| Hazard Type |
| --- |
| FLOOD |
| Probability of Occurrence |
| HIGH |
| Vulnerability |
| MODERATE |
| Risk |
| HIGH |

# Chapter 4.3
# Flood Hazard Profile

## Introduction

Floods in Thurston County are common, and on an annual average basis, are the costliest natural hazard. Between 1962 and 2016, Thurston County received 18 federal disaster declarations related in some part to the adverse effects of flooding. Total countywide flood damage estimates over this period exceed $206 million.[1] The February 1996 flood cost uninsured private property owners in Thurston County losses of more than $22 million. Statewide, the Federal Emergency Management Agency (FEMA) has provided over $72 million in aid to flood victims, businesses, and local governments for the December 2007 floods and over $12.8 million for the January 2009 floods.

Comprehensive flood hazard management must address an entire watershed because rivers and their flood plains span multiple administrative boundaries. Activities outside of Thurston County's border such as forestry, development, and stormwater management practices can adversely influence the severity of flooding in communities downstream within the county. Flood hazard management is a complex process that must balance resource protection, natural ecological functions, flood damage protection, and community growth and development.

This flood hazard profile presents an overview of the sources, effects, risks, and a summary of historical incidents. In 2012 and 2016, Thurston County completed flood scenario modeling using a Geographical Information System (GIS) software tool, HAZUS, to estimate the effects of flooding and potential losses and impacts to Thurston County. This profile includes the results of this modeling from the *Thurston County Flood Hazard Mitigation Plan* and more recent analysis as part of a FEMA RISK MAP process. In addition, GIS hazard exposure data is shown for the incorporated and unincorporated portions of Thurston County, including local government and non-government essential facilities potentially at risk to floods.

# Hazard Identification

In general, a flood is a temporary condition in which a normally dry area of land or infrastructure is inundated by excess standing or flowing water. Floods can occur during any season and at any time. Four principal sources of flooding impact Thurston County and are addressed individually in this hazard profile:

1. Riverine (river and stream)
2. Groundwater
3. Tidal
4. Urban

# 1. Riverine Flooding

Rivers and their floodplains are dynamic systems that perform important ecological functions, benefitting both wildlife and humans. Attempts to control floods by altering the physical characteristics of rivers and flood plains with dams, levees, or other flood control facilities, result in the loss, alteration, or significant reduction in the intrinsic ecological benefits these systems offer.

Flooding is a natural function of rivers, with their effects supporting productivity of wildlife and potentially increasing the fertility of farmlands within flood plains. Communities must balance the need to preserve the natural functions of floodplains with the need to protect property and human activities. Understanding how, when, and where to expect flood impacts is a first step in developing a mitigation strategy to minimize losses from floods and to protect the environment.

Riverine flooding occurs when excess flow and volume of water crests a river channel's normal capacity. Floodwaters consequently inundate areas within the river's floodway, flood plain, and other low lying areas that may not be mapped as flood hazard areas.

## Cause of Riverine Flooding

Two to three days of prolonged rainfall, averaging two to five inches per day, a rapidly melting snow pack, or a combination of these conditions trigger such floods. The actual duration and rainfall amount needed to cause flooding depends on the initial condition of the river or stream, and groundwater and runoff conditions. The Nisqually River and the Chehalis River's extensive watersheds are subject to events outside the county that influence flooding downstream in the county.

Thurston County hydrological research reveals increased rainfall intensity in the region in the last two decades. The county continues to analyze stream flow and precipitation gauge data from its own network of monitoring stations, as well as the National Weather Service and United States Geological Survey (USGS) data. This research provides clues about the types of precipitation patterns that trigger small stream, riverine, and shallow groundwater basin flooding in the county. Initial findings reveal that six precipitation patterns appear to affect peak flood flow pulses in small Thurston County streams and shallow groundwater basins. These heavy rainfall scenarios have occurred within the last two decades (1998-2016) – some more than once. The precipitation patterns also correlate with larger river flood events. The previous five decades of the Olympia rainfall record show only one, two or three of the identified scenarios per decade.

Late wet season precipitation patterns seem to have the most significant effect on groundwater flooding and deep seated landslide susceptibility. Saturation of the subsurface soils peaks in March here. Any additional rainfall during this natural high water mark tends to rapidly overwhelm the remaining horizontal groundwater flow component in near-saturated soils.[2] Table 4.3.1 shows the precipitation patterns that cause major flood events on stream and rivers.

## Table 4.3.1: Six Rainfall Patterns that influence Puget Sound Stream Flooding in Thurston County

<table>
<tr><th>Pattern</th><th>Description</th><th>Example</th></tr>
<tr><td>1</td><td>Early or late wet season rainfall (greater than 3-inch daily storm events) in October (Horton Overland Flow) or prolonged, above average rain in October or March and April</td><td>October 20, 2003: 4.14” storm event;<br>October 2, 1981: 3.56” storm event;<br>September – early October 2013 (September record rainfall);<br>March –April 2016 (prolonged well above average rainfall);<br>October –November 2016 (October record rainfall; November prolonged well-above average)</td></tr>
<tr><td>2</td><td>Five or six consecutive days of greater than 1-inch storm events punctuated by a greater than 2.5-inch storm event in the same series</td><td>November 2, 2006, 1.08”<br>November 3, 2006,1.02”<br>November 4, 2006, 1.5”<br>November 5, 2006, 1.88”<br>November 6, 2006, 4.31”<br>November 7, 2006, 1.02”</td></tr>
<tr><td>3</td><td>Two or more consecutive days of greater than 2-inch daily storm events</td><td>2007:<br>December 2, 2.2”;<br>December 3, 3.19”</td></tr>
<tr><td>4</td><td>Greater than 4-inch daily storm events (high landslide potential)</td><td>January 7, 2009, 4.82 inches<br>November 6, 2006, 4.31 inches<br>October 20, 2003, 4.14 inches<br>November 19, 1962, 4.25 inches</td></tr>
<tr><td>5</td><td>Three or more consecutive months of at or greater than 11-inch monthly totals (larger potential for ground water flooding in key basins)</td><td>Monthly Totals
<table>
<tr><th>Years</th><th>Nov</th><th>Dec</th><th>Jan</th><th>Feb</th></tr>
<tr><td>1955 – 1956</td><td>12.18</td><td>12.59</td><td>10.75</td><td></td></tr>
<tr><td>1973 – 1974</td><td>12.95</td><td>11.61</td><td>10.57</td><td></td></tr>
<tr><td>1998 – 1999</td><td>15.28</td><td>12.99</td><td>12.25</td><td>15.5</td></tr>
<tr><td>2001 – 2002</td><td>13.01</td><td>11.86</td><td>11.42</td><td></td></tr>
</table></td></tr>
<tr><td>6</td><td>A greater than 15-inch monthly total</td><td>November, 2006, 19.68”<br>February, 1999, 15.5”<br>November, 1998, 15.28”<br>November, 1990, 15.06”<br>November, 1964, 15.00”<br>November, 1962, 15”<br>January, 1953, 19.84”</td></tr>
</table>

## Severity

Many factors influence the severity of riverine flooding such as the pre-existing condition of the ground water saturation levels, the topography and size of the watershed, freezing level, and the influence of human activity on the landscape (total amount of impervious surface, stormwater management, and other large-scale land uses such as logging). Thurston County Emergency Management issues three levels of flood severity to monitor flood stages and notify the public:

1. **Minor flooding (or flood stage):** A river exceeds bank-full conditions at one or more locations, generally flooding fields and forests. Some roads may be covered but passable. There may be enhanced erosion of some river banks.
2. **Moderate flooding:** Individual residential structures are threatened and evacuation is recommended for selected properties. Some roads may be closed. Moderate damage may be experienced.
3. **Major flooding:** Neighborhoods and communities are threatened and evacuation is recommended for residents living on specified streets, in specified communities or neighborhoods, or along specified stretches of river. Major thoroughfares may be closed and major damage is expected.

Thurston County Emergency Management identifies flood severity thresholds based on stream flow rates and gauge heights for the Deschutes, Chehalis, Nisqually, and Skookumchuck rivers using select gauges in the region (no USGS gauges are established on the Black River). Rivers are dynamic and all channels are subject to dimensional changes over time due to factors such as sediment and coarse woody debris deposition, and channel migration and braiding. Therefore, a direct comparison of flood events between years or decades for any given river based on flood gauge heights will vary.

The principal factors affecting flood damage are flood depth and velocity. The deeper and faster flood flows become, the greater the potential for damage and adverse impacts. Shallow flooding with high velocities is also capable of causing damage, as is deep flooding with slow velocity. This is especially true when a channel migrates over a broad floodplain, redirecting high velocity flows and transporting debris and sediment. Flood severity is often evaluated by examining peak discharges. Table 4.3.2 lists peak flows FEMA uses to map the floodplains of the planning area.

## Table 4.3.2: Summary of Peak Discharges of Streams and Rivers within Thurston County

| | | | Discharge (cubic feet/second) | | | |
|---|---|---|---|---|---|---|
| Source | Location | Drainage area (sq. mi.) | 10-Year | 50-Year | 100-Year | 500-Year |
| Black River | At County limits | 124 | 2,820a | 4,100a | 4,940a | 6,790 |
| | Downstream of confluence with Beaver Creek | 99 | 1,550 | 2,220 | 2,490 | 3,200 |
| | Downstream of confluence with Waddell Creek | 58.7 | 1,250 | 1,770 | 2,000 | 2,560 |
| | Outlet of Black Lake - At Black Lake | 5 | 210 | 303 | 342 | 431 |
| Chehalis River | U.S. Geological Survey Gauge #12027500 near Grand Mound | 895 | 38,600 | 50,100 | 55,000 | 66,600 |
| Deschutes River | Downstream of Henderson Blvd. | 160 | 5,990 | 7,960 | 8,800 | 10,800 |
| | Upstream of confluence with Spurgeon Creek | 127 | 5,630 | 7,450 | 8,230 | 10,100 |
| | At Vail Loop Rd, Crossing | 89.8 | 4,950 | 6,500 | 7,150 | 8,690 |
| | Upstream of confluence with Mitchell Creek | 44.1 | 2,690 | 3,590 | 3,980 | 4,900 |
| | Upstream of limit of detailed study | 33.3 | 2,120 | 2,860 | 3,180 | 3,930 |
| Nisqually River | At Mouth | 711 | 21,500 | 29,000 | 33,000 | 45,000 |
| | Upstream of confluence with Horn Creek | 488 | 21,000 | 28,000 | 32,000 | 44,000 |
| | Upstream of Confluence with Tanwax Creek | 446 | 20,500 | 27,000 | 31,000 | 43,000 |
| Percival Creek | At Sapp Rd., SW | 1.8 | 94 | 128 | 145 | 180 |
| | At 54th Ave., SW | 0.5 | 33 | 45 | 50 | 62 |
| Scatter Creek | At downstream limit of detailed study | 15.5 | 403 | 561 | 633 | 803 |
| | At confluence with Scatter Creek tributary | 11.0 | 314 | 436 | 492 | 622 |
| | Upstream confluence with Scatter Creek tributary | 4.6 | 167 | 230 | 258 | 324 |
| | Scatter Creek Tributary - At confluence with Scatter Creek | 6.4 | 212 | 293 | 330 | 415 |
| | Scatter Creek Tributary - At State Route 507 | 10.3 | 66 | 90 | 102 | 126 |
| Skookumchuck River | At State Route 507 | 113 | 6,990 | 9,100 | 9,980 | 12,100 |
| | Upstream of Bucoda | 90.2 | 6,400 | 8,290 | 9,060 | 10,900 |
| | Upstream of confluence with Thompson Creek | 65.9 | 5,790 | 7,440 | 8,110 | 9,700 |
| Woodland Creek | At Pleasant Grade Rd., NE | 24.6 | 151 | 205 | 228 | 284 |
| Yelm Creek | From 1st St. to Centralia Canal | 11.2 | 220 | 310 | 350 | 445 |
| | From 103rd Ave. to 1st St. | 9.8 | 200 | 285 | 325 | 410 |
| | Upstream end of study reach, to 103rd Ave. | 9.3 | 185 | 265 | 300 | 375 |

a= Includes effect of overflow from Chehalis River

## Frequency of Riverine Floods

Floods are commonly described as having a 10-, 50-, 100-, and 500-year recurrence interval, meaning that floods of these magnitudes have (respectively) a 10-, 2-, 1-, or 0.2-percent chance of occurring in any given year. The frequency and severity of flooding are measured using a discharge probability, which is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels. The flood frequency equals 100 divided by the discharge probability. For example, the 100-year discharge has a one percent chance of being equaled or exceeded in any given year. The "annual flood" is the greatest flood event expected in a typical year.

Many agencies use the extent of flooding associated with a one percent annual probability of occurrence (the base flood or 100-year flood) as the regulatory boundary. Also referred to as the Special Flood Hazard Area (SFHA), this boundary serves as a convenient tool for assessing vulnerability and risk in flood-prone communities. Many communities' maps show the extent and likely depth of flooding for the base flood. Corresponding water-surface elevations describe the elevation of water resulting from a given discharge level, which is one of the most important factors used in estimating flood damage.

These measurements reflect statistical averages only; it is possible for two or more rare floods (with a 100-year or higher recurrence interval) to occur within a short time period. Assigning recurrence intervals to historical floods on different rivers can help indicate the intensity of a storm over a large area. For example, the 1996 flood event exceeded the flood with 100-year recurrence interval on the Chehalis River, while the recurrence interval of that event for tributaries to the Chehalis such as the Skookumchuck River was determined to be 75 years.[3]

Recent history shows that Thurston County can expect an average of one episode of minor river flooding each winter. Large, damaging floods typically occur every two to five years. Urban portions of the county annually experience nuisance flooding related to stormwater drainage issues.

## Sources of Riverine Floods

Six rivers in Thurston County (Map 4.3.1) experience episodic flooding: 1) Black; 2) Chehalis; 3) Deschutes; 4) Nisqually; 5) Scatter Creek; and 6) Skookumchuck. All the rivers, except for the Nisqually River, are lowland rivers fed primarily by watershed precipitation and groundwater flows. FEMA has mapped the SFHA for each river (Map 4.3.3). Although not a major river, Scatter Creek also has a designated high risk flood zone and has historically produced major floodwaters in southwest Thurston County. The following sections describe the six river systems and their flood stages within the planning area.

## Flood Definitions

**Flood Plain:** A strip of relatively smooth land bordering a stream, built of sediment carried by the stream and dropped in the slack water beyond the influence of the swiftest current.

**100-Year Floodplain:** Lands which are subject to a one percent chance of flooding in any year. These areas are mapped as the "A" zone on the Flood Insurance Rate Maps (FIRM) of FEMA.

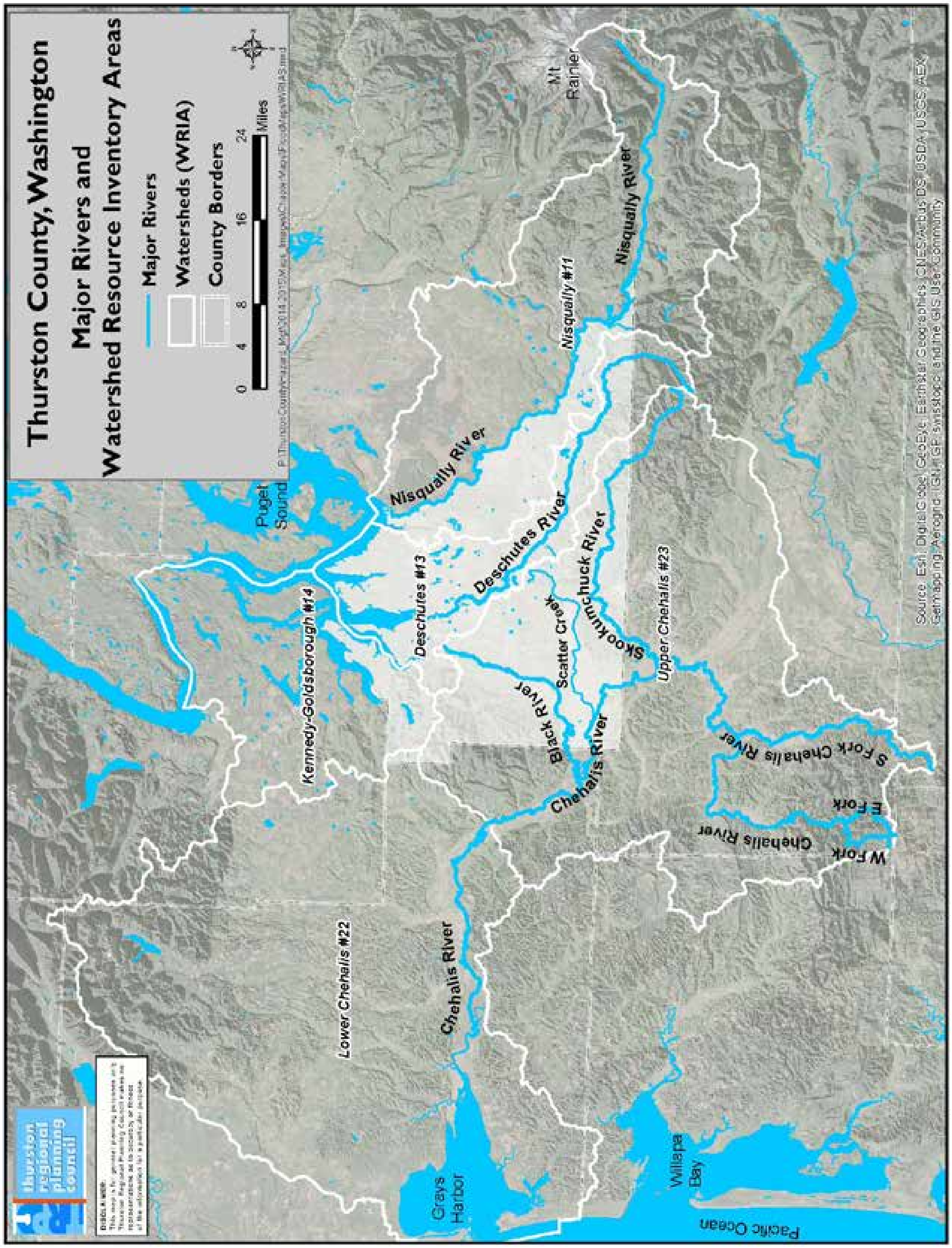
**500-Year Floodplain:** Lands which are subject to a 0.2 percent chance of flooding in any year. These areas are mapped as the "B" zone on the FIRM of FEMA.

**Flood Stage:** The stage at which overflow of the natural streambanks begins to cause damage in the reach in which the elevation is measured. Flood stages for each USGS gaging station are usually provided by the National Weather Service.

**Floodway:** The portion of the floodplain adjoining and including the river channel which discharges the flood water and flow of the river. It does not include portions of the floodplain where water is just standing. These areas are mapped as "Floodway" on both the Floodway and the FIRM of FEMA.

**Special Flood Hazard Area (SFHA):** The land area covered by the floodwaters of the base flood is the Special Flood Hazard Area (SFHA) on National Flood Insurance Program (NFIP) maps. The SFHA is the area where the National Flood Insurance Program's floodplain management regulations must be enforced and the area where the mandatory purchase of flood insurance applies. The SFHA includes Zones A, AO, AH, A1-30, AE, A99, AR, AR/A1-30, AR/AE, AR/AO, AR/AH, AR/A, VO, V1-30, VE, and V.

## Map 4.3.1: Major Rivers and Watershed Resource Inventory Areas, Thurston County



## Black River Basin

The Black River drains southwest from the south end of Black Lake into the Chehalis River near Oakville in Grays Harbor County. The Black River drainage is approximately 144 square miles, with 105 square miles in Thurston County. In general, the Black River is a slow flowing river with a broad floodplain. Most flooding along the main stem of the river is inundation flooding with low-velocity floodwaters.

The Black River drainage basin is divided into two parts. The west half of the basin drains the Capitol Forest area. The main tributaries in this section include Dempsey, Waddell, and Mima creeks. This area ranges in elevation from 2,659 feet at Capitol Peak to 200 feet at the Black River valley floor. The basin is subject to high-intensity, short-duration rain events that can produce flash flooding in these creeks. In general, snowmelt alone does not cause flooding in this area, however snow can compound this flooding.

The east half of the basin drains the relatively flat area south of Tumwater, west of Offutt Lake and north of Tenino. The elevation difference here is approximately 200 feet. The Salmon and Beaver creeks and Bloom Ditch are the main streams that drain this basin. These very slow-flowing water systems tend to cause inundation flooding with no velocity. This side of the basin is susceptible to high-groundwater flooding during periods of extended rain.

Because of its flat topography, the Black River is also susceptible to flooding by waters backing up from the Chehalis River. This appears to be the situation when flooding on the Chehalis River is concurrent with high tides along the coast.

### Black River Flood Stage Impacts

In April 2005, the Washington State Department of Ecology established a river gauging station on the Black River where it crosses U.S. Highway 12 at River Mile 2. Unlike the gauging stations on the Chehalis at Prather Road Bridge and at Porter, this gauge has not been rated and is not modeled to forecast flood levels. However, the following table reflects Thurston County Emergency Management's summary for flood stages at this river gauge.

**Black River Flood Stages and Historic Crests**

| Flood Stage | Gauge Height | Conditions and Previous Years of Occurrence |
|---|---|---|
| Action | 6 Feet | At 6 feet, residents should be aware that the river is likely to flood.<br><br>2006, 2007, 2009, 2010, 2011, 2012, 2015 |
| Flood | 8 Feet | At 8 feet, the Black River has reached flood stage; the river will spill out of its banks into nearby fields and woods with limited water over a few spots on local roads.<br><br>2006, 2007, 2010, 2011, 2015 |
| Moderate | 10 Feet | At 10 feet, moderate flooding will occur. This stage corresponds to 15.5 feet at the Prather Road Bridge on the Chehalis River. At this level, the Chehalis River in Thurston County will flood several roads in Independence Valley with swiftly moving water, including U.S. Highway 12 and James, Independence, Moon and Anderson Roads. Floodwaters will cut off access to and from the Chehalis Reservation and inundate nearby farmlands. Some residential structures may be threatened.<br><br>2006, 2007, 2015 |
| Major | 12 Feet | Major flooding occurs when the Black River reaches 12 feet. During the December 2007 flood, the gauge on the Black River recorded a stage of 14.5 feet.<br><br>2007 |

## Chehalis River Basin

The 174-mile long Chehalis River emerges from three forks in remote forest lands in Lewis and Pacific counties. The river is divided into two watersheds, the Upper Chehalis (WRIA #23) and the Lower Chehalis (WRIA #22). The Chehalis River grows at the confluence of the West Fork Chehalis River and East Fork Chehalis River. From there, the Chehalis flows north and east, collecting tributary streams that drain the Willapa Hills and other lowland mountains in southwestern Lewis County. The South Fork Chehalis River joins the main river a few miles west of the City of Chehalis. The Newaukum River joins the Chehalis River at Chehalis, after which the river turns north, flowing by the city of Centralia, where the Skookumchuck River joins. Beyond Centralia, the Chehalis River flows north and west for a nine-mile course through the southwestern corner of Thurston County.

The Chehalis River flows into Thurston County (WRIA #23) approximately two miles west of Interstate 5 and flows north toward Grand Mound where it drains the Michigan Hill area and receives water from Prairie Creek and Scatter Creek. The river courses west through largely undeveloped rural lowlands scattered with small farms and gentle sloping forested hills. The river continues west and passes through the Confederated Tribes of the Chehalis Reservation before entering Grays Harbor County where it joins the mouth of the Black River.

Beyond Thurston County, the Chehalis River continues northwest where it joins the tributaries of the Satsop and Wynoochee rivers near the City of Montesano. The Chehalis River becomes increasingly affected by tides beyond this location and gradually widens into the Grays Harbor estuary where it is joined by several other rivers, becoming Grays Harbor.

Due to its large drainage area, the Chehalis River tends to rise slowly over a long period. Thurston County Emergency Management describes the three common scenarios for flooding on the Chehalis River within Thurston County:

- The most predictable scenario for the Chehalis occurs when rains fall over all southwestern Washington and all regional rivers and streams rise.
- The Chehalis River can also experience flooding when there is little or no rain in Thurston or Grays Harbor counties, but heavy rain in Lewis and Pacific counties. This causes flooding to occur later than normal.
- Flooding also occurs when heavy rain falls in Grays Harbor County, but not in Thurston or Lewis counties. Feeder streams can then fill the Chehalis and cause water to "back up" into Thurston County.

### Chehalis River Flood Stage Impacts

The flood of record is 20.23 feet from December 4, 2007. The table below summarizes the flood impacts based on the Chehalis River flood stages at the gauge near Grand Mound at Prather Road Bridge, River Mile 59.9.

**Chehalis River Flood Stages and Historic Crests**

| Flood Stage | Gauge Height and Discharge | Conditions and Previous Years of Occurrence |
|---|---|---|
| Action | 12.2 Feet or 16,600 CFS | At 12.2 feet, the Chehalis River will locally spill out of its banks into nearby fields and over a few roads.<br><br>1933, 1936, 1943, 1945, 1946, 1948, 1949, 1953, 1954, 1955, 1956, 1964, 1966, 1980, 1983, 1984, 2003, 2009, 2011, 2012, 2013, 2014, 2015 |
| Flood | 14 or 22,900 CFS | At 14 feet, the Chehalis River will flood several roads in Independence Valley, including James Road, Independence Road and Moon Road. Flood waters will also cover nearby farm lands.<br><br>1933, 1937, 1939, 1941, 1945, 1946, 1947, 1948, 1949, 1950, 1954, 1955, 1956, 1957, 1958, 1959, 1960, 1961, 1963, 1964, 1965, 1966, 1967, 1968, 1970, 1971, 1972, 1974, 1975, 1980, 1981, 1982, 1983, 1986, 1989, 1990, 1992, 1995, 1997, 1998, 1999, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2010, 2011, 2012, 2014, 2015 |
| Moderate | 15.5 Feet or 29,600 CFS | At 15.5 feet, the Chehalis River will flood several roads in Independence Valley with swiftly moving water, including SR-12 and James, Independence, Moon and Anderson Roads. Floodwaters will cut off access to and from the Chehalis Reservation and inundate nearby farm lands. Some residential structures may be threatened.<br><br>1934, 1936, 1949, 1953, 1954, 1955, 1962, 1964, 1966, 1970, 1976, 1977, 1982, 1986, 1987, 1994, 1996, 1997, 1999, 2001, 2006, 2015 |
| Major | 17 Feet or 38,800 CFS | At 17 feet, the Chehalis River will cause major flooding, inundating roads and farm lands in Independence Valley. Deep and swift floodwaters will cover SR-12 and James, Independence and Moon Roads. Flooding will occur all along the river, including headwaters, tributaries and other streams within and near the Chehalis River Basin.<br><br>1935, 1937, 1951, 1971, 1972, 1974, 1975, 1986, 1990, 1991, 1994, 1995, 1996, 1998, 1999, 2007, 2009, 2015 |

## Deschutes River Basin

The Deschutes River is a 53-mile-long lowland river that gives rise within Mt. Baker-Snoqualmie National Forest in north Lewis County. The river is in the Deschutes Watershed (WRIA #13). The Deschutes lies west of the Nisqually River and flows in a parallel pattern. The Deschutes is the fastest rising and falling river in the county, responding quickly to local rainfall and runoff. The river's watershed encompasses a great majority of the land area for the cities of Lacey, Olympia, and Tumwater. As the Deschutes River enters the urban growth area and the City of Tumwater, the river bank and surrounding land use becomes more developed, with several residences in the Tumwater Valley around the periphery of the Tumwater Golf Course. A riprap bank and additional hard banking channels the river through the Tumwater Valley Golf Course and parts of Tumwater Falls Park before it discharges into Capitol Lake near the Historic Olympia Brewery in Tumwater, just south of Interstate 5.

Capitol Lake is an artificial lake formed by a small dam at the north end of the lake in downtown Olympia. Washington State Department of Enterprise Services regulates the dam, which creates a freshwater lake to complement the Capitol Campus. Percival Creek joins the Deschutes River in Capitol Lake's central basin, near Marathon Park, just north of Interstate 5. When the tides and lake water level conditions permit the opening of the dam's radial gate, Capitol Lake drains into Budd Inlet.

Sediments carried down river are slowly accumulating on the lake bottom and effectively decreasing the lake's capacity. A multi-stakeholder study is underway to evaluate how the mouth of the Deschutes River will ultimately interface with Budd Inlet and how it will be managed within a heavily developed urban environment. This study evaluates the environmental, social, and economic implications for a variety of long-term management alternatives. Any final decision will have implications for flood management at the lowest end of the Deschutes River.

### Deschutes River Flood Stage Impacts

The flood of record is 17.01 from January 9, 1990. The table below summarizes the flood impacts based on Deschutes River flood stages at the Rainier Vail Loop Bridge Gauge, River Mile 25.9.

**Deschutes River Flood Stages and Historic Crests**

| Flood Stage | Gauge Height and Discharge | Conditions and Previous Years of Occurrence |
|---|---|---|
| Action | 9 Feet or 2,570 CFS | At 9 feet, the Deschutes River locally spills over its banks into low fields and forested lands, mainly along Vail Cutoff Road and Reichel Road.<br><br>1949, 1950, 1951, 1952, 1953, 1954, 1955, 1956, 1957, 1958, 1959, 1960, 1961, 1962, 1964, 1965, 1966, 1967, 1968, 1970, 1972, 1974, 1975, 1977, 1979, 1982, 1989, 1990, 1991, 1992, 1994, 1995, 1996, 1997, 1998, 1999, 2001, 2002, 2007, 2009, 2011, 2015 |
| Flood | 11 or 3,950 CFS | At 11 feet, the Deschutes River will flood downstream in Tumwater Valley, including the golf course. Minor flooding will also occur in several residential areas, mainly Cougar Mountain and Driftwood Valley. Many roads and farm lands will also be flooded.<br><br>1949, 1953, 1955, 1957, 1960, 1962, 1963, 1964, 1966, 1967, 1970, 1971, 1972, 1975, 1977, 1982, 1987, 1988, 1990, 1994, 1996, 1997, 1998, 2001, 2003, 2006, 2011, 2012, 2014, 2015 |
| Moderate | 13.5 Feet or 5,970 CFS | At 13.5 feet, the Deschutes River will flood residential areas, especially Cougar Mountain, Driftwood Valley and Falling Horseshoe. Downstream flooding will occur in areas of Tumwater Valley, including the golf course. Many roads and farm lands will also be flooded.<br><br>1991, 1996, 1998, 2007, 2009 |
| Major | 15 Feet or 7,330 CFS | At 15 feet, the Deschutes River will cause major flooding, with swift and deep water flooding roads, farmlands and the residential areas of Cougar Mountain, Driftwood Valley, Falling Horseshoe and areas downstream in the Tumwater Valley. Flooding will occur all along the river including headwaters, tributaries and other streams within and near the Deschutes River Basin.<br><br>1972, 1974, 1990, 1996 |

## The Nisqually River

The Nisqually River is the only river system within Thurston County that is fed primarily by melting snow pack and glacial ice. This 80-mile river is located within the Nisqually Watershed (WRIA #11). The river's headwaters begin on the southwestern slope of Mount Rainier at the base of the Nisqually Glacier in Mount Rainier National Park in Pierce County. The river flows west along the Pierce and Lewis County line until constrained by the Alder Dam; nearly halfway (river mile 44.2) to the river mouth at the Puget Sound. From Alder Reservoir, the Nisqually River forms a natural border for approximately 48 miles between Pierce and Thurston counties.

Alder Dam is a 330-foot high concrete arch dam with a crest length of about 1,600 feet, with a spillway designed for a maximum discharge of 85,000 cubic feet per second (cfs). Alder Reservoir is about seven miles long with a 3,065-acre surface area and a 214,500-acre-foot total storage capacity. The LaGrande Dam, a gravity structure 212 feet high and about 710 feet long, is 1.7 miles downstream from Alder Dam.  The dam's spillway was also designed for a maximum discharge of 85,000 cfs. The LaGrande Reservoir provides a total storage capacity of 2,676 acre-feet. Tacoma Power operates both dams for hydroelectric power generation.[4] The reservoirs of both dams are relatively small and Tacoma Power is not required to provide flood control. Even so, Tacoma Power lowers the elevation of the lake, when possible, during winter months to enable some capture of high water inflows from rainstorms and snow melt.

The Nisqually River resumes a mostly natural unrestricted flow as it traverses northwest away from the LaGrande Dam, passing a diversion dam owned by the City of Centralia. The diversion dam and a canal divert water from the Nisqually River to generate 12 megawatts of hydroelectric power during peak flows at a plant northwest of the City of Yelm. The dam provides no floodwater storage capacity. The river courses past scattered residences in unincorporated Thurston County before it passes the communities of McKenna, Yelm, the Nisqually Pines neighborhood, the Nisqually Indian Reservation, and the undeveloped range lands of Joint Base Lewis McChord. Several small farms and residences are in the Nisqually Valley in the vicinity around Interstate 5 and Old Pacific Highway. The river enters the Puget Sound near the Billy Frank Jr. Nisqually National Wildlife Refuge.

Nisqually River flooding relates largely to the amount of water released from Alder and LaGrande dams. Feeder streams such as Ohop, Yelm, and Tanwax creeks also influence flooding, as do high tides in the Nisqually Delta. Conservation efforts including dike removal and revegetation work were recently completed to restore ecological functions of the Nisqually Estuary. It is unknown how this restoration will affect floods in the lower reaches of the river, as major flooding has not occurred since this work was completed.

### Nisqually River Flood Stage Impacts

The flood of record is 17.13 feet from February 8, 1996. The National Weather Service issues a flood warning for the Nisqually River when forecast models indicate the river will reach a stage of 12 feet or higher at the McKenna Gauge at River Mile 21.8.  The table below summarizes the flood impacts based on Deschutes River flood stages at this gauge.

**Nisqually River Flood Stages and Historic Crests**

| Flood Stage | Gauge Height and Discharge | Conditions and Previous Years of Occurrence |
|---|---|---|
| Action | 8 Feet or 9,970 CFS | At 8 feet, residents should be aware that the river is likely to flood.<br><br>1967, 2011, 2014 |
| Flood | 10 or 14,700 CFS | At 10 feet, the Nisqually River will flood at the lower end near the mouth. High tide levels on Puget Sound may increase the amount of flooding. The Nisqually River will also spill over its banks between LaGrande and McKenna.<br><br>1951, 1953, 1955, 1959, 1961, 1964, 1977, 1980, 1982, 1990, 1991, 1994, 1995, 1997, 2003, 2006, 2009, 2015 |
| Moderate | 13 Feet or 23,300 CFS | At 13 feet, the Nisqually River will flood from LaGrande downstream through McKenna to the mouth. Swift waters will flood roads, farms and some residential areas, including the residential care facility in McKenna. Erosion will likely damage properties along river banks.<br><br>1991, 1996, 1998, 2007, 2009 |
| Major | 14 Feet or 26,500 CFS | At 14 feet, the Nisqually River will cause major flooding from LaGrande downstream through McKenna to the mouth. Deep and swift waters will flood roads, farms and residential areas, including the residential care facility in McKenna. Erosion may cause severe damage. Flooding will occur all along the river, including headwaters, tributaries and other streams within and near the Nisqually River Basin.<br><br>1972, 1974, 1990, 1996 |

## Scatter Creek

Located in the Upper Chehalis Watershed (WRIA #23), Scatter Creek is approximately 20 miles long with an additional 9.5 miles of tributaries.  The creek flows west-southwest from McIntosh Lake, east of Tenino, to the Chehalis River near Rochester.

The creek crosses lands chiefly composed of highly porous glacial outwash materials. After Scatter Creek passes through the City of Tenino, the river flows through mostly undeveloped small farmland with scattered residences through unincorporated Thurston County. The lower end of the creek passes through the Grand Mound area which is scattered with residences and light industrial plants and businesses. The lower six miles maintains a year-round flow of water due to pumped groundwater sourced from effluent from a commercial fish farm. Significant reaches of the creek up stream remain dry during the summer because of a lowering of the water table from a variety of active water rights and exempt wells within the watershed.

The Scatter Creek Aquifer system is like a "propped up bathtub" that feeds into the Chehalis (a high ground water gradient and velocity). Ground water flooding in Scatter Creek impacts the municipal well field which is shallow – only 90 feet below ground surface. Even in years when the Chehalis does not flood, the ground water comes to ground surface at the well field. Also, the LIDAR data reveals Scatter Creek as large ancestral flood channels, so the stream itself does not seem to overbank as dynamically as a normal flood plain in the upgradient areas. The river just follows the larger ancestral 'scours.'[5]

No permanent long-term stream flow gauges exist on this creek, so little is known about its long-term hydrography. In addition, very little flood history data is published for this riverine system. The Scatter Creek Habitat Conservation Plan states that from 1993 to 1999, the wet season flows typically ranged from 80 to 400 cfs, with less frequent peaks in the range of 400 to 1,400 cfs. The maximum mean daily discharge during this period was 1,362 cfs on February 14, 1996 (historically a very wet year, coinciding with record flood levels for the Skookumchuck River).

The Scatter Creek Habitat Conservation Plan includes the following passage regarding flood flows[6]:

> *…About 50 percent of the basin delivers stormflow runoff to the valley bottom from the hill portions of the basin. This flow is mostly delivered from seven tributary creeks that enter Scatter Creek and elevated groundwater return flow. If stormflow runoff enters from the tributaries after a dry summer, it takes a while to fill the local groundwater and channel areas. Stormflow onto wet basin conditions creates the largest stormflow peaks. There are insufficient years of recorded flows on Scatter Creek to determine the relationship between flood frequency and magnitude.*

In 1996, Scatter Creek experienced major flooding, covering several county roads along its westward flow including Old Highway 99, Sargent Road, 183rd Avenue, State Route 12, and Denmark Street.[7]

## The Skookumchuck River Basin

The Skookumchuck River is 43-miles-long with headwaters originating within Mt. Baker- Snoqualmie National Forest in north Lewis County. Located in the Upper Chehalis Watershed (WRIA #23), the river is arch-shaped and arcs upward into Thurston County for nearly 26 miles before it returns to Lewis County. The river flows northwest into Thurston County through commercial forest lands with relatively steep forested valley slopes. The Skookumchuck Dam, located about 10 miles east and upstream from the Town of Bucoda, constrains the river as it traverses west. The dam – a rolled earthfill embankment with a crest length of 1,320 feet and a height above streambed of 160 feet – has a gross storage capacity of 35,000 acre-feet. The dam's spillway, an ungated concrete ogee section 130 feet long, can pass the Probable Maximum Flood of 32,500 cfs.[8] TransAlta operates the dam, with a primary function to provide a controlled release of cooling water at the Centralia Steam Electric Plant in Lewis County.

The Skookumchuck River emerges from the reservoir and passes through a relatively flat open valley comprised of scattered small farms and residences. As the river bends south toward Lewis County, the valley narrows as the river flows through the Town of Bucoda. The river winds along the eastern edge of the town's core developed area. From here, the river flows southwest and runs roughly parallel with State Route 507 into Lewis County. The river continues south until it enters the more densely populated City of Centralia. The Skookumchuck River drains into the Chehalis River, in Centralia, just west of Interstate 5 and south of Harrison Avenue.

### Skookumchuck River Flood Stage Impacts

The flood of record is 17.87 feet from February 8, 1996. The National Weather Service issues a flood warning for the Skookumchuck River when forecasts indicate that the river will reach a stage of 13.5 feet at the gauge near Bucoda. The table below summarizes the flood impacts based on Skookumchuck River flood stages at the gauge four miles downstream from Bucoda.

**Skookumchuck River Flood Stages and Historic Crests**

| Flood Stage | Gauge Height and Discharge | Conditions and Previous Years of Occurrence |
|---|---|---|
| Action | 11.5 Feet or 2,750 CFS | At 11.5 feet, residents should be aware that the river is likely to flood.<br><br>1968, 1970, 1972, 1977, 1980, 1982, 1986, 1987, 1994, 1997, 1998, 2001, 2006, 2007, 2010, 2012, 2014 |
| Flood | 13.5 Feet | At 13.5 feet, the Skookumchuck River will flood a few roads and low pasture lands near Bucoda.<br><br>1968, 1972, 1974, 1975, 1976, 1982, 1983, 1986, 1994, 1995, 1996, 1998, 1999, 2001, 2002, 2004, 2005, 2006, 2007, 2011 |
| Moderate | 15 Feet or 5,500 CFS | At 15 feet, the Skookumchuck River will flood several residential and business areas around Bucoda. Flood waters will cover many roads.<br><br>1971, 1972, 1974, 1975, 1977, 1986, 1987, 1990, 1991, 1995, 1996, 1998, 1999, 2001, 2003, 2006, 2014, 2015 |
| Major | 17 Feet or 8,650 | At 17 feet, the Skookumchuck River will cause major flooding in the Bucoda area, with deep and swift flood waters inundating residential and business areas and numerous roads. Flooding will occur all along the river, including headwaters, tributaries and other streams within and near the Skookumchuck River Basin.<br><br>1990, 1996, 2009 |

## Riverine Flood Impacts

Floods kill people in the United States every year. People caught unprepared and isolated by swift moving or flash flood waters can die from drowning, hypothermia, or trauma. The February 1996 flood caused nine deaths in the Pacific Northwest. Fortunately, advances in weather forecasting technology and hydrologic modeling produce accurate flood stage forecasts that provide communities with timely information. Radio broadcasts, television news, websites, social media, and telephone and simple text alert systems can provide residents of flood prone properties timely notification to safeguard belongings or evacuate.

While Thurston County has not experienced any flood-related fatalities in recent years, the 1996 flood involved rescue operations for 300 people. The December 2007 flood also involved rescue efforts for 36 individuals in and around the Rochester community. People with disabilities, elderly individuals, and people lacking transportation are vulnerable to floods as they may require assistance to evacuate or lack a safe place to take temporary shelter.

Fast rising flood waters can also eliminate the opportunity to provide for the safety of livestock and pets. Floods kill livestock and pets causing both economic and emotional hardship. Health risks may also arise if animal carcasses are not properly disposed.

Major and moderate flooding frequently inundate low lying roads around Thurston County, resulting in area-wide transportation disruptions. Flooding has closed both State Route 12 and Interstate 5 multiple times. As flood waters recede, woody debris and other objects left behind can pose hazards to travelers. Electric, gas, water, and communication utilities are also subject to damage and disruption.

Swift moving flood waters can damage or destroy bridges, roads, and railroads. Flood waters also erode streams and river banks and cause loss of wildlife and habitat. Slow moving flood waters can also significantly damage buildings and mechanical equipment. Inundation and sediment deposits can be extensive and require costly clean up and repairs to homes and buildings. Flood waters also damage or destroy vehicles and mechanical equipment. Homeowners are particularly hard hit due to the loss of shelter, furniture, bedding, clothing, household appliances, food, and other personal items. If not properly abated, sanitation problems can arise from contaminated wells, fouled septic systems, and mold growth.

Flood damage renders homes and businesses unsafe for occupancy, displacing individuals and families, and necessitating alternative housing and shelters for extended periods. The cleanup and recovery period is stressful for flood victims and disrupts their normal activities of daily living. Children miss school days, and business owners lose revenue. People recovering from floods may lose income absent emergency leave from their employer.

Despite the many adverse impacts from floods, river flooding is a natural process that can also benefit a variety of wildlife and natural resources. Flood waters can force rivers to change their course. The natural processes of erosion, stream braiding, sediment deposits, and channel migration are critical to the long-term viability of fish and wildlife habitat. The formation of oxbow lakes can support avian, mammalian, and amphibian populations. Deposits of gravel and sediments can foster the growth of alders, willows, and other vegetation and establish new riparian habitat. Trees that fall into rivers from bank erosion can entangle with other trees and coarse woody debris to form fish habitat. Flood deposition of upland sediments can enhance the fertility of valley floors and further support both native vegetation and agriculture.

## Probability of Occurrence

Because rivers and streams cause nuisance flooding annually, and major riverine flooding occurs about every two to five years in Thurston County, there is a high probability of occurrence.

# 2. Groundwater Flooding

Groundwater flooding occurs when there is a high-water table and persistent heavy rains in an area where an upper, thin layer of permeable soils overlays an impermeable layer of hard pan. As the ground absorbs more and more rainwater, the groundwater table rises and causes flooding where it is higher than the surface of the ground. Map 4.3.3 shows high groundwater hazard areas in Thurston County.

## Modes of Groundwater Flooding in Thurston County

Combined local and National Oceanic and Atmospheric Administration data reveal two types of weather patterns that trigger groundwater flood events:

**Type 1: Intense – Short Duration Successional Storms:** These storms are composed of long atmospheric river systems driven by the Pacific jet stream that draw sub-tropical moisture from the Pacific Ocean and release abundant rainfall as they reach land in the Pacific Northwest. They are characterized with warmer than normal temperatures and intense steady rainfall. Groundwater flooding occurs with two separate but successive storm events within a month, or if an atmospheric river system arrives later in the season after normal winter rains have "primed" the groundwater levels to near maximum. Normal high groundwater levels occur in mid- to late March, so if an atmospheric river system coincides with this normal peak, the capacity of the soils is exceeded and groundwater flooding occurs. This pattern appears to be increasing in frequency and intensity. Type 1 storm events also contribute to urban and stream flooding and landslides.

**Type 2: Persistent Low-intensity Precipitation Pattern:** This weather pattern is less common, but produces similar ground water flooding effects. Characterized by weeks of persistent low intensity daily rainfall measuring less than an inch per day that gradually topples the groundwater table. In most cases, this weather pattern causes more widespread flooding throughout the county, both in areas that routinely flood and in those not generally susceptible to groundwater flooding. The county has only experienced this pattern twice in the last decade – in 2002-2003 and in 2006-2007. In both instances, groundwater flooding was widespread and included areas not previously identified as susceptible to routine groundwater flooding. This implies that Type 2 events generate more widespread flooding than Type 1 events. Type 2 events do not appear to cause riverine flooding or landslides, but the data is insufficient to be certain of this conclusion.

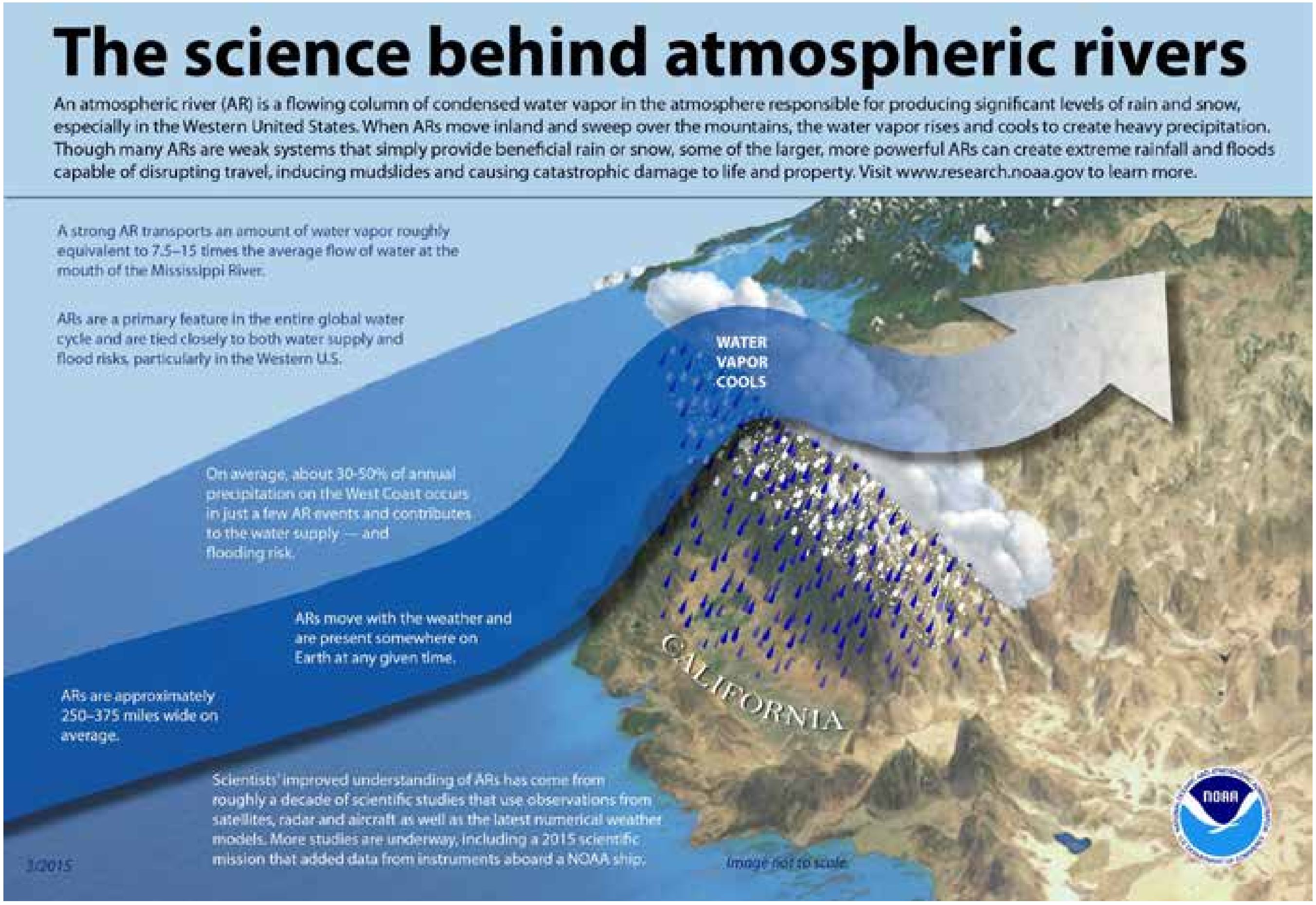



*Image courtesy of the National Oceanic and Atmospheric Administration*

## Severity

Historic groundwater flooding has been most severe in the second and subsequent years of consecutive wet years. According to the U.S. Army Corps of Engineer's post event report on the winter storm of 1996-1997, the frequency of a groundwater flooding disaster is probably on the order of every 25 years. This first widespread groundwater flood event since 1972 and the worst on record until the winter of 1998-1999, is now the "event of record." This event set the benchmark for high groundwater flood hazard requirements implemented by Thurston County.

## Extent

Nearly 54 square miles or 34,363 acres countywide (around seven percent) have experienced groundwater flooding. Areas that experience such flooding are scattered throughout the lowlands in Thurston County (Map 4.3.3), but it is most prevalent around the western and southern end of the Olympia Regional Airport, near Littlerock Road, and south of Tumwater along Case Road. Although groundwater flooding occurs sporadically throughout Thurston County, the geologic conditions present in the Salmon Creek Basin south of Tumwater create the "worst case scenario" for such flooding here.

Since areas of high groundwater are relatively flat, flood waters can remain standing for several months, resembling ponds or lake like conditions. The Salmon Creek Basin experienced significant flooding in 1999, resulting in contiguous bodies of standing flood waters ranging from small puddles to 113 acres. Depths ranged from near ground surface to over 12 feet deep. The volume of flood water above the surface of the ground in the basin was equivalent to 603 football fields covered with four feet of water. This amount combined with the volume of groundwater below the surface at the septic drain field level would be equal to 977 football fields or 28,655 acre feet.

Since 1999, this basin has experienced floods four more times, though none were as severe as in 1999. The combination of increasing storm severity and intensity in the past decade, coupled with population increases in the county, have brought people and floods ever closer together in developing areas. Other affected areas are in the Scatter Creek/lower Black system near Grand Mound and Rochester, eastern portions of the Lacey Urban Growth Area (UGA), Beaver Creek, the Spurgeon Creek systems, and in the Yelm UGA.

## Impacts

In general, the damaging effects of groundwater flooding resemble those of riverine flooding. Traffic disruption may result from road closures. Homes may be inundated if they are not elevated above flood levels. Even if a home is elevated above floodwaters, crawl spaces and basements are subject to flooding. Deep water may surround the properties and make it nearly impossible to access and exit without a boat or makeshift elevated walkway. Septic tanks can become fouled and wells can be rendered useless from contamination. Underground utilities, drainage facilities, and storage tanks are also susceptible to damage from groundwater flooding. In many ways, groundwater flooding impacts can be difficult to mitigate because of limited options. For example, sandbagging and pumping have little effect on this type of flooding. Temporary relocation or evacuation of affected areas is often the best option.

### Probability of Occurrence

Statistically, the U.S. Army Corps of Engineers (Corps) estimates an approximately 70 percent chance that the county will equal or exceed the 1996-1997 flooding at least once during a 30-year mortgage cycle. The Corps estimates that the frequency of a groundwater flooding disaster in Thurston County is probably on the order of every 25 years. Although not as frequent as riverine flooding, this recurrence rate is a high probability of occurrence. Detailed studies of climate trends by the University of Washington and others indicate that the Corps may be overly optimistic in their recurrence interval. In the past decade, the incidence and frequency of large rainfall events has increased, and climate models indicate that this trend may be here to stay. The studies that Thurston County has performed appear to support the trends detailed by climate agencies.

# 3. Tidal Flooding

Spring tides, the highest tides during any month, occur with each full and new moon. When these coincide with a northerly wind piling water in south Puget Sound, tidal flooding can occur. Tidal flooding can also occur without the effect of storm surge. The tides can also enhance flooding in delta areas when rivers or creeks are at or near flood stage.

## Severity

Puget Sound marine flooding by itself does not produce major flooding in the region. However, such flooding will become more frequent and present more adverse impacts in the second half of the 21st Century as sea levels rise. The Climate Change discussion provides more information on the impacts of sea level rise in downtown Olympia and unincorporated Thurston County.

## Extent

The downtown Olympia waterfront, including Port of Olympia properties, face the greatest risk from tidal flooding. Localized flooding is common along 4$^{th}$ and 5$^{th}$ Avenues near the isthmus between Capitol Lake and Budd Inlet and nuisance tidal flooding occurs downtown at 17 feet mean lower low water. Low-lying farmlands in the Nisqually Valley and along McLane Creek near Mud Bay are at risk. Tidal flood impacts are also a concern in delta areas when rivers are at flood stage and high tide exacerbates the situation. Sea level rise will increase the extent of inundation during tidal flooding.

## Impacts

During extreme high tide events, low lying areas are vulnerable to marine flooding. Numerous downtown Olympia stormwater outlets to Budd Inlet lack valves or flood gates and will back up, causing stormwater drains to overflow. Flood waters disrupt traffic, limit access to properties, and can interupt business. This problem is exacerbated during heavy rain events, increasing the extent of flooding in areas of downtown. Storm surge from wind can result in more extensive inundation. Tidal flooding generally subsides as tides recede. Presently, tidal floods are short, often lasting only one to two hours.

High tides influence the timing of dam water release from Capitol Lake near 5th Avenue in downtown Olympia. During the re-construction of portions of Heritage Park, an earthen berm was installed around the north and eastern perimeter of Heritage Park to prevent major flood waters from flowing into downtown from Capitol Lake. However, if the Deschutes River experiences major flooding and a high tide prohibits discharge of lake water into Budd Inlet, floodwaters could crest the lake bank at the southeast end of the north basin and flow into downtown Olympia along the utility road between the Capitol Campus Steam Plant and Water Street. Such flood conditions have not occurred since the berm was constructed.

### Probability of Occurrence

Olympia experiences nuisance tidal flooding one to two times a year. Sea level rise will drastically increase the frequency of tidal floods.

# 4. Urban Flooding

Urban flooding occurs when excess precipitation is not readily absorbed by the ground and stormwater runoff exceeds the ability of stormwater facilities' capacity to safely convey and divert water within suburban and urban environments. As a result, streets, parking lots, homes, and businesses may experience localized flooding.

Excess water accumulation flowing off and over impervious surfaces from heavy rainfall or melting snow over a short period is the most common cause of urban flooding in the cities and developed areas of the county. Leaves, branches, snow or ice, and other debris that clog stormwater drains compounds the problem. Other forms of urban flooding occur in residential neighborhoods constructed with insufficient stormwater conveyance capacity. Until flooding reveals the problem, residents or municipalities may be unaware of deficient drainage systems in newer developments. New urban development or neighborhoods with faulty stormwater systems may adversely impact adjacent neighborhoods that previously did not experience stormwater flooding.

## Severity

In general, properties impacted by urban flooding are not widespread and flood conditions are often localized. However, the impacts to transportation networks can be great. Downtown Olympia is vulnerable to urban flooding when extreme high tides coincide with persistent heavy rainfall and major flooding on the Deschutes River. The city can easily mitigate some stormwater flooding through regular cleaning and maintenance of stormwater conveyance systems.

## Extent

Although it occurs throughout every city in Thurston County, urban flooding has historically impacted west and downtown Olympia.

## Impacts

The impacts of urban flooding on homes, buildings, and utilities are similar to riverine and high groundwater flooding. Standing water can damage buildings and their contents. Excess stormwater flows can overwhelm urban creeks and cause washouts and landslides along steep slopes. Deep standing or flowing water over roads can result in moderate to major traffic disruptions affecting thousands of motorists during peak daily travel periods. Floodwaters can cause power disruptions or disable traffic signal controllers. Engine failure can strand motorists in their cars in deep water.

### Probability of Occurrence

Some level of minor to moderate urban flooding coincides with major flooding on the Deschutes River; about every four and a half years. This frequency suggests a high probability of occurrence.

# Effects of Climate Change on Flooding

Research and climate forecasts offer evidence that long-term climate change will have a measurable impact on the frequency and severity of flooding. The University of Washington Climate Impacts Group published a detailed report on the state of science on climate change and its effects within the region titled, "State of Knowledge: Climate Change in the Puget Sound." The report identifies several factors that will influence flooding for these communities.

Air temperatures are increasing in the Puget Sound Region, and are projected to warm rapidly during the 21st century, especially during the summer. By mid-century, warming will be outside of the range of historical variations. Because of warmer winters, watersheds will become increasingly rain dominant with streamflow projected to peak earlier in winter and decrease in spring and summer. Winter streamflow is projected to increase by 28 to 34 percent on average by the 2080s.

Overall annual precipitation levels are forecast to remain the same, but with greater seasonal variation. Summers will become drier and winters wetter. The frequency of the region's peak 24-hour rain events is expected to more than triple by the end of the 21st century. Such heavy storms are also expected to become more intense, with greater rainfall occurring in shorter periods of time.

For the Thurston County planning area, the following sections describe how climate change is anticipated to impact flood conditions on two fronts—hydrology and sea level rise.

## Hydrology

Changes in temperature and precipitation will continue to decrease snow pack, affecting stream flow and water quality throughout the Pacific Northwest. Warmer temperatures will result in more winter precipitation falling as rain rather than snow, particularly in mid-elevation basins where average winter temperatures are near freezing. This change will result in less winter snow accumulation and higher winter stream flows. The Nisqually River, fed by snowmelt, will likely see earlier peak spring stream flow and lower summer stream flows.

The decline of the region's snowpack is predicted to be greatest at low and middle elevations due to increases in air temperature and less precipitation falling as snow. The average decline in snowpack in the Cascade Mountains, for example, was about 25 percent over the last 40 to 70 years, with most of the decline due to the 2.5°F increase in cool season air temperatures over that period. As a result, seasonal stream flow timing will likely shift significantly in sensitive watersheds.

Thurston County's rivers are less impacted by snowpack than other rivers in Western Washington, so would see less impact from changes to snowpack.  However, any change in hydrograph associated with more concentrated, intense rainfall would greatly impact Thurston County's rivers.

Rivers with dams could experience significant impacts from a changed hydrograph, since dams are designed partly based on assumptions about a river's flow behavior, expressed as hydrographs. Changes in weather patterns can have significant effects on the hydrograph used for the design of a dam. If the hygrograph changes, it is conceivable that the dam can lose some or all its designed margin of safety, also known as freeboard. If freeboard is reduced, dam operators may be forced to release increased flows earlier in a storm cycle to maintain required margins of safety. Such early releases of flow can increase flood potential downstream. Throughout the western United States, communities downstream of dams are already experiencing increases in stream flows caused by earlier releases from dams.

Use of historical hydrologic data has long been the standard of practice for designing and operating water supply and flood protection projects. For example, historical data are used for flood forecasting models and to forecast snowmelt runoff for water supply. This method assumes that the climate of the future will be like that of the period of historical record. However, the hydrologic record cannot be used to predict changes in frequency and severity of extreme climate events such as floods. Going forward, model calibration or statistical relation development must happen more frequently; new forecast-based tools must be developed; and a standard of practice that explicitly considers climate change must be adopted.

Climate change is already impacting water resources, and resource managers have observed the following:

- Historical hydrologic patterns can no longer be solely relied upon to forecast the water future.
- Precipitation and runoff patterns are changing, increasing the uncertainty of water supply and quality, flood management, and ecosystem functions.
- Extreme climatic events will become more frequent, necessitating improvement in flood protection and emergency response.

## Sea Level Rise

In 2016, Thurston Regional Planning Council (TRPC) performed a climate change vulnerability assessment for the development of the *Thurston Climate Adaptation Plan*. The assessment evaluated the impacts of climate change on the troposphere, fresh water ecosystems, marine ecosystems, terrestrial ecosystems, and human health and welfare. The assessment was drawn from numerous publications and data sources.

The marine ecosystems assessment accounted for sea level rise forecast conditions included in the University of Washington Climate Impacts Group's *State of Knowledge: Climate Change in the Puget Sound*. In addition, TRPC evaluated technical reports commissioned by the City of Olympia and LOTT Clean Water Alliance including the *City of Olympia Engineered Response to Sea Level Rise* by Coast and Harbor Engineering and the *Budd Inlet Treatment Plant Vulnerability Assessment Attributed to Climate Change* by Brown and Caldwell. City of Olympia and LOTT Clean Water Alliance staff both contributed data and empirical observations to this assessment. The following passage from TRPC's Thurston Climate Adaptation Plan Vulnerability Assessment describes sea level rise scenarios and their impacts to downtown Olympia and unincorporated Thurston County (the citations may be found in the original report).

> Throughout the 21$^{st}$ century, the Puget Sound region is expected to experience continued, and possibly accelerated, sea-level rise as a result of melting ice sheets and warmer oceans. This may result in permanent inundation of some low-lying areas, and increased frequency, depth, and duration of coastal flooding due to increased reach of tides and storm surges. Sea-level rise may also exacerbate river flooding by slowing the ability of water to drain into Puget Sound, as well as degrade drinking water sources.
>
> Globally, average sea level rose about 8 inches – roughly the same level recorded at the Seattle tidal gauge – during the 20$^{th}$ century. The Puget Sound region's sea level is projected to rise another 24 inches (range: +4 to +56 inches) by the end of this century, relative to [the year] 2000. Levels could be higher or lower than this range, however, depending on the rate that the local coastline is sinking or rising due to geologic factors and the rate that polar ice is melting. The analysis below examines how built and natural assets are vulnerable to coastal flooding and erosion associated with sea-level rise.


*A March 2016 king tide event inundated downtown Olympia's Percival Landing and Sylvester Street. Sea-level rise is expected to raise the risk of coastal flooding associated with such high-tide events. Source: TRPC*

Most Thurston County shorelines are stable. However, Olympia City Hall in downtown is subsiding by about 2.5 millimeters (0.9 inch) per decade. Thus, City of Olympia engineers estimate that sea-level rise could be 11 inches greater amid low-lying downtown – much of which is built atop fill – than the surrounding shoreline areas.

The City of Olympia established a policy in 2010 to protect downtown from flooding resulting from high runoff combined with a high tide that inundates the gravity-fed stormwater drainage system. Downtown Olympia generally experiences nuisance flooding just once or twice a year – sometimes more during periodic El Niño events – but the risk rises with the sea:

- With one foot of sea-level rise, Olympia could expect nuisance flooding 30 times annually, affecting approximately 261 structures and inundating up to 163 acres;
- With two feet of sea-level rise, Olympia could expect nuisance flooding 160 times annually; affecting approximately 328 structures and inundating up to 252 acres;
- With four feet of sea-level rise, Olympia could expect nuisance flooding 440 times annually or during more than half of its high-tide events, affecting approximately 402 structures and inundating up to 368 acres.

Downtown Olympia's importance to the region cannot be understated. The densely-built area is home to dozens of businesses, the Port of Olympia marine terminal, Olympia City Hall, LOTT Budd Inlet Treatment Plant, and other important facilities. Fortunately, local or state government agencies own or control most of the area's shoreline.

In addition to potentially disrupting commerce and damaging billions of dollars in public and private property, flooding amid the greater downtown Olympia area could pose temporary safety risks (e.g., inhibiting the movement of emergency service vehicles), as well as long-term health risks (e.g., mobilizing toxic chemicals at former industrial sites and inundating sewer lines and treatment facilities). To prepare for and cope with such risks, in 2017, the city will begin work on a sea-level rise management plan and funding strategy with assistance from partners including the State of Washington, Port of Olympia, and LOTT Clean Water Alliance.

The LOTT Clean Water Alliance also hired a consultant to evaluate the vulnerability of its Budd Inlet Treatment Plant – a critical facility that handles wastewater from almost 90,000 residential, commercial and industrial customers served by the sewer utilities of Lacey, Olympia, and Tumwater. The 2014 assessment, prepared by the consultant firm Brown and Caldwell, used five scenarios that incorporated University of Washington Climate Impact Group's sea-level rise projections – including combinations of sea-level rise, 100-year tidal flooding, and storm surge flooding – to identify inundation areas and high-level vulnerabilities at the treatment plant.

Under the three higher scenarios, critical infrastructure, including the effluent pump station, main utilidors (underground access tunnels), and a Puget Sound Energy substation, would be inundated. The two most extreme scenarios would also inundate the headworks building, administration building, multiple substations, and backup generators.

Any failure of these core services would likely shut down key sections of the plant, resulting in potential backup. If shutdown or failure of the core infrastructure were to occur, flow would back up through the collection system and exacerbate flooding throughout the sewer system, downtown Olympia, and possibly areas farther upstream.

The assessment recommended a variety of adaptation actions, most of which focus on raising electrical distribution panels above the projected high-water line, and preparing methods to seal off critical areas from flood waters.

Low-lying sections of Interstate 5 and U.S. Route 101 could also be vulnerable to the combined effects of flooding and sea-level rise in the future. These highways are critical to ensuring that commercial trucks, commuter cars, emergency service vehicles, and other automobiles can move within and through the Thurston County region.

McAllister Creek occasionally floods Interstate 5 on- and off-ramps south of the Billy Frank Jr. Nisqually National Wildlife Refuge (milepost 114). Sea-level rise would worsen this, according to a recent Washington State Department of Transportation vulnerability assessment of transportation infrastructure. The embankment atop which Interstate 5 sits was never evaluated for open water at its toe. The levee removal at the Nisqually delta and the rising sea level exposes the toe to potential wave action.

Similarly, along U.S. Route 101, as it crosses Mud Bay west of Olympia, water currently backs up in culverts and floods the highway's median during high tides. There is the potential for water to flood travel lanes temporarily due to sea-level rise.

Increased exposure to water and wave energy resulting from sea-level rise is expected to erode unprotected coastal bluffs, causing both detrimental and beneficial impacts. Coastal bluff erosion may threaten nearby buildings and occupants, yet this naturally occurring process may also contribute sand and gravel that would allow for down-drift shores to become higher and move landward, thereby maintaining the beach profile.

More than a quarter of Puget Sound's shoreline is armored with rock revetments, seawalls and other materials built to protect homes, roads, and other infrastructure. However, such barriers do not guarantee that the land behind them is invulnerable to the sea's growing reach.

Seawalls and revetments are usually designed for a particular set of conditions. If rising sea levels continue to magnify the effects of high tides and waves, the original freeboard will be exceeded by seawater gradually and overtopping will become more frequent. This would increase the probability of structural damage.

*Steven Wyble / Nisqually Valley News*

## Estimates of Flood Losses

Computer models can simulate flood scenarios to estimate potential property losses and other impacts to communities. The HAZUS Flood Model is a standardized tool that uses Geographical Information System (GIS) technology to estimate physical, economic, and social impacts of disasters using a variety of data inputs. FEMA Region X performed a level 2 analysis using local data provided by Thurston County and Thurston Regional Planning Council to develop the county's flood model. The models included the recently adopted Deschutes River SFHA and draft versions of the Chehalis and Coastal SFHAs. Loss estimates were derived for 10-, 25-, 50-, 100-, and 500-year flood scenarios. For these, scenarios, debris generation, sheltering requirements, building exposure, and building losses are presented.[12]

### Debris Generation

HAZUS provides an estimate of the total debris generated by floods. The 500-year flood event – the most wide-spread flood scenario – generates the most debris. HAZUS breaks the debris generation estimates into three categories:

1. Finish (dry wall, flooring, insulation, etc.)
2. Structure (framing, walls, exterior cladding)
3. Foundation (concrete slabs, concrete block or other foundation)

The table below summarizes debris generation for the Chehalis Basin, Deschutes Basin, coastal SFHA, and countywide.

**Estimated Tons of Debris Generation by Flood Scenario**

| CATEGORY | FLOOD EVENT | TOTAL | CHEHALIS | COASTAL | COUNTYWIDE | DESCHUTES |
|---|---|---|---|---|---|---|
| FINISH | 0.2 PERCENT | 3179.09 | 1967.22 | N/A | N/A | 1211.87 |
| | 1 PERCENT | 8272.71 | 1556.28 | 626.31 | 5094.64 | 995.48 |
| | 2 PERCENT | 2324.55 | 1418.81 | N/A | N/A | 905.74 |
| | 4 PERCENT | 2176.42 | 1368.81 | N/A | N/A | 807.61 |
| | 10 PERCENT | 1475.76 | 790.96 | N/A | N/A | 684.8 |
| STRUCTURE | 0.2 PERCENT | 1404.55 | 1240.07 | N/A | N/A | 164.48 |
| | 1 PERCENT | 3072.16 | 700.96 | 544.4 | 1713.68 | 113.12 |
| | 2 PERCENT | 675.26 | 578.69 | N/A | N/A | 96.57 |
| | 4 PERCENT | 618.88 | 537.42 | N/A | N/A | 81.46 |
| | 10 PERCENT | 320.79 | 255.95 | N/A | N/A | 64.84 |
| FOUNDATION | 0.2 PERCENT | 1895.82 | 1618.28 | N/A | N/A | 277.54 |
| | 1 PERCENT | 4168.87 | 1027.56 | 449.28 | 2489.01 | 203.02 |
| | 2 PERCENT | 1064.7 | 886.61 | N/A | N/A | 178.09 |
| | 4 PERCENT | 992.12 | 838.36 | N/A | N/A | 153.76 |
| | 10 PERCENT | 559.44 | 432.79 | N/A | N/A | 126.65 |
| GRAND TOTAL | 0.2 PERCENT | 6479.51 | 4825.61 | N/A | N/A | 1653.9 |
| | 1 PERCENT | 15513.98 | 3284.85 | 1620.1 | 9297.38 | 1311.65 |
| | 2 PERCENT | 4064.43 | 2884.07 | N/A | N/A | 1180.36 |
| | 4 PERCENT | 3787.48 | 2744.58 | N/A | N/A | 1042.9 |
| | 10 PERCENT | 2356 | 1479.66 | N/A | N/A | 876.34 |

## Shelter Requirements

The following HAZUS table provides estimates of the number of people who are displaced by flooding and who may require short-term sheltering.

### Estimates of Displaced People and Sheltering Needs

| | FLOOD EVENT | TOTAL | CHEHALIS | COASTAL | COUNTYWIDE | DESCHUTES |
|---|---|---|---|---|---|---|
| **DISPLACED POPULATION** | **0.2 PERCENT** | **3028** | **1705** | **N/A** | **N/A** | **1323** |
| | 1 PERCENT | 9697 | 1503 | 412 | 6552 | 1230 |
| | 2 PERCENT | 2581 | 1423 | N/A | N/A | 1158 |
| | 4 PERCENT | 2425 | 1356 | N/A | N/A | 1069 |
| | 10 PERCENT | 1936 | 979 | N/A | N/A | 957 |
| **SHORT-TERM SHELTERING** | 0.2 PERCENT | 1982 | 1090 | N/A | N/A | 892 |
| | 1 PERCENT | 6028 | 901 | 274 | 4041 | 812 |
| | 2 PERCENT | 1577 | 822 | N/A | N/A | 755 |
| | 4 PERCENT | 1445 | 766 | N/A | N/A | 679 |
| | 10 PERCENT | 1033 | 439 | N/A | N/A | 594 |

## Building Exposure

HAZUS provides estimates of the number of buildings exposed to floods. Countywide, a total of 5,156 buildings are in Special Flood Hazard Areas.

### Estimates of Buildings in Special Flood Hazard Areas

| COMMUNITY | BUILDINGS IN A SPECIAL FLOOD HAZARD AREA | BUILDINGS IN ZONES A, AE, AO (RIVERINE/STILLWATER) | BUILDINGS IN ZONE AE (COASTAL) | BUILDINGS IN ZONE VE (COASTAL) |
|---|---|---|---|---|
| Bucoda | 194 | 194 | 0 | 0 |
| Chehalis Reservation | 3 | 3 | 0 | 0 |
| Lacey | 27 | 27 | 0 | 0 |
| Nisqually Reservation | 2 | 2 | 0 | 0 |
| Olympia | 355 | 291 | 43 | 21 |
| Rainier | 0 | --- | --- | --- |
| Tenino | 5 | 5 | 0 | 0 |
| Tumwater | 82 | 79 | 3 | 0 |
| Yelm | 23 | 23 | 0 | 0 |
| Thurston County | 1,887 | 1,724 | 40 | 123 |
| **TOTAL** | **2,578** | **2,348** | **86** | **144** |

Note: Buildings identified in a Special Flood Hazard Area by using parcel centroids. Effective Special Flood Hazard Area data used inland. Preliminary Special Flood Hazard Area data used for coastal flood zones.

## Building Value Loss

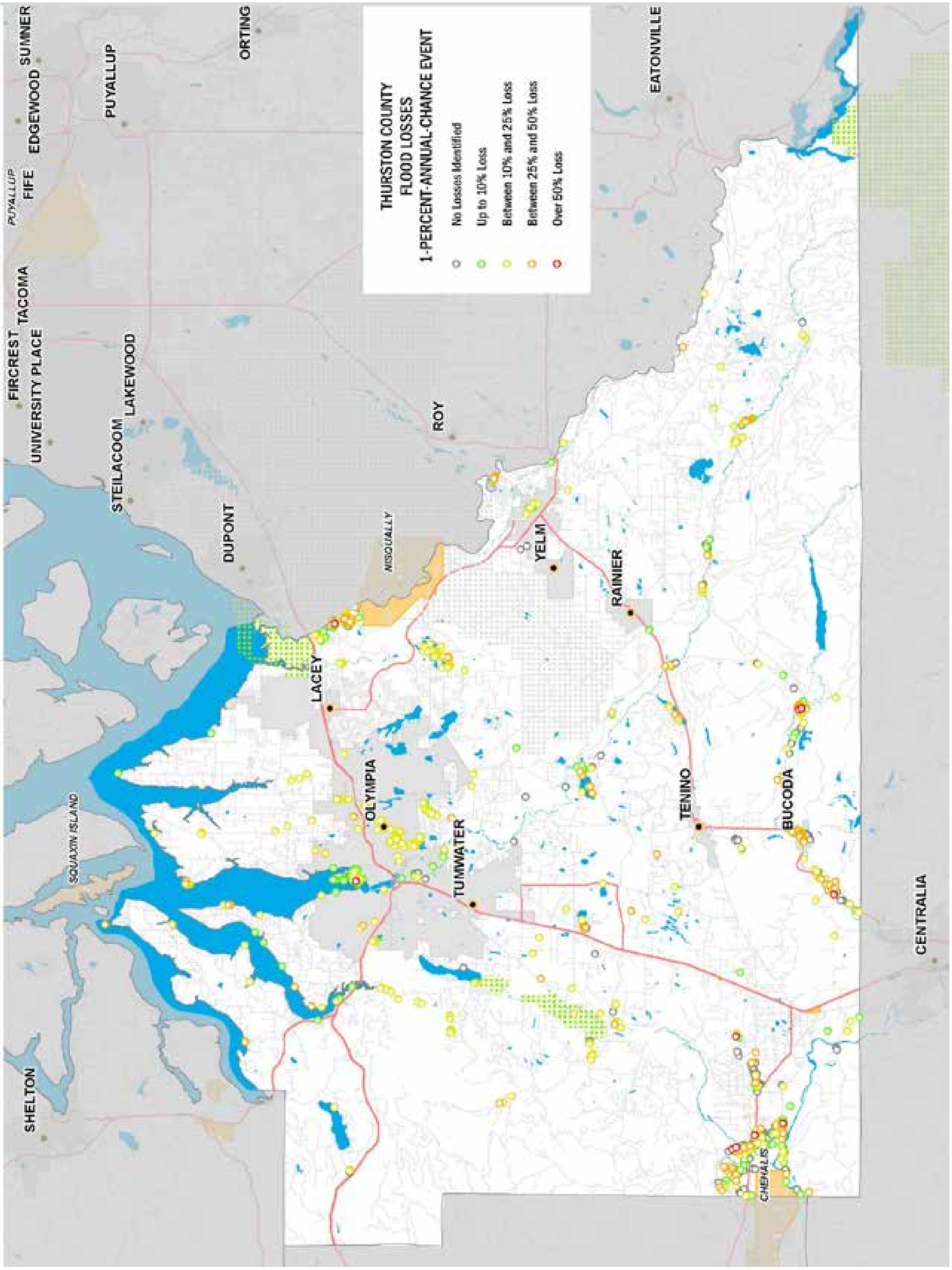
HAZUS calculates estimates of the economic loss of buildings and their contents due to damage from flooding. Below is a summary of losses, by jurisdiction for the 10-, 25-, 50-, 100-, and 500-year flood scenarios. Map 4.3.2 shows the location of building losses for the 100-year flood.

**Estimates of Building Losses by Flood Event**

| | | | 0.2% ANNUAL CHANCE FLOOD | | 1% ANNUAL CHANCE FLOOD | | 2% ANNUAL CHANCE FLOOD | | 4% ANNUAL CHANCE FLOOD | | 10% ANNUAL CHANCE FLOOD | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COMMUNITY | COUNT | TOTAL VALUE | LOSS VALUE | LOSS RATIO | LOSS VALUE | LOSS RATIO | LOSS VALUE | LOSS RATIO | LOSS VALUE | LOSS RATIO | LOSS VALUE | LOSS RATIO |
| Bucoda | 115 | 7.48 | 1.52 | 20.30% | 1.34 | 17.80% | 1.09 | 14.60% | 1.09 | 14.60% | 0.27 | 3.60% |
| Chehalis Reservation | 5 | 0.29 | 0.01 | 4.10% | --- | --- | --- | --- | --- | --- | --- | --- |
| Lacey | 1 | 0.25 | --- | --- | 0.03 | 10.40% | --- | --- | --- | --- | --- | --- |
| Nisqually Reservation | 2 | 0.32 | --- | --- | 0.03 | 9.50% | --- | --- | --- | --- | --- | --- |
| Olympia | 251 | 244.33 | --- | --- | 26.31 | 10.80% | --- | --- | --- | --- | --- | --- |
| Rainier | 0 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tenino | 0 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tumwater | 18 | 12.98 | 0.98 | 7.50% | 0.36 | 2.70% | 0.04 | 0.30% | 0.02 | 0.20% | 0 | 0.00% |
| Yelm | 8 | 1.46 | --- | --- | 0.09 | 6.40% | --- | --- | --- | --- | --- | --- |
| Thurston County | 802 | 95.71 | 9.36 | 9.80% | 12.18 | 12.70% | 4.23 | 4.40% | 3.75 | 3.90% | 1.33 | 1.40% |
| **TOTAL** | **1,202** | **362.83** | **11.87** | **3.30%** | **40.33** | **11.10%** | **5.36** | **1.50%** | **4.86** | **1.30%** | **1.6** | **0.40%** |

Note: Values are expressed in millions of dollars. Dollar losses are reported, as well as a loss ratio, which is calculated as the total building losses/total building value. The loss values are for building and contents only; additional damages to infrastructure are not captured in this table.

## Map 4.3.2: Thurston County Flood Losses, 100-Year (1-Percent Annualized Chance) Flood Event



# Flood Historical Occurrences and Impacts

Several major floods have impacted the Thurston Region over the last two decades. Describing the effects and damages from the most significant events highlights the region's vulnerability to floods and the extent of their damage. Past floods serve as useful reminders to communities to develop strategies to mitigate, prepare, and respond to future floods. The top 10 historic crests for the Nisqually, Deschutes, Skookumchuck, and Chehalis rivers:[9]

**Top Ten Historic Crests for Thurston County Rivers**

| | Nisqually at McKenna | | Deschutes near Rainier | | Skookumchuck near Bucoda | | Chehalis near Grand Mound | |
|---|---|---|---|---|---|---|---|---|
| **Rank** | Gauge Height | Date | Gauge Height | Date | Gauge Height | Date | Gauge Height | Date |
| 1 | 17.13 | 02/08/1996 | 17.01 | 01/09/1990 | 17.87 | 02/08/1996 | 20.23 | 12/04/2007 |
| 2 | 13.00 | 01/29/1965 | 15.74 | 02/08/1996 | 17.72 | 01/08/2009 | 19.98 | 02/09/1996 |
| 3 | 12.48 | 11/30/1995 | 15.68 | 01/15/1974 | 17.33 | 01/10/1990 | 19.34 | 01/10/1990 |
| 4 | 12.39 | 12/26/1980 | 15.28 | 01/21/1972 | 17.23 | 11/25/1990 | 18.41 | 11/25/1986 |
| 5 | 12.38 | 12/12/1955 | 14.29 | 12/29/1996 | 16.82 | 01/21/1972 | 18.39 | 12/29/1937 |
| 6 | 11.78 | 11/23/1959 | 14.10 | 01/08/2009 | 16.82 | 04/05/1991 | 18.21 | 01/21/1972 |
| 7 | 11.31 | 01/10/1990 | 13.76 | 04/05/1991 | 16.76 | 12/30/1996 | 18.18 | 01/09/2009 |
| 8 | 11.30 | 02/11/1951 | 13.75 | 12/03/2007 | 16.60 | 02/11/1990 | 18.12 | 11/25/1990 |
| 9 | 11.14 | 04/05/1991 | 13.55 | 11/26/1998 | 16.60 | 12/09/2015 | 17.73 | 12/05/1975 |
| 10 | 11.04 | 12/10/1953 | 13.42 | 12/28/1998 | 16.51 | 03/09/1977 | 17.66 | 04/06/1991 |

### January 6-16, 2009, Federal Disaster 1817: Severe Winter Storms, Landslides, Mudslides, and Flooding

An atmospheric river storm raised temperatures and dropped heavy rains throughout Western Washington following one of the worst Pacific Northwest snow storms in decades. Severe flooding occurred throughout Western Washington, including the Chehalis, Skookumchuck, Deschutes, Nisqually, and Black rivers. The Skookumchuck River crested at 17.72 feet on January 8, making it the second worst flood in the river's recorded history. The Chehalis River crested at 18.18 feet near Grand Mound causing major flooding in the Chehalis River Basin only 13 months after the December 2007 floods.

Interstate 5 was closed for 20 miles for nearly two days. State Route 12, State Route 8 and Highway 101 were also closed for a period, some for multiple days. During the height of the flood event, 49 county roads were closed. Over 200 homes were isolated in the Bald

Hills Road/Clearwood area, likely over 100 in the Rochester, Grand Mound, and Gate communities, and likely another 50 homes had access issues in the area around Bucoda.

Damages to homes throughout Thurston County were estimated at $3 million. Damage was concentrated in and around the town of Bucoda, the Rochester community, and along the Deschutes River outside of Yelm. Damages to public facilities and roads around Thurston County and the overtime cost for city and county officials to respond to the flooding cost $2.5 million.

Volunteer firefighters went door to door in Bucoda warning residents of imminent flooding before floodwaters swallowed a nine-block stretch of the town (the town's worst flood event since 1996). Residents were forced to evacuate and a Thurston County dive team was deployed to assist residents. At least two households required rescue assistance. One home was identified as too dangerous to inhabit and 12 homes were deemed moderately damaged and only accessible during the daytime. The Intersection of 3rd Avenue and North Nenant Street incurred damages exceeding $12,000. Extensive road damage along five blocks of Market Street also occurred. At least one municipal well was forced to shut down due to possible contamination. The town-owned RV park restroom was also contaminated by floodwaters and required extensive clean up.

On January 8, the City of Lacey shut down two streets for the first time in at least nine years due to urban flooding. Crews closed Rainier Road at the south end of city limits around the Burlington Northern Santa Fe (BNSF) railroad trestle. The City also closed 32nd Avenue Northeast off Marvin Road in the Hawks Prairie area. The heavy rains entering the sewer system in Olympia forced the LOTT Alliance to discharge 6.3 million gallons of partially treated wastewater from its Budd Inlet Sewer Treatment Plant via its emergency outfall at the Fiddlehead Marina.

### December 1-7, 2007, Federal Disaster 1734: Severe Winter Storms, Flooding, Landslides, and Mudslides[10]

Snow followed by a "Pineapple Express" on December 2 and 3 caused major flooding throughout southwest Washington. Heavy rainfall and melting snow resulted in record flooding on the Chehalis River, which crested at 20.23 feet, six feet over flood stage at the Grand Mound gauge. Some sites in the Willapa Hills area collected 14 to 18 inches of rain over the two-day period. Widespread flooding occurred in southwest Thurston County heavily impacting the Rochester community, Grand Mound, and the Independence Valley area. Lewis County was especially hard hit, particularly around the cities of Centralia and Chehalis and the farms around Adna and the Boisfort Valley.

The Deschutes and Black rivers also rose above their banks. The Deschutes River crested 2.75 feet above flood stage near Rainier and flooded residential areas and the Tumwater Valley. The region also experienced stream and urban flooding and flash flood conditions in the Capitol Forest, resulting in washouts and landslides (see landslide hazard profile for other details on this event).

On December 4, Rochester Fire Department developed a command post for evacuation and rescue. They partnered with the Thurston County Sheriff's Office Dive Team, local search and rescue volunteer groups, and the Washington State National Guard and rescued 63 people – 17 by helicopter. Nearly 300 people were rescued or forced to evacuate in Lewis County – some seeking refuge in local area shelters. Thurston County opened a flood relief center at the Rochester Community Center to assist affected residents.

Thurston County documented 44 county roads and bridges that closed from storm and flood damage. The county and cities carried out round-the-clock road repair and maintenance. Estimates reflect that over 400 homes in the area were affected by the road closures in the southwest Thurston County. Interstate 5 closed for 20 miles between Chehalis and Grand Mound for five days. Some portions of Interstate 5 were covered with 10 feet of water. The Washington State Department of Transportation estimated that the closure resulted in $47 million in lost of economic output statewide.[11] Additional closures along Highway 101 and Highway 8 disrupted traffic for thousands of people who live or work in Thurston County, or who were passing through. A railroad bridge over the Nisqually River suffered significant damage due to debris collection against the bridge, resulting in a disruption of statewide rail traffic. West coast rail traffic was also shut down for several days due to flooding.

Nearly 10 inches of rain fell on the City of Olympia's west side resulting in the worst urban flooding ever experienced in that area. On December 3, 2007 during the morning peak commute period, the west side of Olympia experienced major traffic backups for hours due to road closures. One of the highest traffic volume intersections in the region, Cooper Point Road and Black Lake Boulevard off Highway 101, experienced major flooding resulting in permanent damage to the signal controller. Several motorists attempted to drive through the water only to become stranded and forced to abandon their vehicles. Some vehicles were eventually completely submerged. Inundation forced the closure of the Percival Creek Bridge on Cooper Point Road. Several businesses on Olympia's west side were affected by floodwaters and power outages. Puget Sound Energy turned off power as a safety precaution requiring businesses to temporarily close. The Woodshed, a furniture retailer, lost their entire inventory to three feet of water. Replacement cost was estimated at $250,000.

On December 3, the enormous volume of rainfall and runoff caused LOTT Clean Water Alliance's Budd Inlet Sewer Treatment Plant to discharge untreated wastewater into Budd Inlet. At its peak, an estimated 1 million gallons per hour bypassed treatment processes and was sent through the emergency outfall near Fiddlehead Marina. After the flooding, many wells and water supplies were contaminated and non-functional in the unincorporated areas of the county. Public health advisories were issued to flood affected areas to inform the public to boil their water or consume only bottled water.

Preliminary cost estimates for the response, preventive measures, and the damage to public facilities exceeded $4.6 million throughout Thurston County. In many ways, the dollar figures reported for response costs only reflect a fraction of the actual response costs to local governments. For example, the estimates may not include volunteers, such as the local fire districts' volunteer firefighters who provided emergency response. Damage to Thurston County roads and bridges for non-federal aid routes was $2.7 million. Three sites of federal aid roads incurred over $32,000 in damages.

For this disaster, nearly 267 Thurston County residents applied to FEMA for assistance with over $6 million claims in property damages. FEMA awarded $544,928 in aid and the Small Business Administration granted $1.7 million to 30 homeowners and 2 businesses.

### October15-23, 2003, Federal Disaster 1499: Severe Storms and Flooding

At least 11 people reported flood damage within Thurston County, with at least two structures possibly incurring damage exceeding their replacement value. Thurston County was not seriously impacted by this storm event and received a disaster declaration because it bordered counties that experienced more severe flooding (Mason, Pierce, and Grays Harbor counties).

### February 1999 High Ground Water Flooding

Higher than normal rainfall caused major groundwater flooding and urban stormwater flooding throughout Thurston County and its communities. Although no federal disaster was issued, major flooding affected over 200 properties in Lacey, Olympia, Tumwater, and Thurston County. (See landslide hazard profile for more on landslide impacts during this event).

### December 1996 (Federal Disaster 1159) to February 1997 Winter Storm and Flooding

1996 was the third wettest year of the 20th Century. December was especially wet, receiving over twice its normal monthly rainfall. During this time:

- 200 homes countywide were flooded
- 200 drinking water wells were contaminated
- Septic system failures occurred throughout the county
- Response and recovery efforts cost Thurston County government over $340,000
- Response, recovery, and repair costs for other government entities and utilities exceeded $750,000
- Private property owners incurred over $1.75 million in uninsured losses

### February 1996, Federal Disaster 1100: Flooding

The February 1996 flood is one of the most devastating floods on record for Thurston County. Every major river and stream crested their banks. Record flooding occurred on the Nisqually River near McKenna when the river crested at 17.13 feet, seven feet over flood stage on February 8, 1996. Record flooding also occurred on the Skookumchuck River near Bucoda when the river crested at 17.87 feet, four feet over flood stage. Major flooding also occurred on the Deschutes and Chehalis rivers. The 1996 flood resulted in the following impacts:

- Of the over 350 homes inspected, 190 were declared uninhabitable
- 47 homes were destroyed in the Nisqually Valley
- Over two dozen homes were destroyed elsewhere
- Nearly 1,000 people evacuated their homes
- 300 people required rescuing
- More than 300 sections of the county road system were damaged
- Wa He Lut, a contract U.S. Bureau of Indian Affairs School, was destroyed by the Nisqually River
- Interstate 5 was closed at the Lewis County line
- The main north-south railroad line at the Pierce County line was closed
- Response and recovery efforts cost Thurston County government over $2 million
- Response, recovery, and repair costs for other government entities and utilities exceeded $20 million
- Private property owners incurred over $22 million in uninsured losses.

### January 1990, Federal Disaster 852: Severe Storm and Flooding

The Deschutes River at Rainier crested at 17.01 feet, six feet over flood stage – setting the flood record. Major flooding also occurred on the Nisqually, Deschutes, Skookumchuck, and Chehalis rivers. The Thurston Region experienced the following impacts:

- Flood waters in Lewis County killed two people
- Interstate 5 closed for several days between Chehalis and Thurston County
- 83 elderly residents from the Nisqually Valley Care Center in McKenna were evacuated to a Red Cross Shelter at the Yelm High School gymnasium
- Floodwaters reached four feet deep on Bucoda streets and prompted nearly 600 residents to evacuate; one elderly man died from natural causes during the evacuation
- Lowland Nisqually Valley residents were urged to evacuate their homes
- Portions of downtown Olympia experienced urban flooding

# Flood Hazard Exposure Analysis

## Delineation of the Flood Hazard Area

Map 4.3.3 shows the flood hazard areas for the Thurston County planning area. It consists of both the one percent annualized chance of flooding (100-year flood) and the 0.2 percent annualized chance of flooding (500-year flood) Special Flood Hazard Areas from the most current Digital Flood Insurance Rate Map (DFIRM 2012). This map incorporates the latest Deschutes River flood hazard areas provided by FEMA. It also includes Thurston County's High Groundwater Hazard Areas (including 300-foot buffers). These boundaries were used to perform a flood hazard exposure analysis employing a Geographical Information System (GIS) to summarize the total area, population, employment, residential dwellings, valuation of buildings and contents, and essential facilities. This information is summarized by jurisdiction and special districts in Tables 4.3.4 through 4.3.14.

Nearly 34,621 acres or 7.3 percent of the planning area is within the 100-year flood, whereas only 3,644 acres or 0.8 percent of the planning area is within the 500-year Special Flood Hazard Area. A nearly equal portion of the county, 34,214 or 7.3 percent, is within high groundwater hazard areas. Combined, nearly 14 percent of the county is exposed to natural flood hazards. Rural unincorporated Thurston County has the largest flood-prone areas of any community in the planning area (55,138 acres). However, 67 percent of the Chehalis Reservation is exposed to flood hazards and nearly 54 percent for the Town of Bucoda. Tables 4.3.4 and 4.3.5 summarize the total flood hazard delineation area by jurisdiction and special districts.

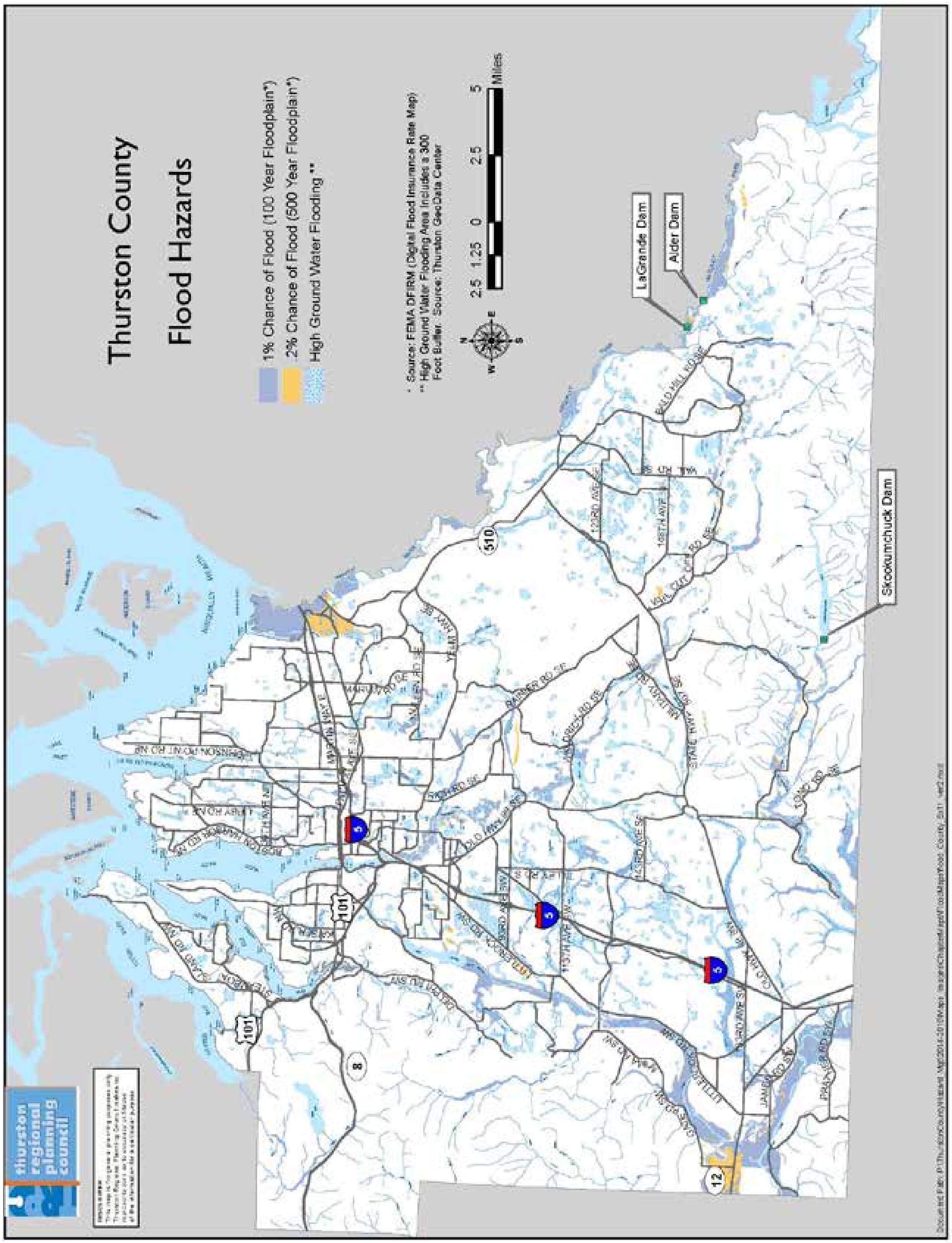
## Population and Employment in the Hazard Area

Approximately 19,300 people (7.3 percent) and 8,400 employees (6.3 percent) live and work within the flood hazard area. Presently, rural unincorporated Thurston County has the greatest number of residents living in flood prone areas (9,750). By the year 2040, population growth in the cities and the present day UGAs will represent a larger portion (64 percent) of the planning area's population affected by floods than in the rural unincorporated county (36 percent). Estimates of the region's population and employment in the flood hazard area are summarized in tables 4.3.6 through 4.3.9. These tables assess an aspect of current and future vulnerability by providing data on the number of people living and working within the hazard area as compared to total population, by jurisdiction, in the years 2015 and 2040.

## Residential Dwellings in the Hazard Area

Countywide, approximately 8,200 dwelling units (7.2 percent) are in flood hazard areas. That number could grow to 13,900 by 2040.

## Map 4.3.3: Thurston County Flood Hazard Areas



## Inventory of Assets and Dollar Value in the Hazard Area

Estimates of the region's structures and their contents in the flood hazard area are summarized in Tables 4.3.12 and 4.3.13. These tables provide an estimate of the existing structures and contents which may be at risk to flooding. The estimated value of at-risk residential property is over $1 billion in 2014 dollars. Seventy-five percent of the Town of Bucoda's housing value is in flood prone areas, the largest share by far of any other community in the planning area. Countywide, nearly $141 million in commercial/industrial and $360 million in government/ institutional building valuation is within flood prone areas.

## Essential Facilities and Infrastructure in Hazard Area

Flooding can destroy or damage facilities critical for responding to emergency events and for maintaining a safe environment and public order. These include communications, electrical generation and transmission, natural gas transmission, water storage and purification and pumping facilities, sewage treatment, hospitals, and police and fire stations. In addition, floods can seriously disrupt the transportation network.

Specific information on the location of essential facilities and infrastructure is housed with Thurston County Emergency Management. Essential facilities include both public and private facilities. Table 4.3.14 lists the type and number of essential facilities located in the flood hazard area.

# Summary Assessment

The history of major flooding within the Thurston Region clearly demonstrates a high probability of occurrence. The December 2007 and January 2009 floods were not as costly as the February 1996 flood, but suggest that the region remains vulnerable to flood impacts. Because only around seven percent of the county's land area, population, and valuation is exposed, a moderate vulnerability is assigned.

On a jurisdictional basis, an exception is the Town of Bucoda, which has a high vulnerability to flooding due to its location and high exposure to floods within the 100-year floodplain. The combined frequency of flooding, the potential for simultaneous flood events, and the historic records of recurrent damaging floods, lead to an overall high risk rating for the entire planning area.

Tidal flooding currently poses little risk within the entire planning area. It is a primary focus for the City of Olympia for developing a mitigation and adaptation strategy to safeguard downtown Olympia and combat the effects of sea-level rise. Climate change is likely to increase the risk of urban flooding as existing stormwater systems may be insufficient to handle more intense future precipitation events.

**Risk Assessment for Flood in the Thurston Region**

| Flood Type | Probability of Occurrence | Vulnerability | Risk |
|---|---|---|---|
| Riverine | High | Moderate | High |
| Groundwater | High | Moderate | High |
| Tidal | Moderate | Low | Low |
| Urban | High | Moderate | Moderate |
| Overall Assessment | High | Moderate | High |

## Table 4.3.4: Flood Hazard Area, by Jurisdiction

| Jurisdiction | | Total Acres | 1% Chance Flood In Hazard Area Acres | % | 0.2% Chance Flood In Hazard Area Acres | % | High Ground Water In Hazard Area Acres | % | Any Flood Hazard In Hazard Area Acres | % |
|---|---|---|---|---|---|---|---|---|---|---|
| Bucoda | **Total** | **380** | **182** | **48.0%** | **7** | **1.9%** | **57** | **15.1%** | **204** | **53.8%** |
| Lacey | City | 10,778 | 517 | 4.8% | 16 | 0.1% | 861 | 8.0% | 1,203 | 11.2% |
| | UGA | 10,416 | 796 | 7.6% | 5 | 0.0% | 411 | 3.9% | 1,187 | 11.4% |
| | **Total** | **21,193** | **1,313** | **6.2%** | **20** | **0.1%** | **1,272** | **6.0%** | **2,390** | **11.3%** |
| Olympia | City | 12,089 | 938 | 7.8% | 4 | 0.0% | 870 | 7.2% | 1,555 | 12.9% |
| | UGA | 3,887 | 309 | 7.9% | 5 | 0.1% | 321 | 8.3% | 589 | 15.1% |
| | **Total** | **15,976** | **1,247** | **7.8%** | **10** | **0.1%** | **1,191** | **7.5%** | **2,144** | **13.4%** |
| Rainier | City | 1,105 | 1 | 0.1% | 0 | 0.0% | 72 | 6.5% | 72 | 6.5% |
| | UGA | 320 | 2 | 0.7% | 0 | 0.0% | 16 | 4.9% | 18 | 5.6% |
| | **Total** | **1,425** | **3** | **0.2%** | **0** | **0.0%** | **87** | **6.1%** | **90** | **6.3%** |
| Tenino | City | 922 | 34 | 3.7% | 7 | 0.7% | 79 | 8.5% | 96 | 10.4% |
| | UGA | 65 | 8 | 11.5% | 0 | 0.0% | 0 | 0.0% | 8 | 11.5% |
| | **Total** | **987** | **42** | **4.2%** | **7** | **0.7%** | **79** | **8.0%** | **104** | **10.5%** |
| Tumwater | City | 11,354 | 915 | 8.1% | 243 | 2.1% | 1,730 | 15.2% | 2,494 | 22.0% |
| | UGA | 2,875 | 152 | 5.3% | 80 | 2.8% | 657 | 22.8% | 857 | 29.8% |
| | **Total** | **14,229** | **1,067** | **7.5%** | **323** | **2.3%** | **2,387** | **16.8%** | **3,351** | **23.5%** |
| Yelm | City | 3,634 | 145 | 4.0% | 5 | 0.1% | 362 | 10.0% | 429 | 11.8% |
| | UGA | 2,396 | 75 | 3.1% | 0 | 0.0% | 407 | 17.0% | 420 | 17.5% |
| | **Total** | **6,030** | **220** | **3.7%** | **5** | **0.1%** | **769** | **12.8%** | **849** | **14.1%** |
| Grand Mound UGA | **Total** | **983** | **11** | **1.1%** | **0** | **0.0%** | **145** | **14.8%** | **149** | **15.2%** |
| Chehalis Res.[1] | **Total** | **833** | **557** | **66.9%** | **0** | **0.0%** | **0** | **0.0%** | **557** | **66.9%** |
| Nisqually Res.[1] | **Total** | **2,147** | **293** | **13.7%** | **0** | **0.0%** | **0** | **0.0%** | **293** | **13.7%** |
| **Total Cities** | | **40,261** | **2,732** | **6.8%** | **282** | **0.7%** | **4,031** | **10.0%** | **6,053** | **15.0%** |
| **Total UGAs[2]** | | **20,943** | **1,352** | **6.5%** | **90** | **0.4%** | **1,957** | **9.3%** | **3,227** | **15.4%** |
| **Total Reservations[1]** | | **2,979** | **851** | **28.6%** | **0** | **0.0%** | **0** | **0.0%** | **851** | **28.6%** |
| **Rural Uninc. County[3]** | | **406,934** | **29,685** | **7.3%** | **3,271** | **0.8%** | **28,226** | **6.9%** | **55,138** | **13.5%** |
| **Thurston County Total** | | **471,117** | **34,621** | **7.3%** | **3,644** | **0.8%** | **34,214** | **7.3%** | **65,270** | **13.9%** |

**Explanations:** Flood Hazard includes the Special Flood Hazard Areas Subject to Inundation by the 1% and 0.2% Annual Chance of Flood and Thurston County High Groundwater Hazard Areas. (Source: Flood Insurance Rate Map, Thurston County Washington October, 2012; Thurston Geo Data).

1. Data are for the Thurston County portion of reservation only.
2. Urban Growth Area (UGA): Unincorporated area designated to be annexed into city limits over 20 years to accommodate urban growth.
3. Rural unincorporated county is the portion of the unincorporated county that lies outside UGA and Reservation boundaries.

## Table 4.3.5: Flood Hazard Area, by Special Districts

| | | 1% Chance Flood | | 0.2% Chance Flood | | High Ground Water | | Any Flood Hazard | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | In Hazard Area | | In Hazard Area | | In Hazard Area | | In Hazard Area | |
| Jurisdiction | Acres | Acres | % | Acres | % | Acres | % | Acres | % |
| **Fire Protection Districts** | | | | | | | | | |
| 1,11 West Thurston RFA | 100,131 | 11,559 | 11.5% | 1,091 | 1.1% | 9,638 | 9.6% | 20,012 | 20.0% |
| 2, 4 S.E. Thurston RFA | 56,030 | 3,167 | 5.7% | 356 | 0.6% | 7,341 | 13.1% | 9,999 | 17.8% |
| 3 Lacey | 36,820 | 4,588 | 12.5% | 1,105 | 3.0% | 2,252 | 6.1% | 7,264 | 19.7% |
| 5, 9 McLane-Black Lake | 51,828 | 2,748 | 5.3% | 87 | 0.2% | 814 | 1.6% | 3,520 | 6.8% |
| 6 East Olympia | 19,677 | 2,417 | 12.3% | 152 | 0.8% | 2,186 | 11.1% | 4,062 | 20.6% |
| 8 South Bay | 20,974 | 869 | 4.1% | 0 | 0.0% | 1,700 | 8.1% | 2,524 | 12.0% |
| 12 Tenino | 19,914 | 1,938 | 9.7% | 185 | 0.9% | 2,465 | 12.4% | 3,889 | 19.5% |
| 13 Griffin | 14,864 | 543 | 3.7% | 0 | 0.0% | 873 | 5.9% | 1,398 | 9.4% |
| 16 Gibson Valley | 18,038 | 1,744 | 9.7% | 48 | 0.3% | 1,533 | 8.5% | 2,495 | 13.8% |
| 17 Bald Hills | 13,926 | 1,431 | 10.3% | 179 | 1.3% | 1,119 | 8.0% | 2,543 | 18.3% |
| **School Districts** | | | | | | | | | |
| Centralia[1] | 12,851 | 1,722 | 13.4% | 44 | 0.3% | 1,187 | 9.2% | 2,140 | 16.7% |
| Griffin | 21,355 | 529 | 2.5% | 0 | 0.0% | 869 | 4.1% | 1,392 | 6.5% |
| North Thurston | 47,081 | 4,393 | 9.3% | 1,013 | 2.2% | 3,445 | 7.3% | 8,078 | 17.2% |
| Olympia | 49,895 | 1,977 | 4.0% | 28 | 0.1% | 1,662 | 3.3% | 3,434 | 6.9% |
| Rainier | 35,550 | 1,459 | 4.1% | 155 | 0.4% | 1,929 | 5.4% | 3,233 | 9.1% |
| Rochester[1] | 55,061 | 7,951 | 14.4% | 923 | 1.7% | 2,782 | 5.1% | 10,575 | 19.2% |
| Tenino | 70,500 | 5,071 | 7.2% | 328 | 0.5% | 6,697 | 9.5% | 10,328 | 14.6% |
| Tumwater | 73,846 | 5,588 | 7.6% | 573 | 0.8% | 7,579 | 10.3% | 12,440 | 16.8% |
| Yelm[1] | 104,854 | 5,974 | 5.7% | 580 | 0.6% | 8,069 | 7.7% | 13,695 | 13.1% |
| **Other Districts** | | | | | | | | | |
| Intercity Transit | 64,390 | 6,823 | 10.6% | 382 | 0.6% | 5,325 | 8.3% | 11,383 | 17.7% |
| LOTT Clean Water Alliance[2] | 16,016 | 530 | 3.3% | 29 | 0.2% | 835 | 5.2% | 1,259 | 7.9% |
| Port of Olympia | 471,117 | 34,621 | 7.3% | 3,644 | 0.8% | 34,214 | 7.3% | 65,270 | 13.9% |
| Thurston County PUD | 471,117 | 34,621 | 7.3% | 3,644 | 0.8% | 34,214 | 7.3% | 65,270 | 13.9% |

**Explanations:** Flood Hazard includes the Special Flood Hazard Areas Subject to Inundation by the 1% and 0.2% Annual Chance of Flood and Thurston County High Groundwater Hazard Areas. (Source: Flood Insurance Rate Map, Thurston County Washington October, 2012; Thurston Geo Data).

1. Data are for Thurston County portion of the district only.
2. Includes the sewered area.

## Table 4.3.6: Flood Hazard Area, Population by Jurisdiction, 2015 and 2040

| | | 2015 Population Estimate | | | 2040 Population Forecast | | |
|---|---|---|---|---|---|---|---|
| | | Total | In Hazard Area | | Total | In Hazard Area | |
| Jurisdiction | | # | # | % | # | # | % |
| Bucoda | **Total** | **565** | **410** | **72.6%** | **1,215** | **710** | **58.4%** |
| Lacey | City | 46,230 | 2,600 | 5.6% | 55,160 | 2,800 | 5.1% |
| | UGA | 33,980 | 990 | 2.9% | 59,030 | 2,080 | 3.5% |
| | **Total** | **80,210** | **3,590** | **4.5%** | **114,190** | **4,880** | **4.3%** |
| Olympia | City | 51,020 | 1,740 | 3.4% | 71,840 | 3,580 | 5.0% |
| | UGA | 11,920 | 700 | 5.9% | 16,770 | 1,300 | 7.8% |
| | **Total** | **62,940** | **2,440** | **3.9%** | **88,610** | **4,880** | **5.5%** |
| Rainier | City | 1,880 | 70 | 3.7% | 2,810 | 105 | 3.7% |
| | UGA | 110 | 5 | 4.5% | 640 | 35 | 5.5% |
| | **Total** | **1,990** | **75** | **3.8%** | **3,450** | **140** | **4.1%** |
| Tenino | City | 1,730 | 40 | 2.3% | 3,675 | 190 | 5.2% |
| | UGA | 15 | 0 | 0.0% | 110 | 0 | 0.0% |
| | **Total** | **1,745** | **40** | **2.3%** | **3,785** | **190** | **5.0%** |
| Tumwater | City | 22,370 | 1,460 | 6.5% | 37,350 | 5,100 | 13.7% |
| | UGA | 3,270 | 560 | 17.1% | 8,960 | 1,750 | 19.5% |
| | **Total** | **25,640** | **2,020** | **7.9%** | **46,310** | **6,850** | **14.8%** |
| Yelm | City | 8,170 | 700 | 8.6% | 25,080 | 2,800 | 11.2% |
| | UGA | 1,420 | 160 | 11.3% | 5,690 | 630 | 11.1% |
| | **Total** | **9,590** | **860** | **9.0%** | **30,770** | **3,430** | **11.1%** |
| Grand Mound UGA | **Total** | **1,285** | **40** | **3.1%** | **1,990** | **40** | **2.0%** |
| Chehalis Reservation[1] | **Total** | **70** | **40** | **57.1%** | **190** | **110** | **57.9%** |
| Nisqually Reservation[1] | **Total** | **605** | **20** | **3.3%** | **705** | **30** | **4.3%** |
| **Total Cities** | | **131,970** | **7,020** | **5.3%** | **197,120** | **15,300** | **7.8%** |
| **Total UGAs[2]** | | **52,000** | **2,460** | **4.7%** | **93,190** | **5,840** | **6.3%** |
| **Total Reservations[1]** | | **670** | **60** | **9.0%** | **890** | **140** | **15.7%** |
| **Rural Unincorporated County[3]** | | **82,770** | **9,750** | **11.8%** | **102,470** | **11,870** | **11.6%** |
| **Thurston County Total** | | **267,400** | **19,300** | **7.2%** | **393,700** | **33,100** | **8.4%** |

**Source:** Thurston Regional Planning Council Population Forecast, 2015
**Explanations:** Flood Hazard includes the Special Flood Hazard Areas Subject to Inundation by the 1% and 0.2% Annual Chance of Flood and Thurston County High Groundwater Hazard Areas. Numbers may not add due to rounding.
1. Data are for the Thurston County portion of reservation only.
2. Urban Growth Area (UGA): Unincorporated area designated to be annexed into city limits over 20 years to accommodate urban growth.
3. Rural unincorporated county is the portion of the unincorporated county that lies outside UGA and Reservation boundaries.

## Table 4.3.7: Flood Hazard Area, Population by Special Districts, 2015 and 2040

| Jurisdiction | 2015 Population Estimate | | | 2040 Population Forecast | | |
|---|---|---|---|---|---|---|
| | Total | In Hazard Area | | Total | In Hazard Area | |
| | # | # | % | # | # | % |
| **Fire Protection Districts** | | | | | | |
| 1,11 West Thurston | 22,010 | 3,160 | 14.4% | 31,120 | 4,870 | 15.6% |
| 2, 4 S.E. Thurston | 24,650 | 2,450 | 9.9% | 50,770 | 5,580 | 11.0% |
| 3 Lacey | 91,660 | 5,290 | 5.8% | 128,070 | 6,850 | 5.3% |
| 5, 9 McLane-Black Lake | 15,890 | 920 | 5.8% | 20,770 | 1,140 | 5.5% |
| 6 East Olympia | 11,140 | 800 | 7.2% | 14,810 | 1,550 | 10.5% |
| 8 South Bay | 11,820 | 1,020 | 8.6% | 15,380 | 1,170 | 7.6% |
| 12 Tenino | 6,230 | 900 | 14.4% | 9,530 | 1,220 | 12.8% |
| 13 Griffin | 5,060 | 500 | 9.9% | 5,700 | 540 | 9.5% |
| 16 Gibson Valley | 590 | 170 | 28.8% | 1,130 | 210 | 18.6% |
| 17 Bald Hills | 4,090 | 430 | 10.5% | 5,440 | 560 | 10.3% |
| **School Districts** | | | | | | |
| Centralia[1] | 490 | 180 | 36.7% | 1,180 | 330 | 28.0% |
| Griffin | 5,950 | 570 | 9.6% | 6,710 | 610 | 9.1% |
| North Thurston | 99,300 | 5,720 | 5.8% | 138,340 | 8,170 | 5.9% |
| Olympia | 66,140 | 2,690 | 4.1% | 87,700 | 3,930 | 4.5% |
| Rainier | 5,210 | 570 | 10.9% | 13,800 | 1,080 | 7.8% |
| Rochester[1] | 14,060 | 1,370 | 9.7% | 18,080 | 1,700 | 9.4% |
| Tenino | 9,850 | 1,760 | 17.9% | 15,510 | 2,510 | 16.2% |
| Tumwater | 39,500 | 3,760 | 9.5% | 63,820 | 9,310 | 14.6% |
| Yelm[1] | 26,900 | 2,670 | 9.9% | 48,530 | 5,510 | 11.4% |
| **Other Districts** | | | | | | |
| Intercity Transit | 176,450 | 8,850 | 5.0% | 269,860 | 19,350 | 7.2% |
| LOTT Clean Water Alliance[2] | 120,960 | 5,100 | 4.2% | 249,110 | 16,610 | 6.7% |
| Port of Olympia | 267,400 | 19,300 | 7.2% | 393,700 | 33,100 | 8.4% |
| Thurston County PUD | 267,400 | 19,300 | 7.2% | 393,700 | 33,100 | 8.4% |

**Source:** Thurston Regional Planning Council Population Forecast, 2015
**Explanations:** Flood Hazard includes the Special Flood Hazard Areas Subject to Inundation by the 1% and 0.2% Annual Chance of Flood and Thurston County High Groundwater Hazard Areas.
1. Data are for Thurston County portion of the district only.
2. Includes the sewered area for 2015 and the Lacey-Olympia-Tumwater Urban Area for 2040.

## Table 4.3.8: Flood Hazard Area, Employment, 2014 and 2040

| | | 2014 Employment Estimate | | | 2040 Employment Forecast | | |
|---|---|---|---|---|---|---|---|
| | | Total | In Hazard Area | | Total | In Hazard Area | |
| Jurisdiction | | # | # | % | # | # | % |
| Bucoda | **Total** | **90** | **70** | **77.8%** | **200** | **140** | **70.0%** |
| Lacey | City | 25,610 | 1,300 | 5.1% | 41,180 | 1,800 | 4.4% |
| | UGA | 5,620 | 140 | 2.5% | 8,520 | 210 | 2.5% |
| | **Total** | **31,230** | **1,440** | **4.6%** | **49,700** | **2,010** | **4.0%** |
| Olympia | City | 53,350 | 1,810 | 3.4% | 74,950 | 2,600 | 3.5% |
| | UGA | 1,800 | 80 | 4.4% | 2,230 | 120 | 5.4% |
| | **Total** | **55,150** | **1,890** | **3.4%** | **77,180** | **2,720** | **3.5%** |
| Rainier | City | 455 | 10 | 2.2% | 690 | 20 | 2.9% |
| | UGA | 25 | 0 | 0.0% | 80 | 0 | 0.0% |
| | **Total** | **480** | **10** | **2.1%** | **770** | **20** | **2.6%** |
| Tenino | City | 870 | 40 | 4.6% | 1,505 | 60 | 4.0% |
| | UGA | 0 | 0 | - | 5 | 0 | 0.0% |
| | **Total** | **870** | **40** | **4.6%** | **1,510** | **60** | **4.0%** |
| Tumwater | City | 22,350 | 1,610 | 7.2% | 33,720 | 2,230 | 6.6% |
| | UGA | 760 | 210 | 27.6% | 1,420 | 350 | 24.6% |
| | **Total** | **23,110** | **1,820** | **7.9%** | **35,140** | **2,580** | **7.3%** |
| Yelm | City | 3,830 | 340 | 8.9% | 11,490 | 1,050 | 9.1% |
| | UGA | 430 | 90 | 20.9% | 670 | 110 | 16.4% |
| | **Total** | **4,260** | **430** | **10.1%** | **12,160** | **1,160** | **9.5%** |
| Grand Mound UGA | **Total** | **1,115** | **50** | **4.5%** | **1,375** | **60** | **4.4%** |
| Chehalis Reservation[1] | **Total** | **760** | **310** | **40.8%** | **1,550** | **650** | **41.9%** |
| Nisqually Reservation[1] | **Total** | **975** | **0** | **0.0%** | **1,865** | **0** | **0.0%** |
| **Total Cities** | | **106,560** | **5,190** | **4.9%** | **163,730** | **7,900** | **4.8%** |
| **Total UGAs[2]** | | **9,740** | **570** | **5.9%** | **14,300** | **850** | **5.9%** |
| **Total Reservations[1]** | | **1,740** | **310** | **17.8%** | **3,410** | **650** | **19.1%** |
| **Rural Unincorporated County[3]** | | **15,880** | **2,320** | **14.6%** | **18,270** | **2,660** | **14.6%** |
| **Thurston County Total** | | **133,900** | **8,400** | **6.3%** | **199,700** | **12,100** | **6.1%** |

**Source:** Thurston Regional Planning Council Population Forecast, 2015
**Explanations:** Flood Hazard includes the Special Flood Hazard Areas Subject to Inundation by the 1% and 0.2% Annual Chance of Flood and Thurston County High Groundwater Hazard Areas. Numbers may not add due to rounding.
1. Data are for the Thurston County portion of reservation only.
2. Urban Growth Area (UGA): Unincorporated area designated to be annexed into city limits over 20 years to accommodate urban growth.
3. Rural unincorporated county is the portion of the unincorporated county that lies outside UGA and Reservation boundaries.

## Table 4.3.9: Flood Hazard Area, Employment – Special Districts, 2014 and 2040

| | 2014 Employment Estimate | | | 2040 Employment Forecast | | |
|---|---|---|---|---|---|---|
| | Total | In Hazard Area | | Total | In Hazard Area | |
| Jurisdiction | # | # | % | # | # | % |
| **Fire Protection Districts** | | | | | | |
| 1,11 West Thurston | 6,290 | 1,250 | 19.9% | 8,480 | 1,960 | 23.1% |
| 2, 4 S.E. Thurston | 6,710 | 710 | 10.6% | 15,170 | 1,490 | 9.8% |
| 3 Lacey | 34,540 | 1,800 | 5.2% | 54,170 | 2,380 | 4.4% |
| 5, 9 McLane-Black Lake | 3,630 | 200 | 5.5% | 4,350 | 230 | 5.3% |
| 6 East Olympia | 1,960 | 190 | 9.7% | 2,350 | 240 | 10.2% |
| 8 South Bay | 1,830 | 270 | 14.8% | 2,250 | 280 | 12.4% |
| 12 Tenino | 1,500 | 190 | 12.7% | 2,210 | 220 | 10.0% |
| 13 Griffin | 990 | 150 | 15.2% | 1,060 | 160 | 15.1% |
| 16 Gibson Valley | 150 | 50 | 33.3% | 180 | 50 | 27.8% |
| 17 Bald Hills | 470 | 60 | 12.8% | 570 | 70 | 12.3% |
| **School Districts** | | | | | | |
| Centralia[1] | 120 | 40 | 33.3% | 170 | 60 | 35.3% |
| Griffin | 1,110 | 160 | 14.4% | 1,190 | 160 | 13.4% |
| North Thurston | 42,280 | 2,120 | 5.0% | 66,290 | 3,010 | 4.5% |
| Olympia | 48,850 | 1,950 | 4.0% | 65,910 | 2,450 | 3.7% |
| Rainier | 980 | 80 | 8.2% | 1,860 | 120 | 6.5% |
| Rochester[1] | 4,630 | 800 | 17.3% | 6,230 | 1,320 | 21.2% |
| Tenino | 2,340 | 390 | 16.7% | 3,320 | 520 | 15.7% |
| Tumwater | 25,670 | 2,080 | 8.1% | 38,080 | 2,910 | 7.6% |
| Yelm[1] | 7,850 | 760 | 9.7% | 16,580 | 1,500 | 9.0% |
| **Other Districts** | | | | | | |
| Intercity Transit | 115,570 | 5,500 | 4.8% | 176,500 | 8,340 | 4.7% |
| LOTT Clean Water Alliance[2] | 91,010 | 3,700 | 4.1% | 162,020 | 7,310 | 4.5% |
| Port of Olympia | 133,900 | 8,400 | 6.3% | 199,700 | 12,100 | 6.1% |
| Thurston County PUD | 133,900 | 8,400 | 6.3% | 199,700 | 12,100 | 6.1% |

**Source:** Thurston Regional Planning Council Population Forecast, 2015
**Explanations:** Flood Hazard includes the Special Flood Hazard Areas Subject to Inundation by the 1% and 0.2% Annual Chance of Flood and Thurston County High Groundwater Hazard Areas.
1. Data are for Thurston County portion of the district only.
2. Includes the sewered area for 2014 and the Lacey-Olympia-Tumwater Urban Area for 2040.

## Table 4.3.10: Flood Hazard Area, Residential Dwellings, 2015 and 2040

| | | 2015 Dwelling Estimate | | | 2040 Dwelling Forecast | | |
|---|---|---|---|---|---|---|---|
| | | Total | In Hazard Area | | Total | In Hazard Area | |
| Jurisdiction | | # | # | % | # | # | % |
| Bucoda | **Total** | **245** | **180** | **73.5%** | **535** | **310** | **57.9%** |
| Lacey | City | 19,840 | 1,130 | 5.7% | 24,400 | 1,240 | 5.1% |
| | UGA | 13,500 | 380 | 2.8% | 23,930 | 800 | 3.3% |
| | **Total** | **33,340** | **1,510** | **4.5%** | **48,330** | **2,040** | **4.2%** |
| Olympia | City | 24,170 | 810 | 3.4% | 35,610 | 1,770 | 5.0% |
| | UGA | 4,850 | 280 | 5.8% | 7,100 | 540 | 7.6% |
| | **Total** | **29,020** | **1,090** | **3.8%** | **42,710** | **2,310** | **5.4%** |
| Rainier | City | 775 | 30 | 3.9% | 1,140 | 40 | 3.5% |
| | UGA | 50 | 0 | 0.0% | 290 | 15 | 5.2% |
| | **Total** | **825** | **30** | **3.6%** | **1,430** | **55** | **3.8%** |
| Tenino | City | 755 | 20 | 2.6% | 1,855 | 100 | 5.4% |
| | UGA | 5 | 0 | 0.0% | 40 | 0 | 0.0% |
| | **Total** | **760** | **20** | **2.6%** | **1,895** | **100** | **5.3%** |
| Tumwater | City | 9,970 | 640 | 6.4% | 16,870 | 2,120 | 12.6% |
| | UGA | 1,420 | 230 | 16.2% | 3,820 | 720 | 18.8% |
| | **Total** | **11,390** | **870** | **7.6%** | **20,690** | **2,840** | **13.7%** |
| Yelm | City | 3,000 | 270 | 9.0% | 9,820 | 1,070 | 10.9% |
| | UGA | 550 | 60 | 10.9% | 2,280 | 260 | 11.4% |
| | **Total** | **3,550** | **330** | **9.3%** | **12,100** | **1,330** | **11.0%** |
| Grand Mound UGA | **Total** | **415** | **10** | **2.4%** | **740** | **20** | **2.7%** |
| Chehalis Reservation[1] | **Total** | **20** | **10** | **50.0%** | **65** | **40** | **61.5%** |
| Nisqually Reservation[1] | **Total** | **200** | **10** | **5.0%** | **255** | **10** | **3.9%** |
| **Total Cities** | | **58,770** | **3,060** | **5.2%** | **90,230** | **6,650** | **7.4%** |
| **Total UGAs[2]** | | **20,790** | **960** | **4.6%** | **38,190** | **2,350** | **6.2%** |
| **Total Reservations[1]** | | **220** | **20** | **9.1%** | **320** | **50** | **15.6%** |
| **Rural Unincorporated County[3]** | | **34,250** | **4,110** | **12.0%** | **41,730** | **4,900** | **11.7%** |
| **Thurston County Total** | | **114,000** | **8,200** | **7.2%** | **170,500** | **13,900** | **8.2%** |

**Source:** Thurston Regional Planning Council Population Forecast, 2015
**Explanations:** Flood Hazard includes the Special Flood Hazard Areas Subject to Inundation by the 1% and 0.2% Annual Chance of Flood and Thurston County High Groundwater Hazard Areas. Numbers may not add due to rounding.
1. Data are for the Thurston County portion of reservation only.
2. Urban Growth Area (UGA): Unincorporated area designated to be annexed into city limits over 20 years to accommodate urban growth.
3. Rural unincorporated county is the portion of the unincorporated county that lies outside UGA and Reservation boundaries.

## Table 4.3.11: Flood Hazard Area, Residential Dwellings – Special Districts, 2015 and 2040

| | 2015 Dwelling Estimate | | | 2040 Dwelling Forecast | | |
|---|---|---|---|---|---|---|
| | Total | In Hazard Area | | Total | In Hazard Area | |
| Jurisdiction | # | # | % | # | # | % |
| **Fire Protection Districts** | | | | | | |
| 1,11 West Thurston | 8,480 | 1,250 | 14.7% | 11,930 | 1,920 | 16.1% |
| 2, 4 S.E. Thurston | 9,800 | 1,000 | 10.2% | 20,190 | 2,200 | 10.9% |
| 3 Lacey | 38,120 | 2,270 | 6.0% | 54,160 | 2,880 | 5.3% |
| 5, 9 McLane-Black Lake | 6,490 | 390 | 6.0% | 8,670 | 500 | 5.8% |
| 6 East Olympia | 4,510 | 330 | 7.3% | 6,010 | 630 | 10.5% |
| 8 South Bay | 4,940 | 420 | 8.5% | 6,370 | 480 | 7.5% |
| 12 Tenino | 2,580 | 370 | 14.3% | 4,200 | 510 | 12.1% |
| 13 Griffin | 2,580 | 250 | 9.7% | 2,910 | 280 | 9.6% |
| 16 Gibson Valley | 240 | 70 | 29.2% | 440 | 80 | 18.2% |
| 17 Bald Hills | 1,770 | 180 | 10.2% | 2,370 | 240 | 10.1% |
| **School Districts** | | | | | | |
| Centralia[1] | 200 | 70 | 35.0% | 470 | 140 | 29.8% |
| Griffin | 3,030 | 290 | 9.6% | 3,430 | 310 | 9.0% |
| North Thurston | 41,820 | 2,480 | 5.9% | 59,460 | 3,590 | 6.0% |
| Olympia | 29,690 | 1,160 | 3.9% | 41,150 | 1,770 | 4.3% |
| Rainier | 2,190 | 240 | 11.0% | 5,690 | 440 | 7.7% |
| Rochester[1] | 5,260 | 540 | 10.3% | 6,670 | 650 | 9.7% |
| Tenino | 4,130 | 730 | 17.7% | 6,720 | 1,060 | 15.8% |
| Tumwater | 16,930 | 1,560 | 9.2% | 27,630 | 3,820 | 13.8% |
| Yelm[1] | 10,790 | 1,090 | 10.1% | 19,260 | 2,170 | 11.3% |
| **Other Districts** | | | | | | |
| Intercity Transit | 76,200 | 3,770 | 4.9% | 119,200 | 8,230 | 6.9% |
| LOTT Clean Water Alliance[2] | 53,760 | 2,240 | 4.2% | 111,730 | 7,190 | 6.4% |
| Port of Olympia | 114,000 | 8,200 | 7.2% | 170,500 | 13,900 | 8.2% |
| Thurston County PUD | 114,000 | 8,200 | 7.2% | 170,500 | 13,900 | 8.2% |

**Source:** Thurston Regional Planning Council Population Forecast, 2015
**Explanations:** Flood Hazard includes the Special Flood Hazard Areas Subject to Inundation by the 1% and 0.2% Annual Chance of Flood and Thurston County High Groundwater Hazard Areas.
1. Data are for Thurston County portion of the district only.
2. Includes the sewered area for 2015 and the Lacey-Olympia-Tumwater Urban Area for 2040.

## Table 4.3.12: Flood Hazard Area, Valuation of Building and Contents, 2014

| Jurisdiction | | Residential Total Mil. $ | Residential In Hazard Area Mil. $ | Residential In Hazard Area % | Commercial/Industrial Total Mil. $ | Commercial/Industrial In Hazard Area Mil. $ | Commercial/Industrial In Hazard Area % | Government/Institutional Total Mil. $ | Government/Institutional In Hazard Area Mil. $ | Government/Institutional In Hazard Area % |
|---|---|---|---|---|---|---|---|---|---|---|
| Bucoda | **Total** | **12** | **9** | **75.0%** | **1** | **0** | **0.0%** | **3** | **3** | **100.0%** |
| Lacey | City | 2,394 | 138 | 5.8% | 914 | 37 | 4.0% | 602 | 38 | 6.3% |
| | UGA | 1,715 | 46 | 2.7% | 69 | 1 | 1.4% | 273 | 9 | 3.3% |
| | **Total** | **4,109** | **184** | **4.5%** | **983** | **38** | **3.9%** | **875** | **47** | **5.4%** |
| Olympia | City | 2,695 | 105 | 3.9% | 1,199 | 47 | 3.9% | 1,941 | 80 | 4.1% |
| | UGA | 785 | 44 | 5.6% | 27 | 1 | 3.7% | 26 | 0 | 0.0% |
| | **Total** | **3,480** | **149** | **4.3%** | **1,226** | **48** | **3.9%** | **1,967** | **80** | **4.1%** |
| Rainier | City | 76 | 3 | 3.9% | 5 | 0 | 0.0% | 30 | 0 | 0.0% |
| | UGA | 5 | 0 | 0.0% | 0 | 0 | - | 1 | 0 | 0.0% |
| | **Total** | **81** | **3** | **3.7%** | **5** | **0** | **0.0%** | **31** | **0** | **0.0%** |
| Tenino | City | 50 | 1 | 2.0% | 12 | 0 | 0.0% | 67 | 9 | 13.4% |
| | UGA | 1 | 0 | 0.0% | 0 | 0 | - | 0 | 0 | - |
| | **Total** | **51** | **1** | **2.0%** | **12** | **0** | **0.0%** | **67** | **9** | **13.4%** |
| Tumwater | City | 1,209 | 71 | 5.9% | 528 | 21 | 4.0% | 556 | 151 | 27.2% |
| | UGA | 130 | 25 | 19.2% | 13 | 3 | 23.1% | 7 | 1 | 14.3% |
| | **Total** | **1,339** | **96** | **7.2%** | **541** | **24** | **4.4%** | **563** | **152** | **27.0%** |
| Yelm | City | 357 | 31 | 8.7% | 105 | 10 | 9.5% | 140 | 24 | 17.1% |
| | UGA | 49 | 5 | 10.2% | 6 | 2 | 33.3% | 13 | 0 | 0.0% |
| | **Total** | **406** | **36** | **8.9%** | **111** | **12** | **10.8%** | **153** | **24** | **15.7%** |
| Grand Mound UGA | | **34** | **1** | **2.9%** | **13** | **1** | **7.7%** | **5** | **4** | **80.0%** |
| Chehalis Reservation[1] | | **1** | **1** | **100.0%** | **4** | **0** | **0.0%** | **0** | **0** | **-** |
| Nisqually Reservation.[1] | | **16** | **0** | **0.0%** | **3** | **0** | **0.0%** | **0** | **0** | **-** |
| **Total Cities** | | **6,793** | **358** | **5.3%** | **2,763** | **116** | **4.2%** | **3,338** | **306** | **9.2%** |
| **Total UGAs[2]** | | **2,719** | **121** | **4.5%** | **128** | **8** | **6.3%** | **325** | **15** | **4.6%** |
| **Total Reservations[1]** | | **17** | **1** | **5.9%** | **6** | **0** | **0.0%** | **0** | **0** | **-** |
| **Rural Unincorp. County[3]** | | **4,977** | **551** | **11.1%** | **113** | **17** | **15.0%** | **1,033** | **40** | **3.9%** |
| **Thurston County Total** | | **14,506** | **1,031** | **7.1%** | **3,010** | **141** | **4.7%** | **4,696** | **360** | **7.7%** |

**Source:** Thurston Regional Planning Council Population Forecast, 2015
**Explanations:** Flood Hazard includes the Special Flood Hazard Areas Subject to Inundation by the 1% and 0.2% Annual Chance of Flood and Thurston County High Groundwater Hazard Areas. Numbers may not add due to rounding.
1. Data are for the Thurston County portion of reservation only.
2. Urban Growth Area (UGA): Unincorporated area designated to be annexed into city limits over 20 years to accommodate urban growth.
3. Rural unincorporated county is the portion of the unincorporated county that lies outside UGA and Reservation boundaries.

## Table 4.3.13: Flood Hazard Area, Valuation of Building and Contents – Special Districts, 2014

| | Residential | | | Commercial/Industrial | | | Government/Institutional | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | In Hazard Area | | Total | In Hazard Area | | Total | In Hazard Area | |
| **Jurisdiction** | **Mil. $** | **Mil. $** | **%** | **Mil. $** | **Mil. $** | **%** | **Mil. $** | **Mil. $** | **%** |
| **Fire Protection Districts** | | | | | | | | | |
| 1,11 West Thurston | 979 | 151 | 15.4% | 57 | 10 | 17.5% | 216 | 25 | 11.6% |
| 2, 4 S.E. Thurston | 1,073 | 114 | 10.6% | 133 | 14 | 10.5% | 202 | 24 | 11.9% |
| 3 Lacey | 4,823 | 264 | 5.5% | 1,008 | 41 | 4.1% | 896 | 52 | 5.8% |
| 5, 9 McLane-Black Lake | 1,121 | 73 | 6.5% | 31 | 2 | 6.5% | 676 | 2 | 0.3% |
| 6 East Olympia | 743 | 47 | 6.3% | 14 | 2 | 14.3% | 49 | 1 | 2.0% |
| 8 South Bay | 939 | 80 | 8.5% | 13 | 2 | 15.4% | 47 | 10 | 21.3% |
| 12 Tenino | 277 | 48 | 17.3% | 17 | 1 | 5.9% | 73 | 10 | 13.7% |
| 13 Griffin | 430 | 47 | 10.9% | 3 | 1 | 33.3% | 26 | 0 | 0.0% |
| 16 Gibson Valley | 20 | 7 | 35.0% | 0 | 0 | - | 1 | 1 | 100.0% |
| 17 Bald Hills | 176 | 15 | 8.5% | 6 | 0 | 0.0% | 7 | 0 | 0.0% |
| **School Districts** | | | | | | | | | |
| Centralia[1] | 17 | 7 | 41.2% | 0 | 0 | - | 1 | 1 | 100.0% |
| Griffin | 498 | 52 | 10.4% | 3 | 1 | 33.3% | 26 | 0 | 0.0% |
| North Thurston | 5,394 | 295 | 5.5% | 1,292 | 48 | 3.7% | 969 | 62 | 6.4% |
| Olympia | 3,990 | 190 | 4.8% | 960 | 44 | 4.6% | 2,344 | 42 | 1.8% |
| Rainier | 241 | 27 | 11.2% | 11 | 0 | 0.0% | 34 | 0 | 0.0% |
| Rochester[1] | 539 | 52 | 9.6% | 42 | 5 | 11.9% | 187 | 22 | 11.8% |
| Tenino | 462 | 83 | 18.0% | 21 | 2 | 9.5% | 81 | 14 | 17.3% |
| Tumwater | 2,155 | 196 | 9.1% | 546 | 26 | 4.8% | 877 | 195 | 22.2% |
| Yelm[1] | 1,208 | 128 | 10.6% | 135 | 14 | 10.4% | 176 | 24 | 13.6% |
| **Other Districts** | | | | | | | | | |
| Intercity Transit | 9,247 | 472 | 5.1% | 2,865 | 121 | 4.2% | 4,172 | 305 | 7.3% |
| LOTT Clean Water Alliance[2] | 6,724 | 313 | 4.7% | 2,498 | 96 | 3.8% | 2,443 | 135 | 5.5% |
| Port of Olympia | 14,506 | 1,031 | 7.1% | 3,010 | 141 | 4.7% | 4,696 | 360 | 7.7% |
| Thurston County PUD | 14,506 | 1,031 | 7.1% | 3,010 | 141 | 4.7% | 4,696 | 360 | 7.7% |

**Source:** Thurston Regional Planning Council Population Forecast, 2015
**Explanations:** Flood Hazard includes the Special Flood Hazard Areas Subject to Inundation by the 1% and 0.2% Annual Chance of Flood and Thurston County High Groundwater Hazard Areas.
1. Data are for Thurston County portion of the district only.
2. Includes the sewered area.

## Table 4.3.14: Essential Facilities in Flood Hazard Area

| Facility Type | Total # | In Hazard Area # | In Hazard Area % |
|---|---|---|---|
| **Medical Care** | | | |
| Adult Family Home | 124 | 5 | 4.0% |
| Assisted Living | 14 | 0 | 0.0% |
| Dentist | 110 | 1 | 0.9% |
| Dialysis Center | 3 | 0 | 0.0% |
| Funeral Home | 6 | 0 | 0.0% |
| Hospital | 2 | 0 | 0.0% |
| Nursing Home | 7 | 0 | 0.0% |
| Pharmacy | 42 | 3 | 7.1% |
| Primary Care | 91 | 7 | 7.7% |
| Urgent Care | 6 | 0 | 0.0% |
| **Government** | | | |
| Court Services | 3 | 1 | 33.3% |
| Cultural Significance | 2 | 0 | 0.0% |
| Detention/Corrections | 1 | 0 | 0.0% |
| Fairgrounds | 35 | 1 | 2.9% |
| Fire Service | 53 | 4 | 7.5% |
| Government Services | 56 | 18 | 32.1% |
| Health and Human Services | 2 | 0 | 0.0% |
| Law and Justice | 4 | 1 | 25.0% |
| Law Enforcement | 8 | 0 | 0.0% |
| Port Facilities | 35 | 1 | 2.9% |
| Public Education | 344 | 18 | 5.2% |
| Public Higher Education | 52 | 5 | 9.6% |
| Public Works | 33 | 2 | 6.1% |
| Solid Waste | 20 | 18 | 90.0% |
| Transit | 4 | 0 | 0.0% |
| Utilities | 238 | 26 | 10.9% |
| **Transportation (Centerline Miles)** | | | |
| Roads | 2,210 | 200 | 9.0% |
| Intercity Transit Routes | 157 | 9 | 5.5% |
| Rural Transit Routes | 96 | 16 | 16.5% |

**Explanations:** Flood Hazard includes areas in the 100 and 500-year flood plains, and high groundwater areas.

# Endnotes

[1] Hazards & Vulnerability Research Institute. 2016. The Spatial Hazard Events and Losses Database for the United States, Version 15.2 [SHELDUS Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org.

[2] Thurston County Water and Waste Management. 2017. Unpublished Data, Courtesy of Mark Biever, Thurston County Environmental Monitoring Program Supervisor

[3] Ibid

[4] Tacoma Power. 2016. Emergency Action Plan for the Nisqually Hydroelectric Project FERC Project No. 1862

[5] Contributed by Nadine Romero, Hydrogeologist, Thurston County Environmental Health. April 22, 2009.

[6] Parametrix. 2003. Scatter Creek Habitat Conservation Plan and Associated Reports. Prepared for Thurston Conservation District.

[7] Thurston County Development Services. 2009. Unpublished Data, Thurston County Flood of Record Reference Monument Locations. Courtesy of Joe Butler.

[8] TransAlta Centralia Generation LLC. 2007. Emergency Action Plan: Skookumchuck Hydroelectric Project FERC Project No. 4441 NATDAM No. WA00153. Revision H, December 2007.

[9] United States Geological Survey. 2017. National Water Information System: Web Interface, USGS Water Data for Washington, Surface Water Data. http://waterdata.usgs.gov/wa/nwis/

[10] Thurston County Emergency Management. 2007. Supplemental Justification Report. December 2-7, 2007 Severe Storm.

[11] Washington State Department of Transportation. 2008. Storm-Related Closures of I-5 and I-90: Freight Transportation Economic Impact Assessment Report Winter 2007-2008.

[12] FEMA. 2016. HAZUS-MH Flood Results for Thurston County RISK MAP Project. Prepared by STARR for FEMA Region X.