Goal 1 Create vibrant centers, corridors, and neighborhoods while accommodating growth.

High Consequence Risks

1. Makes it harder to balance competing demands for water (water available to support new urban development)

Stressor **Increasing Drought**

Consequence **High**
Having adequate water is fundamental to supporting growth (in urban areas — or anywhere, for that matter) and achieving but it would not prevent us from achieving the goal of creating vibrant corridors (which factors in jobs, housing, and other opportunities/amenities).

Likelihood **Medium**
Water quantity (supply-and-demand) vulnerability will likely to be highest in snow-influenced watersheds with existing conflicts over water resources (e.g., fully allocated watersheds with little management flexibility), according to this project's vulnerability assessment. Vulnerability will be lowest where hydrologic change is smallest (i.e., existing rain-dominant watersheds), where there are simple institutional arrangements, and where current water demand rarely exceeds supply.
The Nisqually Watershed (home of Yelm) is projected to shift this century from a mixed rain-and-snow watershed (i.e., a watershed that receives 10-40 percent of its precipitation as snow) to a rain-dominant watershed (i.e., a watershed that gets less than 10 percent of its precipitation as snow); the Kennedy-Goldsborough and Deschutes (home of the Olympia, Tumwater, Lacey and Rainier) watersheds will remain rain-dominant systems.

Spatial Extent **Place**
The risk of balancing water needs and having adequate water to support new urban development will be higher in the snow-influenced Nisqually Watershed than the rain-dominant Deschutes Watershed, where most of the county's urbanized population lives.

Horizon **0-10 years**

Confidence **Low**
Studies conducted in Everett, Tacoma and Seattle and noted in UW CIG's 2015 assessment find that the reliability of municipal water supplies — that is, the probability of meeting demand in a given year — is largely unaffected by projected changes precipitation. The report did not reference any Thurston County communities.

Medium Consequence Risks

2. Increases frequency, depth and duration of inundation of low coastal areas, which could displace coastal residents

Stressor **Sea-level Rise**

Consequence **Medium**
Downtown Olympia, Boston Harbor, Nisqually, Mud Bay, Brewery District are among the region's urban center/neighborhood centers that are directly affected by sea-level rise. Other centers, e.g., Woodland District and downtown Yelm, would not be affected. Thus, this risk would not entirely prevent the region from achieving this goal.

Likelihood **High**
Heavy rain combined with a high-tide event already floods downtown Olympia, and frequency and intensity of flooding is projected to increase with rising sea-levels.

Spatial Extent **Place**
Most of downtown Olympia — targeted for 25% (about 5,000 residents) of the City's population growth over the next 20 years — would be affected by sea-level rise over the 21st century.

Horizon **0-10 years**

Confidence **High**

Goal 1 Create vibrant centers, corridors, and neighborhoods while accommodating growth.

Medium Consequence Risks

3. Increases frequency, depth and duration of inundation of low coastal areas (e.g., downtown Olympia), which could damage or disrupt use infrastructure and result in loss of cultural resources (e.g., homes, roads, etc.)

Stressor **Sea-level Rise**

Consequence **Medium**

Downtown Olympia, Boston Harbor, Nisqually, Mud Bay, Brewery District are among the region's urban center/neighborhood centers that are directly affected by sea-level rise. Other centers, e.g., Woodland District and downtown Yelm, would not be affected. Thus, this risk would not entirely prevent the region from achieving this goal.

Likelihood **High**

Heavy rain combined with a high-tide event already floods downtown Olympia, and frequency and intensity of flooding is projected to increase with rising sea-levels. NOAA flood maps show sea-level rise-exacerbated flooding along much of Thurston County's Puget Sound shoreline.

Spatial Extent **Place**

In addition to downtown Olympia, low-lying sections of Interstate 5 and U.S. Route 101 also could 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 are able to move within and through the Thurston County region.
McAllister Creek occasionally floods I-5 on- and off-ramps south of the Nisqually National Wildlife Refuge (area of Milepost 114), and this would be made worse by sea-level rise, according to a recent Washington Department of Transportation vulnerability assessment of transportation infrastructure. The embankment atop which I-5 sits was never evaluated for open water at its toe. The levee removal at the Nisqually delta and the rising sea level means that the toe of the slope is now exposed 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.

Horizon **0-10 years**

Confidence **High**

4. Causes urban heat islands, which could affect livability/health in heavily developed centers and corridors

Stressor **Warmer Summer**

Consequence **Medium**

Land-use policies call for increasing density within Thurston County's existing urban areas. Fortunately, Thurston County's most densely built urban center — downtown Olympia — is located close to the Puget Sound, which helps moderate temperatures.

Likelihood **Medium**

Models project that the region's summers will be generally hotter and drier in coming decades. The UW CIG report notes that recent research has suggested that changes in atmospheric circulation will cause heat waves to increase less rapidly (in terms of both the frequency and intensity of heat events) in coastal areas of the Puget Sound.

Spatial Extent **Place**

This will affect the county's urban centers.

Horizon **More than 30 years**

Confidence **Medium**

Goal 1 Create vibrant centers, corridors, and neighborhoods while accommodating growth.

Low Consequence Risks

5. Stresses sensitive urban landscaping, which could leave them vulnerable to extreme heat, pests or pathogens

Stressor **Increasing Drought**

Consequence **Low**
Loss of urban landscaping and tree canopy would decrease livability, but many other attributes that make urban centers and corridors livable would be unaffected.

Likelihood **High**
We're already seeing the effects of prolonged drought and extreme heat events on urban landscaping (e.g., ornamental shrubs and non-native trees).

Spatial Extent **Place**
Affects urban areas mostly

Horizon **0-10 years**

Confidence **Medium**
See likelihood explanatory text.

6. Increases range and survival of pests and diseases that kill vegetation (urban landscaping)

Stressor **Warmer Winter**

Consequence **Low**
Loss of urban canopy would decrease livability, but many other attributes that make urban centers and corridors livable would be unaffected.

Likelihood **Medium**
According to the UW CIG report: Some pests will survive winters when they previously had not, and longer growing seasons may allow for more successful reproductive cycles within a given year, resulting in exponentially faster population growth. Conversely, some pests that have historically emerged in tandem with specific crop life stages (e.g., flowering) may no longer emerge at the correct time, resulting in a decrease in economic damage.

Spatial Extent **Place**
Affects the urbanized areas mostly

Horizon **More than 30 years**

Confidence **Low**
Specific projections of changes in Puget Sound agricultural pests are not currently available, but studies have identified links between pests and air temperature.

Goal 2 Preserve environmentally sensitive lands, farmlands, forest lands, prairies, and rural lands and develop compact urban areas.

High Consequence Risks

7. Increases frequency and intensity of heaviest 24-hour rain events and overall volume of winter streamflow, which could scour streambeds and degrade sensitive riparian areas

Stressor **Increasing Storminess**

Consequence **High**
Major storm events could degrade the quality of some of these areas — particularly riparian adjacent to streams.

Likelihood **High**
The Natural Hazards Plan for the Thurston Region finds that damaging rain already has a "high" (38 percent chance) annual chance of occurrence. Climate models project that the frequency and intensity of today's heaviest 24-hour rain events (top 1 percent) would increase this century.

Spatial Extent **Extensive**

Horizon **0-10 years**

Confidence **High**

8. Degrades critical habitat (lakes, rivers and streams) due to changes in water volume and temperature

Stressor **Increasing Drought**

Consequence **High**
impacts people (farming, etc.) and ecosystems directly.

Likelihood **High**
already occurring.

Spatial Extent **Extensive**

Horizon **0-10 years**

Confidence **High**

9. Increases pressure to develop rural areas, which could reduce, fragment and degrade them

Stressor **Population Change**

Consequence **High**
This risk would certainly affect the region's ability to achieve this goal.

Likelihood **Medium**
It is impossible to predict how many people might move to, within or from Thurston County — or when — as a result of climate change. Thus, the likelihood of this risk is low.

Spatial Extent **Extensive**
It is unclear what — if any — parts of Thurston County would be affected by climate change-induced migration/displacement. The type and severity of hazard would likely affect who is displaced — and whether the displacement is temporary or permanent. Given the lack of certainty, the spatial extent should be as broad as possible.

Horizon **More than 30 years**

Confidence **Low**

Goal 2 Preserve environmentally sensitive lands, farmlands, forest lands, prairies, and rural lands and develop compact urban areas.

Medium Consequence Risks

10. Stresses sensitive plants and habitat, which could reduce long-term viability of preserved and restored areas

Stressor **Increasing Drought**

Consequence **Medium**
Drought would affect the health and extent of preserved and restored areas.

Likelihood **High**
There is a high degree of certainty that the region will experience hotter, drier summers, which will affect the health and extent preserved and restored areas.

Spatial Extent **Extensive**

Horizon **0-10 years**

Confidence **High**

11. Degrades critical habitat (rivers and streams) due to reductions in snowpack and runoff

Stressor **Warmer Winter**

Consequence **Medium**
primarily affects Nisqually watershed, but impacts to all watersheds. alters the timing and volume of runoff that affects streamflow and groundwater levels. (pg. 10 of vulnerability assessment). Projected 43%-71% snowpack reduction in Nisqually headwaters over 21st century

Likelihood **High**
both low and high emissions scenarios show extensive changes in snowpack and highland rainfall during winter months

Spatial Extent **Place**
Nisqually Watershed

Horizon **More than 30 years**

Confidence **High**

12. Increases frequency, depth and duration of inundation of low-lying coastal areas, which could turn marshes and other upland areas into mudflats (dams limit sedimentation at Nisqually Delta)

Stressor **Sea-level Rise**

Consequence **Medium**
Sea-level rise could degrade the quality of or reduce the extent of coastal marshes that provide important ecosystems services.

Likelihood **High**
Sea-level rise already affects Thurston County's Puget Sound coastline. Models project sea-level rise of several feet during the 21st century.

Spatial Extent **Place**
Affects Puget Sound coastline

Horizon **0-10 years**

Confidence **Medium**

Goal 2 Preserve environmentally sensitive lands, farmlands, forest lands, prairies, and rural lands and develop compact urban areas.

Medium Consequence Risks

13. Stresses sensitive plants and habitat, which could leave it vulnerable to extreme heat, pests or pathogens

Stressor **Warmer Summer**

Consequence **Medium**
The weakening or loss of native vegetation would degrade the ecosystem services of the region's forests, prairies and other environmentally sensitive lands — even if they're preserved via land-use policies.

Likelihood **High**

Spatial Extent **Extensive**
Affects all parts of project area (and Thurston County)

Horizon **0-10 years**

Confidence **High**

15. Decreases climatic suitability of areas that currently support Garry oak and/or Douglas fir

Stressor **Warmer Summer**

Consequence **Medium**
Land use regulations will have the largest impact on whether the region is able to preserve farms, forests and prairies. However, the loss of key tree species such as Garry oak and Douglas fir would degrade the ecosystem services of these areas — even if they're preserved.

Likelihood **Medium**
The science is mixed, so the likelihood is "medium." Research cited in the UW CIG report notes that Garry oak extent may increase or decrease. The report goes on to note that increasing air temperatures and drier summer conditions are likely to reduce the area of climatically suitable habitat for Douglas fir in lower elevations of the Puget Sound region — specifically South Puget Sound and the southern Olympic Mountains — by the end of 2060s.

Spatial Extent **Extensive**
These tree species are found throughout the entire project area.

Horizon **More than 30 years**

Confidence **Medium**
See "likelihood" explanation.

16. Supports survival of invasive species that could threaten native flora

Stressor **Warmer Winter**

Consequence **Medium**
Proliferation of invasive species would alter the composition and health of the region's forests, prairies and other environmentally sensitive lands — even if they're preserved via land-use policies. We would be able to achieve this goal to an extent.

Likelihood **Medium**
According to the UW CIG report, climate change will affect the establishment, distribution and impact of current and potential non-native species. However, the report said it is difficult to make generalizations regarding such species because responses will be based on species-specific climatic tolerances.

Spatial Extent **Extensive**

Horizon **More than 30 years**

Confidence **Medium**
The UW CIG report underscored that more research is needed to understand how specific invasive and non-native species within the region will respond to climate change, and which new species will emerge as invasive.

Goal 2 Preserve environmentally sensitive lands, farmlands, forest lands, prairies, and rural lands and develop compact urban areas.

Medium Consequence Risks

17. Degrades critical habitat (wetlands) due to changes in water volume and temperature

Stressor **Increasing Drought**

Consequence **Medium**
While wetlands provide many important ecosystem benefits, a reduction of them would not prevent the region from achieving this goal.

Likelihood **Medium**
According to the UW CIG report, Puget Sound wetland ecosystems are projected to decline in extent and number as a result of decreasing water availability during summers. Sea-level rise is also expected to diminish the extent of important saltwater wetlands (e.g., at the Nisqually Delta) by the late 21st century. However, wetter winters are expected to expand the extent of seasonal wetlands on poorly drained soils (e.g., prairie soils).

Spatial Extent **Extensive**
Wetlands cover all parts of the project area (and Thurston County).

Horizon **More than 30 years**

Confidence **High**

18. Shifts the timing of flowering and abundance of pollinators, which could reduce some species of plants throughout the region

Stressor **Warmer Winter**

Consequence **Medium**
Reduction of some plant species — wild or cultivated — would affect the composition of rural and resource lands the region wants to preserve. Still land-use policies would be most important in terms or whether the region is able to preserve such lands and achieve this goal.

Likelihood **Medium**
According to a 2011 U.S. Forest Service study, shifts in timing of flowering and the abundance of insect pollinators could lead to the decline of some plant species if pollinators are absent during times of peak flowering. The study states the risk but not its likelihood. … A 2015 study in the journal Forum noted that "dramatic disruptions, with plant or pollinator suffering complete loss of interaction partners, seem to occur occasionally; and in a few systems these wholesale mismatches may be increasing in frequency with climate
change — although this has not yet been demonstrated for even the best-studied systems."

Spatial Extent **Extensive**
Affects entire project area (and Thurston County)

Horizon **More than 30 years**

Confidence **Medium**

19. Expands range for invasive aquatic species

Stressor **Warmer Water**

Consequence **Medium**

Likelihood **Medium**

Spatial Extent **Extensive**

Horizon **More than 30 years**

Confidence **Medium**

Goal 2 Preserve environmentally sensitive lands, farmlands, forest lands, prairies, and rural lands and develop compact urban areas.

Medium Consequence Risks

20. Increases wind and wave action effects, which could degrade coastal habitat

Stressor **Sea-level Rise**

Consequence **Medium**
Sea-level rise and an increase in wave exposure could degrade coastal habitat but leave most upland rural and resource lands unaffected.

Likelihood **Medium**
Sea-level rise already affects Thurston County's Puget Sound coastline. Models project sea-level rise of several feet during the 21st century. The UW CIG report notes that rising seas will accelerate the eroding effect of waves and surge, causing unprotected areas (beaches, marshes, bluffs) to erode more rapidly.

Spatial Extent **Place**
Affects Thurston County's Puget Sound shoreline

Horizon **10-30 years**

Confidence **Medium**

Low Consequence Risks

21. Alters stream volume

Stressor **Increasing Storminess**

Consequence **Low**

Likelihood **High**

Spatial Extent **Extensive**

Horizon **10-30 years**

Confidence **Medium**

22. Raises the risk of wildfires, which could damage forests and other sensitive lands that provide habitat

Stressor **Increasing Drought**

Consequence **Low**
Even if we have more fires that damage rural and resource lands, our land-use policies could still enable use to spare such spaces from development and focus most growth in urban areas (consistent with the goal). Thus, this risk has more of an effect on habitat quality than extent.

Likelihood **High**
The historical frequency of local wildfires suggests that such hazards have a “high” probability of occurrence, but about 97 percent of future fires will be small — five acres or less — concluded the Natural Hazards Mitigation Plan for the Thurston Region (TRPC, 2009). The plan did not factor in climate change but cautioned that it may create more suitable conditions (e.g., warmer, drier summers) for bigger, more frequent wildfires.

Spatial Extent **Place**
Wildfires occur most often occur in the wildland-urban interface.

Horizon **More than 30 years**

Confidence **High**
One set of fire models for the broader Pacific Northwest projects that total area burned by wildfire could more than double — from 0.5 million acres historically (1916-2006) to 1.1 million acres for the 2040s, per a moderate emissions scenario. While these and other models are limited in their ability to capture unique Puget Sound conditions associated with wildfires, the region is still expected to experience greater wildfire frequency and severity associated with changes in air temperature and precipitation.

Goal 2 Preserve environmentally sensitive lands, farmlands, forest lands, prairies, and rural lands and develop compact urban areas.

Low Consequence Risks

23. Increases pressure on existing parks and open space

Stressor **Population Change**

Consequence **Low**

This risk is about pressure on existing parks and open space. Heavy use might degrade the quality of parks and open space, but we would still be able to achieve this goal to a large degree.

Likelihood **Medium**

It is impossible to predict how many people might move to or within Thurston County — or when — as a result of climate change. Thus, the likelihood of this risk is low.

Spatial Extent **Extensive**

There are parks and open space throughout the entire project area and county.

Horizon **More than 30 years**

Confidence **Low**

Goal 3 Create a robust economy through sustainable practices.

High Consequence Risks

24. Makes it harder to balance competing demands for water (water available to support new development)

Stressor **Increasing Drought**

Consequence **High**
Without widespread water conservation measures, new construction to support population growth will be impacted by water rights restrictions

Likelihood **High**

Spatial Extent **Place**
specific communities lacking water rights will be most impacted

Horizon **0-10 years**

Confidence **Medium**

25. Raises the risk of floods and landslides, which could damage private property and result in economic losses

Stressor **Increasing Storminess**

Consequence **High**

Likelihood **High**

Spatial Extent **Site**

Horizon **0-10 years**

Confidence **High**

26. Threatens to flood low-lying industrial, commercial, agricultural, and residential properties, disrupt commerce and damage infrastructure (power, water, etc.)

Stressor **Sea-level Rise**

Consequence **High**

Likelihood **High**

Spatial Extent **Place**
LOTT Cleanwater Alliance Bud Inlet Treatment Facility on Olympia Port Peninsula, downtown Olympia, and numerous locations throughout the county's marine coastline.

Horizon **More than 30 years**

Confidence **High**

27. Raises the risk of floods and landslides, which could damage infrastructure (roads, utility lines, etc.) and cut off access to goods and services

Stressor **Increasing Storminess**

Consequence **High**

Likelihood **High**

Spatial Extent **Place**
Extent of damage will be principally in areas with steep, unstable slopes, and developed areas affected by flooding.

Horizon **0-10 years**

Confidence **High**
Thurston County has received numerous federal disaster declarations in the last 5 decades due to flood losses.

Goal 3 Create a robust economy through sustainable practices.

High Consequence Risks

28. Threatens to flood local highways, railways, bridges, port marine terminal and other transportation infrastructure that are critical to moving people and goods throughout the region

Stressor **Sea-level Rise**

Consequence **High**
Portions of Interstate 5 in the Nisqually Valley and downtown Olympia are at risk.

Likelihood **High**

Spatial Extent **Place**
I-5 in Nisqually Valley, local access roads throughout downtown Olympia, and in unincorporated Thurston County

Horizon **More than 30 years**

Confidence **High**

Medium Consequence Risks

29. Reduces summer hydropower production, a comparatively clean and inexpensive electricity source for commercial and residential customers

Stressor **Increasing Drought**

Consequence **Medium**

Likelihood **High**

Spatial Extent **Extensive**
Hydropower production is prevalent throughout western Washington, including Thurston County. The impacts will be spread across power customers.

Horizon **More than 30 years**

Confidence **Medium**

30. Increases volume of urban runoff and flooding, which could render inadequate some stormwater/flood-control facilities

Stressor **Increasing Storminess**

Consequence **Medium**
Urban flooding would be a major nuisance — and indeed might be of "high" consequence at some sites — but it would not prevent us from achieving the goal of creating "vibrant" corridors (which factors in jobs, housing, and other opportunities/amenities).

Likelihood **High**
The region's urbanized areas have billions of dollars worth of stormwater and wastewater infrastructure that was designed based on historic conditions. The Natural Hazards Plan for the Thurston Region finds that damaging rain already has a "high" (38 percent chance) annual chance of occurrence. Climate models project that the frequency and intensity of today's heaviest 24-hour rain events (top 1 percent) would increase this century.

Spatial Extent **Place**

Horizon **0-10 years**

Confidence **High**
Intensity of such large rainfall events is project to increase 22 percent by the 2080s, and frequency would increase from two days per year to 7 days per year.

Goal 3 Create a robust economy through sustainable practices.

Medium Consequence Risks

31. Raises the risk of floods and landslides, which could disrupt transportation, business, school, emergency service, and public works and private utility operations [Sec. 6.2, pg. 78]

Stressor **Increasing Storminess**

Consequence **Medium**

Likelihood **High**

Spatial Extent **Place**

Horizon **0-10 years**

Confidence **High**

32. Raises the cost of new development and redevelopment

Stressor **Sea-level Rise**

Consequence **Medium**
Development restrictions will apply to property/zoning affected by sea level rise. Developers will avoid affected areas.

Likelihood **High**

Spatial Extent **Place**

Horizon **More than 30 years**

Confidence **Medium**

33. Raises the risk of wildfires which could damage forests that are important to the region's economy

Stressor **Increasing Drought**

Consequence **Medium**
The incidence of wildland fires in areas that are difficult to access will result in timber losses.

Likelihood **Medium**

Spatial Extent **Place**
Landscapes with large tracts of commercial timber

Horizon **More than 30 years**

Confidence **Medium**

35. Increases demand for and cost to provide services (social, emergency, etc.)

Stressor **Population Change**

Consequence **Medium**

Likelihood **Medium**

Spatial Extent **Extensive**
All Thurston County communities would likely be affected

Horizon **More than 30 years**

Confidence **Low**
The actual population growth due to climate change induced migration is unknown.

Goal 3 Create a robust economy through sustainable practices.

Medium Consequence Risks

36. Puts more strain on transportation (roads, transit, etc.)

Stressor **Population Change**

Consequence **Medium**
The actual population growth due to climate change induced migration is unknown. It is difficult to quantify travel demand with unknown population expansion due to climate change.

Likelihood **Medium**

Spatial Extent **Extensive**

Horizon **More than 30 years**

Confidence **Low**

37. Makes it harder to balance competing demands for water (water available for agriculture and industry)

Stressor **Increasing Drought**

Consequence **Medium**
Without widespread water conservation measures, local food producers and manufacturers may be adversely impacted by water restrictions

Likelihood **Medium**

Spatial Extent **Place**
Water restrictions may be place dependent depending on local water sources and available supply

Horizon **0-10 years**

Confidence **High**

Low Consequence Risks

38. Raises risk of low crop yields or failure due to warmer temperature, reduced summer precipitation and increased pest prevalence

Stressor **Warmer Summer**

Consequence **Low**

Likelihood **High**

Spatial Extent **Extensive**

Horizon **More than 30 years**

Confidence **Medium**

39. Thermally stresses salmonids, which support economically important fisheries

Stressor **Warmer Winter**

Consequence **Low**

Likelihood **High**

Spatial Extent **Extensive**
Throughout streams and rivers entering the Puget Sound

Horizon **0-10 years**

Confidence **High**

Goal 3 Create a robust economy through sustainable practices.

Low Consequence Risks

40. Makes it harder to balance competing demands for water (water available for salmon fishery)

Stressor **Increasing Drought**

Consequence **Low**
Without adequate water conservation measures, salmonid habitat, health, and survival will suffer

Likelihood **High**

Spatial Extent **Extensive**
Throughout Puget Sound watersheds

Horizon **0-10 years**

Confidence **High**

41. Reduces food available for and survival of salmon and other marine life

Stressor **Ocean Acidification**

Consequence **Low**
Salmon fishery is not a significant economic sector in Thurston County. However it is significant to the Nisqually and Squaxin Tribes and culturally significant to the entire Pacific Northwest.

Likelihood **High**

Spatial Extent **Extensive**
Puget Sound

Horizon **More than 30 years**

Confidence **Medium**

42. Reduces snowpack and alters stream volume and temperature, impacting long-term productivity of anadromous fish populations and fisheries

Stressor **Warmer Winter**

Consequence **Low**

Likelihood **High**

Spatial Extent **Extensive**
Across all watersheds with fish bearing streams

Horizon **More than 30 years**

Confidence **High**

43. Raises the risk of floods and landslides, which could damage agricultural crops, buildings and equipment

Stressor **Increasing Storminess**

Consequence **Low**

Likelihood **High**

Spatial Extent **Place**

Horizon **0-10 years**

Confidence **High**

Goal 3 Create a robust economy through sustainable practices.

Low Consequence Risks

45. Increases the risk of marine water stratification and hypoxia, which could alter the timing of spring plankton blooms that support the marine food web (including salmon and other economically important fish)

Stressor	**Warmer Winter**
Consequence	**Low** The entire Puget Sound fisheries industry could be affected
Likelihood	**Medium**
Spatial Extent	**Extensive** Could numerous locations throughout the Puget Sound
Horizon	**More than 30 years**
Confidence	**Medium**

46. Rising temperatures increases risk for heat injuries which will increase demand/cost for emergency medical services and hospitalizations

Stressor	**Warmer Summer**
Consequence	**Low** Limited portion of the population will be affected: Seniors, immunocompromised individuals, youth
Likelihood	**Medium**
Spatial Extent	**Extensive** All communities will be affected
Horizon	**10-30 years**
Confidence	**Medium**

47. Increases the rate of erosion of unprotected coastal bluffs, which could threaten the property and safety of nearby residents

Stressor	**Sea-level Rise**
Consequence	**Low**
Likelihood	**Medium**
Spatial Extent	**Site**
Horizon	**More than 30 years**
Confidence	**Medium**

50. Raises the cost of development (flooding and runoff mitigation measures)

Stressor	**Increasing Storminess**
Consequence	**Low** A development project's proforma will likely avoid development in areas prone to flooding, unless the benefits of the development outweigh the development costs
Likelihood	**Low**
Spatial Extent	**Site**
Horizon	**0-10 years**
Confidence	**Medium**

Goal 3 Create a robust economy through sustainable practices.

Low Consequence Risks

51. Increases extreme heat events, which could result in project delays and increased costs (e.g., in the construction industry)

Stressor	**Warmer Summer**
Consequence	**Low**
Likelihood	**Low**
Spatial Extent	**Site** Construction sites
Horizon	**10-30 years**
Confidence	**Low**

Goal 4 Protect and improve water quality, including groundwater, rivers, streams, lakes, and the Puget Sound.

High Consequence Risks

52. Reduces groundwater recharge (drinking water and in-stream flows)

Stressor **Increasing Drought**

Consequence **High**
See State of Knowledge pg. 8-4: "when extraction outpaces recharge, the risk of saltwater intrusion grows." Impacts people and ecosystems directly

Likelihood **High**

Spatial Extent **Place**

Horizon **0-10 years**

Confidence **Medium**

53. Degrades water quality by supporting algal blooms

Stressor **Warmer Summer**

Consequence **High**
algal blooms affect recreation opportunities (lakes/beaches closed due to toxicity), dissolved oxygen levels (once algal blooms decay), and shellfisheries/food sources (toxicity)

Likelihood **High**

Spatial Extent **Extensive**
Lakes in the region will see increased algal blooms, as will Puget Sound

Horizon **0-10 years**

Confidence **High**

54. Increases water temperatures

Stressor **Warmer Summer**

Consequence **High**
some species may be able to adapt; others may not.

Likelihood **High**

Spatial Extent **Extensive**

Horizon **10-30 years**

Confidence **High**

55. Increases the growth and reach of pathogens (e.g., cyanobacteria) harmful to humans, fish and other water users

Stressor **Warmer Water**

Consequence **High**
affects shellfish and food systems, recreation, drinking water.

Likelihood **High**

Spatial Extent **Extensive**

Horizon **0-10 years**

Confidence **High**
State of Knowledge includes a report of impacts to salmon in California that occurred in 2002 (see pg. 10-4).

Goal 4 Protect and improve water quality, including groundwater, rivers, streams, lakes, and the Puget Sound.

High Consequence Risks

56. Increases concentration of pollutants in first-flush runoff

Stressor **Increasing Drought**

Consequence **High**

Likelihood **Medium**
Drought (e.g., a very dry summer) causes pollutants to build up in the soil. When the rains finally come in the fall, the first-flush runoff carries the pollutants into surface waterbodies.

Spatial Extent **Place**
Associated with urban areas more than rural

Horizon **10-30 years**

Confidence **Medium**
no data on delayed release of pollutants?

57. Contaminates water (turbidity and sedimentation) due to landslides

Stressor **Increasing Storminess**

Consequence **High**

Likelihood **Medium**

Spatial Extent **Place**
has the potential to impact an entire stream system.

Horizon **10-30 years**

Confidence **Medium**

58. Inundates downtown Olympia and LOTT wastewater treatment plant assets, which could threaten the ability to treat and discharge water

Stressor **Sea-level Rise**

Consequence **High**
increases Puget Sound contamination

Likelihood **Medium**

Spatial Extent **Place**

Horizon **More than 30 years**

Confidence **Medium**

59. Increases in ocean pH, coupled with increases in ocean temperature and land-borne pollution, threatens marine water quality

Stressor **Ocean Acidification**

Consequence **High**
impacts marine ecosystem

Likelihood **Medium**

Spatial Extent **Extensive**

Horizon **More than 30 years**

Confidence **Low**

Goal 4 Protect and improve water quality, including groundwater, rivers, streams, lakes, and the Puget Sound.

High Consequence Risks

60. Increases pollution related to development (e.g., more septic systems and impervious surfaces)

Stressor **Population Change**

Consequence **High**

Likelihood **Low**

Spatial Extent **Extensive**
impacts to both urban and rural areas

Horizon **More than 30 years**

Confidence **Low**

Medium Consequence Risks

61. Contaminates water (nutrients) from septic system failure due to high groundwater flooding

Stressor **Increasing Storminess**

Consequence **Medium**

Likelihood **High**
already occurring.

Spatial Extent **Site**
septic systems are located in both urban and rural areas of the watersheds.

Horizon **0-10 years**

Confidence **High**

62. Inundates former industrial sites, which could mobilize pollutants in the soil and degrade water quality

Stressor **Sea-level Rise**

Consequence **Medium**

Likelihood **High**

Spatial Extent **Place**
Sites include downtown Olympia

Horizon **More than 30 years**

Confidence **High**

63. Contaminates water (bacteria, pathogens) due to a greater incidence of combined stormwater/sewer system overflows

Stressor **Increasing Storminess**

Consequence **Medium**

Likelihood **Medium**

Spatial Extent **Place**

Horizon **10-30 years**

Confidence **Medium**
we know there is already a high probability of flooding in some areas with persistent heavy rains. The overall likelihood of stormwater/sewer overflow events, however, is a little murky.

Goal 4 Protect and improve water quality, including groundwater, rivers, streams, lakes, and the Puget Sound.

Medium Consequence Risks

64. Increases periods of low dissolved oxygen and hypoxic conditions in both freshwater and marine areas

Stressor **Warmer Water**

Consequence **Medium**

Likelihood **Medium**

Spatial Extent **Extensive**

Horizon **More than 30 years**

Confidence **Medium**

65. Increases pollution related to transportation (e.g., more automobiles)

Stressor **Population Change**

Consequence **Medium**

Likelihood **Low**

Spatial Extent **Extensive**

Horizon **More than 30 years**

Confidence **Low**

does not identify other types of transportation - more mass transit use? More carpooling? More telework? More people living close to work? More walkers? Will single-occupancy automobile use decrease? Level off?

Low Consequence Risks

66. Contaminates water (turbidity and sedimentation) due to wildfires

Stressor **Increasing Drought**

Consequence **Low**

The historical frequency of local wildfires suggests that such hazards have a “high” probability of occurrence, but about 97% of future fires will be small — five acres or less (pg. 73, Vulnerability Assessment)

Likelihood **High**

Spatial Extent **Place**

Horizon **More than 30 years**

Confidence **Medium**

Since the studies thus far haven't taken into account climate change, unclear how deep the impact will be.

67. Increases recreational activity in waterbodies and risk of boat fuel spills

Stressor **Warmer Summer**

Consequence **Low**

Although the likelihood of spills will go up, regulations are already in place that address them.

Likelihood **Medium**

Spills already occur. Increased boat traffic = increasing number of spills

Spatial Extent **Place**

most recreational lakes affected. Puget Sound

Horizon **10-30 years**

Confidence **Low**

Research is limited.

Goal 5 Plan and act toward zero waste in the region.

Low Consequence Risks

68. Raises the risk of coastal inundation, which could damage public- and private-sector infrastructure (homes, businesses, roads, etc.) and create waste that cannot be reused or recycled

Stressor **Sea-level Rise**

Consequence **Low**

Likelihood **Medium**

Spatial Extent **Place**

Horizon **More than 30 years**

Confidence **Medium**

69. Raises the risk of floods and landslides, which could damage public- and private-sector infrastructure (homes, businesses, roads, etc.) and create waste that cannot be reused or recycled

Stressor **Increasing Storminess**

Consequence **Low**

Debris management from hazard events are costly, however they should not have a long term impact on achieving waste reduction goals.

Likelihood **Medium**

Spatial Extent **Site**

Horizon **More than 30 years**

Confidence **Medium**

71. Increases solid waste volume

Stressor **Population Change**

Consequence **Low**

Population growth will generate additional waste, however the rate of growth from additional climate change induced migration is unknown. The same waste reduction strategies should apply to all.

Likelihood **Low**

Spatial Extent **Extensive**

Horizon **More than 30 years**

Confidence **Low**

72. Increases summer use of parks, which could raise waste volume and disposal costs

Stressor **Warmer Summer**

Consequence **Low**

Existing waste disposal is not a major concern as is vandalism and theft of public park facilities.

Likelihood **Low**

There is no evidence to suggest climate change will alter people's behavior of disposing of waste at parks.

Spatial Extent **Site**

Horizon **More than 30 years**

Confidence **Low**

Goal 5 Plan and act toward zero waste in the region.

Low Consequence Risks

73. Increases winter use of parks, which could raise waste volume and disposal costs

Stressor	**Warmer Winter**
Consequence	**Low** Seasonal park variation will unlikely impact maintenance and disposal costs
Likelihood	**Low**
Spatial Extent	**Extensive**
Horizon	**More than 30 years**
Confidence	**Low**

74. Raises the risk of wildfires, which could damage public- and private-sector infrastructure (homes, businesses, roads, etc.) and create waste that cannot be reused or recycled

Stressor	**Increasing Drought**
Consequence	**Low**
Likelihood	**Low**
Spatial Extent	**Site**
Horizon	**More than 30 years**
Confidence	**Medium**

Goal 6 Ensure that residents have the resources to meet their daily needs.

High Consequence Risks

75. Raises the risk of coastal inundation, which could damage public- and private-sector infrastructure (homes, businesses, roads, etc.)

Stressor **Sea-level Rise**

Consequence **High**

As sea-level rise predictions are high enough to inundate much of downtown Olympia by the end of the century, including the port and LOTT wastewater treatment, this risk has a very high consequence of affecting our ability to provide basic needs to residents within the project area.

Likelihood **High**

The below predictions by the City of Olympia shows the possible extent of affected areas, and for these reasons, there is a high likelihood this risk will occur and affect our region: •With 1 foot of sea-level rise, Olympia could expect nuisance flooding 30 times annually, affecting approximately 261 structures and inundating up to 163 acres;
•With 2 feet of sea-level rise, Olympia could expect nuisance flooding 160 times annually; affecting approximately 328 structures and inundating up to 252 acres;
•With 4 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.

Spatial Extent **Place**

Coastal and near coastal areas will be affected throughout the project area.

Horizon **More than 30 years**

Confidence **High**

76. Raises the risk of coastal inundation, which could cut off key routes that provide residents access to vital goods and services

Stressor **Sea-level Rise**

Consequence **High**

As sea-level rise predictions are high enough to inundate much of downtown Olympia by the end of the century, including the port and LOTT wastewater treatment, this risk has a very high consequence of affecting our ability to provide basic needs to residents within the project area.

Likelihood **High**

All models predicts with fairly high certainty that we will experience significant sea-level rise by the end of the century, and there is a high amount of critical infrastructure that lies within the sea-level rise zone.

Spatial Extent **Place**

This will be limited to low-lying coastal areas, and potentially freshwater areas as coastlines move inland.

Horizon **More than 30 years**

Confidence **High**

Goal 6 Ensure that residents have the resources to meet their daily needs.

High Consequence Risks

77. Increases demand for water (drinking, irrigation, etc.)

Stressor **Population Change**

Consequence **High**

If population change is extreme enough to stress our water demand and distribution network, then it could have intense consequences for the region and basic needs of our residents.

Likelihood **Low**

As we are comparatively 'water rich' in this region, we could be a destination for climate refugees. However, it is unknown to what extent population change and migration will be due to climate change, and even more so, unsure how that will affect water resources.

Spatial Extent **Extensive**

This could affect all residents within the project area.

Horizon **More than 30 years**

Confidence **Medium**

This is a new area of study, so I am not very confident in our being able to predict how population change will affect our region, as it's difficult to take into account how we will change development and infrastructure over time to accommodate higher population density.

Medium Consequence Risks

78. Introduces or exacerbates disease vectors (carriers), which could harm human health (warmer, wetter winters also exacerbate exposure to pathogens and other health threats)

Stressor **Warmer Summer**

Consequence **Medium**

Warmer summers have the potential to foster the growth of many diseases that could have an extreme adverse effect on human health and vitality, as well as the health and vitality of our food sources.

Likelihood **High**

Climate change is projected to exacerbate or introduce a wide range of health threats, including infectious diseases from exposure to viruses and bacteria, which would affect human health outcomes in Thurston County and the broader Puget Sound region. Exposure pathways include food, water, air, soil, trees, insects and animals. Specific types of harmful algae, cyanobacteria, enteric bacteria & protozoan parasites, viruses, fungi, and bacteria all have the potential to increase in extent and frequency with warmer summers. (Source: TRPC, adapted from table in USGCRP, 2016)

Spatial Extent **Extensive**

This risk has the potential to affect the entire project area and greater region.

Horizon **More than 30 years**

Confidence **Medium**

Goal 6 Ensure that residents have the resources to meet their daily needs.

Medium Consequence Risks

79. Threatens the survival of salmon, which support cultural and economic practices and ecosystem services

Stressor **Warmer Water**

Consequence **Medium**

While it is very likely this risk will occur and salmon species will be very affected, there is medium confidence this will affect the health and vitality of residents in the project area. Some are sure to be affected, however it will not likely lead to mass loss of health and economic resources.

Likelihood **High**

The average annual temperature of most streams within the project area is projected to rise roughly 5°F for the 2040s and 2080s [Figures 29 & 30, on pgs. 41-42] per a moderate emissions scenario , according to U.S. Forest Service modeling. Theoretically, suitable conditions for salmonids and other aquatic species would shift upstream to higher elevations as air and water temperatures warm. Some fish may even shift their migration timing earlier as stream temperature and volume conditions change. This will likely have a larger effect on the ecosystem, as well as those who rely on salmon for subsistence living and economic vitality. Additionally, as stated above, this will have a great affect on the ecosystems.

Spatial Extent **Extensive**

This effects of this will be observed throughout the entire project area and greater region.

Horizon **10-30 years**

Confidence **High**

80. Reduces aquifer recharge and could spur more groundwater pumping when surface water is scarce, which could lower well levels and raise the cost of pumping water from greater depths

Stressor **Increasing Drought**

Consequence **Medium**

Water availability, being on the most basic needs of residents in the area, is directly threatened by increasing drought. A future with warmer, drier summers could spur growing communities around the state to increase their groundwater withdrawals when surface water is limited (Pitz, 2016). This could exacerbate water quantity and affordability vulnerabilities.

Likelihood **High**

This will primarily effect those residents that rely on wells and groundwater recharge. Studies conducted in Everett, Tacoma and Seattle and noted in UW CIG's 2015 assessment find that the reliability of municipal water supplies — that is, the probability of meeting demand in a given year — is largely unaffected by projected changes precipitation (Mauger et al., 2015). The report did not reference any Thurston County communities, although we can infer similar results.

Spatial Extent **Place**

This is taking place in subsections of our project area.

Horizon **10-30 years**

Confidence **Medium**

Goal 6 Ensure that residents have the resources to meet their daily needs.

Medium Consequence Risks

81. Makes it harder to balance competing demands for water (reduces energy, water and food security)

Stressor **Increasing Drought**

Consequence **Medium**
Drought would affect surface water (streams and reservoirs) and groundwater (large municipal and small private wells), ultimately affecting peoples' ability to meet their daily need of having clean water.

Likelihood **High**
Models project a more than 20 percent decline in summer precipitation by the 2050s and 2080s for the Puget Sound region, per the high and low scenarios. Changes in temperature are also expected to exacerbate periodic El Nino and La Nina cycles and the intensity of seasonal rainfall and drought events.

Spatial Extent **Extensive**
This will affect the entire project area, however, there will likely be larger adverse effects in the Nisqually watershed, where it is mixed snow-rain dominant.

Horizon **0-10 years**

Confidence **Medium**

82. Raises the risk of wildfires and elevated levels of PM10 from smoke

Stressor **Increasing Drought**

Consequence **Medium**
Increases in PM10 and other windblown dust particles due to wildfire could degrade air and water quality, directly impeding our ability to provide all residents with a healthy environment.

Likelihood **High**
The historical frequency of local wildfires suggests that such hazards have a “high” probability of occurrence, but about 97 percent of future fires will be small — five acres or less — concluded the Natural Hazards Mitigation Plan for the Thurston Region. The plan did not factor in climate change but cautioned that it may create more suitable conditions (e.g., warmer, drier summers) for bigger, more frequent wildfires.

Spatial Extent **Extensive**
Forests cover much of the project area and broader county. Wildfires occur in all parts of the project area and county — particularly the wildland-urban interface.

Horizon **More than 30 years**

Confidence **High**

83. Makes it harder for calcifying organisms to form shells, and ultimately harms commercial and recreational shellfisheries

Stressor **Ocean Acidification**

Consequence **Medium**
Ocean acidification is projected to increase the frequency, magnitude and duration of harmful pH conditions throughout Puget Sound (Mauger et al, 2016). This could have medium to high consequence for a specific population of people and their ability to meet their daily needs.

Likelihood **High**
This has a medium likelihood because lower ocean pH will affect development of shell forming organisms. This will have a significant effect on commercial and recreational shellfisheries.

Spatial Extent **Place**
Coastal and near coastal areas will be affected throughout the project area.

Horizon **10-30 years**

Confidence **High**

Goal 6 Ensure that residents have the resources to meet their daily needs.

Medium Consequence Risks

84. Raises the risk of floods and landslides, which could cut off access to goods and services

Stressor **Increasing Storminess**

Consequence **Medium**
There are many smaller, rural communities in Thurston county that are more intensely affected and cut off by floods and landslides. Additionally, within the urban centers, floods and landslides can shut down roads and access routes for fire and emergency services.

Likelihood **Medium**
There are already instances within the county where floods or landslides temporarily cut off residents' abilities to meet their daily needs. This would likely become worse with increased storminess. More than 65,000 acres and $1.5 billion in buildings and contents are currently within Thurston County's flood hazard areas (TRPC, 2009).

Spatial Extent **Place**

Horizon **0-10 years**

Confidence **Medium**

85. Shifts life cycle of fish, fowl and animals, which could reduce populations that support subsistence and recreational hunting

Stressor **Warmer Winter**

Consequence **Medium**
The native tribes, as well as many locals, use fishing and hunting as a food source. If these wildlife populations are stressed by a change in the reproductive cycles within the food web due to warmer winters, people may not be able to rely on those food sources, and it may further stress local food distribution networks and potentially drive up prices.

Likelihood **Medium**
There is not a scientific consensus on how this will pan out, however, assuming this does happen, there is a medium likelihood that having fewer resources to fish and hunt would adversely affect the ability for people and families to meet their daily needs.

Spatial Extent **Extensive**
Warmer winters have the potential to affect reproductive cycles of wildlife across the region, and across different ecosystems.

Horizon **10-30 years**

Confidence **Low**
I was unable to find any scientific consensus to back this up.

86. Raises the risk of floods and landslides, which could damage homes and businesses and cause personal injury or death

Stressor **Increasing Storminess**

Consequence **Medium**
While the effects would be more localized than landslides and floods cutting off goods and services, this has the potential to be extremely detrimental to residents living in the areas that may not be maintainable in the future due to floods and landslides. Culverts, flood control systems, and bridges can be built, but they can only do so much. This could be mitigated by some sort of relocation program if residents actually get cut off, however, that is yet to be determined.

Likelihood **Medium**
It is fairly like this will happen at some location within the project area. How likely it is to affect this goal depends on how the community responds to the need to build flood and landslide controls, and/or work on a relocation effort if residents and communities look like they are going to be cut off permanently. More than 65,000 acres and $1.5 billion in buildings and contents are currently within Thurston County's flood hazard areas (TRPC, 2009).

Spatial Extent **Place**
While it will most likely be just specific sites, there is the potential larger communities or subdivisions will be affected.

Horizon **10-30 years**

Confidence **Medium**

Goal 6 Ensure that residents have the resources to meet their daily needs.

Medium Consequence Risks

87. Puts more strain on services (social, emergency, etc.)

Stressor **Increasing Storminess**

Consequence **Medium**
If increased storminess leads to increased stress on emergency services, those services will not be as able to provide relief to those in need, which has a large consequence for making sure residents have their daily needs met.

Likelihood **Medium**
At the rate we are seeing increases in storminess, emergency services will likely be able to adapt and work to be more nimble in a changing environment.

Spatial Extent **Extensive**
This has the potential to be a region-wide issue.

Horizon **10-30 years**

Confidence **Medium**

88. Puts more strain on transportation (roads, transit, etc.)

Stressor **Population Change**

Consequence **Medium**
The potential consequence from increased population on our transportation network is high, being that a functional transportation network is essential for meeting the basic needs of our community.

Likelihood **Low**
The timeline at which population increase is happening will likely give transportation agencies and planners time to plan for increased population. This is a new field of scientific study, so there is not much research to determine when and how intense population change due to climate change may be in our area.

Spatial Extent **Extensive**
This could have region wide impacts

Horizon **More than 30 years**

Confidence **Low**

89. Puts more strain on schools (e.g., unplanned influx or loss of students)

Stressor **Population Change**

Consequence **Medium**
The potential consequence from increased population on schools is high, being that access to quality education is a cornerstone of a healthy community.

Likelihood **Low**
The timeline at which population increase is happening will likely give school districts time to plan for increased student enrollment. This is a new field of scientific study, so there is not much research to determine when and how intense population change due to climate change may be in our area.

Spatial Extent **Extensive**
People throughout the entire project area could be affected.

Horizon **More than 30 years**

Confidence **Low**
This is a new area of study, so I am not very confident in our being able to predict how population change will affect our region, as it's difficult to take into account how we will change development and infrastructure over time to accommodate higher population density.

Goal 6 Ensure that residents have the resources to meet their daily needs.

Medium Consequence Risks

90. Puts more strain on services (social, emergency, etc.)

Stressor **Population Change**

Consequence **Medium**

The potential consequence from increased population on services is high, being that access to quality social and emergency services are part of having a healthy and vibrant community.

Likelihood **Low**

The timeline at which population increase is happening will likely give social and emergency service providers time to plan for increased population. This is a new field of scientific study, so there is not much research to determine when and how intense population change due to climate change may be in our area.

Spatial Extent **Extensive**

This could affect all residents within the project area.

Horizon **More than 30 years**

Confidence **Low**

This is a new area of study, so I am not very confident in our being able to predict how population change will affect our region, as it's difficult to take into account how we will change development, services, and infrastructure over time to accommodate higher population density.

91. Increases summer peak energy demand for cooling residential and commercial buildings, which could place more demand on grid and reduce energy security

Stressor **Warmer Summer**

Consequence **Medium**

Increases in peak energy could potentially hinder our ability to ensure residents meet their daily needs. However, given the many different types of energy production in the region, we will likely be able to shift the balance of production to accommodate needs.

Likelihood **Low**

PSE's 2015 Integrated Resource Plan — which uses scenarios to evaluate energy supply and demand decisions over the ensuing 20 years — projects that PSE's base peak demand growth rate will average 1.6 percent annually (almost 1,000 additional megawatts, from 2015-2035) (Puget Sound Energy, 2015). The resource plan does not call for additional hydropower generation capacity. Rather, the plan targets significant investments in energy efficiency, wind power generation and other measures to meet projected demand. This could mean higher reliance on fossil fuels, which may affect the consequence of other risks.

Spatial Extent **Extensive**

Accommodating peak energy demand is a region-wide issue.

Horizon **0-10 years**

Confidence **High**

Goal 6 Ensure that residents have the resources to meet their daily needs.

Low Consequence Risks

92. Increases extreme temperatures, which could cause hyperthermia — a major risk for people who are elderly, homeless or work outdoors

Stressor **Warmer Summer**

Consequence **Low**

As of now we have more mild temperature extremes than other parts of the region. However we are seeing trends that support hotter, more extreme summers, which has the potential to increase chances of hyperthermia and threaten the basic needs of those most vulnerable in our region: homeless, elderly, children, and outdoor workers.

Likelihood **High**

Populations especially vulnerable to extreme heat and other exposure pathways include people who work outdoors, people who are homeless, people with chronic disease (e.g., diabetes, asthma, obesity), people with mental illness, and people who are socially isolated and economically disadvantaged (Thurston County, 2010). If extreme summer temperatures continue to increase, these populations will be severely inhibited from meeting their daily needs.

Spatial Extent **Place**

While spatially, this may occur throughout the project area, it is likely to affect certain people disparately, such as the homeless or the elderly. For that reason, it's likely focused on hospitals, elderly care centers, urban centers, and other congregation places for these populations.

Horizon **0-10 years**

Confidence **Medium**

93. Reduces snowpack that supports winter recreation activities

Stressor **Warmer Winter**

Consequence **Low**

Reduced snowpack could stop winter ski/snowboard resorts, and other winter resorts from operating throughout the winter, potentially forcing them to close. While closing some recreation areas may be problematic for individuals, the region as a whole will likely not feel a great effect from winter recreational activities and resorts closing.

Likelihood **High**

It is likely a reduced snowpack would severely lessen opportunities for winter recreation.

Spatial Extent **Site**

It would affect only certain sites in the region, such as winter recreational areas and ski/snowboard resorts.

Horizon **10-30 years**

Confidence **High**

94. Raises the risk of wildfires, which could damage utility infrastructure

Stressor **Increasing Drought**

Consequence **Low**

Wildfires damaging utility infrastructure could directly impede our ability to accomplish the goal of residents meeting their daily needs and having resources at their disposal.

Likelihood **Medium**

The historical frequency of local wildfires suggests that such hazards have a “high” probability of occurrence, but about 97 percent of future fires will be small — five acres or less — concluded the Natural Hazards Mitigation Plan for the Thurston Region. The plan did not factor in climate change but cautioned that it may create more suitable conditions (e.g., warmer, drier summers) for bigger, more frequent wildfires. Higher frequency of wildfires, with potentially more and larger fires during the season, could inhibit the ability of utility companies to repair their infrastructure, resulting in longer downtimes for affected residents.

Spatial Extent **Place**

Forests cover much of the project area and broader county. Wildfires occur in all parts of the project area and county — particularly the wildland-urban interface.

Horizon **More than 30 years**

Confidence **Medium**

Goal 6 Ensure that residents have the resources to meet their daily needs.

Low Consequence Risks

95. Raises the risk of wildfires, which could close roads and cut off access to vital goods and services

Stressor **Increasing Drought**

Consequence **Low**
While wildfires have their own risk associated directly with them, the cutting off of resources directly inhibits accomplishing this goal, however, any 'cut off' from resources due to wildfire would likely be temporary.

Likelihood **Medium**
The historical frequency of local wildfires suggests that such hazards have a “high” probability of occurrence, but about 97 percent of future fires will be small — five acres or less — concluded the Natural Hazards Mitigation Plan for the Thurston Region. The plan did not factor in climate change but cautioned that it may create more suitable conditions (e.g., warmer, drier summers) for bigger, more frequent wildfires.

Spatial Extent **Extensive**
Forests cover much of the project area and broader county. Wildfires occur in all parts of the project area and county — particularly the wildland-urban interface.

Horizon **0-10 years**

Confidence **Medium**

96. Parches farm fields and other open spaces, which could erode and release windblown dust (e.g., PM10) that degrades air quality

Stressor **Increasing Drought**

Consequence **Low**
Drought would affect ability to irrigate fields, both leading to decreases in crop yield, and increases in PM10 and other windblown dust particles which could degrade air quality, directly impeding our ability to provide all residents with a healthy environment.

Likelihood **Medium**

Spatial Extent **Place**

Horizon **More than 30 years**

Confidence **Medium**

97. Raises home cooling costs (e.g., buying, installing, and using air-conditioning), leaving less money to meet basic needs

Stressor **Warmer Summer**

Consequence **Low**
We have relatively low cost of electricity in the region, however for financially stressed families, any amount of increase in expenses could be problematic for fulfilling core needs.

Likelihood **Medium**
It is somewhat likely that utility costs will go up as the climate becomes more extreme, and there is a medium likelihood that the rise in utility costs will stress families to the extent that they cannot meet their basic needs. The more likely scenario is that this, combined with other costs associated with a changing climate, could affect a families' ability to meet their basic needs.

Spatial Extent **Extensive**
PSE serves 1.1 million customers across the region, and serves most customers within the project area.

Horizon **10-30 years**

Confidence **Medium**
It's variable as to how sharply PSE's rates will increase, as it is a private company.

Goal 6 Ensure that residents have the resources to meet their daily needs.

Low Consequence Risks

98. Increases frequency, depth and duration of inundation of low coastal areas (e.g., downtown Olympia), which could reduce shoreline recreation opportunities

Stressor **Sea-level Rise**

Consequence **Low**
Shoreline recreation opportunities has little to do with meeting the daily needs of the community. Perhaps a small amount of people who are reliant on shoreline recreation for income / business will be affected, however, shorelines will still be there, they just may change. For that reason, I believe this risk has low consequence.

Likelihood **Low**
It is fairly likely that due to predicted sea-level rise, some shoreline recreational activities will be displaced.

Spatial Extent **Place**
This would only affect coastal areas.

Horizon **More than 30 years**

Confidence **Low**

99. Raises the risk of wildfires, which could result in personal injury or death

Stressor **Increasing Drought**

Consequence **Low**

Likelihood **Low**

Spatial Extent **Place**

Horizon **More than 30 years**

Confidence **Low**

100. Puts more strain on energy grid

Stressor **Population Change**

Consequence **Low**
We have a robust energy supply network, with many diverse sources of energy.

Likelihood **Low**
Because of the diversity of our energy sources, it is unlikely that population change over the course of decades will affect our ability to provide electricity to residents in the project area / region.

Spatial Extent **Extensive**
The entire project area / region would be affected.

Horizon **More than 30 years**

Confidence **Low**

Goal 7 Support local food systems to increase community resilience, health, and economic prosperity.

High Consequence Risks

101. Makes it harder to balance competing demands for water (reduces water available to junior water right holders, threatening the survival of livestock and crops for newer farmers)

Stressor	**Increasing Drought**
Consequence	**High** Water could be limiting factor for new farms as groundwater extraction is more closely regulated
Likelihood	**High**
Spatial Extent	**Extensive** Most of Thurston County's watersheds are likely over-appropriated.
Horizon	**0-10 years**
Confidence	**High** Recent court cases are driving an increasing scrutiny of water rights

102. Threatens the survival of salmon, which support cultural and economic practices and ecosystem services

Stressor	**Warmer Water**
Consequence	**High** Salmonid species are very sensitive to temperature and are limited in how much they can shift migration patterns to adjust for changing habitat.
Likelihood	**High**
Spatial Extent	**Extensive**
Horizon	**0-10 years**
Confidence	**High** Rising temperatures and effect on salmonids have been studied extensively.

103. Makes it harder for calcifying organisms to form shells, and ultimately harms commercial and recreational fisheries

Stressor	**Ocean Acidification**
Consequence	**High** Could undermine Washington's natural and commercial shellfisheries
Likelihood	**High**
Spatial Extent	**Extensive** All marine areas
Horizon	**0-10 years**
Confidence	**High** Shellfish growers are already seeing impacts

Goal 7 Support local food systems to increase community resilience, health, and economic prosperity.

High Consequence Risks

104. Reduces food available for and survival of salmon and other marine life

Stressor	**Ocean Acidification**
Consequence	**High** Would undermine survival of natural and commercial salmonids
Likelihood	**Medium**
Spatial Extent	**Extensive** Would affect salmon populations throughout Puget Sound
Horizon	**10-30 years**
Confidence	**Low** Although acidification is happening, its direct effect on the food chain, as well as timing, is uncertain.

Medium Consequence Risks

105. Raises the risk of lower crop yield or failure

Stressor	**Increasing Drought**
Consequence	**Medium** Farmers could shift to other less water-intensive crops
Likelihood	**Medium**
Spatial Extent	**Extensive** Will affect all farmed areas of Thurston County
Horizon	**10-30 years**
Confidence	**Medium** Studies show projected declines related to lower irrigation levels

106. Increases range and survival of pests and diseases that affect crops

Stressor	**Warmer Winter**
Consequence	**Medium** Depends on type of disease and whether alternative, resistant crops are available
Likelihood	**Medium**
Spatial Extent	**Extensive** Effects are likely to be regional
Horizon	**0-10 years**
Confidence	**High** Expansion of range of some pests have already been observed.

Goal 7 Support local food systems to increase community resilience, health, and economic prosperity.

Medium Consequence Risks

107. Accelerates risk of food spoilage and increases need for better refrigeration, storage and distribution infrastructure

Stressor **Warmer Summer**

Consequence **Medium**

Likelihood **Medium**

Spatial Extent **Extensive**
Affects general infrastructure throughout region

Horizon **10-30 years**

Confidence **Low**
Sources are mostly theoretical/anecdotal

Low Consequence Risks

108. Increases risk of flooding that could damage agricultural lands and assets (crops and livestock)

Stressor **Increasing Storminess**

Consequence **Low**
This is likely a manageable agricultural concern.

Likelihood **High**

Spatial Extent **Place**
Farmland in floodplains — Nisqually Delta, along Deschutes River, etc.

Horizon **0-10 years**

Confidence **Medium**
Although the likelihood of flooding is high, it is not known how many assets may be at risk in the floodplain.

109. Pushes saltwater farther into estuaries, which may inundate near-coastal farms and ranches

Stressor **Sea-level Rise**

Consequence **Low**
Could use more information on how many acres of farmland falls into SLR projections; how much of that compares with county-wide acres of farmland?

Likelihood **High**

Spatial Extent **Site**
Will affect only the limited number of farms affected by SLR — such as on Eld Inlet

Horizon **More than 30 years**

Confidence **Medium**
Based on FEMA flood maps and IPCC projections of SLR, but timing of SLR and compounding role of subsidence introduces some uncertainty

Goal 7 Support local food systems to increase community resilience, health, and economic prosperity.

Low Consequence Risks

110. Increases heat stress risk for dairy cows and other large livestock

Stressor **Warmer Summer**

Consequence **Low**

Likelihood **Medium**

Spatial Extent **Place**

Horizon **10-30 years**

Confidence **Medium**

111. Increases in atmospheric CO2 decreases the nutritional quality of forage and pasture lands for livestock and wild animals

Stressor **Warmer Summer**

Consequence **Low**
This is likely a manageable agricultural concern, if nitrogen levels are increased to match increasing yields

Likelihood **Medium**

Spatial Extent **Extensive**
This will likely affect all watersheds in the planning area and county

Horizon **More than 30 years**

Confidence **Medium**
Based on experiments, rather than in-field demonstration

112. Turns coastal marshes and forests into mudflats that alters nesting habitat

Stressor **Sea-level Rise**

Consequence **Low**
Animals may be able to shift to other available habitat

Likelihood **Medium**

Spatial Extent **Place**
Nisqually Delta and other shoreline areas

Horizon **More than 30 years**

Confidence **Medium**
Based on modeled changes

113. Increases pressure to develop rural areas, which could reduce, fragment and/or degrade agricultural lands

Stressor **Population Change**

Consequence **Low**
Existing regulations will limit extent of development in rural areas

Likelihood **Low**

Spatial Extent **Extensive**

Horizon **More than 30 years**

Confidence **Low**
Limited concrete data on how climate change will affect population shifts

Goal 8 Ensure that the region's water supply sustains people in perpetuity while protecting the environment.

High Consequence Risks

114. Makes coastal groundwater more vulnerable to saltwater intrusion and inundation

Stressor **Sea-level Rise**

Consequence **High**
Saltwater intrusion makes well water undrinkable.

Likelihood **High**
High likelihood for shallow, coastal wells.

Spatial Extent **Place**
Limited to coastal areas

Horizon **10-30 years**

Confidence **High**

115. Makes it harder to balance competing demands for water (all uses)

Stressor **Increasing Drought**

Consequence **High**
An adequate supply of water is critical to the survival of Thurston County residents, business and industry, and flora and fauna.

Likelihood **High**
The effects of warmer summers and drought on stream flow and temperature are already being observed. The Deschutes River, Henderson Inlet, Totten/Eld Inlets, and Upper Chehalis River violate water temperature standards. [Vulnerability Assessment pg. 43]

Spatial Extent **Extensive**
All of Thurston County

Horizon **10-30 years**

Confidence **Medium**
Our region is already experiencing warmer summers (Climate Change Science Summary pg. 12) and stream temperature violations have been observed [Vulnerability Assessment pg. 38].

116. Decreases precipitation volume and groundwater recharge, which could raise pollutant concentrations in shallow wells and surface waters

Stressor **Increasing Drought**

Consequence **High**
Increased concentration of pollutants to undrinkable levels reduces the quantity of water available for households, agriculture, and other uses.

Likelihood **Medium**
Thurston County residents rely on a mix of private wells and municipal water systems for drinking water. Concentrated contaminants is not considered a risk for municipal systems, most of which rely on deep well, but could be a concern for private water systems. (Vulnerability Assessment pg. 51)

Spatial Extent **Extensive**
Countywide

Horizon **10-30 years**

Confidence **Low**
U.S. Global Climate Change Research Program reports that there are few studies looking into the specific health consequences arising from contamination and depletion of groundwater (USGCRP, 2016 pg. 108)

Goal 8 Ensure that the region's water supply sustains people in perpetuity while protecting the environment.

High Consequence Risks

117. Makes it harder to balance competing demands for water (all uses)

Stressor **Population Change**

Consequence **High**
Increased population growth in Thurston will have a significant impact on groundwater, the source of most of Thurston County's drinking water.

Likelihood **Low**
Thurston County's population is expected to increase by over 40%; migration due to climate change could increase that number and the amount of drinking water needed to support the County's residents.

Spatial Extent **Extensive**
Countywide

Horizon **10-30 years**

Confidence **High**

Medium Consequence Risks

118. Increases plant transpiration (root uptake and leaf release of water) during winter months, which could lower water table.

Stressor **Warmer Winter**

Consequence **Medium**
Lower water table could affect the ability for water consumers (households, farms, etc.) to pump water from wells. Lower water table would also affect stream levels.

Likelihood **Low**

Spatial Extent **Extensive**
Countywide

Horizon **More than 30 years**

Confidence **Low**
Unknown how much of an effect warmer winters will have on evapotranspiration and the water table. The effect could be counteracted by increasing drought which could stress vegetation and reduce transpiration.

Low Consequence Risks

119. Increases volume of urban runoff and flooding, which decrease groundwater recharge

Stressor **Increasing Storminess**

Consequence **Low**
Lower water table could affect the ability for water consumers (households, farms, etc.) to pump water from wells. Lower water table would also affect stream levels.

Likelihood **Low**
Increased runoff due to more intense storms is expected however the impacts on groundwater are less certain.

Spatial Extent **Extensive**
Countywide

Horizon **10-30 years**

Confidence **Low**

Goal 9 Move toward a carbon-neutral community.

Medium Consequence Risks

120. Increases summer peak energy demand for cooling residential and commercial buildings, which — depending on the energy source — may increase carbon emissions

Stressor **Warmer Summer**

Consequence **Medium**

To achieve carbon neutrality, the region would need to zero-out its greenhouse gas emissions (e.g., via carbon offsets, carbon-free renewables, or energy conservation and efficiency measures) across several sectors (buildings, transportation, waste, water, etc.). Any emissions increase from buildings would make achieving this goal more difficult.

Likelihood **Medium**

According to one study, residential cooling demand is projected to increase to 4.8-9.1 percent of Washington's total energy demand for the 2080s, relative to 1970-1999, due to the combined effects of higher air temperature, population growth, and greater use of air conditioners. The likelihood that this would increase the region's carbon footprint, however, depends on our energy sources. Washington state's Renewable Portfolio Standard (RCW 19.285) requires large utilities to obtain 15 percent of their electricity from new renewable resources (e.g., carbon-free solar and wind) by 2020 and to undertake cost-effective energy conservation measures. Currently, hydropower accounts for 36 percent of the electricity PSE delivers to its customers; coal and natural gas account for 35 percent and 24 percent, respectively, while nuclear wind and other sources account for the rest of the utility's energy portfolio.

Spatial Extent **Extensive**

Horizon **0-10 years**

Confidence **Medium**

121. Increases overall energy consumption (transportation, buildings, waste, etc.)

Stressor **Population Change**

Consequence **Medium**

Assuming more people move here and use more energy that is generated from fossil fuels, this risk would affect the region's ability to achieve this goal. Investments in renewable energy, as well as energy conservation and efficiency would impact the consequence of this risk.

Likelihood **Low**

It is impossible to predict how many people might move to, within or from Thurston County — or when — as a result of climate change. Further, it is impossible to predict how long climate migrants will stay here and how much energy they will consume. While not impossible, it is difficult to predict what energy sources the region will use in coming decades. Thus, the likelihood of this risk is low.

Spatial Extent **Extensive**

Horizon **Unclear**

Confidence **Medium**

Goal 9 Move toward a carbon-neutral community.

Low Consequence Risks

122. Raises the risk of wildfires, which could destroy forests that serve as a net carbon sink

Stressor **Increasing Drought**

Consequence **Low**

More frequent and intense wildfires would damage forests and release their stored carbon. This would be but one source of emissions, however, so this risk is of "medium" consequence to this goal of carbon neutrality.

Likelihood **High**

The historical frequency of local wildfires suggests that such hazards have a “high” probability of occurrence, but about 97 percent of future fires will be small — five acres or less — concluded the Natural Hazards Mitigation Plan for the Thurston Region. The plan did not factor in climate change but cautioned that it may create more suitable conditions (e.g., warmer, drier summers) for bigger, more frequent wildfires.

Spatial Extent **Extensive**

Forests cover much of the project area and broader county. Wildfires occur in all parts of the project area and county — particularly the wildland-urban interface.

Horizon **0-10 years**

Confidence **Medium**

123. Causes erosion and loss of organic materials (e.g., plants) that build up in reservoirs (e.g., Alder Lake), decay and emit greenhouse gases (e.g., methane)

Stressor **Increasing Storminess**

Consequence **Low**

There are few reservoirs in Thurston County (Alder Lake, LaGrande Reservoir and Skookumchuck Lake), so this risk would be of "medium" consequence to the region's ability to achieve its carbon-neutrality goal.

Likelihood **High**

A new study in the journal BioScience finds that reservoirs emit more methane than natural lakes, ponds, rivers, or wetlands. Microbes break down organic materials — sometimes doing so in the absence of oxygen — a process that leads to methane as a byproduct.

Spatial Extent **Place**

Within the project area: LaGrande and Alder Lake reservoirs; outside the project area: Skookumchuck Lake

Horizon **0-10 years**

Confidence **Low**

We are unaware of any studies that assess this risk locally.

124. Accelerates release of carbon stored in soils

Stressor **Warmer Summer**

Consequence **Low**

To achieve carbon neutrality, the region would need to zero-out its greenhouse gas emissions (e.g., via carbon offsets, carbon-free renewables, or energy conservation and efficiency measures) across several sectors (buildings, transportation, waste, water, etc.). Any emissions increase from soils would make achieving this goal more difficult.

Likelihood **Medium**

Research shows that warmer temperatures may accelerate the release of carbon (from ancient organic materials) stored in soils. A recent study by Oregon State University researchers, for example, finds that as warmer weather and more atmospheric CO2 stimulate plants to grow faster, they produce more root compounds that help free up "stored" carbon that is bonded to minerals in the soil. A separate study in the journal Nature finds that other factors — - including chemical composition and water content — also affect the release of carbon stored in soils.

Spatial Extent **Extensive**

Horizon **0-10 years**

Confidence **Low**

There is evidence that the region's temperature is warming. However, it is unclear whether our region's soils are more or less vulnerable to the release of stored carbon.

Goal 9 Move toward a carbon-neutral community.

Low Consequence Risks

125. Lowers reservoir levels, which exposes organic materials and causes them to decay and emit greenhouse gases

Stressor **Increasing Drought**

Consequence **Low**

While the Alder and LaGrande dams do not provide power for Thurston County residents, the reservoirs behind the dams are located within Thurston County. Thus, greenhouse gas emissions from decomposing organic materials on the exposed lake beds would affect the Thurston Region's ability to achieve its carbon-neutrality goal. This would be one of but many sources of greenhouse gases in the county, however, so the risk is of "medium" consequence to the goal.

Likelihood **Medium**

Warmer temperatures cause more water evaporation in rivers and reservoirs. Precipitation and stream volume also affect reservoir levels. We are not aware of any research that projects how changes evaporation rates would affect Alder Lake's volume. A federal Bureau of Reclamation study offers a potential reference case: Modeling projected that a 5-degree temperature increase would increase Lake Roosevelt's (Columbia River Basin) net evaporation rate by 1.3 inches (5.4 percent) annually by 2080. Given the number of local variables (known and unknown) that affect lake volume, we rate this risk as having a "medium" likelihood of affecting this goal.

Spatial Extent **Site**

Alder Lake and LaGrande dams.

Horizon **0-10 years**

Confidence **Low**

126. Increases energy consumed to pump wastewater and stormwater

Stressor **Sea-level Rise**

Consequence **Low**

Given the many sources of energy consumption in the region, this risk is of "medium" consequence to the goal. This also assumes that some of the region's energy portfolio comes from fossil fuel sources (e.g., coal and natural gas) that emit greenhouse gases.

Likelihood **Medium**

Models project more frequent and intense precipitation events and several feet of sea-level rise over the 21st century. Such changes could require the region's municipalities to consume more energy to pump stormwater and wastewater so as to prevent flooding and backups.

Spatial Extent **Extensive**

Horizon **10-30 years**

Confidence **Medium**

Goal 9 Move toward a carbon-neutral community.

Low Consequence Risks

127. Decreases production of hydropower (more summer evaporation) and increases pressure to remove dams on Nisqually River

Stressor **Warmer Summer**

Consequence **Low**

The two hydropower dams at the Alder Lake complex (Alder Lake and LaGrande dams) generate electricity for Tacoma Power and its customers in Pierce County. Thus, changes in these dams' power output — and long-term viability — would not affect the Thurston County region's ability to achieve its carbon neutrality goal. … Puget Sound Energy — which has about 120,000 electric customers in Thurston County — owns and operates two dams, on the snowmelt-fed Baker and Snoqualmie rivers; PSE also purchases additional power from Central Washington public utility districts with Columbia River dams.

Likelihood **Low**

Warmer temperatures cause more water evaporation in rivers and reservoirs. Precipitation and stream volume, however, also affect reservoir levels. The only hydropower dams within the project area are operated by Tacoma Power, so there is low likelihood this risk will affect this particular goal.

Spatial Extent **Site**

Alder Lake and LaGrande dams on the Nisqually River

Horizon **More than 30 years**

Confidence **Medium**

128. Decreases capacity to produce clean hydropower (less rainfall and water behind dams)

Stressor **Increasing Drought**

Consequence **Low**

The two hydropower dams at the Alder Lake complex generate electricity for Tacoma Power and its customers in Pierce County. Thus, changes in these dams' capacity to generate power would not affect the Thurston County region's ability to achieve its carbon neutrality goal.

Likelihood **Low**

Drought — a deficiency in precipitation over an extended period — would likely reduce local reservoir water levels and the capacity to generate hydropower at the Alder Lake and LaGrande dams. However, as noted previously, this dams provide power for residents beyond the region. Thus, this risk has a "low" likelihood of affecting the Thurston Region's ability to more toward carbon neutrality.

Spatial Extent **Site**

Alder Lake and LaGrande dams

Horizon **0-10 years**

Confidence **Medium**

129. Necessitates moving water farther distances, which consumes more energy/causes more greenhouse gas emissions

Stressor **Increasing Drought**

Consequence **Low**

Transporting water farther distances would require more energy, which would affect the region's ability to achieve this goal. Given the many other sources of energy consumption, this risk is of "medium" consequence to the goal.

Likelihood **Low**

According to a recent Ecology Department study, scarcity of surface water could spur more consumption of groundwater. This could require pumping water from greater depths, which consumes more energy. Depending on the energy source, it could also cause more energy emissions.

Spatial Extent **Extensive**

Horizon **10-30 years**

Confidence **Medium**

Goal 9 Move toward a carbon-neutral community.

Low Consequence Risks

130. Reduces extent and volume of snowpack and glaciers, exacerbating sediment runoff that builds up in Alder Lake and reduces the reservoir's capacity to generate hydropower

Stressor **Warmer Winter**

Consequence **Low**

The two hydropower dams at the Alder Lake complex generate electricity for Tacoma Power and its customers in Pierce County. Thus, changes in these dams' power output — and long-term viability — would not affect the Thurston County region's ability to achieve its carbon neutrality goal.

Likelihood **Low**

Climate models project major reductions in snowpack and glacier volume and extent over the 21st century, which would leave soil more vulnerable to runoff and accretion behind the Alder Lake dam. A USGS study found that the increasing volume of sediment decreased Alder Lake's storage capacity by 15 percent between 1945 (dam completion date) and 2011. These risks, while clear and measureable, are still unlikely to affect the Thurston Region's ability to achieve its carbon neutrality goal because the power generated at Alder Lake is for customers in Pierce County.

Spatial Extent **Site**

Alder Lake reservoir and dam

Horizon **0-10 years**

Confidence **High**

Goal 10 Maintain air quality standards.

High Consequence Risks

131. Increases overall energy consumption (transportation, buildings, waste, etc.)

Stressor **Population Change**

Consequence **High**
Assuming more people move here and use more energy that is generated from fossil fuels, this risk would affect the region's ability to achieve this goal. Investments in renewable energy, as well as energy conservation and efficiency would impact the consequence of this risk.

Likelihood **Low**
It is impossible to predict how many people might move to, within or from Thurston County — or when — as a result of climate change. Further, it is impossible to predict how long climate migrants will stay here and how much energy they will consume. While not impossible, it is difficult to predict what energy sources the region will use in coming decades. Thus, the likelihood of this risk is low.

Spatial Extent **Extensive**

Horizon **More than 30 years**

Confidence **Low**

Medium Consequence Risks

132. Increases production of surface ozone (VOCs interacting with NOx) and accumulation of fine particulate matter (PM2.5)

Stressor **Warmer Summer**

Consequence **Medium**
The federal standard for Particulate Matter (PM) 2.5 is 12 micrograms per cubic meter of air, annual average. The federal standard for surface ozone is 0.075 parts per million, 8 hour average. The Thurston Region is currently below these thresholds. According to Olympic Region Clean Air Agency data: Our three-year average for 2012-2015 was 7.0.micrograms of PM2.5 per cubic meter of air; our three-year average for surface ozone was 0.058 ppm for the same period. Increases in PM2.5 and ozone as a result of warmer summers would be of "medium" consequence in meeting this goal.

Likelihood **Medium**
Modeling indicates that, with locally higher surface temperatures in polluted regions, regionally triggered feedbacks in chemistry and local emissions will, with “medium confidence,” (IPCC, 2013) increase peak levels of surface ozone and PM2.5 (particulate matter smaller than 2.5 micrometers in diameter).

Spatial Extent **Extensive**

Horizon **0-10 years**

Confidence **Medium**

133. Raises the risk of wildfires and elevated levels of PM10 from smoke

Stressor **Increasing Drought**

Consequence **Medium**
ORCAA currently measures the region's PM10 — the biggest source of which is wood smoke (household stoves and brush piles). An increase in this coarse particulate matter from wildfires would have a "medium" effect the Thurston Region's ability to remain in attainment for this air-quality standard.

Likelihood **Medium**
The historical frequency of local wildfires suggests that such hazards have a “high” probability of occurrence, but about 97 percent of future fires will be small — five acres or less — concluded the Natural Hazards Mitigation Plan for the Thurston Region. The plan did not factor in climate change but cautioned that it may create more suitable conditions (e.g., warmer, drier summers) for bigger, more frequent wildfires.

Spatial Extent **Extensive**

Horizon **0-10 years**

Confidence **Medium**

Goal 10 Maintain air quality standards.

Low Consequence Risks

134. Increases summer peak energy demand for cooling residential and commercial buildings, which — depending on the energy source — could degrade air quality

Stressor **Warmer Summer**

Consequence **Low**

Buildings are currently one of the largest sources of energy consumption and emissions in Thurston County, according to the Thurston Climate Action Team. Any increase in building energy consumption — assuming the power is generated by some fossil fuels (e.g., coal or natural gas) — would affect our ability to achieve this goal.

Likelihood **Medium**

According to one study, residential cooling demand is projected to increase to 4.8-9.1 percent of Washington's total energy demand for the 2080s, relative to 1970-1999, due to the combined effects of higher air temperature, population growth, and greater use of air conditioners. The likelihood that this would degrade the region's air quality, however, depends on our energy sources. Washington state's Renewable Portfolio Standard (RCW 19.285) requires large utilities to obtain 15 percent of their electricity from new renewable resources (e.g., carbon-free solar and wind) by 2020 and to undertake cost-effective energy conservation measures. Currently, hydropower accounts for 36 percent of the electricity PSE delivers to its customers; coal and natural gas account for 35 percent and 24 percent, respectively, while nuclear wind and other sources account for the rest of the utility's energy portfolio.

Spatial Extent **Extensive**

Horizon **0-10 years**

Confidence **Medium**

135. Parches farm fields and other open spaces, which could erode and release windblown dust (e.g., PM10) that degrades air quality

Stressor **Increasing Drought**

Consequence **Low**

ORCAA currently measures the region's PM10 — the biggest source of which is wood smoke. An increase in this coarse particulate matter in the form windblown dust would have a "medium" effect the Thurston Region's ability to remain in attainment for this air-quality standard.

Likelihood **Medium**

Models project a more than 20 percent decline in summer precipitation by the 2050s and 2080s for the Puget Sound region, per the high and low scenarios. Changes in temperature are also expected to exacerbate periodic El Nino and La Nina cycles and the intensity of seasonal rainfall and drought events. The "medium" likelihood works under the assumption that there would be more windblown dust with more drought events.

Spatial Extent **Extensive**

Horizon **10-30 years**

Confidence **Medium**

Goal 10 Maintain air quality standards.

Low Consequence Risks

136. Increases use of polluting generators following storm-induced power outages

Stressor **Increasing Storminess**

Consequence **Low**

If people use generators following a major storm event, the use would be temporary and have a "low" consequence of on this goal.

Likelihood **Medium**

The Natural Hazards Plan for the Thurston Region finds that damaging rain already has a "high" (38 percent chance) annual chance of occurrence. Climate models project that the frequency and intensity of today's heaviest 24-hour rain events (top 1 percent) would increase this century. However, this risk assumes a particular human response — using polluting generators — to this hazard. Given uncertainty over this particular human response, we contend that this risk has a "medium" likelihood of occurring and affecting this goal.

Spatial Extent **Extensive**

Horizon **0-10 years**

Confidence **Low**

This assessment relies on major assumptions about a human response to a hazard, which models show might be more frequent and intense.

Goal 12 Make strategic decisions and investments to advance sustainability regionally.

Medium Consequence Risks

137. Makes it harder to balance competing demands for water (all uses)

Stressor **Increasing Drought**

Consequence **Medium**
Drought would affect surface water (streams and reservoirs) and groundwater (large municipal and small private wells).

Likelihood **High**
Models project a more than 20 percent decline in summer precipitation by the 2050s and 2080s for the Puget Sound region, per the high and low scenarios. Changes in temperature are also expected to exacerbate periodic El Nino and La Nina cycles and the intensity of seasonal rainfall and drought events. This could necessitate that we make strategic investments to advance sustainability in the region.

Spatial Extent **Extensive**
Water supply-and-demand vulnerability is projected to be lowest in rain-dominant watersheds (Deschutes and Kennedy-Goldsborough) where there are simple institutional arrangements and where demand rarely exceeds supply. Vulnerability would be greater in snow-influenced watersheds such as the Nisqually.

Horizon **10-30 years**

Confidence **High**

138. Necessitates retrofitting stormwater and wastewater infrastructure to mitigate flooding and backups that threaten water quality and human health and welfare

Stressor **Increasing Storminess**

Consequence **Medium**
The region's urbanized areas have billions of dollars worth of stormwater and wastewater infrastructure that was designed based on historic conditions. Retrofitting such infrastructure to accommodate bigger rain events would be extremely costly.

Likelihood **High**
The Natural Hazards Plan for the Thurston Region finds that damaging rain already has a "high" (38 percent chance) annual chance of occurrence. Climate models project that the frequency and intensity of today's heaviest 24-hour rain events (top 1 percent) would increase this century.

Spatial Extent **Place**
This risk would affect urbanized areas.

Horizon **0-10 years**

Confidence **High**
Intensity of such large rainfall events is project to increase 22 percent by the 2080s, and frequency would increase from two days per year to 7 days per year.