

Chapter 4.0

Risk Assessment

This Chapter is comprised of seven sections:

- 4.0 Risk Assessment Introduction
- 4.1 Earthquake Hazard Profile
- 4.2 Storm Hazard Profile
- 4.3 Flood Hazard Profile
- 4.4 Landslide Hazard Profile
- 4.5 Wildland Fire Hazard Profile
- 4.6 Volcanic Hazards Profile

This section introduces the basis for conducting a risk assessment, explains its role in informing the plan's mitigation strategy, and articulates how this chapter complies with the Disaster Mitigation Act. The section also describes all the hazards and threats that affect the planning area, and the hazard profile format and hazard analysis definitions to orient the reader to each hazard profile's contents.

Sections 4.1 through 4.6 contain the individual hazard profiles, with detailed information about the six major hazards that constitute the risk assessment.

Risk Assessment Introduction

The Federal Emergency Management Agency (FEMA) states, "Risk, for the purpose of hazard mitigation planning, is the potential for damage, loss, or other impacts created by the interaction of hazards with community assets."

For multi-jurisdictional hazard mitigation plans, each participating community must evaluate the potential impacts of hazards within the planning area and determine its overall vulnerability to those hazards, as those risks are unique to each

Community risk from hazards (FEMA Local Mitigation Planning Handbook).



community and must be addressed. The risk assessment covers both the entire planning area and provides details, where available, for each community within the planning area.

The plan followed the “Local Mitigation Planning Handbook” (FEMA, 2013) to compile a comprehensive risk assessment of the major natural hazards that threaten the Thurston Region. This chapter provides the factual basis for communities to develop effective mitigation strategies. 44CFR Section 201.6(c)(2) of the Disaster Mitigation Act’s (DMA) planning regulation identifies the specific requirements needed in the risk assessment. The regulatory requirements of the risk assessment serve as a useful checklist for preparing a comprehensive and meaningful summary of the hazards the region faces. Section 201.6(c) risk assessment planning requirements are as follows: ¹

(2) ... Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards. The risk assessment shall include:

(i) A description of the type, location, and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.



(ii) A description of the jurisdiction’s vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. All plans approved after October 1, 2008 must also address NFIP insured structures that have been repetitively damaged by floods. The plan should describe vulnerability in terms of:

(A) The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas;

(B) An estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate;

(C) Providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

(iii) For multi-jurisdictional plans, the risk assessment section must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

In general, the Federal DMA planning requirements with the words “**shall**” and “**must**” indicate that the item is mandatory and must be included in the plan, otherwise it will not be approved by FEMA. Regulations with the word “**should**” indicate that the item is strongly recommended to be included in the plan, but its absence will not cause FEMA to disapprove the plan.

Federal Disaster Declarations

Communities subject to emergencies resulting from hazards supply the first line of defense. The federal government issues disaster declarations under the Stafford Act when local and state government combined response capabilities cannot address major emergencies. Federal declarations activate a variety of federal funding programs to assist communities, businesses, and individuals with recovery. Hazard mitigation assistance grants are made available to states through the Disaster Mitigation Act following declarations and are a chief source of funding for developing hazard mitigation plans and mitigation projects. Washington State has received 52 major federal disaster declarations since 1956².



Photo courtesy Thurston County.

Thurston County has received 22 declarations, six issued since the region’s Hazard Mitigation Plan was first adopted in October 2003. Table 4.0.2 lists the Federal Disaster Declarations that have included Thurston County.

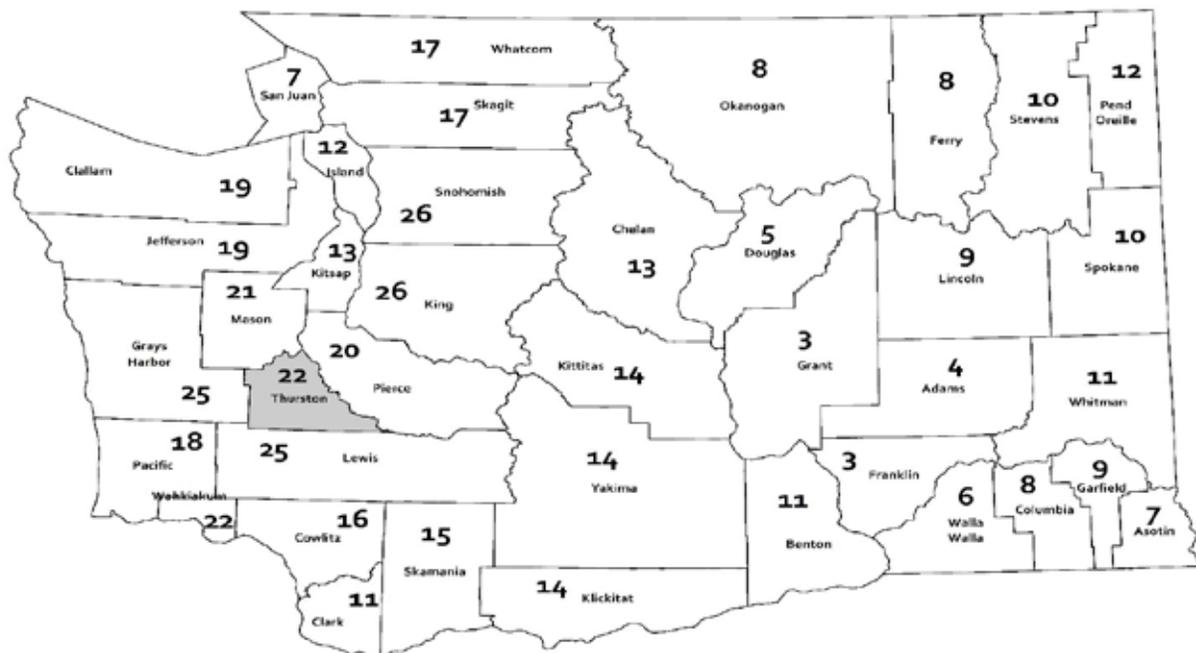
Table 4.0.2: Thurston County Federal Disaster Declarations, 1965 to 2016

Disaster Number	Declaration Date	Incident Type	Title
196	May-1965	Earthquake	Earthquake
322	Feb-1972	Flood	Severe storms & flooding
328	Mar-1972	Flood	Heavy rains & flooding
414	Jan-1974	Flood	Severe storms, snowmelt & flooding
492	Dec-1975	Flood	Severe storms & flooding
545	Dec-1977	Flood	Severe storms, mudslides, & flooding
623	May-1980	Volcano	Volcanic eruption, Mt. St. Helens
852	Jan-1990	Flood	Severe storms & flooding
883	Nov-1990	Flood	Severe storms & flooding
981	Mar-1993	Severe Storm(s)	Severe storms & high wind
1079	Jan-1996	Severe Storm(s)	Severe storms, high wind, and flooding
1100	Feb-1996	Flood	High winds, severe storms and flooding
1159	Jan-1997	Severe Storm(s)	Severe winter storms, land & mudslides, flooding
1172	Apr-1997	Flood	Heavy rains, snow melt, flooding, land & mud slides
1361	Mar-2001	Earthquake	Earthquake
1499	Nov-2003	Severe Storm(s)	Severe storms and flooding
1671	Dec-2006	Severe Storm(s)	Severe storms, flooding, landslides, and mudslides
1682	Feb-2007	Severe Storm(s)	Severe winter storm, landslides, and mudslides
1734	Dec-2007	Severe Storm(s)	Severe storms, flooding, landslides, and mudslides
1817	Jan-2009	Flood	Severe winter storm, landslides, mudslides, and flooding
1825	Mar-2009	Severe Storm(s)	Severe winter storm and record and near record snow
4056	Mar-2012	Severe Storm(s)	Severe winter storm, flooding, landslides, and mudslides

The number and frequency of federal disaster declarations affecting Thurston County paints a picture of the risks that natural hazards pose to the region. The following statistics highlight the frequency of major natural disaster in Thurston County:

- Between 1965 and 2016, Thurston County has received 22 federal disaster declarations.
- Only 147 counties or U.S. Census designated places have received 20 or more federal disaster declarations; only four percent of counties or U.S. places share this distinction.
- As of 2016, eight counties in Washington State have experienced 20 or more disaster declarations. Thurston County and Wahkiakum County are tied for having the 5th highest rate of declarations in the state.

Figure 4.1: Federal Disaster Declarations by Counties in Washington State, 1956 to June 2016



Hazard Identification

Communities in Thurston County are subject to a wide variety of natural hazards and human-induced threats. Some communities face greater risks than others simply due to their location and environmental conditions. This section presents an overview of the hazards and threats, not profiled in the risk assessment, that occur in the planning area or have a likelihood of affecting the Thurston Region.

The plan uses several sources to identify the hazards that threaten the Thurston Region, principally Thurston County's and other local jurisdictions' Hazard Identification and Vulnerability Analysis (HIVA) reports and the Washington State Enhanced Hazard Mitigation

Plan (2013). Other sources include the National Climate Data Center, the Hazards and Vulnerability Research Institute, the National Weather Service, the United States Geological Survey, FEMA, and the Washington State Departments of Natural Resources and Ecology.

Critical Shortage – Critical shortage is the lack or reduction of essential goods or services due to a disruption in their supply caused by events that occur elsewhere. These events may include embargoes, strikes, natural disasters, epidemics, crop failures, over exploitation of a natural resource, terrorist activities, or political unrest. For example, a fuel shortage would greatly impact the nation's economy.



Cyber-Attack – A cyber-attack is an offensive maneuver against individuals or organizations that targets computer information systems, infrastructure, networks, or personal devices. These attacks attempt to disable operations, steal information, or hold systems ransom. They may be launched by nation states, criminal organizations, or hackers acting with malicious intent. Local government infrastructure such as signal controllers, water systems, and other utilities that are controlled remotely by computers may be at risk.

Dam Failure – There are 38 dams in or adjacent to Thurston County. The Washington Department of Ecology Dam Safety rates each dam’s Downstream Hazard Classification to provide a simple characterization of the setting downstream of a dam to reflect the general nature of consequences if the dam were to fail and release the reservoir into the downstream valley. Three dams are classified as high hazard dams in the county, Alder and LaGrande Dams on the Nisqually River and the Skooumchuck Dam, on the Skookumchuck River. Table 4.0.3 shows the Downstream Hazard Classification of Thurston County dams.

Dam failures can be caused by major floods or an earthquake, but they are also subject to failure from poor construction, operation, maintenance, or repair. The effects of a dam failure are highly variable depending on the dam, the amount of water stored behind the dam, the current stream flow, and the size and proximity of the downstream population. Some of the effects of a major dam failure include loss of life, destruction of homes and property, damage to roads, bridges, powerlines, and other infrastructure, loss of power generation and flood control capabilities, disruption of fish stock and spawning beds, and the erosion of stream and river banks.

The three high hazard dams in the county are well-maintained and comply with current dam safety regulations. Thurston County has not experienced a major dam failure, and the Hazard Inventory and Vulnerability Analysis report has assigned a low risk rating to the

Table 4.0.3: Downstream Hazard Classification of Thurston County Dams

Dam	Classification	Rating
Alder Dam; and Skookumchuck Dam	1A	High – Greater than 300 lives at risk
LaGrande Dam	1B	High – From 31 to 300 lives at risk
All other Dams	39	Low – No lives at risk

other 35 dams. However, in the event of a failure, each of the three dams could affect a population of 300 or more, inundate major transportation routes and industries, and cause long-term effects on water quality and wildlife. The high hazard dams in Thurston County are operated for electrical power generation and are licensed by the Federal Energy Regulatory Commission. Accordingly, they are inspected regularly and staffed 24 hours a day. If a dam were to show signs of failure, dam operators would initiate their emergency action plans and notify emergency management personnel and evacuation procedures would be implemented.

Refer to the Volcanic Hazard Profile for dam failure attributed to a catastrophic lahar. More information regarding Alder and LaGrande Dam failure can be found in Tacoma Power's "Emergency Action Plan for the Nisqually Hydroelectric Project." For the Skookumchuck Dam, refer to TransAlta's "Skookumchuck Dam Emergency Action Plan".

Drought – Drought is a condition of climatic dryness severe enough to reduce soil moisture levels and water levels below the minimum necessary for sustaining plant, animal, and human life systems. While there were no major losses during Thurston County's drought conditions in 2015, there were reports of some residential wells drying up and the death of countless immature trees. Climate change projections for the Puget Sound Region indicate that longer, warmer, and drier summers will become the norm by mid-century. Drought can destroy or lower crop yields, impact fish habitat, and increase risk for wildland fires.

Epidemic – Epidemics are outbreaks of disease that affect or threaten to affect a significant portion of a population in a relatively short period of time. Although usually referring to a human contagious disease, epidemics can also affect domestic and wild animals and crops. Epidemic diseases such as influenza, West Nile Virus, and the Zika Virus are usually introduced into an area from remote regions and inflict devastation because of a lack of natural or induced immunity.

Hazardous Material Incident – Hazardous materials include chemicals used in manufacturing, household chemicals, crude oil and petroleum products, pesticides, herbicides, fertilizers, paints, medical wastes, radioactive materials, and a host of other substances. Their manufacture, transport, storage, use, and disposal place public property and the environment at risk from their inadvertent or intentional release. Local communities have little to no knowledge of when and what type of hazardous materials are being transported by highways or railroads through Thurston County.

Heat Wave – A heat wave is characterized by five or more consecutive days of unusually hot weather. Locally, the National Weather Service considers 90 degrees or higher as hot weather. Prolonged periods of extreme temperatures can result in heat injuries or dehydration for the young, elderly, and people who work outdoors. Heat waves are expected to become more frequent as warmer summers increase from the effects of climate change.

Space Weather/Solar Wind/Geomagnetic Storm – The behavior and energy output of the sun varies according to its 11-year cycle. A coronal mass ejection or other solar phenomena can release magnetic storms that can severely disrupt and damage electrical distribution systems and electric devices on Earth. Some examples: In March 1989, a current surge induced by the changing magnetic fields at ground level affected transformers at power stations in Canada. The surge led to power blackouts throughout Quebec that lasted for several hours, and the power company lost more than 21,500 megawatts of its production capacity. An induced current fatally damaged a transformer at a nuclear-power plant in New Jersey.

Terrorist Attack – Terrorism is the force or violence against persons or property violating the criminal laws of the United States for purposes of intimidation, coercion, or ransom. Terrorists often use threats to create fear among the public; try to convince citizens that their government is powerless to prevent terrorism; and try to garner publicity for their causes. Bombings and mass shootings are the most frequently used terrorist methods in the United States. Other possibilities include attacks upon transportation facilities, utilities, or other public services, or an incident involving chemical or biological agents.



Tsunami – A tsunami is an incredibly destructive sea wave of extremely long length generated by a seismic disturbance (earthquake, volcanic eruption, or debris slide) below or on the ocean floor. Wave lengths may exceed sixty miles and travel 300-600 mph. They can be of local or distant origins such as Alaska or Japan. It is unlikely that Thurston County would be directly impacted by such a tsunami, as the wave energy would be depleted by the time it reaches the South Sound. However, the county could be indirectly affected by tsunami impacts to communities on the coast.

Hazard Profiles

The plan includes detailed profiles of hazards that pose the greatest risk to the planning area. Each hazard profile documents each of the following criteria. There is:

1. A high probability of the natural hazard occurring in Thurston County within the next 25 years
2. The potential for significant damage to buildings and infrastructure; and/or
3. The potential for loss of life.

The following hazards meet one or more of the above criteria. Every hazard profile was evaluated and updated during the plan update process.

Hazard	Probability of Occurrence	Vulnerability	Risk
Earthquake	High	High	High
Storm	High	High	High
Flood	High	Moderate	High
Landslide	High	Low	Moderate
Wildland Fire	High	Moderate	Moderate
Volcanic Events	Low	High	Moderate

Contents

The Hazard Profiles in sections 4.1 through 4.6 address the DMA Risk Assessment Planning Requirements identified in the introductory section of this chapter: hazard definitions, causes, sources, severity, effects and impacts, probability of occurrence, historical occurrences, geographic extent or delineation, and the portion of the population, assets, and essential facilities potentially exposed to the hazard. The information is presented for general audiences and includes figures, maps, and tables.

A variety of sources, including local, state, and federal government staff, scientists, plans, scientific journals, newspaper articles, federal and state agency websites, and other online data sources informed development of the hazard profiles. Endnotes are provided. The narrative identifies some gaps where sections in the profile may lack sufficient information and data to adequately address some of the required components of the risk assessment.

Severity: Severity describes or measures the strength or magnitude of hazard elements or hazard events. For example, wind speed can

be measured in miles per hour, temperatures in degrees Fahrenheit, snow depth accumulations in inches and, earthquakes in magnitude. Severity can also describe the duration or spatial extent of a hazard effect. Severity is an important factor for assessing vulnerability.

Impacts: Descriptions of the adverse physical, economic, environmental, and social consequences resulting from the effects of natural hazards, based on both actual past events in the planning area or in Washington State as well as potential effects.

Probability of Occurrence: Probability is an important component for evaluating risk. This statistical measure articulates the likelihood of a hazard event occurring during a specific time period such as annually, every 25 years, or for a specific period of recorded observations. The plan describes probability in both numeric and qualitative terms. Numerically it is expressed by the ratio of the number of actual occurrences to the total number of possible occurrences. The summary assessment (see below) considers probability for a 25-year interval.

Historical Occurrences and Impacts: Past events reveal the type and extent of losses that communities can expect from future disaster events. This section includes a chronological listing of notable events that impacted Thurston County and the Pacific Northwest. While not an exhaustive list of past events, it offers sufficient representation of the type, location, extent, and specific consequences.

*Find information about the data and procedures used to develop the risk assessment in **Appendix C.***

Delineation of Hazard Area: This is a description of the geographical extent of the hazard area based on the hazard profile such as special flood hazard areas, liquefaction zones, and lahar inundation zones, and which communities are most vulnerable to a hazard. Geographical extent is also depicted on one or more countywide maps for every hazard except for the Storm Hazard Profile. Each participating jurisdiction's annex will include community-level maps. The portion of each jurisdiction's area exposed to the hazards are summarized in tables.

Population and Employment in the Hazard Area: Each profile includes several tables that summarize an aspect of current and future planning-level hazard exposure including population, employment, and residential dwelling units. Chapter 3, Thurston County Community Profile, contains more information about population and growth trends. Since the entire county is vulnerable to the effects of storm damage, the plan omits exposure data for storm hazards. Total population affected by storm can be inferred from the "total" columns from the other hazard profiles.

Inventory of Assets and Dollar Value in the Hazard Area: Tabular data reflects a planning-level number of existing and future structures which are potentially impacted by the hazards. An estimate of structure and building contents' value is also included to provide information on potential dollar losses. The plan provides estimates of buildings' value by residential, commercial/industrial, and government/institutional for each hazard. The values in the

tables represent the sum of both the building replacement and content replacement values. Tables are provided by jurisdiction for the years 2015 and 2040. Data for storm are not included as the entire county is vulnerable to the effects of storms. Total assets affected by storm can be inferred from the "total" columns from the other hazard profiles.

Essential Facilities in Hazard Area: Hazards can destroy or damage facilities that may be critical for responding to the disaster and for maintaining a safe environment and public order. Nearly 1,300 public and private essential facilities in Thurston County are inventoried in a Geographical Information System. Planning-level estimates on the types and quantities of



Photo courtesy Steve North.

essential facilities that occur in hazard areas is summarized in a table within each profile. Thurston County Emergency Management maintains specific information about the location of critical facilities and infrastructure.

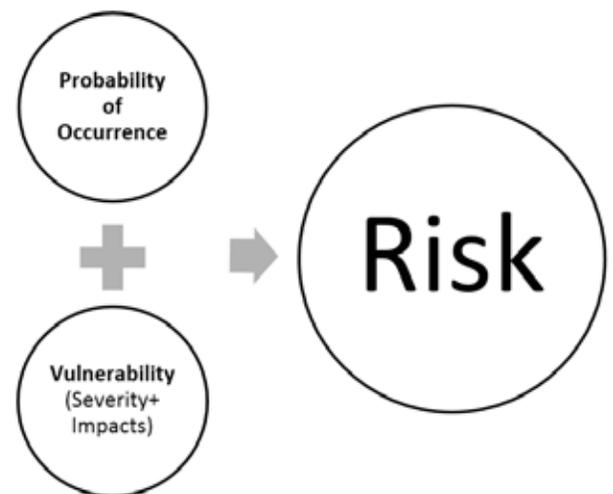
Summary Assessment: An overall risk is assigned to each hazard in the profiles. Each hazard's risk is based on a subjective examination of that hazard's probability of occurrence combined with the region's overall vulnerability to the hazard. A 25-year recurrence interval is the basis for examining a hazard's probability of occurrence. This interval approximates the communities' established forecast horizon for long-range planning, and is within a recurrence interval for a major earthquake, the hazard presenting the greatest risk to Thurston County.

Hazard Analysis Definitions

The Thurston Region Hazard Mitigation Plan uses a subjective risk measurement process based on Thurston County's Hazard Inventory and Vulnerability Assessment or HIVA. This methodology rates elements of each hazard's risk characteristics using the descriptors high, moderate, and low. These descriptors are applied to the hazards' probability of occurrence, vulnerability, and overall risk. The following is an overview of this risk measurement model:

Risk Rating: A description (high, moderate, or low) of the subjective estimate of the combination of any given hazard's probability of occurrence and the region's vulnerability to the hazard.

- High – There is strong potential for a disaster of major proportions.
- Moderate – There is medium potential for a disaster of less than major proportions.
- Low – There is little potential for a disaster.



Probability of Occurrence: A description (high, moderate, or low) of the probability of a hazard impacting Thurston County within the next 25 years.

- High – There is great likelihood that a hazardous event will occur within the next 25 years.
- Moderate – There is medium likelihood that a hazardous event will occur within the next 25 years.
- Low – There is little likelihood that a hazardous event will occur within the next 25 years.

Vulnerability: A description (high, moderate, or low) of the potential impact a hazard could have on Thurston County. Vulnerability can be expressed as a combination of the severity of a hazard’s effect and its consequential impacts to the community. It considers the population, property, commerce, infrastructure, and services at risk relative to the entire county.

- High – The total population, property, commerce, infrastructure, and services of the county are uniformly exposed to the effects of a hazard of potentially great magnitude. In a worst case scenario, there could be a disaster of major to catastrophic proportions.
- Moderate – The total population, property, commerce, infrastructure, and services of the county are exposed to the effects of a hazard of moderate influence; or the total population, property, commerce, infrastructure, and services of the county are exposed to the effects of a hazard of moderate influence, but not

all to the same degree; or an important segment of population, property, commerce, infrastructure and services of the county are exposed to the effects of a hazard. In a worst case scenario, a disaster could be moderate to major, but not catastrophic, proportions.

- Low – A limited area or segment of population, property, commerce, infrastructure, or service is exposed to the effects of a hazard. In a worst case scenario, there could be a disaster of minor to moderate proportions.

Community Variations to the Risk Assessment

Each planning partner describes where or how their risk varies from what is described in the hazard profiles. Variations are documented in the risk assessment section in their annex to the plan, if appropriate.

Endnotes

¹ 44 Code of Federal Regulations § 201.6(c)(2). Local Mitigation Plans.

² FEMA. 2016. Disaster Declarations by State/Tribal Government. Data obtained online: <https://www.fema.gov/disasters/grid/state-tribal-government>.

