, communities and government entities are turning to land use planning options that will increase resilience to the next catastrophic event of this type.

Current Programs

Before using the Land Use Guide, community staff and citizen volunteers should have a good understanding of the community's land use and development program and the specific tsunami risk for the area. Communities should first review the DOGAMI Tsunami Inundations Maps (TIMs) to get a better sense of areas and key facilities at risk of tsunami inundation. This can help evaluate relative risk and exposure in the community based on the various inundation scenarios in order to lead future community discussions on risk tolerance and potential mitigation tools. As a second preliminary step, the guide urges the appointment of an advisory committee. This committee can be appointed by the County Commissioners and should include some of the stakeholders in the community, including a mix of public and private leaders. This committee would make recommendations to the County Commission concerning tsunami hazards and are subject to public meeting laws.

After research and correlated preliminary steps have been completed, Local governments can choose to use the Land Use Guide in whole or in part depending on the community's exposure to tsunami inundation, and geographic situation. Using the Land Use Guide may result in comprehensive plan and development code amendments to be adopted by the local jurisdiction and be administered within the local land use planning program. The Guide offers a model Tsunami Hazard Overlay Zone ordinance, which provides a mechanism to apply an additional tier of regulations on new development specifically addressing tsunami risk. As with any model code, not all of the approaches or standards in the Land Use Guide will be suitable for use in every community. It is up to the individual jurisdiction to carefully consider the community's unique challenges and opportunities, in order to tailor the model ordinance to ensure the best fit.

The Tsunami Hazard Overlay zone is designed to serve as the principal implementation mechanism for land use measures addressing tsunami risk. It is designed to be applied in the form of an overlay zone based on scientific inundation mapping, such as DOGAMI's TIMs or any other generally adopted inundation line. The model overlay focuses on three main approaches to reducing risk:

- Placing restrictions and limitations on certain categories of uses. Applying mainly to uses listed as serving an essential function during or after a disaster event such as hospitals, schools, or emergency response facilities.

- Integrating the development of evacuation infrastructure into the land use and development review process. Providing a consistent evacuation planning program throughout the jurisdiction.
- Providing incentives for development designs which reduce risk and increase resiliency. Offer modifications to development code standards that would improve risk reduction on a per development basis.

Key Takeaways for Tillamook County

Because the risk of tsunami inundation is high in Tillamook County a Tsunami Hazard Overlay could help to mitigate that risk. The Land Use Guide produced by DLCD offers a model ordinance that is in depth enough to be adopted outright by the County. However, it is important to note that there are many unique aspects of Tillamook County's tsunami risk that need to be considered.

A Tsunami Hazard Overlay for the entire county of Tillamook would be would be a large regulatory task that may be controversial, but the Land Use Guide provides a framework that the County can use to balance citizen concerns while also dealing with the increasing reality of a tsunami event. Tillamook County should also actively involve the Community Advisory Committees (CACs) when designing their Tsunami Hazard Overlay.

The Oregon Model Tsunami Overlay Zone is specifically designed to be used in conjunction with DOGAMI Tsunami Inundation Maps and its model overlay code language could be applied to Tillamook County. Clatsop County, OR was the first to attempt implementing the DLCD Tsunami Hazard Overlay model. That discussion was later tabled due to concerns of overregulation, however Coos County and Curry County are now both in the process of adopting a Tsunami Overlay Zone utilizing the Tsunami Land Use Guide and their processes should inform Tillamook County. The adoption of a countywide or high hazard area overlay would demonstrate that Tillamook County takes seriously the threat of natural hazards in the unincorporated community.

Key Resources

Source	Description
DOGAMI	Tsunami Mapping and Scientific Research
National Tsunami Hazard Mitigation Program	Provides national framework for tsunami mitigation.
Douglas County	Tsunami Overlay Code in Douglas County.
Preparing for a Cascadia Subduction Zone Tsunami: A Land Use Guide for Oregon Coastal Communities, Department of Land Conservation and Development, 2015	Provides coastal communities examples of comprehensive plan language and development code provisions that can serve to help communities reduce their risk to tsunami hazards.

COASTAL EROSION: BLUFFTOP SETBACKS SAN LUIS OBISPO COUNTY, CA

Introduction

The purpose of this case study is to evaluate the San Luis Obispo County, California's Coastal Zone Land Use Ordinance. In particular, the adoption of a blufftop setback that protects structures for 75 years of erosion minimizing the need for shoreline protective devices and protecting the actual structure from coastal erosion. This study briefly describes the context of the setback in San Luis Obispo County. Then the specific code requirements pertaining to the setback are highlighted, and the implications for adoption of a similar setback in Tillamook County are discussed.

Context

San Luis Obispo County is located on the central coast of California roughly equidistant from San Francisco and Los Angeles. The county has 96 miles of coastline that range from rugged headlands and rocky shorelines to sheltered coves and sand beaches. A number of small incorporated and unincorporated communities dot the coast.

California utilizes a Coastal Commission that is guided by the 1976 California Coastal Act to oversee coastal development permitting. Local Coastal Programs (LCPs) are local government planning tools that must be consistent with the policies of Coastal Act and protect public access and coastal resources. LCPs are reviewed by the Coastal Commission prior to the transfer

Case Study Significance

San Luis Obispo County utilizes a countywide blufftop setback requirement that is designed to protect development for a period of 75-years.

Cynthia Lambert, The Tribune

Eroding bluff near development in Pismo Beach, San Luis Obispo County.

"New development [should] minimize risks and neither create nor contribute to erosion or require construction of protective devices."

- *California Coastal Commission*

of coastal permitting authority from the state to the local government. San Luis Obispo LCPs was first approved in 1984 and has undergone periodic review and updates with the latest review and recertification occurring in 2001.

Current Programs

The San Luis Obispo County Development Code utilizes a distinct Coastal Zone Land Use Ordinance that applies to all land use and development activities within the unincorporated areas of the county that are located in the California Coastal Zone as established by the California Coastal Act. Section 23.04.118 of the land use ordinance stipulates blufftop setbacks within the Coastal Zone that apply to new development or expansion of existing uses proposed to be located adjacent to a beach or coastal bluff.

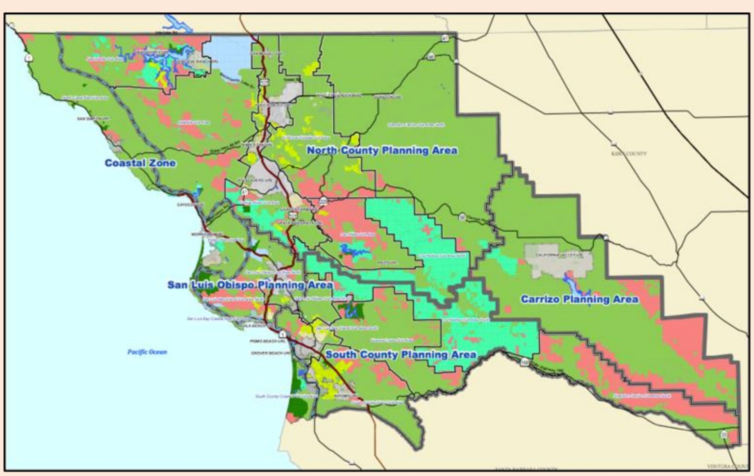
Land Use Ordinance Section 23.04.118

New development or expansion of existing uses on blufftops shall be designed and set back from the bluff edge a distance sufficient to assure stability and structural integrity and to withstand bluff erosion and wave action for a period of 75 years without construction of shoreline protection structures that would in the opinion of the Planning Director require substantial alterations to the natural landforms along bluffs and cliffs. A site stability evaluation report shall be prepared and submitted by a certified engineering geologist based upon an on-site evaluation that indicates that the bluff setback is adequate to allow for bluff erosion over the 75-year period according to County established standards.

LCP Periodic Review

In 2001 San Luis Obispo County's Local Coastal Program underwent review by the California Coastal Commission. The Coastal Commission encouraged the county to increase the blufftop setback period from 75 years to 100 years. This recommendation was made in light of the commissions finding that "the 75-year economic life may not reflect the actual lifetime of a structure or the length of time a coastal site will be occupied" as the "value of coastal land and the lack of alternative coastal locations" make it unlikely for buildings to be retired after 75 years. Further consideration for increased erosion rates and/or events from rising sea level and increased wave action provide further rational for a larger setback.

After 75 years the setback will likely have eroded to the point of endangering the structure and either coastal relocation of the structure of armoring of the shoreline



San Luis Obispo Rural Land Use Map

The Coastal Zone is designated with the dashed gray and blue line roughly paralleling the coastline.

will have to occur. In particular, shoreline armoring is explicitly to be avoided by the Coastal Act regulation.

The commission ended up modifying this suggestion after receiving comments from the county in favor of the county in favor of adding a requirement to incorporate a safety factor either as a multiplier or as a set distance, as developed through an Area Wide Shoreline Management Plan.

Key Takeaways for Tillamook County

A blufftop setback requirement does not currently exist in Tillamook County outside of the Neskowin Coastal Hazards Overlay Zone that requires a 50-year setback protection. Tillamook County would benefit from conducting an analysis of the economic lifespan of development along the coast. Similar to the analysis in the periodic review process, Tillamook should consider how impact of land value and availability is possibly increasing building life when determining an appropriate blufftop setback for the county.

A blufftop setback requirement for the entire county of Tillamook would have to be drafted and adopted in the County Land Use Ordinance and this process would likely be controversial, but when citizens are properly informed and aware of coastal erosion hazards mitigation requirements such as this can be passed. Tillamook County should actively involve the Community Advisory Committees (CACs) when drafting this and all other code change recommendations.

The Oregon Model Coastal Erosion Overlay Zone provides example code language. In addition, the Neskowin Coastal Hazards Overlay Zone provides a local example of how the Oregon model overlay was modified to fit the Tillamook context. Adoption of a countywide blufftop setback would protect people and property within Tillamook County from the chronic and episodic effects of coastal erosion.

Key Resources

Source	Description
San Luis Obispo Coastal Zone County Land Use Ordinance	Describes the regulatory land use requirements for development in the Coastal Zone
San Luis Obispo County Zoning Maps	Shows the extent of the Coastal Zone in San Luis Obispo County
California Coastal Commission	Provides regulatory review of county's Coastal Zone regulations
San Luis Obispo County's Local Coastal Program Periodic Review	The California Coastal Commission's review and recommendations for San Luis Obispo County

COASTAL EROSION: GEOLOGIC HAZARDS OVERLAY NEWPORT, OR

Introduction

The purpose of this case study is to evaluate Newport, Oregon's Geologic Hazards Overlay code and its utilization of the Oregon Department of Geological and Mineral Industries (DOGAMI) mapped bluff or dune backed shoreline areas within high or active hazard zones. This study briefly describes the need for such an overlay in Tillamook County. The specific code requirements pertaining to coastal erosion are highlighted and the implications of this hazard overlay for Tillamook County are discussed.

Context

Newport is a coastal community of 10,000 located in central Lincoln County where the Yaquina River meets the Pacific Ocean. As with all coastal communities in Oregon, coastal erosion threatens life and property in coastal Newport. In 2004, DOGAMI completed maps of both landslide and coastal erosion risks within the community, and in 2010 the city planning department took the initiative to adopt these maps as the city's municipal code Geologic Hazard Overlay boundaries.

The public drafting of the ordinance was met with strong opposition, particularly due to concerns of decreased property values from "readily removable" building stipulations in high hazard areas, proposed hazard disclosures, and liability waivers that were proposed as part of the comprehensive review of the Geologic Hazard Areas Section of the Zoning

Case Study Significance

The Geological Hazard Overlay code in Newport, OR uses DOGAMI hazard mapped zones to implement their hazard overlay code that protects people and development from the dangers of coastal erosion.

Faith Cathcart, The Oregonian

An eroding cliff side in Newport, OR threatens coastal development.

Newport is very courageous in stepping out front, and they've bent over backwards to make sure the local population is able to join in that conversation.

- George Priest, DOGAMI Geologist

Ordinance (Section 2-4-7) and development code (chapter 14.21). A lengthy public comment and review process mitigated citizen concerns, and in 2011 and City of Newport Planning Commission and its Citizens

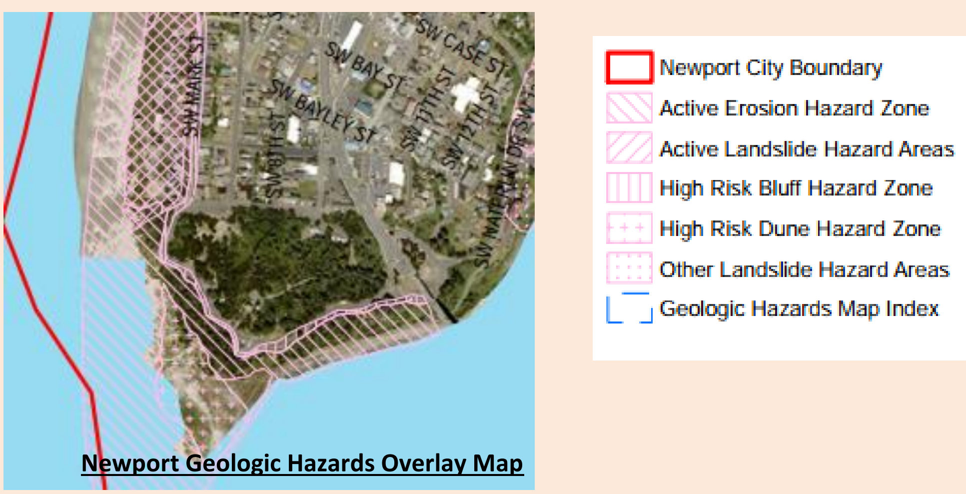
Advisory Committee submitted their code change requests. These were adopted by Newport with city ordinance No. 2017. The significant end result of this process is the Geologic Hazards Overlay, Chapter 14.21 of Newport's current municipal code.

Current Programs

The Newport Geological Hazard Overlay borrows language heavily from the Oregon Model Coastal Erosion Overlay Zone and DOGAMI mapped active or potential landslide areas, prehistoric landslides, or other landslide risk areas, as well as bluff or dune backed shoreline areas within high or active hazard zones are utilized for the Geologic Hazard Overlay Maps. For any property within, or partially within, the mapped hazard zones the following major requirements are applied.

- A geologic report prepared by a certified engineering geologist is required to establish that the site is suitable for the proposed development.
- The engineering report must detail any site remediation that is necessary to make the site more suitable for development.
- Erosion control measure are stipulated by the engineering geologist for the construction process.
- Structures that conform to the Zoning Ordinance that incur damage for any reason may be replaced with a building or structure of up to the same size provided a Geologic Report is prepared by a certified engineering geologist.

Additionally, the city subdivision ordinance was amended to include a requirement that new undeveloped lots in land divisions must include a minimum of 1000 sq. ft. of buildable site outside of active/high risk areas. Further text amendments were made to the Natural Features Chapter of the Newport Comprehensive Plan to ensure consistency between the comprehensive plan and the development code.



Newport Geologic Hazards Overlay Map

Key Takeaways for Tillamook County

In 2014, DOGAMI produced an *Evaluation of Erosion Hazard Zones for the Dune-Backed Beaches of Tillamook County* (Open-File Report O-14-02) that uses the same bluff backed shoreline erosion hazard ranking and mapping as found in the Newport DOGAMI report, although the methodology between the reports differs slightly.

A Geological Hazard Overlay for the entire county of Tillamook would be a large regulatory task that may be controversial, but Newport's overlay code adoption process demonstrates the ability to balance citizen concerns while also dealing with the inescapable reality of the documented risks. Newport actively involved its Citizens Advisory Committee in reviewing the proposed code changes and their recommendations helped to create an overlay with development requirements that were not overly restrictive. Tillamook County should actively involve the Community Advisory Committees (CACs) when designing their Geologic Hazard Overlay.

The Oregon Model Coastal Erosion Overlay Zone is specifically designed to be used in combination with DOGAMI Coastal Hazard Risk Zone Maps. Newport and Neskowin serve as examples of communities that have adopted and adapted the model overlay code language to fit their communities. The coastal erosion hazard is detailed and mapped in the Tillamook wide DOGAMI O-14-02 report. The report should therefore be utilized to protect people and property with Tillamook County. The adoption of a countywide or high hazard area overlay would demonstrate that Tillamook County takes seriously the threat of natural hazards in the unincorporated community.

Key Resources

Source	Description
Newport Geologic Hazards Overlay	Section 14.21 of the Newport OR Development Code
DOGAMI O-04-09	Defines the Newport Geologic Hazard Overlay
DOGAMI O-14-02	Could be used for a costal erosion overlay in Tillamook County
Oregon Model Coastal Erosion Overlay Zone	Model code language used extensively in the Newport Geologic Hazards Overlay

COASTAL EROSION: EROSION CONTROL AND STORMWATER MANAGEMENT ASTORIA, OR

Introduction

The purpose of this case study is to evaluate Astoria's Erosion Control and Stormwater Development Code regulations. This study briefly describes the need for such regulations in Astoria. The specific code requirements pertaining to coastal erosion are highlighted and the implications of this type of development code section are considered for Tillamook County are discussed.

Context

Located on the south shore of the Columbia River in far North West Oregon, Astoria has gone through numerous boom and bust economic cycles and has remade itself most recently as "little San Francisco."

With 10,000 residents, Astoria relies heavily on its deepwater port to support the local economy and the community has taken measures to protect its water resources from potential negative effects during development. Stormwater runoff, both during and after construction, can contribute to and exacerbate coastal erosion by eroding and channelizing ocean cliffs, bluffs, and dunes.

Astoria has sought to prevent the transport of sediment and other soil borne pollutants into the Columbia River estuary and its tributaries, wetlands and riparian areas by adding an Erosion Control and Stormwater Management section to their development code.

Case Study Significance

Astoria utilizes an Erosion Control and Stormwater Development code section for any proposed clearing, grading, filling, stripping, or excavating (regulated activity) within 100 feet of a known geologic hazard.

The Columbia River as seen from the Astoria Column just outside of Astoria, OR.

"Minimize the erosion of land during clearing, excavation, grading, construction and post-construction activities."

Erosion Control and Stormwater Development Code

Current Programs

Astoria's Erosion Control and Stormwater Development Code regulations are applied to any proposed clearing, grading, filling, stripping, or excavating (regulated activity) within 100 feet of a known geologic hazard. The regulations seek to;

1. Minimize impacts associated with excavation and grading.
2. Minimize the erosion of land during clearing, excavation, grading, construction and post-construction activities.
3. Prevent the unnecessary clearing, excavation, and stripping of land; and
4. To reduce the amount of soil exposure during construction.

To achieve these goals, a permit is required to clear, grade, excavate, strip, or fill land. Permits are obtained from the Engineering Department. All permits are reviewed and approved by both the Astoria Engineering Department and Community Development Department for compliance with this Ordinance and other City codes and building codes. Permits are subject to numerous conditions including cut and fill standards and the following requirements:

- Natural vegetation shall be retained and protected wherever possible.
- Sedimentation barriers shall be placed to control sedimentation from entering the river, bay, streams, wetlands, adjacent property or City streets and storm sewers. The barriers shall be installed prior to site clearance or grading activities.
- The City Engineer or Building Official may require areas to be temporarily stabilized with straw mulch, sod, mat or blanket in combination with seeding, or other acceptable sediment control method. Prior to the completion of construction, such areas shall be permanently stabilized by seeding or other vegetative ground cover.
- Stormwater catch basins, inlets or culverts shall be protected by sediment traps or filter barriers such as "bio bags."
- Soil storage piles or fill shall be located so as to minimize the potential for sedimentation of streams, wetlands, adjacent property or City streets or storm sewers. The City Engineer or Building Official may require temporary stabilization of soil storage piles or fill.
- Temporary sedimentation control, not in conjunction with a structure, shall be required in any situation where the City Engineer or Building Official determine that sedimentation or erosion may affect streams, wetlands, adjacent property, City streets or storm sewers.
- Erosion and sedimentation control measures shall be continually maintained during the period of land disturbance and site development in a manner that ensures adequate performance. Soil that has been transported by any means to a street or any area where stormwater flows to a storm drain or surface water, shall be cleaned up to prevent transport to the drain or surface water. All temporary erosion and sedimentation control measures shall remain in place until the disturbed area is stabilized with permanent vegetation.
- Sediment trapped by sediment control methods shall be redistributed onsite, removed, or permanently stabilized to prevent further erosion and sedimentation.
- The City shall make periodic inspections to ascertain that erosion and sediment control measures as proposed have been implemented and are being effectively maintained. The City Engineer or the Building Official

are authorized to place an immediate "stop work" order on any project that does not meet the standards imposed in this ordinance.

Through these requirements and permit process, Astoria is able to effectively mitigate the erosive effects of stormwater to better protect both hillsides and water quality.

Key Takeaways for Tillamook County

Astoria's Erosion Control and Stormwater Development Code regulations are contained as an appendix to the Oregon Model Coastal Erosion Overlay Zone for reference and use by other communities. Tillamook County currently lacks a stormwater management development code section and as a first step the County should look to adopt erosion control permits and requirements similar to Astoria for areas of high risk to coastal erosion and landslide.

Tillamook County currently applies a limited set of Erosion Control and Stormwater Management development regulations within the Neskowin Community Boundary and Neskowin Coastal Hazard Overlay Zone through the Neskowin Erosion Control and Stormwater Management code section (5.100). This code and the Astoria code both serve as examples for an Erosion Control and Stormwater Management code section for all areas of the county that are at risk to coastal erosion and landslide.

Providing consistent and clear erosion control and stormwater management development code regulations for all areas of unincorporated Tillamook County that are at risk of landslide and coastal erosion is important for protecting both people and property as well as for preserving water quality.

Key Resources

Source	Description
Astoria, OR Development Code	Section 3.300 is the Erosion Control and Stormwater Management code section
Do I Need a Grading and Erosion Control Permit?	Astoria's informational flyer on the Grading and Erosion Control Permit process
Model Coastal Hazards Overlay Zone	Appendix D: Astoria Erosion Control and Stormwater Management Code Language, page 25
Tillamook County Article 5: Special Uses and Standards	Section 5.100 is the Neskowin Erosion Control and Stormwater Management code section

LANDSLIDE: GEOLOGIC HAZARD ABATEMENT SAN RAMÓN, CA

Introduction

The purpose of this case study is to evaluate the City of San Ramon's use of a Geologic Hazard Abatement District (GHAD). This study will provide a brief description of the community's unique geologic setting, analyze the history of the program, and examine locally applicable best practices. Examination of implementation strategies will be identified and discussed, ultimately illustrating the feasibility and relevancy to Tillamook County's goal of natural hazards mitigation.

Context

Located within Contra Costa County, the city of Sam Ramon is surrounded by rolling hills, the Diablo Mountain Range, and the SanRamon Valley. Slides and earth flows pose a serious hazard to the city. The city is located 25 miles south of the Oakland and serves as a bedroom community for employees traveling to San Francisco, Silicon Valley, and San Jose. The population is 74,378, with an expected build-out population of approximately 90,000, making it the fourth largest city in the county.

In January 1982, the President declared a major Disaster Declaration under PL 93-288, indicating severe damages in the hills of Contra Costa and six other surrounding counties. Federal and state damage estimates indicate a high level of destruction:

- 6300 Damaged Structures

Case Study Significance

For over fifteen years, California has utilized Geologic Hazard Abatement Districts to engage communities in geologic mitigation actions.

The city of San Ramon has demonstrated the efficacy of local voluntary programming, gathering the necessary economic and social support to addresses the unique conditions that influence landslide threat.

2011 Landslide in Contra Costa County

What is an Abatement District?

Abatement districts vary in specific characteristics, however, they all aim to reduce the damage caused by a specific hazard. To lessen the impact threat, communities come together to combine funding through monthly required fees. The fees vary based on the requirements set forth in a district agreement. Funding is put towards a variety of mitigation actions and also set aside for an emergency event.

- 231 Destroyed Structures
- 33 Deaths
- $109 million total damages

Source: *National Weather Service, 1982*

Following this incident, state and county officials became increasingly concerned with the threat of landslide hazard, eventually prompting discussion regarding response efforts. The integration of Geologic Hazard Abatement Districts became increasingly attractive after a disaster of such magnitude. The 1979 Beverly Act provided for the establishment of Geologic Hazard Abatement Districts (GHADs) as independent public agencies to oversee geologic hazards in defined geographic areas. There are currently over 35 GHADs in California working to prevent, mitigate and abate geologic hazards (California Association of GHADs, 2016).

Under authority of the California Public Resources Code (Division 17, commencing with Section 26500), the City of San Ramon, in 1990, adopted Resolution No. 90-106 forming the West Branch Geologic Hazard Abatement District ("GHAD" or "District") 1990-01. The primary mission of the GHAD is the prevention, mitigation, abatement, and/or control of geologic hazards within its boundaries that have damaged, or that pose a significant threat of damage to site improvements within the developed areas of the projects. (Revised Plan of Control 2009) As a resident, the GHAD is beneficial as it provides a type of insurance and security, as well as management and maintenance.

Current Programs

Assessment

Assessment is a vital component for the management of an abatement district. To property and appropriately allocate funding, it is essential that the district be fully informed on the current conditions that may impact hazard threat levels. The assessment is a legal document that states how the district should be maintained and prevents damage resulting from earth movement by identifying and monitoring potential geologic hazards and undertaking improvements as appropriate. GHAD assessment can be easily collected since the assessment can be collected along with the general property tax. This avoids requiring separate collection by a private entity. Assessments are updated and approved annually by the GHAD Board. The primary purpose of the assessment is to fund maintenance activities and projects defined within the Plan of Control. The Certified Engineering Geologist (CGE) prepares the plan "which describes in detail a geologic hazard, its location and the area affected thereby, and a plan for the prevention, mitigation, abatement, or control thereof" (Section 26509).

Funding

A funding program provides concise organization and structure for the distribution and collection of finances. This pool of money serves preemptive reduction actions and also acts as insurance for residents in the event of an emergency event. Each fiscal year, the District Engineer prepares an Engineer's Report to outline budgetary allowances, costs, monitoring, and maintenance fees that are needed. Funds are utilized for all services included within the GHAD boundary. Volatile and at-risk areas are determined by the results of the assessment. Additionally, a reserve fund is set aside to mitigate and repair large landslides and other disastrous events. All property owners contribute an equal payment for annual assessment.

The proposed assessment for fiscal year 2014/15 is $141 per residential unit and $0.0451 per square foot of nonresidential area. Without the majority of consent of the property owners, the assessment rate cannot rise above $250 per residential unit and $0.10 per square foot of nonresidential structures (GHAD No. 1990-01 Brochure).

Key Takeaways for Tillamook County

Tillamook County contains a significant portion of preexisting developments that exist in high-susceptibility regions. In all unincorporated areas, 35% of building structures are exposed and the resulting destruction would cost close to $500,000,000. In the unincorporated county, there are six public facilities located in landslide high susceptibility regions; four schools and two fire departments (Tillamook Multi-Hazard Risk Report, 2016 draft).

Geologic Hazard Abatement Districts resolve issues related to all aspects of the disaster cycle. Through planning programs, rapid response initiatives, recovery aid and services, and mitigation funding and practices, the districts address both potential and actual geologic hazards. GHADs also serve as documentation for property conditions, maintenance and repairs. However, it is important to consider the disadvantages of GHADs, especially in relation to community politics. GHADs can be added to by a vote of 51% of the adjacent property owners, which places a burden on reticent parties and forces residents to comply. GHADs are an entity that can be enjoined in legal action by disgruntled members or adjacent parcel owners, increasing operating cost. It is important to consider the demographics and interests of the residents within the proposed district boundary and collaborate to minimize unrest.

A Geologic Hazard Area has been defined in the development code in 4.130, however, the code lacks enforceable monitoring or regulatory measures. Following the practices set forth by San Ramon's example, Tillamook County could adopt a Landslide Hazard Abatement District. The district would provide the protection of life and properties from landslide risk. An abatement district would mitigate hazard and be very beneficial throughout the unincorporated county. Moving forward, the cities should determine whether a GHAD would be politically viable in their community.

Key Resources

Source	Description
California Geologic Hazard Abatement Districts	Provides information related to GHADs in the state of California.
San Ramon Plan of Control	Establishes the key components of San Ramon's district.
San Ramon GHAD Staff Report	Assessment includes economic analysis, monitoring of ongoing projects, as well as discussion of new development.
GHAD Brochure	An educational public outreach packet that provides key information regarding the role of the district and how the district impacts residents.

LANDSLIDE: POINT BASED ASSESSMENT MARION COUNTY AND SALEM, OR

Introduction

The purpose of this case study is to analyze the strengths of a point-based geologic hazard overlay system modeled by Marion County and Salem. A partnership between the City, County, and DOGAMI produced a hillside development ordinance that is based on landslide hazard maps. This case study will evaluate the use of maps to inform development patterns through a quantitative allocation scheme to determine if these best practices would be effective for landslide mitigation in Tillamook County.

Context

Salem is the capital of Oregon and serves as the seat for Marion County. The city is the third most populous, after Portland and Eugene, and is home to over 150,000 residents. The metropolitan area serves as an employment center for a variety of both public and private sector jobs. The transportation infrastructure includes Interstate 5, Oregon Route 99E, and Oregon Route 22, connecting coastal and inland communities.

Troubling high rain events have prompted increased landslide mitigation efforts. Four separate flooding events in 1996/1997 involving heavy rains and landslides caused severe damage and led to Federal Disaster Declarations for Marion County and other counties in the State.

From November 1998 through January 2000, representatives from DLCD, DOGAMI, and a Landslide Hazard Advisory

Case Study Significance

Geologic hazard threat is determined based on a point-based system that gives a value to the site based on certain geologic, topographic, and development characteristics.

Salem and Marion County's assessment scheme provides a way to classify different proposed development sites and then mandates geologic report requirements based on the assessment score.

Heavy rains flood Salem in December, 2015

Step 6. Determine Landslide Hazard Risk

PART VI.	Total Risk Assessment Policy Provision	
Category A - Low Landslide Risk (4 or less point value)	**Category B - Moderate Landslide Risk** (5 - 8 point value)	**Category C - High Landslide Risk** (9 or greater point value)
No Requirements.	Geologic Assessment * * If the Geologic Assessment indicates landslide hazards on the site, the Planning Director or Building Inspection Official shall specify the requirements of a High Landslide Risk Assessment.	Engineering Geology Report Geotechnical Report

Step 6 from the hazard assessment table in the Marion County Land Use Code determines appropriate course of action based on combined point values.

Committee (LHAC) worked together to review landslide hazard issues, hillside development and other hazard ordinances from jurisdictions around the country. They developed a framework for landslide hazard regulations and draft landslide hazard ordinance provisions that were reviewed and refined by the LHAC, Oregon State Board of Geologic Examiners, members of the State Board of Engineering and Land Survey, and the staff of various city and county departments.

Salem Landslide Code

The city's ordinance is based on landslide hazard data and maps produced by DOGAMI. Building plans and development applications are evaluated based upon a point system that combines the landslide risk exhibited by the subject property (a function of soil types, slopes, underlying geological conditions, etc.). The accumulated point value guides specific action.

- For combined point values that represent Low Landslide Risk, no additional requirements are placed on the applicant beyond those otherwise associated with the development application.
- For combined point values that exhibit Moderate or High Landslide Risk, the applicant is required to submit a geological assessment performed by a Certified Engineering Geologist that examines the soil and geological conditions of the site to determine if mitigation strategies will need to be used to ensure safe development.

A geotechnical report provides concise information regarding the adequacy of the proposed development from an engineering standpoint, as well as conclusions regarding the effect of geologic conditions on the proposed development, and any recommended design and building features necessary to mitigate landslide hazard risks.

Ideally, geological assessments and/or geotechnical reports will be performed at the subdivision level, where a developer can submit one report for the entire subdivision.

Key Takeaways for Tillamook County

A point-based method to landslide mitigation may be an effective approach to addressing the landslide risk that persists throughout the entire county. Current mapping and susceptibility evaluation is primarily at the state or county scale, which may not be sufficient for accurately capturing site-specific characteristics and details that impact landslide threat. A point based assessment system and stipulations for a geotechnical report brings a more informed opinion that can supplement development proposals and guide better informed decisions regarding future land use practices at a local level.

Key Resources

Source	Description
Marion County Land Use Code	Contains the Geologically Hazardous Areas Overlay Zone Ordinance.
DLCD Natural Hazards Model Ordinances	DLCD has evaluated a series of hazard ordinances and outlined the successes and best practices that might be adopted in other areas.

LANDSLIDE: REVEGETATION REQUIREMENTS MUKILTEO, WA

Introduction

This case study is intended to outline specific code language that pertains to vegetation practices for development located in areas considered to be geologically hazardous and at risk to slope destabilization (landslides and coastal erosion). The city of Mukilteo, WA addresses the high level of landslide vulnerability that impacts the majority of the jurisdiction and has introduced more stringent requirements for future development. Mukilteo's regulatory approach provides a framework that sets forth clear definitions, standards, and practices that offer a strategy for Tillamook to target slides through a mitigation measure that revolves around increasing slope stability.

Context

The city of Mukilteo is the home to 20,000 individuals and is located on the shore of the Puget Sound within Snohomish County, Washington. Originally a small blue collar village that supported fishing, trade, and lumber, the city has experienced substantial growth and development along the waterfront. The boathouses have been demolished and replaced with apartment complexes and hotels, and industry now revolves around the nearby Boeing factory in Everett and professional audio equipment manufacturing. Perhaps the most prominent feature of the city is the transportation infrastructure that serves as a hub between Seattle and Everett. The waterfront location offers ferry services,

Case Study Significance

The city of Mukilteo has integrated strong regulation for vegetation standards within geologically sensitive areas.

- This is a model of a community that felt that existing development code was not sufficient and elected to adopt higher regulatory standards for the city.
- Vegetation and pruning requirements are informed by the Department of Ecology
- A hillside's root system greatly impacts the probability and magnitude of a landslide event.

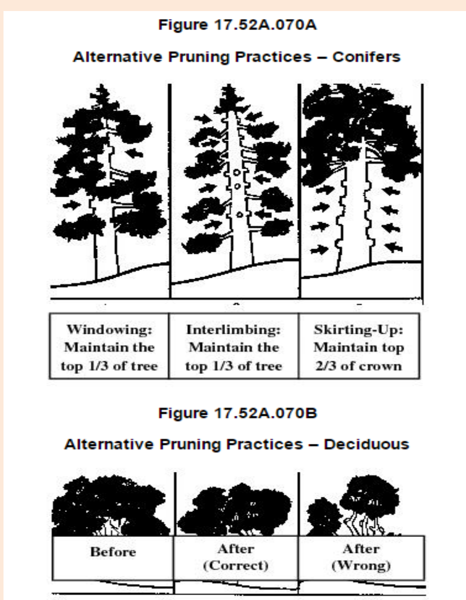
A mudslide buries the BNSF railroad tracks running alongside Puget Sound, near Everett.

while train service is provided by Sound Transit through the Sounder commuter rail.

The city aligns with the Southern Whidbey Island fault zone, and precariously, most of the community is concentrated on a hillside that faces the Island. The steep terrain surrounding development motivated city planners to examine the development code and include specific standards for geologically hazardous areas.

Many landslides occurred on the coastal bluffs between Seattle and Everett, WA during the winters of 1996 and 1997. The landslides caused significant property damaged and interfered with rail traffic; future landslides in the area pose significant hazards to property and public safety. In the past 10 years there have been more than 200 landslides along the Seattle to Everett coastline. Each slide that covers or disturbs rail lines triggers a mandatory 48-hour halt to passenger train traffic while BNSF clears tracks and ensures the area is stable (WSDOT, 2015).

On December 28th, 2014, a landslide dumbed debris five feet high and 30 feet long, including a 50-foot tree. BNSF Railway Co. responded by imposing a moratorium on passenger trains between Seattle and Everett, which had serious implications for Amtrak Cascades and Empire Builder trains.



Depiction of allowed pruning practices

WSDOT, Amtrak, BNSF Railway, Sound Transit and other partners formed the Landslide Mitigation Work Group to research historical slide locations and causes along coastal bluffs. The group also meets with local governments and citizens about ways landowners can help prevent slides on their property (WSDOT, 2014).

Best Practice

Chapter 17.52A defines geologically sensitive areas based on associated maps provided by the city that reflect geologic, hydrologic, and topographic characteristics.

Beyond distinguishing geologically sensitive areas, the ordinance also provides stringent regulations and requirements for vegetation management on slopes greater than forty percent. The vegetation specifications are based on recommendations outlined in the Department of Ecology's handbook *"Vegetation Management: A Guide for Puget Sound Bluff Property Owners".*

- Defining certain tree types that may be cut and removed in a method approved by the planning director and public works director.
- Stumps and root systems must be left undisturbed to protect the slope from erosion.
- Defining certain deep-rooted bushes or ground cover that shall be planted around the remnant stumps to establish erosion control functions.
- Defining certain tree types that cannot be cut down, except with the submittal of a geotechnical report.

- Trimming must preserve a minimum of sixty percent of original canopy/foliage
- "Windowing", "interlimbing", or "skirting-up" trimming practices may be utilized, but must adhere to requirements based on type of trimming practice.

Key Takeaways for Tillamook County

Tillamook County's existing code mentions revegetation however, this requirement is deficient and lacks the specificity needed to mandate a level of accountability as described below. Section 2.1 "Landslides" of the Comprehensive Plan stipulates that vegetation removal in areas of mass movement topography shall be engineered to minimize sliding (7-17). Section 4.130-2 instructs the documentation of "minimum removal of vegetation to accommodate use" within an associated geologic hazard report. These requirements are ambiguous and can easily be taken advantage of without clearly stated accountability measures and/or consequences.

Root systems are necessary for stabilization of soils to reduce the risk of shallow landslides. Bare soils are recognized as unstable material contributing to slope failure. After heavy rain, the shallow portion of the landslide is caused by saturated soil and decreased support of the slope. However, if the slopes have native forest cover, the probability of landslide occurrence becomes very low. Introduction of higher regulation for development, especially in areas replete with steep slopes, would substantially reduce the probability and magnitude of a landslide event.

Key Resources

Source	Description
Mukilteo Geologic Sensitive Area Regulations	Chapter 17.52A defines geologically sensitive areas and acknowledges specific mitigation strategies that must be taken to reduce threat.
Washington Department of Transportation Slide Program News, 2015	The Washington State Department of Transportation initiated slide management projects that targeted six historically slide prone sites.
WSDOT Landslide Mitigation Action Plan	WSDOT created the plan that defines the roles of the Landslide Mitigation Work Group, as a team to develop short and long term strategies to reduce landslide impacts and improve transportation and infrastructure throughout the Pacific Northwest Rail Corridor.

LANDSLIDE: LANDSLIDE HAZARD AREA CODE KING COUNTY, WA

Case Study Significance

Severe landslide events resulting from the Nisqually Earthquake had major implications for transportation and infrastructure.

The county recognized the need for increased landslide mapping and hazard analysis, and the results led to increased regulatory code language to best mitigate landslide risk.

Highway 101 landslide after the 2001 Nisqually earthquake

Introduction

The purpose of this case study is to evaluate the efficacy of King County's implementation of stringent buffer zone requirements in landslide hazard areas. The analysis includes important context and history that directly impacts the applicability of this best practice. Additionally, the connection between terminology and definitions included within the code will be examined, and implementation strategies will be identified and discussed.

Context

King County is the most populous county in Washington State and encompasses the tri-city metropolitan areas of Seattle, Tacoma, and Bellevue. These urban areas are linked by I-5 and I-90, bordered by the Cascadian Range to the East, and the Pacific Ocean/Puget Sound waterbodies to the West. In addition to this unique geographic setting, the county is exceedingly vulnerable because high concentrations of development have been located on steep slopes subject to landslides. Many of the major valleys and shoreline bluffs of Puget Sound are bordered by steeply sloping unconsolidated glacial deposits that are highly susceptible to landslides.

Historically, landslides have originated after severe storm events, however, one of the most destructive events occurred after the 2001 Nisqually earthquake. The earthquake is considered one of the largest in recent history, measuring 6.8 in magnitude with a maximum intensity of VIII (Severe) in the Capitol Hill area of Olympia and Pioneer Square in downtown Seattle. Beyond damages associated with earthquake, the sudden seismic movement triggered a landslide that blocked a portion of the Cedar River. Overflowing water caused

damage to the surrounding structures and uplifted a significant area of trees and debris.

The threat to life and property stimulated landslide conversation that launched many planning initiatives. By June 2014, the King County Flood Control District approved funding for a two-year investigation to update landslide hazard information for King County's river valleys and floodplains.

In addition to research and geospatial analyses, the county has also reviewed development code and integrated more rigorous requirements for building in a landslide hazard area.

Best Practice

Title 21A of the zoning code(21A.06.680) defines landslide hazard areas through a variety of metrics that include slopes greater than 15%, impermeable soils, and areas subject to inundation by debris flows or deposition of stream-transported sediments. The comprehensive definition limits any room for ambiguity and meticulously addresses all levels of landslide susceptibility.

Beyond distinguishing landslide hazard areas, the ordinance also provides stringent regulations and requirements for proposed development. One of the most effective attributes of the code involves buffer zone requirements which are based on a critical area report prepared by a geotechnical engineer or geologist.

The critical area report assesses a variety of unique variables such as habitat type, vegetation, slope, and development on the site. An applicant is asked to provide additional information with the permit application in order to enable Permitting Department staff to better assess potential impacts the development might have on these critical areas. The report also stipulates that the resident file a Notice on Title with the King County Office of Records and Elections prior to permit approval to record the presence of critical areas and buffers on the property. The Notice on Title provides a public record of the critical areas and associated development restrictions and is a requirement of the Zoning Code (KCC 21A.24.170).

- If a critical area report is not submitted to the department, the minimum buffer is fifty feet with an additional 15-foot building setback requirement.
- The buffer zone is predicated on the form of proposed development.

Key Takeaways for Tillamook County

Tillamook County's development code does not include provisions related to the area surrounding structures proposed within a high-risk landslide area. The County can reduce the potential damage to structures through a buffer zone regulation. The amended code would include language modeled after King County's example and would include a requirement for a critical area report that would specify buffer zone standards based on the findings of the report. This approach does not require a high level of involvement and will not be a significant burden for community members, as the responsibility falls on the developer to fulfill the buffer requirement.

Key Resources

Source	Description
King County Title 21A Zoning Code	King County land use code, including title 21A for analysis of landslide hazard areas.
2001 Post-Quake Analysis	A USGS publication that accounts landslide damages and losses resulting from the 2001 Nisqually, WA Earthquake.

Wildfire: Hillside Overlay Colorado Springs, CO

Introduction

This case study describes Colorado Springs Development Code Section 8.4.105 amendment to International Fire Code, which introduces a highly regulated Hillside Overlay Zone for areas determined as highly vulnerable to fire threat. This study describes process that motivated the city to reevaluate the standardized set of stipulations and then outlines the more rigorous language that was included into the development code. The specific recommendations taken from this practice involve the integration of an overlay district for Wildland Urban Interface areas and mitigation requirements surrounding roof materials and fuel management.

Context

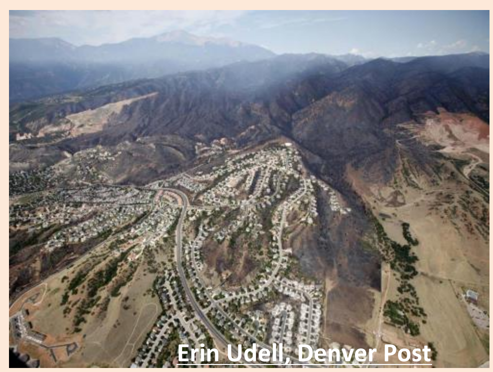
Colorado Springs, home to over 445,000 people is located 60 miles south of Denver. The city is located in a very arid desert mountain environment and is highly vulnerable to wildfire, and experienced severe damage from wildfires in 2012 and 2013. The Waldo Canyon and Black Forest fires represent the state's most damaging wildfire incidents, destroying over 850 houses and leading to 70,000 evacuations. After these events, the city reviewed the development code and determined that higher regulatory action was necessary to protect the people and property.

Colorado Spring's Land Use code, updated in September 2015, proposes a variety of modifications that increase mitigation

Case Study Significance

Colorado Springs, CO reevaluated city code after many devastating wildfire events.

- New development requirements amend International Fire Code with the addition of more stringent regulations
- The city has integrated an overlay zone with specific standards to reduce wildfire risk.
- Mitigation strategies focus on Fuel Management and Roof Requirements



Destruction from Waldo Canyon Fire, Colorado Springs, 2012

"Over 850 houses destroyed and 70,000 people evacuated."

activities for wildfire hazard. *Section 7.3.504* specifically targets the utilization of an overlay zone with wildfire mitigation standards required for all new building construction or reconstruction, regardless of development plan approval date. The Hillside Ordinance does not apply to homes constructed prior to its adoption. As described below the most important stipulations relate to: designation of a specific 'safety zone', "Fuels Management Requirements" and "Roof Requirements".

Current Programs

Appendix K and the Hillside Overlay Zoning Code aim to set forth compliance standards with specific criteria that are applied to areas with significant vulnerability to wildfire risk.

Fuels Management Requirements for the safety zone:

- Brush patches or clusters may be left in the safety zone, but shall be separated by clear areas of ten (10) feet or more of noncombustible materials or grass mown to not more than four (4) inches in height.
- No brush shall be allowed within ten (10) feet of the main structure.
- Large trees shall not have overlapping limbs and shall be pruned of dead limbs to a height of ten (10) feet above the ground. Tree clusters may be allowed if sufficient clear area is provided.
- Tree branches shall not extend over or under the roof eaves and shall not be within fifteen (15) feet of a wood burning appliance chimney.

Roof Requirements

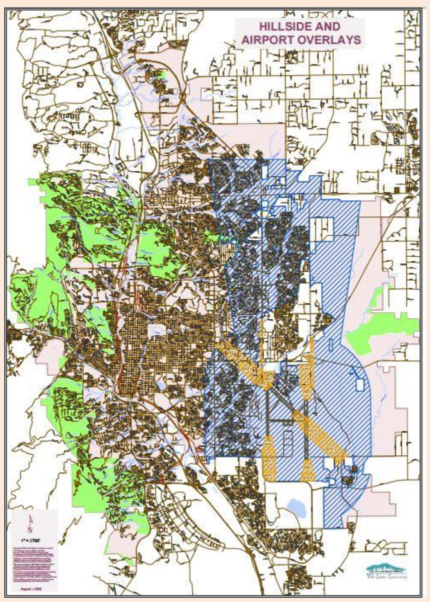
- A minimum of a Class A roof covering (excluding solid wood roofing products) shall be installed on all Residential Occupancies.
- A minimum Class B roof covering shall be installed on all remaining occupancies when an application is made for a roofing or re-roofing building permit within the limits of the City of Colorado Springs, Colorado.

Regulation/Monitoring Practices

- The Development Services Department ensures notes required by Section E., Wildfire Risk Mitigation, of the Hillside Overlay Zone Ordinance are included on all applicable development plans and subdivision plats.
- The Zoning Administration office ensures that notes are included on all Hillside Site Plans.
- The Zoning Office informs the applicant of the required fuels management measures for each individual lot at time of review.
- The Zoning office will identify the structures requiring Class C roofing materials and fire protection system installation and mark the HSS/LGP plan accordingly.

Key Takeaways for Tillamook County

The wildfire hazard Impacts only 0.7% of buildings in unincorporated areas of Tillamook County, however, future growth projections indicate increased development and eastward expansion into wildfire areas. It is important for Tillamook County to review and improve code language with supplementary requirements to reduce structural vulnerability to damage from wildfire.



Colorado Springs *Hillside Overlay Map* provides a reference for areas that must comply with wildfire mitigation development requirements.

A regulatory Wildfire Hazard Overlay modeled after Colorado Springs Hillside Overlay for the entire county would provide additional wildfire safety measures for communities and residences within the wildfire prone regions of the county. The Overlay would not impose on development outside of the overlay and would serve primarily as a protective measure for anticipated growth trends.

The adoption of a high hazard area overlay would reflect far-sighted decision-making and demonstrate Tillamook's informed planning practices regarding development requirements. It would be most judicious to address the threat of wildfire before development rates increase and mitigate potential tensions with prospective homeowners.

A Wildfire Hazard Overlay Zone is designed to be used in conjunction with the Risk Report Wildfire Hazard Risk Zone Maps. The specific code language can be modeled after the best practices related to Colorado Springs Fuel Management and Roofing Requirements.

Key Resources

Source	Description
Colorado Springs Hillside Development Guide	An extensive presentation of model code language, diagrams, and requirements for development occurring within the hillside overlay. Provides information on how to minimize terrain disturbance, integrate vegetation, and mitigate impacts.
WUI Mitigation Ordinance	An amendment to the fire prevention code to include Appendix K to outline Wildland Urban Interface Mitigation Requirements for Hillside Overlay
Colorado Springs City Code	Section 7.3.504 designates the use of a hillside overlay zone.

Wildfire: Firewise Communities Ashland, OR

Introduction

Ashland, OR has been recognized as a model Firewise Communities/USA® since it's recognition award for Oak Knoll Meadows in 2011. This case study outlines the practices and successes of Ashland's twelve Firewise neighborhoods. This study highlights the feasibility for such a program in Tillamook County.

Context

Ashland is a city located within Jackson County, OR. Just north of the California border, the city is home to 20,000 residents (2015, Portland State University). The city has a unique culture that is tied to Southern Oregon University, as well as many restaurants, galleries, the Oregon Shakespeare Festival, parks, and urban recreation areas. At the foothills of the Siskiyou and Cascade mountain ranges, this inland area receives less rainfall than the coastal communities.

In 2009 the city was impacted by the Siskiyou Fire that was outside the city limits, but created a big smoke column that had serious implications for public health and led to the evacuation of many neighborhoods. This event caught the attention of the public and initiated interest in wildfire mitigation. In 2011, the severity of wildfire hazard was reiterated when the Oak Knoll Fire took 11 homes in a neighborhood outside of the designated Wildfire Hazard Zone. Many of these neighborhoods have been in existence for decades, and were constructed when building codes did not reflect Firewise principles.

Case Study Significance

In 2011, Ashland, OR, a small city (20,000 residents), took the initiative to form its first Firewise community.

- The city has less available resources, however, the political and social will to reduce risk for people and property catalyzed many important mitigation actions that have greatly reduced wildfire risk.
- The community has access to valuable information regarding vegetation, defensible space standards, and location of different hazard zones.
- Events and services include free yard debris disposal, an annual 5k run, and a Firewise Clean-Up day.

A map of Ashland's twelve neighborhood *Firewise sites*.

Current Programs

Since 2011, the City of Ashland has established twelve neighborhood based Firewise communities. Despite having no standards for defensible space in either Ashland or Jackson County's development codes this voluntary program has been highly effective. Firewise events are regularly held, led the local fire protection district, with assistant from students at Southern Oregon University.

The events provide community members information on their wildfire risk, the conditions that impact their community, and provide important insight and tools to reduce their risk. One of the most effective annual events is the "Ashland Firewise Clean-up Day", where representatives from the Wildfire Mitigation Commission, Recology Ashland, and Ashland Fire & Rescue work together to promote vegetative fuel removal and disposal and encourage residents to create a defensible yard before the fire season starts.

Education opportunities include courses regarding Firewise landscaping for local professionals, as well as comprehensive online tools that integrate mapping, infographics, and simple actions that homeowners can take to mitigate wildfire.

For the community of Oak Knoll Meadows, successful Firewise project initiatives include removing rows of highly flammable leland cypress and juniper in common spaces where they were within 30 feet of homes and could act as fuel bridges for fire to carry between homes, as well as replacing some wood shake roofs, and some areas underneath decks and overhangs (*City of Ashland*).

Key Takeaways for Tillamook County

Historically, wildfires have burned vast areas of land and property in Tillamook County. Current protective measures, extents of existing fire protection districts, and coverage throughout the Forest Zone may be insufficient in terms of regulating wildfire mitigation. The Forest zone (F-zone) is effective, however, regulations are not in place for residential areas within the F-Zone. Encouraging the formation of Firewise communities is a non-regulatory approach that is highly effective at mitigating wildfire. As exemplified by Ashland, size and available resources do not inhibit the efficacy and success of the program.

Key Resources

Source	Description
Firewise.Org Successful Stories	The NFPA and Firewise Communities website identifies model communities that have taken initiative and formed highly effective programs.
City of Ashland	The City of Ashland provides an in-depth overview of the Firewise Community history, as well as helpful informational resources, news, maps, tips, and references for service providers in the area.
Firewise	The NFPA and Firewise offer a website that outlines the history of the program, FAQ, online courses, and a blog.

MULTI-HAZARD: LOW-IMPACT DEVELOPMENT GUIDANCE STATE OF WASHINGTON, PUGET SOUND PARTNERSHIP

Introduction

The purpose of this case study is to evaluate the Puget Sound Partnership's Low-Impact Development (LID) Land Use Guidance Report. In particular, this case study evaluates the adoption of alternative regulatory standards for stormwater management. This study briefly describes the context of LID in the Puget Sound of Washington State. Lastly, specific land use code language and programmatic implementation steps pertaining to the stormwater management strategy are highlighted, and the implications for adoption of similar standards in Tillamook County are discussed.

Context

The Puget Sound Partnership has been a national leader in the research and development of strategies to implement low-impact development since holding the first national LID conference in 2000. Since then the Partnership has commissioned studies and technical reports related to the subject. The Puget Sound offers a unique and ideal location to conduct these studies due to recent scientific reports showing the effect of urbanization and poor stormwater management techniques on the Puget Sound. As water quality became a serious issue, salmon and other aquatic animals began to reduce in population until they became threatened species.

As a response to this, from 2005-2009 the Partnership led discussions with the Washington Department of Ecology to

Case Study Significance

By managing stormwater in small-scale, distributed facilities, the flooding effects to downstream properties from flash storm events are reduced.

An example of Low-Impact Development in Lacey, WA.

"Conventional practices, like stormwater ponds surrounded by chain link fences, can be eyesores and typically provide only the one function while LID techniques, such as bioretention and vegetated roofs, provide multiple benefits."

- Bruce Wulkan, Puget Sound Partnership

facilitate the LID Local Regulation Assistance Project, which provided detailed recommendations to 36 local governments for removing barriers to LID, and either encouraging or requiring LID.

With the creation and adoption of the recommendations of the Assistance Project, came a wealth of knowledge related to LID regulations, standards, and best practices. The information and best practices collected from the project, which involved 36 local governments, were consolidated and synthesized into the *LID Technical Guidance Manual*. The technical manual is targeted to an array of professionals including engineers, planners, landscape architects, technical staff, policy makers, and developers. The specific code language sections and standards in this case study are directly from the Guidance Manual or from the Partnership's resource guide *Integrating LID into Local Codes.*

Current Programs

The Puget Sound Partnership's *Integrating LID into Local Codes* identifies not only model development code language but it also includes a significant amount of information related to incentive programs to encourage the use of LID. The Partnership encourages municipalities to use these incentive based programs because they are often "the most successful measure taken by local governments to spark LID for those who are not inclined to require its use." The incentives programs included in the guide are as follows:

- Reduced Permit Review Time
- Reduced Application Fees
- Dedicated Review Team
- Property Tax Reduction
- Public Recognition
- Increased Densities
- Flexibility in Building Restrictions
- Adjustments to Required Parking
- Reduced Surface Water Fees
- Lower SDC fees
- Fee Restructuring
- Reduced Stormwater Requirements
- City-Furnished LID Materials

While this is a fairly comprehensive list, the guide understands that many of these incentive programs may not work in all jurisdictions. The Partnership recommends developing an advisory committee (project team) of staff and stakeholders who are familiar with the jurisdiction and its policies to best adapt the programs to the local context.

Topics to Address

Once the project team is assembled and a common level of understanding of LID is established among the participants, the next step is to establish a work program that includes what topics are to be addressed. The Partnership recommends the project team focus their efforts on:

- Site Planning and Assessment
- Healthy Soils
- Landscaping and Vegetation
- Hard and Impervious Surfaces
- Bulk and Dimensional Considerations
- Clearing and Grading
- Streets and Roads
- Parking
- Design Guidelines
- Site-Specific Stormwater Management
- Subdivision and Planned Unit Development
- Shoreline Management

By narrowing its focus on these areas, the project team can become deeply familiar with the challenges and opportunities LID presents. This step in the process can be used to educate outside stakeholders about how LID policies, regulations, and standards fit into the larger regulatory context.

Perform Gap Analysis

Once a local government's project team identifies what should be addressed under an LID approach, the next step is to determine where changes need to be made to integrate LID fully into a jurisdiction's policies, regulatory code, and standards. This step focuses on the review of codes and standards against what is needed to determine where changes are needed for LID integration. This step discusses the major topics that should be reviewed during the LID integration process and shows where these topics are typically found within development regulations and standards. It is important to note that no two codes are integrated in the same-manner. Each jurisdiction should consult planning and public works staff to understand how development regulations and standards can best be modified.

A gap analysis identifies those places in a jurisdiction's codes and policies where amendments or new codes and policies may be needed in order to allow LID where feasible. These major topics include the following:

- Comprehensive Plan Goals and Policies
- Zoning Code
  - Landscaping, Native Vegetation, Tree Protection, and Open Space
  - Impervious Surface Standards
  - Bulk and Dimensional Standards
  - Site Plan Review
  - Parking
- Development Code and Standards
  - Clearing and Grading Standards
  - Engineering and Street Standards

After the project team identifies where there are gaps and barriers in existing codes and standards, the next step is to fill the gaps and remove the barriers by amending existing codes and developing new code language. This step will likely

Reduced width one-way street and short driveways minimizing impervious surfacing.

be an iterative process as the project team reviews concepts and examples of how existing code and standards may be modified to emphasize an LID approach.

Before starting the code amendment process, it is a good idea to lay out the steps of the intended project-specific LID review and approval process to provide a framework for the process. Because LID site design mimics the natural hydrology of the site, it is very important to specify the details that need to be known by the applicant and jurisdiction early in the project review and approval process so there is sufficient technical information to guide design of the site. Collaboration is a critical piece to this review process. Through the process of an initial site and feasibility assessment, the applicant typically will survey and test the development site to understand its physical characteristics. In a LID site assessment, additional on-site studies should be conducted to determine soil quality, drainage, vegetative cover, etc. Establishing these standards early is the key to ensuring this process runs as efficiently as possible. Once the process for site assessment is standardized, LID policies can be further implemented throughout the Comprehensive Plan, Subdivsion Code, Engineering and Street Standards, and Zoning Code.

Both guides produced by the Puget Sound Partnership, *Integrating LID in Local Codes* and the *LID Technical Guidance Manual* offer a plethora of model codes and specific language that can be adapted or adopted by local governments. These codes range from highly regulatory standards such as determining the size of trees needed to mitigate runoff to non-regulatory on-site stormwater management incentive based programs. All code language in these guides are standards pulled directly from implementing jurisdictions and may need to be altered to best fit within the Tillamook County context.

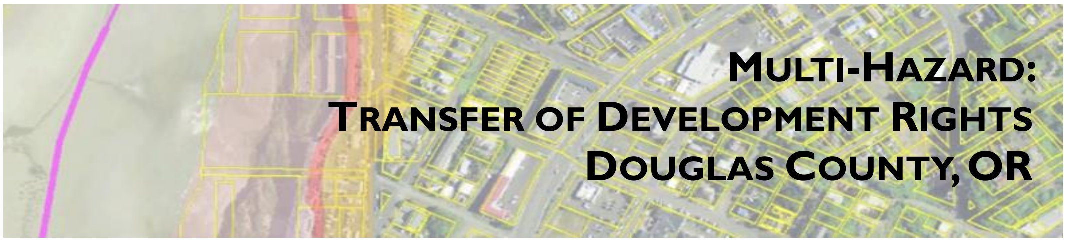
Key Takeaways for Tillamook County

Stormwater management is a mitigation strategy that effects many natural hazards. Maintaining runoff on-site can help reduce risk for landslide and natural absorption of water causes less flooding. Additionally, low-impact development is a sustainable practice that can greatly improve water quality, provide habit for species on land, and protect habit for aquatic species receiving stormwater runoff. However, LID is not without its challenges. A common misconception about LID is that it produces an undue cost burden on the property owner by requiring them to institute stormwater management practices that are above and beyond what is minimally required. As LID becomes more common and better understood, the initial building cost continues to fall. Over the long-term, LID practices can actually save property owners money as maintenance costs are significantly lower than that of traditional stormwater practices.

Another important aspect to note, is that in many jurisdictions LID practices are offered as an alternative to traditional stormwater management practices. Typically, property owners have the option to "opt-in" to the LID standards in order to achieve an incentive, ranging from reduced fees to additional density bonuses. Because Tillamook County has a large geographic area of varying ecological situations, this "opt-in" strategy may be an attractive regulatory direction. The County can develop LID standards and regulations based on the Puget Sound Partnership best practices and model ordinances but only enforce them on properties that decide to use the alternative. This would add an additional step to the site and development review process but can make a drastic difference in mitigation of natural hazards and wildlife habit preservation in Tillamook County

Key Resources

Source	Description
Puget Sound Partnership Integrating LID into Local Codes	Describes the regulatory process of adopting LID standards into local codes.
Puget Sound Partnership LID Technical Guidance Manual	Provides policy decision makers with technical assistance in adopting LID standards
ECONorthwest The Economics of Low-Impact Development: A Literature Review	Studies the economic and financial feasibility, effectiveness, and implications of LID
Green Girl Development Solutions	Provide LID resources and best practices.



MULTI-HAZARD: TRANSFER OF DEVELOPMENT RIGHTS DOUGLAS COUNTY, OR

Introduction

The Transfer of Development Rights (TDR) program in Douglas County, OR presents a process and model code language that reflects a successful mitigation strategy to prevent development in high hazard areas. This case study will highlight the Douglas County program and then evaluate the feasibility of implementing a similar program in Tillamook. Ultimately, this example sets the framework for counties across Oregon that may be interested in utilizing TDR programs.

Context

Located in the southwest coastal region of Oregon, Douglas County spans over 5,000 square miles and is the fifth largest county in the state. This area includes many notable natural features such as Crater Lake, Umpqua National Forest, and Willamette National Forest, and beautiful bays. There were roughly 109,000 residents in the county (Portland State University, 2015), with a significant level of employment in the timber/forestry industry (30% of labor) (2014, Census Bureau).

Recently, Douglas County has experienced severe destruction from both flooding and landslides. In December 2015, a landslide closed Highway 42 for close to a week, forcing traffic to take a detour that impacted a significant portion of the population. Then again in February (2016), a massive rockslide occurred on Tyee Access Road about 15 miles west of Sutherlin. According to the Public Works

Case Study Significance

Douglas County, OR contains many communities that are at high risk to a variety of natural hazards such as floods, landslides, rock slides, and coastal erosion.

- After receiving a grant from DLCD, the county funded mapping and research projects to inform and develop a TDR program.
- The county's TDR program is noted as a successful model framework for which other counties can follow if they wish to implement a similar TDR program.
- The program limits risk to future development within natural hazard prone areas by transferring rights away from a highly susceptible area.

High rains led to severe flooding and landslides for Douglas County in December 2014.

Department, the rock is 40-feet in length and 40-feet tall and it could cost as much as $50,000 to clean up *(Douglas County Public Works Department)*.

The county is highly susceptible to many natural hazards, which ultimately drove the initiation of a TDR program. Senate Bill 12 establishes Oregon's policy for protecting the public from rapidly moving landslide hazard and was adopted in the wake of the catastrophic landslide events that occurred in Oregon in 1996. The Oregon Department of Land Conservation and Development (DLCD) received money from this legislature and awarded a grant to Douglas County to develop a a model program to help in the mitigation of rapidly moving landslide hazards. These funds were awarded to Douglas County. Douglas County agreed to produce four main products: a model landslide hazards ordinance, model documents to support implementation of Senate Bill 12, a model Transfer of Development Rights program, and procedures to integrate DOGAMI's "further review area" maps into local tax parcel maps (*DLCD*).

Current Program

The Douglas County Transfer of Development Rights Guide includes the following recommendations for other counties considering adaptation of a similar program:

- Local government should consider approaching TDRs as a unique tool that mitigates environmental, economic, social and energy (transportation) issues for rural areas.
- Local government should view TDR programs as density transfers. Density transfers should be treated much like a water/mineral right with the exception of not issuing a stock certificate.
- Completion of a credit exchange would require parties to document the process and provide jurisdictional proof of redemption. The sending property would record with the County Clerk findings stating completion of the transaction and placement of a redemption covenant.

Key Takeaways for Tillamook County

When addressing areas that may be subject to multiple hazard threats, Tillamook County should consider initiating a TDR program. Douglas County set the framework for Oregon and established a legal precedent and foundation for which hazard mitigation can be addressed through development rights. By transferring the development right from the at-risk property, the county insures that there will be no future threat to potential residents or structures.

Key Resources

Source	Description
DLCD Natural Hazards Model Ordinances	DLCD has evaluated a series of hazard related ordinances throughout the state and outlined the successes and best practices that might be adopted in other areas.
Douglas County Model TDR Guide	Written in 2000, this document examines the political feasibility of TDRs in relation to Senate Bill 100.

C. Planning Process

1. Plan Maintenance: Record of Revisions Form

DATE	JURISDICTION(S)	REVISION

2. Meeting Agendas and Sign-In Sheets

Tillamook County Commissioners and Planning Commission Joint Meeting: April 6, 2016

UNIVERSITY OF OREGON

CPW

Agenda

Meeting: FEMA Risk MAP Joint Workshop
Date: April 6, 2016
Time: 1:30-3:30 PM
Location: Tillamook County Courthouse (201 Laurel Ave)

I.	**Intro by Bryan Pohl**	**5 minutes**
II.	**Steve Lucker – Risk MAP Coordinator** a. Introduction to Risk MAP b. Status update on Risk Map	**15 minutes**
III.	**Jed Roberts – DOGAMI Flood Mapping Coordinator** a. Overview of multi-hazard risk assessment	**30 minutes**
IV.	**Community Planning Workshop Presentation** a. Background on project b. Toolbox of mitigation strategies c. Next steps in project	**30 minutes**
V.	**Marian Lahav – DLCD Natural Hazard Planner** a. Introduction to Natural Hazard Mitigation Plan	**15 minutes**
VI.	**Follow-up Questions**	**25 minutes**

COMMUNITY PLANNING WORKSHOP • COMMUNITY SERVICE CENTER
1209 University of Oregon, Eugene, Oregon 97403 | T.541.346.3889 | http://csc.uoregon.edu/cpw

Tillamook County Mayors and City Administrators Meeting: April 20, 2016

MEETING NOTICE

Mayors and Administrators of Cities in Tillamook County
Wednesday, April 20, 2016
12:00 p.m. – 1:30 p.m.
Rockaway Beach City Hall

Note on lunch: Please feel free to bring a lunch to eat during the meeting. Our quarterly meetings are "Brown Bag" meetings.

TENTATIVE AGENDA

1. Updating City and County Hazard Mitigation Plans (Marian Lahav, DLCD)
2. Update on Tillamook County Year of Wellness
3. Update on County Transient Lodging Tax grant funding
4. Report on Pacific City meeting on possible incorporation
5. Small Cities Support Network Region 1 meetings
6. Announcements
7. LOC Small Cities Support Network Region 1 and LOC Regional Meeting: Friday, June 3, 2016, 11:30a.m., Astoria, City Council Chambers, 1095 Duane Street
8. Next regular Mayors/Administrators meeting: Wednesday, July 20, 2016
9. Adjourn

Steering Committee Meeting: June 6, 2016

Tillamook County MJNHMP Update
Steering Committee Meeting

Monday, June 6, 2016 | Tillamook County Public Library, Hatfield Room
1:00 – 4:00 PM | 1716 3rd Street, Tillamook, OR 97141

AGENDA

I. Welcome & Introductions	10 minutes
II. Tillamook County MJNHMP Update Project Overview	10 minutes
III. Memorandum of Agreement	10 minutes
A. Memorandum of Agreement	
1. Purpose	
2. Content (FEMA Pre-Disaster Mitigation Grant)	
a. Period of Performance & Extension	
b. No exchange of funds	
c. Cost Share	
d. MJNHMP Adoption Requirement	
e. Signing	
IV. Tillamook County MJNHMP Content	20 minutes
A. Risk Assessment	
1. Risk MAP Risk Report	
B. Mitigation Strategy	
1. Plan Maintenance	
a. Integration Crosswalk	
b. Tillamook County Code Review	
2. Planning Process	
◈◈◈ **10-MINUTE BREAK** ◈◈◈	
V. Statement of Work & Project Schedule	
A. Roles and Responsibilities	20 minutes
1. Steering Committee	
2. Technical Advisory Committee	
3. DLCD	
B. Public Engagement Program	30 minutes
1. Technical Advisory Committee Membership	
2. Special Districts	
◈◈◈ **10-MINUTE BREAK** ◈◈◈	
3. Public Engagement Program	20 minutes
C. Project Schedule	20 minutes
VI. Post-Project Integration	10 minutes
VII. Next Steps	10 minutes

Meeting Materials

1. Meeting Agenda
2. Steering Committee Roster
3. Copy of Project Overview Presentation
4. Overview Handout
5. Memorandum of Agreement & Statement of Work
6. Cost Share Documentation Form
7. FEMA Local NHMP Regulations (44 CFR 201.6)
8. FEMA Local NHMP Review Tool
9. Risk MAP Risk Report Handout
10. Draft Technical Advisory Committee Roster
11. Draft Public Engagement Program
12. Project Schedule

Tillamook County Multi-Jurisdictional NHMP Meeting
Monday, June 6, 2016

PLEASE PRINT

Name	Email Address
Kate Skinner	Kskinner ODF.
Melissa Thompson-Kiefer Nehalem	recorder@ci.nehalem.or.us
Geoff Wallschlager	citymgrwallschlager@nehalemtel.net
Jerry Taylor City of Manzanita	jtaylor@ci.manzanita.or.us
Bill BAERTLEIN BOCC	
Liane Welch	PW.
Luke Shepard City of Rockaway	luke.shepard@rockawaybeach.or.us
Rachel Hagerty Tillamook County	rhagerty@co.tillamook.or.us
Paul Wyntergreen City of Tillamook	pwyntergreen@tillamookor.gov
Patrick Wingard DLCD	patrick.wingard@state.or.us
Stevie Burden City of Wheeler	
Tilda Jones TBHEID	
Angie Cherry City of Bay City	acherry@ci.bay-city.or.us
Sarah Absher DCC	
Gordon McCraw OEM	
Mark Labhart	BOCC

(Please use reverse if necessary)

Tillamook County Multi-Jurisdictional NHMP Meeting
Monday, June 6, 2016

PLEASE PRINT

Name		**Email Addresss**
John O'Leary		john@ci.garibaldi.or.us
Sarah Absher	Sarah Absher	sabsher@co.tillamook.or.us

(Please use reverse if necessary)

Steering Committee Meeting: September 23, 2016

Tillamook County MJNHMP Update
Steering Committee Meeting

Friday, September 23, 2016
9:00 AM – 12:00 PM

Tillamook County Public Library, Hatfield Room
1716 3rd Street, Tillamook, OR 97141

AGENDA

I.	Welcome & Introductions	10 minutes
II.	Review minutes and materials from last meeting	10 minutes
III.	Plan Structure and Content Decisions A. With or Without Addenda? B. Which Hazards to Address?	30 minutes

◈◈◈ 10-MINUTE BREAK ◈◈◈

IV.	Tillamook County Multi-Hazard Risk Report and Discussion Jed Roberts, Flood Mapping Coordinator Oregon Department of Geology & Mineral Industries (DOGAMI)	50 minutes

◈◈◈ 10-MINUTE BREAK ◈◈◈

V.	OEM Hazard Analysis Exercise and Discussion	50 minutes
VI.	Next Steps	10 minutes

Meeting Materials

1. Agenda
2. Meeting Notes from June 6, 2016 meeting
3. Updated Steering Committee Roster
4. Updated Technical Advisory Committee Roster
5. Updated Cost Share Form
6. Updated Public Engagement Plan
7. Table of Contents Examples (with and without addenda)
8. Risk Assessment Chapter Example (without addenda)
9. Worksheet: Which Hazards to Address?
10. DRAFT Tillamook County Multi-Hazard Risk Assessment
11. OEM Hazard Analysis Exercise Packet

Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan
Steering Committee

Friday, September 23, 2016, 9:00 AM-12:00 PM

411 W. 8th Street, Room 330, Medford Room
Medford, OR 97501

PLEASE SIGN IN (initial your name or add to the list)

	Name	Title	Representing	Phone	Email
1	Mark Labhart, Chair — (came late ~ 11:05, MJ)	County Commissioner	Tillamook County	(503) 842-3403	mlabhart@co.tillamook.or.us
2	Sarah Absher	Community Development Planner	Tillamook County	(503) 842-3408 x3123	sabsher@co.tillamook.or.us
3	Shaena Peterson	Mayor	Bay City	(503) 812-6773	speterson@ci.bay-city.or.us
4	Lin Downey LD Linda Downey	City Recorder	Bay City	(503) 377-2179	ldowney@ci.bay-city.or.us
5	Angie Cherry AC Angie Cherry	City Planning Secretary	Bay City	(503) 377-2288	acherry@ci.bay-city.or.us
6	Terry Kandle	City Council President & City Emergency Preparedness Manager	Garibaldi	(503) 322-3327	city@ci.garibaldi.or.us
7	John O'Leary	City Manager	Garibaldi	(503) 322-3327	john@ci.garibaldi.or.us
8	Linda Kozlowski	City Council Member	Manzanita	(503) 368-7630	president@evcnb.org
9	Jerry Taylor	City Manager	Manzanita	(503) 3685343	jtaylor@ci.manzanita.or.us
10	Jim Welch	City Council Member	Nehalem	(503) 368-6026	jjwelsh@nehalemtel.net
11	Dale Shafer Dale Shafer	City Manager & City Recorder	Nehalem	(503) 368-5627	manager@ci.nehalem.or.us
12	Joanne Aagaard	Mayor	Rockaway Beach	(503) 355-2291	joanne.aagaard@gmail.com
13	Lars Gare	City Manager	Rockaway Beach	(503) 355-2291	citymanager@rockawaybeachor.us
14	Suzanne Weber	Mayor	Tillamook City	(503) 842-2472	sweber@tillamookor.gov
15	Paul Wyntergreen	City Manager	Tillamook City	(503) 812-2472 x3460	pwyntergreen@tillamookor.gov
16	Stevie Burden	Mayor	Wheeler	(503) 368-5767	stevieburden@msn.com
17	Geoff Wullschlager	City Manager	Wheeler	(503) 368-5767	citymgrwheeler@nehalemtel.net
18	Michael Saindon	General Manager	Port of Garibaldi		manager@portofgaribaldi.org
19	Terry Fullan	Treasurer	Port of Nehalem		tfullan@portofnehalem.org
20	Michele Bradley	General Manager	Port of Tillamook Bay	503-842-2413 x111	mbradley@potb.org
21	Aaron Palter	Project Coordinator	Port of Tillamook Bay	503-842-2413 x116	apalter@potb.org
22	Melissa Thompson-Kiefer	City Recorder	City of Nehalem		recorder@ci.nehalem.or.us
23	~~Liane Welch~~ / Jeanette Steinbar	Assistant Director, Road Department	Tillamook County		lwelch@co.tillamook.or.us JSTEINBA@CO.TILLAMOOK.OR.US
24	Luke Shepard	Director, Public Works Department	City of Rockaway Beach		luke.shepard@rockawaybeach.or.us
25	Rachel Hagerty	Legal Secretary	Tillamook County Commissioners		rhagerty@co.tillamook.or.us

PLEASE SIGN IN (initial your name or add to the list)

	Name	Title	Representing	Phone	Email
26	Tilda Jones		Tillamook Bay Habitat & Estuary Improvement District		
27	Gordon McCraw Gordon McCraw	Director, Emergency Management	Tillamook County	503842 3412	gmccraw@co.tillamook.or.us
28	Kate Skinner	District Forester	Oregon Department of Forestry		Kate.J.Skinner@oregon.gov
29	Patrick Wingard PW.	North Coast Regional Representative	Department of Land Conservation and Development		patrick.wingard@state.or.us
30	Laren Woolley	Coastal Specialist	Department of Land Conservation and Development		laren.woolley@state.or.us
31	Meg				mgardner@dlcd.state.or.us
32	Marian Lahav	Natural Hazards Planner	Department of Land Conservation and Development		marian.lahav@state.or.us
33	Jed Roberts	Flood Mapping Coordinator	DOGAMI		jed.roberts@oregon.gov
34	Ed Wallmark EHW	ODF - Tillamook CWPP	ODF		edward.h.wallmark@oregon.gov
35					
36					
37					
38					
39					
40					
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					
51					

Steering Committee Meeting: December 15, 2016

Tillamook County MJNHMP Update
Steering Committee Meeting

Thursday, December 15, 2016
9:00 AM – 12:00 PM

Tillamook County Public Library, Hatfield Room
1716 3rd Street, Tillamook, OR 97141

AGENDA

I.	Welcome & Introductions	10 minutes
II.	Public Involvement Website Presentation Sarah Absher, Barrett Chaix, and Jeff Underwood Tillamook County Department of Community Development Review Public Engagement Plan Marian Lahav, Oregon Department of Land Conservation and Development	40 minutes
III.	Review 9/23/16 Meeting Notes	10 minutes
IV.	Steering Committee Membership	10 minutes

◈◈◈ **10-MINUTE BREAK** ◈◈◈

IV.	Post-Disaster Funding	30 minutes
VI.	Project Schedule Update	30 minutes
VII.	Tillamook County Multi-Hazard Risk Report and Discussion Jed Roberts and Matt Williams Oregon Department of Geology & Mineral Industries (DOGAMI)	40 minutes
VIII.	Adjourn	

Meeting Materials

1. Agenda
2. Post-Disaster Funding Handout
3. Meeting Notes from September 23, 2016 meeting
4. Updated (12/15/16) Project Schedule
5. Updated (9/23/16) Public Engagement Plan
6. Final Draft Multi-Hazard Risk Report (December 1, 2016)

Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan Update
Tillamook County Public Library, Hatfield Room
1716 3rd Street, Tillamook, OR 97141

Steering Committee Meeting
Thursday, December 15, 2016
9:00 AM – 12:00 PM

PLEASE SIGN IN (initial your name or add to the list)

	Name	Title	Representing	Phone	Email
1	Mark Labhart, Chair	County Commissioner	Tillamook County	(503) 842-3403	mlabhart@co.tillamook.or.us
2	Sarah Absher Sarah Absher	Community Development Planner	Tillamook County	(503) 842-3408 x3123	sabsher@co.tillamook.or.us
3	Shaena Peterson	Mayor	Bay City	(503) 812-6773	speterson@ci.bay-city.or.us
4	Lin Downey	City Recorder	Bay City	(503) 377-2179	ldowney@ci.bay-city.or.us
5	Angie Cherry A Cherry	City Planning Secretary	Bay City	(503) 377-2288	acherry@ci.bay-city.or.us
6	Terry Kandle Terry Kandle	City Council President & City Emergency Preparedness Manager	Garibaldi	(503) 322-3327 805 8709	~~city@ci.garibaldi.or.us~~ TERRYONTHEBAY@CENTURYLINK.NET
7	John O'Leary JO John	City Manager	Garibaldi	(503) 322-3327	john@ci.garibaldi.or.us
8	Linda Kozlowski LK.	City Council Member	Manzanita	(503) 368-7630	president@evcnb.org
9	Jerry Taylor	City Manager	Manzanita	(503) 3685343	jtaylor@ci.manzanita.or.us
10	Jim Welch	City Council Member	Nehalem	(503) 368-6026	jjwelsh@nehalemtel.net
11	Dale Shafer Dale Shafer	City Manager & City Recorder	Nehalem	(503) 368-5627	manager@ci.nehalem.or.us
12	Joanne Aagaard	Mayor	Rockaway Beach	(503) 355-2291	joanne.aagaard@gmail.com
13	Lars Gare	City Manager	Rockaway Beach	(503) 355-2291	citymanager@rockawaybeachor.us
14	Suzanne Weber	Mayor	Tillamook City	(503) 842-2472	sweber@tillamookor.gov
15	Paul Wyntergreen	City Manager	Tillamook City	(503) 812-2472 x3460	pwyntergreen@tillamookor.gov
16	Stevie Burden	Mayor	Wheeler	(503) 368-5767	stevieburden@msn.com
17	Geoff Wullschlager Geoff Wullschlager	City Manager	Wheeler	(503) 368-5767	citymgrwheeler@nehalemtel.net
18	Michael Saindon	General Manager	Port of Garibaldi		manager@portofgaribaldi.org
19	Terry Fullan	Treasurer	Port of Nehalem		tfullan@portofnehalem.org
20	Michele Bradley	General Manager	Port of Tillamook Bay		mbradley@potb.org
21	Aaron Palter AP	Project Coordinator	Port of Tillamook Bay	503-842-2413, x.116	apalter@potb.org ✓
22	Melissa Thompson-Kiefer	City Recorder	City of Nehalem		recorder@ci.nehalem.or.us
23	Liane Welch Liane Welch	Director, Road Department	Tillamook County		lwelch@co.tillamook.or.us
24	Luke Shepard	Director, Public Works Department	City of Rockaway Beach		luke.shepard@rockawaybeach.or.us (not valid address)
25	Rachel Hagerty	~~Legal Secretary~~ General Services Administrator (Isabel)	Tillamook County Commissioners	503-842-3403	rhagerty@co.tillamook.or.us -not attending Isabel

Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan Update
Tillamook County Public Library, Hatfield Room
1716 3rd Street, Tillamook, OR 97141

Steering Committee Meeting
Thursday, December 15, 2016
9:00 AM – 12:00 PM

PLEASE SIGN IN (initial your name or add to the list)

	Name	Title	Representing	Phone	Email
26	Tilda Jones		Tillamook Bay Habitat & Estuary Improvement District		
27	Gordon McCraw Gordon McCraw	Director, Emergency Management	Tillamook County	503 842 3412	gmccraw@co.tillamook.or.us
28	Kate Skinner	District Forester	Oregon Department of Forestry		Kate.J.Skinner@oregon.gov
29	Patrick Wingard	North Coast Regional Representative	Department of Land Conservation and Development		patrick.wingard@state.or.us
30	Meg Reed	Coastal Specialist	Department of Land Conservation and Development		meg.reed@state.or.us
31	Marian Lahav	Natural Hazards Planner	Department of Land Conservation and Development		marian.lahav@state.or.us
32	Bill BAERTLEIN Bill Baertlein	Commissioner, Tillamook	Tillamook County	(503) 842-3403	bbaertle@co.tillamook.or.us
33	Barrett Chaix	Land Use Planner, Community Development	Tillamook County DCD		bchaix@co.tillamook.or.us
34	Paul Wyntergreen	City Manager	City of Tillamook	(503) 812-6133	pwyntergreen@tillamookor.gov
35					
36					
37					
38					
39					
40					
41					
42					
43					
44					
45					
46					
47					
48					

Steering Committee Meeting: January 31, 2017

Tillamook County MJNHMP Update
Steering Committee Meeting

Tuesday, January 31, 2017
1:00 PM – 4:00 PM

Tillamook County Public Library, Hatfield Room
1716 3rd Street, Tillamook, OR 97141

AGENDA

I.	Welcome & Introductions	15 minutes
II.	Follow-up from 12/15/16 Meeting	15 minutes
III.	Resilience Meeting	45 minutes
IV.	Draft Risk Assessment	55 minutes
V.	Mitigation Goals	45 minutes
VI.	Next Steps	5 minutes
VII.	Adjourn	

Meeting Materials

I. Welcome & Introductions
   A. Agenda
   B. Sign-in Sheets & Cost Share
   C. Updated Steering Committee Roster
II. Follow-up from 12/15/16 Meeting
   A. Meeting Notes 12/15/16
   B. Response to Requests for Assistance
III. Resilience Meeting
   A. Resilience Meeting Example Materials (Agenda, Worksheets 1 & 2)
   B. Project Schedule
   C. Resilience Meeting Schedule Options
   D. Mitigation Strategy Meetings Sign-Up Sheet
IV. Draft Risk Assessment
V. Mitigation Goals Worksheet

Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan Update
Tillamook County Public Library, Hatfield Room
1716 3rd Street, Tillamook, OR 97141

Steering Committee Meeting
Tuesday, January 31, 2017
1:00 PM – 4:00 PM

PLEASE SIGN IN

	Printed Name and FULL SIGNATURE !	Title	Representing	Phone	Email
1	Bill Baertlein, Chair Bill H. Baertlein	County Commissioner	Tillamook County	(503) 842-3403	bbaertle@co.tillamook.or.us
2	Sarah Absher Sarah Absher	Community Development Planner	Tillamook County	(503) 842-3408 x3123	sabsher@co.tillamook.or.us
3	Shaena Peterson	Mayor	Bay City	(503) 812-6773	speterson@ci.bay-city.or.us
4	Lin Downey	City Recorder	Bay City	(503) 377-2179	ldowney@ci.bay-city.or.us
5	Angie Cherry Angie Cherry	City Planning Secretary	Bay City	(503) 377-2288	acherry@ci.bay-city.or.us
6	Terry Kandle Terry Kandle	~~City Council President~~ & City Emergency Preparedness Manager	Garibaldi	(503) 322-3327	~~city@ci.garibaldi.or.us~~ TerryonThebay@CenturyLink.NET
7	John O'Leary	City Manager	Garibaldi	(503) 322-3327	john@ci.garibaldi.or.us
8	Linda Kozlowski Linda Kozlowski	City Council Member	Manzanita	(503) 368-7630	~~president@evcpb.org~~ Linda.Kozlowski@gmail.com
9	Jerry Taylor	City Manager	Manzanita	(503) 3685343	jtaylor@ci.manzanita.or.us
10	Jim Welch	City Council Member	Nehalem	(503) 368-6026	jjwelsh@nehalemtel.net
11	Dale Shafer Dale Shafer	City Manager & City Recorder	Nehalem	(503) 368-5627	manager@ci.nehalem.or.us
12	Joanne Aagaard	Mayor	Rockaway Beach	(503) 355-2291	joanne.aagaard@gmail.com
13	Lars Gare	City Manager	Rockaway Beach	(503) 355-2291	citymanager@rockawaybeachor.us
14	Suzanne Weber SW Suzanne Weber	Mayor	Tillamook City	(503) 842-2472	sweber@tillamookor.gov
15	Paul Wyntergreen	City Manager	Tillamook City	(503) 812-2472 x3460	pwyntergreen@tillamookor.gov
16	Stevie Burden	Mayor	Wheeler	(503) 368-5767	stevieburden@msn.com
17	Geoff Wullschlager Geoffrey Wullschlager	City Manager	Wheeler	(503) 368-5767	citymgrwheeler@nehalemtel.net
18	Michael Saindon	General Manager	Port of Garibaldi		manager@portofgaribaldi.org
19	Terry Fullan	Treasurer	Port of Nehalem		tfullan@portofnehalem.org
20	Michele Bradley	General Manager	Port of Tillamook Bay	(503) 842-2413 x111	mbradley@potb.org
21	Aaron Palter	Project Coordinator	Port of Tillamook Bay	(503) 842-2413 x116	apalter@potb.org
22	Melissa Thompson-Kiefer	City Recorder	City of Nehalem		recorder@ci.nehalem.or.us
23	Liane Welch	Director	Tillamook County Public Works Road/Solid Waste		lwelch@co.tillamook.or.us
24	Jeanette Steinbach	Assistant Director	Tillamook County Public Works	(503) 842-3419	jsteinba@co.tillamook.or.us
25	Luke Shepard	Director, Public Works Department	City of Rockaway Beach		luke.shepard@rockawaybeach.or.us

Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan Update
Tillamook County Public Library, Hatfield Room
1716 3rd Street, Tillamook, OR 97141

Steering Committee Meeting
Tuesday, January 31, 2017
1:00 PM – 4:00 PM

PLEASE SIGN IN

	Printed Name and FULL SIGNATURE	Title	Representing	Phone	Email
26	Rachel Hagerty	~~Legal Secretary~~ General Services Administrator	Tillamook County Commissioners		rhagerty@co.tillamook.or.us
27	Tilda Jones		Tillamook Bay Habitat & Estuary Improvement District		
28	Gordon McCraw	Director, Emergency Management	Tillamook County		gmccraw@co.tillamook.or.us
29	Kate Skinner	District Forester	Oregon Department of Forestry		Kate.J.Skinner@oregon.gov
30	Ed Wallmark Ed Wallmark	Unit Forester	Oregon Department of Forestry		edward.h.wallmark@oregon.gov
31	Patrick Wingard Patrick Wingard	North Coast Regional Representative	Department of Land Conservation and Development		patrick.wingard@state.or.us
32	Meg Reed Meg Reed	Coastal Specialist	Department of Land Conservation and Development		meg.reed@state.or.us
33	Marian Lahav	Natural Hazards Planner	Department of Land Conservation and Development		marian.lahav@state.or.us
34	Jed Roberts	Flood Mapping Coordinator	Department of Geology & Mineral Industries		jed.roberts@oregon.gov
35	Matt Williams	Geohazards Analyst	Department of Geology & Mineral Industries		matt.williams@oregon.gov
36	Cynthia Alamillo. Cynthia Alamillo	asst. city mngr.	Manzanita.		calamillo@ci.manzanita.or.us.
37	Isabel Gilda Isabel Gilda	Board Secretary	BOCC-Tillamook		igilda@co.tillamook.or.us
38	TERRI MICHEL Terri Michel	CITY RECORDER	CITY OF ROCKAWAY BEACH		terri@rockawaybeach.or.us
39	TERRY KANDLE Terry Kandle				
40	Bryan Pohl Bryan Pohl	Director - DCD	Tmook DCD		bpohl@co.tillamook.or.us
41					
42					
43					
44					
45					
46					
47					

Individual Jurisdiction Meetings

Tillamook County & Port of Tillamook Bay: February 27, 2017

Tillamook County MJNHMP Update
Tillamook County & Port of Tillamook Bay Meeting

Monday, February 27, 2017	Tillamook County Courthouse, Commissioners Meeting Rooms A & B
8:30 AM – 11:30 AM	201 Laurel Avenue, Tillamook, OR 97141

AGENDA

I. Welcome & Introductions

II. Background & Purpose of Meeting

III. Review Information from Risk Assessment

IV. Review/Draft Mitigation Goals

V. Review/Draft Mitigation Actions

VI. Prioritize Mitigation Actions (STAPLEE)

VII. Assess Capabilities

VIII. Develop Plan Maintenance/Public Involvement Strategy

IX. Next Steps
- Countywide Meeting next Tuesday, March 7, 2017
- Resilience Meeting – FEMA Questions

X. Adjourn

Meeting Materials
- Agenda
- Sign-in Sheets
- Excerpts from Draft Risk Assessment
  - ◻ Community Risk Profiles & AOMI
  - ◻ Community Profile
- Current Mitigation Goals and Actions
- STAPLEE Worksheet
- Capabilities Worksheet

Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan Update
Tillamook County Courthouse, Commissioners Meeting Rooms A & B
201 Laurel Avenue, Tillamook, OR 97141

Tillamook County & Port of Tillamook Bay Mitigation Strategy Meeting
Monday, February 27, 2017
8:30 AM – 11:30 AM

PLEASE SIGN IN

	Printed Name and FULL SIGNATURE	Title	Representing	Phone	Email
1	Richard Hook	Neskowin CAC Chair	Neskowin	8327296080	richard.hook@sbcglobal.net
2	Leonard Lau Brogden	Building Official / Till County	Tillamook County	503-842-3408	lbrogden@co.tillamook.or.us
3	Ed Wallmark	ODF - Prot. Unit Forester	ODF	503-815-7050	edward.h.wallmark@oregon.gov
4	Aaron Palter	Project Coordinator	POTB	503-842-2413x116	apalter@potb.org
5	TONY OWEN	MANAGER	PCSWSA	5039656636	TOwen@PCSWSA.com
6	Gordon McCraw	TCEM	TCEM	5038423412	gmccraw@co.tillamook.or.us
7	Bill BAERTLEIN	Commissioner	BOCC	503 801 1099	bbaertle@co.tillamook.or.us
8	JACK MULDER	POTB Commissioner	POTB / TCCA	503 801 1734	jmulder@tillamook.com jmulderPOTB@gmail.com
9	Bill Busch William H. Busch	Neskowin CAC Vice-chair	Neskowin	503 392 3341	whbbat@gmail.com
10	Barrett Chaix	Associate Planner	Tillamook County	503-842-3408	bchaix@co.tillamook.or.us
11	Sarah Absher	Senior Planner	" "	503-842-3408	sabsher@co.tillamook.or.us
12	Michele Bradley	G. M.	POTB	503 842-2413	mbradley@potb.org
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

City of Nehalem: February 27, 2017

Tillamook County MJNHMP Update
City of Nehalem Meeting

Monday, February 27, 2017
1:00 PM – 4:00 PM

Nehalem City Hall
35900 8th Street, Nehalem, OR 97131

AGENDA

I. Welcome & Introductions

II. Background & Purpose of Meeting

III. Review Information from Risk Assessment

IV. Review/Draft Mitigation Goals

V. Review/Draft Mitigation Actions

VI. Prioritize Mitigation Actions (STAPLEE)

VII. Assess Capabilities

VIII. Develop Plan Maintenance/Public Involvement Strategy

IX. Next Steps
- Countywide Meeting next Tuesday, March 7, 2017
- Resilience Meeting – FEMA Questions

X. Adjourn

Meeting Materials
- Agenda
- Sign-in Sheets
- Excerpts from Draft Risk Assessment
  - ☐ Community Risk Profiles & AOMI
  - ☐ Community Profile
- Current Mitigation Goals and Actions
- STAPLEE Worksheet
- Capabilities Worksheet

Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan Update
Nehalem City Hall
35900 8th Street, Nehalem, OR 97131

City of Nehalem Mitigation Strategy Meeting
Monday, February 27, 2017
1:00 PM – 4:00 PM

PLEASE SIGN IN

	Printed Name and FULL SIGNATURE	Title	Representing	Phone	Email
1	Donald Dean Davidson Jr.	Public Work Dir.	City of Nehalem	503-368-5627	pw@ci.nehalem.or.us
2	Melissa K. Thompson-Kiefer Melissa K Thompson-Kiefer	Asst. City Manager/Recorder	City of Nehalem	503-368-5627	recorder@ci.nehalem.or.us
3	Katherine Dale Shafer, Katherine Dale Shafer	City Manager	City of Nehalem	503-368-5627	manager@ci.nehalem.or.us
4	Brian Keith Moore [signature]	Public Work - maint.	City of Nehalem	503-368-5627	~~[illegible]~~
5					pw@ci.nehalem.or.us
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

City of Wheeler: February 28, 2017

Tillamook County MJNHMP Update
City of Wheeler Meeting

Tuesday, February 28, 2017
1:00 PM – 4:00 PM

Wheeler City Hall
775 Nehalem Boulevard, Wheeler OR 97147

AGENDA

I. Welcome & Introductions

II. Background & Purpose of Meeting

III. Review Information from Risk Assessment

IV. Review/Draft Mitigation Goals

V. Review/Draft Mitigation Actions

VI. Prioritize Mitigation Actions (STAPLEE)

VII. Assess Capabilities

VIII. Develop Plan Maintenance/Public Involvement Strategy

IX. Next Steps
- Countywide Meeting next Tuesday, March 7, 2017
- Resilience Meeting – FEMA Questions

X. Adjourn

Meeting Materials
- Agenda
- Sign-in Sheets
- Excerpts from Draft Risk Assessment
  - Community Risk Profiles & AOMI
  - Community Profile
- Current Mitigation Goals and Actions
- STAPLEE Worksheet
- Capabilities Worksheet

Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan Update
Wheeler City Hall
775 Nehalem Boulevard, Wheeler OR 97147

City of Wheeler Mitigation Strategy Meeting
Tuesday, February 28, 2017
1:00 PM – 4:00 PM

PLEASE SIGN IN

	Printed Name and FULL SIGNATURE	Title	Representing	Phone	Email
1	MIKE ANDERSON Michael H Anderson	PLANNING COM		503-530-0315	mikeorcoast@yahoo.com
2	David Thompson David Thompson	Planning Commission		503.798.5664	dabetho@nehalemtel.net
3	Betsy Chase Betsy Chase	citizen		503.840.0087	bachase411@gmail.com
4	Phil Olderway Phil Olderway	Planning Co		503 707 0705	nverpmo@gmail.com
5	PAUL KNIGHT [illegible]	CIC/PYN		503-730 2421	knightofolde@hotmail.com
6	Joe Velkinburg Joseph Velkinburg	Public works	City of Wheeler	503-812-9214	WHEELERCityPW@NEHALEMTEL.NET
7	Stevie S Burden Stevie S Burden	Mayor	City of Wheeler	5038124966	steviburden@msn.com
8	Geoff Wullschlager Geoffrey L Wullschlager	City Manager	City of Wheeler	503-368-5767	citymgrwheeler@nehalemtel.net
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

City of Tillamook: March 1, 2017

Tillamook County MJNHMP Update
City of Tillamook Meeting

Wednesday, March 1, 2017
9:00 AM – 12:00 PM

Tillamook City Hall
210 Laurel Avenue, Tillamook, OR 97141

AGENDA

I. Welcome & Introductions

II. Background & Purpose of Meeting

III. Review Information from Risk Assessment

IV. Review/Draft Mitigation Goals

V. Review/Draft Mitigation Actions

VI. Prioritize Mitigation Actions (STAPLEE)

VII. Assess Capabilities

VIII. Develop Plan Maintenance/Public Involvement Strategy

IX. Next Steps
- Countywide Meeting next Tuesday, March 7, 2017
- Resilience Meeting – FEMA Questions

X. Adjourn

Meeting Materials
- Agenda
- Sign-in Sheets
- Excerpts from Draft Risk Assessment
  - Community Risk Profiles & AOMI
  - Community Profile
- Current Mitigation Goals and Actions
- STAPLEE Worksheet
- Capabilities Worksheet

Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan Update
Tillamook City Hall
210 Laurel Avenue, Tillamook, OR 97141

City of Tillamook Mitigation Strategy Meeting
Wednesday, March 1, 2017
9:00 AM – 12:00 PM

PLEASE SIGN IN

	Printed Name and FULL SIGNATURE	Title	Representing	Phone	Email
1	Debbi Reeves Debbi Reeves	Executive Assitant to City Manager	City of Tillamook	503-374-1830	dreeves@tillamookor.gov
2	Rueben Descloux [illegible]	Fire Marshal	Tillamook Fire Dist.	503-842-7587	rdescloux@tillamookfire.com
3	Sierra Lauder [illegible]	Director of Events & Downtown Development	Tillamook Area Chamber of Commerce	503 842 7525	Sierra@tillamookchamber.org
4	Tim Lyda Tim Lyda	City of Tillamook Public works	City of Tillamook	503-812-8802	Tlyda@Tillamookor.gov
5	David Mattison [illegible]	City of Tillamook Planner	City of Tillamook	503 842-3443	
6	Paul Wyntergreen [illegible]	City Manager	" " "	503 812-6135	pwyntergreen@tillamookor.gov
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					

City of Manzanita: March 1, 2017

Tillamook County MJNHMP Update
City of Manzanita Meeting

Wednesday, March 1, 2017
2:00 PM – 5:00 PM

Manzanita City Hall
543 Laneda Avenue, Manzanita OR 97130

AGENDA

I. Welcome & Introductions

II. Background & Purpose of Meeting

III. Review Information from Risk Assessment

IV. Review/Draft Mitigation Goals

V. Review/Draft Mitigation Actions

VI. Prioritize Mitigation Actions (STAPLEE)

VII. Assess Capabilities

VIII. Develop Plan Maintenance/Public Involvement Strategy

IX. Next Steps
- Countywide Meeting next Tuesday, March 7, 2017
- Resilience Meeting – FEMA Questions

X. Adjourn

Meeting Materials
- Agenda
- Sign-in Sheets
- Excerpts from Draft Risk Assessment
  - Community Risk Profiles & AOMI
  - Community Profile
- Current Mitigation Goals and Actions
- STAPLEE Worksheet
- Capabilities Worksheet

Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan Update
Manzanita City Hall
543 Laneda Avenue, Manzanita OR 97130

City of Manzanita Mitigation Strategy Meeting
Wednesday, March 1, 2017
2:00 PM – 5:~~00~~ 30 PM

PLEASE SIGN IN

	Printed Name and FULL SIGNATURE	Title	Representing	Phone	Email
1	Jerry Taylor [signature]	City Manager	City of Manzanita	503-368-5343	jtaylor@ci.manzanita.or.us
2	Cynthia alamillo [signature]	asst. city manager	city of manzanita	503-388-5343	calamillo@ci.manzanita.or.us.
3	Linda Kozlowski [signature]	City Council	City of Manzanita	503 799-5550	Linda.Kozlowski@gmail.com
4	Daniel Weitzel [signature]	Public Works Director	City of Manzanita	503-368-5347	dweitzel@ci.manzanita.or.us
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					

City of Garibaldi: March 2, 2017

Tillamook County MJNHMP Update
City of Garibaldi Meeting

Thursday, March 2, 2017
9:00 AM – 12:00 PM

Garibaldi City Hall
107 6th St, Garibaldi, OR 97118

AGENDA

I. Welcome & Introductions

II. Background & Purpose of Meeting

III. Review Information from Risk Assessment

IV. Review/Draft Mitigation Goals

V. Review/Draft Mitigation Actions

VI. Prioritize Mitigation Actions (STAPLEE)

VII. Assess Capabilities

VIII. Develop Plan Maintenance/Public Involvement Strategy

IX. Next Steps
  - Countywide Meeting next Tuesday, March 7, 2017
  - Resilience Meeting – FEMA Questions

X. Adjourn

Meeting Materials
- Agenda
- Sign-in Sheets
- Excerpts from Draft Risk Assessment
  - □ Community Risk Profiles & AOMI
  - □ Community Profile
- Current Mitigation Goals and Actions
- STAPLEE Worksheet
- Capabilities Worksheet

Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan Update
Garibaldi City Hall
107 6th St, Garibaldi, OR 97118

City of Garibaldi Mitigation Strategy Meeting
Thursday, March 2, 2017
9:00 AM – 12:00 PM

PLEASE SIGN IN

	Printed Name and FULL SIGNATURE	Title	Representing	Phone	Email
1	John O'Leary – [signature]	City Manager	City of Garibaldi	(503) 322-3327	john@ci.garibaldi.or.us
2	TERRY KANDLE Terry Kandle	EOPS PLANS	"	503 805 8709	TerryonThebay@centurylink.net
3	BLAKE LETTENMAIER, Blake Lettenmaier	CITY ENGINEER	"	503-322-3327	blake@ci.garibaldi.or.us
4	Marty McCormick, Marty McCormick	Public works	"	(503) 322-0217	McCormickgpw@Gmail.com
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

City of Rockaway Beach: March 2, 2017

Tillamook County MJNHMP Update
City of Rockaway Beach Meeting

Thursday, March 2, 2017
1:30 PM – 4:30 PM

Rockaway Beach City Hall
276 Hwy 101 South, Rockaway Beach, OR 97136

AGENDA

I. Welcome & Introductions

II. Background & Purpose of Meeting

III. Review Information from Risk Assessment

IV. Review/Draft Mitigation Goals

V. Review/Draft Mitigation Actions

VI. Prioritize Mitigation Actions (STAPLEE)

VII. Assess Capabilities

VIII. Develop Plan Maintenance/Public Involvement Strategy

IX. Next Steps
   - Countywide Meeting next Tuesday, March 7, 2017
   - Resilience Meeting – FEMA Questions

X. Adjourn

Meeting Materials
- Agenda
- Sign-in Sheets
- Excerpts from Draft Risk Assessment
  - ☐ Community Risk Profiles & AOMI
  - ☐ Community Profile
- Current Mitigation Goals and Actions
- STAPLEE Worksheet
- Capabilities Worksheet

Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan Update
Rockaway Beach City Hall
276 Hwy 101 South, Rockaway Beach, OR 97136

City of Rockaway Beach Mitigation Strategy Meeting
Thursday, March 2, 2017
1:30 PM – 4:30 PM

PLEASE SIGN IN

	Printed Name and FULL SIGNATURE	Title	Representing	Phone	Email
1	Luke Shepard	Public Works Director	City of Rockaway Beach	503-355-2982	lukeshepard@rockawaybeachor.us
2	TERRI MICHEL	CITY RECORDER	CITY OF ROCKAWAY BEACH	503 355 2291	terri@rockawaybeachor.us
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

City of Bay City: March 3, 2017

Tillamook County MJNHMP Update
City of Bay City Meeting

Friday, March 3, 2017
10:00 AM – 1:00 PM

Bay City City Hall
5525 B Street, Bay City, OR 97107

AGENDA

I. Welcome & Introductions

II. Background & Purpose of Meeting

III. Review Information from Risk Assessment

IV. Review/Draft Mitigation Goals

V. Review/Draft Mitigation Actions

VI. Prioritize Mitigation Actions (STAPLEE)

VII. Assess Capabilities

VIII. Develop Plan Maintenance/Public Involvement Strategy

IX. Next Steps
- Countywide Meeting next Tuesday, March 7, 2017
- Resilience Meeting – FEMA Questions

X. Adjourn

Meeting Materials
- Agenda
- Sign-in Sheets
- Excerpts from Draft Risk Assessment
  - Community Risk Profiles & AOMI
  - Community Profile
- Current Mitigation Goals and Actions
- STAPLEE Worksheet
- Capabilities Worksheet

Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan Update
Bay City City Hall
5525 B Street, Bay City, OR 97107

City of Bay City Mitigation Strategy Meeting
Friday, March 3, 2017
10:00 AM – 1:00 PM

PLEASE SIGN IN

	Printed Name and FULL SIGNATURE	Title	Representing	Phone	Email
1	Sabrina Pearson [signature]	CITY PLANNER	BAY CITY	503 440 3015	plandevelopment@msn.com
2	Darrell Griffith [signature]	Fire Chief	Bay City FD	503 377-0233	firedept@ci.bay-city.or.us
3	Brian Bettis [signature]	Public works Director	Bay City	503 377-4121	bbettis@ci.bay-city.or.us
4	Linda Downey [signature]	Recorder	Bay City	503-377-2288	ldowney@ci.bay-city.or.us
5	Angie Cherry [signature]	Planning Secretary	Bay City	503-377-2288	acherry@ci.bay-city.or.us
6	David McCall [signature]	City Councilor	Bay City	503 812 8127	dmccall@ci.bay-city.or.us
7	Shaena Peterson [signature]	Mayor	Bay City	503-812-6773	speterson@ci.bay-city.or.us
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					

Tillamook County MJNHMP Update
Countywide Mitigation Strategy Meeting

Tuesday, March 7, 2017
12:00 PM – 4:00 PM

Port of Tillamook Bay, Large Conference Room
4000 Blimp Blvd. Suite 100, Tillamook OR, 97141

AGENDA

I. Welcome & Introductions

II. Background & Purpose of Meeting

III. Review and Decide Countywide Goals, Objectives, Actions

IV. Prioritize Countywide Actions

V. Review Individual Jurisdiction Mitigation Actions

VI. Develop Plan Maintenance/Public Involvement Strategy

IX. Next Steps
- Resilience Meeting - Tentatively April 4, 2017
- Open Houses - Week of April 24 – 28

X. Adjourn

Meeting Materials
Agenda
Countywide Goals, Objectives, Actions
Individual Jurisdiction Mitigation Actions

Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan Update
Port of Tillamook Bay, Large Conference Room
4000 Blimp Blvd. Suite 100, Tillamook OR, 97141

Countywide Mitigation Strategy Meeting
Tuesday, March 7, 2017
1:00 PM – 4:00 PM

PLEASE SIGN IN

	Printed Name and FULL SIGNATURE	Title	Representing	Phone	Email
1	Bill Baertlein, Chair Bill Baertlein	County Commissioner	Tillamook County	(503) 842-3403	bbaertle@co.tillamook.or.us
2	Sarah Absher Sarah Absher Sarah Absher	Community Development Planner	Tillamook County	(503) 842-3408 x3123	sabsher@co.tillamook.or.us
3	Shaena Peterson	Mayor	Bay City	(503) 812-6773	speterson@ci.bay-city.or.us
4	Lin Downey	City Recorder	Bay City	(503) 377-2179	ldowney@ci.bay-city.or.us
5	Angie Cherry Angie Cherry Angie Cherry	City Planning Secretary	Bay City	(503) 377-2288	acherry@ci.bay-city.or.us
6	Terry Kandle Terry Kandle	~~City Council President & City Emergency Preparedness Manager~~ See last sheet	Garibaldi	(503) 322-3327	~~city@ci.garibaldi.or.us~~ TerryontheBay@centurylink.net
7	John O'Leary	City Manager	Garibaldi	(503) 322-3327	john@ci.garibaldi.or.us
8	Linda Kozlowski	City Council Member	Manzanita	(503) 368-7630	president@evcnb.org
9	Jerry Taylor Jerry Taylor	City Manager	Manzanita	(503) 3685343	jtaylor@ci.manzanita.or.us
10	Jim Welch	City Council Member	Nehalem	(503) 368-6026	jjwelsh@nehalemtel.net
11	Dale Shafer Dale Shafer	City Manager & City Recorder	Nehalem	(503) 368-5627	manager@ci.nehalem.or.us
12	Joanne Aagaard	Mayor	Rockaway Beach	(503) 355-2291	joanne.aagaard@gmail.com
13	Lars Gare	City Manager	Rockaway Beach	(503) 355-2291	citymanager@rockawaybeachor.us
14	Suzanne Weber	Mayor	Tillamook City	(503) 842-2472	sweber@tillamookor.gov
15	Paul Wyntergreen	City Manager	Tillamook City	(503) 812-2472 x3460	pwyntergreen@tillamookor.gov
16	Stevie Burden	Mayor	Wheeler	(503) 368-5767	stevieburden@msn.com
17	Geoff Wullschlager Geoff Wullschlager	City Manager	Wheeler	(503) 368-5767	citymgrwheeler@nehalemtel.net
18	Michael Saindon	General Manager	Port of Garibaldi		manager@portofgaribaldi.org
19	Terry Fullan	Treasurer	Port of Nehalem		tfullan@portofnehalem.org
20	Michele Bradley	General Manager	Port of Tillamook Bay	(503) 842-2413 x111	mbradley@potb.org
21	Aaron Palter	Project Coordinator	Port of Tillamook Bay	(503) 842-2413 x116	apalter@potb.org
22	Melissa Thompson-Kiefer	City Recorder	City of Nehalem		recorder@ci.nehalem.or.us
23	Liane Welch	Director	Tillamook County Public Works Road/Solid Waste		lwelch@co.tillamook.or.us
24	Jeanette Steinbach	Assistant Director	Tillamook County Public Works	(503) 842-3419	jsteinba@co.tillamook.or.us
25	Luke Shepard	Director, Public Works Department	City of Rockaway Beach		luke.shepard@rockawaybeach.or.us

Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan Update
Port of Tillamook Bay, Large Conference Room
4000 Blimp Blvd. Suite 100, Tillamook OR, 97141

Countywide Mitigation Strategy Meeting
Tuesday, March 7, 2017
1:00 PM – 4:00 PM

PLEASE SIGN IN

	Printed Name and FULL SIGNATURE	Title	Representing	Phone	Email
26	Rachel Hagerty	Legal Secretary	Tillamook County Commissioners		rhagerty@co.tillamook.or.us
27	Tilda Jones Tilda Jones	Staff	Tillamook Bay Flood Improvement District	503-815-8164	tbfid@tillamookoffice.com
28	Gordon McCraw	Director, Emergency Management	Tillamook County		gmccraw@co.tillamook.or.us
29	Kate Skinner	District Forester	Oregon Department of Forestry		Kate.J.Skinner@oregon.gov
30	Ed Wallmark	Unit Forester	Oregon Department of Forestry		edward.h.wallmark@oregon.gov
31	Patrick Wingard [signature]	North Coast Regional Representative	Department of Land Conservation and Development	503.812.5448	patrick.wingard@state.or.us
32	Meg Reed Meg Reed Meg Reed	Coastal Specialist	Department of Land Conservation and Development		meg.reed@state.or.us
33	Marian Lahav	Natural Hazards Planner	Department of Land Conservation and Development		marian.lahav@state.or.us
34	Jed Roberts	Flood Mapping Coordinator	Department of Geology & Mineral Industries		jed.roberts@oregon.gov
35	Matt Williams	Geohazards Analyst	Department of Geology & Mineral Industries		matt.williams@oregon.gov
36	Darrell Griffith [signature]	Bay City Fire, Chief	City of Bay City		firedept@ci.bay-city.or.us
37	Cynthia Alamillo Cynthia Alamillo	Ass. City Manager	Manzanita		calamillo@ci.manzanita.or.us
38	Sabrina Pearson [signature]	City Planner Bay City	Bay City	503 440 3015	plandevelopment@msn.com
39	Sierra Lauder [signature]	Director of Events & Downtown Development	Tillamook Area Chamber of Commerce	503 354 4400	Sierra@tillamookchamber.org
40	David Mattison [signature]	City Planner	City of Tillamook	503-842-3443	dmattison@tillamookor.gov
41	Tilda Jones Tilda Jones	Staff	TBFID	503-815-8164	tbfid@tillamookoffice.com
42	Terri Michel [signature]	City Recorder	City of Rockaway Beach	503-355-2291	terri@rockawaybeach.us
43					
44					
45					
46					
47					
48					

Public Open Houses

Public Open House: May 16, 2017

Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan Update
Nehalem City Hall
5900 8th Street, Nehalem, OR 97131

Open House
Tuesday, May 16, 2017
5:30 PM – 7:30 PM

PLEASE SIGN IN

	Printed Name and FULL SIGNATURE	Title	Representing	Phone	Email
1	Bill Baertlein, Chair	County Commissioner	Tillamook County	(503) 842-3403	bbaertle@co.tillamook.or.us
2	Sarah Absher	Community Development Planner	Tillamook County	(503) 842-3408 x3123	sabsher@co.tillamook.or.us
3	Shaena Peterson	Mayor	Bay City	(503) 812-6773	speterson@ci.bay-city.or.us
4	Lin Downey	City Recorder	Bay City	(503) 377-2179	ldowney@ci.bay-city.or.us
5	Angie Cherry	City Planning Secretary	Bay City	(503) 377-2288	acherry@ci.bay-city.or.us
6	Terry Kandle	City Council President & City Emergency Preparedness Manager	Garibaldi	(503) 322-3327	terryonthebay@centurylink.net
7	John O'Leary	City Manager	Garibaldi	(503) 322-3327	john@ci.garibaldi.or.us
8	Linda Kozlowski	City Council Member	Manzanita	(503) 368-7630	linda.kozlowski@gmail.com
9	Jerry Taylor	City Manager	Manzanita	(503) 3685343	jtaylor@ci.manzanita.or.us
10	Jim Welch	City Council Member	Nehalem	(503) 368-6026	jjwelsh@nehalemtel.net
11	Dale Shafer	City Manager & City Recorder	Nehalem	(503) 368-5627	manager@ci.nehalem.or.us
12	Joanne Aagaard	Mayor	Rockaway Beach	(503) 355-2291	joanne.aagaard@gmail.com
13	Lars Gare	City Manager	Rockaway Beach	(503) 355-2291	citymanager@rockawaybeachor.us
14	Suzanne Weber	Mayor	Tillamook City	(503) 842-2472	sweber@tillamookor.gov
15	Paul Wyntergreen	City Manager	Tillamook City	(503) 812-2472 x3460	pwyntergreen@tillamookor.gov
16	Stevie Burden	Mayor	Wheeler	(503) 368-5767	stevieburden@msn.com
17	Geoff Wullschlager	City Manager	Wheeler	(503) 368-5767	citymgrwheeler@nehalemtel.net
18	Michael Saindon	General Manager	Port of Garibaldi		manager@portofgaribaldi.org
19	Terry Fullan	Treasurer	Port of Nehalem		tfullan@portofnehalem.org
20	Michele Bradley	General Manager	Port of Tillamook Bay	(503) 842-2413 x111	mbradley@potb.org
21	Aaron Palter	Project Coordinator	Port of Tillamook Bay	(503) 842-2413 x116	apalter@potb.org
22	Melissa Thompson-Kiefer	City Recorder	City of Nehalem		recorder@ci.nehalem.or.us
23	Liane Welch	Director	Tillamook County Public Works Road/Solid Waste		lwelch@co.tillamook.or.us
24	Jeanette Steinbach	Assistant Director	Tillamook County Public Works	(503) 842-3419	jsteinba@co.tillamook.or.us
25	Luke Shepard	Director, Public Works Department	City of Rockaway Beach		luke.shepard@rockawaybeach.or.us

Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan Update
Nehalem City Hall
5900 8th Street, Nehalem, OR 97131

Open House
Tuesday, May 16, 2017
5:30 PM – 7:30 PM

PLEASE SIGN IN

	Printed Name and FULL SIGNATURE	Title	Representing	Phone	Email
26	Rachel Hagerty	Legal Secretary	Tillamook County Commissioners		rhagerty@co.tillamook.or.us
27	Tilda Jones		Tillamook Bay Flood Improvement District		
28	Gordon McCraw	Director, Emergency Management	Tillamook County		gmccraw@co.tillamook.or.us
29	Kate Skinner	District Forester	Oregon Department of Forestry		Kate.J.Skinner@oregon.gov
30	Ed Wallmark	Unit Forester	Oregon Department of Forestry		edward.h.wallmark@oregon.gov
31	Patrick Wingard Patrick W	North Coast Regional Representative	Department of Land Conservation and Development		patrick.wingard@state.or.us
32	Meg Reed	Coastal Specialist	Department of Land Conservation and Development		meg.reed@state.or.us
33	Marian Lahav	Natural Hazards Planner	Department of Land Conservation and Development		marian.lahav@state.or.us
34	Jed Roberts	Flood Mapping Coordinator	Department of Geology & Mineral Industries		jed.roberts@oregon.gov
35	Matt Williams	Geohazards Analyst	Department of Geology & Mineral Industries		matt.williams@oregon.gov
36	Barrett Chase [illegible]	Associate Planner	Tillamook		
37	RAY STEELE			530 306 9867	canyon_man95726@yahoo.com
38	Tom Bender	Me	Me	503-440-9525	tbender@nehalemtel.net
39	[illegible]				
40	John Coopersmith			812 2052	jcoop71@gmail.com
41	Marian Lahav Marian Lahav				
42					
43					
44					
45					
46					
47					
48					

Public Open House: May 17, 2017

Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan Update
Kiwanda Community Center
34600 Cape Kiwanda Drive, Pacific City, OR 97135

Open House
Wednesday, May 17, 2017
5:30 PM – 7:30 PM

PLEASE SIGN IN

	Printed Name and FULL SIGNATURE	Title	Representing	Phone	Email
1	Bill Baertlein, Chair	County Commissioner	Tillamook County	(503) 842-3403	bbaertle@co.tillamook.or.us
2	Sarah Absher Sarah Absher	Community Development Planner	Tillamook County	(503) 842-3408 x3123	sabsher@co.tillamook.or.us
3	Shaena Peterson	Mayor	Bay City	(503) 812-6773	speterson@ci.bay-city.or.us
4	Lin Downey	City Recorder	Bay City	(503) 377-2179	ldowney@ci.bay-city.or.us
5	Angie Cherry	City Planning Secretary	Bay City	(503) 377-2288	acherry@ci.bay-city.or.us
6	Terry Kandle	City Council President & City Emergency Preparedness Manager	Garibaldi	(503) 322-3327	terryonthebay@centurylink.net
7	John O'Leary	City Manager	Garibaldi	(503) 322-3327	john@ci.garibaldi.or.us
8	Linda Kozlowski	City Council Member	Manzanita	(503) 368-7630	linda.kozlowski@gmail.com
9	Jerry Taylor	City Manager	Manzanita	(503) 3685343	jtaylor@ci.manzanita.or.us
10	Jim Welch	City Council Member	Nehalem	(503) 368-6026	jjwelsh@nehalemtel.net
11	Dale Shafer	City Manager & City Recorder	Nehalem	(503) 368-5627	manager@ci.nehalem.or.us
12	Joanne Aagaard	Mayor	Rockaway Beach	(503) 355-2291	joanne.aagaard@gmail.com
13	Lars Gare	City Manager	Rockaway Beach	(503) 355-2291	citymanager@rockawaybeachor.us
14	Suzanne Weber	Mayor	Tillamook City	(503) 842-2472	sweber@tillamookor.gov
15	Paul Wyntergreen	City Manager	Tillamook City	(503) 812-2472 x3460	pwyntergreen@tillamookor.gov
16	Stevie Burden	Mayor	Wheeler	(503) 368-5767	stevieburden@msn.com
17	Geoff Wullschlager Geoff Wullschlager	City Manager	Wheeler	(503) 368-5767	citymgrwheeler@nehalemtel.net
18	Michael Saindon	General Manager	Port of Garibaldi		manager@portofgaribaldi.org
19	Terry Fullan	Treasurer	Port of Nehalem		tfullan@portofnehalem.org
20	Michele Bradley	General Manager	Port of Tillamook Bay	(503) 842-2413 x111	mbradley@potb.org
21	Aaron Palter Aaron J. Palter	Project Coordinator	Port of Tillamook Bay	(503) 842-2413 x116	apalter@potb.org
22	Melissa Thompson-Kiefer	City Recorder	City of Nehalem		recorder@ci.nehalem.or.us
23	Liane Welch	Director	Tillamook County Public Works Road/Solid Waste		lwelch@co.tillamook.or.us
24	Jeanette Steinbach	Assistant Director	Tillamook County Public Works	(503) 842-3419	jsteinba@co.tillamook.or.us
25	Luke Shepard	Director, Public Works Department	City of Rockaway Beach		luke.shepard@rockawaybeach.or.us

Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan Update
Kiwanda Community Center
34600 Cape Kiwanda Drive, Pacific City, OR 97135

Open House
Wednesday, May 17, 2017
5:30 PM – 7:30 PM

PLEASE SIGN IN

	Printed Name and FULL SIGNATURE	Title	Representing	Phone	Email
26	Rachel Hagerty	Legal Secretary	Tillamook County Commissioners		rhagerty@co.tillamook.or.us
27	Tilda Jones		Tillamook Bay Flood Improvement District		
28	Gordon McCraw	Director, Emergency Management	Tillamook County		gmccraw@co.tillamook.or.us
29	Kate Skinner	District Forester	Oregon Department of Forestry		Kate.J.Skinner@oregon.gov
30	Ed Wallmark	Unit Forester	Oregon Department of Forestry		edward.h.wallmark@oregon.gov
31	Patrick Wingard PatWK	North Coast Regional Representative	Department of Land Conservation and Development	503.812.5448	patrick.wingard@state.or.us
32	Meg Reed Meg Reed Meg Reed	Coastal Specialist	Department of Land Conservation and Development	541-574-0811	meg.reed@state.or.us
33	Marian Lahav	Natural Hazards Planner	Department of Land Conservation and Development		marian.lahav@state.or.us
34	Jed Roberts	Flood Mapping Coordinator	Department of Geology & Mineral Industries		jed.roberts@oregon.gov
35	Matt Williams	Geohazards Analyst	Department of Geology & Mineral Industries		matt.williams@oregon.gov
36	Marian Lahav Marian Lahav	Natural Hazards Planner	DLCD		
37					
38					
39					
40					
41					
42					
43					
44					
45					
46					
47					
48					

Public Open House: May 18, 2017

Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan Update
Tillamook Bay Community College
4301 Third Street, Tillamook, OR 97141

Open House
Thursday, May 18, 2017
5:30 PM – 7:30 PM

PLEASE SIGN IN

	Printed Name and FULL SIGNATURE	Title	Representing	Phone	Email
1	Bill Baertlein, Chair	County Commissioner	Tillamook County	(503) 842-3403	bbaertle@co.tillamook.or.us
2	Sarah Absher	Community Development Planner	Tillamook County	(503) 842-3408 x3123	sabsher@co.tillamook.or.us
3	Shaena Peterson	Mayor	Bay City	(503) 812-6773	speterson@ci.bay-city.or.us
4	Lin Downey	City Recorder	Bay City	(503) 377-2179	ldowney@ci.bay-city.or.us
5	Angie Cherry Angie Cherry	City Planning Secretary	Bay City	(503) 377-2288	acherry@ci.bay-city.or.us
6	Terry Kandle	City Council President & City Emergency Preparedness Manager	Garibaldi	(503) 322-3327	terryonthebay@centurylink.net
7	John O'Leary	City Manager	Garibaldi	(503) 322-3327	john@ci.garibaldi.or.us
8	Linda Kozlowski	City Council Member	Manzanita	(503) 368-7630	linda.kozlowski@gmail.com
9	Jerry Taylor	City Manager	Manzanita	(503) 3685343	jtaylor@ci.manzanita.or.us
10	Jim Welch	City Council Member	Nehalem	(503) 368-6026	jjwelsh@nehalemtel.net
11	Dale Shafer	City Manager & City Recorder	Nehalem	(503) 368-5627	manager@ci.nehalem.or.us
12	Joanne Aagaard	Mayor	Rockaway Beach	(503) 355-2291	joanne.aagaard@gmail.com
13	Lars Gare	City Manager	Rockaway Beach	(503) 355-2291	citymanager@rockawaybeachor.us
14	Suzanne Weber	Mayor	Tillamook City	(503) 842-2472	sweber@tillamookor.gov
15	Paul Wyntergreen	City Manager	Tillamook City	(503) 812-2472 x3460	pwyntergreen@tillamookor.gov
16	Stevie Burden	Mayor	Wheeler	(503) 368-5767	stevieburden@msn.com
17	Geoff Wullschlager	City Manager	Wheeler	(503) 368-5767	citymgrwheeler@nehalemtel.net
18	Michael Saindon	General Manager	Port of Garibaldi		manager@portofgaribaldi.org
19	Terry Fullan	Treasurer	Port of Nehalem		tfullan@portofnehalem.org
20	Michele Bradley	General Manager	Port of Tillamook Bay	(503) 842-2413 x111	mbradley@potb.org
21	Aaron Palter	Project Coordinator	Port of Tillamook Bay	(503) 842-2413 x116	apalter@potb.org
22	Melissa Thompson-Kiefer	City Recorder	City of Nehalem		recorder@ci.nehalem.or.us
23	Liane Welch	Director	Tillamook County Public Works Road/Solid Waste		lwelch@co.tillamook.or.us
24	Jeanette Steinbach	Assistant Director	Tillamook County Public Works	(503) 842-3419	jsteinba@co.tillamook.or.us
25	Luke Shepard	Director, Public Works Department	City of Rockaway Beach		luke.shepard@rockawaybeach.or.us

Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan Update
Tillamook Bay Community College
4301 Third Street, Tillamook, OR 97141

Open House
Thursday, May 18, 2017
5:30 PM – 7:30 PM

PLEASE SIGN IN

	Printed Name and FULL SIGNATURE	Title	Representing	Phone	Email
26	Rachel Hagerty	Legal Secretary	Tillamook County Commissioners		rhagerty@co.tillamook.or.us
27	Tilda Jones		Tillamook Bay Flood Improvement District		
28	Gordon McCraw	Director, Emergency Management	Tillamook County		gmccraw@co.tillamook.or.us
29	Kate Skinner	District Forester	Oregon Department of Forestry		Kate.J.Skinner@oregon.gov
30	Ed Wallmark	Unit Forester	Oregon Department of Forestry		edward.h.wallmark@oregon.gov
31	Patrick Wingard	North Coast Regional Representative	Department of Land Conservation and Development		patrick.wingard@state.or.us
32	Meg Reed	Coastal Specialist	Department of Land Conservation and Development		meg.reed@state.or.us
33	Marian Lahav	Natural Hazards Planner	Department of Land Conservation and Development		marian.lahav@state.or.us
34	Jed Roberts	Flood Mapping Coordinator	Department of Geology & Mineral Industries		jed.roberts@oregon.gov
35	Matt Williams	Geohazards Analyst	Department of Geology & Mineral Industries		matt.williams@oregon.gov
36	David Mattison [illegible]	City of Tillamook Planner	City of Tillamook	503 842-3443	dmattison@tillamookor.gov
37	Cynthia alamillo Cynthia Alamillo	ass. city manager	City of Manzanita		
38	Marian Lahav Marian Lahav	DLCD			
39	Phyllis Thompson Phyllis	Faculty adjunct	Self		
40					
41					
42					
43					
44					
45					
46					
47					
48					

3. Notices

Public Comment Period: March 2017

Affidavit of Publication

RECEIVED
MAR 15 2017

State of Oregon, County of Tillamook, -ss.

I, Lisa Browning, being first duly sworn, depose and say that I am a Clerk of the Headlight-Herald, 1908 Second St., Tillamook, Or 97141 a newspaper of general circulation as defined by ORS 193.010 and 193.020.
state; that

H17-072
Department of Community Development
Notice of Public Comment Period

a printed copy of which is hereto annexed, was published in the entire issue of said newspaper for 1 successive and consecutive week in the following issue:

03/01/17

Subscribed and sworn to before me this 1st day of March 2017

Notary Public of Oregon

OFFICIAL STAMP
ANDREA LYNN OSTENSEN
NOTARY PUBLIC OF OREGON
COMMISSION NO. 946600
MY COMMISSION EXPIRES JANUARY 26, 2020

Price charge for this notice $ 88.20

H17-072
NOTICE OF PUBLIC COMMENT PERIOD
Date of Public Comment Period: March 1, 2017 to March 15, 2017
The purpose of the Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan is to assist the County, its cities, and the Port of Tillamook Bay in reducing risk from natural hazards. This Draft Risk Assessment, one part of the Plan, identifies and assesses the natural hazards facing the County, its cities, and the Port of Tillamook Bay and identifies and assesses their potential vulnerabilities to those hazards. The public is invited to review and comment on the Draft Risk Assessment between Wednesday, March 1, 2017 and Wednesday, March 15, 2017.
The Risk Assessment Draft is available for inspection on the Tillamook County Department of Community Development website: http://www.co.tillamook.or.us/gov/ComDev/NHMP/February/17%2002%2010%20R0%20DraftRiskAsst_Reduced.pdf and is also available for inspection at the Department of Community Development office located at 1510-B Third Street in Tillamook, Tillamook County Library Branches and city hall offices for the Cities of Bay City, Garibaldi, Manzanita, Nehalem, Rockaway Beach, Tillamook, Wheeler as well as the Port of Tillamook Bay main office. For additional information concerning this public review comment period or the Risk Assessment Draft, please contact the Department of Community Development at 1-800-488-8280 ext. 3317 any weekday between 8:00 a.m. and 4:00 p.m. or any of the city offices listed above.
Sincerely,
Sarah Absher, CFM, Senior Planner
Tillamook County Department of Community Development

Public Comment Period and Notice of Open Houses: May 2017

5/15/2017 LEGAL NOTICE: TILLAMOOK COUNTY MULTI-JURISDICTIONAL NATURAL HAZARD MITIGATION PLAN (NHMP) NOTICE: – Tillamook County ...

Today is Monday, May 15, 2017

Tillamook County Pioneer

The news and people of Tillamook County, Oregon. Every day.

HOME ABOUT BUSINESS COLUMNS EVENTS EXPLORE OBIT OUTDOORS/SPORTS

HEALTH & WELLNESS WEATHER

LEGAL NOTICE: TILLAMOOK COUNTY MULTI-JURISDICTIONAL NATURAL HAZARD MITIGATION PLAN (NHMP) NOTICE:

Editor May 12, 2017 Legal Notices Leave a Comment

SEARCH OUR SITE ...

Search ... SEARCH

https://www.tillamookcountypioneer.net/legal-notice-tillamook-county-multi-jurisdictional-natural-hazard-mitigation-plan-nhmp-notice/ 1/4

The Tillamook County Multi-Jurisdictional NHMP is being updated. The Draft Risk Assessment and Mitigation Strategy chapters are available for public review and comment through May 26, 2017.

Click here to view or download the Draft:
http://www.co.tillamook.or.us/gov/ComDev/NHMP/April2017/910517_05_08_R0_DRAFT_R/

Please email your comments to bchaix@co.tillamook.or.us or mail them to:
Tillamook County Department of Community Development
Attn: Barrett Chaix
1510 B Third Street
Tillamook, OR 97141

Three open houses are being held to provide information about the Plan and gather your input:

* Tuesday, May 16, 5:30 PM – 7:30 PM
Nehalem City Hall, 5900 8th Street, Nehalem, OR 97131
* Wednesday, May 17, 5:30 PM – 7:30 PM
Kiwanda Community Center, 34600 Cape Kiwanda Drive, Pacific City, OR 97135
* Thursday, May 18, 5:30 PM – 7:30 PM
Tillamook Bay Community College, 4301 Third Street, Tillamook, OR 97141

For more information please feel free to contact Sarah Absher, Senior Planner, sabsher@co.tillamook.or.us, (503) 842-3408×3317.

Email to Neighboring Jurisdictions

Lahav, Marian

From:	Lahav, Marian
Sent:	Thursday, May 11, 2017 7:57 AM
To:	'comdev@co.clatsop.or.us'; tbrown@co.clatsop.or.us; 'glen.higgins@co.columbia.or.us'; 'steve.pegram@co.columbia.or.us'; 'lutplan@co.washington.or.us'; 'Scott_Porter@co.washington.or.us'; 'planning@co.yamhill.or.us'; 'youngb@co.yamhill.or.us'; 'mcguigan.austin@co.polk.or.us'; 'bender.dean@co.polk.or.us'; 'ohusing@co.lincoln.or.us'; 'vdemaris@co.lincoln.or.us'
Cc:	Sarah Absher
Subject:	Notice of Open Houses & Public Comment Period: Tillamook County Multi-Jurisdictional NHMP

The Tillamook County Multi-Jurisdictional NHMP is being updated. The Draft Risk Assessment and Mitigation Strategy chapters are available for review and comment through May 26, 2017.

Click here to view or download the Draft.

Please email your comments to bchaix@co.tillamook.or.us or mail them to:
Tillamook County Department of Community Development
Attn: Barrett Chaix
1510 B Third Street
Tillamook, OR 97141

Three open houses are being held to provide information about the Plan and gather your input. Attend the one most convenient for you!

- Tuesday, May 16, 5:30 PM – 7:30 PM
  Nehalem City Hall, 5900 8th Street, Nehalem, OR 97131
- Wednesday, May 17, 5:30 PM – 7:30 PM
  Kiwanda Community Center, 34600 Cape Kiwanda Drive, Pacific City, OR 97135
- Thursday, May 18, 5:30 PM – 7:30 PM
  Tillamook Bay Community College, 4301 Third Street, Tillamook, OR 97141

For more information please feel free to contact me (contact information below) or Sarah Absher, Senior Planner, sabsher@co.tillamook.or.us, (503) 842-3408.

Sincerely,

Marian Lahav

Marian Lahav | Natural Hazards Planner
Planning Services Division
Oregon Dept. of Land Conservation and Development
635 Capitol Street NE, Suite 150 | Salem, OR 97301-2540
Office: (503) 934-0024 | Fax: (503) 378-5518
marian.lahav@state.or.us | www.oregon.gov/LCD

1

Email to Steering Committee, Technical Advisors, and Other Interested Parties

Lahav, Marian

From:	Lahav, Marian
Sent:	Monday, May 15, 2017 10:21 AM
To:	Lahav, Marian
Subject:	Notice of Open Houses & Public Comment Period: Tillamook County Multi-Jurisdictional NHMP

The Tillamook County Multi-Jurisdictional NHMP is being updated. The Draft Risk Assessment and Mitigation Strategy chapters are available for review and comment through May 26, 2017.

Click here to view or download the Draft.

Please email your comments to bchaix@co.tillamook.or.us or mail them to:
Tillamook County Department of Community Development
Attn: Barrett Chaix
1510 B Third Street
Tillamook, OR 97141

Three open houses are being held to provide information about the Plan and gather your input. Attend the one most convenient for you!

- Tuesday, May 16, 5:30 PM – 7:30 PM
  Nehalem City Hall, 5900 8th Street, Nehalem, OR 97131
- Wednesday, May 17, 5:30 PM – 7:30 PM
  Kiwanda Community Center, 34600 Cape Kiwanda Drive, Pacific City, OR 97135
- Thursday, May 18, 5:30 PM – 7:30 PM
  Tillamook Bay Community College, 4301 Third Street, Tillamook, OR 97141

For more information please feel free to contact me (contact information below) or Sarah Absher, Senior Planner, sabsher@co.tillamook.or.us, (503) 842-3408.

Please forgive any cross-postings.

Sincerely,

Marian Lahav

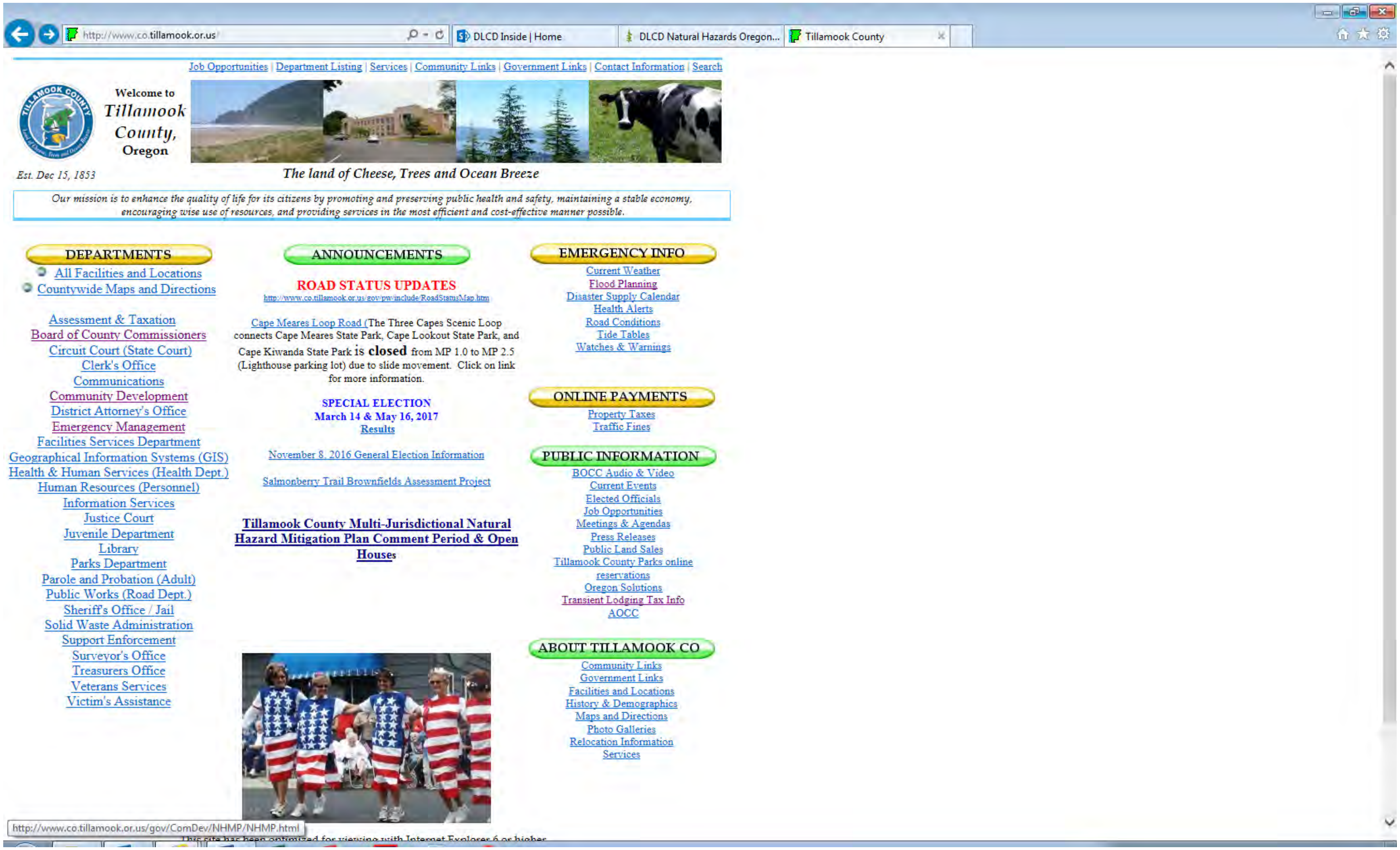
Marian Lahav | Natural Hazards Planner
Planning Services Division
Oregon Dept. of Land Conservation and Development
635 Capitol Street NE, Suite 150 | Salem, OR 97301-2540
Office: (503) 934-0024 | Fax: (503) 378-5518
marian.lahav@state.or.us | www.oregon.gov/LCD

1

NOTE: This message was emailed using BCC (therefore the addresses do not show on the email) to the Steering Committee, Technical Advisors, and other interested parties, totaling more than 120.

4. Examples of Jurisdictions' Web Pages

Tillamook County Website



http://www.co.tillamook.or.us/gov/ComDev/NHMP/NHMP.html | DLCD Inside | Home | DLCD Natural Hazards Oregon... | co.tillamook.or.us

Tillamook County
Oregon

You are here: www.co.tillamook.or.us ComDev NHMP

Job Opportunities
Department Listing
Services
Community Links
Government Links
Contact Information
Search

Com. Dev. Home
Planning Home
Building Home
Sanitation Home
Short Term Rental
Code Enforcement
Lodging Tax (TLT)
FAQ
Flooding
C.A.C
Planning Commission

Tillamook County Multi-Jurisdictional Hazard Mitigation Plan Update

Comment Period & Open Houses:

Tillamook County Multi-Jurisdictional Natural Hazard Mitigation Plan

The Tillamook County Multi-Jurisdictional NHMP is being updated. The Draft Risk Assessment and Mitigation Strategy chapters are available for review and comment through May 26, 2017. Click **here** to view or download the Draft. Please email your comments to **bchaix@co.tillamook.or.us** or mail them to:

Tillamook County Department of Community Development

Attn: Barrett Chaix
1510 B Third Street
Tillamook, OR 97141

Three open houses are being held to provide information about the Plan and gather your input. Attend the one most convenient for you!

- Tuesday, May 16, 5:30 PM – 7:30 PM
  Nehalem City Hall, 5900 8th Street, Nehalem, OR 97131
- Wednesday, May 17, 5:30 PM – 7:30 PM
  Kiwanda Community Center, 34600 Cape Kiwanda Drive, Pacific City, OR 97135
- Thursday, May 18, 5:30 PM – 7:30 PM
  Tillamook Bay Community College, 4301 Third Street, Tillamook, OR 97141

Meeting Information

May 2017	**Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan DRAFT Risk Assessment & Mitigation Strategy May 8, 2017**	
March 2017	**March 7 Multi-Jurisdictional Natural Hazards Mitigation Goals and Objectives** **March 3 DRAFT Risk Assessment** **March 1 DRAFT Risk Assessment**	
February 2017	**February 10 DRAFT Risk Assessment**	

http://www.co.tillamook.or.us/gov/ComDev/NHMP/NHMP.html | DLCD Inside | Home | DLCD Natural Hazards Oregon... | co.tillamook.or.us

March 2017	March 3 DRAFT Risk Assessment March 1 DRAFT Risk Assessment	
February 2017	February 10 DRAFT Risk Assessment	
January 2017	Agenda Sign-in Sheet Steering Committee Roster Follow-up from December Meeting Revised Project Schedule Option 1 Revised Project Schedule Option 2 Revised Project Schedule Option 3 Mitigation Strategy Meeting Sign-up Draft Risk Assessment County & State Mitigation Plan Goals	Meeting Notes
December 2016	Agenda Post-Disaster Funding Revised Project Schedule Public Engagement Plan Tillamook County Multi-Hazard Risk Report NHMP Presentation	
September 2016	Agenda OEM Hazard Analysis Exercise Packet Updated Steering Committee Roster Updated Technical Advisory Committee Roster Updated Cost Share Form Updated Public Engagement Plan Table of Contents Examples Risk Assessment Chapter Example Tillamook County Multi-Hazard Risk Report NHMP Presentation Worksheet - Which Hazards to Address	Meeting Notes
June 2016	Agenda Steering Committee Roster Project Overview Presentation Overview Handout Memorandum of Agreement/Statement of Work FEMA Local NHMP Regulations FEMA Local NHMP Review Tool Risk Map Risk Report Handout Technical Advisory Committee Roster Public Engagement Program Project Schedule	Meeting Notes

Read the draft plan online

http://www.co.tillamook.or.us/gov/ComDev/NHMP/NHMP.html | DLCD Inside | Home | DLCD Natural Hazards Oregon... | co.tillamook.or.us

Project Schedule

Read the draft plan online

or

Request a hard copy of the draft plan at one of the following locations:

Manzanita Library Branch
Rockaway Library Branch
Garibaldi Library Branch
Bay City Library Branch
Tillamook Library
South County Library Branch in Pacific City

Comments

The purpose of the Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan is to assist the County, its cities, and the Port of Tillamook Bay in reducing risk from natural hazards. This Draft Risk Assessment, one part of the Plan, identifies and assesses the natural hazards facing the County, its cities, and the Port of Tillamook Bay and identifies and assesses their potential vulnerabilities to those hazards. The public is invited to review and comment on the Draft Risk Assessment between Wednesday, March 1, 2017 and Friday, March 17, 2017.

Please send any comments to the Department of Community Development via email

Comment by mail to:

Tillamook County Department of Community Development
Attn: Barrett Chaix
1510 B Third Street
Tillamook OR 97141

What is mitigation?

Mitigation is the effort we take to reduce loss of life and property by lessening the impact of disasters. By taking action now - before the next disaster - we reduce the human and financial consequences later. Examples of mitigation actions include restoring flood plains to prevent flooding, retrofitting public infrastructure to withstand earthquakes, and locating or relocating development away from hazard areas.

Why do we need a Natural Hazard Mitigation Plan?

Mitigation planning creates safer communities, saves money, and enables individuals to recover more rapidly from disasters. With a federally approved plan in place, Tillamook County and its cities are also eligible to apply for grant funding for hazard mitigation projects. These funds can assist with mitigation actions identified during the hazard mitigation planning process.

http://www.co.tillamook.or.us/gov/ComDev/NHMP/NHMP.html | DLCD Inside | Home | DLCD Natural Hazards Oregon... | co.tillamook.or.us

Tillamook County Department of Community Development
Attn: Barrett Chaix
1510 B Third Street
Tillamook OR 97141

What is mitigation?

Mitigation is the effort we take to reduce loss of life and property by lessening the impact of disasters. By taking action now - before the next disaster - we reduce the human and financial consequences later. Examples of mitigation actions include restoring flood plains to prevent flooding, retrofitting public infrastructure to withstand earthquakes, and locating or relocating development away from hazard areas.

Why do we need a Natural Hazard Mitigation Plan?

Mitigation planning creates safer communities, saves money, and enables individuals to recover more rapidly from disasters. With a federally approved plan in place, Tillamook County and its cities are also eligible to apply for grant funding for hazard mitigation projects. These funds can assist with mitigation actions identified during the hazard mitigation planning process.

What is the Local Governments' role in updating the plan?

The Tillamook County Multi-Jurisdictional Natural Hazard Mitigation Plan addresses hazard mitigation in both the incorporated and rural areas of Tillamook County. The plan is updated every five years to reflect changes in development, progress in local mitigation efforts, and changes in priorities. We are currently in the process of a major update that includes the Tillamook County and the cities of Manzanita, Nehalem, Rockaway Beach, Garibaldi, Bay City, and Tillamook, as well as the unincorporated communities of Oceanside-Netarts, Pacific City, and Neskowin.

Questions?

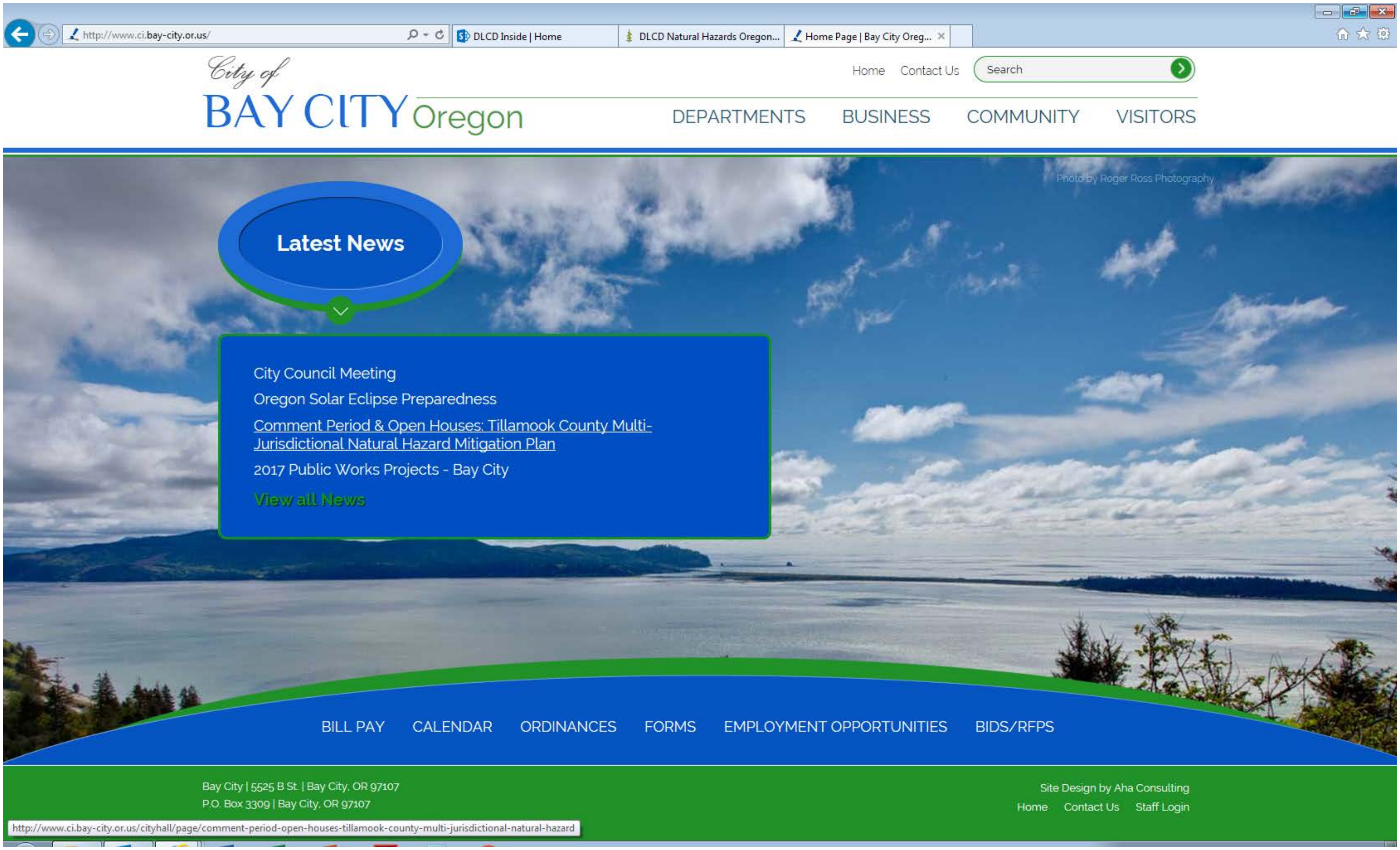
Contact:

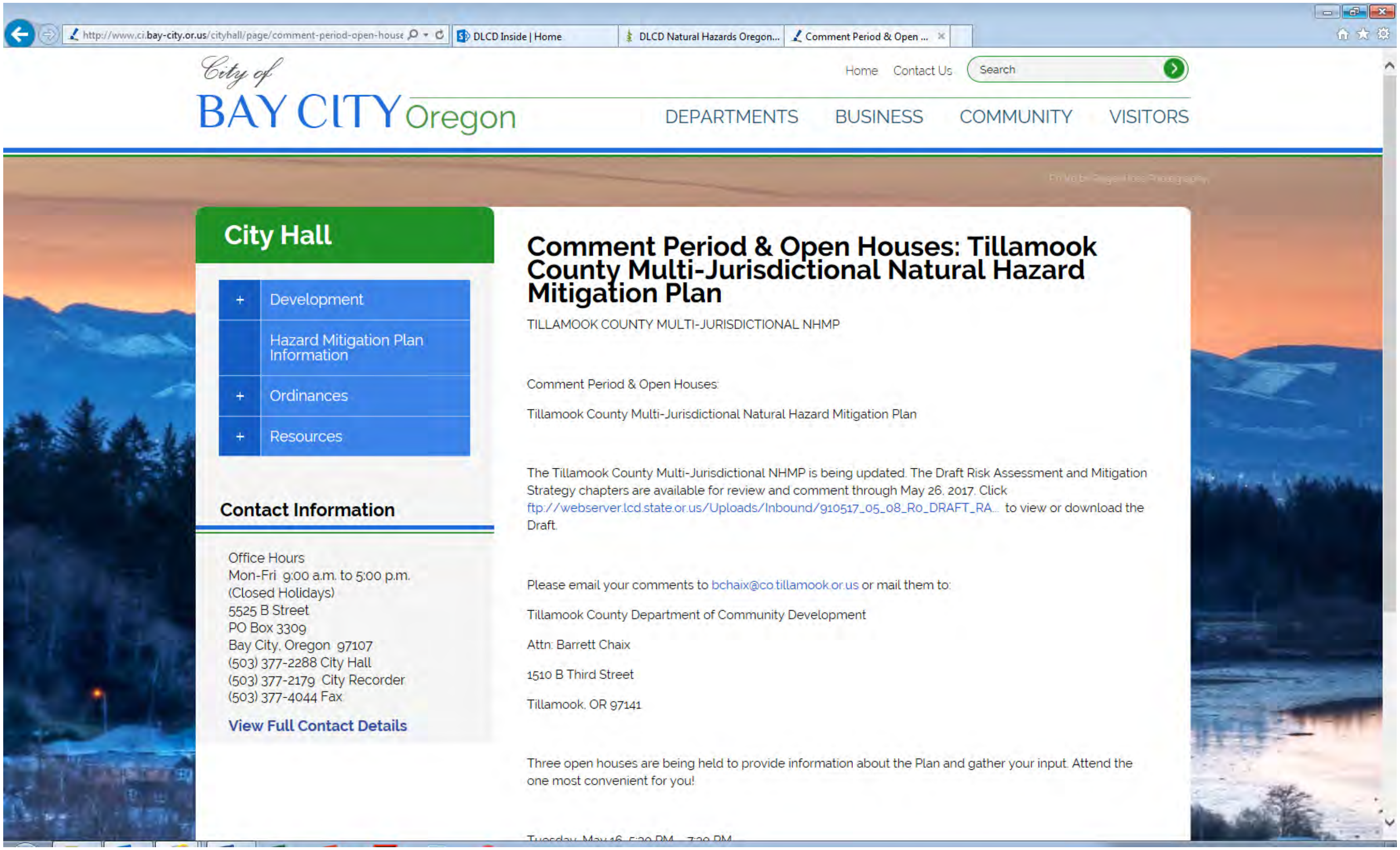
Sarah Absher, CFM, Senior Planner - (503) 842-3408 x3317, sabsher@co.tillamook.or.us

Barrett Chaix, Land Use Planner 2 - (503) 842-3408 x3315, bchaix@co.tillamook.or.us

Wednesday May 10, 2017 01:45 PM

City of Bay City Website





http://www.ci.bay-city.or.us/cityhall/page/comment-period-open-house

DLCD Inside | Home

DLCD Natural Hazards Oregon...

Comment Period & Open ...

City of BAY CITY Oregon

Home Contact Us Search

DEPARTMENTS BUSINESS COMMUNITY VISITORS

City Hall

- \+ Development
- Hazard Mitigation Plan Information
- \+ Ordinances
- \+ Resources

Contact Information

Office Hours
Mon-Fri 9:00 a.m. to 5:00 p.m.
(Closed Holidays)
5525 B Street
PO Box 3309
Bay City, Oregon 97107
(503) 377-2288 City Hall
(503) 377-2179 City Recorder
(503) 377-4044 Fax

View Full Contact Details

Comment Period & Open Houses: Tillamook County Multi-Jurisdictional Natural Hazard Mitigation Plan

TILLAMOOK COUNTY MULTI-JURISDICTIONAL NHMP

Comment Period & Open Houses:

Tillamook County Multi-Jurisdictional Natural Hazard Mitigation Plan

The Tillamook County Multi-Jurisdictional NHMP is being updated. The Draft Risk Assessment and Mitigation Strategy chapters are available for review and comment through May 26, 2017. Click ftp://webserver.lcd.state.or.us/Uploads/Inbound/910517_05_08_Ro_DRAFT_RA... to view or download the Draft.

Please email your comments to bchaix@co.tillamook.or.us or mail them to:

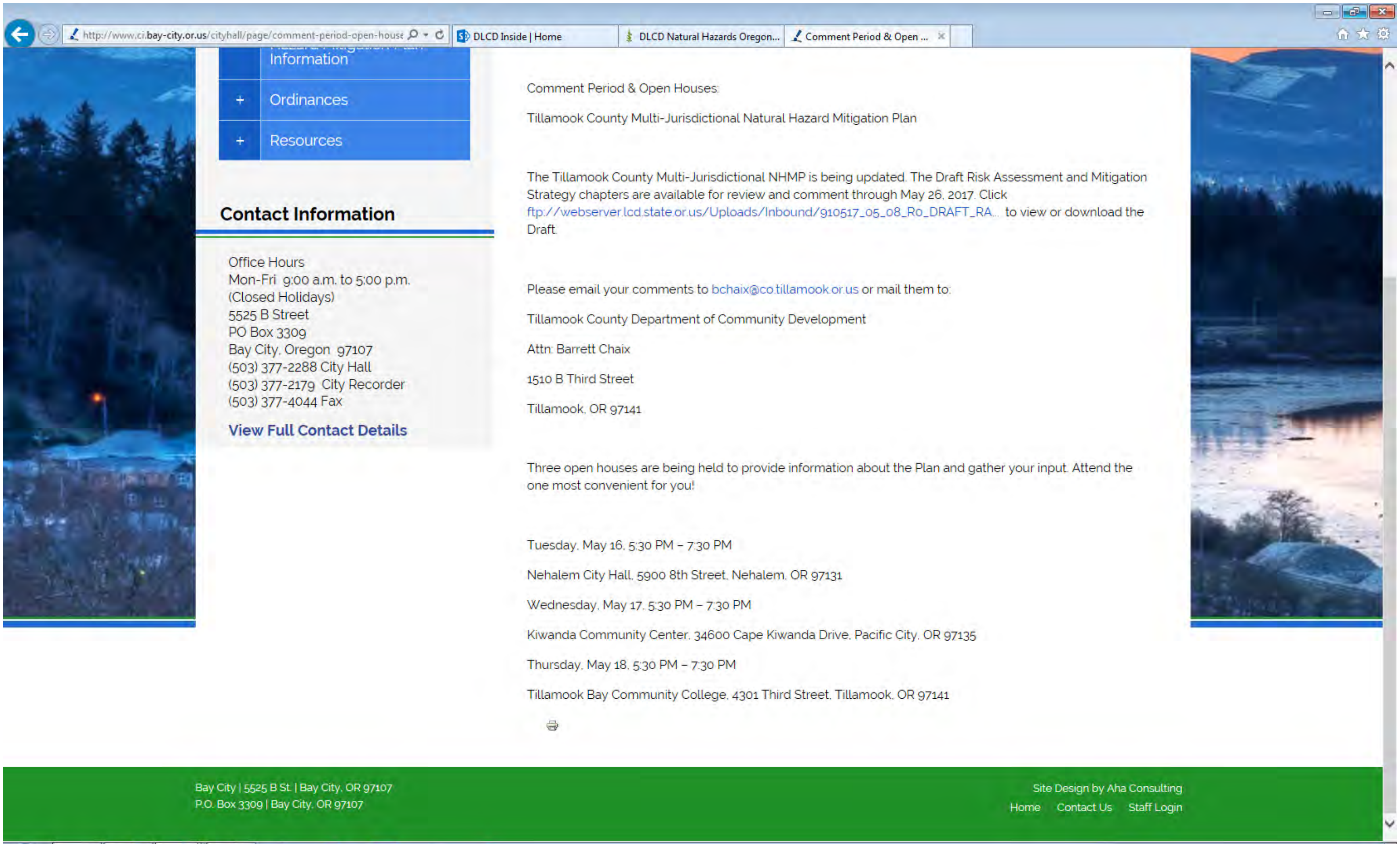
Tillamook County Department of Community Development

Attn: Barrett Chaix

1510 B Third Street

Tillamook, OR 97141

Three open houses are being held to provide information about the Plan and gather your input. Attend the one most convenient for you!



http://www.ci.bay-city.or.us/cityhall/page/comment-period-open-house | DLCD Inside | Home | DLCD Natural Hazards Oregon... | Comment Period & Open ...

Information

+ Ordinances

+ Resources

Contact Information

Office Hours
Mon-Fri 9:00 a.m. to 5:00 p.m.
(Closed Holidays)
5525 B Street
PO Box 3309
Bay City, Oregon 97107
(503) 377-2288 City Hall
(503) 377-2179 City Recorder
(503) 377-4044 Fax

View Full Contact Details

Comment Period & Open Houses:

Tillamook County Multi-Jurisdictional Natural Hazard Mitigation Plan

The Tillamook County Multi-Jurisdictional NHMP is being updated. The Draft Risk Assessment and Mitigation Strategy chapters are available for review and comment through May 26, 2017. Click ftp://webserver.lcd.state.or.us/Uploads/Inbound/910517_05_08_Ro_DRAFT_RA... to view or download the Draft.

Please email your comments to bchaix@co.tillamook.or.us or mail them to:

Tillamook County Department of Community Development

Attn: Barrett Chaix

1510 B Third Street

Tillamook, OR 97141

Three open houses are being held to provide information about the Plan and gather your input. Attend the one most convenient for you!

Tuesday, May 16, 5:30 PM – 7:30 PM

Nehalem City Hall, 5900 8th Street, Nehalem, OR 97131

Wednesday, May 17, 5:30 PM – 7:30 PM

Kiwanda Community Center, 34600 Cape Kiwanda Drive, Pacific City, OR 97135

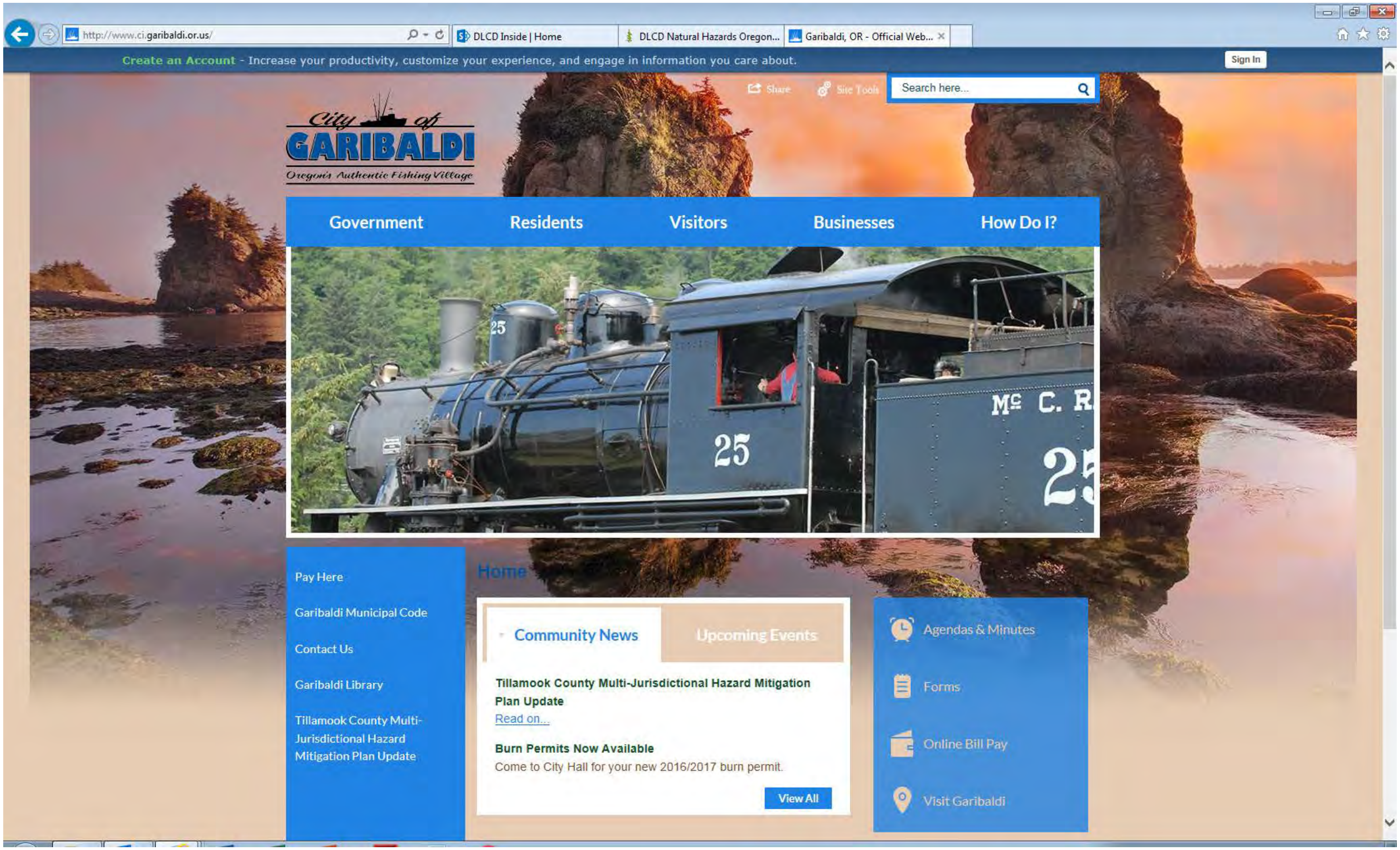
Thursday, May 18, 5:30 PM – 7:30 PM

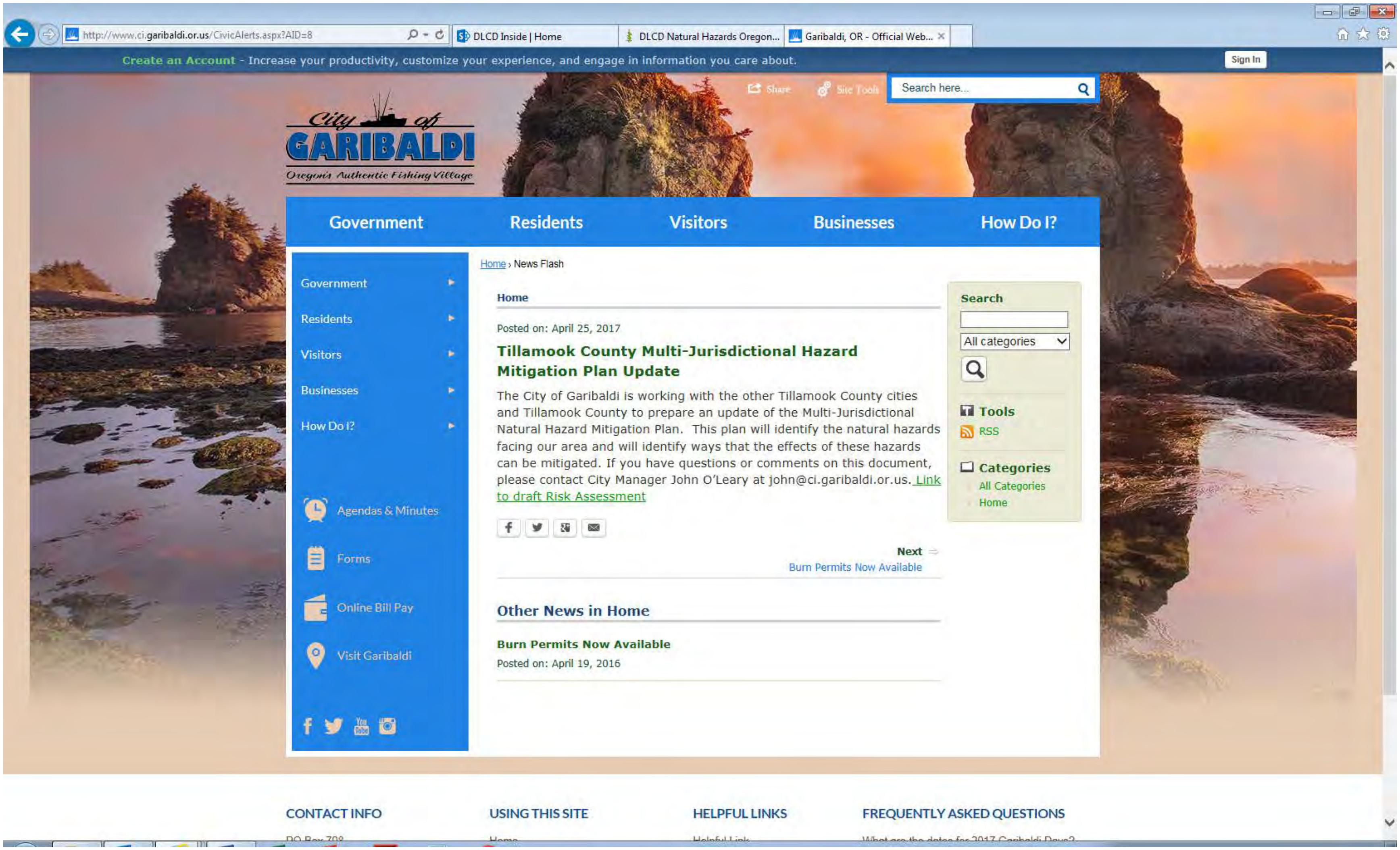
Tillamook Bay Community College, 4301 Third Street, Tillamook, OR 97141

Bay City | 5525 B St. | Bay City, OR 97107
P.O. Box 3309 | Bay City, OR 97107

Site Design by Aha Consulting
Home Contact Us Staff Login

City of Garibaldi Website




http://www.ci.garibaldi.or.us/CivicAlerts.aspx?AID=8
DLCD Inside | Home
DLCD Natural Hazards Oregon...
Garibaldi, OR - Official Web...
Create an Account - Increase your productivity, customize your experience, and engage in information you care about.
Sign In
Share
Site Tools
Search here...
City of GARIBALDI
Oregon's Authentic Fishing Village
Government
Residents
Visitors
Businesses
How Do I?
Government
Residents
Visitors
Businesses
How Do I?
Agendas & Minutes
Forms
Online Bill Pay
Visit Garibaldi
Home › News Flash
Home
Posted on: April 25, 2017
Tillamook County Multi-Jurisdictional Hazard Mitigation Plan Update
The City of Garibaldi is working with the other Tillamook County cities and Tillamook County to prepare an update of the Multi-Jurisdictional Natural Hazard Mitigation Plan. This plan will identify the natural hazards facing our area and will identify ways that the effects of these hazards can be mitigated. If you have questions or comments on this document, please contact City Manager John O'Leary at john@ci.garibaldi.or.us. Link to draft Risk Assessment
Next
Burn Permits Now Available
Other News in Home
Burn Permits Now Available
Posted on: April 19, 2016
Search
All categories
Tools
RSS
Categories
All Categories
Home
CONTACT INFO
USING THIS SITE
HELPFUL LINKS
FREQUENTLY ASKED QUESTIONS

City of Manzanita Website

http://www.ci.manzanita.or.us/news.html
DLCD Inside | Home
State of Oregon: Oregon Depar...
City of Manzanita | News

News

April 3, 2017

CITIZEN OF THE YEAR NOMINATIONS OPEN

Nominations are now being accepted for the 2017 Manzanita Citizen of the Year. Each year the City seeks to honor those persons who have made a major contribution to the Manzanita community as a community leader, business leader, volunteer, educator, and/or creative artist. A committee which includes former Citizens of the Year will meet in May to consider nominations and select the individual or couple to be honored this year.

To qualify for this honor, one must be a resident of Manzanita, live within the Manzanita Urban Growth Boundary, or operate a business in Manzanita. Currently serving elected officials and City employees are not eligible. The Citizen of the Year may be an individual or couple who performs any volunteer community service that benefits our citizens.

Nominations must be in writing and be submitted by April 28th to the Manzanita Citizen of the Year Committee c/o City Hall, P.O. Box 129, Manzanita, OR 97130.

List of previous Citizens of the Year

February 23, 2017

HAZARD MITIGATION PLAN UPDATE UNDERWAY

The City of Manzanita is working with the other Tillamook County cities and Tillamook County to prepare an update of the Multi-Jurisdictional Natural Hazard Mitigation Plan. This plan will identify the natural hazards facing our area and will identify ways that the effects of these hazards can be mitigated. A draft Risk Assessment has been prepared and is available for review at the link below. The Plan to be developed will include a plan specifically for Manzanita and a coordinated plan for the entire County.

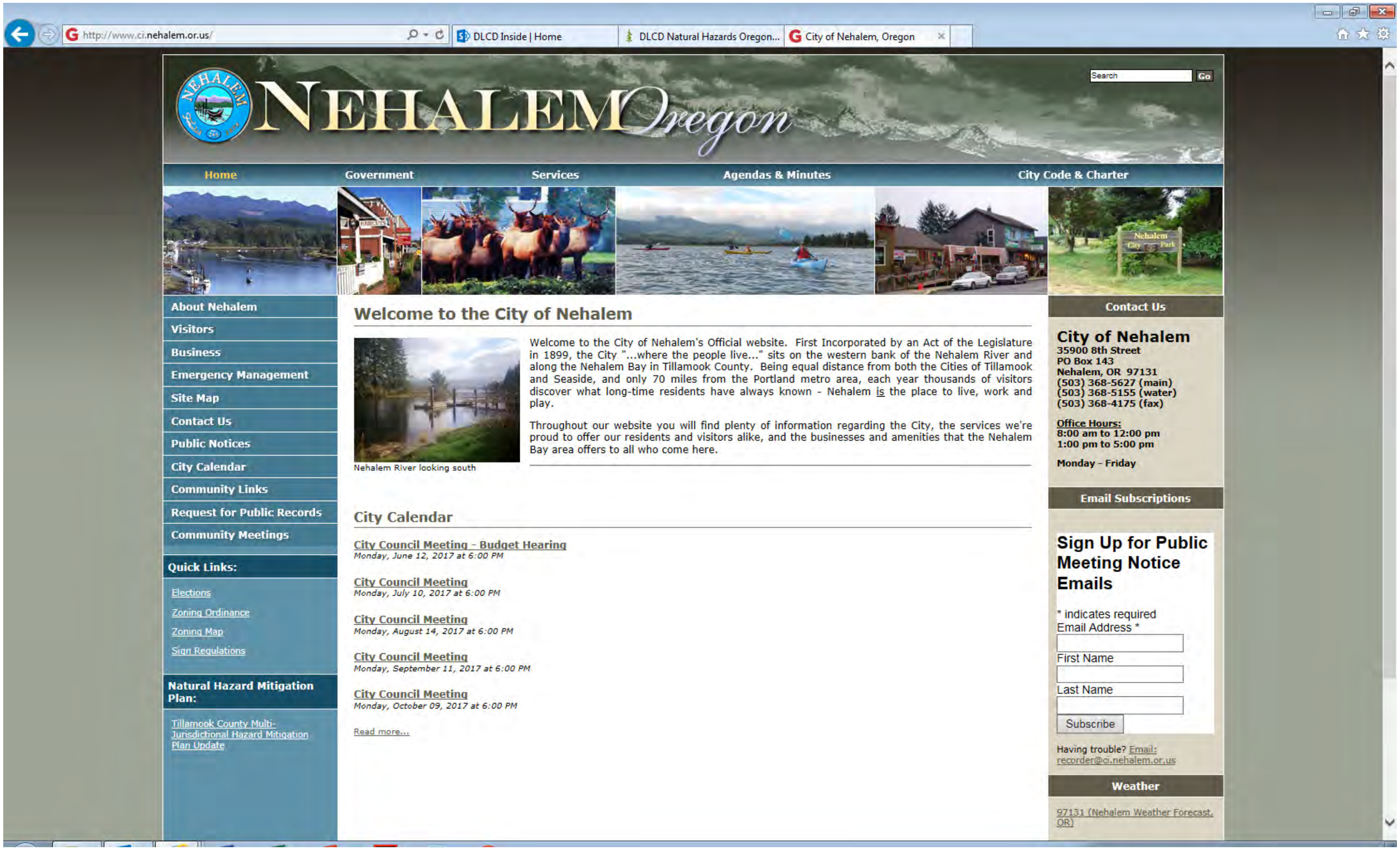
If you have questions or comments on this document, please contact City Manager Jerry Taylor at jtaylor@ci.manzanita.or.us.
Link to draft Risk Assessment

Related Information

PO Box 129 · Manzanita, OR 97130-0129 · cityhall@ci.manzanita.or.us
The City of Manzanita is an Equal Opportunity Provider and Employer

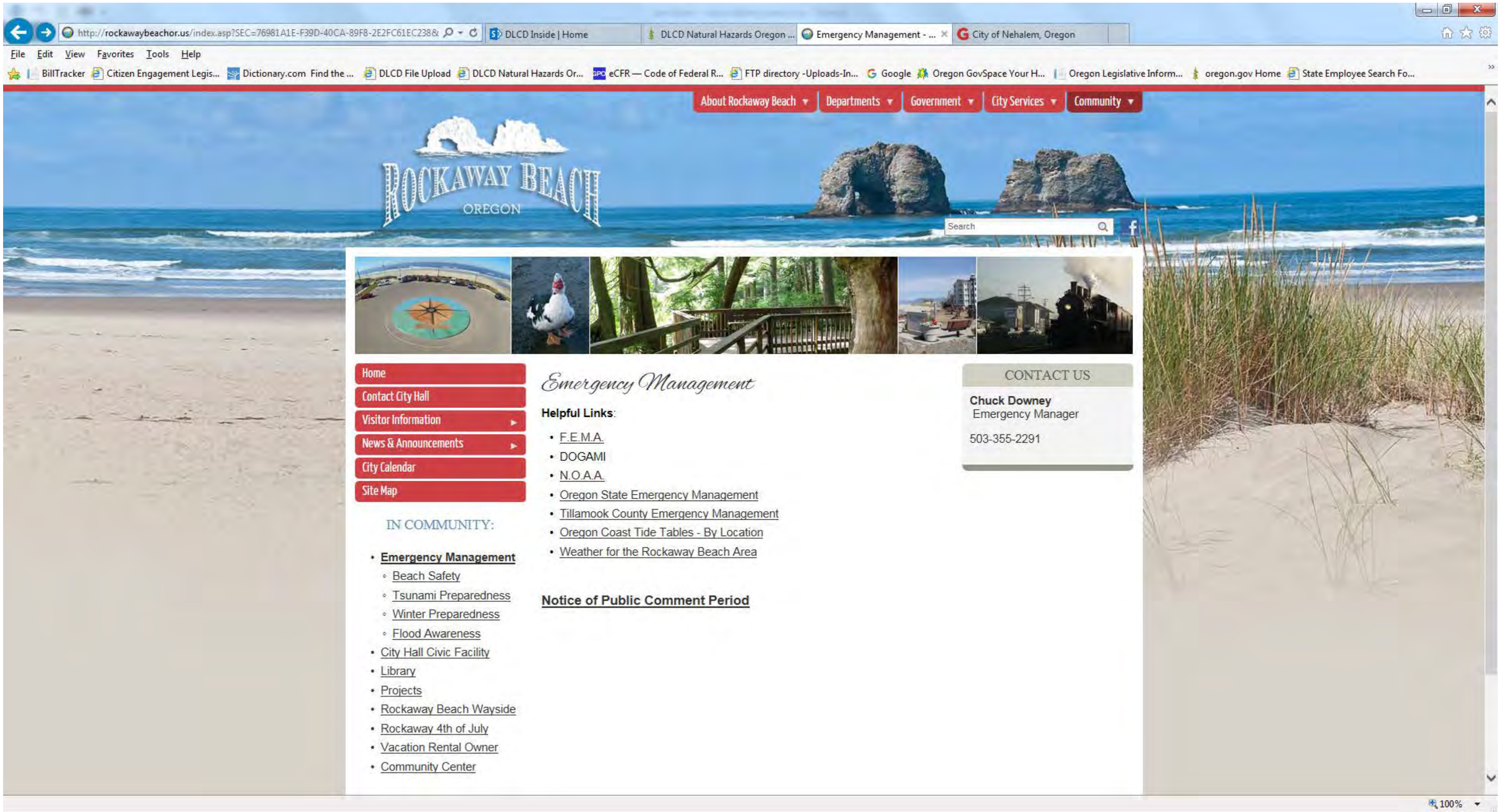
Design & Hosting: Glow Virtual Web Services

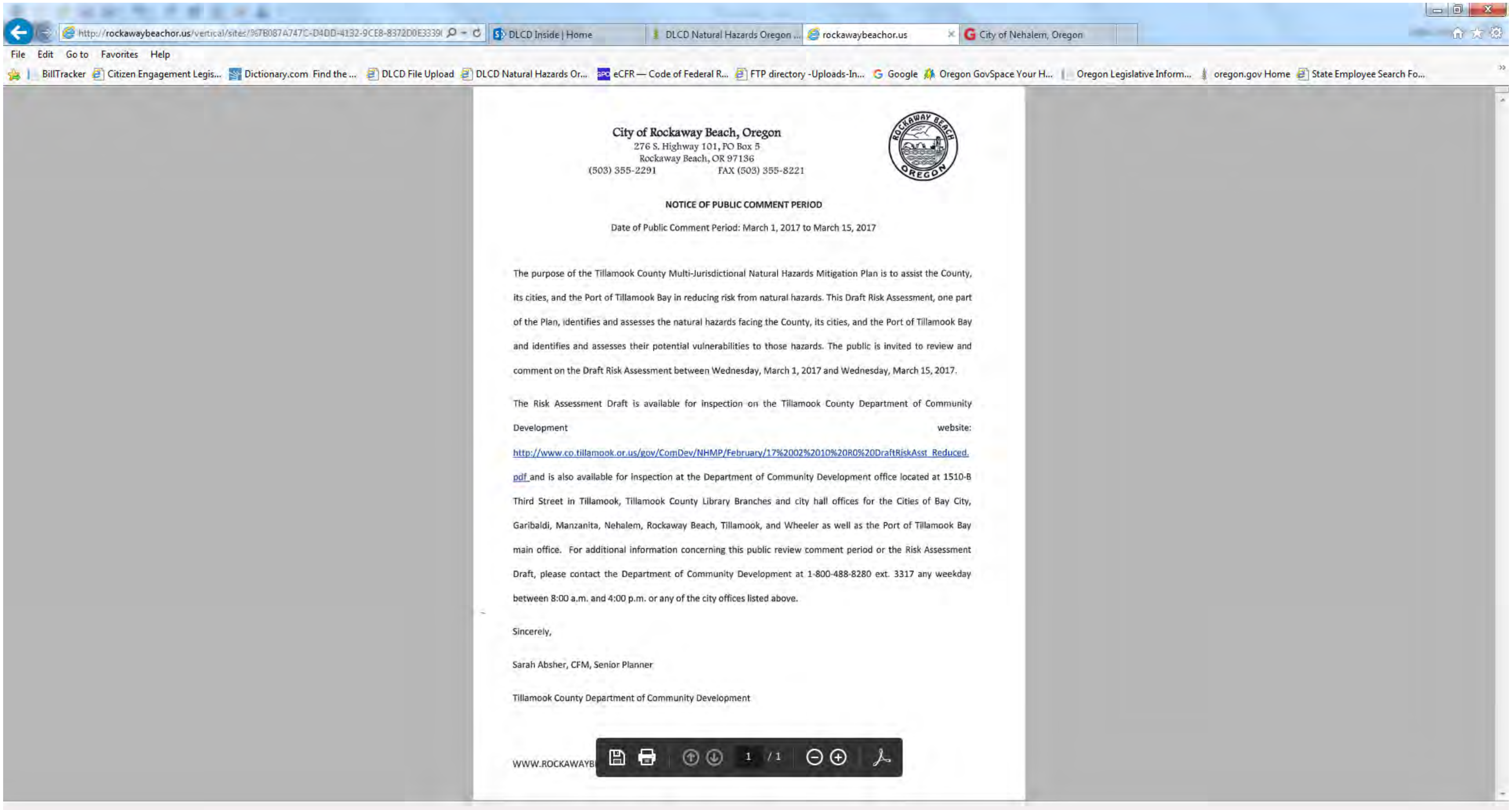
City of Nehalem Website



Note: Link goes to Tillamook County website.

City of Rockaway Beach Website





City of Rockaway Beach, Oregon
276 S. Highway 101, PO Box 5
Rockaway Beach, OR 97136
(503) 355-2291 FAX (503) 355-8221

NOTICE OF PUBLIC COMMENT PERIOD

Date of Public Comment Period: March 1, 2017 to March 15, 2017

The purpose of the Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan is to assist the County, its cities, and the Port of Tillamook Bay in reducing risk from natural hazards. This Draft Risk Assessment, one part of the Plan, identifies and assesses the natural hazards facing the County, its cities, and the Port of Tillamook Bay and identifies and assesses their potential vulnerabilities to those hazards. The public is invited to review and comment on the Draft Risk Assessment between Wednesday, March 1, 2017 and Wednesday, March 15, 2017.

The Risk Assessment Draft is available for inspection on the Tillamook County Department of Community Development website: http://www.co.tillamook.or.us/gov/ComDev/NHMP/February/17%2002%2010%20R0%20DraftRiskAsst_Reduced.pdf and is also available for inspection at the Department of Community Development office located at 1510-B Third Street in Tillamook, Tillamook County Library Branches and city hall offices for the Cities of Bay City, Garibaldi, Manzanita, Nehalem, Rockaway Beach, Tillamook, and Wheeler as well as the Port of Tillamook Bay main office. For additional information concerning this public review comment period or the Risk Assessment Draft, please contact the Department of Community Development at 1-800-488-8280 ext. 3317 any weekday between 8:00 a.m. and 4:00 p.m. or any of the city offices listed above.

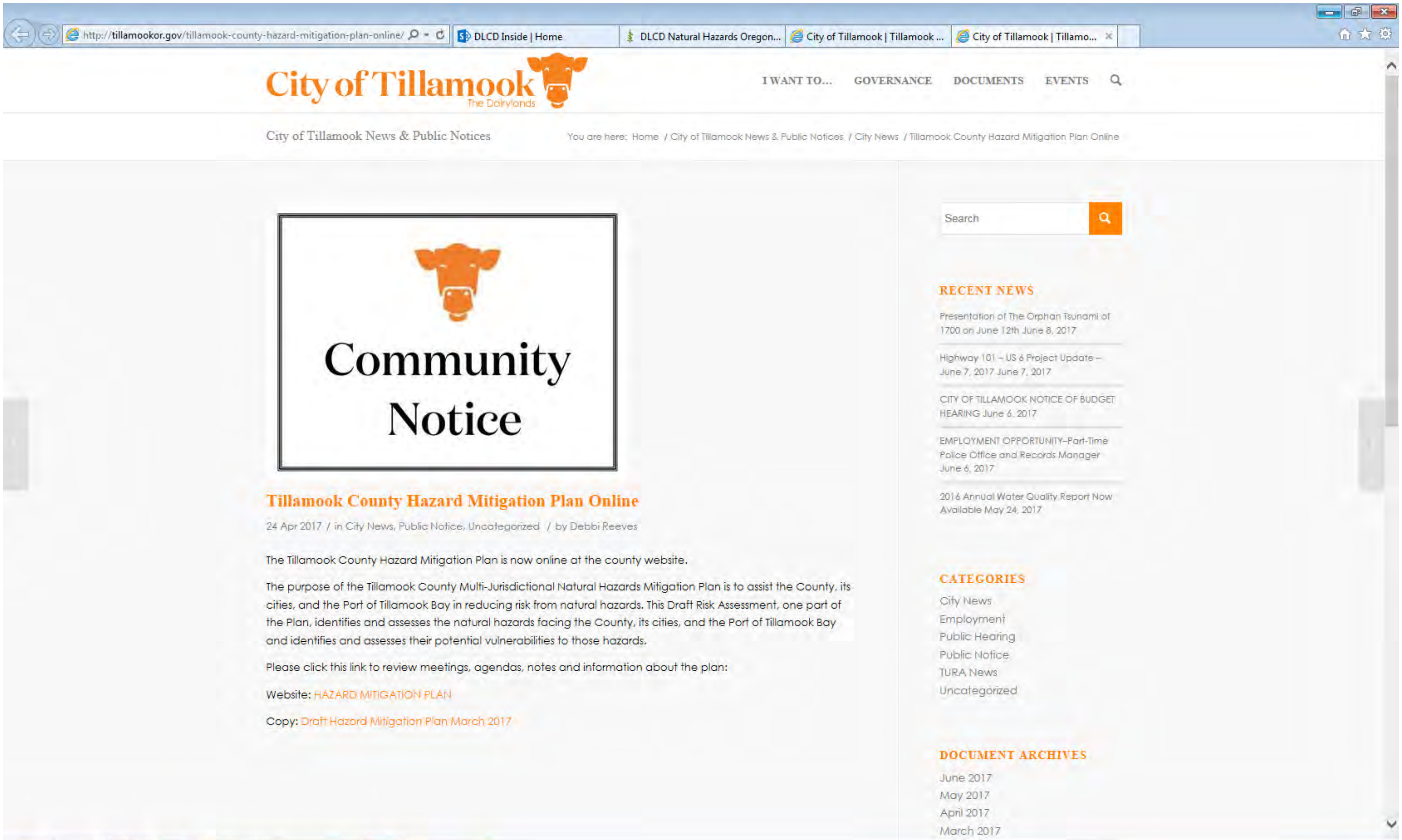
Sincerely,

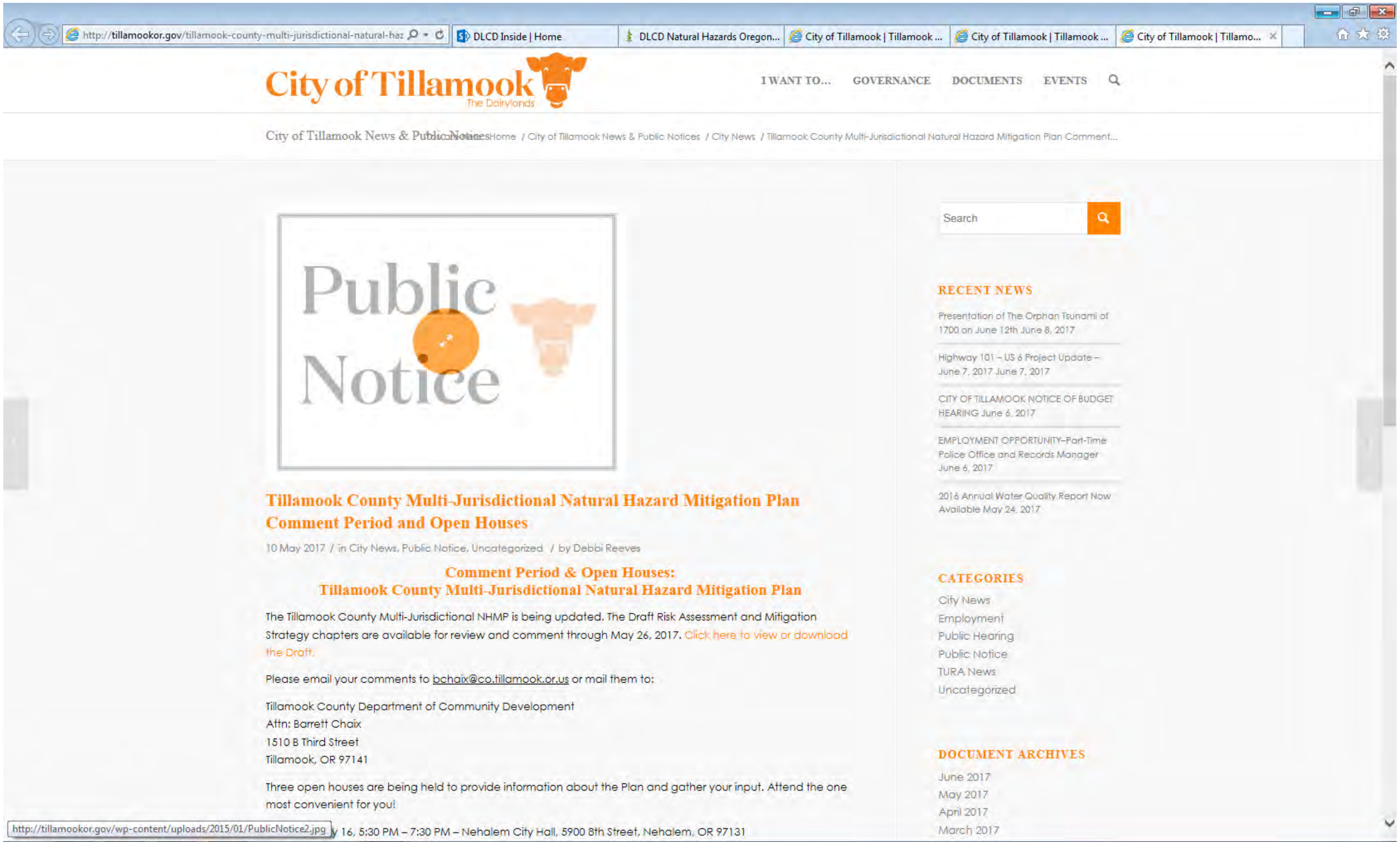
Sarah Absher, CFM, Senior Planner

Tillamook County Department of Community Development

WWW.ROCKAWAYB

City of Tillamook Website





http://tillamookor.gov/tillamook-county-multi-jurisdictional-natural-haz | DLCD Inside | Home | DLCD Natural Hazards Oregon... | City of Tillamook | Tillamook ... | City of Tillamook | Tillamook ... | City of Tillamook | Tillamo...

City of Tillamook
The Dairylands

I WANT TO... GOVERNANCE DOCUMENTS EVENTS

City of Tillamook News & Public Notices Home / City of Tillamook News & Public Notices / City News / Tillamook County Multi-Jurisdictional Natural Hazard Mitigation Plan Comment...

Public Notice

Tillamook County Multi-Jurisdictional Natural Hazard Mitigation Plan Comment Period and Open Houses

10 May 2017 / in City News, Public Notice, Uncategorized / by Debbi Reeves

Comment Period & Open Houses:
Tillamook County Multi-Jurisdictional Natural Hazard Mitigation Plan

The Tillamook County Multi-Jurisdictional NHMP is being updated. The Draft Risk Assessment and Mitigation Strategy chapters are available for review and comment through May 26, 2017. Click here to view or download the Draft.

Please email your comments to bchaix@co.tillamook.or.us or mail them to:

Tillamook County Department of Community Development
Attn: Barrett Chaix
1510 B Third Street
Tillamook, OR 97141

Three open houses are being held to provide information about the Plan and gather your input. Attend the one most convenient for you!

http://tillamookor.gov/wp-content/uploads/2015/01/PublicNotice2.jpg y 16, 5:30 PM – 7:30 PM – Nehalem City Hall, 5900 8th Street, Nehalem, OR 97131

Search

RECENT NEWS

Presentation of The Orphan Tsunami of 1700 on June 12th June 8, 2017

Highway 101 – US 6 Project Update – June 7, 2017 June 7, 2017

CITY OF TILLAMOOK NOTICE OF BUDGET HEARING June 6, 2017

EMPLOYMENT OPPORTUNITY–Part-Time Police Office and Records Manager June 6, 2017

2016 Annual Water Quality Report Now Available May 24, 2017

CATEGORIES

City News
Employment
Public Hearing
Public Notice
TURA News
Uncategorized

DOCUMENT ARCHIVES

June 2017
May 2017
April 2017
March 2017

http://tillamookor.gov/tillamook-county-multi-jurisdictional-natural-haz | DLCD Inside | Home | DLCD Natural Hazards Oregon... | City of Tillamook | Tillamook ... | City of Tillamook | Tillamook ... | City of Tillamo...

City of Tillamook

I WANT TO... GOVERNANCE DOCUMENTS EVENTS

Tillamook County Multi-Jurisdictional Natural Hazard Mitigation Plan Comment Period and Open Houses

10 May 2017 / in City News, Public Notice, Uncategorized / by Debbi Reeves

Comment Period & Open Houses:
Tillamook County Multi-Jurisdictional Natural Hazard Mitigation Plan

The Tillamook County Multi-Jurisdictional NHMP is being updated. The Draft Risk Assessment and Mitigation Strategy chapters are available for review and comment through May 26, 2017. Click here to view or download the Draft.

Please email your comments to bchaix@co.tillamook.or.us or mail them to:

Tillamook County Department of Community Development
Attn: Barrett Chaix
1510 B Third Street
Tillamook, OR 97141

Three open houses are being held to provide information about the Plan and gather your input. Attend the one most convenient for you!

Tuesday, May 16, 5:30 PM – 7:30 PM – Nehalem City Hall, 5900 8th Street, Nehalem, OR 97131

Wednesday, May 17, 5:30 PM – 7:30 PM – Kiwanda Community Center, 34600 Cape Kiwanda Drive, Pacific City, OR 97135

Thursday, May 18, 5:30 PM – 7:30 PM – Tillamook Bay Community College, 4301 Third Street, Tillamook, OR 97141

RECENT NEWS

Presentation of The Orphan Tsunami of 1700 on June 12th June 8, 2017

Highway 101 – US 6 Project Update – June 7, 2017 June 7, 2017

CITY OF TILLAMOOK NOTICE OF BUDGET HEARING June 6, 2017

EMPLOYMENT OPPORTUNITY–Part-Time Police Office and Records Manager June 6, 2017

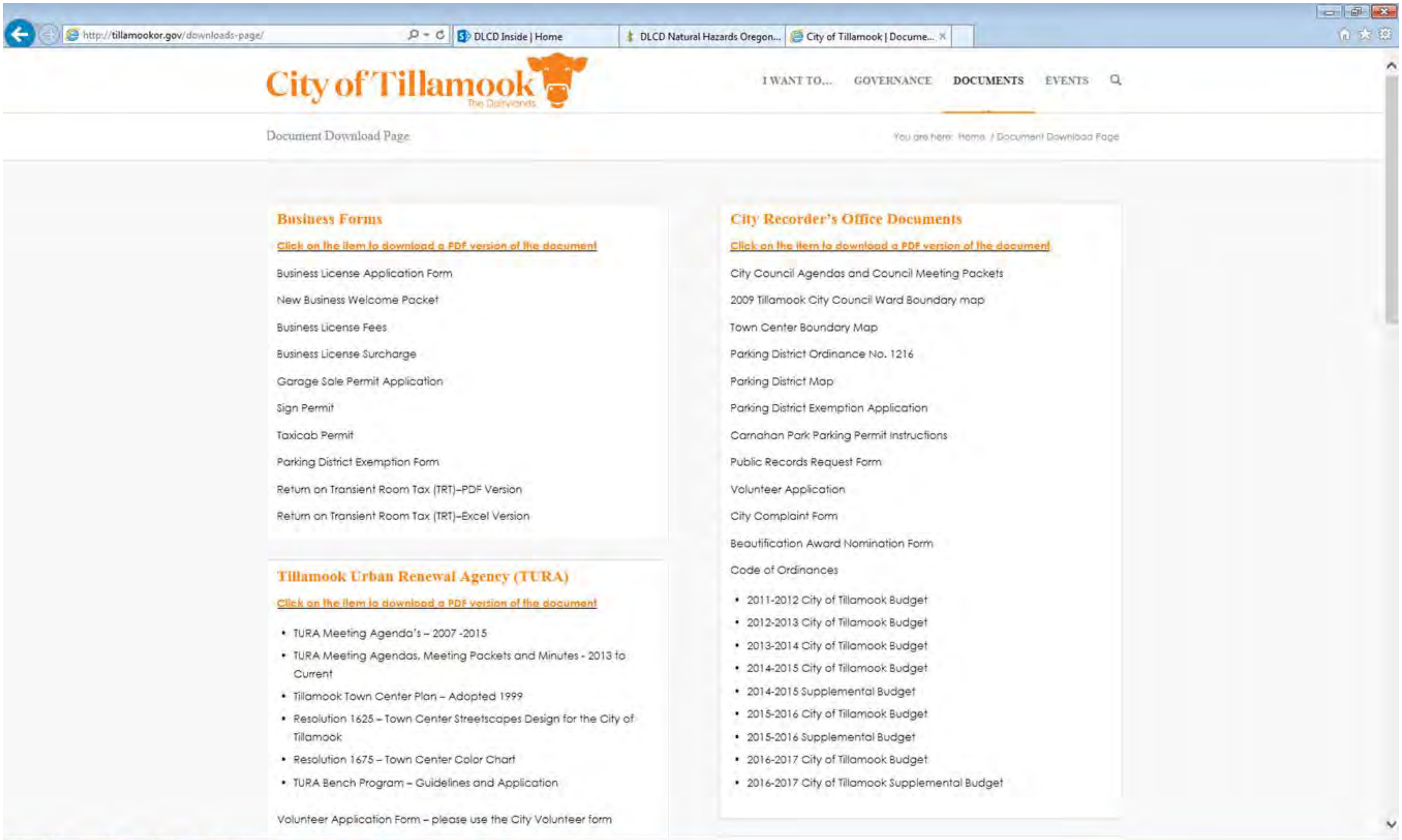
2016 Annual Water Quality Report Now Available May 24, 2017

CATEGORIES

City News
Employment
Public Hearing
Public Notice
TURA News
Uncategorized

DOCUMENT ARCHIVES

June 2017
May 2017
April 2017
March 2017
February 2017
January 2017
December 2016
November 2016
October 2016
September 2016
August 2016
July 2016
June 2016



http://tillamookor.gov/downloads-page/

DLCD Inside | Home

DLCD Natural Hazards Oregon...

City of Tillamook | Docume...

City of Tillamook

The Dairylands

I WANT TO... GOVERNANCE DOCUMENTS EVENTS

Document Download Page

You are here: Home / Document Download Page

Business Forms

Click on the item to download a PDF version of the document

Business License Application Form

New Business Welcome Packet

Business License Fees

Business License Surcharge

Garage Sale Permit Application

Sign Permit

Taxicab Permit

Parking District Exemption Form

Return on Transient Room Tax (TRT)–PDF Version

Return on Transient Room Tax (TRT)–Excel Version

Tillamook Urban Renewal Agency (TURA)

Click on the item to download a PDF version of the document

- TURA Meeting Agenda's – 2007 -2015
- TURA Meeting Agendas, Meeting Packets and Minutes - 2013 to Current
- Tillamook Town Center Plan – Adopted 1999
- Resolution 1625 – Town Center Streetscapes Design for the City of Tillamook
- Resolution 1675 – Town Center Color Chart
- TURA Bench Program – Guidelines and Application

Volunteer Application Form – please use the City Volunteer form

City Recorder's Office Documents

Click on the item to download a PDF version of the document

City Council Agendas and Council Meeting Packets

2009 Tillamook City Council Ward Boundary map

Town Center Boundary Map

Parking District Ordinance No. 1216

Parking District Map

Parking District Exemption Application

Carnahan Park Parking Permit Instructions

Public Records Request Form

Volunteer Application

City Complaint Form

Beautification Award Nomination Form

Code of Ordinances

- 2011-2012 City of Tillamook Budget
- 2012-2013 City of Tillamook Budget
- 2013-2014 City of Tillamook Budget
- 2014-2015 City of Tillamook Budget
- 2014-2015 Supplemental Budget
- 2015-2016 City of Tillamook Budget
- 2015-2016 Supplemental Budget
- 2016-2017 City of Tillamook Budget
- 2016-2017 City of Tillamook Supplemental Budget

http://tillamookor.gov/downloads-page/ | DLCD Inside | Home | DLCD Natural Hazards Oregon... | City of Tillamook | Docume...

City of Tillamook

I WANT TO... GOVERNANCE DOCUMENTS EVENTS

- 2011-2012 TURA Budget
- 2010-2011 TURA Budget
- 2009-2010 TURA Budget
- 2008-2009 TURA Budget
- 2007-2008 TURA Budget

TURA Plans and Documents

- 2012 TURA Plan
- 2012 Report Accompanying the Plan
- 2012 Staff Report on Plan
- 2012 District Boundary Map
- 2012 Boundary Change Map
- 2012 District Zoning Map
- TURA Bylaws Revised 12-12-12
- TURA Board Volunteer Application
- Front Porch Initiative Brochure

TURA Assistance Applications

- TURA Pre-Application Form
- TURA Goals and Objective Information
- TURA FAQ Sheet
- Grant Loan Application Packet
- Blade Sign Grant Application Packet
- Design Assistance Grant Application Packet
- Facade Grant Program Application Packet

TURA Financial Audits

- June 30, 2015 Financial Audit
- June 30, 2014 Financial Audit
- June 30, 2013 Financial Audit
- June 30, 2012 Financial Audit
- June 30, 2011 Financial Audit
- June 30, 2010 Financial Audit

Land Use Application

Public Works Permit Application

Sign Permit Application

Zoning Permit Application

Tillamook Zoning Map

2014 Zoning Ordinance

2009 Tillamook Wetlands Hazard Flood Map (5.4 MB)

Trees, Plants, and Shrubs

2012 Comprehensive Plan

Right-of-Way (ROW) Use Permit

City Complaint Form

Planning Commission Volunteer Application

Tillamook County Natural Hazard Mitigation Plan – Draft March 2017

Temporary Business Siting Info

Click on the item to download a PDF version of the document

Unit Siting Standards

Unit Siting Fee Schedule

Unit Siting Application Form

Public Works Department Documents

Click on the item to download a PDF version of the document

City of Tillamook Water Master Plan 2015

Resolution 1693 Adopting the Water Rate Master Plan 2014

Water & Sewer Rates

- 2015 Water Quality Report PDF
- 2014 Water Quality Report PDF
- 2013 Water Quality Report PDF

City of Wheeler Website

http://ci.wheeler.or.us/ | DLCD Inside | Home | DLCD Natural Hazards Oregon... | Wheeler, Oregon

Home | Government » | Business Guide » | The Community » | Explore » | History » | Photo Tour » | Calendar

Wheeler, the gem of the Oregon Coast

2013 – Wheeler's Centennial Year

The lovely little village of Wheeler lies at the edge of the Pacific on Nehalem Bay along Oregon's spectacular north coast. Wheeler was born in the early 1900's when a railroad link was completed connecting Portland to the timber-rich area surrounding the bay. The train delivered lumber as well as seafood to eager markets to the east.

The lumber mills and fish packing plants of Wheeler's early decades are gone now….leaving a village of charming, historic buildings strung together on the edge of that beautiful bay as if they were displayed on a holiday mantle.

Oregon Treasurer Ted Wheeler, Eunice Massie, and Mayor Stevie Burden cutting the ribbon for the new Centennial Historical Display

Wheeler enjoys a wonderful "mini" climate and is often bathed in sunshine while surrounding coastal areas enjoy fog and mist. Natives call Wheeler "Pukalani" (hole in the sky) as the surrounding hills seem to protect Wheeler from the prevailing northwest wind and fog. Our sunsets can be some of the best in the world!

Wheeler has been called "the little town with the million-dollar view!". It is a coastal refuge where people come to relax, refresh, and enjoy the scenic splendor of Oregon's north coast. Wheeler is small enough to be peaceful and unhurried — yet big enough to offer the services and advantages of a tight-knit community. We are very proud of our sweet little town.

Welcome to Wheeler — for a visit …. or a lifetime!

" This organization is an Equal Opportunity Provider"

what's new

Happy spring to all and welcome to the City of Wheeler's homepage. As we pull ourselves out of the long winter we just experienced, I am happy to share some of the goings on here in town with you. Fist and foremost, the City is closing in on the adoption of our Comprehensive Plan Update. This document represents the overarching land use policies for the community, and we have worked hard to incorporate the community's vision throughout. You can think of it as a guiding document and compilation of statements that share the community voice as we build for the future. There will be several public hearings to share your input on the completed draft with both the Planning Commission, and the City Council, so stay tuned and check in here on the home page for schedule and updates. I also wanted to make mention of this years clean up day which is scheduled for June 10, 2017. We moved the starting time to 9 am (from 10) to handle those who come early to beat the heat. This year we will have no home pickup of yard debris. We will still have home pickup of other discards. This year, yard debris will only be accepted at city Hall after 1:00 PM. Our loading problem is that with yard debris/branches on the bottom of the dumpster, it makes it very difficult to load bulky discards like appliances or furniture on top. I hope that if you are a Wheeler resident, we see you on the 10th, and that you take advantage of this annual event. Stevie S.Burden Mayor, City of Wheeler http://ci.wheeler.or.us/ DLCD Inside | Home DLCD Natural Hazards Oregon... | Wheeler, Oregon

enough to be peaceful and unhurried — yet big enough to offer the services and advantages of a tight-knit community. We are very proud of our sweet little town.

Welcome to Wheeler — for a visit .... or a lifetime!

" This organization is an Equal Opportunity Provider"

Announcements

WHEELER CITY COUNCIL

The Wheeler City Council is currently soliciting interest from Wheeler residents for appointment to the City's primary legislative body to complete the terminus of a vacant position. The Wheeler City Council is principally responsible for policy formulation, goal setting, oversight of City administrative activity, and developing the vision and course of the municipality. This is a great opportunity to serve your community and become involved in local government. All Wheeler residents who reside within the city limits of Wheeler are eligible for application to serve. Please contact City Manager Geoff Wullschlager at (503)368-5767 if you are interested in learning more.

HWY 53 CLOSURE

Highway 53 will be closed for paving improvements near County Line Rd. on 4/20/17 from 8:00 am to 4:00 pm. There will be follow up work in late May as well. When details of this closure become available, this information will be updated.

MULTI-JURISDICTIONAL HAZARD MITIGATION PLAN UPDATE

The City of Wheeler is currently working with the Oregon Department of Land Conservation and Development, Tillamook County, the other incorporated Cites of the County, and several Port Districts in updating its Hazard Mitigation Plan. This plan identifies the natural hazards that exist within the City's jurisdiction, and offers a mitigation strategies for these hazards. A draft of the Risk Assessment has been completed and can be found at the link below. Upcoming Open House meetings are being scheduled for May and will be updated here as the dates and times become available.

ftp://webserver.lcd.state.or.us/Uploads/Inbound/910517_05_08_R0_DRAFT_RA_MS_RED.pd

Comment Period & Open Houses:

Tillamook County Multi-Jurisdictional Natural Hazard Mitigation Plan

The Tillamook County Multi-Jurisdictional NHMP is being updated. The Draft Risk Assessment and Mitigation Strategy chapters are available for review and comment through May 26, 2017. Click here to view or download the Draft. Please email your comments to bchaix@co.tillamook.or.us<mailto:bchaix@co.tillamook.or.us> or mail them to:

Tillamook County Department of Community Development

Attn: Barrett Chaix

1510 B Third Street

Tillamook, OR 97141

Three open houses are being held to provide information about the Plan and gather your input. Attend the one most convenient for you!

furniture on top. I hope that if you are a Wheeler resident, we see you on the 10th, and that you take advantage of this annual event. Stevie S.Burden Mayor, City of Wheeler

blogroll

- Planning Commission Solicitation
- Planning Commission Solicitation

links

- Local Emergency Preparedness
- ODOT Road Conditions
- Rinehart Clinic
- Suggest Ideas
- The Wave – Bus Service
- Tide Table – Nehalem Bay
- Tillamook Transportation Dist.
- Weather

Wheeler, OR
54 °F
Overcast
at 11:55 AM
Click for Forecast

http://ci.wheeler.or.us/ | DLCD Inside | Home | DLCD Natural Hazards Oregon... | | Wheeler, Oregon

within the City's jurisdiction, and offers a mitigation strategies for these hazards. A draft of the Risk Assessment has been completed and can be found at the link below. Upcoming Open House meetings are being scheduled for May and will be updated here as the dates and times become available.

ftp://webserver.lcd.state.or.us/Uploads/Inbound/910517_05_08_R0_DRAFT_RA_MS_RED.pd

Comment Period & Open Houses:

Tillamook County Multi-Jurisdictional Natural Hazard Mitigation Plan

The Tillamook County Multi-Jurisdictional NHMP is being updated. The Draft Risk Assessment and Mitigation Strategy chapters are available for review and comment through May 26, 2017. Click here to view or download the Draft. Please email your comments to bchaix@co.tillamook.or.us<mailto:bchaix@co.tillamook.or.us> or mail them to:

Tillamook County Department of Community Development

Attn: Barrett Chaix

1510 B Third Street

Tillamook, OR 97141

Three open houses are being held to provide information about the Plan and gather your input. Attend the one most convenient for you!

* Tuesday, May 16, 5:30 PM – 7:30 PM

Nehalem City Hall, 5900 8th Street, Nehalem, OR 97131

* Wednesday, May 17, 5:30 PM – 7:30 PM

Kiwanda Community Center, 34600 Cape Kiwanda Drive, Pacific City, OR 97135

* Thursday, May 18, 5:30 PM – 7:30 PM

Tillamook Bay Community College, 4301 Third Street, Tillamook, OR 97141

WHEELER PLANNING COMMISSION

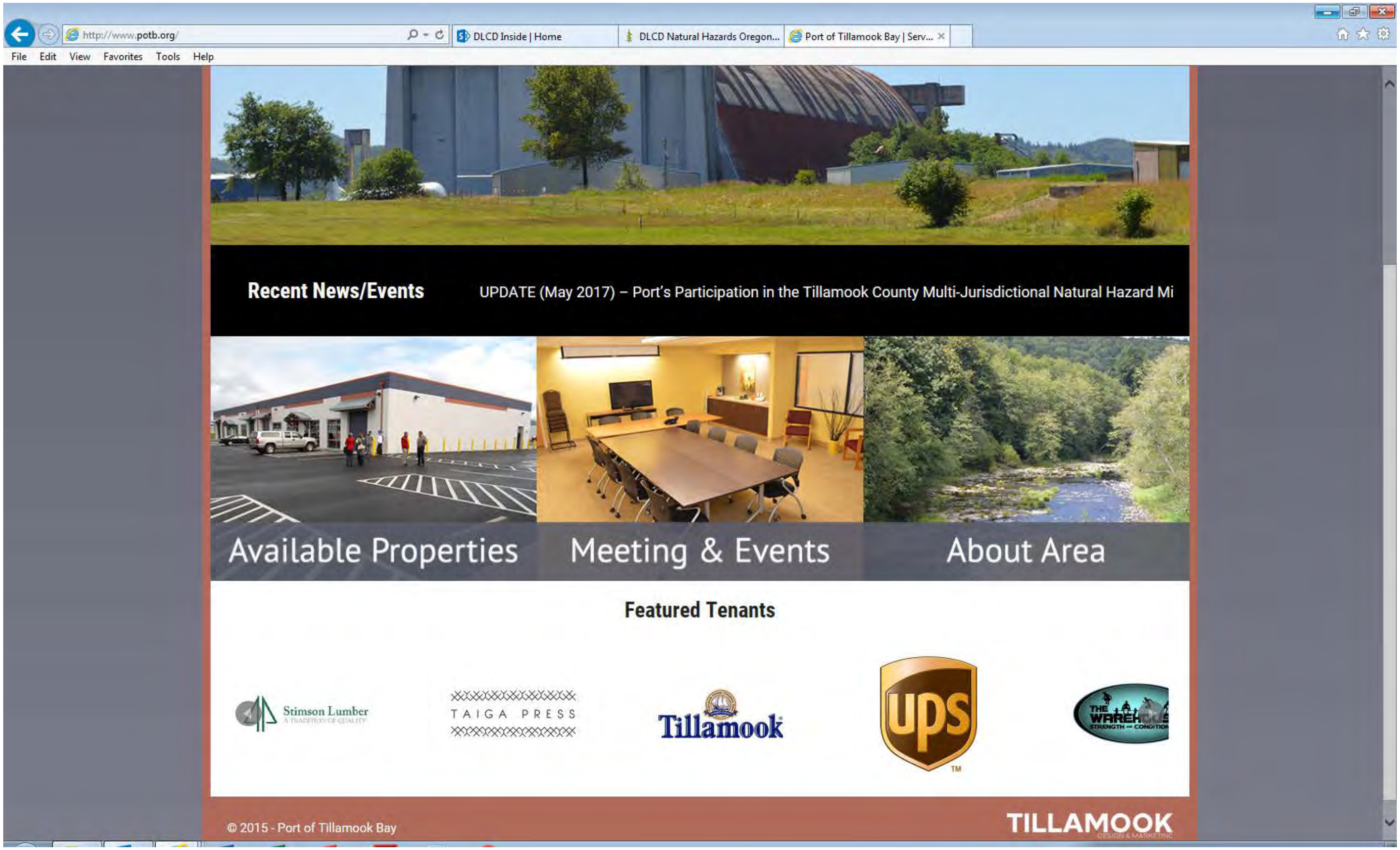
The Wheeler Planning Commission is currently soliciting interest from Wheeler residents for appointment to the City's primary citizen involvement and land use oversight board. The Planning Commission is actively involved in reviewing land use applications that require public consideration, long term community development and planning, and matters that relate to administration of the floodplain. This is a great opportunity to serve your community and become involved in local government. All Wheeler residents who reside within Wheeler and the Urban Growth Boundary are eligible for application to serve, as are non-residents who own property or a business that operates within the City or its Urban Growth Area. Please contact City Manager Geoff Wullschlager at (503)368-5767 if you are interested in learning more.

The city of Wheeler is an equal opportunity provider

- Tillamook Transportation Dist.
- Weather

Wheeler, OR
54 °F
Overcast
at 11:55 AM
Click for Forecast

Port of Tillamook Bay Website



http://www.potb.org/MJNHMP%20Update/

DLCD Inside | Home | DLCD Natural Hazards Oregon... | MJNHMP Update | Port of ...

PORT OF TILLAMOOK BAY

STAFF LOGIN CONTACT US

Industry at the Port | Business with the Port | About the Port

MJNHMP UPDATE

PROPERTY LIST

6825 Officers Row

May 10, 2017

PUBLIC NOTICE

TILLAMOOK COUNTY MULTI-JURISDICTIONAL NATURAL HAZARD MITIGATION PLAN UPDATE

-oOo-

COMMENT PERIOD

&

OPEN HOUSES TO BE HELD

The Tillamook County Multi-Jurisdictional Natural Hazard Mitigation Plan (Plan) is being updated. The Draft Risk Assessment and Mitigation Strategy chapters are available for review and comment through May 26, 2017.

The Draft Risk Assessment is available for download at the following link: ftp://webserver.lcd.state.or.us/Uploads/Inbound/910517_05_08_R0_DRAFT_RA_MS_RED.pdf

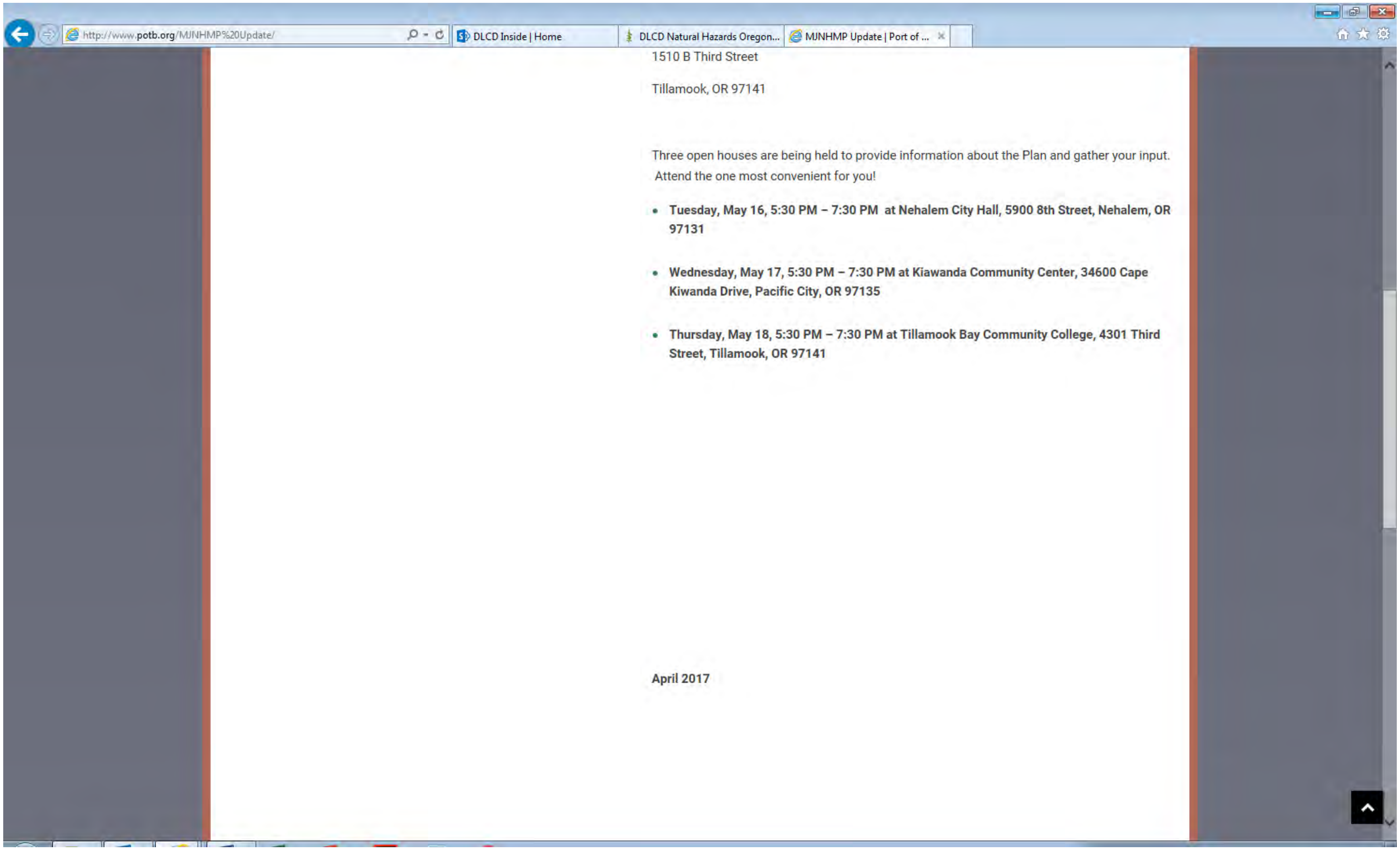
Please email your comments to bchaix@co.tillamook.or.us or mail them to:

Tillamook County Department of Community Development

Attn: Barrett Chaix

1510 B Third Street

Tillamook, OR 97141



http://www.potb.org/MJNHMP%20Update/

DLCD Inside | Home

DLCD Natural Hazards Oregon...

MJNHMP Update | Port of ...

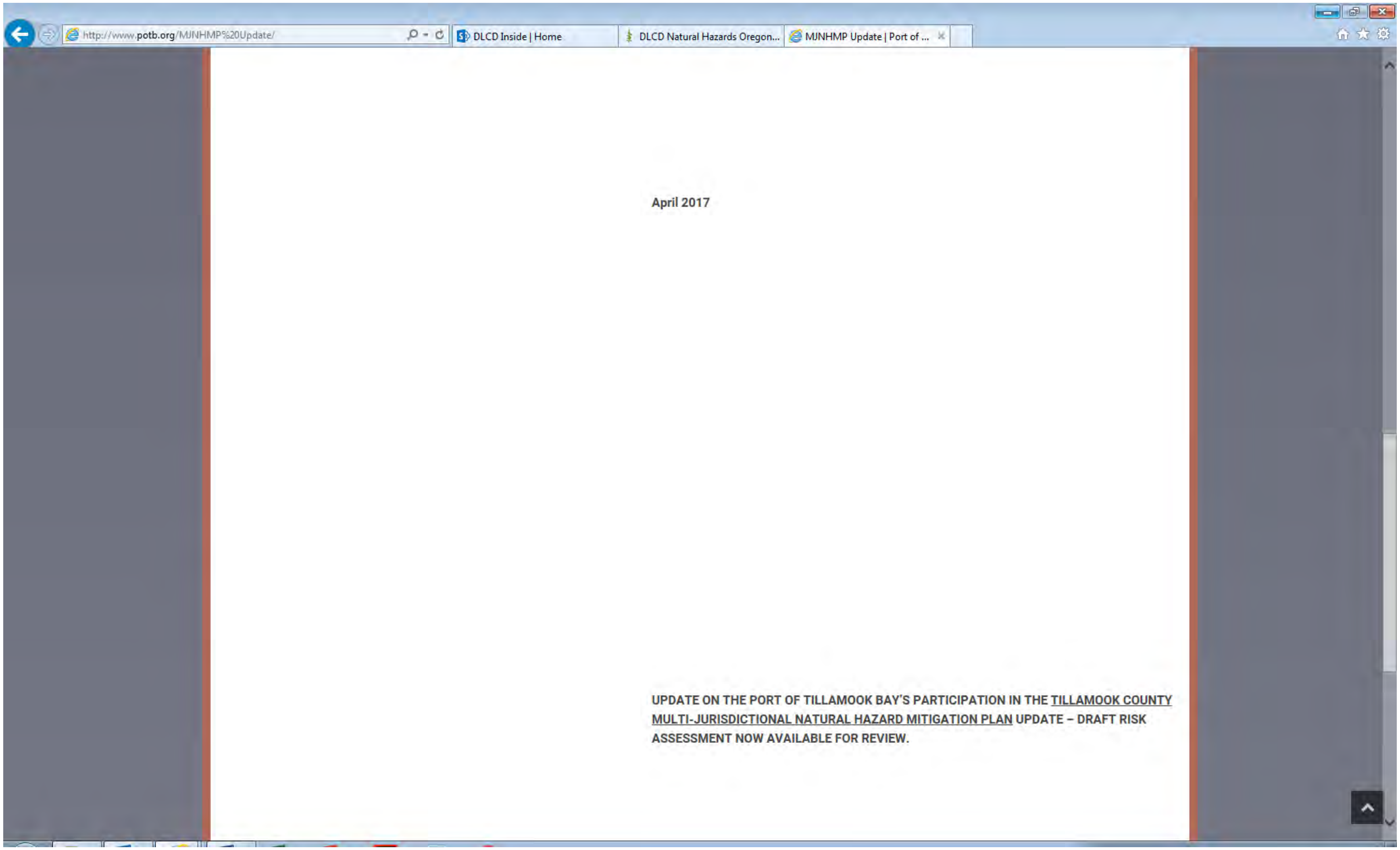
1510 B Third Street

Tillamook, OR 97141

Three open houses are being held to provide information about the Plan and gather your input. Attend the one most convenient for you!

- **Tuesday, May 16, 5:30 PM – 7:30 PM at Nehalem City Hall, 5900 8th Street, Nehalem, OR 97131**
- **Wednesday, May 17, 5:30 PM – 7:30 PM at Kiawanda Community Center, 34600 Cape Kiwanda Drive, Pacific City, OR 97135**
- **Thursday, May 18, 5:30 PM – 7:30 PM at Tillamook Bay Community College, 4301 Third Street, Tillamook, OR 97141**

April 2017



http://www.potb.org/MJNHMP%20Update/

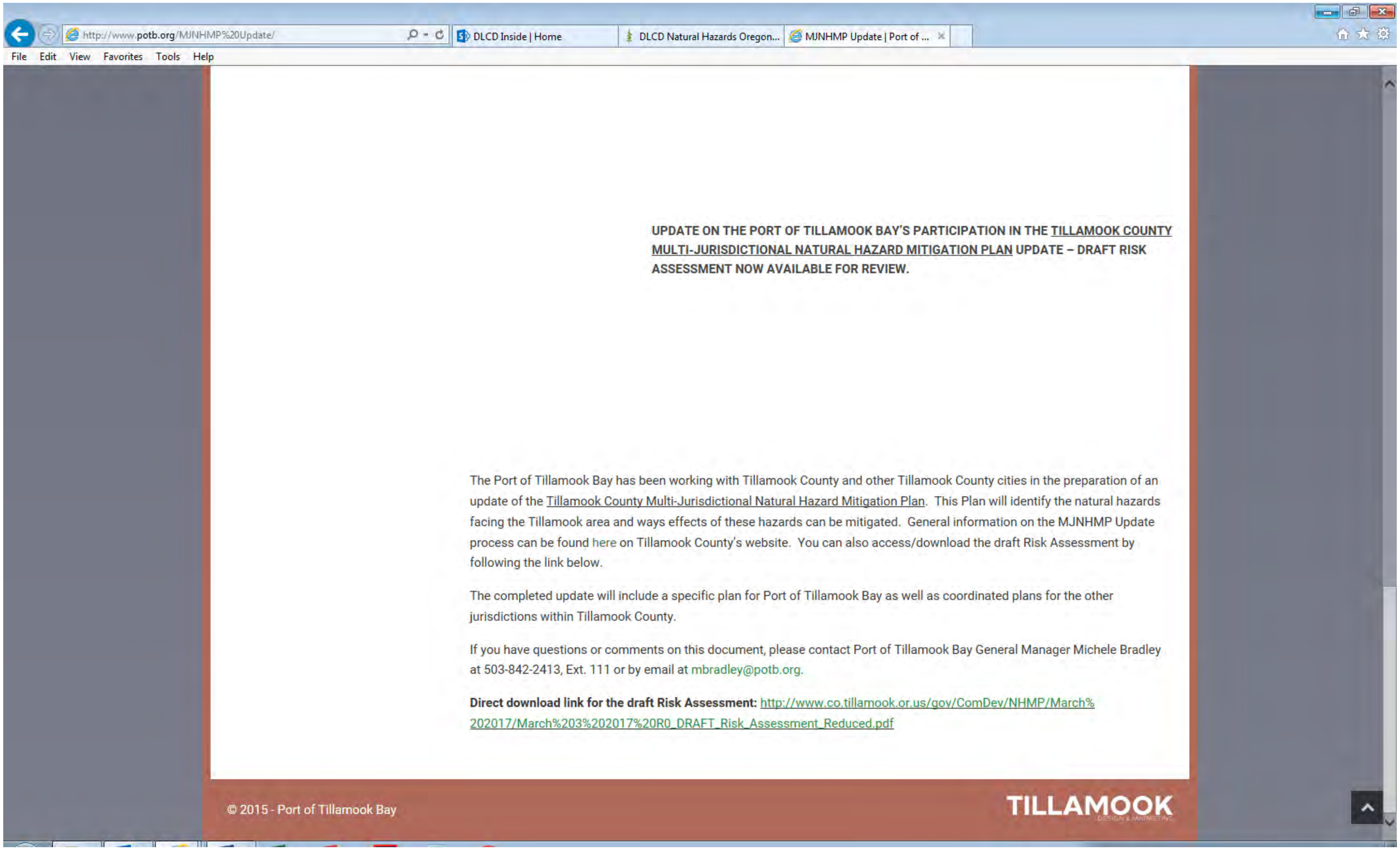
DLCD Inside | Home

DLCD Natural Hazards Oregon...

MJNHMP Update | Port of ...

April 2017

UPDATE ON THE PORT OF TILLAMOOK BAY'S PARTICIPATION IN THE TILLAMOOK COUNTY MULTI-JURISDICTIONAL NATURAL HAZARD MITIGATION PLAN UPDATE – DRAFT RISK ASSESSMENT NOW AVAILABLE FOR REVIEW.



UPDATE ON THE PORT OF TILLAMOOK BAY'S PARTICIPATION IN THE TILLAMOOK COUNTY MULTI-JURISDICTIONAL NATURAL HAZARD MITIGATION PLAN UPDATE – DRAFT RISK ASSESSMENT NOW AVAILABLE FOR REVIEW.

The Port of Tillamook Bay has been working with Tillamook County and other Tillamook County cities in the preparation of an update of the Tillamook County Multi-Jurisdictional Natural Hazard Mitigation Plan. This Plan will identify the natural hazards facing the Tillamook area and ways effects of these hazards can be mitigated. General information on the MJNHMP Update process can be found here on Tillamook County's website. You can also access/download the draft Risk Assessment by following the link below.

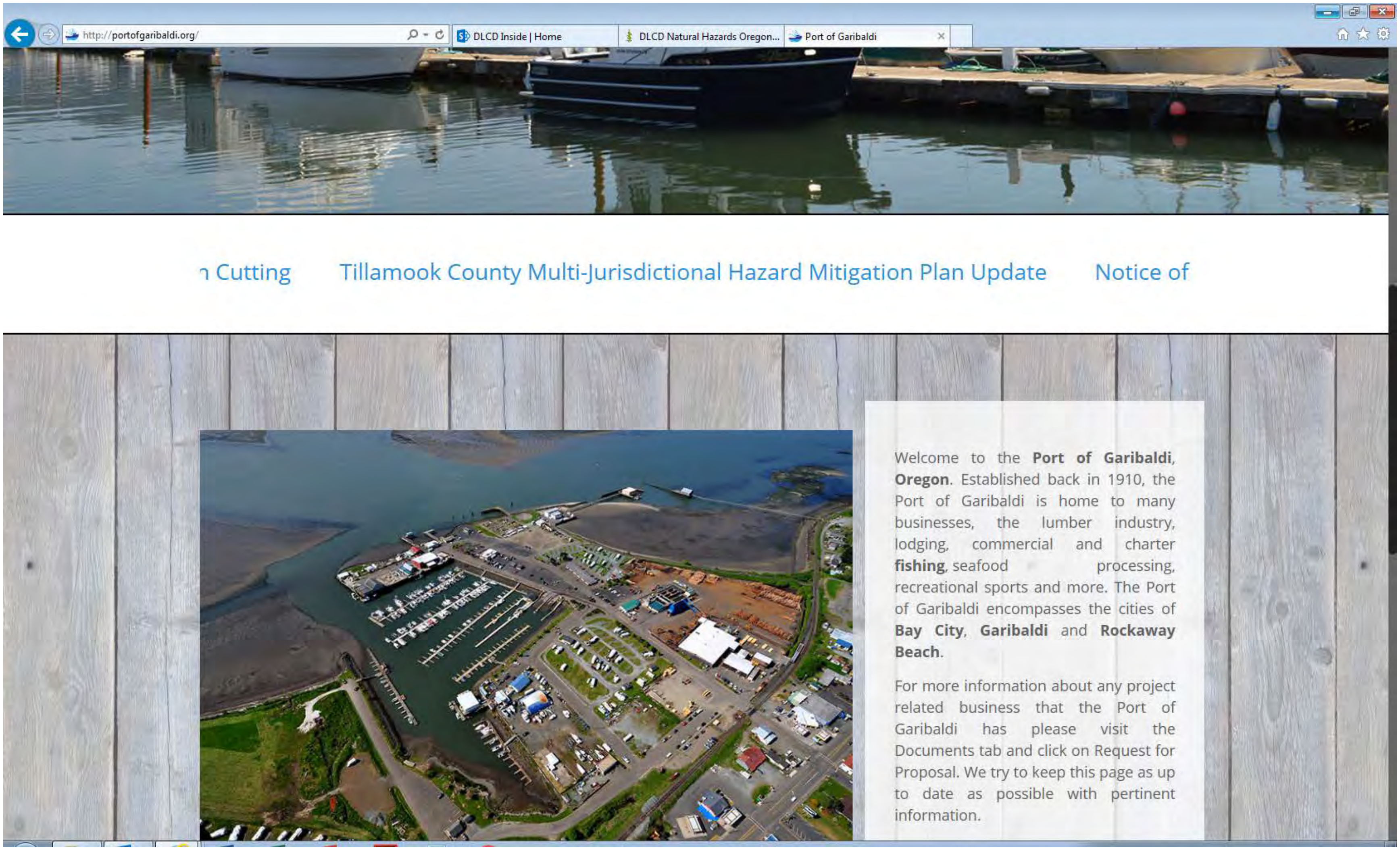
The completed update will include a specific plan for Port of Tillamook Bay as well as coordinated plans for the other jurisdictions within Tillamook County.

If you have questions or comments on this document, please contact Port of Tillamook Bay General Manager Michele Bradley at 503-842-2413, Ext. 111 or by email at mbradley@potb.org.

Direct download link for the draft Risk Assessment: http://www.co.tillamook.or.us/gov/ComDev/NHMP/March%202017/March%203%202017%20R0_DRAFT_Risk_Assessment_Reduced.pdf

TILLAMOOK

Port of Garibaldi Website



Note: Link goes to Tillamook County website.

D. Approval Process

1. Approved Pending Adoption Letters

Jurisdiction	APA Letter Date
Tillamook County	
City of Bay City	
City of Garibaldi	
City of Manzanita	
City of Nehalem	
City of Rockaway Beach	
City of Tillamook	
City of Wheeler	
Port of Tillamook Bay	
Port of Garibaldi	

2. Signed Resolutions

Jurisdiction	Resolution (Y/N)	Date Signed
Tillamook County		
City of Bay City		
City of Garibaldi		
City of Manzanita		
City of Nehalem		
City of Rockaway Beach		
City of Tillamook		
City of Wheeler		
Port of Tillamook Bay		
Port of Garibaldi		

3. FEMA Final Approval Letters

Jurisdiction	Date Approved	Expiration Date
Tillamook County		
City of Bay City		
City of Garibaldi		
City of Manzanita		
City of Nehalem		
City of Rockaway Beach		
City of Tillamook		
City of Wheeler		
Port of Tillamook Bay		
Port of Garibaldi		

The End.